BHP Iron Ore Pty Ltd

Jimblebar Hub Mine Closure Plan

December 2023, Revision 0

Site code: S0001345

Tenements: ML 244SA, M266SA, L52/108, L52/109

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Rev 0	Amalgamates the OB17/18/31 (Rev 1) and Jimblebar (Rev 3) mine closure plans and incorporates updated information on closure designs and approaches.	December 2023

SUBMISSION DETAILS

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Executive summary

The OB17/18/31 and Jimblebar operations (referred to as Jimblebar Hub within this document) are located approximately 35 km east of Newman. This Mine Closure Plan (MCP) combines Revision 3 of the Jimblebar MCP (BHP, 2021i) and Revision 1 of the OB17/18/31 MCP (BHP, 2022j) into one plan to support a request to the Environmental Protection Authority (EPA) for a significant amendment to the Jimblebar Hub Iron Ore Mining Operations, under Section 38 of the *Environmental Protection Act 1986 (WA)* (EP Act) (BHP, 2023a), which would allow the OB17/18/31 and Jimblebar mining operations to be managed as an integrated hub. Activities for which approval is being sought are:

- Above and below water table mining at East Jimblebar deposits.
- New Overburden Storage Areas (OSAs) north of East Jimblebar.
- Beneficiation plant at Jimblebar to remove alumina and silica from the fines.
- In-pit storage of tailings generated by the Jimblebar beneficiation plant in the OB17/18 Swan and De Grey pits.

Approval is also being sought for possible future in-pit storage of tailings in WH123, WHASH, South Jimblebar and / or OB31. The pits to be used have not yet been selected, and consequently, closure designs have not been progressed. Initial deposition into the proposed De Grey and Swan in-pit Tailings Storage Facilities (TSFs) will occur for 3 to 5 years (with subsequent deposition cycles following periods of consolidation), and an update of the MCP will be submitted prior to the commissioning of any new in-pit TSFs. Closure designs for additional in-pit TSFs will be provided in future iterations of this MCP along with the outcomes of studies conducted to support the designs.

Existing / approved activities are:

- Mining above and below water table at:
  - Jimblebar - Wheelarra Hill (WH123, WH4), Wheelarra Hill / Hashimoto (WHASH), Hashimoto (H234) and South Jimblebar (Sylvania, Mindoona, Capricorn, Pain Killer) deposits.
  - OB17 - Swan (eastern end).
  - OB18 - Avon, Blackwood, De Grey, Swan (western end).
  - OB31.
- Placement of mined overburden in ex-pit OSAs or as backfill / In-pit Storage Areas (ISAs).
- Dewatering to enable access to the below water table deposits and discharge of surplus water via local pipelines to Ophthalmia Dam, the Caramulla Managed Aquifer Recharge (MAR) borefield and (seasonally / short term) to Copper Creek, Orebody 31 Creek, Jimblebar Creek and Caramulla Creek in accordance with the Jimblebar Water Management Plan (BHP, 2020b) and Eastern Pilbara Water Resource Management Plan (BHP, 2021g). Surplus water is also discharged to the OB18 MAR[1] which is operated in accordance with the EP Act Part V Licence L5415/1988/9.
- Use of OB17/18 and Jimblebar borefields for water supply.
- Ore processing and transport using overland conveyors, primary crushing facilities, ore handling plants, rail loops and train load-out facilities at OB17/18 and Jimblebar.
- Construction and maintenance of ancillary infrastructure including haul roads, light vehicle access roads, service corridors, fuel supply, water treatment and power generation facilities and various buildings to support all phases of the operation (i.e., exploration, mining, progressive rehabilitation and closure).

Map E 1 shows the areas of Jimblebar Hub that have been disturbed to date and Map E 2 shows the indicative future footprint which includes approved areas and areas for which approval is being requested through the Jimblebar Operations Significant Amendment Environmental Review Document (ERD). The design of each future area to be disturbed is confirmed as mining of that area approaches.

This MCP addresses how Jimblebar Hub will be rehabilitated and closed in a manner that meets the requirements of:

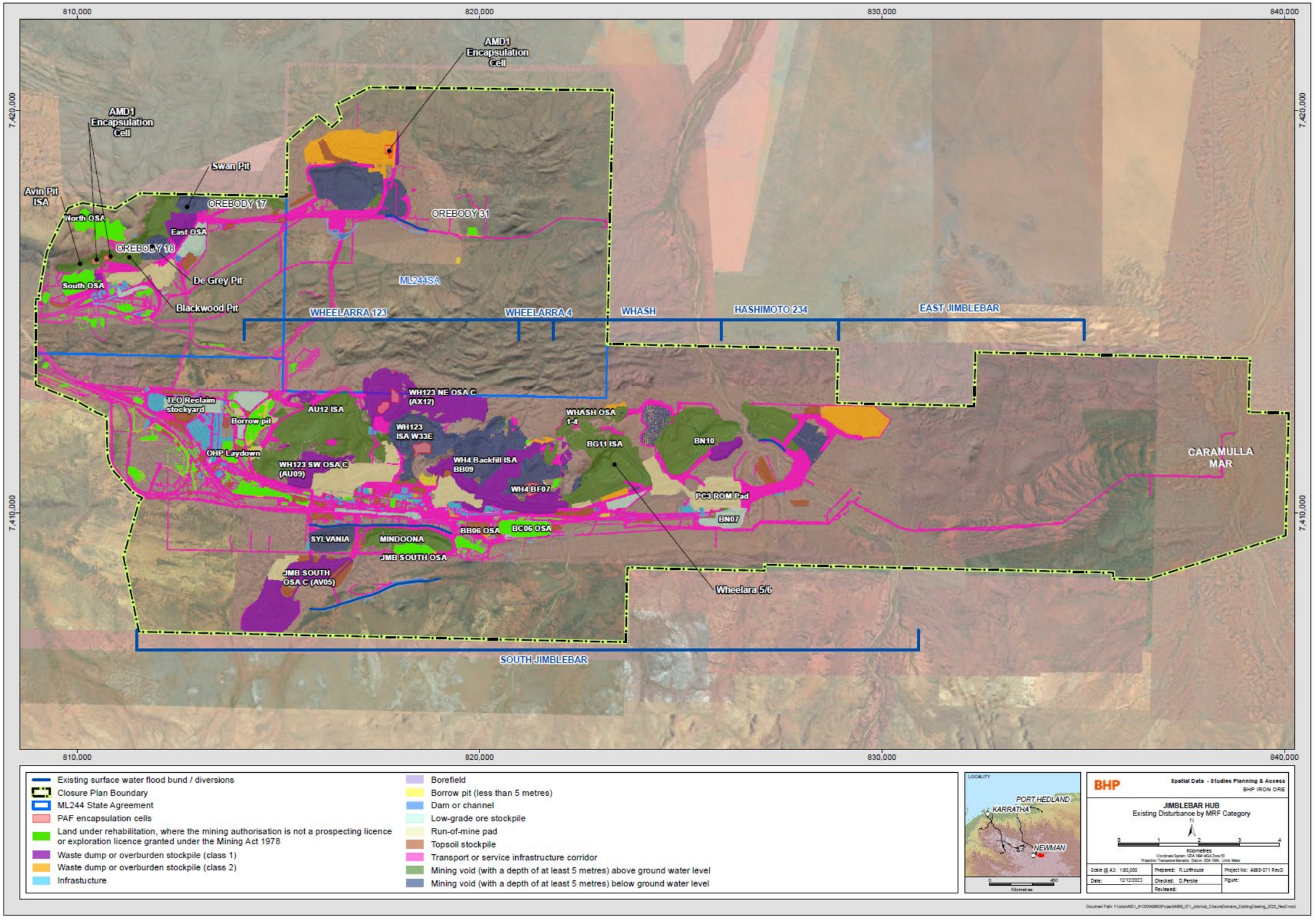
- Ministerial Statements 439, 1021 and 1126;
- Department of Mines, Industry Regulation and Safety[2] (DMIRS) Guidelines for Preparing Mine Closure Plans (2020a; 2020b); and
- BHP[3] corporate guidelines.

The estimated date for cessation of operations at Jimblebar Hub is 2053.

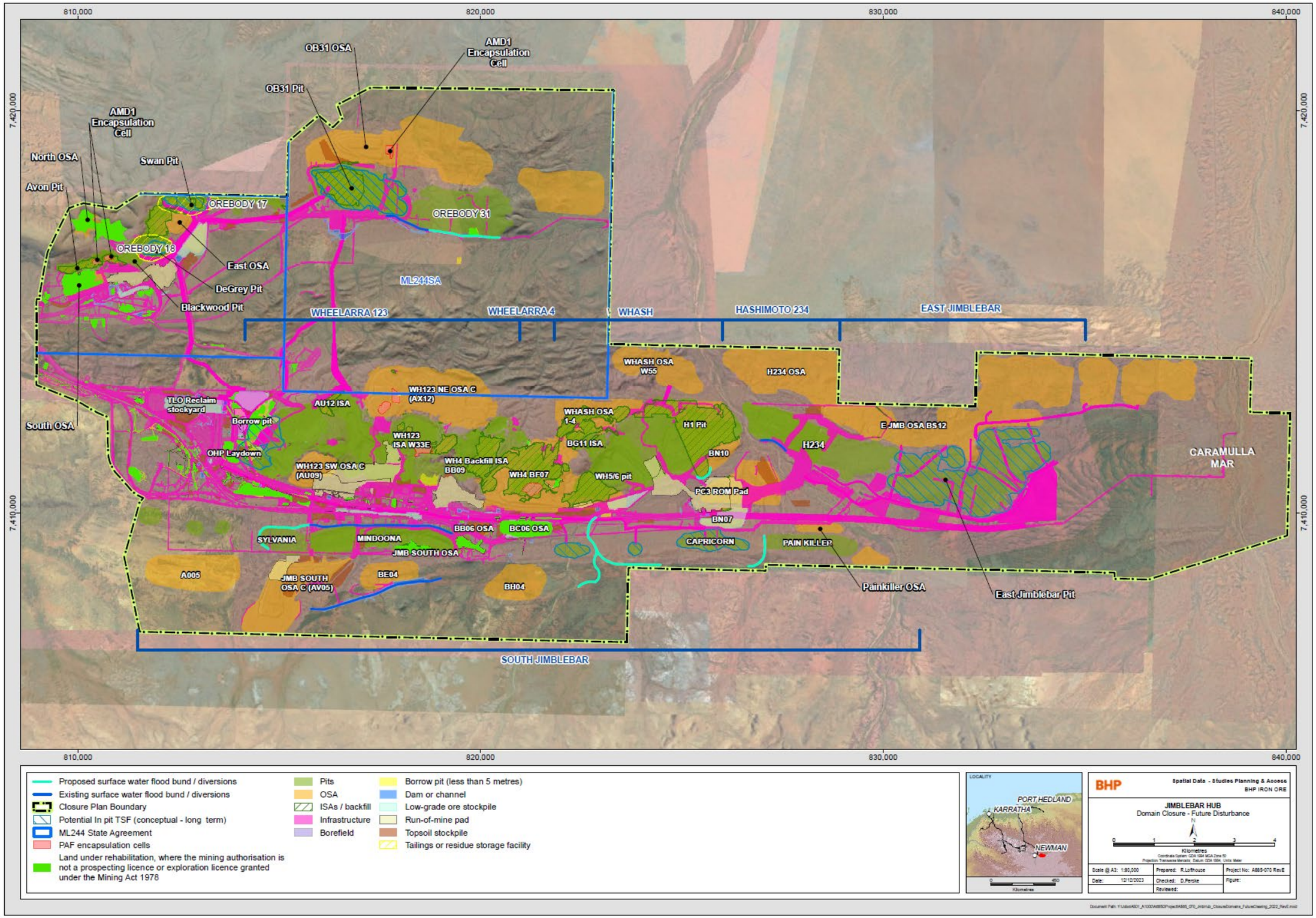
1 The OB18 MAR second zone is also referred to as the Ninga MAR.

2 Since the publication of the guidelines, the department's name has changed to Department of Energy Mines Industry Regulation and Safety (DEMIRS). All references to publications will remain as DMIRS as this is the name on the document, however, other references have been amended to DEMIRS.

3 Several terms have been used to refer to the company in this document:
- BHP refers to the corporate entity
- BHP Western Australian Iron Ore (WAIO) refers to the local Western Australian operation
- BHP Iron Ore Pty Ltd (BHPIO) is the legal company name for licences and approvals



Map E 1 **Jimblebar Hub current mine footprint**



Map E 2 **Jimblebar Hub indicative future footprint - closure domains**

BHP is committed to environmental stewardship. The BHP Charter is the overarching document that articulates the corporate vision and values and what BHP stands for. The first value in the Company Charter is:

> *Sustainability: putting health and safety first, being environmentally responsible and supporting our communities.*

The BHP Western Australian Iron Ore (WAIO) closure and rehabilitation objective is to:

> *Develop a safe, stable, non-polluting and sustainable landscape that is consistent with key stakeholder agreed social and environmental values and aligned with creating optimal business value.*

To guide the development and implementation of mine closure and rehabilitation for the Pilbara operations, BHP has established a set of guiding closure principles which are applied to the Jimblebar Hub. The guiding closure principles address post-mining land use, land management, safety, landforms, mine planning, ecosystem sustainability, water, decommissioning, contaminated sites, human resources and community assets.

The mine operates on the lands of the Nyiyaparli people and copies of this plan have been provided to the Karlka Nyiyaparli Aboriginal Corporation (KNAC) for their review and comment on behalf of the Nyiyaparli people[4]. BHP takes into consideration the views and feedback of the Traditional Owners as part of the closure planning process and closure was also considered as part of the Social Surrounds consultation process for the Jimblebar Hub Significant Amendment. Consultation on closure and rehabilitation is an ongoing process and further closure-specific consultation is required, as outlined in the Jimblebar Social and Cultural Heritage Management Plan (BHP, 2023g).

Executive Summary Table 1 provides a summary of key closure information by domain including:

- Post mining land use. At this stage BHP has adopted post mining land uses consistent with the Australian Land Use and Management Classifications (ABARES, 2016) and the underlying tenure to provide interim target to which closure and rehabilitation planning can work. However, we recognise that the Nyiyaparli people will be custodians of the land post-closure and further consultation is required to determine how traditional uses can be factored into these land uses.
- Key closure outcomes. These outcomes provide the overarching objectives that guide the more detailed closure criteria presented within the body of this MCP.
- Key closure risks. This column provides a brief summary of the closure risks associated with each domain. Further information on causes and potential impacts is provided within the body of this MCP.
- The main controls that are being, or will be, implemented to achieve the key outcomes and mitigate the closure risks.
- A summary of knowledge gaps that are still to be addressed.
- The forward work program to address the outstanding knowledge gaps and enable closure planning to be refined and progressed towards execution.

[4] KNAC is the registered native title body corporation through which engagement with the Nyiyaparli people is facilitated.

Executive Summary Table 1 – Summary of Key Risks and Management Approaches

Domain	Post-mining land use	Key outcomes	Key closure risks	Controls (treatment)	Key knowledge gaps	Forward work program

General – applicable to all domains	**Underlying tenure - Unallocated Crown Land (UCL)**
	Natural environment for managed resource protection
	Underlying tenure – Pastoral
	Relatively natural environment for pastoral grazing purposes
	Underlying tenure - Pastoral or UCL
	Mine voids - further assessment required
		• Post-closure land use has been informed by consultation with relevant stakeholders.
		• Protection of cultural values, and access to sites of cultural importance has been incorporated into mine closure planning following consultation with the Traditional Owners.
		• Long-term land management requirements have been addressed.
		• Visual amenity of constructed landforms is compatible with that of local Pilbara landforms.
			• Traditional owner values not achieved post-mining.
			• Land condition is not suited to the post-closure land use.
			• Impact to visual amenity post-mining.
				• Consultation will continue to be undertaken with:
				  - Traditional Owners to develop closure strategies to address heritage and cultural values and inform post-mining land uses.
				  - Other key stakeholders to inform post-mining land use performance objectives and completion criteria.
				• Archaeological and ethnographic surveys are conducted prior to ground disturbance and inform closure designs and execution.
				• Closure execution activities are approved via BHP's Project Environmental and Aboriginal Heritage Review (PEAHR) procedure.
				• Post-closure land management and maintenance requirements will be tracked through the post-closure monitoring program and, where requirements exceed those of surrounding land, arrangements will be made in consultation with key stakeholders for ongoing management post-relinquishment.
				• Options for managing visual impacts post-closure will be incorporated into designs following consultation with stakeholders. Infrastructure will be removed, and the footprint rehabilitated unless transferred to a third party.
					• Further consultation with key stakeholders (including Traditional Owners) is required to obtain more information on their views of:
					  - Post-mining land use performance objectives and requirements for safe access.
					  - Visual amenity.
					• Further consultation with the Nyiyaparli people is required in relation to:
					  - Requirements for protection, management and post-closure access to sites of cultural significance.
					  - Management of cultural artefacts.
					  - Landform and rehabilitation designs including creation of special places.
						• Consultation with stakeholders including Traditional Owners.
						• Visual impacts of post-closure landforms will be considered during the detailed design phase.

		• Contaminated sites have been documented and managed to achieve a classification commensurate with the post-mining land use.	• Identified areas of contamination have not been managed during operations or the contaminated sites classification under the *Contaminated Sites Act 2003* is not suitable for the agreed post-mining land use.	• Pre-closure monitoring enables groundwater and surface water contamination to be identified and remediated, if required. • WAIO has a contaminated sites register and a risk-based schedule for investigation and remediation of contamination during operations. • Any contamination remaining at closure will be investigated and remediated to a standard commensurate with the post-closure land use, as required by the *Contaminated Sites Act 2003*. • Demolition and decommissioning plans will be developed which address the management of hydrocarbons and other potential contaminants during closure execution.	• Contamination assessment and remediation is incomplete for known and suspected contaminated sites.	• Investigation of suspected contaminated sites. • Remediation of known contamination, as required.

Applicable to all domains where revegetation is planned (OSAs, pits backfilled to surface, infrastructure footprint)	**Underlying tenure UCL**
	Natural environment for managed resource protection
	Underlying tenure – Pastoral
	Relatively natural environment for pastoral grazing purposes
		• A suitable growth medium has been identified to facilitate plant establishment and growth.
		• Vegetation is suited to the final landform and post-mining land use.
		• Demonstrated capacity of the site to recover from fire, drought and other disturbances.
		• Department of Biodiversity Conservation and Attractions (DBCA) priority list weed species to be managed so as not to cause unacceptable risk to surrounding environments.
		• Total weed cover to be typical for each site and landform and reflect the post-mining land use.
		• Vegetated areas provide fauna habitat.
			• Rehabilitation values do not achieve ecological criteria.	• BHP has a range of rehabilitation standards and procedures that it uses to guide rehabilitation and manage weeds. These will continue to be used in the rehabilitation of the Jimblebar Hub.
				• Topsoil is stockpiled and available volumes are reconciled with volumes required for rehabilitation.
				• To address topsoil deficits, overburden types are analysed to assess their suitability for use as growth media. Trials of different growth media types provide additional information on their suitability for use in rehabilitation.
				• The Botanic Gardens and Park Authority and the University of Western Australia have been conducting research on a range of factors influencing rehabilitation success including seed collection, storage, processing and use, alternate growth media, and rehabilitation techniques. This research informs updates to BHP's rehabilitation practices and procedures.
				• The seed list for Jimblebar includes species of cultural significance to the Nyiyaparli people.
				• BHP is commencing a program with the Nyiyaparli people focused on rehabilitation. It is anticipated that this program would enhance the re-establishment of culturally significant species.
				• Local provenance seed is used in rehabilitation.
				• Opportunities to provide habitat for fauna are considered during rehabilitation.
				• Monitoring of the success of progressive rehabilitation will be used to inform future rehabilitation practices.
					• Growth media to address topsoil deficit.
					• Optimisation of rehabilitation strategy including research into return of culturally significant flora and fauna species.
					• Appropriate species for use in backfilled pits.
					• Options for increasing resilience to climate change.
						• Ongoing identification of potential growth media sources to address the topsoil deficit.
						• The results of seed and tube stock research / trials, and work with the Nyiyaparli rehabilitation team will inform the revegetation strategy.
						• Appropriate species for use in rehabilitation of pits with backfill to surface will be investigated.
						• A watching brief will be maintained on research associated with the appropriate use of out of provenance seed sources to increase genetic diversity to provide resilience to climate change.
						• A research program is planned to investigate fauna habitat and the return of fauna to rehabilitated areas, including consideration of key species of significance to the Nyiyaparli people.
						• Locations will be investigated that may be available for a minimum of 5 years for use in rehabilitation / landform trials.
						• Completion criteria will continue to be refined to incorporate findings from ongoing research and development programs including landform trials, rehabilitation monitoring programs, and consultation with stakeholders.
						• Reviews will be conducted of:
						  - Opportunities for providing habitat for conservation significant species during rehabilitation.
						  - Early opportunities to rehabilitate the northern side of the OB31 OSA to minimise impacts to the adjacent Priority 1 flora species.

Domain	Post-mining land use	Key outcomes	Key closure risks	Controls (treatment)	Key knowledge gaps	Forward work program
OSAs (Overburden Storage Areas)	**Underlying tenure UCL** Natural environment for managed resource protection **Underlying tenure – Pastoral** Relatively natural environment for pastoral grazing purposes	• Constructed landforms are safe and geotechnically stable. • The constructed surface is stable and showing no signs of significant erosion or release of sediment causing adverse impacts to drainage lines. • Surface water quality is acceptable at key receptors. • There are no unsafe areas where members of the general public could gain inadvertent access.	• Erosion or weathering event exposes buried overburden and releases overburden and / or sediment onto downslope areas. • Geotechnical instability causes failure of OSA into pit or to adjacent land area. • Site safety measures fail or are inadequate.	• Landforms are designed generally in accordance with BHP's Mines Closure Design Guidance Procedure. Designs are based on materials characterisation and the outcomes of erosion modelling. • Competent overburden is used on the outside of OSAs to achieve erosional stability. • Inert overburden class coding (which identifies competent and problematic overburden) is included within the mining model. The mining model indicates that competent overburden is available for stabilising landforms. • ISAs are utilised, where possible, to minimise ex-pit OSA footprints and facilitate the management of overburden more susceptible to erosion. • Flood modelling is conducted (and updated as the mine footprint changes) to inform landform placement and design. OSAs are generally located outside the 1 in 10,000-year flood plain. However, where this is not possible, and flood modelling indicates a possible impact to landform stability, flood bunds, diversions or other erosion protection measures (such as rock armour) are provided to prevent impacts to the stability of OSAs. If required, flood bunds and diversions will be upgraded at closure to accommodate extreme rainfall conditions. • Pit wall stability assessments will be conducted, and where failure of pit walls may impact nearby infrastructure (e.g., abandonment bunds / OSAs / flood bunds), buttressing or backfill may be considered. Consideration may also be given to relocation of the impacted landform. • Reasonable duty of care control measures (such as abandonment bunding and fencing) will be installed to prevent access to hazardous areas. • Fibrous material will be covered by 1 m of inert (non-fibrous) overburden.	• Final landform designs and materials balance to support execution.	• Further investigations will be conducted over the life of mine to assess the erosion characteristics of key lithologies at Jimblebar Hub and the volumes of competent overburden available for use in rehabilitation. • The backfill strategy will continue to be refined to optimise closure outcomes, including consideration of: - The current draft of the Nyiyaparli principles for closure. - Reducing the risks associated with landforms constructed of material that is prone to erosion, or adjacent to flood plains. • Final landform designs will be progressively developed and will consider erosion modelling outputs, historical performance of comparable areas, the Nyiyaparli people's principles for closure, and following consultation with stakeholders, options for safe access post-closure and visual characteristics. • The performance of rehabilitated landforms will continue to be monitored to validate design assumptions and inform future rehabilitation practice during the operational life of mine. • As the hub approaches closure, detailed mine void stability analyses will be conducted to: - Identify the need for controls such as buttressing or backfill. - Inform the location of abandonment bunds. - Determine the final location of permanent infrastructure.
		• Materials with poor chemical properties do not compromise rehabilitation (landform stability and revegetation) or water quality. • There are no unsafe areas where members of the general public could gain inadvertent access to hazardous materials such as those that are Potentially Acid Forming (PAF) or contain fibrous materials.	• Acid and Metalliferous Drainage (AMD) release occurs from PAF material within OSAs, and low-grade stockpiles remaining at closure and impacts groundwater and / or surface water quality. *The AMD hazard varies across the Jimblebar Hub with material mined from OB17, OB31, WH4, H234 and South Jimblebar representing low source hazards and OB18, WH123, WHASH and East Jimblebar representing moderate to high source hazards. Material classified as AMD 1 (PAF below water table) is currently stored in OB31 OSA, and AX12 and AU09 OSAs at WH123.* • Measures to prevent exposure to hazardous material fail or are inadequate.	• BHP implements a range of internal standards and procedures to identify PAF material and manage AMD. • Geochemical testing is conducted, and overburden is classified as AMD 0 (Non-Acid Forming; NAF), AMD 1 (PAF below water table), AMD 2 / 3 (PAF above water table and lower risk). Based on these classifications, the AMD risk associated with each deposit is assessed. • Geochemical characterisation is incorporated into mining models and areas of AMD 1, 2 or 3 are identified for appropriate management. • AMD 1 material is encapsulated within designated locations in OSAs or ISAs to minimise the potential for AMD generation. Management of AMD 2 and 3 materials is based on risk. • BHP has, and continues to, conduct trials and research to identify the best options for covering PAF material to minimise the potential for AMD. The results inform updates to BHP's AMD management procedures. PAF material covers will be implemented at Jimblebar Hub generally in accordance with these procedures. • Pre-closure and post-closure monitoring (including surface water and groundwater quality) will be conducted to assess the effectiveness of AMD management controls. • Fibrous material will be covered by 1 m of inert (non-fibrous) overburden.	• Further assessment of the hazards associated with AMD 2 and 3 materials and mobility of metals under variable environmental conditions. • Priorities for monitoring OSAs / ISAs storing AMD 1. • Further characterisation of South and East Jimblebar deposits	• As part of a BHP-wide geochemical program, further investigations will be conducted into the geochemical hazards associated with: - AMD 2 and 3 materials. - Leach test wok to assess metal mobilisation under variable environmental conditions. • BHP is reviewing OSAs / ISAs across the Pilbara based on storage of AMD 1 overburden to identify priorities for monitoring. • Additional geochemical testing will be conducted on material from the East Jimblebar and South Jimblebar (Sylvania and Capricorn) deposits.

Domain	Post-mining land use	Key outcomes	Key closure risks	Controls (treatment)	Key knowledge gaps	Forward work program
ISAs (In-pit Storage Areas)	Areas may not support a specific post-closure land-use due to ingress / egress restrictions. Land use classification may be 'extractive industry not in use'. Further assessment required as design of mine voids (including ISAs) progresses.	• Constructed landforms are safe and geotechnically stable. • Materials with poor chemical properties do not compromise water quality. • There are no unsafe areas where members of the general public could gain inadvertent access to hazardous materials such as those classified as PAF.	• AMD release occurs from PAF within ISAs remaining at closure and impacts groundwater. *The AMD hazard varies across the Jimblebar Hub with material mined from OB17, OB31, WH4, H234 and South Jimblebar representing low source hazards and OB18, WH123, WHASH and East Jimblebar representing moderate to high source hazards. Material classified as AMD 1 (PAF below water table) is currently stored in ISAs at OB18 (Avon and Blackwood), WH123 (W33E) and WH4 (BF07).* • Measures to prevent exposure to hazardous material fail or are inadequate.	As for OSA geochemical controls, plus: • AMD 1 material is encapsulated in dedicated cells within ISAs located above the water table to minimise the potential for AMD generation. Management of AMD 2 and 3 materials is based on risk. • Reasonable duty of care control measures (such as abandonment bunding and fencing) will be installed to prevent access to hazardous areas.	• As for OSA geochemical knowledge gaps	• As for OSA geochemical forward work program
Mine voids	Areas may not support a specific post-closure land-use due to ingress / egress restrictions. Land use classification may be 'extractive industry not in use'. Further assessment required as design of mine voids progresses.	• There are no unsafe areas where members of the general public could gain inadvertent access.	• Site safety measures fail or are inadequate.	• Mine voids conform to DMIRS (2019) guidelines for structural stability. • Pit wall stability assessments inform abandonment bund locations. Where pit wall stability does not allow abandonment bunds or infrastructure remaining post-closure to be located outside the zone of instability, buttressing may be considered. • Abandonment bunds will be installed that conform to the Department of Energy Mines Industry Regulation and Safety (DEMIRS) guidance (DoIR, 1997) and the outcomes of recent consultation with DEMIRS on abandonment bunds.	• Stability of final voids remaining post-closure. • Final mine void closure strategy.	• As the site approaches closure, detailed slope stability analysis will be conducted to assess potential interactions of final mine voids with flood bunds / diversions and inform abandonment bund locations and the need for pit wall stabilisation measures such as buttressing or backfill. • Consultation will be conducted with stakeholders on post-mining land uses and safe access.
		• Groundwater levels are acceptable at key receptors.	• Mine voids have unacceptable impacts on groundwater levels at key receptors.	• BHP conducts groundwater modelling to assess the potential for impacts to ecohydrological receptors and inform pit closure strategies. Modelling includes sensitivity testing. • Pre-closure monitoring during dewatering enables groundwater models and resulting mine void closure strategies to be refined. • The current base case for closure is that below water table voids at OB17/18 are backfilled with tailings or overburden (to at least 5 m above the pre-mining water table). The closure strategy for the OB31 mine void is still under review. • BHP acknowledges the Nyiyaparli people's stated preference for the avoidance of pit lakes, and the Jimblebar operations' progressive closure philosophy includes a priority focus on progressively backfilling into mined out pits. The backfill strategy for the Jimblebar Hub is continually reviewed as the mine plan is updated. Based on a backfill scenario analysis conducted in 2019, between 40 - 60% of mined overburden may be progressively backfilled into mined out pits at Jimblebar. This is expected to minimise the extent of post-closure pit lakes. BHP's long-term beneficiation strategy will also contribute to backfill through the in-pit storage of tailings.	• Groundwater models require updating during operations to enable mine void closure strategies to be refined and post-mining impacts to be assessed as mine void closure strategies evolve.	• The closure strategies for below water table pits will be reviewed in the light of the Nyiyaparli people's principles for closure, future operational decisions and refinements in groundwater modelling as new information becomes available through the pre-closure groundwater monitoring program.

Domain	Post-mining land use	Key outcomes	Key closure risks	Controls (treatment)	Key knowledge gaps	Forward work program
Mine voids	Areas may not support a specific post-closure land-use due to ingress / egress restrictions. Land use classification may be 'extractive industry not in use'. Further assessment required as design of mine voids progresses.	• Materials with poor chemical properties do not compromise water quality. • Groundwater quality is acceptable at key receptors. • No significant adverse impact to fauna from pit lakes	• AMD release from pit wall exposures of PAF material impacts pit lake or groundwater quality. • Impact to groundwater quality could occur from an open mine void that becomes a temporary groundwater through-flow system (e.g., through uncontrolled release of surface water flows to pit). *The predicted hazards associated with wall rock exposures of PAF material are low at OB17, OB31 WH4, H234 and South Jimblebar and represent a low risk. Exposures at OB18, Swan pit and De Grey pit are higher (~5% of total wall rock) and moderate or high at WH123, WHASH and East Jimblebar.* *Studies have shown that acidity generation rates from wall rock are low.*	• BHP implements a range of internal standards and procedures to identify PAF material and manage AMD. • Geochemical testing is conducted, and wall rock exposures of AMD 1 (PAF below water table), AMD 2 / 3 (PAF above water table and lower risk) are identified. Based on these classifications, the AMD risk associated with each deposit is assessed. • Significant wall rock exposures of AMD 1 material remaining above the recovered groundwater table will be managed to minimise the potential for AMD generation (e.g., by covering with overburden or tailings), if required. • Below water table voids at OB17/18 will be backfilled with tailings or overburden (to 5 m above the water table) and no permanent pit lake will persist. • The backfill strategy for Jimblebar is continually reviewed with the progressive closure philosophy focusing on progressively backfilling into mined out voids which is expected to minimise pit lakes. • Closure is considered during the operational design of flood bunds / diversions to prevent uncontrolled release of surface water to mine voids resulting in a temporary through-flow system. These features will be upgraded to accommodate extreme rainfall conditions that could occur post-closure. The design of the bunds / diversions will be informed by surface water modelling and pit wall stability assessments. The bunds / diversions will be located outside the zone of instability of pit walls.	• Potential impact of future operational decisions (e.g., use of pits for tailings storage) on closure strategies for below water table pits. • Requirements for PAF wall rock management measures. • Closure design for flood bunds and diversions taking into account final void stability. • Impacts of pit lakes.	• The closure strategies for below water table pits will be reviewed in the light of Nyiyaparli people's principles for closure, future operational decisions for in-pit tailings storage, and refinements in groundwater modelling as new information becomes available through the pre-closure groundwater monitoring program. • Further assessment will be conducted of the short- and long-term risks associated with wall rock exposures of PAF material above the level of backfill and to pit lakes, and implications for closure including the need to manage PAF wall rock exposures. • As the site approaches closure: - Detailed mine void stability analyses will be conducted to identify the need for controls such as buttressing or backfill. - Closure designs will be developed for the flood bunds and diversions. • As the backfill strategy for Jimblebar evolves, the potential impacts of pit lakes will be assessed.
In-pit TSFs	Areas may not support a specific post-closure land-use due to ingress / egress restrictions. Land use classification may be 'extractive industry not in use'. Further assessment required as design of in-pit TSF closure strategies progress.	• Materials with poor chemical properties do not compromise water quality. • Groundwater quality is acceptable at key receptors.	• Impact to groundwater quality from in-pit TSFs. • Dust emissions from tailings surface post-deposition (and pre-closure) impacts adjacent vegetation.	• Geochemical testing of tailings has been conducted and: - The tailings have been characterised as NAF - Both the tailings leachate and supernatant have low salinity, nutrients and metal(oid)s. • During deposition, wall rock exposures of fresh (AMD 1) PAF material will be submerged by tailings. Tailings will consolidate and settle by tens of metres following deposition. Post settlement, PAF wall rock exposures will remain submerged in Swan pit, and will be covered by fine, low permeability tailings deposited on the benches and slopes of De Grey pit. This tailings layer is expected to minimise oxidation and create a physical barrier that would limit the potential for precipitation to contact the PAF wall rock and generate AMD. A cover will be placed over the tailings to prevent erosion of the deposited tailings and exposure of PAF wall rock. • While tailings surfaces tend to form crusts if left undisturbed and their susceptibility to wind erosion is low, a cover will further limit the potential for dust emissions. A tailings management plan will be implemented to actively manage dust during the period between deposition and placement of the cover. • The East OSA which is adjacent to the Swan and De Grey in-pit TSFs will be designed to direct surface water away from the final landform to prevent permanent ponding of water on the TSFs post-closure. • BHP conducts groundwater assessments to assess the potential for impacts associated with any seepage based on groundwater monitoring and modelling conducted during operations. Given the geochemical nature of the tailings (NAF, low metal(oid)s, salinity and nutrients), low permeability and closure design which prevents permanent ponding of water on the final landform, no impacts to groundwater receptors such as Ethel Gorge Threatened Ecological Community (TEC) are expected.	• Consolidation behaviour during deposition. • Opportunities for enhancing tailings settlement and drainage to reduce the timeframe over which closure works can be safely operated (currently tailings will take 10 to 20 years to consolidate enough to allow earthmoving machinery to place the cover). • Confirmation of groundwater behaviour during and after deposition.	Further studies for the closure of the in-pit TSFs will include: • Consolidation modelling for the detailed design study (in progress) and subsequent monitoring and model validation during operations. • Review of options to enhance tailings settlement and drainage to reduce the timeframe over which closure works can be safely executed. • Seepage modelling (in progress) and pre-closure monitoring of groundwater to confirm / refine the groundwater impact assessment. • A review of alternate cover systems to investigate the impacts of different designs and material characteristics on final closure outcomes. • Consultation with Nyiyaparli people regarding the final landform design, acknowledging the Nyiyaparli people's preference to backfill to surface or create water gaining sites.

Domain	Post-mining land use	Key outcomes	Key closure risks	Controls (treatment)	Key knowledge gaps	Forward work program

Surface water infrastructure	**Underlying tenure UCL**
	Natural environment for managed resource protection
	Underlying tenure – Pastoral
	Relatively natural environment for pastoral grazing purposes
		• Constructed landforms are safe.
		• Erosion of the constructed surface performs as expected.
		• Rehabilitation drainage patterns have been established and impacts on natural surface water flows are acceptable at key receptors.
		• Surface water quality is acceptable at key receptors.
			• Erosion or weathering event causes unacceptable sediment impacts (i.e., beyond design criteria).
			• Post-closure landform impacts surface water flows beyond the parameters accepted by project approvals.
				• Surface water assessments and modelling inform surface water management designs for closure. Modelling includes sensitivity testing and consideration of climate change.
				• Closure is considered during the operational design of flood bunds / diversions. These will be upgraded to withstand closure conditions. The design flood event Annual Recurrence Intervals (ARIs) are selected according to risk which considers catchment size, sensitivity and impacts to the receiving environment from a change in flows, and risk of creek capture or compromising stability of landforms such as OSAs.
				• The Hashimoto 2/3 and WHASH pits have been designed to avoid the 1:10,000-year flood plain.
				• Significant creek diversions will be designed to achieve comparable hydraulic and geomorphological characteristics to the original creek systems.
				• Flood bunds / diversions will be located outside the zone of instability of the relevant pits, or pits will be backfilled / buttressed to achieve an appropriate Factor of Safety (FoS).
				• Bunds will be constructed of appropriate materials. Materials characterisation will inform construction materials selection.
					• Closure design for the flood bunds / diversions taking into account final void stability.	• As the site approaches closure:
						  - Detailed mine void stability analyses will be conducted to identify the need for additional controls such as buttressing or backfill.
						  - Closure designs will be developed for flood bunds and diversions.
						• As mining progresses, and further creek diversions are required, hydrological studies will be carried out, impacts assessed, and appropriately designed infrastructure developed.

Infrastructure, road & rail	**Underlying tenure UCL** Natural environment for managed resource protection **Underlying tenure – Pastoral** Relatively natural environment for pastoral grazing purposes	• There are no unsafe areas where members of the general public could gain inadvertent access. • Infrastructure remaining post-closure has been agreed with key stakeholders.	• Site safety measures fail or are inadequate at closed site.	• Consultation will be undertaken with stakeholders to identify infrastructure that will be transferred post-closure. • If not being transferred to a third-party post-closure, infrastructure will be removed to a depth of 0.6 m below ground level unless a risk assessment indicates that removal to a greater depth is required, or a different standard is agreed with stakeholders. • Where infrastructure is to be transferred, infrastructure condition will be assessed, and the condition included in stakeholder agreements prior to transfer. • Reasonable duty of care control measures such as fencing, and signage will be installed, if required.	• Stakeholder requirements for infrastructure post-closure.	• Consultation with post-mining landowners / managers, including Traditional Owners.

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Abbreviations and Acronyms

Abbreviation / Acronym	Meaning
AAR	Annual Aquifer Review
ABA	Acid Base Accounting
ABBC	Acid Buffering Characteristic Curve
ACARP	Australian Coal Association Research Program
AEP	Annual Exceedance Probability
AER	Annual Environmental Report
Ag	Silver
Al	Aluminium
AMD	Acid and Metalliferous Drainage
ANC	Acid Neutralising Capacity
ANZECC	Australia and New Zealand Environment and Conservation Council
ANZMEC	Australian and New Zealand Minerals and Energy Council
ARD	Acid Rock Drainage
ARI	Average Recurrence Interval
ARR	Australian Rainfall and Runoff
As	Arsenic
AS/NZS ISO	Australian and New Zealand International Standards Organisation
AWT	Above Water Table
B	Boron
Ba	Barium
BAM Act	*Biosecurity and Agriculture Management Act 2007 (WA)*
BC Act	*Biodiversity Conservation Act 2016 (WA)*
BCM	Bank Cubic Metres
Be	Beryllium
BHPIO	BHP Iron Ore Pty Ltd
Bi	Bismuth
BIF	Banded Iron Formation
BoM	Bureau of Meteorology
BWT	Below Water Table
Ca	Calcium
$CaCO_3$	Carbonate
CAP	Corporate Alignment Planning
Cd	Cadmium
Ce	Cerium
CEC	Cation Exchange Capacity
CEO	Chief Executive Officer
Cl	Chloride
Cr	Chromium
CS Act	*Contaminated Sites Act 2003 (WA)*
CSIRO	Commonwealth Scientific Investigation and Research Organisation
Cu	Copper
DBCA	Department of Biodiversity Conservation and Attractions
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DEC	Department of Environment and Conservation (now DWER and DBCA)
DEMIRS	Department of Mines Industry Regulation and Safety (now Department of Energy Mines Industry Regulation and Safety)
DER	Department of Environment Regulation (now Department of Water and Environmental Regulation)
DES	Queensland Department of Environment and Science
DFRP	Decommissioning and Final Rehabilitation Plan
DISR	Department of Industry, Science and Resources
DJTSI	Department of Jobs Science and Tourism
DMIRS	Department of Mines Industry Regulation and Safety (now Department of Energy Mines Industry Regulation and Safety)
DMP	Department of Mining and Petroleum (now Department of Mines Industry Regulation and Safety)
DoIR	Department of Industry and Resources (now Department of Mines Industry Regulation and Safety)

Abbreviation / Acronym	Meaning
DoL	Department of Lands (now Department of Planning, Lands and Heritage)
DoW	Department of Water
DPIRD	Department of Primary Industries and Regional Development
DPLH	Department of Planning, Lands and Heritage
DPS	Definition Phase Study
DSI	Detailed Site Investigation
dS/M	Deci Siemens per metre
DWER	Department of Water and Environmental Regulation
EC	Electrical Conductivity
ECEC	Effective Cation Exchange Capacity
EFA	Ecosystem Function Analysis
EIA	Environmental Impact Assessment
EMP	Environmental Management Programme
EP Act	*Environmental Protection Act 1986 (WA)*
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999 (Cwlth)*
EPS	Environmental Protection Statement
ERD	Environmental Review Document
ESP	Exchangeable Sodium Percentage
EWR	Ecological Water Requirement
F	Fluorine
Fe	Iron
FY	Financial Year
FoS	Factor of Safety
g	gram
GAI	Global Abundance Index
GPS	Global Positioning System
GSDM	Generalised Short Duration Method
GTSMR	Generalised Tropical Storm Method
GWL	Ground Water Licence
GWOS	Ground Water Operating Strategy
ha	Hectare
HCO_3	Bicarbonate
Hg	Mercury
IBRA	Interim Biogeographic Regionalisation for Australia
ICMM	International Council on Mining and Metals
IFD	Intensity Frequency Duration
INAP	International Network for Acid Prevention
InSAR	Interferometric Synthetic Aperture Radar
IPCC	Intergovernmental Panel on Climate Change
IPS	Identification Phase Study
ISA	In-pit Storage Area
K	Potassium
km	Kilometre
km^2	Kilometre squared
kN	Kilo Newton
KNAC	Karlka Nyiyaparli Aboriginal Corporation
LiDAR	Light Detection and Ranging
LoA	Life of Asset
m	Metre
m^2	Metre squared
m^3/s	Cubic metre per second
MAR	Managed Aquifer Recharge or Mandatory Audit Report
MBCM	Million Bank Cubic Metres
mbgl	Metres below ground level
MCA	Minerals Council of Australia

Abbreviation / Acronym	Meaning
MCP	Regulatory Mine Closure Plan
meq	Milliequivalents
Mg	Magnesium
mg/L	Milligrams per litre
ML	Mineral Lease or Megalitres
MLCM	Million Loose Cubic Metres
mm	Millimetres
Mn	Manganese
Mo	Molybdenum
MPA	Maximum Potential Acidity
MRF	Mining Rehabilitation Fund
mRL	Metres reduced level
MS	Ministerial Statement
N	Nitrogen
Na	Sodium
NAF	Non-Acid Forming
NAG	Net Acid Generation
NAPP	Net Acid Production Potential
Ni	Nickel
NMD	Neutral and Metalliferous Drainage
NO_3	Nitrate
NUDLC	National Uniform Drillers Licensing Committee
NVCP	Native Vegetation Clearing Permit
OB	Orebody
OEPA	Office of the Environmental Protection Authority (OEPA) now DWER
OSA	Overburden Storage Area
P	Phosphorus
PAF	Potentially Acid Forming
PAW	Plant Available Water
Pb	Lead
PEAHR	Project Environmental and Aboriginal Heritage Review
PEC	Priority Ecological Community
PFAS	Per- and polyfluoroalkyl substances
PGA	Peak Ground Acceleration
pH	Numeric scale used to specify acidity or basicity
PMF	Probable Maximum Flood
PMLU	Post Mining Land Use
PMP	Possible Maximum Precipitation
ppm	parts per million
PRMP	Progressive Rehabilitation Management Plan
PSI	Preliminary Site Investigation
QXRD	Quantitative X-Ray Diffraction
RAP	Remediation Action Plan
RFFE	Regional Flood Frequency Estimation
RL	Reduced Level
ROM	Run Of Mine
RORB	Runoff Routing
RUSLE	Revised Universal Soil Loss Equation
S	Sulphur
SAP	Sampling and Analysis Plan
Sb	Antimony
Se	Selenium
SiO_2	Silicon dioxide
SILO	Scientific Information for Landowners (SILO)
SMART	Specific, Measurable, Achievable, Realistic and Time Bound
Sn	Tin

Abbreviation / Acronym	Meaning
SO_4	Sulphate
SPS	Selection Phase Study
Sr	Strontium
SRE	Short Range Endemic
t	tonnes
TAR	Triennial Aquifer Review
TARP	Trigger Action Response Plan
TDS	Total Dissolved Solids
TEC	Threatened Ecological Community
Th	Thorium
TSF	Tailings Storage Facility
µS/cm	micro siemens per centimetre
U	Uranium
UC	Uncertain
UCL	Unallocated Crown Land
V	Vanadium
VAR	Voluntary Audit Report
WA	Western Australia
WABSI	Western Australian Biodiversity Science Institute
WAIO	BHP's Western Australian Iron Ore Operations
WEPP	Water Erosion Prediction Project
WIR	Water Information Reporting
XRD	X-Ray Diffraction
yr	Year
Zn	Zinc
ZOI	Zone of Instability

1 Introduction

This Mine Closure Plan (MCP) combines the previously submitted MCPs for Orebody 17/18/31 and Jimblebar operations into one document (refer to Section 1.1 for further details). The combined operation is referred to as the Jimblebar Hub. The Jimblebar Hub is operated by BHP[5] and is located approximately 35 kilometres east of Newman, in the Pilbara Region of Western Australia (Map 1-1), within Mineral Lease (ML) 244SA and Mining Lease M266SA.

The Jimblebar Hub operations are described in Section 2.1 and comprise:

- The Jimblebar mining operation which includes above and below water table mining at Wheelarra Hill (WH123, WH4), Hashimoto (H234), Wheelarra / Hashimoto (WHASH), East Jimblebar and South Jimblebar (Sylvania, Mindoona, Capricorn, Pain Killer) deposits.
- The OB17/18/31 mining operation which includes above and below water table mining at OB17 (Swan), OB18 (Avon, Blackwood, De Grey) and OB31. Mining at OB17 and OB18 is nearing completion and the OB17 and OB18 mine voids are proposed for in-pit tailings storage as part of an integrated management scenario for beneficiation operations at the Jimblebar operations. Mining at OB31 is ongoing.

In-pit storage of tailings in other pits is also under consideration by BHP, but no decision has yet been made as to which of these pits will be selected. The forward work program for this MCP (Section 7.6) summarises the key studies that will be conducted to assess the closure approach for new in-pit TSFs, and the outcomes of these studies and closure designs for new in-pit TSFs will be described in future iterations of this MCP.

1.1 Purpose of the plan

This Jimblebar Hub MCP has been prepared ahead of the usual regulatory review cycles for the OB17/18/31 and Jimblebar MCPs to support a request to the Environmental Protection Authority (EPA) for a significant amendment to the Jimblebar Hub Iron Ore Mining Operations under Section 38 of the *Environmental Protection Act 1986 (WA)* (EP Act) (BHP, 2023a). The OB17/18/31 MCP Revision 1 (BHP, 2022j) and the Jimblebar MCP Revision 3 (BHP, 2021i) are being combined into one MCP as the two sites are to be managed as an integrated mining hub with tailings arising from beneficiation at Jimblebar being deposited in the Swan and De Grey pits at OB17/18.

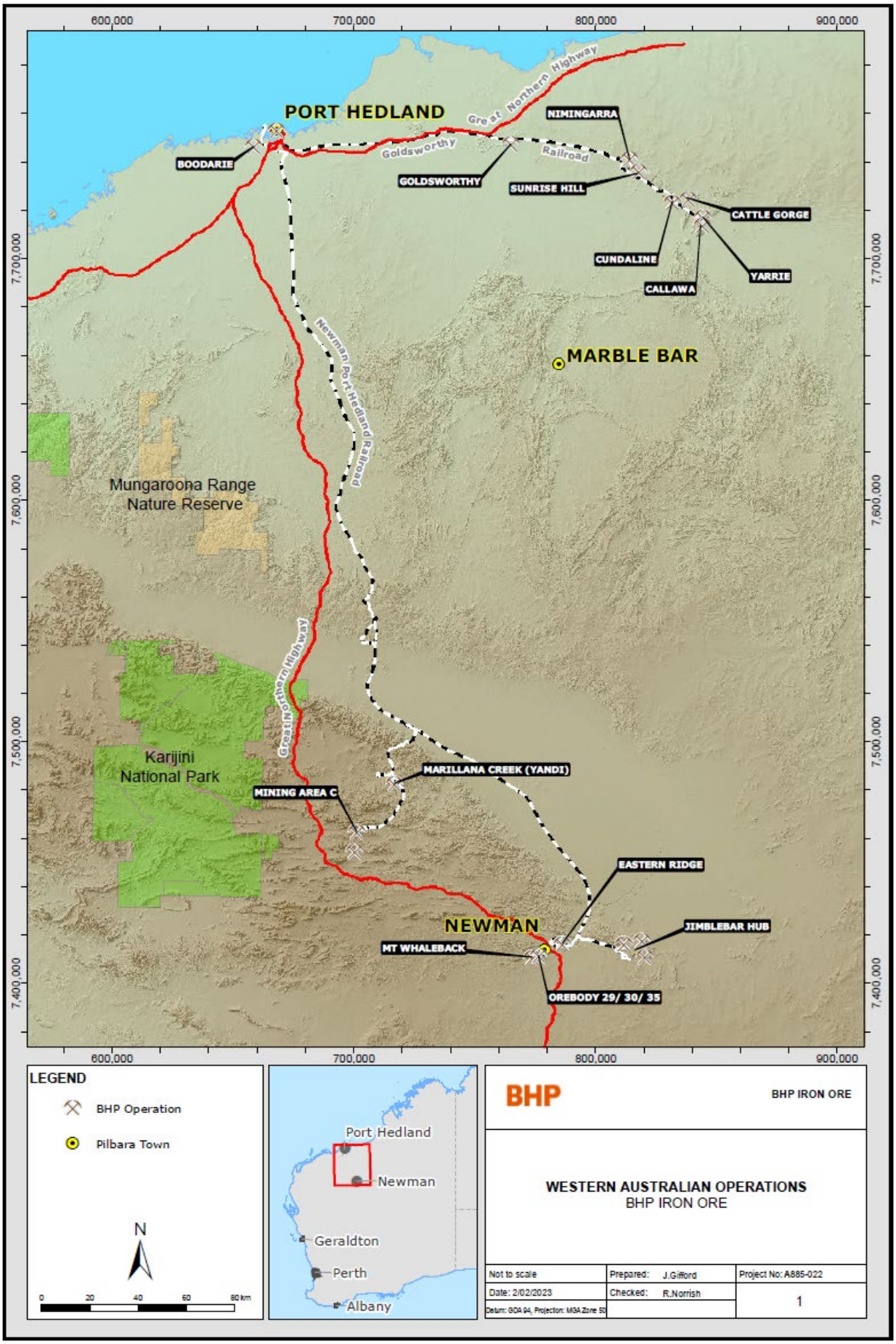
This MCP describes how the Jimblebar Hub mining hub will be rehabilitated and closed in a manner that:

- Meets the requirements of:
  - Conditions 5-1 and 9-1 of Ministerial Statements 439, 1021 and 1126;
  - The Department of Mines, Industry Regulation and Safety[6] (DMIRS) Statutory Guidelines for Mine Closure Plans (DMIRS, 2020a) and Mine Closure Plan Guidance (DMIRS, 2020b) (Mine Closure Guidelines);
  - BHP corporate guidelines; and
- Addresses feedback from Department of Water and Environmental Regulation (DWER) on the 2021 Jimblebar MCP, Revision 3.

This MCP will be used by BHP and its contractors in the implementation of appropriate rehabilitation and mine closure strategies at Jimblebar Hub.

[5] Several terms have been used to refer to the company in this document:
- BHP refers to the corporate entity
- BHP Western Australian Iron Ore (WAIO) refers to the local Western Australian operation
- BHP Iron Ore Pty Ltd (BHPIO) is the legal company name for licences and approvals

[6] Since the publication of the guidelines, the department's name has changed to Department of Energy Mines Industry Regulation and Safety (DEMIRS). All references to publications will remain as DMIRS as this is the name on the document, however, other references have been amended to DEMIRS.



Refer to Appendix Q for pdf version

Map 1-1 Jimblebar Hub location plan

1.2 Document history

As discussed in Section 1.1 this document (Jimblebar Hub MCP Revision 0) combines, updates and will supersede:

- OB17/18/31 Mine Closure Plan Revision 1, 2022.
- Jimblebar Mine Closure Plan Revision 3, March 2021.

The history of the OB17/18/31 and Jimblebar MCPs is summarised in Table 1-1

Section 13.1 outlines the changes between this amalgamated plan and those that it supersedes. Section 13.2 addresses feedback provided by DWER on the Jimblebar MCP Revision 3, 2021. At the time of submitting this amalgamated plan, no feedback had been received on the recently submitted OB17/18/31 Revision 1.0, MCP. Section 13.2, therefore summarises how this plan addresses feedback provided by DWER on the 2018 (Revision 0) OB17/18/31 MCP.

Table 1-1 Summary of the history of the OB17/18/31 and Jimblebar closure plans prior to merger

Date	Revision history
OB17/18/31	
2000	A conceptual closure plan (referred to as Revision 1) for the Orebody 18 mine was prepared in 2000 by Golder Associates in accordance with Condition 5-2 of Ministerial Statement No. 439
2007	The document was revised internally (Revision 2) to capture proposed modifications to the Orebody 18 mine (BHPBIO, 2007) which were granted approval in 2008
2013	Revision 3 (titled Decommissioning and Rehabilitation Plan) was prepared to incorporate changes represented by the Section 45C application for the Orebody 17/18 mine modification (BHPBIO, 2013), granted 17 June 2013.
2015	Following submission of Revision 3 of the Decommissioning and Final Rehabilitation Plan, BHPBIO received feedback from the Office of the Environmental Protection Authority (OEPA) [now DWER] requesting additional information. A key driver for the additional information request was proximity of closure for the Orebody 17/18 mine. This update was included in a document titled '*Orebody 17/18 Mine Closure Plan'* Revision 1. The OB17/18 Mine Closure Plan Revision 1, 2015, superseded the Orebody 17/18 Decommissioning and Final Rehabilitation Plan, Revision 3, 2013.
2015	The original MCP for Orebody 31 was prepared in August 2015, in support of the assessment of OB31 under Part IV of the Environmental Protection Act 1986. The proposal and MCP were approved in 2015 subject to the conditions of Ministerial Statement No. 1021.
2018	The OB17/18/31 MCP Revision 0 combined and updated the 2015 plans.
2022	Triennial update to meet Condition 9-3 of Ministerial Statement (MS) 1021 and provide alignment with the *Statutory Guidelines for Mine Closure Plans* (DMIRS, 2020a; 2020b)
Jimblebar	
2008	A Progressive Rehabilitation Management Plan (PRMP) was prepared to satisfy Condition 10-1 of MS 683, Condition 6-1 of MS 809 and Condition 12 of MS 857. A Decommissioning and Final Rehabilitation Plan (DFRP) was prepared to satisfy Condition 11-1 of MS 683, Condition 6-1 of MS 809, and Condition 13 of MS 857.
2009	Peer review of Revision 1 of the PRMP and Revision 2 of the DFRP was conducted by Syrinx Environmental Pty Ltd in November 2009 in accordance with Condition 6-3 of MS 809. Revisions 2 and 3 of the PRMP and DFRP respectively, were prepared to incorporate the findings of the peer review in accordance with Condition 6-4 of MS 809.
2010	Subsequent versions of the PRMP (Revision 3) and DFRP (Revision 4) were prepared as part of the Jimblebar Iron Ore Project environmental impact assessment. The revised PRMP and DFRP were included as supporting documents to the Jimblebar Iron Ore Project Environmental Protection Statement (EPS) (BHPBIO, 2010).
2016	The Jimblebar MCP Revision 1 was prepared to combine and supersede PRMP (Revision 3) and DFRP (Revision 4)
2019	The Jimblebar MCP Revision 2 was submitted to the EPA in support of the *Jimblebar Optimisation Proposal*. Condition 8-5 of MS 1126 requires that Revision 2 shall be implemented until the CEO has confirmed by notice in writing that the MCP submitted under Condition 8-2 satisfies the requirements for the plan.
2021	The Jimblebar MCP Revision 3 (a minor update to Revision 2) was submitted to satisfy Condition 8-2 of MS 1126 and provide alignment with the *Statutory Guidelines for Mine Closure Plans* (DMIRS, 2020a; 2020b).

1.3 BHP business guidance

BHP is committed to environmental stewardship. The BHP Charter is the overarching document that articulates the corporate vision and values and what BHP stands for. The first value in the Company Charter is:

Sustainability: putting health and safety first, being environmentally responsible and supporting our communities.

This commitment provides the starting point from where the mine closure and rehabilitation policy and procedures begin. The remaining values are integrity, respect, performance, simplicity and accountability.

A series of *Our Requirements* documents (previously Group Level Documents; GLDs) that underpin the Charter have been developed, which describe the performance requirements and accountabilities for definitive business obligations, processes, functions and activities. Compliance with these documents ensures minimum standards are met for all BHP operations.

The *Our Requirements* documents considered relevant to Mine Closure include:

- **Closure and Legacy Management** – as stewards of the land on which we operate and members of the communities which host us, we have a responsibility to leave a sustainable, positive legacy for host communities, the environment and future land users. In line with Our Purpose and Our Charter, delivering optimised closure outcomes and objectives supports our licence to operate, our commitment to social value and our aspiration to build a better world. BHP's closure management process manages closure risks throughout the entire lifecycle of a site by considering BHP's values, external expectations, safety and costs, while addressing legal obligations and public commitments (BHP, 2023h).
- **Environment and Climate Change** – we acknowledge that the nature of our operations can have adverse or positive environmental impacts and that climate change can amplify the sensitivities of our natural systems. We aim to minimise impacts through every stage of our operations and contribute to resilience of, and positive impact to, the natural environment. We also recognise that our environmental performance and management of our environmental impacts on our host communities is an important part of contribution to social value (BHP, 2022a).
- **Water and Tailings Storage Facilities -** a failure of a Water Storage Facility or Tailings Storage Facility (TSF) could impact the safety of our people and local communities and cause social and environmental harm. This risk must be effectively managed when we plan, design, construct, operate, maintain, conduct surveillance, close, and make decisions regarding Water Storage Facilities and TSFs (BHP, 2023i).
- **Risk Management** – through the delivery of best-in-class risk management, we protect what BHP has today and grow value for tomorrow. The identification and management of risks is central to achieving our strategic objectives. An essential element of effective risk management is to have an enterprise view so that the full risk exposure can be prioritised, and the aggregate impact from cumulative risks can be understood. As such, BHP operates to one Risk Framework for all risks (BHP, 2022b).
- **Corporate Alignment Planning** – the Corporate Alignment Planning (CAP) process is fundamental to creating alignment across the organisation; it guides the development of plans, targets and budgets to help us decide where best to deploy capital and invest resources with the fundamental aim of delivering sector leading operational performance, financial returns and social value. The CAP process has two discrete phases: it starts with directional planning to understand the strategic options and growth plans to maximise long-term value of our assets; then moves into delivery planning, which focuses on short and medium-term plans to deliver against the agreed strategic objectives. We regularly review our strategy against the constantly changing external environment to capture the risks and opportunities presented and cascade any changes through our planning processes. The intent of the CAP process and deliverables is to facilitate robust discussion, informed decision-making and disciplined delivery of quality planning outcomes (BHP, 2022c).
- **Global Investment Process and Capital Projects** – our investments are governed by a single process which is structured in phases so that appropriate levels of work and associated reviews can be done to support the business case and a decision on whether an investment should progress. These requirements are designed to make sure that investments and capital projects have gone through the appropriate level of study, critical thinking and planning so that they are aligned with BHP's strategy and values, are technically achievable and maximise financial and social value (BHP, 2022d; BHP, 2022e).
- **Communications, Community and External Engagement** – working openly with the communities in which we operate and with government contributes to economic and social development and social licence to operate (BHP, 2022f).

From the Charter and Our Requirements flow various business level documents and procedures that provide a framework for the application of the corporate vision and values with respect to mine closure planning and rehabilitation. These include for example:

- Closure and Rehabilitation Management Strategy (WAIO, 2016);
- Closure Planning Standard (BHP, 2021b);
- Rehabilitation Standard 0001074, Version 4 (WAIO, 2020a);
- Closure Provision and Life of Asset Cost Procedure 0005144 (WAIO, 2017a);
- Mined Materials Management Standard (BHP, 2021a);
- Acid and Metalliferous Drainage Management Standard 0096370 (WAIO, 2022a);
- Biodiversity Strategy 0120098 (WAIO, 2018);
- Environment and Climate Change Management Procedure (WAIO, 2019b);
- Mines Closure Design Guidance Technical Process Instruction (WAIO, 2022f); and
- Water Management (WAIO, 2022g).

It should be noted that the procedures and standards referenced in this document are periodically updated and where there is a difference between the procedure referenced in this plan and the controlled version in BHP's document system, the version in the document system takes precedence.

1.4 Navigating this document

The pdf of this document has been saved with bookmarks that can be used to quickly navigate between sections and appendices (Figure 1-1). To access these bookmarks, the navigation pane will need to be opened. The location of this pane is dependent on the browser used, but typically can be identified from a bookmark icon similar to that shown circled in red in Figure 1-1.

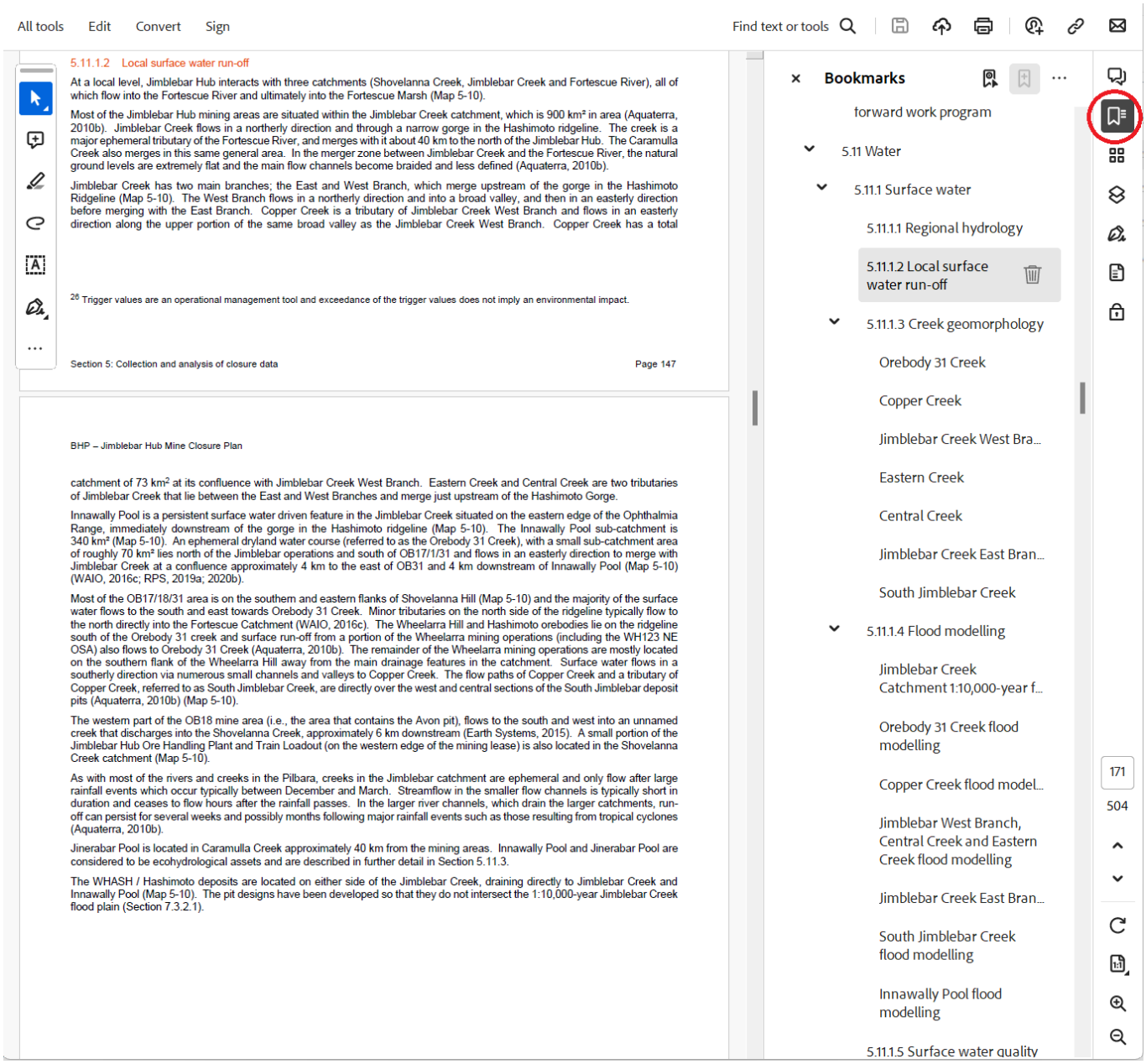


Figure 1-1 Snapshot showing pdf browser navigation pane with bookmarks

2 Project summary

2.1 Jimblebar Hub operations overview

This MCP covers existing and approved activities at the Jimblebar Hub as well as proposed developments for which approval is being requested via the Jimblebar Hub Iron Ore Mining Operations Significant Amendment Environmental Review Document (ERD) – Referral Supplementary Report (BHP, 2023a).

Existing / approved activities are:

- Mining above and below water table at:
  - Jimblebar - Wheelarra Hill (WH123, WH4), Wheelarra Hill / Hashimoto (WHASH), Hashimoto (H234), and South Jimblebar (Sylvania, Mindoona, Capricorn, Pain Killer).
  - OB17 - Swan (eastern end).
  - OB18 - Avon, Blackwood, De Grey, Swan (western end).
  - OB31.
- Placement of mined overburden in ex-pit Overburden Storage Areas (OSAs) or as backfill / In-pit Storage Areas (ISAs).
- Dewatering to enable access to the below water table deposits and discharge of surplus water via local pipelines to Ophthalmia Dam, the Caramulla Managed Aquifer Recharge (MAR) borefield and (seasonally / short term) to Copper Creek, Orebody 31 Creek, Jimblebar Creek and Caramulla Creek in accordance with the Jimblebar Water Management Plan (BHP, 2020b) and Eastern Pilbara Water Resource Management Plan (BHP, 2021g). Surplus water is also discharged to the OB18 MAR[7] which is operated in accordance with the EP Act Part V Licence L5415/1988/9.
- Use of OB17/18 and Jimblebar borefields for water supply.
- Ore processing and transport using overland conveyors, primary crushing facilities, ore handling plants, rail loops and train load-out facilities at OB17/18 and Jimblebar.
- Construction and maintenance of ancillary infrastructure including haul roads, light vehicle access roads, service corridors, fuel supply, water treatment and power generation facilities and various buildings to support all phases of the operation (i.e., exploration, mining, progressive rehabilitation and closure).

Proposed developments for which approval is being sought via the Jimblebar Hub Iron Ore Mining Operations Significant Amendment ERD are:

- Above and below water table mining at East Jimblebar deposits.
- New OSAs north of East Jimblebar.
- Beneficiation plant at Jimblebar to remove alumina and silica from the fines.
- In-pit storage of tailings generated by the Jimblebar beneficiation plant in the OB17/18 Swan and De Grey pits.

The ERD also seeks approval for several other in-pit TSF locations, however, no decision has yet been made as to which of pits will be selected for tailings storage and consequently, these facilities are considered possible future developments and are not described in detail in this MCP (refer to Section 2.1.1 for further details).

Further detail of existing and proposed mine features is provided in Section 2.2.

2.1.1 Possible future developments

BHP is considering in-pit storage of tailings in WH123, WHASH, South Jimblebar and / or OB31 as part of its long-term plans. The pits to be used have not yet been selected and consequently, closure designs have not been progressed. Initial deposition into the proposed De Grey and Swan in-pit TSFs will occur for 3 to 5 years (with subsequent deposition cycles following periods of consolidation), and an update to the MCP will be submitted prior to the commissioning of any new in-pit TSFs. Closure designs for additional in-pit TSFs will be provided in future iterations of this MCP along with the outcomes of studies conducted to support the designs. The forward work program for this MCP summarises the key studies that will be conducted to assess the closure approach for new in-pit TSFs.

[7] The OB18 MAR second zone is also referred to as the Ninga MAR.

2.2 Closure features and domains

The current mine footprint is shown on Map 2-1 and detailed in Table 2-1. To facilitate effective mine closure planning, the features outlined in Table 2-1 have been divided into several physically distinct domains. The domains are composed of features that have similar rehabilitation and closure requirements. The indicative future footprint of each domain is outlined in Table 2-1 and shown on Map 2-2. It should be noted that the indicative footprint is refined and confirmed during the design process for each future area to be disturbed. Mine designs continue to be refined as the time for mining a new area approaches. Designs undergo an internal review process before being finalised. This process seeks the input of different teams within BHP to determine whether there are any issues that need to be managed or designed out (e.g., intersection of significant drainage lines).

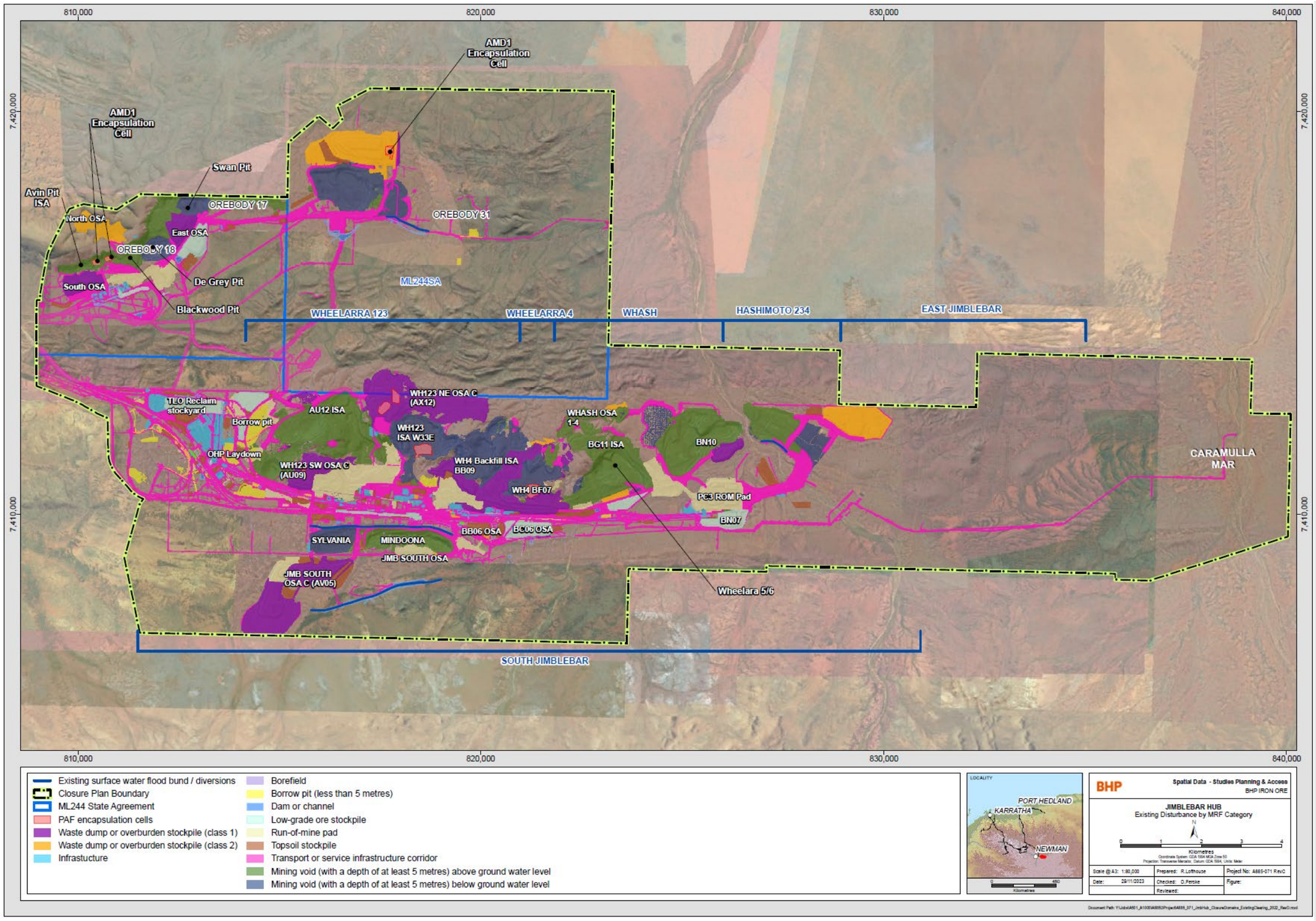
2.3 Estimated completion date

The estimated completion date for mining at Jimblebar Hub is 2053 based on the life of OB31. Mining at Jimblebar is expected to be complete in 2049. Mining at OB17 and OB18 is largely complete, but in-pit disposal of tailings from the Jimblebar beneficiation plant is proposed for the Swan and De Grey pits (until ~2051) as part of the Jimblebar Hub Iron Ore Mining Operations Significant Amendment ERD. In addition, the infrastructure at OB17/18 is used to support mining at OB31 so will remain in place until mining at OB31 ceases.

Table 2-1 Domains and features of the Jimblebar Hub operations

Domain		Mining Rehabilitation Fund (MRF) Description	MRF Category	Current footprint (ha)[1]	Indicative Future footprint[2] (ha)	Feature
OSAs / ISAs / stockpiles / Run of Mine (ROM) pad		Overburden Class 1	A	835	3,840	WH123 SW OSA C (AU09), WH123 NE (AX12), A005, JMB South, BE04, BB06, BC06 (BD06), BH04, BN07, BN10, WHASH, H234, East JMB, Painkiller, OB31, South, North, East, Blackwood OSAs
		Overburden Class 2	B	178		
		Topsoil	E	205		Topsoil stockpiles
		Low Grade Ore Class 1	B	95		Low-grade ore stockpiles
		Low Grade Ore Class 2	C	157		
		ROM pads	C	535		ROM Pads
		Mine Void (ISA)[3]	Within mine void footprint			WH123, BB09, BF07, WHASH, BG11, WH5/6, H1, H234, Avon, Blackwood, East and OB31
TOTAL				**2,005**	**3,840**	
Mine Voids		Above Water Table	C	1,288	3,878	Jimblebar (WH123, WH4, H234, East Jimblebar[5], WHASH, H234, South Jimblebar - Sylvania, Mindoona, Capricorn[5], Pain Killer[5]), OB17 (Swan - eastern end), OB18 (Avon, Blackwood, De Grey, Swan -western end) OB31
		Below Water Table	B	547		
		In-pit TSF Class 2	B	-	74 (included in mine void footprint)	Swan, De Grey pits
TOTAL				**1,835**	**3,878**	
Infrastructure	Process & supporting infrastructure	Workshop	B	23	1,811	Light and heavy vehicle workshops;
		Building other than workshop or camp	C	10		Administration offices
		Plant site	B	66		Train load-out; ore crushing and processing facilities
		Fuel storage facility	B	1		Fuel storage, refuelling stations, washdown facilities
		Freshwater dam	B	8		Freshwater dams
		Sewage pond	C	3		Wastewater treatment plant
		Evaporation pond	A	4		Evaporation pond
		Landfill site	B	1		Landfill
		Laydown / hard stand	C	57		Laydown areas
		Land (other than land under rehabilitation or rehabilitated land) that is cleared of vegetation and is not otherwise described in this Table	D	183		Other disturbance.
	Transport or infrastructure corridor		C	1,042		Main access road; haul roads; access tracks; railway, powerlines and corridors.
	Borefield		C	18		OB18, Shovelanna, Jimblebar, Caramulla and OB18 / Ninga MAR borefields
	Borrow pit		C	107		Borrow pits
	Surface water management	Diversion channel or drain	B	47		OB31, South Jimblebar flood bund, South Jimblebar Creek Diversion, SJG2 / SJH2 diversion, H1A1 flood bund, H2B1 flood bund
TOTAL				**1,570**	**1,811**	
Rehabilitated land[5]				361[4]		**Current**: OB18 North OSA, OB18 South OSA, Jimblebar South OSA, PC1 ROM, various borrow pit, stockpile and infrastructure areas **Future**: All where revegetation is planned

Notes:
1. Rounded to the nearest ha and based on disturbance data reported in the 2022 Annual Environmental Report (AER).
2. Future footprint based on current mine plan including areas for which approval is being sought via the Jimblebar Hub Iron Ore Mining Operations Significant Amendment ERD.
3. Shown as OSAs within or overlapping existing mine voids on Map 2-2.
4. This value has not been deducted from current footprint areas reported.
5. Future pit.



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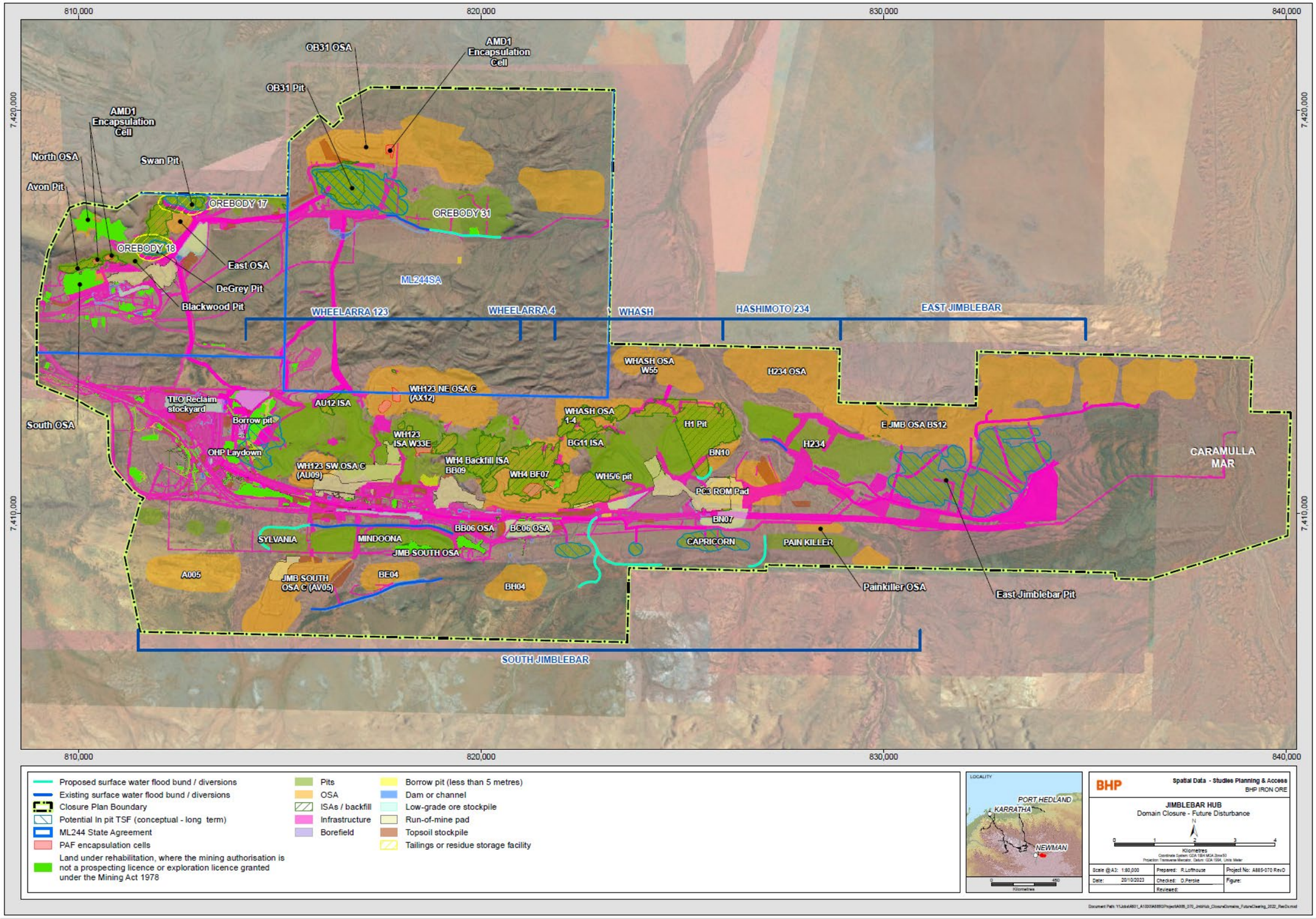
Map 2-1 Jimblebar Hub current mine footprint



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Map 2-2 Jimblebar Hub indicative future footprint - closure domains

2.4 Tenure and ownership

Jimblebar Hub is managed and operated by BHP on behalf of BHP Iron Ore (Jimblebar) Pty Ltd and the Mount Newman Joint Venture partners including:

- BHP Minerals Pty Ltd (85%).
- Mitsui-Itochu Iron Pty Ltd (10%).
- ITOCHU Minerals & Energy of Australia Pty Ltd (5%).

The tenure of Jimblebar Hub and the ownership of each tenement is shown on Map 2-3 and detailed in Table 2-2 together with the legislation under which tenure has been granted. As part of the Significant Amendment to the Jimblebar Hub Iron Ore Mining Operations, an application will be made to convert the areas of exploration licence E52/1776-I, shown within the closure planning boundary on Map 2-3, into ML 266SA.

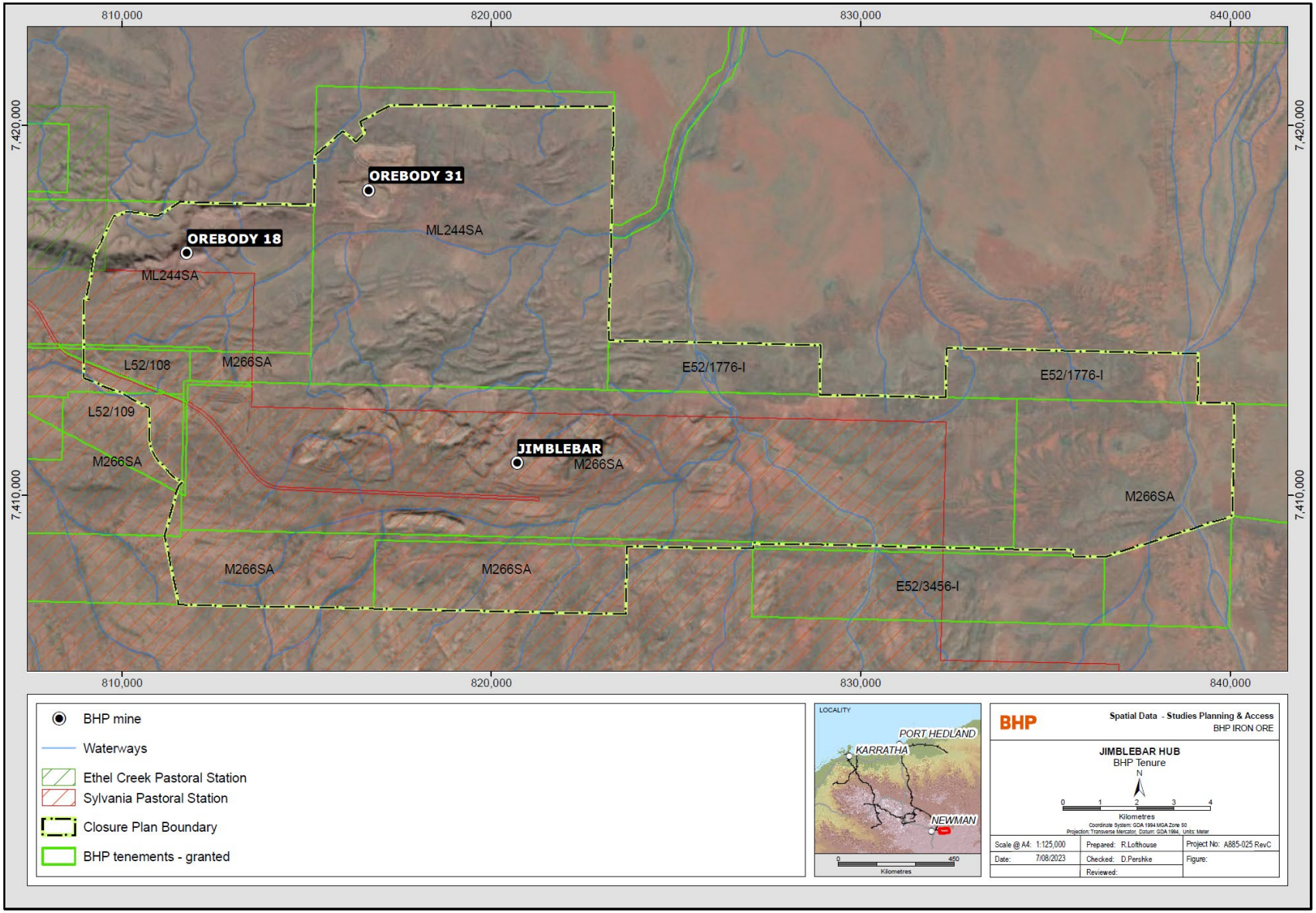
Table 2-2 Tenements underlying Jimblebar Hub

Lease	Description	Legislation	Ownership
M266SA	Mining Lease 266SA	*Iron Ore (McCamey's Monster) Agreement Authorisation Act 1972 (WA)* *Mining Act 1978 (WA)*	BHP Iron Ore (Jimblebar) Pty Ltd (100%)
ML244SA	Mineral Lease 244SA	*Iron Ore (Mount Newman) Agreement Act 1964 (WA)* *Mining Act 1978 (WA)*	BHP Minerals Pty Ltd (85%) Mitsui-Itochu Iron Pty Ltd (10%) ITOCHU Minerals and Energy of Australia Pty Ltd (5%)
L52/108	Miscellaneous Licence 52/108	*Iron Ore (Mount Newman) Agreement Act 1964 (WA)* *Mining Act 1978 (WA)*	BHP Minerals Pty Ltd (85%) Mitsui-Itochu Iron Pty Ltd (10%) ITOCHU Minerals and Energy of Australia Pty Ltd (5%)
L52/109	Miscellaneous Licence 52/109	*Iron Ore (Mount Newman) Agreement Act 1964 (WA)* *Mining Act 1978 (WA)*	BHP Minerals Pty Ltd (85%) Mitsui-Itochu Iron Pty Ltd (10%) ITOCHU Minerals and Energy of Australia Pty Ltd (5%)

The Jimblebar Hub is located on the land of the Nyiyaparli people (Native Title Determination [WCD2018/008] see Section 3.4.6 for further details), with their connection to the land stretching back over 40,000 years.

The underlying tenure for OB17, OB31, a major part of OB18, and the northern and eastern portions of Jimblebar is Unallocated Crown Land (UCL). A very small portion of OB18 pit falls within Ethel Creek Pastoral Lease N049924 registered in the names of BHP Minerals Pty Ltd (50%) and Pilbara Pastoral Company Pty Limited (50%). The southern portion of the OB18 mine and most of Jimblebar is located on Sylvania Pastoral Lease N049932 registered in the name of BHP Direct Reduced Iron Pty Ltd (100%) (Map 2-3).

The contact details for BHP Iron Ore Pty Ltd are City Square, 125 St Georges Terrace, PERTH WA 6000 (Phone: 6321 6000).



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Map 2-3 Jimblebar Hub tenure overview

3 Closure obligations and commitments

The management measures contained within this MCP have been developed with reference to the obligations summarised below.

3.1 Approval history

Mining was first approved at Jimblebar (Wheelarra 4 deposit) via a State Agreement Proposal submitted in 1987 in accordance with the *Iron Ore (McCamey's Monster) Agreement Authorisation Act 1972* (WA) (McCamey's State Agreement Act) (Section 3.4.1). Several further proposals were submitted in 1988, 1990, 1991, 1992, 1994 and 1999 to expand operations at Wheelarra 4 and commence mining at W3 to W6 scree deposits. In 2005, an Environmental Protection Statement (EPS) was submitted under the EP Act (Section 3.2) for mining Wheelarra Hill W1 to W6 deposits. This was followed by further submissions under the EP Act in 2009, 2010, 2015 and 2019 to expand infrastructure, commence / expand mining at South Jimblebar and Hashimoto deposits and expand the development envelope to accommodate OSAs at Wheelarra Hill. Corresponding proposals were also submitted in accordance with the McCamey's State Agreement Act. Approval for train load-out, rail and associated infrastructure was granted via Mining Proposals submitted in accordance with the *Mining Act 1978* (Section 3.4.2) in 2009 and 2010.

Mining was first approved at OB18 via a Consultative Environmental Review submitted in accordance with the EP Act in July 1996. Further submissions under the EP Act were made in 2007, 2013, 2014 and 2015 to amend OB18 operations and add mining at OB17 and OB31 (Section 3.2). Corresponding proposals were submitted in accordance with the *Iron Ore (Mount Newman) Agreement Act* 1964 (WA) (Newman State Agreement Act) (Section 3.4.1).

3.2 Part IV Environmental Protection Act 1986 Approvals

Part IV of the EP Act establishes provisions for the EPA to carry out formal environmental impact assessments of proposals which may have a significant impact on the environment and the setting of statutory conditions by the Minister for the Environment.

A summary of the history of Part IV approvals at Jimblebar Hub is as follows:

- The 1996 Consultative Environmental Review to develop mining operations at OB18 was approved by the EPA in February 1997 via Ministerial Statement (MS) 439.
- Subsequently, three modifications to the proposal (BHPBIO, 2007; 2013; 2014b) were assessed and approved under Section 45C of the EP Act. Approval for these modifications was granted in 2008, 2013 (OB17 was added) and 2015.
- The OB31 mine was referred to the EPA on 11 March 2015 (BHPBIO, 2015) and was subjected to an Assessment on Proponent Information – Category A (Assessment Number 2047). MS 1021 approving the operation was issued on 12 November 2015.
- The Wheelarra Hill Extension Project EPS (BHPBIO, 2005), the Wheelarra Hill Mine Modification proposal (BHPBIO, 2009), and the Jimblebar Iron Ore Project EPS (BHPBIO, 2010) were approved by the EPA via MS 683, MS 809 and MS 857.
- In 2016, the EPA amended MS 857 via MS 1029 under Section 46 of the EP Act.
- In 2019, the *Jimblebar Optimisation Proposal* (BHP, 2019a) was submitted to the EPA and MS 1126 was issued on 17 March 2020. MS 1126 supersedes MS 683, MS 809 and MS 857 (as amended by MS 1029).

The Jimblebar Hub Iron Ore Mining Operations Significant Amendment ERD seeks to combine the OB17/18/31 and Jimblebar mining operations under one Ministerial Statement with the development envelope shown on Map 3-1.

Closure relevant statements made in the submissions to the EPA are recorded in Appendix A.

3.2.1 Ministerial statements

Closure conditions and commitments for Jimblebar Hub from MS 439, MS 1021 and MS 1126 are shown in Table 3-1 and the areas covered by each Ministerial Statement in Map 3-1.

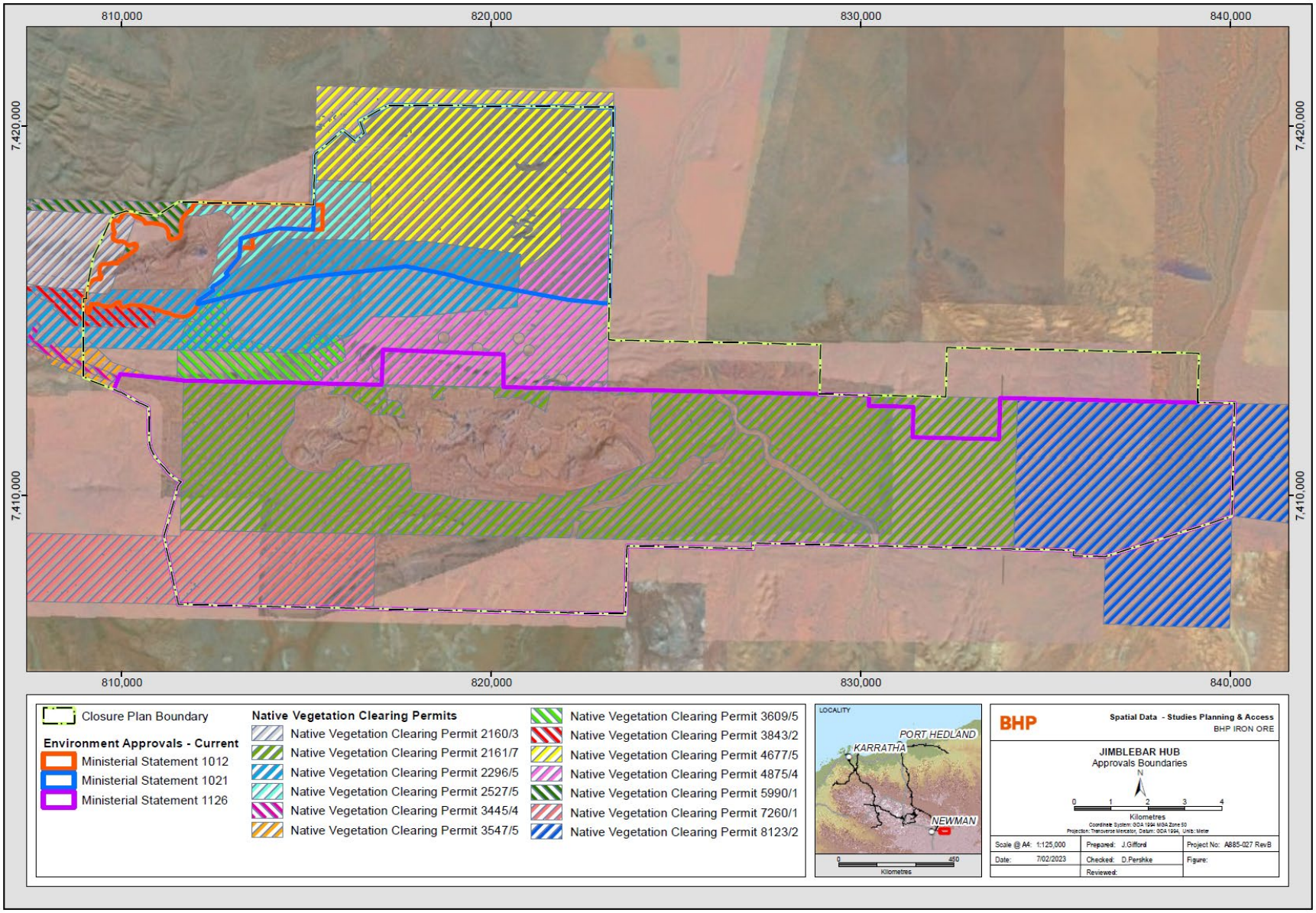
Of note is the conflicting requirements between MS 1021 and MS 1126 for the frequency of the update of the MCP. Given the long life of the Jimblebar Operations, and the five-year frequency specified in MS 1126, BHP will seek CEO approval for a five yearly update of the combined Jimblebar Hub MCP.

Table 3-1 Ministerial Statement conditions related to closure and rehabilitation at Jimblebar Hub

Condition Number	Closure Condition
MS 439 (OB17/18)	
5-1	The proponent shall achieve the satisfactory decommissioning of the project, removal of plant and installations and rehabilitation of the site and its environs.
5-2	To achieve the objective of condition 5-1, within five years following commissioning, or at such later time considered appropriate by the Minister for the Environment on advice of the Department of Environmental Protection [now DWER], the proponent shall prepare a plan which: • describes the process for the decommissioning and rehabilitation of the project area; • provides for the long-term management of water quality; and • provides for the development of a 'walk away' solution[8] for the decommissioned mine pits, overburden storage areas, the ore processing facilities and associated infrastructure including the rail spur, to the requirements of the Environmental Protection Authority on advice of the Department of Environmental Protection [now DWER], the Department of Resources Development [now Department of Jobs Tourism Science and Innovation - DJTSI], the Department of Minerals and Energy [now Department of Energy Mines Industry Regulation and Safety; DEMIRS] and the Water and Rivers Commission [now DWER].
5-3	The proponent shall implement the plan required by condition 5-2.
MS 1021 (OB31)	
9-1	The proponent shall ensure that the proposal is decommissioned and rehabilitated in an ecologically sustainable manner, through implementation of the Mine Closure Plan required by condition 9-2.
9-2	The proponent shall implement the Mine Closure Plan (Revision No. 0, dated 12 August 2015).
9-3	The proponent shall review and revise the Mine Closure Plan required by condition 9-2, on the advice of DMP [now DEMIRS] and to satisfaction of the CEO in accordance with the Guidelines for Preparing Mine Closure Plans, and any updates, at intervals not exceeding three years, or as otherwise specified by the CEO.
9-4	The proponent shall implement the latest revision of the Mine Closure Plan, which the CEO has confirmed by notice in writing, satisfies the requirements of condition 9-3.
MS 1126 (Jimblebar)	
5-1	The proponent shall manage the implementation of the Revised Proposal to meet the following environmental objective: (1) protect flora and vegetation so that biological diversity and ecological integrity are maintained, and in particular: (a) avoid and minimise direct and indirect impacts on flora taxa listed as priority flora.
5-2	In order to meet the objective specified in condition 5-1, the proponent shall implement the Jimblebar Flora and Vegetation Management Plan (Revision 0, November 2019).
6-1	The proponent shall manage the implementation of the proposal to meet the following environmental outcome: (1) protect subterranean fauna so that biological diversity and ecological integrity are maintained, and in particular: (a) avoid and minimise direct and indirect impacts on the Ethel Gorge aquifer stygobiont community Threatened Ecological Community.
6-2	In order to meet the outcome specified in condition 6-1, the proponent shall implement the Subterranean Fauna provisions of the Eastern Pilbara Water Resource Management Plan (Version 6, April 2018) (the Subterranean Fauna Environmental Management Plan).

[8] As advised by the Department of Environment (DoE) Environmental Services Group on December 2012 in response to Wheelarra Iron Ore Decommissioning and Final Rehabilitation Plan, the term "walk-away solution" is no longer consistent with the DMIRS Guidelines. This document does not make further reference to this term.

Condition Number	Closure Condition
7-1	The proponent shall manage the implementation of the proposal to meet the following environmental outcomes: (1) maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected, including where relevant avoiding and minimising direct and indirect impacts of the proposal, on: (a) wetland types which may be poorly represented; (b) ecosystems which support conservation significant flora / vegetation and fauna species or communities, including migratory waterbirds, bats, groundwater dependent biota and subterranean fauna; and (c) ecosystems which support significant amenity, recreation and cultural values.
7-2	In order to meet the outcomes specified in condition 7-1, the proponent shall implement the Jimblebar Water Management Plan (Revision 0, November 2019).
8-1	The proponent shall manage the implementation of the proposal to meet the following environmental objective: (1) ensure that the proposal is decommissioned, and the site of the proposal rehabilitated to be safe, stable and non-polluting and in an ecologically appropriate and sustainable manner.
8-2	Within twelve (12) months of the issue of this Statement the proponent shall prepare and submit a Mine Closure Plan in accordance with the Guidelines for Preparing Mine Closure Plans, May 2015, (or any subsequent revisions of the guidelines), to the requirements of the CEO, on advice of the Department of Mines, Industry Regulation and Safety, and the Department of Water and Environmental Regulation.
8-3	The proponent shall review and revise the Mine Closure Plan required by condition 8-2 at intervals not exceeding five (5) years, or as otherwise specified by the CEO, and submit the plan to the CEO at the agreed interval.
8-4	The proponent shall implement the latest revision of the Mine Closure Plan, which the CEO has confirmed by notice in writing, satisfies the requirements of condition 8-2.
8-5	The proponent shall implement the Jimblebar Mine Closure Plan (Version 2, August 2019) until the CEO has confirmed by notice in writing the Mine Closure Plan required by condition 8-2 satisfies the requirements of the CEO on advice of the Department of Mines, Industry Regulation and Safety.



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Map 3-1 Jimblebar Hub approval boundaries

3.2.2 Environmental management plans

Several environmental management plans have been prepared to meet the requirements of Ministerial Statement conditions. These are revised from time to time. Areas of potential relevance to closure in the approved plans at the time of writing (BHPBIO, 2014a; BHP, 2018c; 2020a; 2021g; 2023g) are outlined in Table 3-2. Several revised management plans have been submitted with the Significant Amendment ERD. Reference to relevant aspects of these plans will be incorporated into future iterations of the MCP once the plans have been approved.

Table 3-2 Management plan commitments with relevance to closure and rehabilitation

Section / Schedule	Proposed Management Actions
Orebody 17/18 Mining Operations - Environmental Management Plan Required by Condition 4 of MS 439	
Section 3 (Table 3.2)	Sets objectives and management measures for weeds and invasive fauna.
OB31 Biodiversity Management Plan Required by Condition 6 of MS 1021	
Schedule 1	Requires that direct impacts to *Acacia* sp. *East Fortescue* [now known as *Acacia corusca*] and associated buffer area are avoided and includes provisions for the following in the event that trigger / threshold criteria are exceeded: • Rehabilitate northern side of OSA adjacent to 'impact populations' as soon as practicable. • Accelerate progressive rehabilitation of northern side of OSA adjacent to 'impact populations'.
Jimblebar Flora and Vegetation Management Plan Required by Condition 5 of MS 1126	
Section 2 (Table 3)	Sets objectives and management measures for weeds and riparian vegetation.
Jimblebar Water Management Plan Required by Condition 7 of MS 1126	
Section 2 (Table 3)	• Limits the extent of surface water discharge in Jimblebar Creek (to avoid Innawally Pool) • Limits the extent of surface water discharge in Caramulla Creek • Limits groundwater level rise (mounding) from groundwater injection in the Caramulla regional aquifer
Eastern Pilbara Water Resources Management Plan Required by Condition 6 of MS1126	
Section 2 (Table 11)	Sets trigger (action) and threshold (mitigate) criteria for: • The Ethel Gorge Threatened Ecological Community (TEC) Primary Habitat Monitoring Zone. • The OB31 surplus water discharge to Jimblebar Creek.
Social and Cultural Heritage Management Plan (SCHMP)	
Section 2 (Table 5)	Commits to: • Ongoing engagement throughout the life of the Jimblebar Hub Proposal in relation to Nyiyaparli social, cultural and heritage values and interests. • Providing: - The opportunity for Nyiyaparli representatives to participate in environmental surveys, rehabilitation trials and training opportunities. - Annual updates on rehabilitation and closure at Implementation Committee meetings.

3.3 Environmental Protection Act (Part V)

3.3.1 Operating Licence

Licence L5415/1988/9 issued for the Jimblebar Hub under Part V of the Environmental Protection Act governs the operations at Jimblebar, OB18 and the discharge of surplus water from the OB18, OB31 (Shovelanna) and Jimblebar operations via MAR, and discharges into Ophthalmia Dam, Copper Creek, Orebody 31 Creek, Jimblebar Creek and Caramulla Creek. Most of the conditions of this licence relate to operational matters, but the conditions outlined in Table 3-3 may have relevance to closure and closure execution.

Table 3-3 Environmental licence conditions with relevance to closure execution

Condition No	Aspect	Licence Condition
1.2.4	Closure of landfills	The Licensee shall manage the landfilling activities to ensure: • waste is placed and compacted to ensure all faces are stable and capable of retaining restoration material; and • restoration of a cell or phase takes place within 6 months after disposal in that cell or phase has been completed.
1.2.5		Inert Waste Type 2 (tyres and conveyor belts only) shall be covered with 500 mm soil as soon as practical following the achievement of final waste levels in the area(s) in which tyres are deposited.

Condition No	Aspect	Licence Condition
2.4.2	Decommissioning	No specific condition for closure, but a limit of 15 mg/L for total recoverable hydrocarbons is placed on emissions to land. This may have some relevance during decommissioning activities.
3.2	Monitoring	Monitoring of ambient surface water and groundwater quality will be conducted in accordance with the licence (see Sections 10.1.7 and 10.1.8 for further details).

3.3.2 Native vegetation clearing permits

The obligations relating to closure or rehabilitation identified in Native Vegetation Clearing Permits (NVCPs) are shown in Table 3-4. Map 3-1 shows the areas to which each permit applies.

Table 3-4 Closure and rehabilitation commitments in NVCPs

NVCP & Condition No.	Relevant Closure Condition
Weeds	
2160/3 Condition 7 2161/7 Condition 8 2527/5 Condition 7 2269/5 Condition 6 3445/4 Condition 8 3547/5 Condition 8 3609/5 Condition 8 3843/2 Condition 6 4677/5 Condition 6 5990/1 Condition 8 4875/4 Condition 7 7260/2 Condition 6 8123/2 Condition 8	When undertaking any clearing or other activity authorised under this Permit, the Permit Holder must take the following steps to minimise the risk of the introduction and spread of weeds: (i) clean earth-moving machinery of soil and vegetation prior to entering and leaving the area to be cleared; (ii) ensure that no weed-affected soil, mulch, fill or other material is brought into the area to be cleared; and (iii) restrict the movement of machines and other vehicles to the limits of the areas to be cleared.
3445/4 Condition 8	At least once in each 12-month period for the term of the permit, remove or kill any weeds growing within areas cleared under the permit.
Retain and spread vegetative material and topsoil	
2160/3 Condition 8 2527/5 Condition 7 2269/5 Condition 7 3445/4 Condition 9 3547/5 Condition 10 3609/5 Condition 9 3843/2 Condition 7 4677/5 Condition 7 5990/1 Condition 11 2161/7 Condition 10 4875/4 Condition 10 7620/1 Condition 8 8123/2 Condition 12	The Permit Holder shall: (a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared [or area cross-hatched yellow on the plans attached to NVCP 2161/7 and NVCP 3843/2].
2160/3 Condition 8 2527/5 Condition 7 2269/5 Condition 7 3445/4 Condition 10 3547/5 Condition 10 3609/5 Condition 9 3843/2 Condition 7 4677/5 Condition 7 5990/1 Condition 11 7620/1 Condition 8 2161/7 Condition 10 4875/4 Condition 10 8123/2 Condition 12	within 12 months following clearing, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared by: (i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land (not applicable to NVCPs 3445/4, 3846/2 or 8123/1); and (ii) ripping the ground on the contour to remove soil compaction (not applicable to NVCP 7260/1); and (iii) laying the vegetative material and topsoil retained under Condition 8 [or 7 or 9 or 10 or 11] (a) on the cleared area.
3445/4 Condition 9	within 12 months following clearing, revegetate and rehabilitate the areas no longer required for the purpose for which they were cleared, the permit holder must revegetate and rehabilitate the area cross-hatched yellow on the attached plan by: (i) laying the vegetative material and topsoil retained under condition 9(a) on the cleared areas; and (ii) ensuring only local provenance seeds and propagating material are used to revegetated and rehabilitate the area

NVCP & Condition No.	Relevant Closure Condition
2160/3 Condition 8 2527/5 Condition 7 2269/5 Condition 7 3445/4 Condition 9 3547/5 Condition 10 3843/2 Condition 7 4677/5 Condition 7 7620/1 Condition 8 2161/7 Condition 10 4875/4 Condition 10 8123/2 Condition 12	within 4 years (24 months for NVCP 3445/4) of laying the vegetative material and topsoil on the cleared area in accordance with Condition 8 [or 7] (b) of this Permit: (i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition structure and density determined under Condition 8 [or 7, 9, 10, 11, 12] (c) (i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and / or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to pre-clearing vegetation types in that area and ensuring only local provenance seeds and propagating material are used.
Surface water	
3547/5 Condition 9 5990/1 Condition 9 7620/1 Condition 7 8123/2 Condition 11	(b) where a watercourse or drainage line is to be impacted by clearing, the Permit Holder shall ensure that surface flow is maintained, or is reinstated downstream into existing natural drainage lines [not applicable to NVCP 8123/2].
Record keeping	
2160/3 Condition 10 2527/5 Condition 9 2269/5 Condition 8 3445/4 Condition 10 3547/5 Condition 11 3609/5 Condition 10 3843/2 Condition 8 4677/5 Condition 8 5990/1 Condition 12 7620/1 Condition 9 2161/7 Condition 12 4875/4 Condition 11 8123/2 Condition 13	The Permit Holder must maintain the following records for activities done pursuant to this Permit: In relation to the revegetation and rehabilitation of areas pursuant to Condition 10 [or 7 or 8 or 9] of this Permit [see Table 1, No 2 in NVCP 2269/5 and Table 1 No 3 in NVCP 4875/4]: (i) the location of any areas revegetated and rehabilitated, recorded using a Global Positioning System (GPS) unit set to Geocentric Datum Australia 1994 (GDA94), expressing the geographical coordinates in Eastings and Northings or decimal degrees; (ii) a description of the revegetation and rehabilitation activities undertaken; and (iii) the size of the area revegetated and rehabilitated (in hectares).
3445/4 Condition 10	(iv) the species composition, structure and density of revegetation and rehabilitation
Reporting	
2160/3 Condition 11 2527/5 Condition 10 2269/5 Condition 9 3445/4 Condition 11 3547/5 Condition 12 3609/5 Condition 11 4677/5 Condition 9 5990/1 Condition 13 7620/1 Condition 10 2161/7 Condition 12 4875/4 Condition 12 8123/2 Condition 14	Prior to 30 November 2028 [or 2027, 2025, 2030, 2032, 2033, 2034 or 2035] [or 31 July 2025] [or 19 April 2029], the Permit Holder must provide to the General Manager Environmental Compliance, Resource and Environmental Compliance Division, Department of Mines, Industry Regulation and Safety a written report of records required under Condition 11 [or 8 or 9 or 10 or 11 or 12] of this Permit where these records have not already been provided under Condition 12 [or 9 or 10 or 11 or 12 or 13 or 14] (a) of this Permit.

3.4 Other regulatory mechanisms

3.4.1 State Agreement Act

The OB17/18/31 operations take place on ML244SA which is held pursuant to the *Iron Ore (Mount Newman) Agreement Act* 1964 (WA) (Newman State Agreement Act), and Jimblebar operations take place on M266SA which is held pursuant to the *Iron Ore (McCamey's Monster) Agreement Authorisation Act 1972* (WA) (McCamey's State Agreement Act). Works on these tenements are implemented pursuant to approved proposals under the relevant State Agreement Acts. As outlined in Section 3.1, several proposals have been submitted for the Jimblebar Hub operations. Closure-related statements made in the approved proposals are summarised in Appendix A. Section 3.4.4 summarises the conditions of tenure held under the State Agreement Acts.

Section 9A(3)(k) of the Newman State Agreement requires additional areas to be mined to have an environmental program for rehabilitation, protection and management of the environment.

Under Clause 9A of both State Agreement Acts, a continuous program of investigation and research is required to be carried out to ascertain the effectiveness of the measures being taken to rehabilitate, protect and manage the environment. Regular reports on the effectiveness of this research are required to be reported to the Minister.

Environmental compliance (including closure and rehabilitation) is governed by the applicable environmental legislation.

Both the State Agreements contain provisions for infrastructure and equipment, including the rail line, to become the property of the State. BHP is required to notify the State prior to removing infrastructure, and the give the option for the State to purchase certain infrastructure subject to valuation.

3.4.2 Mining Act 1978

Two Mining Proposals have been submitted to the Department of Energy Mines Industry Regulation and Safety (DEMIRS) under the *Mining Act 1978* to gain approval for infrastructure developments on miscellaneous licences 52/108 (L52/108) and 52/109 (L52/109). Closure-related statements made in these documents are summarised in Appendix A.

3.4.3 Rail Safety National Law WA (2015) Act

The *Rail Safety National Law WA (2015) Act* and associated *Rail Safety National Law (WA) Regulations (2015)* govern the safe operation and decommissioning of railway infrastructure and rolling stock. Under the act and associated regulations, there must be a documented set of operational procedures and engineering and safety standards and procedures, for *inter alia*, decommissioning or disposal of rail infrastructure and rolling stock.

3.4.4 Tenement Conditions

There are no conditions associated with ML244SA which relate to closure. Table 3-5 outlines the conditions of M266SA which are relevant to closure along with the closure-relevant conditions of L52/108 and L52/109 which are held pursuant to the Newman State Agreement Act and *Mining Act 1978* for the rail line and associated infrastructure.

Table 3-5 Tenement conditions with relevance to closure

Tenement No	Condition Number	Closure Condition
M266SA	4	The lessee shall, on completion of the project, rehabilitate the rail spur and before completion of the project, the lessee shall provide, to the satisfaction of the Environmental Protection Authority, a programme for that rehabilitation.
	5	The lessee shall remove, stockpile and use topsoil from the process site in the rehabilitation of the lease area to the satisfaction of the State Mining Engineer.
	8	The rights of ingress to and egress from Miscellaneous Licence 52/108 being at all times preserved to the licensee and no interference with the purpose of installations connected to the licence.
	10	No interference with the transmission line or the installations in connection therewith, and the rights of ingress to and egress from the facility being at all times preserved to the owners thereof.
L52/108 and L52/109	3	All topsoil that may be removed ahead of pipelaying operations to be stockpiled for replacement in accordance with the directions of the Environmental Officer, Department of Industry and Resources [now DEMIRS].
L52/108 and L52/109	6	On the completion of the life of mining operations in connection with this licence the holder shall: • remove all installations constructed pursuant to this licence; and • on such areas cleared of natural growth by the holder or any of its agents, the holder shall plant trees and / or shrubs and / or any other plant as shall conform to the general pattern and type of growth in the area and as directed by the Environmental Officer, Department of Industry and Resources [now DEMIRS] and properly maintain same until the Environmental Officer advises regrowth is self-supporting; unless the Minister responsible for the *Mining Act 1978* orders or consents otherwise.
L52/108 and L52/109	12	On the completion of the life of mining operations in relation to this licence the holder shall: • remove all installations constructed pursuant to this licence; • cover over all wells and holes in the ground to such degree of safety as shall be determined by the Environmental Officer, Department of Industry and Resources [now DEMIRS]; and • on such areas cleared of natural growth by the holder or any of its agents, the holder shall plant trees and / or shrubs and / or any other plant as shall conform to the general pattern and type of growth in the area and as directed by the Environmental Officer, Department of Industry and Resources and properly maintain same until the Environmental Officer advises regrowth is self-supporting; unless the Minister responsible for the *Mining Act 1978* orders or consents otherwise.
L52/108 and L52/109	28 or 29	All topsoil being removed ahead of all mining operations from sites such as pit areas, waste disposal areas, ore stockpile areas, pipeline, haul roads and new access roads and being stockpiled for later respreading or immediately respread as rehabilitation progresses.
L52/108 and L52/109	29 or 30	At the completion of operations, all buildings and structures being removed from site or demolished and buried to the satisfaction of the Director, Environment Division, DMP [now DEMIRS].

3.4.5 Contaminated Sites Act

The Contaminated Sites Act 2003 (CS Act), regulates the reporting, management and remediation of contaminated sites. Under the Act remediation of contaminated sites is the responsibility of the polluter or current site owner. Reporting and management of contaminated sites occurs throughout operations, and BHP has reported known and suspected contaminated sites at Jimblebar Hub to DWER in general accordance with the Act (Section 5.12). BHP also provides regular updates to DWER as sites are investigated and remediated (Section 4.2). Section 5.12, Table 5-69, summarises the current status of Jimblebar Hub contamination targets and Section 9.1.5 provides further details of BHP's processes for management of contaminated sites.

3.4.6 Native title and Aboriginal Heritage Act[9]

Jimblebar Hub falls within the boundary of the Nyiyaparli people [WCD2018/008] Native Title Determination Area [WCD2018/008]. BHP has entered into a comprehensive agreement with the Nyiyaparli people which contractually obliges BHP to consult with the Nyiyaparli Traditional Owners in relation to the operation of Jimblebar Hub and, therefore, its eventual closure.

Agreements with the Nyiyaparli people include the following commitments:

- Traditional Owners will be engaged to inform the rehabilitation programme based on their holistic understanding of 'healthy country'.
- The integrity of, and access to, places of cultural significance will be maintained in the closure design.
- Salvaged artefacts will be returned to Country post-closure as per the wishes of the Nyiyaparli people.

Where there is the potential for closure works to impact on sites of cultural significance, the provisions of the current Aboriginal Heritage legislation will also apply.

Consultation with the Nyiyaparli people on closure and post-closure land use is undertaken through the ongoing stakeholder engagement process (Section 4)

3.4.7 Rights in Water and Irrigation Act

Groundwater abstraction for mining operations is permitted by Groundwater Licence (GWL)156786(10) for OB18, GWL181025(4) for OB31 and GWL 158795(11) for Jimblebar.

There are no specific conditions relevant to closure within the licences, but the licences specify that operations must comply with the Groundwater Licence Operating Strategies for OB18/31 (Shovelanna) Number 0119324, Version 3.0 (BHP, 2018b) and Jimblebar Number 0019543 (BHP, 2018a). The groundwater operating strategies and results from the operating phase inform the closure groundwater monitoring program (Section 10.1.8), updates to conceptual and numerical models, and completion criteria.

Below water table mining at Jimblebar Hub generates a surplus of water from dewatering operations after usage. This surplus is reinjected through MAR schemes which are regulated under the EP Act Part V Environmental Licence L5415/1988/9 and the Jimblebar Water Management Plan (Sections 3.2.2 and 3.3.1). Licence L5415/1988/9, Jimblebar Water Management Plan and Eastern Pilbara Water Resource Management Plan also variously regulate surplus water discharge to Ophthalmia Dam and Copper, Orebody 31, Jimblebar and Caramulla creeks.

3.5 Closure guidelines and industry standards

BHP governs closure planning, on a corporate level, by Our Requirements: Corporate Alignment Planning (BHP, 2022c) and Our Requirements: Closure (BHP, 2023h). The purpose of these documents is to incorporate closure planning in the Business Planning Processes throughout the life cycle of a project.

This MCP has been prepared to satisfy the relevant components of BHP's Corporate Alignment Planning and Closure planning processes and has been finalised for external review in line the DMIRS Statutory Guidelines (2020a). In addition, this MCP incorporates relevant aspects from other closure guidelines and industry standards including:

- *Mine Closure Plan Guidance – How to prepare in accordance with Part 1 of the Statutory Guidelines for Mine Closure Plans* (DMIRS, 2020b);
- *Integrated Mine Closure Good Practice Guide* (ICMM, 2019);
- *Strategic Framework for Mine Closure* (ANZMEC & MCA, 2000);
- *Mine Closure and Completion* (DISR, 2016a);
- *Preventing Acid and Metalliferous Drainage* (DISR, 2016c);
- *Mine Rehabilitation* (DISR, 2016b);
- *Evaluating Performance Monitoring and Auditing* (DISR, 2016d);
- *Technical Guidance - A framework for developing mine-site completion criteria in Western Australia* (Young, et al., 2019); and
- *Global Industry Standard on Tailings Management* (ICMM, 2020).

[9] At the time of writing the Aboriginal Cultural Heritage Act 2021 was being repealed and an amended Aboriginal Heritage Act 1972 being reinstated.

4 Stakeholder consultation

4.1 Objectives

BHP recognises the importance of engaging with relevant stakeholders. The ability to build relationships and work collaboratively and transparently with our host communities is critical to the Company's long-term success. BHP has established a comprehensive consultation program to support ongoing, effective dialogue with stakeholders potentially impacted by, or interested in, the implications of the Company's operations. This approach is consistent with BHP's Purpose, which is to bring people and resources together to build a better world, and the company's Values which include a commitment to supporting communities.

> *"We believe we are successful when we work in partnership with communities to achieve long-term social, environmental and economic outcomes. We seek to create and contribute to social value in the communities in which we operate. We seek meaningful long-term relationships that respect local cultures. We aim to support the development of diversified and resilient local economies, contributing to quality-of-life improvements that continue beyond the life of our operated assets."* (BHP, 2020e).

BHP has an ongoing consultation program relating to its Jimblebar Hub operations with government agencies (both state and local), Traditional Owners and landowners based on interest and proximity to the project location. The objectives of the program are to:

- Provide information and the opportunity to comment to government agencies and other stakeholders who may potentially be interested in activities (including closure and rehabilitation) at the Jimblebar Hub operations;
- Identify the key issues and concerns of government agencies and other stakeholders regarding the design and management of activities (including closure and rehabilitation) at the Jimblebar Hub operations;
- Discuss objectives for the development of the Jimblebar Hub operations and their ultimate rehabilitation and closure;
- Periodically provide updated information and results of the development and closure planning process to government agencies and other stakeholders as more information comes to hand; and
- Allow for adjustments to the design and / or management of any proposed activities to accommodate concerns or issues raised by government agencies and other stakeholders, where relevant.

4.2 Consultation program

BHP's locally based Community and Indigenous Affairs team are active members of the Newman community, and, through continued community engagement, they have established:

- Supportive working relationships between BHP and the Newman community;
- An environment conducive to productive dialogue;
- An understanding of key issues and concerns of the community in relation to developments in the area; and
- An avenue to share key project information as it becomes available.

As part of the broad consultation program for Jimblebar Hub, BHP consults with identified stakeholders on closure related issues during each project phase (pre-approval, operations, rehabilitation and post-closure) to enable legal requirements, risks and internal and external stakeholder views of the closure at Jimblebar Hub to be taken into account at an appropriate time and as far as practicable.

In line with DMIRS guidelines (DMIRS, 2020a), BHP considers the key stakeholders for closure to be post-mining owners or managers, including Traditional Owners, and relevant regulators. The current focus of the Jimblebar Hub closure consultation is primarily with the key stakeholders the Nyiyaparli people, DWER, EPA and DEMIRS.

As Jimblebar Hub approaches cessation of mining (nominally within 5 years of this time) closure-specific consultation will increase with broader stakeholder groups such as those listed below.

Government agencies:

- DWER.
- DEMIRS.
- EPA.
- Department of Planning Lands and Heritage (DPLH).
- Department of Biodiversity Conservation and Attractions (DBCA).
- Department of Jobs Tourism Science and Innovation (DJTSI).
- Main Roads Western Australia.
- Department of Health.
- Heritage Council of WA.
- Department of Primary Industries and Regional Development (DPIRD).
- Pilbara Development Commission.

- Federal Department of Climate Change, Energy, the Environment and Water (DCCEEW).

Shire, Local Government, Politicians

- Shire of East Pilbara.
- Local Member for the Pilbara.
- Minister for Environment.
- Minister for Mines and Petroleum.
- Minister for Heritage; Local Government.
- Minister for Regional Development

Landowners and managers

- Traditional landowners (Nyiyaparli people).
- Sylvania Pastoral Station Manager.

Communities / local and regional groups:

- Newman Chamber of Commerce and Industry.
- Wildflower Society of WA.
- Conservation Council of WA.
- Greening Australia.
- Newman Community Consultative Group.
- Project employees.
- Project contractors.

An indicative stakeholder consultation program for Jimblebar Hub to be conducted in advance of the next closure plan update is shown in Table 4-1.

Table 4-1 Stakeholder consultation program

Stakeholder(s)	Timing	Communications
Traditional owners Nyiyaparli people via Karlka Nyiyaparli Aboriginal Corporation (KNAC)[10]	Ongoing as part of regular stakeholder consultation (nominally associated with any new development proposals, and each MCP update).	BHP acknowledges that mine closure and rehabilitation are critical issues for the Nyiyaparli people, and the consultation program currently includes: • Progressive rehabilitation and technical studies update. • Post-closure land use and access considerations. The program is being refined during progressive engagement with KNAC and the Nyiyaparli people and, as outlined in the SCHMP, will include ongoing engagement on: • Nyiyaparli social, cultural and heritage values and interests. • Opportunities for Nyiyaparli representatives to participate in environmental surveys, rehabilitation trials and training opportunities. • Annual updates on rehabilitation and closure. Social surrounds workshops conducted as part of environmental approvals also consider closure issues.
DWER	Annual	Update on contaminated sites management (WAIO wide).
DEMIRS, EPA, DWER, DPLH	Ongoing as part of regular stakeholder consultation (nominally associated with new development proposals, and MCP updates)	MCP update briefing including: • Progressive rehabilitation. • Technical studies update. • Completion criteria. • Post-closure land use studies.

4.3 Consultation undertaken to date

Table 4-2 describes the key issues discussed with stakeholders and comments received relating to mine site rehabilitation and closure during consultation undertaken from 2013 onwards. Prior stakeholder engagement records are provided in Appendix B.

Key themes arising from previous stakeholder consultation are:

[10] KNAC is the registered native title body corporation through which engagement with the Nyiyaparli people is facilitated.

- The representatives of the Nyiyaparli people are interested in mine closure and rehabilitation specifically in regard to the following (but not limited to):
  - Water management;
  - Landforms and potential for computer modelling to provide visual representations;
  - Employment opportunities;
  - Environmental impact, including weeds;
  - Plants and animals; and
  - Cumulative impact.
- DWER interests are reflected in their feedback on the OB17/18/31 MCP, Version 0 and Jimblebar MCP, Version 3.0 discussed in Section 13.2.
- The EPA is interested in whether leaving the South Jimblebar pits open post-closure would have a significant impact on the beneficial use of groundwater resources and / or other relevant environmental values in the Project area and surrounds.

BHP will continue ongoing dialogue with selected stakeholders over the lifetime of the mine in line with the Stakeholder Engagement Management Plan, with closure remaining an ongoing point of discussion.

Table 4-2 Summary of stakeholder consultation for Jimblebar Hub

Date	Orebody	Description of Engagement	Stakeholders	Stakeholder comments / issue	Proponent response and / or resolution
25 March 2013	OB17/18	Rehabilitation update meeting on development of ecological completion criteria including rehabilitation strategy, seed management, growth media, rehabilitation monitoring, timeline to developing completion criteria including planned milestones.	Department of Mining and Petroleum (DMP) (now DEMIRS)	Supportive of strategy. Interested in changes to monitoring program especially in relation to defining progress and use towards developing completion criteria. Keen to be kept up to date as work progresses.	Progress to be reported annually.
16 December 2013	OB17/18	Closure and Rehabilitation Regional Management Strategy. Engagement with DMP regarding MCP submissions.	DMP (now DEMIRS)	DMP advised that they are keen to be provided with an update on the MCP prior to submission through a brief update presentation (not a full draft MCP). A schedule of when the updates are due would help manage DMP resources.	WAIO will provide a list of the scheduled MCP updates and coordinate update sessions in advance of the MCP submissions.
27 February 2014	OB31	Overview of the preliminary environmental impacts, conclusion of the impact assessment process for the Project and discussion regarding rehabilitation and closure mechanisms.	Office of the Environmental Protection Authority (OEPA) (now DWER)	Sought an understanding of project scope and key characteristics.	Outlined preliminary key factors and timeframe for remainder of Environmental Impact Assessment (EIA) studies and anticipated submission timeframe.
17 March 2014	OB17/18	Meeting to discuss Closure Planning update. Provided Hard copy (pdf soft copy by email) of the Draft Closure and Rehabilitation Management Strategy for DMP consultation. Provided look ahead for next 12 month of MCPs that are anticipated to be submitted to EPA / DMP	DMP (now DEMIRS)	Noted upcoming items. DMP agreed to provide feedback to BHP on the Draft Closure and Rehabilitation Management Strategy by about the end March 14.	No response required.
8 April 2014	OB17/18	Contaminated sites debrief. Discussed the risk-based management approach adopted by WAIO for its suspected and known contaminated sites at its Pilbara operations. Presentations delivered showing current status of contaminated sites management at the three hubs (i.e., Eastern, Infrastructure and Central). The highest ranked sites at OB17/18 are still considered to be low when compared with other WAIO sites.	Department of Environmental Regulation (DER) Contaminated Sites Branch (now DWER)	Agreed that presentations on the progress of WAIOs contaminated sites should happen on a regular basis detailing what works have been undertaken and what is proposed for the annual program.	WAIO to arrange annual contaminated sites debrief with DER.
14 April 2014	OB17/18	Provided an overview of the Closure and Rehabilitation Regional Management Strategy.	Department of Water (DoW) (now DWER)	Supportive of the regional strategic approach and the alignment with the Pilbara Water Resource Management Strategy.	No response required.
31 July 2014	OB17/18/31	Discussion regarding a proposed MCP for OB31 and a revised MCP for the OB18 Mine Hub. Opportunities exist for synergies across the operations particularly in terms of overburden management.	DMP (now DEMIRS)	The DMP concurred that it makes sense from a closure planning and implementation perspective, to consider overburden from a regional perspective.	Further meetings will be held as the draft plans progress.
3 December 2014	OB31	Regarding rehabilitation across all current and future WAIO hubs.	DMP (now DEMIRS)	Discussion of progress to date on achievements and challenges in the development of Ecological Completion Criteria and alignment on new target date for defining agreed draft criteria possibly 2020.	Progress to be reported in the WAIO Annual Environmental Review documents annually.
3 December 2014	OB17/18	Discussion held over potential for misalignment on targets defined in 2014 Annual Environmental Report (AER) where hectares planned for rehabilitation could be interpreted as being completed during FY2015. Review of ecological completion criteria development meeting summary (from 26th March 2013). Discussion of progress to date on achievements and challenges in the development of ecological completion criteria and alignment on new target date for defining agreed draft criteria now 2020.	DMP (now DEMIRS)	• Expressed concern over WAIO's ability to complete earthworks to an acceptable standard where using production fleet to execute bulk earthworks (regrade). • Interest in development of execution tolerances for rehabilitation earthworks. • Supportive that growth media requirements are embedded in planning process for rehabilitation projects. • Understand that delays in executing project works have resulted in push back in the delivery date for agreed draft completion criteria. • Interest in development of alternative rehabilitation monitoring approach using remote sensing / photogrammetry. • Supportive of proposed approach, keen to be kept up to date as work progresses.	DMP concerns about BHP's ability to execute earthworks to an acceptable standard were addressed by engaging a rehabilitation contractor to complete the works. Progress to be reported in AER.

Date	Orebody	Description of Engagement	Stakeholders	Stakeholder comments / issue	Proponent response and / or resolution
29 January 2015	OB17/18/31	General update on closure planning technical studies and closure strategy. Site Closure is not expected for a number of decades (post ~2045). OB17/18 deposit completion will occur within next 5 years and progressive infill is underway. OSAs are progressively being completed and rehabilitated. Infrastructure will remain active supporting adjacent operations (OB31). Technical briefing on landform, Acid and Metalliferous Drainage (AMD) and hydrological studies completed in past 12-18 months. Discussion on integrated OB31 & OB17/18 closure strategy. OB17/18 MCP update (addressing OEPA feedback on 2013 plan) will be submitted in Early Feb 2015.	DMP (now DEMIRS)	DMP agreed to an update cycle of five years for OB31 given the long life of project. DMP acknowledged there is an opportunity to integrate the existing OB18 MCP with the plan for OB31 in the future.	Integrate the OB17/18/31 MCPs.
30 January 2015	OB17/18	Overview of Closure and Rehabilitation for OB17/18 including: • Overburden management. • Landform design. • Pit backfill. • Water management. • Revegetation. • Progressive rehabilitation • Cumulative impacts. • AMD.	Nyiyaparli people	The representatives of the Nyiyaparli people are interested in mine closure and rehabilitation specifically in regard to the following (but not limited to): • Water management. • Landforms. • Employment opportunities. • Environmental impact. • Plants and animals. • Cumulative impact.	WAIO will continue to consult with the Nyiyaparli people in regard to mine closure and rehabilitation. This can be undertaken through the Implementation Committee (formalised process outlined in the Agreement) or as otherwise arranged between WAIO (Mine Closure Team) and the Nyiyaparli people and / or their representatives.
12 February 2015	OB31	WAIO provided a copy of the OB31 referral package to the DMP via email. The package included the environmental referral supporting document, the draft MCP and preliminary AMD risk assessment study.	DMP (via email) (now DEMIRS)	Formal questions and comments were received from the DMP in writing on 25 May 2015. Comments and questions related to surface water management, geophysical characterisation, Potentially Acid Forming (PAF) overburden disposal options, surplus water discharge to Jimblebar Creek and soil and landform impact assessments.	WAIO provided a written response to DMP to address questions on 15 June 2015. WAIO committed to update the MCP with the comments and questions raised by the DMP.
17 April 2015	OB31	The OEPA released Scoping Guidelines to WAIO seeking additional information to inform its assessment of the Project.	OEPA (now DWER)	The OEPA sought additional information on: • Hydrological processes (Jimblebar Creek discharge). • Inland waters environmental quality (Ethel Gorge stygobiont community). • Flora and vegetation (Acacia sp. East Fortescue [now known as *Acacia corusca*]). • Rehabilitation and decommissioning (closure options and PAF).	WAIO commenced gathering the additional information and arranged a meeting with the OEPA, DMP and the Department of Water (DoW) (now DWER). WAIO provided formal response (see 8 May 2015 below).
21 April 2015 and 8 May 2015	OB31	Meeting at WAIO offices to discuss the Scoping Guidelines process and clarification of additional information required.	OEPA (now DWER) DMP (now DEMIRS)	Discussions focused on clarification of some additional information required to address the Scoping Guidelines.	WAIO provided a report response to the OEPA containing the additional information as requested.
27 August 2015	WAIO General	Closure Planning update providing an overview of the Strategic Environmental Assessment approach	DMP (now DEMIRS)	Appreciated the update and can see the value of the regional approach. Interested in deep dive sessions on: • Ecohydrological change assessment. • AMD assessment. • Visual impact assessment. • Offered to have joint deep dives with other agencies if this avoids duplication on WAIO side. As the rehabilitation of the disturbance footprint is to be managed through business-as-usual progressive rehabilitation, did not show strong interest in deep dive in this area.	Arrange deep dive session on AMD assessment, visual impact and ecohydrological change.
12 October 2015	WAIO General	Deep dive session on AMD and water	DMP (now DEMIRS)	Noted the strategic approach to be very useful context, particularly when assessing site by site closure plans.	No response required.
6 September 2016	Jimblebar	Email from OEPA	OEPA (now DWER)	Request for further information on the management and monitoring of AMD to enable approval of the Jimblebar MCP Revision 1 as satisfying Conditions 11-2 to 11-7 of Ministerial Statement 857.	Further information provided (see 2 February 2017).
14 October 2016	Jimblebar	Letter from OEPA	OEPA (now DWER)	Letter approves Jimblebar MCP Revision 1 as satisfying Condition 11-5 of Ministerial Statement 683.	No response required.
2 February 2017	Jimblebar	Email from WAIO	OEPA (now DWER)	In response to the OEPA's request for further information, WAIO's AMD management standard was supplied along with a summary of AMD testing.	-
17 March 2017	Jimblebar	Letter from OEPA	OEPA (now DWER)	Letter approves Jimblebar MCP Revision 1 as satisfying Conditions 11-2 to 11-3 of Ministerial Statement 857.	No response required

Date	Orebody	Description of Engagement	Stakeholders	Stakeholder comments / issue	Proponent response and / or resolution
19 July 2017	WAIO General	General closure planning discussion: • BHP Closure Plans developed in accordance with DMP / EPA Guidelines for Preparing Mine Closure Plans 2015. • BHP Iron Ore division routinely reviews, updates and submits mining area closure plans to government. • BHP Nickel West division recent deep consultation with DoL (Nov-16 through to May-17) on post mining land use assessment outcomes and recommendations. • Seeking to continue this collaboration on post land use with DoL	Department of Lands (DoL; now DPLH)	Noted.	No response required
18 October 2018	Jimblebar	Biannual meeting. WAIO's general approach to surplus water management in the Pilbara and upcoming environmental approvals (including Jimblebar). A discussion on how best to engage with Nyiyaparli people on broader (non-approval related) environmental issues such as water, rehabilitation etc.	Nyiyaparli people	Asked about potential for surplus water to be used on pastoral station operated by KNAC for irrigated agriculture.	Surplus water opportunities continue to be reviewed and discussed as part of ongoing consultation processes.
6 March 2019	WAIO General	WAIO presented and discussed the sustainability section of the draft WAIO rehabilitation completion criteria.	DMIRS (now DEMIRS) & DBCA	Meeting attendees generally happy with the approach proposed and the detail. During the meeting, it was noted that weeds will require addressing.	WAIO has incorporated weeds into criteria.
6 March 2019	Jimblebar	Meeting to discuss rehabilitation planning and reporting.	EPA and DWER	EPA Chairman's preference was for successful closure and rehabilitation to standard and was not confident that this could be achieved. He requested real, achievable, science-based completion criteria supported by a scorecard.	BHP has developed a rehabilitation report that provides an analysis of rehabilitation across WAIO's sites (Appendix C).
16 April 2019	Jimblebar	Biannual meeting.	Nyiyaparli people	Approvals and engagement.	WAIO committed to provide a copy of the closure plan for review and comment in August 2019 (see below).
5 August 2019	Jimblebar	BHP provided the Jimblebar Mine Closure Plan for review in advance of referral of the Project to the EPA for assessment under s38 of the EP Act. A site visit was proposed to further discuss key areas of interest to the Nyiyaparli people in relation to the implementation and the long-term on-ground management of this Project. The visit was scheduled for March 2020, but was cancelled due to COVID-19 restrictions.	Nyiyaparli people	The Nyiyaparli people responses relevant to closure were: • What is BHP's responsibility if an introduced weed takes hold? While they have a spraying program, weeds are still found there. What happens when they leave? Are they responsible to make sure all weeds are removed after leaving? • Can we get a computer model / picture of what the Jimblebar mine area (landscape) will look like after BHP has finished mining? Understanding that this could change as BHP makes business decisions in the intervening time.	BHP acknowledged the long-term interest in these issues over the life of any mine and beyond for the Nyiyaparli people and provided the following responses: • BHP is responsible for removing weeds if they are introduced by the Proposal. BHP does spray for weeds every year and removes any new weeds found if they are able to access the weeds. There are conditions and management requirements under the current Part IV approval and BHP proposes to continue these standard management practices for the site. The proposed Flora and Vegetation Management Plan explains how weeds will be managed. The MCP also includes proposed completion criteria (including for weeds), which describes the objectives and targets relating to acceptable levels and management of weeds that BHP wants to achieve when the mine is closed. • The Jimblebar MCP includes detail of the final conceptual landscape design including some pictures; however, BHP acknowledges that a computer model would make it easier to understand how the mine will look after mining is finished and will explore the feasibility of producing this as part of the ongoing closure review for the site.
13 August 2019	Jimblebar	Pre-referral meeting on the Jimblebar Optimised Proposal – approvals and MCP.	EPA	The MCP was discussed as part of the session, key points were: 1) Submission of a single MCP for Jimblebar. 2) Request for a 5-year review cycle (single period not the 3 different periods contained in current approvals). 3) Implementation of new Ministerial Conditions aligned with the Strategic Proposal Ministerial Condition (MS 1105). 4) Traditional Owner review of the MCP has been undertaken as part of the document development. EPA indicated that a single MCP for Jimblebar would be appropriate.	-
6 February 2020	WAIO General (Mt Goldsworthy)	WAIO discussed abandonment bunds with DMIRS in relation to the Mt Goldsworthy site, but the principles of the conversation are relevant to other sites	DMIRS (now DEMIRS)	OSAs may be considered to form part of abandonment bunds on a case-by-case basis, but OSAs with slopes of 20° are not sufficient to be a deterrent to the public and will not control void access. Staggered large boulders have been used in creek beds.	Incorporate principles of abandonment bund discussion into abandonment bund planning for all sites.
30 June 2021	Eastern Pilbara	Implementation committee meeting with KNAC. BHP provided an update on Social Surrounds schedule and an introduction to per- and polyfluoroalkyl substances (PFAS) management and monitoring via an interim PFAS Site Management Plan.	KNAC & Nyiyaparli people	-	-

Date	Orebody	Description of Engagement	Stakeholders	Stakeholder comments / issue	Proponent response and / or resolution
28 July to 1 August 2021	WAIO General	General closure planning discussion as part of Implementation Committee meeting and social surrounds workshop across the East Pilbara including Jimblebar Hub.	KNAC & Nyiyaparli people	The engagement included a field visit on country and workshop. Key matters of interest to the Nyiyaparli people which were communicated to BHP, related to water, dust, fire, access to country and heritage. Specific points discussed with potential relevance to closure included: • The Nyiyaparli people expressed interest in being involved in: - Water quality monitoring; and - Rehabilitation. • Recording pre-mining conditions via aerial footage captured by drones. • The Nyiyaparli people would like surveys of traditional hunting animals to be undertaken. • Nyiyaparli women showed the group some bush medicine and bush tucker species. They would like a full survey of the area for these values. Nyiyaparli people would like to better understand the landscape evolution at each stage pre-mining to mid-mining and then post mining. Is 3D modelling available to demonstrate?	BHP committed to: • Investigating opportunities for Nyiyaparli people involvement in water quality monitoring and rehabilitation. BHP advised that there are Traditional Owner only business tenders. BHP Indigenous Affairs offered to assist and communicate directly with Nyiyaparli people to advise on how to submit tenders. • Initiate steps to capture aerial footage of project areas covering the general development area and close up footage along creek lines and areas of cultural significance including pools. There may be the potential to include one of the Nyiyaparli social surrounds team in the capture of the footage. • Investigating scopes for survey of fauna species used for traditional hunting. Survey to include Nyiyaparli representatives. • Exploring resources available / accessible to better portray the landscape pre-mining, during mining and at closure outcomes.
14 September 2021	WAIO General	Closure Planning and process for ongoing engagement in closure planning including closure plan review processes.	KNAC & Nyiyaparli people	Agreement on the process for review and submission of MCPs.	WAIO to follow process including development of summary closure planning documents for discussion in the Implementation Committee meetings.
14 September 2021	Eastern Pilbara	Implementation committee meeting with KNAC. BHP provided a presentation to Nyiyaparli people on PFAS Monitoring at Newman - Multi Level Control System Trigger Action Response Plan (TARP).	KNAC & Nyiyaparli people	-	-
9 November 2021	OB171831 and Jimblebar	KNAC feedback on OB17/18/31 (2018) MCP and Jimblebar MCP (2021) on behalf of the Nyiyaparli people.	KNAC on behalf of Nyiyaparli people	Feedback was provided on many topics (see Appendix B-4) which have been summarised into the following themes: post-closure land uses, final voids, impacts to water, impacts to habitats (flora and fauna), rehabilitation success, and the future usability of the land. Specifically, the Nyiyaparli people asked for the following points to be recorded as important: • Progressive rehabilitation; • The impacts of dust accumulation; • Protection of heritage places during and after closure; • Access to country; • Keeping places for artefacts and cultural material; and • Involvement of Nyiyaparli people in rehabilitation activities. The Nyiyaparli people stated that they would welcome the opportunity to visit the rehabilitated areas of OB17/18/31.	WAIO to follow up individual matters raised over coming routine engagements and document in the following MCP updates. BHP's response to comments is provided in Appendix B-4.
16 November 2021	WAIO General	Implementation committee meeting with the KNAC. Discussion of Nyiyaparli people feedback on closure plans, discussion about Traditional Owner values as they relate to closure and rehabilitation. Update on closure planning activities.	KNAC & Nyiyaparli people	KNAC is developing a standard closure framework which will form the basis for ongoing consultation. It was also noted that closure will form an element of ongoing social surrounds discussions.	BHP will work through the KNAC standard closure framework, when available, in consultation with the Nyiyaparli people to establish social values and objectives.
10 March 2022	Eastern Pilbara	KNAC and Nyiyaparli Implementation Committee meeting. Update on closure planning. Provided overview of AX12 OSA final landform design to protect heritage site.	KNAC & Nyiyaparli people	-	-
21 March 2022	WAIO General	Briefing and feedback from DMIRS on current closure and environment upcoming approvals. The discussion included upcoming changes to legislation, Northern OSA, MCP updates and priorities.	DMIRS (now DEMIRS)	Review of list of MCPs currently under review and request that BHP provide a priority list for assessment along with reasons for the priority.	Priority list and meetings to be organised.
14 July 2022	WAIO General	KNAC and Nyiyaparli Implementation Committee meeting. Update on closure planning. Provided overview of: • Closure planning. • Opportunities for Nyiyaparli feedback throughout closure planning lifecycle. • Possible areas for collaboration. • Schedule of closure plan updates.	KNAC & Nyiyaparli people	There was no verbal discussion on closure. A data pack was provided.	Questions will be taken on notice for the next engagement.

Date	Orebody	Description of Engagement	Stakeholders	Stakeholder comments / issue	Proponent response and / or resolution
19 October 2022	Eastern Pilbara	Implementation Committee meeting. Provided overview of: • Project phases and closure inputs to those phases. • Considerations in closure planning and opportunities for Nyiyaparli people's input. • Topics for discussion in CY23. • Progress of rehabilitation activities.	KNAC & Nyiyaparli people representatives	KNAC to supply BHP the draft closure principles of the Nyiyaparli people.	-
November 2022	Eastern Pilbara	Draft Nyiyaparli Baseline Closure Principles / Preferences	KNAC & Nyiyaparli people	Key matters of interest are as follows (see Appendix B-2 for full document): • Safe and culturally appropriate post-mining access. • Post-closure landform design as natural as possible with inclusion of "nice places" (e.g., small water holes that represent nice camping spots). • Backfilling mine voids and avoidance of pit lakes. If residual voids are unavoidable consideration to be given to: - Providing post-mining access and rehabilitating backfilled area, if possible. - Alternative uses (e.g., solar farms). - Making pit lakes assets rather than liabilities. • Long term impacts upon places of outstanding cultural importance and repatriation of artefacts. • Drone footage of mining areas, visualisations of future impacts and visual impact assessment. • Ongoing consultation on mine closure design and rehabilitation, including the opportunity to be involved in monitoring activities, on-site workshops and review of and input into MCPs. • Baseline ethnoecological surveys. • Opportunities for business tenders, employment and training.	BHP has incorporated acknowledgement of Nyiyaparli people's closure principles into Section 5.14 of this MCP and several forward work programs (Section 7.6) have been established to address them including optimising backfill of pits to minimise pit lakes and further consultation regarding landform and rehabilitation designs, post-mining access and repatriation of artefacts.
May 2023	Jimblebar Hub	Social surrounds engagement #1 A site visit was conducted to the rehabilitated OB18 North OSA and to the proposed tailings location.	KNAC & Nyiyaparli people	Feedback was provided on matters of interest including: • Preserving the landscape, flora, fauna, and water for future generations to maintain stories and Songlines, and bush tucker and medicine knowledge. • The shared responsibility of Traditional Owner groups through which the Fortescue River and its tributaries flows and the Nyiyaparli people's cultural responsibility to see it managed appropriately for its ongoing use and protection of its cultural importance. Human movement follows water sources, based on knowledge and skills passed down through generations. • Future use of Country by the Nyiyaparli people, including accessibility, native fauna barricades, and weed management. • Re-establishment of traditional cultural activities – with a strong preference to not be left with the liability of abandoned pits that are unsafe to enter and have no use. • Closure bunds placed on-Country which are perceived to hinder amenity and impact cultural uses of Country. • The consultant for the Nyiyaparli people suggested that female elders should look at the species composition on the OSA. Further information was requested on impacts to and management of water values, the process of backfilling and PAF material management, weed management and rehabilitation management.	BHP developed specific content for Social Surrounds Engagement #2 (August 2023) to hold further more detailed discussions around closure and rehabilitation processes, tailings and tailings storage facility closure concepts.

Date	Orebody	Description of Engagement	Stakeholders	Stakeholder comments / issue	Proponent response and / or resolution
August 2023	Jimblebar Hub	Social surrounds engagement #2 A site visit and discussion with Nyiyaparli people, KNAC including supporting consultants covering the topics of Closure and Rehabilitation outcomes, tailings and beneficiation including closure concepts for tailings storage facilities. There was a site visit to the rehabilitation at South Jimblebar OSA.	KNAC & Nyiyaparli people	A summary of discussions is as follows: • The Nyiyaparli people have a goal to have healthy and accessible country into the future which enables knowledge to be passed to future generations. The use of landscape features in Songlines means that the Songline can lose its meaning if a landscape feature is removed or damaged. • The visual amenity of final pit walls was discussed with a request to consider how to soften the visual impact. • Investigation of flora and fauna combinations, fauna habitat return and seeding with species that attract native fauna of cultural significance were discussed (refer to Section 5.14 for further details). Incorporation of vegetation species of cultural significance was also identified as important. • The visit to the South Jimblebar OSA noted rehabilitation efforts were very good quality and that revegetation was showing good vegetation cover and diversity. The constructed fauna habitat rockpile and the overall shape of the top of the OSA looked more natural [than other mine landforms]. • The need for further discussion about options for alternate post-mining landscapes at closure was identified, including: - Water-rich places within backfilled pits and revegetating with *Triodia* grasslands and *Eucalyptus* and *Acacia* species. - Nyiyaparli people's preferences for design of post-closure landscapes. - Constructing OSA or other landforms to blend with the surrounding area. • The Nyiyaparli people requested to be informed of future developments in mine planning and updates to the post-closure landscape and would like to participate in rehabilitation processes.	BHP has recorded details provided on cultural values during the consultation in Section 5.14 for future reference in closure planning and is committed to further consultation on mine closure planning (Section 4.2). BHP has requested further details on design principles that can be used to inform landform designs and the rehabilitated landscape. Details of BHP's responses to incorporating vegetation of cultural significance into rehabilitation seed mixes and fauna habitat research have been provided in Sections 7.5.6 and 7.6 and Appendix F).
September 2023	Jimblebar Hub	Provision of draft Jimblebar Hub ERD and MCP for review	KNAC & Nyiyaparli people	KNAC reviewed the draft Jimblebar Hub ERD and MCP on behalf of the Nyiyaparli people and provided several comments on the MCP and some comments on the ERD with relevance to closure. These are reproduced in full in Appendix B-3. A brief summary of the comments follows: • The pre-mining ecosystem is of intrinsic value to the Nyiyaparli people and reflects their care for country ethos. • Further ongoing consultation on closure, rehabilitation and post-mining land use is of key importance. This includes visual amenity and the ability to access areas of cultural significance post-closure. • The ABARES (2016) post-mining land uses do not adequately reflect Traditional Owner values. The Nyiyaparli people would like a post-mining landscape and land use which is suitable for future generations to use and learn from. • Abandoned pit lakes with poor quality water that cannot be used impact cultural values. The Nyiyaparli people have expressed their preference for the avoidance of pit lakes. Management of water more broadly on a regional scale is also important and it is each Traditional Owner group's responsibility to manage water on their country as it travels to the next group. • The establishment of vegetation with a more complete re-instatement of species (including recalcitrant species and species of cultural significance) is important. • Habitat for fauna species of cultural significance is also important and return and data on the return of key species (such as kangaroo, emu and goanna) to rehabilitated areas is requested. • With regard to the closure of the Swan and De Grey pits, the Nyiyaparli people would like to continue to engage with BHP on these plans as backfilling to surface, or creation of water gaining sites may lead to better outcomes than just backfilling to 5 m above water table.	BHP's response to each of KNAC's comments relevant to closure is provided in Appendix B-3. A brief summary of responses follows: • BHP is committed to ongoing consultation on closure and rehabilitation matters and to understanding how cultural values can be integrated into mine closure and rehabilitation plans (Section 4.2). • BHP acknowledges that further consultation is required with the Nyiyaparli people to define post-mining land uses and this is detailed in Section 6.2 of this MCP. • BHP acknowledges the Nyiyaparli people's stated preference for the avoidance of pit lakes and has placed a high priority on progressing the backfill study (Section 7.6). • The seed mix used for rehabilitation is provided in Appendix J and highlights those species identified as important to Nyiyaparli people in the Nyiyaparli People and Country Plan (KNAC, 2023) and BHP's ethnobotanical database (BHP, 2023f). BHP has an ongoing program of research into improving rehabilitation (Section 7.5.6.1 and Appendix F). The results of research and work with the Nyiyaparli rehabilitation team will inform the revegetation strategy (Section 7.6). • A research program is being developed for fauna habitat including consideration of fauna of key species of significance to the Nyiyaparli people (Section 7.6). BHP is in the process of reviewing its rehabilitation monitoring procedures to determine how fauna use of rehabilitated areas can be integrated into the monitoring program (Sections 7.6 and 10.1.4).

5 Collection and analysis of closure data

Consistent with the adaptive management approach in the Mine Closure Guidelines (DMIRS, 2020a; 2020b), BHP has commissioned several studies to inform relevant considerations during mine closure planning. The studies and trials are progressive and can be iterative, as many closure considerations are interlinked. Given the long life of the Jimblebar Hub, the knowledge base associated with areas approaching closure / rehabilitation will be more mature than newer areas, or areas that have not yet been mined. As areas progress through operations to closure, additional studies will be conducted to help inform the closure and rehabilitation of these areas.

Sections 5.1 to 5.15 provide a summary of our current knowledge of the physical, biological and cultural heritage environment at Jimblebar Hub, as well as an overview of local land uses. Key information presented includes:

- Local climatic conditions and projected future climate change for the area (Section 5.1);
- Geology, soils, overburden and tailings characterisation including geochemical properties, soil and overburden structure and stability (i.e., erodibility), tailings physical properties and consolidation modelling, and growth medium type (Sections 5.2 to 5.5);
- Seismicity and slope stability assessments (Section 5.6);
- Landforms, land systems and local and regional information on flora, fauna, ecology, communities and habitats (Sections 5.7 to 5.10);
- Hydrology and hydrogeology (Section 5.11);
- Site contamination (Section 5.12); and
- Visual amenity, cultural heritage and values, and local land use (Sections 5.13 to 5.15).

Following the DMIRS (2020a; 2020b) Guidelines, studies informing closure designs (e.g. PAF cover trials, in-pit TSF closure) and design option analyses, are also presented in this section (Section 5.16). Where a study is primarily focused on assessing the residual risk of a design, this information has been presented in Section 7.3 to meet the DMIRS (2020a; 2020b) requirement to describe risk pathways and impacts as part of the risk assessment section.

Closure approaches and designs will be refined over the coming years through further assessments and design studies. For major capital projects, which include closure projects, BHP has a defined study process that starts with an Identification Phase Study (IPS) that looks at possible closure options and then conducts sufficient technical work to enable these options to be refined to a list of viable alternatives and selection of a preferred alternative. Following selection of a preferred alternative, a Selection Phase Study (SPS) is conducted to refine and optimise the preferred designs / approaches. A Definition Phase Study (DPS) follows the SPS and develops detailed designs and execution plans.

The proposed closure management of Jimblebar Hub presented in this plan is based on our current understanding of the surrounding environment and the outcomes of monitoring, studies and research trials.

5.1 Climate

5.1.1 Existing climate

The Jimblebar Hub is in the Pilbara region of Western Australia, which has an arid climate and experiences regular cyclonic activity during November to March. Characteristic climatic features of the region include seasonally low rainfall with high temperatures, high evaporation rates and a high daily temperature range.

Average maximum monthly temperatures at Newman range between 23°C in June and July and 39°C in January and December. Average minimum monthly temperatures at Newman range from 6.5°C in July to 25°C in January (Table 5-1). The hottest temperature experienced at Newman was 47°C in January 1998 (BoM, 2020).

Table 5-1 Temperature at Newman Aero

Record	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
Mean maximum temperature °C	39.0	37.4	35.6	32.2	27.1	23.1	23.2	26.2	30.6	35.3	37.6	39.3
Mean minimum temperature °C	25.1	24.1	22.2	17.8	11.8	7.5	6.5	8.0	12.3	17.9	21.2	24.1

Source: Bureau of Meteorology (BoM, 2020) - BoM station number 007176

Rainfall in the Pilbara is highly variable and annual evaporation significantly exceeds rainfall (Table 5-2). The highest rainfall events are typically associated with cyclonic activity and thunderstorms, which are common in the Pilbara region with approximately 20 to 30 occurring per year.

Different data sources have been used by different technical studies supporting the closure designs provided in this MCP and reflect the variability in rainfall estimates over different timeframes and spatial distribution. Table 5-2 records the data used by the technical studies which have been sourced from the Bureau of Meteorology (BoM), Department of Agriculture, and SILO, the enhanced climate database hosted by Queensland Department of Environment and Science's Scientific Information for

Landowners (SILO) Data Drill (DES, 2021). The SILO rainfall and evaporation datasets are based on interpolated gridded data (using an approximate 5 km × 5 km grid spacing) derived from records at over 6,000 weather stations in Australia.

Table 5-2 Average monthly rainfall and evaporation (mm)

Record	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Total
Rainfall													
Newman Aero[1]	69.8	70.2	41.7	21.3	18.4	15.9	14.4	6.4	3.6	5.9	12.4	34.9	324.3
SILO[3]	58.5	67.4	39.0	18.4	18.3	17.9	13.4	6.3	3.0	4.9	9.8	31.5	288.3
Evaporation													
Dept Ag[2]	461	369	343	290	174	173	199	193	264	377	424	466	3,733
SILO[3]	380.9	308.5	303.6	234.7	176.0	134.3	146.1	189.1	255.5	342.3	377.1	400.5	3,248.8

Sources:

[1] BoM (2020) rainfall records; BoM station number 007176.

[2] Luke et al. (1987).

[3] Scientific Information for Landowners (SILO) Data Drill (DES, 2021).

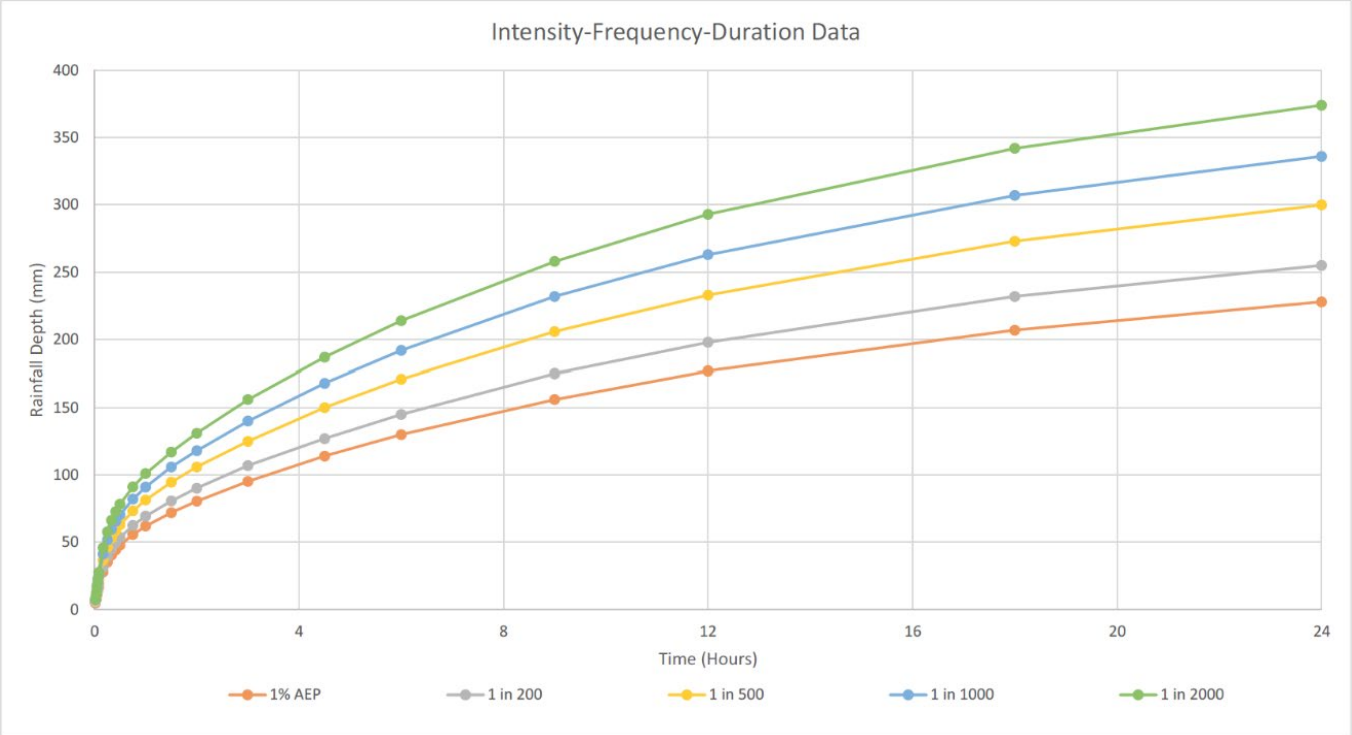
Rainfall intensity-frequency-duration (IFD) relationships were sourced by Surface Water Consulting (2021) from the Australian Rainfall & Runoff (ARR) data hub for the Jimblebar catchment centroid (Table 5-3). Gridded IFD data were also downloaded for the Jimblebar Creek catchment to assess the variability across the catchment. Selected results are shown in Figure 5-2. The centroid point data and the average gridded values for the catchment differ by less than 3%. The centroid results are shown graphically in Figure 5-1.

Table 5-3 IFD for Jimblebar Creek catchment centroid from ARR data hub

Duration	Rainfall depth (mm) by Annual Recurrence Interval					
	1 in 100	1 in 200	1 in 500	1 in 1000	1 in 2000	1 in 10,000[1]
1 hour	62	69	81	91	101	140 - 251
1.5 hour	72	81	95	106	117	160
2 hour	81	90	106	118	131	175 - 324
3 hour	95	107	125	140	156	205
4.5 hour	114	127	150	168	187	250
6 hour	130	145	171	192	214	295 - 520
9 hour	156	175	206	232	258	358
12 hour	177	198	233	263	293	405 -706
18 hour	207	232	273	307	342	450
24 hour	228	255	300	336	374	480 - 909

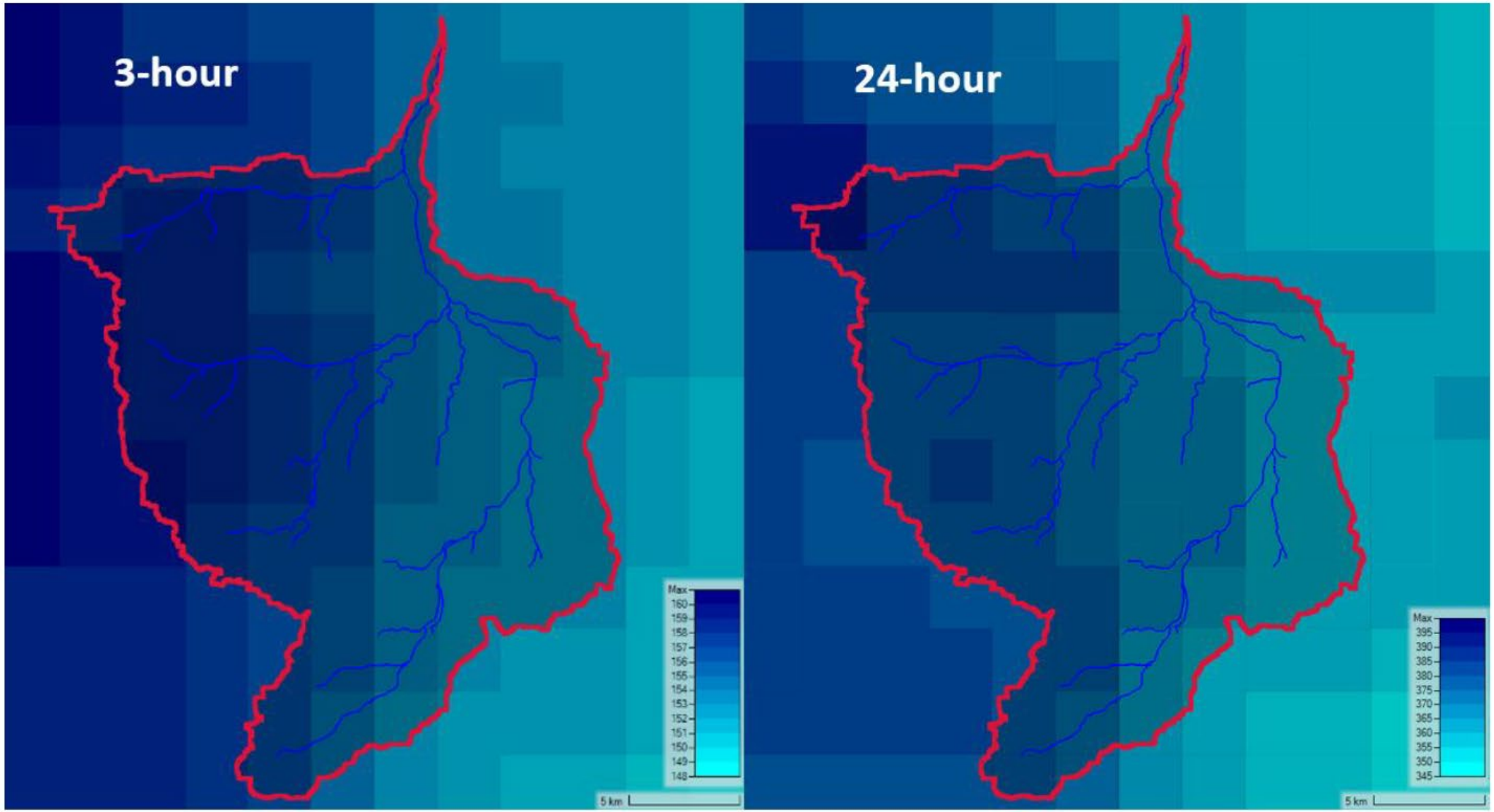
[1]Note: Lower values interpolated by Surface Water Consulting (2021) between BoM point data and Probable Maximum Precipitation (PMP) calculated using the BoM Generalised Short Duration Method (GSDM) and the revised Generalised Tropical Storm Method (GTSMR). Upper values calculated by RPS (2022) based on ~1.25 x 2,000-year rainfall depths.

Source: Surface Water Consulting (2021)



Source: Surface Water Consulting (2021)

Figure 5-1 IFD rainfall intensities for Jimblebar Creek Catchment



Source: Surface Water Consulting (2021)

Figure 5-2 Gridded 0.05% (1 in 2,000) Annual Exceedance Probability (AEP) rainfall depths for Jimblebar Catchment

5.1.2 Climate change

BHP accepts the Intergovernmental Panel on Climate Change's (IPCC) current view that warming is unequivocal, human influence is clear and physical impacts have occurred and will continue to intensify (IPCC, 2023). BHP believes the world must pursue the aims of the Paris Agreement with increased levels of national and global ambition to limit the impacts of climate change. BHP's' Climate Transition Action Plan (BHP, 2021f) sets out the strategic approach to achieving our long-term greenhouse gas emissions reduction goals and Our Requirements: Environment and Climate Change (BHP, 2022a) focuses on climate change risk management and strategies, including operational greenhouse gas emissions reduction by using and investing in low emissions technology, supporting emissions reduction in our value chain and promoting product stewardship and increasing our resilience to physical climate change impacts.

Climate change is a complex issue, with inherent uncertainty about the timing, pace, and severity of possible impacts. Risks from climate change to the stability of landforms, mobilisation of contaminants and re-vegetation are some of the identified vulnerabilities are considered in closure planning.

We have worked with the CSIRO to obtain regional analyses of climate change science and understand that climate change will amplify existing risks in BHP's mining and associated port and rail operations in the Pilbara region. CSIRO (2015) forecasted Pilbara region climate conditions for 2030 and 2050 under various emissions scenarios and concluded that:

- Conditions would be hotter (both averages and extremes) with higher potential evaporation:
  - Forecast temperature changes were 1.5 to 1.6°C for 2030 and 2.1 to 2.9°C for 2050.
  - Projected changes to evaporation ranged from annual increases of 3% to 4% for 2030 and from 4% to 7% for 2050.
- Tropical cyclones may decrease in number but increase in intensity and duration over the same period.
- There may be more unpredictable characteristics of other climate-related hazards, including flooding, storm surges and wildfires, e.g., in 2050 CSIRO forecast up to 100% increase in days with extreme forest fire danger index from the current average of 23 days per year, up to 44 days per year.

Climate models indicate that there could be wetter or drier conditions with models predicting wet conditions indicating rainfall increases of 3.2% by 2030 under an intermediate emissions scenario and 7.8% by 2050 under a high emissions scenario. Models predicting dry conditions indicate a decrease in rainfall from 4.2% by 2030 under an intermediate emissions scenario and 17% by 2050 under a high emissions scenario (CSIRO, 2015). Given the high level of uncertainty associated with the direction and likely magnitude of rainfall change, WAIO conducts sensitivity analyses to understand the impacts of changes in rainfall to proposed closure designs where this may be critical to the design (e.g., flood protection bunds).

5.1.3 Knowledge gaps & forward work program

No knowledge gaps have been identified.

5.2 Geology

5.2.1 Regional stratigraphy

The Pilbara region comprises a portion of the ancient continental Western Shield that dominates the geology of WA. The Western Shield is composed of pre-Cambrian, Proterozoic and Archaean rocks. The Pilbara Craton dates back to the Archaean and includes some of the oldest rocks in the world. It is overlain by Proterozoic rocks deposited in the Hamersley and Bangemall Basins. The mineralised ore bodies and formations at Jimblebar Hub are contained within the Hamersley Group located in the Pilbara Basin. The regional geologic sequence and stratigraphic descriptions are provided in Table 5-4.

Table 5-4 Generalised stratigraphy of the Hamersley Group

Stratigraphy		Description
Formation	Member	
Tertiary sediments	-	Tertiary alluvial sediments have been deposited in the east-west valley south of Shovelanna Hill, and overlie the eroded bedrock of the Wittenoom Formation, with a thickness of up to 80 m. The sediments are composed of semi-consolidated and cemented alluvium, colluvium / detritals comprising sands, silts, clays, lignite and ligneous clays and calcrete deposits.
Boolgeeda Iron	-	Predominantly black fine grained and flaggy iron formation. The formation is approximately 200 m thick and comprises upper and lower units of interbedded Banded Iron Formation (BIF) and shales, and a central BIF zone.
Woongarra Rhyolite	-	Consists of three sub-units; the lowermost unit is a massive rhyolite and is overlain by BIF, dolerite and shale (the median raft complex). The upper unit consists of a massive and porphyritic rhyolite and is capped by 10-20 m of interbedded tuff and chert.
Weeli Wolli	-	Up to 300 m thick and consists of alternating beds of red or black micro-BIF, red chert and tuffaceous shale with abundant dolerite intrusions.

Stratigraphy		Description
Formation	Member	
Brockman Iron	Dales Gorge Member	Interlayered sequence of 17 BIF and 16 shale macro-bands.
	Whaleback Shale Member	30 m of shale interbedded with chert and BIF. A lower shale zone is dominated by pyritic black shale; a central zone is composed of chert; and the upper zone is dominated by carbonate-rich material.
	Joffre Member	Dominated by BIF with minor shale bands.
	Yandicoogina Shale Member	Uppermost member of the Brockman Iron Formation and comprises a sequence of interbedded chert and shale with dolerite sill intrusions.
Mt McRae Shale	-	Approximately 30 m thick consisting of alternating bands of black carbonaceous shale and chert and is commonly capped with pyritic chert bands. The Mt McRae Shale forms the footwall to the ore horizons in the Brockman Iron Formation and contains a limited enriched ore zone. Several zones within the unit contain abundant pyrite nodules up to 5 cm across.
Mt. Sylvia	-	Three BIF units separated by interlayered shale and dolomite as well as small amounts of chert. The top of the formation is marked by Bruno's band which consists of a 5-10 m thick interval of dark, well micro-banded BIF.
Wittenoom	West Angela Member	Dolomite, dolomitic argillite, minor chert.
	Paraburdoo Member	Thin to thick-bedded dolomite, minor chert and argillite, tabular bedding.
	Bee Gorge Member	Alternating beds of shale and dolomite with minor cherts, volcaniclastics and BIF.
Marra Mamba Iron	Nammuldi member	Yellow weathering chert, cherty BIF and some shale bands. It has a maximum thickness of 100 m.
	Macleod member	Shale with thin BIF interbeds and chert with a maximum thickness of 45 m.
	Mt. Newman member	Podded BIF with interbedded carbonates and shales. It is the major ore-bearing horizon of this formation.
Jeerinah	-	Interbedded shales, siltstone, chert and quartzite.

Source: Adapted from BHP (2022i); Earth Systems (2015) and Landloch (2013a)

5.2.2 Local geology

The local geology of the Jimblebar Hub area is shown on Map 5-1 and described below.

5.2.2.1 OB17/18

Most mineralisation at OB17/18 occurs within the Dales Gorge member of the Brockman Iron Formation, located within the keel of the western plunging Shovelanna syncline. Major rock units in the vicinity of the OB17 and OB18 pits include the Whaleback Shale member, Dales Gorge member, Mt McRae Shale and Mt Sylvia Formation (RPS, 2013b).

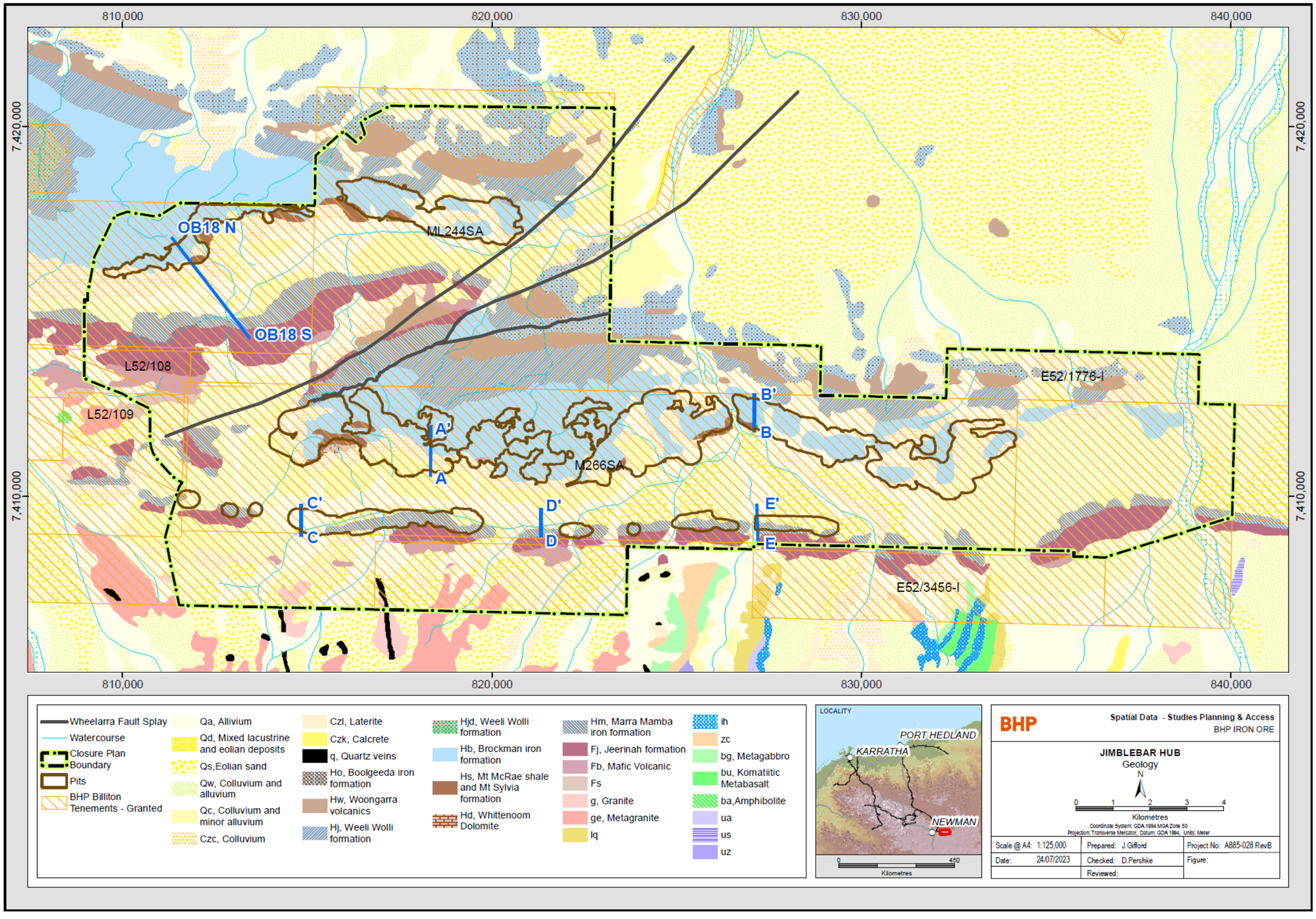
The Dales Gorge member and Mt McRae Shale Formation are intersected by the Swan pit. The majority of the ore occurs in the Dales Gorge member, but enrichment also occurs in the upper Colonial Chert member (RPS, 2013b).

Drilling at the Swan pit indicates the presence of a shallow, south westerly dipping thrust fault (named the Dansop Thrust) at the western extent of OB17, continuing eastward across the OB17 project area between 355882E and 356395E (Figure 5-3) (RPS, 2013b). It outcrops on the western end of OB17.

Thin colluvial and scree deposits occur at the base and on the slopes of Shovelanna Hill. Scree is located in the southeast corner of the De Grey and Swan pits (RPS, 2013b).

Weathering is deep throughout the OB17/18 area:

- Below the north wall of the De Grey pit, weathering depth ranges from 150 m to 220 m.
- Below the eastern and southern walls of the De Grey pit, weathering depth ranges from 65 m to 160 m, deeper weathering to typically 150 m is encountered below the De Grey pit basin.
- Below the Swan pit, weathering depth ranges from 95 m to 185 m (RPS, 2013b).



Refer to Appendix Q for pdf version

Map 5-1 Jimblebar Hub geology

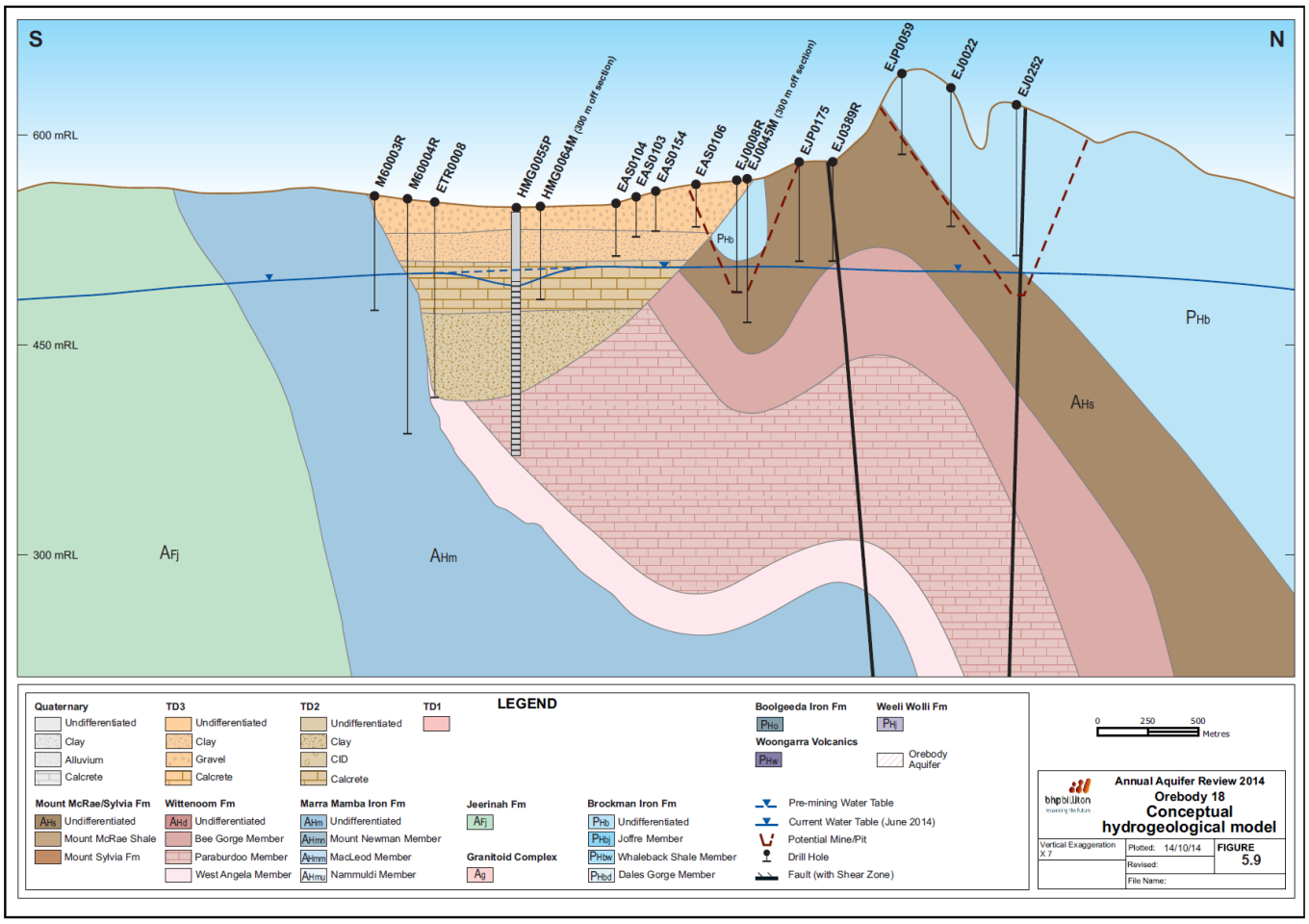


Figure 5-3 Conceptual OB18 geological cross section

The dominant stratigraphies of overburden materials from both mined (to August 2021) and unmined areas of OB17/18 are Tertiary Detritals and Dales Gorge (Table 5-5).

Table 5-5 OB17/18 overburden material proportions by stratigraphy

Stratigraphy		Abbreviation	% Volume Mined	% Volume to be Mined
Formation	**Member**			
Surface scree		SZ	1.37%	0.72%
Tertiary Detritals		TD3	19.89%	20.91%
Dykes & sills		K	0.19%	0.06%
Brockman Iron	Joffre	J3/J5	1.58%	0.00%
		J6	0.09%	0.00%
		J2	2.79%	0.00%
		J1 (Shaly)	2.58%	0.00%
	Whaleback Shale	W	5.91%	0.01%
	Dales Gorge	D4	15.48%	0.43%
		D3	17.58%	5.21%
		D2	15.89%	26.89%
	Colonial Chert	D1	10.53%	26.09%
Mt McRae Shale	Upper	RU	3.24%	13.93%
	Nodule Zone	RN	0.95%	2.62%
	Chert	RC	1.93%	3.14%
Wittenoom		O	0.43%	0.00%

Source: BHP (2021h)

5.2.2.2 OB31

The OB31 deposit is an east-west elongated deposit that extends ~4.8 km along strike and is ~1 km wide. The eastern-most extent of OB31 is truncated by sub-parallel splays of the north-east trending Wheelarra Fault. The pit shell intersects the Mt Sylvia and Mt McRae formations, Dales Gorge, Whaleback Shale, Joffre and Yandicoogina members of the Brockman Iron Formation, and Weeli Wolli Formation. Most mineralisation occurs in the Dales Gorge and Joffre members (BHPBIO, 2015). The Mt Sylvia Formation and Mt McRae Shale form the footwall along the southern pit margin, and the Yandicoogina member and Weeli Wolli Formation will form the hanging wall along the northern pit margin (BHP, 2022i).

The dominant stratigraphies of the overburden materials mined (to 2022) are the Tertiary Detritals, Weeli Wolli dolerite, and Yandicoogina Shale, Joffre and Dales Gorge members of the Brockman Iron Formation whereas yet to be mined overburden was dominated by the Yandicoogina Shale, Joffre, Whaleback Shale and Dales Gorge (Table 5-6).

Table 5-6 OB31 overburden material proportions by stratigraphy

Stratigraphy		Abbreviation	% Volume Mined	% Volume to be Mined
Formation	Member			
Surface scree		SZ	0.10%	0.00%
Tertiary Detritals		TD3	16.60%	8.30%
		TD2	1.90%	0.70%
Weeli Wolli	Dolerite	HE	11.80%	4.70%
	-	HJ	4.60%	1.50%
Brockman Iron	Yandicoogina Shale (Dolerite Sills)	YE	0.00%	0.20%
	Yandicoogina Shale	Y	20.40%	12.20%
	Joffre	J6	8.60%	7.40%
		J5 (shaly)	3.00%	5.10%
		J4	1.70%	2.80%
		J3 (shaly)	2.00%	3.30%
		J2	3.60%	5.10%
		J1 (shaly)	4.20%	7.00%
	Whaleback Shale	W	6.20%	17.10%
	Dales Gorge	D4	2.40%	4.00%
		D3 (shaly)	5.50%	7.90%
		D2	2.10%	2.00%
	Colonial Chert	D1	2.70%	6.40%
Mt McRae Shale	Upper	RU	1.70%	3.00%
	Nodule Zone	RN	0.50%	0.80%
	Chert	RC	0.10%	0.20%
	Lower	RL	0.30%	0.40%
Mt Sylvia	Undifferentiated	S	0.03%	0.10%

Source: BHP (2022i)

5.2.2.3 Jimblebar

The Jimblebar mine lies within the Ophthalmia Fold Belt and comprises a series of east-west trending folded and tilted formations:

- The Jeerinah Formation comprising interbedded shales, siltstone, chert and quartzite, and partly forming the footwall of the South Jimblebar mine pits.
- The Marra Mamba Iron Formation, which forms the rolling ridgeline south of the Copper Creek valley. It comprises Banded Iron Formation (BIF), shales and siltstone and significant haematite mineralisation forming the South Jimblebar orebody.
- The Wittenoom Formation, comprising shales, cherts and dolomite. This formation has been preferentially eroded forming a major paleo-valley in the Jimblebar region which has subsequently in-filled with Tertiary sediments. Weathering has resulted in karst-like development in the dolomites of the Paraburdoo member. The West Angela member, a shale unit, is situated between the Marra Mamba Iron Formation and the Paraburdoo dolomite member.
- Mt McRae Shale and Mt Sylvia Formation which comprise shales, BIF and cherts.
- The Brockman Iron Formation comprising a sequence of interbedded BIF, shales, siltstones and cherts and significant haematite mineralisation in the Dales Gorge and Joffre members, forming the Wheelarra and Hashimoto orebodies. The formation is resistant to weathering and forms the east-west trending Wheelarra Hill and Hashimoto ridgelines.
- The Tertiary valley fill sediments which overlie the Wittenoom Formation comprise semi-consolidated and cemented alluvium, colluvium, detritals and secondary calcrete.

A description of the local geology of the Wheelarra Hill, Hashimoto, and East and South Jimblebar deposits is provided below.

Wheelarra Hill deposits

Wheelarra Hill is composed of units from the Brockman Iron Formation which form a prominent strike ridge rising 200 m to 300 m above the surrounding countryside, notably at the northern boundary of M266SA. This Brockman Iron Formation is composed of chert, ferruginous chert and minor shale bands.

The Weeli Wolli Formation outcrops to the north of the Wheelarra Hill ridge (Map 5-1). It consists of interbedded BIF, chert and shale. Closely associated with this formation are rocks of the Woongarra Volcanics, which consist of partially metamorphosed igneous rhyolite and rhyodacite as sills or flows.

In the valley to the immediate south of the Wheelarra Hill ridge, sedimentary deposits are found, taking the form of partly consolidated and cemented colluvium in Tertiary valley fill deposits. These deposits are derived from dissection of the Proterozoic rocks.

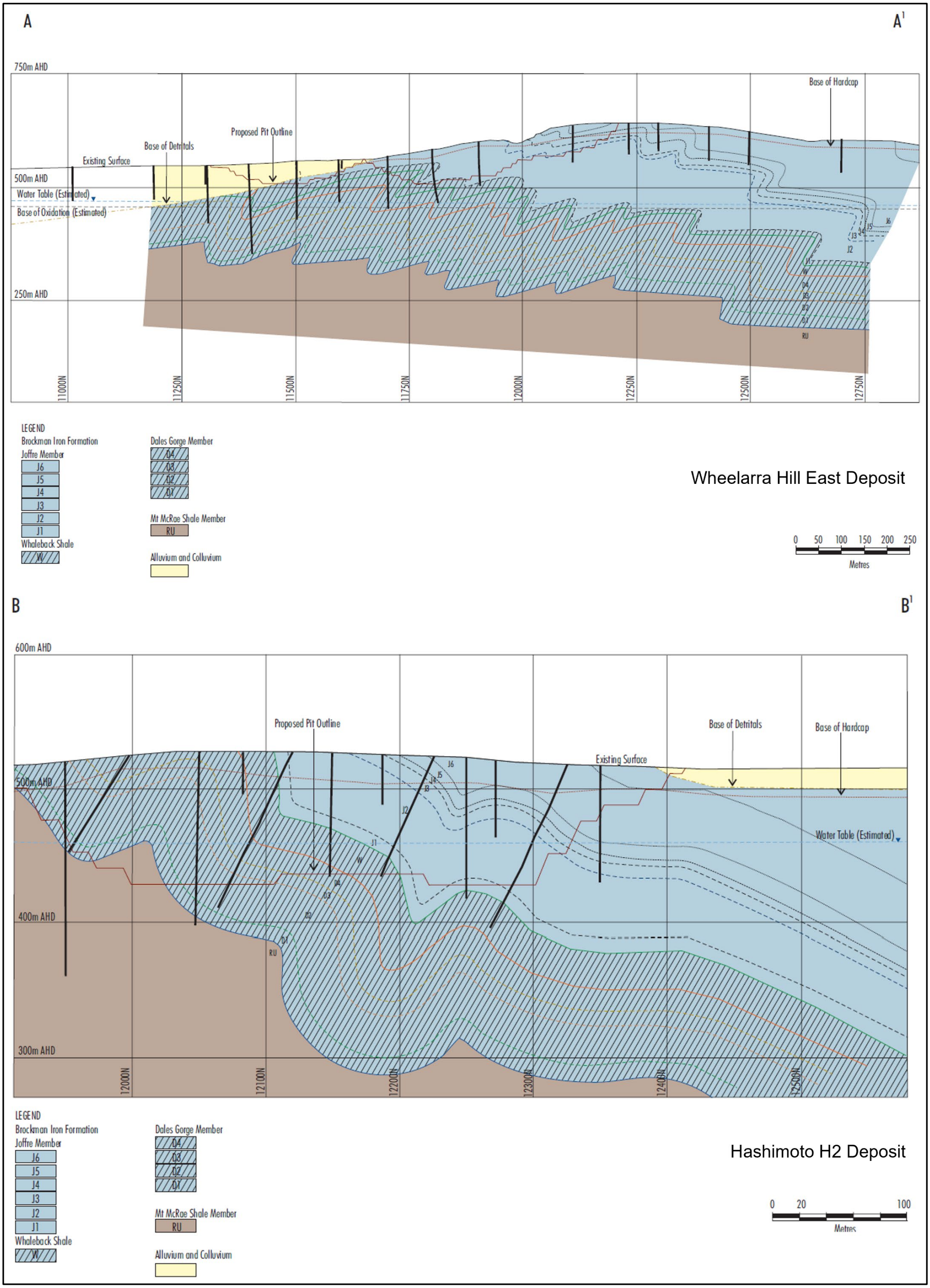
Quaternary deposits occur as scree slopes, in drainage channels and associated floodplains that lie at the base of the Wheelarra Hill ridge. A geological cross-section of the Wheelarra Hill WH3 East deposit is shown on Figure 5-4**.** Several north-west trending faults (including the Wheelarra Hill Fault) occur across the Wheelarra Hill ridge (Map 5-1).

The dominant stratigraphies of overburden materials mined from the WH123 pit (to 2022) were from the Joffre and Dales Gorge members of the Brockman Iron Formation. The dominant stratigraphies of the overburden materials yet to be mined are Tertiary Detritals and Dales Gorge (Table 5-7).

Table 5-7 Wheelarra Hill (WH1234) overburden material proportions by stratigraphy

Stratigraphy		Abbreviation	% Volume Mined	% Volume to be Mined
Formation	Member			
Dykes / sills		K	0.3%	<0.1%
Surface scree		SZ	<0.1%	-
Tertiary Detritals		TD3	6.7%	39.9%
		TD2	-	2.7%
Weeli Wolli		WW	0.3%	<0.1%
Brockman Iron	Yandicoogina Shale	Y	3.7%	<0.1%
	Joffre	J6	13%	1.4%
		J5 (shaly)	4.3%	0.2%
		J4	3.6%	0.2%
		J3 (shaly)	4.4%	0.3%
		J2	15.5%	5.3%
		J1 (shaly)	6%	2.6%
	Whaleback Shale	W	11.3%	8.0%
	Dales Gorge	D4	6.2%	7.2%
		D3 (shaly)	10.7%	9.2%
		D2	4.4%	6.0%
	Colonial Chert	D1	5.0%	7.3%
Mt McRae Shale	Upper	RU	0.1%	-
	Nodule Zone	RN	<0.1%	-
	Chert	RC	<0.1%	-
	Undifferentiated	R	4.4%	7.9%
Mt Sylvia	Undifferentiated	S	0.1%	1.4%
Marra Mamba	Nammuldi	MU	<0.1%	0.1%
Jeerinah	Undifferentiated	JN	<0.1%	<0.1%
Muccan Granite	Granites	AG	-	<0.1%

Source: BHP (2022i)



Source: BHPBIO (2010)

Figure 5-4 Wheelarra and Hashimoto geological cross sections (A1-A, B1-B)

Hashimoto deposits

The Hashimoto deposits are orebodies that are laterally continuous, extensive and form prominent ridges (albeit somewhat lower than Wheelarra Hill) along the northern boundary of M266SA. Structurally, the deposits are dominated by folding in the east with diminishing deformation effect towards relatively flat lying strata in the west.

Iron mineralisation at the Hashimoto deposits is contained within the Dales Gorge member and the Joffre member of the Brockman Iron Formation (Figure 5-4). Tertiary-aged detrital and recent alluvium / colluvium deposits are prevalent on the northern and southern sides of the Hashimoto deposits, and in some cases obscure the orebody. Where drilling has occurred below the water table, ore has been intercepted at depths exceeding 120 m.

Small to medium scale thrust faulting has been mapped in the Hashimoto deposits and is interpreted as being related to the hinges of small-scale folds. Immediately to the east of Hashimoto H1 deposit is Jimblebar Creek which acts as a natural truncation of the orebody and contains large volumes of detrital material. This creek is considered likely to represent the surface expression of a geological structure (probable fault) running between the Hashimoto H1 deposit and the H2 deposit.

The dominant stratigraphies in mined overburden at WHASH (as of 2022) were the Joffre and Dales Gorge members of the Brockman Iron Formation whereas the dominant stratigraphies of overburden yet to be mined are Tertiary Detritals, Joffre and Dales Gorge (Table 5-8). The dominant stratigraphies of overburden to be mined from H234 pit are the Yandicoogina Shale and Joffre members of the Brockman Iron Formation (Table 5-9).

Table 5-8 WHASH overburden material proportions by stratigraphy

Stratigraphy		Abbreviation	% Volume Mined	% Volume to be Mined
Formation	Member			
Not classified		NC	<0.1%	0.5%
Tertiary Detritals	Clay	CY3	0.2%	1.5%
	Siltstone	ST3	8.3%	11.0%
	Gravelly siltstone	GS3	6.1%	7.3%
	Calcrete	CA2	-	0.05%
	Clay	CY2	0.02%	0.2%
	Vuggy breccia	VB2	0.2%	4.1%
	Lignite clay	LT2	-	<0.1%
	Dykes / sills	K	0.8%	<0.1%
	Surface scree	SZ	5.7%	5.9%
Brockman Iron	Yandicoogina Shale	Y	0.1%	0.6%
	Joffre	J6	3.1%	7.8%
		J5 (shaly)	2.6%	2.3%
		J4	2.3%	1.6%
		J3 (shaly)	3.3%	2.8%
		J2	9.7%	6.8%
		J1 (shaly)	7.6%	5.9%
	Whaleback Shale	W	15.9%	14.5%
	Dales Gorge	D4	11.6%	9.6%
		D3 (shaly)	12.2%	8.8%
		D2	2.9%	1.4%
	Colonial Chert	D1	4.6%	2.9%
Mt McRae	Upper	RU	1.2%	1.7%
	Nodule Zone	RN	0.6%	1.0%
	Chert	RC	0.2%	0.4%
	Lower	RL	0.4%	0.7%
Mt Sylvia	Undifferentiated	S	0.3%	0.7%
Wittenoom	Bee Gorge	OD	-	<0.1%

Source: BHP (2022i)

Table 5-9 H235 overburden material proportions by stratigraphy

Stratigraphy		Abbreviation	% Volume to be Mined
Formation	**Member**		
Dykes / sills		K	<0.1%
Surface scree		SZ	2.4%
Tertiary Detritals		TD3	10.9%
		TD2	1.5%
Weeli Wolli		HE (dolerite)	3.1%
		HJ	7.1%
Brockman Iron	Yandicoogina Shale	YE (dolerite sills)	1.6%
		Y	19.1%
	Joffre	J6	8.9%
		J5 (shaly)	2.7%
		J4	2.3%
		J3 (shaly)	3.3%
		J2	6.4%
		J1 (shaly)	4.2%
	Whaleback Shale	W	9.0%
	Dales Gorge	D4	4.5%
		D3 (shaly)	4.4%
		D2	1.9%
	Colonial Chert	D1	2.4%
Mt McRae Shale	Upper	RU	1.8%
	Nodule Zone	RN	0.8%
	Chert	RC	0.4%
	Lower	RL	0.7%
Mt Sylvia	Undifferentiated	S	0.5%
Wittenoom	Bee Gorge	OD	<0.1%

Source: BHP (2022i)

East Jimblebar deposits

The East Jimblebar deposits are located within the Brockman Iron Formation. Mining has not yet commenced at this location. Table 5-10 summarises the overburden materials expected to be intersected by stratigraphy. The dominant stratigraphies to be mined are Tertiary sediments and the Joffre, Whaleback Shale, Dales Gorge and Colonial Chert members of the Brockman Iron Formation.

Table 5-10 East Jimblebar overburden material proportions by stratigraphy

Stratigraphy		Abbreviation	% Volume to be Mined
Formation	**Member**		
Tertiary sediments		T	19.65%
Brockman Iron	Yandicoogina Shale	Y	3.80%
	Joffre	J6	6.53%
		J3J5 (undifferentiated)	4.26%
		J2	3.97%
		J1 (shaly)	6.30%
	Whaleback Shale	W (undifferentiated_	15.57%
	Dales Gorge	D4	2.87%
		D3 (shaly)	10.09%
		D2	3.77%
	Colonial Chert	D1	13.04%
Mt McRae Shale		R (undifferentiated)	9.37%
Mt Sylvia		S (undifferentiated)	0.79%

Source: BHP (2022i)

South Jimblebar deposits

Iron mineralisation at the South Jimblebar deposit (Mindoona, Sylvania, Capricorn and Pain Killer pits) is primarily hosted within the Mt Newman member, but also occurs regularly within the MacLeod member and the base of the West Angela member of the Marra Mamba Iron Formation (Figure 5-5). High grade mineralisation is not wholly continuous across the entire orebody, being rather patchy in some places, particularly at the western end of the deposit. Low grade mineralisation can also vary greatly across sections of the deposit. The thickness of mineralisation varies significantly across strike from less than 10 m to over 200 m.

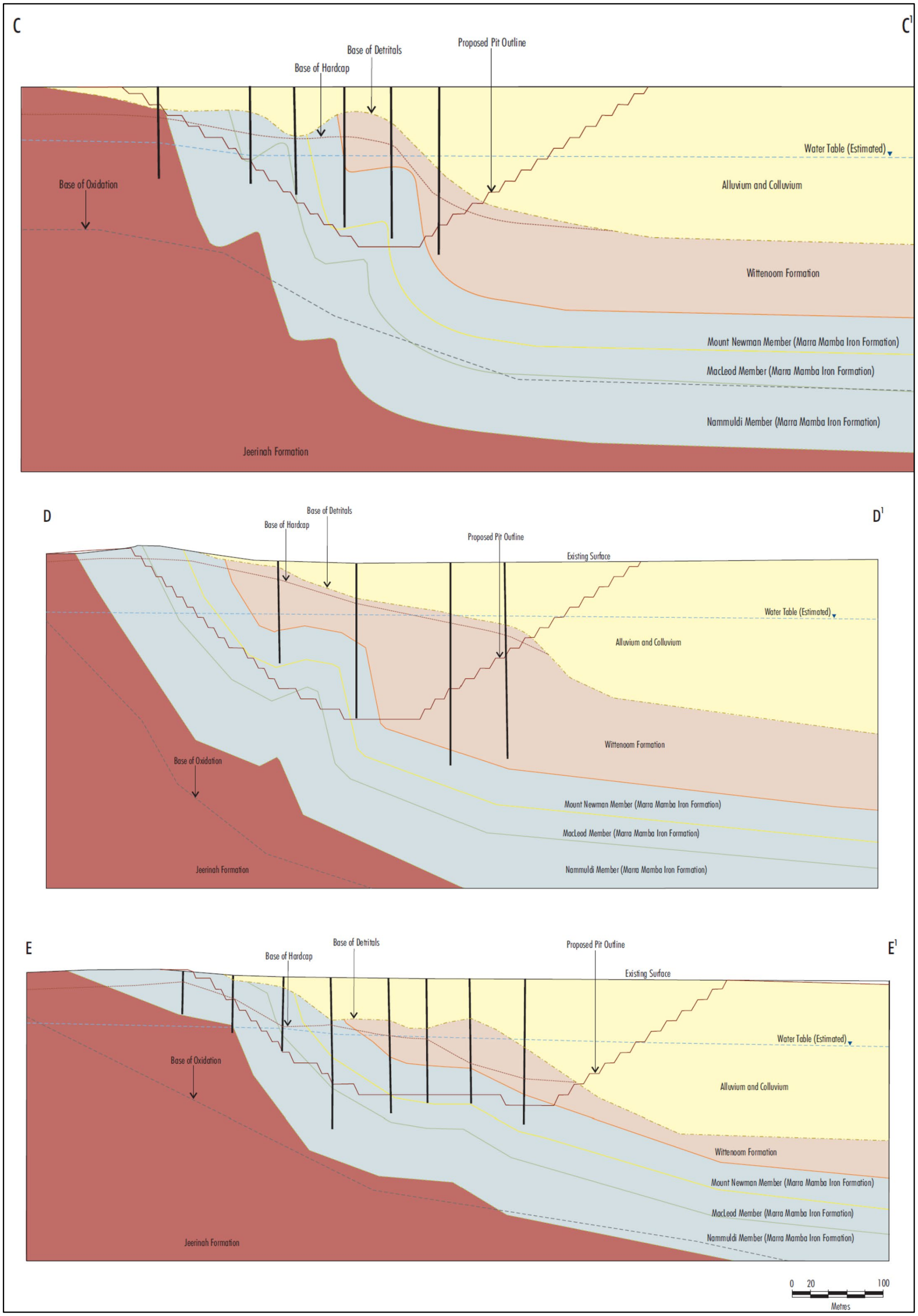
The South Jimblebar deposit varies from simple straight dipping units to intensely folded units, with some small areas of significant faulting. Folding varies from moderately to steeply dipping strata towards the north that typically do not alter greatly across strike and do not appear to directly control mineralisation.

Dominant stratigraphies in overburden (both mined and to be mined) are Tertiary Detritals, the West Angela member of the Wittenoom Formation and the MacLeod and Newman members of the Marra Mamba Formation (Table 5-11).

Table 5-11 South Jimblebar overburden materials by stratigraphy

Stratigraphy		Abbreviation	% Volume Mined	% Volume to be Mined
Formation	Member			
Not classified		NC	<0.1%	0.5%
Surface scree		SZ	5.0%	4.8%
Tertiary Detritals	Clay	CY3	-	1.1%
	Siltstone	ST3	0.1%	11.5%
	Gravelly siltstone	GS3	0.1%	1.5%
	Calcrete	CA2	-	0.01%
	Clay	CY2	-	10.4%
	Sand	SD2	-	0.2%
	Vuggy breccia	VB2	-	3.3%
	Lignite clay	LT2	-	0.1%
	Hematite conglomerate	HC1	-	0.05%
	-	TD3	35.3%	6.9%
	-	TD2	2.6%	2.1%
	-	TD1	-	<0.1%
	-	T	0.1%	13.7%
Wittenoom	Paraburdoo	OB	<0.1%	0.01%
	West Angela	WA2	12.2%	8.7%
		WA1	5.3%	2.9%
		OA		5.5%
Marra Mamba	Mt Newman	N3	3.8%	1.0%
		N2	4.5%	1.0%
		N1	5.7%	1.5%
		MN		3.0%
	MacLeod	MM	16.6%	10.9%
	Nammuldi	MU	8.7%	6.2%
Jeerinah	Undifferentiated dolerite	XX		<0.1%
	Undifferentiated	JN	<0.1%	3.1%

Source: BHP (2022i)



Source: BHPBIO (2010)

Figure 5-5 South Jimblebar geological cross sections (C^1-C, D^1-D, E^1-E)

5.3 Overburden characterisation

Materials at BHP sites are characterised based on their geological, geochemical, and physical characteristics. This characterisation process allows BHP to identify overburden types and manage their placement appropriately, including segregation and selective placement of Potentially Acid Forming (PAF) overburden. This approach is consistent with the Mine Closure (DISR, 2016a), Preventing Acid and Metalliferous Drainage (DISR, 2016c) and Mine Rehabilitation (DISR, 2016b) Leading Practice Handbooks.

5.3.1 Overburden classification system

BHP classifies overburden to inform the management of different overburden types according to their physical and geochemical properties using two interconnected classifications: Acid and Metalliferous Drainage (AMD) class, and physical property (WMAT) class (Table 5-12). These classifications have been devised to support informed management of beneficial and problematic overburden during mine planning. The preliminary classifications are incorporated into mining and geological models, with classifications confirmed though analysis and inspection of blast cone chips prior to mining. Furthermore, targeted test work is also conducted, as required, to validate AMD classification assumptions (Section 5.3.2) and physical materials properties (Section 5.3.3).

Table 5-12 Geochemical and physical overburden classification categories

Classification	Geochemical / Physical Stability Stratigraphy	Description
AMD 1	**Geochemically problematic:** All stratigraphies below water table, NAPP ≥3 kgH_2SO_4/tonne	**Adverse AMD overburden** for containment within OSAs following specific guidance due to the adverse geochemical properties leading to AMD. **Management recommended:** AMD 1: Paddocked dumped and encapsulated. AMD 2 / AMD 3: Covered by at least 10 m of geochemically stable overburden**.**
AMD 2	**Geochemically problematic:** All stratigraphies above water table, NAPP ≥3 kgH_2SO_4/tonne	
AMD 3	**Geochemically problematic:** All non-bedrock stratigraphies, i.e., detritals. NAPP ≥3 kgH_2SO_4/tonne; includes alluvial, Scree and Tertiary Detritals	
WMAT 1	**Geochemically inert** (AMD 0, NAPP <3) AND **Physically inert:** Weeli Wolli (HJ and WW), Brockman Iron Formation (Dales Gorge D2 to D4 and Joffre J4 and J3/5), and Wittenoom Formation.	**Beneficial competent and inert overburden** for placement on outer OSA surfaces due to inherent hardness, mean rock size (rockiness) and physical properties that promote a stable landform surface. **Management recommended:** To be used on final surface with a minimum thickness of 1 m.
WMAT 2 / WMAT 3	**Geochemically inert** (AMD 0, NAPP < 3) AND **Physically problematic**: Surface scree, Tertiary Detritals, Tertiary sediments, Weeli Wolli (dolerite), Dykes and Sills, Mt Sylvia Formation, Mt McRae Shale Formation, Brockman Iron Formation (Whaleback Shale, Joffre (J1, J2, J3, J5, J6), Colonial Chert and Yandicoogina Shale members), Wittenoom, Marra Mamba Iron Formation and Jeerinah Formation	**Potential (WMAT 2) and Certain (WMAT 3)** geochemically inert but physically problematic overburden for placement within OSAs, beneath outer surface material due to the unfavourable physical properties (dispersive, fine grained) that promote a highly erosive and unstable landform surface. **Management recommended:** Avoid placement on final surface. To be placed below WMAT 1.

Notes: NAPP – Net Acid Production Potential (see below for explanation)

Further detail on the geochemical and physical classification systems summarised in Table 5-12 is provided in the relevant sub-sections below.

5.3.1.1 Geochemical classification

Introduction to AMD

AMD is used to describe low-quality seepage or drainage that has been affected by the oxidation of sulphide minerals (primarily pyrite), and / or by the dissolution of acid generating sulphate minerals (such as jarosite, melanterite, etc).

AMD may be produced when sulphide minerals are exposed to oxygen and water, or when acid sulphate salts are leached. Oxidation of sulphide minerals and / or leaching of acid sulphate salts may result in the production of sulphate (SO_4^{-2}), acid (H+), release of metals (Mg, Ca, Fe, Al, Mn, Zn, Cu, Ni, As, etc.) and salinity (SO_4^{-2}, Ca, Mg, HCO_3^-, Cl^-) depending on mineralogy. For AMD to occur, a sample must contain sulphides or acid generating sulphates. If a sample does not contain reactive sulphur, then AMD reactions cannot occur.

AMD can be acidic, pH circum-neutral, alkaline or saline (INAP, 2014; DISR, 2016c). Whether contact water is acidic and metalliferous (Acid [Rock] Drainage), neutral / alkaline and metalliferous (Neutral and Metalliferous Drainage (NMD)) or just saline (high sulphate, Saline Drainage) largely depends on the relative proportion of sulphide minerals (acid generating) and carbonate minerals (acid neutralising) in the source materials.

Acidic drainage is generated when the acid generating capacity of a material exceeds its acid buffering capacity (Acid Neutralising Capacity; ANC). In this case, the drainage is acid, contains elevated metal concentration and is saline (mostly sulphate salinity).

NMD is formed when the acid generating capacity of a material is less than its ANC. In this case, the drainage is near neutral / alkaline (around pH 6-8) and can contain low levels of metals that are soluble at higher pH if they are present (manganese, cobalt, zinc, arsenic). Salinity is dominated by sulphate, calcium, magnesium and bicarbonate.

Saline drainage (oxidative) occurs when the acid buffering capacity of a system far exceeds its acid generating capacity; in this case, drainage pH is alkaline (> pH 8) and saline (mostly sulphate, calcium, magnesium, carbonate salinity) and has limited (potentially manganese) or no metals in solution.

The hazard for metalliferous and saline drainage associated with AMD reactions is linked to total sulphur (and specifically sulphide sulphur) concentrations. The higher the sulphur and ANC concentrations in Non-Acid Forming (NAF) materials, the higher the potential to generate NMD and saline drainage. It is generally accepted that neutral metalliferous and saline drainage are generally of concern for materials characterised by total sulphur concentration above 1 wt.%.

Distinct from AMD reactions, other potential processes that may release salinity and metals are associated with the dissolution of readily soluble mineral groups such as salts, some sulphates (gypsum, epsomite), and carbonates (non-oxidative metalliferous and saline drainage). Some of these mineral groups may contain impurities and / or metals absorbed on their surface that may impact the quality of contact water upon mineral dissolution. However, based on the mineralogy of the stratigraphic units mined across BHP deposits, these minerals are not expected to be present in large quantities. Thus, it is not expected that non-oxidative metalliferous and saline drainage will be a key process impacting on contact water quality. Leach test data can assist with understanding the impacts on contact water quality associated with oxidative and non-oxidative processes.

Use of competent rock (WMAT 1, which is rocky and hard) on the final landform surface will minimise the potential for mobilisation of salts / metals associated with non-oxidative weathering in run-off and contact water.

BHP geochemical classification system

BHP classifies PAF material according to the Net Acid Production Potential (NAPP) system. The NAPP classification evaluates the balance between acid generating and acid neutralising potential of a sample, or mining or geological block. Where unweathered (un-oxidised) material is assessed as having a NAPP ≥ 3 kg H_2SO_4/t, it is classified as AMD 1. Weathered and detrital materials having a NAPP ≥ 3 kg H_2SO_4/t are classified as AMD 2 or AMD 3 respectively (Table 5-12). AMD 1, AMD 2 and AMD 3 overburden are PAF and are managed according to their geochemical hazard. Thus, the current AMD classification manages geochemical risk associated with sulphide oxidation (pyrite) and leaching of acid sulphate salts from already oxidised materials.

The BHP classification uses primary assay data to estimate the acid generating and acid neutralisation capacity of a sample. Regardless of the acid generating mineral (i.e., sulphides or sulphates), the classification embedded in the geological and mining models assumes that all sulphur is associated with pyrite, which it is usually not, and thus is especially conservative for AMD 2 and AMD 3 overburden types. All mined materials are classed into inert (AMD 0), or reactive (AMD 1, AMD 2, AMD 3) groups based on a NAPP cut-off value of 3 kg H_2SO_4/t, as follows:

- **NAPP <3 kg H_2SO_4/t:**
  - **AMD 0**: inert overburden which is then segregated based on its physical properties into WMAT 1, WMAT 2 and WMAT 3 overburden type (see below).
- **NAPP ≥ 3 kg H_2SO_4/t:**
  - **AMD 1**: geochemically reactive overburden associated with fresh material (i.e., overburden located below the water table and assumed to contain pyrite).
  - **AMD 2**: potentially geochemically reactive overburden located above the water table.
  - **AMD 3**: associated with detrital lithologies and containing potentially geochemically reactive overburden.

AMD 1 overburden is likely to contain fresh sulphides (i.e., pyrite) and thus, poses the highest risk to water quality. AMD 2 materials are unlikely to contain sulphide minerals, however, they may contain acid sulphate minerals such as, alunite, jarosite, Na-alum. AMD 3 materials may contain fresh sulphides (pyrite) particularly in the lignite horizons associated with the Tertiary Detritals 2 (TD2) unit, while other stratigraphies within the detritals may contain acid sulphate minerals. AMD 1, AMD 2 and AMD 3 overburden can generate water of poor quality and thus require management. However, acid sulphate salts minerals are sparingly soluble and pose a much lower risk to water quality compared to AMD 1 type overburden, as recently determined from on-going AMD studies conducted by BHP.

5.3.1.2 Physical classification

The WMAT classification manages physical property risks associated with how AMD 0 material responds to weathering. AMD 0 overburden is segregated into three classes based on the propensity of each of the mined stratigraphic units to withstand erosion (Table 5-12):

- **WMAT 1**: comprises stratigraphies that are blocky, competent and resistant to erosion. This material is recommended for placement on the final surface with a minimum thickness of 1 m and used for armouring of final landforms. WMAT 1 is considered an asset, and should be differentially handled, stockpiled and / or placed on landforms in strategic locations.
- **WMAT 2**: is potentially problematic overburden, with properties to be confirmed during mining. WMAT 2 overburden requires management and is to be placed at least 1 m below the final surface of OSAs.
- **WMAT 3**: known non-competent stratigraphies, to be placed at least 1 m below the final surface of OSAs.

5.3.2 Geochemical characterisation

As required by the WAIO AMD Management Standard (WAIO, 2022a), AMD Risk Assessments have been undertaken for OB17/18 (Earth Systems, 2015) , OB31 and Jimblebar (BHP, 2022i). SRK (2022) has also conducted a review of the potential for NMD more broadly across WAIO's Pilbara deposits. The outcomes of these assessments are summarised below.

Summary of key points

- An AMD source hazard assessment has been conducted for the Jimblebar Hub deposits based on the outputs from the mining model which in turn relies on the chemical assay data contained within BHP's drill-hole database. This information is supplemented by BHP's environmental geochemistry database which is used to refine assessments of the potential AMD hazard of key materials based on potential acidity, neutralising potential, and leaching of metals / metalloids, and salts.
- The AMD source hazards associated with overburden and low-grade ore have been assessed as:
  - Low at OB17, OB18, OB31, WH4, H234 and South Jimblebar.
  - Low to moderate at WH123 due to ~3.4 Mm^3 (1.1%) of overburden classified as AMD 2 (refer to Section 5.3.1.1 for classification system).
  - Moderate to high at:
    - WHASH due to ~1.9 Mm^3 (1.2%) of the yet to be mined overburden classed as AMD 1.
    - East Jimblebar due to ~1.8 Mm^3 (0.8%) of yet to be mined overburden classed as AMD 1.
- The AMD source hazards associated with wall rock have been assessed as:
  - Low at OB17, OB31, WH4, H234 and South Jimblebar.
  - Moderate to high at WH123 due to a predicted 189,300 m^2 exposure of AMD 2 (2.3% of the WH123 main pit shell).
  - High at:
    - OB18 as PAF blocks represent ~5% of the total wall rock.
    - WHASH due to a predicted 97,700 m^2 exposure of AMD 1 (1.4% of the pit shell).
    - East Jimblebar due to a predicted 113,500 m^2 exposure of AMD 1 (~2% of the pit shell).

  However, it should be noted that, while test work conducted by Earth Systems (2018) showed a strong, positive and linear correlation between a sample's surface area and wall rock acid generation, the estimated annual acidity generation rate was low. A wall rock exposure of 1,000 m^2 containing 1 wt.% FeS_2 would only generate 27 to 34 kg of H_2SO_4/year and, therefore, represents a small component of in-pit acidity loads which are more likely to be controlled by variables such as sulphidic rocks spalled off reactive batters and lying on old bench tops due to blasting or weathering, or reactive rubble on pit floors.
- While some elements are enriched in the solid matrix (arsenic, manganese, molybdenum, antimony and selenium) at Jimblebar Hub, elemental concentrations in circum-neutral leachate, from short term leach tests, were generally at or below the limit of reporting. This suggests a low contaminant mobility potential for Jimblebar Hub NAF samples and thus a low potential for NMD. However, the leachate data for samples with acidic leachate chemistry (pH 2.4 to 3.3) suggests potential mobility of aluminium, arsenic, copper, iron, nickel and zinc.
- These results are consistent with those of a detailed assessment of leach extract data from samples across BHP's Pilbara operations which focused on identifying possible controls on leaching at near-neutral pH, and concluded that:
  - Most elements are present in the solids in a form that is not readily soluble, either due to slow reaction kinetics, or because a solubility limit prevents further dissolution.
  - The key control for most element mobilisation is represented by pH, not sulphur concentration.
  - For many parameters, low solubility at neutral / alkaline pH dictates low dissolved concentrations irrespective of the sulphur content in the solid. For some parameters (e.g., Se, Mo) there is evidence that leachable quantities are lower in low sulphur samples, suggesting that the potential for NMD from low sulphur materials is low. The Jimblebar Hub deposits generally contain very low sulphur.
  - When considering the influence of more soluble mineral sources (e.g., gypsum, halite), a low water to solids contact ratio (such as expected within OSAs) may result in dissolved concentrations in early seepage (the 'initial flush') being higher than indicated in leach extract datasets. However, because most of the readily soluble minerals are present in limited supply, they would be expected to be leached from the overburden within a relatively short period.

5.3.2.1 OSA and stockpile AMD source hazard

The source hazard assessments for overburden and low-grade ore[11] are based on the outputs from the mining model which in turn relies on the chemical assay data contained within the BHP drill-hole database. This information is supplemented by BHP's environmental geochemistry database (refer to Section 5.3.2.3) which is used to refine assessments of the potential AMD hazard of key materials based on potential acidity, neutralising potential, metals / metalloids, and salts. Acid Base Accounting (ABA) data are used validate the acid generation characteristics of overburden through determination of the ANC and the maximum potential acidity (MPA), and elemental enrichment assessment and leach testing are used to assess the potential for metal / metalloid release (BHP, 2022i).

OB17/18

Mining model AMD classification

Total PAF material mined and yet to be mined from OB17/18 is 473,000 Bank Cubic Metres (BCM) according to the August 2021 mining model (Table 5-13).

Table 5-13 Volumes of OB17/18 overburden by AMD class

AMD Class	Volume Mined to Date (BCM)	Volume Not Yet Mined (BCM)	Total (BCM)
0	66,087,200	2,498,000	68,585,200
1	88,400	12,000	100,400
2	332,800	11,600	344,400
3	28,000	-	28,000

Sulphur content

Earth Systems (2015) conducted an AMD risk assessment for the OB17/18 deposits based on chemical assay data contained within the BHP drill hole database (5,476 samples from OB17 and 22,244 from OB18). The sulphur values within samples for both the OB17 and OB18 orebodies were low, with the 95th percentile value for all stratigraphies being less than 0.1 wt.% (Appendix E-1). Within OB17, the maximum sulphur values were low and found within the Mt McRae Shale (0.95 wt.%), followed by Dales Gorge (0.64 wt.%) and Mt Sylvia (0.47 wt.%). At OB18, maximum sulphur values were higher (Earth Systems, 2015):

- 12.0 wt.% in the Mt McRae Shale;
- 3.88 wt.% in the Mt Sylvia;
- 2.19 wt.% in the Whaleback Shale; and
- 1.22 wt.% in the Dales Gorge.

Net acid production potential

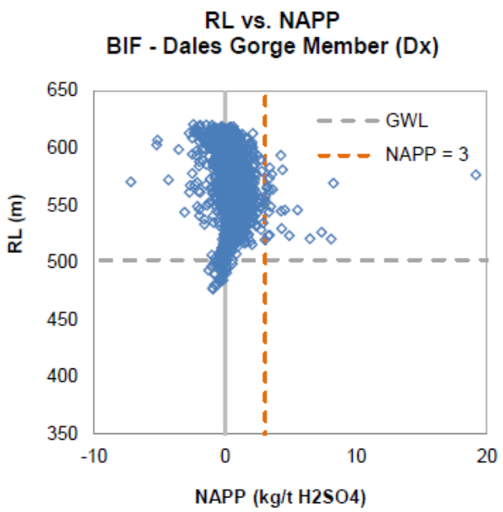
Analysis of geological logs by Earth Systems (2015) showed that dolomite was the key acid neutralising carbonate mineral, and this was used to calculate an indicative (conservative) ANC for each sample within the drillhole database. The ANC was then used in conjunction with MPA derived from the sulphur values to calculate NAPP (Appendix E-1). As discussed in Section 5.3.2, a NAPP value of greater than 3 kg/t H_2SO_4 is considered to be PAF according to BHP's classification system.

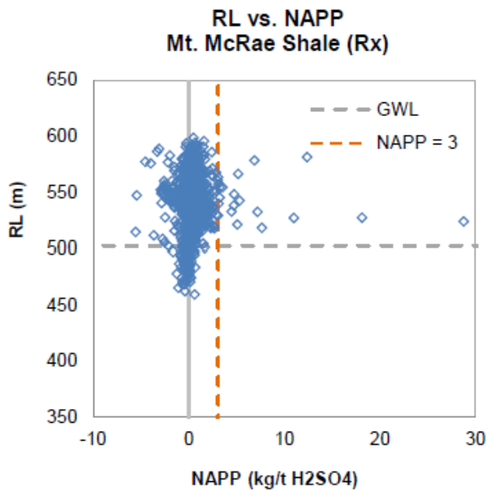
The 95th percentile NAPP values for all stratigraphies were below 3 kg/t H_2SO_4 at OB17. Most PAF classified intervals within the OB17 deposit were identified within the Mt. McRae Shale Formation and the Dales Gorge member (Figure 5-6) (Earth Systems, 2015). Very little ANC was found to be present in the OB17 deposit. The few high ANC intervals were associated with undefined rock types.

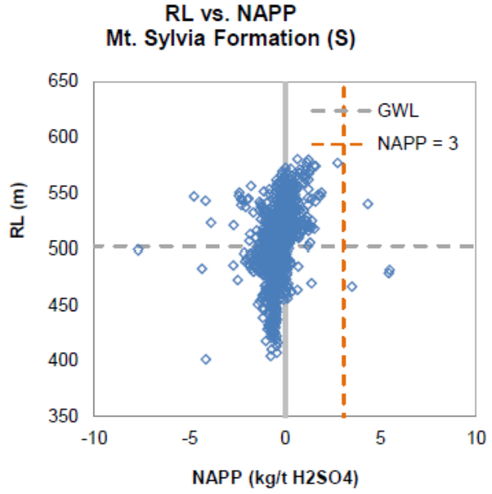
Only 1.3 % of the OB17 overburden intervals (as opposed to ore or wall rock) were classified as PAF. The base of oxidation within the OB17 deposit is unclear from the data provided, however relative to the pre-mining water table, it is likely that the sulphur within these samples is in its oxidised form, present as secondary minerals (e.g., gypsum, jarosite or alunite). While some of these sulphate minerals have the potential to release acid upon dissolution, it is likely that the NAPP of some or all of the intervals is overestimated (Earth Systems, 2015).

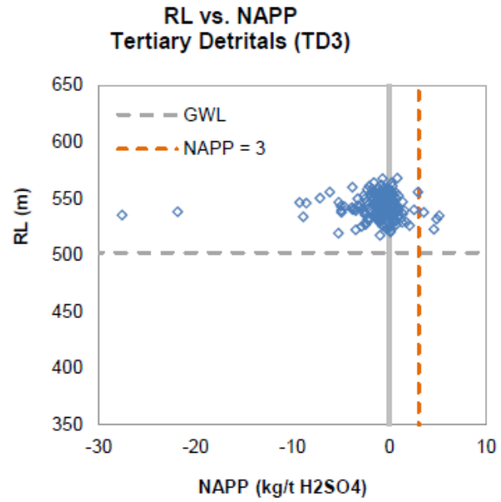
Earth Systems (2015) concluded that AMD is unlikely to be generated from OB17 (eastern part of Swan pit) overburden or temporary ore stockpiles as only 1.3% of the overburden drill hole intervals were classified as PAF.

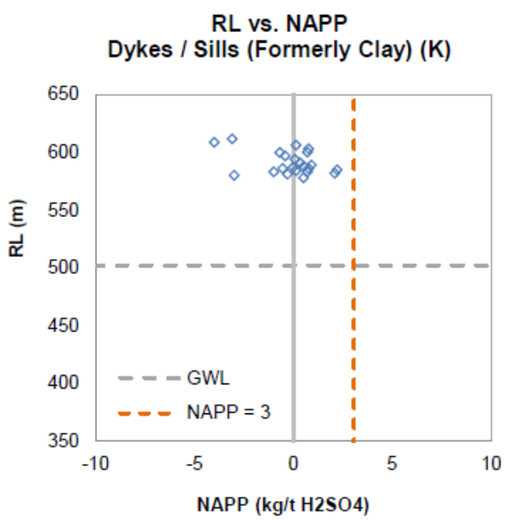
[11] Note that while all overburden (not ore) is likely to be stockpiled in the OSAs, low-grade ore may be stockpiled separately for blending and, ultimately, shipped out of site. The proportion of low-grade ore regarded as ore rather than overburden is generally not known until excavated, and may change as a function of market conditions. There is, therefore, potential for some or all of the low-grade ore to be permanently stored in the OSAs (BHP, 2022i)

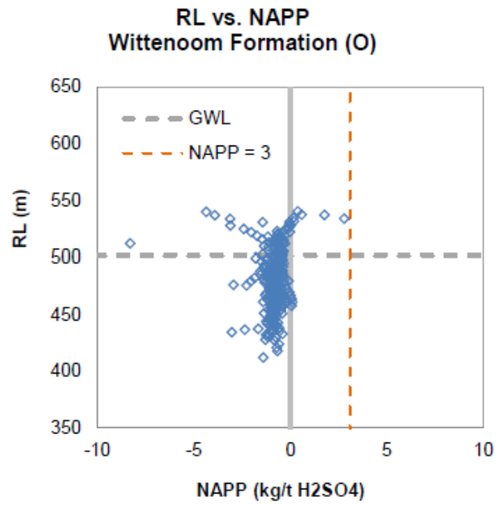


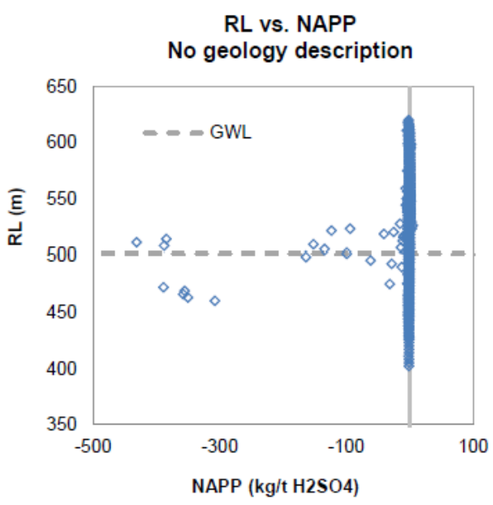












Source: Earth Systems (2015)

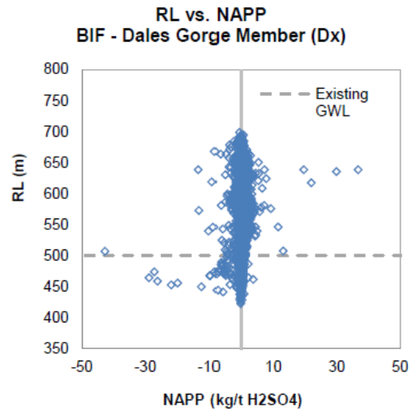
Notes: NAPP = 3 kg H_2SO_4/t is plotted where appropriate to distinguish between PAF and NAF classified intervals. The indicative pre-mining groundwater level (502 mRL) is plotted for reference. Note the different scales used on the x-axes when interpreting these charts.

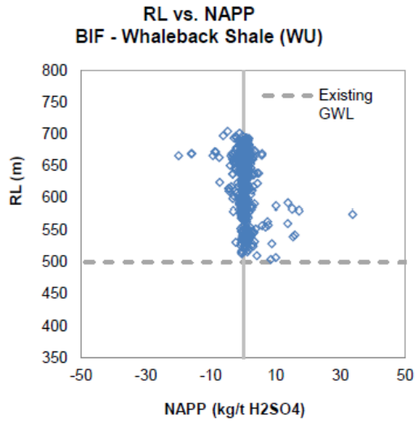
Figure 5-6 NAPP vs RL for stratigraphies intersected by the OB17 deposit

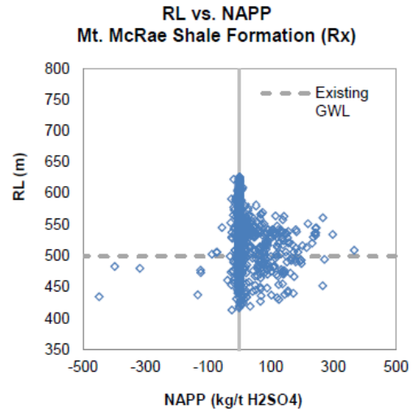
At OB18, the 95th percentile NAPP value was 28 kg/t H_2SO_4 for the Mt McRae Shale but less than 3 kg/t H_2SO_4 for all other stratigraphies (Appendix E-1). The median NAPP values were less than 0.5 kg/t H_2SO_4 for all stratigraphies. The majority of elevated NAPP values were associated with Mt. McRae shale intervals (generally the RC and RN units), however some samples from other formations also had elevated NAPP (Figure 5-7) (Earth Systems, 2015).

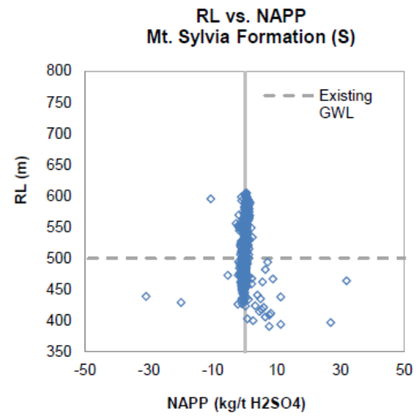
Intervals at OB18 with high ANC were generally associated with very little or no sulphur and were considered likely to represent calcite dominated horizons. The highest ANC values were associated with the Tertiary Detritals, which are known to contain calcrete horizons. Calcrete can potentially be used as an AMD neutralising material (Earth Systems, 2015).

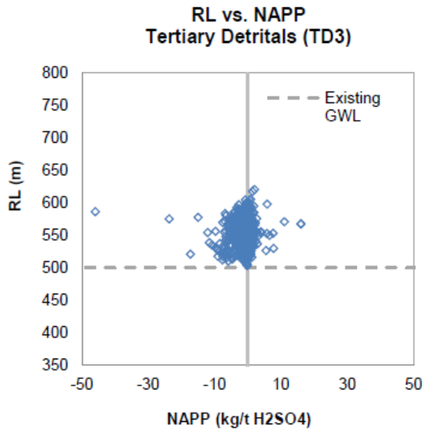
Earth Systems (2015) calculated that approximately 98% of the OB18 overburden was classified as NAF and only 2% PAF. Most of the PAF overburden blocks were above the pre-mining water table suggesting that it is likely that the sulphur within these samples would be in its oxidised form and present as secondary minerals (e.g., gypsum, jarosite or alunite) (i.e., represents AMD 2 material as opposed to AMD 1).

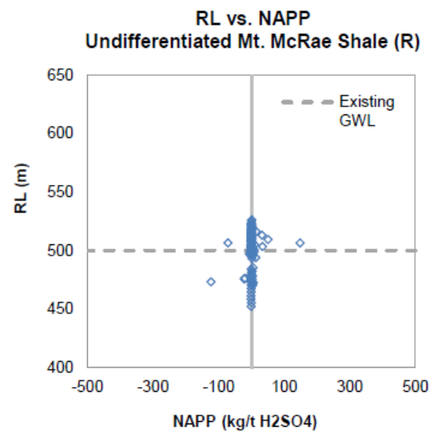


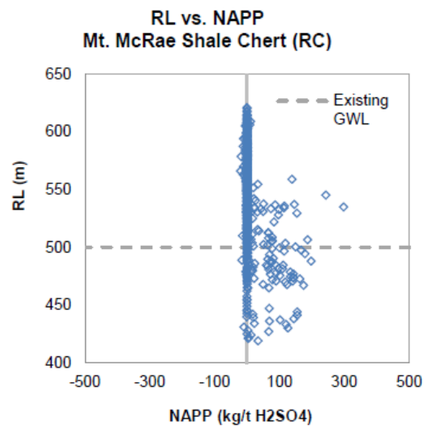


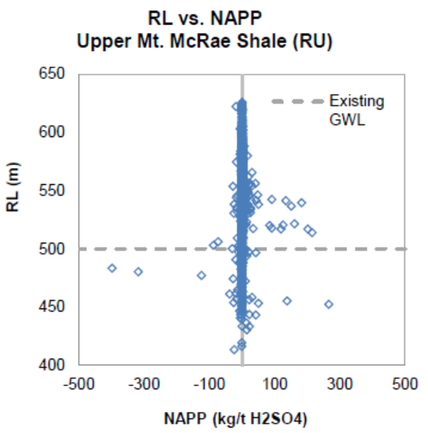


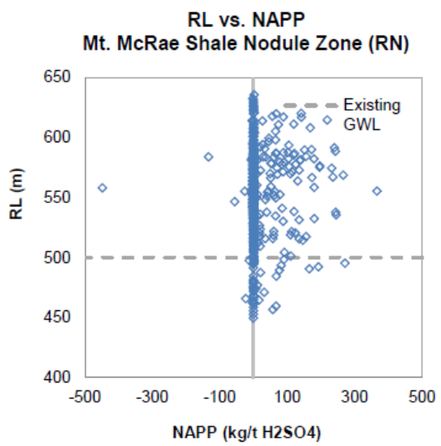












Source: Earth Systems (2015)
Notes: The indicative pre-mining groundwater level (502 mRL) is plotted for reference. Note the different scales used on the x-axes when interpreting these charts.

Figure 5-7 NAPP vs RL for stratigraphies intersected by the OB18 deposit

OB31

Mining model AMD classification

Based on the mining model BHP (2022i) concluded that the AMD hazard associated with OB31 is very low. No AMD 1 overburden or low-grade ore has been mined (to 2022) and only 0.02% of overburden yet to be mined has been classified as AMD 1. Approximately 21,300 m^3 (0.08%) of overburden mined to 2022 has been classified as AMD 2, but no further volumes of AMD 2 or 3 overburden, or low-grade ore are predicted to be mined (Table 5-14).

Table 5-14 Volume of OB31 overburden & low grade ore by AMD class

Status	Material type	AMD 0 (BCM)	AMD 1 (BCM)	AMD 2 (BCM)	AMD 3 (BCM)	Total Volume (BCM)
As-mined	Overburden	27,768,400	0	34,800	0	27,803,200
	Low grade ore	1,280,400	0	0	0	1,280,400
To-be-mined	Overburden	126,932,000	18,800	0	0	126,950,800
	Low grade ore	10,533,200	0	0	0	10,533,200
Total		166,533,200	18,800	34,800	0	166,567,600
Total (%)		>99.9%	<0.1%	<0.1%	0%	100.00%

Source: BHP (2022i)

Sulphur content

The median total sulphur content for overburden and low-grade ore blocks in the mining model (which is based on the assay data from 416,419 samples) was found to be low for both the mined and to be mined overburden and low-grade ore (Figure 5-8) (BHP, 2022i):

- Mined overburden and low-grade ore had median total sulphur values of approximately 0.01 wt.% across all stratigraphies. When considered separately, individual stratigraphies had median total sulphur concentrations below 0.05 wt.%.
- For yet to be mined material, the median total sulphur content was found to be approximately 0.01 wt.% for both overburden and low-grade ore considered together, and <0.05 wt.% when individual stratigraphies were considered separately.

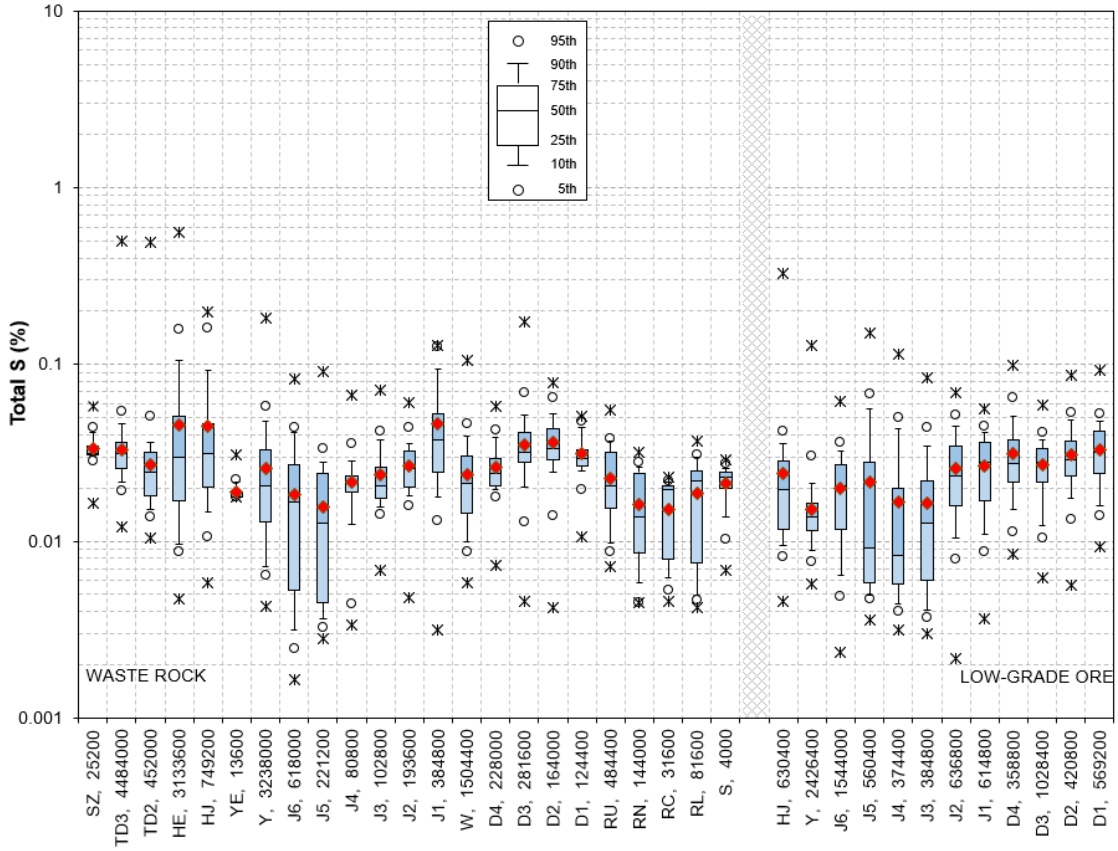
No high (≥1 wt.%) sulphur overburden blocks were identified in the as-mined material and only a minor amount of high sulphur overburden (28,000 m^3) was predicted to be mined within the Weeli Wolli Formation (HE and HJ). This high sulphur overburden is <0.1% of the total to-be-mined overburden (BHP, 2022i).

For as mined overburden, low to moderate (0.2 - 0.5 wt.%) and moderate (0.5 - 1 wt.%) overburden sulphur blocks were limited to the Weeli Wolli Formation (HE and HJ) and Tertiary Detritals (TD2 and TD3). Low to moderate sulphur overburden constituted 0.3% of the total as-mined overburden and moderate sulphur material constitutes <0.01% of the total as-mined overburden (BHP, 2022i).

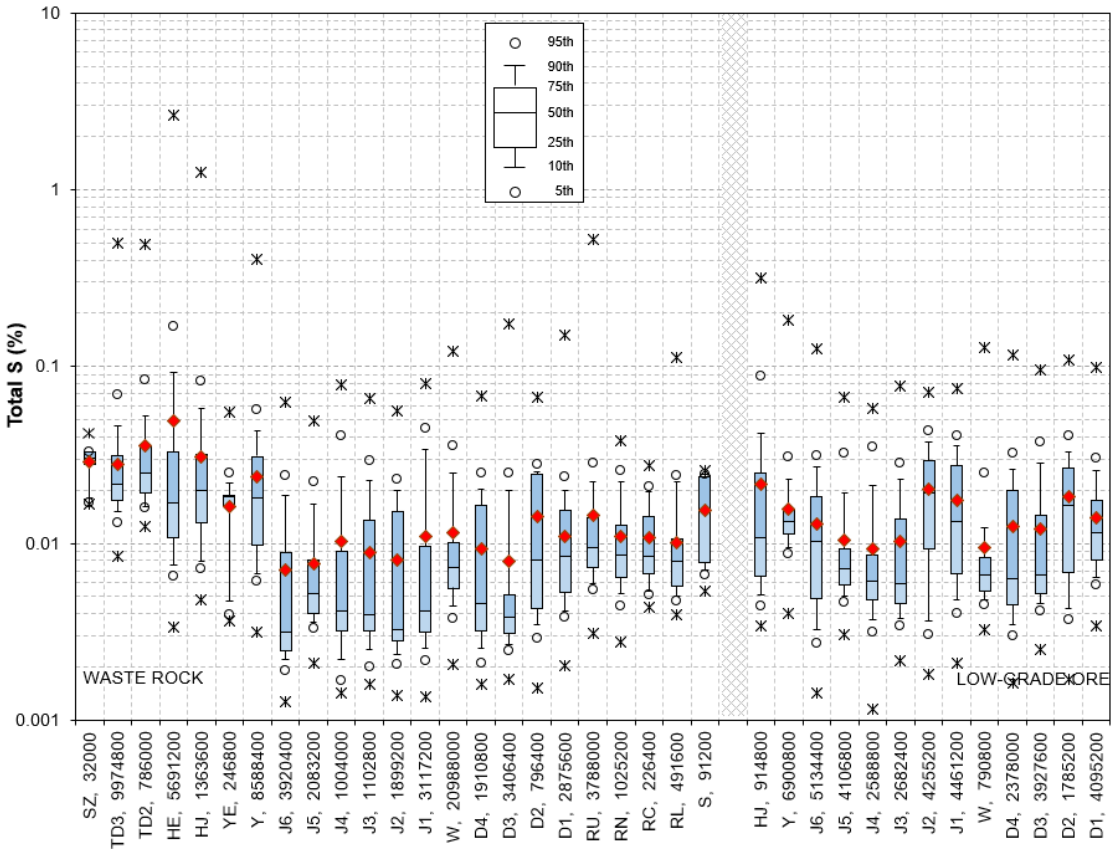
For overburden yet to be mined, approximately 72,400 m^3 of moderate total sulphur (0.5 - 1 wt.%) overburden has been predicted to be mined and is limited to the Weeli Wolli Formation (HE and HJ), Mt McRae Shale (RU), and Tertiary Detritals (TD3) (BHP, 2022i).

Acid neutralising capacity

For as-mined overburden, the median calculated ANC within the mining model was approximately 3 kg H_2SO_4/t and 1.8 kg H_2SO_4/t for overburden and low-grade ore, respectively, with materials from the Weeli Wolli Formation (HJ and HE) showing relatively higher ANC distribution (median ANC values ≥30 kg H_2SO_4/t for overburden) in comparison to other stratigraphies. For yet to be mined overburden, the median modelled ANC was approximately 2.5 kg H_2SO_4/t and 1.8 kg H_2SO_4/t for overburden and low-grade ore, respectively, with overburden from the Weeli Wolli Formation (HE) and Tertiary Detritals showing relatively higher ANC distribution (median ANC ≥30 kg H_2SO_4/t) (BHP, 2022i).



As-mined overburden - distribution of sulphur as a function of stratigraphy



To be mined overburden – distribution of sulphur as a function of stratigraphy

Notes: the volume of each stratigraphic unit (m^3) is reported next to the rock type ID.
Source: BHP (2022i)

Figure 5-8 Distribution of sulphur at OB31 by stratigraphy

Jimblebar

Mining Model AMD classification

Based on the mining model, the source hazard associated with overburden has been assessed as low for WH4, H234 and South Jimblebar, low to moderate for WH123, and moderate to high for WHASH and East Jimblebar. Approximately 98.7% of the total mined overburden and low-grade ore volumes, and 99.5% of overburden and low-grade volumes that are yet to be mined have been classified as AMD 0 (Table 5-15) (BHP, 2022i).

AMD 1 material is restricted to approximately 0.4% (3,666,900 m^3) of the overburden that has yet to be mined. No AMD 1 material was identified in the overburden or low-grade ore mined to 2022. The bulk (>99%) of the AMD 1 material is present in the WHASH and East Jimblebar deposits and is associated exclusively with overburden (Table 5-15) (BHP, 2022i).

AMD 2 blocks comprise approximately 1.3% (2,794,550 m^3) of the total mined volume and 0.1% (1,116,975 m^3) of the volume of material yet to be mined. The bulk of the AMD 2 material (~86%) is present in the WH123 deposit. AMD 2 material is mostly associated with overburden (Table 5-15) (BHP, 2022i).

AMD 3 material is restricted to the overburden that has yet to be mined and comprises <0.1% (125,125 m^3) of the total volume. It is present in the WH123, WHASH, H234 and South Jimblebar deposits (Table 5-15) (BHP, 2022i).

Table 5-15 Volume of Jimblebar overburden & low-grade ore by AMD class

Deposit	Status	Material type	AMD 0 (BCM)	AMD 1 (BCM)	AMD 2 (BCM)	AMD 3 (BCM)	No Class (BCM)	Total Volume (BCM)
WH123	As-mined	Overburden	98,604,375	0	2,654,375	0	0	101,258,750
		Low grade ore	774,375	0	625	0	0	775,000
	To-be-mined	Overburden	209,681,250	4,375	713,125	41,875	0	210,440,625
		Low grade ore	780,000	0	0	0	0	780,000
W4	As-mined	Overburden	30,217,600	0	35,200	0	0	30,252,800
		Low grade ore	1,299,200	0	5,600	0	0	1,304,800
	To-be-mined	Overburden	0	0	0	0	0	0
		Low grade ore	0	0	0	0	0	0
WHASH	As-mined	Overburden	47,627,500	0	96,875	0	0	47,724,375
		Low grade ore	2,186,875	0	1,875	0	0	2,188,750
	To-be-mined	Overburden	157,940,000	1,878,125	92,500	47,500	0	159,958,125
		Low grade ore	4,599,375	0	1,250	0	0	4,600,625
H234	As-mined	Overburden	0	0	0	0	0	0
		Low grade ore	0	0	0	0	0	0
	To-be-mined	Overburden	162,245,000	0	25,000	23,750	0	162,293,750
		Low grade ore	3,035,625	0	7,500	0	0	3,043,125
East Jimblebar	As-mined	Overburden	0	0	0	0	0	0
		Low grade ore	0	0	0	0	0	0
	To-be-mined	Overburden	220,458,400	1,782,400	172,800	0	0	222,413,600
		Low grade ore	10,408,400	0	4,400	0	0	10,412,800
South Jimblebar	As-mined	Overburden	29,160,800	0	0	0	1,600	29,162,400
		Low grade ore	149,200	0	0	0	0	149,200
	To-be-mined	Overburden	159,329,200	2,000	100,400	12,000	792,400	160,236,000
		Low grade ore	470,000	0	0	0	0	470,000
Total	**As-mined**	**All as-mined**	**210,019,925**	**0**	**2,794,550**	**0**	**1,600**	**212,816,075**
	To-be mined	**All to be mined**	**928,947,250**	**3,666,900**	**1,116,975**	**125,125**	**792,400**	**934,648,650**
% Total	**As-mined**	**All as-mined**	**98.7%**	**N/A**	**1.3%**	**N/A**	**<0.1%**	**100.0%**
	To-be mined	**All to be mined**	**99.4%**	**0.4%**	**0.1%**	**<0.1%**	**0.1%**	**100.0%**

Source: BHP (2022i)

Sulphur content

A summary of the sulphur distribution within the overburden and low-grade ore blocks in the mining model (which is based on the assay data from >100,000 samples) for the Wheelarra, WHASH, Hashimoto, East Jimblebar and South Jimblebar deposits is provided below.

WH123

The median sulphur content has been found to be low for both mined and to be mined overburden and low-grade ore (Figure 5-9) (BHP, 2022i):

- Mined materials had median total sulphur values of approximately 0.03 wt.% across all stratigraphies. All overburden and low-grade ore stratigraphies apart from the Jeerinah Formation (JN) had a total sulphur concentration below 0.1 wt.%. The Jeerinah Formation overburden had a median sulphur concentration of 2.9 wt.%. This stratigraphy, however, represents <0.1% of the total overburden expected from the WH123 orebody (Table 5-7, Section 5.2.2.3).
- For overburden and low-grade ore that has yet to be mined, the median total sulphur across all stratigraphies was approximately 0.02 wt.%. Each stratigraphy also had a median total sulphur concentration below 0.1 wt.%.

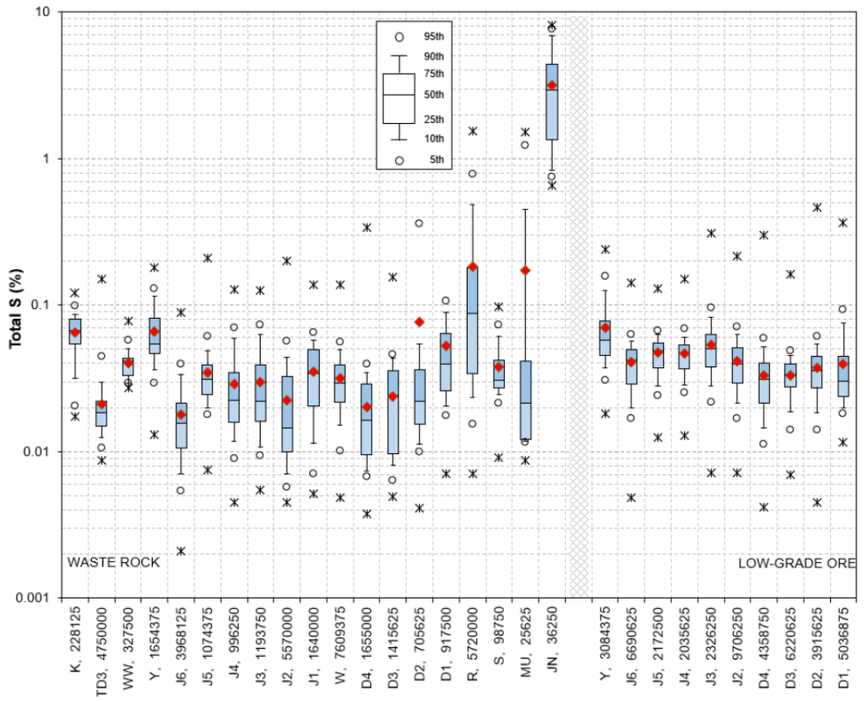
High sulphur (≥1 wt.%) overburden constitutes 0.2% (204,375 m^3) of the total mined overburden and <0.1% (31,250 m^3) of the overburden yet to be mined. High sulphur overburden blocks were from the Dales Gorge member (D1 and D2), the Mt McRae Shale (R), the Marra Mamba Iron Formation (MU) and the Jeerinah Formation (JN). No high sulphur blocks were identified within the low-grade ore (BHP, 2022i).

Low to moderate sulphur (0.2 - 0.5 wt.%) overburden constituted 0.9% (938,750 m^3) of the total mined overburden and 0.1% (189,375 m^3) of the overburden yet to be mined. Moderate sulphur material (0.5 - 1 wt.%) comprised 0.2% (204,375 m^3) of mined overburden and <0.1% (43,125 m^3) of the overburden yet to be mined. Low to moderate and moderate overburden sulphur blocks were located within the Yandicoogina Shale member (Y), Joffre member (J1, J2, J3 and J5), Whaleback Shale, Dales Gorge member (D1, D2 and D4), the Mt McRae Shale (R), Mt Sylvia Formation, Marra Mamba Iron Formation (MU) and Jeerinah Formation (JN). No low to moderate or moderate sulphur blocks were identified within the low-grade ore (BHP, 2022i).

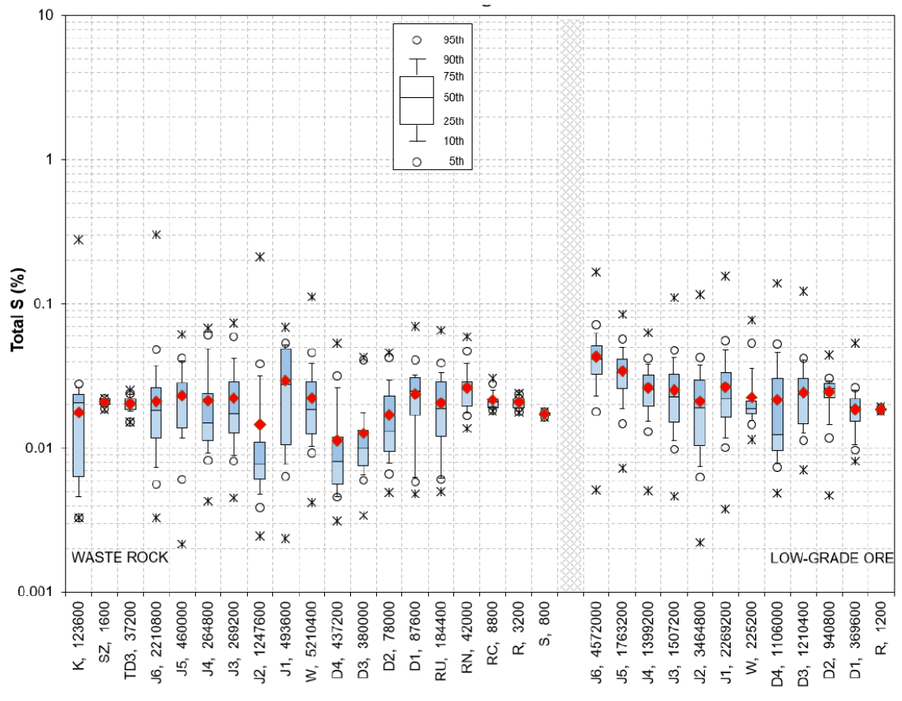
WH4

The median total sulphur was approximately 0.02 wt.% for mined overburden and approximately 0.03 wt.% for mined low grade ore across all stratigraphies. When considered individually, all mined overburden and low-grade ore stratigraphies had median total sulphur concentrations below 0.05 wt.% (Figure 5-9) (BHP, 2022i).

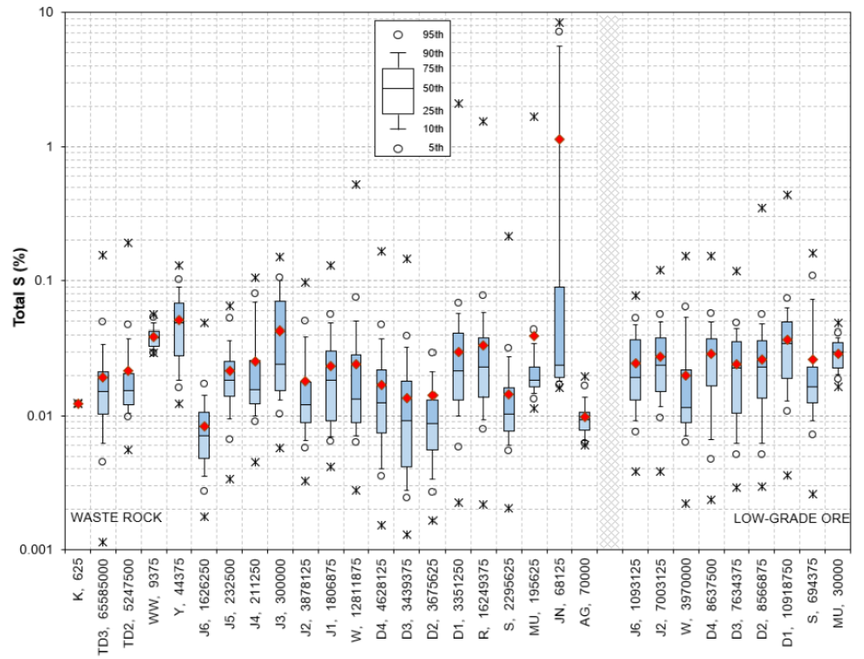
No moderate (0.5 – 1wt.%) or high (≥1 wt.%) sulphur blocks were identified in the mined overburden or low-grade ore. Low to moderate (0.2 - 0.5 wt.%) sulphur blocks were limited to overburden classified as dykes / sills (K), the Joffre member (J2 and J6) and the Dales Gorge member (D3). Low to moderate sulphur overburden constituted 0.04% of the total overburden mined (11,600 m^3). No low to moderate sulphur blocks were identified in the low-grade ore (BHP, 2022i).



WH123 as-mined overburden - distribution of sulphur as a function of stratigraphy



WH4 as-mined overburden - distribution of sulphur as a function of stratigraphy



WH123 to be mined overburden – distribution of sulphur as a function of stratigraphy

Notes: the volume of each stratigraphic unit (m^3) is reported next to the rock type ID.
Source: BHP (2022i)

Figure 5-9 Distribution of sulphur at WH123 and WH4 by stratigraphy

WHASH

The median total sulphur of mined overburden and low-grade ore was approximately 0.03 wt.% and 0.02 wt.% respectively across all stratigraphies. Each mined overburden and low-grade ore stratigraphy had a median total sulphur concentration <0.1 wt.%. The median total sulphur of yet to be mined material was approximately 0.01 wt.%. Five of the yet to be mined stratigraphies had median total sulphur concentrations >0.1 wt.%; Lignite Clay (LT2 – 1.4 wt.%), Yandicoogina Shale member (Y – 0.17 wt.%) and the Mt McRae Shale (RN – 1.1 wt.%; RC – 2.0 wt.%; RL – 1.0 wt.%) (Figure 5-10) (BHP, 2022i).

No high (>1 wt.%) sulphur blocks were identified for the mined material, however, approximately 1.3% (2,038,125 m^3) of yet to be mined overburden was predicted to have high sulphur. Stratigraphies with high sulphur are the Lignite Clay (LT2), Joffre member (J1), Whaleback Shale (W), Mt McRae Shale (RU, RN, RC, RL) and the Mt Sylvia Formation (S). No high sulphur blocks have been identified within low-grade ore (BHP, 2022i).

Low to moderate sulphur (0.2 - 0.5 wt.%) overburden blocks constituted approximately 0.1% (47,500 m^3) of the mined overburden and 755,625 m^3 (0.5%) of the yet to be mined overburden. Moderate sulphur (0.5 – 1 wt.%) overburden blocks comprised approximately 0.03% (12,500 m^3) and 0.3% (532,500 $m^{3)}$ of the mined and yet to be mined overburden, respectively. No low to moderate or moderate sulphur blocks were identified for the low-grade ore (BHP, 2022i).

H234

The median total sulphur was approximately 0.02 wt.% and 0.01 wt.% for yet to be mined overburden and low-grade ore respectively. Each stratigraphy had a median total sulphur concentration below 0.1 wt.% (Figure 5-10) (BHP, 2022i).

A moderate amount of high total sulphur (≥1 wt.%) overburden (426,857 m^3) was predicted within the Surface Scree (SZ), Tertiary Detritals (TD3), Weeli Wolli Dolerite (HE) and Yandicoogina Shale member (Y). This high sulphur overburden constituted 0.3% of the total overburden to be mined. Most (~97%) of the high sulphur material was from the Tertiary Detritals TD3 (BHP, 2022i).

Approximately 2,617,500 m^3 of low to moderate sulphur (0.2 - 0.5 wt.%) and 643,125 m^3 of moderate sulphur (0.5 - 1 wt.%) overburden have been identified in the H234 mine model, and represent 1.6% and 0.4%, respectively, of the total overburden to be mined (BHP, 2022i).

East Jimblebar

Overburden and low-grade ore to be mined from East Jimblebar had median total sulphur contents of 0.02 wt.% and 0.01 wt.%, respectively. Each overburden and low-grade ore stratigraphy had a median total sulphur concentration below 0.5 wt.% (Figure 5-10) (BHP, 2022i).

High (>1 wt.%) sulphur blocks were limited to the Dales Gorge member (D1) and Mt McRae Shale (R) and constituted approximately <0.1% (12,000 m^3) of the overburden material to be mined (BHP, 2022i).

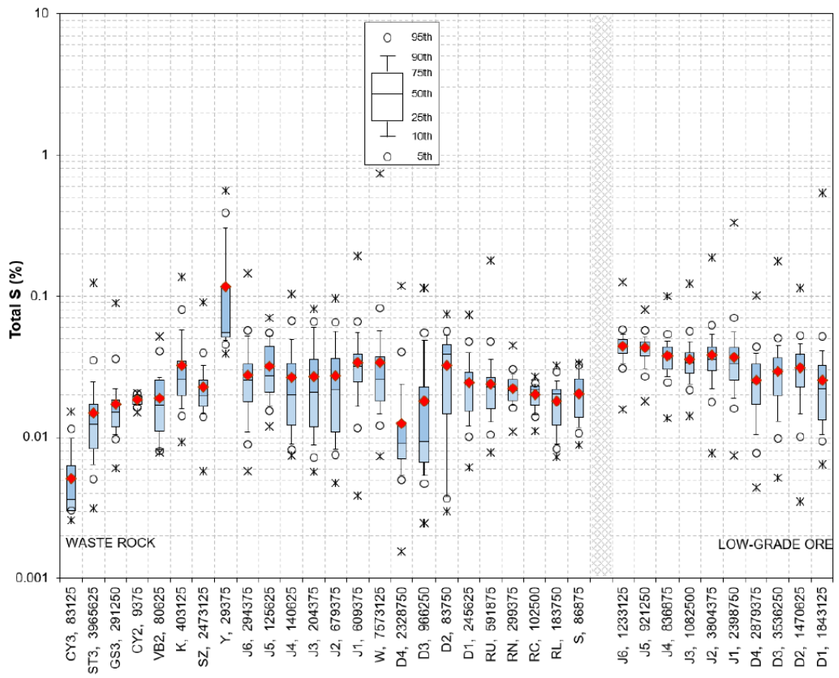
Moderate sulphur (0.5 - 1 wt.%) overburden comprised 0.3% (572,800 m^3) of the overburden to be mined and was limited to the Yandicoogina Shale member (Y), Dales Gorge member (D1) and Mt McRae Shale (R) (BHP, 2022i).

South Jimblebar

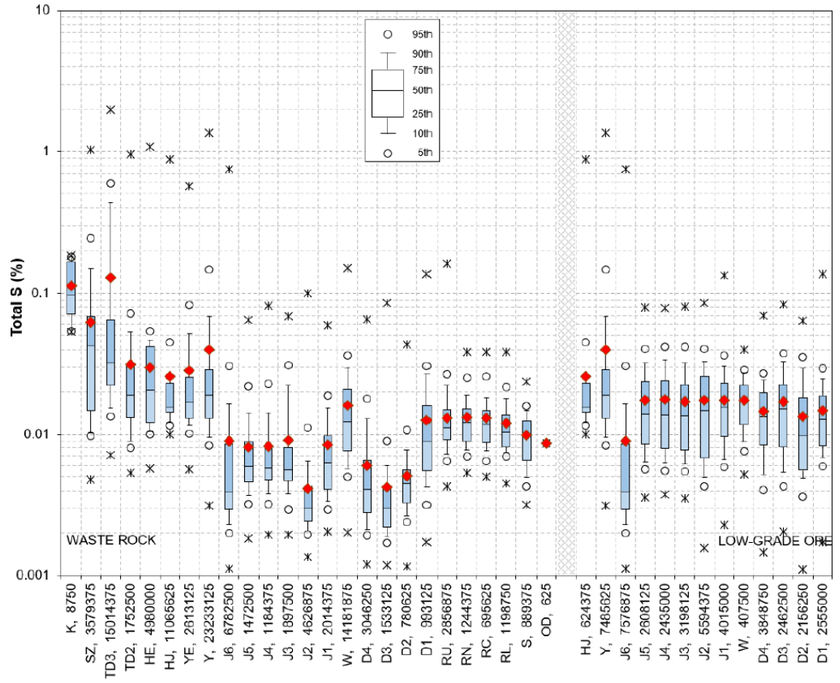
The median total sulphur was approximately 0.02 wt.% for mined overburden and low-grade ore and 0.01 wt.% for material that has yet to be mined. All mined and yet to be mined overburden and low-grade ore stratigraphies had median total sulphur concentrations below 0.1 wt.% (Figure 5-11) (BHP, 2022i).

No high sulphur (>1 wt.%) overburden or low-grade ore blocks had been mined to 2022 and <0.1% (12,400 m^3) of the yet to be mined overburden had high sulphur. This material was limited to rocks from the Jeerinah Formation (JN).

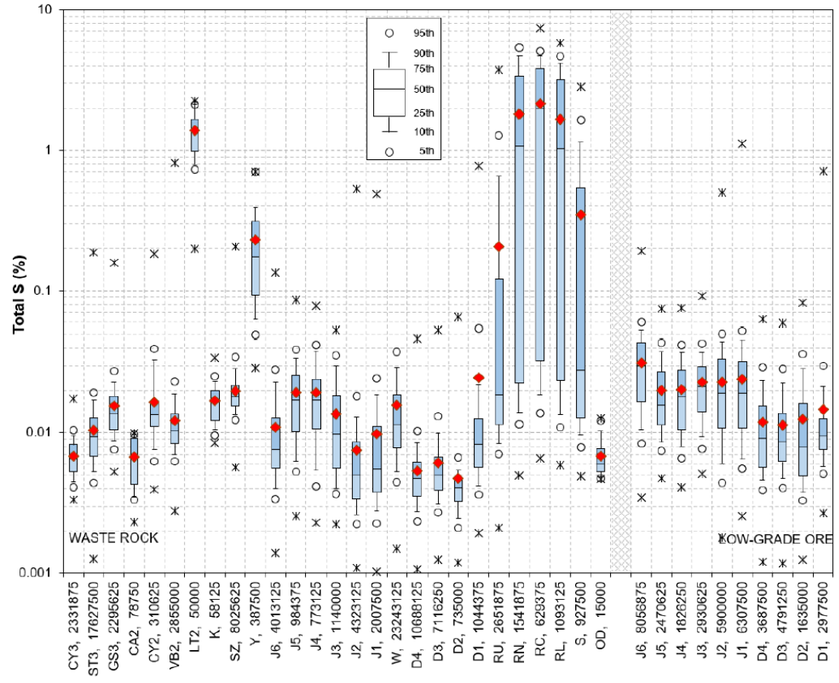
Low to moderate sulphur (0.2 - 0.5 wt.%) overburden constituted <0.1% (800 m^3) of the mined overburden and 0.05% (78,000 m^3) of the overburden yet to be mined. No moderate sulphur (0.5 – 1 wt.%) overburden had been mined to 2022 and only 16,800 m^3 (0.01%) was predicted to be mined. Low to moderate and moderate sulphur blocks were limited to material from the Tertiary Detritals (ST3, CY2 and LT2), MacLeod (MM) and Marra Mamba Iron (MU) formations (BHP, 2022i).



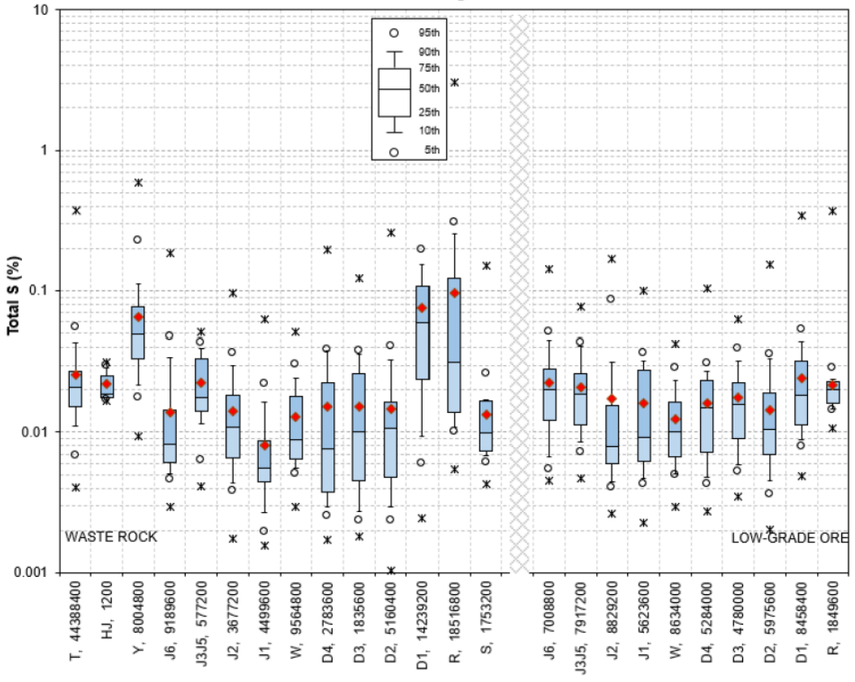
WHASH as-mined overburden - distribution of sulphur as a function of stratigraphy



H234 to be mined overburden - distribution of sulphur as a function of stratigraphy



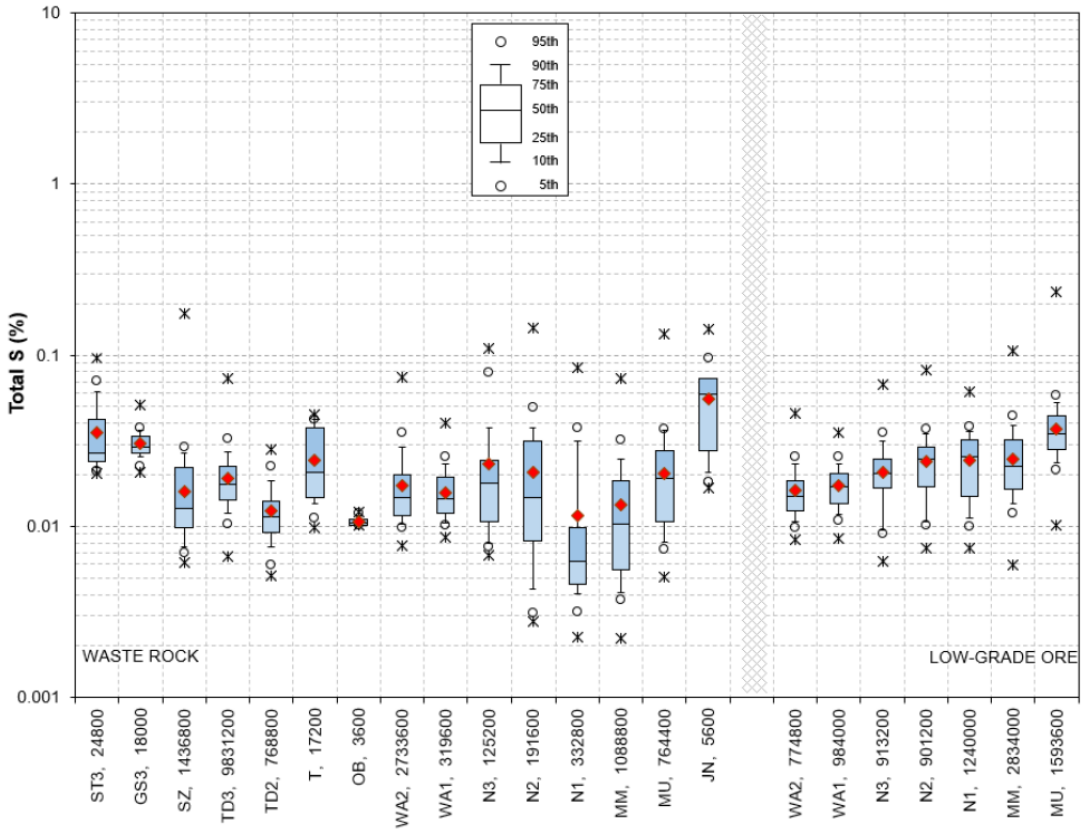
WHASH to be mined overburden – distribution of sulphur as a function of stratigraphy



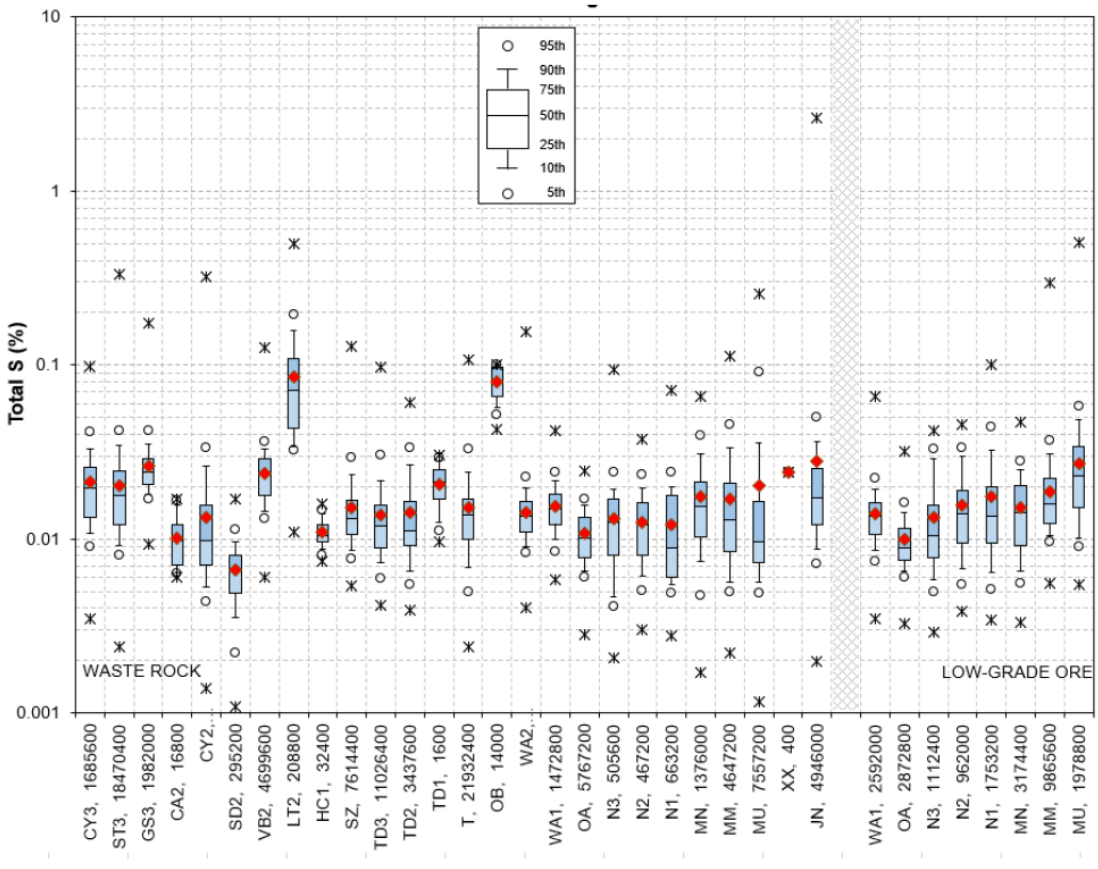
East Jimblebar to be mined overburden – distribution of sulphur as a function of stratigraphy

Notes: the volume of each stratigraphic unit (m^3) is reported next to the rock type ID.
Source: BHP (2022i)

Figure 5-10 Distribution of sulphur at WHASH, H234 and East Jimblebar by stratigraphy



South Jimblebar as-mined overburden - distribution of sulphur as a function of stratigraphy



South Jimblebar as-mined overburden - distribution of sulphur as a function of stratigraphy

Notes: the volume of each stratigraphic unit (m^3) is reported next to the rock type ID.
Source: BHP (2022i)

Figure 5-11 Distribution of sulphur at South Jimblebar by stratigraphy

Acid neutralising capacity

WH 123

The median calculated ANC within the mining model was approximately 1.0 kg H_2SO_4/t for mined overburden and 1.2 kg H_2SO_4/t for mined low-grade ore. All mined lithologies had median ANC values of <10 kg H_2SO_4/t. The median calculated ANC for yet to be mined overburden and low-grade ore was approximately 1.9 kg H_2SO_4/t and 1.1 kg H_2SO_4/t, respectively. However, the yet to be mined Tertiary Detritals (TD3) unit had relatively high ANC distribution (median ANC values ≥30 kg H_2SO_4/t) (BHP, 2022i).

WH4

The median calculated ANC within the mining model for mined overburden and low-grade ore, was approximately 0.7 kg H_2SO_4/t and 0.9 kg H_2SO_4/t, respectively. All lithologies had median ANC values of <10 kg H_2SO_4/t (BHP, 2022i).

WHASH

The median calculated ANC within the mining model was approximately 2.1 kg H_2SO_4/t and 1.4 kg H_2SO_4/t for mined overburden and low-grade ore, respectively. Clay material (CY3) had the highest median ANC value (11 kg H_2SO_4/t) and all other lithologies had median ANC values of <10 kg H_2SO_4/t. The median modelled ANC for yet to be mined overburden and low-grade ore was approximately 2.1 kg H_2SO_4/t and 1.4 kg H_2SO_4/t, respectively. Apart from Calcrete (CA2), all stratigraphies yet to be mined had modelled median ANC <30 kg H_2SO_4/t. The Calcrete (CA2) had a modelled ANC of 520 kg H_2SO_4/t but was present at a relatively limited volume of 78,759 m^3 (compared to a total volume of material (155,745,000 m^3) which is yet to be mined) (BHP, 2022i).

H234

For the to-be-mined overburden and low-grade ore stratigraphies, the median modelled ANC was approximately 2.6 kg H_2SO_4/t and 1.5 kg H_2SO_4/t respectively. All material had modelled median ANC <30 kg H_2SO_4/t.

East Jimblebar

The median ANC was approximately 2.4 kg H_2SO_4/t and 1.5 kg H_2SO_4/t for overburden and low-grade ore blocks, respectively. All stratigraphies had median ANC <30 kg H_2SO_4/t.

South Jimblebar

The median calculated ANC within the mining model was approximately 4.4 kg H_2SO_4/t and 1.4 kg H_2SO_4/t for mined overburden and low-grade ore, respectively. All lithologies had median ANC values of <20 kg H_2SO_4/t. The median ANC for overburden and low-grade ore, yet to be mined was approximately 5.9 kg H_2SO_4/t and 1.3 kg H_2SO_4/t, respectively. Stratigraphies with high median ANC values included Calcrete (CA2, median ANC of 410 kg H_2SO_4/t), Tertiary Detritals (TD2, median ANC of 204 kg H_2SO_4/t) and the Paraburdoo member of the Wittenoom Formation (OB, median ANC of 260 kg H_2SO_4/t).

5.3.2.2 Wall rock AMD source hazard

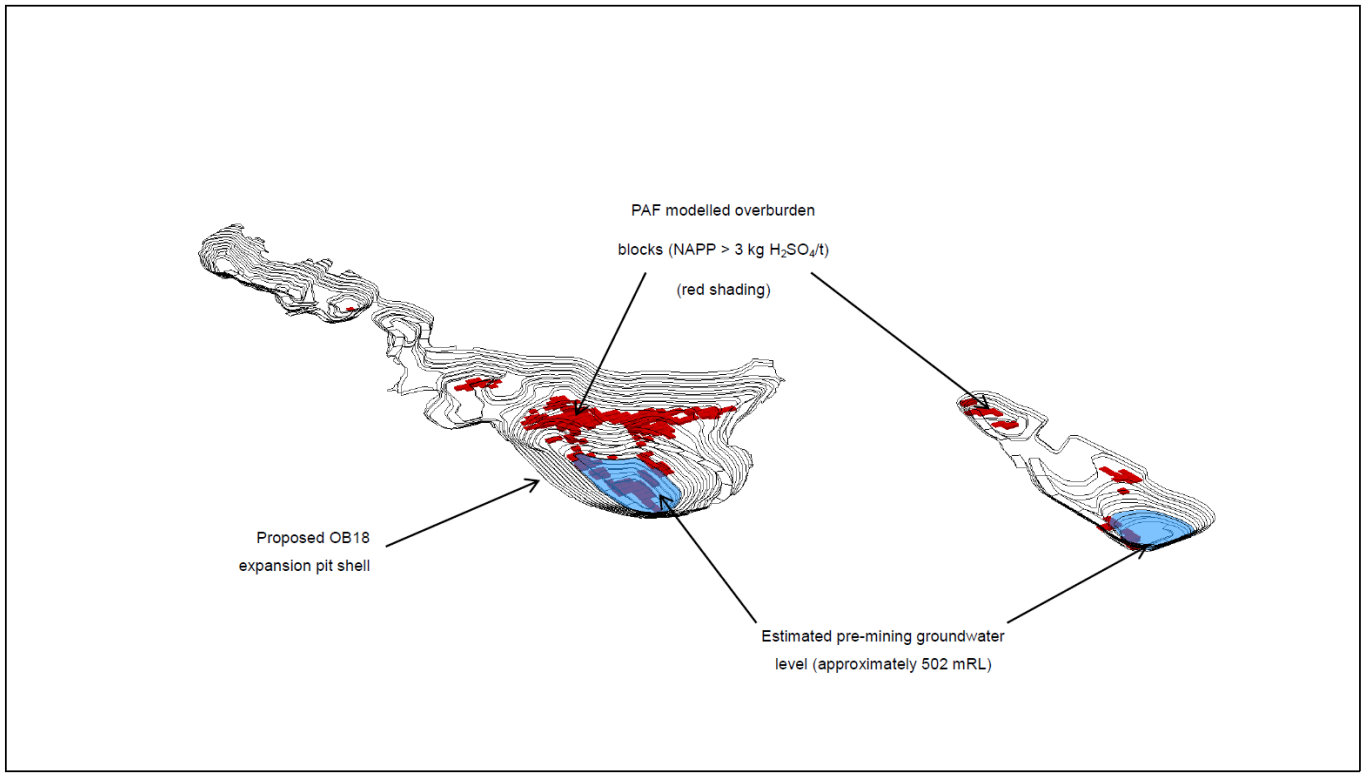
This section outlines the hazards associated with predicted wall rock exposures of PAF material at OB17/18, OB31 and Jimblebar. This is followed by a summary of work conducted on wall rock acidity generation rates.

OB17/18

Earth Systems (2015) established that there was a low risk of AMD from wall rock at OB17 (eastern part of Swan pit); only four of 558 (0.7%) sampling intervals were classified as PAF. The 95th percentile value for sulphur was 0.06 wt.% and the maximum value was 0.16 wt.%. The 95th percentile NAPP value was 1.5 kg H_2SO_4/t and the maximum value 4.3 kg H_2SO_4/t.

At OB18, PAF blocks represent approximately 5% of the total wall rock. The PAF blocks are largely associated with the Mt McRae Shale Formation (approximately 85%) and Dales Gorge member of the Brockman Iron Formation (approximately 15%). They are located predominantly along the north-west wall of the De Grey pit and at the base (sub-groundwater level) of the De Grey and western part of Swan pit (Figure 5-12) (Earth Systems, 2015).

PAF wall rock blocks ranged in NAPP from 3 to 158 kg H_2SO_4/t with a median NAPP of 10 kg H_2SO_4/t. Most of the PAF blocks were above the current groundwater level, however the logged degree of weathering in these zones indicated both weathered (oxidised) and unweathered material (Earth Systems, 2015). Further assessment of wall rock (see below) has, however, indicated that acidity generation rates from wall rock are typically low.



Source: Earth Systems (2015)

Figure 5-12 Distribution of PAF wall rock at OB18

OB31

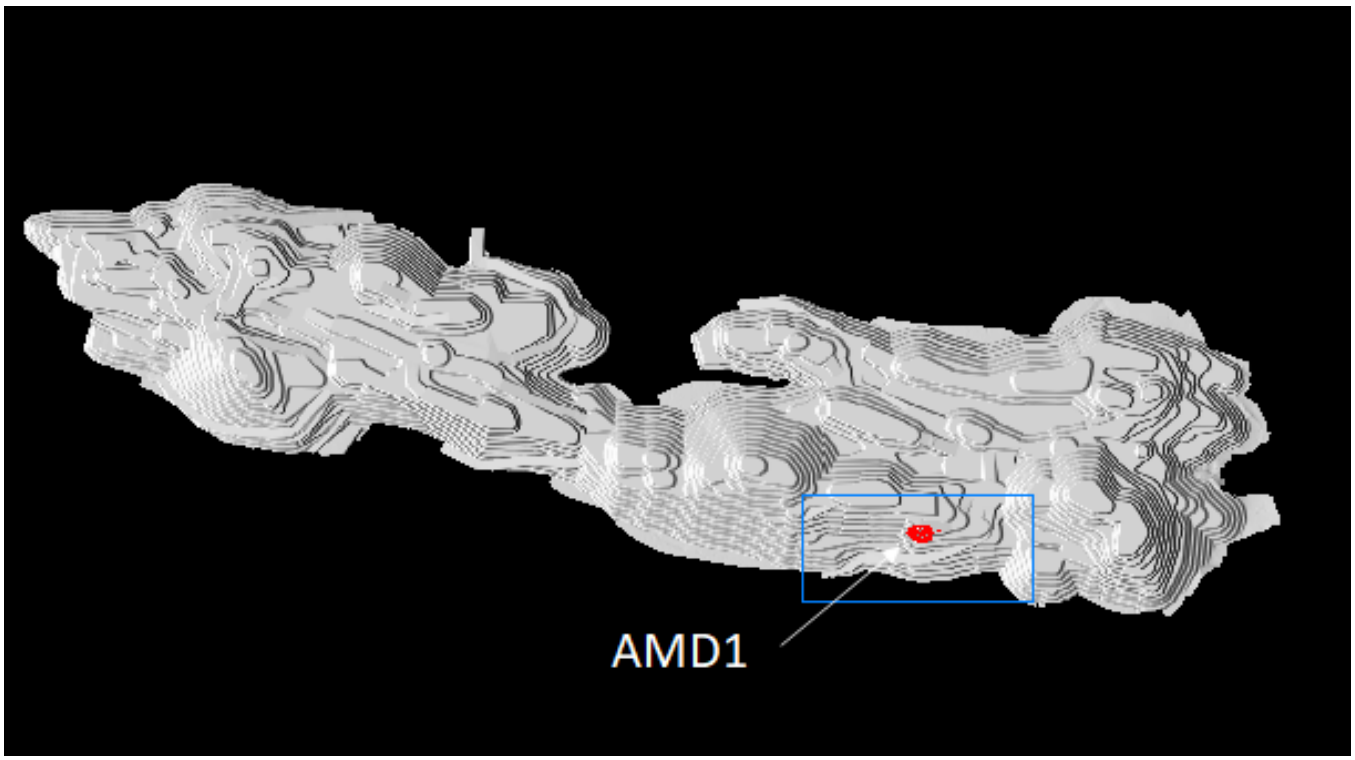
No exposures of AMD 2 or AMD 3 were identified within the final pit surfaces of OB31. A minor exposure of AMD 1 (~5,000 m^2) was identified in the toe of the southen wall of the eastern section of the pit (at a depth of 422 - 442 mRL) representing <0.1% of the total surface area of the OB31 pit shell (Table 5-16 and Figure 5-13) (BHP, 2022i).

The potential AMD 1 exposure in the OB31 pit is associated with the Mt McRae Shale (RN and RU), and the Colonial Chert member of the Brockman Iron Formation (D1) (BHP, 2022i).

Table 5-16 OB31 surface area of exposed pit wall per AMD Class

2D Pit Footprint (ha)	Total Surface Area (m^2)				AMD 1-3 (% of total)
	Total 3D Pit	AMD 1	AMD 2	AMD 3	
444.5	5,211,200	5,000	0	0	<0.1%

Source: BHP (2022i)



Source: BHP (2022i)

Figure 5-13 Wall rock exposure of AMD 1 in the OB31 life of asset pit shell

Jimblebar

WH123

The WH123 pit contains approximately 192,100 m^2 of potential exposures of AMD 1 (<0.1%), AMD 2 (2.2%) and AMD 3 (<0.1%) material representing 2.3% of the total surface area of the main WH123 pit (Table 5-17 and Figure 5-14). There are no predicted PAF material exposures in the sattelite pit (BHP, 2022i).

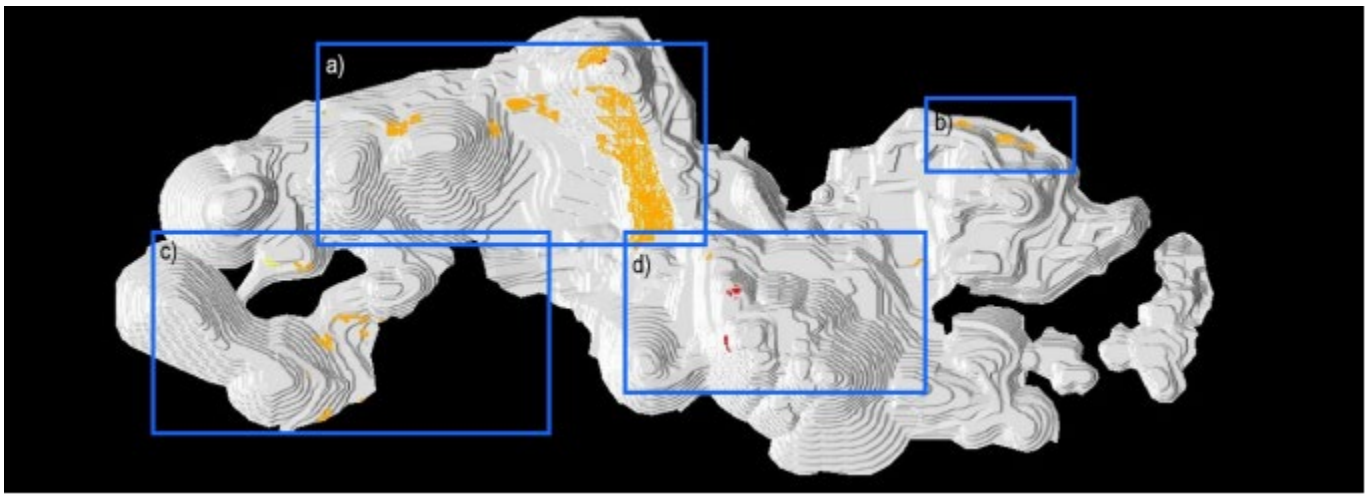
The stratigraphic units associated with the PAF material exposures are (BHP, 2022i):

- AMD 1 - Colonial Chert (D1), Mt McRae Shale (R) and Mt Sylvia (S).
- AMD 2 – Yandicoogina Shale (Y), Joffre (J3), Dales Gorge / Colonial Chert (D, D2/D1), Mt McRae Shale (R) and Mt Sylvia (S).
- AMD 3 – Tertiary Detritals (TD3).

Table 5-17 WH123 surface area of exposed pit wall per AMD Class

Pit	2D Pit Footprint (ha)	Total Surface Area (m^2)				AMD 1-3 (% of total)
		Total 3D Pit	AMD 1	AMD 2	AMD 3	
Main	53.2	8,419,800	1,800	189,300	1,000	2.3%
Satellite	27.4	315,700	0	0	0	0

Source: BHP (2022i)



Source: BHP (2022i)
Notes: Red shading represents AMD 1 exposures, orange shading AMD 2 exposures and light yellow AMD 3.

Figure 5-14 Wall rock exposure of AMD 1, AMD 2 and AMD 3 in the WH123 life of asset pit shell

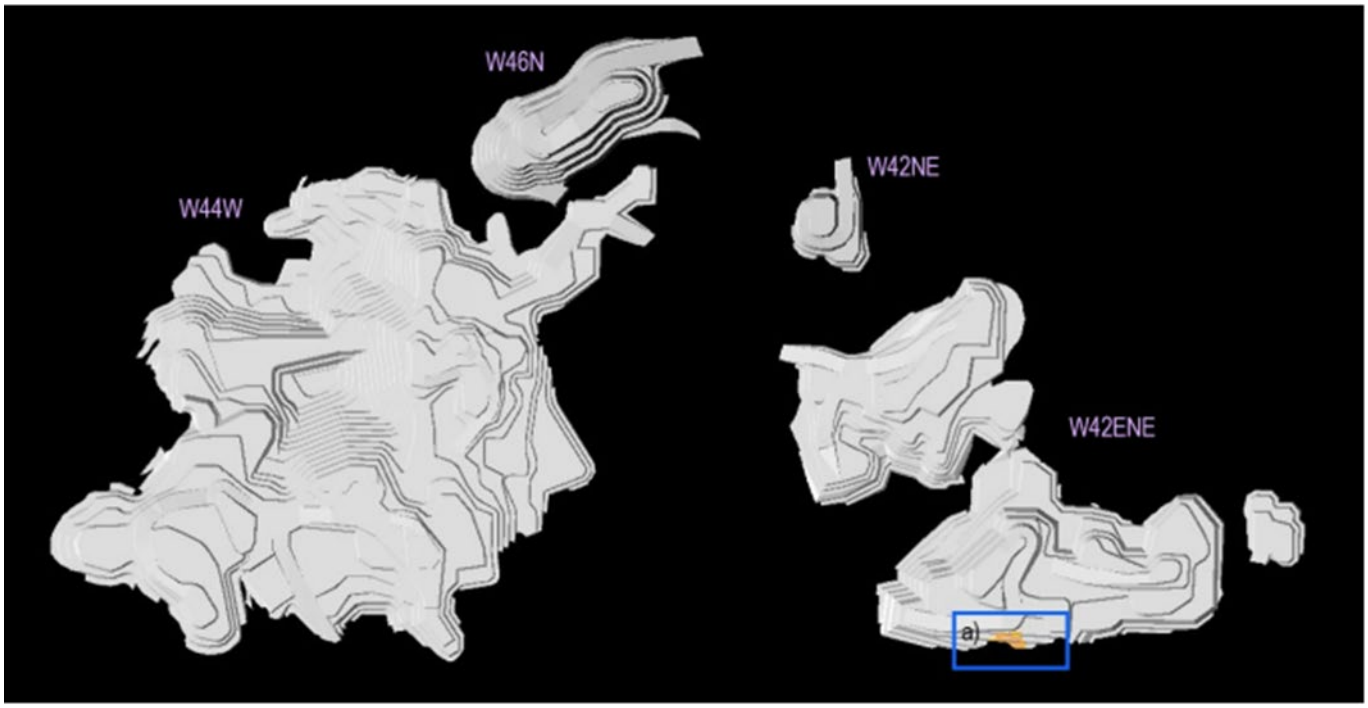
WH4

The WH4 deposit contains approximately 2,100 m^2 of potential surface exposures of AMD 2 material within the Joffre (J2) stratigraphic unit of the W42ENE pit. This exposure represents 0.3% of the total surface area of the W42ENE pit (Table 5-18 and Figure 5-15) (BHP, 2022i). This pit has been backfilled.

Table 5-18 WH4 surface area of exposed pit wall per AMD Class

Pit	2D Pit Footprint (ha)	Total Surface Area (m^2)				AMD 1-3 (% of total)
		Total 3D Pit	AMD 1	AMD 2	AMD 3	
W46N	12.4	179,100	0	0	0	0
W42NE	3.4	45,600	0	0	0	0
W44W	104.4	1,311,000	0	0	0	0
W42ENE	52.3	682,800	0	2,100	0	0.3%

Source: BHP (2022i)



Source: BHP (2022i)
Notes: Orange shading represents AMD 2 exposures.

Figure 5-15 Wall rock exposure of AMD 2 in the WH4 life of asset pit shell

WHASH

The WHASH pit contains approximately 106,900 m^2 of potential exposures of AMD 1 (1.4%), AMD 2 (<0.1%) and AMD 3 (<0.1%) material representing 1.6% of the total surface area of the WHASH pit (Table 5-19 and Figure 5-16) (BHP, 2022i).

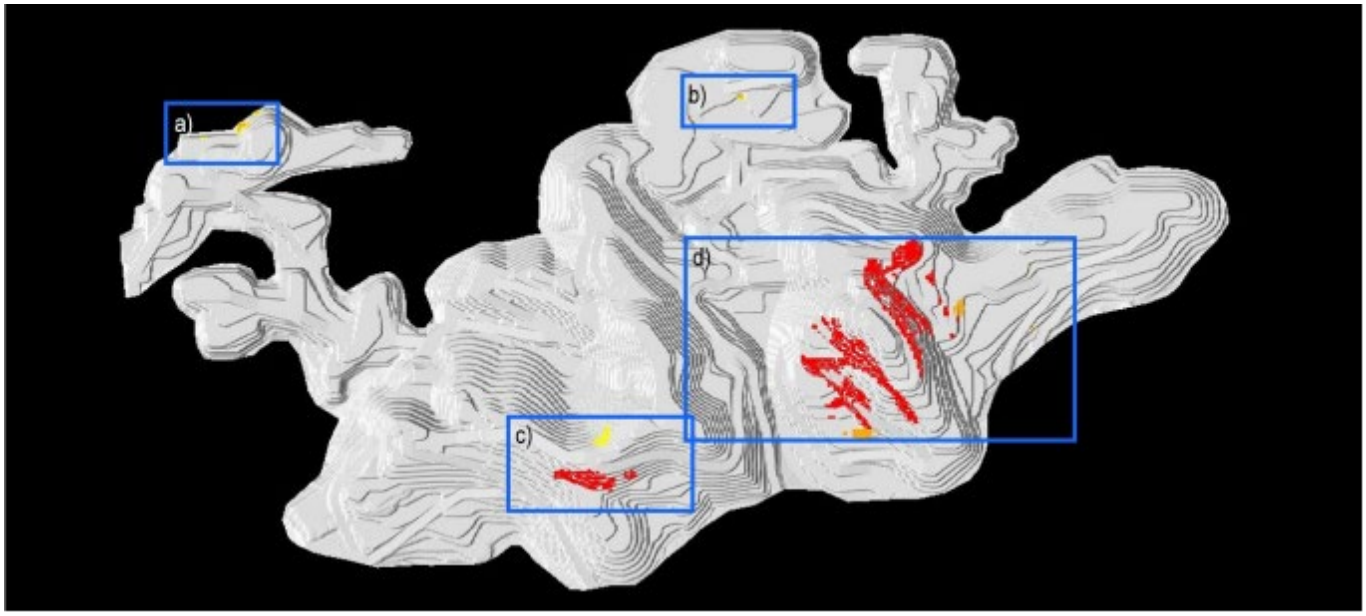
The stratigraphic units associated with the PAF material exposures are (BHP, 2022i):

- AMD 1 – Dales Gorge and Colonial Chert (D2 - D1), Mt McRae Shale (R), Mt Sylvia (S) and Bee Gorge (OD).
- AMD 2 - Yandicoogina Shale (Y), Joffre (J6), Colonial Chert (D1) Mt McRae Shale (RU, RN, R).
- AMD 3 – Tertiary Detritals (VB2, LT2).

Table 5-19 WHASH surface area of exposed pit wall per AMD Class

2D Pit Footprint (ha)	Total Surface Area (m^2)				AMD 1-3 (% of total)
	Total 3D Pit	AMD 1	AMD 2	AMD 3	
569.1	6,866,200	97,700	6,700	2,500	1.6%

Source: BHP (2022i)



Source: BHP (2022i)
Notes: Red shading represents AMD 1 exposures, orange shading AMD 2 exposures and light yellow AMD 3.

Figure 5-16 Wall rock exposure of AMD 1, AMD 2 and AMD 3 in the WHASH life of asset pit shell

H234

The H234 life of mine pit shell pit does not contain any potential exposures of AMD 1, AMD 2 or AMD 3 material (Figure 5-17).

Source: BHP (2022i)

Figure 5-17 Wall rock exposure of AMD material in the H234 life of asset pit shell (no potential exposures)

East Jimblebar

The East Jimblebar pit contains approximately 120,300 m^2 of potential exposures of AMD 1 (2%) and AMD 2 (0.1%) material representing 2.1% of the total surface area of the pit shell (Table 5-20 and Figure 5-18) (BHP, 2022i).

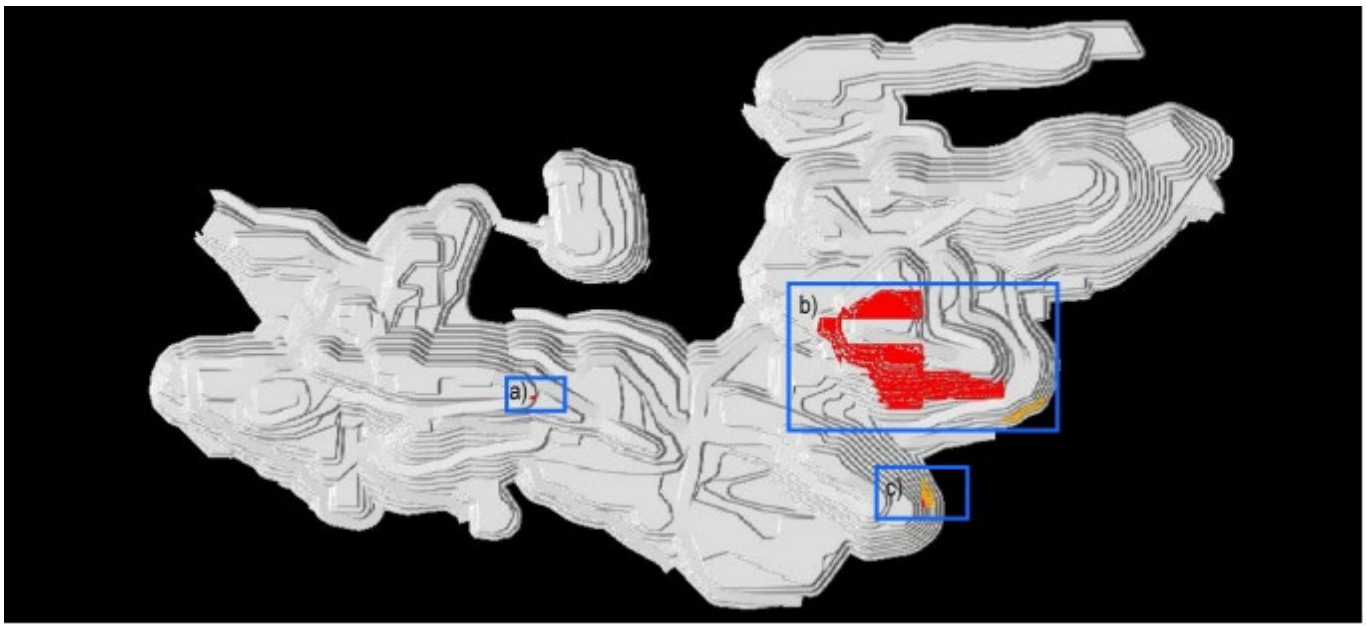
The stratigraphic units associated with the PAF material exposures are (BHP, 2022i):

- AMD 1 - Dales Gorge and Colonial Chert (D2 - D1), Mt McRae Shale (R), Mt Sylvia (S) and Bee Gorge (OD).
- AMD 2 - Yandicoogina Shale (Y), Joffre (J6), Colonial Chert (D1) Mt McRae Shale (RU, RN, R).
- AMD 3 - Tertiary Detritals (VB2, LT2).

Table 5-20 East Jimblebar surface area of exposed pit wall per AMD Class

2D Pit Footprint (ha)	Total Surface Area (m^2)				AMD 1-3 (% of total)
	Total 3D Pit	AMD 1	AMD 2	AMD 3	
452.9	5,707,700	113,500	6,800	0	2.1%

Source: BHP (2022i)



Source: BHP (2022i)
Notes: Red shading represents AMD 1 exposures, orange shading AMD 2 exposures.

Figure 5-18 Wall rock exposure of AMD 1 and AMD 2 in the East Jimblebar life of asset pit shell

South Jimblebar

The South Jimblebar Pit D (Sylvania / Mindoona) contains approximately 3,000 m^2 of potential exposures of AMD 1, AMD 2 and AMD 3 material representing <0.1% of the total surface area of the pit shell (Table 5-21 and Figure 5-19). No other South Jimblebar pits contained AMD exposures.

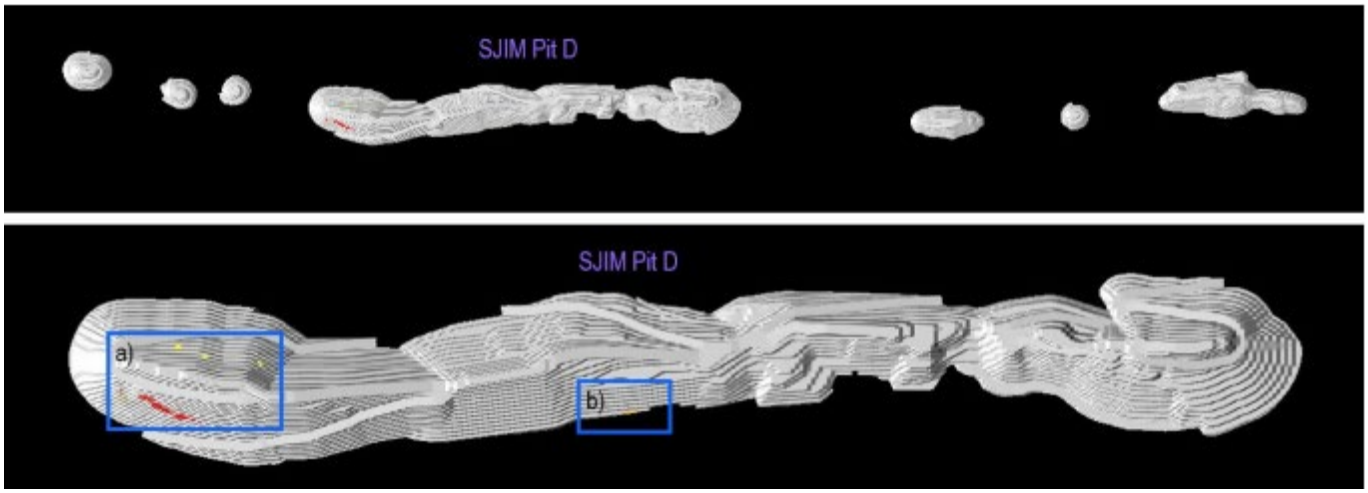
The stratigraphic units associated with the PAF material exposures are (BHP, 2022i):

- AMD 1 - Jeerinah Formation (JN).
- AMD 2 - Jeerinah Formation (JN) and Nammuldi member of the Marra Mamba Formation (MU).
- AMD 3 - Tertiary Detritals (LT2).

Table 5-21 South Jimblebar surface area of exposed pit wall per AMD Class

Pit	2D Pit Footprint (ha)	Total Surface Area (m^2)				AMD 1-3 (% of total)
		Total 3D Pit	AMD 1	AMD 2	AMD 3	
A	22.6	285,700	0	0	0	0
B	12.9	162,000	0	0	0	0
C	10.3	125,500	0	0	0	0
D	259.7	3,330,600	2,200	400	400	<0.1%
E	27.6	348,800	0	0	0	0
F	8.6	106,700	0	0	0	0
G	64.1	853,800	0	0	0	0

Source: BHP (2022i)



Source: BHP (2022i)
Notes: Red shading represents AMD 1 exposures, orange shading AMD 2 exposures and light yellow AMD 3.

Figure 5-19 Wall rock exposure of AMD 1, AMD 2 and AMD 3 in the South Jimblebar life of asset pit shell

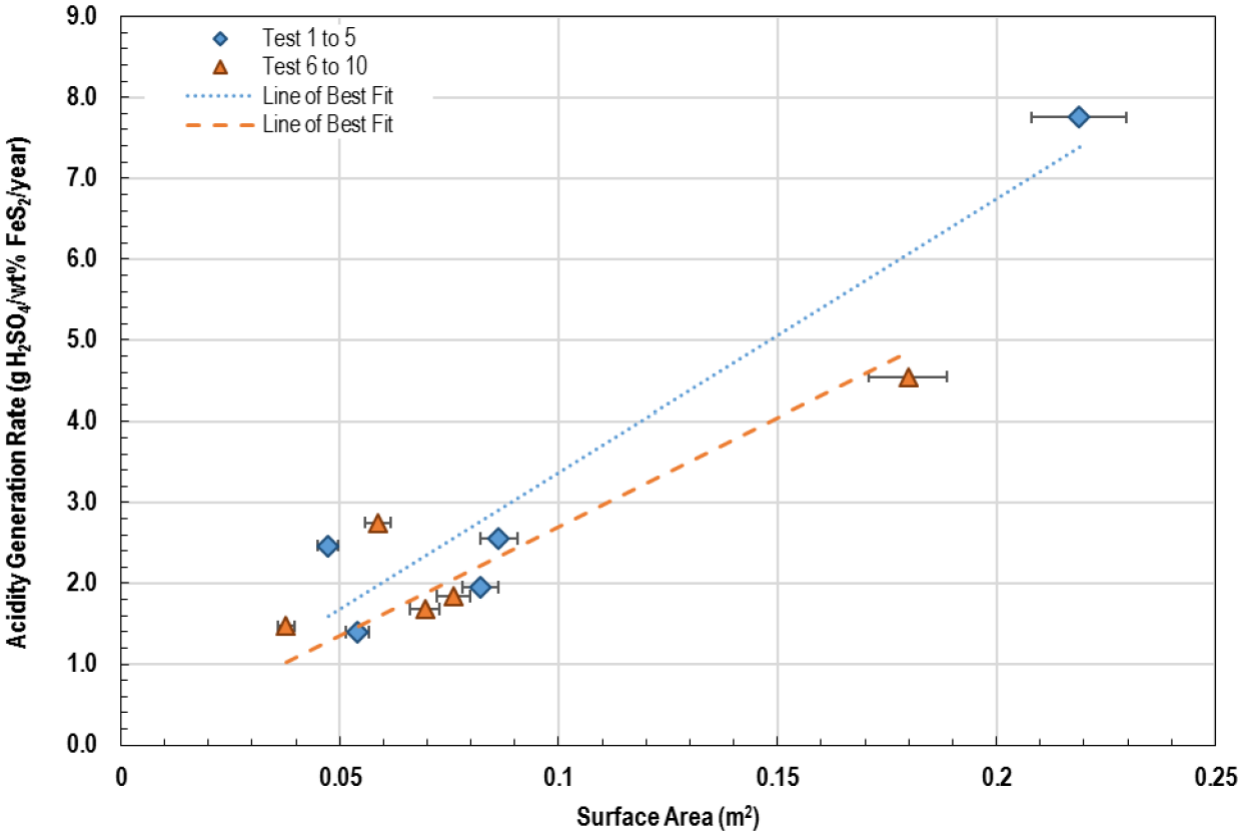
Acidity generation rates from wall rock

A study was conducted by Earth Systems (2018) to quantify acidity generation rates from sulphidic Mt McRae Shale wall rock taken from Jimblebar and other mines. The test work showed a strong, positive and linear correlation between a sample's surface area and acid generation (Figure 5-20). However, the estimated annual acidity generation rate was low. Based on measured oxygen consumption rate data, the acidity generation rate for wall rock with 1.48 wt.% FeS_2 was 40 to 50 grams H_2SO_4/m^2/year. If normalised by dividing by 1.48, then the acidity generation rate representative of wall rock with 1 wt.% FeS_2 would be 27 to 34 g H_2SO_4/wt.% FeS_2/m^2/year. A wall rock exposure of 1,000 m^2 containing 1 wt.% FeS_2 would, therefore, only generate 27 to 34 kg of H_2SO_4/year (Earth Systems, 2018).

Earth Systems (2018), therefore, concluded that acidity generation from sulphidic pit wall rock is a very small component of in-pit acidity generation and that acidity loads are more likely to be produced by some or all of the following factors (Earth Systems, 2018):

- Sulphidic rocks spalled off reactive batters and lying on old bench tops due to blasting or weathering;
- Reactive rubble on pit floors (sub-drill zone) following blasting that was retained to provide a flat operating surface; and
- Ramps cut through or constructed from sulphidic overburden as part of pit access works.

This has potential implications for the most effective closure management techniques to control AMD (see Section 7.5.1).



Source: Earth Systems (2018)

Figure 5-20 Acidity generation rates as a function of surface area after normalising pyrite content to 1 wt.%

5.3.2.3 Environmental geochemistry test work

BHP's environmental geochemistry database contains 423 samples taken across the OB31, Wheelarra Hill, Hashimoto and South Jimblebar deposits (Appendix E-1).

ABA and NAG test results

A review of ABA and Net Acid Generation (NAG) test results (Appendix E-1) for samples taken across the OB31, Wheelarra Hill, Hashimoto and South Jimblebar deposits and comparison with AMIRA (2002) classifications (Table 5-22) indicated that of the 423 samples for which there were ABA data, 391 samples were classified as NAF, three were classified as UC(NAF), five as UC(PAF) and 24 as PAF[12] (BHP, 2022i):

- Of the 24 PAF samples, 20 were from the Mt McRae Shale stratigraphy (R, RU, RN, RC and RL) from the OB31 and WHASH deposits, two were lignite samples (LT2) from the South Jimblebar (Mindoona) deposit and two were from the Wittenoom Formation (Bee Gorge member – OD) and the Mt Sylvia Formation (S) from the WHASH deposit. One of the PAF samples had a calculated NAPP of <3 kg H_2SO_4/t using the primary assay data and was, therefore, classified as NAF using the WAIO classification system.
- The five samples classified as PAF(UC) had conflicting acidic NAG pH (2.9 - 4.3) and negative NAPP values (-14.2 to -0.1 kg H_2SO_4/t). Three of these samples were classified as AMD 1 (PAF) based on calculated NAPP values from assay data. Two of the samples had low total sulphur (0.09 - 0.12 wt.%) and were classified as NAF using WAIO's classification system as applied to assay data. NAG pH testing indicated that the measured ANC may not be readily available or may be present as non-neutralising carbonates (e.g., siderite). Sulphate analyses suggested that measured sulphur was predominantly sulphidic.
- The three UC(NAF) samples had conflicting NAG pH (5.0 - 8.8) and positive NAPP values (3.7 - 61.9 kg H_2SO_4/t). These samples had low, moderate and high sulphur. Two of these samples would have been classed as AMD 1 based on WAIO's classification system as applied to assay data, and one would be AMD 0.
- All samples tested from the Weeli Wolli, Yandicoogina, Joffre member, Whaleback Shale, Dales Gorge member and Mt Newman member were classified as NAF.

[12] Sample selection for environmental test work is biased towards higher sulphur samples. Therefore, the proportion of NAF / PAF samples in the sample set are not representative of the distribution of such materials in-pit.

Table 5-22 AMIRA AMD classifications

AMIRA Classification	Definition
NAF	NAPP <0 and NAG pH of ≥4.5. (Note that NAF samples may have potential to generate NMD / saline drainage if total S is elevated).
PAF	NAPP ≥0 and NAG pH <4.5.
UC	Where the NAPP and NAG results are not in agreement. Uncertain samples are generally given a tentative classification that is shown in brackets UC(NAF) or UC(PAF), as applicable.

Source: AMIRA (2002)

Median paste pH values ranged from acidic to alkaline (pH 4.4 – 9.1), and the median paste pH values were circum-neutral for the majority of stratigraphies, indicating little or limited stored acidity if any, and / or absence of sparingly soluble sulphates in most samples. The only material with a median pH value <5 was the lignite clay Tertiary Detrital (LT2) material which had a median pH of 4.4 (BHP, 2022i).

Median paste Electrical Conductivity (EC) values ranged from 50 to 6,000 µS/cm, with most (>80%) of stratigraphies having median EC below 500 µS/cm, suggesting low to moderate salinity of paste extracts and limited readily soluble salts present in most samples. Only one stratigraphy (Tertiary Detritals - TD2) had a median EC >1,000 µS/cm. This stratigraphy also had the sample with the most elevated EC (6,000 µS/cm) (BHP, 2022i).

Median ANC values were typically low (≤5 kg H_2SO_4/t) and only 30 samples (of 423) had high ANC (>100 kg H_2SO_4/t). These samples were from the Weeli Wolli dolerite (HE), Mt Sylvia Formation (S), Mt McRae Shale (R), and Bee Gorge (OD) and Paraburdoo (OB) members of the Wittenoom Formation. The samples had ANC values between 100 and 978 kg H_2SO_4/t. Acid Buffering Characteristic Curve (ABCC) testing on the five high ANC OB samples from WHASH suggested that measured ANC was available with effective neutralisation capacities ($ENC_{4.5}$) equivalent to ANC. ABCC results for one RU sample from OB31 also showed that measured ANC was available with $ENC_{4.5}$ approximately 93% of the measured ANC within this sample. A total of 42 samples had slightly negative ANC values and circum-neutral paste pH. However, it is unlikely the negative ANC values are due to the presence of existing acidity as this would typically be supported by acidic paste pH values (BHP, 2022i).

In summary, the ABA data indicate a low risk of acid generating potential for most stratigraphies. However, fresh Mt McRae Shale and lignite clay within the Tertiary Detritals, as expected, represent potentially acid generating source hazards (BHP, 2022i).

Total elemental concentrations

Total elemental scans were carried out on 128 samples which included NAF, UC and PAF samples. Results were assessed using the Geochemical Abundance Index (GAI) (Förstner, Ahlf, & Calmano, 1993) to identify elements that may be enriched with respect to the average crustal abundances. A GAI of 0 indicates that the content of the element is less than, or similar to, the average crustal-abundance. Generally, a GAI of 3 or greater signifies enrichment that warrants further examination but does not imply mobility or bioavailability which are dependent on several factors such as elemental form (mineralogy), solubility, and environmental conditions affecting solubility (e.g., redox conditions). The samples were sourced from all key stratigraphies encountered including the Tertiary Detritals (CY2, LT2 and TD3), Weeli Wolli Formation (HE and HJ), Brockman Iron Formation (Y, J1, J2, J3, J5, J6, W, D1, D2, D3 and D4), Mt McRae Shale (RU, RC, RL and RN), Mt Sylvia Formation (S), Wittenoom Formation (OB, OD, WA2, N2) and the Marra Mamba Iron Formation (MM, MU) (BHP, 2022i).

Total elemental analyses showed enrichment in some elements (refer to Appendix E-1 for results), namely arsenic (As), bismuth (Bi), cadmium (Cd), iron (Fe), mercury (Hg), manganese (Mn), molybdenum (Mo), lead (Pb), antimony (Sb) and selenium (Se). The most frequently enriched elements in tested samples were selenium (66 samples), followed by arsenic (65 samples), and antimony (50 samples). Elemental enrichment of selenium, arsenic, and antimony was most pronounced in the Weeli Wolli Formation (HE), Joffre member (J6) and Whaleback Shale (W) of the Brockman Iron Formation, Mt McRae Shale (RU and RL) and Mt Sylvia Formation (BHP, 2022i).

Short-term leach data

Short-term leach test data were available for 93 samples from the OB31 and Jimblebar deposits. Testing included samples classified as NAF, UC and PAF and had total sulphur concentrations ranging from 0.001 to 9.74 wt.%. The samples were sourced from all key stratigraphies encountered at the Jimblebar Hub including the Tertiary Detritals (CY2 and TD3), Weeli Wolli Formation (HE and HJ), Brockman Iron Formation (Y, J1, J2, J3, J5, J6, W, D1, D2, D3 and D4), Mt McRae Shale ((RU, RC, RL and RN), Mt Sylvia Formation (S) and Wittenoom Formation (OD) (BHP, 2022i).

The test results are provided in Appendix E-1 and are outlined below (BHP, 2022i):

- Leachate pH ranged between 2.4 and 8.9 with a median value of 7.3. Most samples (86 of 93 samples, approximately 92%) had circum-neutral pH to somewhat alkaline pH ranging between 6.4 and 8.9. The sample returning the most acidic pH (2.4) was a high sulphur (1.56 wt.%) PAF classified OD sample from the Wittenoom Formation at WHASH. Five PAF classified Mt McRae Shale samples (R, RN and RL) from OB31, and WHASH also generated acidic pH (3.1 - 3.3). These samples generally contained high total sulphur (0.91 - 9.7 wt.%).
- Leachate EC ranged from 65 µS/cm to 4,230 µS/cm with a median EC of 225 µS/cm, indicating low to moderate salinity in the leachates and limited readily soluble salts present in solids. Other than a low sulphur (0.02 wt.%) Weeli Wolli Formation (HE) sample classified as NAF, measurements above 1,000 µS/cm were associated with high sulphur (1.01 - 9.7 wt.%) samples of Mt McRae Shale (R, RN, RL and RU), Mt Sylvia Formation (S) and Wittenoom Formation (OD) PAF samples.
- Total alkalinity of the leachates ranged from below the limit of reporting of <5 mg/L to 125 mg/L as $CaCO_3$, with a median value of 25 mg/L.

- The concentrations of elements that were always, or generally above detection limit in the leachates included the major ions (sulphate, chloride, calcium, magnesium, sodium, and potassium), nitrate and limited trace elements (aluminium, boron, barium, manganese and strontium).
- Except for manganese, concentrations of elements that were enriched in solid rock (i.e., arsenic, bismuth, cadmium, iron, mercury, molybdenum, lead, antimony, and selenium) were generally below or close to the limit of reporting in the leachates, suggesting low mobility of these elements under the conditions of the deionised static leach test. Manganese concentrations were two orders of magnitude above the limit of reporting in samples taken from the Tertiary Detritals (TD3), Brockman Iron Formation (J5), and Mt McRae Shale (RC and RN).
- Trace elements were elevated in samples with acidic leachate chemistry (pH 2.4 to 3.3), as expected. The leachate data for these samples suggests potential mobility of aluminium, arsenic, copper, iron, nickel and zinc under acid conditions.

In summary, the short-term leach testing data suggests a low contaminant mobility potential for NAF samples, but potential mobility for samples with acidic leachate chemistry.

5.3.2.4 Neutral metalliferous drainage hazard

The NMD hazard associated with BHP's Pilbara-wide operations has been assessed by SRK (2022). The outcomes of this study have been supplemented by a specific review of the NMD hazard associated with the OB31 and Jimblebar operations based on the environmental geochemistry test work outlined in Section 5.3.2.3 (BHP, 2022i). The results of both studies have been summarised in the sub-sections below.

Pilbara-wide review of NMD potential

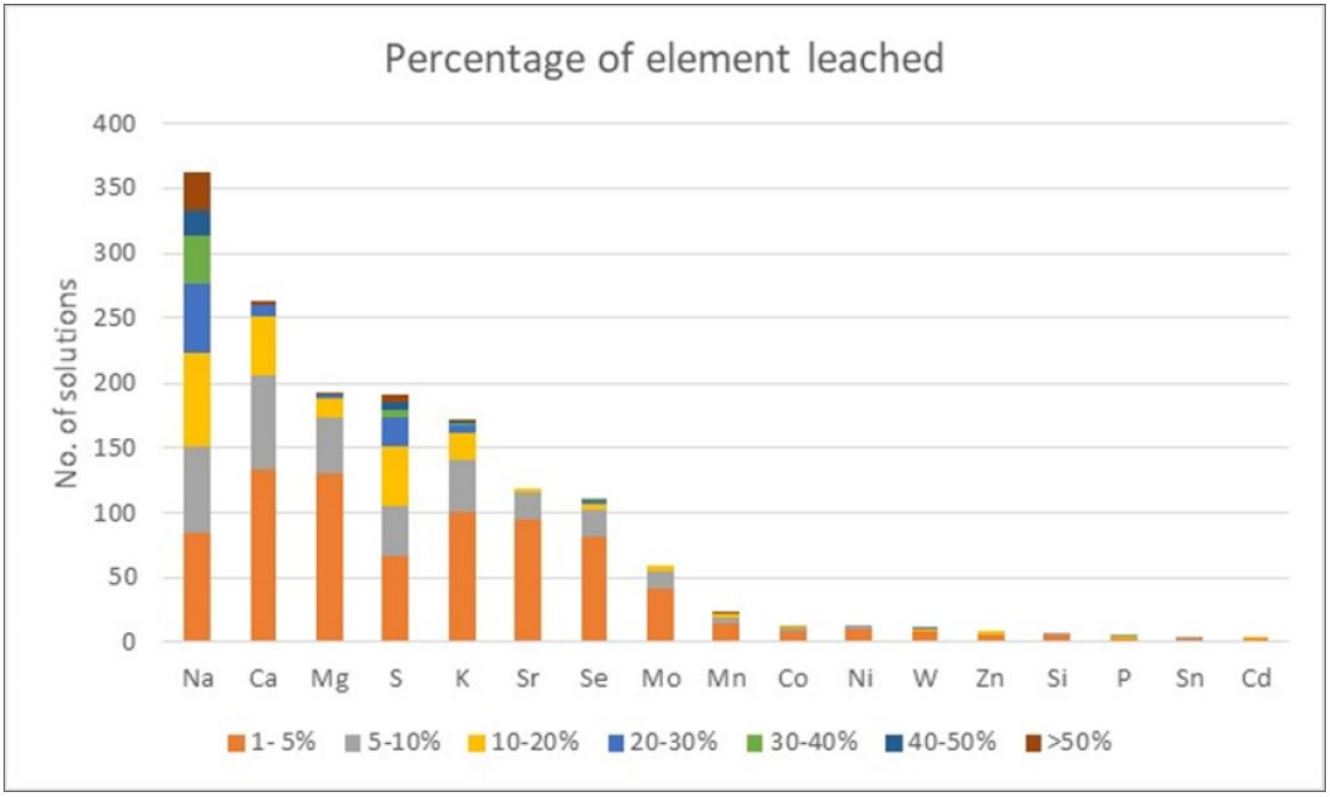
SRK (2022) conducted a detailed assessment of leach extract data from samples across BHP's Pilbara operations. The focus of the review was on identifying possible controls on leaching at near-neutral pH. For the purpose of the review, near neutral was defined as solutions with pH greater or equal to 5 and extending to alkaline values.

The statistical data analysed during SRK's (2022) assessment are presented in Appendix E-1. As one of the key objectives of the assessment was to evaluate the potential for NMD from low sulphur overburden, statistics for all samples and only low sulphur samples (i.e., total sulphur content below 0.1 wt.%) were analysed separately.

In general, higher dissolved concentrations of most solutes were found to be coincident with acidic leachate pH. Conversely, antimony (Sb), lead (Pb) and selenium (Se) showed limited dependence on pH and molybdenum (Mo) showed a trend towards higher dissolved concentrations in both acid (pH <3, in Mt McRae samples) and alkaline pH (pH 7 to 9 – in a range of lithologies) leachates. In neutral pH leachates (pH ≥5) higher (but still relatively low) dissolved concentrations of some parameters were associated with samples that contained greater than 0.1 wt.% total sulphur (SRK, 2022).

Within the neutral pH dataset, for most tests (i.e., below the 95th percentiles), the dissolved concentrations for many elements were recorded at or below detection limits (for example, silver (Ag), beryllium (Be), cadmium (Cd), cerium (Ce), mercury (Hg), phosphorus (P), lead (Pb), tin (Sn), thorium (Th), uranium (U) and vanadium (V)) despite the fact that the materials (bulk chemistry) contained significant quantities of some elements (i.e., geochemical abundance index >1-3). The first leach is generally characterised by the highest dissolved concentration and mobilisation, however, for most elements, less than 1% of the total elemental mass present in the solid was mobilised during the tests. There were some exceptions (SRK, 2022):

- Elements such as sodium (Na), calcium (Ca), magnesium (Mg), sulphur (S), and potassium (K) were regularly present in the leachates at dissolved concentrations corresponding to more than 20% of the total elemental mass present in the solid (Figure 5-21). These elements are typically mobile and generally associated with readily soluble minerals.
- Strontium (Sr), selenium (Se) and molybdenum (Mo) leached more readily in several tests (50 or more) and more than 5% of total elemental mass leached in a few tests (Figure 5-21). As discussed above, there is evidence that samples with lower sulphur content leach lower quantities of these elements.



Source: SRK (2022)

Figure 5-21 Number of solutions within different % leached categories (leachate pH ≥5)

Potential solubility controls inferred by SRK (2022) from PHREEQC modelling (Table 5-23) were oxide and hydroxides (Al, Fe, Cu, Mn), sulphates (Ba) and carbonates (Cu, Mn).

Table 5-23 Summary of inferred mineral solubility controls

Element	Possible Solubility Control	Comment
SO_4	Gypsum ($CaSO_4.2H_2O$)	Leachates were dominantly undersaturated with respect to gypsum – if present at all, gypsum is leached completely from the sample and has not reached equilibrium with the contacting solution. Eight leachates were at or near saturation; X-Ray Diffraction (XRD) analysis identified gypsum in two of these samples.
Ca, Mg	Gypsum ($CaSO_4.2H_2O$) Calcite ($CaCO_3$) Dolomite ($CaMg(CO_3)_2$)	Gypsum described above. Calcite and dolomite were at or near saturation for most solutions above pH 7. For most other solutions, these carbonates were undersaturated. XRD analysis identified calcite in seven of these samples and dolomite in three of these samples.
Al	Gibbsite ($Al(OH)_3$) Jurbanite ($AlOHSO_4$) Alunite ($Kal_3(OH)_6(SO_4)_2$) Diaspore (α-AlO(OH)) Boehmite (γ-AlO(OH)	A selection of hydroxides and hydroxysulphate minerals were calculated to be close to saturation or oversaturated in many of the solutions. In the near-neutral to alkaline pH range, hydroxides are the most likely mineral control. While not specifically identified in samples submitted for leach testing, gibbsite has been identified in mineralogical studies (XRD) of analogous samples in the wider BHP Pilbara database.
Ba	Barite ($BaSO_4$)	Barite was found to be close to equilibrium in a significant proportion (~80%) of the leachates, across a range of pH.
Cu	Malachite ($Cu_2CO_3(OH)_2$) Tenorite (CuO)	Leachates were dominantly undersaturated with respect to these minerals. However, within the near-neutral to alkaline pH range, 29 solutions were close to equilibrium with tenorite, and 2 with malachite.
Fe	Ferrihydrite ($Fe(OH)_3$) K-Jarosite ($Kfe_3(SO_4)2(OH)_6$) Na-Jarosite	A selection of hydroxides and hydroxysulphate minerals were calculated to be close to saturation or oversaturated in the solutions. In the near-neutral to alkaline pH range, hydroxides are the most likely mineral control. While not specifically identified in samples submitted for leach testing, jarosite and alunite have been identified in mineralogical studies (XRD) of analogous samples in the wider BHP Pilbara database.
Mn	Manganite (MnOOH) Rhodochrosite ($MnCO_3$)	Most solutions are undersaturated with respect to these minerals. However, within the near-neutral dataset, between 24 (rhodochrosite) and 15 (manganite) solutions were either close to or oversaturated with respect to these minerals.

Element	Possible Solubility Control	Comment
Si	Chalcedony (SiO_2)	Most solutions (more than 80%) were close to equilibrium with chalcedony. While the source of Si may be a range of aluminosilicate minerals, dissolved Si concentrations are likely limited by chalcedony precipitation.

Source: SRK (2022)

Many leachates contained elevated concentrations of solutes (such as Cl) for which no solubility controls were identified. To identify possible source minerals (and verify the inferred solubility controls indicated by speciation modelling), SRK (2022) evaluated correlations between solute concentrations. Based on these correlations the main soluble mineral sources were inferred to be (SRK, 2022):

- Halite (NaCl), as inferred from the positive correlation between Na and Cl (Pearson correlation coefficient, R = 0.94).
- Calcium and magnesium sulphates (possibly gypsum, epsomite), as inferred from the positive correlations between Ca and SO_4, and Mg and SO_4. Within the near-neutral subset of data (pH ≥5), the correlations were strong (R coefficients of 0.86 and 0.87, respectively).
- Carbonates (calcium, dolomite). The mineralogical data suggested that many samples contained quantities of carbonate (up to 56% dolomite and 9% calcite). While sparingly soluble at neutral pH, such minerals may represent a source of small quantities of Ca, Mg, and carbonate alkalinity in the leachate solutions.

In summary (SRK, 2022):

- The low dissolved concentrations observed in most tests suggested that most elements are present in the solids in a form that is not readily soluble, either due to slow reaction kinetics, or because a solubility limit prevents further dissolution.
- The key control for most element mobilisation is represented by pH, not sulphur concentration. This means that at lower pH, most elements are mobilised more readily. However, antimony (Sb), lead (Pb) and selenium (Se) do not show any specific dependence on pH, while molybdenum (Mo) mobilisation appears to be enhanced at very low pH (<3) and alkaline to moderately alkaline pH (pH <7).
- For many parameters, low solubility at neutral / alkaline pH dictates low dissolved concentrations irrespective of the sulphur content in the solid. For some parameters (e.g., Se, Mo) there is evidence that leachable quantities are lower in low sulphur samples, suggesting that the potential for NMD from low sulphur materials is low.
- When considering the influence of more soluble mineral sources (e.g., gypsum, halite), a low water to solids contact ratio (such as expected within OSAs) may result in dissolved concentrations in early seepage (the 'initial flush') being higher than indicated in leach extract datasets. However, because most of the readily soluble minerals are present in limited supply, they would be expected to be leached from the overburden within a relatively short period.

It should be noted that the leach test work was conducted using a solid to water ratio of 1:2 which is close to field conditions, and on pulverised / fine grained materials. These latter conditions promote a higher level of leaching compared to field conditions due to the large surface area of the laboratory samples, which enhances dissolution and metal mobilisation.

Review of NMD potential of Jimblebar Hub deposits

The overwhelming low sulphur concentration at OB18 and OB17 deposits (95th percentile value for all stratigraphies <0.1 wt.%) and the low proportion of overburden (0.7%) that has potential for AMD suggests that the potential for NMD and / or saline drainage is low, and that leachate is unlikely to mobilise metals and cations under near-neutral conditions (refer to *Pilbara-wide review* above).

The OB31 and Jimblebar deposits generally contain very low sulphur, as indicated by the mining block model data (Section 5.3.2.1), thus NMD is not expected to be a hazard for the vast majority of the overburden and low-grade ore. The overburden and low-grade ore with total sulphur >0.5 wt.% and appreciable ANC constitutes a very small proportion of the overburden and low-grade ore within these deposits (Table 5-24) (BHP, 2022i).

Table 5-24 AMD 0 material with moderate to high sulphur (i.e., ≥0.5 wt.%)

Deposit	Relevant stratigraphies	% overburden / low grade ore
OB31	Weeli Wolli Formation (HE and HJ), Mt McRae Shale (RU) and Tertiary Detritals (TD3).	<0.01% of mined overburden <0.1% of overburden yet to be mined
WH123	Dales Gorge / Colonial Chert members (D1 and D2), Mt McRae Shale (R), Marra Mamba Formation (MU) and Jeerinah Formation (JN).	<0.01% of all overburden and low-grade ore
WH4	No overburden or low-grade ore blocks with total sulphur ≥0.5 wt.%	
WHASH	Lignite Clay (LT2), Yandicoogina Shale member (Y), Joffre member (J1 and J2), Whaleback Shale (W), Colonial Chert (D1), Mt McRae Shale (RU, RN, RC and RL) and Mt Sylvia Formation (S).	<0.5% of all overburden and low-grade ore
H234	Surface Scree (SZ), Tertiary Detritals (TD2 and TD3), Weeli Wolli Dolerite (HE and HJ) and Yandicoogina Shale member (Y).	0.7% of overburden yet to be mined
East Jimblebar	Yandicoogina Shale member (Y), Colonial Chert (D1) and Mt McRae Shale (R).	0.3% of overburden yet to be mined
South Jimblebar	Lignite Clay (LT2), Marra Mamba Iron Formation (MU) and Jeerinah Formation (JN).	0.02% of overburden yet to be mined.

Source: BHP (2022i)

While some elements are enriched in the solid matrix (arsenic, manganese, molybdenum, antimony and selenium), elemental concentrations in circum-neutral leachate were generally at or below the limit of reporting in short term leach tests (see *Pilbara-wide review* sub-section above and Section 5.3.2.3) (BHP, 2022i).

5.3.2.5 Geochemical source hazard assessment

The significance of the potential sources of AMD at the Jimblebar Hub have been ranked (low, moderate or high) based on the type (i.e. AMD 1, 2 or 3) and quantity (both volume / area and percentage) of the source (Table 5-25 and Table 5-26). The results of the assessment are provided in Table 5-27.

Table 5-25 Source hazard risk categories (overburden rock and low-grade ore)

Source Hazard Risk	AMD 1		AMD 2 and AMD 3	
	Volume (Mm^3)	Percentage	Volume (Mm^3)	Percentage
Low	<0.1	<0.5%	<1	<5%
Moderate	0.1 - 0.5	0.5 - 2.5%	1 - 10	5% - 10%
High	>0.5	>2.5%	>10	>10%

If a different source hazard risk exists between different AMD types, the highest source hazard risk applies.

Table 5-26 Source hazard risk categories (pit surface exposures)

Source Hazard Risk	AMD 1		AMD 2 and AMD 3	
	Surface Area (m^2)	Percentage	Surface Area (m^2)	Percentage
Low	<2,500	<0.2%	<25,000	<2%
Moderate	2,500 - 25,000	0.2% - 1%	25,000 - 125,000	2% - 10%
High	>25,000	>1%	>125,000	>10%

If a different source hazard risk exists between different AMD types, the highest source hazard risk applies.

Table 5-27 Jimblebar Hub AMD source hazard summary

Deposit	Ex-pit OSAs	Pit Walls	Comments
OB17	Low	Low	-
OB18	Low	High	PAF blocks represent ~5% of the total wall rock
OB31	Low	Low	
WH123	Low to moderate	Moderate to high	~3.4 Mm^3 (1.1%) of overburden is classified as AMD 2 189,300 m^2 exposure of AMD 2 comprising 2.3% of the WH123 main pit shell
WH4	Low	Low	-
WHASH	Moderate to high	High	~1.9 Mm^3 (1.2%) of the yet to be mined overburden is classed as AMD 1 97,700 m^2 exposure of AMD 1 equal to 1.4% of the WHASH pit shell
H234	Low	Low	
East Jimblebar	Moderate to high	High	~1.8 Mm^3 (0.8%) of yet to be mined overburden is classed as AMD 1 113,500 m^2 exposure of AMD 1 comprising ~2% of the pit shell
South Jimblebar	Low	Low	-

Source: adapted from Earth Systems (2015) and BHP (2022i)

5.3.3 Physical characterisation

This section provides an overview of the WMAT classifications contained within the Jimblebar Hub mining model and the work conducted to support these classifications (Section 5.3.3.1). Supplementary studies on samples of materials mined from the Jimblebar Hub are summarised in Section 5.3.3.2 and the outcomes of erosion trials established at the OB18 South OSA in Section 5.3.3.3.

Summary of key points

BHP has conducted physical materials characterisation testing, erosion simulations and field studies on different stratigraphies across its Pilbara operations to broadly classify stratigraphies into competent (WMAT 1) or other overburden (WMAT 2 and 3). These classifications have been incorporated into the Jimblebar Hub mining model. In general, BHP's broad testing program has shown that most overburden associated with Marra Mamba deposits, needs to be considered highly erodible, therefore particular care is required in the development of OSA designs for landforms constructed of these materials (such as those associated with the South Jimblebar deposit). Brockman deposits generally contain stratigraphic units that are more resistant to erosion.

Supplementary physical materials characterisation and erosion modelling has been conducted on the following materials from the Jimblebar Hub:

- Dales Gorge (D1 and D3) materials which represent significant proportions of overburden at the following deposits:
  - D3 - 10% to 18% of the overburden at OB17/18, WH1234, WHASH and East Jimblebar deposits.
  - D1 - ~10% of mined overburden and 26% of overburden yet to be mined at OB17/18, and 13% of overburden to be mined at East Jimblebar.
- Joffre (J2 and J6) which represent significant proportions of the overburden mined at WH123 and WH4 (J2 - ~16% and J6 - 13%) and WHASH (J2 - 10%).
- Mt McRae Shale, Scree, topsoil and various mixes of topsoil and other materials from OB18.
- Hard cap material from Jimblebar.

Conclusions arising from the erosion modelling studies are as follows:

- Broad assessment of the Dales Gorge D3 materials across BHP's operations has indicated that this material can usually be classified as WMAT 1 and predicted erosion rates for D3 materials from Jimblebar materials are consistent with this classification and indicated that the materials would be stable on linear batter slopes of 15° up to 20 m high. However, the erosion modelling of D3 materials at OB18 indicated that the Dales Gorge materials at OB18 would require stabilisation with a mix of other materials (topsoil and / or rock) to develop erosionally stable landform slopes. Addition of 40 to 50% rock resulted in acceptable erosion rates on 10 m high batters with linear slopes up to 18°.
- The Joffre J2 material was erosionally stable for slopes of 18° up to 20 m. Increased batter heights could be achieved with the addition of rock.
- The Joffre J6 material was not erosionally stable at any practical batter configuration, however, 10 m high batters with 15° and 18° slopes are possible with 40% rock cover. Increased percentages of rock cover may allow further increases in batter heights.
- There are no linear or concave profiles that would result in acceptable erosion rates for Mt McRae Shale even with the addition of rock, and consequently, this material is considered unsuitable for use on outer surfaces of OSAs.
- Scree materials are predicted to be stable at linear batter heights of up to 40 m with gradients of 12° to 18°. Several concave profiles with up to 40 m high batters were also modelled to be stable.
- Acceptable erosion rates can be achieved for a Wheelarra topsoil (from OB18) on 12° linear batters up to 10 m high, and the addition of 35% rock cover would result in acceptable erosion rates on 10 m linear batters with up to 18° slopes.
- Topsoil / scree mixes are stable at a batter height of 20 m with a 12° slope or slopes of up to 18° if the batter height is reduced to 10 m.
- Marra Mamba materials are known to be prone to erosion. Opportunities exist to stabilise OSAs constructed from this material with more competent overburden types such as Jimblebar hard cap, or Brockman Iron Formation WMAT 1 materials. Erosion modelling has shown that Jimblebar hard cap materials would be stable on slopes 15 m high with gradients up to 12°

Erosion trials on OB18 South OSA have confirmed modelling predictions that rock treatments increase erosion resistance. Monitoring results to date have indicated that once surfaces have armoured, erosion rates are low for surfaces treated with rock.

5.3.3.1 Mining model classification of overburden materials

As discussed in Section 5.3.1, BHP has conducted physical materials characterisation testing, erosion simulations and field studies of different stratigraphies across its Pilbara operations to broadly classify stratigraphies into competent (WMAT 1) or other overburden (WMAT 2 and 3). Analysis has included physical testing of materials under laboratory conditions simulating rainfall and overland flow using predicted rainfall events based on local rainfall data. Rainfall simulation and overland flow has been conducted over a range of gradients to quantify:

- Interrill erodibility (Ki);
- Rill erodibility (KR);
- Critical shear (tc); and
- Effective hydraulic conductivity (Ke).

These data have then been used in numerical modelling to assess how well a specific overburden type (or blends of overburden types) behave under surface flow conditions. Numerical modelling tools used include Water Erosion Prediction Project (WEPP) model, SIBERIA landform evolution model and the Revised Universal Soil Loss Equation (RUSLE).

Initial assessment of field erosion data has showed that WEPP predicts run-off satisfactorily and reasonable agreement exists between measured and predicted cumulative erosion rates (Landloch, 2012). Field erosion trials are being used to collect data and further calibrate the WEPP model predictions. Monitoring of field trial areas will continue for several years.

SIBERIA modelling (Landloch, 2016a) has analysed the performance of alternative landform design options including:

- Design profiles (linear slopes, concave slopes and bench and berm designs) (refer to Section 5.16.2.1 for example profiles);
- Landform heights and angles; and
- Overburden types including mixes (i.e., rockier material, growth media).

Outcomes of modelling corroborate that erosion is a function of the rock size distribution (well graded), slope grade and height. The application of concave slopes and augmentation of additional rock percentage to poorer performing overburden material have successfully improved performance.

Based on the broad testing outlined above, the physical characteristics of the stratigraphies intersected at Jimblebar Hub are classified in the mining model according to the classification scheme outlined in Section 5.3.1.2 (Table 5-28). However, there can be a high degree of variability between material from similarly classified geological units from different locations. For example, detritals can contain high proportions of clay rich materials or high levels of coarse fragments, significantly altering their response to erosive forces (Figure 5-22). The broad mining model classifications have, therefore, been supplemented with additional studies on materials at the Jimblebar Hub as summarised in Section 5.3.3.2.

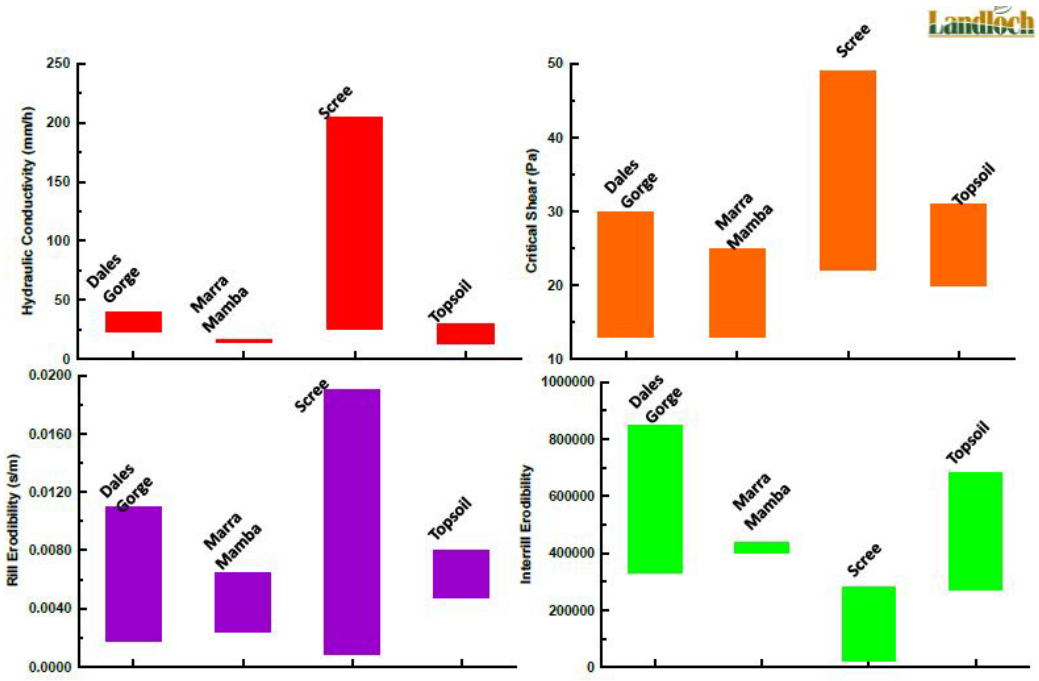


Figure 5-22 Variability in WEPP erodibility parameters for overburden and soils WAIO operations

In general, BHP's broad testing program has shown that most overburden associated with Marra Mamba deposits, needs to be considered highly erodible (Landloch, 2013b) (Table 5-28), therefore particular care is required in the formulation of OSA designs for landforms constructed of these materials (such as those associated with the South Jimblebar deposit). Brockman deposits generally contain stratigraphic units that are more resistant to erosion (Table 5-28).

Table 5-28 WMAT class of stratigraphies intersected at Jimblebar Hub

Stratigraphy		Abbreviation	WMAT Class
Formation	Member		
Surface scree		SZ	3
Tertiary Detritals		ST3, GS3, CY2, VB2, SD2, LT2, CA2, HC1, AG, TD3, TD2	3
Tertiary Sediments		T	3
Dykes & sills		K	3
Weeli Wolli	Dolerite	HE	3
	Iron	HJ	1
	Undifferentiated	WW	1
Brockman Iron	Yandicoogina Shale (Dolerite Sills)	YE	3
	Yandicoogina Shale	Y	3
	Joffre	J3/J5 (undifferentiated)	1
		J6	2
		J5 (Shaly)	2
		J4	1
		J3 (Shaly)	2
		J2	2
		J1 (Shaly)	2
	Whaleback Shale	W	3

Stratigraphy		Abbreviation	WMAT Class
Formation	**Member**		
Brockman Iron continued	Dales Gorge	D4	1
		D3 (Shaly)	1
		D2	1
	Colonial Chert	D1	2
Mt McRae	Upper	RU	3
	Nodule Zone	RN	3
	Chert	RC	3
	Lower	RL	3
	Undifferentiated	R	3
Mt Sylvia	Undifferentiated	S	3
Wittenoom	West Angela A2	WA2	3
	West Angela A1	WA1	3
	West Angela Undifferentiated	OA	3
Marra Mamba Iron	Mt Newman – N3	N3	3
	Mt Newman – N2 (Shaly)	N2	3
	Mt Newman – N1	N1	2
	Mt Newman undifferentiated	MN	3
	MacLeod	MM	3
	Nammuldi	MU	2
Jeerinah	Undifferentiated	JN	3

5.3.3.2 Jimblebar Hub characterisation studies

Supplementary physical materials characterisation and erosion modelling has been conducted on the following materials from the Jimblebar Hub:

- Dales Gorge (D1 and D3) material from OB18 and Jimblebar (WH123 and WHASH) (Landloch, 2013a; 2015b; 2016a).
- Joffre (J2 and J6) material from Jimblebar (WH123 and WHASH pits) (Landloch, 2015b).
- Mt McRae Shale, Scree, topsoil and various mixes of topsoil and other materials from OB18 (Landloch, 2013a; 2016a).
- Hard cap material from Jimblebar (Landloch, 2016b).

Each material was subjected to various laboratory analyses (Table 5-29) and WEPP erosion modelling (Table 5-30). The erosion modelling studies used an acceptability threshold of long-term average annual erosion (averaged over the whole slope) of less than 5t/ha/y and maximum long term average annual erosion rate (at any point on the slope) of less than 10t/ha/y. However, since these studies were conducted, the understanding of erosion in the Pilbara has evolved, and a rate of 6/t/ha/y has been established as a threshold for mean annual erosion rates. In addition, it has been established that the erosion rate at any point on a slope should not exceed the target threshold average rate by more than 100% (Landloch, 2018). The results in Table 5-30 have all been compared to the contemporary thresholds established by Landloch (2018) for consistency.

The outcomes of the studies are reported by overburden type below. Erosion modelling studies conducted to support specific landform designs are outlined in Sections 5.16.2 and 9.3.1, and Appendix L.

Table 5-29 Laboratory analysis of Jimblebar Hub materials

Analyses		Units	Material Type / Location									
			OB18	OB18	OB18	JMB	OB18	OB19	OB18	JMB	JMB	JMB
			Colonial Chert (D1)	Dales Gorge (D3) - A	Dales Gorge (D3) - B	Dales Gorge (D3)	Scree - A	Scree - B	Topsoil	Joffre (J2)	Joffre (J6)	Marra Mamba Hard Cap
pH		pH units	5.42	5.83	5.49	-	6.8	7.06	5.89	-	-	-
EC		dS/m	0.03	0.39	0.34	-	0.23	0.1	0.03	-	-	-
Exchangeable Cations	Calcium	meq/100g	335	158	151	0.81	622	503	148	0.59	0.76	1.3
	Magnesium	meq/100g	90.6	91.9	82.3	1.15	218	171	105	0.61	0.76	0.26
	Potassium	meq/100g	68.3	61.7	44.3	0.15	95.1	70.7	14.6	0.12	0.18	0.13
	Sodium	meq/100g	37.6	165	134	0.21	326	219	20.6	0.52	0.46	0.13
	Aluminium	meq/100g	0	0.3	0.4	0.01	0.7	0.8	8.7	0.01	0.01	0.01
	Cation Exchange Capacity	meq/100g	2.8	2.4	2.1	2.32	6.6	5.1	1.8	1.85	2.17	1.8
	Exch. Sodium Percentage	%	5.9	29.5	27.2	9.12	21.5	18.7	4.87	28.18	21.21	7
	Exch. Aluminium Percentage	%	-	-	-	-	0.12	0.17	5.23	-	-	-
Particle Size Distribution of Fine Fraction	Coarse Sand 0.2-2.0mm	%	32	32.2	26.4	42.3	64.1	67.8	23.8	32.9	27.3	35.2
	Fine Sand 0.02-0.2mm	%	60.7	46.7	54.9	37.4	29.7	26	61.8	38.4	40.9	42
	Silt 0.002-0.02mm	%	6.7	18.8	18.3	13	1.9	0	1.8	22.3	26.9	1.8
	Clay <0.002mm	%	0.6	2.3	0.4	7.3	4.3	6.1	12.5	6.4	4.9	21.1
Coarse Fragments	2.0mm	%	49.63	58.43	53.53	3.63	90.2	92.2	64.3	4.34	10.9	13.6
	5.0mm	%				2.31				2.11	3.53	11.1
	Coarse gravel	%				6.72				6.64	11.37	35.5
	Pebbles	%	-	-	-	4.4	-	-	-	6.87	7.43	20.9
	Rock	%	-	-	-	1.38	-	-	-	12.01	2.21	18.9
Emerson Dispersion Potential		Class	-	-	-	6	-	-	-	6	6	6
Rock Particle Density		g/cm^3	-	-	-	1.5	-	-	-	2.9	3.3	3.2
Rock Water Absorption		%	-	-	-	23.3	-	-	-	3.5	5.8	5.5

Sources: Landloch (2013a; 2015b; 2016b)

Table 5-30 WEPP modelling of Jimblebar Hub materials

Deposit	Overburden Type & Sample ID	Output	Predicted Erosion (t/ha/y)											
			batter 10 m high			batter 20 m high			batter 30 m high			batter 40 m high		
			12°	15°	18°	12°	15°	18°	12°	15°	18°	12°	15°	18°
OB18	Colonial Chert (D1)	Avg	122	134	142	265	294	312	368	415	447	439	Not analysed	
		Max	320	345	360	556	618	659	674	775	847	729		
OB18	Dales Gorge (D3) - A	Avg	38	43	47	55	67	76	60	76	88	62		
		Max	74	86	95	80	100	118	78	100	120	77		
OB18	Dales Gorge (D3) - B	Avg	11	13	14	27	32	34	37	44	50	43		
		Max	35	39	42	63	73	79	70	86	97	71		
Jimblebar	Dales Gorge (D3)	Avg	0.02	0.02	0.03	0.43	0.81	1.28	3.11	5.19	6.99	7.25	10.37	13.05
		Max	0.02	0.05	0.23	3.65	6.56	10.8	22.1	30.5	36.2	29.4	36.4	43
OB18	Topsoil & Colonial Chert (D1)	Avg	15	17	19	36	42	46	49	58	65	56	Not analysed	
		Max	46	52	56	81	94	103	89	108	124	88		
OB18	Topsoil & Dales Gorge (D3)	Avg	4	6	8	15	20	25	20	27	33	21		
		Max	21	28	34	40	52	62	39	51	62	37		
OB18	Topsoil	Avg	2	3	3	9	12	15	15	20	24	19		
		Max	10	14	16	32	40	46	38	48	56	37		
OB18	Scree - A	Avg	0	0	0	0	0	0	0	0	0	0		
		Max	0	0	0	0	0	0	0	0	0	0		
OB18	Scree - B	Avg	0.4	0.4	0.5	0.9	1.1	1.3	1	1.3	1.5	1		
		Max	1.4	1.7	1.8	1.8	2.2	2.5	1.8	2.1	2.4	1.8		
OB18	Topsoil & Scree	Avg	2	2	3	5	6	7	7	8	10	7		
		Max	7	8	9	12	15	17	12	16	19	11		
Jimblebar	Joffre (J2)	Avg	0.23	0.37	0.51	2.68	3.59	4.32	6.78	8.65	10.15	10.71	13.59	15.84
		Max	1.66	2.59	3.25	13	16.3	18.9	25.5	30.7	34.8	33.4	40.2	45.8
Jimblebar	Joffre (J6)	Avg	6.03	7.36	8.22	17.98	21.11	23.41	25.18	30.36	34.39	28.8	35.64	41.31
		Max	23.2	26.7	28.7	44.8	52	57.2	49.1	60	69.3	47.8	60.4	72.3
OB18	Mt McRae Shale	Avg	30	34	35	68	73	77	96	105	111	118	Not analysed	
		Max	80	85	87	144	156	162	185	204	217	211		

Notes: Orange shaded cells indicate batter configurations with predicted average erosion values greater than 6 t/ha/y or maximum values greater than 12 t/ha/y. Cells shaded green indicate batter configurations with predicted erosion values less than these thresholds.

Sources: Landloch (2013a; 2015b)

Scree material

Exchangeable Sodium Percentage (ESP) provides a measure of clay dispersion potential and, assuming low salinity and a material with appreciable clay content (10 - 15%), values >6% indicate a material with a clay fraction prone to dispersion. Materials that are potentially dispersive are more prone to (Landloch, 2013a):

- Hard-setting surfaces.
- Increased run-off potential.
- Increased erosion potential.
- Initiation of tunnel erosion.

The ESPs of scree materials were above 6% (Table 5-29), however, the samples were also low in salinity and clay content, so Landloch (2013a) concluded that they would be unlikely to display tunnelling but would be more prone to surface sealing and hard-setting.

Scree materials were predicted to be erosion resistant for all batter configurations modelled (Table 5-30), and when mixed with soil, predicted erosion rates remained acceptably low for 10 m high batters with gradients ranging from 12° to 18° and 20 m high batters with 12° slopes. However, it is likely that the underlying materials would be less permeable than the Scree materials placed at the surface resulting in the potential for the Scree to saturate, lose cohesion and slip from the batter slope. Should it be placed over less permeable surfaces, the Scree would need to be subjected to geotechnical studies to determine the risk of mass failure. Alternately, the scree could be mixed with soil to address this issue (Landloch, 2013a).

For batter heights over 10 m, the following concave profiles were predicted to result in acceptable erosion rates for a topsoil / Scree mix (Landloch, 2013a):

- 20 m high batters – 3 segment concave profile of 18°, 15° and 12°.
- 30 m high batters – 4 segment concave profile of 18°, 15°, 12° and 9°.
- 40 m high batters – 5 segment concave profile of 18°, 15°, 12°, 9° and 6°.

Dales Gorge materials

The Dales Gorge D3 materials represent a significant proportion (10% to 18%) of the overburden at OB17/18, WH1234, WHASH and East Jimblebar deposits (Section 5.2.2). Colonial Chert D1 material represents ~10% of mined overburden and 26% of overburden yet to be mined at OB17/18, and 13% of overburden to be mined at East Jimblebar.

The Colonial Chert (D1) and all three of the Dales Gorge (D3) materials sampled had ESP above 6% (Table 5-29), however:

- The OB18 materials were also low in salinity and clay content and Landloch (2013a) concluded that they would be unlikely to display tunnelling but would be more prone to surface sealing and hard-setting.
- The Jimblebar material had low clay content and the Emerson test did not indicate a dispersion risk. The amount of rock in this material reduces the risk of structural decline caused by clay dispersion. The main issue regarding the use of this material is the potential to hard-set (Landloch, 2015b).

Erosion modelling showed that the Colonial Chert (D1) had unacceptable erosion rates for all batter configurations modelled which is consistent with the classifications in the mining model (Section 5.3.3.1).

Broad assessment of the Dales Gorge D3 materials across BHP's operations has indicated that this material can usually be classified as WMAT 1 (Section 5.3.3.1). The results of a study on the Jimblebar materials were consistent with this classification and indicated that the materials would be stable on linear batter slopes of 15° up to 20 m high (Landloch, 2015b). However, the erosion modelling study conducted by Landloch (2013a) for materials at OB18 indicated that the Dales Gorge materials at OB18 would require stabilisation with a mix of other materials (topsoil and / or rock) to develop erosionally stable landform slopes (Table 5-30).

Further analysis of the OB18 materials indicated that addition of 40 to 50% rock to the D3 (sample B) material could achieve acceptable erosion rates on 10 m high batters with linear slopes up to 18° (refer to Appendix E-2 for further information). Acceptable erosion rates were also achieved on a 2-segment concave profile of 18° and 9° for the topsoil and D3 mix (Landloch, 2013a).

A similar analysis conducted for the Jimblebar D3 material indicated that batter heights of 40 m with slopes of 15° and 18° could be achieved with the addition of 50% and 60% of rock respectively (Appendix E-3) (Landloch, 2015b).

Joffre materials

Joffre J2 and J6 materials represent significant proportions of the overburden mined at WH123 and WH4 (~16% and 13% respectively) and WHASH (J2 - 10%) (Section 5.2.2).

Analysis of chemical and physical parameters indicated that these materials, like Dales Gorge materials, are unlikely to present a dispersion risk. While the ESP is greater than the 6% threshold (21 - 28%), both materials have low Cation Exchange Capacity (CEC) (<2.3 meq/100g) and low clay content (<7.3%), and the Emerson test results did not indicate a dispersion risk (Table 5-29). The amount of rock in the materials reduces the risk of structural decline caused by clay dispersion. The main issue likely to arise in using these materials is hard-setting which will have implications for seeding the OSAs (Landloch, 2015b).

Materials that have a rock density >2.7 g/cm^3 are termed 'excellent' for use in hydraulic structures (CIRIA, 2007). This classification applies to the J2 and J6 materials tested. However, water absorption results of <2% are classified as 'good,' and the rocky fractions of the Joffre materials have water absorption >2% (Table 5-29) (Landloch, 2015b).

WEPP modelling results (Table 5-30) showed that the J2 overburden material was erosionally stable for slopes of 18° up to 20 m high although Landloch (2015b) noted that at 20 m heights, the batter would require armouring at the toe to avoid unacceptable erosion rates. Increased batter heights could be achieved with the addition of rock Appendix E-3.

The J6 material was not erosionally stable at any practical batter configuration (Table 5-30), however, Landloch (2015b) ran several WEPP simulations to estimate what OSA configuration might be possible if the rock cover is increased. The results are provided in Appendix E-3 and indicate that 10 m high batters with 15° and 18° slopes are possible with 40% rock cover and that 90% rock cover would be required for batter heights of ~25 m at 18° and 27 m at 15°.

Mt McRae Shale

Erosion modelling of the Mt McRae Shale indicated that there are no linear or concave profiles that would result in acceptable erosion rates (Table 5-30). An assessment of the potential to use rock to stabilise the slopes (Appendix E-2) indicated that complete coverage by rock would be required and it was, therefore, concluded that these materials would not be suitable for placement on the surface of constructed OSAs (Landloch, 2013a).

Topsoil

A Wheelarra topsoil from OB18 was sampled and tested by Landloch (2013a). The physical and chemical characteristics of topsoil are reported in Table 5-29 above. Erosion modelling shows that 12° linear batters up to 10 m high will result in acceptable erosion rates (Table 5-30). An assessment of the potential to use rock to stabilise the slopes indicated that the addition of 35% rock cover would result in acceptable erosion rates on 10 m linear batters with up to 18° slopes (Appendix E-2). A 4-segment concave profile of 18°, 15°, 12° and 6° was also assessed to have acceptable erosion rates (Landloch, 2013a).

Jimblebar hard cap

The ESP of Jimblebar hard cap is greater than 6, however, exchangeable sodium is <0.3 meq/100g and Effective Cation Exchange Capacity (ECEC) is low (<3 meq/100g). The elevated ESP levels are, therefore, unlikely to lead to tunnel erosion. The Emerson test result did not indicate a dispersion risk, and the amount of rock in the material further lowers the risk of structural decline caused by dispersion (Table 5-29). The main issue in using these materials in rehabilitation will potentially be a hard-setting surface which may have implications for seeding the OSAs at closure (Landloch, 2016b).

The rock density (3.2 g/cm^3) and water absorption (5.5%) results for the Jimblebar hard cap material (Table 5-29) both indicate that it is durable and suitable for use within a rock mulch layer (Landloch, 2016b).

WEPP modelling was conducted for a 15 m high linear batter with gradients of 12°, 15°, and 18° and indicated that the material would be erosionally stable on slopes up to 12° (Table 5-31).

Table 5-31 Erosion modelling results for Jimblebar hard cap material

Batter Height (m)	Batter Gradient (°)	Predicted Erosion (t/ha/y)	
		Average	Max
15	12	1.3	8.5
15	15	2.0	12.4
15	18	2.7	15.4

Notes: Orange shaded cells indicate batter configurations with predicted average erosion values greater than 6 t/ha/y or maximum values greater than 12 t/ha/y. Cells shaded green indicate batter configurations with predicted erosion values less than these thresholds.
Source: Landloch (2016b)

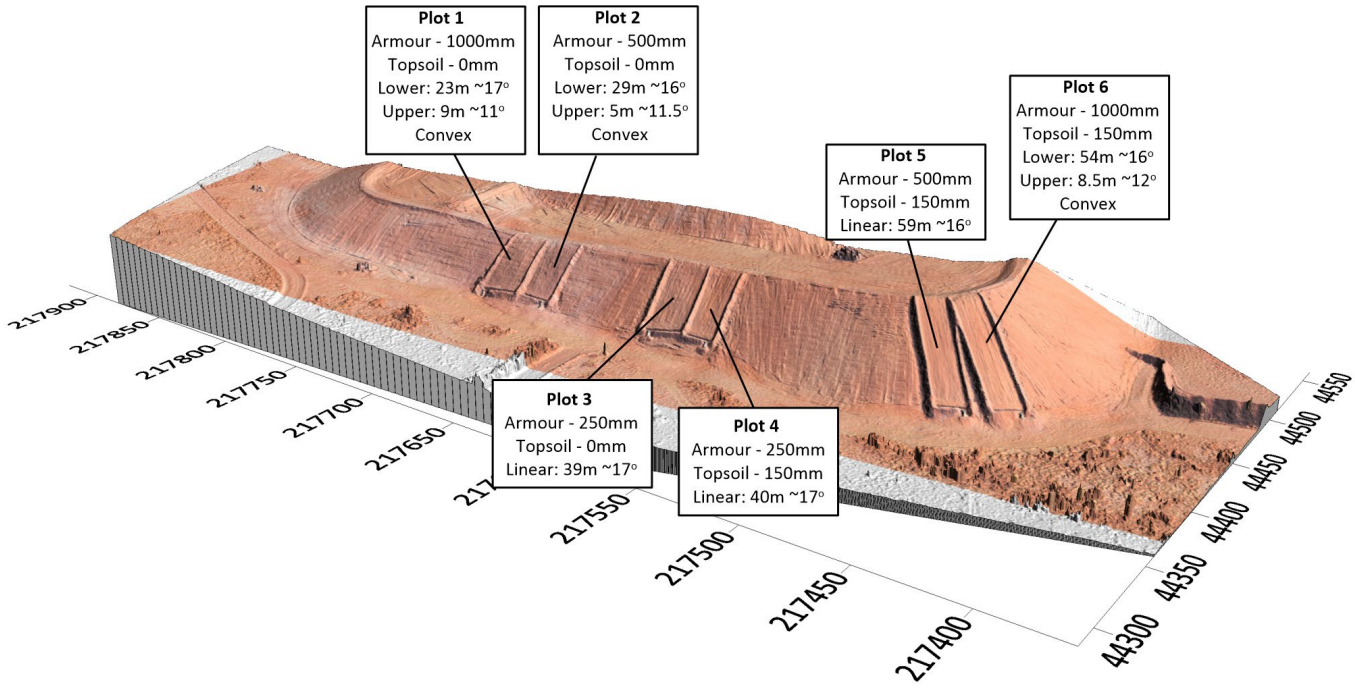
5.3.3.3 OB18 South OSA erosion trials

Six erosion trial plots were installed on the OB18 South OSA in December 2018 (Table 5-32 and Figure 5-23). The purpose of the trial was to test variable slope design, armour and topsoil thicknesses. Convex and linear slope designs were tested to inform and refine regrade design parameters. Convex slope profiles are present in the Pilbara and BHP was interested in understanding the slope design performance in a rehabilitation context.

Table 5-32 OB18 Erosion plot details and surface treatment

Plot ID	Plot details						Surface treatment	
	Average width (m)	Average length (m)	Approximate area (m^2)	Batter height (m)	Average gradient (°)	Profile	Armour (mm)	Topsoil[1] (mm)
1	16.5	35	577	9.0	15.6	Convex	1 000	0
2	15.8	35	549	8.5	15.9	Convex	500	0
3	18.1	39	713	11.2	17.0	Linear	250	0
4	14.2	40	568	11.5	17.0	Linear	250	150
5	13.5	59	789	15.5	16.0	Linear	500	150
6	13.9	63	881	16.3	15.2	Convex	1000	150

Note: [1]There was no ripping or mixing of the topsoil into the underlying rock armour.
Source: Landloch (2019)



Source: Landloch (2019)

Figure 5-23 Overview of OB18 Plots

Composite samples (compiled from four locations on each plot, sampled to a depth of 100 mm) were subject to soil characterisation testing with the results presented in Table 5-33. The soils were moderately acidic to neutral and non-saline. Soils on plots 1, 2, 4 and 5 had ESP values >6%, which on its own could indicate sodic and dispersive soils with susceptibility to tunnel erosion, surface crusting, low infiltration capacity, hard-set surface layers that impede plant growth, and dense subsoils. In practice, however, the potential for a soil to disperse is controlled not simply by ESP, but by complex interactions between clay and rock content, exchangeable cation concentrations, and soil salinity (Landloch, 2019).

The surface materials in the trial plots all contain a relatively large proportion of coarse fragments >2 mm diameter. The presence of an appreciable coarse fraction, coupled with a low CEC, low exchangeable sodium concentration, and relatively low clay content means that the surface materials are unlikely to be prone to tunnel erosion. However, the very low salinity ($EC_{1:5}$) could potentially lead to some dispersion of the clay fraction that could manifest as hard-set surfaces, and reduced infiltration capacity. Although the total coarse fragments (>2 mm) of all composite samples were fairly consistent, the surface materials of the armour only plots (plots 1 to 3) generally had a larger rock size than the plots with topsoil (plots 4 to 6) which is likely to make them less prone to erosion. Within plots 1 to 3, plot 3 had a lower mean rock size. Plot rockiness may change as the plots are subjected to rainfall over time (Landloch, 2019).

Table 5-33 Surface material characterisation data of OB18 erosion plots

Property		Unit	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
$pH_{1:5}$ (water)		pH units	6.9	6.8	6.7	6.0	6.1	5.8
EC1:5		dS/m	0.19	0.12	0.10	0.09	0.08	0.09
Exchangeable Cations	Calcium	meq/100g	1.38	1.32	1.75	1.64	1.69	1.64
	Magnesium	meq/100g	0.76	0.78	0.77	0.62	0.70	0.64
	Potassium	meq/100g	0.11	0.13	0.20	0.31	0.28	0.31
	Sodium	meq/100g	0.40	0.36	0.16	0.25	0.19	0.13
	Aluminium	meq/100g	0.01	0.01	0.02	0.06	0.06	0.06
Effective Cation Exchange Capacity		meq/100g	2.66	2.59	2.89	2.88	2.90	2.77
Exchangeable Sodium Percentage		%	14.95	13.85	5.45	8.62	6.47	4.69
Coarse Fragments > 2.0mm		%	78.97	77.99	78.46	72.26	76.07	75.21
Particle Size Distribution (Full)								
Particle Size Distribution (Full)	Rock >50mm	%	18.98	11.13	13.89	13.25	1.99	5.37
	Pebbles 25-50mm	%	17.33	20.55	18.54	8.14	17.95	15.55
	Coarse gravel 5-25mm	%	30.85	33.23	31.38	39.21	44.37	43.86
	Fine gravel 2-5mm	%	11.82	13.08	14.64	11.66	11.76	10.43
	Fines <2mm	%	21.03	22.01	21.54	27.74	23.93	24.79
Particle Size Distribution (Fine fraction <2mm)	Coarse Sand 0.2-2.0mm	%	55.90	53.63	42.75	25.69	29.10	23.66
	Fine Sand 0.02-0.2mm	%	23.29	26.87	42.34	57.97	56.55	61.72
	Silt 0.002-0.02mm	%	8.18	8.71	3.65	3.60	3.51	1.79
	Clay <0.002mm	%	12.63	10.79	11.26	12.74	10.84	12.83
Plant Available Water Content		%	5	5	4	3	4	4
Dispersion Potential		Class	6	5	5	3	3	3
Rock Particle Density		g/cm^3	3.5	3.8	3.4	3.8	4.0	4.0
Water Absorption		%	4.36	4.07	3.83	1.06	2.01	1.17
D_{50} (rain armoured ex. <20mm)		mm	44	40	26	29	24	26
Rock cover (rain armoured surface)		%	50	50	40	40	35	50

Source: Landloch (2019)

There have been several monitoring events for the plots. Two monitoring events occurred in the months immediately following installation; from Dec 2018 to March 2019 (Event Period 1) and March 2019 to April 2019 (Event Period 2). Table 5-34 records the effective rainfall[13] experienced during these monitoring periods (Landloch, 2019). Further monitoring occurred in subsequent years and the effective rainfall and erosivity[14] of the rainfall experienced during these events is recorded in Table 5-35. The rainfall erosivity for the 2018-19 wet season was very low. The 2019-20 and 2020-21 wet seasons recorded rainfall erosivity values of more than double that of the long-term average (Landloch, 2022a).

13 Effective rainfall is defined as rainfall excluding rainfall with intensities of <0.2 mm in a 10-minute period and daily rainfall totals <2 mm. These small events are unlikely to generate runoff and their removal improves the correlation between rainfall and runoff, and runoff and erosion (Landloch, 2019).

14 Erosivity values are calculated using 10-minute rainfall data from OB18 and storm events that contribute to effective rain only (Landloch, 2022a)

Table 5-34 Peak and average rainfall intensities for the effective rainfall events (Event Periods 1 and 2)

Event Period	Event Date	Event Effective Rainfall (mm)	Average Rainfall Intensity (mm/hr)	Peak Rainfall Intensity (mm/hr)
1	31/12/18	2.2	4	6
	15/01/19	3.0	6	9
	25/01/19	12	9	25
	14/02/19	10	15	24
	04/03/19	2.2	13	13
	12/03/19	7.0	11	28
2	16/03/19	13.6	20	43
	17/03/19	22.6	11	56
	19/03/19	2.6	8	12
	28/03/19	2.6	5	7

Source: Landloch (2019)

Table 5-35 Effective rainfall and erosivity 2019 to 2022

Month	2018-19^		2019-20		2020-21		2022*
	Effective rainfall (mm)	Erosivity (MJ.mm/ha/hr)	Effective rainfall (mm)	Erosivity (MJ.mm/ha/hr)	Effective rainfall (mm)	Erosivity (MJ.mm/ha/hr)	Effective rainfall (mm)
Jul	-	-	0	0	0	1	-
Aug	-	-	8.4	5	0	1.9	-
Sep	-	-	0	0	0	0	-
Oct	-	-	2	1	11	16	141
Nov	-	-	4	3	6	14	
Dec	2	1	5	8	124	215	
Jan	15	30	229	1,803	60	55	
Feb	10	42	41	200	100	571	
Mar	51	255	0	3	16	73	-
Apr	0	1	0	0	70	920	-
May	0	0	6	2	0	1	-
Jun	4	1	0	1	0	6	-
ANNUAL	**82**	**330**	**295**	**2,017**	**387**	**1,839**	**-**

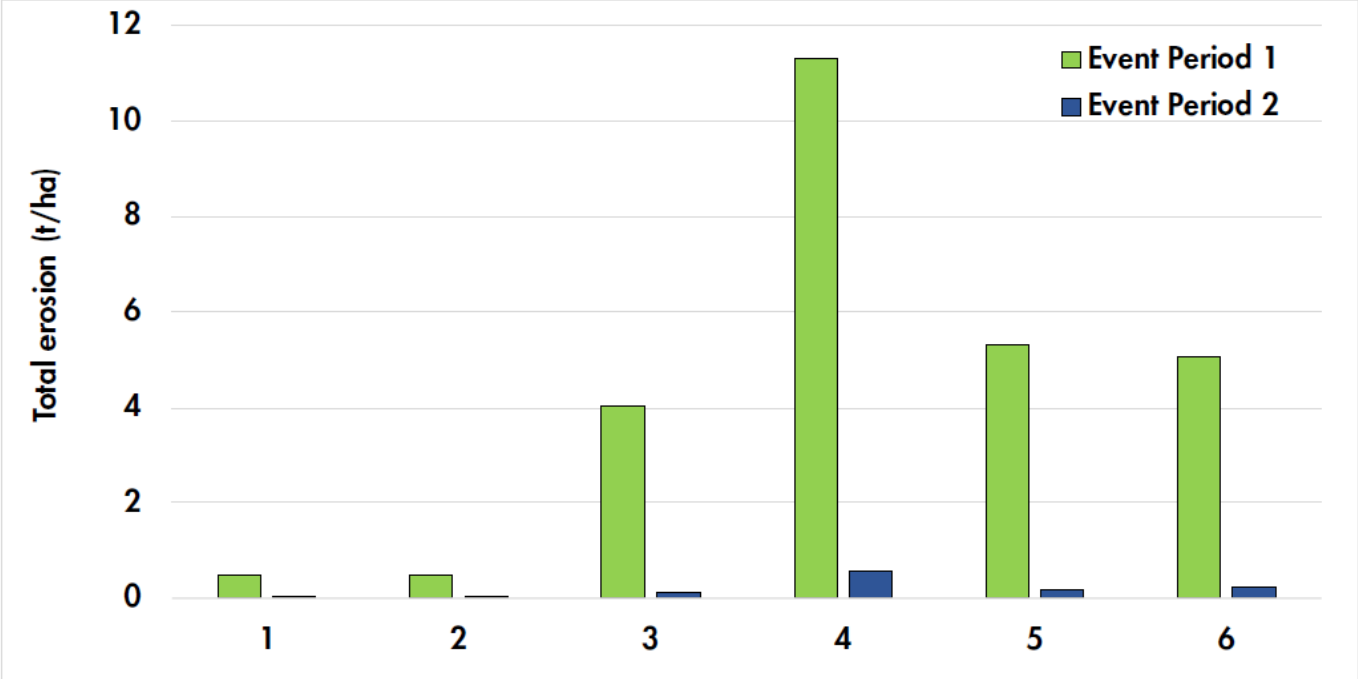
Source: Landloch (2022a; 2022b)

Notes: ^ Recorded from 14/12/2018

* Recorded 25/02/22 to 01/11/22; no data on erosivity

The long term annual average erosivity for OB18 is ~900 MJ.mm/ha/yr

Erosion rates for Event Period 1 were higher than Event Period 2 for all plots (Figure 5-24 and Table 5-36) despite the higher effective rainfall and greater rainfall intensity experienced in Event Period 2 (Table 5-34). Erosion rates measured in the 2022 monitoring period, were similarly low to those measured in Event Period 2 (Table 5-36). Landloch (2019) attributed the difference in Event Period 1 erosion rates compared to those of subsequent monitoring events, to the freshly installed, unconsolidated and unarmoured state of the erosion plots prior to Event Period 1. Erosion rates during this consolidation and armouring phase were 16 to 50 times (average 30) greater than erosion of the armoured surface (Figure 5-24) (Landloch, 2019; 2022b).



Source: Landloch (2019)

Figure 5-24 Erosion of Plots 1 to 6 for monitoring event periods 1 and 2

Between 2018 and 2021, the cumulative erosion of plots 1 - 3 (armour only) was lower (5.8 - 18.7 t/ha) than plots 4 - 6 (topsoil overlying armour) (32 - 59.6 t/ha) (Table 5-36). Erosion from plot 3 was higher than plots 1 and 2. This is consistent with the higher run-off rates observed for plot 3 compared to plots 1 and 2 which could be caused by smaller rock sizes and lower rock cover percent measured for the surface materials and / or lower infiltration. It is also consistent with the greater micro-relief observed on plot 3 that has likely caused greater flow concentration resulting in higher rates of erosion (Landloch, 2022a).

Of the topsoil overlying armour trials, plots 4 and 6 recorded similar erosion rates. Plot 5 recorded similar run-off rates to plots 4 and 6, however, erosion rates measured for plot 5 were almost twice that of plots 4 and 6 and were mostly associated with three dominant gullies which are likely to have formed due to (Landloch, 2022a):

- The increased plot length and uneven micro-relief existing on plot 5 increasing flow concentration and the likelihood of gully initiation, particularly in the lower areas of the plot; and / or
- The lower surface rock cover measured on plot 5 (40%) compared to plots 4 and 6 (45%).

Table 5-36 Erosion performance of Plots 1 to 6

Plot ID	Treatment	Erosion – Event Period 1 (t/ha)	Erosion – Event Period 2 (t/ha)	Erosion - 2022 Monitoring Period (t/ha)	Cumulative Erosion 2018 to 2021 (t/ha)
1	Convex, 1,000 mm armour, no topsoil	0.48	0.03	0.05	5.8
2	Convex, 500 mm armour, no topsoil	0.49	0.01	0.04	9
3	Linear, 250 mm armour no topsoil	4.05	0.11	0.04	18.7
4	Linear 250 mm armour, 150 mm topsoil	11.31	0.55	0.05	32
5	Linear, 500 mm armour, 150 mm topsoil	5.33	0.18	0.03	59.6
6	Convex, 1,000 mm armour, 150 mm topsoil	5.07	0.23	0.04	33.9

Source: Landloch (2019; 2022b)

A significant rainfall event was received on the plots during 8 and 9 January 2020 (191 mm of total rainfall in a ~22-hour period, including 10-minute rainfall intensities of >60 mm/hr). The armour only plots (plots 1 - 3) were considerably more erosion resistant than the plots with overlying topsoil (plots 4 - 6). Minor (essentially negligible) rilling was observed on plots 1 and 2. However, shallow water flow paths were observed in areas of preferential run-off concentration. Minor rill development in the lower areas of plot 3 was observed. Rilling was clearly visible on plots 4 - 6 and gullying typically occurred to depths of <~150 mm (the depth of topsoil). The number and size of the gullies on these plots has increased over time. No significant erosion into the underlying rockier overburden has been observed. As expected, these observations indicate that the topsoils have a higher erosion potential than the underlying overburden (Landloch, 2022a).

Vegetation cover has increased over time (Figure 5-25) with estimated cover levels by June 2021 being ~50% on plots 1 - 3 and 6, and 30 - 40% on plots 4 and 5. Rock cover levels for all plots have also been observed to increase over time (Landloch, 2022a).

While the rainfall between 2018 and 2021 was comparable to the long-term average, erosivity was >~2 times higher than the long-term average (Table 5-35). The plots are, therefore, likely to be more erosionally stable in the long term than they appear at this stage of the trial (Landloch, 2022a).

Plot 3 showing little to no rilling and progressive vegetation cover as at December 2018 (left), March 2020 (middle) and June 2021 (right).

Plot 5 showing a progressive increase in gully development and vegetation cover as at December 2018 (left), March 2020 (middle) and June 2021 (right)

Source: Landloch (2022a)

Figure 5-25 OB18 erosion plot observations 2018 to 2021

5.3.4 Overburden balance

The overburden balances for backfill and competent overburden are summarised in Sections 5.3.4.1 and 5.3.4.2 respectively.

5.3.4.1 Backfill

BHP has committed to backfilling the Swan and De Grey pits to 5 m above the water table. The current plan for these pits is to use them for storage of tailings which will meet this commitment. A conceptual design has been developed for a tailings cover and an indication of the bulk fill requirements associated with this design is provided in Table 5-37. An ISA is currently planned at the western end of OB31 (Map 2-1, Section 2.2), however the degree to which this pit will be backfilled over the life of mine is under review, and future use of the pit for tailings storage may be considered. Should groundwater modelling indicate that the entire OB31 void is required to be backfilled to above the water table, Table 5-37 shows that there is sufficient overburden to accomplish this.

The Jimblebar Life of Asset (LoA) mine plan includes approximately 20% below water table mining. No commitment to backfill below water table voids exists, however backfilling mined out pits is a priority focus. Backfill scenario analysis indicates that between 40 and 60% of mined overburden can be progressively backfilled into mined out voids over the Jimblebar LoA. Sufficient overburden exists to backfill voids to the pre-mining water table should that be necessary to mitigate associated risk issues (Table 5-37). The future use of Jimblebar pits for storage of tailings is also under consideration and will influence in-pit overburden placement.

Table 5-37 Jimblebar overburden balance

Description	Volume (MBCM)	
	OB17/18/31	Jimblebar
Mined overburden volume to August 2021	96	290
LoA overburden still to be mined volume	140	942
Total overburden volume	**236**	**1232**
BWT void space (Wheelarra / WHASH / Hashimoto)		190
BWT void space (South Jimblebar)		141
BWT void (East Jimblebar)		136
Bulk fill required to cover De Grey in-pit TSF*	5	
Bulk fill required to cover Swan in-pit TSF*	4	
Volume of OB31 void to 5 m above the water table	198	
Total fill required for to backfill all BWT void space & cover the in-pit TSFs	**207**	**467**
Surplus overburden if all BWT voids are backfilled and in-pit TSFs covered	**29**	**765**

Source: Financial Year (FY) 20 LoA plan

Notes: BWT - Below Water Table; MBCM - Million Bank Cubic Metres

*Makes allowance for loss of fill into tailings during placement of pioneer layer

5.3.4.2 Competent overburden

According to BHP's WMAT classification, in the order of 30% of the total predicted overburden at OB17/18/31 comprises competent (WMAT 1) overburden (Table 5-38). The key lithologies comprising competent overburden are the D2 to D4, J4 and HJ units. As discussed in Section 5.3.3, materials characterisation data has indicated that there is some variability in the physical characteristics of the D3 unit. It should be noted that visual inspections at OB17/18/31 have noted a significant quantity of blocky overburden that has not necessarily been sampled as part of erosion modelling studies.

At Jimblebar, WMAT 1 material comprises approximately 23% of overburden from WH123, WH4 and WHASH deposits and 20% of overburden from H234 and East Jimblebar deposits. There is no WMAT 1 material at South Jimblebar (Table 5-38).

Table 5-38 Overburden volumes by WMAT classification

Deposit	Mined (MBCM)			Yet to be Mined (MBCM)		
	WMAT 1	WMAT 2	WMAT 3	WMAT 1	WMAT 2	WMAT 3
OB17/18	31.3	10.7	24.5	0.7	0.7	1.2
OB31	5.1	7.5	16.6	27.8	49.2	60.5
Total OB17/18/31	**36.4**	**18.2**	**41.2**	**28.5**	**49.9**	**61.7**
WH123	32	56.1	41.7	45.8	32.6	130.2
WH4	8.1	40.7	17.3	0.3	0.1	0.5
WHASH	11.9	17.7	28.3	38.6	45.1	76
H234	0.05	0.1	0.4	33.7	46.1	87.2
East Jimblebar	-	-	-	47.5	65.8	113.6
South Jimblebar	-	5.4	35.4	-	12.9	151.4
Total Jimblebar	**52.05**	**120**	**123.1**	**165.9**	**202.6**	**558.9**

Source: Financial Year (FY) 20 LoA plan

Approximately 3 Million Loose Cubic Metres (MLCM)[15] of competent overburden is required for rehabilitation of OB17/18. These volumes are small compared to the volumes of competent overburden mined / to be mined (Table 5-39), even allowing for the fact that some of the D3 overburden at OB17/18 may not fall into the WMAT 1 category. Based on current mine plans, there is also sufficient competent overburden from the Jimblebar and OB31 orebodies for use in rehabilitation of ex-pit OSAs. However, the deficit of competent material at South Jimblebar, means that overburden from these pits will either need to be backfilled into mined out voids or competent material will need to be transported from the orebodies to the north.

Table 5-39 Competent overburden requirements

Deposit	WMAT 1 Required (MLCM)	WMAT 1 Available (MLCM)	
		Mined	Yet to be Mined
OB17/18	**1.3**	**41.6**	**0.9**
OB31	**1.6**	**6.6**	**36.1**
WH123	Provided as total	41.6	59.5
WH4		10.5	0.4
WHASH		15.5	50.2
H234		0.1	43.8
East Jimblebar			61.8
South Jimblebar		-	-
Jimblebar Total	**14**	**68**	**216**

5.3.4.3 Fibrous material

There is potential for small volumes of fibrous materials to be generated during mining at OB17/18/31, WH123, WHASH, East Jimblebar and South Jimblebar (Table 5-40). Section 7.5.7 summarises how these materials are managed.

Table 5-40 Potentially fibrous material volumes

Deposit	Volume MBCM
OB17/18	10.9
OB31	<0.01
WH123	<0.01
WHASH	0.4
East Jimblebar	2.7
South Jimblebar	<0.01

[15] Which equates to 2.3 MBCM based on a conversion factor of 1.3.

5.3.5 Knowledge gaps & forward work program

As part of a BHP-wide geochemical program, further investigations will be conducted into the geochemical hazards associated with:

- AMD 2 and 3 materials.
- Leach test work to further understand metal mobilisation under various environmental conditions.
- The short- and long-term risks associated with AMD generated from wall rock.

Additional investigations will also be conducted at Jimblebar Hub to further assess the:

- Geochemical characteristics of materials at the East Jimblebar, Sylvania and Capricorn orebodies.
- Erosion characteristics of key lithologies at Jimblebar Hub and the volumes of competent overburden available for use in rehabilitation.

5.4 Tailings characteristics

The in-pit TSF studies were in progress and transitioning from SPS to DPS during the preparation of this MCP. Because of this, there are elements of information presented in this section that are from different phases of study and, therefore, have slightly different input assumptions due to new information arising as studies become progressively more detailed. At this stage of closure planning, these differences are not material. Information arising from more detailed phases of study will be integrated into future iterations of this MCP. The studies used in the preparation of this section are outlined below:

- Golder (2021a) conducted a review of the geotechnical characteristics of the Jimblebar tailings for the SPS. This was updated for the DPS and reported in Golder (2022b). The different tailings compositions analysed for the SPS and DPS are summarised in Table 5-41. The results of both the SPS and DPS physical characterisation studies are reported in Section 5.4.2 as consolidation modelling for the DPS samples had not been completed at the time of writing this MCP, so the results of the SPS modelling (Golder, 2021b) have been provided in Section 5.4.2.3. While the details of DPS consolidation modelling were not available, some early results were referenced in the cover design report (WSP, 2023) and have also been provided in Section 5.4.2.3.
- Golder (2022b) reports on the geochemical characteristics of tailings samples analysed as part of the DPS (Table 5-41). The outcomes of this work are summarised in Section 5.4.1.

Table 5-41 Tailings composite samples tested during SPS and DPS

Study	Applicable Section	Sample ID	P2 Blend[16] (%)	Joffre (%)	Marra Mamba (%)	Dales (%)
SPS	Physical characterisation & consolidation modelling (Section 5.4.2)	Joffre	-	100	-	-
		Dales	-	-	-	100
		Blend 60:40	-	40	-	60
		Blend 90:10	-	10	-	90
DPS	Geochemical characterisation (Section 5.4.1). Physical characterisation & preliminary consolidation modelling (Section 5.4.2)	P2 Blend	100	-	-	-
		High Joffre	40	60	-	-
		High Marra Mamba	50	25	25	-
		Average Blend	52.5	40	7.5	-
		High Dales	82.5	10	7.5	-

Source: Golder (2022b)

5.4.1 Geochemical characterisation

Summary of key points

- All tailings solids samples were very low in sulphur (0.01 - 0.02 wt.%) and NAF / barren. Sulphur was mainly present as sulphate.
- Leach testing was conducted using de-ionised water, a saline leach solution and peroxide.
- Except for salinity, the de-ionised water and saline leachates were similar with circum-neutral pH (7.2 - 7.7), low alkalinity, nutrients (total nitrogen and total phosphorus) below the limit of laboratory reporting and low metal(loid) concentrations typically below the laboratory limit of reporting, and / or internal trigger values for the OB17/18/31 area. Barium was the only metal(loid) to consistently exceed an internal trigger value[17] in both the de-ionised water and saline leachates.

16 The P2 blend comprised three drums of material extracted from the Jimblebar feed.

17 Note, trigger values are an operational management tool and exceedance of the trigger values does not imply an environmental impact. In addition, leachate samples represent 'at source' concentrations and not a concentration at a receptor or compliance boundary.

Aluminium, zinc, silver, chromium and iron also variously exceeded trigger values in the High Joffre tailings de-ionised water leachate, and the 10 mg/L saline water leachates for the Average and P2 blends.

- The salinity of the de-ionised water leachate was very low and similar across all samples (fresh; EC 163 - 179 µS/cm). As expected, the salinity of the saline leachate was elevated (3,290 - 3,380 µS/cm in the 2 mg/L leach test and 14,700 - 15,200 µS/cm in the 10 mg/L leach test), but this was due to the leach solution composition.
- Peroxide leach (i.e., NAG liquor) was mildly acidic pH (6.09 - 6.18) and had:
  - Very low salinity and nutrients below the limit of laboratory reporting, consistent with the de-ionised water leachate.
  - Lower levels of cations and anions than the saline or de-ionised water leachates except for sodium which was similar.
  - Concentrations of metal(loid)s similar to the de-ionised water leachate except for:
    - Chromium, molybdenum, silicon and vanadium which were higher, most likely because of enhanced solubility under strong oxidizing conditions. However, only chromium exceeded internal trigger values.
    - Barium, which was above internal trigger values, but below those of the de-ionised water and saline leachates.
- Five tailings supernatant samples, a process water sample (from a source likely to be used in the beneficiation plant) and a decant water sample were analysed. All solutions were fresh and had a slightly alkaline pH (7.94 - 8.35), low to moderate alkalinity and low nutrients. The supernatant and decant waters showed limited variation but differed from the process water sample which had a slightly higher EC and a different major ion composition which could be related to groundwater mixing, and / or geochemical processes occurring in the tailings. Except for barium, dissolved and total metal(loid)s were below the limit of laboratory reporting and / or internal trigger values for all supernatant, process and decant water samples. Dissolved and total barium exceeded internal trigger values in the supernatant and decant water samples, but not the process water sample.

The geochemistry of various tailings blends (refer to Table 5-41 above) was analysed for the DPS by Golder (2022b). A summary of the results follows, and further details of analytical results are provided in Appendix E-4.

5.4.1.1 Tailings solids

The mineralogical composition of tailings (determined by QXRD) was similar for all composite samples and primarily comprised hematite (31.1 - 40.3%), goethite (37.4 - 52.1%) and kaolinite (12.4 - 16.0%), with only minor quartz (0.5 - 1.3%) and gibbsite (<1%). Amorphous (non-diffracting) materials (3.1 - 6.7%) were present in all tailings composites. No sulphidic (acid-generating) or carbonate (acid-neutralising) minerals were identified (Golder, 2022b).

The tailings solids for all samples had a similar major and minor elemental chemical composition (Table 5-42) and the total sulphur content was consistently very low (between 0.01 wt.% and 0.02 wt.%) and mainly present as sulphate sulphur (Table 5-43) (Golder, 2022b).

Table 5-42 Bulk geochemistry of tailings solids

Sample ID	Al (%)	Ca (%)	Fe (%)	K (%)	Mg (%)	Na (%)	P (%)	S (%)	Ti (%)
P2 Blend	3.88	0.04	49.00	0.02	0.06	0.01	0.16	0.02	0.12
High Joffre	4.12	0.04	48.50	0.01	0.04	0.01	0.15	0.02	0.11
High Marra Mamba	3.59	0.04	50.00	0.01	0.07	0.01	0.14	0.02	0.10
Average Blend	3.82	0.04	48.40	0.01	0.05	0.01	0.15	0.02	0.10
High Dales	3.80	0.04	48.60	0.02	0.06	0.01	0.15	0.02	0.11
Average	**3.84**	**0.04**	**48.90**	**0.01**	**0.06**	**0.01**	**0.15**	**0.02**	**0.11**

Source: Golder (2022b)

An acid base accounting analysis (Table 5-43) indicated that all tailings composites were classified as NAF. All samples had a near-neutral paste $pH_{(1:2)}$ (7.6 - 7.8), a NAG pH >6.9 and a negative NAPP (-2 to -0.4 kg H_2SO_4/t). The ANC was low (0.9 - 2.4 kg H_2SO_4/t), indicating that the tailings have limited capacity to buffer acidity, which together with a very low sulphur concentration resulted in a very low capacity to generate acidity (NAF / barren) (Golder, 2022b).

Table 5-43 Acid base accounting for tailings samples

Sample	$pH_{(1:2)}$	$EC_{(1:2)}$	Total S	Sulphide S	Sulphate S	Total C	TIC	TOC	ANC	NAG pH	MPA	NAPP
Units	pH Units	µS/cm	wt.%	wt.%	wt.%	wt.%	wt.%	wt.%	kg H_2SO_4/t	pH Units	kg H_2SO_4/t	kg H_2SO_4/t
P2 Blend	7.6	369	0.02	<0.020	0.015	0.07	0.07	<0.02	0.9	7.1	0.61	-0.4
High Joffre	7.7	371	0.02	<0.020	0.016	0.11	0.10	<0.02	1.2	6.9	0.61	-0.7
High Marra Mamba	7.8	369	0.01	<0.020	0.014	0.08	0.08	<0.02	2.4	7.1	0.31	-2.0
Average Blend	7.8	350	0.02	<0.020	0.012	0.09	0.09	<0.02	1.6	7.3	0.61	-1.2
High Dales	7.7	388	0.02	<0.020	0.011	0.07	0.06	<0.02	1.2	7.3	0.61	-0.9

Source: Golder (2022b)

5.4.1.2 Leach testing

Solubility assessments were conducted using a de-ionised water leach, saline leach and peroxide leach (NAG liquor). The deionised water and saline leach tests were conducted with a 1:2 solid to liquid ratio, and the peroxide leach test at 1:100. The saline leach tests were conducted with a salinity (NaCl) of 2 mg/L and 10 mg/L (Golder, 2022b). The results are summarised below (refer to Appendix E-4 for further details).

De-ionised water and saline leach tests

The de-ionised water and saline leachates had the following characteristics (Golder, 2022b):

- The pH of both the de-ionised water and saline leachates was circum-neutral for all samples (7.2 - 7.7).
- The salinity of the de-ionised water leachate was very low and similar across all samples (fresh; EC 163 - 179 µS/cm). As expected, the salinity of the saline leachate was elevated (3,290 - 3,380 µS/cm in the 2 mg/L leach test and 14,700 - 15,200 µS/cm in the 10 mg/L leach test), but this was due to the leach solution composition.
- For the de-ionised water solution, major anions were dominated by bicarbonates (HCO_3) (26 - 48 mg/L as $CaCO_3$), chloride (21 - 25 mg/L) with lower sulphate (13 -14 mg/L) and trace fluoride (<1 mg/L). Major cations were dominated by sodium (24 - 26 mg/L) and calcium (7 - 8 mg/L) with minor potassium and magnesium (2 - 3 mg/L). Calcium was higher in the saline water leachate compared to the deionised water leachate, as expected, due to cation exchange reactions promoted by the saline leach between the saline solution and the solids in the sample.
- Both de-ionised water and saline leach solutions had low alkalinity (26 - 51 mg/L as $CaCO_3$) and nutrient levels (total nitrogen and total phosphorus) below the laboratory limit of reporting.
- Metal(loid) concentrations were low in both de-ionised water and saline leachates with concentrations typically below the laboratory limit of reporting, and / or internal trigger values for the OB17/18/31 area (Appendix E-4). Barium was the only metal(loid) to consistently exceed an internal trigger value[18] in both the de-ionised water and saline leachates. The de-ionised water leachates for the High Joffre sample had aluminium (0.204 mg/L) and zinc (0.028 mg/L) concentrations above internal trigger values of 0.055 mg/L and 0.024 mg/L respectively. Whereas the exceedances of internal trigger values in the 10 mg/L saline leach were associated with the:
  - Average Blend for silver (0.001 mg/L), aluminium (0.08 mg/L), chromium (0.0176 mg/L) and iron (0.158 mg/L) compared to internal trigger values of 0.00005 mg/L, 0.055 mg/L, 0.01 mg/L and 0.1 mg/L, respectively.
  - P2 Blend for zinc (0.154 mg/L compared to an internal trigger value of 0.024 mg/L).

  There were no exceedances of internal trigger values in the 2 mg/L saline leachate.

Peroxide (NAG liquor) tests

The NAG liquor, which is an indication of the metal(loid)s that may become soluble following any oxidation of reduced mineral phases, had the following characteristics (Golder, 2022b):

- Very mildly acidic pH (6.09 - 6.18).
- Very low salinity (EC 113 - 125 µS/cm) consistent with the de-ionised water leachate.
- Low nutrient levels (total nitrogen and total phosphorus) below the laboratory limit of reporting, similar to the de-ionised water and saline leachates.
- Major cations and anions near to, or below, the laboratory limit of reporting, except for sodium which was in a similar range to the de-ionised water leachate (21 - 23 mg/L).

[18] Note, trigger values are an operational management tool and exceedance of the trigger values does not imply an environmental impact. In addition, leachate samples represent 'at source' concentrations and not a concentration at a receptor or compliance boundary.

- Elevated levels of barium and chromium which exceeded internal trigger values. The barium levels were lower than the concentrations in the de-ionised water and saline leachates. The chromium levels were 0.05 - 0.06 mg/L compared to an internal trigger value of 0.01 mg/L.
- Concentrations of molybdenum, silicon and vanadium higher than the de-ionised water and saline leachates, but below internal trigger values.
- All other metal(loid)s above the laboratory limit of reporting were similar to, or less than, the de-ionised water leachate.

The elevated concentrations of chromium, molybdenum, silicon and vanadium compared to the de-ionised water leachates are likely to be related to enhanced solubility of these metal(loid)s under strong oxidizing conditions.

5.4.1.3 Tailings associated water (supernatant), process and decant water

Five tailings supernatant samples, a process water sample (from a source likely to be used in the beneficiation plant) and a decant water sample were analysed (Golder, 2022b) and the results are summarised below with further details provided in Appendix E-4.

All solutions had a slightly alkaline pH (7.94 - 8.35) with the process water having the highest pH. The supernatant and decant waters showed limited variation but differed from the process water sample which had a slightly higher EC and a different major ion composition which could be related to groundwater mixing, and / or geochemical processes occurring in the tailings:

- The EC of supernatant and decant water ranged between 772 - 839 µS/cm, and the process water had an EC of 1200 µS/cm. All samples were representative of a sodium (Na) - chloride (Cl) water type.
- The major cation composition of supernatant and decanted water samples was dominated by sodium (105 - 109 mg/L) and calcium (24 - 30 mg/L) with lower concentrations of potassium (8 - 13 mg/L) and magnesium (8 - 9 mg/L). In comparison, the process water sample had slightly higher sodium (139 mg/L), lower calcium (10 mg/L), higher potassium (58 mg/L), and comparable magnesium (12 mg/L).
- The major anion composition of supernatant and decanted water samples was dominated by chloride (199 - 219 mg/L), with lower bicarbonate alkalinity (63 - 78 mg/L as $CaCO_3$) and sulphate (30 - 45 mg/L), and trace fluoride (<1 mg/L). The process water sample had comparable chloride (243 mg/L) and trace fluoride concentrations but higher sulphate (148 mg/L) and bicarbonate alkalinity (127 mg/L as $CaCO_3$).
- All samples displayed low to moderate alkalinity (63 - 131 mg/L as $CaCO_3$), present as bicarbonate.
- Total phosphorous was below the laboratory limit of reporting for all samples and total nitrogen was near detection limit (~0.1 mgN/L) and present as nitrate (0.09 - 0.18 mgN/L).
- Except for barium, dissolved and total metal(loid)s were below the limit of laboratory reporting and / or internal trigger values for all supernatant, process and decant water samples. Dissolved and total barium exceeded internal trigger values in the supernatant and decant water samples, but not the process water sample.

5.4.2 Physical characterisation

Summary of key points

- There have been two phases of physical characterisation of tailings conducted during the SPS and DPS for the in-pit TSFs. The SPS analysed Joffre and Dales Gorge tailings and various blends of these streams. The DPS analysed a P2 blend (comprising three drums of material sourced from the Jimblebar feed) and various other combinations of Dales Gorge, Joffre and Marra Mamba tailings.
- The physical characteristics of the SPS and DPS samples are as follows:
  - The SPS Joffre tailings samples were classified as brown high plasticity CLAY/SILT and Dales Gorge as brown low plasticity CLAY.
  - The five tailings samples tested during the DPS were classified as reddish brown, low to medium plasticity SILTY CLAYs.
  - The SPS Dales Gorge tailings samples had a much higher settled dry density (1.38 t/m^3), compared to Joffre (0.81 t/m^3).
  - The settled dry densities of the DPS samples ranged from 0.86 to 0.95 t/m^3 with Joffre having the highest settled dry density (0.95 t/m^3) followed by the average blend which comprised 52% P2, 40% Joffre and 7.5% Marra Mamba, and had a settled dry density of 0.9 t/m^3. The remaining samples all had similar final settled dry densities (~0.86 t/m^3).
- SPS consolidation modelling of a 60:40 (Dales Gorge : Joffre) tailings blend deposited into the De Grey and Swan pits:
  - Sequentially indicated that 90% of settlement could be achieved in ~16 and ~10 years in De Grey and Swan respectively. However, due to the high magnitude of the settlements (~54 m and ~35 m for De Grey and Swan respectively), ongoing settlements in the order of metres were predicted to occur even after 90% of the settlement had occurred.
  - Simultaneously resulted in higher average dry densities and reduced settlement (~48 m and ~28 m for De Grey and Swan respectively).
- At the time of writing this MCP, consolidation modelling was being conducted for the DPS samples, however, early results from the updated modelling are referred to in the WSP (2023) cover design study discussed in Section 5.16.4 and are as follows:

  - Initial filling of the pits is expected to be completed in approximately 3 to 5 years with subsequent filling cycles taking place as settlements progressively occur. This would result in deposition of tailings in the pits until 2051.
  - Tailings are expected to continue to settle post-closure for an estimated period of 10 years for Swan, and 20 years for De Grey, before deformations are less than 1 m/yr.
  - Settlements will be variable across the in-pit TSFs, with less settlement occurring on the edges of the pits and the greatest settlements occurring in the deepest areas of the pits.
  - Total settlements are likely to be in the order of:
    - 39% to 52% of the tailings thickness for Swan, resulting in the lowest tailings elevation being 517 - 527 mRL.
    - 41% to 51% of the tailings thickness for De Grey, resulting in the lowest tailings elevation being 512 - 522 mRL.
- SPS tailings samples did not contain asbestos mineral fibres.

Golder (2021a; 2022b) conducted geotechnical analyses of samples of tailings from pilot plants. The Golder (2021a) study was conducted during SPS and the Golder (2022b) study was conducted to inform the DPS (refer to Table 5-41 above for a summary of the SPS and DPS sample compositions).

Analyses conducted during both study phases included classification tests (Section 5.4.2.1) and dry density and void ratio tests (Section 5.4.2.2). The results of the Golder (2021a) (SPS) characterisation study were used in the consolidation modelling conducted by Golder (2021b) which is reported in Section 5.4.2.3. Updated consolidation modelling was in progress at the time of writing this MCP. Early results have been referred to in the WSP (2023) cover design study discussed in Section 5.16.4 and have been integrated into Section 5.4.2.3. The results of the completed DPS consolidation modelling will be reported in future iterations of this MCP.

5.4.2.1 Classification test results

Index test results indicated that (Table 5-44 and Figure 5-26):

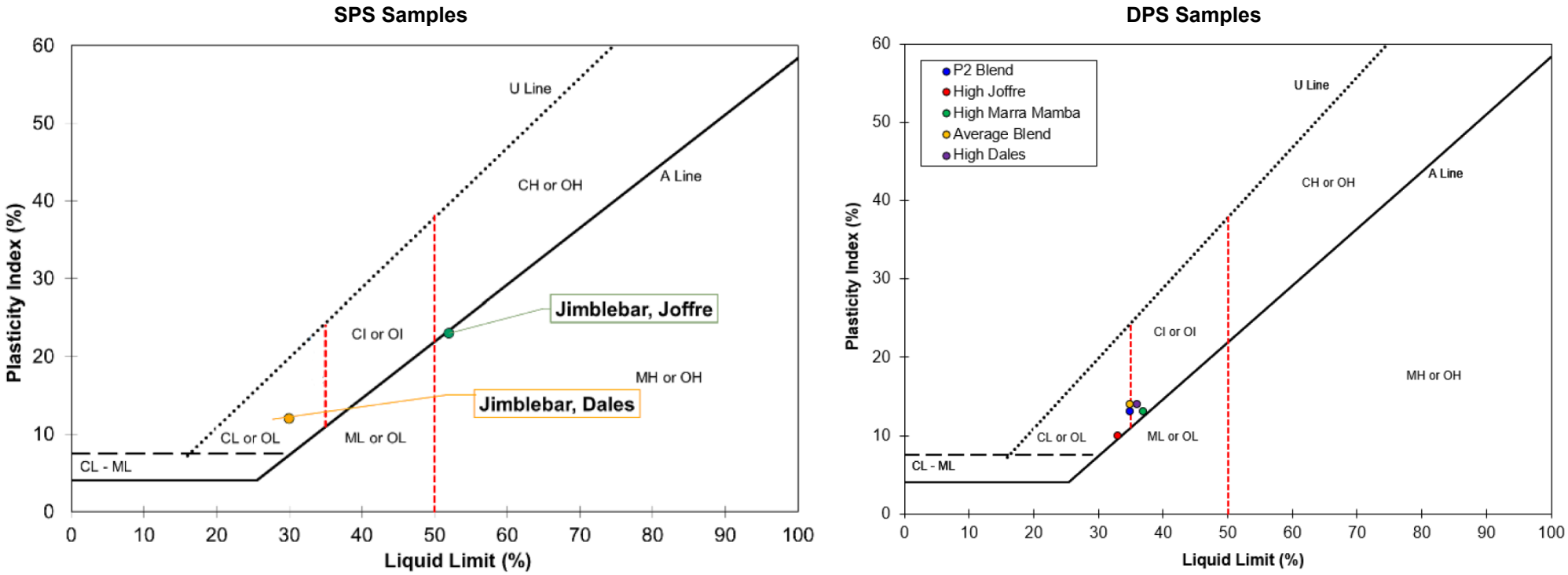
- The Joffre sample was classified as a brown high plasticity CLAY/SILT (Golder, 2021a).
- The Dales Gorge sample was classified as a brown low plasticity CLAY (Golder, 2021a).
- The five tailings samples tested during the DPS were classified as reddish brown, low to medium plasticity SILTY CLAYs (Golder, 2022b).

The presence of asbestiform minerals was assessed using scanning electron microscopy with elemental analysis by energy dispersive spectroscopy and concluded that the tailings samples did not contain asbestos mineral fibres (Golder, 2021a).

Table 5-44 Classification test results

Study	Sample Name	Particle density (t/m^3)	Particle Size Distribution (%)			Atterberg Limits (%)			
			Sand (2 mm to 75 µm)	Fines – Silt (75 µm to 2 µm)	Fines – Clay (<2 µm)	Liquid Limit	Plastic Limit	Plasticity Index	Linear Shrinkage
SPS	Joffre	3.74	0.7	53.2	46.1	52	29	23	5.0
	Dales	4.28	0.1	72.0	27.9	30	18	12	4.0
DPS	P2 Blend	4.07	0.4	59.1	40.5	35	22	13	5.5
	High Joffre	3.97	0.5	63.1	36.4	33	23	10	5
	High Marra Mamba	4.03	0.5	60.4	39.0	37	24	13	5.5
	Average Blend	3.99	0.5	61.7	37.8	35	21	14	5
	High Dales	4.02	0.4	62.9	36.7	36	22	14	5

Source: Golder (2021a; 2022b)



Source: Golder (2021a; 2022b)

Figure 5-26 Plasticity charts

5.4.2.2 Dry density estimation

Settling tests

Settling tests (top drainage) showed that that the SPS Dales Gorge tailings had a much higher settled dry density (1.38 t/m^3), compared to the Joffre SPS sample (0.81 t/m^3), and consequently a greater settled dry density was achieved with a greater proportion of Dales Gorge in the blends (Table 5-45) (Golder, 2021a). The settled dry densities of the DPS samples (in the top drained test) ranged from 0.86 to 0.95 t/m^3 with Joffre having the highest settled dry density (0.95 t/m^3) followed by the average blend (0.9 t/m^3). The remaining samples all had similar final settled dry densities with Marra Mamba achieving a final settled dry density (0.87 t/m^3) in a shorter period (~16 days) compared to P2 Blend (~21 days) and High Dales (~19 days) which both had an equivalent settled dry density of 0.86 t/m^3 (Table 5-45) (Golder, 2022b).

Air drying tests

Following air drying, a final dry density of 1.58 t/m^3 was indicated after a period of 26 days for the SPS Joffre sample and 2.07 t/m^3 after a period of 18 days for the SPS Dales Gorge sample (Figure 5-27 and Figure 5-28). The 90:10 blend indicated an improvement of ~25% (i.e., 1.97 t/m^3 after ~11 days) and ~16% for 60:40 blend (i.e., 1.83 t/m^3 after ~13 days), compared to Joffre alone (Golder, 2021a). Of the DPS samples, the P2 Blend achieved the highest final dry density of 1.95 t/m^3 at a water content of ~22 % after ~33 days while the High Joffre sample reached the lowest dry density of 1.75 t/m^3 at ~31% water content after ~27 days (Figure 5-27 and Figure 5-28) (Golder, 2022b).

Consolidation tests

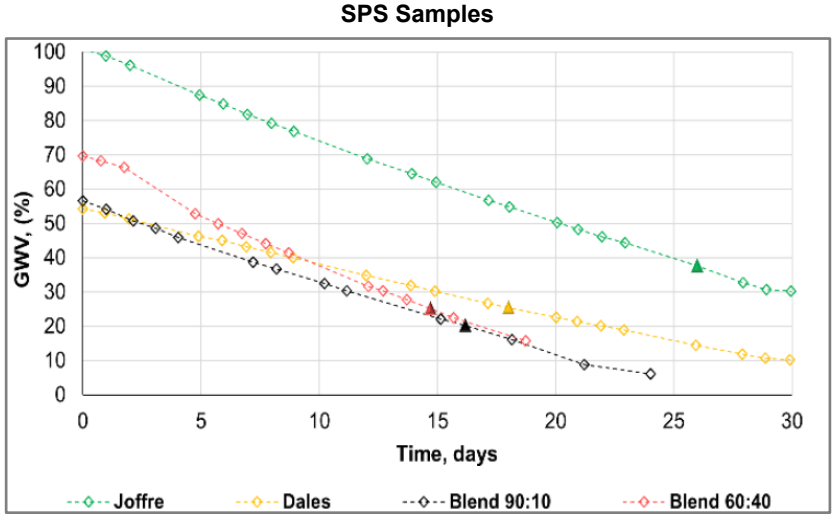
Consolidation tests showed that, owing to a higher proportion of Dales Gorge tailings, the consolidation behaviours of the SPS blend samples were improved when compared to the SPS Joffre tailings alone (Table 5-45 and Figure 5-29 to Figure 5-32) (Golder, 2021a). The DPS Average Blend and High Joffre samples had the highest hydraulic conductivities and coefficients of consolidation under the pressure range tested which resulted in the lowest void ratios and higher dry densities when compared to the remaining DPS tailings composite samples (Table 5-45 and Figure 5-29 to Figure 5-32) (Golder, 2022b).

Table 5-45 Dry density & consolidation test results

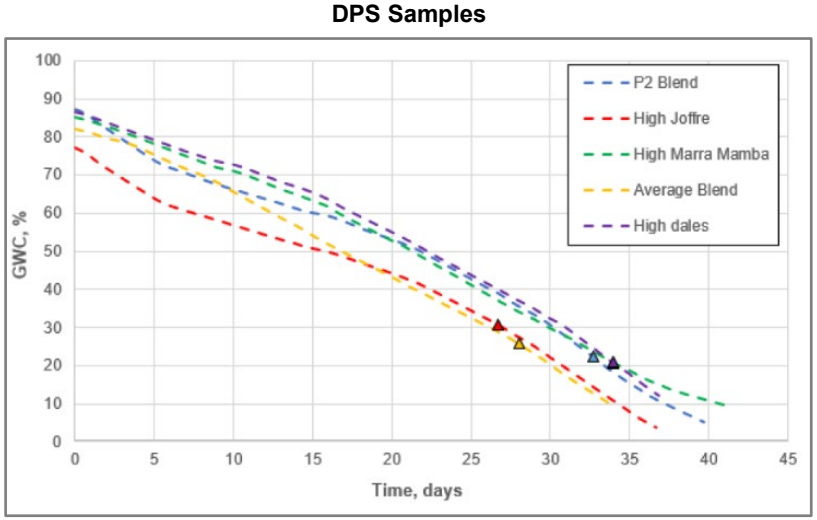
Test	Parameter	SPS Samples				DPS Samples				
		Joffre	Dales	Blend 90:10	Blend 60:40	P2 Blend	High Joffre	High Marra Mamba	Average Blend	High Dales
Classification	Particle density (t/m^3)	3.74	4.28	4.23	4.06	4.07	3.97	4.03	3.99	4.02
e_0 beaker test	Solid's concentration at e_0 (%)	45.2	55.3	53.8	50.7	46.5	49.9	47.0	49.4	47.1
	Water content (%)	121.3	80.8	86.0	97.4	115.2	100.3	112.5	102.2	112.2
	Initial void ratio e_0	4.55	3.47	3.64	3.97	4.70	3.99	4.54	4.09	4.52
Settling test with top drainage*	Final settled dry density (t/m^3)	0.81	1.38	1.27	1.05	0.86	0.95	0.87	0.90	0.86
	Approximate time to achieve 95% of final settled dry density (days)	8.9	5.8	4.3	5.7	9.7	8.9	7.5	8.8	8.9
	Approximate time to achieve final settled dry density (days)	19.9	9.8	6.7	9.9	20.8	18.8	15.8	19.8	18.8
One-dimensional consolidation	Pressure range tested (kPa)	10 to 1600								
	Coefficient of consolidation (m^2/yr)	14 to 226	15 to 467	15 to 255	15 to 238	7.2 to 70.7	13.4 to 123	16.9 to 126	4.5 to 170	5.2 to 82.9
	Dry density (t/m^3)	1.00 to 1.58	1.61 to 2.17	1.58 to 2.12	1.39 to 1.91	1.30 to 2.02	1.40 to 1.99	1.29 to 1.93	1.34 to 2.03	1.31 to 1.99
	Hydraulic Conductivity (m/s)	3.25×10^{-8} to 2.94×10^{-9}	2.73×10^{-8} to 4.71×10^{-9}	1.76×10^{-8} to 2.71×10^{-9}	1.47×10^{-8} to 2.67×10^{-9}	1.25×10^{-8} to 7.68×10^{-10}	1.67×10^{-8} to 1.35×10^{-9}	1.67×10^{-8} to 1.35×10^{-9}	1.01×10^{-8} to 1.13×10^{-9}	5.4×10^{-9} to 9.17×10^{-10}

Source: Golder (2022b)

*Notes: This test represents an indication of the initial settled dry density where pumping removes the supernatant pond from tailings surface.

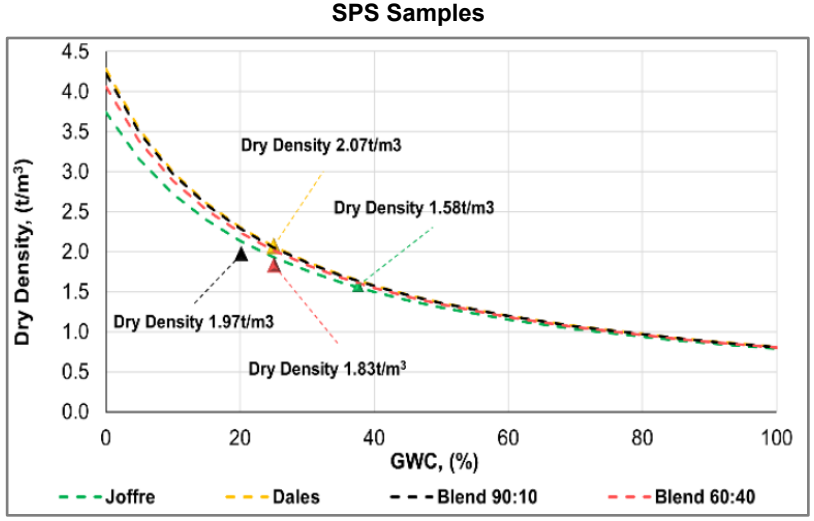


Source: Golder (2021a)

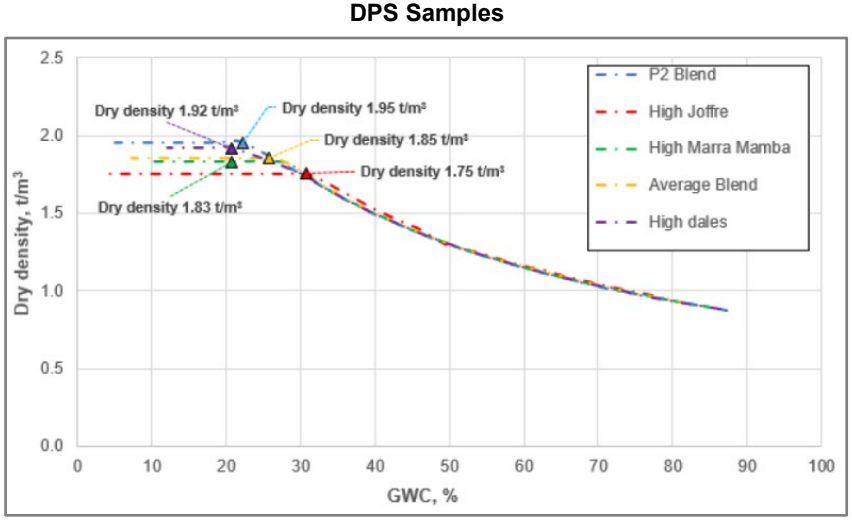


Source: Golder (2022b)

Figure 5-27 Water content vs time

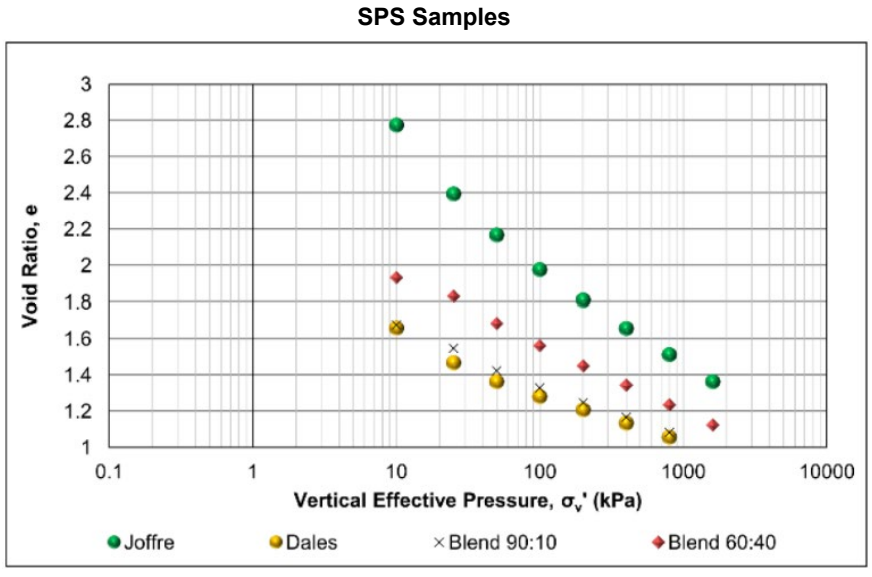


Source: Golder (2021a)

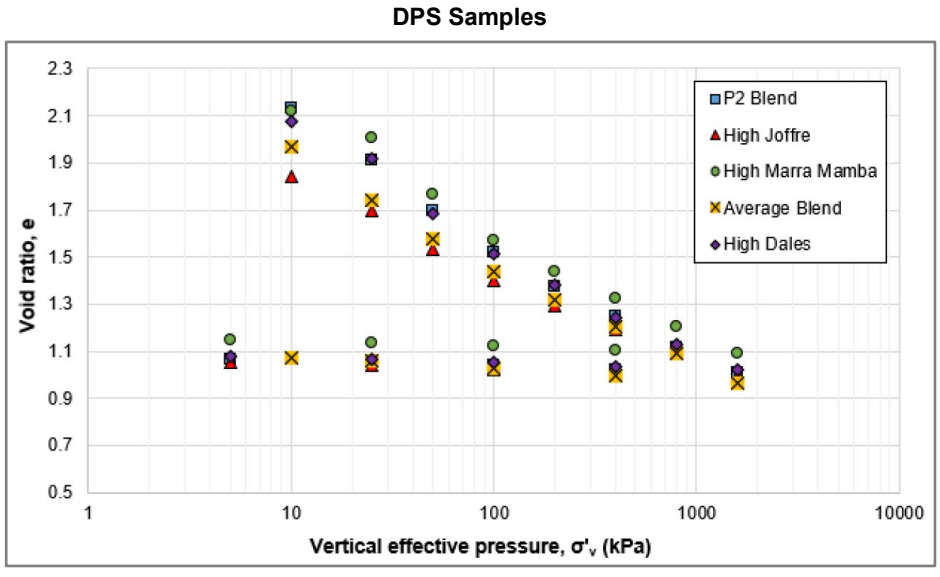


Source: Golder (2022b)

Figure 5-28 Dry density vs water content

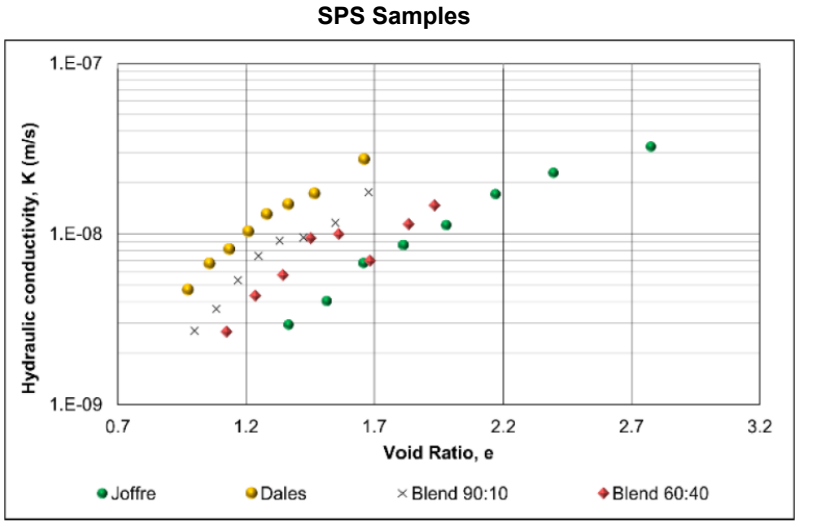


Source: Golder (2021a)

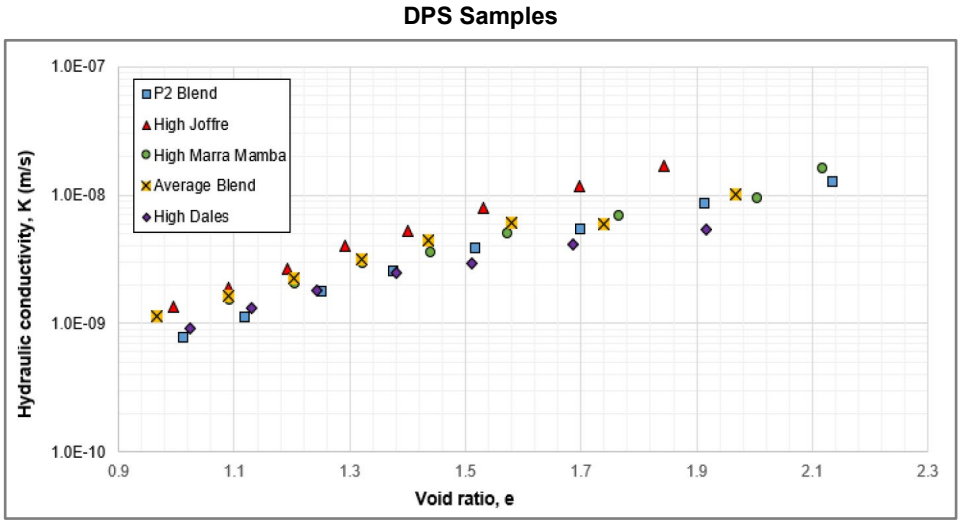


Source: Golder (2022b)

Figure 5-29 Void ratio vs. vertical effective stress

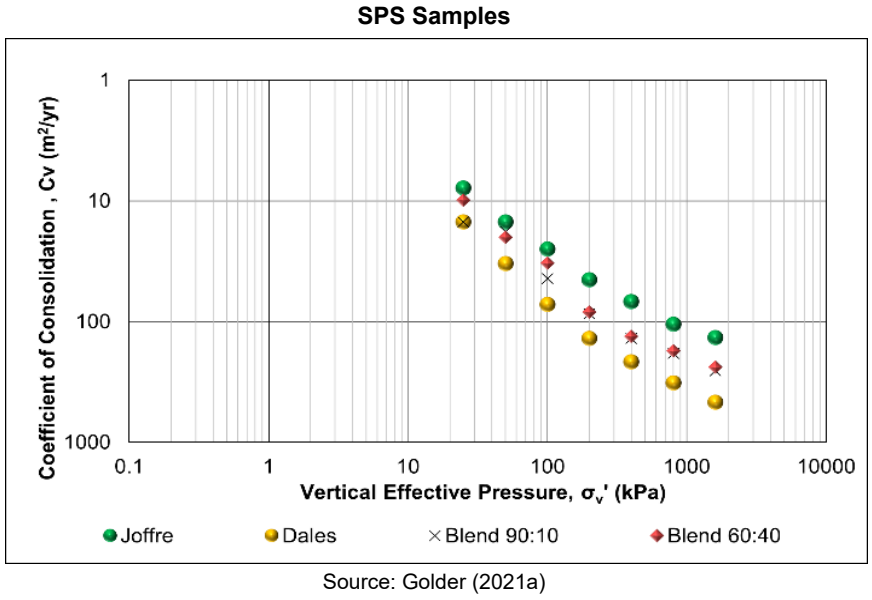


Source: Golder (2021a)

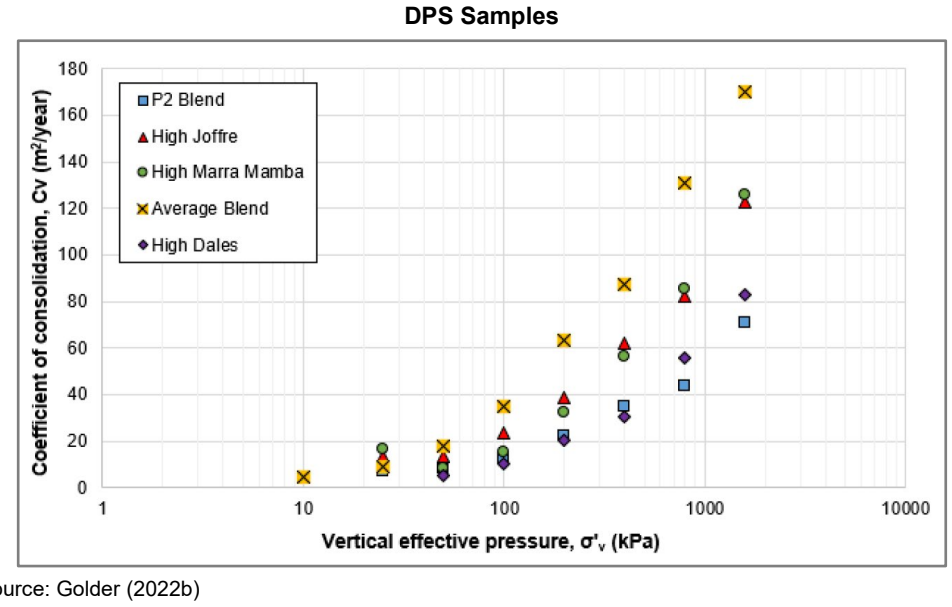


Source: Golder (2022b)

Figure 5-30 Permeability vs. void ratio

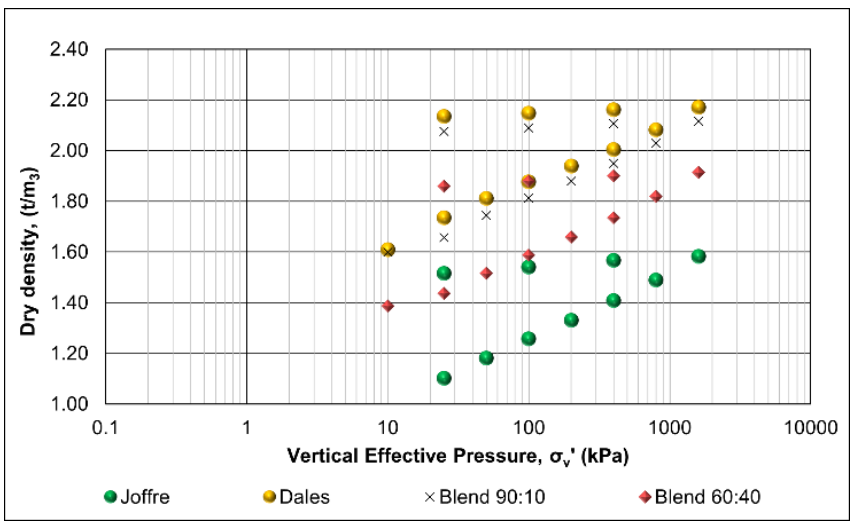


Source: Golder (2021a)

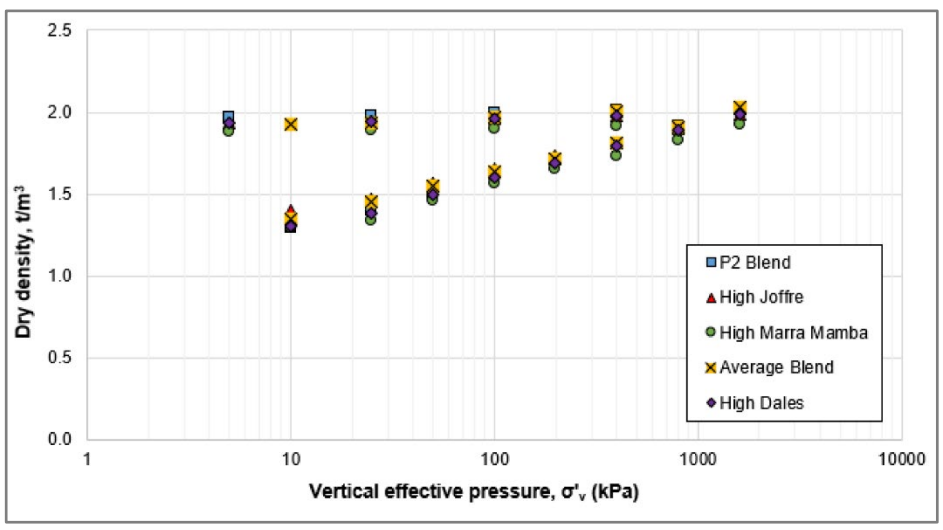


Source: Golder (2022b)

Figure 5-31 Coefficient of consolidation vs. vertical effective stress



Source: Golder (2021a)



Source: Golder (2022b)

Figure 5-32 Dry density vs. vertical effective stress

5.4.2.3 Consolidation Modelling

One dimensional (1D) large-strain consolidation modelling was conducted by Golder (2021b) based on the SPS sample results in Sections 5.4.2.1 and 5.4.2.2, using the consolidation software package FSConsol V3, to estimate the magnitude of, and timeframe for, settlement of the tailings surface during and after tailings deposition. This program was selected for the Jimblebar pits as a 1D representation is reasonable for estimation of the dry density and settlements, and the results are reported below. At the time of writing, updated consolidation modelling was being conducted based on the DPS physical characterisation results outlined in Sections 5.4.2.1 and 5.4.2.2. The results of the updated modelling will be summarised in future iterations of this MCP. Early results from this modelling reported in WSP's (2023) cover design study (Section 5.16.4) are incorporated into the summary below.

SPS modelled consolidation (void ratio vs. elevation) from cessation of tailings deposition into De Grey (at ~2.1 t/y) and Swan (at ~ 1.7 t/y) are shown in Figure 5-33. The model assumed deposition of a 60:40 Dales : Joffre blend of tailings sequentially into each pit. The weighted average void ratio (accounting for the specific geometry of each pit) was 3.65 for De Grey, equivalent to an average stored dry density of 0.90 t/m^3, and 3.59 for Swan, equivalent to an average stored dry density of 0.91 t/m^3. These values were considered reasonable given the high rate of rise and the low potential for air drying (Golder, 2021b).

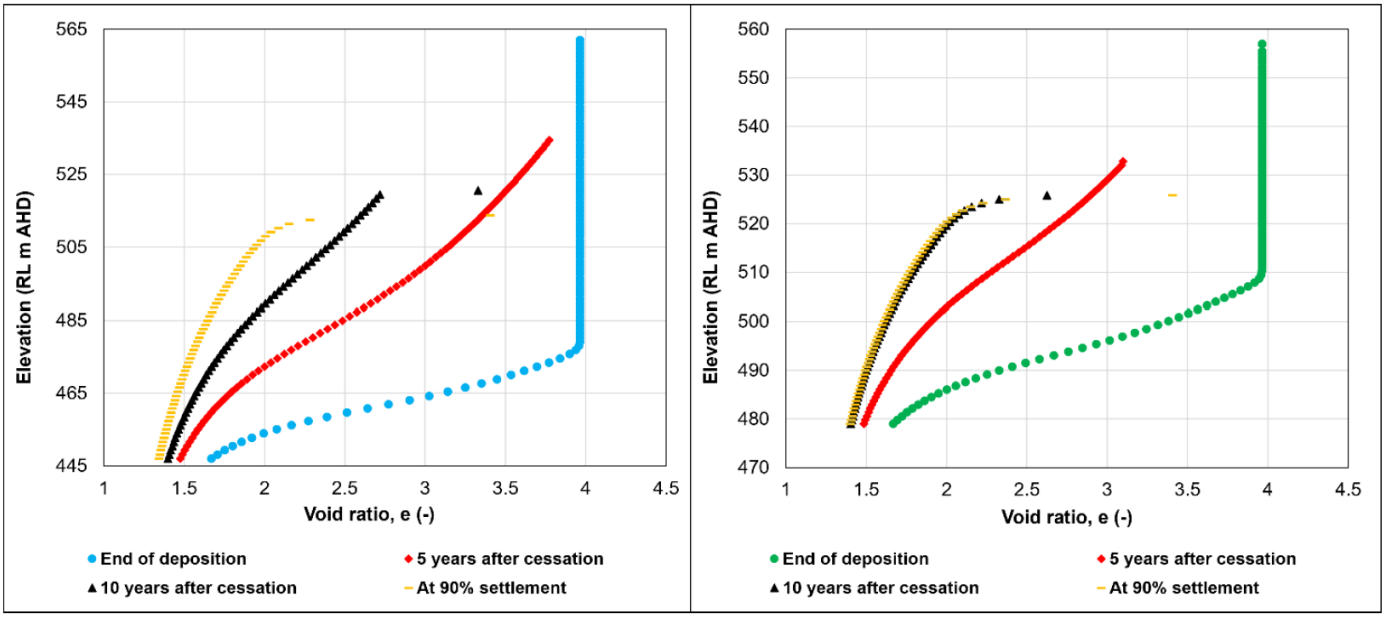
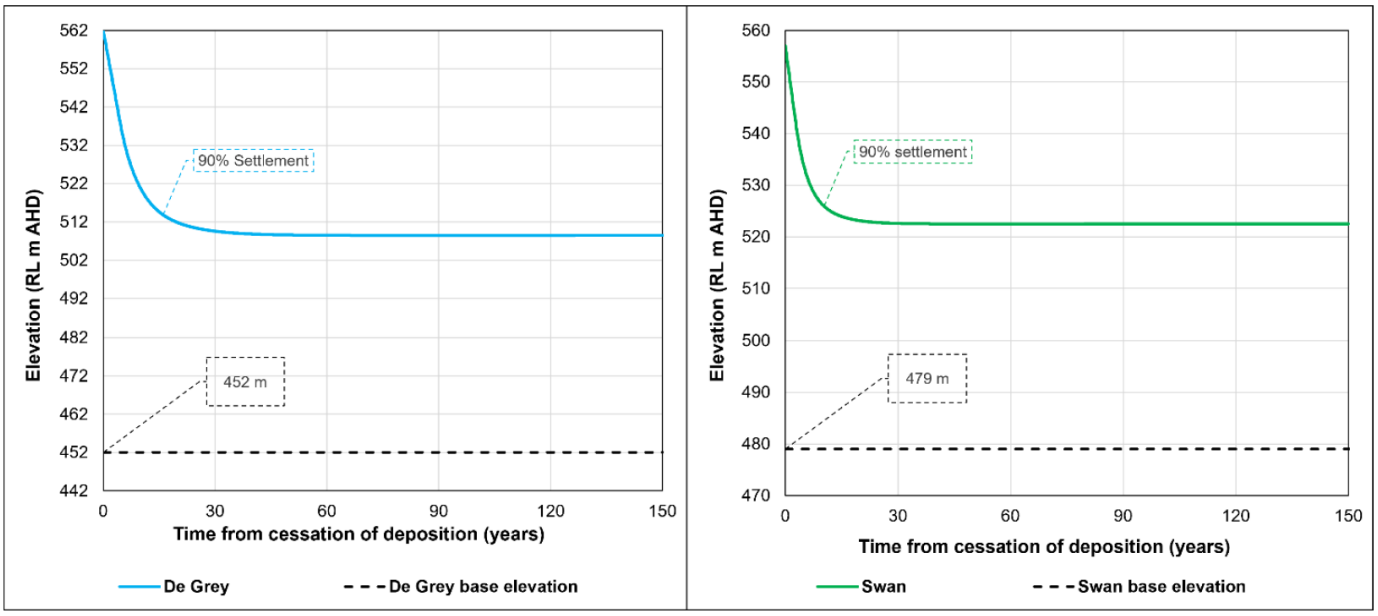


Figure 5-33 Void ratio results of De Grey (left) and Swan (right)

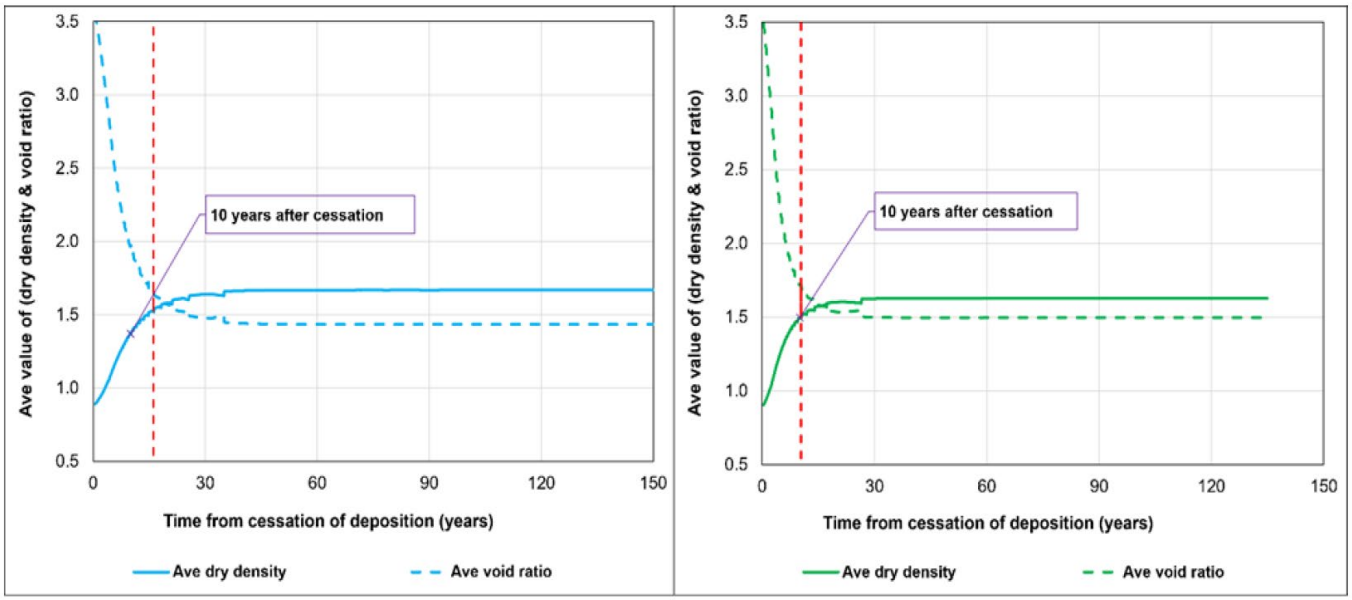
Following cessation of tailings deposition, settlements in the order of ~53.5 m and ~34.5 m were predicted to occur within the De Grey and Swan pits, respectively, and the estimated time for 90% of settlement from cessation of deposition in the De Grey pit was ~16 years, and ~10 years for Swan (Figure 5-34). However, due to the high magnitude of the settlements (tens of metres), ongoing settlements in the order of metres were considered likely to occur even after 90% of the settlement has occurred (Figure 5-34) (Golder, 2021b).

The average void ratios and average dry densities from cessation of deposition are illustrated in Figure 5-35. The weighted average void ratio 10 years from cessation of tailings deposition was 2.0 for De Grey, equivalent to an average stored dry density of 1.4 t/m^3, and 1.7 for Swan, equivalent to an average stored dry density of 1.5 t/m^3 (Golder, 2021b).



Source: Golder (2021b)

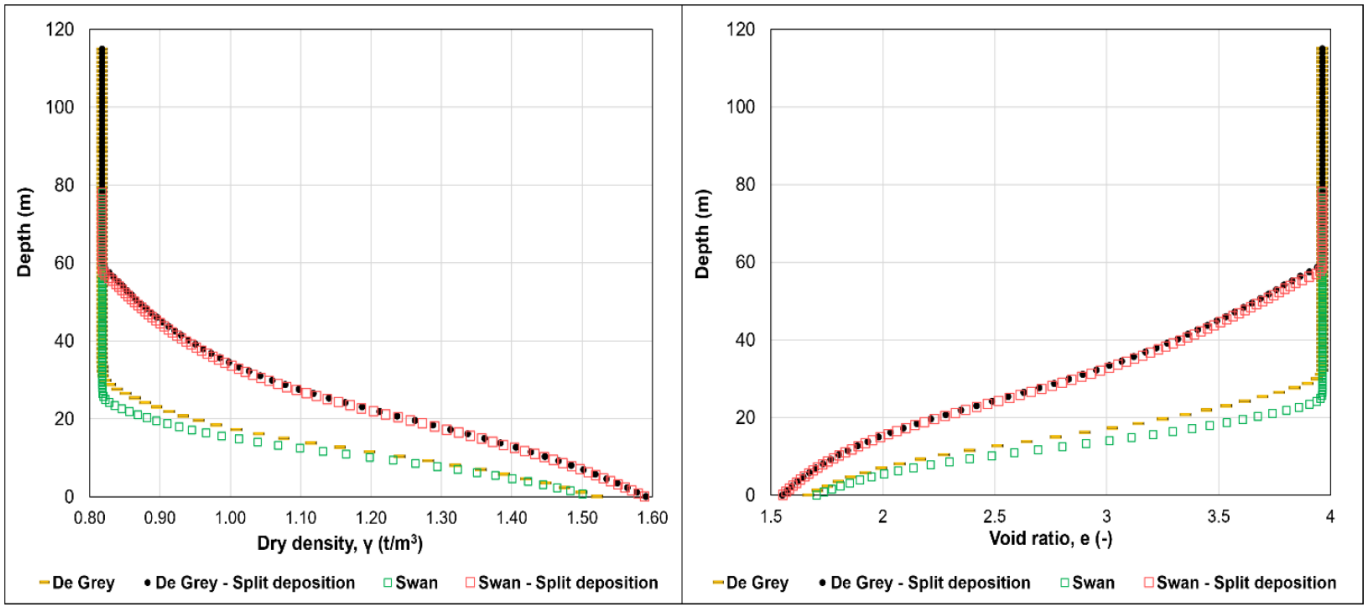
Figure 5-34 Tailings elevation vs. time from cessation of deposition, De Grey (left) and Swan (right)



Source: Golder (2021b)
Notes: the red dash indicates the boundary of 90% settlement from cessation of deposition occurred within the pit.

Figure 5-35 Average void ratio and dry density results of De Grey (left) and Swan (right) cessation of deposition

There would be an advantage in terms of consolidation if tailings were deposited simultaneously (or rotated regularly) within De Grey and Swan pits. For the purposes of the SPS, an estimated depositional split of ~54.5% to De Grey and ~45.5% to Swan was modelled, based on the relative volumes of the pits. Under this scenario, a higher average dry density was achieved, increasing the dry density to 0.98 t/m^3 for De Grey and 1.05 t/m^3 for Swan (Figure 5-36) (Golder, 2021b).



Source: Golder (2021b)

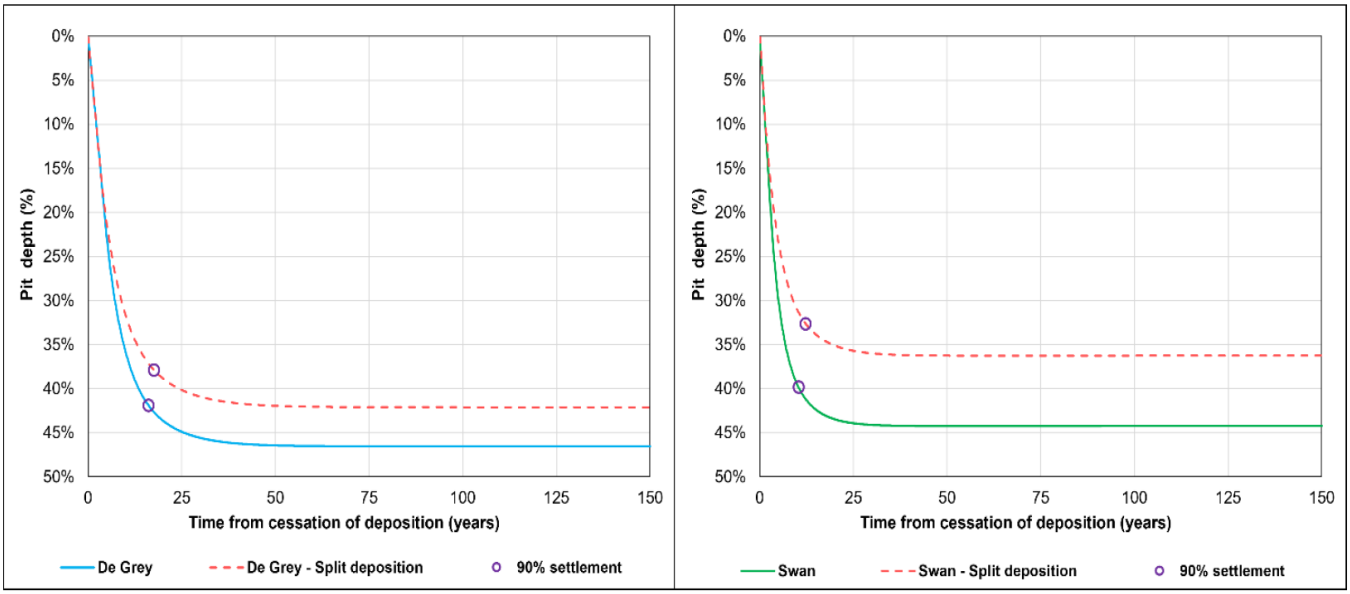
Figure 5-36 Dry density results of De Grey and Swan comparing split deposition to single deposition

Depositing tailings simultaneously has a positive influence on the magnitude of settlement (Table 5-46 and Figure 5-37) and for the SPS, reduced the modelled settlement by 10% and 22% within De Grey and Swan, respectively, compared to deposition in sequence (Table 5-46). Subsequent deposition into the pits, as settlements progressively occur, can use the remaining pit capacities, and this approach is being factored into the consolidation modelling being conducted for the DPS (Golder, 2021b; WSP, 2023).

Table 5-46 Comparison of series and parallel deposition

Parameters	De Grey	De Grey Split	Swan	Swan Split
Average dry density (t/m^3)	0.90	0.98	0.91	1.05
Average void ratio (-)	3.65	3.33	3.59	3.06
Total Settlement (m)	53.5	48.4	34.5	28.3
Settlement ratio (%)	46.5	42.1	44.2	36
Time to 90% dissipation (from end of deposition)	16.1	17.6	10.3	12.2

Source: Golder (2021b)

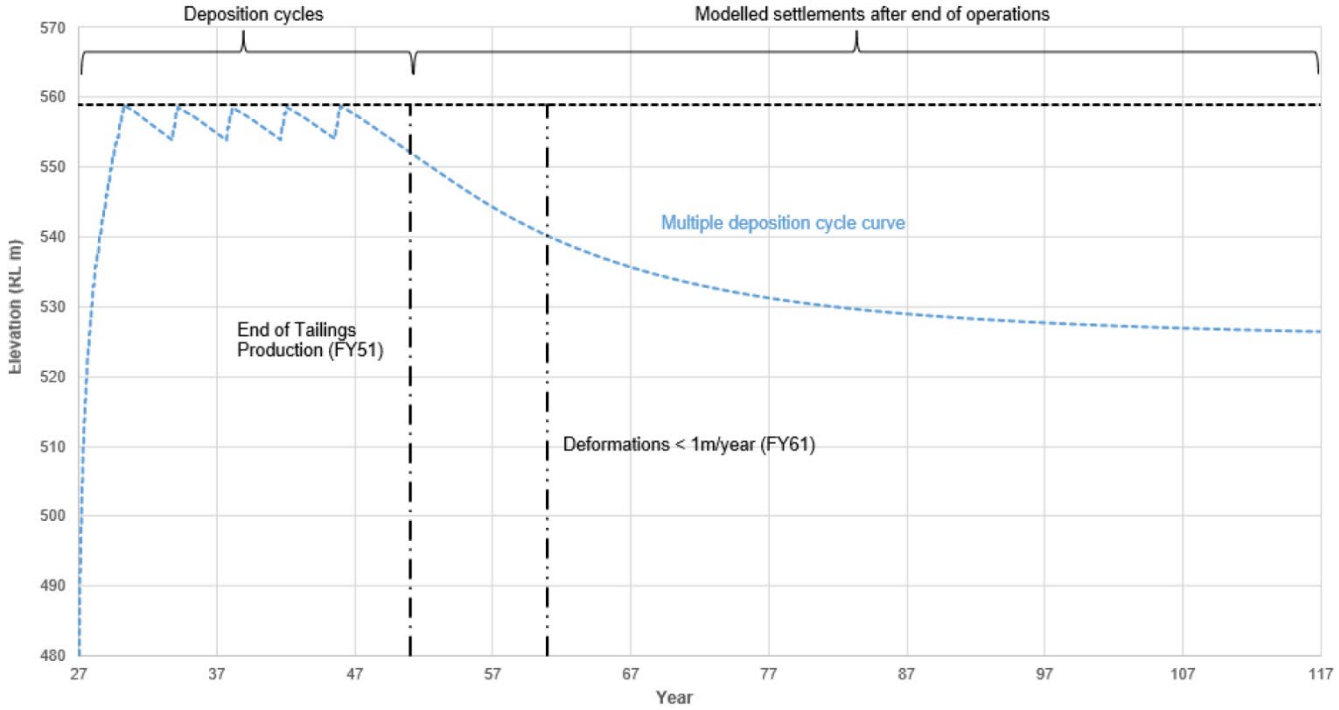


Source: Golder (2021b)

Figure 5-37 Settlement ratio vs. time from cessation of deposition comparing split deposition to single deposition

DPS consolidation modelling was being conducted at the time of writing this MCP. WSP (2023) used some preliminary results as the basis of its conceptual cover design (Sections 5.16.4 and 9.2.1.3) as follows:

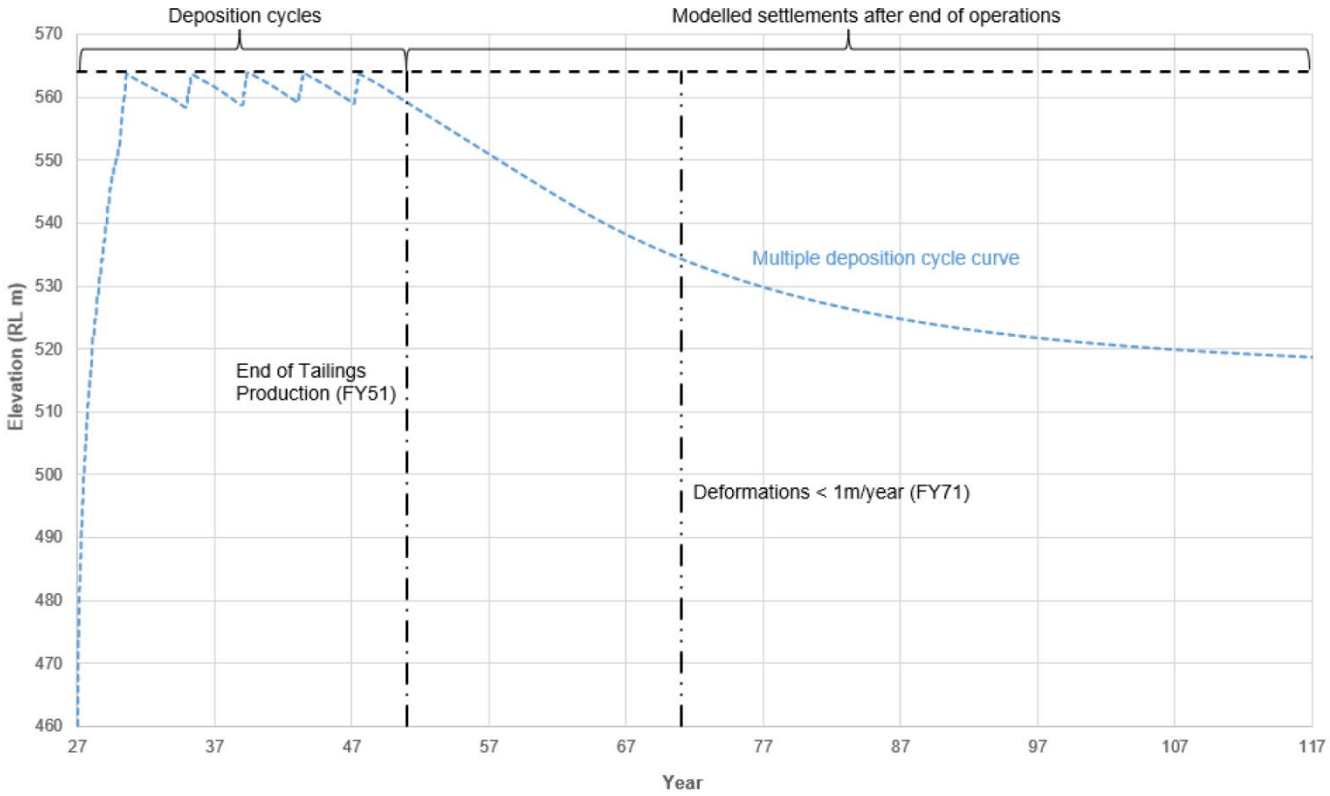
- Initial filling of the pits is expected to be completed in approximately 3 to 5 years with subsequent filling cycles taking place as settlements progressively occur (Figure 5-38 and Figure 5-39). This would result in deposition of tailings in the pits until 2051.
- Tailings are expected to continue to settle post-closure for an estimated period of 10 years for Swan, and 20 years for De Grey, before deformations are less than 1 m/yr (Figure 5-38 and Figure 5-39).
- Settlements will be variable across the in-pit TSFs, with less settlement occurring on the edges of the pits and the greatest settlements occurring in the deepest areas of the pits (Figure 5-40 and Figure 5-41).
- Total settlements are likely to be in the order of:
  - 39% to 52% of the tailings thickness for Swan, resulting in the lowest tailings elevation being 517 - 527 mRL (Figure 5-40).
  - 41% to 51% of the tailings thickness for De Grey, resulting in the lowest tailings elevation being 512 - 522 mRL (Figure 5-41).



Source: WSP (2023)

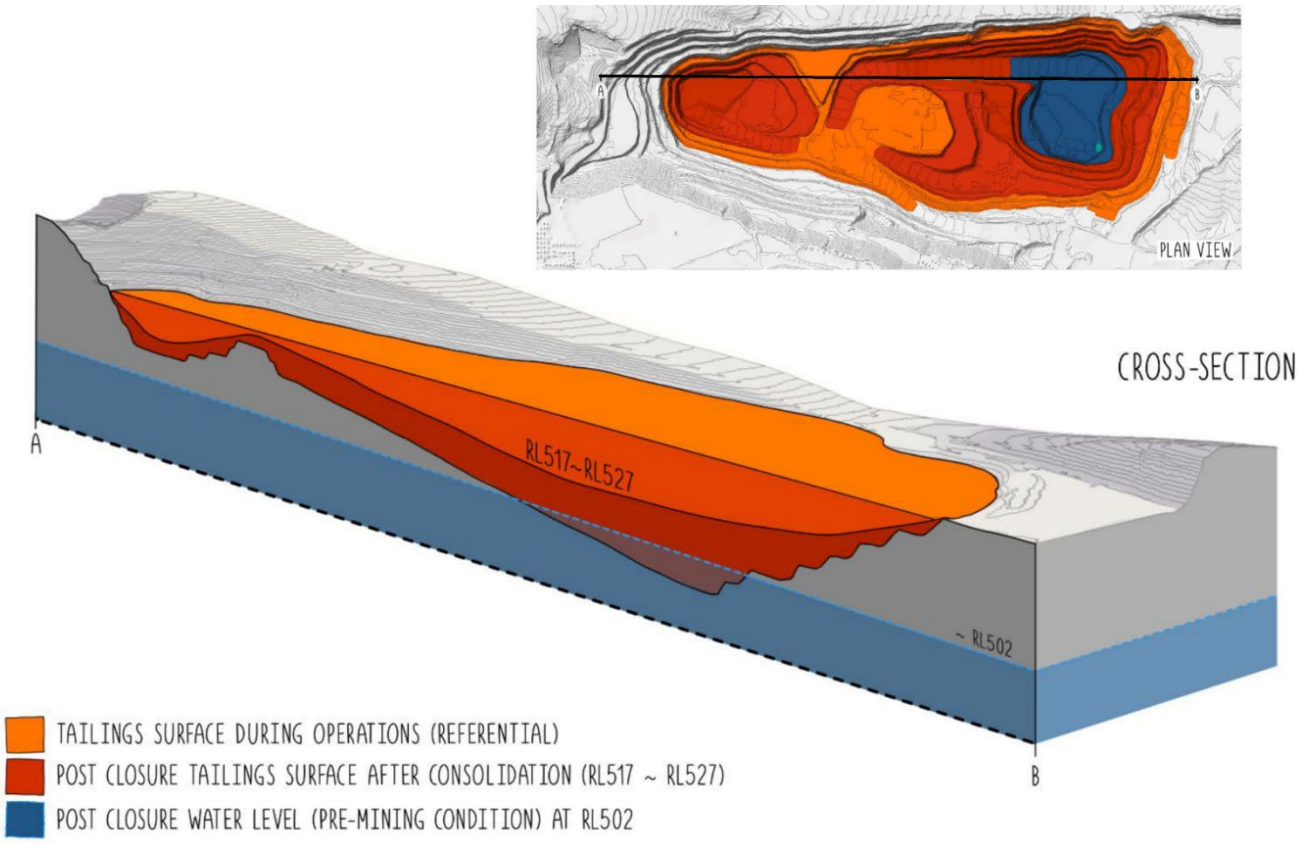
Notes: graph represents the minimum estimated tailings elevation with time at the point of the in-pit TSF with the largest tailings thickness. Elevations towards the edge of the pit will be higher.

Figure 5-38 Conceptual assessment of deposition cycles and tailings elevation over time for Swan in-pit TSF



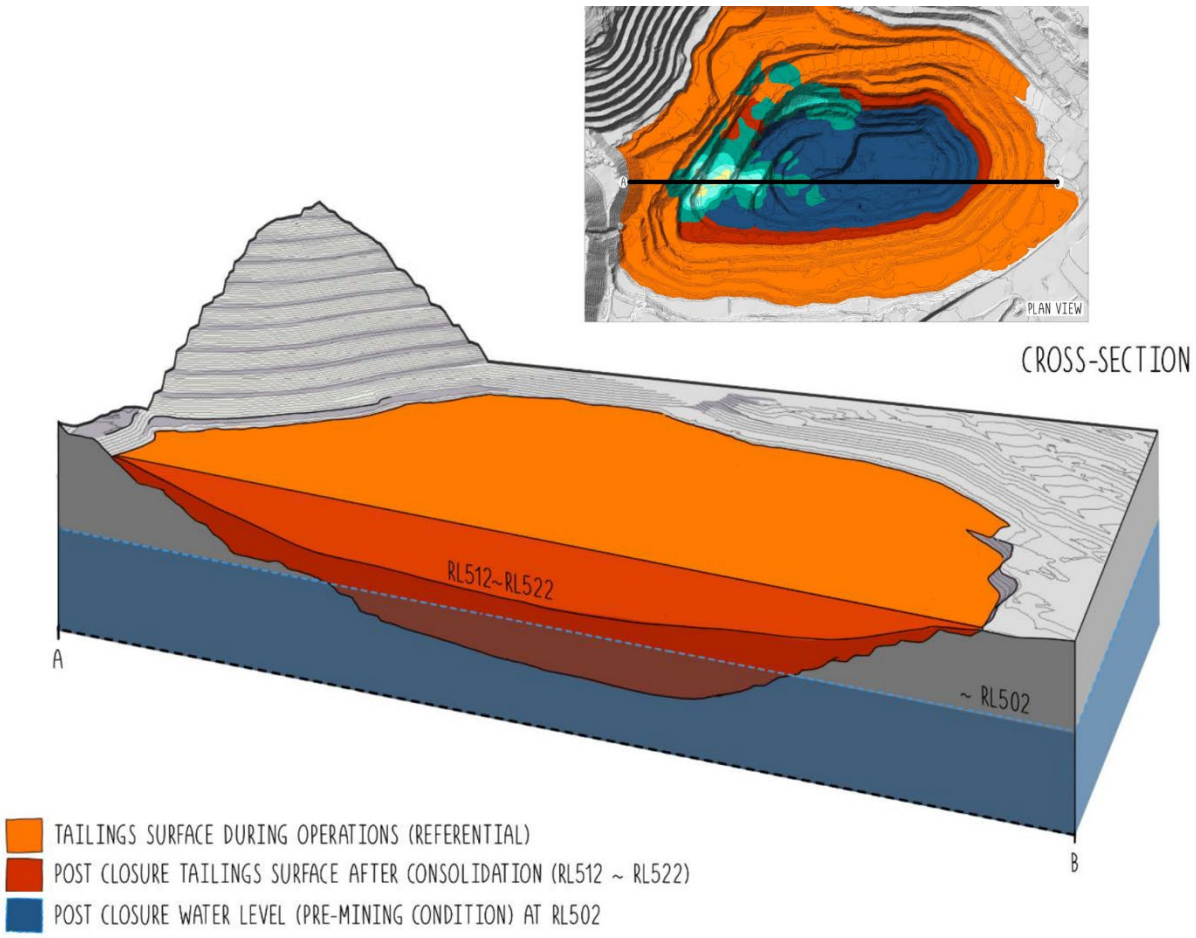
Source: WSP (2023)
Notes: Graph represents the minimum estimated tailings elevation with time at the point of the in-pit TSF with the largest tailings thickness. Elevations towards the edge of the pit will be higher.

Figure 5-39 Conceptual assessment of deposition cycles and tailings elevation over time for De Grey in-pit TSF



Source: WSP (2023)

Figure 5-40 Conceptual illustration of final tailings surface in Swan pit following consolidation



Source: WSP (2023)

Figure 5-41 Conceptual illustration of final tailings surface in De Grey pit following consolidation

5.4.3 Knowledge gaps & forward work program

Jimblebar tailings will be further tested during operations to confirm physical and geochemical characteristics.

Updated consolidation modelling is currently in progress and will be reported in future iterations of this MCP.

5.5 Soil characteristics

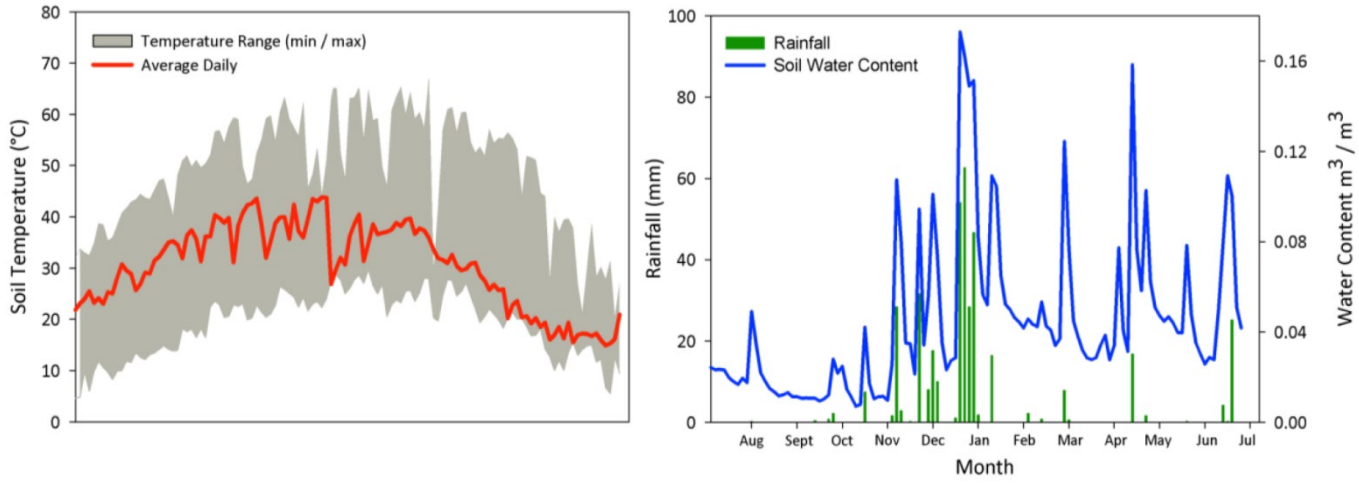
Summary of key points:

- Research into the soil environment in the Pilbara has concluded that soil temperature and moisture are inter-related and influence germination and establishment in the field. The majority of species will germinate over a wide temperature range (10 - 35°C), but require ample moisture, which is characteristic of cyclone rain events (with at least 4 rain events occurring within a 10-day period). Most species germinate in spring and summer (December to March), in correspondence with the highest moisture levels in the Pilbara.
- Baseline soil surveys have been conducted at each deposit and have concluded that except for the 'flat -gypsiferous' soil / landform association at OB31, topsoils are suitable for use in rehabilitation. In general, topsoils with higher coarse fractions are located higher in the landscape. These soils are likely to be less prone to erosion than soils with lower coarse fractions and, therefore, more suitable for use on the outer slopes of OSAs.
- A topsoil balance has indicated that there is a deficit of ~4.4 Mm^3 topsoil.
- The suitability of several OB18 and Jimblebar overburden types (Scree, Dales Gorge, Joffre and McRae Shale) have been assessed in relation to their potential to support plant growth and the chemical characteristics of these materials would not have a negative impact on plant growth. Landloch (2013a; 2015b; 2016b) recommended that the materials be amended to increase nitrogen if used in rehabilitation. Further investigation of alternate growth media sources is required as landforms are progressively rehabilitated.

5.5.1 Pilbara soil environment

The Pilbara soil environment is as follows:

- Soil temperatures range from a low of 5°C during winter to over 65°C during summer (Figure 5-42).
- Soils experience intermittent periods of wetting and drying, which occurs more frequently during the summer months (December to March) (Figure 5-42).
- During intense summer rainfall events, soil temperatures drop with the influx of soil moisture (for example, from 65°C to 25°C when fully saturated).
- Following a large rainfall event, due to high evaporation rates, soil dries quickly (with soil moisture rarely persisting in the top 5 cm of the soil profile beyond one week) (Figure 5-42).
- Lower evaporation rates from May to August mean that smaller rainfall events that occur during this time can lead to relatively high soil moisture levels, but these increases in soil moisture are short-lived (Figure 5-42).



Notes: Recorded during 2013 / 2014 at a depth of 3-5 cm below the soil surface at a site in the Pilbara near Newman, WA
Source: Erickson, Barrett, Symons, Turner, & Merritt (2016)

Figure 5-42 Relationship between soil temperature, rainfall and soil moisture content

Temperature and soil moisture are inter-related and influence germination and establishment in the field. The majority of Pilbara species will germinate over a wide temperature range (10 - 35°C), but require ample moisture, which is characteristic of cyclone rain events (with at least 4 rain events occurring within a 10-day period). Germination for most species occurs in spring and summer (December to March), in correspondence with the highest moisture levels in the Pilbara (Restoration Seedbank Initiative, 2020a; 2020b; 2020c).

5.5.2 Local soils

The most recent and detailed mapping of WA's Rangelands and Arid interior was collated by Tille (2006) into a hierarchy of soil-landscape mapping units. Jimblebar Hub is in the Fortescue Province, an area that occupies 160,050 km^2. The Fortescue Province contains ten soil-landscape zones; Jimblebar Hub is located within the Hamersley Plateaux Zone, which covers approximately 44,450 km^2 and is described by Tille (2006) as:

> *'Hills and dissected plateau (with some stony plains and hardpan wash plains) on sedimentary and volcanic rocks of the Hamersley Basin (Ophthalmia Fold Belt). Stony soils with Red shallow loams and some Red / brown non-cracking clays and Red loamy earths.'*

OB17/18

A soil survey at OB17/18 identified two main soil types (Outback Ecology, 2006) which is consistent with the results of earlier soil mapping by Bettenay et al. (1967) who described the two soil units that occur within the OB17/18/31 area as follows:

- Fa13: The soils are frequently stony and shallow and there are extensive areas without soil cover. Chief soils are shallow stony earthy loams (Um5.51) along with some (Uc5.11) soils on the steeper slopes. Associated soils are (Dr2.33, Dr2.32) on the limited areas of dissected pediments, while (Um5.52) and (Uf6.71) soils occur on the valley plains.
- Mz25: Plains associated with the Fortescue valley; there is a surface cover of stony gravels close to the ranges and hills. Chief soils are acid red earths (Gn2.11) with some neutral red earths (Gn2.12); red-brown hardpan is absent. Associated soils are areas of calcareous earths (Gc) and loams (Um1) on calcrete (kunkar) and some hard red (Dr) soils around creek lines.

As part of a study into landform design options for OB18, Landloch (2013a) conducted an analysis of the erosion characteristics of stockpiled topsoil samples. The results are presented in Section 5.3.3.

OB31

A baseline soil survey of the OB31 area (MWH, 2015) identified six soil / landform associations including:

- Three 'flat' soil landform associations (gravel carbonates, gypsiferous and drainage);
- Two 'mid-slope' soil / landform associations (gravelly and rocky); and
- One 'low-rise' soil / landform association (fractured calcrete).

Soils located lower in the landscape, from the flat soil / landform associations, generally had higher clay contents and were classed as sandy clay loams to light clays. Soils located higher in the landscape, from the mid-slope and low-rise soil / landform associations, had lower clay contents and were typically classed as sandy loams. The coarse material (>2 mm) fraction was variable (ranging between 4.8 and 86.8%) and largely dependent on position within the landscape. The average coarse material content was lowest in soils from the 'flat – drainage' soil / landform association, and highest in soils from the 'mid-slope – gravelly' soil / landform association (MWH, 2015).

Most soil would not be prone to hard-setting but may exhibit partial clay dispersion upon severe disturbance. The hydraulic conductivity of most samples was classed as 'moderate' or 'moderately rapid'. Soils that contained higher amounts of coarse material and were lower in clay content typically reported increased hydraulic conductivities (MWH, 2015).

Soil pH ranged between pH 4.7 (moderately acidic) and pH 8.5 (strongly alkaline) with most samples classed as neutral. Overall, most soil samples were non-sodic and 'non-saline', but samples from the 'flat - gypsiferous' soil / landform association were 'extremely saline' and a sample from one site within the 'mid-slope - gravelly' soil / landform association was also extremely saline (MWH, 2015).

While most of the soils sampled were very low in organic carbon and plant-available nutrients, this is typical of soils in the Pilbara region (MWH, 2015).

Samples from the 'flat -gypsiferous' soil / landform association are not suitable for use in rehabilitation works due to their salinity, however, soils from all other landform associations are considered a valuable source of rehabilitation material (MWH, 2015).

Jimblebar

Baseline soil surveys have been conducted at Jimblebar by Ecologia (1999) and Outback Ecology (2009b). Both surveys concluded that soil types could be broadly correlated with landforms with a number of different soil types found within each soil / landform association. The soil / landform associations identified by Ecologia and Outback Ecology were broadly similar (Table 5-47).

Table 5-47 Jimblebar Soil / Landform Associations

Ecologia (1999) Soil / Landform Associations	Outback Ecology (2009b) Soil / Landform Associations
Hill crest	Ridges and hillcrests
Upper slope	Rocky scree slope
Lower hill slope	Stony plains
Minor drainage line	Minor drainage lines
Base plains	Sandy plains, flats
Creek bank	Jimblebar Creek (major drainage lines) and floodplain
Creek base	

Sources: Ecologia (1999); Outback Ecology (2009b)

Both baseline studies (Ecologia, 1999; Outback Ecology, 2009b) found that morphological soil characteristics varied across the study areas, with large variations in soil depth and the degree of pedological development between the different soil / landform associations. The soils from higher positions in the landscape were typically shallower with a higher percentage of coarse material than the soils located at lower positions on the landscape. Soils from lower positions in the landscape typically contained finer textured soils than those at higher positions. The bed and margins of Jimblebar Creek were found to contain uniform soils of coarse texture, with no pedologic organisation evident in the soils of the bed (Ecologia, 1999). Outback Ecology (2009b) also noted some correlations between soil texture and depth of sample, with percentage clay generally increasing with depth at most sites.

None of the soils sampled by Outback Ecology (2009b) were identified as being completely dispersive, however some exhibited partial clay dispersion upon disturbance. Soils from the flats, Jimblebar creek line, and most minor drainage line and stony plain sites were typically observed to be non-dispersive / structurally stable, with the remainder of the soil / landform associations having soils which exhibited minor amounts of clay dispersion. None of the soils sampled had a soil strength high enough to be considered hard-setting or potentially problematic. These results were reflected in the low levels of ESP measured, with most soils classified as non-sodic. Only two soils from the scree slope soil / landform association recorded ESP values greater than 6% (i.e., classed as sodic).

The range of Plant Available Water (PAW) measured within the study area was considered to be 'low' to 'moderate', ranging from 4.0% to 19.9%. There was a relatively consistent range of water retention characteristics measured for the <2 mm soil fraction from most sampling sites, with the percentage of coarse material in the soils being the most influential factor governing PAW. Soils from positions within the landscape with higher amounts of coarse material, i.e., soils from the ridge and hill crest, rocky scree slope and the gravel mantled stony plains soil / landform associations, therefore, have a lower PAW than those soils with low percentages of coarse material (Outback Ecology, 2009b).

Most soil samples were classed as slightly acid to neutral (i.e., between pH 6 and 8), however, soil pH values ranged between pH 5.3 (strongly acid), and pH 9.2 (strongly alkaline). Creek beds and banks were observed to be more alkaline than other areas. Soils were typically non-saline (Ecologia, 1999; Outback Ecology, 2009b).

While most of the soils sampled were very low in organic carbon and plant-available nutrients, this is typical of soils in the Pilbara region (Ecologia, 1999; Outback Ecology, 2009b).

Overall, none of the soils in the Jimblebar area were considered to be overly problematic from an erodibility or re-vegetation perspective, although the different properties of the soils from different positions in the landscape may influence where / how they are used in rehabilitation. For example, soils with higher coarse fractions are likely to be less prone to erosion and, therefore, more suitable for use on OSA slopes (Outback Ecology, 2009b).

5.5.3 Topsoil balance

A high-level topsoil balance based on the current topsoil stockpiles and existing disturbance that has not yet been rehabilitated is provided in Table 5-48. In summary, the existing disturbance at Jimblebar Hub requires approximately 6.9 Mm^3 of soil for closure. A total topsoil deficit has been estimated at 4.4 Mm^3. Typically topsoil deficits occur due to:

- The greater surface area of three-dimensional landforms (OSAs) compared the original landform;
- Some areas of the pre-mining surface may not have had topsoil, whereas the re-created landforms do require growth media;
- Losses incurred during stripping, storage and relocation to rehabilitation areas.

Table 5-48 Jimblebar Hub topsoil balance

Deposit	Current topsoil stockpiles (m^3)	Topsoil requirements (m^3)	Deficit based on current topsoil stockpiles (m^3)
OB17/18/31	487,500	731,000	244,000
Jimblebar	2,028,400	6,206,000	4,177,600
TOTAL	**2,515,900**	**6,937,000**	**4,421,020**

5.5.4 Growth media

To address the shortfall of topsoil stockpiled across site, ongoing investigations are assessing the suitability of various overburden types, at the Jimblebar Hub mines and other BHP sites, as growth media to be used during the rehabilitation process. The suitability of several OB18 and Jimblebar overburden types (Scree, Dales Gorge, Joffre and McRae Shale) have been assessed in relation to their potential to support plant growth (Landloch, 2013a; 2015b; 2016b). The analytical results are presented in Table 5-49.

The studies concluded that material pH is generally consistent with values common for mineral soils in the Pilbara. Amendment is not necessary as the pH is not expected to significantly affect plant growth. EC is also very low and will not have a negative impact on plant growth. Materials sampled have total nitrogen (N) and organic carbon values that are consistent with levels measured by Landloch in this region. It is recommended that the materials be amended to increase N if they are to be used in rehabilitation activities. Of the other nutrients, total phosphorus (P) was at medium levels but the available levels were low and available potassium (K) was adequate for Scree and Jimblebar hard cap, but very low for the other materials (Landloch, 2013a; 2015b; 2016b).

BHP also has an ongoing research program which includes research on approaches to rehabilitation that can enhance soil function in the absence of topsoil, as well as seed enhancements with the potential to reduce topsoil requirements. Appendix F summarises research conducted to date which includes soil quality indicators and methods for improving the fertility of overburden materials.

5.5.5 Knowledge gaps & forward work program

Ongoing research and identification of potential growth media sources to address the topsoil deficit is required as landforms are progressively rehabilitated.

Table 5-49 Topsoil and growth media analysis OB18 and Jimblebar[19]

Analyses		Unit	Topsoil	Scree	D1	D3 (1)	D3 (2)	McRae Shale	JMB Hard Cap	D3	J2	J6
			(Landloch, 2013a)				(Landloch, 2016b)			(Landloch, 2015b)		
pH		pH units	5.86 – 6.53	6.02 – 6.66	4.43 – 4.76	4.4 – 8.65	4.48 – 4.5	4.46 – 5.01	8.27	6.86	6.70	6.61
Electrical Conductivity		dS/m	0.01 – 0.07	0.06 – 0.14	0.02 – 0.03	0.08 – 0.2	0.01 – 0.03	0.02 – 0.05	0.09	0.50	0.27	0.25
Total Nitrogen		mg/kg	56.8 - 116	<10	<10	< 10	<10	11.5 - 488	317	<50	<50	<50
Total Phosphorus		mg/kg	132 - 275	146 - 185	198 - 499	134 - 282	93.6 - 178	740 - 1048	134	542.0	383.0	602.0
Organic Carbon		%	0.22 – 0.29	<0.1	<0.1	<0.1	<0.1	<0.1	0.39	<0.5	<0.5	<0.5
Plant Available Nutrients	Phosphorus - Colwell	mg/kg	11.2 – 15.8	9.6 – 13.4	10.7 – 14.9	10.8 – 15.4	9.2 – 10.5	10.9 – 45.2	17.00	13.20	11.30	
	Potassium - Colwell	mg/kg	126 - 255	194 - 274	<10 – 37.3	<10 - 101	9.2 – 11.9	44.9 - 109	198.0	117.0	132.0	
	Sulphur - KCl	mg/kg	0.8 – 7.5	10.9 – 23.7	7.7 – 13.1	7.6 – 27.5	4.6 – 30.2	11.6 – 23.9	111.00	91.00	72.50	
	Copper – DTPA	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.23	0.21	<0.2	
	Iron – DTPA	mg/kg	4.8 – 7.4	5.9 – 19.8	4.0 – 8.6	5.9 – 10.6	3.6 – 5.5	0.9 – 1.5	8.52	4.78	7.61	
	Manganese – DTPA	mg/kg	4.5 – 21.9	<0.5	<0.5	<0.5	<0.5 – 1.6	0.5 – 3.9	7.38	<0.5	<0.5	
	Zinc – DTPA	mg/kg	<0.5	<0.5	0.7 – 1.0	<0.5	<0.5 – 1.2	<0.5 – 1.3	11.30	2.81	6.79	
Plant available water content		%								10	9	9

Source: Landloch (2013a; 2015b; 2016b)

[19] See Table 5-29 in Section 5.3.3 for exchangeable cation levels and physical properties

5.6 Stability and seismicity

Summary of key points:

- Probabilistic seismic hazard assessments indicate that the Jimblebar Hub is located in an area with a low to moderate seismic hazard.
- The stabilities of the Swan and De Grey pit walls were analysed to inform studies for tailings deposition. Analyses indicated that:
  - The walls of unfilled voids were stable (Factor of Safety (FoS) ≥1.3) in the dry case (i.e., no groundwater recovery), but De Grey pit had a FoS of <0.8 as water levels started to recover although this improved as water levels increased. Despite this, the bedding type of failure mechanisms typically mean slope crests are largely stable within the model, and should the voids remain unfilled, a 10 m stand-off distance for abandonment bunding achieves a FoS >1.5 for all sections modelled.
  - Following backfill with tailings to above the pre-mining water table, pit wall stability achieves FoS >1.5.
- Further pit wall stability assessments will be conducted:
  - To inform measures for managing long term pit wall stability (if required) and the abandonment bund locations for pits (other than De Grey and Swan) as the pits approach closure.
  - As part of the DPS for tailings storage in Swan and De Grey pits (in progress).

5.6.1 Seismic hazard analysis

A probabilistic seismic hazard assessment was conducted on selected WAIO operations in the Pilbara by Meynink Engineering Consultants (2012). The assessment was based on area seismic sources as no evidence of recent fault activity was recognised close to the WAIO operations in the Pilbara during the preliminary neotectonic observations. The observations showed that an inferred segmented fault system appears to run across the area, but there was no indication of recent fault activity (Meynink Engineering Consultants, 2012).

The Meynink Engineering Consultants (2012) study estimated peak ground acceleration values at Wheelarra Hill (WH) for different types of material and different probabilities of exceedance (Table 5-50) at a representative location at WH3. A further seismic hazard assessment has also been conducted by the Seismology Research Centre (2016) for the Whaleback TSF (approximately 40 km to the east of Jimblebar). The peak ground accelerations from this study are also reported in (Table 5-50) for comparison.

Table 5-50 Estimated peak ground acceleration values

Representative Location	Return Period 1 in x years	Peak Ground Acceleration (PGA) (g)				PGA (mm/s^2)
		Tertiary Sediments (vs^{30} 500 m/s)	Moderately Weathered Rock (vs^{30} 760 m/s)	Shale (vs^{30} 865 m/s)	Fresh BIF (vs^{30} 1800 m/s)	(vs^{30} 1800 m/s)
Whaleback	10,600*	No data			0.204 g	2,000
WH3	2475[1]	0.216g	0.196g	0.189g	0.138g	No data
Whaleback	1,580*	No data			0.071 g	700
WH3	975[2]	0.123g	0.109g	0.105g	0.077g	No data
Whaleback	841*	No data			0.051 g	500
WH3	475[3]	0.078g	0.068g	0.066g	0.048g	No data

Source: Meynink Engineering Consultants (2012) and Seismology Research Centre (2016)

Notes: *for Magnitude (Mw) 5 and above calculated by the Seismology Research Centre (2016)
[1]equivalent to 2% probability in 50 years
[2]equivalent to 5% probability in 50 years
[3]equivalent to 10% probability in 50 years

Since the Meynink Engineering Consultants (2012) study, recent observations at Area C have confirmed a significant fault structure which shows clear cross cutting relationships and displacement of the detritals sequence. This fault traverses the entire detritals stratigraphic sequence (>100 metres in thickness) and breaks through the Quaternary Detrital surface colluvium unit at the current surface, where recent tension cracking due to mine site blasting activities, can also be observed. This implies relatively recent re-activation of basement fault structures in the Pilbara region that affect the youngest Quaternary aged deposits (<2 Ma).

Meynink Engineering Consultants (2012) concluded that in the Australian context, the peak ground acceleration values estimated from the study correspond to a low to moderate seismic hazard. Recent observations have not given BHP reason to believe that the seismic hazard is significantly higher.

5.6.2 Slope stability

Golder (2022a) conducted slope stability assessments for the Swan and De Grey pits for two scenarios as part of the SPS; empty voids with limited water in the base and voids filled with tailings. The outcomes of this study are reported below. Further DPS assessments were being conducted at the time of writing. The outcomes of these assessments will be reported in future iterations of the MCP.

5.6.2.1 Review of pit design

A feasibility study was carried out in 2006 which informed the original pit design, and subsequent work was undertaken in 2012 following update of the geological model, to assess potential slope stability issues resulting from the update. This work indicated that initial designs had been followed, pit performance had been satisfactory, and no significant recommendations were made that would influence the designs of De Grey and Swan pits (Golder, 2022a).

5.6.2.2 Slope stability model inputs

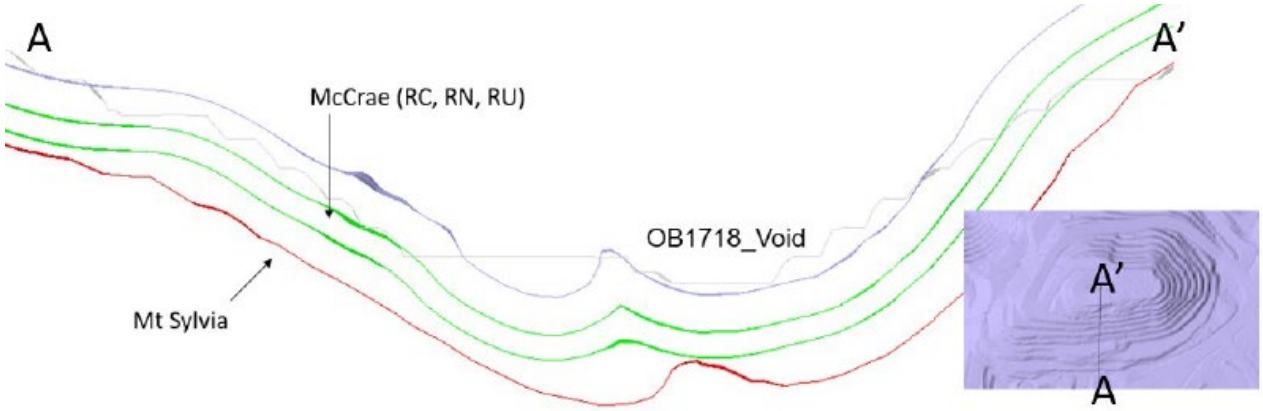
Inputs to the slope stability model included (Golder, 2022a):

- Pit shell designs merged with current mined topography.
- The geological model (Figure 5-43 and Figure 5-44) which shows:
  - The pit walls at De Grey are formed primarily within the McRae Shale unit as the floor is the base of a syncline.
  - Southern walls at Swan are in McRae shale and northern walls in Dales Gorge.
- Pre-mining water table at 502 mRL.
- Rock mass properties outlined in Table 5-51.
- Bedding shear strength friction (Phi) 29° and cohesion 4 Kpa.
- An undrained tailings shear strength ratio Su/sigma'v of 0.16, with a maximum indicated strength of 60 kPa (which is relatively low).

Table 5-51 Rock mass shear strength material properties

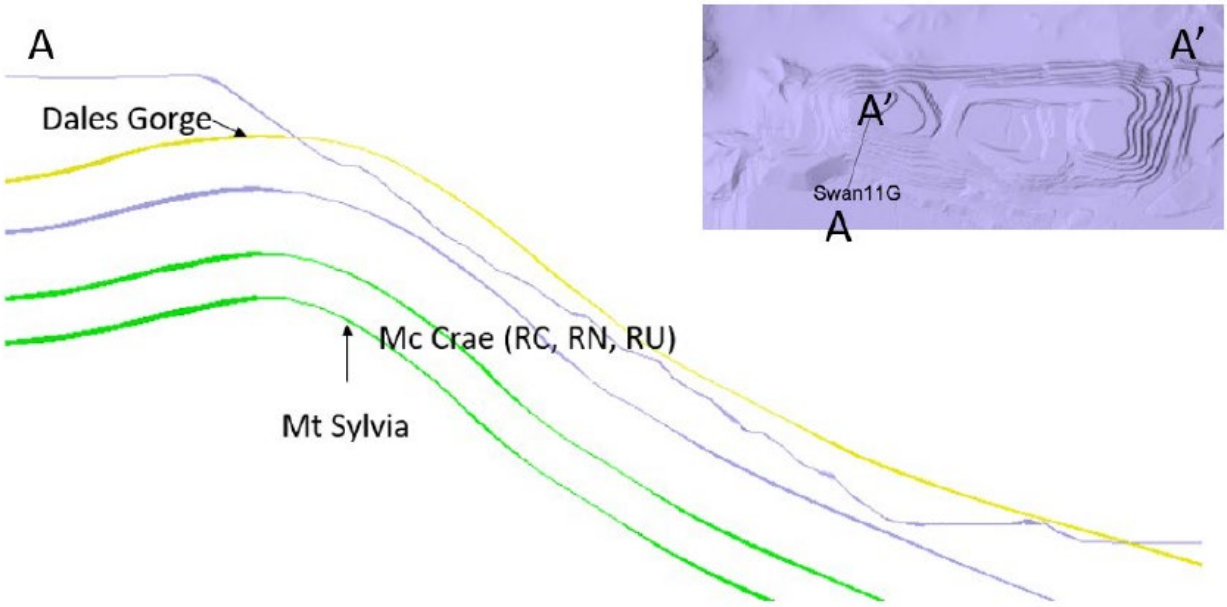
Unit	Weathering Grade	Hoek Brown Input Parameters				Mohr Coulomb	
		UCS (Mpa)	GSI	mi	D	Phi (°)	C (kPa)
Dales Gorge	Weathered	33	50	10	0		
Whaleback Shale	Weathered	15	42	6	0		
McRae Shale	Weathered	15	44	7	0		
Mt Sylvia	Weathered	38	48	8	0		
Detritals	Weathered	NA	NA	NA	NA	20	70

Source: Golder (2022a)



Source: Golder (2022a)

Figure 5-43 De Grey geological model cross section (42G)

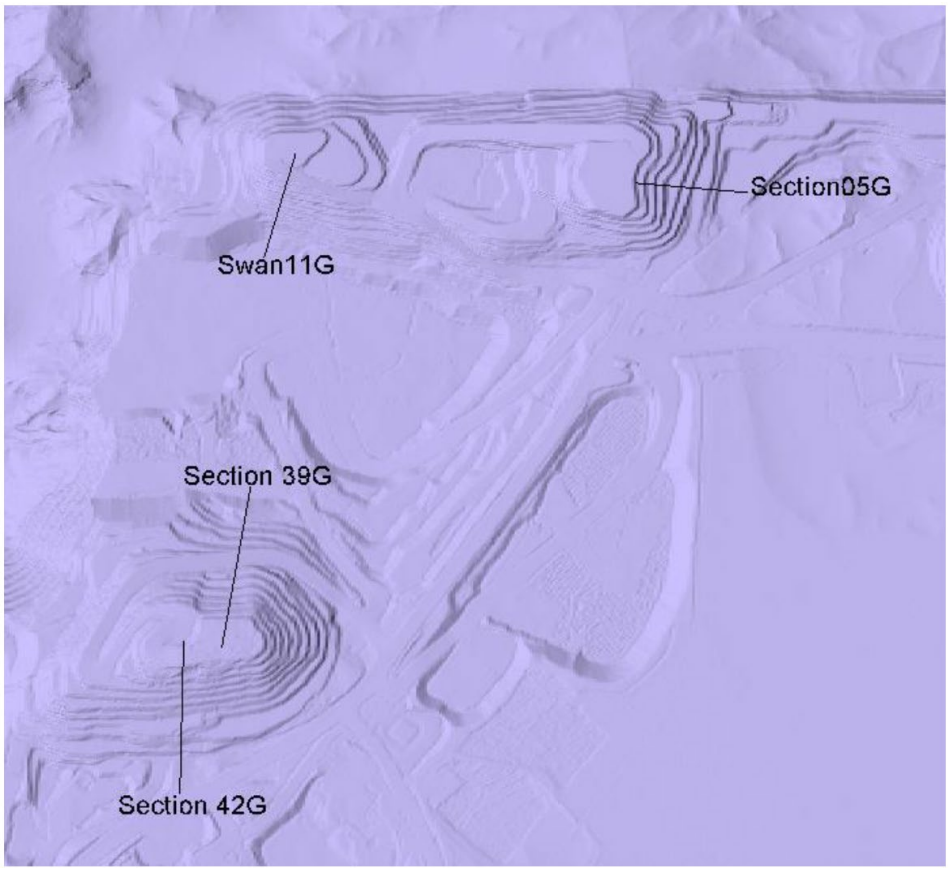


Source: Golder (2022a)

Figure 5-44 Swan geological model cross section (11G)

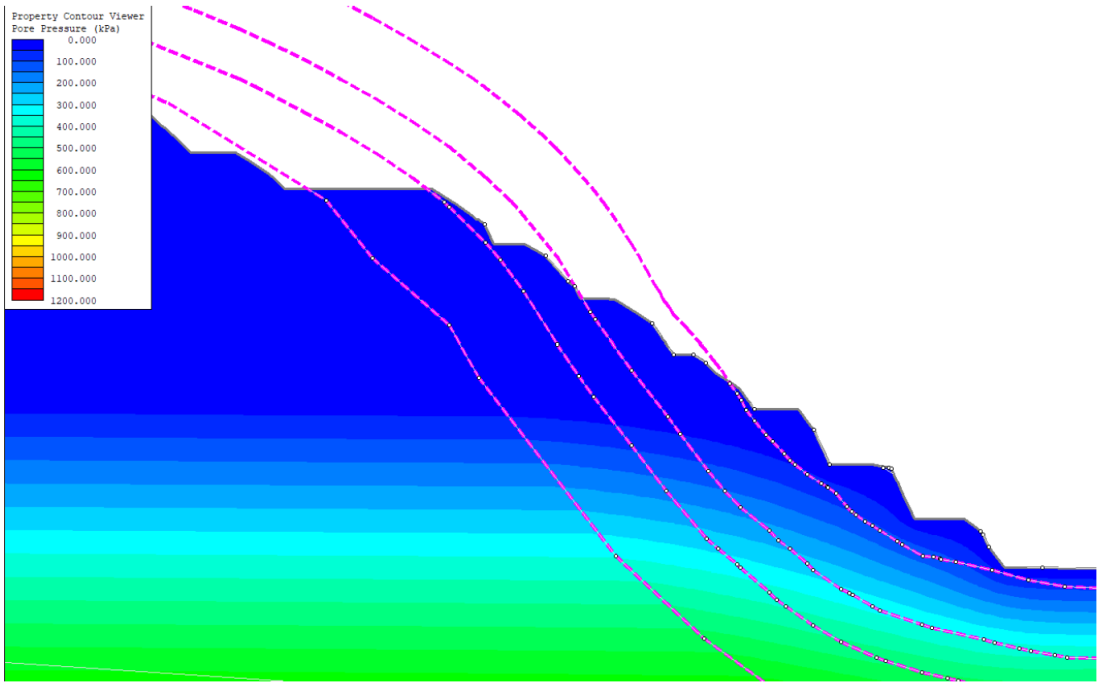
5.6.2.3 Slope stability analyses

2-dimensional limit equilibrium (2DLE) analyses were performed using Rocscience Slide2 (2D) on the sections shown in Figure 5-45. A sensitivity analysis has been conducted to assess the impact of cessation of dewatering prior to completion of tailings deposition to above the pre-mining water table. This analysis assumed hydrostatic conditions (see Figure 5-46 for example pore pressure grid) (Golder, 2022a).



Source: Golder (2022a)

Figure 5-45 Sections used for limited equilibrium analysis



Source: Golder (2022a)

Figure 5-46 Example pore pressure grid developed on Section 42G

Stability analysis results (Table 5-52) indicate that sections 39G and 42G (De Grey) are unstable in a no fill scenario based on the pore pressure assumptions adopted for this assessment. The failure mechanisms are bedding controlled in the McRae Shale. Both sections are stable when run with the no fill dry case, which indicates the wall is highly sensitive to pore pressures. An analysis of the impact of groundwater rebound on section 39G in a no fill scenario indicated that the Factor of Safety (FoS) drops to <0.8 as the water table starts to rebound and then starts to improve due to the confining effect of the water (Golder, 2022a).

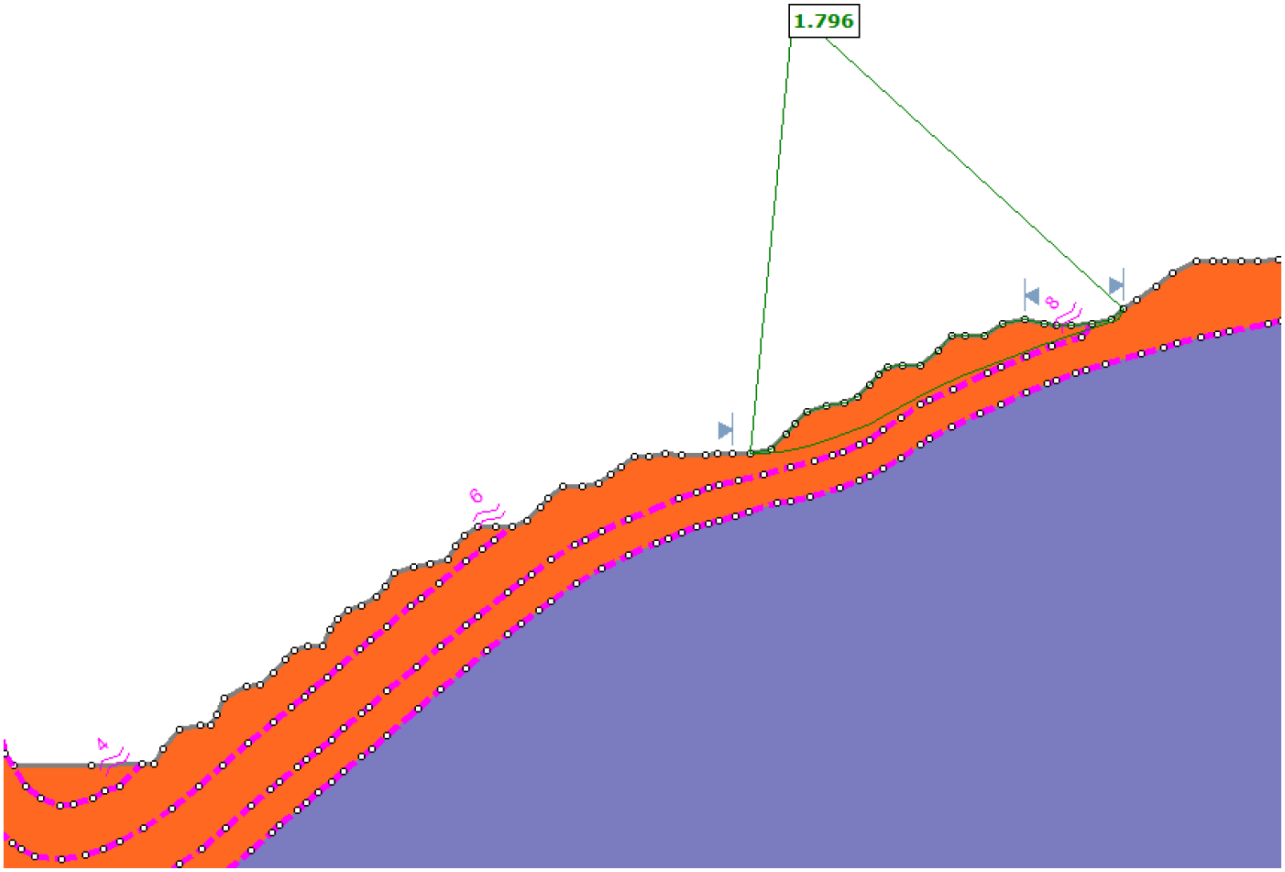
Site geotechnical reports indicate that there is a bedding inter ramp scale mechanism on north wall which correlates well with the mechanism identified in Slide modelling (section 39G). The seepage force during groundwater rebound would likely reactivate this failed mass. A smaller multi batter scale mechanism on the south wall is also replicated well in section 42G. Site records indicate movement has been highly sensitive to external stimuli including blasting / rainfall etc., (Golder, 2022a).

An additional analysis was conducted above the ramp in Section 39G to assess the upper slope, which has a large OSA adjacent to the crest. Results are presented in Figure 5-47 and indicate the upper slope is stable (Golder, 2022a).

Table 5-52 Results of slope stability analyses

Pit	Section	Fill Scenario	FoS	Pore pressure
De Grey	39G	No fill	0.88	PPG
		No fill	1.61	DRY
		560 m RL (TSF filling complete)	>2.0	PPG
	42G	No fill	0.72	PPG
		No fill	1.28	DRY
		560 m RL (TSF filling complete)	>2.0	PPG
Swan	5G	No fill	1.48	PPG
		No fill	1.43	DRY
		560 m RL (TSF filling complete)	>2.0	PPG
	11G	No fill	1.27	DRY
		560 m RL (TSF filling complete)	>2.0	DRY

Source: Golder (2022a)
Notes: PPG – Pore Pressure Grid



Source: Golder (2022a)

Figure 5-47 Section 39G upper slope stability analysis

Following backfill with tailings to above the pre-mining water table, pit wall stability achieves FoS >1.5. The bedding type of failure mechanism at Swan and De Grey typically means slope crests are largely stable within the model, and should the voids remain unfilled, a 10 m stand-off distance for abandonment bunding achieves a FoS >1.5 for all sections modelled (Golder, 2022a). Parts of the East OSA lie within the 10 m stand-off distance from the Swan pit crest and will require rectification works if the Swan void is not backfilled with tailings.

5.6.3 Knowledge gaps & forward work program

Further pit wall stability assessments will be conducted:

- To inform measures for managing long term pit wall stability (if required) and the abandonment bund locations for pits (other than De Grey and Swan) as the pits approach closure.
- As part of the DPS for tailings storage in Swan and De Grey pits (in progress).

5.7 Landforms and land systems

Summary of key points:

- The Jimblebar Hub region contains mainly rounded ranges and hills.
- OB17/18 occurs on the southern and eastern sides of Shovelanna Hill.
- OB31 occurs at the eastern end of the Ophthalmia Range that slopes east to Jimblebar Creek.
- The Jimblebar Wheelarra, WHASH, Hashimoto and East Jimblebar deposits are located on the Wheelarra Hill Ridge. The eastern end of the ridge (i.e., where the Hashimoto and East Jimblebar deposits are located), is lower and generally more rounded than the west. The topography of the Wheelarra Hill ridge typically ranges from 50 m to 150 m higher than the surrounding valley floors.
- The South Jimblebar deposits are very flat-lying and are often represented by low rounded hills less than 20 m above surrounding plains.
- The dominant land system occupied by the mining areas is hills and ranges with spinifex grasslands. Other land systems include stony plains with either spinifex grasslands or acacia shrublands, sandplains with shrubby spinifex grasslands and wash plains on hardpan with Mulga shrublands.

5.7.1 Topography

The Jimblebar Hub mine is located at the eastern end of the Ophthalmia Range, which together with the Hamersley Range, encompass the Hamersley Plateau. The Hamersley Plateau is characterised by long strike ridges composed of Brockman Iron Formation BIF material, rising 300 m or more above valley floors, and flats with other characteristic landforms of the general area including stony plains and some alluvial plains and sandplains (Tille, 2006). The entire region contains mainly rounded ranges and hills in contrast to the characteristic 'mesa form' hills that are located further north.

OB17/18 occurs on the southern and eastern sides of Shovelanna Hill. The southern margin of the OB17 area rises steeply to the ridge, shallowing gradually towards the north. OB31 occurs at the eastern end of the Ophthalmia Range that slopes east to Jimblebar Creek.

The Wheelarra Hill ridge is approximately 10 km long and has been separated from the main part of the Ophthalmia Range by several faults, including the Wheelarra Fault on the western side of the ridge. The topography of the eastern end of the Wheelarra Hill ridge (i.e., where the Hashimoto and East Jimblebar deposits are located), is lower and generally more rounded than the west. The Hashimoto H234 and East Jimblebar deposits are located to the east of Jimblebar Creek on a relatively low-lying series of rounded hills composed of Brockman Iron Formation BIF material. These hills are also oriented in an east-west direction and extend as far east as Caramulla Creek.

The topography of the Wheelarra Hill ridge typically ranges from 50 m to 150 m higher than the surrounding valley floors.

By comparison, the South Jimblebar deposits are very flat-lying and are often represented by low rounded hills less than 20 m above surrounding plains. These hills are formed by outcrops of the Marra Mamba Iron Formation and the underlying Jeerinah Formation and are also oriented in an east-west direction. To the south of Jimblebar mining operations, the country is generally flat to gently sloping, with occasional isolated low hills that are often associated with outcropping Archaean granitoid rocks.

Mining activities will modify the original topography through the excavation of open mine voids and overburden placement.

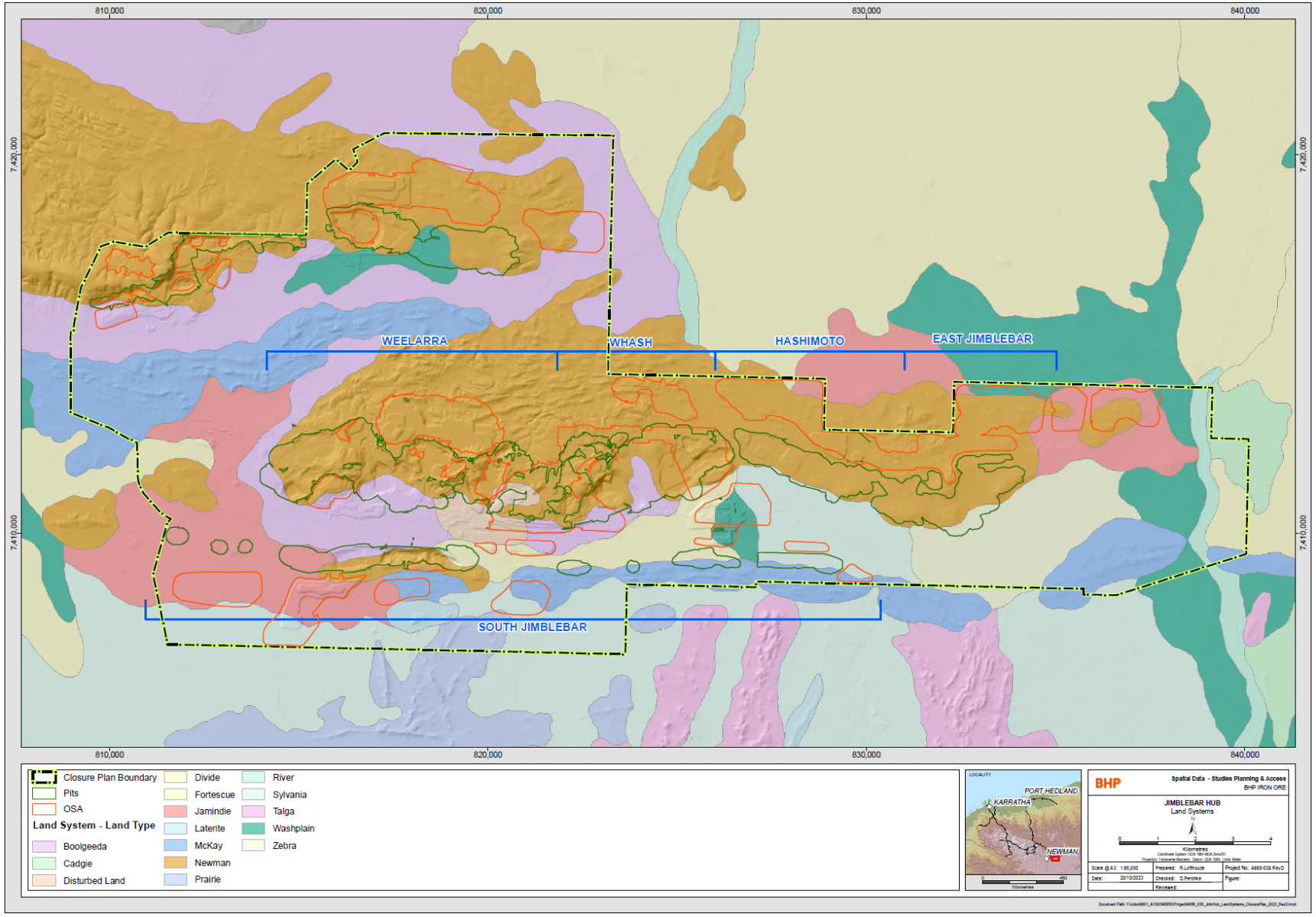
5.7.2 Land systems

Land systems across much of the grazing and pastoral lands of WA were surveyed, described and categorised during a series of surveys conducted by the Department of Agriculture. The Jimblebar Hub operation lies within the Pilbara Region, which was surveyed in the period between 1995 and 1999, by Van Vreeswyk et al. (2004), with the results published in Technical Bulletin No. 92. Jimblebar Hub is located on the land systems shown on Map 5-2 and described below:

- Newman land system: Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands.
- Boolgeeda land system: Stony lower slopes and plains below hill systems supporting hard and soft Spinifex grasslands and Mulga shrublands.
- Washplain land system: Hardpan plains supporting groved Mulga shrublands.
- McKay land system: Hills, ridges, plateaux remnants and minor breakaways of sedimentary and meta sedimentary rocks, supporting hard spinifex grassland.
- Jamindie land system: Stony hardpan plains and rises supporting groved Mulga shrublands, occasionally with spinifex understorey.
- Sylvania land system: Gritty surfaced plains and low rises on granite supporting *acacia-eremophila-cassia* shrublands.
- Divide land system: Sandplains and occasional dunes supporting shrubby hard spinifex grasslands.
- Zebra land system: Hardpan plains with large linear gravelly sand banks supporting acacia shrublands with soft and hard spinifex.

5.7.3 Knowledge gaps & forward work program

No knowledge gaps which have impacts on closure outcomes have been identified.



Refer to Appendix Q for pdf version

Map 5-2 Jimblebar Hub land systems

5.8 Vegetation

Summary of key points:

- The Jimblebar Hub operations lie in the Hamersley and Fortescue Plains sub-regions of the Pilbara IBRA (Interim Biogeographic Regionalisation for Australia) bioregion and border the Augustus sub-region of the Gascoyne bioregion.
- The Hamersley sub-region is dominated by *Eucalyptus leucophloia* over *Triodia* hummock grassland on skeletal soils atop mountains and slopes, while swathes of Mulga woodland occur over hard and soft grasses on fine-textured soils of the plains and valleys.
- The Fortescue Plains sub-region comprises the Fortescue Marsh and, outside of the marsh, River Red Gum (*Eucalyptus camaldulensis*) woodlands fringing drainage lines and deeply incised gorge systems.
- Over 50 vegetation surveys have been completed across the Jimblebar Hub and have mapped 120 vegetation associations in the Jimblebar mine area. Five vegetation associations fall within the following ecosystems defined by DBCA as at risk (BHP, 2023a):
  - Major drainage line vegetation mapped as Acacia Low Open Forest (associations MA AciAcp CocrTefc Cc and MA AciAcp Mg CcTtEua) and Eucalyptus Open Woodland (association MA EcrEv AciApypMg CcEuaTt) which represent riparian vegetation mapped within Jimblebar and Caramulla creeks.
  - Banded Mulga which are dependent on sheet-flow and have been mapped as Acacia Low Woodland association HP AaChApr DopeErfoSeah TtChfAri and Acacia Low Woodland association HP AptAa SesmErlnSeah Tb.
- Except for a small area of the Orebody 31 Creek where groundwater levels were 5 to 25 metres below ground level (mbgl), the regional water table is too deep for the root systems of groundwater dependent vegetation to access. Potential impacts to the facultative vegetation in this area of the Orebody 31 Creek were noted in BHPBIO (2015) and approved via MS 1021.
- The Jimblebar Hub does not intersect any State or Federally listed Threatened or Priority Ecological Communities.
- No species listed as Threatened under the *Environment Protection and Biodiversity Conservation Act 1999* (*Cth)* (EPBC Act) or *Biodiversity Conservation Act (WA)* (2016), have been identified within the Jimblebar Hub closure planning area, but seven priority flora species have been recorded.
- Twenty-seven introduced flora species have been recorded within the Jimblebar Hub. None of these are designated as Declared Weeds under the *Biosecurity and Agriculture Management Act* 2007 *(WA)* (BAM Act) or as Priority Alert by DBCA (2019a). However, several are rated as high risk, due to invasiveness and / or ecological impact, by DBCA (2019a).
- Species of importance to the Nyiyaparli people are discussed in Section 5.14.
- Vegetation communities have a role in providing habitat for fauna, and research is currently being planned on fauna habitat for key species (see Section 5.9)

5.8.1 Regional flora and vegetation

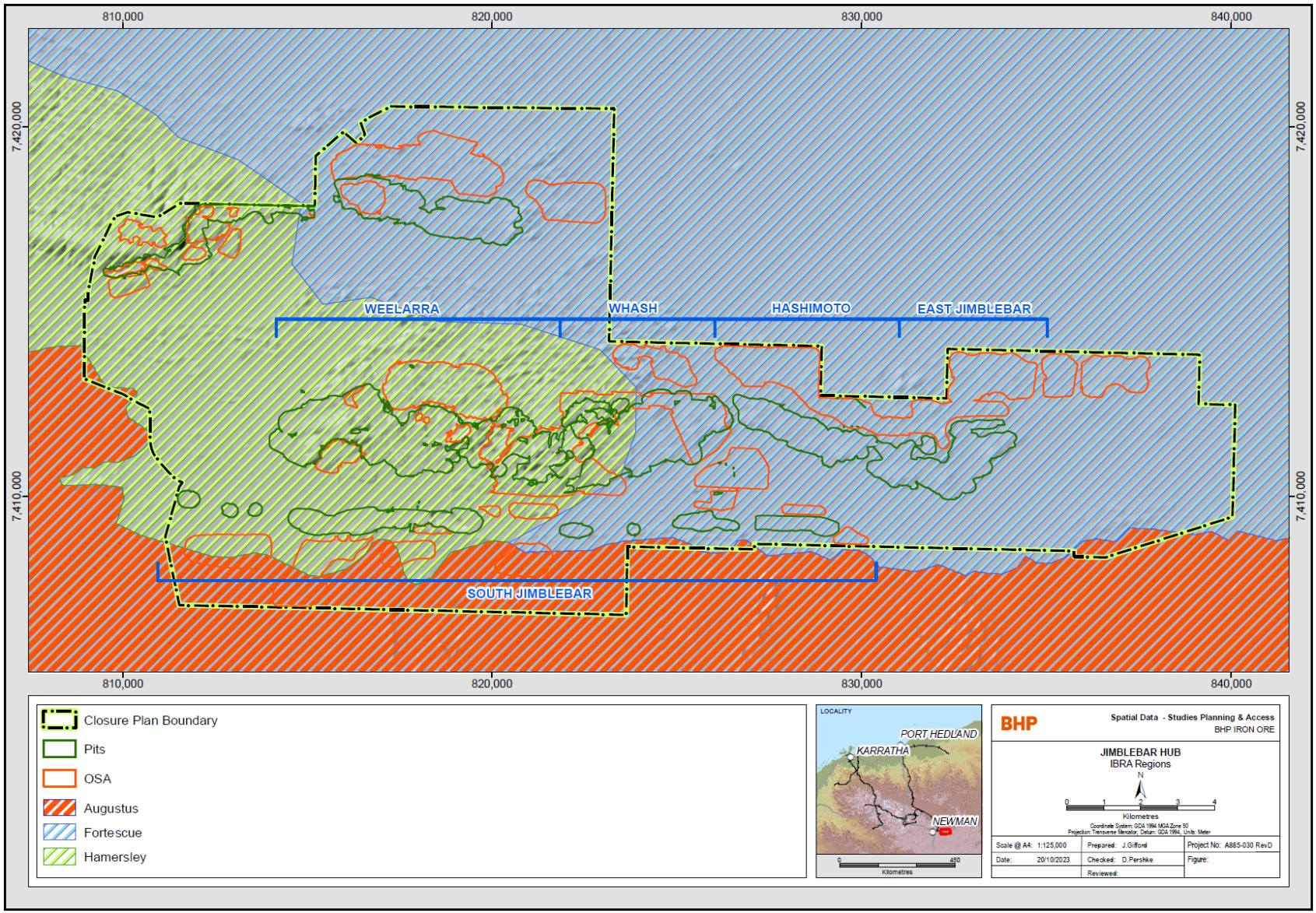
The latest version of the Interim Biogeographic Regionalisation for Australia (IBRA 7) divides Australia into 89 bioregions based on climate, geology, landform, native vegetation and species information (DCEEW, 2021) and includes 419 sub-regions. The bioregions and sub-regions are the reporting unit for assessing the status of native ecosystems and their level of protection in the National Reserve System.

The Jimblebar Hub mines lie predominantly on the southern fringe of the Pilbara bioregion with a small portion in the Gascoyne bioregion as defined by IBRA 7 (Thackway, 1995). The Pilbara bioregion consists of four sub-regions: Chichester, Fortescue, Hamersley and Roebourne. The Jimblebar Hub operations lie in the Hamersley and Fortescue Plains sub-regions and border the Augustus sub-region of the Gascoyne bioregion (Map 5-3).

The Hamersley sub-region is dominated by *Eucalyptus leucophloia* over *Triodia* hummock grassland on skeletal soils atop mountains and slopes, while swathes of Mulga woodland occur over hard and soft grasses on fine-textured soils of the plains and valleys (Kendrick, 2001).

The Fortescue Plains sub-region contains the Fortescue Marsh, which is listed in the Directory of Important Wetlands in Australia (Environment Australia, 2001) as a wetland of regional and national significance and is a proposed Ramsar site (DBCA, 2018a). Outside the Marsh, this sub-region is characterised by River Red Gum (*Eucalyptus camaldulensis*) woodlands fringing drainage lines and deeply incised gorge systems (Kendrick, 2001). The vegetation in the general Jimblebar area, particularly to the north of the Jimblebar closure planning area, also has elements of the Little Sandy Desert IBRA Region which is located to the east (Thackway, 1995).

Within the Augustus sub-region, Mulga woodland with *Triodia* occur on shallow stony loams on rises, while the shallow earthy loams over hardpan on the plains are covered by Mulga parkland (Desmond, Kendrick, & Chant, 2001).



Refer to Appendix Q for pdf version

Map 5-3 Interim Biogeographic Regionalisation

5.8.2 Local flora and vegetation

Flora and vegetation mapping of the Jimblebar Hub area has been undertaken over multiple studies and years. A total of 54 flora and vegetation surveys have been undertaken wholly or partially within the proposed closure planning area. These surveys comprised 31 detailed surveys, eight reconnaissance surveys, eleven targeted surveys and four desktop assessments. A complete list and summary of these surveys is provided in (BHP, 2023a).

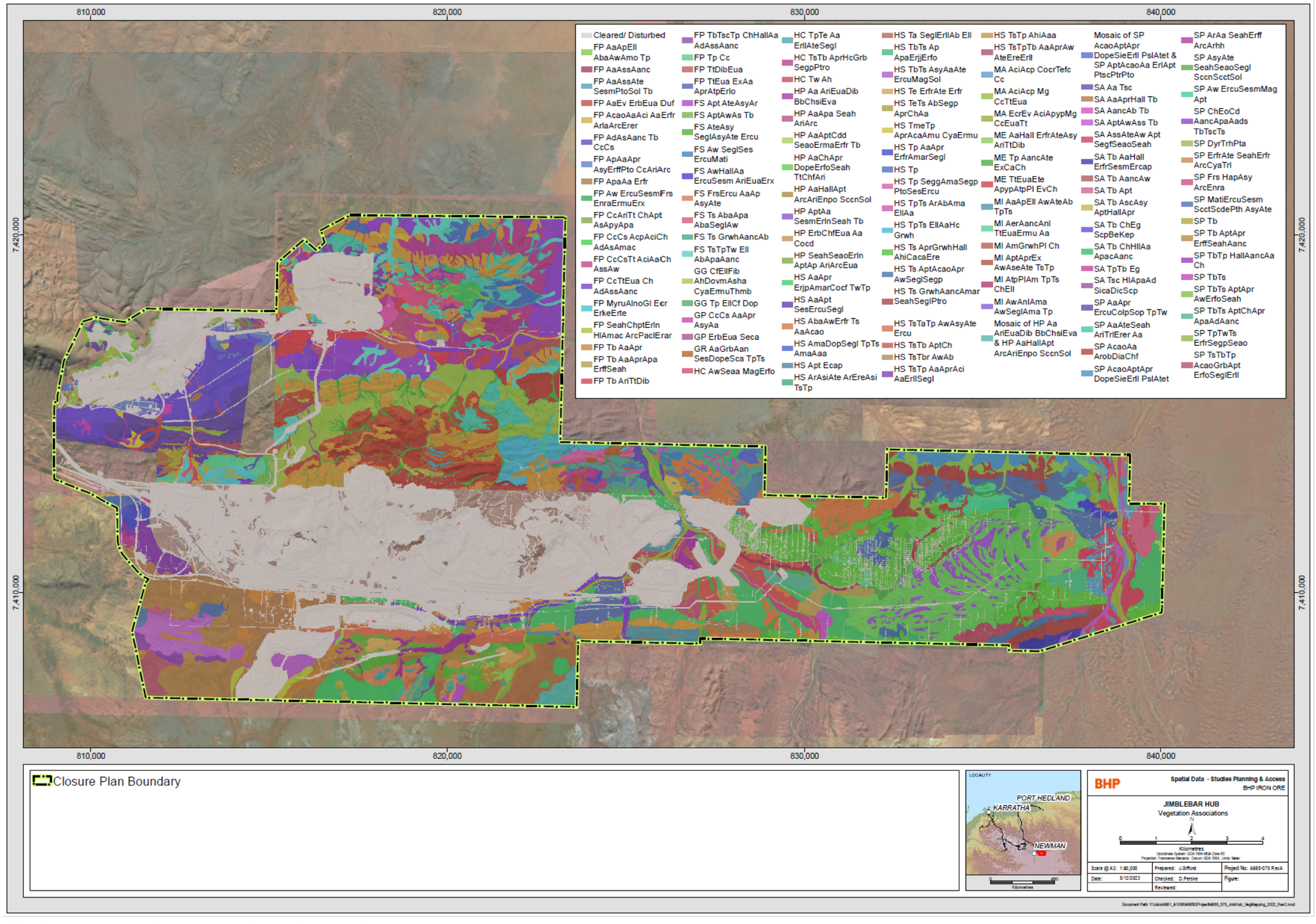
The results of vegetation mapping across the Jimblebar Hub were consolidated by Onshore Environmental in 2023 and are presented in Map 5-4 and Table 5-53. A total of 120 vegetation associations (including two mosaic units) have been mapped across 26 broad floristic formations. The dominant vegetation associations of the closure planning area are *Acacia* scrublands on plains and *Triodia* hummock grassland communities occurring on hill slopes.

Five vegetation associations fall within the following ecosystems defined by DBCA as at risk (BHP, 2023a) (Map 5-5 and Table 5-53):

- Major drainage line vegetation mapped as associations MA AciAcp CocrTefc Cc, MA AciAcp Mg CcTtEua and MA EcrEv AciApypMg CcEuaTt which represent riparian vegetation mapped within Jimblebar and Caramulla creeks .
- Banded Mulga which are dependent on sheet-flow and have been mapped as associations HP AaChApr DopeErfoSeah TtChfAri and HP AptAa SesmErlnSeah Tb.

The unmapped portion of the Jimblebar area is associated with mining operations that commenced in 1989, prior to BHP ownership and the introduction of survey requirements. There are some additional unmapped areas that represent gaps in survey coverage between or adjacent to approved proposal areas.

Section 5.14 discusses flora species of significance to the Nyiyaparli people.



Refer to Appendix Q for pdf version and Table 5-53 for a description of each vegetation association mapped

Map 5-4 Jimblebar Hub vegetation associations

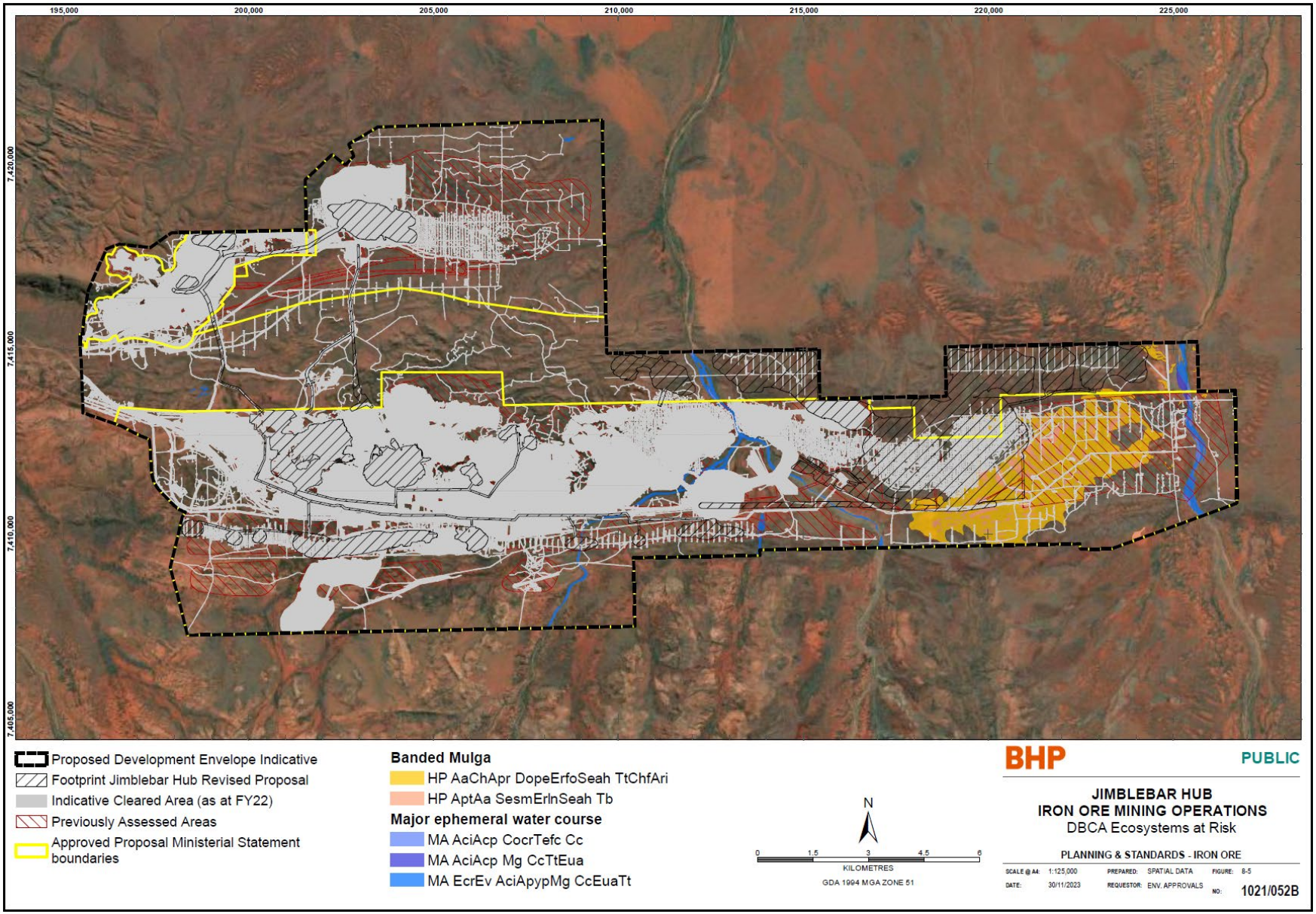
Table 5-53 Jimblebar Hub vegetation associations

Vegetation code	Broad floristic formation	Vegetation association description
FP AaApEll AbaAwAmo Tp	Acacia Low Open Forest	Low Open Forest (to Low Woodland) of *Acacia aptaneura, Acacia paraneura* and *Eucalyptus leucophloia* subsp. *leucophloia* over Open Scrub (to High Shrubland) of *Acacia balsamea, Acacia wanyu* and *Acacia monticola* over Open Hummock Grassland of *Triodia pungens* forming mulga groves on floodplains and minor drainage lines through undulating ironstone ridges, hills and valleys
FP AaAssAanc Tp	Acacia High Shrubland	High Shrubland of *Acacia aptaneura, Acacia sclerosperma* subsp. *sclerosperma* and *Acacia ancistrocarpa* over Very Open Hummock Grassland of *Triodia pungens* on red brown sandy loam on floodplains and medium drainage lines
FP AaAssAte SesmPtoSol Tb	Acacia High Shrubland	High Shrubland of *Acacia aptaneura, Acacia sclerosperma* subsp. *sclerosperma* and *Acacia tetragonophylla* over low open shrubland of *Senna* sp. Meekatharra (E. Bailey 1-26), *Ptilotus obovatus* and *Solanum lasiophyllum* over scattered hummock grassland of *Triodia basedowii* on red loamy sands on drainage areas and floodplains
FP AaEv ErbEua Duf	Acacia Closed Forest	Closed Forest of *Acacia aptaneura* and *Eucalyptus victrix* over Open Tussock Grassland of *Eriachne benthamii* and *Eulalia aurea* with Open Shrubland of *Duma florulenta* on red brown clay on floodplains
FP AcaoAaAci AaErfr ArlaArcErer	Acacia Low Open Woodland	Low Open Woodland (to Low Woodland) of *Acacia catenulata* subsp. *occidentalis*, *Acacia aptaneura* and *Acacia citrinoviridis* over High Open Shrubland of *Acacia aptaneura* and *Eremophila fraseri* over Very Open (to Open) Tussock Grassland of *Aristida latifolia, Aristida contorta* and *Eragrostis eriopoda* on red brown silty clay on floodplains
FP AdAsAanc Tb CcCs	Acacia High Shrubland	High Shrubland of *Acacia dictyophleba, Acacia sclerosperma* and *Acacia ancistrocarpa* over Open Hummock Grassland of *Triodia basedowii* over Open Tussock Grassland of **Cenchrus ciliaris* and **Cenchrus setiger* in brown sands on floodplains
FP ApaAa Erfr TsTp	Acacia High Open Shrubland	High Open Shrubland of *Acacia paranerua* and *Acacia aptaneura* over Open Shrubland of *Eremophila fraseri* over Very Open Hummock Grassland of *Triodia vanleeuwenii* and *Triodia pungens* on red clay loam on floodplains and stony plains
FP ApAaApr AsyErffPto CcAriArc	Acacia Low Woodland	Low Woodland of *Acacia paraneura, Acacia aptaneura* and *Acacia pruinocarpa* over Open Shrubland of *Acacia synchronicia, Eremophila forrestii* subsp. *forrestii* and *Ptilotus obovatus* over Open Tussock Grassland of **Cenchrus ciliaris, Aristida inaequiglumis* and *Aristida contorta* on red brown loam on floodplains
FP Aw ErcuSesmFrs EnraErmuErx	Acacia High Shrubland	High Shrubland of *Acacia wanyu* over Low Shrubland of *Eremophila cuneifolia, Senna* sp. Meekatharra (E. Bailey 1-26) and *Frankenia setosa* over Open Tussock Grassland of *Enteropogon ramosus, Eriachne mucronata* and *Eragrostis xerophila* on brown loamy sands on drainage areas, foot slopes and stony plains
FP CcAriTt ChApt AsApyApa	*Cenchrus Open Tussock Grassland	Open Tussock Grassland of **Cenchrus ciliaris, Aristida inaequiglumis*, and *Themeda triandra* with Low Open Woodland of *Corymbia hamersleyana* and *Acacia pteraneura* and High Open Shrubland of *Acacia sclerosperma, Acacia pyrifolia* and *Acacia pachyacra* on brown loamy sand on floodplains
FP CcCs AcpAciCh AdAsAmac	*Cenchrus Tussock Grassland	Tussock Grassland of **Cenchrus ciliaris* and **Cenchrus setiger* with Low Woodland of *Acacia coriacea* subsp. *pendens, Acacia citrinoviridis* and *Corymbia hamersleyana* and High Open Shrubland of *Acacia dictyophleba, Acacia sclerosperma* and *Acacia macraneura* in brown sands on floodplains
FP CcCsTt AciAaCh AssAw	*Cenchrus Tussock Grassland	Tussock grassland of **Cenchrus ciliaris*, **Cenchrus setiger* and *Themeda triandra* with low woodland of *Acacia citrinoviridis, Acacia aptaneura* and *Corymbia hamersleyana* over high open shrubland of *Acacia sclerosperma* subsp. *sclerosperma* and *Acacia wanyu* on brown sand on floodplains and drainage areas
FP CcTtEua Ch AdAssAanc	*Cenchrus Tussock Grassland	Tussock grassland of **Cenchrus ciliaris, Themeda triandra* and *Eulalia aurea* with low woodland of *Corymbia hamersleyana* over high open shrubland of *Acacia dictyophleba, Acacia sclerosperma* subsp. *sclerosperma* and *Acacia ancistrocarpa* on brown sand on floodplains and drainage areas
FP MyrAlnoGolm Ecr ErkeErte	Myriocephalus Herbs	Herbs of *Myriocephalus rudallii, Alternanthera nodiflora* and *Goodenia lamprosperma* with Low Woodland of *Eucalyptus camaldulensis* over Open Tussock Grassland of *Eragrostis kennedyae* and *Eragrostis tenellula* on red brown sandy loam on floodplains and drainage areas
FP SeahChptErln HlAmac ArcPaclErar	Senna Low Open Shrubland	Low Open Shrubland of *Senna artemisioides* subsp. *helmsii, Chrysocephalum pterochaetum* and *Eremophila lanceolata* with Scattered Tall Shrubs of *Hakea lorea var. lorea* and *Acacia macraneura* over Scattered Tussock Grasses of *Aristida contorta, Paspalidium clementii* and *Eriachne aristidea* on red brown sandy loam on floodplains
FP Tb AaApr Erff	Triodia Hummock Grassland	Hummock Grassland of *Triodia basedowii* with Low Open Woodland of *Acacia aptaneura* and *Acacia pruinocarpa* over Open Shrubland of *Eremophila forrestii* subsp. *forrestii* on red sandy loam on floodplains
FP Tb AaAprApa ErffSeah	Triodia Hummock Grassland	Hummock Grassland of *Triodia basedowii* with Low Open Woodland of *Acacia aptaneura, Acacia pruinocarpa* and *Acacia pachyacra* over Open Shrubland of *Eremophila forrestii* subsp. *forrestii* and *Senna artemisioides* subsp. *helmsii* on red sandy loam on floodplains
FP Tb AriTtDib Ch	Triodia Hummock Grassland	Hummock Grassland of *Triodia basedowii* with Low Open Woodland of *Aristida inaequiglumis, Themeda triandra* and *Digitaria brownii* over Open Shrubland with scattered *Corymbia hamersleyana* on red sandy loam on floodplains
FP TbTscTp ChHallAa AdAssAanc	Triodia Open Hummock Grassland	Open hummock grassland of *Triodia basedowii, Triodia schinzii* and *Triodia pungens* with low open woodland of *Corymbia hamersleyana, Hakea lorea* subsp. *lorea* and *Acacia aptaneura* over open shrubland of *Acacia dictyophleba, Acacia sclerosperma* subsp. *sclerosperma* and *Acacia ancistrocarpa* on red sandy loam on floodplains and drainage areas
FP Tp Cc AancAbPl	Triodia Open Hummock Grassland	Open hummock grassland of *Triodia pungens* with open tussock grassland of **Cenchrus ciliaris* with high open shrubland of *Acacia ancistrocarpa, Acacia bivenosa* and *Petalostylis labicheoides* with scattered low trees of *Corymbia hamersleyana* on red clayey sands on drainage areas and floodplains
FP TtDibEua AaExCh	Themeda Tussock Grassland	Tussock Grassland of *Themeda triandra, Digitaria brownii* and *Eulalia aurea* with Open Shrubland of *Acacia aptaneura, Eucalyptus xerothermica* and *Corymbia hamersleyana* on red brown clay loam on unincised drainage lines and floodplains
FP TtEua ExAa AprAtpErlo	Themeda Tussock Grassland	Tussock Grassland of *Themeda triandra* and *Eulalia aurea* with Low Woodland of *Eucalyptus xerothermica* and *Acacia aptaneura* over Open Shrubland of *Acacia pruinocarpa, Acacia tumida* var. *pilbarensis* and *Eremophila longifolia* on red brown clay loam on unincised drainage lines and floodplains
FS Apt AteAsyAr Segl	Acacia Low Woodland	Low Woodland of *Acacia pteraneura* over High Open Shrubland of *Acacia tetragonophylla, Acacia synchronicia* and *Acacia rhodophloia* over Open Shrubland of *Senna glutinosa* subsp. *luerssenii* on brown sandy loam on footslopes and low hills
FS AptAwAs Tb Apt	Acacia High Shrubland	High Shrubland of *Acacia pteraneura, Acacia wanyu* and *Acacia sclerosperma* over Open Hummock Grassland of *Triodia basedowii* with Low Open Woodland of *Acacia pteraneura* on brown sandy clay loam on footslopes
FS AteAsy SeglAsyAte Ercu	Acacia High Open Shrubland	High Open Shrubland of *Acacia tetragonophylla* and *Acacia synchronicia* over Open Shrubland of *Senna glutinosa* subsp. *luerssenii, Acacia synchronicia* and *Acacia tetragonophylla* over Low Open Shrubland of *Eremophila cuneifolia* on brown silty loam on footslopes
FS Aw SeglSes ErcuMati	Acacia High Open Shrubland	High Open Shrubland of *Acacia wanyu* over open shrubland of *Senna glutinosa* subsp. *luerssenii* and *Senna stricta* over Low Open Shrubland of *Eremophila cuneifolia* and *Maireana triptera* on brown silty loams on foot slopes and stony plains
FS AwHallAa ErcuSesm AriEuaErx	Acacia High Open Shrubland	High Open Shrubland of *Acacia wanyu, Hakea lorea* subsp. *lorea* and *Acacia aptaneura* over Low Shrubland of *Eremophila cuneifolia* and *Senna* sp. Meekatharra (E. Bailey 1-26) over Open Tussock Grassland of *Aristida inaequiglumis, Eulalia aurea* and *Eragrostis xerophila* on red sandy loam on foot slopes and stony plains
FS FrsErcu AaAp AsyAte	Frankenia Low Shrubland	Low Shrubland of *Frankenia setosa* and *Eremophila cuneifolia* with Low Open Woodland of *Acacia aptaneura* and *Acacia paraneura* and High Open Shrubland of *Acacia synchronicia* and *Acacia tetragonophylla* on brown silty loam on footslopes
FS Ts AbaApa AbaSeglAw	Triodia Hummock Grassland	Hummock Grassland of *Triodia vanleeuwenii* with Low Open Woodland of *Acacia balsamea* and *Acacia pachyacra* over Open Shrubland of *Acacia balsamea, Senna glutinosa* subsp. *luerssenii* and *Acacia wanyu* on red brown loam on footslopes, low undulating hills and stony plains
FS Ts GrwhAancAb	Triodia Hummock Grassland	Hummock Grassland of *Triodia vanleeuwenii* with Open Shrubland of *Grevillea wickhamii* subsp. *hispidula, Acacia ancistrocarpa* and *Acacia bivenosa* on red brown loam on footslopes, low undulating hills and stony plains
FS TsTpTw Ell AbApaAanc	Triodia Hummock Grassland	Hummock Grassland of *Triodia vanleeuwenii, Triodia pungens* and *Triodia wiseana* with Low Open Woodland of *Eucalyptus leucophloia* subsp. *leucophloia* and Open Shrubland of *Acacia bivenosa, Acacia pachyachra* and *Acacia ancistrocarpa* on red brown loam on footslopes, low undulating hills and stony plains

Vegetation code	Broad floristic formation	Vegetation association description
GG CfEllFib AhDovmAsha CyaErmuThmb	Corymbia Low Woodland	Low Woodland of *Corymbia ferriticola, Eucalyptus leucophloia* subsp. *leucophloia* and *Ficus brachypoda* over Open Shrubland of *Acacia hamersleyensis, Dodonaea viscosa* subsp. *mucronata* and *Astrotricha hamptonii* over Open Tussock Grassland of *Cymbopogon ambiguus, Eriachne mucronata* and *Themeda* sp. Mt Barricade on red brown loam along clifflines and gorge walls
GG Tp EllCf Dop	Triodia Hummock Grassland	Hummock Grassland of *Triodia pungens* with Low Woodland of *Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia ferriticola* over Open Shrubland of *Dodonaea pachyneura* on red brown sandy clay loam in gullies
GP CcCs AaApr AsyAa	*Cenchrus Open Tussock Grassland	Open Tussock Grassland of **Cenchrus ciliaris* and **Cenchrus setiger* with Low Open Woodland of *Acacia aptaneura* and *Acacia pruinocarpa* over High Open Shrubland of *Acacia synchronicia* and *Acacia aptaneura* on red sandy clay loam on gilgai plains
GP ErbEua Seca	Eriachne Open Tussock Grassland	Open tussock grassland of *Eriachne benthamii* and *Eulalia aurea* with scattered low shrubs of *Sesbania cannabina* on red cracking clays on gilgai plains
GR AaGrbAan SesDopeSca TpTs	Acacia Low Open Forest	Low Open Forest of *Acacia aptaneura, Grevillea berryana* and *Acacia aneura* over Shrubland of *Senna stricta, Dodonaea petiolaris* and *Scaevola acacioides* over Open Hummock Grassland of *Triodia pungens* and *Triodia vanleeuwenii* in brown silty loams on ironstone outcrops
HC AwSeaa MagErfo	Acacia Open Shrubland	Open shrubland of *Acacia wanyu* and *Senna artemisioides* subsp. *x artemisioides* over low open shrubland of *Maireana georgei* and *Eremophila forrestii* on red silty loams on hillcrests and upper hillslopes
HC TpTe Aa ErllAteSegl	Triodia Hummock Grassland	Hummock Grassland of *Triodia pungens* or *Triodia epactia* with Low Open Woodland of *Acacia aptaneura* and Open Shrubland of *Eremophila latrobei* subsp. *latrobei, Acacia tetragonophylla* and *Senna glutinosa* subsp. *luerssenii* on brown sandy loam on hillcrests
HC TsTb AprHcGrb SegpPtro	Triodia Hummock Grassland	Hummock Grassland of *Triodia vanleeuwenii* and *Triodia basedowii* with High Open Shrubland of *Acacia pruinocarpa, Hakea chordophylla* and *Grevillea berryana* and Open Shrubland of *Senna glutinosa* subsp. *pruinosa* and *Ptilotus rotundifolius* on brown sandy loam on hillcrests
HC Tw Ah EkkEgCh	Triodia Hummock Grassland	Hummock Grassland of *Triodia wiseana* with Shrubland of *Acacia hamersleyensis* and Open Mallee of *Eucalyptus kingsmillii* subsp. *kingsmillii, Eucalyptus gamophylla* and *Corymbia hamersleyana* (mallee form) on red brown loam and silty loam on hill crests
HP Aa AriEuaDib BbChsiEva	Acacia Low Open Forest	Low Open Forest of *Acacia aptaneura* over Open Tussock Grassland of *Aristida inaequiglumis, Eulalia aurea* and *Digitaria brownii* over Very Open Herbs of **Bidens bipinnata, Cheilanthes sieberi* and *Evolvulus alsinoides* on brown sandy clay loam on hardpan plains
HP AaApa Seah AriArc	Acacia Woodland	Woodland of *Acacia aptaneura* and *Acacia pachyacra* over open shrubland of *Senna artemisioides* subsp. *helmsii* over scattered low tussock grassland of *Aristida inaequiglumis* and *Aristida contorta* on red loamy sand on hardpan plains and sand plains
HP AaAptCdd SeaoErmaErfr Tb	Acacia Low Open Woodland	Low open woodland of *Acacia aptaneura, Acacia pteraneura* and *Corymbia deserticola* subsp. *deserticola* over open shrubland of *Senna artemisioides* subsp. *oligophylla, Eremophila margarethae* and *Eremophila fraseri* over very open hummock grassland of Triodia basedowii on red loamy sand on hardpan plains and sand plains
HP AaChApr DopeErfoSeah TtChfAri	Acacia Low Woodland	Low woodland of *Acacia aptaneura, Corymbia hamersleyana* and *Acacia pruinocarpa* over mid open shrubland of *Dodonaea petiolaris, Eremophila forrestii* and *Senna artemisioides* subsp. *helmsii* over very open tussock grassland of *Themeda triandra, Chrysopogon fallax* and *Aristida inaequiglumis* on red clayey loams on hardpan plains, drainage areas and floodplains
HP AaHallApt ArcAriEnpo SccnSol	Acacia Low Open Woodland	Low Open Woodland of *Acacia aptaneura, Hakea lorea* subsp. *lorea* and *Acacia pteraneura* over Very Open Tussock Grassland of *Aristida contorta, Aristida inaequiglumis* and *Enneapogon polyphyllus* over Scattered Low Shrubs of *Sclerolaena cornishiana* and *Solanum lasiophyllum* on brown sandy loam on hardpan plains
HP AptAa SesmErlnSeah Tb	Acacia Scattered Tall Shrubs	Scattered tall shrubs of *Acacia pteraneura* and *Acacia aptaneura* over scattered shrubs of *Senna* sp. Meekatharra (E. Bailey 1-26), *Eremophila lanceolata* and *Senna artemisioides* subsp. *helmsii* over scattered hummock grassland of *Triodia basedowii* on red clayey loams on hardpan plains
HP ErbChfEua Aa Cocd	Eriachne Open Tussock Grassland	Open tussock grassland of *Eriachne benthamii, Chrysopogon fallax* and *Eulalia aurea* with high open shrubland of *Acacia aptaneura* with scattered low trees of *Corymbia candida* subsp. *dipsodes* on red clayey loam on hardpan plains
HP SeahSeaoErln AptAp AriArcEua	Senna Low Open Shrubland	Low open shrubland of *Senna artemisioides* subsp. *helmsii, Senna artemisioides* subsp. *oligophylla* and *Eremophila lanceolata* with scattered low trees of *Acacia pteraneura* and *Acacia paraneura* over scattered low tussock grassland of *Aristida inaequiglumis, Aristida contorta* and *Eulalia aurea* on red clayey loams on hardpan plains
HS AaApr ErjpAmarCocf TwTp	Acacia Low Woodland	Low Woodland of *Acacia aptaneura* and *Acacia pruinocarpa* over Shrubland of *Eremophila jucunda* subsp. *pulcherrima, Acacia marramamba* and *Codonocarpus cotinifolius* over Open Hummock Grassland of *Triodia wiseana* and *Triodia pungens* on red brown loam on steep hill slopes
HS AaApt SesErcuSegl	Acacia Shrubland	High shrubland of *Acacia aptaneura* and *Acacia pteraneura* over low open shrubland of *Senna* sp. Meekatharra (E. Bailey 1-26), *Eremophila cuneifolia* and *Senna glutinosa* subsp. x *luerssenii* on red sandy loams on hill slopes and undulating low hills
HS AbaAwErfr Ts AaAcao	Acacia High Shrubland	High shrubland of *Acacia balsamea, Acacia wanyu* and *Eremophila fraseri* over open hummock grassland of *Triodia vanleeuwenii* with low scattered trees of *Acacia aptaneura* and *Acacia catenulata* subsp. *occidentalis* on red sandy loams on hill slopes and undulating low hills
HS AmaDopSegl TpTs AmaAaa	Acacia Shrubland	Shrubland of *Acacia maitlandii, Dodonaea pachyneura* and *Senna glutinosa* subsp. *luerssenii* over Open Hummock Grassland of *Triodia pungens* and *Triodia vanleeuwenii* with Low Open Shrubland of *Acacia maitlandii* and *Acacia adoxa* var. *adoxa* in brown silty loams on hill slopes
HS Apt Ecap Ts	Acacia Low Woodland	Low Woodland of *Acacia pteraneura* over Low Shrubland of *Eremophila capricornica* over Open Hummock Grassland of *Triodia vanleeuwenii* in brown sandy loams on undulating low hills
HS ArAsiAte ArEreAsi TsTp	Acacia High Shrubland	High Shrubland of *Acacia rhodophloia, Acacia sibirica* and *Acacia tetragonophylla* over Shrubland of *Acacia rhodophloia, Eremophila exilifolia* and *Acacia sibirica* over Open Hummock Grassland of *Triodia vanleeuwenii* and *Triodia pungens* in brown silty loams on hill slopes
HS Trag SeglErllAb Ell	Triodia Open Hummock Grassland	Open Hummock Grassland of *Triodia angusta* with Open Shrubland of *Senna glutinosa* subsp. x *luerssenii, Eremophila latrobei* subsp. *latrobei* and *Acacia bivenosa* with scattered *Eucalyptus leucophloia* subsp. *leucophloia* on red clayey loam on hill slopes and undulating low hills
HS TbTs Ap ApaErjjErfo	Triodia Open Hummock Grassland	Open Hummock Grassland of *Triodia basedowii* and *Triodia vanleeuwenii* with Low Open Woodland of *Acacia ?paraneura* over scattered shrubs of *Acacia pachyacra, Eremophila ?jucunda* subsp. *jucunda* and *Eremophila forrestii* on red clayey loam on hill slopes and undulating low hills
HS TbTs AsyAaAte ErcuMagSol	Triodia Open Hummock Grassland	Open Hummock Grassland of *Triodia basedowii* and *Triodia vanleeuwenii* with Open Shrubland of *Acacia synchronicia, Acacia aptanerua* and *Acacia tetragonophylla* over Low Open Shrubland of *Eremophila cuneifolia, Maireana georgei* and *Solanum lasiophyllum* on red sandy loam on floodplains and lower hill slopes
HS Te ErfrAte Erfr	Triodia Hummock Grassland	Hummock Grassland of *Triodia epactia* with High Open Shrubland of *Eremophila fraseri* and *Acacia tetragonophylla* and Open Shrubland of *Eremophila fraseri* on brown sandy loam on hillslopes
HS TeTs AbSegp AprChAa	Triodia Hummock Grassland	Hummock Grassland of *Triodia epactia* and *Triodia vanleeuwenii* with Open Shrubland of *Acacia bivenosa* and *Senna glutinosa* subsp. *pruinosa* and Scattered Low Trees of *Acacia pruinocarpa, Corymbia hamersleyana* and *Acacia aptaneura* on brown loamy sand on hillslopes
HS TmeTp AprAcaAmu CyaErmu	Triodia Open Hummock Grassland	Open Hummock Grassland of *Triodia* sp. Mt Ella (M.E. Trudgen 12739) and *Triodia pungens* with Low Open Woodland of *Acacia pruinocarpa, Acacia catenulata* subsp. *occidentalis* and *Acacia mulganeura* over Open Tussock Grassland of *Cymbopogon ambiguus* and *Eriachne mucronata* on red brown loam on steep rocky upper hill slopes
HS Tp AaApr ErfrAmarSegl	Triodia Open Hummock Grassland	Open Hummock Grassland of *Triodia pungens* with Low Open Woodland of *Acacia aptaneura* and *Acacia pruinocarpa* over Open Shrubland of *Eremophila fraseri, Acacia marramamba* and *Senna glutinosa* subsp. x *luerssenii* on red brown loam on undulating hills
HS Tp ApaAsy	Triodia Open Hummock Grassland	Open Hummock Grassland of *Triodia pungens* with Open Shrubland of *Acacia pachyacra* and *Acacia synchronicia* on red brown loam on undulating hills
HS Tp SeggAmaSegp PtoSesErcu	Triodia Hummock Grassland	Hummock Grassland of *Triodia pungens* with Open Shrubland of *Senna glutinosa* subsp. *glutinosa*, *Acacia maitlandii* and *Senna glutinosa* subsp. *pruinosa* and Low Open Shrubland of *Ptilotus obovatus, Senna stricta* and *Eremophila cuneifolia* in brown sandy loams on hill slopes
HS TpTs ArAbAma EllAa	Triodia Hummock Grassland	Hummock Grassland of *Triodia pungens* and *Triodia vanleeuwenii* with Open Shrubland of *Acacia rhodophloia, Acacia bivenosa* and *Acacia maitlandii* with scattered *Eucalyptus leucophloia* subsp. *leucophloia* and *Acacia aptaneura* on brown sandy loams on hill slopes

Vegetation code	Broad floristic formation	Vegetation association description
HS TpTs EllAaHc Grwh	Triodia Hummock Grassland	Hummock Grassland of *Triodia pungens* and *Triodia vanleeuwenii* with Low Open Woodland of *Eucalyptus leucophloia* subsp. *leucophloia, Acacia aptaneura* and *Hakea chordophylla* over High Open Shrubland of *Grevillea wickhamii* subsp. *hispidula* in brown sandy loams on hill slopes
HS Ts AprGrwhHall AhiCacaEre	Triodia Hummock Grassland	Hummock Grassland of *Triodia vanleeuwenii* with high open shrubland of *Acacia pruinocarpa, Grevillea wickhamii* subsp. *hispidula* and *Hakea lorea* subsp. *lorea* over low open shrubland of *Acacia hilliana, Calytrix carinata* and *Eremophila exilifolia* on red sandy loam on hill slopes and undulating low hills
HS Ts AptAcaoApr AwSeglSegp	Triodia Hummock Grassland	Hummock Grassland of *Triodia vanleeuwenii* with low open woodland of *Acacia pteraneura, Acacia catenulata* subsp. *occidentalis* and *Acacia pruinocarpa* over open shrubland of *Acacia wanyu, Senna glutinosa* subsp. *luerssenii* and *Senna glutinosa* subsp. *pruinosa* on red loamy sands on hill slopes and undulating low hills
HS Ts GrwhAancAmar SeahSeglPtro	Triodia Hummock Grassland	Hummock Grassland of *Triodia vanleeuwenii* with High Open Shrubland of *Grevillea wickhamii* subsp. *hispidula, Acacia ancistrocarpa* and *Acacia marramamba* over Open Shrubland of *Senna artemisioides* subsp. *helmsii, Senna glutinosa* subsp. *luerssenii* and *Ptilotus rotundifolius* on red sandy loams on hill slopes and undulating low hills
HS TsTragTp AwAsyAte Ercu	Triodia Hummock Grassland	Hummock Grassland of *Triodia vanleeuwenii, Triodia angusta* and *Triodia pungens* with Open Shrubland of *Acacia wanyu, Acacia synchronicia* and *Acacia tetragonophylla* over Low Open Shrubland of *Eremophila cuneifolia* on red loamy sands
HS TsTb AptCh AsiAw	Triodia Open Hummock Grassland	Open Hummock Grassland of *Triodia vanleeuwenii* and *Triodia basedowii* with Low Open Woodland of *Acacia pteraneura* and *Corymbia hamersleyana* over Open Shrubland of *Acacia sibirica* and *Acacia wanyu* on red loamy sands
HS TsTbr AwAb Segl	Triodia Hummock Grassland	Hummock Grassland of *Triodia vanleeuwenii* and *Triodia brizoides* with Open Shrubland of *Acacia wanyu* and *Acacia bivenosa* over Low Open Shrubland of *Senna glutinosa* subsp. *luerssenii* on red loamy sand on upper hill slopes
HS TsTp AaAprAci AaErllSegl	Triodia Hummock Grassland	Hummock Grassland of *Triodia vanleeuwenii* and *Triodia pungens* with High Open Shrubland of *Acacia aptaneura, Acacia pruinocarpa* and *Acacia citrinoviridis* and Open Shrubland of *Acacia aptaneura, Eremophila latrobei* subsp. *latrobei* and *Senna glutinosa* subsp. x *luerssenii* on red loamy sand on upper hill slopes
HS TsTp AhiAaa EllCh	Triodia Hummock Grassland	Hummock Grassland of *Triodia vanleeuwenii* and *Triodia pungens* with Open High Shrubland of *Acacia hilliana* and *Acacia adoxa var. adoxa* and scattered *Eucalyptus leucophloia* subsp. *leucophloia* and *Corymbia hamersleyana* on red sandy loam on hill slopes
HS TsTpTb AaAprAw AteEreErll	Triodia Open Hummock Grassland	Open Hummock Grassland of *Triodia vanleeuwenii, Triodia pungens* and *Triodia basedowii* with Low Open Woodland of *Acacia aptaneura, Acacia pruinocarpa* and *Acacia wanyu* and Open Shrubland of *Acacia tetragonophylla, Eremophila exilifolia* and *Eremophila latrobei* subsp. *latrobei* on red sandy loam on hill slopes
MA AciAcp CocrTefc Cc	Acacia Low Open Forest	Low Open Forest of *Acacia citrinoviridis* and *Acacia coriacea* subsp. *pendens* over Open Shrubland of *Corchorus crozophorifolius* and *Tephrosia rosea* var. Fortescue creeks (M.I.H. Brooker 2186) over Tussock Grassland of **Cenchrus ciliaris* on brown clay loam on banks of major drainage lines
MA AciAcp Mg CcTtEua	Acacia Low Open Forest	Low Open Forest of *Acacia citrinoviridis* and *Acacia coriacea* subsp. *pendens* over Open Shrubland of *Melaleuca glomerata* and *Corchorus crozophorifolius* over Tussock Grassland of **Cenchrus ciliaris, Themeda triandra* and *Eulalia aurea* on brown clay loam on banks of major drainage lines
MA EcrEv AciApypMg CcEuaTt	Eucalyptus Open Woodland	Open Woodland of *Eucalyptus camaldulensis* subsp. *refulgens* and *Eucalyptus victrix* over High Open Shrubland of *Acacia citrinoviridis, Acacia pyrifolia* var. *pyrifolia* and *Melaleuca glomerata* over Tussock Grassland of **Cenchrus ciliaris, Eulalia aurea* and *Themeda triandra* on brown clay loam on banks of major drainage lines
ME AaHall ErfrAteAsy AriTtDib	Acacia Low Open Forest	Low Open Forest of *Acacia aptaneura* and *Hakea lorea* subsp. *lorea* over High Open Shrubland of *Eremophila fraseri, Acacia tetragonophylla* and *Acacia synchronicia* over Open Tussock Grassland of *Aristida inaequiglumis, Themeda triandra* and *Digitaria brownii* on brown loamy sand on medium drainage lines
ME Tp AancAte ExCaCh	Triodia Hummock Grassland	Hummock Grassland of Triodia pungens with High Shrubland of *Acacia ancistrocarpa* and *Acacia tenuissima* with Low Open Woodland of *Eucalyptus xerothermica, Corymbia aspera* and *Corymbia hamersleyana* on clay loam on medium drainage lines
ME TtEuaEte ApypAtpPl EvCh	Themeda Tussock Grassland	Tussock Grassland of *Themeda triandra, Eulalia aurea* and *Eriachne tenuiculmis* with High Shrubland of Acacia *pyrifolia* var. *pyrifolia, Acacia tumida* var. *pilbarensis* and *Petalostylis labicheoides* and Open Woodland of *Eucalyptus victrix* and *Corymbia hamersleyana* on red brown silty loam on medium drainage lines and flood plains
MI AaApEll AwAteAb TpTs	Acacia Low Open Forest	Low Open Forest of *Acacia aptaneura, Acacia paraneura* and *Eucalyptus leucophloia* subsp. *leucophloia* over Open Scrub of *Acacia wanyu, Acacia tetragonophylla* and *Acacia bivenosa* over Open Hummock Grassland of *Triodia pungens* and *Triodia vanleeuwenii* on brown loam on minor drainage lines through undulating ironstone ridges, hills and valleys
MI AerAancAnl TtEuaErmu Aa	Acacia High Shrubland	High Shrubland of *Acacia eriopoda, Acacia ancistrocarpa* and *Androcalva luteiflora* with Open Tussock Grassland of *Themeda triandra, Eulalia aurea* and *Eriachne mucronata* with Low Open Woodland of *Acacia aptaneura* on brown sand on minor drainage lines
MI AmGrwhPl Ch Tp	Acacia Open Shrubland	Open Shrubland of *Acacia monticola, Grevillea wickhamii* subsp. *hispidula* and *Petalostylis labicheoides* with Low Open Woodland of *Corymbia hamersleyana* over Open Hummock Grassland of *Triodia pungens* in minor drainage lines
MI AptAprEx AwAseAte TsTp	Acacia Low Open Woodland	Low open woodland of *Acacia pteraneura, Acacia pruinocarpa* and *Eucalyptus xerothermica* over high shrubland of *Acacia wanyu, Acacia sericophylla* and *Acacia tetragonophylla* over open hummock grassland of *Triodia vanleeuwenii* and *Triodia pungens* on red silty clay loams on minor drainage lines, drainage areas and floodplains
MI AtpPlAm TpTs ChEll	Acacia High Shrubland	High Shrubland of *Acacia tumida* var. *pilbarensis, Petalostylis labicheoides* and *Grevillea wickhamii* over Open Tussock Grassland of *Cymbopogon ambiguus, Eriachne tenuiculmis* and *Themeda triandra* with Low Open Woodland of *Corymbia hamersleyana* in minor drainage lines and gorges
MI AwAnlAma AwSeglAma Tp	Acacia Open Scrub	Open Scrub of *Acacia wanyu, Androcalva luteiflora* and *Acacia maitlandii* over Shrubland of *Acacia wanyu, Senna glutinosa* subsp. *luerssenii* and *Acacia maitlandii* over Open Hummock Grassland of *Triodia pungens* in brown loamy sands on minor drainage lines
Mosaic of HP Aa AriEuaDib BbChsiEva & HP AaHallApt ArcAriEnpo SccnSol	Mosaic of Acacia Low Open Forest and Acacia Low Open Woodland	Mosaic of Low Open Forest of *Acacia aptaneura* over Open Tussock Grassland of *Aristida inaequiglumis, Eulalia aurea* and *Digitaria brownii* over Very Open Herbs of **Bidens bipinnata, Cheilanthes sieberi* and *Evolvulus alsinoides* on brown sandy clay loam on hardpan plains and Low Open Woodland of *Acacia aptaneura, Hakea lorea* subsp. *lorea* and *Acacia pteraneura* over Very Open Tussock Grassland of *Aristida contorta, Aristida inaequiglumis* and *Enneapogon polyphyllus* over Scattered Low Shrubs of *Sclerolaena cornishiana* and *Solanum lasiophyllum* on brown sandy loam on hardpan plains
Mosaic of SP AcaoAptApr DopeSieErll PslAtet & SP AptAcaoAa ErlApt PtscPtrPto	Mosaic of Acacia Low Open Forest and Acacia Scattered Low Trees	Mosaic of Low Open Forest of *Acacia catenulata* subsp. *occidentalis*, *Acacia pteraneura* and *Acacia pruinocarpa* over Shrubland of *Dodonaea petiolaris, Sida ectogama* and *Eremophila latrobei* subsp. *latrobei* with High Open Shrubland of *Psydrax latifolia* and *Acacia tetragonophylla* in brown silty clay loams on stony plains and Scattered Low Trees of *Acacia pteraneura, Acacia catenulata* subsp. *occidentalis* and *Acacia aptaneura* over Scattered High Shrubs of *Eremophila latrobei* subsp. *latrobei* and *Acacia pteraneura* over Scattered Low Shrubs of *Ptilotus schwartzii, Ptilotus roei* and *Ptilotus obovatus* in brown silty clay loams on stony plains
SA Aa Tsc ErffSeao	Acacia Low Woodland	Low Woodland of *Acacia aptaneura* over Open Hummock Grassland of *Triodia schinzii* with Open Shrubland of *Eremophila forrestii* subsp. *forrestii* and *Senna artemisioides* subsp. *oligophylla* on sandy plains and lower slopes
SA AaAprHall Tb Erff	Acacia Low Woodland	Low Woodland of *Acacia aptaneura, Acacia pruinocarpa* and *Hakea lorea* subsp. *lorea* over Open Hummock Grassland of *Triodia basedowii* with Open Shrubland of *Eremophila forrestii* subsp. *forrestii* on brown loamy sand on plains
SA AancAb Tb ChHall	Acacia Open Scrub	Open Scrub of *Acacia ancistrocarpa* and *Acacia bivenosa* over Open Hummock Grassland of *Triodia basedowii* with Low Open Woodland of *Corymbia hamersleyana* and *Hakea lorea* subsp. *lorea* in red sands on sandplains
SA AptAwAss Tb Apt	Acacia High Shrubland	High Shrubland of *Acacia pteraneura, Acacia wanyu* and *Acacia sclerosperma* subsp. *sclerosperma* over Open Hummock Grassland of *Triodia basedowii* with Scattered Low Trees of *Acacia pteraneura* on brown sandy clay loam on sand plains and floodplains
SA AssAteAw Apt SegfSeaoSeah	Acacia High Open Shrubland	High Open Shrubland of *Acacia sclerosperma* subsp. *sclerosperma, Acacia tetragonophylla* and *Acacia wanyu* with Scattered Low Trees of *Acacia pteraneura* over Low Open Shrubland *Senna glaucifolia, Senna artemisioides* subsp. *oligophylla* and *Senna artemisioides* subsp. *helmsii* on sandy plains and hardpan plains

Vegetation code	Broad floristic formation	Vegetation association description
SA Tb AaHall ErfrSesmErcap	Triodia Open Hummock Grassland	Open Hummock Grassland of *Triodia basedowii* with High Open Shrubland of *Acacia aptaneura* and *Hakea lorea* subsp. *lorea* over Open Shrubland of *Eremophila fraseri, Senna* sp. Meekatharra (E. Bailey 1-26) and *Eremophila ?capricornica* on red loamy sand on sandy/ stony plains
SA Tb AancAw Ch	Triodia Hummock Grassland	Hummock Grassland (to Open Hummock Grassland) of *Triodia basedowii* with Open Shrubland of *Acacia ancistrocarpa* and *Acacia wanyu* with Low Scattered *Corymbia hamersleyana* on brown loamy sand on sand plains
SA Tb Apt AriArhhTrl	Triodia Hummock Grassland	Hummock Grassland of *Triodia basedowii* with Low Open Woodland of *Acacia pteraneura* over Very Open Tussock Grassland of *Aristida inaequiglumis, Aristida holathera* var. *holathera* and *Tripogonella loliiformis* on brown loamy sand on sand plains
SA Tb AscAsy AptHallApr	Triodia Hummock Grassland	Hummock Grassland of *Triodia basedowii* with High Shrubland of *Acacia sclerosperma* and *Acacia synchronicia* and Low Open Woodland of *Acacia pteraneura, Hakea lorea* subsp. *lorea* and *Acacia pruinocarpa* in orange sands on sandplains
SA Tb ChEg ScpBeKep	Triodia Hummock Grassland	Hummock Grassland of *Triodia basedowii* with Low Open Woodland of *Corymbia hamersleyana* and *Eucalyptus gamophylla* over Low Open Shrubland of *Scaevola parvifolia, Bonamia erecta* and *Kennedia prorepens* on red loamy sand on sand plains
SA Tb ChHllAa ApacAanc	Triodia Hummock Grassland	Hummock Grassland of *Triodia basedowii* with Low Open Woodland of *Corymbia hamersleyana, Hakea lorea* subsp. *lorea* and *Acacia pruinocarpa* with High Open Shrubland of *Acacia ancistrocarpa* on orange brown sand on sand plains
SA TpTb Eg AkAs	Triodia Hummock Grassland	Hummock Grassland of *Triodia pungens* and *Triodia basedowii* with Open Mallee of *Eucalyptus gamophylla* and High Shrubland of *Acacia kempeana* and *Acacia sclerosperma* on red loamy sand on sand plains and drainage areas
SA Tsc HlApaAd SicaDicScp	Triodia Hummock Grassland	Hummock Grassland of *Triodia schinzii* with Open Shrubland of *Hakea lorea* subsp. *lorea, Acacia pachyacra* and *Acacia dictyophleba* over Low Open Shrubland of *Sida cardiophylla, Dicrastylis cordifolia* and *Scaevola parvifolia* on red loamy sand on sandy plains
SP AaApr ErcuColpSop TpTw	Acacia Low Open Forest	Low Open Forest of *Acacia aptaneura* and *Acacia pruinocarpa* over with Low Open Shrubland of *Eremophila cuneifolia, Corchorus lasiocarpus* subsp. *parvus* and *Solanum phlomoides* over Hummock Grassland of *Triodia pungens* and *Triodia wiseana* on red brown clay loam on stony plains
SP AaAteSeah AriTrlErer Aa	Acacia Open Shrubland	Open Shrubland of *Acacia aptaneura, Acacia tetragonophylla* and *Senna artemisioides* subsp. *helmsii* over Very Open Tussock Grassland of *Aristida inaequiglumis, Tripogon loliformis* and *Eragrostis eriopoda* with Scattered Low Trees of *Acacia aptaneura* on brown loamy sand on stony plains
SP AcaoAa ArobDiaChf	Acacia Low Open Forest	Low Open Forest of *Acacia catenulata* subsp. *occidentalis* and *Acacia aptaneura* over Very Open Tussock Grassland of *Aristida obscura, Digitaria ammophila* and *Chrysopogon fallax* on red brown silty clay loam on stony plains
SP AcaoAptApr DopeSieErll PslAtet	Acacia Low Open Forest	Low Open Forest of *Acacia catenulata* subsp. *occidentalis, Acacia pteraneura* and *Acacia pruinocarpa* over Shrubland of *Dodonaea petiolaris, Sida ectogama* and *Eremophila latrobei* subsp. *latrobei* with High Open Shrubland of *Psydrax latifolia* and *Acacia tetragonophylla* in brown silty clay loams on stony plains
SP ArAa SeahErff ArcArhh	Acacia Low Open Forest	Low Open Forest of *Acacia rhodophloia* and *Acacia aptaneura* over Low Open Shrubland of *Senna artemisioides* subsp. *helmsii* and *Eremophila forrestii* subsp. *forrestii* over Open Tussock Grassland of *Aristida contorta* and *Aristida holathera* var. *holathera* on brown loam on stony plains
SP AsyAte SeahSeaoSegl SccnScctSol	Acacia High Open Shrubland	High Open Shrubland of *Acacia synchronicia* and *Acacia tetragonophylla* over Open Shrubland of *Senna artemisioides* subsp. *helmsii, Senna artemisioides* subsp. *oligophylla* and *Senna glutinosa* subsp. *luerssenii* and Low Open Shrubland of *Sclerolaena cornishiana, Sclerolaena cuneata* and *Solanum lasiophyllum* on brown loam on stony plains
SP Aw ErcuSesmMag Apt	Acacia High Open Shrubland	High Open Shrubland of *Acacia wanyu* over Low Open Shrubland of *Eremophila cuneifolia*, *Senna* sp. Meekatharra (E. Bailey 1-26) and *Maireana triptera* with scattered low trees of *Acacia pteraneura* on red clayey loams on stony plains and drainage areas
SP ChEoCd AancApaAads TbTscTs	Corymbia Low Open Woodland	Low Open Woodland of *Corymbia hamersleyana, Eucalyptus odontocarpa* and *Corymbia deserticola* subsp. *deserticola* over Open Shrubland of *Acacia ancistrocarpa, Acacia pachyacra* and *Acacia adsurgens* over Open Hummock Grassland of *Triodia basedowii, Triodia schinzii* and *Triodia vanleeuwenii* on red brown sandy loam on footslopes and stony plains
SP DyrTrhPta	Dysphania Herbs	Herbs of *Dysphania rhadinostachya, Tribulus hirsutus* and *Ptilotus aervoides* on brown clay on undulating stony plains
SP ErfrAte SeahErfr ArcCyaTrl	Eremophila High Open Shrubland	High Open Shrubland of *Eremophila fraseri* and *Acacia tetragonophylla* over Open Shrubland of *Senna artemisioides* subsp. *helmsii* and *Eremophila fraseri* over Very Open Tussock Grassland of *Aristida contorta*, *Cymbopogon ambiguus* and *Tripogonella loliiformis* on brown silty loam on stony plains
SP Frs HapAsy ArcEnra	Frankenia Low Shrubland	Low Shrubland of *Frankenia setosa* with Scattered Tall Shrubs of *Hakea preissii* and *Acacia synchronicia* over Very Open Tussock Grassland of *Aristida contorta* and *Enteropogon ramosus* on orange brown loamy sand on stony plains
SP MatiErcuSesm ScctScdePth AsyAte	Maireana Low Shrubland	Low Shrubland of *Maireana triptera, Eremophila cuneifolia* and *Senna* sp. Meekatharra (E. Bailey 1-26) over Very Open Herbs of *Sclerolaena cuneata, Sclerolaena densiflora* and *Ptilotus helipteroides* with Scattered Tall Shrubs of *Acacia synchronicia* and *Acacia tetragonophylla* on brown sandy loam on stony plains
SP Tb AbAprAads	Triodia Hummock Grassland	Hummock Grassland of *Triodia basedowii* with Shrubland of *Acacia bivenosa, Acacia pruinocarpa* and *Acacia adsurgens* on red loamy sand on stony plains
SP Tb AptApr ErffSeahAanc	Triodia Hummock Grassland	Hummock Grassland of *Triodia basedowii* with Low Open Woodland of *Acacia pteraneura* and *Acacia pruinocarpa* and Open Shrubland of *Eremophila forrestii* subsp. *forrestii, Senna artemisioides* subsp. *helmsii* and *Acacia ancistrocarpa* in brown loamy sands on sandy / stony plains
SP TbTp HallAancAa Ch	Triodia Hummock Grassland	Hummock Grassland of *Triodia basedowii* and *Triodia pungens* with High Open Shrubland of *Hakea lorea* subsp. *lorea, Acacia ancistrocarpa* and *Acacia aptaneura* with Scattered Low Trees of *Corymbia hamersleyana* on red brown loamy sand on stony plains
SP TbTs AptApr AwErfoSeah	Triodia Hummock Grassland	Hummock Grassland of *Triodia basedowii* and *Triodia vanleeuwenii* with Low Open Woodland of *Acacia pteraneura* and *Acacia pruinocarpa* over Open Shrubland of *Acacia wanyu, Eremophila forrestii* and *Senna artemisioides* subsp. *helmsii* on brown loamy sands on sandy / stony plains and minor drainage lines
SP TbTs AptChApr ApaAdAanc	Triodia Open Hummock Grassland	Open hummock grassland of *Triodia basedowii* and *Triodia vanleeuwenii* over low open woodland of *Acacia pteraneura*, *Corymbia hamersleyana* and *Acacia pruinocarpa* over high open shrubland of *Acacia pachyacra, Acacia dictyophleba* and *Acacia ancistrocarpa* on red sandy loams on sandy / stony plains
SP TpTwTs ErfrSegpSeao	Triodia Hummock Grassland	Hummock Grassland of *Triodia pungens, Triodia wiseana* and *Triodia vanleeuwenii* with Open Shrubland of *Eremophila fraseri, Senna glutinosa* subsp. *pruinosa* and *Senna artemisioides* subsp. *oligophylla* on red brown loamy sand on stony plains and hill slopes
SP TsTbTp AcaoGrbApt ErfoSeglErll	Triodia Open Hummock Grassland	Open Hummock Grassland of *Triodia vanleeuwenii, Triodia basedowii* and *Triodia pungens* with low open woodland of *Acacia catenulata* subsp. *occidentalis*, *Grevillea berryana* and *Acacia pteraneura* over open shrubland of *Eremophila forrestii, Senna glutinosa* subsp. *luerssenii* and *Eremophila latrobei* subsp. *latrobei* on red silty loams on stony plains, hill slopes and undulating low hills



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Map 5-5 Jimblebar Hub significant ecosystems

5.8.3 Flora of conservation significance

No plant taxa gazetted as Threatened Flora under the *Biodiversity Conservation Act 2016* (BC Act) or listed under the federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) have been recorded in the Jimblebar Hub area or are likely to occur based on available habitat (Onshore Environmental, 2015a; BHP, 2023a).

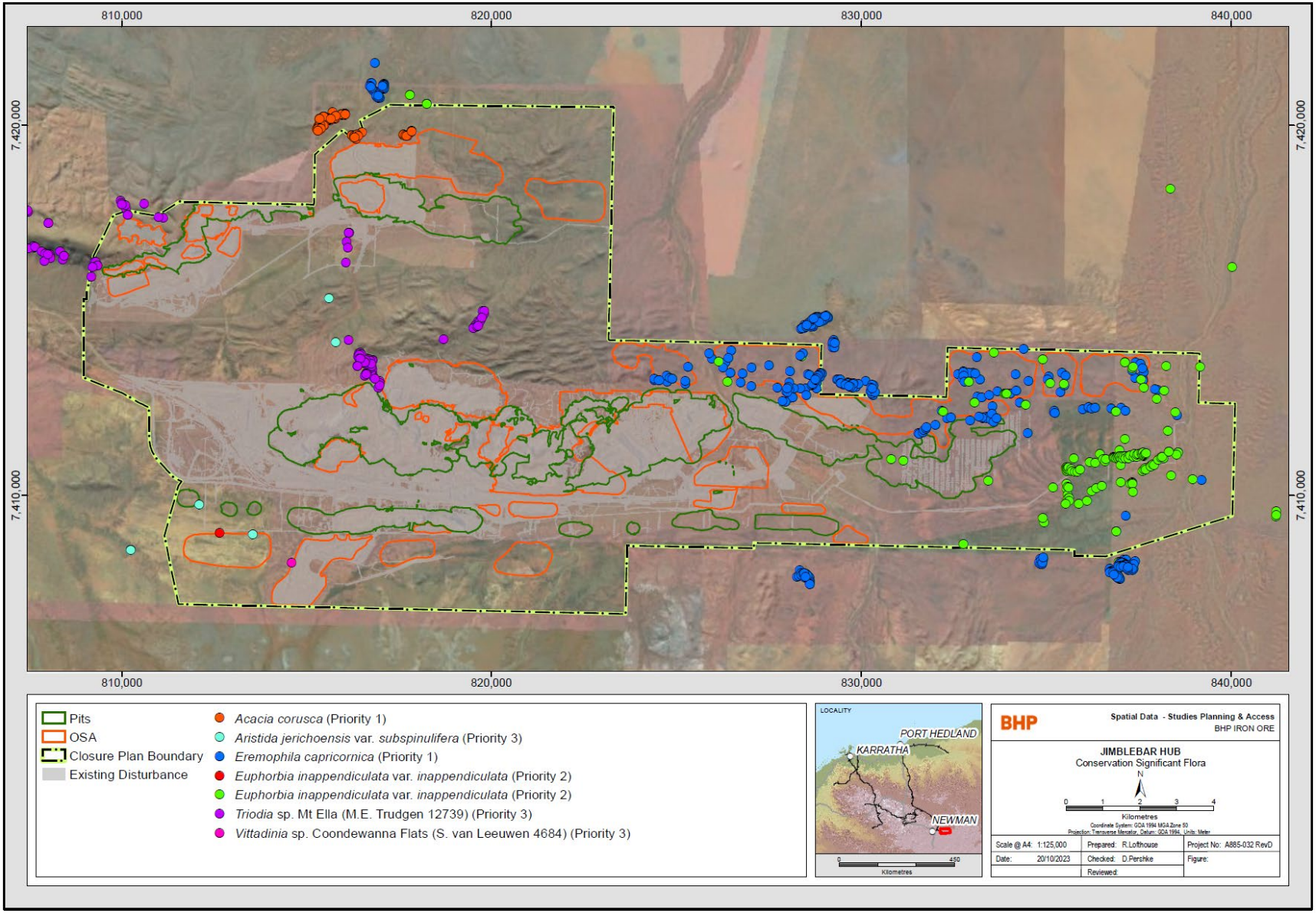
Seven priority flora species listed by DBCA have been recorded within the Jimblebar Hub area (Map 5-6) and are listed in Table 5-54 in order of Priority ranking. One species previously listed as Priority 4 (*Goodenia nuda*) was delisted in 2022 (DBCA, 2022). One species, *Acacia clelandii,* was recorded by Onshore Environmental (2015a) as a range extension.

Table 5-54 Priority Flora species recorded within Jimblebar Hub

Scientific Name	Priority Status [1]
Acacia corusca	P1
Eremophila capricornica	P1
Euphorbia inappendiculata var. inappendiculata	P2
Aristida jerichoensis var. subspinulifera	P3
Rhagodia sp. Hamersley (M. Trudgen 17794)	P3
Triodia sp. Mt Ella (M.E. Trudgen 12739)	P3
Vittadinia sp. Coondewanna Flats (S. van Leeuwen 4684)	P3

[1] DBCA (2022)

Source: Onshore Environmental (2015a); BHP (2023a)



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Map 5-6 Jimblebar Hub conservation significant flora species locations

5.8.4 Weeds and Declared Plants

No ‘declared plants’ listed under the *Biosecurity and Agriculture Management Act* 2007 (WA) (BAM Act) (DPIRD, 2023) or on the DBCA Pilbara Region Priority Alert list (DBCA, 2019a) have been recorded within Jimblebar Hub.

However, 27 introduced species have been recorded (Table 5-55 and Map 5-7) (ENV Australia, 2007a; Onshore Environmental, 2015a; Astron, 2017; Ecologia, 1995; BHP, 2023e; 2023a). Several of the weed species present, are rated as high risk in terms of potential invasiveness and environmental impacts (DBCA, 2019a).

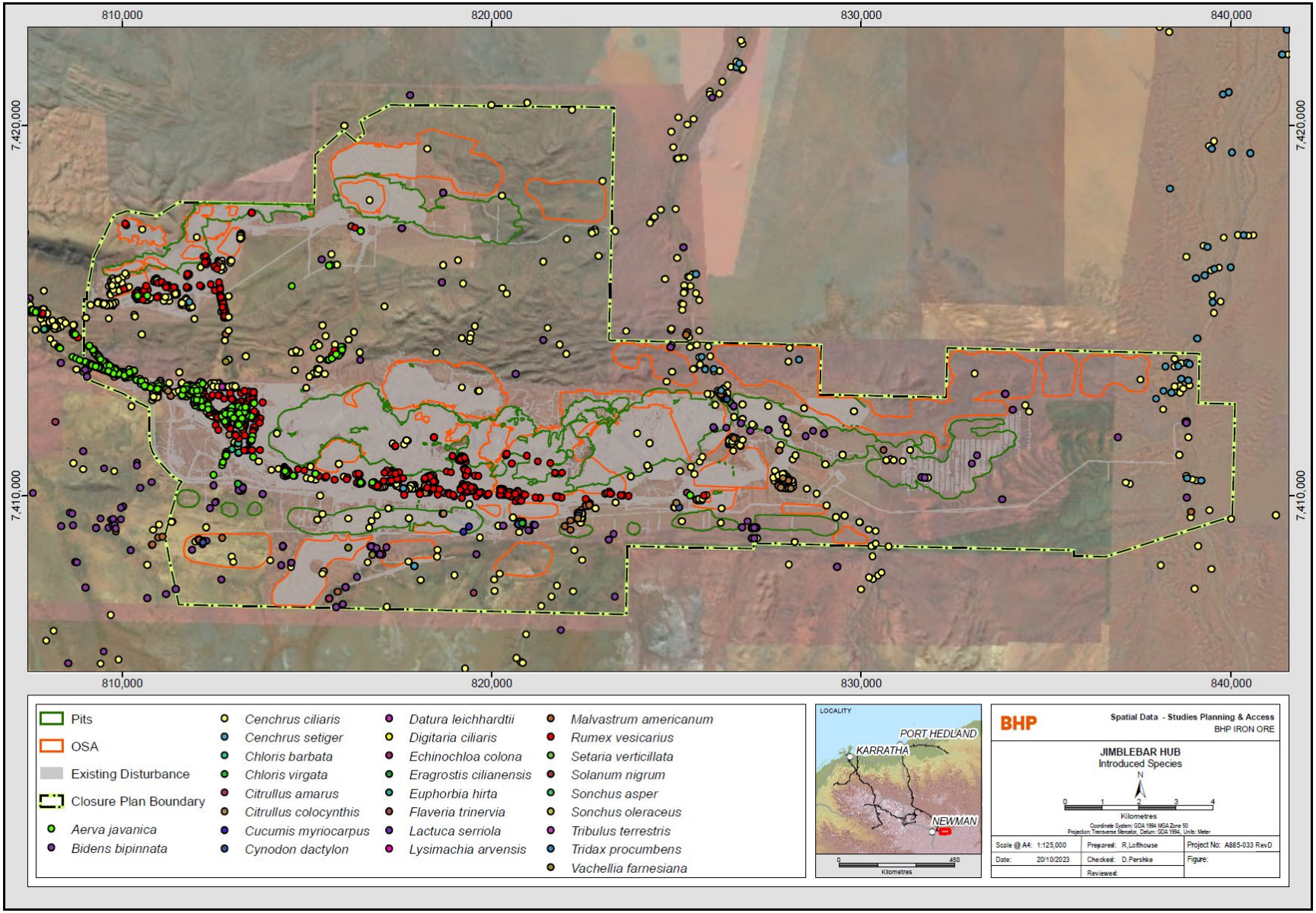
Generally, ‘weed risk’ areas are associated with drainage lines, floodplains or existing disturbance and infrastructure areas (ENV Australia, 2007a; BHP, 2023a). Buffel grass (*Cenchrus ciliaris*) is the most frequently recorded weed species at Jimblebar.

Table 5-55 Introduced flora species recorded at Jimblebar Hub

Scientific Name	Common Name	Ecological Impact	Invasiveness	Comment
**Aerva javanica*	Kapok bush	High	Rapid	A common weed in the Pilbara rangelands, preferring deeper soils and disturbance. Permitted under S 11 of the BAM Act (DPIRD, 2023).
**Bidens bipinnata*	Bipinnate Beggartick	Unknown	Rapid	Commonly observed in association with Mulga vegetation and creek lines in the Pilbara. Permitted under S 11 of the BAM Act (DPIRD, 2023).
**Cenchrus ciliaris*	Buffel Grass	High	Rapid	Common at Jimblebar, along drainage lines, Jimblebar Creek and its tributaries. Widespread in the Pilbara. Permitted under S 11 of the BAM Act (DPIRD, 2023).
**Cenchrus setiger*	Birdwood grass	High	Rapid	Is closely related to Buffel grass, also introduced as a fodder species and grows in similar habitats. Permitted under S 11 of the BAM Act (DPIRD, 2023).
**Chloris barbata*	Purpletop chloris	High	Rapid	Short lived grass that grows rapidly in wet conditions. One occurrence along the Jimblebar rail line. Permitted under S 11 of the BAM Act (DPIRD, 2023).
**Chloris virgata*	Feathertop	High	Rapid	Annual grass preferring clay or sandy soils. Responds rapidly to rainfall events. Recorded in two locations in the Jimblebar closure planning area, in close proximity to the rail line. Permitted under S 11 of the BAM Act (DPIRD, 2023).
**Citrullus amarus*	Wild melon	Unknown	Moderate	Previously classified as *Citrullus lanatus.* Permitted under S 11 of the BAM Act (DPIRD, 2023).
**Citrullus colocynthis*	Milk thistle	Unknown	Moderate	Trailing perennial, herb or climber of disturbed areas and floodplains. Permitted under S 11 of the BAM Act (DPIRD, 2023).
**Cucumis myriocarpus*	Prickly Paddy Melon	Low	Rapid	Widespread in rangelands and natural communities. Prefers disturbed areas with summer moisture. Permitted under S 11 of the BAM Act (DPIRD, 2023).
**Cynodon dactylon*	Couch	High	Rapid	Recorded in a creek line within the Jimblebar closure planning area. Permitted under S 11 of the BAM Act (DPIRD, 2023).
**Datura leichhardtii*	Native thornapple	Unknown	Unknown	Native to the Mediterranean, this species is very hardy and persists in arid conditions. Permitted under S 11 of the BAM Act (DPIRD, 2023).
**Digitaria ciliaris*	Summer grass	Low	Slow	Decumbent, tufted annual, grass-like or herb, 0.02 - 1 m high. Permitted under S 11 of the BAM Act (DPIRD, 2023).
**Echinochloa colona*	Awnless barnyard grass	High	Rapid	Tufted annual grass. Widespread throughout the Pilbara near watercourses and swamps. Permitted under S 11 of the BAM Act (DPIRD, 2023).
**Eragrostis cilianensis*	Stinkgrass	Not listed	Not listed	Robust annual grass-like or herb widely naturalised throughout much of Australia. Permitted under S 11 of the BAM Act (DPIRD, 2023).
**Euphorbia hirta*	Asthma Plant	Low	Slow	Annual herb found in alluvial soils and often along watercourses. Permitted under S 11 of the BAM Act (DPIRD, 2023).
**Flaveria trinervia*	Speedy weed	Not listed	Not listed	An annual daisy common in the Pilbara and occurs in drainage and disturbed areas. Permitted under S 11 of the BAM Act (DPIRD, 2023).
**Lactuca serriola*	Prickly lettuce	Not listed	Not listed	Colonises a range of disturbed habitats including wetlands. Permitted under S 11 of the BAM Act (DPIRD, 2023).
**Lysimachia arvensis*	Scarlet Pimpernel	Not listed	Not listed	Low-growing annual plant with brightly coloured flowers. Permitted under S 11 of the BAM Act (DPIRD, 2023).

Scientific Name	Common Name	Ecological Impact	Invasiveness	Comment
**Malvastrum americanum*	Spiked malvastrum	High	Rapid	Typically occurs in Mulga vegetation, drainage areas and floodplains and can also be recorded on steep hill slopes and rock piles. Permitted under S 11 of the BAM Act (DPIRD, 2023).
**Rumex vesicarius*	Ruby dock	High	Rapid	Common within disturbed areas in the arid zone. Permitted under S 11 of the BAM Act (DPIRD, 2023).
**Setaria verticillata*	Whorled pigeon grass	High	Rapid	Loosely tufted annual, grass-like or herb. Permitted under S 11 of the BAM Act (DPIRD, 2023).
**Solanum nigrum*	Blackberry nightshade	Low	Rapid	Short lived perennial herb typically occurs in Mulga vegetation, drainage lines and on floodplains. Permitted under S 11 of the BAM Act (DPIRD, 2023).
**Sonchus asper*	Spiny sowthistle	Not listed	Not listed	An erect robust, spiny annual or biennial herb. This species favours dunes, valleys, seasonally wet areas, watercourses, lakes, wetlands and disturbed sites. Permitted under S 11 of the BAM Act (DPIRD, 2023).
**Sonchus oleraceus*	Common sowthistle	Low	Rapid	Common and widespread in disturbed areas. Permitted under S 11 of the BAM Act (DPIRD, 2023).
**Tribulus terrestris*	Caltrop	Unknown	Moderate	Found widely throughout WA. Grows rapidly and produces sharp, spiny burrs with up to 20,000 seeds produced on each plant that can remain dormant for up to 5 years. Permitted under S 11 of the BAM Act (DPIRD, 2023).
**Tridax procumbens*	Tridax daisy	Not listed	Not listed	Prostrate to erect perennial herb, white and yellow flowers. Weed of wet and disturbed ground. Permitted under S 11 of the BAM Act (DPIRD, 2023).
**Vachellia farnesiana*	Mimosa bush	High	Rapid	Thicket forming thorny shrub isolated occurring along drainage systems and in adjacent low-lying areas. Permitted under S 11 of the BAM Act (DPIRD, 2023).

Source: Biologic (2019b); Ecologia (1995); ENV Australia (2007a); Onshore Environmental (2015a; 2019); Astron (2017); DBCA (2019a); DPIRD (2023); BHP (2023a)



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Map 5-7 Weed species locations

5.8.5 Groundwater dependent vegetation

Vegetation mapping across the Jimblebar hub and immediate surrounds has not identified any groundwater dependent vegetation (i.e., associations containing obligate phreatophyte species). The pre-mining regional water table is more than 25 m (and generally greater than 50 m) below the ground surface at the Jimblebar Hub, and is considered too deep for root systems of groundwater dependent vegetation, including Eucalyptus species to access[20] (BHP, 2023a). However, in the south and southeast corner of the OB31 project area, depth to groundwater was between 5 to 25 metres below ground level (mbgl) and a small area of facultative vegetation[21] was identified in the form of *Eucalyptus victrix*. This area of vegetation was associated with the Orebody 31 Creek line that discharges to Jimblebar Creek and was identified in the 2015 Orebody 31 Iron Ore Mine Project Environmental Referral Document (BHPBIO, 2015) as being potentially impacted by mining operations. Approval for the Orebody 31 Iron Ore Mine Project was granted via MS 1021.

Vegetation associations dominated by the facultative phreatophyte, tree species *Eucalyptus victrix* and *E. camaldulensis*, may occasionally utilise groundwater when it is at a depth accessible by the root systems and occur along the Jimblebar and Caramulla creeks (Map 5-5).

Given the depth to groundwater across the Jimblebar Hub, riparian vegetation in major drainage lines is generally likely to rely on the availability of soil moisture (replenished by rainfall and creek flows).

5.8.6 Sheet-flow dependent Mulga

Two of the vegetation associations mapped within the Jimblebar hub support Mulga (*Acacia aneura* and close relatives) that has been identified as being sheet-flow dependent (Map 5-5).

Mulga has an extensive shallow root system that efficiently utilises ephemeral surface water. Mulga communities that occur in a patterned sequence of alternating grove and inter-groves are considered likely to be dependent on sheet-flow water for resource (nutrient and water) capture. As discussed in Section 5.8.2, this type of Mulga has been identified as an 'ecosystem at risk' in the Hamersley and Fortescue subregions, and is represented by vegetation associations HP AaChApr DopeErfoSeah TtChfAri and HP AptAa SesmErlnSeah Tb (Map 5-5 and Table 5-53) in the Jimblebar Hub. An area of grove and inter-grove Mulga has also been identified to the north outside of the eastern portion of the closure planning area (identified from aerial photography) that may also be sheet-flow dependant (BHP, 2023a).

5.8.7 Knowledge gaps & forward work program

Vegetation communities have a role in providing habitat for fauna, and research is currently being planned to investigate fauna habitat for key species (see Section 5.9.5).

5.9 Fauna

Summary of key points:

There have been over 40 fauna surveys within the Jimblebar Hub area including several short-range endemic (SRE) invertebrate fauna surveys. Excluding disturbed areas, eleven habitat types have been identified in the area:

- Breakaway / cliff
- Hillcrest / hillslope.
- Gorge / gully.
- Minor drainage line.
- Major drainage line.
- Drainage area / floodplain.
- Sand or gravel plain.
- Stony plain.
- Hardpan plain.
- Mulga woodland.
- Claypan (also referred to as Gilgai Plain).

The vertebrate habitat types considered to be of greatest importance are the gorge / gully habitat, followed by major drainage line, hardpan plain, hillcrest / hillslope, sand plain and Mulga woodland habitats because these are most likely to support

[20] Tree roots of *Eucalyptus victrix* can potentially extend tens of metres to water table depth (Florentine 1999 in Biologic 2021a) and have been confirmed to reach a maximum depth of 21 m (Muir Environmental 1995).

[21] Facultative phreatophyte – a plant that can utilise groundwater to satisfy a proportion of its ecological water requirement (EWR) when it is available. However, some individuals may satisfy their EWR solely from upper unsaturated soils layers where groundwater is inaccessible.

conservation significant species. Ten natural water features and twelve cave structures with the potential to support conservation significant fauna have also been identified in the Jimblebar closure planning area.

Several conservation significant species have been recorded within the Jimblebar Hub including the EPBC listed Ghost Bat. There is a single record of the EPBC listed Northern Quoll (scat from an OSA) within the Jimblebar Hub closure planning area, however a targeted survey with significant sampling effort failed to record any further evidence of Northern Quoll and it is unlikely that there is a population within or nearby the closure planning boundary.

The stygofauna community of the Jimblebar Hub area is depauperate by Pilbara standards due to the depth to groundwater. The troglofauna community of the Jimblebar Hub area is of moderate diversity.

Most habitats within the Jimblebar closure planning area are of low to moderate / low suitability for SRE invertebrate fauna with the gorge / gully and hillcrest / hillslope habitats being most likely to support SRE species. Two confirmed[22] and nineteen potential[23] SRE species have been recorded within the closure planning area.

Section 5.14 discusses key fauna species of significance to the Nyiyaparli people.

The return of fauna is important to the Nyiyaparli people and research is being planned to investigate fauna habitat attributes of importance for conservation significant species and also some of the key species of significance to the Nyiyaparli people.

The habitats and fauna identified within Jimblebar Hub, and the surrounding regional area are consistent with those identified for the Hamersley and Fortescue sub-regions of the Pilbara IBRA and the Augustus sub-region of the Gascoyne bioregion.

A total of 42 vertebrate fauna surveys and seven short-range endemic (SRE) invertebrate fauna surveys have been undertaken wholly or partially within the Jimblebar hub. These surveys comprise 23 detailed surveys, 15 basic surveys, seven targeted surveys, and four desktop surveys. A complete list and summary of these surveys is provided in BHP (2023a).

5.9.1 Terrestrial vertebrate fauna

Eleven fauna habitat types have been recorded in the Jimblebar Hub areas (Map 5-8, Map 5-9 and Table 5-56) (BHP, 2023a). As described in Section 5.8.2 a portion of the Jimblebar hub is unmapped and is associated with operations that commenced prior to BHP ownership and the requirement for survey or gaps in survey coverage between or adjacent to approved proposal areas.

The vertebrate habitat types considered to be of greatest importance are the gorge / gully habitat, followed by major drainage line, hardpan plain, hillcrest / hillslope, sand plain and Mulga woodland habitats because these are most likely to support conservation significant species (Section 5.8.3) (ENV Australia, 2007b; 2013b; Biologic, 2019a).

Ten natural water features and twelve cave structures with the potential to support conservation significant fauna have also been identified in the Jimblebar closure planning area (Map 5-8 and Map 5-9). Five of the water features occur west of OB18 and two north of Jimblebar and are classified as temporary small surface water pools forming in Gorge / Gully or Mulga Woodland habitats following rainfall (with a high amount of rain falling during the surveys when these water features were recorded). The remaining water features include two temporary surface water pools that form after significant rainfall to the south of Jimblebar and Innawally Pool which is a semi-permanent feature within Jimblebar Creek. The cave structures are variously classified as potential or confirmed day or night feeding roosts for Ghost Bat. Several cave structures that may be utilised by Ghost Bats have also been identified within 6 km south and 5 km west of the Jimblebar hub (BHP, 2023a).

Section 5.14 discusses key fauna species of significance to the Nyiyaparli people.

Table 5-56 Fauna habitat description

Habitat	Description	Distinguishing habitat characteristics	Value to conservation significant fauna[24]
Breakaway / Cliff	Rugged, incised rocky hills and ranges, generally occurring within the hillcrest / hillslope habitat type	Habitat tends to contain large rock fragments and more rock outcropping than other habitats. Vegetation can be dense and complex in areas of soil deposition or sparse and simple where erosion has occurred.	Contains critical roosting habitat for Ghost Bat (where Category 1 or 2 caves present)

[22] Confirmed SRE have a known distribution of <10,000km^2. The taxonomy is well known, and the group is well represented in collections and/ or via comprehensive sampling.

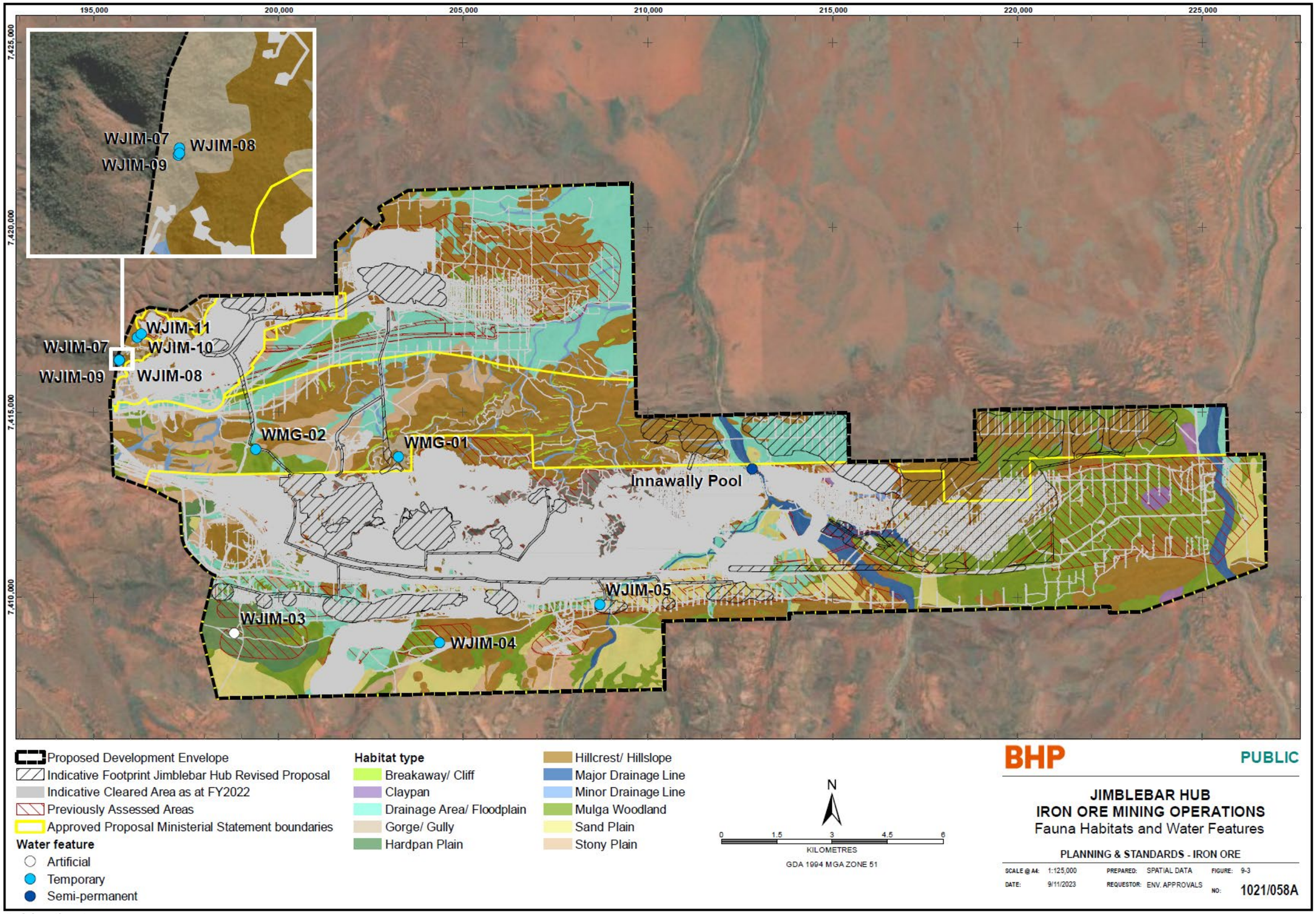
[23] Potential SRE are classified where patchy sampling has resulted in incomplete knowledge of geographic distribution. There is incomplete taxonomic knowledge. The group is not well represented in collections. The category applies where there are significant knowledge gaps.

[24] Value to conservation significant fauna relates to those species known to have populations within the Jimblebar hub.

Habitat	Description	Distinguishing habitat characteristics	Value to conservation significant fauna[24]
Hillcrest / hillslope	Crests and slopes of rocky range, dominated by *Eucalyptus* woodlands, *Acacia* and *Grevillea* shrublands and *Triodia* spp. low hummock grasslands. These habitats also contain minor drainage line features associated with minor gullies and depressions	These fauna habitats tend to be open, structurally simple, and are dominated by varying species of spinifex. A common feature of these habitats is a rocky substrate, often with exposed bedrock, and skeletal red soils.	Supporting foraging habitat for Ghost Bat with varying (but generally limited) foraging value
Gorge / gully	The gorge/ gully habitat type occurs across small, isolated areas within the hillcrest / hillslope habitat type. Gorges and gullies are rugged, steep-sided valleys incised into the surrounding landscape. Gorges tend to be deeply incised, with vertical cliff faces, while gullies are more open.	Gorges and gullies are very rocky, with large rock fragments and more rock outcropping than other fauna habitats. Caves and rock pools are most often encountered in this habitat type. Vegetation can be dense and complex in areas of soil deposition or sparse and simple where erosion has occurred.	Contains critical roosting habitat for Ghost Bat (where Category 1 or 2 caves present) and support foraging habitat
Minor Drainage line	Located within the minor gullies and depressions, generally through the hillcrest / hillslope or drainage area / floodplain habitat types. Consists primarily of *Acacia* low shrubland with occasional scattered *Corymbia* trees	The understory generally lacks density and often consists solely of sparse tussock grassland, often including the weed Buffel Grass (**Cenchrus ciliaris*) where it has been introduced. The substrate can be sandy in places but generally consists of a skeletal loam gravel or stone.	Critical foraging habitat for Ghost Bat (where proximal (<12 km) to critical roosting habitat), otherwise comprises supporting foraging habitat.
Major Drainage line	Major drainage lines comprise mature River Red Gums / Coolabahs over dry river pools. Open, sandy or gravelly riverbeds characterise this habitat type. In non-grazed areas, the vegetation adjacent to the main channel or channels is denser, taller and more diverse than adjacent terrain.	Major drainage lines may hold temporary waterbodies (days to weeks) following significant rainfall.	Critical foraging habitat for Ghost Bat (where proximal (<12 km) to critical roosting habitat), otherwise comprises supporting foraging habitat
Sand plain	Flat or gently sloping plains and foot slopes of sand and gravel. This habitat type often occurs as terraces along drainage lines and extensive plains.	Sand Plain habitat type is characterised by relatively deep sandy soils supporting dense spinifex grasslands, sparse shrubs and scattered *Corymbia* and *Acacia* trees. The woodland provides extensive shelter and a relatively complex structure, while the sandy substrate provides ease of burrowing.	Supporting foraging habitat for Ghost Bat with varying (but generally limited) foraging value
Stony plain	These are erosional surfaces of gently undulating plains, ridges and associated foot slopes. This habitat may contain minor drainage line features associated with minor gullies and depressions.	A common habitat type within the Pilbara. Mainly supports hard spinifex (and occasionally soft spinifex) with mixed *Acacia, Hakea* and *Senna* species open shrubland with a mantle of gravel and pebbles.	Supporting foraging habitat for Ghost Bat with varying (but generally limited) foraging value
Hardpan plain	Gently inclined alluvial plains with shallow loams and loamy earths, sometimes with a covering of coarse gravel.	Occurs sporadically throughout the Pilbara. Typically containing no vegetation, or small herbs only, due to the hardpan close to the surface, and soil depth is insufficient to support vegetation. These areas are also periodically inundated following rainfall.	-
Drainage area / floodplain	Flood plains and low-lying areas beneath the main ridge generally located adjacent to drainage lines, and have been shaped by the presence of water and surface water movement.	This habitat is characterised by a low woodland over broad-leafed *Acacia* shrubland on sandy loam soils, sometimes with exposed rocky areas. These can have high vegetation density, complexity and diversity, and because they tend to occur on depositional areas, often have deeper and richer soils than other fauna habitat types. Grasses tend to be dominated by tussock grasses rather than spinifex. After heavy rains, standing water may attract migratory species including waders.	Critical foraging habitat for Ghost Bat (where proximal (<12 km) to critical roosting habitat), otherwise supporting foraging habitat

Habitat	Description	Distinguishing habitat characteristics	Value to conservation significant fauna[24]
Mulga woodland	Woodland or tall shrubland dominated by *Acacia aneura* and close relatives. The extent of ground cover varies with canopy density.	It consists of broad groves on stony or sandy soils, with little undergrowth. Within the eastern portion of the Jimblebar Hub, this habitat type occurs in bands or groves adjacent to drainage lines and lower relief drainage areas and floodplains.	Critical foraging habitat for Ghost Bat (where proximal (<12 km) to critical roosting habitat), otherwise comprises supporting foraging habitat
Claypan (also referred to as gilgai plain)	Comprises *Acacia* shrubs over native and introduced grasses on loamy / clay soils. A large proportion of the shrublands has been previously disturbed by cattle grazing, resulting in large areas with very limited understorey or groundcover vegetation. There are also areas with little evidence of disturbance, which retain some structural diversity.	Claypan habitat occupies a very small portion of the Jimblebar Hub. Claypans are often isolated features associated with tussock grasses. Cracking clay soils, usually containing weak crabhole (gilgai) micro-relief, are generally saline at depth. Surface mantles are absent or common to abundant as pebbles and cobbles of ironstone, basalt and other rocks. The environment has areas of good ground covers, litter, logs or debris	-
Disturbed areas	Includes mine voids, OSAs (rehabilitated or not), road and rail corridors and other infrastructure.	These varied habitats tend to have poorly developed communities, and a higher proportion of weeds. Generally, of low importance for conservation significant species, although provision of water may attract some species such as waders.	-

Source: Adapted from Biologic (2013b; Biologic, 2019a); GHD (2019); BHP (2023a)



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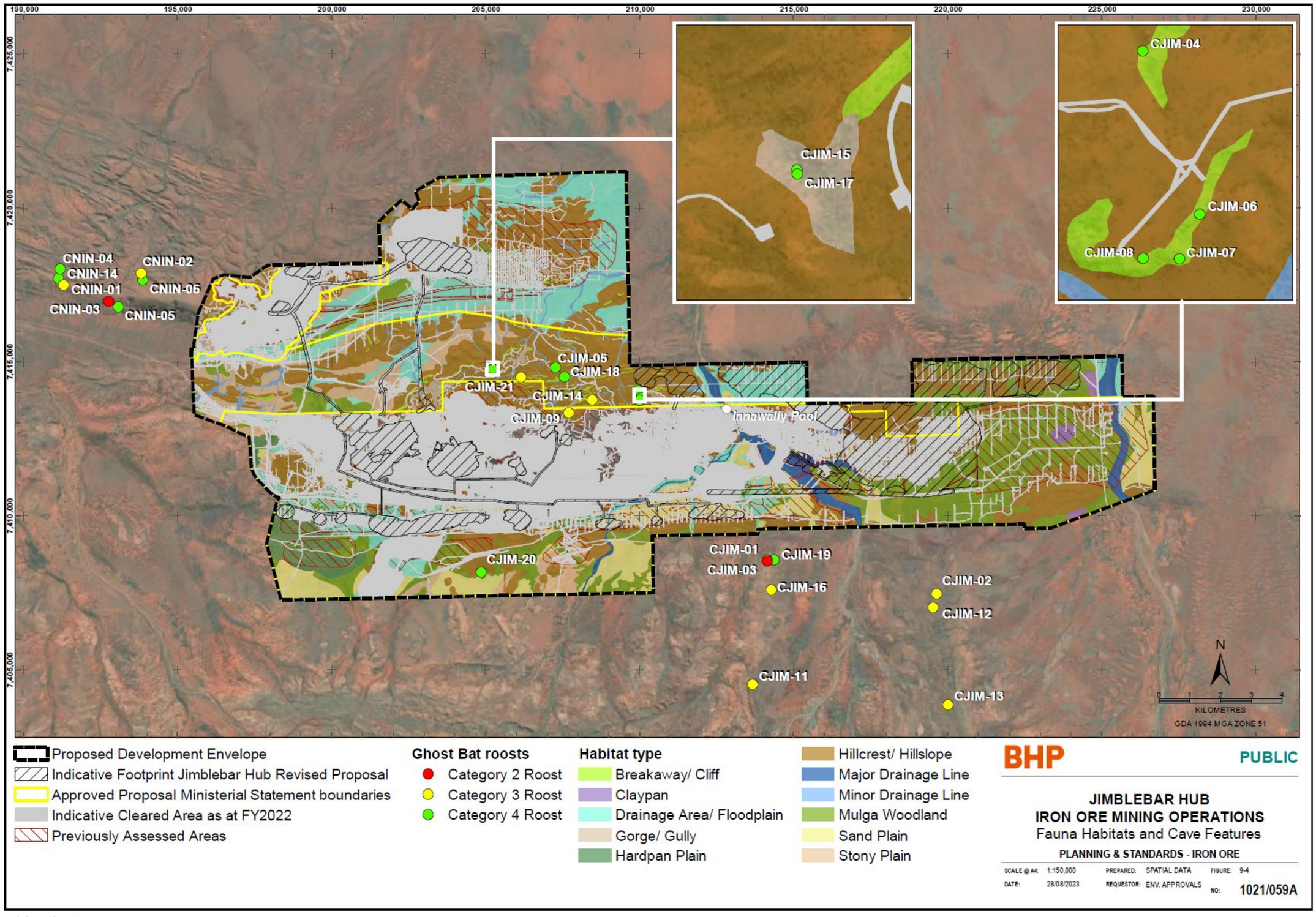
Map 5-8 Jimblebar Hub fauna habitat and water features



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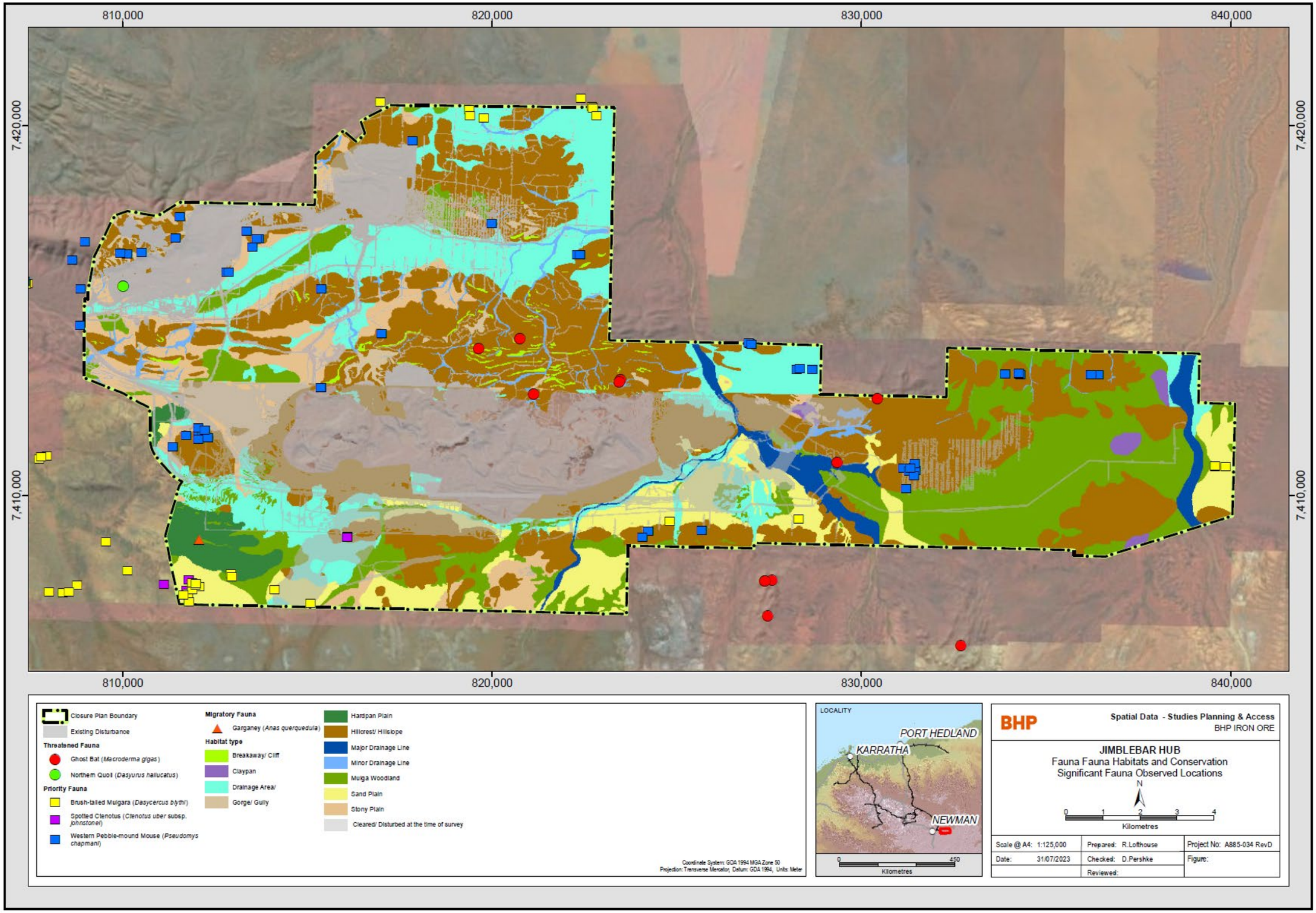
Map 5-9 Jimblebar Hub fauna habitat and cave features

5.9.2 Conservation significant fauna

Conservation significant fauna species recorded within Jimblebar Hub are listed in Table 5-57 with records shown on Map 5-10.

The status of the Ghost bat (*Macroderma gigas*) has been increased to vulnerable under the EPBC and BC Acts. Regional review of the ghost bat by WAIO has resulted in a better understanding of their ecology and therefore our potential impacts to the species and management options during operations and at closure. Artificial roost habitat is being trialled at Mining Area C and at Goldsworthy North Area (GNA).

GHD (2021b) completed a survey of suitable habitat for the Greater Bilby (*Macrotis lagotis*) within the East Jimblebar and Caramulla area. No signs of the species were recorded during the survey and there are no known records within the Jimblebar area and only one record within a 40 km buffer area. It was, therefore, concluded that occurrence in the area is unlikely despite suitable habitat being present.



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Map 5-10 Jimblebar Hub – significant vertebrate fauna

Table 5-57 Priority fauna species recorded within Jimblebar Hub

Scientific Name	Common Name	Conservation Status	Comment
BC Act and EPBC Act Threatened Species			
Macroderma gigas	Ghost Bat	BC Act Vulnerable EPBC Act Vulnerable	Ghost Bats roost in deep, complex caves beneath bluffs of low, rounded hills, granite rock piles and abandoned mines. These features often occur within habitats including gorge / gully, hill crest / hill slope and low hills. Within the Jimblebar closure planning area there are several records showing evidence of Ghost Bats over numerous years. Twelve cave structures have been recorded within the closure planning area. Of the twelve caves, three are suitable for diurnal roosts and the remaining caves are shallow and structurally simple and may only be used opportunistically. No breeding roosts have been recorded. Category 2 roosts have been recorded 1 km to the south and 3 km to the west of the development envelope.
Dasyurus hallucatus	Northern Quoll	BC Act Endangered EPBC Act Endangered	Known from a single record within the Jimblebar Hub (a scat collected from a rehabilitated OSA). A subsequent targeted survey with significant sampling effort failed to record any evidence of Northern Quoll. There have been few, isolated records within 100 km of the Jimblebar Hub and a population is considered unlikely to occur within or nearby the closure planning boundary (BHP, 2023a).
BC Act and EPBC Act Threatened Species			
Anas querquedula	Garganey	BC Act Migratory EPBC Act Migratory/Marine	Garganey is small teal. This duck is a rare visitor to Australia recorded from well vegetated freshwater wetlands, lakes and inland waterbodies. Recorded within the Jimblebar Hub associated with an artificial water feature WJIM-03 (Map 5-8).
DBCA Priority Species			
Dasycercus blythi	Brush-tailed Mulgara	Priority 4	Thirty-one records within the closure planning boundary. At OB17/18/31 individuals were found in the sand plain habitat. This species prefers arid, sandy areas, preferring mature spinifex on sandy soils. Brush-tailed Mulgara inhabit spinifex grasslands with medium to dense cover (Biologic, 2014a). At Jimblebar, the species has been recorded in sandplain and hillcrest / hillslope habitats (Biologic, 2019a).
Pseudomys chapmani	Western Pebble-mound Mouse	Priority 4	This species prefers gentler slopes of rocky ranges where ground is covered with a stony mantle and vegetated by spinifex, often with sparse overstorey of eucalypts and scattered shrubs (Van Dyck & Strahan, 2008) as cited in Biologic (2014a). At Jimblebar the species has been recorded in hillcrest / hillslope and stony plain habitats (Biologic, 2019a). 57 mounds have been recorded within the Development Envelope.
Ctenotus uber subsp. *Johnstonei*	Spotted Ctenotus	Priority 2	Records of the Spotted Ctenotus (*Ctenotus uber* subsp. *Johnstonei*) all occur within areas assessed under MS 1021 (OB31).

Source: Biologic (2013b; 2014a; 2019a); GHD (2019; GHD, 2021a; GHD, 2021b); DBCA (2018b); BHP (2023a)

5.9.3 Subterranean fauna

5.9.3.1 Troglofauna

Troglofauna have been identified by Biologic (2023) as most commonly occurring within the mineralised Brockman Iron Formation and Marra Mamba Formation in the Jimblebar are Hub and Ophthalmia Range. The broad geology of the area comprises colluvial and alluvial deposits occurring between ridges in floodplains and drainage channels, with colluvium in the floors of minor valleys. The alluvial or colluvial sediments in valley floors are less prospective troglofauna habitat than surrounding ridges and more elevated areas. The Joffre and Dales Gorge units of the Brockman Iron Formation have been identified as most consistently suitable habitat for troglofauna and are known to occur throughout the surrounding landscape. Habitat for troglofauna is, therefore, expected to occur extensively and be well-connected throughout the eastern Jimblebar area (BHP, 2023a).

The troglofauna community of the Jimblebar Hub area is of moderate diversity. The results of troglofauna surveys conducted in the vicinity of the Jimblebar Hub mine areas are summarised in Table 5-58.

Table 5-58 Results of troglofauna studies within the vicinity of Jimblebar Hub

Troglofauna studies undertaken	Summary results
OB17/18 (Bennelongia, 2013b)	13 species recorded with species composition and abundance similar to that of other areas of the Ophthalmia Range
OB31 (Bennelongia, 2014d)	17 species representing 12 orders collected
Jimblebar (Bennelongia, 2013a; 2023; Biologic, 2023)	72 tax recorded from the Jimblebar Hub and Ophthalmia Range. 7 species appear to have localised distributions within the eastern Jimblebar area, with the remaining species being considered widespread.
Mt Whaleback area (Bennelongia, 2011)	15 species representing 9 orders collected
Eastern Ridge and Homestead Creek area (Bennelongia, 2014a; 2014e)	16 species representing 14 orders collected at Orebody 25 18 species representing 12 orders collected at Orebody 24 21 species representing 14 orders collected at Homestead

5.9.3.2 Stygofauna

Habitat modelling conducted by (Biologic, 2023) indicated that the depth to groundwater in the Jimblebar Hub is too great to be conducive to a diverse stygofauna community, and that palaeovalley features, which can be prospective for stygofauna, are largely absent from the Jimblebar Hub area (BHP, 2023a). This is supported by stygofauna surveys conducted in the Jimblebar Hub areas (Table 5-59) which have concluded that the area is depauperate by Pilbara standards (Bennelongia, 2014d; 2014b; 2023). Sampling undertaken throughout the wider Jimblebar area has indicated that stygofauna are rarely present (<3% of samples) at groundwater depths greater than 40 m below ground level. However, the Hub lies approximately 12 km to the east of Ethel Gorge which hosts a stygofauna community that is listed as a Threatened Ecological Community (TEC) by the State (Section 5.10)

Table 5-59 Results of stygofauna studies within the vicinity of Jimblebar Hub

Stygofauna Studies undertaken	Summary Results
Mt Whaleback area (Bennelongia, 2013c)	Nine species recorded in the Orebody 29, 30 and 35 area
Orebody 17/18 area (Bennelongia, 2014c)	One species recorded near the mine and a further two species from the alluvial plain to the south of the operations
OB31 (Bennelongia, 2014d)	Eleven species recorded belonging to seven groups (Nematoda, Rotifera, Ostracoda, Copepoda, Syncarida, Amphipoda and Tubificida)
Jimblebar area (Bennelongia, 2013a; 2021; 2023)	136 taxa recorded from within the Jimblebar area and Ophthalmia Range. 44 taxa recorded within predicted the cumulative drawdown area (including East Jimblebar), 5 of which were species known from a single location; *Atopobathynella* sp. 'BSY241', *Enchytraeus* sp. 'Ench3', Phreodrilidae sp. 'BOL084', *Schizopera* sp. 'BHA285', *Tubificidae* sp. 'BOL074'.
Eastern Ridge and Homestead Creek area (Bennelongia, 2014a)	Seventeen species have been recorded at Homestead and three species at Orebody 24

5.9.4 Short range endemic species

Seven key types of short range endemic (SRE) invertebrate fauna habitats have been identified in the OB17/18/31 area (Biologic, 2013a; 2014b):

- Ridgelines and breakaways;
- Vegetation groves (mostly dominated by Mulga);
- Gorges and deep gullies;
- Drainage foci and lines;
- Shallow gullies; and
- Rocky outcrops.

The majority of the fauna habitats occurring within the Jimblebar area have been assessed as being of low to moderate / low suitability for SRE invertebrate fauna as they provide little or limited protection and complexity, and are often widespread and continuous through the landscape, thus allowing easy dispersal for invertebrate taxa that occupy such habitats. The habitats considered to be of greatest likelihood to support SRE species are (BHP, 2023a):

- The gorge / gully habitat (high suitability for gorges and south-facing gullies, and moderate / high for north-facing gullies); and
- Hillcrest / hillslope habitats (moderate / high suitability).

Gorge / gully habitat provides the highest level of protection, isolation and complexity, with a higher persistence of moisture, while hillcrest / hillslope habitats can also act as terrestrial islands, providing suitable rocky habitats and microhabitats for a number of SRE taxa (BHP, 2023a).

Two confirmed[25] SRE species (mygalomorph spiders) and nineteen potential[26] SRE species have been recorded within the Jimblebar closure planning area (Table 5-60). The confirmed SRE are also known from records outside the development envelope (BHP, 2023a).

Table 5-60 Confirmed and potential SRE species recorded within the Jimblebar development envelope

Family	Species	Status[25,26]	Habitat
Clenizidae	*Conothele* MY G279	Confirmed	Drainage habitat
Idiopidae	*Anidiops* MY G286-DNA	Confirmed	Drainage habitat
	Idiosoma sp. Indet.	Potential	Sandy plain
Selenopidae	*Karaops* ARA003-DNA	Potential	Rocky microhabitats of gorges and breakaways
	Karaops ARA004-DNA	Potential	Rocky microhabitats of gorges and breakaways
	Karaops sp. Indet.	Potential	Undulating low hills
Buthidae	*Lychas* sp. 'bituberculatus group'	Potential	Rocky microhabitats of hillcrest / hillslope
Armadillidae	*Buddelundia* sp. '10NM'	Potential	Rocky microhabitats of hillcrest / hillslope
	Buddelundia sp. '14CR'	Potential	Rocky microhabitats of hillcrest / hillslope and drainage habitats
	Buddelundia sp. '36NM'	Potential	Rocky microhabitats of hillcrest / hillslope
	Buddelundia sp. '49'	Potential	Rocky microhabitats of hillcrest / hillslope and drainage habitats
	Buddelundia sp. 'Biologic-ISOP014'	Potential	Sandy plain / drainage habitat
	Buddelundiinae sp. 'WN'	Potential	Ridge breakaway and rocky outcrops
Olpiidae	*Austrohorus* sp. 'Biologic-PSEU023'	Potential	Sandy stone plain / undulating low hills
	Austrohorus sp. 'Biologic-PSEU024'	Potential	Gorge / gully / undulating low hills
	Austrohorus sp. 'Biologic-PSEU025'	Potential	Sandy / stony plain
	Beierolpium sp. Indet.	Potential	Sandy / stony plain
	Indolpium sp. 'Biologic-PSEU026'	Potential	Sandy / stony plain / undulating low hills
	Indolpium sp. 'Biologic-PSEU027'	Potential	Sandy / stony plain / undulating low hills and drainage habitats
	Indolpium sp. Indet.	Potential	Sandy / stony plain
Garypidae	*Synsphyronus* sp. Indet	Potential	Rocky microhabitats of hillcrest / hillslope / undulating low hills

Source: Biologic (2014b; 2019a; 2020a; Biologic, 2020b); BHP (2023a)

[25] Confirmed SRE have a known distribution of <10,000km^2. The taxonomy is well known, and the group is well represented in collections and/ or via comprehensive sampling.

[26] Potential SRE are classified where patchy sampling has resulted in incomplete knowledge of geographic distribution. There is incomplete taxonomic knowledge. The group is not well represented in collections. The category applies where there are significant knowledge gaps.

5.9.5 Knowledge gaps & forward work program

The return of fauna is important to the Nyiyaparli people and research is being planned to investigate fauna habitat attributes of importance for conservation significant species and also some of the key species of significance to the Nyiyaparli people.

5.10 Threatened or priority ecological communities

No Threatened Ecological Communities (TECs) or Priority Ecological Communities (PECs) have been recorded from within, or adjacent to, the Jimblebar Hub. The nearest TEC is the Ethel Gorge aquifer stygobiont community, a State listed TEC. The 2 km buffer of this TEC occurs ~12 km west of the Jimblebar Hub. The community includes some stygofauna species endemic to this location. The current spatial extent of the Ethel Gorge TEC and buffer zone, as defined by DBCA (Map 5-20, Section 5.11.3), is understood to be based on the surface expression of calcrete in the area. The quality of stygofauna habitat is influenced by the level of connectivity between pores, cavities and fractures, which facilitate fauna movement and dispersal (RPS, 2014a).

None of the mapped vegetation associations at the Jimblebar Hub are affiliated with Federal or State listed TECs, or State listed PECs (Onshore Environmental, 2013; BHPBIO, 2015; Onshore Environmental, 2021).

5.10.1 Knowledge gaps & forward work program

No knowledge gaps which have impacts on closure outcomes have been identified.

5.11 Water

5.11.1 Surface water

Summary of key points:

- Jimblebar Hub interacts with four catchments (Shovelanna Creek, Jimblebar Creek, Caramulla Creek and Fortescue River), all of which flow into the Fortescue River and ultimately into the Fortescue Marsh.
  - Most of the mining areas are situated within the Jimblebar Creek catchment.
  - The eastern part of the East Jimblebar deposit flows into the Caramulla Creek catchment.
  - Minor tributaries on the north side of the OB17/18/31 ridgeline typically flow to the north directly into the Fortescue Catchment.
  - The western part of the OB18 mine area (i.e., the area that contains the Avon pit) and part of the Ore Handling Plant and Train Load Out facility, flow into an unnamed creek that discharges into the Shovelanna Creek.
- Jimblebar Creek is a major ephemeral tributary of the Fortescue River and flows in a northerly direction and through a narrow gorge in the Hashimoto ridgeline. Innawally Pool is a persistent surface water driven feature in the Jimblebar Creek situated immediately downstream of the gorge. The pool is of cultural significance. The WHASH / Hashimoto deposits are located on either side of the Jimblebar Creek, draining directly to the creek and Innawally Pool. The pit designs have been developed so they do not intersect the 1:10,000-year floodplain.
- Jimblebar Creek has two main branches, East and West which merge upstream of the gorge in the Hashimoto Ridgeline.
  - Jimblebar Creek West Branch comprises a historically incised and confined, largely single-thread channel. However, widespread aggradation (deposition) of sands and gravels has resulted in the infilling of the channel and the development of lateral and mid-channel bars that have created several secondary flow channels, particularly in the downstream reaches. The Jimblebar West Branch and its tributaries (Central and Eastern Creeks) intersect the South Jimblebar Capricorn pits.
  - The portion of Jimblebar Creek East Branch adjacent to the H2B1 pit is relatively confined and would concentrate flows within well-defined creek banks.
- Copper Creek is a tributary of the Jimblebar Creek West Branch and is characterised by a very flat valley without a defined channel. The flow paths of Copper Creek and one of its tributaries, referred to as South Jimblebar Creek, interact with the South Jimblebar Sylvania and Mindoona pits. The South Jimblebar Creek has very shallow bank slopes with ill-defined channel geometry.
- Orebody 31 Creek flows into the Jimblebar Creek downstream of Innawally Pool. This creek line lies to the south of the OB17/18/31 mining areas and interacts with the OB31 pit footprint. The flow path of the creek is largely undefined, with a wide shallow flood footprint.
- In addition to Innawally Pool, there are several (temporary) pools within the closure planning area. Jinerabar Pool (an intermittent pool) is located in Jimblebar Creek outside the closure planning area (~40 km to the north).
- Flood modelling and a review of the geomorphology of creek lines intersecting mine infrastructure have been conducted to inform surface water management designs for closure. Design studies are discussed in Section 5.16.
- Surface water quality around the Jimblebar Hub area and adjacent creek systems is fresh with typically <500 mg/L total dissolved solids (TDS) and pH 6-8 (neutral). Some minor / isolated exceedances of internal trigger values have been

observed for copper, iron, manganese, nitrate, sulphate, total dissolved solids and alkalinity[27]. The forward work program includes a more detailed analysis of existing data and a review of the suitability of the current surface water quality sampling program to inform closure and completion criteria.

5.11.1.1 Regional hydrology

Jimblebar Hub is located within the Fortescue River Upper Catchment, which drains into the Fortescue Marsh, located approximately 80 km north of the site. The Fortescue Marsh is an extensive intermittent wetland of about 104,800 ha within a total catchment area of approximately 2,979,100 ha. Surface water enters the marsh during rainfall events and cyclonic activity via the surrounding landscapes and tributaries. Through the evaporation process, the loss of water results in an accumulation of salts and results in wetland water quality alternating between fresh, saline and hypersaline (EPA, 2013). Groundwater below the marsh is saline to hypersaline (Aquaterra, 2009).

Although the Jimblebar Hub is located within the greater Fortescue Marsh catchment area, it is not located within the Fortescue Marsh management area boundary identified in the EPA's Strategic Advice to the Minister for Environment titled: *environment and water assessments relating to mining and mining-related activities in the Fortescue Marsh management area* (EPA, 2013).

5.11.1.2 Local surface water run-off

At a local level, Jimblebar Hub interacts with four catchments (Shovelanna Creek, Jimblebar Creek, Caramulla Creek and Fortescue River), all of which flow into the Fortescue River and ultimately into the Fortescue Marsh (Map 5-11).

Most of the Jimblebar Hub mining areas are situated within the Jimblebar Creek catchment, which is 900 km² in area. Jimblebar Creek flows in a northerly direction and through a narrow gorge in the Hashimoto ridgeline. The creek is a major ephemeral tributary of the Fortescue River, and merges with it about 40 km to the north of the Jimblebar Hub. The Caramulla Creek, which has a catchment area of about 1,130 km^2, runs through the eastern portion of the mine closure planning area and also merges with the Fortescue River in this same general location. In the merger zone between Jimblebar Creek and the Fortescue River, the natural ground levels are extremely flat and the main flow channels become braided and less defined (Aquaterra, 2010b).

Jimblebar Creek has two main branches; the East and West Branch, which merge upstream of the gorge in the Hashimoto Ridgeline (Map 5-11). The West Branch flows in a northerly direction and into a broad valley, and then in an easterly direction before merging with the East Branch. Copper Creek is a tributary of Jimblebar Creek West Branch and flows in an easterly direction along the upper portion of the same broad valley as the Jimblebar Creek West Branch. Copper Creek has a total catchment of 73 km^2 at its confluence with Jimblebar Creek West Branch. Eastern Creek and Central Creek are two tributaries of Jimblebar Creek that lie between the East and West Branches and merge just upstream of the Hashimoto Gorge.

Innawally Pool is a persistent surface water driven feature in the Jimblebar Creek situated on the eastern edge of the Ophthalmia Range, immediately downstream of the gorge in the Hashimoto ridgeline (Map 5-11). The Innawally Pool sub-catchment is 340 km² (Map 5-11). An ephemeral dryland water course (referred to as the Orebody 31 Creek), with a small sub-catchment area of roughly 70 km² lies north of the Jimblebar operations and south of OB17/1/31 and flows in an easterly direction to merge with Jimblebar Creek at a confluence approximately 4 km to the east of OB31 and 4 km downstream of Innawally Pool (Map 5-11) (RPS, 2019a; 2020).

Jinerabar Pool is an intermittent pool also located in Jimblebar Creek, but outside the closure planning area (approximately 40 km to the north).

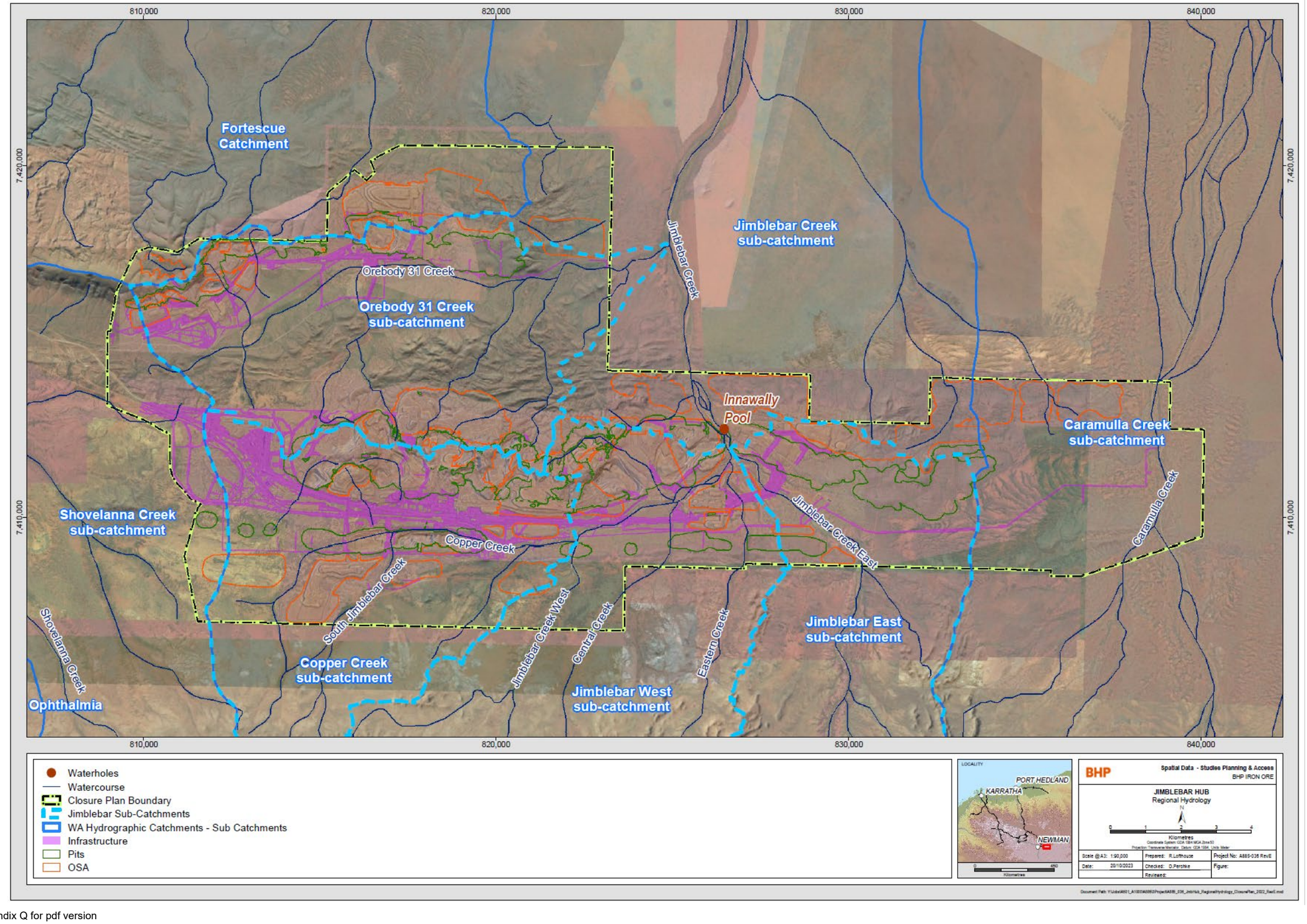
Several temporary small water pools are located within the closure planning area. Along with Innawally Pool and Jinerabar Pool, these temporary surface water features are considered to be ecohydrological assets and are described in further detail in Section 5.11.3.

Most of the OB17/18/31 area is on the southern and eastern flanks of Shovelanna Hill (Map 5-11) and the majority of the surface water flows to the south and east towards Orebody 31 Creek. Minor tributaries on the north side of the ridgeline typically flow to the north directly into the Fortescue Catchment. The Wheelarra Hill and WHASH orebodies lie on the ridgeline south of the Orebody 31 creek and surface run-off from a portion of the Wheelarra mining operations (including the WH123 NE OSA) also flows to Orebody 31 Creek. The remainder generally flows in a southerly direction via numerous small channels and valleys to Copper Creek. The flow paths of Copper Creek and a tributary of Copper Creek, referred to as South Jimblebar Creek, are directly over sections of the South Jimblebar Sylvania and Mindoona pits (Aquaterra, 2010b). Jimblebar West, Central and Eastern Creeks intersect the South Jimblebar Capricorn pits (Map 5-11).

The East Jimblebar and H234 orebodies lie on a ridgeline to the east of Jimblebar Creek, with surface water flowing both to the north and south into the Jimblebar Creek and Caramulla Creek catchments (BHP, 2023b) (Map 5-11).

The western part of the OB18 mine area (i.e., the area that contains the Avon pit), flows to the south and west into an unnamed creek that discharges into the Shovelanna Creek, approximately 6 km downstream (Earth Systems, 2015). A small portion of the Jimblebar Hub Ore Handling Plant and Train Loadout (on the western edge of the mining lease) is also located in the Shovelanna Creek catchment (Map 5-11).

[27] Trigger values are an operational management tool and exceedance of the trigger values does not imply an environmental impact.



Refer to Appendix Q for pdf version

Map 5-11 Jimblebar Hub hydrology

As with most of the rivers and creeks in the Pilbara, creeks in the Jimblebar catchment are ephemeral and only flow after large rainfall events which occur typically between December and March. Streamflow in the smaller flow channels is typically short in duration and ceases to flow hours after the rainfall passes. In the larger river channels, which drain the larger catchments, run-off can persist for several weeks and possibly months following major rainfall events such as those resulting from tropical cyclones (Aquaterra, 2010b).

The WHASH / Hashimoto deposits are located on either side of the Jimblebar Creek, draining directly to Jimblebar Creek and Innawally Pool (Map 5-11). The pit designs have been developed so that they do not intersect the 1:10,000-year Jimblebar Creek flood plain (Section 7.3.2.1).

5.11.1.3 Creek geomorphology

Waterways within the Pilbara Craton are broadly characterised by bedrock and fault-controlled (straight) or broad braided, sand dominated channels with steep to low slopes and narrow gorges with rocky beds in upland areas. They generally have moderate sediment loads which range in size (including cobbles). Upper catchment waterways encompass a range of river styles including laterally unconfined anabranching channels, bedrock confined channels, partially confined single channels, and partially confined anabranching channels. Channels typically contain coarse armoured beds and bar forms that are established through the presence of vegetation and large boulders. Common in-channel features, include bank attached bars / benches, mid-channel / longitudinal bars, inset floodplains, meander scrolls, and incised pools. Vegetation is a key channel roughness parameter as it reinforces channel banks and contributes to a high level of floodplain roughness. Vegetation also initiates the creation of bar forms within the channels and further stabilises them (Hydrobiology, 2022).

The geomorphology of the sections of creeks for which surface water management measures have been designed is summarised below.

Orebody 31 Creek

The Orebody 31 creek flows along a 16 km valley prior to entering Jimblebar Creek. The valley is confined by relatively steep rocky ridges on each side and slopes from RL 565 m in the west to about RL 500 m at the Jimblebar Creek confluence, with a typical bed slope of 0.3% (RPS, 2019a).

The flow path is largely undefined, with a wide shallow flood footprint. There is no mobile (sand / gravel) bed, just some silt and sand in the flow path. The flow path is better vegetated in parts, and typical of the general valley vegetation in others. Water courses enter the valley from the ridges on the valley sides, but form deltas and reach the creek as sheet-flow (RPS, 2019a).

At about 5 km from the Jimblebar Creek confluence, the main flow path becomes a defined creek channel with a sand and gravel bed, and significant contributing water courses (RPS, 2019a).

Copper Creek

Copper Creek is characterised by a very flat valley without a defined main channel. This channel has very low stream power (<7 W/m² in the 2-year Average Recurrence Interval (ARI) flow), well below guideline parameters. Excessive sediment deposition does not appear to occur as a result, and it is assumed that creek flows are sediment starved (RPS, 2019b).

Copper Creek has a total catchment area of 73 km^2 at its confluence with Jimblebar Creek, and 56 km^2 at the eastern end of the South Jimblebar pits (prior to any creek diversions associated with pit development). The creek is dry outside of seasonal rainfall events with a typical bed slope of 0.2% (RPS, 2019b).

Jimblebar Creek West Branch

Jimblebar Creek West Branch comprises a historically incised and confined, largely single-thread channel. However, widespread aggradation of sands and gravels has resulted in the infilling of the channel and the development of lateral and mid-channel bars that have created several secondary flow channels, particularly in the downstream reaches (Hydrobiology, 2022). An analysis of LiDAR data between 2014 and 2021, indicated that sediment is depositing on the very flat bed slopes and that the sand bed has aggraded (risen) by 14 - 40 mm/year. This is consistent with the low natural stream power / velocities / shear stress parameters which suggest that the creek would be naturally depositing (RPS, 2022).

The reach of the Jimblebar Creek West Branch upstream of the proposed diversion (refer to Section 5.16.3.5) is largely confined by adjacent cemented colluvial skeletal soils consisting of coarser gravels in a matrix of fine material. It comprises a low-moderately sinuous channel with irregular meanders (sinuosity = 1.26) and a very low gradient (0.0023). The banks of the reach abut the colluvial valley margin, so comprise similar colluvial skeletal soils with scattered trees. Significant swathes of sand and gravels have aggraded throughout the reach with deposition largely driven by the low slope. This material has resulted in the infilling of the channel by an estimated 2 m and has created a generally trapezoidal channel due to the flatter nature of the bed. The aggradation has resulted in banks reducing in height to 0.5 -1.5 m, although some higher banks have been noted where the channel abuts the valley margin. The aggradation has also resulted in a largely uniform bed, although some variability exists (Hydrobiology, 2022).

The existing reach of the Jimblebar Creek West Branch (to be replaced by the proposed diversion; Section 5.16.3.5) is confined upstream of the Copper Creek confluence and has a low slope (0.002 m/m) and a large meander bend (curvature radius ~ 230 m). This meander bend increases the sinuosity of the reach, but the overall sinuosity (sinuosity = 1.05) remains low. The reach downstream of the Copper Creek confluence is characterised by a low-sloped (0.002 m/m), shallow (mean 1.5 m deep) channel. The level of confinement notably decreases downstream of the Copper Creek confluence, with a resulting shift in channel type to a more wandering / anabranching system comprising vegetated bars and secondary channels within the bank-full confines.

Sediment supply generally exceeds transport capacity, although larger events (e.g., 50 or 100-year events) would mobilise and scour the bed material. Bank stability is generally good, although isolated erosion is occurring where the low flow channel abuts the northern colluvial margin (Hydrobiology, 2022).

The reach of the Jimblebar Creek West Branch downstream of the proposed diversion comprises a low gradient (0.002 - 0.0005 m/m) confined channel with large anabranches evident. In-channel features reflect those seen in the existing reach (downstream of the Copper Creek confluence), and include:

- Vegetation driven deposition, with deposition of finer (sands / fine gravels) material in the lee of vegetation.
- A coarse gravel bed mixed with a surficial layer of deposited fines (mostly sands and fine gravel).
- Large stands of vegetation and associated bar formation.
- Anabranches forced by vegetated islands / bars.

Eastern Creek

Eastern Creek comprises a broad, flat, vegetated floodplain with discontinuous (and in places, eroding) low sinuosity (1.18) low flow channels between 0.5 and 1 m deep and often <5 m wide. While the upper catchment contains tributaries that drain the steeper geology, the reaches in and around the proposed South Jimblebar Capricorn pits (Section 5.16.3.5) are very flat (0.004 m/m) (Hydrobiology, 2022).

Central Creek

Central Creek is a flat / poorly defined creek (RPS, 2022). Central Creek forms a small headward eroding gully into alluvial and colluvial deposits. Upstream of the gully head, flows occur via sheetwash, while downstream sheetwash of the lower sloped gully outwash areas also occurs (Hydrobiology, 2022).

Jimblebar Creek East Branch

The portion of Jimblebar Creek East Branch adjacent to the H2B1 pit (Section 5.16.3.7) is relatively confined and would concentrate flows within well-defined creek banks. This indicates that the flood depth would generally be more sensitive to magnitude of flow, when compared to other, ill-defined (shallow) creeks around Jimblebar (such as Copper Creek and Orebody 31 Creek). In these creeks a change in flow generally results in small change in flood depth (but large change in flood extents).

South Jimblebar Creek

A significant tributary to Copper Creek (referred to as South Jimblebar Creek), with a catchment of 17 km^2, runs through the range to the south of the Sylvania and Mindoona orebodies, past the western end of Stage 2 of the Mindoona pit and through Stage 3 (Section 5.16.3.3). The creek tends to have very shallow bank slopes with ill-defined channel geometry and moderate vegetation within the thalweg. These characteristics have the tendency to reduce peak flows. The creek has a ~10 m bed channel, 0.3 m to 0.5 m deep (RPS, 2020).

5.11.1.4 Flood modelling

Several flood modelling studies have been conducted for the Jimblebar Hub operations areas. These include:

- Modelling of a 0.01% (1:10,000-year) Annual Exceedance Probability (AEP) flood event for the entire Jimblebar Creek catchment. This modelling is used to inform an initial assessment of potential requirements for closure designs. Section 7.5.3 provides further information on BHP's process for defining appropriate design events for closure.
- Modelling of the Orebody 31 Creek peak flows to inform operational flood bund designs.
- Modelling of the Copper Creek and South Jimblebar Creek peaks flows to inform operational flood bund / diversion designs.

The outputs of these studies are described in the sub-sections below and inform the design studies summarised in Section 5.16.3.

Jimblebar Creek Catchment 1:10,000-year flood modelling

Surface Water Consulting (2021) conducted a 1 in 10,000-year modelling study for the Jimblebar Creek Catchment. A rainfall-run-off model and a two-dimensional (2D) rain-on-grid hydraulic model of the Jimblebar mine site catchment area were developed for a range of events spanning from the 1% AEP event to the Probable Maximum Flood (PMF). Precipitation depths for the 1 in 10,000 AEP event were interpolated between the 1 in 2,000 AEP depths available from the Australian Rainfall and Runoff data hub (Ball, et al., 2019) and computed Probable Maximum Precipitation (PMP) rainfall depths spanning a range of durations from 1 hour to 24 hours. Rainfall-run-off modelling was conducted using RORBW in Version 6.45, with catchment delineations conducted using ArcRORB Version 1.7 with ArcHydro for ArcMap 10.7.1. Hydraulic modelling was conducted using HEC-RAS Version 5.0.7.

Manual adjustments were made to the terrain and catchment delineations to account for features not present within LiDAR data. The following features were added to the terrain data based on design drawings, and the sub-catchment delineations were adjusted accordingly (Surface Water Consulting, 2021):

- Copper Creek flood bund (see Section 5.16.3.3 for further details).
- South Jimblebar Creek diversion (refer to Section 5.16.3.4).

In addition, the confluence location for Sub-catchment K (Map 5-13) was adjusted to reflect the existing set of ten 1.5-m diameter culverts through the overland conveyor and roadway embankments (Surface Water Consulting, 2021).

The RORB model was used to derive hydrographs for rainfall event durations of 1 to 24 hours and the peak 1 in 10,000-year AEP discharge rates for the nodes shown on Map 5-12. Peak flows at each node are outlined in Table 5-61. Critical durations generally ranged from 6 to 12 hours (Surface Water Consulting, 2021).

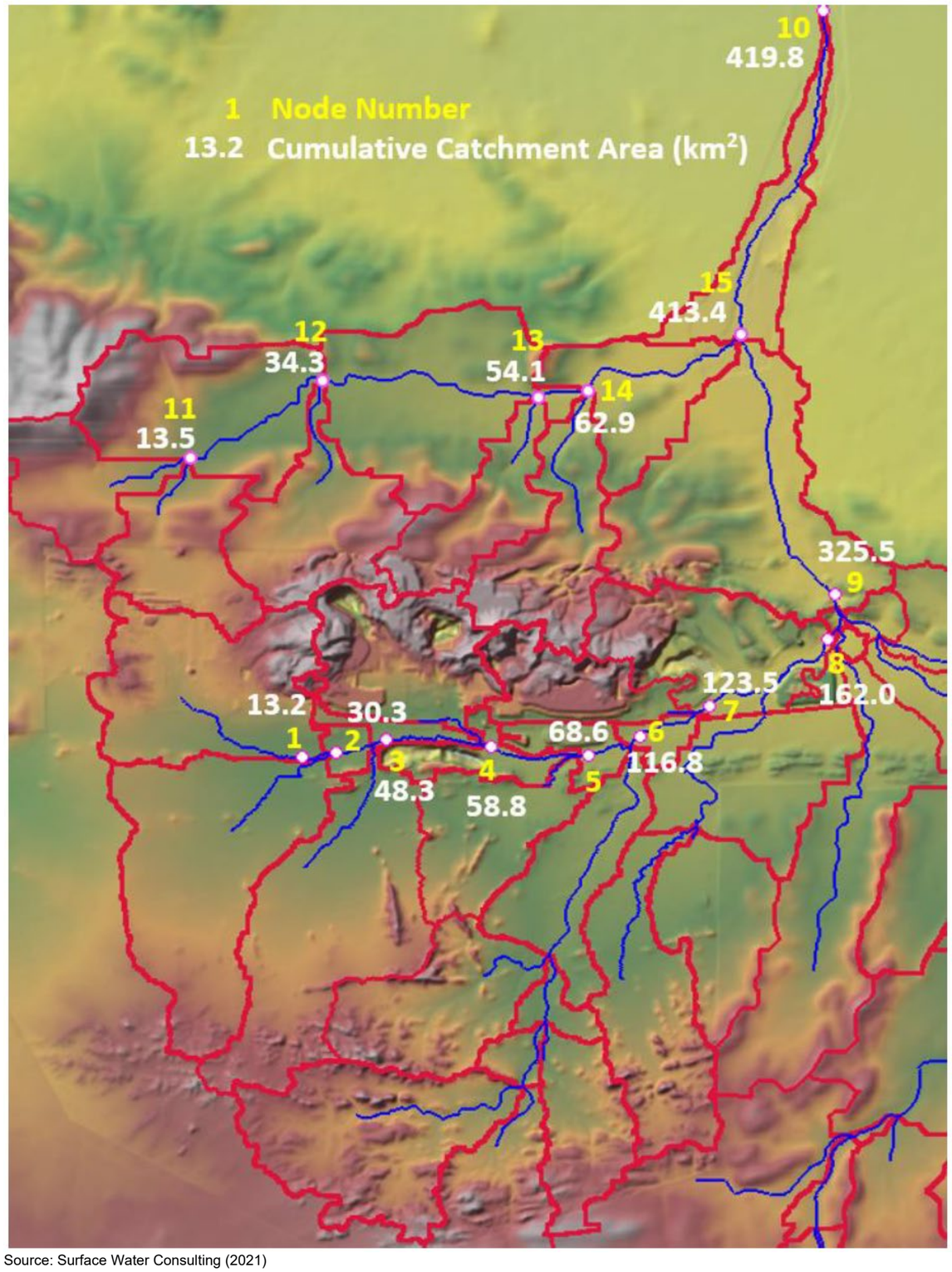
Table 5-61 Peak 1 in 10,000 AEP discharge rates

Node #	Catchment Area (km^2)	Peak Discharge (m^3/s)
1	13.2	286
2	30.3	381
3	48.3	454
4	58.8	669
5	68.6	1,028
6	116.8	1,048
7	123.5	1,233
8	162.0	1,391
9	325.5	2,357
10	419.8	2,534
11	13.5	147
12	34.3	492
13	54.1	596
14	62.9	606
15	413.4	2,702

Source: Surface Water Consulting (2021)

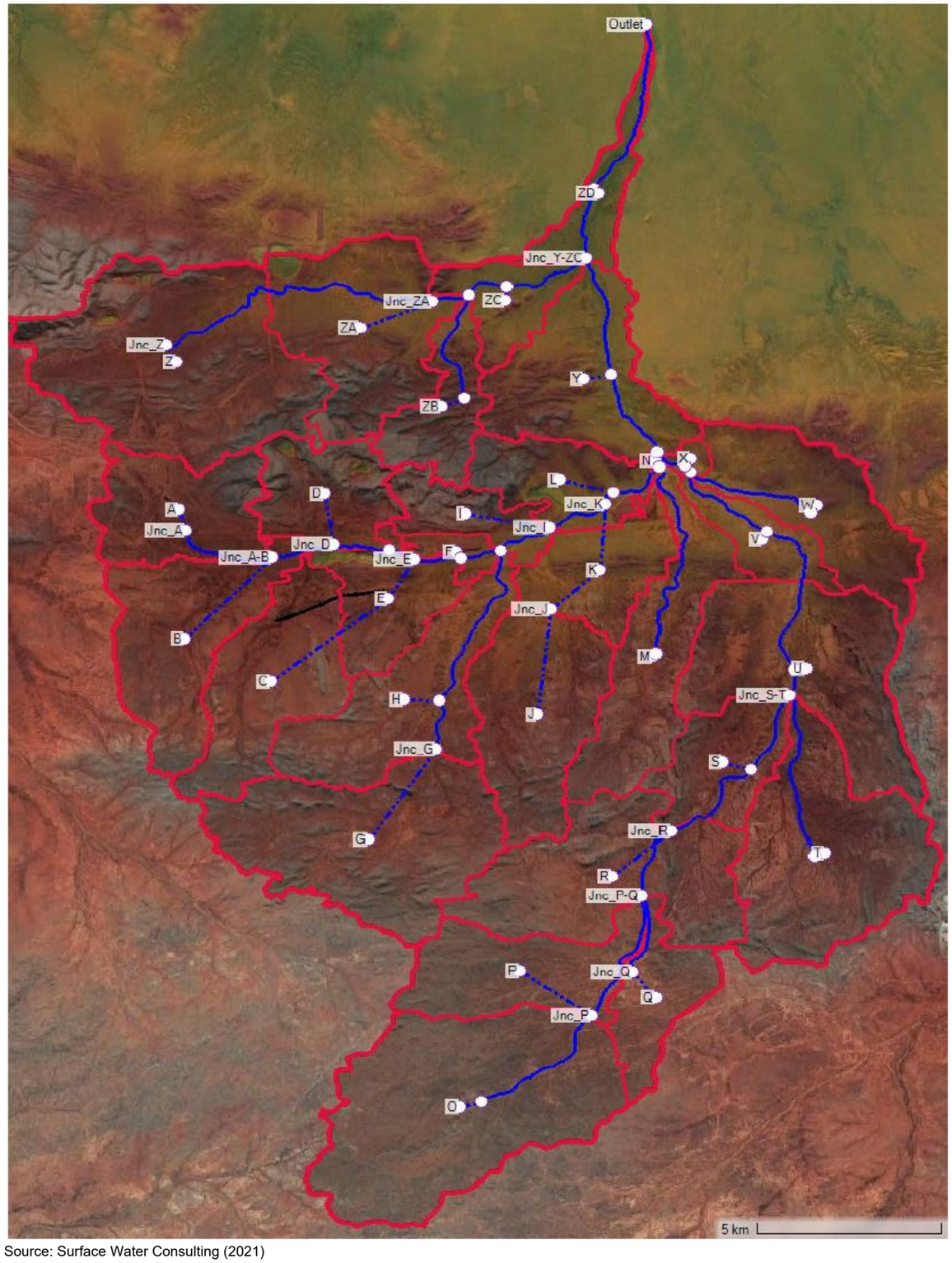
The peak discharge rates at Nodes 11 and 12 are affected by attenuation related to the presence of railway and roadway embankment fill. The estimated flow rates were reduced based on the railway culvert capacity (Node 11) and weir overflow along the haul road (Node 12) (Surface Water Consulting, 2021).

The 1 in 10,000-year flood extent derived from Surface Water Consulting's (2021) modelling is shown in Map 5-14.



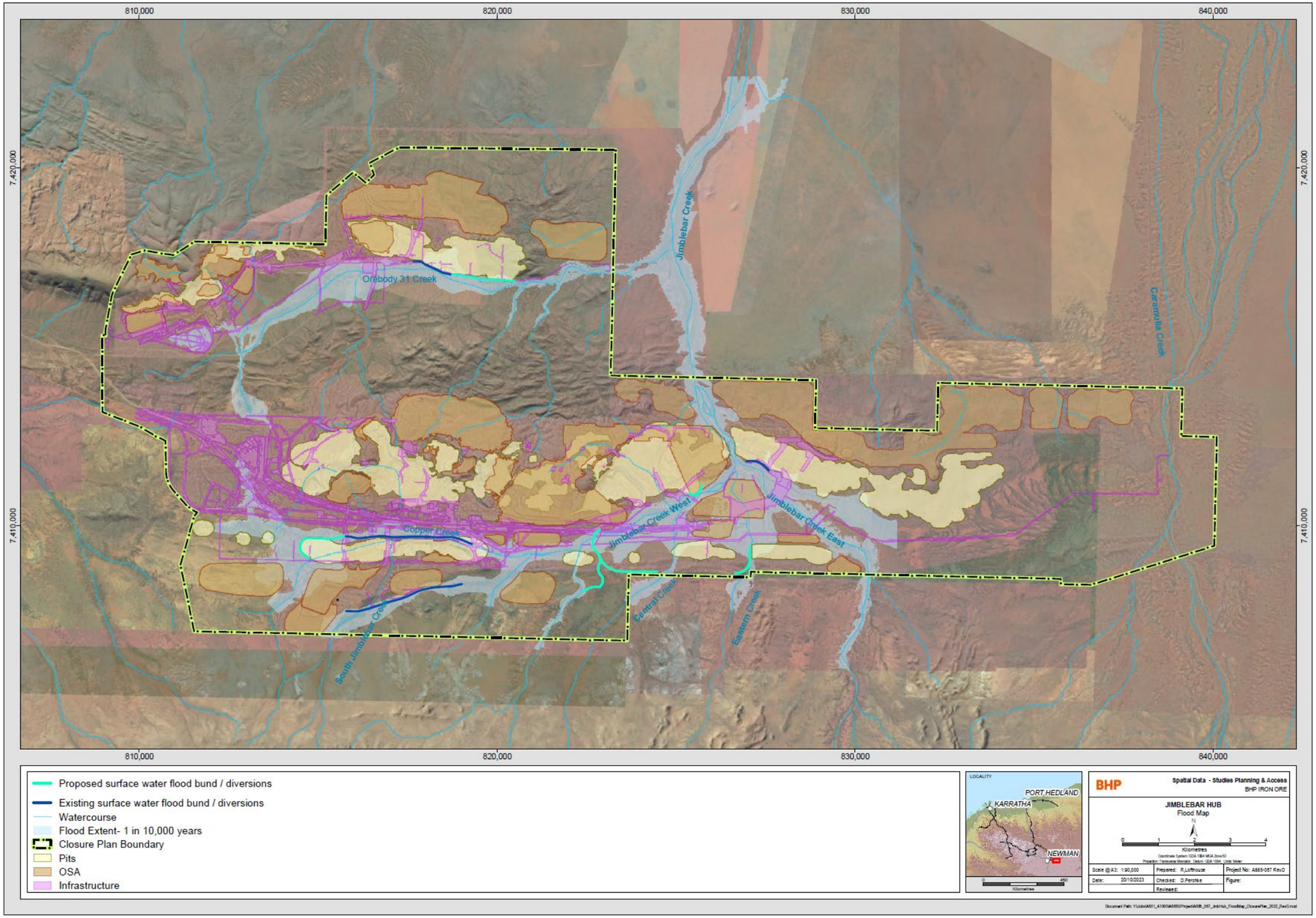
Source: Surface Water Consulting (2021)

Map 5-12 Cumulative catchment areas for Jimblebar Creek and modelled nodes



Source: Surface Water Consulting (2021)

Map 5-13 RORB schematic sub-catchment & flow path delineation



Refer to Appendix Q for pdf version

Map 5-14 Jimblebar catchment 1 in 10,000-year flood extent

Orebody 31 Creek flood modelling

Modelled 100-year flood extents (RPS, 2019a) intersect the planned OB31 pit and detailed modelling of events up to a 1% AEP (1 in 100-years) was conducted to calculate peak flows to inform the operational design for the Orebody 31 Creek flood bund (Section 5.16.3.2). The peak flows were calculated using the RAFTS method and the 1% AEP peak flow at the Orebody 31 Creek flood bund was modelled to be 82.6 m3/s (RPS, 2021).

Details of the Orebody 31 Creek flood bund design are discussed in Section 5.16.3.2.

Copper Creek flood modelling

RPS (2019b) conducted flood modelling to inform the design of the Copper Creek flood bund proposed for construction to the north of the Jimblebar South Sylvania pits (refer to Section 5.16.3.3). The catchment of the creek is impacted by the proposed diversion of the South Jimblebar Creek tributary (Section 5.16.3.4) which flows into Copper Creek (see sub-section below for discussion of South Jimblebar Creek flows). Without the South Jimblebar Creek diversion, Copper Creek has a total catchment area of 56 km² at the eastern end of the Sylvania pits and 73 km^2 at the confluence with Jimblebar Creek. With the diversion in place, the Copper Creek catchment is reduced to area of 56 km² at its confluence with Jimblebar Creek, 39 km² at the eastern end of the Sylvania pits and 32 km^2 at the western end of the Stage 2 pit (RPS, 2019b).

RAFTS was used to estimate flood discharge flows and the Regional Flood Frequency Estimation (RFFE) Model was used to estimate flood patterns. With the South Jimblebar Creek diversion in place, flood flows are estimated to be (RPS, 2019b; 2020):

- 59 m^3/s (100-year ARI) and 193 m^3/s (10,000-year ARI) at the western end of the Stage 2 (Mindoona) pit.
- 79 m^3/s (100-year ARI) and 243 m^3/s (10,000-year ARI) at the eastern end of the Stage 1 (Mindoona) pit.

The Stage 4 pit is not impacted by the South Jimblebar Creek diversion, and 100-year and 10,000-year flows have been estimated to be 60 m^3/'s and 180 m^3/s, respectively (RPS, 2022).

Jimblebar West Branch, Central Creek and Eastern Creek flood modelling

RPS (2022) assessed peak floods for the Jimblebar Creek West Branch, Central Creek and Eastern Creek catchments that impact on the WHASH H1A1 pit (Section 5.16.3.6) and the South Jimblebar SJG2 / SJH2 (Capricorn) pits (Section 5.16.3.5) using RAFTS modelling. The 100-year and 10,000-year ARI modelled peak flood estimates are shown in Table 5-62.

Table 5-62 Jimblebar Creek West Branch, Eastern Creek and Central Creek peak flood estimates

AEP (%)	ARI (yrs)	Flows (m^3/s)			
		Jimblebar Ck West Upstream of Copper Creek (47.7 km²)	Central Ck (23.5 km²)	Eastern Ck (27.3 km²)	Jimblebar Ck West at H1A1 (176 km²)
1%	100	71	38	27	271
0.01	10,000	215	130	108	810

Source: RPS (2022)

Jimblebar Creek East Branch

To inform the flood bund at Hashimoto H2B1 pit (Section 5.16.3.7), RAFTS was used to estimate the peak flow estimates from the contributing catchments along Jimblebar Creek East Branch (Table 5-63) (BHP, 2022k).

Table 5-63 Jimblebar Creek East Branch peak flow estimates

AEP (%)	ARI (yrs)	Peak flows (m^3/s) Jimblebar Creek East Branch (total catchment area 188 km²)			
		West Catchment (18 km²)	Central Catchment (157 km²)	East Catchment (10 km²)	North-East Catchment (4 km²)
1	100	49	238	29	15
0.01	10,000	121	633	71	35

Source: BHP (2022k)

South Jimblebar Creek flood modelling

To inform the design of the South Jimblebar Creek diversion (Section 5.16.3.4), peak flows were estimated up to the 1% (100-year) AEP event using RAFTS from contributing catchments (Table 5-64) (RPS, 2020).

Table 5-64 South Jimblebar Creek peak flow estimates

AEP %	ARI (Yr)	C1 (16.1 km²)	C2 (3.1 km²)	C3 (4.0 km²)
1	100	35.3	10.2	13.3

Source: RPS (2020)

Innawally Pool flood modelling

Flows at Innawally Pool have been used to inform the design of the Hashimoto H2B1 flood bund study (Section 5.16.3.7). 1 in 100-year flows have been estimated as 549 m^3/s and 1 in 10,000-year flows have been estimated as 2,357 m^3/s[28] (BHP, 2022k; Surface Water Consulting, 2021).

5.11.1.5 Surface water quality

RPS Aquaterra (2014b) recorded the surface water quality around the Jimblebar Hub area and adjacent creek systems as fresh with typically <500 mg/L total dissolved solids (TDS) and pH 6-8 (neutral). Surface water quality data collected between 1997 and 2008[29] is provided in Table 5-65 along with water quality data for Innawally Pool prior to the commencement of mining in the adjacent WHASH and H234 pits, and recent data for Jimblebar and Copper creeks (both upstream of the mining area and downstream of surplus water discharge areas). The data has been compared to some internal trigger values[30]. A brief analysis of data follows, however, BHP has a forward work program to conduct a more detailed analysis of existing data and review the suitability of the current surface water quality sampling program to inform closure and completion criteria. The outcomes of this review will be included in future iterations of this MCP.

Surface water quality samples can only be obtained when creeks are flowing which limits the number of samples that can be obtained during sampling campaigns. The time that samples are taken can also influence water chemistry. For example, during a high flow event, suspended solids may be high (upstream as well as downstream) due to the sediment mobilised by the energy of these events. Table 5-65 indicates that during the period 2019 - 2022, there were some exceedances of internal targets as follows:

- Minor exceedances of the target for copper (0.0014 mg/L) were detected at all locations with the highest value being at the OB31 downstream sampling location (0.006 mg/L). However, a copper level in a similar range (0.004 mg/L) was also detected at the Jimblebar upstream sampling location.
- Iron levels of 3.7 mg/L were detected in Jimblebar Creek upstream (compared to an internal target of 0.92 mg/L) and levels up to 2.2 mg/L at downstream locations. These values are commensurate with those from 1997 - 2008.
- A minor exceedance for manganese occurred at the Jimblebar downstream location (2.1 mg/L compared to a target of 1.9 mg/L).
- Exceedances of the nitrate target (0.7 mg/L[31]) were detected at all locations, including the Jimblebar upstream location (2 mg/L), with the highest values detected at Innawally Pool (3.4 mg/L). Nitrate was not analysed between 1997 and 2008.
- One minor exceedance of the pH target range (pH 7 - 8) occurred at the OB31 downstream location (pH 8.1).
- One minor exceedance of the sulphate target (50 mg/L) was detected downstream of OB31 discharge (58 mg/L).
- One exceedance of TDS occurred downstream of OB31 discharge (600 mg/L compared to 500 mg/L).
- One exceedance of alkalinity was detected downstream of OB31 (750 mg/L compared to 560 mg/L).

28 The design study for H2B1 flood bund approximated 10,000-year flood conditions from published BoM data for a 1.25 x 2,000-year event and as a result used a slightly lower peak flow to provide an indication of design modifications that may be required at closure. However, this difference is not significant since further studies will be conducted closer to the time of closure to take into account modifications to the site footprint and to determine the flows on which closure bund designs should be based.

29 Approval to commence mining at Wheelarra Hill (WH 4) was provided in 1988, but this was not expanded to South Jimblebar and Hashimoto deposits until 2011.

30 Trigger values are an operational management tool and exceedance of the trigger values does not imply an environmental impact.

31 It should be noted that this target is consistent with ANZECC / ARMCANZ (2000), but recent studies have shown that the background level of nitrate in the Pilbara is typically higher than this and in the order of 2 mg/L.

Table 5-65 Surface water quality ranges

Analyte	Units	Internal Target	"Baseline Data" (1997 - 2008)				Innawally Pool Baseline (2019) Prior to Mining WHASH / H234	Sample Results 2019 - 2022			
			Jimblebar Creek Upstream	Jimblebar Creek Downstream	Copper Creek Upstream	Copper Creek Downstream		Jimblebar Creek Upstream	Jimblebar Creek Downstream	Copper Creek Downstream	OB31 Discharge Downstream
No of Samples	n/a	-	5	5	2	5	1	5	3	3	2
Sampling Dates	n/a	-	1997 to 2008	1997 to 2008	1997 to 1998	1997 to 2008	2019	2019 - 2022	2019 - 2021	2019 - 2022	2020 - 2021
Conductivity	µS/cm	-	43 – 180	39 - 240	43 - 45	48 - 280	n/r	n/r	n/r	n/r	n/r
Bicarbonate	mg/L	-	15 - 85	15 - 130	5 - 10	5 - 65	n/r	n/r	n/r	n/r	n/r
Carbonate	mg/L	-	<1	<1	<1	<1	n/r	n/r	n/r	n/r	n/r
Aluminium	mg/L	0.95	<0.1 - 0.2	<0.1 - 0.11	0.3 - 0.7	<0.01 - 0.2	0.012	<0.005 - 0.28	<0.005 - 0.043	<0.005 - 0.25	<0.005 - 0.059
Arsenic	mg/L	0.03	0.002	0.001 - 0.002	n/r	0.001 - 0.003	<0.001	<0.001	<0.001	<0.001	<0.001 - 0.004
Barium	mg/L	0.42	0.04	0.02 - 0.05	n/r	0.02 - 0.04	0.031	0.008 - 0.052	0.012 - 0.11	0.004 - 0.12	0.064 - 0.068
Boron	mg/L	2.7	n/r	n/r	n/r	n/r	0.11	0.011 - 0.027	0.015 - 0.072	0.027 -0.051	0.093 - 0.11
Cadmium	mg/L	0.0002	<0.001	<0.001	n/r	<0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001 - 0.0001
Calcium	mg/L	217	0.2 - 15	0.1 - 10	1.9 - 4.4	3 - 11	17	1 - 9	2.6 - 15	2.9 - 11	4.9 - 37
Chloride	mg/L	964	<5 - 19	5 - 15	<1 - <5	5 - 37	37	1 - 3	3 - 140	3 - 13	74 - 91
Chromium	mg/L	6	<0.005	<0.005	n/r	<0.005	<0.001	<0.001	<0.001	<0.001	<0.001 - 0.001
Copper	mg/L	0.0014	<0.005 - 0.04	<0.005 - 0.03	<0.01 - 0.01	<0.005 - 0.01	0.003	<0.001 - 0.004	0.001 - 0.003	0.001 - 0.005	<0.001 - 0.006
Fluoride	mg/L	1.6	n/r	n/r	n/r	n/r	0.2	<0.1	<0.1 - 0.1	<0.1 - 0.1	0.1 - 0.2
Iron (soluble)	mg/L	0.92	<0.1 - 2.8	<0.1 - 12	<0.1 - 0.3	<0.1 - 0.2	0.014	<0.005 - 3.7	<0.005 - 0.045	0.007 - 0.18	<0.005 - 2.2
Lead	mg/L	0.006	<0.005	<0.005	n/r	<0.005	<0.001	<0.001	<0.001	<0.001	<0.001
Magnesium	mg/L	175	3 - 8.8	1.2 - 20	0.7 - 1.2	1.1 - 5.8	8.5	0.4 - 2.4	1 - 5.4	1.2 - 7.6	10 - 25
Manganese	mg/L	1.9	<0.01 - 0.5	<0.1 - 0.36	<0.01 - 0.04	<0.01 - 0.36	0.03	<0.001 - 0.89	<0.001 - 2.1	<0.001 - 0.25	<0.001 - 0.51
Mercury	mg/L	0.002	<0.0005	<0.0005	n/r	<0.0005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Molybdenum	mg/L	0.02	<0.1	<0.1	n/r	<0.1	0.001	<0.001	<0.001	<0.001	<0.001 - 0.001
Nickel	mg/L	0.04	<0.005	<0.005	n/r	<0.005	0.001	<0.001 - 0.002	<0.001 - 0.002	<0.001 - 0.001	<0.001 - 0.003
Nitrate (as NO_3)	mg/L	0.7	n/r	n/r	n/r	n/r	3.8	<0.05 - 2	<0.05 - 1	<0.05 - 3.2	<0.05 - 0.15
pH	pH units	6 to 8	6.2 - 7.9	5.8 - 7.5	6.1 - 6.6	6.3 - 7.1	7.4	6.7 - 7.5	7.1 - 7.5	6.9 - 7.5	7.4 - 8.1
Potassium	mg/L	87	2 - 28	2.6 - 20	2 - 3.2	0.2 - 5.1	5.8	2.8 - 4.6	1.7 - 4.9	2.7 - 4.2	11 - 73
Selenium	mg/L	0.01	<0.01	<0.01	n/r	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001 - 0.006
Sodium	mg/L	613	21	1.3 - 22	n/r	8-10	24	<0.5 - 3.5	1.9 - 11	1.9 - 21	29 - 39
Soluble silicon (as SiO_2)	mg/L	103	n/r	n/r	n/r	n/r	6.2	2.7 - 17	3.6 - 13	4 - 13	11 - 16
Sulphate	mg/L	50	<5 - 10	3 - 10	1.8 - 3.2	2 - 32	43	<1 - 2	4 - 21	4 - 22	36 - 58
TDS	mg/L	500	30 - 120	25 - 160	30	30 - 180	210	13 - 150	86 - 130	26 - 170	340 - 600
Alkalinity (as $CaCO_3$)	mg/L	560	10 - 70	10 - 100	4 - 5	5 - 55	40	<5 - 47	14 - 63	12 - 55	140 - 750
Total Hardness (by calc. as $CaCO_3$)	Mg/L	-	n/r	n/r	n/r	n/r	78	8 - 33	11 - 50	56 - 67	190
Total Suspended Solids	mg/L	-	<5 - 5,400	<5 - 6,200	130 - 630	430 - 3,500	47	<5 - 4,500	170 - 1,800	230 - 710	80 - 2,700
Zinc	mg/L	10	<0.01 - 0.02	<0.01-0.4	0.02 - 0.11	0.04 - 0.08	<0.005	<0.005	<0.005	<0.005	<0.005 - 0.039

Source: BHPBIO (2010)
Notes: n/r - not recorded

5.11.2 Groundwater

Summary of key points:

- The regional aquifer is composed of the Paraburdoo dolomite and the Tertiary Detritrals. The regional pre-mining water table is typically 50 m or more below the ground surface with the main flow direction being towards the east. However, an area in the south and southeast corner of the OB31 project area had a pre-mining depth to groundwater of between 5 to 25 m below ground level and a surface drainage floodway in the central Capricorn deposit (not yet mined) has a groundwater level of ~25 m below ground surface.
- The Jimblebar and OB17/18/31 groundwater systems are disconnected as the Wheelarra Fault behaves as a barrier to groundwater flow and separates the groundwater systems of the two areas.
- At Jimblebar:
  - The regional aquifer extends from the Wheelarra Fault in the west to an inferred flow boundary ~40 km to the east. The local aquifers are made up of the Brockman Iron Formation orebodies in the north and the Marra Mamba Formation orebodies in the south (with the regional aquifer between them).
  - The Central Fault (a dolerite dyke) behaves as a barrier to groundwater flow through both the regional and local aquifers. This separates the Jimblebar groundwater system into two compartments; a western compartment (containing the Mindoona, Sylvania and WH123 mining areas) and an eastern compartment (containing the Capricorn, WHASH, Hashimoto and East Jimblebar mining areas). There is some connection across the dyke in the area of WHASH.
  - The orebody and regional aquifers in the western compartment are well connected to each other, however, the fault structures in the area of WH2/3 provide a partial barrier to flow.
  - The orebody and regional aquifers in the eastern compartment also seem well connected although there is still significant uncertainty which can only be addressed during monitoring of dewatering operations. The data collected to date indicate that the northern orebodies may be well connected along strike i.e., WHASH, Hashimoto, East Jimblebar and Caramulla.
  - The groundwater levels south of the Marra Mamba orebodies are much higher than the local and regional aquifer levels and show no response to dewatering. This suggests the presence of low permeability rocks to the south.
  - To the north, it is possible that some permeability (either within the rock mass or through structures) persists in that direction.
- At OB17/18/31
  - The regional aquifer is continuous between the Ethel Gorge TEC aquifer and OB17/18/31. However, there are at least two partial flow barriers between OB17/18/31 and the TEC. These are likely dykes which are present in the dolomite and orebody aquifers, but not the Tertiary Detritals (hence flow can still occur in the saturated thickness of the Tertiary Detritals, but at a reduced rate).
  - Current data show that the regional aquifer does not directly flow into the Ethel Gorge TEC, rather just to the north of it (hence any flow from OB17/18/31 would not be expected to interact with the TEC).
  - There is no hydraulic connection to the north of the OB17/18/31 orebodies.
  - OB31 is hydraulically connected to the regional aquifer to the south.
  - The OB17 (Swan) orebody is hydraulically disconnected from the regional aquifer directly to the south but is connected to the OB31 aquifer and, therefore, has an indirect connection to the regional aquifer south of OB31.
  - The OB18 (De Grey) aquifer is not directly or indirectly hydraulically connected to the regional aquifer, or adjacent orebodies.
- Groundwater at both OB17/18/31 and Jimblebar is fresh to brackish with generally low metals. Some minor and / or isolated exceedances of internal trigger values[32] for boron, chromium and zinc have been observed at Jimblebar and exceedances of internal trigger values for iron, zinc and barium have been noted at De Grey pit. The nitrate trigger value has also been exceeded in the Wittenoom Formation at OB17/18/31 and at Jimblebar, with the most significant exceedances being at the Regional West area (west of WH123 pits).

5.11.2.1 Regional hydrogeology

The pre-mining regional water table is typically 50 m below the ground surface (Aquaterra, 2009). The regional aquifers which are located through the central valleys of the Jimblebar area are made up of (BHP, 2021l):

- Weathered Paraburdoo (and Bee Gorge) members of the Wittenoom Formation. The Paraburdoo dolomite in particular, can be karstic and highly permeable.

[32] Trigger values are an operational management tool and exceedance of the trigger values does not imply an environmental impact.

- Sand and gravel occurrences in the Tertiary Detritals. The detritals are very thick in places, reaching up to 360 m thick in some areas (Jimblebar). These units are characterised by primary permeability and porosity with secondary weathering-induced permeability in calcrete horizons.

The Wittenoom Formation and Tertiary Detritals aquifer units are considered to be in hydraulic connection.

The Wheelarra Fault behaves as a barrier to groundwater flow and separates the Jimblebar area from the Shovelanna area (OB17/18/31). Groundwater levels recorded in exploration holes at the western end of South Jimblebar (west of the fault) show an average 50 m difference in hydraulic head across the fault. Within the vicinity of Wheelarra Hill, this difference in hydraulic head varies from around 26 to 80 m; the magnitude of the water level difference varying along strike with changes in the geology on the northern side of the fault. The most recent observations show groundwater levels lower by many metres on the southern side of the fault (due to abstraction at South Jimblebar), whilst they have remained relatively unchanged on the northern side. The fault is mapped as being continuous to the north and south and, as the movement along it has been estimated to be about 10 km, it is likely that the conceptually lower permeability granites will provide a continuous barrier to flow along the southwestern boundary of the groundwater catchment at Jimblebar (i.e., directly west of South Jimblebar) (BHP, 2019c; BHP, 2021l). Given the separation of the groundwater systems at OB17/18/31 and Jimblebar due to the fault, the conceptual models for the Shovelanna (OB17/18/31) and Jimblebar areas are described separately in Sections 5.11.2.2 and 5.11.2.3, respectively.

5.11.2.2 OB17/18/31 conceptual model

The conceptual model for OB17/18/31 and its connection with the Ethel Gorge TEC aquifer was updated in 2022 based on a review of recent and historical groundwater monitoring data (BHP, 2022g; 2022h). This updated model (described below) refines our previous understanding of the flow pathways between Ethel Gorge TEC and the regional aquifer in the OB17/18/31 mining area and indicates that the regional aquifer does not lead directly into the TEC, rather just to the north of it.

Groundwater levels

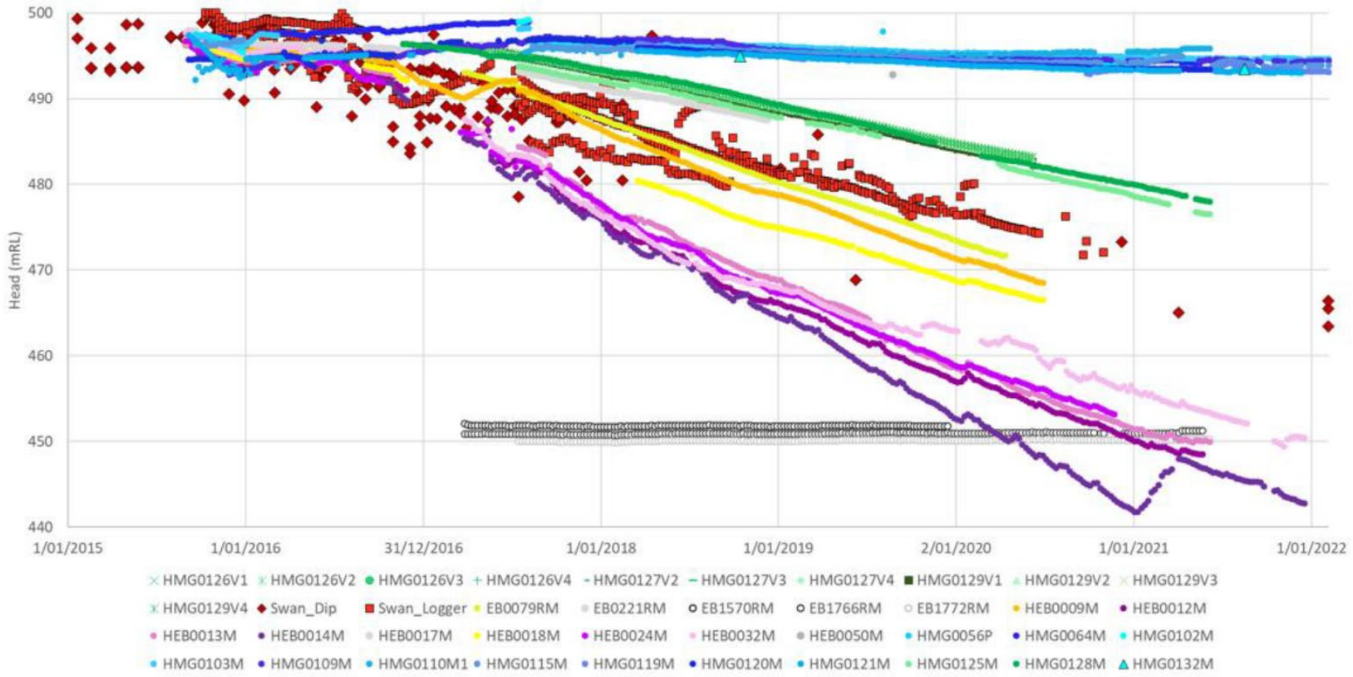
Pre-mining groundwater levels in the OB17/18/31 area ranged between 496 mRL and 507 mRL (generally 30 mbgl in the vicinity of OB31 to 40 mbgl at OB18).

Connection between OB17/18/31, regional aquifer and the Ethel Gorge TEC

The regional weathered dolomite and Tertiary Detritals aquifer is continuous from just to the north of the Ethel Gorge TEC aquifer to the south of OB17/18/31. The dolomite runs in a roughly straight line (striking WNW – ESE) from the Ethel Gorge TEC for about 15 km before making a turn north (just to the southwest of OB18) where it then continues (in a NE – SW direction) for another 6 km before reaching OB31. Prior to dewatering at OB31 (2017), the groundwater level in the regional aquifer was approximately 498 mAHD south of OB17/18/31 falling to approximately 495 mAHD to the north of the Ethel Gorge TEC. Groundwater management activities in the area have been ongoing since 2005 however, which makes any conclusions from the analysis of water levels uncertain. Time variant groundwater monitoring throughout this time and area show that (BHP, 2022h):

- The regional aquifer presents a high transmissivity and hydraulic homogeneity.
- To the north of the regional aquifer lies the Brockman Iron Formation and to the south is the Marra Mamba Formation. These form a relatively continuous ridge to the north and some isolated ridges to the south. They host numerous orebodies which form local aquifers.
- The lithology to the north of the OB17/18/31 orebodies presents a very low permeability and there is, therefore, no hydraulic connection to the north of these orebody aquifers, as shown in Figure 5-48 (white) by the over 40 m head difference and the lack of response in the water levels once dewatering of OB17/18/31 commenced compared to the rest of the observations.
- The Brockman Iron Formation to the north of OB17, which is outside of BHP tenure, should be considered a continuation of the OB17 orebody aquifer.
- OB31 has a direct hydraulic connection to the regional aquifer in the south.
- The OB17 (Swan) orebody is hydraulically disconnected from the regional aquifer directly to the south but is connected to the OB31 aquifer and, therefore, has an indirect connection to the regional aquifer south of OB31. Hydraulic connection between the Swan aquifer and the OB31 aquifer (rather than direct connection between the Swan aquifer and regional aquifer) is evidenced in Figure 5-48 by the steady decline in Swan aquifer heads (red) which are lower than the regional aquifer heads (blue and green) and higher than the OB31 aquifer heads (purple). This connection between OB31 and Swan orebody must, however, be relatively constrained by low to moderate transmissivity material between the orebodies (otherwise dewatering rates from Swan would have been much higher).
- The OB18 (De Grey) aquifer is not directly or indirectly hydraulically connected to the regional aquifer, or adjacent orebodies.

The conceptual model for the OB17/18/31 mining area is summarised in Map 5-15.



Source: BHP (2022g)

Figure 5-48 Groundwater level hydrographs

There are at least two partial flow barriers (probably dykes) across (perpendicular to) the regional aquifer flow path between OB17/18/31 and Ethel Gorge TEC. These form the following three distinct aquifer compartments between OB31 and the TEC (Map 5-16):

- Warrawandu / Ninga MAR compartment.
- Mesa Gap compartment.
- OB17 (Swan) / OB31 compartment.

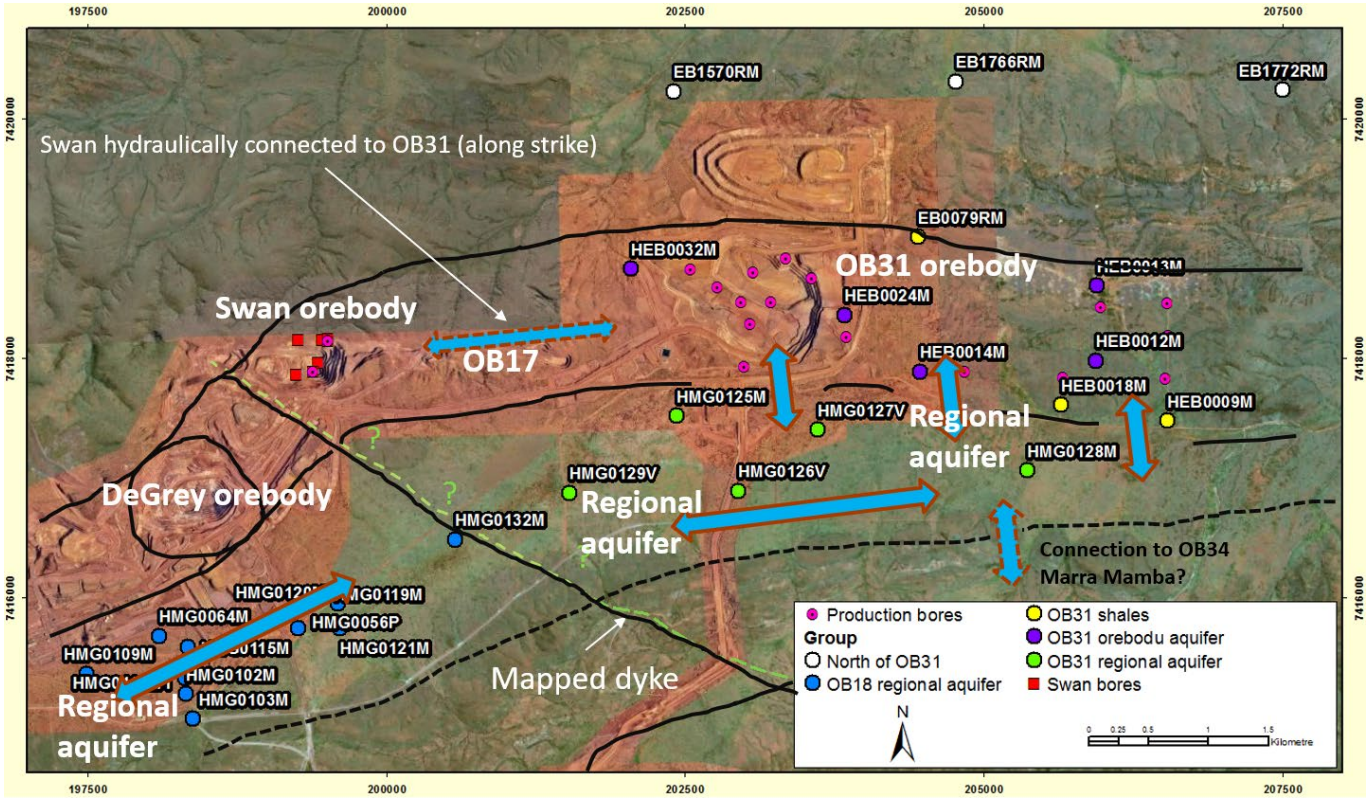
The historical monitoring data shown in Figure 5-48 provides evidence for the high transmissivity of the regional aquifer and the effect of the partial flow barriers by the uniform but diverging regional aquifer heads (blue and green) (BHP, 2022h).

The dykes (partial flow barriers) will be present in the bedrock (i.e., cut through the dolomite and orebody aquifers) but absent in the Tertiary Detritals above. The Tertiary Detritals are likely to be saturated up to a few tens of metres in these locations, and depending on their hydraulic characteristics, some flow will occur above the dyke through the saturated detritals, but at a greatly reduced rate compared to the flow in the dolomite (BHP, 2022h).

The OB17/31 orebodies are within the compartment furthest from the TEC. This compartment is defined by flow barriers on all sides (Map 5-16) and appears to present the highest groundwater levels in the area. If the heads are higher in the OB31 regional aquifer (and adjacent orebody aquifers) than in Mesa Gap, and above the top of the dyke, then flow will occur from OB31 to Mesa Gap. The flow direction from Mesa Gap is almost certainly to the west, towards Ethel Gorge TEC; the exploration data suggest that the heads in the OB31 regional system in 2012 and 2013 were a few metres higher than the heads across the dyke to the west (Mesa Gap) and at this time flow would have occurred to the west (BHP, 2022g; BHP, 2022h).

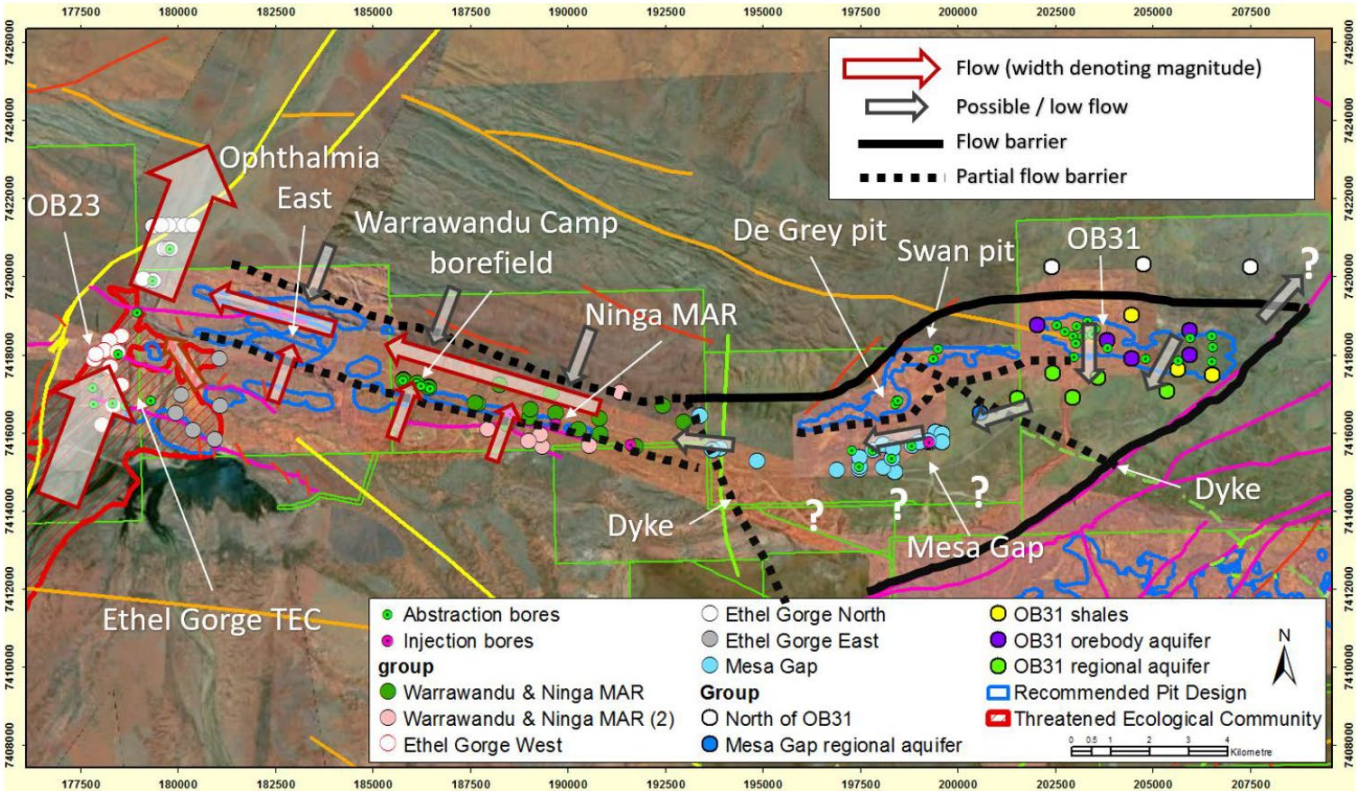
Current data show that the regional aquifer does not flow directly into the Ethel Gorge TEC, rather just to the north of it (Map 5-16). From this point, the flow direction is to the north (away from the TEC), as indicated by time variant data and the groundwater level data from 2017 (Map 5-17).

The aquifers supporting the TEC may contribute some flow into the Warrawandu / Ninga MAR / Ophthalmia East regional aquifer. But flow will not occur the other way around (i.e., flow from Mesa Gap travels to the north of the Ethel Gorge TEC and then joins the main flow path which continues north) (Map 5-17) (BHP, 2022h).



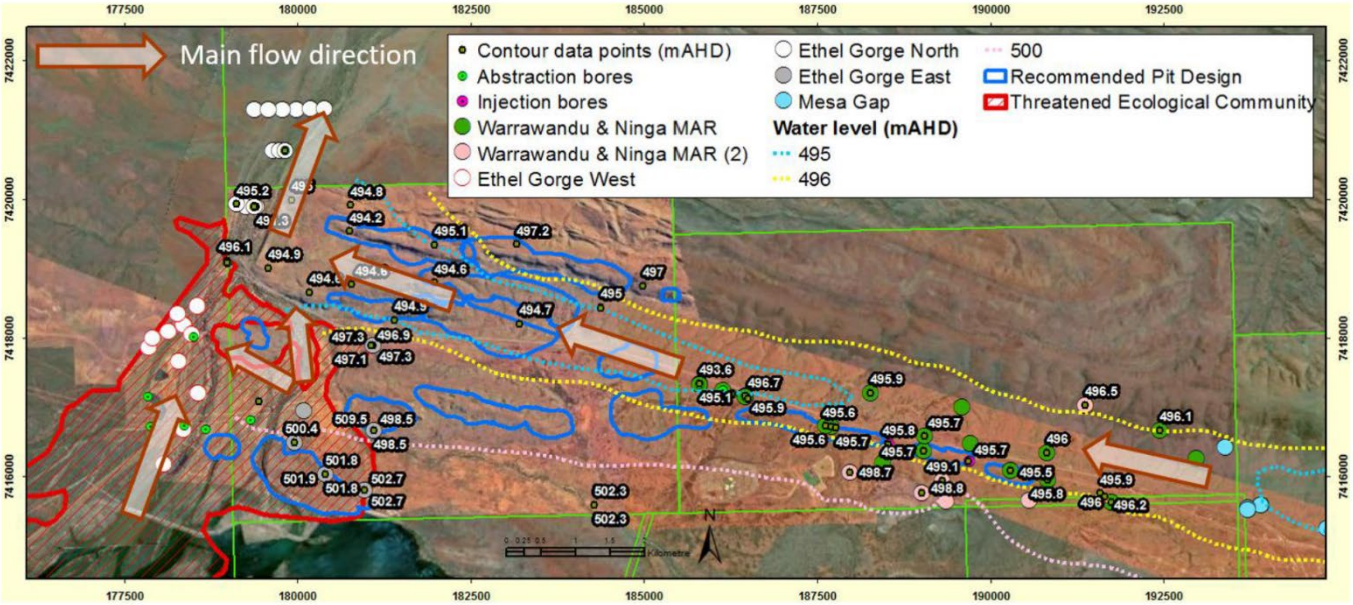
Source: BHP (2022g)

Map 5-15 Conceptual model for the OB17/18/31 mining area



Source: BHP (2022h)

Map 5-16 Conceptual model - flow between OB17/18/31 and Ethel Gorge TEC



Source: BHP (2022h)

Map 5-17 Groundwater levels in 2017

5.11.2.3 Jimblebar conceptual model

The conceptual model for Jimblebar outlined below includes reference to some deposits for which approval to mine has not yet been sought (Caramulla north and south). The areas around these deposits have been included in the description below as they are important to the conceptual understanding of the Jimblebar groundwater system.

Groundwater levels and regional flows

The regional aquifer at Jimblebar extends all the way from the Wheelarra Fault in the west to an inferred flow boundary approximately 40 km to the east (BHP, 2023c).

Pre-development groundwater levels were relatively flat in the Jimblebar development envelope, particularly in the areas of the orebody and regional aquifers. The general groundwater flow direction was probably from the orebody and regional aquifers to the north and out of the catchment. The extent of outflow to the north is unknown due to limited pre-development head data. It is hypothesised that groundwater may flow to the north beneath the WHASH, Hashimoto, East Jimblebar and Caramulla North orebodies where heads are marginally lower (range from 454 - 459 mRL). There may be some inflow from the southern bedrock into the Marra Mamba orebodies where heads are significantly higher, but the rocks are most likely very low permeability (BHP, 2021l).

Pre-development depth to groundwater was (BHP, 2021l):

- Wheelarra: WH123 ~100 m; WH4 >110 m.
- WHASH: >80 m.
- Hashimoto: >70 m.
- East Jimblebar: >90 m.
- South Jimblebar: Sylvania and Mindoona ~80 m; Capricorn ~70 m; Painkiller ~ 70 m.
- Caramulla: ~65 m.
- Valley alluvial fill (Tertiary Detritals): South Jimblebar area 100 m (west) to 50 m (east); East Jimblebar / Caramulla area 50 m.

The opportunity for direct interaction between the groundwater and surface water systems in the Jimblebar area is limited by the significant depth to groundwater over the entire area, and groundwater is typically well below the root zone of vegetation. Infiltration of surface water contributes to soil moisture budgets which support the different vegetation environments. The shallowest depth to groundwater is associated with a surface drainage floodway which occurs in the central Capricorn deposit of South Jimblebar. Water levels here are about 25 m below ground surface (BHP, 2021l).

Aquifers and flows

The orebody aquifers at Jimblebar are made up of mineralised and sub-mineralised material of the:

- Marra Mamba Formation, which forms an almost continuous east / west striking aquifer in the south. Some of these orebodies reach depths of about 350 mRL (~110 m below water table).
- Brockman Iron Formation, which forms discontinuous east / west striking aquifers in the north. Whilst they are discontinuous, they can be very large, as in the case of the WHASH orebody. The WHASH orebody reaches a depth as low as 324 mRL

(~140 m below water table) and the WH123 orebody reaches a maximum depth of about 354 mRL (~110 m below water table).

The orebody and regional bedrock aquifers are separated by the various shale members of the Wittenoom and Brockman Iron Formations. The West Angela Shale is found to the north of the Marra Mamba orebodies and the Mt McRae and Mt Sylvia shales are present to the south of the Brockman orebodies. In some areas, the Tertiary Detrital aquifers are in direct contact with the orebody aquifers whereas in others, they too are separated by the shale formations (BHP, 2021l).

The bedrock to the south of the Marra Mamba orebodies is made up of shales and dolerites of the Jeerinah Formation and granites of the Sylvania Inlier. Whilst the Jeerinah Formation may have a moderate permeability, particularly in the west of the area, the granites form a hydraulic barrier to the south of Jimblebar, as evidenced by the very high groundwater levels and lack of an obvious response to dewatering (BHP, 2021l).

The bedrock north of the Brockman orebodies consists of Yandicoogina Shale and Weeli Wolli Formation. These units are conceptually low permeability and form a hydraulic barrier to the north. However, the permeability of this material may be higher than the granites to the south, as evidenced by the flatter groundwater heads and the hypothesised through-flow out of the catchment to the north beneath WHASH (BHP, 2021l).

Even with the presence of these conceptually lower permeability materials, at a regional scale, all the aquifers are assumed to present a high degree of hydraulic connection. For example, dewatering of the southern Marra Mamba orebodies has been observed to significantly reduce groundwater levels in the northern Brockman orebodies. However, regional and local structures play a significant role in the Jimblebar groundwater system and generally behave as either partial or complete barriers to groundwater flow (Map 5-18 and Map 5-19). These include (BHP, 2021l):

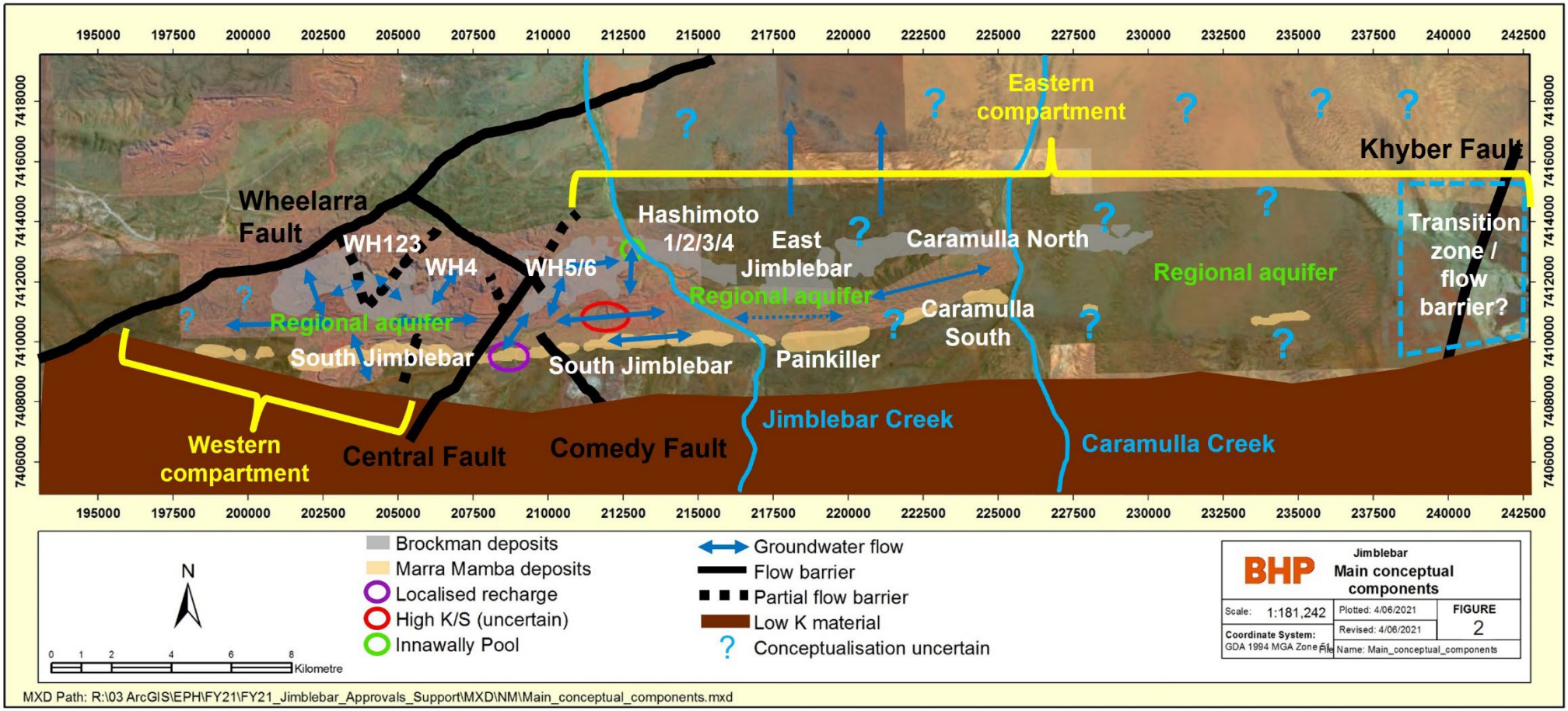
- The Wheelarra Fault (Map 5-18) which forms the western boundary to the Jimblebar groundwater catchment. The fault is a major strike-slip fault which has had the effect of bringing the granites and dolerites of the Sylvania Inlier to the north on the western side, which puts them adjacent to the Marra Mamba and Brockman orebodies on the eastern side.
- The NE-SW trending structure(s) that passes through Caramulla in the far east of the catchment (Khyber Fault on Map 5-18) is shown by observed water levels to be significant (although as yet untested by drawdown) and is likely to act as the eastern boundary to the system.
- The Central Fault which clearly separates all the aquifers into western and eastern compartments and allows very little flow across it (Map 5-18). This may happen through a combination of dyke infill (dolerite generally 10 m wide) in the bedrock part of the fault and low permeability clay in the Tertiary Detritals immediately above it. This is important because the Tertiary Detritals are saturated in this area and would otherwise enable unimpeded flow between the eastern and western sides of the fault (which does not happen). Under dewatering conditions, these western and eastern compartments on either side of the Central Fault can be thought of as separate entities. Current mine plans do not intersect the Central Fault below the water table. However, if the fault were to be removed, groundwater levels would be similar in the eastern and western compartments post-closure as they were pre-mining.
- The Comedy Fault (infilled with dolerite), which seems to be significant in the Marra Mamba orebody of South Jimblebar. The Central Dyke is thought to cut the Comedy Dyke.
- The Monster Fault (shown as B on Map 5-19) and other, unnamed, faults around WH123 form a partial barrier to groundwater flow. This effect may also be due to, or as well as, lower hydraulic conductivity bedrock in this area.

There may be other structures that are hydraulically significant in the eastern part of the Jimblebar area (e.g., the Nacho and Morton Bay faults; refer to F and G on Map 5-19) but these are only likely to become apparent after several years of dewatering of the eastern orebodies (BHP, 2021l).

All monitoring bores within the Western compartment (Map 5-18) have shown a relatively uniform response to dewatering at Mindoona 1 pit and indicate that the entire system within these stratigraphic and structural boundaries behaves in a very connected and uniform manner. The response at WH3 is subdued due to the Monster Fault and other unnamed faults in this area. Clays of the Tertiary Detritals are the only lithologies that show variable responses to dewatering (in some locations they don’t respond at all) (BHP, 2021l).

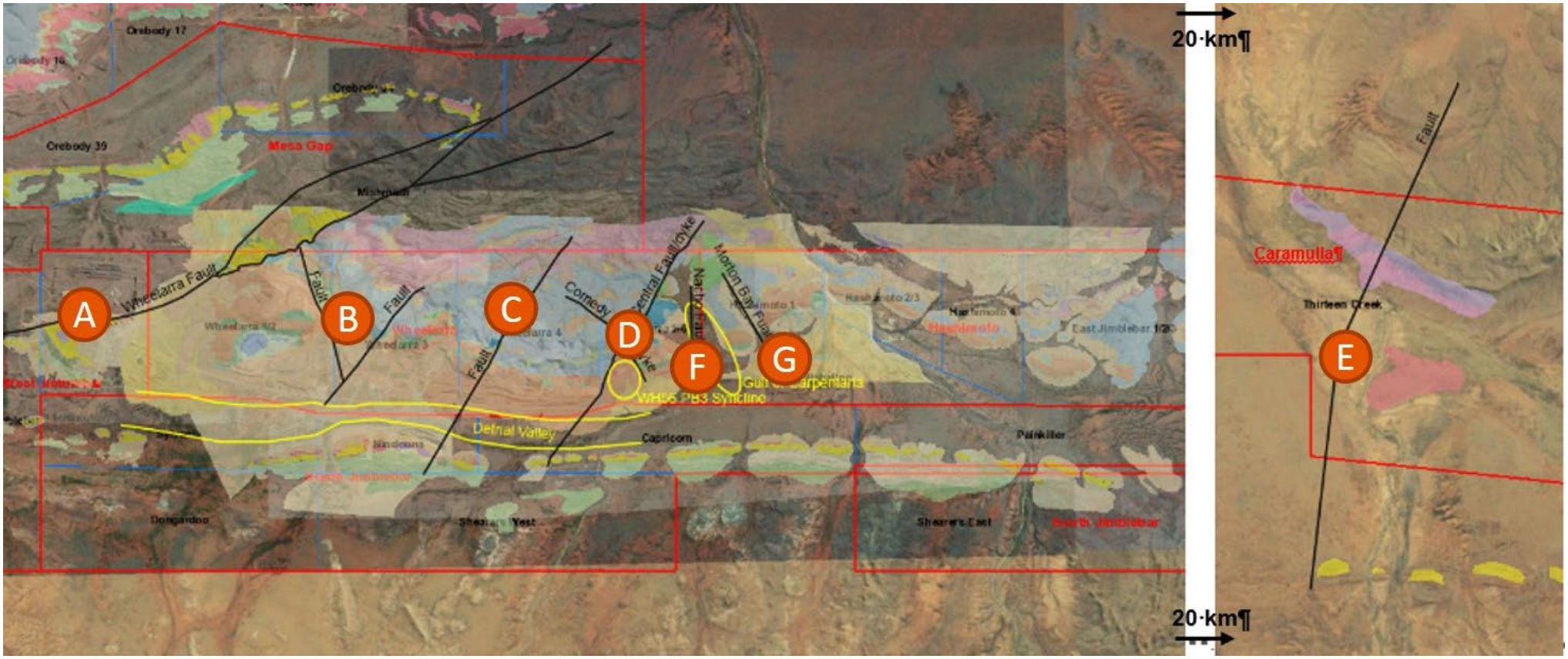
While the Central Fault behaves as a barrier to flow through the regional aquifer and southern orebodies, data from the WHASH area suggest that there is connection across the Fault to the north, through the northern orebodies.

The regional aquifer system south of WHASH shows a clear response to WHASH dewatering and is, therefore, well connected to the WHASH orebody aquifer.



Source: BHP (2021l)

Map 5-18 Conceptual groundwater model - Jimblebar



Source: BHP (2021l)

Map 5-19 Location of faults

Dewatering has not yet commenced at Hashimoto (along strike from WHASH), but all bores in the Hashimoto orebody show drawdown in response to dewatering at WHASH which suggests that these aquifers are hydraulically connected, and that the orebody aquifer is continuous in this area. Whilst data show that the full strike length of the Hashimoto orebody is responding to WHASH dewatering, there may be some heterogeneity within the orebody aquifer. There may also be some connection between the orebody and the volcanics to the north / northeast.

The heads at the Capricorn deposit (south of WHASH and south of the regional aquifer) seem to have responded to the commencement of dewatering at the eastern part of WHASH, suggesting that the Capricorn orebody is hydraulically connected to regional aquifer system (and therefore WHASH). However, there may be some hydraulic heterogeneity and possible disconnection through the Capricorn orebody aquifer itself.

All bores in the East Jimblebar and Caramulla areas have shown a response to dewatering at WHASH. The response is very consistent through the Caramulla north and south orebody aquifers and the regional aquifer system between them. There is, however, evidence to suggest that there is a hydraulic barrier to the west (through the regional aquifer system) although the nature of the hydraulic barrier is unknown at present. Connection to the regional system in this area may be primarily through the orebody aquifers of East Jimblebar and Caramulla.

The regional aquifer systems generally exhibit high transmissivity and storage. However, the system between Caramulla north and south deposits shows signs of being high transmissivity but also low storage (BHP, 2021l).

Hydraulic parameter values characteristic of the various aquifer units are summarised in Table 5-66. However, there is likely a significant degree of heterogeneity within hydro-stratigraphic units across the Jimblebar area (BHP, 2021l).

Table 5-66 Summary of key hydraulic parameters

Material	Hydraulic conductivity	Specific yield
Marra Mamba orebody aquifer	0.5 to 50 m/d	1 to 20%
Brockman orebody aquifer	5 to 100 m/d	5 to 20%
Regional aquifer (weathered dolomite)	20 m/d	5%
Regional aquifer (Tertiary Detritals)	0.001 to 50 m/d	5 to 15%

Source: BHP (2021l)

5.11.2.4 Recharge & discharge

Recharge in the area is expected to be highly variable with zones of higher recharge at the base of the ridges and along drainage lines and less recharge along the ridgelines and valley flanks (RPS, 2013b). The regional aquifer is recharged through direct rainfall infiltration over the valley, run-off from the southern side of the Wheelarra Hill ridge, and via infiltration through the alluvial material in creek lines during flood events.

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Some minor groundwater through-flow from the OB31 creek valley may contribute to recharge but overall, recharge occurs mainly by infiltration and rainfall run-off. Rainfall recharge to outcropping / sub-cropping orebody aquifers is relatively rapid and anticipated to vary between 1 and 2% of mean annual rainfall. Other than the areas around Ethel Gorge, none of the regional aquifer systems show significant responses to rainfall. In many cases the orebody aquifers to the north and south seem to present higher heads than the regional aquifer. This suggests that there is very limited direct rainfall recharge into the regional aquifer and that at least some of the inflow into it could be from the adjacent orebody aquifers. Recharge to the regional aquifer system may, therefore, be a very slow process, only occurring after significant or prolonged rainfall events (BHP, 2019c; BHP, 2022h).

Jimblebar

Recharge to the Jimblebar aquifer system via regional through-flow is estimated to be low, given the various low permeability barriers that bound the system to the west, south and east (BHP, 2021l).

The mechanism and rate of recharge is uncertain. It is likely, however, that rainfall recharge is quite infrequent and may occur only during very high rainfall events. The latest numerical modelling assumed the following rates (BHP, 2021l):

- Tertiary Detritals and South Jimblebar orebody areas (0.5% average annual rainfall).
- WH123 and WHASH orebody areas and Weeli Wolli Formation (0.25% average annual rainfall).
- Jeerinah Formation and granites to the south of orebody aquifers (0.1 to 0.01% average annual rainfall).

Due to the depth to water, discharge via evapotranspiration was not likely to contribute anything to the water balance pre-mining. It is, therefore, likely that all discharge from the system prior to mining was via flow to the north in the central part of the Jimblebar catchment (i.e., north of the WHASH, Hashimoto, East Jimblebar and Caramulla North orebodies) (BHP, 2021l).

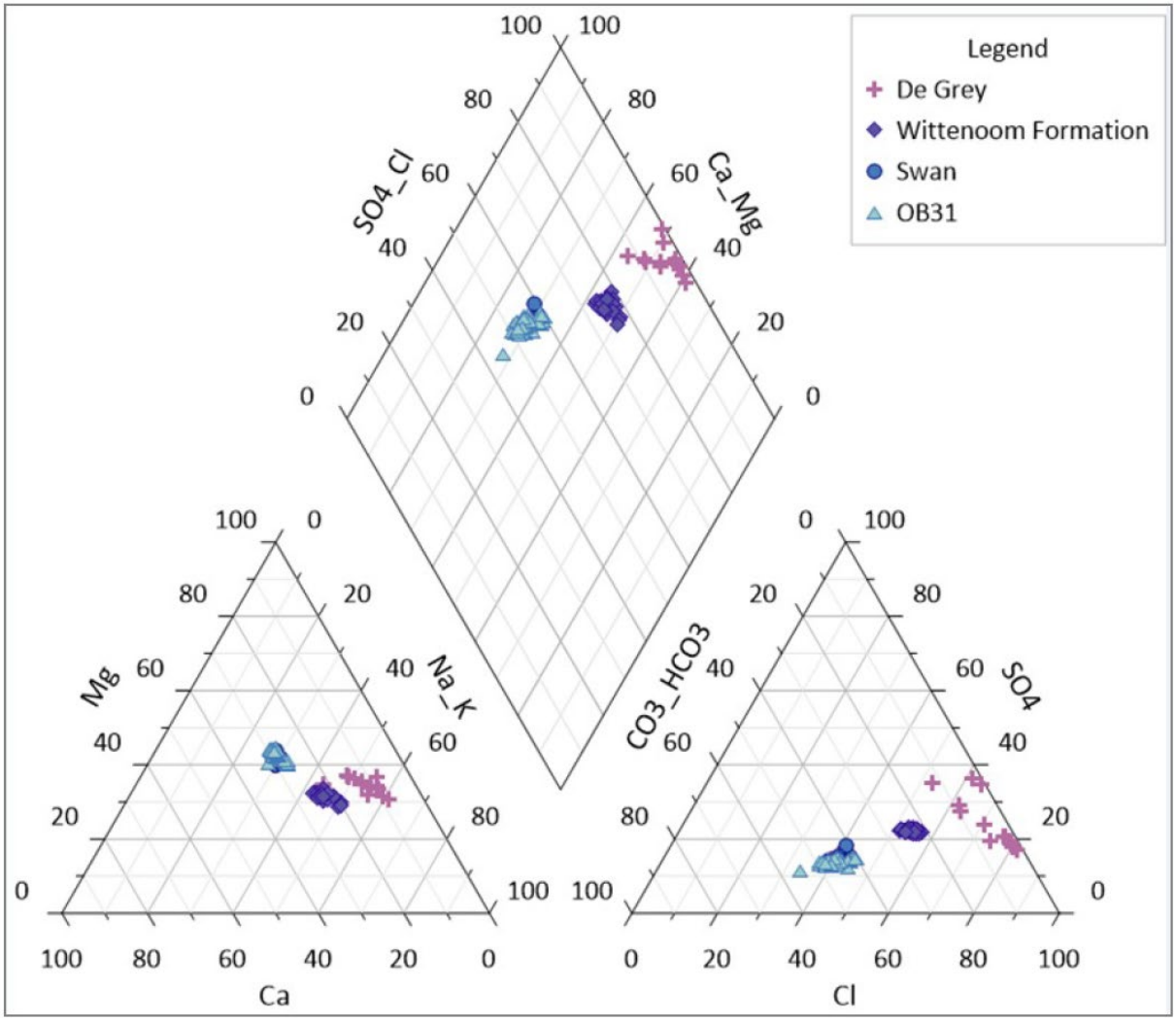
A significant amount of groundwater discharge now occurs via abstraction for both mine dewatering and water supply. There has also been some recharge in the form of injection of surplus water to the three injection bores on the eastern side of the Central Fault (BHP, 2021l).

5.11.2.5 Groundwater quality

OB17/18/31

Groundwater quality has been found to be fresh to brackish (TDS ranging 580 to 670 mg/L) and neutral to slightly alkaline (pH ranging 7.2 to 8.3).

Figure 5-49 compares the major element concentrations in groundwater from different locations in the OB17/18/31 area. The Swan and OB31 data form a relatively tight cluster, which is distinct from the Wittenoom Formation data (also a tight cluster). The De Grey data are distinct from the other data clusters. The compositional differences provide support for the supposition that the De Grey pit is not hydraulically connected to the adjacent pits / aquifers.



Source: SRK (2020)

Figure 5-49 Piper plot comparing ionic compositions of groundwater at OB17/18/31

Table 5-67 summarises laboratory data for groundwater from the Wittenoom Formation, De Grey, Swan and OB31 pits in comparison to internal trigger values[33] (BHP, 2020g; SRK, 2020). The results show:

- An exceedance of nitrate levels in the Wittenoom Formation.
- Exceedances of iron, zinc and barium in groundwater from the De Grey pit.

[33] Trigger values are an operational management tool and exceedance of the trigger values does not imply an environmental impact.

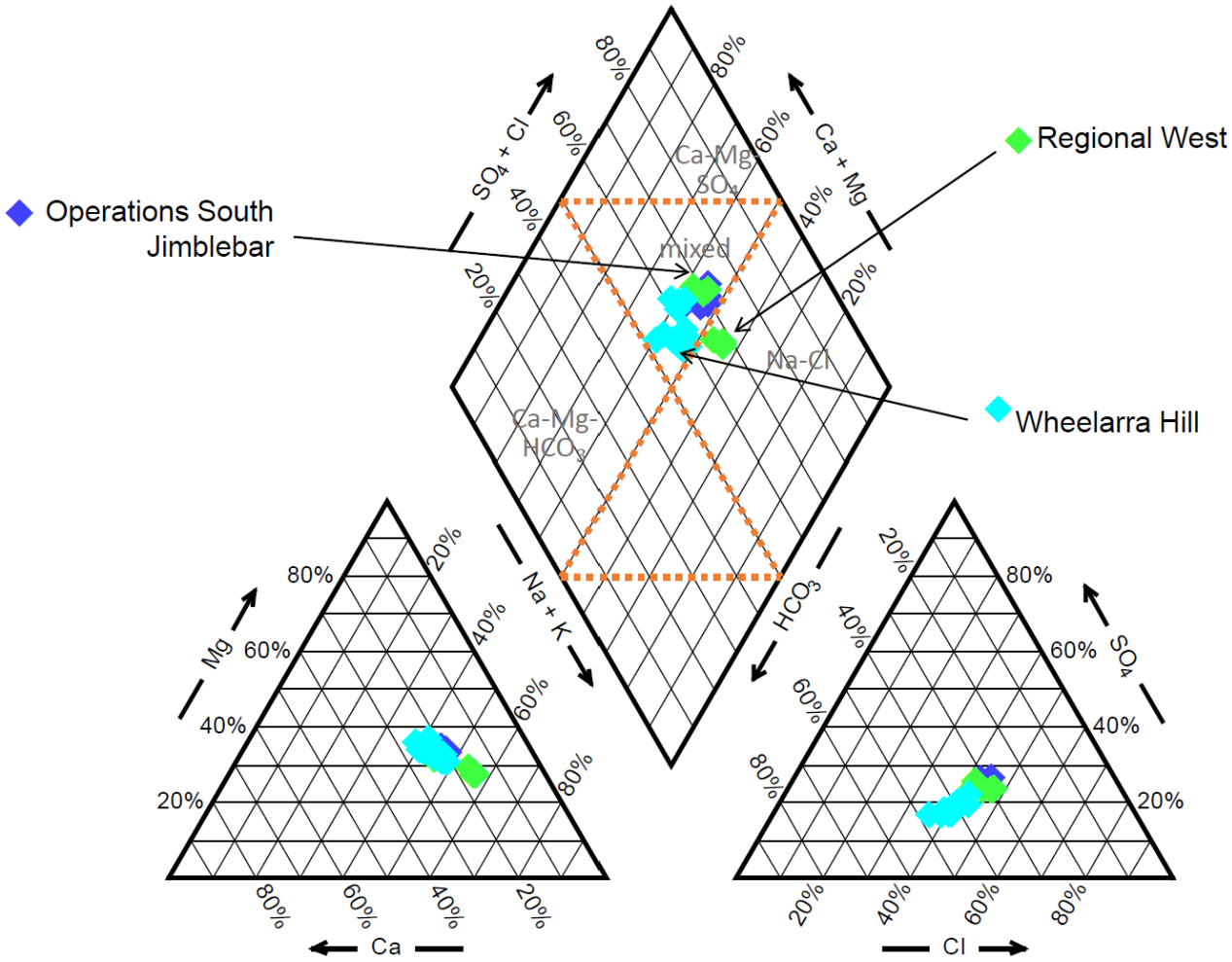
Table 5-67 OB17/18/31 groundwater quality

Parameter	Units	Internal Trigger Values	Wittenoom Formation[2]	De Grey Pit[2]	Swan Pit[1]	OB31[1]
pH	pH Unit	6.0 - 8.5	7.6	6.8	7.8 - 8.1	7.8 – 8.2
Conductivity @ 25°C	µS/cm	1,450 - 2,450	-	-	940 - 970	1,000 - 1,300
Total Dissolved Solids	mg/L	-	-	-	530 - 560	600 - 760
Total hardness as $CaCO_3$	mg/L	-	-	-	340 - 350	360 - 420
Fluoride	mg/L	-	-	-	0.4	0.2 - 0.3
Chloride	mg/L	-	370	230	140 - 160	160 - 200
Sulphate	mg/L	-	200	110	61 - 67	71 - 93
Nitrate as NO_3	mg/L	3.1	4	0.001	0.49 – 0.75	0.98 - 3.1
Calcium	mg/L	-	92	27	55 - 57	59 - 69
Iron	mg/L	0.1	0.0062	0.17	<0.005 - 0.014	<0.005 - 0.02
Potassium	mg/L	-	15	14	11 - 12	13 - 14
Magnesium	mg/L	-	79	39	48 - 51	53 - 60
Manganese	mg/L	1.9	0.21	0.15	0.002 - 0.055	<0.001
Sodium	mg/L	-	190	97	56 - 63	64 - 84
Aluminium	mg/L	0.055	0.0055	0.016	<0.005	<0.005
Copper	mg/L	0.0014	0.001	0.0011	<0.001	<0.001
Zinc	mg/L	0.012	0.0098	0.38	<0.005	<0.005 - 0.009
Lead	mg/L	0.0034	0.001	0.001	<0.001	<0.001
Arsenic	mg/L	0.013	0.001	0.0011	<0.001	<0.001
Cadmium	mg/L	0.0002	0.0001	0.0001	<0.0001	<0.0001
Barium	mg/L	0.015	0.013	0.068	0.01 - 0.019	0.012 - 0.065
Boron	mg/L	0.49	-	-	0.22 - 0.32	0.18 - 0.24
Chromium	mg/L	0.01	0.0016	0.0011	<0.001 - 0.002	<0.001
Molybdenum	mg/L	0.001	-	-	<0.001	<0.001
Nickel	mg/L	0.011	0.0039	0.0035	<0.001 - 0.005	<0.001
Selenium	mg/L	0.011	0.0011	0.002	<0.001	<0.001
Mercury	mg/L	0.0006	-	-	<0.00005	<0.00005

Sources: [1] BHP (2020g); [2]SRK (2020)

Jimblebar

The average water types from the three major aquifers (Marra Mamba, Tertiary Detritals and Wittenoom dolomite) are similar. The major ion proportions illustrated in Figure 5-50 show the Wheelarra Hill groundwater bore samples clustering in the centre of the diamond, suggesting consistent groundwater quality from a single source or aquifer. The signature of the cluster is generally “mixed” where none of the major cations or anions dominate the water composition (BHP, 2022l).

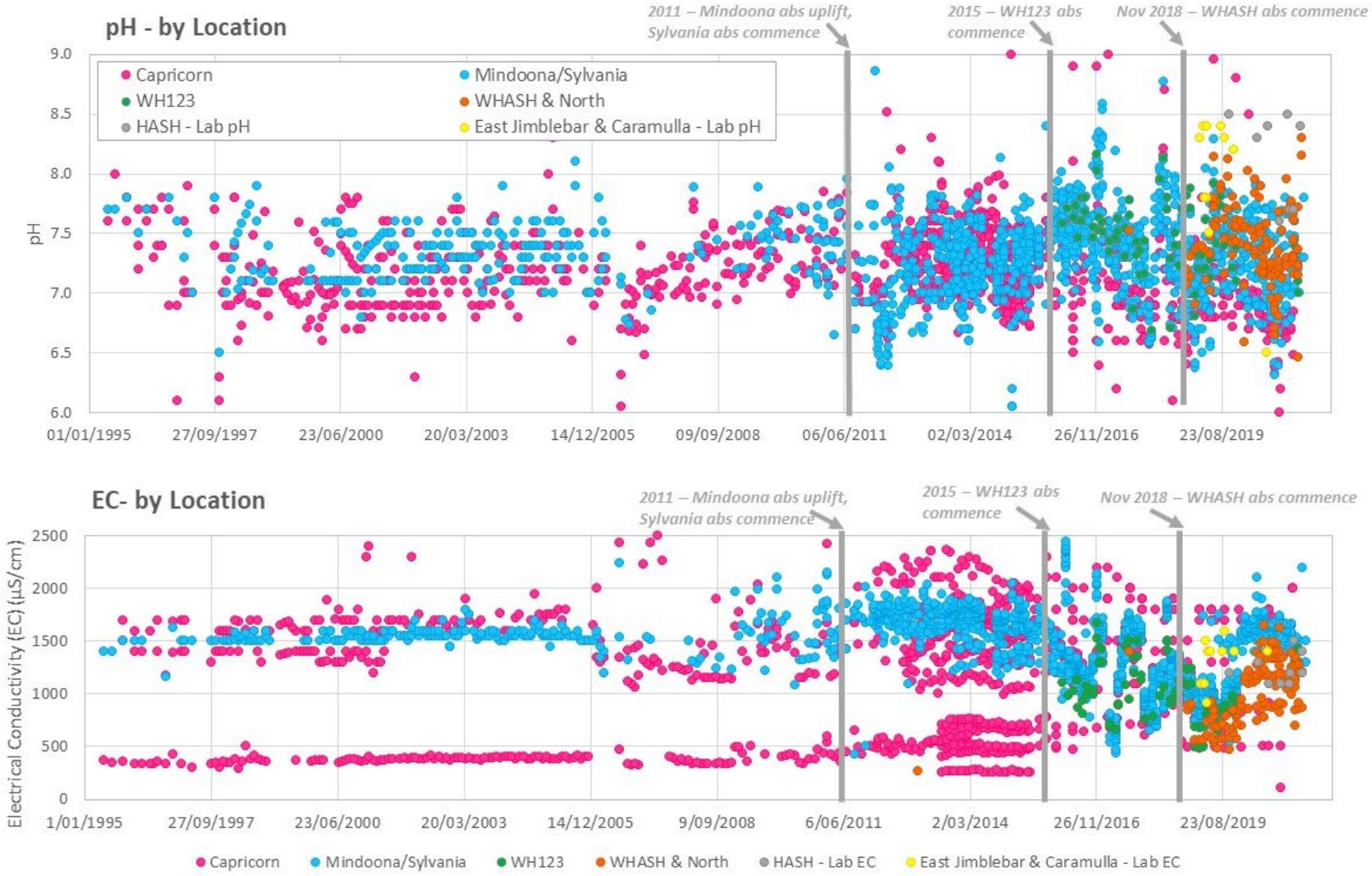


Source: BHP (2022l)

Figure 5-50 Piper plot comparing ionic compositions of groundwater at Jimblebar

Historical EC and pH trends are shown in Figure 5-51 and show significant variability with time once dewatering commences. It is difficult to determine whether this variability corresponds to dewatering stressors and / or reflects the natural variation in chemistry from increased spatial monitoring. The data show that (BHP, 2021l):

- EC varies between 250 and 2,000 µS/cm (fresh to brackish) with:
  - Fresh groundwater (250 – 750 µS/cm) located in the western region of the Capricorn orebody, in close proximity to Copper Creek which may be an indication of enhanced rainfall recharge (via Copper Creek) at this location compared to elsewhere in Jimblebar.
  - Brackish groundwater (1000+ µS/cm) in all other locations within the Jimblebar groundwater system.
- pH is primarily between 7.0 - 8.0, with some data existing within a wider range of 6.0 - 10.0.



Source: BHP (2022l)

Figure 5-51 Historical trends in EC and pH

Table 5-68 summarises laboratory analysis data from the recent Triennial Aquifer Review for Jimblebar (BHP, 2022l) compared to internal trigger values[34] and groundwater monitoring conducted between 1997 and 2008 prior to dewatering (Aquaterra, 2009). The results show:

- Significant exceedances of nitrate at Regional West (area west of WH123 pits), less significant exceedances at South Jimblebar and isolated minor exceedances at Wheelarra Hill.
- Isolated minor exceedances of zinc at Wheelarra Hill and Regional West which is consistent with data prior to dewatering.
- Isolated minor exceedances for boron at Regional West and South Jimblebar.
- Isolated exceedances of chromium at Regional West.

Table 5-68 Jimblebar groundwater quality

Parameter	Unit	Internal Trigger Value	Groundwater Quality 1997 - 2008	Wheelarra Hill	South Jimblebar	Regional West*
Aluminium	mg/L	0.055	0.005 - 1.4	<0.005 - 0.006	<0.005	<0.005 - 0.025
Arsenic	mg/L	0.013	<0.001 - 0.003	<0.001 - 0.001	<0.001	<0.001
Barium	mg/L	-	<0.01 - 0.37	<0.001 - 0.021	0.001 - 0.034	0.023 - 0.058
Bicarbonate Alkalinity as HCO_3	mg/L	-	140 - 440	240 - 340	310 - 380	-
Boron	mg/L	0.61	0.23 - 0.54	0.31 - 0.5	0.49 - 0.62	0.47 - 0.66
Cadmium	mg/L	0.0002	<0.001 - 0.01	<0.0001	<0.0001	<0.0001
Calcium	mg/L	-	7 - 160	1.6 - 73	65 - 76	46 - 63
Chloride	mg/L	-	<10 - 430	110 - 230	250 - 300	200 - 220
Chromium	mg/L	0.01	<0.001 - 0.07	<0.001 - 0.002	<0.001 - 0.004	0.005 - 0.13
Copper	mg/L	0.01	<0.005 - 0.06	<0.001	<0.001	<0.001 - 0.002
EC at 25°C	µS/cm	670 - 1,880	-	840 - 1500	1600 - 1800	-
Fluoride	mg/L	-	<0.1 - 1.4	0.4 - 0.7	0.5 - 0.7	0.3 - 0.7
Iron Sol.	Mg/L	0.1	<0.01 - 0.11	<0.005 - 0.05	<0.005 - 0.018	<0.005 - 0.02
Lead	mg/L	0.0034	<0.001 - 0.01	<0.001	<0.001	<0.001
Magnesium	mg/L	-	<0.1 - 150	33 - 63	66 - 75	47 - 53
Manganese	mg/L	1.9	<0.001 - 0.51	<0.001 - 0.025	<0.001 - 0.18	<0.001 - 0.091
Mercury	mg/L	0.0006	<0.0005	<0.00005	<0.00005	<0.00005
Molybdenum	mg/L	0.01	<0.005 - 0.006	<0.001	<0.001 - 0.001	<0.001 - 0.002
Nickel	mg/L	0.011	<0.005 - 0.03	<0.001 - 0.008	<0.001 - 0.002	<0.001 - 0.001
Nitrate as N	mg/L	0.7	-	0.3 - 0.55	0.41 - 1	12 - 17
Nitrate as NO_3	mg/L		<0.1 - 1.4	0.16 - 3.9	0.8 - 14	53 - 77
pH	pH	6.0 - 8.5	-	7.6 - 8.3	7.5 - 8.5	-
Potassium	mg/L	-	2 - 78	7.4 - 14	8.8 - 9.9	8.8 - 11
Reactive Silica as SiO_2	mg/L	-	-	12 - 20	14 - 29	18 - 36
Selenium	mg/L	0.011	<0.001 - 0.01	<0.001	<0.001	0.003 - 0.005
Silica	mg/L	-	-	3 - 19	13 - 28	16 - 34
Sodium	mg/L	-	2 - 350	70 - 310	150 - 180	120 - 180
Sulphate as SO_4^{2-}	mg/L	-	<10 - 430	69 - 140	170 - 230	140 - 180
Suspended Solids	mg/L	-	-	<5 - 9	<5 - 44	<5 - 24
Total Alkalinity as $CaCO_3$	mg/L	-	-	200 - 270	260 - 310	180 - 240
Total Dissolved Solids at 180°C	mg/L	-	150 - 2,300	480 - 860	930 - 1100	790 - 930
Total Hardness as $CaCO_3$	mg/L	-	-	150 - 440	440 - 490	310 - 380

[34] Trigger values are an operational management tool and exceedance of the trigger values does not imply an environmental impact.

Parameter	Unit	Internal Trigger Value	Groundwater Quality 1997 - 2008	Wheelarra Hill	South Jimblebar	Regional West*
Zinc	mg/L	0.024	<0.01 - 9	<0.005 - 0.032	<0.005 - 0.017	<0.005 - 0.096

Sources: BHP (2022l); Aquaterra (2009)
*Notes: located west of WH123 pits

5.11.3 Ecohydrological assets

Summary of key points:

- An ecohydrological asset is an ecosystem with a relationship to hydrological regimes. An ecohydrological asset which has a degree of regional water dependency is referred to as an ecohydrological receptor. In contrast, other ecological assets can be defined as areas which do not have a regional water dependency, such as ecological systems which rely on direct rainfall or local perched aquifer systems away from mining areas and will not be affected by the mining activities.
- Key ecohydrological assets in the Jimblebar Hub region are:
  - The Ethel Gorge Aquifer Stygobiont TEC. The TEC is located ~12 km to the west of the Jimblebar Hub and is listed as a TEC due to the abundant and diverse stygofauna community which contains some stygofauna species endemic to the Ethel Gorge area. The gorge itself is also a site of cultural significance to the Nyiyaparli people.
  - Innawally Pool which is a semi-permanent water feature in Jimblebar Creek, between the Hashimoto Ranges. It is located upstream of the confluence of Orebody 31 Creek and Jimblebar Creek. The pool supports fringe vegetation, including *Eucalyptus camaldulensis* and *Eucalyptus victrix,* and also potentially supports aquatic ecosystems. The water in the pool is fresh, fed by direct rainfall and creek flow in the wet season, and storage from shallow alluvial aquifers that bank the pool in the dry season. It is disconnected from the deeper regional groundwater system. The pool is of cultural significance to the Nyiyaparli people.
  - Jinerabar Pool which is an intermittent river pool located outside the closure planning area, approximately 40 km to the north. The pool supports vegetation including *Eucalyptus victrix* and is of cultural significance to the Nyiyaparli people.
  - Temporary surface water features. In addition to Innawally Pool, nine natural temporary pools (which form after large rainfall events) have been identified within the proposed closure planning area and a further 30 within 5 km of the closure planning area (to the west of OB18). The temporary pools are of cultural significance to the Nyiyaparli people.
  - Riparian vegetation. The majority of the Jimblebar mining area supports taxa which do not rely on access to groundwater for survival. However, in the south and southeast corner of the Shovelanna area where depth to groundwater was between 5 to 25 mbgl, a facultative (may use groundwater) species (*Eucalyptus victrix)* was associated with the Orebody 31 Creek and noted as potentially impacted in BHPBIO (2015) and approved via MS 1021. The facultative species *Eucalyptus victrix and Eucalyptus camaldulensis* have also been mapped along Jimblebar and Caramulla Creeks.
  - Sheet-flow dependent Mulga communities which occur in the east of the Jimblebar mine area.
  - Third party groundwater users. A Priority 1 drinking water reserve intersects the western tenements of the Jimblebar Hub, but the reserve boundaries are not currently intersected by mining operations. The Jigalong Aboriginal Reserve (~50 to 60 km east of Jimblebar) has several water supply bores, but these draw water from shallow alluvial and calcrete aquifers and would not be affected by changes to regional groundwater. Pastoral station bores also target shallow alluvial systems and the regional fault system. There are also several bores owned by other mining companies.

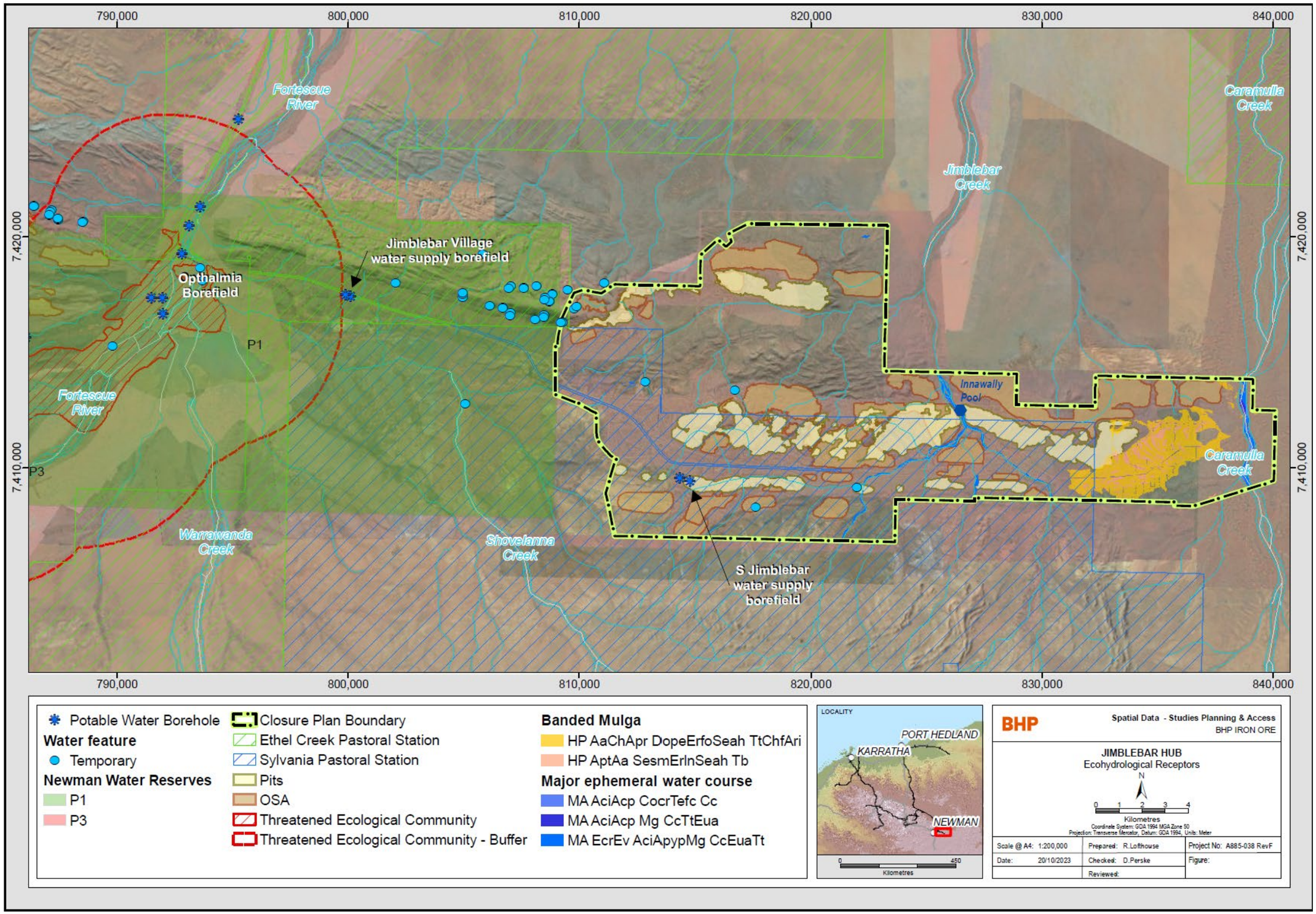
Ecohydrology provides an understanding of relationships between hydrological regimes and ecosystems. An ecohydrological asset which has a degree of regional water dependency is referred to as an ecohydrological receptor. An ecohydrological receptor might be sensitive to changes in regional groundwater and / or surface water. In contrast, other ecological assets can be defined as areas which do not have a regional water dependency, such as ecological systems which rely on direct rainfall or local perched aquifer systems away from mining areas and will not be affected by the mining activities.

The key assets that occur in the region include (BHP, 2021l) (Map 5-20):

- The Ethel Gorge Aquifer Stygobiont TEC;
- Innawally Pool;
- Jinerabar Pool;
- Temporary surface water features;
- Riparian vegetation;
- Sheet-flow dependent Mulga communities; and
- Third party groundwater users.

These assets are described in further detail below.

Mujee Pool and Cubana Well are features listed on the DWER wetlands, but the features are situated 7.9 km upstream of the Jimblebar operations and outside of the predicted extent of groundwater drawdown, hence have not been considered further.



Refer to Appendix Q for pdf version

Map 5-20 Jimblebar Hub ecohydrological assets

5.11.3.1 Ethel Gorge TEC

Ethel Gorge TEC is located approximately 12 km to the west of the Jimblebar Hub. It is located on the Fortescue River at the confluence of Homestead, Shovelanna and Warrawandu Creeks. The Fortescue River then flows through a narrow gap in the Ophthalmia Range where flow is restricted, and natural recharge of the shallow groundwater aquifer and extensive sub-surface development of calcrete occurs. The TEC has groundwater levels of less than 10 mbgl in the valleys which allows interactions between the groundwater and terrestrial environments (BHP, 2023a).

The calcrete and alluvium aquifers host a stygofauna community which comprises the Ethel Gorge TEC with the core habitat in and around the area of Ophthalmia Dam. The alluvium contains the most abundant and diverse stygofauna community. The stygofauna habitat underlies the broad Ophthalmia Valley and Ethel Gorge.

Ethel Gorge is a regional outflow zone for the upper reaches of the Fortescue River Catchment. The natural recharge system for the calcrete and alluvium aquifers is predominantly from river flows. Historical data show impacts on groundwater levels in this area in response to the water supply abstraction from the Ophthalmia Borefield, prior to the construction of Ophthalmia Dam. The dam now provides a significant source of recharge to the calcrete and alluvium aquifers to mitigate the impact of groundwater abstraction. WAIO manages surplus dewatering water from Jimblebar by pumping to Ophthalmia Dam. The conceptual ecohydrological model for the Ethel Gorge TEC is shown in Figure 5-53.

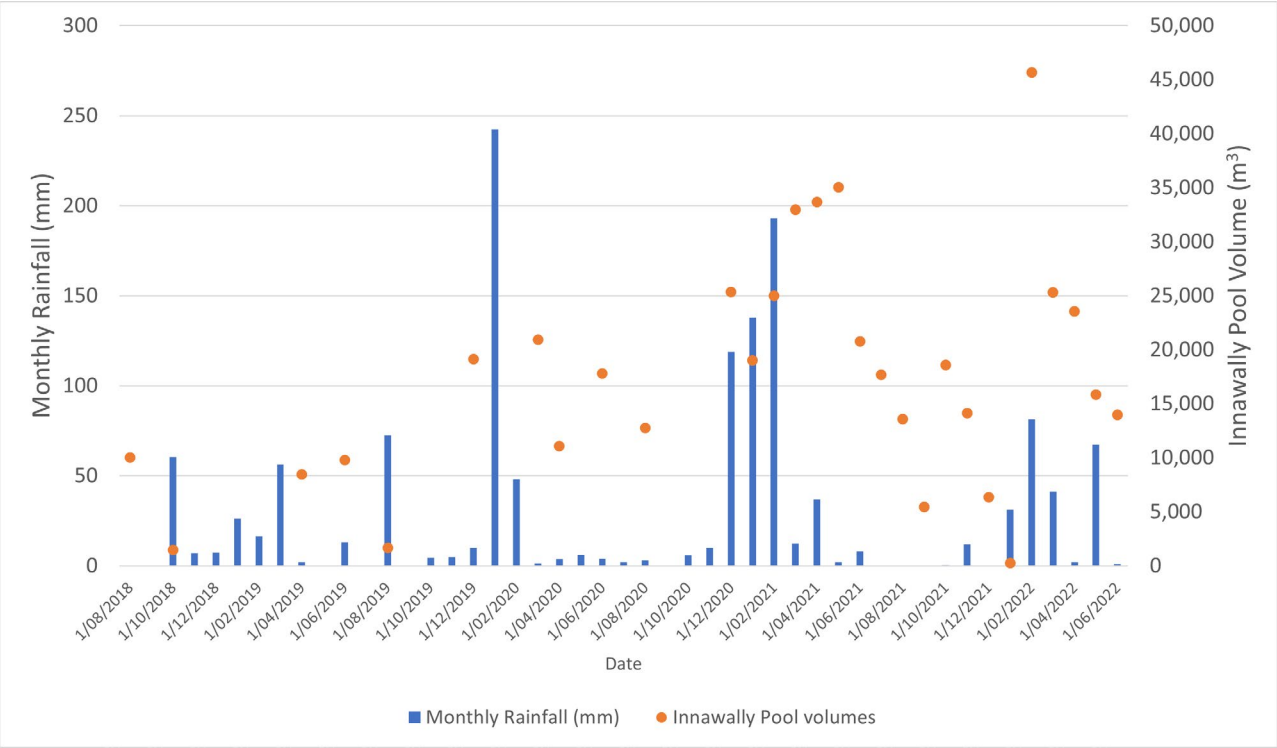
Ethel Gorge itself is also a site of significance to the Nyiyaparli people (Section 5.14).

5.11.3.2 Innawally Pool

Innawally Pool (Map 5-20) is a semi-permanent surface water driven feature in Jimblebar Creek, between the Hashimoto Ranges. It is located upstream of the confluence of Orebody 31 Creek and Jimblebar Creek.

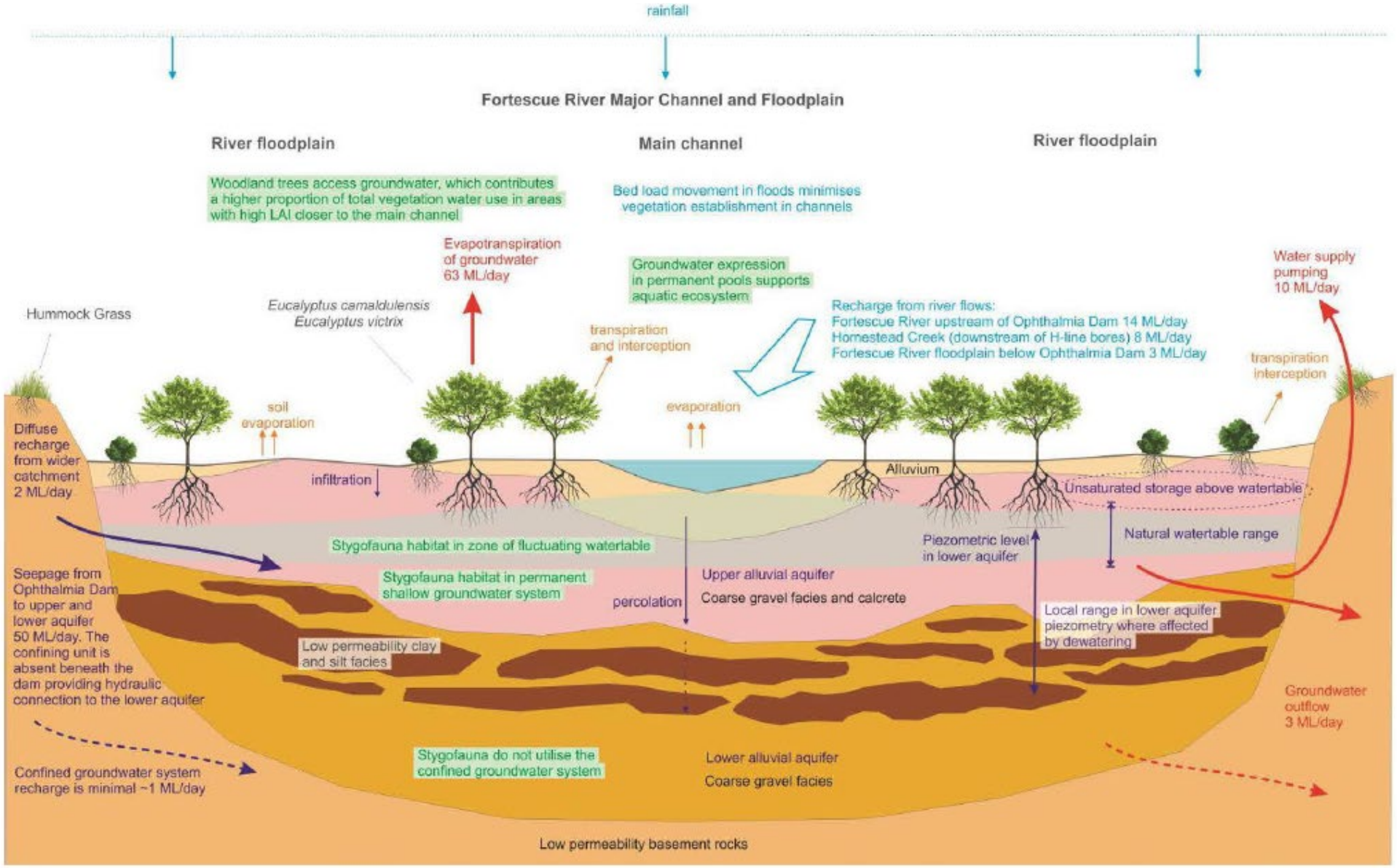
The pool supports fringe vegetation, including *Eucalyptus camaldulensis* and *Eucalyptus victrix*, which depend on the semi-permanent nature of the pool for part of their water requirements. It also supports aquatic fauna including turtles and frogs. Water quality measurements taken in the wet season (March 2015) and dry season (July 2016) indicate that the pool is fresh (salinity less than 200 mg/L), with a pH of approximately 7.8 (consistent with more recent sampling conducted in 2019). Nutrient levels exceed Australia and New Zealand Environment and Conservation Council (ANZECC) guidelines (BHP, 2019a).

The pool formed in an erosional scour in basement rocks where the confluence of the main two tributaries of Jimblebar Creek flow through a narrow gorge between the Hashimoto hills. The extent of the pool changes seasonally. The water in the pool is fed by direct rainfall and creek flow in the wet season, and storage from shallow perched alluvial aquifers that flank the pool in the dry season (Figure 5-54). Further into the dry season when the creek bed alluvium has dried out, the pool becomes a stranded pond, perched within the scour depression. Figure 5-52 shows the correlation between rainfall and Innawally Pool volumes. When full, the pool is 1,000 m long and up to 40 m wide. The pool water is hydrochemically distinct from the deeper groundwater system confirming its lack of hydraulic connectivity (RPS, 2014a).



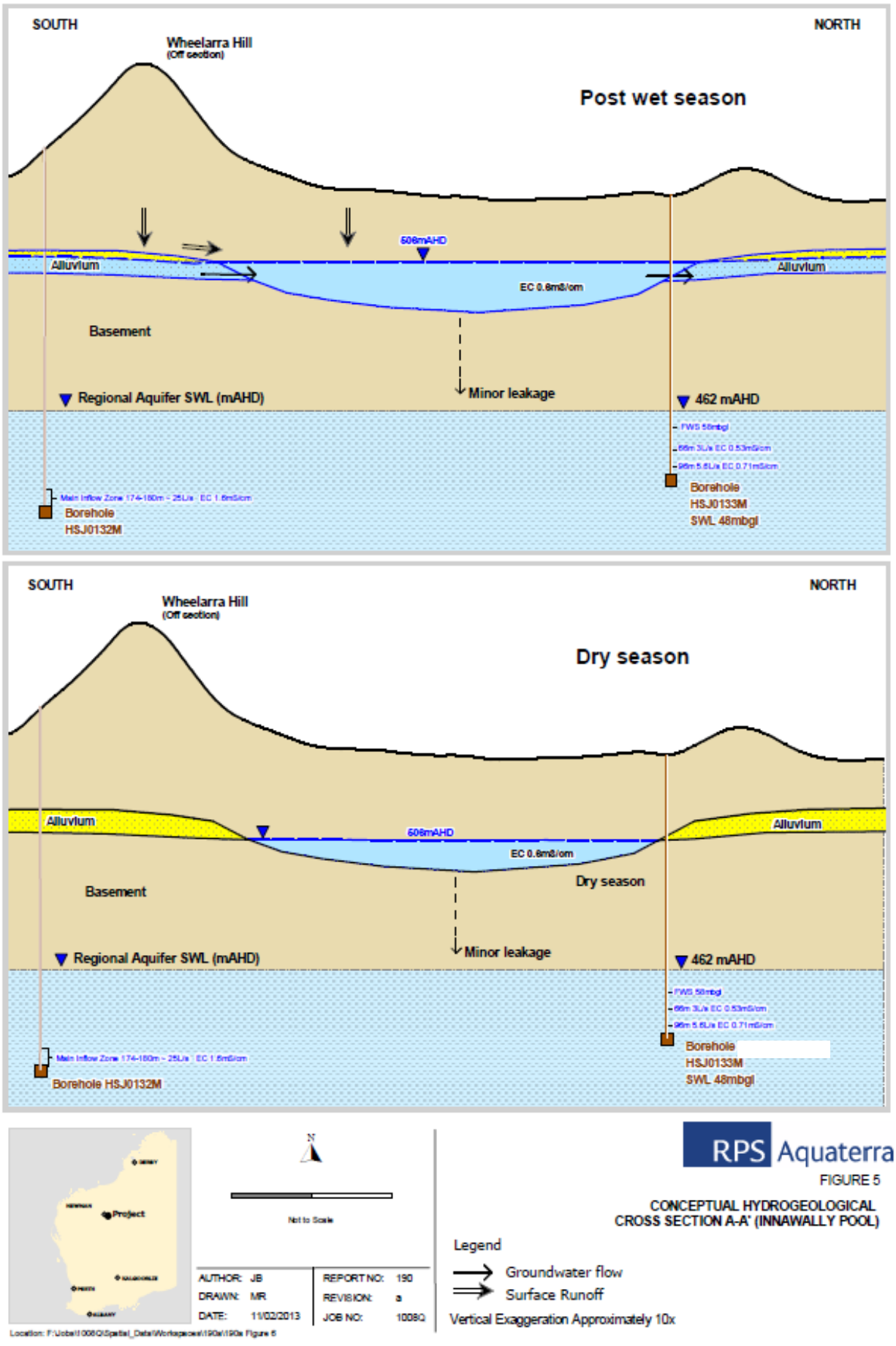
Notes: pool volumes calculated from water level footprint

Figure 5-52 Rainfall vs Innawally Pool volumes



Source: RPS (2014a)

Figure 5-53 Ethel Gorge TEC ecohydrological conceptualisation



Source: RPS Aquaterra (2013a)

Figure 5-54 Ecohydrological conceptualisation of Innawally Pool

Regional groundwater levels are currently in excess of 80 m below the base of Innawally pool and monitoring bores have been installed adjacent to the Pool to assess seasonal water table (perched and permanent) fluctuations and to confirm hydraulic disconnection between the pool and deeper groundwater system. Two of these monitoring points have records that date back to 2012 and display clear mounding of the regional (deep) aquifer (total 0.7 m) from the South Jimblebar reinjection borefield but no discernible response to the Jan 2014 (220 mm) and Jan / March 2017 (~150 mm) rainfall events.

Innawally Pool has cultural heritage significance and is the subject of ongoing consultation with the Nyiyaparli people.

5.11.3.3 Jinerabar Pool

Jinerabar Pool is an intermittent river pool filled by surface run-off which supports vegetation, including *Eucalyptus victrix*, which is likely to depend on the pool for some of its water requirements (Pinder, Lyons, Collins, Lewis, & Quinlan, 2017). The pool is located 1.5 km upstream of the confluence between Jimblebar and Caramulla creeks and the Fortescue River, on the alluvial Fortescue Land System where flow merges during large floods (BHP, 2019a). Recent social surrounds engagements conducted during the preparation of the Jimblebar Hub Significant Amendment ERD indicated that the pool is of significance to the Nyiyaparli people.

5.11.3.4 Temporary surface water features

In addition to Innawally Pool, nine other natural small surface water features have been identified within the proposed closure planning area (Map 5-20) and a further 30 within 5 km of the closure planning area (to the west of OB18). All are considered to be temporary, forming after large rainfall events and were surveyed in the wet season. Due to the very deep groundwater levels in the Jimblebar area, none of these other surface water features are considered to be groundwater-dependent (BHP, 2023a). The temporary surface water features are of significance to the Nyiyaparli people.

5.11.3.5 Riparian vegetation

Riparian vegetation has been mapped along Jimblebar and Caramulla creeks (Map 5-5, Section 5.8.2). None of the vegetation associations had any affiliation with Federal or State listed TECs, or State listed PECs. The key riparian tree species dominant along Jimblebar creek are *Acacia citrinoviridis, Eucalyptus camaldulensis and Eucalyptus victrix* (Onshore Environmental, 2015b).

The riparian vegetation along the main channel of Caramulla Creek is characterised by *Eucalyptus camaldulensis* subsp. *Refulgens* low open woodland over *Acacia coriacea* subsp. *Pendens* and *Acacia citrinoviridis* shrubs with scattered tussock grassland of **Cenchrus ciliaris* (Buffel Grass). The adjacent banks are dominated by tussock grasslands of **Cenchrus ciliaris* with low open woodland of *Corymbia hamersleyana* (Astron Environmental, 2018; Onshore Environmental, 2018).

Flora surveys (Section 5.8) have not identified any phreatophytic species local to the Jimblebar Mine area. Most of the area supports taxa which do not rely on access to groundwater for survival. However, in the south and southeast corner of the Shovelanna area where depth to groundwater was between 5 to 25 mbgl, facultative vegetation community types (*Eucalyptus victrix*) were identified in the 2015 Orebody 31 Iron Ore Mine Project Environmental Referral Document (BHPBIO, 2015) as being potentially impacted by mining operations. Approval for the Orebody 31 Iron Ore Mine Project was granted via MS 1021.

5.11.3.6 Sheet-flow dependent Mulga

Several of the vegetation associations support *Acacia aptaneura* (Mulga) as a dominant upper storey component (Map 5-5, Section 5.8). While Mulga is drought tolerant, it is reliant on overland flow of surface water following heavy summer rains to survive. Interruption of surface water flows may impact on the integrity of Mulga stands and ultimately lead to tree decline. Areas of sheet-flow dependent Mulga vegetation have been mapped to the east of the Jimblebar mine and identified to the north outside of the eastern portion of the closure planning area (from aerial photography) (Section 5.8.6).

5.11.3.7 Third party groundwater users

Third party users of groundwater are discussed below.

Pastoral station bores

Nearby pastoral bores are on Sylvania Station (owned by BHP). These bores are west and southwest of the Jimblebar mining area and are underlain by granites and shales. The bores are all shallow (ranging in depth from 13 to 30 m) and target shallow alluvial systems and the regional fault system (BHP, 2023c).

Mining / unknown companies

The DWER Water Information Reporting (WIR) tool indicates (BHP, 2023c):

- One Atlas Iron bore (drilled to 64 mbgl in colluvium) in proximity to Jimblebar (to the north).
- A Rio Tinto bore (drilled in 1999 to a depth of 34 mbgl) approximately 21 km south east of South Jimblebar production bores.
- An unknown bore approximately 18 km south of the BHP tenure boundary.

Newman Water Reserve

A Priority 1 drinking water reserve (the Newman Water Reserve) overlays Newman town, BHP Whaleback and Eastern Ridge mines . The reservoir protection zone was implemented to protect the Newman town water supply, which is sourced from WAIO's Ophthalmia and Homestead borefields. While the western tenements of the Jimblebar Hub are included within the boundaries of the water reserve, the reserve is not currently intersected by mining operations (Map 5-20) (BHP, 2023c).

The Jimblebar Village Potable Borefield is located between OB18 and Ophthalmia Dam and draws water from the Wittenoom Formation.

Jigalong Aboriginal Reserve

Bore information provided form the WIR tool lists within 30 km of Jimblebar 14 bores owned by the Jigalong Community. Records indicate all bores at a shallow depth with two bores being approximately 30 m in depth with the majority under 20 mbgl. However of the 14 records, two are classed as Windmills and all other bores are described as unequipped, collapsed or abandoned (BHP, 2023c).

5.11.4 Knowledge gaps & forward work program

Further refinement of the conceptual groundwater models for Jimblebar and OB17/18/31 is required as dewatering progresses and further monitoring data become available.

A more detailed analysis of Jimblebar Hub surface water monitoring data will be conducted, and the surface water and riparian vegetation monitoring programs will be reviewed, and if appropriate revised, to inform closure and completion criteria.

Flood modelling for closure conditions will require updating as significant changes to mine infrastructure occur that affect creek flows. More detailed flood modelling will be conducted, as required, as the mine approaches closure to inform the closure designs for surface water management infrastructure.

5.12 Site contamination

Summary of key points:

- BHP maintains a register of known or suspected contamination targets. These are progressively investigated and remediated in accordance with a risk-based schedule which is discussed with DWER at regular intervals.
- Investigations and remediation are conducted in accordance with the *Contaminated Sites Act, 2003 (WA).*

Known or potentially contaminated targets at Jimblebar Hub are listed in Table 5-69, and illustrated on Map 5-21. These targets are managed generally in accordance with the WAIO Contaminated Sites Management Procedure (WAIO, 2023a) and the *Contaminated Sites Act, 2003 (WA)* (CS Act). An inspection schedule is maintained across site to inspect targets on a periodic basis (the frequency determined by risk posed) and the contamination is controlled. Should any further suspected contaminated targets be identified in future, investigation will be prioritised based on risk, as discussed with DWER in regular meetings (see Section 4.2).

Table 5-69 Jimblebar Hub known or suspected contaminated targets

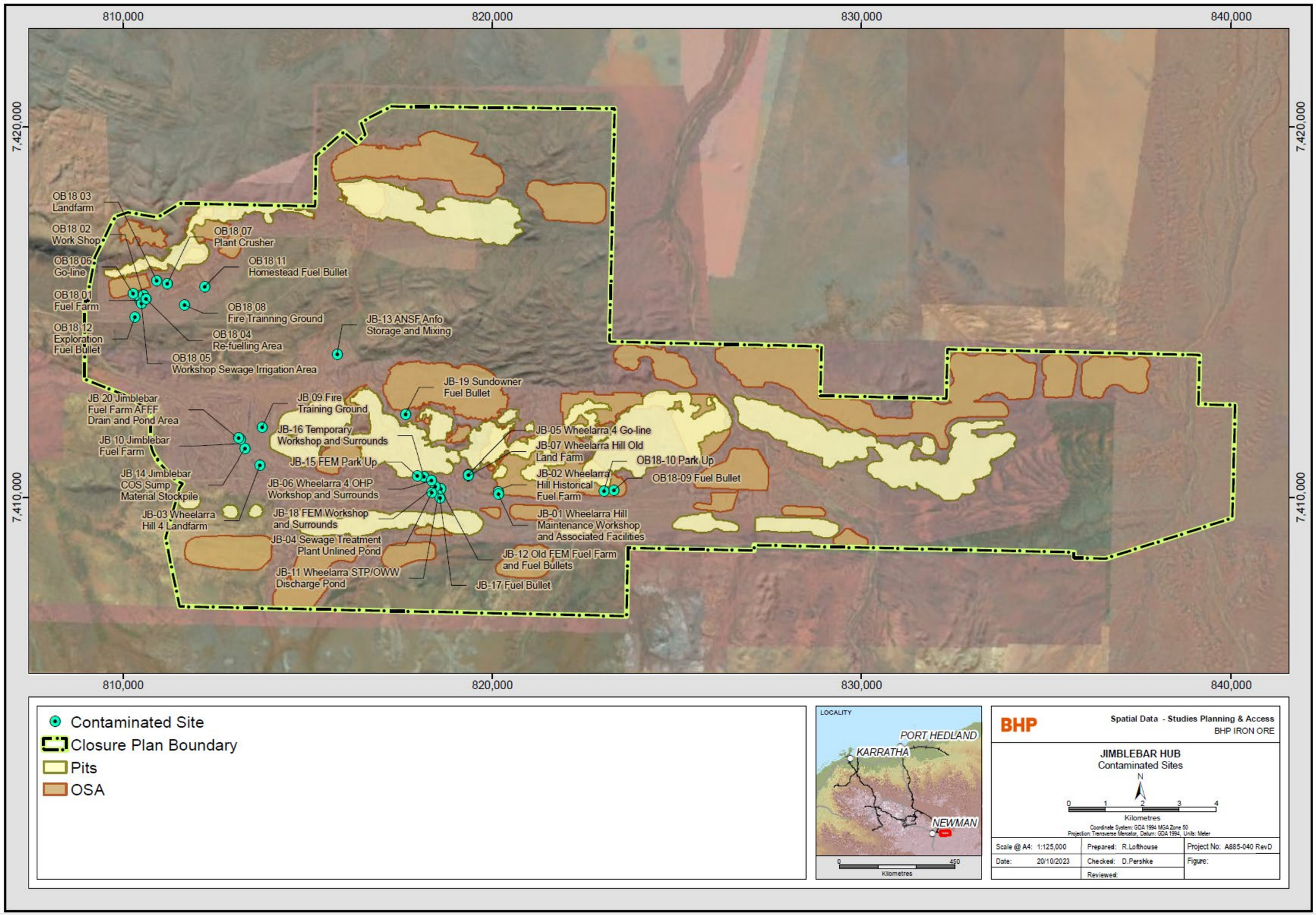
Contaminant of Concern	Reference	Status
Hydrocarbons	OB18-01 Fuel farm	Investigation complete. The Detailed Site Inspection (DSI) report was reviewed by an auditor and interim auditor advice was provided on 27 April 2021 supporting the classification status of the site. No further actions required. The auditor considered the areas assessed should be classified as 'Report Not Substantiated' on the basis of information contained in the Preliminary Site Investigation (PSI) and DSI.
Hydrocarbons	OB18-02 Workshop	Investigation complete, DSI Report reviewed by an auditor and interim auditor advice was provided on 27 April 2021 supporting the classification status of the site following localised removal of hydrocarbon impacted soils at closure. No further action required as per interim auditor advice. An internal site management plan procedure has been put in place.
Hydrocarbons	OB18-03 Landfarm	A Remediation Action Plan (RAP) was developed, the contaminated material removed, and a remediation validation report developed to confirm appropriate execution of RAP.
Hydrocarbons	OB18-04 Refuelling area	Investigation complete. The DSI report was reviewed by an auditor and interim auditor advice was provided on 27 April 2021 supporting the classification status of the site. No further actions required. The auditor considered the areas assessed should be classified as 'Report Not Substantiated' on the basis of information contained in the PSI and DSI.
Per- and polyfluoroalkyl substances (PFAS) / Sewage	OB18-05 Workshop sewage irrigation area	This site was investigated as part of a PSI in July 2018 where elevated nutrients were observed in soils. The PSI confirmed the site is consistent with a restricted use classification. No further action required. Further investigation is required for PFAS.

Contaminant of Concern	Reference	Status
Hydrocarbons	OB18-06 Go-line	PSI completed in July 2018. The PSI confirmed the site is consistent with a restricted use classification. No further action required.
Hydrocarbons	OB18-07 Plant crusher	PSI completed July 2018. The PSI confirmed the site is consistent with a restricted use classification. No further action required.
PFAS	OB18-08 Fire training ground	DSI for PFAS scheduled for the period 2023 - 2025. Currently awaiting data and risk assessments as part of the PFAS baseline investigation and the ongoing targeted source drilling being conducted as part of the regional PFAS assessments.
Hydrocarbons	OB18-09 OB18 Fuel Bullet	Minor – no action required at this time.
Hydrocarbons	OB18-10 OB18 Park Up	Minor – no action required at this time.
Hydrocarbons	OB18-11 Homestead fuel bullet	Minor – no action required at this time.
Hydrocarbons	OB18-12 Exploration fuel bullet	Minor – no action required at this time.
Hydrocarbons	JB-01 Wheelarra Hill maintenance workshop and associated facilities	DSI completed in 2016. RAP completed in 2017. Voluntary audit report completed in 2017. PFAS investigation scheduled for the period 2025 - 2027. Currently awaiting data and risk assessments as part of the PFAS baseline investigation and the ongoing targeted source drilling being conducted as part of the regional PFAS assessments.
Hydrocarbons	JB-02 Wheelarra Hill historical fuel farm	DSI completed in 2016. RAP completed in 2017. Voluntary audit report completed in 2017. PFAS investigation scheduled for the period 2023 - 2025. Currently awaiting data and risk assessments as part of the PFAS baseline investigation and the ongoing targeted source drilling being conducted as part of the regional PFAS assessments.
Hydrocarbons	JB-03 Wheelarra Hill 4 Landfarm	Minor - no action required at this time.
Sewage / PFAS	JB-04 Sewage Treatment Plant unlined pond	Not currently scheduled in the 5-year plan. Currently awaiting data and risk assessments as part of the PFAS baseline investigation and the ongoing targeted source drilling being conducted as part of the regional PFAS assessments.
Hydrocarbons	JB-05 Wheelarra 4 Go Line	Minor - no action required at this time.
Hydrocarbons	JB-06 Wheelarra 4 OHP Workshop and surrounds	Minor - no action required at this time.
Hydrocarbons	JB-07 Wheelarra Hill historical land farm	Remediated - reported to DWER as closed with restricted use.
Hydrocarbons	JB-08 Warrawandu Camp	Minor - no action required at this time.
PFAS	JB-09 JB Fire Training Ground	DSI scheduled for the period 2023 - 2025. Currently awaiting data and risk assessments as part of the PFAS baseline investigation and the ongoing targeted source drilling being conducted as part of the regional PFAS assessments.
Hydrocarbons	JB-10 Jimblebar - Fuel Farm	Investigation scheduled to commence 2045.
Hydrocarbons / PFAS	JB-11 Wheelarra STP/OWW discharge pond	Not currently scheduled in the 5-year plan. Currently awaiting data and risk assessments as part of the PFAS baseline investigation and the ongoing targeted source drilling being conducted as part of the regional PFAS assessments.
Hydrocarbons / PFAS	JB-12 Old FEM Fuel Farm	Assessed for PFAS during the PFAS baseline assessment (Coffey 2022). No further actions currently scheduled in the 5-year plan. Currently awaiting data and risk assessments as part of the PFAS baseline investigation and the ongoing targeted source drilling being conducted as part of the regional PFAS assessment.
Nutrients / hydrocarbons	JB-13 ANSF - Anfo storage and mixing	Minor - no action required at this time.
Hydrocarbons	JB-14 Jimblebar COS Sump material stockpile	Investigation revealed minimal contamination.
Hydrocarbons	JB-15 FEM Park Up	Not currently scheduled in the 5-year plan. Investigation to be scheduled prior to closure and rehabilitation.

Contaminant of Concern	Reference	Status
Hydrocarbons	JB-16 Temporary Workshop	Not currently scheduled in the 5-year plan. Investigation to be scheduled prior to closure and rehabilitation.
Hydrocarbons	JB-17 Fuel Bullet	Not currently scheduled in the 5-year plan. Investigation to be scheduled prior to closure and rehabilitation.
Hydrocarbons	JB-18 - FEM Workshop and Surrounds	Not currently scheduled in the 5-year plan. Investigation to be scheduled prior to closure and rehabilitation.
Hydrocarbons	JB-19 Sundowner Fuel Bullet	Minor - no action required at this time.
PFAS	JB-20 Jimblebar - Fuel Farm aqueous firefighting foam drain and pond area	DSI scheduled for the period 2023 - 2025. Currently awaiting data and risk assessments as part of the PFAS baseline investigation and the ongoing targeted source drilling being conducted as part of the regional PFAS assessments.

5.12.1 Knowledge gaps & forward work program

Sites will be investigated generally in accordance with the schedule outlined in Table 5-69, and remediated, if required, prior to closure.



Refer to Appendix Q for pdf version

Map 5-21 Jimblebar Hub contamination targets

5.13 Visual amenity

Visual impact assessments have been conducted for OB31 (360 Environmental, 2014) and Jimblebar (Urbis, 2009) operations. These assessed several vantage points (Table 5-70) and concluded that visual impacts of the mines would be low to negligible during their operational life. However, these assessments did not consider views of importance to the Nyiyaparli people. In addition, it is likely that visual impact in the context of a closed site will be perceived differently to one that is operational. Further work is required to consider these aspects.

Table 5-70 Viewpoints surveyed in the visual landscape impact assessments for Jimblebar Hub

Viewpoint	Site for Which Impact Assessed		Comments
	OB31 (360 Environmental, 2014)	Jimblebar (Urbis, 2009)	
Radio Tower Hill, Newman	✓	✓	Approximately 40 km to the west of the Jimblebar Hub. Low-negligible visual risk.
Ophthalmia Dam Picnic Area	✓	✓	Approximately 27 km to the west of the Jimblebar Hub. Low-negligible visual risk.
Ophthalmia Dam Wall	✓		
Round Hill	✓		Low: located more than 25 km from the site.
Trugallenden Pool	✓		Not considered a potential key site.
Innawally Pool	✓		Not considered a potential key site.
Kalgan Pool	✓		Low-negligible: the development envelope is nestled within a creek bed surrounded by gorges.
Marble Bar Road – Rest Stop 1	✓		Low: distance and vegetation cover make direct impacts from OB31 likely to be very low.
Marble Bar Road – Rest Stop 2	✓		Low: distance and vegetation cover make direct impacts from OB31 likely to be very low.
Marble Bar Road – Rest Stop 3	✓		Not considered a potential key site.
Jinerabar Pool	✓		Not considered a potential key site.
Great Northern Hwy and Marble Bar Road	✓	✓	Approximately 33 km to the west. Vegetation screening, high travel speeds, low elevation, large distance and the presence of the Ophthalmia Range on either side of the road result in a low risk of overall impact.
Warrawandu Village		✓	Approximately 8 km to the west.
Wheelarra Mine Access Road		✓	Approximately 5 to 10 km to the west.
Sylvania Station Homestead		✓	Approximately 18 km to the south.

Sources: adapted from 360 Environmental (2014) and Urbis (2009)

A landform design and opportunities assessment was undertaken by ERM (2014) for OB17/18/31 (see Appendix G). The analysis reviewed the natural landforms in the area and compared these to mined landforms. Natural landforms in the area include:

- Linear ranges with concave slopes.
- Cone shaped hills with convex slopes.
- Composite landform shapes comprising a convex slope above a hard geological band with concave slopes below the band.

This analysis supports the application of BHP's landform design practice to the Jimblebar Hub area (refer to Section 9).

5.13.1 Knowledge gaps & forward work program

Further work is required during the detailed design phase to consider the visual characteristics of landforms that have not yet been rehabilitated, including consultation with the Nyiyaparli people. Section 9.2.4 provides visualisations of the closed mining area to facilitate this consultation.

5.14 Cultural values and heritage

The Jimblebar Hub mining area falls within the boundary of the Nyiyaparli Native Title Determination [WCD2018/008]. The Nyiyaparli Native Title Holders have been involved in a number of cultural heritage surveys of the development envelope and

surrounds. The locations and extent of the recorded Aboriginal heritage sites are not recorded in this MCP out of respect for the wishes of Traditional Owners.

Some of the Nyiyaparli people's cultural values are articulated in the "*Nyiyaparli People and Country Plan Fortescue Marsh 2023 - 2032"* (KNAC, 2023). Key elements of this plan with potential relevance to mine closure planning, rehabilitation and post-closure management and maintenance are summarised below.

- The plan specifically identifies Fortescue Marsh, Caramulla Creek and Ethel Gorge as important sites of cultural significance. Fortescue Marsh is described as of immense cultural significance and there are several important ceremonial and mythological sites nearby. The flood plains continue to be used for hunting and camping.
- Continued access to sites of cultural significance is of importance. Nyiyaparli people engage in their culture by being on Country. This engagement is through storytelling, ceremony and law practice, hunting, fishing, and collecting bush fruits or vegetables. It is important to have and maintain access to Country to ensure cultural wellbeing, transfer of Traditional Knowledge, that law and ceremony continue to be carried out, and to spend time with family.
- Bush food harvest and preparation maintains an important place in Nyiyaparli people's diet and cultural practices. Important Bush meats (Mantu) include Jarnkurta (Emu), Marlu (Plains Kangaroo), Maruntu (Sand Goanna) and Marningarra (Bush Turkey).
- Bush plants are used by Nyiyaparli people for food (marta), to heal illnesses and ailments, to create artefacts and bough sheds during ceremony time, and as firewood. Ensuring that plants are healthy, and flourishing is central to the lives of animals, birds, fish, reptiles and Marlpa, who are themselves part of the seasonal, and long term inter-dependent relationships of life within Country. Some important Nyiyaparli plants are listed in Appendix D.
- Water holds great cultural significance to Nyiyaparli people. This includes permanent waterholes or springs known as Yindas, as well as seasonal creeks and soaks. Yindas and springs are places that need to be respected and the Nyiyaparli people follow specific cultural protocols at Yindas to show their respect. Yindas also provide important places for animals to rest and drink away from the largely arid landscape of Nyiyaparli Country.
- Appropriate fire management is important. Small patchy fires at the start of the dry season are used to clean up country for hunting, regenerating food and medicinal plants.

The values outlined in the *Nyiyaparli People and Country Plan Fortescue Marsh 2023 - 2032* were echoed in KNAC's review of the draft 2023 MCP and the social surroundings engagements conducted during the preparation of the Jimblebar Hub Significant Amendment ERD including (BHP, 2023a):

- The need to preserve the landscape, flora, fauna, and water for future generations to maintain stories and Songlines, and bush tucker and medicine knowledge.
- Desktop mapping of plant species that hold cultural significance, including *Eucalyptus leucophloia* (Snappy Gum) and *Corymbia hamersleyana* (known as Boonarah), which are both known to have been used for honey collection, and other plants with edible berries, gum and seeds or used for soothing ailments. BHP has committed to working with the Nyiyaparli Traditional Owners to enable ongoing safe access to these resources, where possible, and to incorporate ethnobotanical species in rehabilitation programs.
- Advice from Nyiyaparli representatives that native fauna is valued for hunting and can also have special meaning during different times of life for Nyiyaparli Traditional Owners. While all fauna are important, animals of particular cultural significance include:
  - Kangaroos;
  - Wallabies;
  - Emus;
  - Turkeys;
  - Goannas (Gould's Sand goanna for hunting and Spinytail skink, Red nose skink, and blue tongue goanna for reintroduction to rehabilitated areas);
  - Birds (notably: willy wagtails, crows / ravens, black swans, kingfisher, curlew, eagles, eaglehawks, magpies);
  - Snakes;
  - Native bees;
  - Pebble Mouse;
  - Fish (notably Spangled Perch);
  - 'Porcupine' (echidna); and
  - Dingoes.
- Nyiyaparli representatives have expressed concern about the loss of fauna habitat across their country and are interested in the recreation of suitable habitats post-closure and during rehabilitation. BHP is in the process of planning a research program on fauna habitat (Sections 5.9.5 and 7.6).
- The importance of the management of water including ephemeral creeks, temporary water features and impacts from abstraction / drawdown. Both Innawally Pool and Jinerabar Pool are significant heritage places for the Nyiyaparli Traditional Owners. However, management of water more broadly on a regional scale is also important to the Nyiyaparli people and other Traditional Owner groups, and it is each group's responsibility to manage water on their country as it travels to the next group.

- Re-iteration of the importance of ongoing access to country. BHP will continue to enable access to the site for Nyiyaparli Traditional Owners as per the BHP and Nyiyaparli Comprehensive Agreement Land Access Protocol Entry.

KNAC has also provided initial information on the Nyiyaparli people's principles and preferences for closure which provide further insight into values relevant for consideration during closure planning. The current draft of these principles is reproduced in full in Appendix B-2, and summarised below:

- Safe and culturally appropriate access.
- Preference for a post-closure land design to resemble (as close as possible) pre mining conditions. Constructed landforms should look as natural as possible and include 'nice places' (e.g., nice 'camping spots' that support healthy country by providing habitat and food sources for other animals etc.). The Nyiyaparli people provided an example of a nice place during social surrounds engagement (the area behind OB31) and explained, that it is attractive due to the presence of native vegetation in and around the creek that provide areas of shade and amenity.
- Backfilling of voids, especially if they are in a highly visible area and / or require permanent creek diversions. If voids are unavoidable, consideration should be given to maintaining safe access and rehabilitation if possible, or alternative productive uses (e.g., solar farms).
- Natural surface and groundwater systems to be self-sustaining and non-polluting.
- Avoidance of pit lakes. If they are unavoidable, then consideration should be given to creation of an asset, not a liability (e.g., suitable for recreation, or other agreed purpose / standard).
- Potential long-term impacts upon places of outstanding cultural importance and repatriation of artefacts.

While the KNAC (2023) *Nyiyaparli People and Country Plan Fortescue Marsh 2023 - 2032* and Nyiyaparli people's closure principles and preferences (Appendix B-2) provide some insight into cultural values. Further work is ongoing to gain a better understanding of the specific cultural values relevant to the closure of the Jimblebar Hub. The Nyiyaparli people have expressed a strong interest in rehabilitation and closure with the aim of creating a post-mining landscape and land use which is suitable for future generations to use and learn from. This includes final landforms, the types of plant species to be used in seeding for revegetation, changes to surface and groundwater regimes following cessation of mining and dewatering and safety. BHP is committed to working with the Nyiyaparli people to investigate how they might be engaged in rehabilitation and land management activities.

5.14.1 Knowledge gaps & forward work program

Further work is ongoing to gain a better understanding of the cultural values relevant to the closure of the Jimblebar Hub as part of BHP's engagement program outlined in Section 4.2.

BHP is working to integrate the Nyiyaparli people's principles into its design philosophies and practices and has included reference to the principles in several of the forward work programs outlined in Section 7.6.

5.15 Local land use

On a regional setting, the primary land use is low intensity grazing with iron ore mining being the dominant industry.

The current land uses, as defined according to the Australian Land Use and Management Classification (ABARES, 2016), for areas not directly affected by mining in the vicinity of Jimblebar Hub operations area include:

- Natural environments for managed resource protection; and
- Relatively natural environments for pastoral grazing purposes.

These land uses reflect the underlying land tenure which is (Map 2-3, Section 2.4):

- Predominantly unallocated crown land across the OB17/18/31 and east Jimblebar areas; and
- Ethel Gorge and Sylvania Pastoral Leases for portions of OB18 and the central and southern portions of the Jimblebar area.

The town of Newman lies approximately 40 km to the west of the Jimblebar Hub area. It provides accommodation and services for mine employees and contractors including an airstrip. Several tourist attractions are located within Newman and its surrounds and are linked with the Warlu Way, a driving trail connecting Newman with Karijini National Park and coastal attractions.

Tourists are also attracted to areas surrounding the Newman Township between July and September each year to view Spinifex grass flowering (360 Environmental, 2014).

The Aboriginal community of Jigalong is located 130 km to the east of Newman and has a population of approximately 300 people. The Traditional Owners are the Nyiyaparli and Martu peoples.

The mine itself is located on the land of the Nyiyaparli people (Section 3.4.6) who have historically used this area for a range of traditional uses and continue to do so.

5.15.1 Knowledge gaps & forward work program

No knowledge gaps which have impacts on closure outcomes have been identified.

5.16 Design studies, trials and analyses

A range of studies have been conducted which inform closure planning for Jimblebar Hub including:

- PAF cover trials (Section 5.16.1).
- OSA landform design studies (5.16.2).
- Studies informing permanent flood bund and creek diversion designs (Section 5.16.3).
- Studies informing the closure of the in-pit TSFs at De Grey and Swan (Section 5.16.4).
- Assessments of the impacts of different mine void closure scenarios (Section 5.16.5).
- Rehabilitation trials and research (Section 5.16.6).

Remaining knowledge gaps and work programs planned to address them are identified in each section.

5.16.1 PAF cover design trials & monitoring

BHP has been researching PAF placement techniques and cover designs at Whaleback since 1997. As part of this research, it was established that layering PAF material with NAF material during overburden placement and covering with 5 m of NAF material significantly reduced gas and water flux within an OSA (and hence the potential for AMD generation) (Okane, 2020). Following this research, the WAIO AMD management standard requires that AMD 1 materials (higher risk overburden) are stored in a paddock dumped configuration, layered with inert overburden, to limit oxygen ingress into reactive overburden.

Further trials have been conducted on different final cover systems and have concluded that (Okane, 2020):

- A store and release cover system is an effective means of limiting moisture ingress into OSAs.
- Where run-off can be appropriately managed and erosion controlled, a system generating run-off during heavy rainfall, or multiple short period rainfall events, may be advantageous in reducing net percolation.
- Of the store and release cover system permutations, an enhanced store and release cover system incorporating a low flux layer and constructed of both WMAT 1 and WMAT 3 materials, is more effective at limiting net percolation than a cover without the WMAT 3 low flux layer.
- Vegetation increases transpiration and, therefore, net percolation.
- A thicker cover which includes a low permeability layer, likely results in lower seepage rates through the cover system and increased water residence time in the upper layer of cover material, enabling the material to remain above field capacity following rain events for longer than other cover systems. This facilitates successful establishment of vegetation and limits net percolation.

5.16.1.1 Knowledge gaps & forward work program

BHP is currently in the process of reviewing OSAs / ISAs across its Pilbara operations based on storage of AMD 1 to identify priorities for AMD monitoring based on the risk posed by each landform.

5.16.2 OSA design studies

Summary of key points:

- Erosion modelling has been conducted to inform the closure designs for several OSAs.
- This section only reports the outcomes of studies for landforms that have yet to be reshaped / rehabilitated. Design studies conducted to inform the designs of OSAs that have already been reshaped and rehabilitated are summarised in Section 9.3.1 and Appendix L.

This section outlines the outcomes of the design studies that have been conducted to inform closure planning at the Jimblebar Hub, in general, and studies conducted specifically for certain OSAs. The section focuses on landforms that have yet to be reshaped / rehabilitated. Design studies conducted to inform the designs of OSAs that have already been reshaped and rehabilitated are summarised in Section 9.3.1 and Appendix L.

5.16.2.1 SIBERIA modelling to inform landform design options

Landloch (2016a) conducted SIBERIA modelling of a series of representative slope profiles (Table 5-71 and Figure 5-55) for the OB18 D3 and Jimblebar D3 materials to assess the impact of slope profiles on erosion performance. The study provides broad guidance for the rehabilitation of landforms at the Jimblebar Hub.

Table 5-71 Landform geometries for which SIBERIA modelling was conducted

Landform Height	Landform Profile			
	Single linear	Stacked linear	Single Concave	Stacked Concave
20 m	✓			
40 m		✓	✓	
60 m		✓	✓	
80 m		✓		✓
100 m		✓		✓

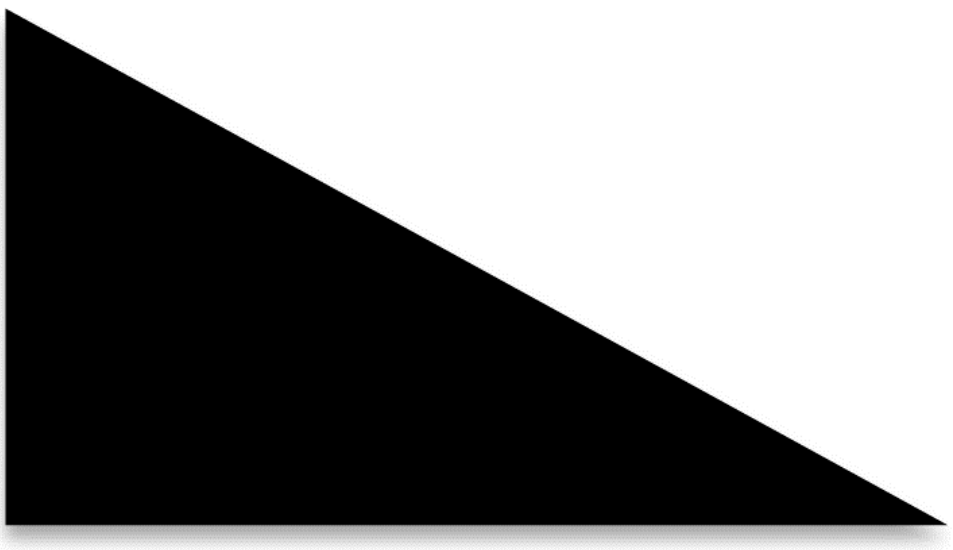
Source: Landloch (2016a)

The outputs of the modelling illustrated that the erosion performance of stacked concave slopes was generally better than linear slope profiles and that higher single slope landforms could be achieved with a concave profile (Table 5-72). Creation of a concave landform while maintaining a fixed toe line will decrease storage capacity under the batter, although the impact of this reduction depends on the size of the OSA, and the volume of overburden stored within the OSA but not within the batter zone. In areas where the toe can be moved, storage capacity can be maintained or increased while at the same time reducing the number of berms required. The multiple berms associated with stacked linear options represent additional construction effort and surface water containment engineering required for rainfall events above a 1 in 200-year 72 hr event (Landloch, 2016a).

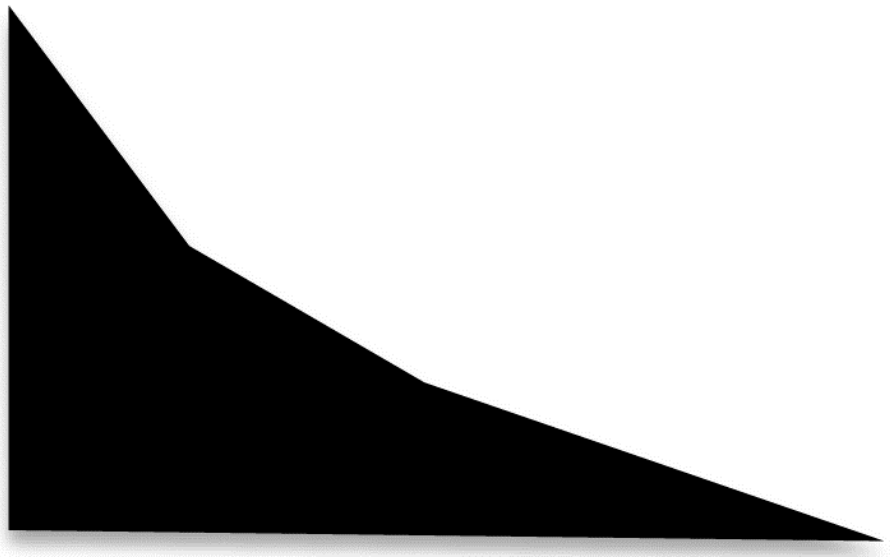
Table 5-72 Modelled soil loss from representative slopes

Modelled Slope Profile			Average Annual Soil Loss (t/ha/y)	
Single / stacked	Geometry	Height (m)	OB18 D3	Jimblebar D3
Single	Linear	20	18.9	2.5
Single	Concave	40	11.1	1.2
Stacked	Linear	40	25.6	3.6
Single	Concave	60	8.6	1.1
Stacked	Linear	60	25.5	5.0
Stacked	Linear	80	19.1	3.3
Stacked	Concave	80	12.3	2.0
Stacked	Linear	100	19.2	5.4
Stacked	Concave	100	9.6	1.5

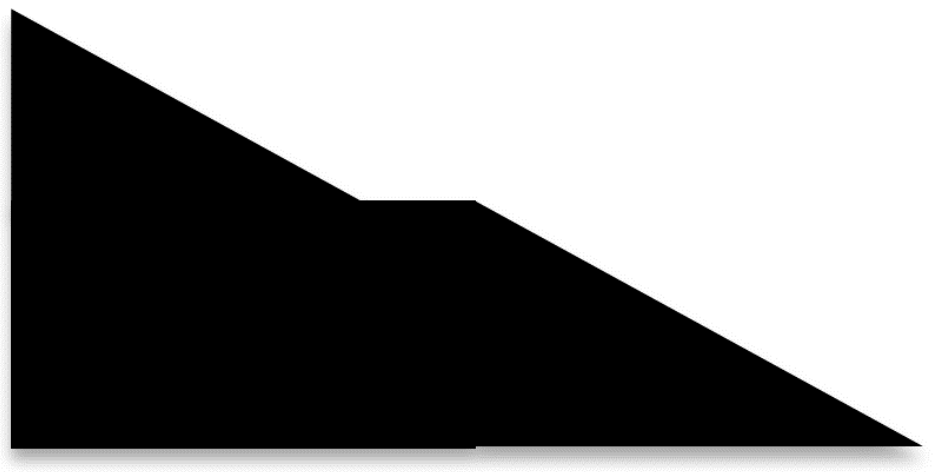
Source: Landloch (2016a)



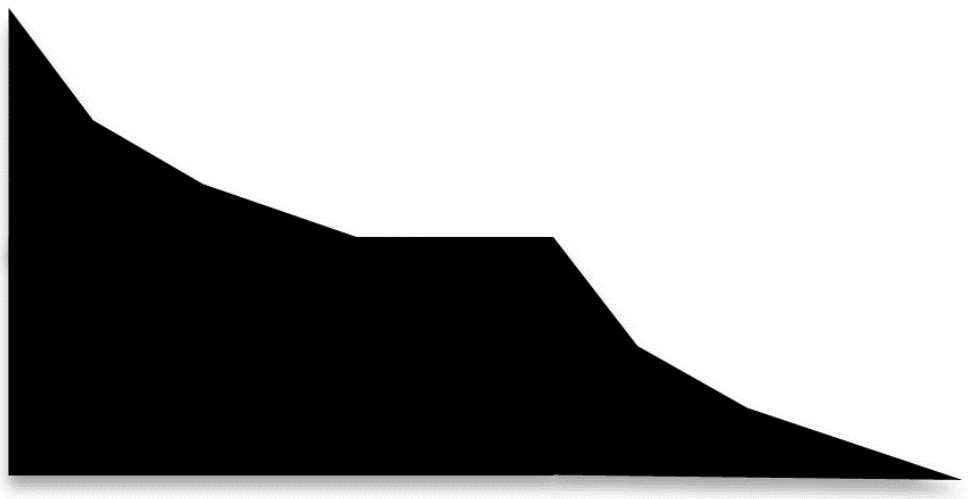
Single linear example cross section



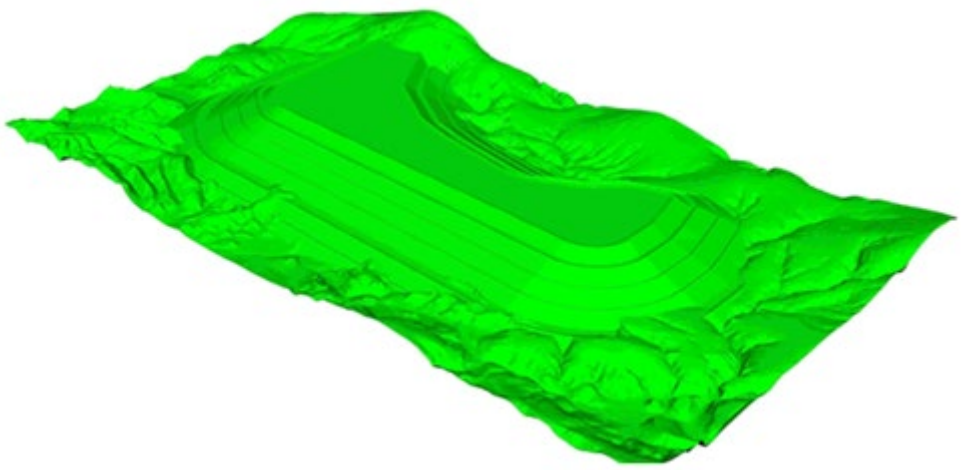
Single concave example cross section



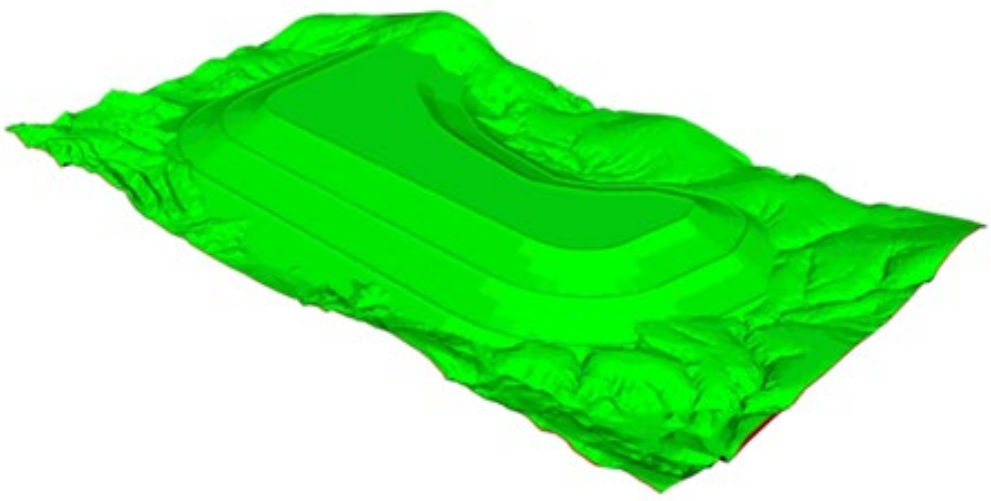
Stacked linear example cross section



Stacked concave example cross section



Stacked linear example landform



Stacked concave example landform

Figure 5-55 Example linear and concave landform profiles

Berm widths

Landloch (2016a) calculated the berm capacity required to retain a 1:200-year 72 hour rainfall event and the depth of sediment arising from erosion after 200 years for different batter heights (Table 5-73). The calculations used a conservative run-off coefficient of 0.7, and assumed a berm top width of 1 m, a 20° gradient on the rear face of the bund, and a 16° gradient on the front face of the bund. Erosion rates were derived from WEPP model outputs for materials at Jimblebar Hub and other mining areas.

Table 5-73 Berm widths required to store a 1:200-year 72-hour rainfall event after 200 years

Height (m)	Required width of rehabilitation berm for a bund height of:				
	0.8 m	1.3 m	1.8 m	2.3 m	2.8 m
20 m linear	99	36	25	22	21
40 m concave	312	101	63	48	40
60 m concave	570	185	110	81	64
80 m concave	1,000	315	188	135	105
100 m concave	1,235	387	231	165	128

Source: Landloch (2016a)
Note: Allows for 0.3 m freeboard. Berm width value includes both the length of the floor and the width of the frontal berm.

5.16.2.2 BF07

Landloch (2021a) conducted SIBERIA modelling to evaluate several design options for the BF07 OSA as outlined in Table 5-74.

Table 5-74 BF07 design options modelled

Landform geometry	Sheeted with WMAT 1[1]	Sheeted with WMAT 2[2]
Linear benches with no ramps Up to 6 lifts each comprising a 20 m high batter with a gradient of 15° and benches typically 20 m wide. 2 m crest bunds located on each bench and at the surface of the OSA. The lowest lift on the southern face remains at angle of repose (30-37°). All ramps are removed (Figure 5-56).	✓	×
Linear benches with ramps As above, except for inclusion of permanent ramp features located on the southern and eastern side of the OSA. Each ramp extends from the crest to toe of a lift with a gradient of 5°. A crest bund (2 m) is included at the top and bottom of each ramp segment (Figure 5-56).	✓	×
Concave with ramps Concave slopes on eastern and western faces. The eastern face comprises two concave slopes separated by a 50 m wide bench. The top concave is 40 m high with a 20 m slope at 16°, and 2 x 10 m slopes at 10° and 8° respectively. The lower concave is 60 m high with slopes of 20 m at 16°, 10° and 8°. The western face comprises a 60 m concave slope (with 20 m high slopes of 15°, 8° and 6°) with a 75 m wide bench separating a 20 m high linear batter with a 15° gradient. The southern and northern faces have linear batters with ramps as described above. 2 m crest bunds are located on each bench and at the surface of the OSA (Figure 5-56).	✓	✓

Source: adapted from Landloch (2021a)

The outputs of the SIBERIA modelling are outlined in Table 5-75 and Figure 5-56 and show that all of the landform design options modelled meet the target erosion threshold of 6 t/ha/y and are erosionally stable when sheeted with WMAT 1 material. The concave slopes are the most erosionally stable and erode at about 50% of the rate of linear batters. When sheeted with WMAT 2 material, both the linear and concave slopes erode at rates higher than the target threshold and use of this material is predicted to result in erosionally unstable batters in the long term (Landloch, 2021a).

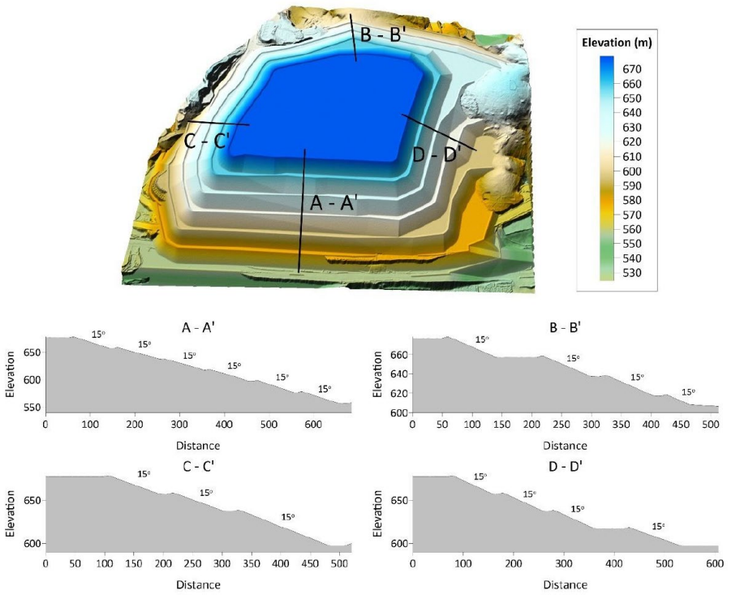
Table 5-75 BF07 SIBERIA modelling outputs

Landform design	Surface material	Simulation Year	Max Gully Depth (m)	Average Erosion Rate (t/ha/y)	Cumulative Erosion (mm)
Linear benches no ramps	WMAT 1	50	<0.3	3.9	13
		100	<0.3	3.7	26
		200	<0.3	3.5	37
		300	0.3	3.3	48
Linear benches with ramps	WMAT 1	50	<0.3	4.0	14
		100	<0.3	3.8	26
		200	<0.3	3.4	38
		300	0.3	3.2	48

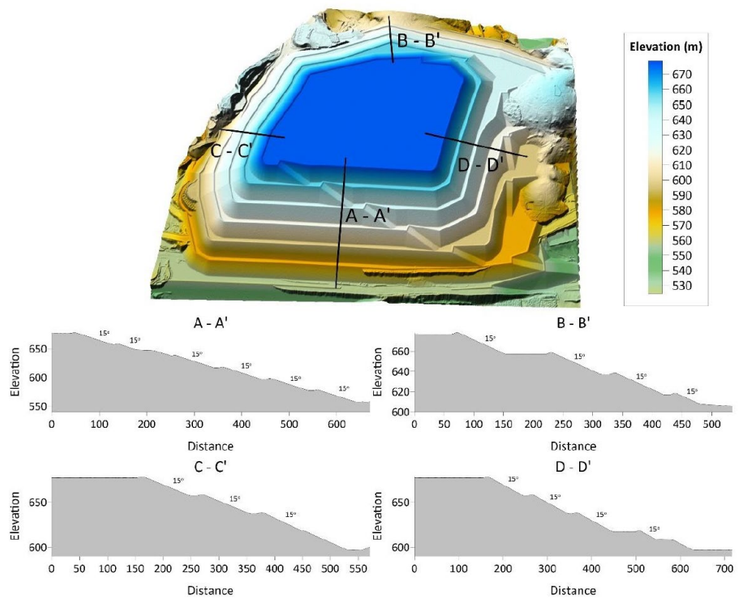
Landform design		Surface material	Simulation Year	Max Gully Depth (m)	Average Erosion Rate (t/ha/y)	Cumulative Erosion (mm)
Concave with ramps	Eastern & western concave slopes	WMAT 1	50	-	2.2	7
			100	-	2.2	14
			200	-	2.2	22
			300	0.3	2.2	29
	Northern & southern linear slopes		50	-	3.8	13
			100	-	3.7	25
			200	-	3.4	36
			300	0.3	3.2	47
Concave with ramps	Eastern & western concave slopes	WMAT 2	50	-	12.7	24
			100	0.4	11.5	81
			200	0.7	10.0	114
			300	1.1	9.0	144
	Northern & southern linear slopes		50	-	27.9	93
			100	0.4	23.5	172
			200	0.8	19.3	236
			300	1.2	16.7	292

Source: adapted from Landloch (2021a).

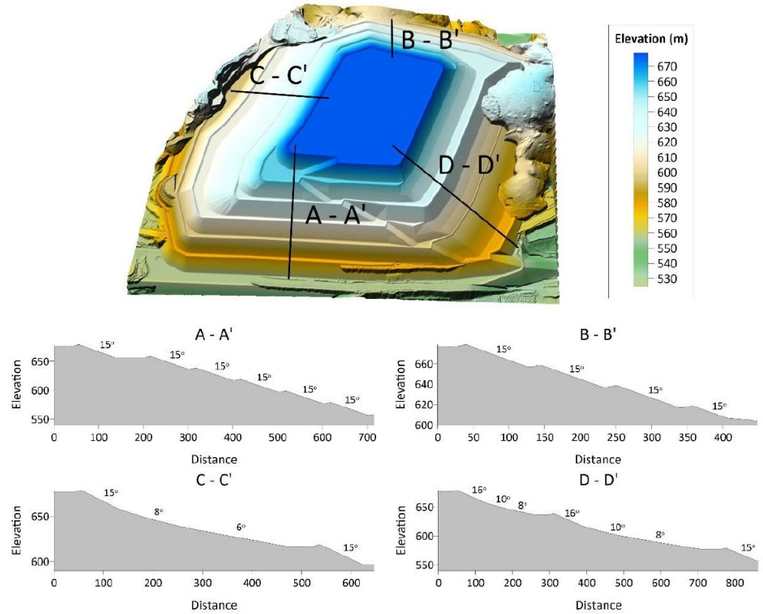
Linear benches with no ramps

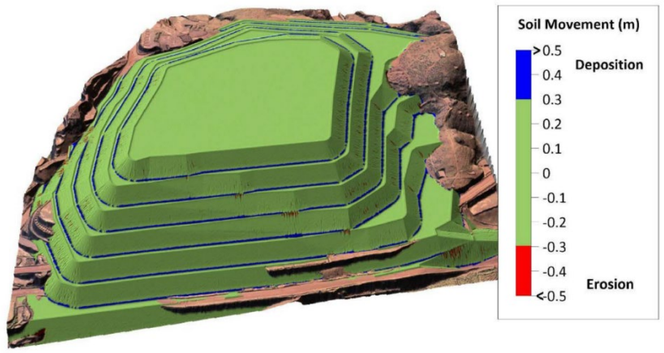


Linear benches with ramps

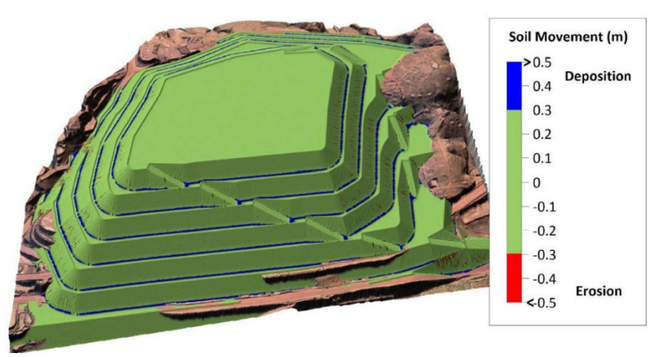


Concave with ramps

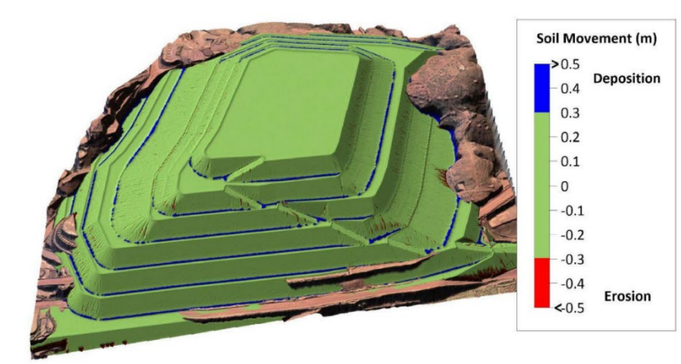




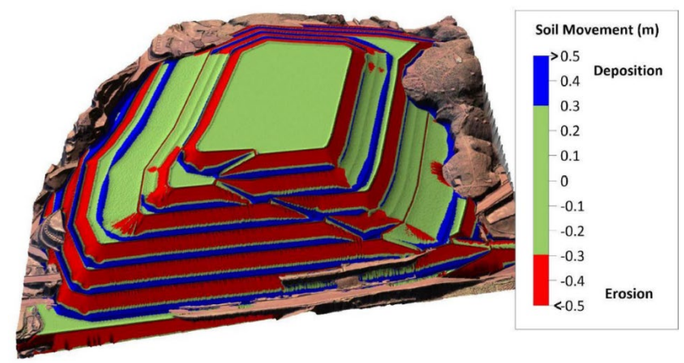
Erosion at 300 years – WMAT 1 sheeting



Erosion at 300 years – WMAT 1 sheeting



Erosion at 300 years - WMAT 1 sheeting



Erosion at 300 years – WMAT 2 sheeting

Source: Landloch (2021a)

Figure 5-56 BN07 landform design options – SIBERIA modelling outputs

The inclusion of ramps has a minimal impact on the overall rate of erosion for the linear bench design with similar erosion rates occurring in both designs (Table 5-75). The design of the ramps is an important factor in limiting their potential impact on erosion. A key feature of the ramps is the inclusion of bunds at the top and bottom of each ramp segment, which include a berm sufficient to store sediment eroding off the ramp. This is critical to the overall OSA stability, as each segment of ramp has been hydraulically disconnected from the next (Landloch, 2021a).

While the overall impact of the ramps is low, the ramps act as 'knickpoints', with rill and gully erosion initiating as water runs off the ramp and onto the batter slope below (Figure 5-57). Overall, this effect results in the occurrence of minor erosion features but does not impact on the overall stability of the landform (Landloch, 2021a).

There are areas where designs could be refined to reduce erosion including (Landloch, 2021a):

- Some corners of the OSA have a reduced berm capacity that drives increased surface water flows, contributing to higher levels of erosion.
- The lowest southern batter of the linear bench design incorporates batter gradients at angle of repose (~35°), as opposed to the consistent 15° batter gradients adopted across most of the landform. This section is predicted to be prone to rill erosion and will erode at a slightly higher rate.

Source: Landloch (2021a)

Figure 5-57 Knickpoints on ramps where erosion has initiated

5.16.2.3 BN07

Landloch (2021b) conducted SIBERIA modelling to evaluate several design options for BN07 OSA. The main differences in the designs relate to slight alterations to the western section, except for Option 7 which applies to the whole OSA. The options are outlined in Table 5-76 and Figure 5-58. The surface of the OSA comprises WMAT 1 material.

The outputs of the modelling are provided in Table 5-76 and Figure 5-59.

Table 5-76 BN07 OSA SIBERIA modelling outputs

Design Option	Simulation Year	Maximum Gully Depth (m)	Average Erosion Rate (t/ha/y)	Cumulative Erosion (mm)
Option 1 Linear batter, 14 m wide western section, crest bunding	50	-	4.3	14
	100	-	4.2	29
	200	-	4.1	42
	300	0.3	4.0	56
Option 2 Linear batter, 18 m wide western section, crest bunding	50	-	4.3	15
	100	-	4.3	29
	200	-	4.1	43
	300	0.3	4.0	56
Option 3 Linear batter, 20 m wide western section, no crest bunding	50	-	4.4	15
	100	-	4.3	29
	200	-	4.1	43
	300	0.3	4.0	56

Design Option	Simulation Year	Maximum Gully Depth (m)	Average Erosion Rate (t/ha/y)	Cumulative Erosion (mm)
Option 4 Linear batter, 20 m wide western section, water shedding	50	-	4.1	14
	100	-	4.0	27
	200	-	4.0	41
	300	0.3	3.9	53
Option 5 Linear / concave batters, water shedding	50	-	4.1	14
	100	-	4.1	27
	200	-	3.9	40
	300	0.3	3.8	53
Option 6 Linear batter, 25 m wide western section, crest bunding	50	-	3.5	12
	100	-	3.4	23
	200	-	3.3	40
	300	-	3.2	45
Option 7 Concave batters, 25 m wide western section, crest bunding	50	-	4.3	14
	100	-	4.2	29
	200	-	4.1	42
	300	0.3	4.0	56

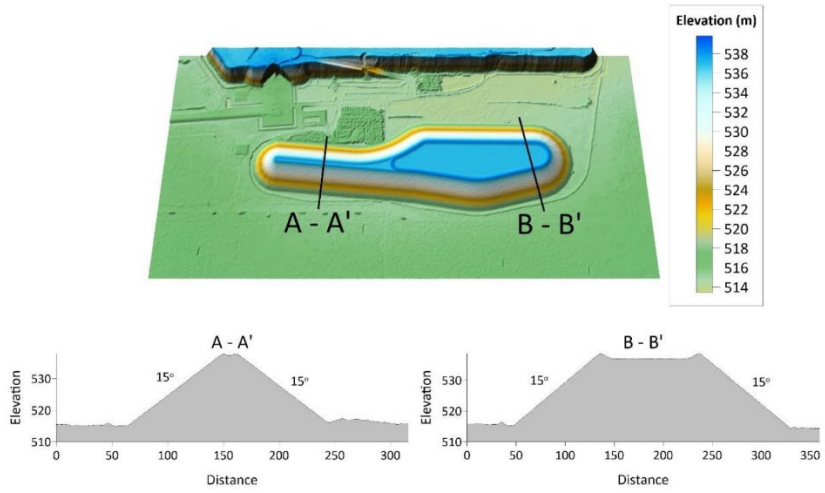
Source: Landloch (2021b)

All modelled designs meet the target average erosion threshold of 6 t/ha/y. However, the lowest erosion rates were observed for Option 6; 15° linear batters, a 25 m wide western section and 1.5 - 2 m high crest bunding (Table 5-76) (Landloch, 2021b).

Results show that inclusion of crest bunds in rehabilitation landform designs is likely to have minimal impact on erosion (Table 5-76). This is due to the small area of the BN07 OSA top that can contribute to run-off and erosion. If the top were larger and greater run-off was generated and allowed to discharge to the outer batters, it is likely that the erosion of the landforms without crest bunding would be much higher (Landloch, 2021b).

Similar average erosion rates were predicted for landforms with water shedding tops as opposed to flat tops (Table 5-76). Rilling was shown to be more prevalent on the crest of the western section where the top surface was designed to be water shedding, (Figure 5-59) although this increase in rilling was not reflected as a change in gully erosion. Overall, the change in erosion associated with the inclusion of water shedding features was shown to be minor and consequently, is not predicted to have significant impact on overall erosion potential. This is also likely to be due to the small area of the BN07 OSA top that can contribute to run-off and erosion (Landloch, 2021b).

Comparison of concave slopes against linear batters for the western section of the landform showed that both profile shapes erode at similar rates, indicating that for this design, the use of a concave slope offers no additional benefit in terms of erosion reduction (Table 5-76) (Landloch, 2021b).



Option 1: linear batter, 14 m wide western section, crest bunding

- Single batter ~25 m high with a 15° linear slope.
- Crest bunds located on the outer edge of the top surface; 0.5 m high, 6 m wide at base with a 9-10° backslope on western section & 2 m high, 20 m wide at base with a 10-11° backslope on eastern section.
- Top surface flat with max. widths of 14 m & 130 m in the western & eastern sections respectively.

Option 2: linear batter, 18 m wide western section, crest bunding

- As for Option 1 with the exception of the top surface of the western section which extends out by approximately 4 m, reaching a max. width of 18 m.

Option 3: linear batter, 20 m wide western section, no crest bunding

- As for Options 1 & 2 except that the top surface of the western section remains flat with no crest bunds & the max. width of the top surface is 20 m.

Option 4: linear batter, 20 m wide western section, water shedding

- As for Option 3 except that the western section is water shedding rather than flat.

Option 5: linear / concave batters, water shedding

- Similar to Option 4 except that the batters of the western section have concave slopes with the top 15 m at 18° & lower 5 m at 5°.

Option 6: linear batter, 25 m wide western section, crest bunding

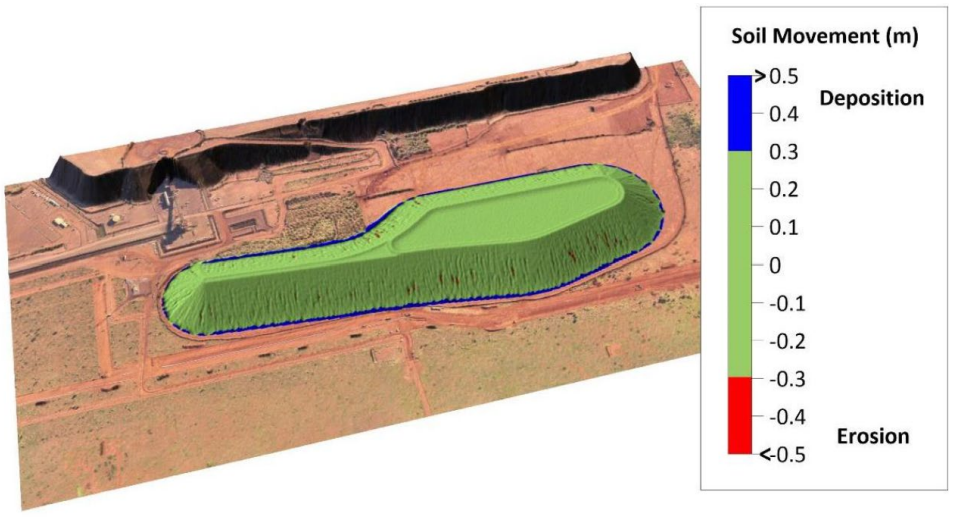
- Linear batters with a 15° slope; 20 m & 25 m high in the western & eastern sections respectively.
- Crest bunds located on the outer edge of the top surface; 1.5 m high, 15 m wide at base with a 13° backslope on western section & 2 m high, 20 m wide at base with a 10-11° backslope on eastern section.
- Top surface flat with a max. width of 25 m in the western section & 130 m in the eastern section.

Option 7: concave batters, 25 m wide western section, crest bunding

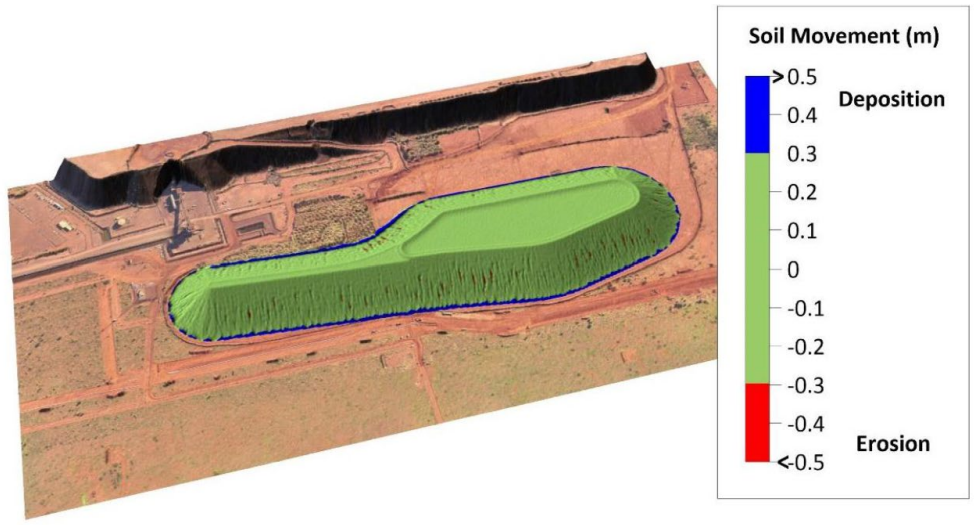
- Concave batters ~20 m high in the western section & ~25 m high in the eastern section. The upper 10-15 m of the concave slope is 18° & the lower 10 m is 13°.
- Crest bunds 1.5 m high on the western section & 2 m high on the eastern section.
- Top surface is flat with a max. width of 25 m & 130 m in the western & eastern sections respectively.

Source: Landloch (2021b)

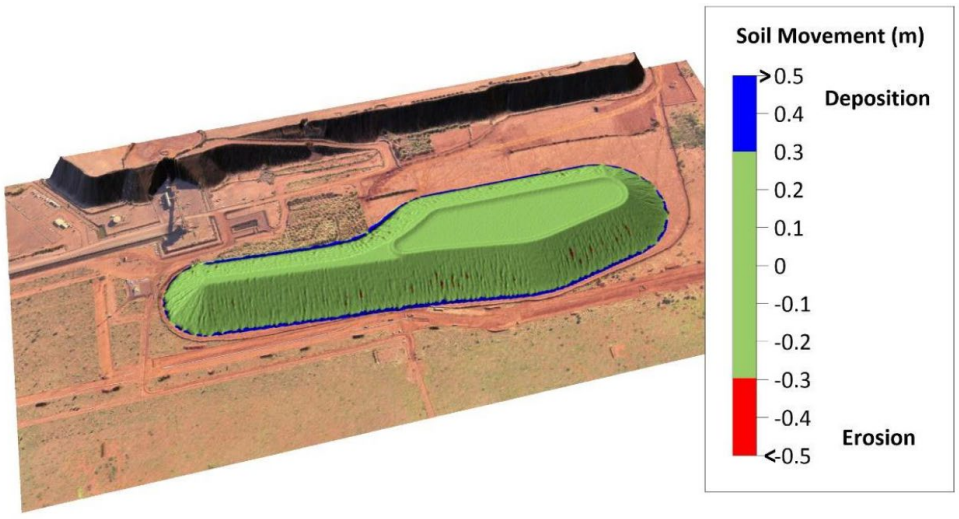
Figure 5-58 BN07 OSA design options modelled



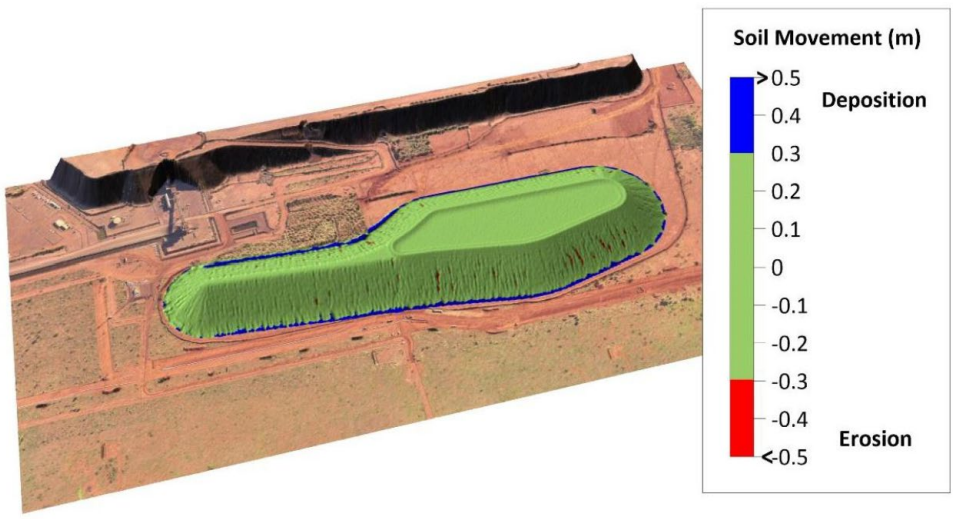
Option 1: linear batter, 14 m wide western section, crest bunding



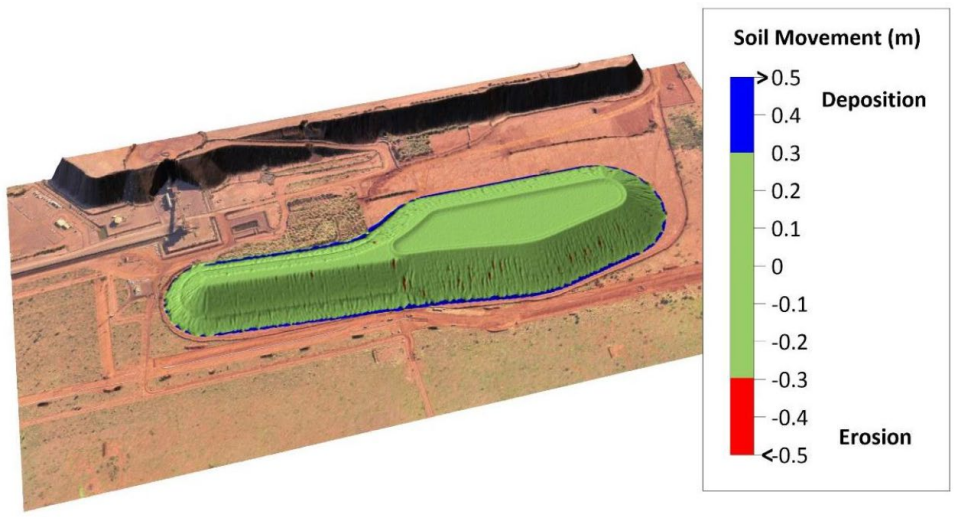
Option 2: linear batter, 18 m wide western section, crest bunding



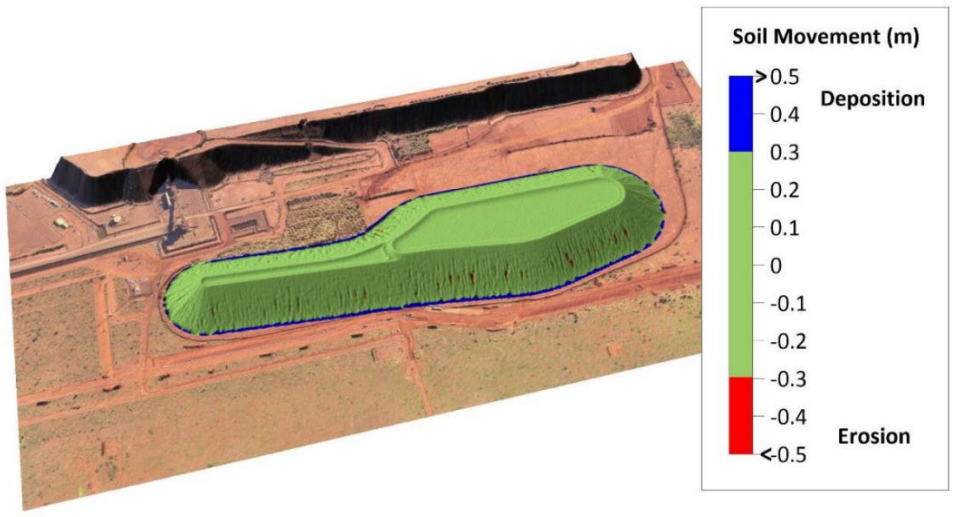
Option 3: linear batter, 20 m wide western section, no crest bunding



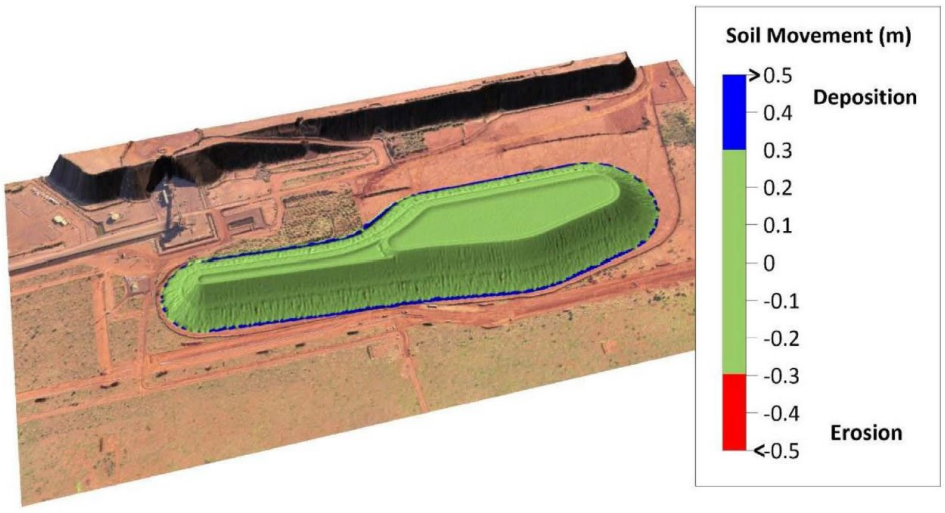
Option 4: linear batter, 20 m wide western section, water shedding



Option 5: linear / concave batters, water shedding



Option 6: linear batter, 25 m wide western section, crest bunding



Option 7: concave batters, 25 m wide western section, crest bunding

Source: Landloch (2021b)

Figure 5-59 BN07 OSA – SIBERIA modelling outputs at 300 years

5.16.3 Flood bunds and creek diversions

Summary of key points:

- Operational designs have been developed for several flood bunds and creek diversions. Some of which have been constructed and some which are yet to be constructed.
- While the operational designs focus on accommodating the storm events appropriate to an operating site (1 in 100-year), the designs have considered potential modifications that may be required for closure conditions. 1 in 10,000-year modelling has typically been used to inform an initial assessment of potential requirements for closure conditions, however, the appropriate event for the final design will be selected based on the final mine footprint and an assessment of risk, as outlined in Section 7.5.3.
- Closure designs will be progressed prior to closure but final mine / OSA footprints and performance of the operational infrastructure will inform closure designs, so these closure designs will not be progressed until closer to the time of closure.

The footprints of mining areas and OSAs are confirmed during the design process as each area approaches commencement of mining / disturbance. During this process, the need for flood bunds or diversions is considered. Flood protection bunds and diversion drains installed or proposed at Jimblebar Hub, based on current confirmed footprints include (Map 2-2, Section 2.2):

- A bund designed as detailed in Section 5.16.3.2 to allow mining of Orebody 31 which falls within the floodplain of Orebody 31 Creek (Section 5.16.3.2).
- Bunds constructed on the southern margin of the Copper Creek channel to protect the South Jimblebar operations against flooding (Section 5.16.3.3).
- A diversion drain designed to allow mining of the South Jimblebar (Stage 3) deposit and construction of associated OSAs (Section 5.16.3.4).
- A diversion of Jimblebar Creek West Branch to allow mining of the SJG2 and SJH2 (Capricorn) pits. Two minor diversions are also required to divert Central Creek to the gap between SJG2 and SJX pits and to prevent capture of the Eastern Creek by the eastern end of the SJH2 pit (Section 5.16.3.5).
- Flood bunds at H1A1 (Section 5.16.3.6) and H2B1 (Section 5.16.3.7) to prevent creek capture by the Hashimoto pits.

5.16.3.1 BHP construction standards for levees

BHP's standards require levees to be constructed of General Fill Type C1, Type A2 or A4 Select Fill material (refer to Appendix E-5 for definitions). The material must be conditioned to ± 2% of optimum moisture content and compacted (92% maximum dry density) in lifts <300 mm loose thickness. If poorer quality material is used[35], it must be encapsulated internally within the bund. Depending on flow velocity and shear stress, rock armouring underlaid by geotextile may also be required.

5.16.3.2 OB31 flood bund design

An operational design for the OB31 flood bund has been progressed to a Definition Phase Study (DPS)[36] (RPS, 2021), although this study focuses on the area required to be diverted for OB31 pit pushback 1 as the future pushbacks, extending further east are not due for several years, and are subject to change (RPS, 2021). A Selection Phase Study (SPS) has been conducted for the potential full extent of the flood bund and considers closure options (RPS, 2019a). The outcomes of these two studies are summarised below.

Operational design

The current flood bund design is located 75 m beyond the planned pit edge. The analyses below conservatively assume that poorer quality material (Section 5.16.3.1 and Appendix E-5) will be used in the construction of the bund.

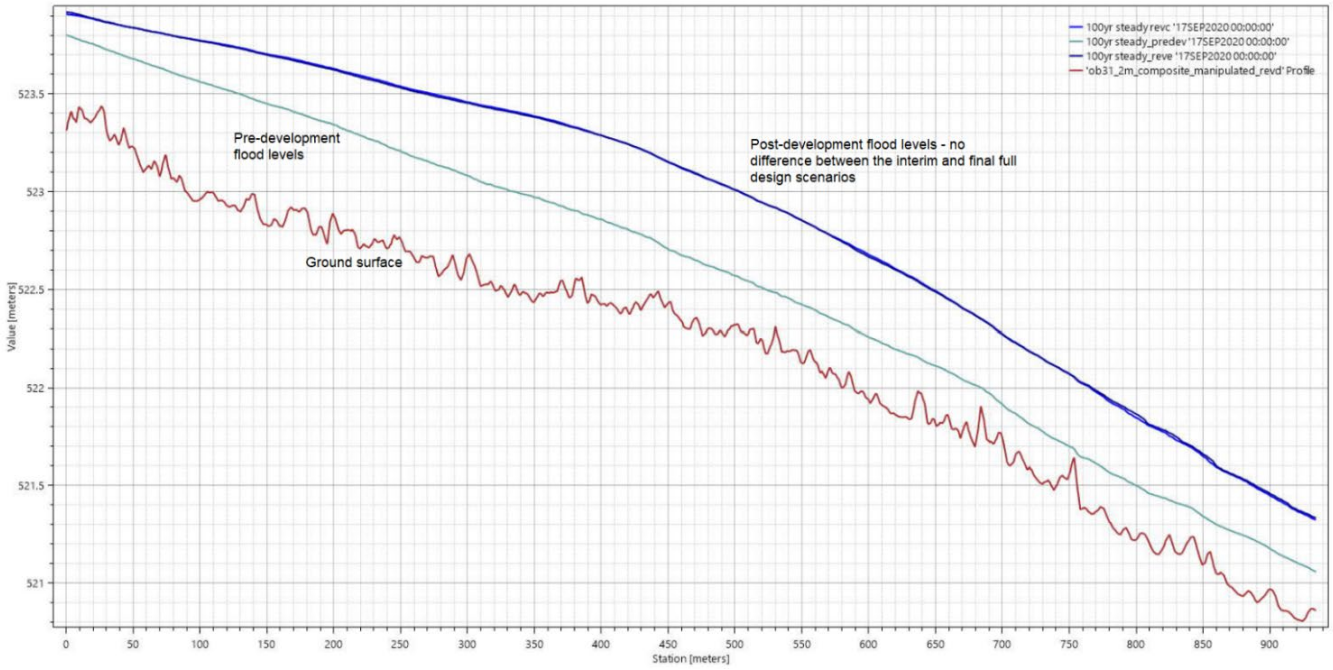
Crest level (flood level and freeboard)

Hydraulic modelling was undertaken to determine 100-year design flood levels for both the interim design for the flood bund around OB31 pushback 1 and the full design scenario (Figure 5-60). The flood levels for the interim and full design scenarios are comparable (Figure 5-60). The flood bund has been designed to accommodate the modelled 100-year flood levels plus 1 m freeboard. Modelled velocities for the interim flood bund design are less than 1 m/s, and for the full design are generally less than 1 m/s but reach up to 1.5 m/s at the eastern end of the bund. These velocities indicate that rock armour is not required[37]. A 5 m crest width has been proposed for robustness and constructability (RPS, 2019a; 2021).

35 The material must be non-dispersive (Emerson class number 5 or higher), non-permeable (<10m/d), or deemed to comply if the material includes some fines - minimum 10% and is not gap graded). The required compaction must be achievable (RPS, 2021).

36 Refer to the introduction to Section 5 for an explanation of different study phases.

37 Generally, it is not considered necessary to armour an operational embankment or channel against velocities <2m/s for the design flood event (RPS, 2019a).



Source: RPS (2021)

Figure 5-60 Flood modelling pre- and post-development (interim and full design scenarios)

Foundation conditions

The OB31 flood bund design crosses two main soil types. Toward the beginning of the alignment (i.e., west end), soils are generally colluvial fan deposits and sloping alluvial wash surfaces, predominately GRAVEL (GP-GC) with trace clays and Clayey SAND (SC). Within the watercourse, (alluvial) soils are predominantly Sandy CLAY (CL) over ferricrete. On the margins of the watercourse, very gently sloping wash slopes (alluvial wash surface) predominate, typically Clayey SAND (SC) with varying amounts of gravel. Where the flood bund runs along the creek (valley), there is a chance the bund is located on an alluvium foundation. Sandy foundations with little or no cohesion may need to be boxed out as “unsuitable” material (to limit erosion of the embankment foundation and limit seepage via the foundation interface) (RPS, 2021).

Seepage modelling

As flood bunds only retain water for a short period of time, they are not required to be impermeable. However, seepage may be a concern in regard to slope stability, or local damage / erosion (externally or internally as piping failure). Seepage modelling was conducted by RPS (2021) based on the following assumptions:

- A rocky / ferricrete layer (high shear strength, lower permeability) below the flood bunds at ~3 m depth.
- A water table at 1 m below ground level. A high antecedent moisture above the water table was modelled by capillary suction.
- The permeability of the blended construction material was estimated to be 3 x 10^{-5} m/s (2.5 m/d).
- The existing foundations of silty to clayey soil mixtures have low permeability due to a high fines content, however, a conservatively high permeability of 10^{-5} m/s (1 m/d) was assumed.
- Poorer encapsulated material would typically contain fines, but a conservatively high permeability of 10^{-4} m/s (10 m/d) was assumed.

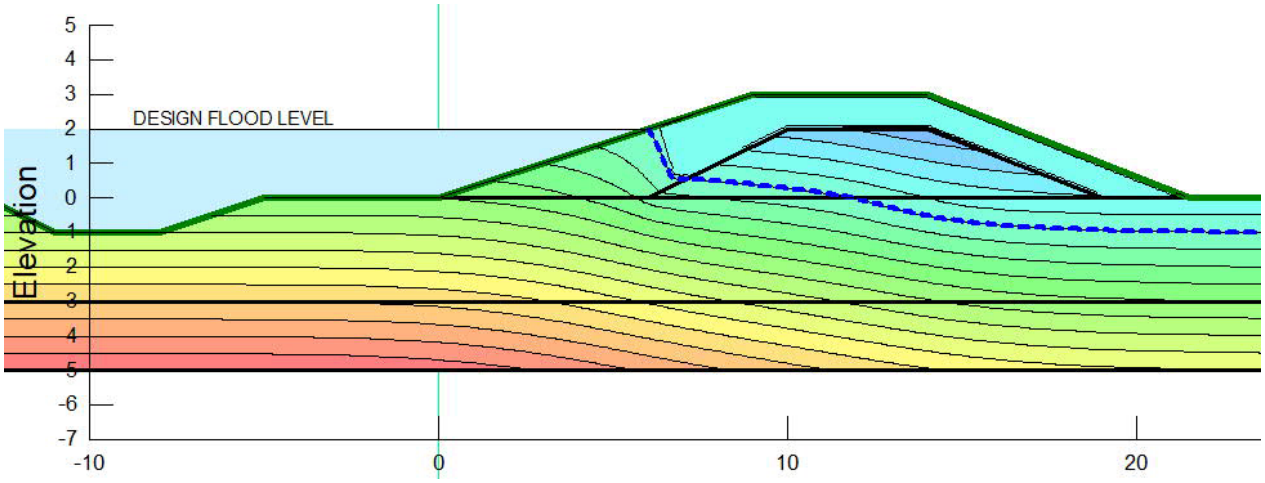
A temporal model was developed based on a gradual (~7 hour) increase in water level to the top level, holding for 24 hours, followed by rapid draw down (recession) at 0.5 m/hr (RPS, 2021).

Two cases are shown below (Figure 5-61 and Figure 5-62) for a 3 m high bund (RPS, 2021):

- Design case with 1 m freeboard above flood height.
- Water level up to crest level (no freeboard).

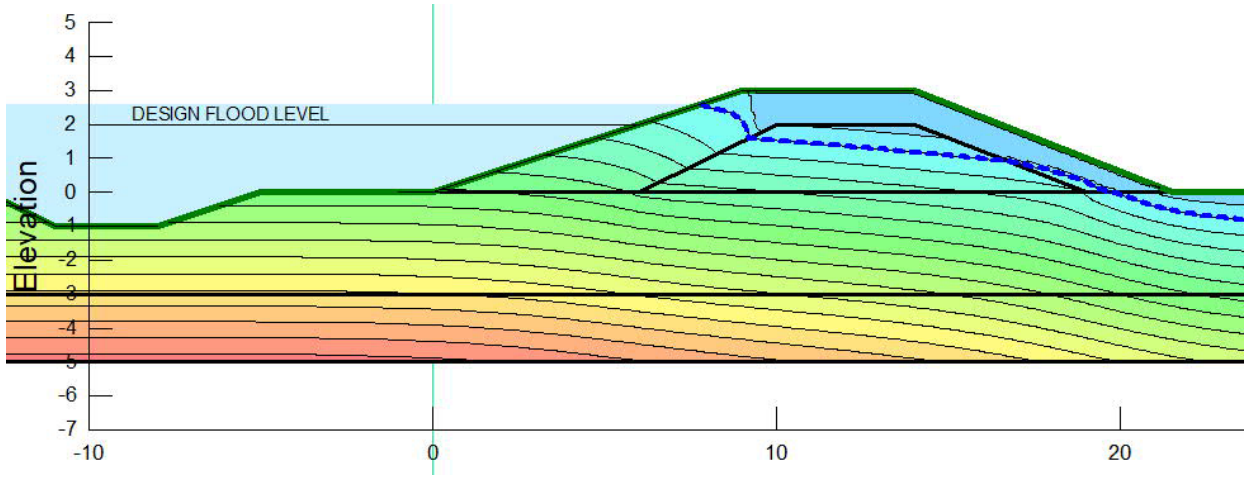
Figure 5-61 and Figure 5-62 show the dashed blue phreatic line at its highest level during the flood level changes. The phreatic surface (0 kPa pore water pressure contour) does not intersect the downstream batter face for either case, and the chance of piping is minimised. The pore pressure contours shown are positive below the phreatic line, negative (soil suction) above (RPS, 2021).

The water up to crest level is considered unlikely to occur, however, for robustness, the bund should be effective at the overtopping level. The flow rates for the design and water level to crest cases reach 0.9 L/min/m (1.3 m³/day/m) and 3.5 L/min/m (5 m³/day/m) respectively. These flow rates are considered low and inconsequential. Seepage rates would be considerably lower for dryer antecedent moisture and shorter inundation times (RPS, 2021).



Source: RPS (2021)

Figure 5-61 Design Case (water level up to 1 m below crest)



Source: RPS (2021)

Figure 5-62 Water level up to crest level

Slope stability assessment

A geotechnical stability assessment for the OB31 flood bund was conducted by RPS (2021) and assumed:

- An effective friction angle of 38° (with no cohesion) and a unit weight of 24 kN/m^3 for the blended construction material.
- An effective friction angle of 30° (with no cohesion) and unit weight of 25 kN/m^3 for encapsulated material.
- A worst-case effective friction angle of 33° with no effective cohesion and a unit weight of 22 kN/m^3 for foundation material. It is expected that under dry conditions the foundation material would likely exhibit some cohesive strength, but this has been ignored for the ease of analysis. No foundation boxout was assumed in the analysis.

Using these assumptions, the bund meets stability criteria (Table 5-77).

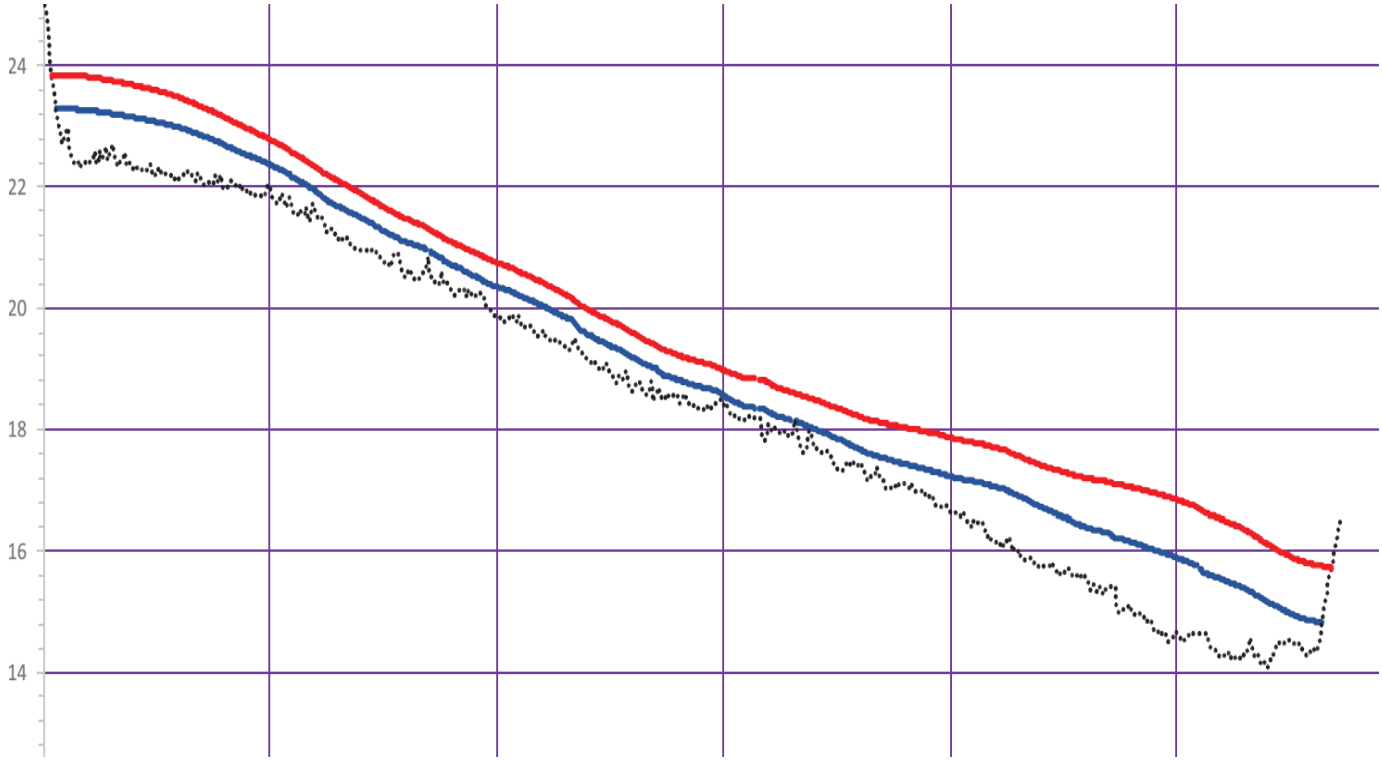
Table 5-77 Slope stability design factor of safety

Location	Scenario	Design case (FoS)		Water level to crest (FoS)		FoS Required
		Upstream face	Downstream face	Upstream face	Downstream face	
Flood Bund (5 m wide, 3 m high)	Dry	2.3	1.8	2.3	1.8	1.5
	Operational (after 1 day flood exposure)	2.7	1.8	2.7	1.6	1.5
	Rapid draw down	1.8	1.8	1.6	1.6	1.3

Source: RPS (2021)

Closure considerations

1 in 10,000-year flood modelling was conducted to provide an initial assessment of potential closure requirements for the OB31 flood bund. As discussed in the introduction to this section, the OB31 pit shell may change as mine planning progresses and consequently the modelling has been based on a nominal pit extent. The modelling showed that if the flood bund is constructed to accommodate a 1 in 10,000-year flood level, then the wall needs to be up to 2 m high (Figure 5-63).

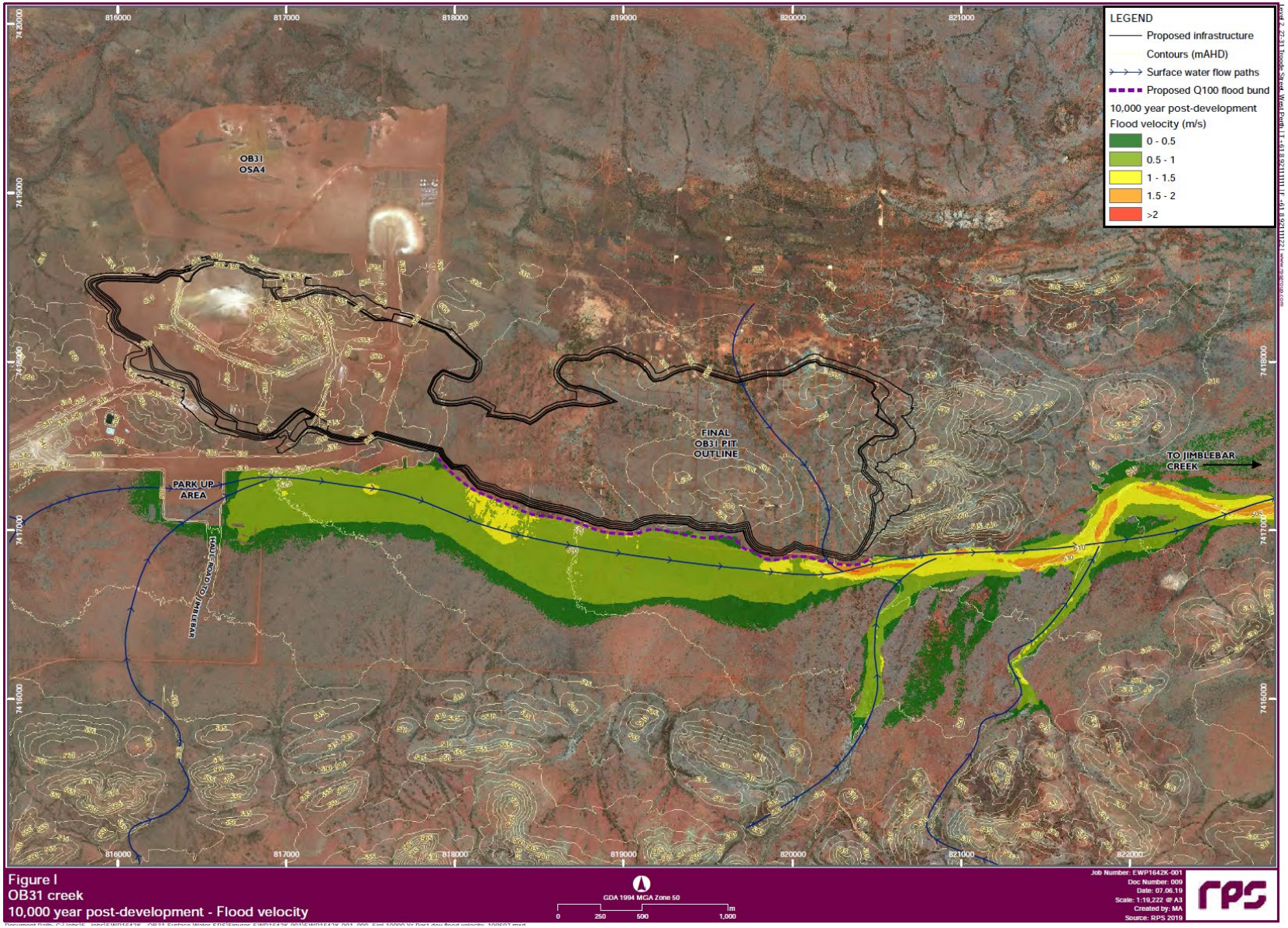


Source: RPS (2019a)

Figure 5-63 1 in 10,000-year flood levels along OB31 bund

Flood modelling for a 1 in 10,000-year event (Map 5-22) indicates that velocities may reach up to 2 m/s at the eastern end of the bund and may require rock protection for long term stability.

The appropriate flood event to be used as the basis of the final design will be selected as discussed in Section 7.5.3. Flood bund closure design concepts are discussed in Section 9.2.3.4.



Source: RPS (2019a)

Map 5-22 Modelled 0.01% (10,000-year) AEP flood velocities with the OB31 flood bund in place

5.16.3.3 South Jimblebar flood bund designs

An operational phase flood bund for the South Jimblebar Stage 1 and 2 pits (Mindoona) and Stage 3 (Sylvania) pit has already been constructed and an operational phase flood bund design for the Stage 4 extension of the South Jimblebar (Sylvania) pits has progressed to SPS (RPS, 2022). Designs for future extensions to the pit (Stage 5) are yet to be developed.

Operational design

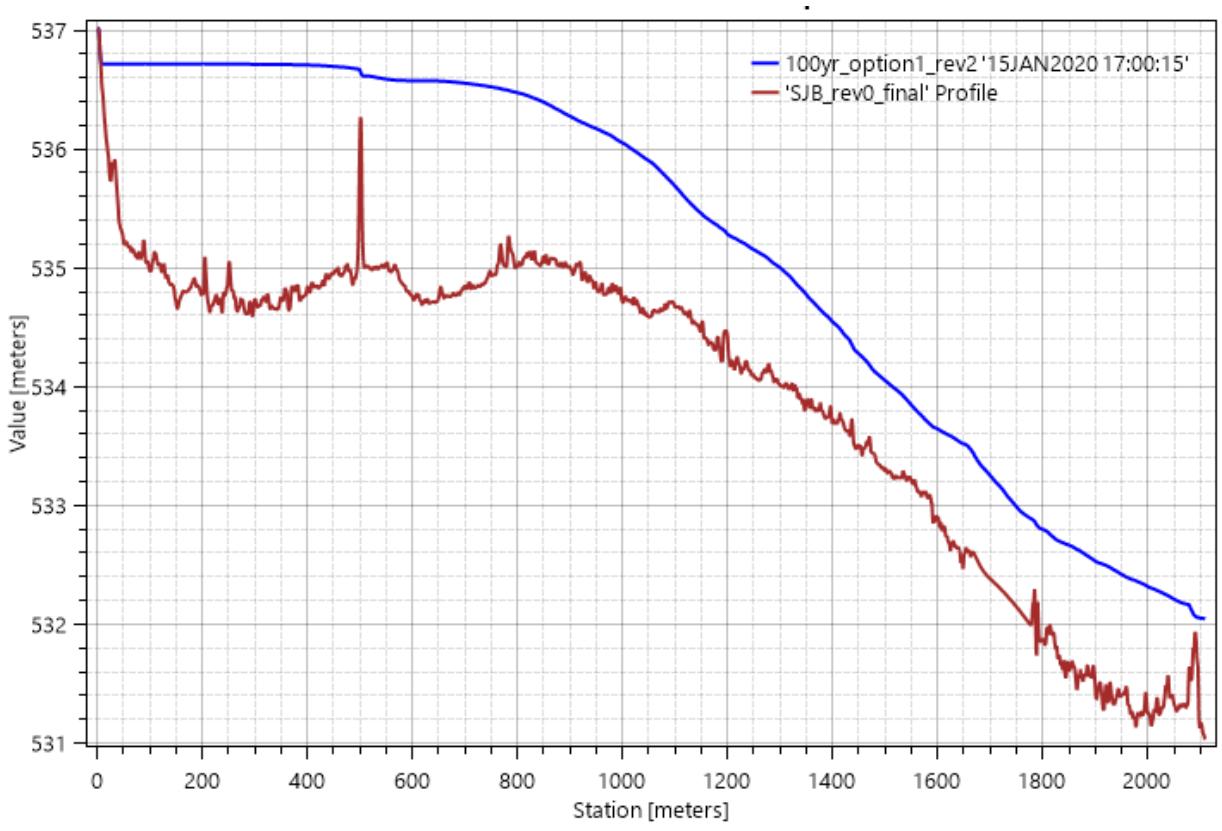
The operational flood bund has been designed for a 1 in 100-year event plus 1 m freeboard (refer to Section 5.11.1.4 for modelled flows).

Crest level and bund geometry

With the introduction of a bund along the Stage 3 and 4 pits, 100-year flood levels reach a maximum of 1.8 m - 1.9 m along the proposed Stage 3 flood bund, (Figure 5-64) and around 2 m along the Stage 4 flood bund (Map 5-23). The bund is therefore, required to have a maximum height of ~3 m including 1 m freeboard. Velocities tend to be low <1.1 m/s, which indicates rock armouring is not required, and provided the designs have minimal disturbance to existing floodplain vegetation, there should be minimal impact to downstream geomorphology (RPS, 2020; Hydrobiology, 2022).

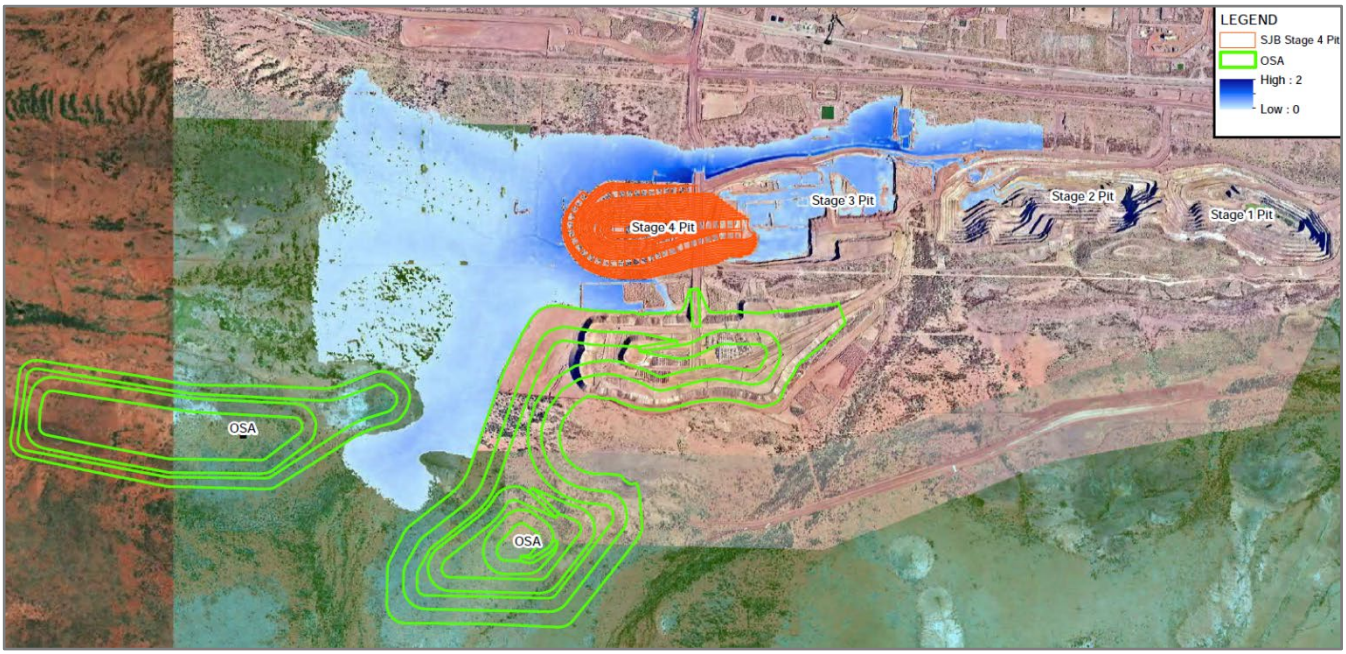
The bund geometry incorporates a wet side batter slope of 1V:3H (to reduce erosion during flooding events, rather than for geotechnical stability), dry side batter slope of 1V:2.5H, and a crest width of 5 m for stability and constructability. Any (poorer quality) encapsulated material should be offset toward the dryer side for reduced permeability and increased strength, with a 1 m minimum exterior thickness of A4 material (Appendix E-5). The nominal encapsulated cross section has a top width of 4 m, and internal slopes of 1V:2H (wet side) and 1V:2.5H (dry side) (RPS, 2020).

A bund toe drain is required to drain the flat longitudinal gradient created by the flood bund and reduce ponding upstream and adjacent to the bund. This is a narrow-cut drain following a longitudinal grade of ~0.2% (RPS, 2020).



Source: RPS (2020)

Figure 5-64 South Jimblebar Copper Creek flood levels



Source: RPS (2022)

Map 5-23 South Jimblebar Stage 4 flood bund 100-year flood levels post-development

Foundation conditions

The proposed Copper Creek bund alignment crosses two main soil types. Within the watercourse, (alluvial) soils are predominantly Sandy CLAY (CL) over ferricrete. On the margins of the watercourse, very gently sloping wash slopes (alluvial wash surface) predominate, typically Clayey SAND (SC) with varying amounts of gravel over ferricrete or rock. Both units are broadly similar (rather than distinct units), being high in sand and fines content of low plasticity. The extent of Mulga vegetation broadly indicates the areas of increased clay soil. Where the flood bund runs along the creek (valley), there is a chance the bund is located on an alluvium foundation. Sandy foundations with little or no cohesion may need to be boxed out as "unsuitable" material (to limit erosion of the embankment foundation and limit seepage via the foundation interface) (RPS, 2020).

Seepage modelling

Seepage modelling was carried out using the same assumptions and with the same results as presented for the OB31 flood bund in Section 5.16.3.2 (Figure 5-61 and Figure 5-62) (RPS, 2020). The results show that the potential for piping is minimised, and the modelled seepage rates are low and inconsequential.

Stability assessments

A slope stability assessment was completed for the South Jimblebar Stage 3 flood bund using the same assumptions listed for the OB31 flood bund geotechnical assessment in Section 5.16.3.2 (RPS, 2020). The results indicate that the bund meets stability criteria.

An assessment of the realignment stability indicated that the Stage 3 bund will meet ACARP (Australian Coal Association Research Program) guidelines for stability of realigned creeks (Table 5-78). Creek diversion morphology will change over time, so should be periodically monitored (particularly after major flooding events). However, the diversion should be allowed to gradually take on a natural morphology, provided the diversion remains generally stable, and does not reduce the overall capacity to support the 1:100-year storm.

Table 5-78 Stage 3 South Jimblebar Flood Bund water course stability (maximums)

Parameter	Scenario		ACARP Guidelines	
	2 yr ARI (vegetated)	50 yr ARI	2 yr ARI (vegetated)	50 yr ARI
Stream Power (W/m^2)	20	70	<60	<150
Velocity (m/s)	0.8	1.3	<1.5	<2.5
Shear Stress (N/m^2)	30	50	<40	<50

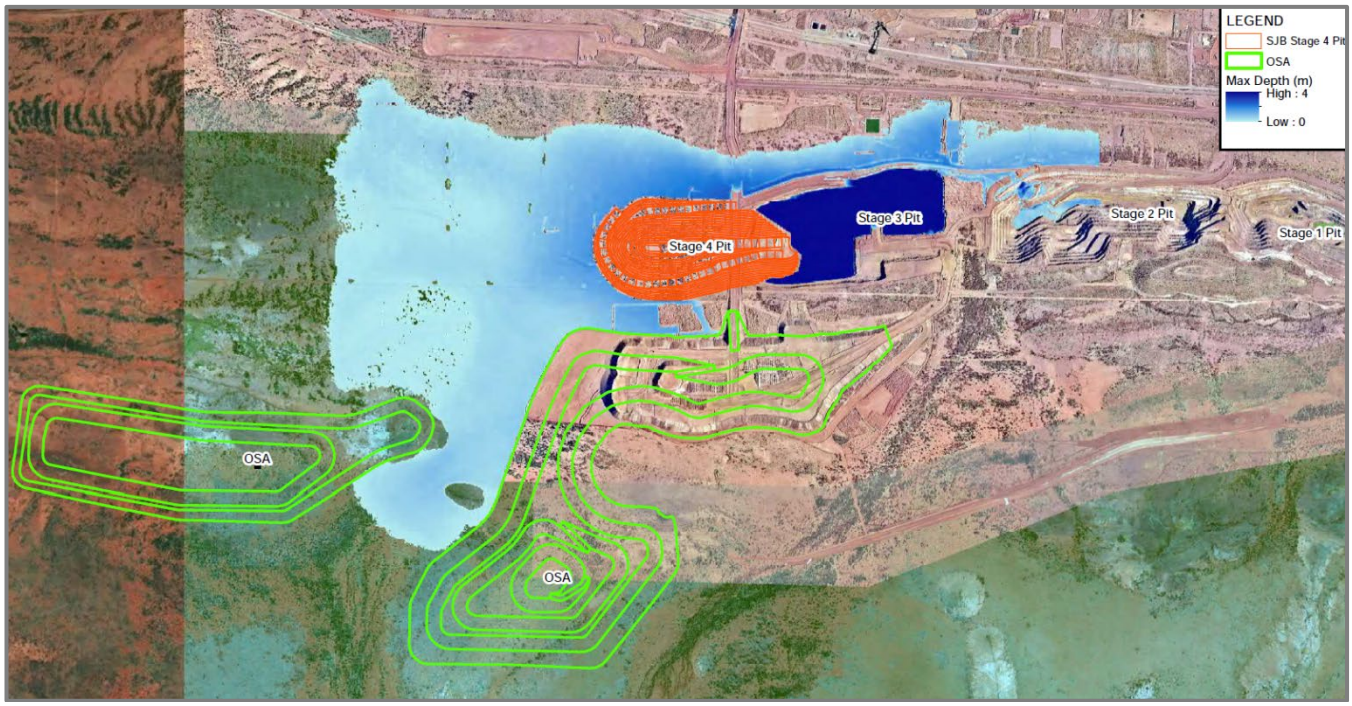
Source: RPS (2020)

Closure considerations

The 10,000-year floods are 2.0 m higher than the 100-year operational design case (Figure 5-65 and Map 5-24), with velocities typically 1.5 - 2.0 m/s (RPS, 2019b; 2022). The appropriate flood event to be used as the basis of the final design will be selected as discussed in Section 7.5.3. Closure concepts for the flood bunds are discussed in Section 9.2.3.4.

Source: RPS (2019b)

Figure 5-65 Flood levels along diversion bund



Source: RPS (2022)

Map 5-24 South Jimblebar Stage 4 flood bund 10,000-year flood levels post-development

5.16.3.4 South Jimblebar Creek diversion

An operational phase design has been developed for the South Jimblebar Creek (a tributary of Copper Creek) diversion. However, post-closure diversion channel geometry was considered, to account for the long term and enable the diversion to be developed into a permanent creek system, with no legacy issues. A typical stream has natural features that develop through geomorphologic processes, and artificial diversions should (RPS, 2020):

- Perform and function similarly with a hydraulic design underpinned by geomorphological principles;
- Be stable in the long term (i.e., not subject to significant erosion or sediment deposition); and
- Mimic natural stream characteristics.

Velocity, shear stress and stream power characteristics should be similar to the existing creek (or similar local creek) and similarly convey bank-full flows. The more frequent flood events concentrate in the channel banks and have the most influence on reshaping channel cross-sections and alignments. Larger flows spread into the floodplain and attenuate floodwaters, with lower cross-sectional velocities and less potential for erosion (RPS, 2020).

The basic channel geometry described below is suited for the long term (i.e., closure) but modifications will be required for closure as discussed in the subsection *"closure considerations"*.

Operational design

Several creek diversion options were investigated, and the preferred alignment is shown in Figure 5-66. The selected alignment connects the lowest point in the channel with drainage to the east and generally continues from the existing creek alignment (before the creek naturally meanders to the north). The interception location is, therefore, considered suitable, as creek flows should maintain a reasonable creek alignment (not change direction considerably to enter the diversion). A bund along the north side of the channel alignment prevents flow to the north and ponding which could result in death of vegetation, nuisance animals / pests in the area, mosquitoes, boggy areas, etc. It should be noted that, in the absence of a bund / OSA, pit inundation would also occur. The channel at the discharge eastern end was aligned to minimise damage to vegetation (RPS, 2020).

Sheet-flow must enter the channel from the south and a general flatter southern channel batter is located in the area of the creek diversion / inlet area and at a water course along the route (RPS, 2020).

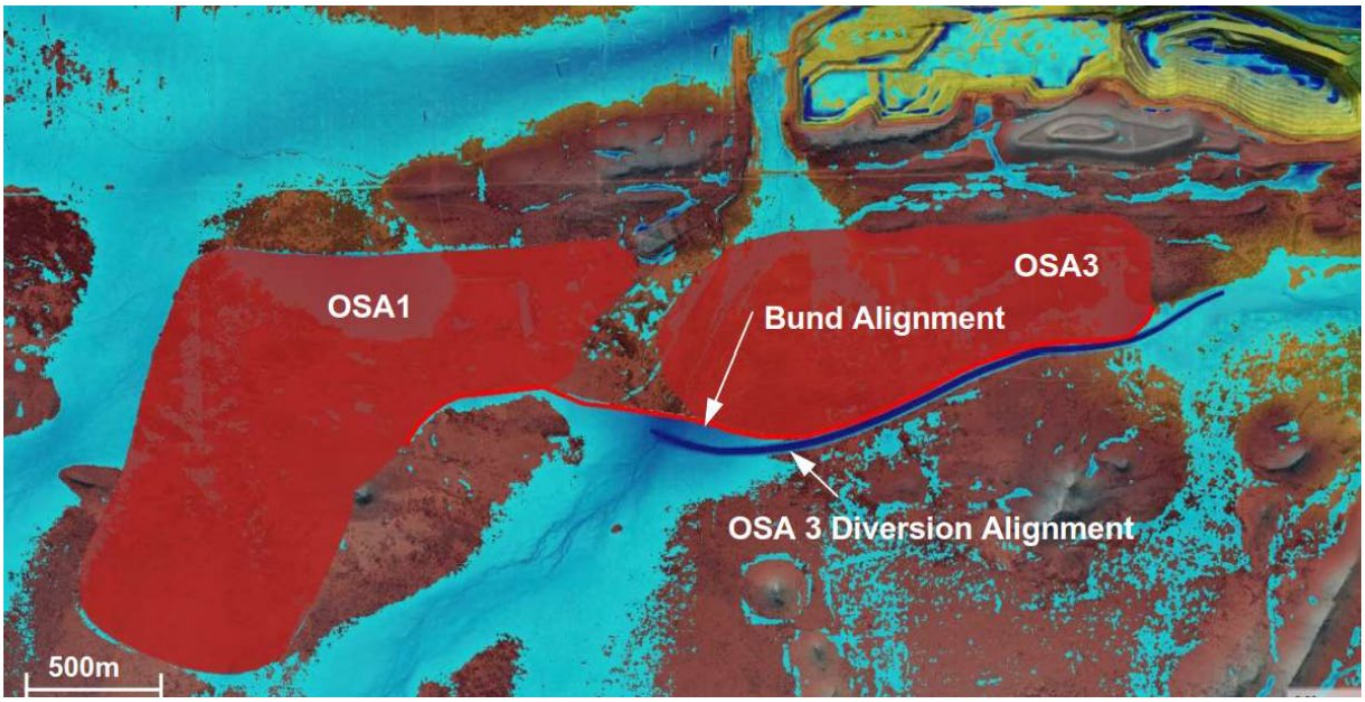
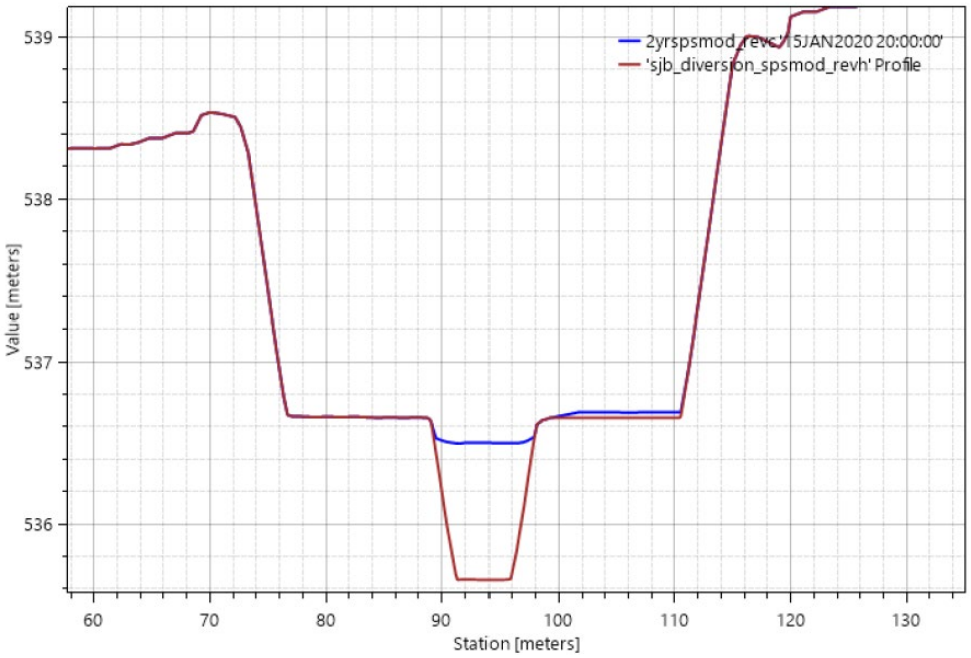


Figure 5-66 South Jimblebar Creek diversion alignment

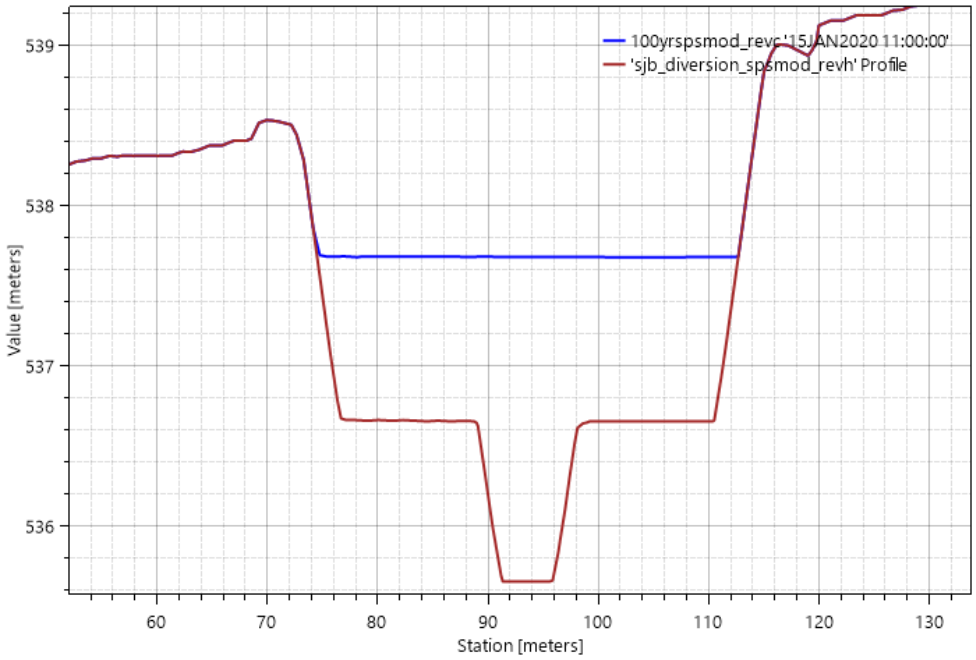
Channel geometry

The natural creek (Section 5.11.1.3) had an ill-defined geometry with a flood plain that spread out for over 1 km. This is not feasible to emulate in an engineered channel geometry. The channel geometry is, therefore, as follows (Figure 5-67) (RPS, 2020):

- 5 m base width (low flow channel).
- 1 m deep low flow channel.
- 12.5 m bench / floodplain either side of channel.
- Bed grade 0.25%.



Design channel 2-year ARI storm



Design channel 100-year ARI storm

Source: RPS (2020)

Figure 5-67 Diversion channel geometry

This geometry was designed to convey the 2-year storm entirely within the low flow channel while allowing more extreme events to spill out onto the constructed floodplain either side of the channel (Figure 5-67). In the 2-year storm, the channel geometry provides a minimum stream power of ~9 W/m^2 and flows ~0.8 m deep (Figure 5-67). Generally, a stream power of 10 W/m^2 is considered a reasonable lower limit for stability, however, due to the restricted grade and constructability tolerance, 9 W/m^2 was deemed to be an acceptable compromise. The channel capacity supports a 100-year flood with flows a maximum of 2 m deep (Figure 5-67) and velocities of <2 m/s which indicates that armouring is not required (RPS, 2020).

Channel stability

An assessment of the diversion's stability (Table 5-79) indicated that the diversion will generally meet ACARP guidelines. The 50-year storm shear stress is just outside guidelines limits at the discharge end of the channel (which may tend to cause minor scour).

Table 5-79 Channel water course stability (maximums)

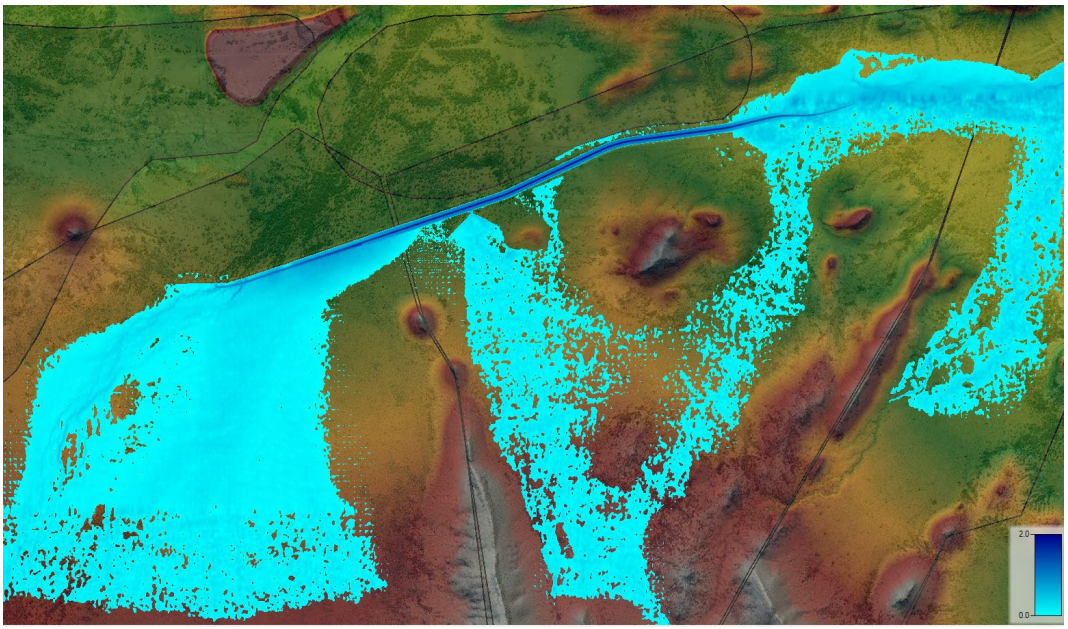
Parameter	Scenario		ACARP Guidelines	
	2 yr ARI (vegetated)	50 yr ARI	2 yr ARI (vegetated)	50 yr ARI
Stream Power (W/m^2)	13	90	<60	<150
Velocity (m/s)	0.9	1.5	<1.5	<2.5
Shear Stress (N/m^2)	20	60	<40	<50

Source: RPS (2020)

Creek diversion morphology will change over time (particularly after major flooding events). RPS (2020) recommended that the diversion should be allowed to gradually take on a natural morphology, provided inspection demonstrates that the channel remains generally stable and does not reduce the overall capacity to support the 100-year ARI storm.

Channel intakes

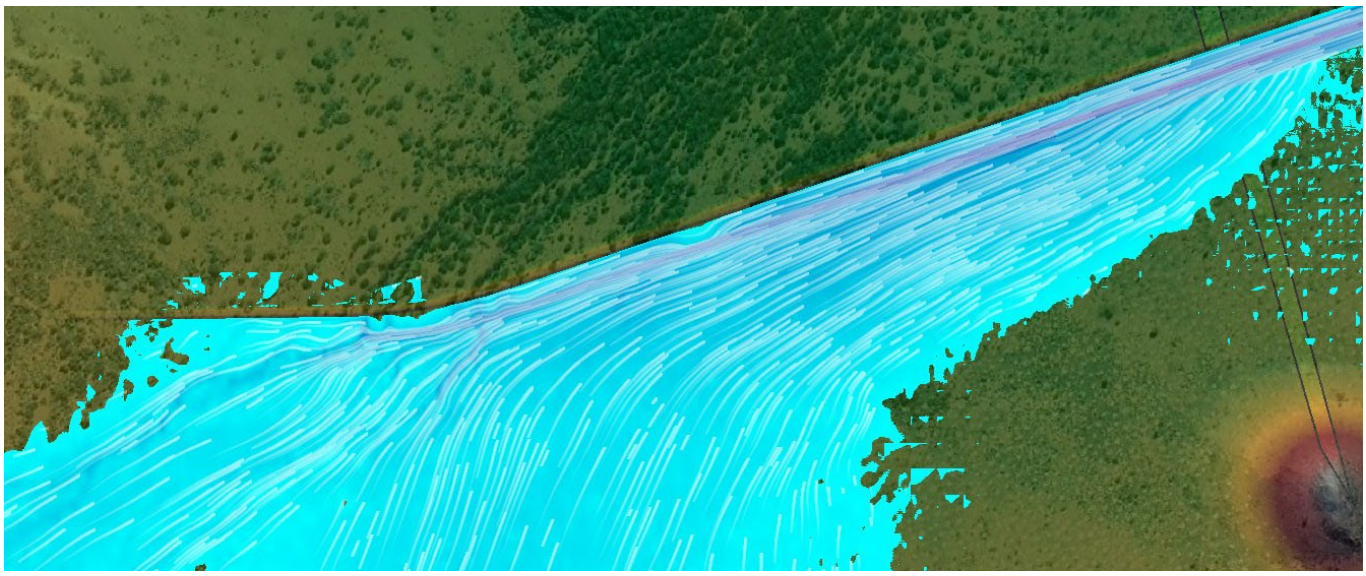
Due to restrictions on elevations and grades, the start of the diversion channel is shallow and, therefore, uses some of the floodplain to the south to support the flood extents, with the bund containing the flood within the diversion (and providing freeboard), until the channel is at sufficient depth to contain the flow with freeboard (Figure 5-68) (RPS, 2020).



Source: RPS (2020)

Figure 5-68 100-year diversion channel flood extents (max depth gradient shown)

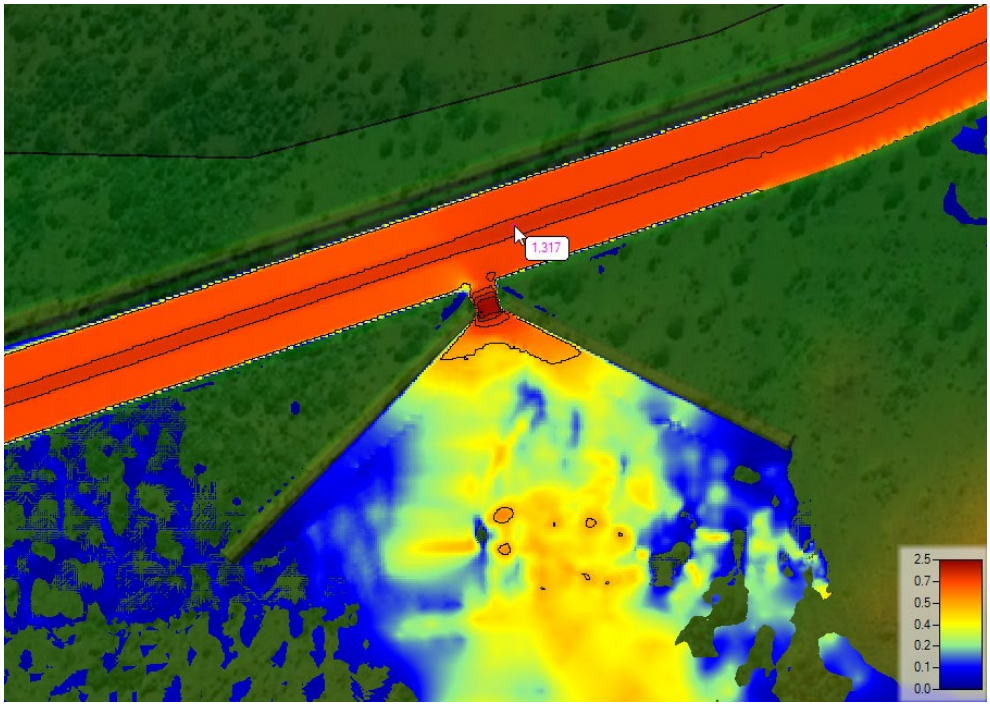
The inlet to the diversion extends approximately 800 m along the floodplain. In this section, the channel depth is minor, and the floodplain carries most of the flow with the result that most of the flow paths are aligned parallel with the bund in bank-full conditions (Figure 5-69), rather than running down channel embankments. This is expected to reduce the likelihood of scouring the embankments during peak flow conditions and erosion may only tend to occur due to rilling produced by minor flows (until the low flow channel is submerged). To help prevent this, the channel invert and the cut batter slope design slopes have been flattened to 1V:10H and constructed of compact engineering fill (RPS, 2020).



Source: RPS (2020)

Figure 5-69 Channel inlet extents

As the channel intersects another catchment approximately halfway along, a formalised inlet drain has been incorporated into the design. The inlet consists of guide bunds that direct the water toward a 1V:10H rip-rap lined chute. Velocities are expected to reach 2-3 m/s within the chute, which is considered acceptable with rock armouring (RPS, 2020).



Source: RPS (2020)

Figure 5-70 100yr ARI side inlet channel velocity map (m/s)

Closure considerations

The basic creek geometry of the diversion should be suitable for closure, and as a goal, support an eco-hydrological environment comparable with the natural creek. The creek diversion will be modified for closure to accommodate flood levels and flows associated with the flood event selected as the basis of the final design in accordance with the processes discussed in Section 7.5.3. Closure concepts are discussed in Section 9.2.3.4.

5.16.3.5 SJG2 / SJH2 diversion

A major permanent diversion of the Jimblebar Creek West Branch is required to mine the South Jimblebar SJG2 and SJH2 (Capricorn) pits. Two minor diversions are also required to divert Central Creek to the gap between SJG2 and SJX pits and to prevent capture of the Eastern Creek by the eastern end of the SJH2 pit (Map 5-25).

An options analysis was conducted by RPS (2022) as part of the SPS for the Jimblebar Creek West Branch diversion to determine the best diversion alignment. Given that the diversion will be permanent, the study included consideration of both operational and closure conditions. Further design work is required to optimise the preferred alignment.

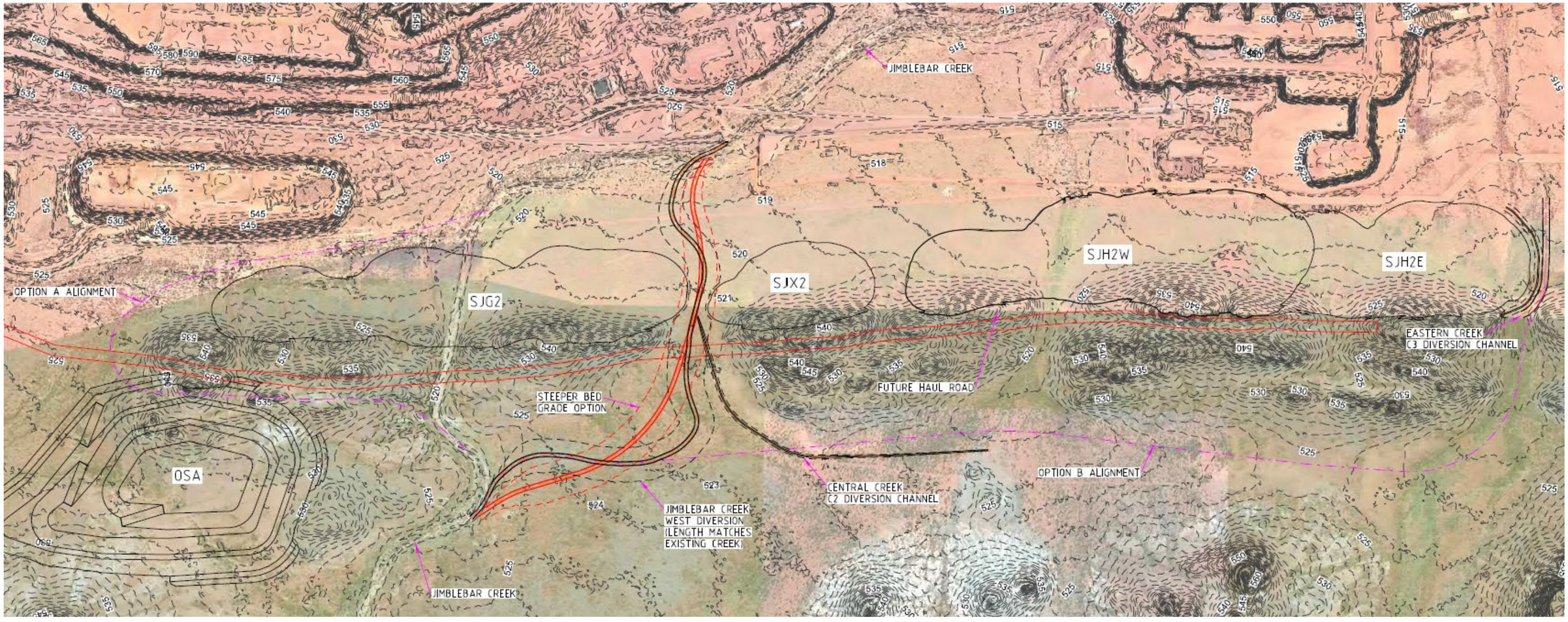
SPS operational designs have been developed by RPS (2022) for the minor diversions of Central and Eastern Creeks. The need for modification to these designs to accommodate closure conditions will be reviewed closer to the time of closure once the final mine footprint is known.

Further details of these studies are provided in the relevant sub-sections below.

Jimblebar Creek West Branch diversion options assessment

Three potential alignment options for the diversion of Jimblebar Creek West Branch were considered (Map 5-25) (RPS, 2022):

- **Option A** - divert the creek around the western end of SJG2 pit, with a 1.5 km long channel diversion west to Copper Creek (past the haul road and proposed OSA). This option was assessed as not feasible as the end point in Copper Creek is higher than the start point in Jimblebar Creek. The excavated diversion would, therefore, need to be extended further down Copper Creek to the confluence with Jimblebar Creek. While this would provide a positive grade of 0.065%, it would:
  - Increase the overall length of the creek / diversion by about 2 km.
  - Be destructive of Copper Creek.
  - Be approximately three times flatter than the current creek (0.21%), and therefore, would not be geomorphologically sustainable.
- **Option B** - divert the creek around the eastern end of SJH2, over 6.0 km with bed grade 0.08%. This diversion would be approximately two times flatter than the existing creek and, therefore, would not be geomorphologically sustainable.
- **Option C** - divert the creek between pits SJG2 and SJX2. This was assessed as the only viable option (without changing the mine plan).



Source: RPS (2022)

Map 5-25 Jimblebar West diversion options and Eastern and Central Creek diversion alignments

Operational design

Jimblebar Creek West Branch

The design principle for the selected option (Option C) is to mimic the characteristics and function of the natural stream system. Hydrobiology (2022) worked with RPS (2022) to define a diversion design that reflects the geomorphological characteristics outlined in Section 5.11.1.3. The Option C diversion:

- Replicates the original length and bed grade of the Jimblebar Creek West Branch by mimicking the natural meandering planform of Jimblebar Creek West Branch (sinuosity 1.20 - 1.25) i.e., restoring the grade to 0.21%.
- Incorporates the following features to reproduce a similar geometry to the existing creek while accommodating the constriction between the two pits (Figure 5-71):
  - A low flow channel 15 m wide and 0.75 m deep, with inset floodplains.
  - Floodplains with a low transverse gradient (1V:27H) out to the intersection with the natural terrain.
  - A hyporheic layer, possibly 1.0 - 1.5 m deep (depth to be determined once more data is available at the detailed design stage), under the low flow channel to maintain consistent roughness and sediment transport conditions. This material would be sourced from the existing creek and stockpiled during diversion construction.

The constriction between the two pits does not have much impact on 1% AEP flood levels. However, in a 10,000-year flood event, the flood levels are expected to rise by about 1.2 m due to this constriction (RPS, 2022).

The modelled 50% AEP and 2% AEP stream power, velocities and shear stress flow parameters were compared against existing creek characteristics and indicated that the design has similar hydraulic properties to the existing creek (RPS, 2022).

Hydrobiology (2022) assessed sediment transport and scour associated with the diversion and concluded that:

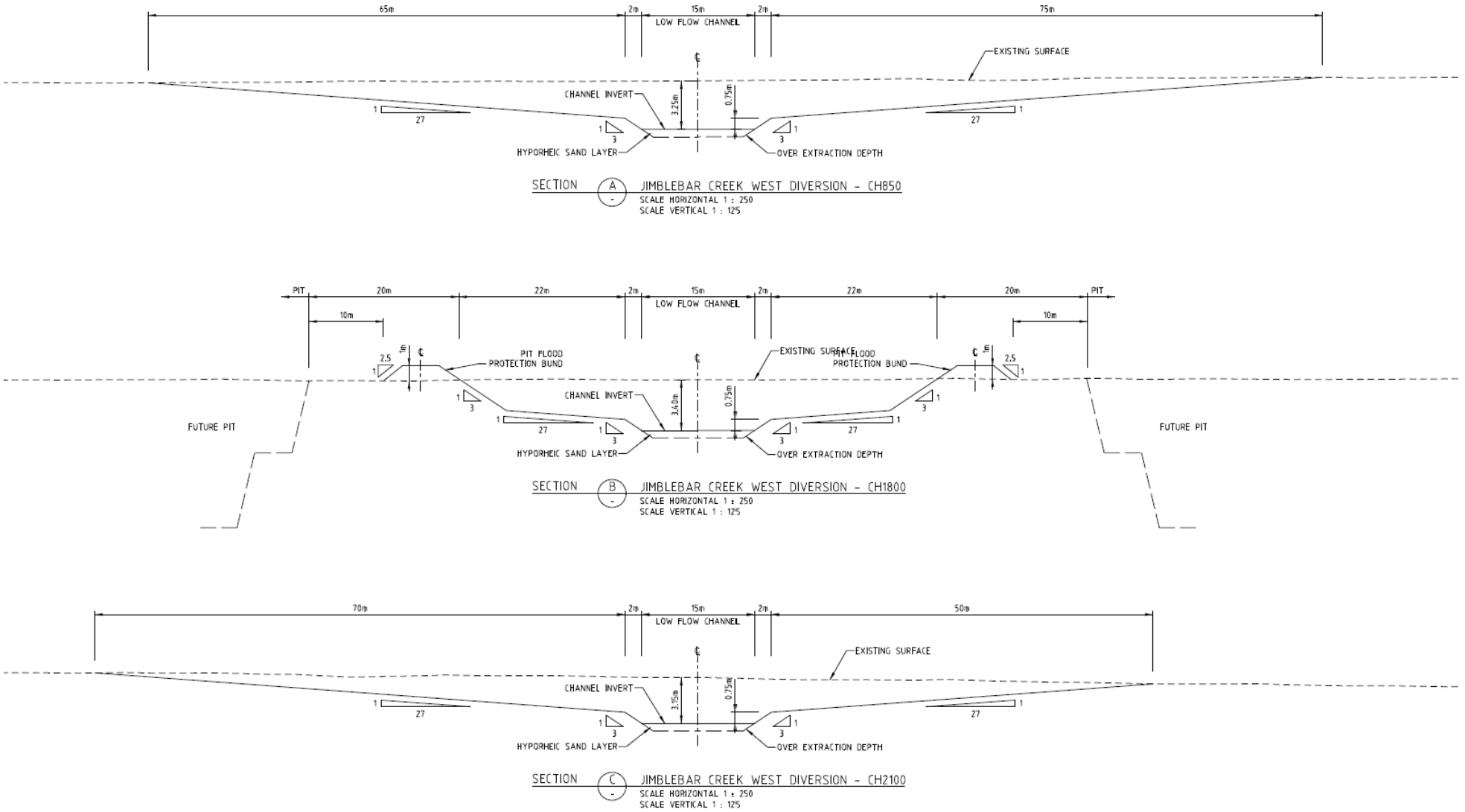
- The proposed diversion shows comparable sediment incipient motion and scour characteristics as the existing reach.
- Despite sediment mobilisation occurring throughout the diversion in all modelled events, it is likely to remain in equilibrium (or surplus) and scour depths are unlikely to affect channel stability, provided a hyporheic layer is included in the design.
- A hyporheic layer of about 1 m should be sufficient to withstand any major widespread scour.

Modelling showed that in a 2-year event, very little sediment mobilisation occurred throughout the Jimblebar Creek West Branch reaches in the study, with mobilisation only occurring in the low flow channel and only in isolated patches for the existing and upstream reaches. This reflects the observations of widespread aggradation in the existing undisturbed reaches of the creek (Section 5.11.1.3). The proposed diversion shows greater mobilisation than the existing reach and reflects the downstream reach in mobilising sediment within the low flow channel. However, the hydraulics remain very low and comparable with the existing reach and the increase in mobilisation is unlikely to result in any issues, given the considerable supply of sediment from upstream reaches (Hydrobiology, 2022).

Widespread mobilisation of sediment was modelled to occur throughout all reaches in the 1 in 50-year and 100-year events, suggesting that these larger events would easily mobilise and transport sediment. The reaches in the study area are, therefore, likely to undergo cut and fill processes, experiencing deposition most of the time and scour during larger events (Hydrobiology, 2022).

Scour depths were predicted to be very low, with median scour depths for the existing and diversion reaches in the 1 in 2-year event of about 0.18 m and 0.19 m, respectively, although scour depth maximums were about 1 m for both reaches. Median scour depths for the existing and diversion reaches in the 1 in 50-year and 100-year events were about 0.40 m and 0.29 m, respectively, although scour depth maximums were about 1.6 - 2 m for both reaches. These maximum scour depths would occur in isolated locations and would not affect overall diversion stability (Hydrobiology, 2022).

Since the existing creek is aggrading, similar hydraulic properties in the diversion may lead to sediment deposition that causes the diversion to become less effective. An option to shorten the diverted creek alignment will, therefore, be considered during detailed design, to increase hydraulic parameters. The existing diversion grade of 0.21% could be increased by up to 20%, to 0.25% (still a very flat bed grade) as shown in Map 5-25 as a “steeper bed grade option” (RPS, 2022).

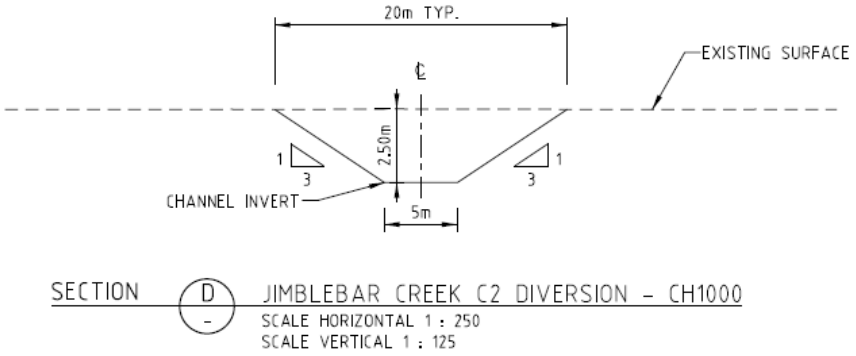


Source: RPS (2022)

Figure 5-71 Jimblebar Creek West Branch diversion typical cross sections

Central Creek

Central creek needs to be diverted west (Diversion C2) through the same gap into the proposed Jimblebar Creek diversion (Map 5-25), on a similarly flat grade to the existing channel (Section 5.11.1.3) and, therefore, is not expected to introduce sedimentation or erosion issues) (RPS, 2022). Figure 5-72 shows a typical cross section of the proposed diversion.

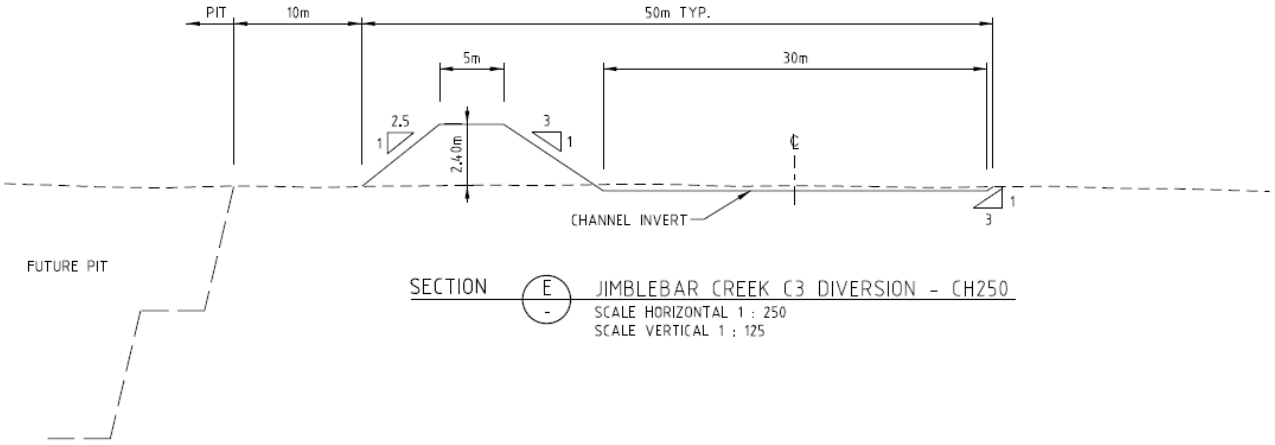


Source: RPS (2022)

Figure 5-72 Central Creek diversion typical cross section

Eastern Creek

At the eastern end of SJH2, the current pit footprint encroaches into the floodplain of Eastern Creek. Based on the geomorphology of the creek, Hydrobiology (2022) suggested that any diversion / redirection of this stream would need to consider the requirement for a wide floodplain, a small or no low flow channel, and widespread vegetation. The creek needs to squeeze between the pit and adjacent higher ground / hill, so a widened flow path past the pit bund is required (Diversion C3, Map 5-25). Figure 5-73 shows a typical cross section of the proposed diversion. The maximum depth in the 1% AEP flood is about 0.8 - 0.9 m, so the operational flood bund in this area (Map 5-25) would be up to 2 m high (RPS, 2022).



Source: RPS (2022)

Figure 5-73 Eastern Creek diversion typical cross section

Other minor impacting catchments

The 6 km long west-east line of pits cuts off several minor catchments impacting the southern side of the proposed pits. A haul road (refer Map 5-25) will run along the south side of the pits, which will connect to PC03 ROM and OSAs. The construction of the haul road will cut off / fill in these small impacting catchments, and generally act as a long flood bund protecting the pits from northward drainages.

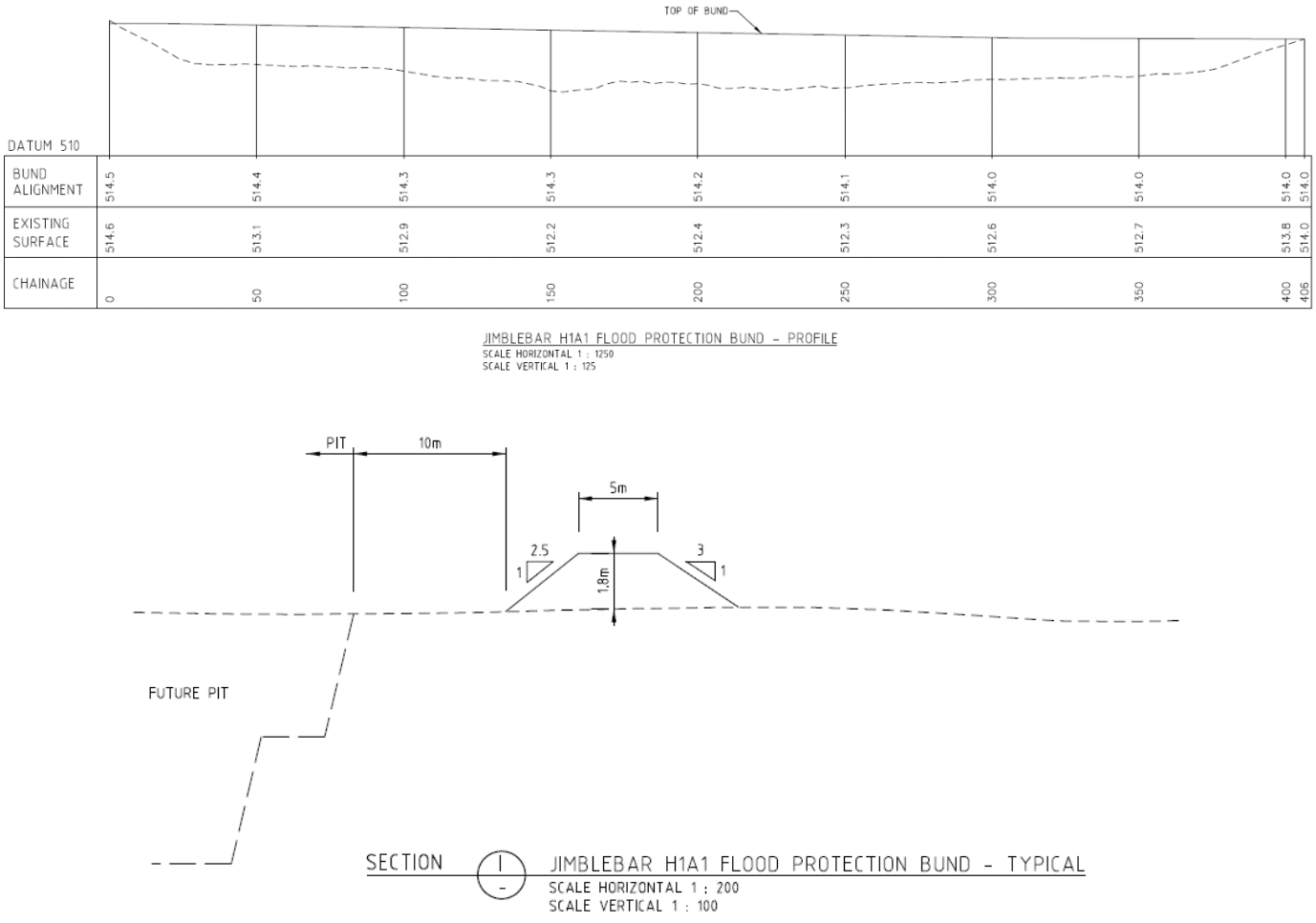
Closure considerations

The basic geometry of the Jimblebar Creek West Branch diversion should be suitable for closure, and broadly mimic the natural creek conditions. Map 5-27 shows the modelled 1:10,000-year flood conditions based on the current expected mine footprint with the diversions / flood bunds in place. A review of the diversion design will be required closer to the time of closure to consider upgrades required for closure in the light of the final mine footprint and associated 1:10,000-year flood conditions. A review will also be conducted of the Central and Eastern Creek diversions and minor impacting catchments to determine modifications required based on the final mine footprint and the design flood events selected in accordance with the processes discussed in Section 7.5.3..

5.16.3.6 H1A1 flood bund

Operational design

The southern tip of the H1A1 pit encroaches into the Jimblebar Creek West Branch floodplain and will require a relatively minor flood bund at that location (Map 5-26). The 1% AEP flood is about 1 m deep in the vicinity of the pit. Therefore, the flood bund would be 400 m long and up to 2 m high, matching to higher ground at either end (Figure 5-74).

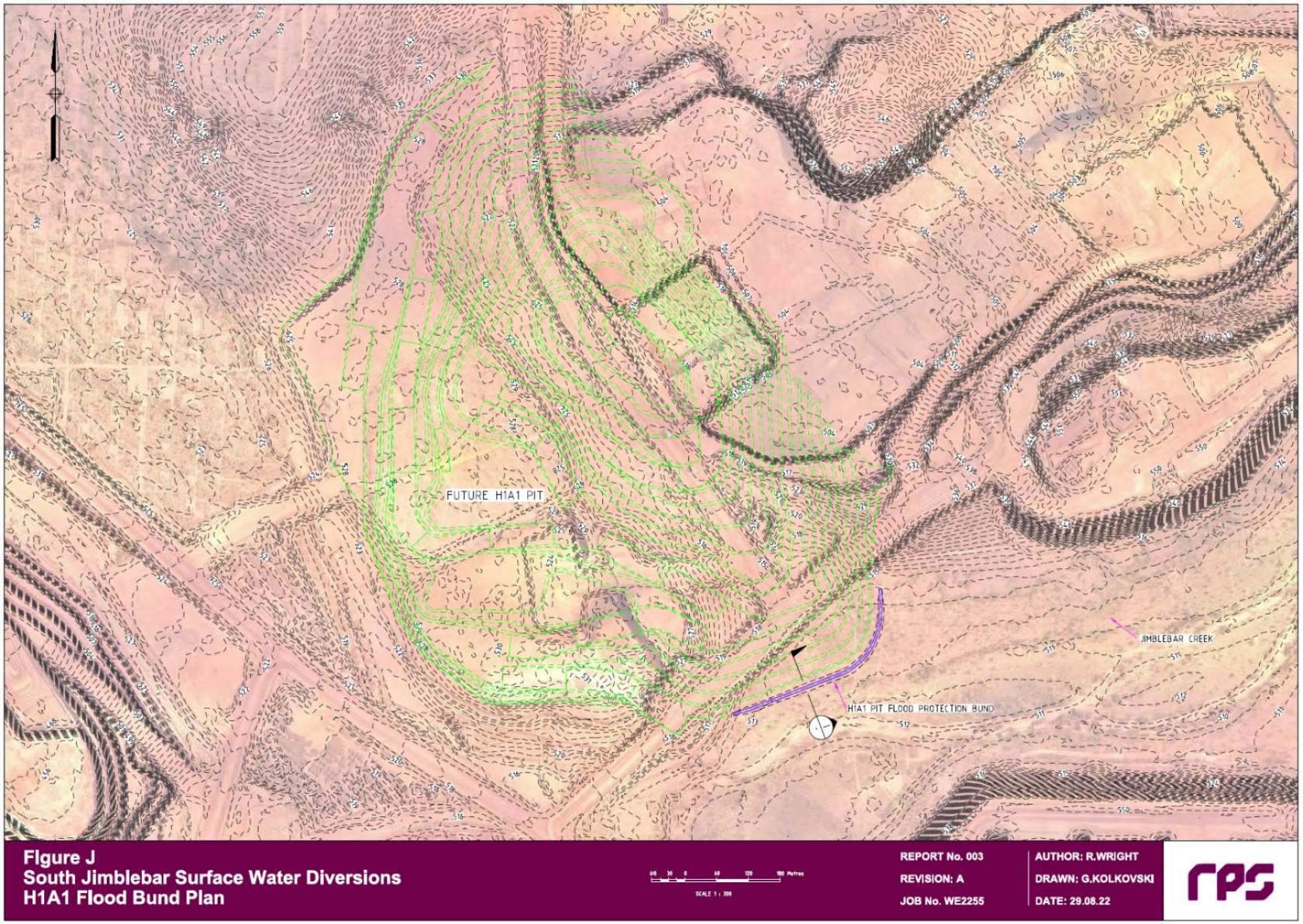


Source: RPS (2022)

Figure 5-74 H1A1 flood bund typical cross section

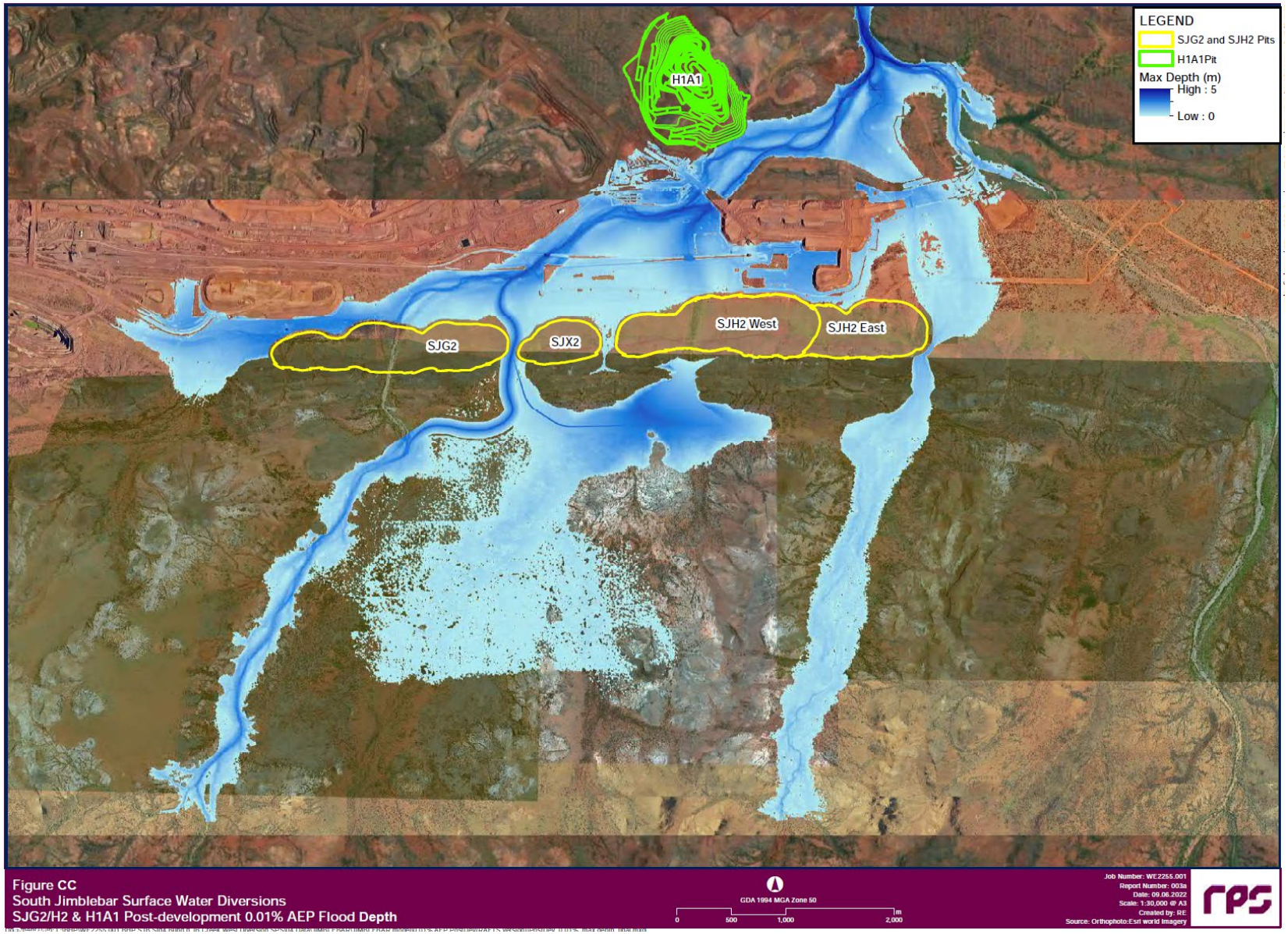
Closure considerations

The closure design for the flood bund will be dependent on the final backfill design of the H1A1 pit and the final PC03 landform. Closure concepts for flood bunds are discussed in Section 9.2.3.4.



Source: RPS (2022)

Map 5-26 H1A1 flood bund location



Source: RPS (2022)

Map 5-27 1 in 10,000-year flood levels with diversions / flood bunds at H1A1, Jimblebar West, Central and Eastern Creek

5.16.3.7 H2B1 flood bund

A DPS has been conducted to determine the operational design for the H2B1 flood bund (BHP, 2022k), and this design has been constructed. The sections below summarise the operational design and considerations for closure.

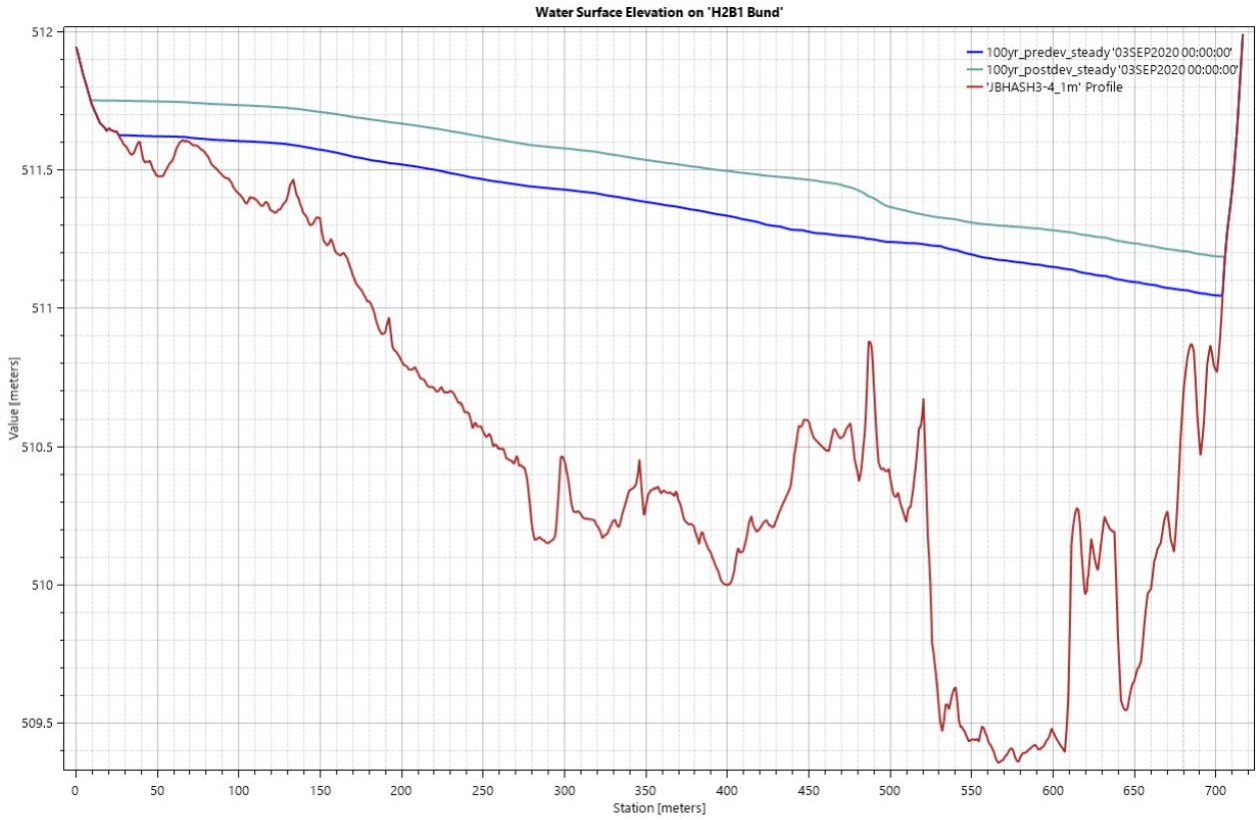
Operational design

The operational flood bund has been designed for a 1 in 100-year event plus 1 m freeboard (refer to Section 5.11.1.4 for modelled flows) (BHP, 2022k).

Crest level and bund geometry

Hydraulic modelling was undertaken to determine 100-year design flood levels and location of the bund. The inundation zone is ~650 m (Figure 5-75) and, with a 1 m freeboard, the flood bund crest would interface with the natural terrain ~80 m east / upstream of the modelled flood extents. Post-development, the 100-year flood levels increase by ~0.15 m. Where the bund crosses a water course, the maximum flood depth is ~2 m (Figure 5-75).

The bed grade on Jimblebar Creek East Branch is very low at H2B1, and modelled velocities are <1 m/s along the bund and consequently scour protection of the operational bund surface is not required. Shear stress along the bund is also low (6 - 7 Pa) compared to an allowable shear stress of 24 - 40 Pa for well compacted engineering fill. The bund has a 5 m crest width for robustness and constructability.



Source: BHP (2022k)

Figure 5-75 H2B1 flood modelling pre- and post-development

Foundation conditions

The BHP (2022k) design report indicated that foundation conditions would mainly consist of silty loam soils but given the sandbars / sediment deposits in the creek, foundation conditions within the creek alluvium would likely be very loose and of poor quality. Areas with poor foundation conditions should be boxed out and replaced with suitable material in order to provide a robust foundation (and avoid the risk of piping). Where alluvium is deep and it is not practical to excavate the material out, the BHP specifications provide for surface boxout and foundation compaction. A local / large sediment deposit / sandbar may justify additional box out (BHP, 2022k).

Seepage modelling

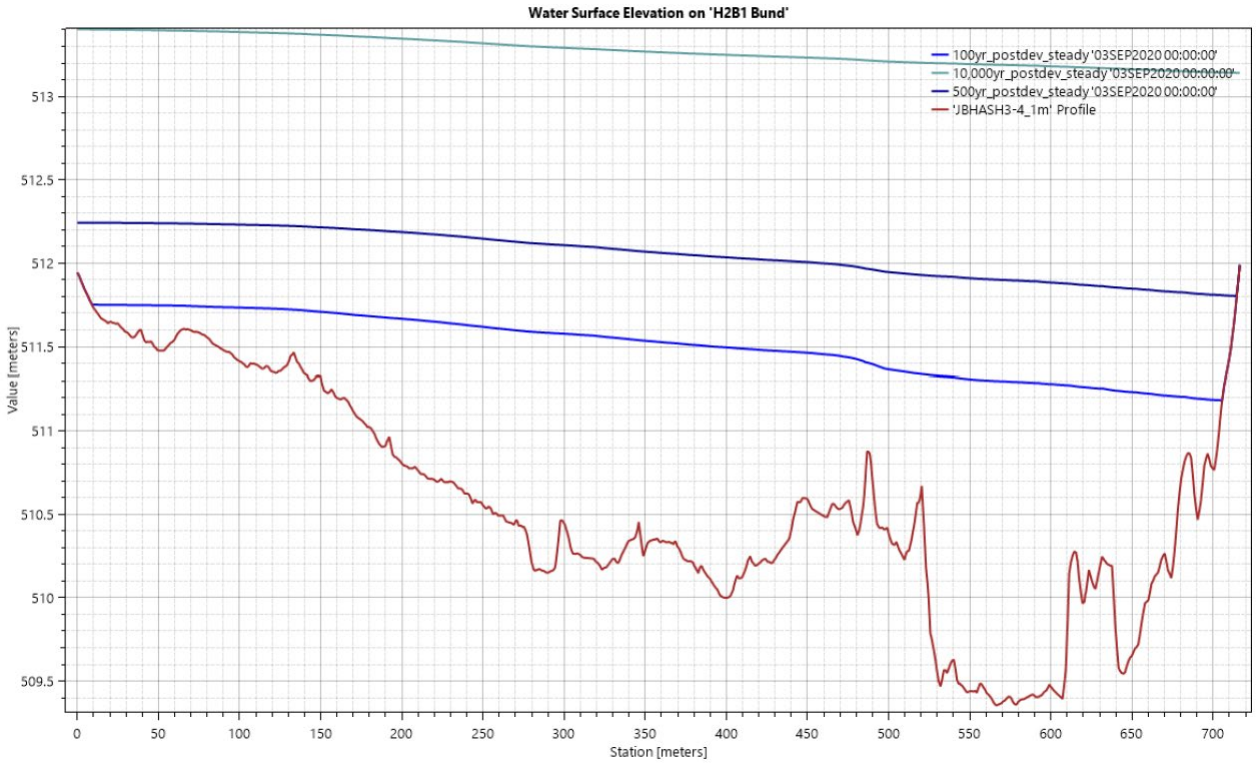
Seepage modelling was carried out using the same assumptions and with the same results as presented for the OB31 flood bund in Section 5.16.3.2 (Figure 5-61 and Figure 5-62). The results show that the potential for piping is minimised, and the modelled seepage rates are low and inconsequential (BHP, 2022k).

Stability assessments

A slope stability assessment was completed for the H2B1 flood bund using the same assumptions listed for the OB31 flood bund geotechnical assessment in Section 5.16.3.2. The results indicate that the bund meets stability criteria (BHP, 2022k).

Closure considerations

The modelled 10,000-year post-development flood levels are 1.3 m higher than the 100-year post-development flood levels (Figure 5-76). The appropriate flood event to be used as the basis of the final design will be selected as discussed in Section 7.5.3. Closure concepts for flood bunds are discussed in Section 9.2.3.4.



Source: BHP (2022k)

Figure 5-76 1 in 10,000-year flood levels along H2B1 flood bund

5.16.3.8 Knowledge gaps & forward work program

Detailed operational designs have yet to be developed for the full extent of the OB31 flood bund, Stage 4 and 5 South Jimblebar flood bunds, SJG2 / SJH2 diversion and the H1A1 flood bund.

While closure has been considered as part of operational designs, the Jimblebar Hub is a long-lived mining operation and the final mine footprint and backfill designs (including use of pits for in-pit tailings storage) are likely to change over the life of mine. The upgrades required for closure will be considered closer to the time of closure. This approach will also enable the performance of the operational designs to be monitored over the life of mine and these results to be considered during the development of closure designs.

5.16.4 Swan & De Grey in-pit tailings closure studies

Summary of key points:

- A cover design is not required to minimise infiltration of water through the tailings since:
  - Analysis of the tailings and supernatant shows the tailings are NAF and both the tailings leachate and supernatant have low salinity, nutrients and metal(oid)s.
  - During deposition, wall rock exposures of fresh (AMD 1) PAF material will be submerged by tailings. Post settlement, PAF wall rock exposures will either be submerged by (Swan pit), or covered with (De Grey pit), fine, low permeability tailings which are expected to minimise oxidation and create a physical barrier that would limit the oxidation of the PAF wall rock and mobilisation of AMD.
- The key objectives of the closure cover design are, therefore, to reduce:
  - Dust from the tailings post-closure
  - The potential for the fines deposited against the pit walls and benches (and covering PAF exposures) to be eroded due to surface run-off and / or wind.
- These objectives will be fulfilled by a 1 - 5 m layer of benign overburden. Placement of this layer will require ongoing settlement rates to be less than 1 m/year (currently predicted to be achieved after 10 and 20 years for Swan and De Grey respectively). Methods for enhancing tailings settlement and drainage to reduce the consolidation period will be investigated over the life of the facilities. A pioneer layer of 1 - 2 m placed with smaller low ground pressure equipment will be required prior to construction of the main cover layer.
- Permanent ponding on the final landforms will be prevented by shaping the adjacent East OSA to direct run-off away from the in-pit TSFs. This will mean that there are no large hydraulic gradients driving seepage. The potential for seepage post-deposition will also be controlled by the low permeability of the tailings and pit walls.
- Further studies will be conducted during DPS and over the life of asset to refine closure designs.

WSP (2023) has developed a conceptual cover design for the Swan and De Grey in-pit TSFs. This is primarily based on data available from the SPS, but also includes the early findings of some DPS studies. Refinements to the proposed TSF cover design arising from the DPS and subsequent studies conducted through the operational life of the TSFs, will be integrated into future iterations of this MCP.

5.16.4.1 Cover design objectives

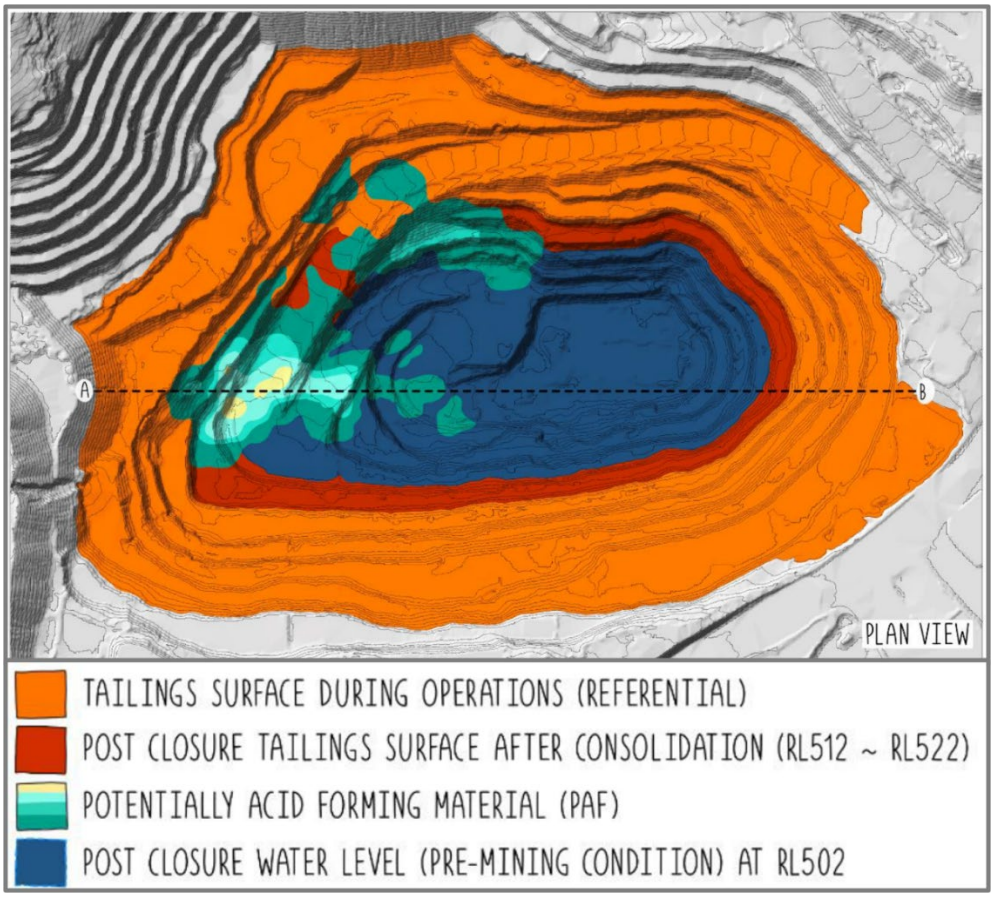
A cover design is not required to minimise infiltration of water through the tailings since (WSP, 2023):

- Analysis of the tailings and supernatant shows the tailings are NAF and both the tailings leachate and supernatant have low salinity, nutrients and metal(oid)s (Section 5.4.1).
- While there are fresh (AMD 1) PAF wall rock exposures above the pre-mining water table of 502 mRL in De Grey pit (Section 5.3.2.2), these will be covered with fine, low permeability tailings (which are expected to minimise oxidation) during deposition (Figure 5-77), and as settlements occur post-closure, the tailings are likely to remain on the benches and slopes of the pit and continue to cover pit wall exposures of AMD 1 material. The layer of tailings over the PAF exposures is expected to create a physical barrier that would limit the oxidation of the PAF wall rock and mobilisation of AMD.
- PAF wall exposures in Swan pit will be fully covered by low permeability tailings, even after post-closure settlements are completed (Figure 5-78).

The key objectives of the closure cover design are, therefore, to reduce (WSP, 2023):

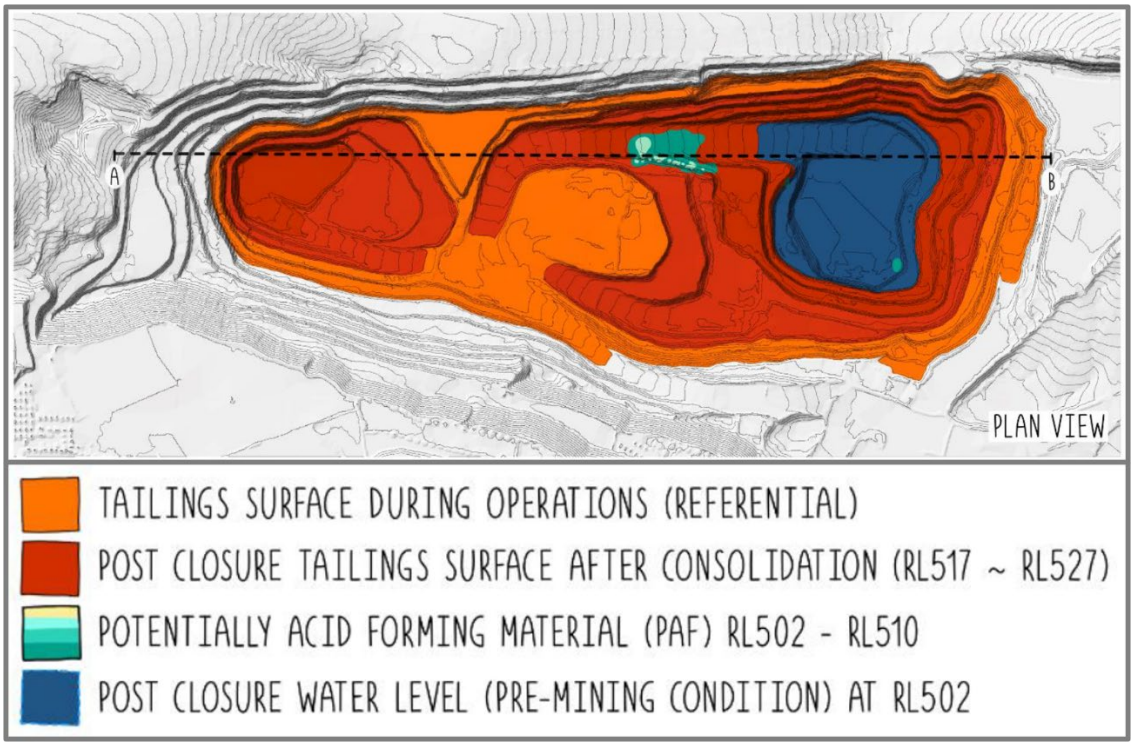
- Dust from the tailings post-closure.
- The potential for the fines deposited against the pit walls and benches (and covering PAF exposures) to be eroded due to surface run-off and / or wind.

Management of surface water is also a consideration so that only temporary / sporadic ponding occurs within the final in-pit TSF landform (WSP, 2023).



Source: WSP (2023)
Note: NOT TO SCALE

Figure 5-77 De Grey in-pit TSF - illustration of operational and settled tailings relative to PAF wall rock exposures



Source: WSP (2023)
Note: NOT TO SCALE

Figure 5-78 Swan in-pit TSF - illustration of operational and settled tailings relative to PAF wall rock exposures

5.16.4.2 Cover design

Cover thickness

The key objectives of preventing dust emissions and erosion of the tailings layer covering PAF wall rock will be achieved through placement of a nominal 1 - 5 m thick layer of benign overburden over any tailings exposed at the surface after settlements have taken place. The final cover thicknesses will be defined as an understanding of differential settlements improves during operational monitoring (WSP, 2023).

Surface water controls

The calculated mean daily inflows and outflows for the in-pit TSFs (assuming no decant pumping) are shown in Figure 5-79. The largest inflow contribution is supernatant water followed by run-off from the adjacent OSAs and then run-off from the remaining external catchments (i.e., pit walls and external undisturbed catchments).

Supernatant inflows will cease at the end of deposition, so the key control for preventing permanent ponding on the closed TSF landform is managing run-off from the adjacent East OSA. The final surface of the East OSA will, therefore, be profiled to shed water away from the in-pit TSFs (i.e., reduce the contributing catchments to the pits to create a net evaporative water balance at closure). Reshaping activities will be conducted as the material is excavated for the in-pit TSF covers. The materials balance and resulting final OSA landforms will be refined following measurement of settlement rates during operations, and validation of final projected settlements based on measured performance (WSP, 2023).

Cover placement

Based on the settlements estimated from preliminary consolidation models (Section 5.4.2.3), it is estimated that deformations will progressively decrease with time and that the surface of the tailings will densify to a point where access can be safely achieved. At this conceptual level, it is expected that the final cover will be progressed from the edges of the pit, where settlements are likely to be completed in the short term, to the deepest sections of the in-pit TSFs where settlements are expected to be the largest. At this concept level, it has been assumed that the deepest sections of the in-pit TSFs will only be accessible for closure cover placement once settlements / deformations become less than 1 m/year (which from preliminary modelling is predicted to be 10 and 20 years after the end of tailings deposition for Swan and De Grey pits, respectively). The settlement rate and surface desiccation will be closely tracked throughout operations to refine the estimated time at which closure works can be safely executed (WSP, 2023).

Given that settlement rates are a key constraint to the execution of the final closure works, further assessments, investigations, and trials will be conducted during the life of the in-pit TSFs to assess methods that may assist in enhancing tailings settlement, drainage and desiccation which could include (WSP, 2023):

- Wick-drains, stone columns, or similar drainage system.
- Blast densification (where controlled blasting is used to induce liquefaction and densification of the tailings).
- Vibro-densification of the tailings.
- Tailings farming (as per the normal practices used in the Alumina industry).

It is expected that access to the consolidated tailings surface by earthmoving equipment will have to be a staged process with an initial pioneer / working platform layer placed by smaller lower ground pressure equipment. This initial layer is expected to be between 1.0 to 2.0 m thick and, once constructed, larger equipment would be used to complete the final landform.

5.16.4.3 Groundwater impact assessment

Post-closure impacts to groundwater quality from seepage are expected to be low as the tailings are NAF and both the tailings leachate and supernatant have low salinity, nutrients and metal(oid)s (Section 5.4.1). Furthermore, as shown in Figure 5-79, supernatant water contributes as much as approximately 90% of the total inflow volumes for both De Grey and Swan pits and is driven by the tailings deposition rates and dry densities. This inflow would cease after the end of tailings deposition and consequently, the potential for any seepage from the in-pit TSFs would reduce post-deposition. Post-closure, direct precipitation over the final landform is expected to be controlled by the low permeability of the tailings and pit walls (and the fact that no large hydraulic gradients due to permanent ponding will be generated within the final landform) (WSP, 2023).

As discussed in Section 5.11.2.2, the De Grey pit is not connected to the regional dolomite aquifer adjacent to the pit and consequently, any impacts associated with seepage from the De Grey in-pit TSF would be expected to be localised. The Swan pit is not directly connected to the adjacent regional aquifer but is indirectly connected to the aquifer via the pit's established connection to OB31 which is known to be in direct connection with the regional aquifer. During operations, any seepage from the Swan in-pit TSF would be captured by the drawdown from the OB31 pit. If the OB31 pit remains a void post-closure, then any seepage from the Swan in-pit TSF would continue to be captured by the residual drawdown from this pit. If the OB31 pit is backfilled and groundwater levels recover, regional flow towards Ethel Gorge TEC will be constrained by at least two partial flow barriers, and seepage water from the in-pit tailings facilities (if any) would not be expected to enter the TEC area.

Although some PAF materials exist within the De Grey pit walls, these will be covered by fine, low permeability tailings, which should significantly reduce oxidation. For the Swan pit, although through-flow conditions may occur once groundwater levels have recovered, there are no PAF materials expected to be left exposed that could result in AMD in the long term (WSP, 2023).

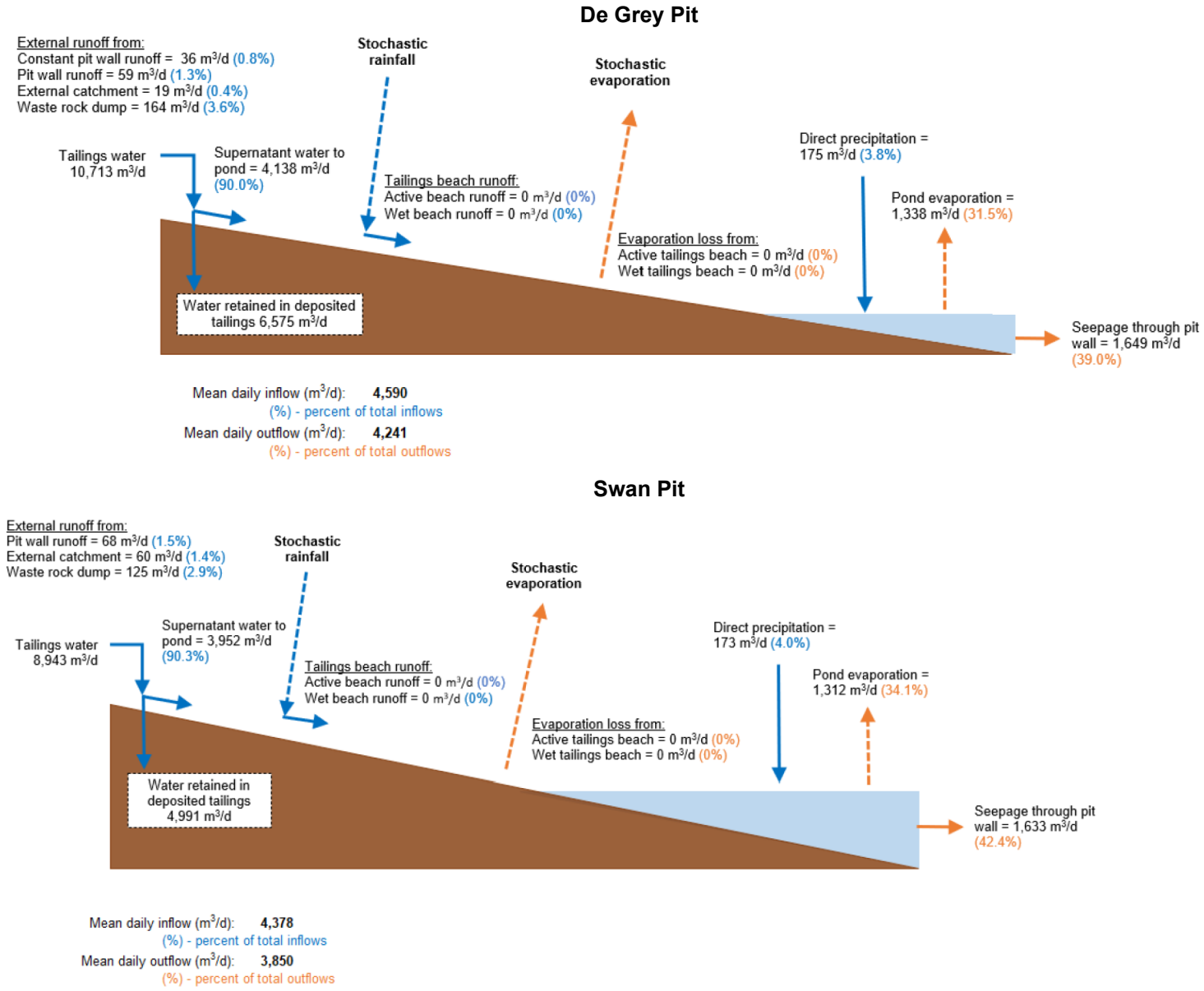


Figure 5-79 Mean daily inflows and outflows for the TSFs (assuming no pumping of decant water)

5.16.4.4 Knowledge gaps & forward work program

Further studies for the closure of the Swan and De Grey in-pit TSFs will include:

- Consolidation modelling for the DPS (in progress) and subsequent monitoring and model validation during operations.
- Review of options to enhance tailings settlement and drainage to reduce the timeframe over which closure works can be safely executed.
- Seepage modelling (in progress) and pre-closure monitoring of groundwater to confirm / refine groundwater impact assessment.
- A review of alternate cover systems to investigate the impacts of different designs and material characteristics on final closure outcomes.
- Consultation with Nyiyaparli people regarding the final landform design, acknowledging the Nyiyaparli people's preference to backfill to surface or create water gaining sites.

5.16.5 Mine void closure studies

This section considers the impacts of different mine void closure strategies on groundwater levels (Section 5.16.5.1) and pit lakes (Section 5.16.5.2).

Summary of key points:

- The backfill strategy for Jimblebar Hub (including the use of mined-out pits for tailings storage) is being reviewed and refined. The change to groundwater levels and occurrence of pit lakes post-closure depends on the mine void closure (backfill / in-pit TSF) scenario implemented.
- In all cases the OB17/18 below water table pits (Swan and De Grey) will be backfilled to above the pre-mining water table by either overburden or tailings. Therefore, pit lakes would not form.
- If OB31 remains an open void, then a pit lake will form. Based on the current mine plan, pit lakes would also be expected to form at WH123, WHASH, East Jimblebar, Sylvania and Mindoona pits. A small pit lake may form at Hashimoto, but this pit is more likely to remain dry. The pits at OB31 and Jimblebar would be expected to remain sinks (i.e., the pit lake levels would be lower than the surrounding water table and groundwater would discharge to the pits). Pit lake water quality would be expected to deteriorate as a result of evapo-concentration of naturally occurring salts and metals in groundwater.
- An insignificant area of AMD 1 exposure in the OB31 pit wall would not be expected to represent a significant hazard to pit lake quality. There are AMD 2 (sparingly soluble) wall rock exposures in WH123 and minor exposures of AMD 1. South Jimblebar also has minor exposures of AMD 1. WHASH and East Jimblebar have larger exposures. However, studies have shown that acidity generation rates from wall rock are low (Section 5.3.2.2). An assessment of the impacts to pit lake quality will be conducted and BHP's backfill and tailings storage strategy will be refined to manage any significant impacts to receptors.
- The impacts to groundwater levels from Jimblebar and OB17/18/31 are different due to the separation of the two systems by the Wheelarra Fault (Section 5.11.2).
- The post-closure groundwater levels at OB17/18/31 will be influenced by the final closure strategy for the OB31 pit. If the pit is backfilled, groundwater levels will eventually recover to pre-mining levels. However, if the pit remains a void, groundwater levels would stabilise below pre-mining levels. The recent conceptual model for OB31 has identified two leaky flow barriers (dykes) between OB31 and Ethel Gorge TEC. This, combined with the rate of recharge in the Ethel Gorge aquifer area (including the contribution from Ophthalmia Dam) and the fact that the flow path from OB31 passes just to the north, mean that drawdown is unlikely to impact the Ethel Gorge TEC. Given the low rate of rainfall recharge, groundwater recovery will take several hundred years, regardless of whether OB31 is backfilled or left as a void.
- Groundwater levels at Jimblebar would be expected to reach equilibrium in 500 to 3,000 years post mining. This large range is due to the uncertainty associated with rainfall recharge rates. Drawdown at the end of operations is not predicted to migrate west of the Wheelarra Fault or south into the granite bedrock. It is predicted to propagate to the east in the regional aquifers until it reaches the hydraulic barrier that is situated to the east of the Caramulla deposits. The future migration and magnitude of drawdown to the north is uncertain and hard to predict without further data.
- Two closure scenarios were modelled for Jimblebar; no backfill (all pits remain open voids) and backfill of WH123 and WHASH pits to above the water table:
  - In the scenario with no backfill, groundwater levels were predicted to remain 100 to 200 m below pre-mining levels in the vicinity of the pits following groundwater recovery.
  - In the scenario where WH123 and WHASH pits were backfilled to above the pre-mining water table, drawdown was predicted to be 80 to 100 m below pre-mining levels in the vicinity of the pits due to the effect of other voids that remain open.
- The Caramulla MAR has been modelled to reduce operational drawdown in the regional aquifer by almost 20 m close to the MAR borefield, however, the MAR scheme would not be expected to change the extent of the overall drawdown footprint. Operation of the Caramulla MAR scheme will reduce the groundwater recovery time post-closure, however, will not have a significant impact on the order of magnitude of recovery time.

5.16.5.1 Groundwater levels

Operational drawdown

Jimblebar

The conceptual and numerical models for Jimblebar have been reviewed and updated since the last Jimblebar MCP (Revision 3 dated 2021). Numerical modelling (BHP, 2023c) now includes mining of the East Jimblebar deposit as well as amendments to the model arising from an improved understanding of the conceptual model based on data on aquifer responses to dewatering.

The update to the numerical model used steady-state and time-variant historical models to vary model settings and improve the match between the observed and simulated groundwater levels. The model runs that produced the best fit with historical data were then used to predict drawdown scenarios. Drawdown scenarios were run with, and without, the Caramulla MAR scheme (BHP, 2023d).

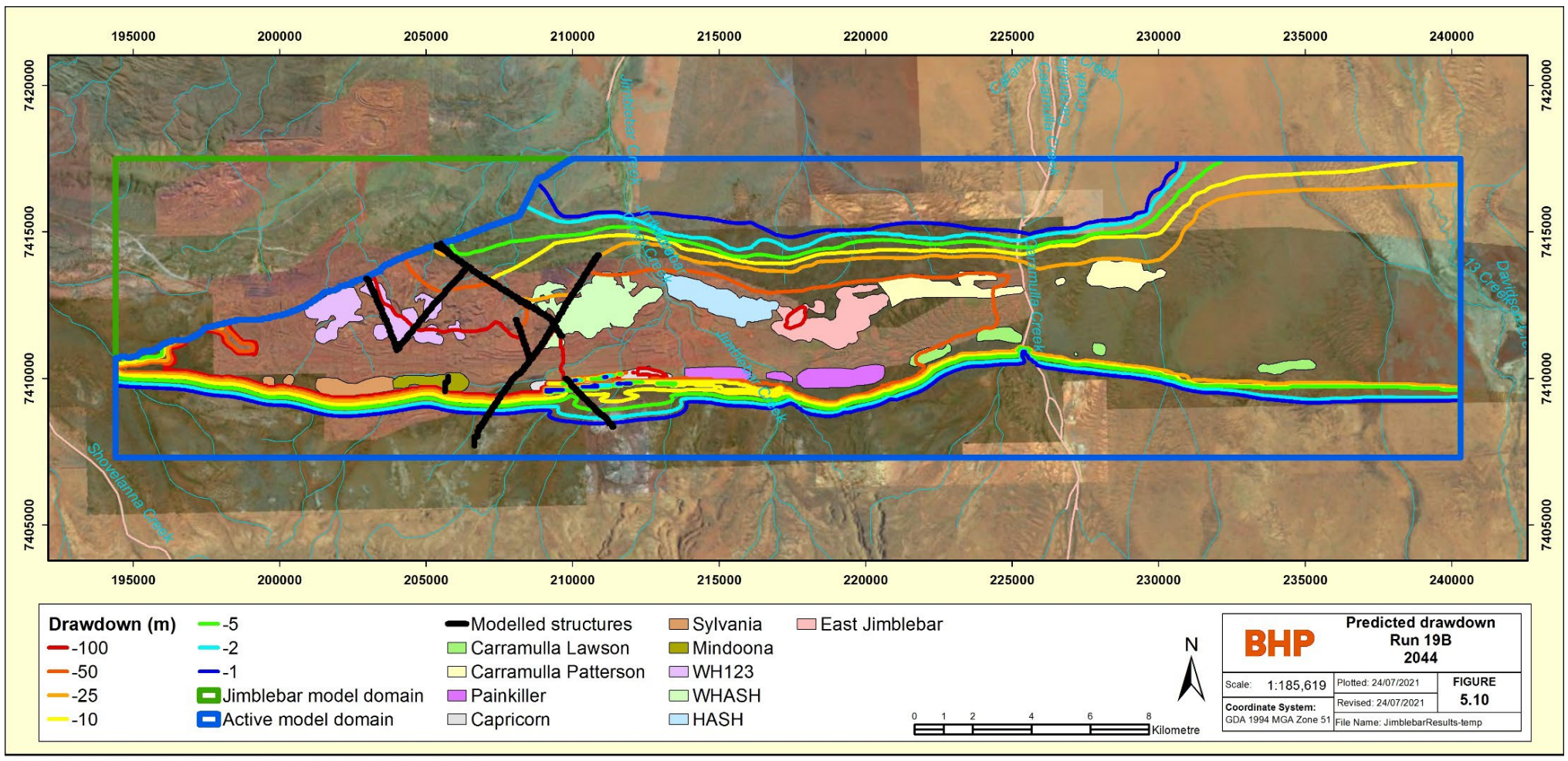
Predicted drawdown at the end of mining (without the Caramulla MAR) is extensive within the Marra Mamba and Brockman Iron Formation orebody aquifers, and the dolomite and Tertiary Detrital regional aquifers. This drawdown may exceed 100 m at the north western boundary of the model domain (along the Wheelarra Fault), up to 25 m at the northern and eastern boundaries, and less than 1 m at the southern boundary compared to pre-development groundwater levels (Figure 5-80) (BHP, 2023d).

Drawdown is not predicted to migrate west of the Wheelarra Fault or south into the granite bedrock. Drawdown is predicted to propagate to the east in the regional aquifers until it reaches the hydraulic barrier that is situated to the east of the Caramulla deposits. The future migration and magnitude of drawdown to the north is uncertain and hard to predict without further data (BHP, 2023c).

Figure 5-81 shows the drawdown that would occur when the Caramulla MAR scheme is taken into account and shows that the MAR reduces the drawdown in the regional aquifer by almost 20 m close to the MAR borefield and 10 m as far west as the area directly south of WHASH. However, it does not change the extent of the drawdown footprint (i.e., the position of the 2 m drawdown contour is unchanged compared to the without MAR case) (BHP, 2023c).

Jimblebar Hub-wide cumulative drawdown

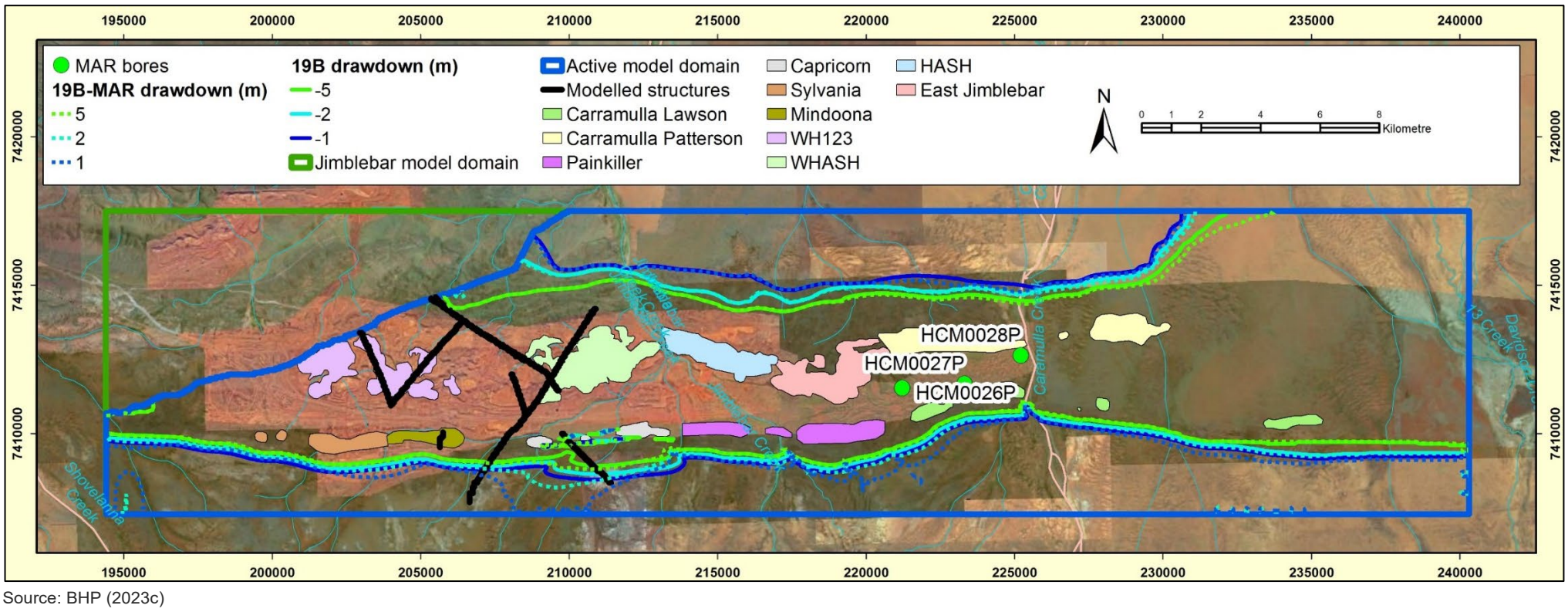
A cumulative operational drawdown assessment was conducted for the Jimblebar Hub Significant Amendment ERD (BHP, 2023d) and is illustrated in Figure 5-82. Figure 5-82 shows drawdown contours calculated for various historical assessments under Part IV of the EP Act, as well as more recent assessments supporting the ERD. The lateral drawdown extent from the 2023 Jimblebar groundwater modelling is predicted to increase (all to the east) compared to the previously assessed drawdown for Jimblebar, OB31 and OB17/18 mines at the end of the modelled operational dewatering period. As previously assessed for the OB31 mine in 2015, drawdown from the Shovelanna area will not reach the Ethel Gorge aquifer in the vicinity of the Ethel Gorge TEC to the west (BHP, 2023a).



MXD Path: R:\03 ArcGIS\EPH\FY21\FY21_Jimblebar_Approvals_Support\MXD\NM\JimblebarResults-temp.mxd

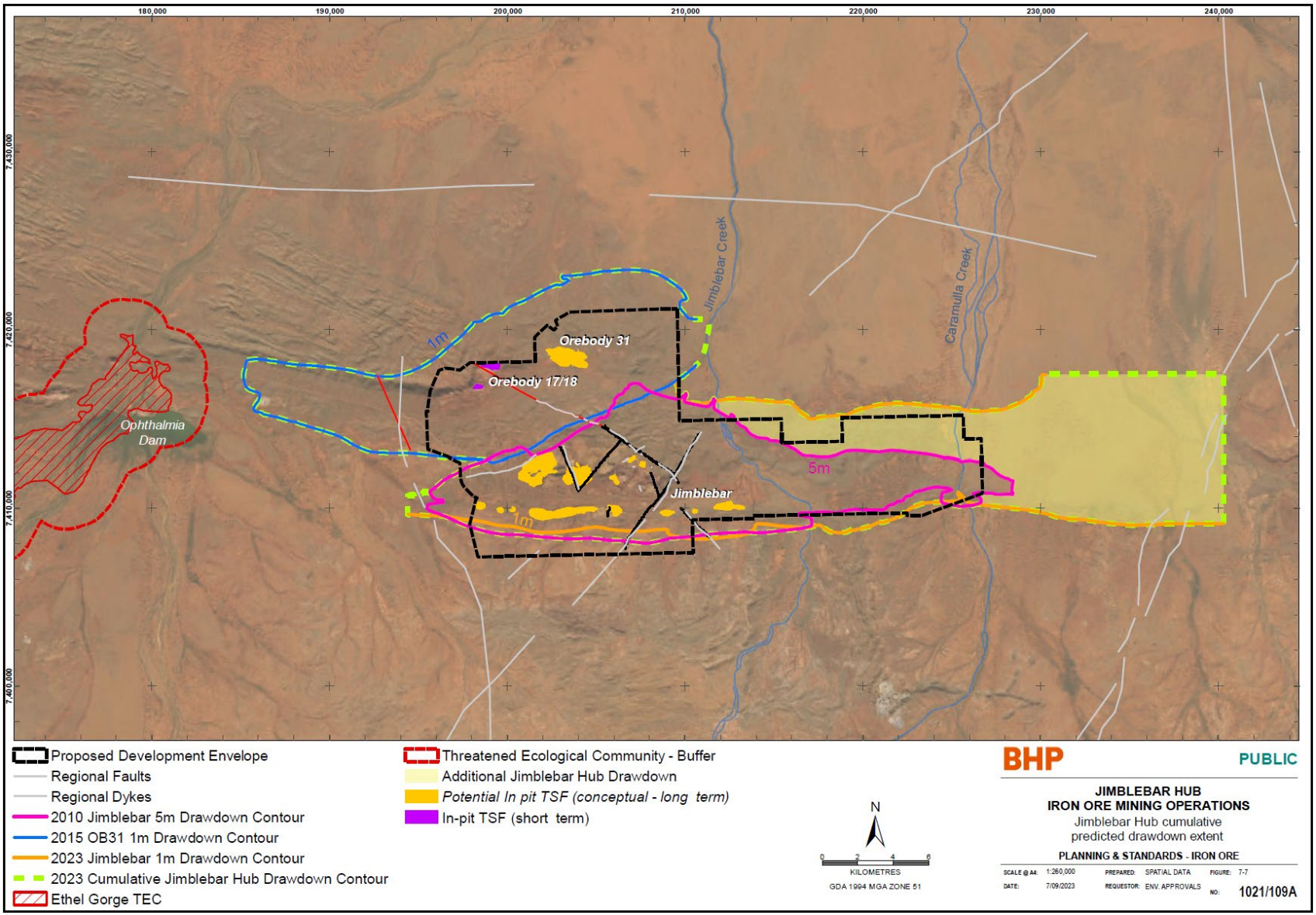
Source: BHP (2023c)

Figure 5-80 Predicted drawdown at the end of operations without Caramulla MAR



Source: BHP (2023c)

Figure 5-81 Predicted drawdown at the end of operations with Caramulla MAR



Source: BHP (2023a)

Figure 5-82 Jimblebar Hub cumulative operational drawdown

Post-closure groundwater levels

OB17/18

The closure options for the OB17/18 below water table voids (Swan and De Grey) are backfill with tailings or overburden to above the pre-mining water table. Post-closure water levels will be influenced by the closure strategy for the OB31 void.

OB31

The conceptual model for OB17/18/31 has been updated since the last (2022) closure plan (Section 5.11.2.2). The backfill strategy for OB31 is still under review and may include in-pit storage of tailings. A summary of the implications of the new conceptual model for post-mining groundwater levels in both a residual void and backfill scenario is provided below.

OB31 remains a void

In the scenario where OB31 remains a void, a pit lake is likely to form, and the equilibrium level will be significantly lower (tens of metres) than the pre-development groundwater level at this location. The void will, therefore, become a permanent groundwater sink (i.e., groundwater will flow to the pit from the regional system). Numerical groundwater modelling conducted in 2016 (and reported in Revision 1 (2022) of the OB17/18/31 MCP) was based on an earlier conceptual model. The recent conceptual model has identified two leaky flow barriers (dykes) between OB31 and the TEC which, together with the rate of recharge in the Ethel Gorge aquifer area (including the contribution from Ophthalmia Dam), influence the extent and pathway of drawdown from the OB31 pit. Based on the current (updated conceptual model), drawdown will be retarded by the leaky flow barriers and if it does reach all the way to the west, it is unlikely to impact the TEC because flow passes just to the north and does not interact directly with the TEC.

OB31 is backfilled

If OB31 is backfilled, the pre-development groundwater regime will be restored.

Groundwater recovery rates

Dewatering of OB31 will involve removing a significant amount of groundwater storage. This will be replenished by rainfall recharge. Given the low rate of rainfall recharge, this will take several hundred years, regardless of whether OB31 is backfilled or left as a void.

Jimblebar

Post mine closure, recovery of groundwater levels within the Jimblebar catchment will be driven by rainfall recharge only. No other inputs of water to the system are anticipated. Using the predicted volume of water abstracted over the life of mine, the area over which rainfall recharge can occur and the rate at which recharge occurs, simple calculations suggest that the time period for full recovery of groundwater levels could be between 500 and 3,000 years. This large difference in recovery times reflects the significant uncertainty in rainfall recharge. For the purposes of calculating recovery rates, rainfall recharge rates (as a percentage of historical annual rainfall) were assumed to be a high of 2% or a low of 0.5% for the South Jimblebar Valley and orebodies and a high of 1% and a low of 0.25% in all other areas. Operation of the Caramulla MAR scheme will reduce the recovery time, although, as there will be some recirculation into the dewatering bores, the MAR will not have a significant impact on the order of magnitude of recovery time (BHP, 2023c).

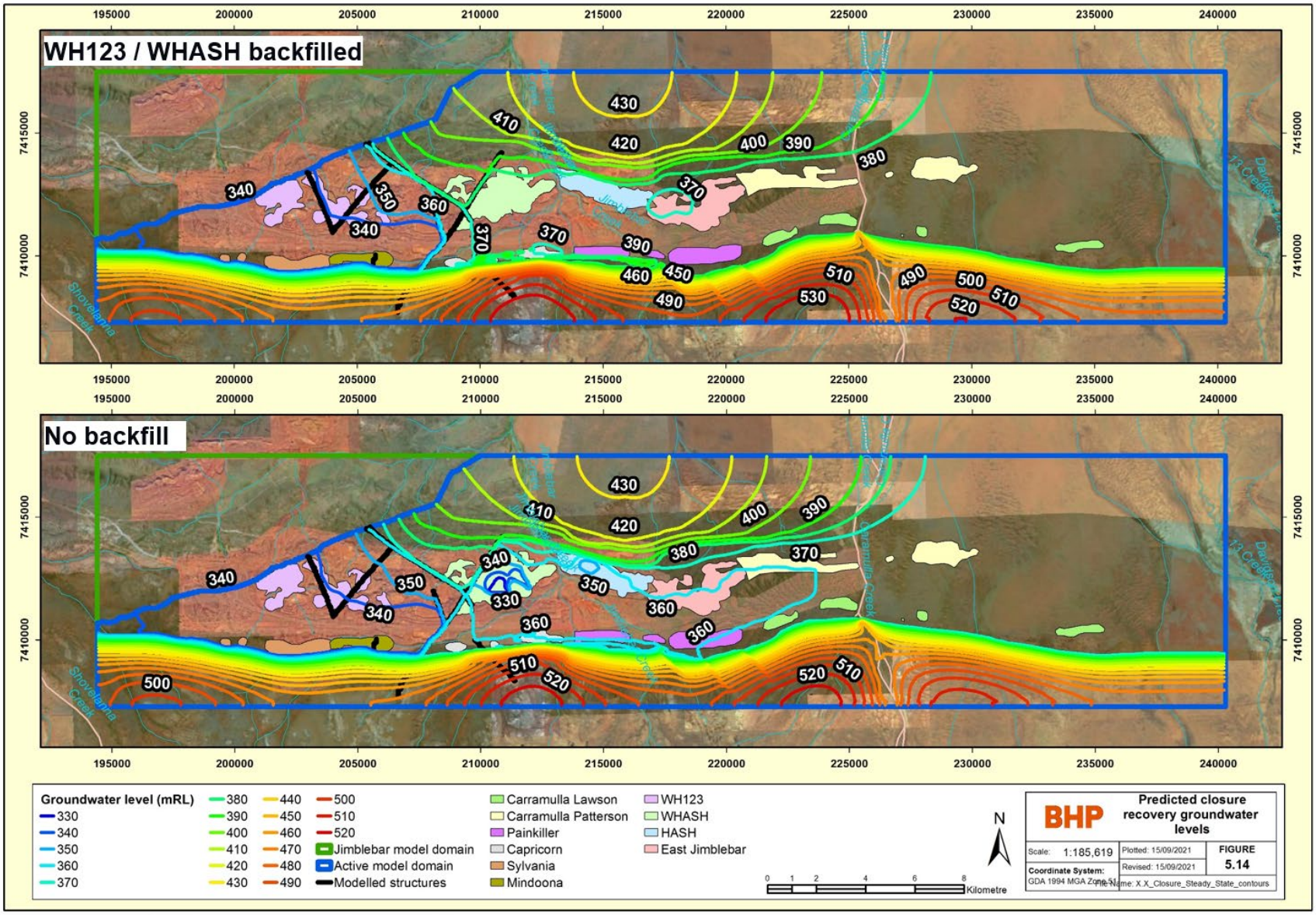
Two closure scenarios were modelled to assess the influence on groundwater recovery levels; all pits left as open voids with no backfill, and a scenario which considered the backfill of selected pits to above the water table; nominally WH123 and WHASH. The model assumed a very low recharge environment (0.5% and 0.25% of rainfall and no enhanced recharge into the open voids) and can be considered very conservative.

The predicted equilibrium recovery levels show that (Figure 5-83):

- In the no backfill case, water levels recover to about 340 mRL in the western compartment and 360 mRL in the eastern compartment compared to 462 mRL pre-development levels (i.e., remain 100 to 120 m below pre-mining levels).
- In the WH123 and WHASH pit backfill case, water levels recover to about 340 mRL in the western compartment and 370 to 380 mRL in the eastern compartment (compared to 462 mRL pre-development levels) (i.e., remain 80 to 100 m below pre-mining levels).

There is no difference between scenarios in the western compartment because the water levels are controlled by evaporation from the Sylvania open void with its base at 338 mRL. There are higher recovery levels in the eastern compartment in the backfill scenario because the deepest pits W123 (324 mRL) and WHASH (339 mRL) are backfilled and the deepest remaining open voids, Capricorn and East Jimblebar have void depths of 368 mRL and 360 mRL respectively. However, the analysis suggests that whether or not selected pits are backfilled, groundwater levels in a scenario with any open voids will remain significantly lower than pre-development levels.

The potential impacts to ecohydrological receptors of permanent changes to groundwater levels are described in Section 7.3.2.2.



Source: BHP (2023c)

Figure 5-83 Predicted drawdown post-closure

5.16.5.2 Pit lakes

BHP acknowledges the Nyiyaparli people's stated preference for the avoidance of pit lakes, and the Jimblebar operations progressive closure philosophy includes a priority focus on progressively backfilling overburden, and potentially tailings, into mined out pits.

OB17/18

Regardless of the closure scenario (backfill with overburden or fill with tailings), pit lakes would not form in the below water table Swan or De Grey pits.

OB31

For OB31, pit closure scenarios are still being evaluated. In the event that the void remains open, the pit is expected to remain a sink (Section 5.16.5.1) and consequently, pit lake water quality would be expected to deteriorate as a result of evapo-concentration of naturally occurring salts and metals in groundwater. An insignificant area of AMD 1 is predicted to be exposed on the OB31 pit wall (Section 5.3.2.2) and is not considered to represent a significant hazard to pit lake quality (Section 5.3.2.2). Further analysis of the potential for seepage from the in-pit TSFs at Swan and De Grey to impact pit lake quality is required as the OB31 pit closure options evolve.

Jimblebar

Based on a backfill scenario analysis conducted in 2019, between 40 and 60% of mined overburden may be progressively backfilled into mined out pits. This is expected to minimise the extent of post-closure pit lakes.

A conceptual assessment of the formation of pit lakes has been conducted based on the current mine plan. This assessment indicated that pit lakes are likely to form at WH123, WHASH, East Jimblebar, Sylvania and Mindoona pits. A small pit lake may form at Hashimoto, but this pit is more likely to remain dry (Figure 9-26, Section 9.2.4). Other pits mined below the water table are also likely to be dry post-mining due to permanent reductions in groundwater levels (Section 5.16.5.1).

Pit lakes are expected to remain sinks (Section 5.16.5.1). The salinity of these pit lakes will initially be controlled by the salinity of inflowing groundwater and rainfall run-off. However, in the longer term, pit lake salinity will gradually increase due to evapo-concentration. There are AMD 2 (sparingly soluble) wall rock exposures in WH123 and minor exposures of AMD 1. South Jimblebar also has minor exposures of AMD 1. WHASH and East Jimblebar have larger exposures. However, studies have shown that acidity generation rates from wall rock are low (Section 5.3.2.2). An assessment of the impacts to pit lake quality will be conducted and BHP's backfill strategy will be refined to manage any significant impacts to receptors.

5.16.5.3 Knowledge gaps & forward work program

Further analysis of the potential for seepage from the Swan and De Grey in-pit TSFs to impact OB31 pit lake quality is required as the OB31 pit closure options evolve.

An assessment of the impacts to pit lake quality from wall rock exposures of PAF material will be conducted and BHP's backfill strategy will be refined to manage any significant impacts to receptors. The backfill strategy (including in-pit tailings storage) for Jimblebar continues to evolve with updates to mine plans and any changes will be reported in future iterations of this MCP.

5.16.6 Jimblebar Hub rehabilitation research

WAIO conducts a range of rehabilitation research activities across its sites. This research is summarised in Appendix F. This section summarises the outcomes of rehabilitation research trialled at Jimblebar Hub.

5.16.6.1 Seeding trials

Summary of key points:

- Research shows that:
  - *Triodia* seed treatments to alleviate dormancy and application of a range of seed enhancement technologies (e.g., flash flaming and / or seed coating) can produce a significant increase in seedling recruitment compared to un-treated seed.
  - For native seeds of the Pilbara, the sowing depth needs to be within 20 - 30 mm of the soil surface.
  - Precision seeding combined with seed treatments have resulted in a four-fold increase in seedling recruitment.

As part of the Global Innovation Linkage Program, a four year federally funded research program managed by Kings Park Science in partnership with mining companies including BHP and Rio Tinto, a 30 ha trial was established at OB18 South OSA in 2019 to investigate (BHP, 2020h):

- The benefits of a range of *Triodia* seed enhancement treatment applications. The treatments were applied to an area totalling 5 ha and included material:
  - Left in the florets but flash flamed.
  - Left in the florets, flash flamed and hydro-primed in a smoke solution.
  - Cleaned seeds (floret husk removed) and coated in a calcium carbonate coating.
  - Cleaned seeds, hydro-primed in a smoke solution and coated in a calcium carbonate coating.

- Precision placement of seed across a 25 ha trial site, using a new seeding apparatus that fits directly into D10 bulldozers (aspects of this research remain confidential at this stage). The seeder unit replaces the standard heavy-duty, deep ripping tynes and is designed to leave seeds within the upper 20 mm of the soil surface. Seed used for this trial was left in the florets, but flash flamed (BHP, 2020h).

After receiving significant rains from Cyclone Blake in January 2019, and some follow-up thunderstorms, seedling recruitment has been extensive. All of the seed enhancement approaches evaluated (flaming versus cleaned seeds and priming / coating) produced at least a 4-fold increase in seedling recruitment above the un-treated, off-the-shelf material (Figure 5-84). Follow up monitoring has indicated that *Triodia* grass establishment remains high in the treatment zones that were sown with seeds treated to alleviate dormancy, and the application of a range of seed enhancement technologies (e.g., flash flaming and / or seed coating treatments) (Figure 5-85), when compared to un-treated seed material. This treatment effect appears to be carrying forward into longer-term plant establishment (BHP, 2021k).

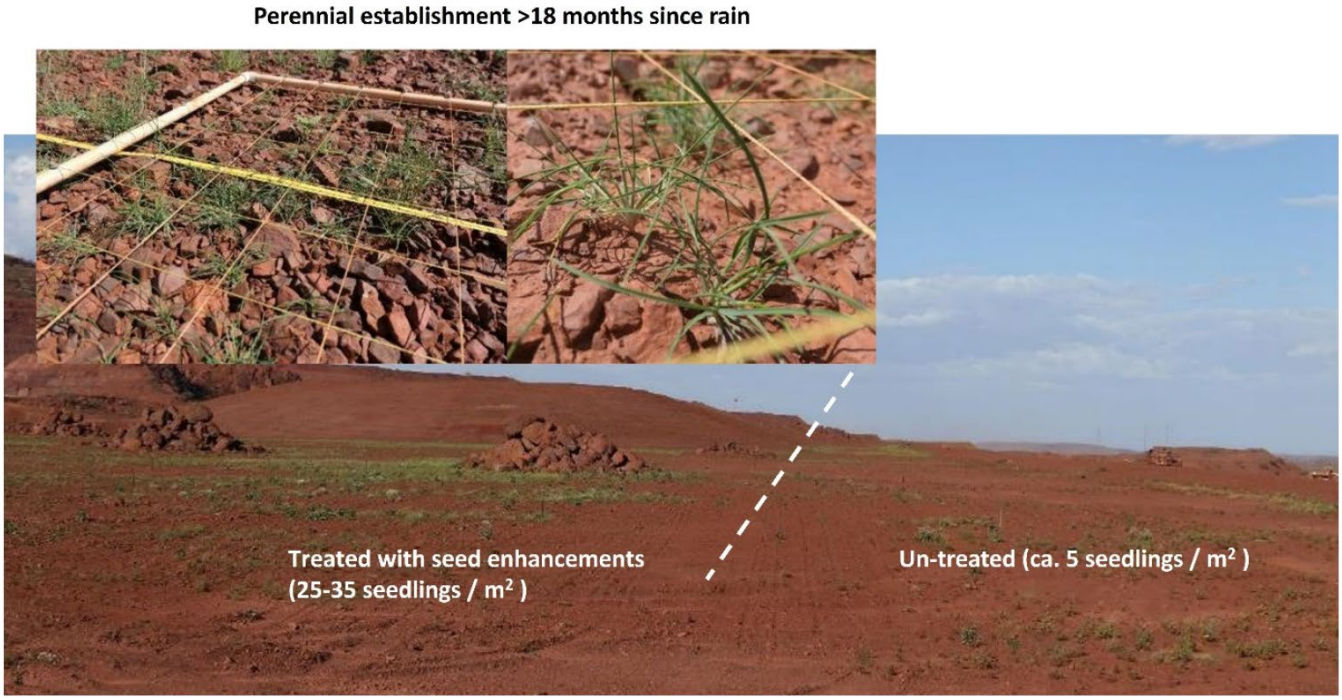


Figure 5-84 OB18 South OSA seeding trial (seed treatments and precision seed placement)

Un-treated seed **Treated seed**

Photo credit: Todd Erickson

Figure 5-85 Comparison of areas seeded with treated and untreated *Triodia* seed

Further larger scale trials have been duplicated across the Pilbara at multiple mining partner sites and have highlighted the need for precision seed placement. For native seeds of the Pilbara, the evidence suggests the sowing depth needs to be within ~20 mm

of the soil surface. Buried too deep, the seeds lack the energy reserves to emerge. Sowing on the soil surface is also problematic as seeds are exposed to extreme temperature conditions and high evaporation rates (BHP, 2021k).

Knowledge gaps & forward work program

Utilise the results of seeding trials to inform the revegetation strategy (Section 9.1.3).

5.16.6.2 Orebody 18 fire trial

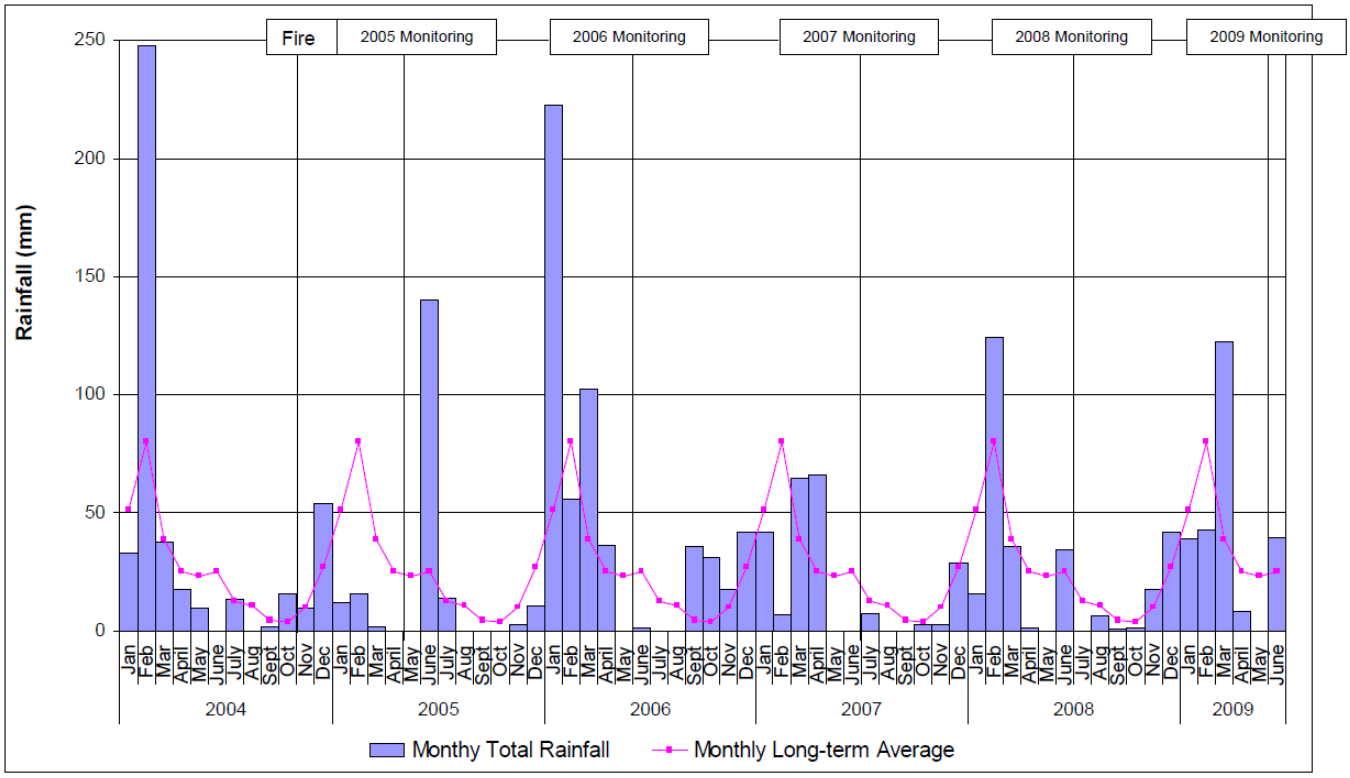
Summary of key points:

- Post fire Spinifex Shrubland ecosystem regeneration is dependent on rainfall and water availability, both annual rainfall (cumulative rain over the previous twelve months) and short-term rainfall (rain occurring in the two months prior to monitoring).
- Except for nutrient cycling and infiltration, the landscape function indices of burnt sites mirrored those of the analogues suggesting that one of the largest influencing factors of the recovery of these sites related to the frequency and timing of rainfall events. Nutrient cycling and infiltration indices were affected by litter cover, which in 2009 averaged 9.6% for analogue sites and 2.8% for burnt sites.
- The cover values for *Triodia* at both burnt and unburnt transects followed the same trend although the value for fire-affected sites was considerably lower. *Triodia* density was, however, higher for burnt sites, reflecting the smaller average crown size of immature plants compared with those of unburnt transects.
- *Acacia* density varied annually for both burnt and unburnt sites, however, density remained similar over time, and Acacia cover on burnt sites mimicked unburnt analogue sites suggesting that healthy regeneration of the burnt areas had taken place.
- Burnt areas achieved higher plant diversity values than the corresponding unburnt analogues. It is likely that, as the cover of *Triodia* and woody perennials increases at the burnt sites, plant diversity will decline.
- It could be expected that as burnt vegetation communities continue to regenerate and mature, landscape functions indices will normalise to levels comparable to those found at the unburnt analogues.

In April 2005, monitoring sites were established to examine ecosystem development and regeneration in *Triodia* dominated natural bushland surrounding Orebody 18 following a burn in November 2004. Three analogue unburnt sites and six burnt sites were variously established on lower, mid and upper slope areas in order to compare responses to fire on these three different slope types. The major landscape zones identified across the monitoring sites were ‘rocky slopes’, ‘plant slopes’ and ‘spinifex slopes’. Ecosystem Function Analysis (EFA) was used to assess trends for regenerating areas and comparable unburnt analogue sites (Outback Ecology, 2009a).

Post-fire Spinifex Shrubland ecosystem regeneration is dependent on rainfall and water availability, both annual rainfall (cumulative rain over the previous twelve months) and short-term rainfall (rain occurring in the two months prior to monitoring). Vegetation typically flowers and regenerates opportunistically in response to favourable conditions. As such, increased water availability in the months before monitoring will have a significant impact on vegetation, especially annual species whose life cycles are short-lived and dependant on moisture availability (Outback Ecology, 2009a).

Total rainfall at Newman for the 12 months preceding 2009 monitoring was slightly less than the long-term average (317 mm) with approximately 314 mm recorded. However, rainfall in the two months preceding the site visit was only 17% of the long-term average for the two months, April and May. Similarly, rainfall recorded for two months preceding the site visit in 2008 was 3% of the long-term average. This contrasted with 2006 and 2007 monitoring where rainfall was higher than average by 287% and 136% respectively (Figure 5-86) (Outback Ecology, 2009a).

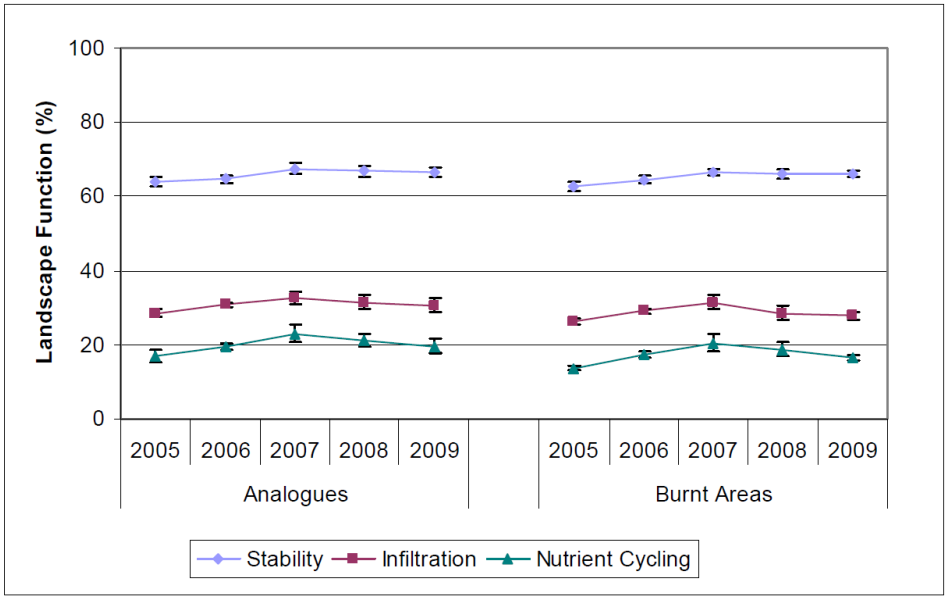


Source: Outback Ecology (2009a)
Notes: Vertical lines indicate timing of EFA monitoring

Figure 5-86 Monthly rainfall for Orebody 18 from January 2004 to May 2009

Overall landscape function indices

As a whole, the landscape function indices of burnt sites mirrored those of the analogues (Figure 5-87) suggesting that one of the largest influencing factors of the recovery of these sites related to the frequency and timing of rainfall events. Landscape function indices changed very little from the time monitoring began but peaked in 2007, when pre-monitoring rainfall was highest. Values decreased in later, lower rainfall, years. Average burnt versus unburnt data indicated that landscape function differed between the two site types, predominantly with regard to nutrient cycling and to a lesser extent, infiltration indices, which were lower on burnt transects. Nutrient cycling and infiltration indices were affected by litter cover, which in 2009 averaged 9.6% for analogue sites and 2.8% for burnt sites. Fire did not appear to have greatly affected stability, with indices more impacted by soil parameters than above ground vegetation. It could be expected that as burnt vegetation communities continue to regenerate and mature, landscape function indices will normalise to levels comparable to those found at the unburnt analogues (Outback Ecology, 2009a).

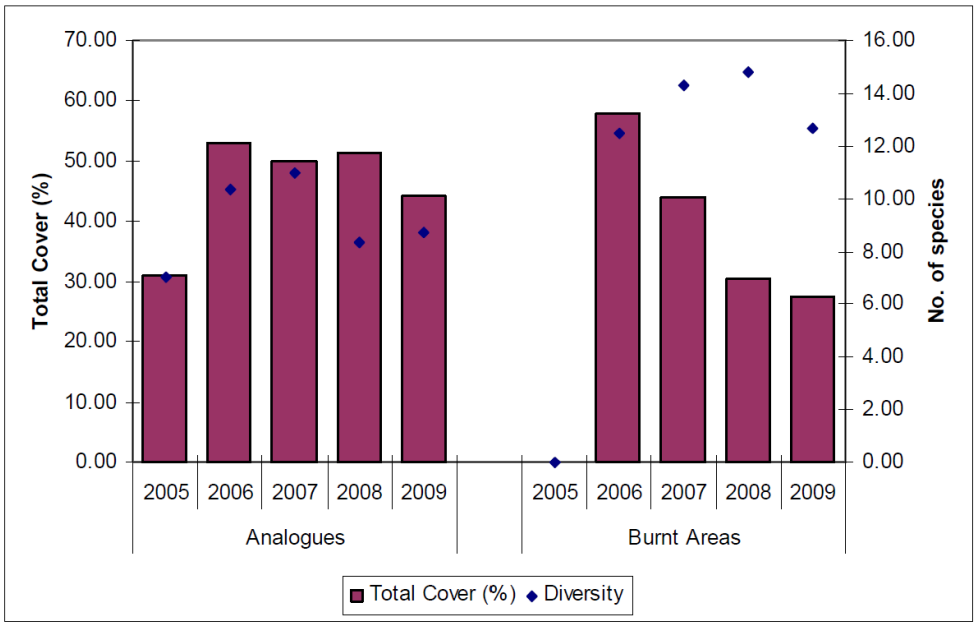


Source: Outback Ecology (2009a)

Figure 5-87 Average landscape function analysis indices for all unburnt (analogue) and burnt transects

Plant cover

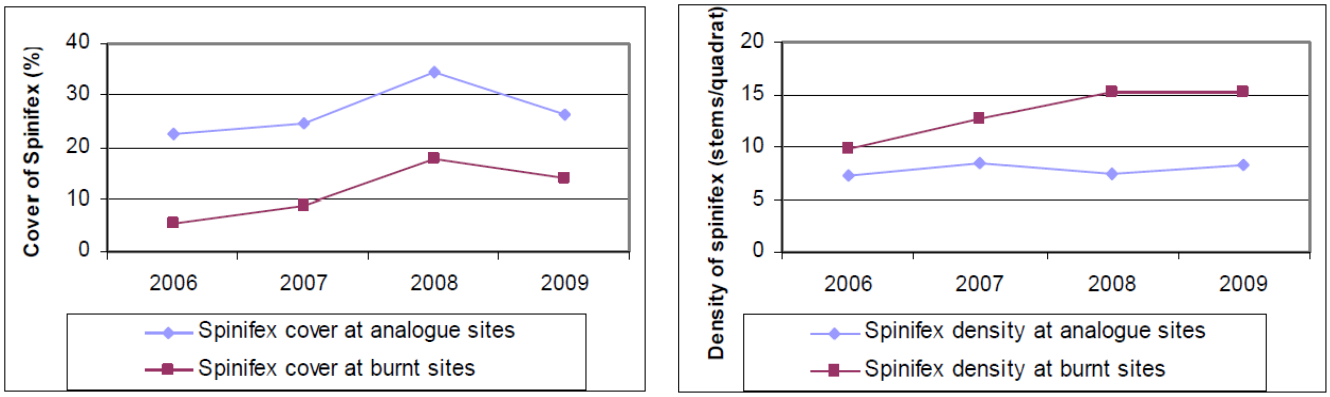
High plant cover values were recorded during 2006 monitoring following above average annual rainfall, and high rainfall immediately prior to monitoring (Figure 5-88). Vegetation recorded during this time (particularly on burnt sites) indicated that short-lived species had taken advantage of temporarily high water availability. Unburnt analogue sites recorded less variation in cover, likely due to a high pre-existing cover of *Triodia* restricting the growth of shorter-lived species (Outback Ecology, 2009a).



Source: Outback Ecology (2009a)
Notes: 2005 results are for perennial species only

Figure 5-88 Average cover and diversity values for all analogue (unburnt) and burnt transects

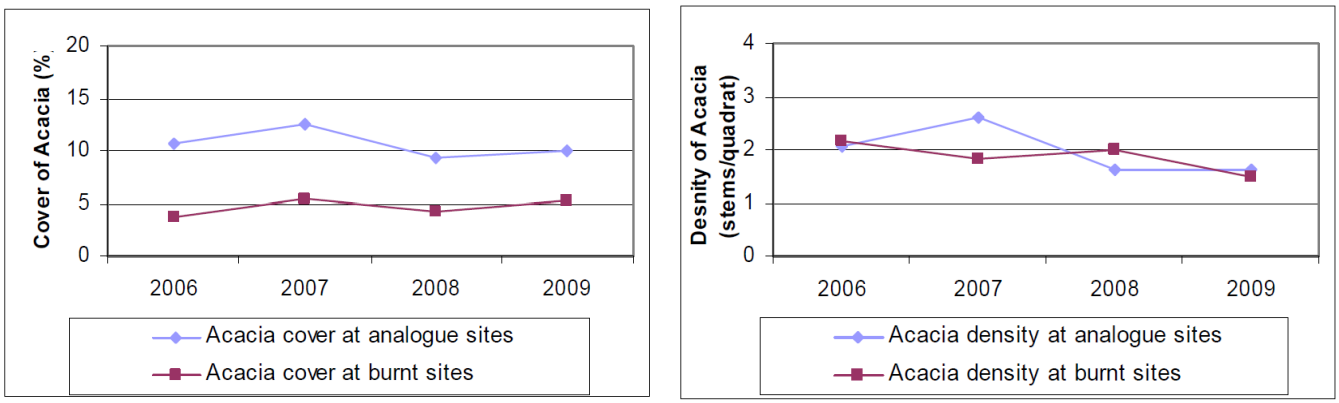
Triodia, specifically *T. wiseana*, was the dominant species within the study area, comprising 65% of total plant cover in 2009. The cover values for *Triodia* at both burnt and unburnt transects followed the same trend although the value for fire-affected sites was considerably lower (Figure 5-89). *Triodia* density was, however, higher for burnt sites, reflecting the smaller average crown size of immature plants compared with those of unburnt transects. A divergence of the density data for burnt and unburnt sites reflected the relative stability of unburnt populations, compared with the ongoing regeneration and establishment of juveniles at fire-affected transects. The value for *Triodia* density began to plateau during the 2009 assessment as the younger *Triodia* plants matured (Figure 5-89) (Outback Ecology, 2009a).



Source: Outback Ecology (2009a)
Notes: Density for BFA9 could not be determined, due to lack of definition between individual hummocks

Figure 5-89 Changes to *Triodia* cover and density at analogue (unburnt) and burnt transects

Acacia species, dominated by *Acacia hilliana,* was the second major vegetation component, comprising 19% of total cover in 2009. *Acacia* cover varied on a yearly basis but was generally stable based on data trends. Burnt sites had consistently less cover than the unburnt sites (Figure 5-90). In contrast, *Acacia* density varied annually for both burnt and unburnt sites. Given that *Acacia* density remained similar over time, and that the Acacia cover on burnt sites mimicked unburnt analogue sites, it could be suggested that healthy regeneration of the burnt areas had taken place (Outback Ecology, 2009a).

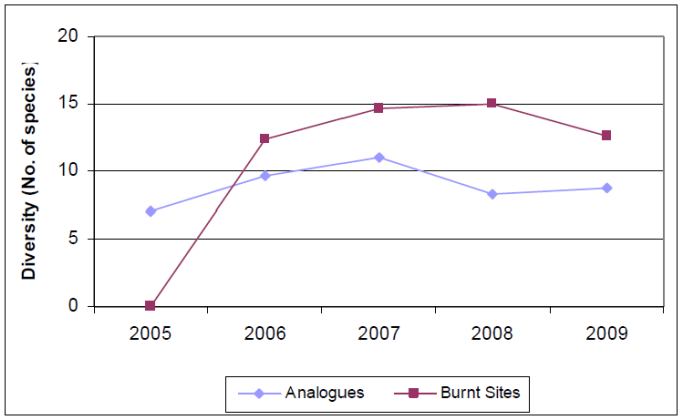


Source: Outback Ecology (2009a)

Figure 5-90 Changes to *Acacia* cover and density at analogue (unburnt) and burnt transects

Plant diversity

Burnt areas achieved higher plant diversity values than the corresponding unburnt analogues (Figure 5-91). This potentially related to a lack of available space and competition for resources on the established unburnt *Triodia* hummocks. It is likely that as the cover of *Triodia* and woody perennials increases at the burnt sites, plant diversity will decline (Outback Ecology, 2009a).



Source: Outback Ecology (2009a)
Notes: 2005 data is for perennial species only

Figure 5-91 Average plant diversity at all analogue (unburnt) and burnt transects over time

6 Post mining land use

6.1 Context

To support post-mining land use planning, BHP conducted a strategic post-closure land use opportunity assessment of its central and eastern Pilbara operations in 2019 (Pershke Consulting, 2019b). This assessment was informed by a context analysis (Pershke Consulting, 2019a) which identified various strategic objectives for, and initiatives within, the region from plans developed by:

- Economic development and land use planning agencies such as Pilbara Development Commission, Tourism WA and DPIRD.
- Conservation and environmental protection agencies such as DBCA and DWER.

The key themes arising from the review of strategic plans which could influence post-mining land use were:

- The need for economic diversification in the Pilbara. Various strategies to achieve this aim focused on:
  - Renewable energy production and export (Pilbara Development Commission, 2015; DJTSI, 2018).
  - High value agriculture and cropping, aquaculture, algae biofuels and co-products (Pilbara Development Commission, 2015; DJTSI, 2018).
  - Tourism, including opportunities to promote Aboriginal tourism (WPAC & Department of Planning, 2012; Pilbara Development Commission, 2015; Tourism Australia, 2011; Tourism WA, 2012).
  - Waste management (Pilbara Development Commission, 2015).
  - Space applications and support infrastructure (DJTSI, 2018).
- Improving opportunities for pastoral businesses in the Pilbara including irrigated agriculture and carbon farming opportunities (DISER, 2020).
- Protecting and sustainably managing nature and biodiversity (Australian Government, 2017; Government of Western Australia, 2017).
- Improving outcomes for Aboriginal people (COAG & Coalition of Aboriginal & Torres Strait Islander Peak Organisations, 2019; DBCA, 2019b; DPIRD, 2017).

The provisional post-mining land use outlined in Section 6.2 has been based on current land uses and the underlying tenure, however, land use opportunities arising from the themes outlined above may be considered in further detail as the mine life progresses.

6.2 Post-mining land use

The post mining land use will be informed by stakeholder consultation. In advance of the final post mining land use being defined for the Jimblebar Hub mines, BHP has adopted post mining land uses consistent with the Australian Land Use and Management Classifications (ABARES, 2016) and the underlying tenure (Section 2.4) to guide the closure and rehabilitation of the site (Table 6-1 and Map 6-1). These provide an interim target to which closure and rehabilitation planning can work. However, we also recognise that the Nyiyaparli people will be custodians of the land post-closure, and further consultation is required to determine how traditional uses may be factored into these land use classifications. Feedback from KNAC on behalf of the Nyiyaparli people has indicated that it may be appropriate to factor in the following to the post-mining land use:

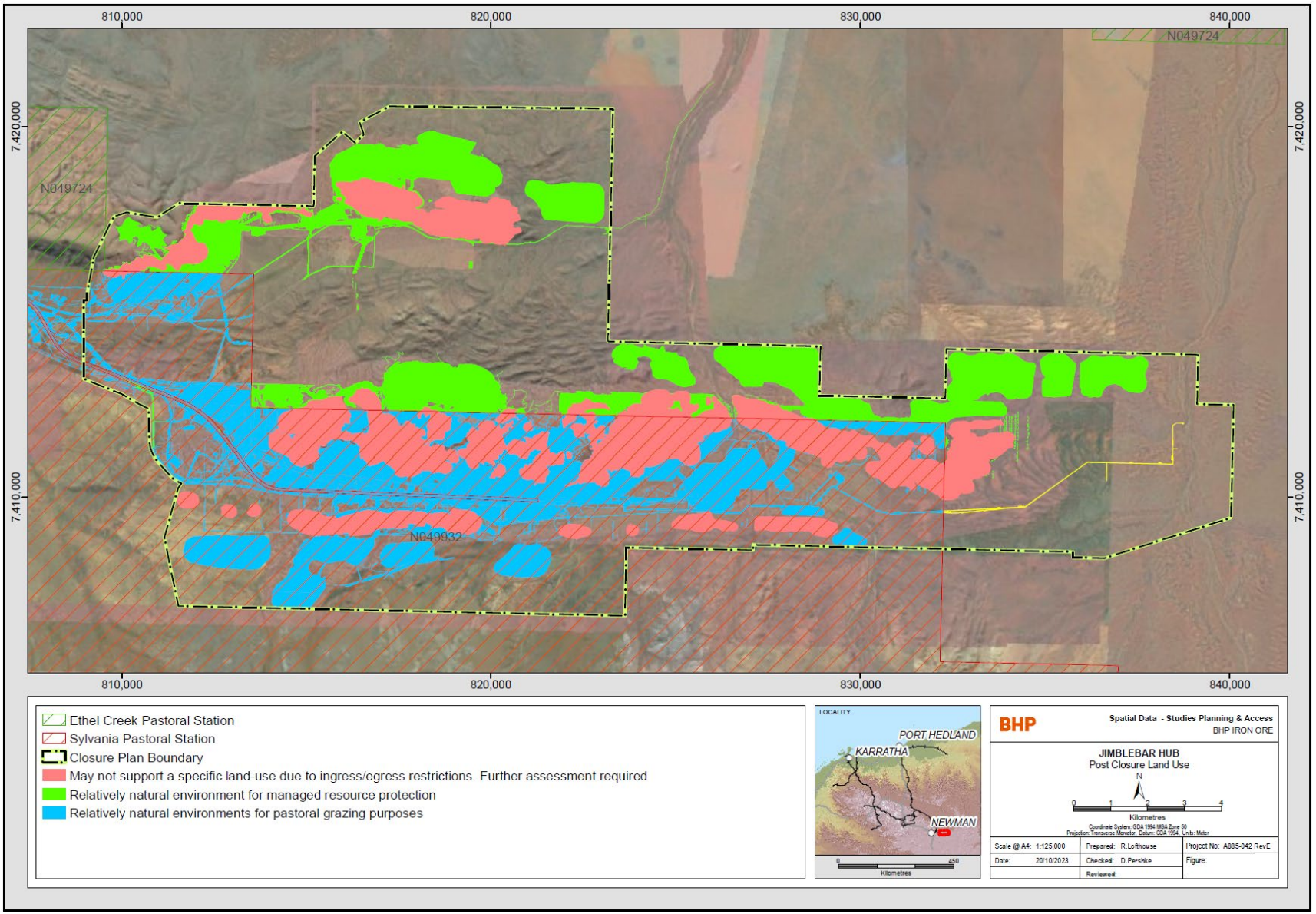
- Plant species with tucker, medicinal or other cultural significance to the Nyiyaparli people (Appendix D).
- Creation of habitat to encourage culturally significant fauna species to re-occupy rehabilitation areas.
- Creation of places where the Traditional Owners can conduct cultural activities to replace those that have been lost through mining.
- Beneficial use of mine voids and pit lakes.

It should be noted that BHP currently holds the underlying Ethel Creek and Sylvania pastoral leases. Depending on the final land use, and in line with the level of landscape disturbance at Jimblebar, revegetated areas will align with the 'rehabilitation' outcome as described in the National Standards for Ecological Restoration (SERA, 2021) and, in line with this outcome, BHP will target two or three stars across each of the six attributes in the SERA (2021) framework.

Table 6-1 Provisional post-closure land use by site domain

Domain	Underlying Tenure	Post-closure land use
OSAs	UCL	Natural environments for managed resource protection.
	Pastoral lease	Relatively natural environments for pastoral grazing purposes.
Infrastructure	UCL	Natural environments for managed resource protection.
	Pastoral lease	Relatively natural environments for pastoral grazing purposes.

Domain	Underlying Tenure	Post-closure land use
Mine Voids (including in-pit TSFs)	UCL and pastoral lease	Areas may not support a specific post-closure land-use due to ingress / egress restrictions. Land use classification may be 'extractive industry not in use'. Further assessment is required as design of mine voids (including ISAs) progresses. BHP acknowledges concerns raised by KNAC on behalf of the Nyiyaparli people about the restricted post-closure access to pits and will continue to optimise pit closure strategies, including backfill designs, that may, in some instances allow for safe access, however, regulatory requirements for managing access will also need to be met.
Roads and Rail	UCL	Natural environments for managed resource protection.
	Pastoral lease	Relatively natural environments for pastoral grazing purposes.



Refer to Appendix Q for pdf version

Map 6-1 Provisional post-closure land use

7 Assessment and management of risk

The successful planning and execution of sustainable closure and rehabilitation in the Pilbara requires a holistic, long-term view of landscape scale outcomes coupled with progressive operational level activities that implement or preserve options toward meeting these outcomes.

Adaptive management at BHP applies a suite of modelling and assessment tools to assist in identifying closure issues and guide the application of management approaches to address them. Monitoring programs provide data and information to support and inform the progressive development of the mine closure strategy for a site (Figure 7-1).

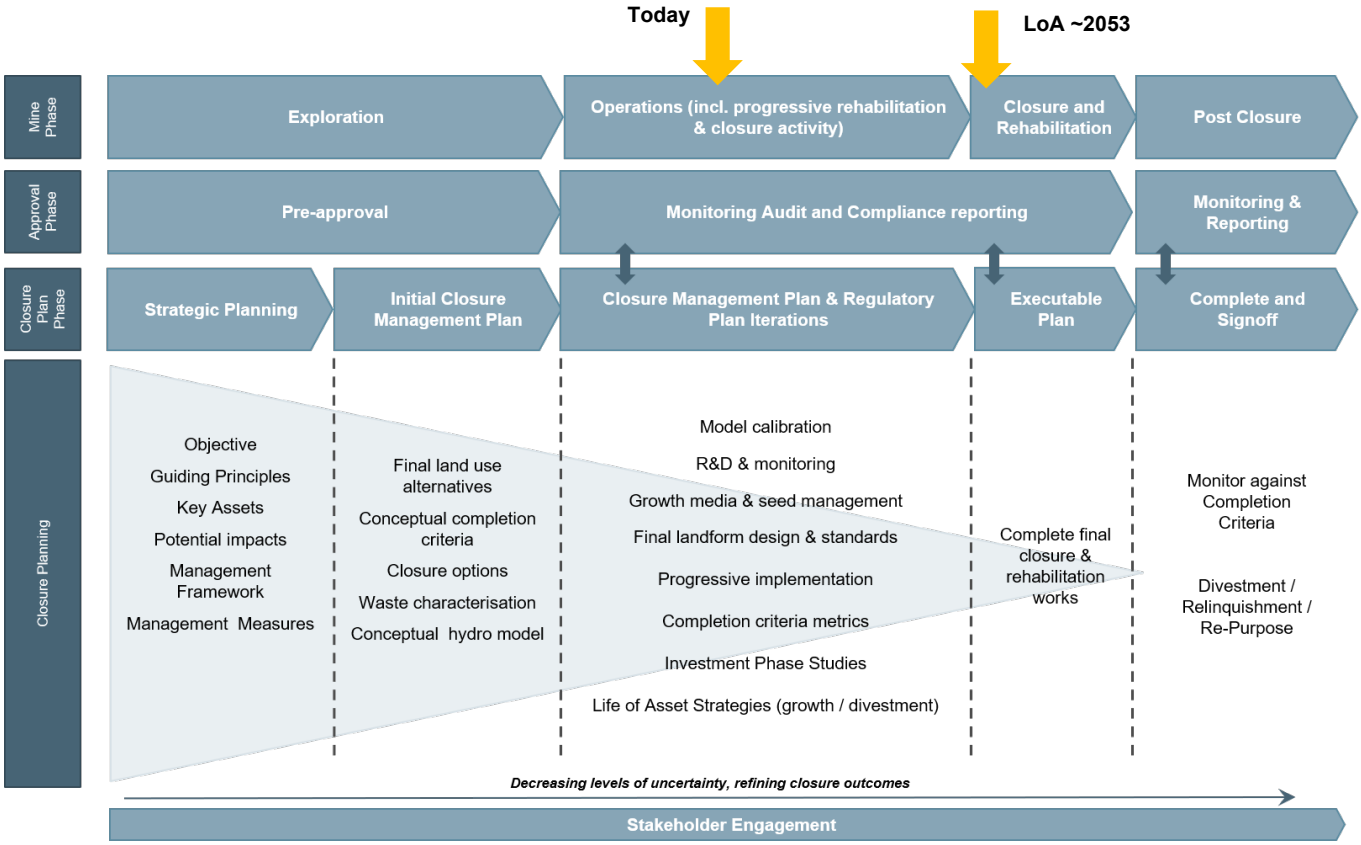


Figure 7-1 Closure planning over the Jimblebar Hub life cycle

7.1 Adaptive management

The concept of adaptive management is a structured, procedural, iterative approach to decision making (Figure 7-2). It allows incremental improvement in the success of mine closure techniques by review of rehabilitation monitoring data and integration of findings into forward work programs and future closure and rehabilitation designs. The adaptive management approach allows for the investigation and continual evaluation of preferred mitigation controls so that they are progressively improved and refined, or entirely alternate solutions adopted.

This adaptive management approach is applied to the Jimblebar Hub operations and associated closure considerations taking into account the results of rehabilitation and trials from BHP's other Pilbara operations and best practice rehabilitation techniques used elsewhere in the mining industry.

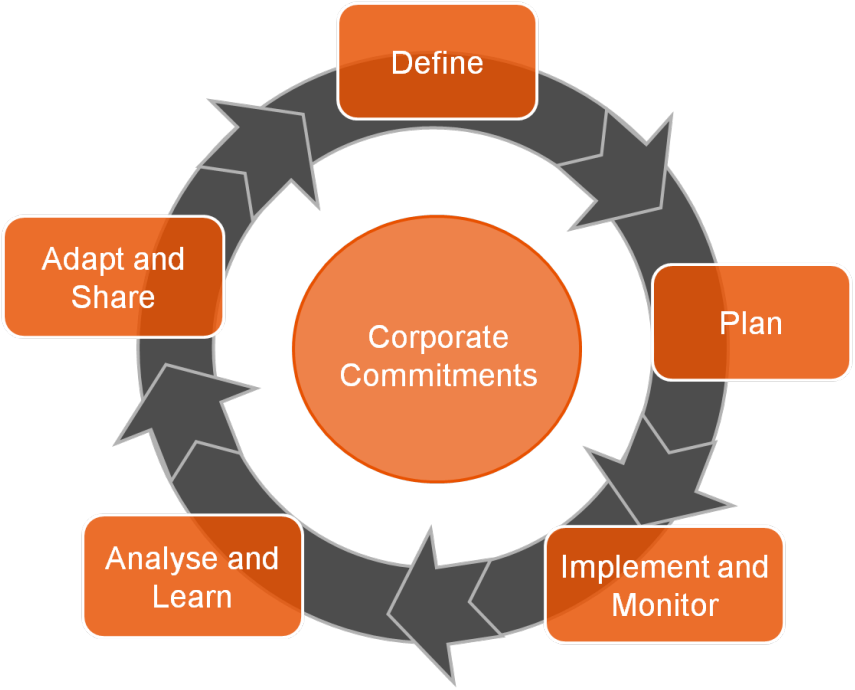


Figure 7-2 BHP's adaptive management approach

7.1.1 Rehabilitation trials and research

BHP has undertaken progressive rehabilitation at several of its Pilbara operations (Appendix C), which enables learnings from one project area to be applied to new areas through an adaptive management approach (described in Section 7.1). Assessment of rehabilitation monitoring results assists in refining closure techniques and completion criteria (Section 8.3).

Section 5.16, Appendix C and Appendix F provide a summary of current research projects / trials and historical research findings. The outcomes of monitoring, research and trials are reported in further detail in the Annual Environmental Reports (AERs) for BHP's operations. Additional ongoing external research programs, through the Botanic Gardens and Parks Authority and the University of Western Australia, continue to provide input to improving rehabilitation success across BHP's Pilbara operations. The results and recommendations are used to refine BHP's rehabilitation procedures.

7.2 Risk management

Risk Management is an integral component of the BHP Closure planning process. Risk management is undertaken to guide the selection of closure options, assess specific risks, and identify controls for the design and execution of closure projects.

In accordance with BHP's Corporate Alignment Planning process (BHP, 2022c), risk assessments are conducted for all of BHP's operations in order to prioritise and manage risks consistent with Australian Risk Management Standard AS/NZS ISO 31000:2018 Risk Management – Principles and Guideline (Standards Australia, 2018).

The primary objective of BHP's risk assessment and management system is to minimise risk in all aspects of its operations; including closure planning. The risk assessment process for closure, and the development of a risk profile are undertaken in accordance with BHP Our Requirements: Risk Management (BHP, 2022b); and the guidance included in DMIRS (2020b) on environmental risk assessments for closure plans.

In the closure context, risk management processes include three main types of risk assessment:

- Closure planning risk assessment (health, safety, environment, legal, community, financial): a predominantly qualitative assessment (including stakeholder consultation) to identify mine closure risks and opportunities, and management strategies to preserve, maintain or enhance values or beneficial uses. These assessments also include consideration of post-closure event risks (i.e., failure).
- Scientific risk assessments: scientific source, pathway and receptor risk assessments for environmental, ecological or human health risk, involving technical specialists in quantitative assessment, and based on scientific data and information. For example, AMD risk assessments and ecological risk assessments.
- Construction / workplace risk assessments: as a closure project reaches execution, risk management is used to guide the effective management of risk in the execution phase.

Closure planning risk assessments are undertaken to optimise the closure outcome. Mitigating unacceptable risks to a tolerable level may involve the development of control options against each of the risk factors, including the commissioning of additional technical studies and / or research. Such a process is iterative and is aimed at providing, on balance, the most appropriate closure outcome given the key risk drivers. Closure risks are reviewed annually at a minimum (BHP, 2022b), and are recorded and maintained in a closure risk register. As the mine closure strategy is developed, the risk assessments progressively mature with the increase in knowledge and information over the life of the mine.

Closure planning and construction risk assessments at BHP, involve people with a cross section of relevant knowledge and experience, including employees, contractors and other stakeholders. Stakeholders and specialists may be called upon to advise on aspect areas of significance or where in-house expertise is unavailable or unsuitable. Evaluation of identified risks is undertaken by the level of management that is consistent with the significance of the closure risk.

Scientific risk assessments are undertaken by specialists in the relevant field and are typically conducted to investigate the risks associated with a specific issue (e.g., significance of results from contaminated sites investigations) in more detail. The need for such investigations is identified through the closure planning process (i.e., review of knowledge base and closure planning risk assessments).

7.3 Identification & analysis of closure issues

Section 5 outlines:

- Baseline information which helps to identify:
  - Key sources of risk (e.g., materials with poor geochemical or physical characteristics);
  - Potential receptors and their significance; and
  - Pathways by which receptors may be impacted.
- The outcomes of studies conducted to inform closure designs.

This section summarises information on key stressors (Section 7.3.1) and studies assessing the residual risk associated with selected closure designs (Sections 7.3.2 and 7.3.3). This information, together with that in Section 5, informs the risk assessment in Section 7.4.

7.3.1 Stressors

There are several mining related activities that have the potential to result in environmental impacts at closure if not assessed and managed. These include:

- Exposure of materials that may give rise to AMD, NMD or saline drainage;
- Contaminated seepage / discharges from OSAs, ISAs, pits and TSFs;
- Erosion of material from OSAs impacting on surface water flow and quality;
- Interruption of surface water flow patterns, ponding, and reduction in flow volumes to downstream ecosystems due to mining infrastructure;
- Residual mine voids resulting in pit lakes and changes to groundwater water levels;
- Dust from surfaces that have not been rehabilitated; and
- Operational activities such as dewatering discharge to Copper, Jimblebar and Caramulla Creeks, and Caramulla and OB18 / Ninga MARs that may also produce stresses on the environment that need to be managed following closure of the site.

7.3.2 Change assessment

Potential changes are described by receiving environment:

- Surface water (Section 7.3.2.1).
- Groundwater (Section 7.3.2.2).
- Air (Section 7.3.2.3).

The implications of these changes for potential environmental receptors are discussed in Section 7.3.3.

7.3.2.1 Surface water

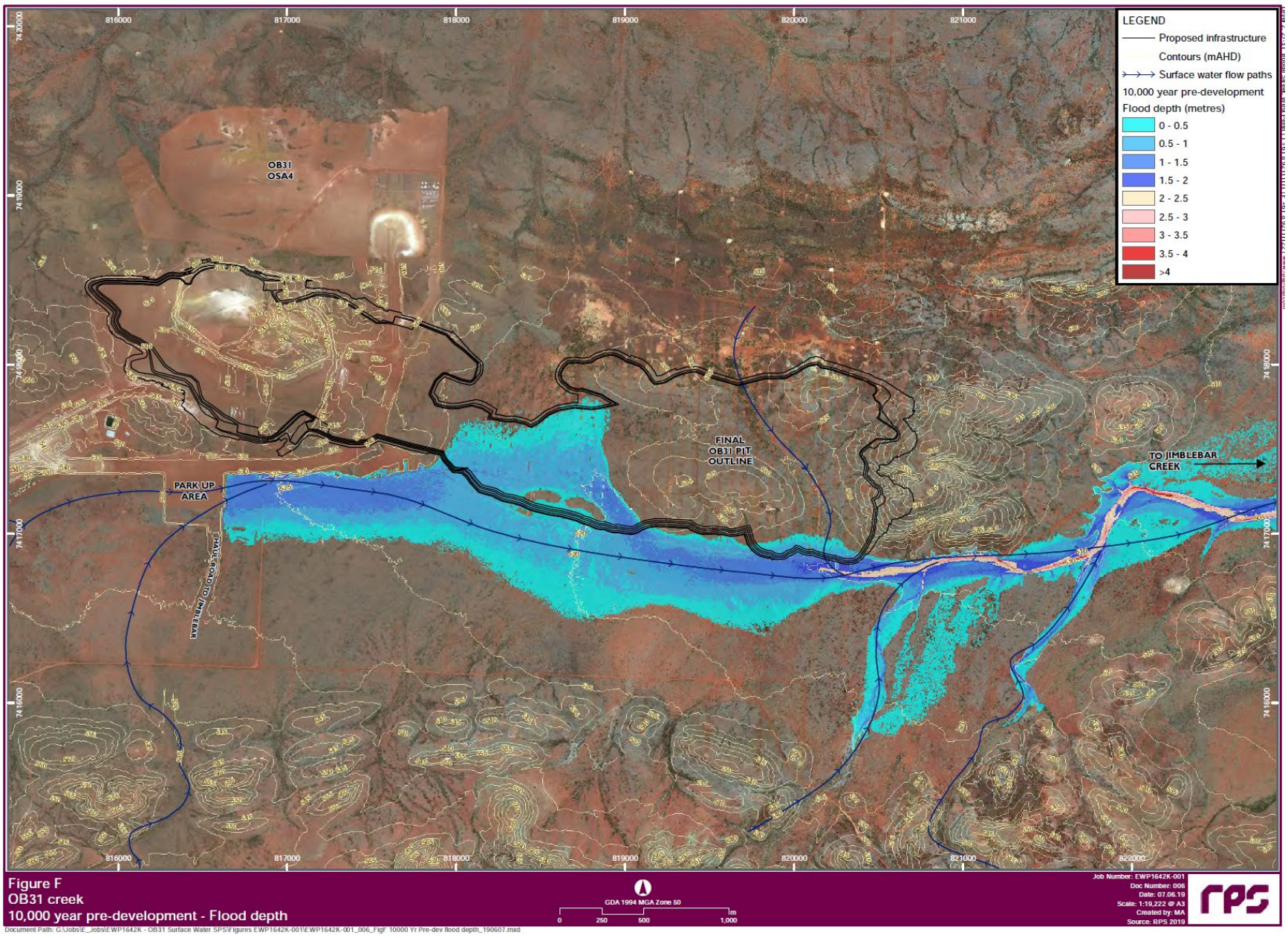
Potential surface water impacts are described below.

Changes to surface water flow patterns

OB17/18/31

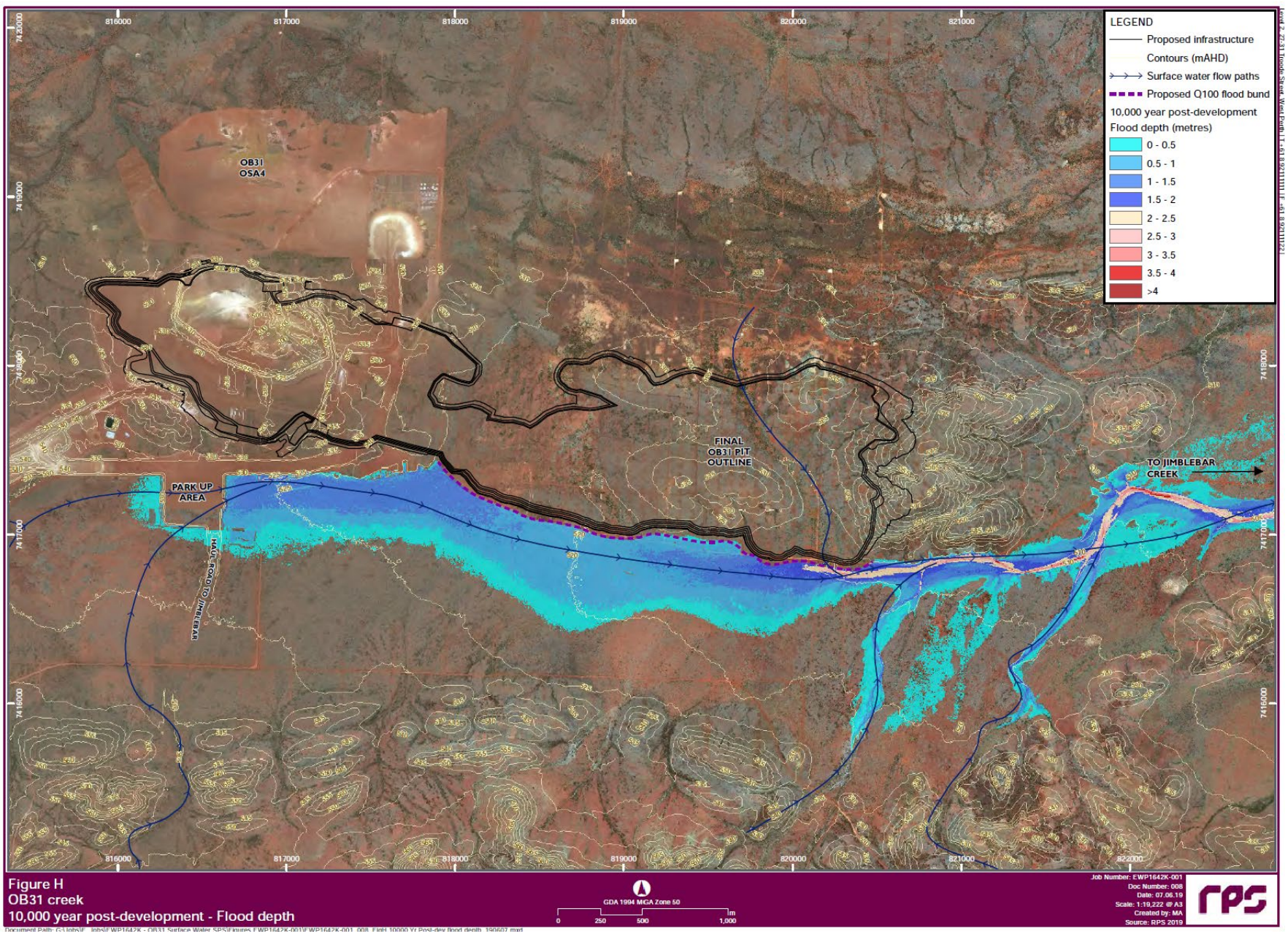
Given the position of the OB17/18 pits on the ridgeline, interception of water by mine infrastructure is unlikely to have a significant impact on the overall availability of water downstream.

As part of the operational design for the OB31 flood bund, an initial assessment of potential closure conditions was conducted, and 1 in 10,000-year flood conditions were modelled with the bund in place (Map 7-2). Comparison of pre-development flood levels (Map 7-1) with predicted post-development flood levels (Map 7-2) indicates that flood extents to the south remain similar, but depths may increase slightly. The appropriate flood event to be used as the basis of the final design will be selected as discussed in Section 7.5.3.



Source: RPS (2019a)

Map 7-1 Modelled 0.01% (10,000-year) AEP flood depths pre-development



Source: RPS (2019a)

Map 7-2 Modelled 0.01% (10,000-year) AEP flood depths with the OB31 flood bund in place

Jimblebar

The Wheelarra, Hashimoto and East Jimblebar mine pits, OSAs and stockpiles are generally located on the ridgelines away from the main creek pathways, however, there is the potential for some areas to interact with surface water drainage lines. The South Jimblebar deposit pits and associated OSAs are mainly located on the valley floor to the south of the ridgelines and have a footprint over a portion of creek flow paths. The key areas where permanent mine infrastructure (voids and OSAs) has the potential to interact with creek flow paths are outlined below with commentary on the potential changes arising from these interactions:

- WHASH and Hashimoto 2/3 pits are located either side of Innawally Pool. The existing pit shells have been designed so that the pit walls are located outside the 1:10,000-year flood plain of Jimblebar Creek in this area, and avoid intersecting alluvium under the flood plain which is regularly recharged by streamflow and which feeds Innawally Pool (Figure 7-3 and Appendix I-2).
- There is the potential for a 1:10,000-year flood of Jimblebar Creek to intersect Hashimoto 2/3 pit (Map 7-3). The H2B1 operational flood bund (designed for a 100-year flood) has been constructed to the south of the pit to prevent capture of creek flows (Section 5.16.3.7). The bund design will be upgraded for closure based on the risks to Jimblebar Creek and Innawally Pool posed by the final mine footprint and associated backfill design.
- The southeastern portion of the WHASH pit intersects the 1:10,000-year flood plain of Jimblebar Creek (Map 7-3). The H1A1 operational flood bund (designed for a 100-year flood) is proposed to prevent capture of creek flows and maintain flow to Innawally Pool (Section 5.16.3.6). The bund design will be upgraded for closure based on the risks to Jimblebar Creek and Innawally Pool posed by the final mine footprint and associated backfill design.
- South Jimblebar Sylvania pit Stages 1 to 5 intersect the 1:10,000-year flood plain of Copper Creek (Map 7-3). A flood bund has already been constructed along the north side of Stages 1 to 3, and further bunds are planned for construction along Stages 4 and 5. The Stage 4 bund has been designed (Section 5.16.3.3). A design for Stage 5 will be developed once the pit footprint has been confirmed. These diversions prevent creek capture by the Mindoona and Sylvania pits and, while flood depths are increased upstream of the embankments, flow is maintained to Copper Creek. The bund design will be upgraded based on the risks associated with the final mine footprint and backfill design as discussed in Section 7.5.3.
- The South Jimblebar Capricorn pits (SJG2 and SJH2) intersect the Jimblebar West, Central and Eastern Creeks (Map 7-3). A permanent diversion of Jimblebar Creek West Branch has been designed to maintain flows along Jimblebar Creek to Innawally Pool (Section 5.16.3.5). Further work is required to optimise the design, but the basic design principle is that the diversion geometry mimics the hydraulic characteristics of the existing creek. The operational design has considered a 1 in 10,000-year event, but the design will be reviewed as the site approaches closure to determine the impact of the 1:10,000-year flood characteristics associated with the final mine footprint and backfill design, and any upgrades required at this time. Minor diversions of Eastern and Central creeks will be established to manage 100-year floods during operations. The need for modification to these designs to accommodate closure conditions will be reviewed closer to the time of closure once the final mine footprint is known.
- A tributary of Copper Creek (South Jimblebar Creek) intersects the Stage 3 pit and South Jimblebar OSAs AV05 and BE04 (Map 7-3). A permanent diversion has been constructed to divert the creek to the south of the OSAs into the catchment of another tributary which joins Copper Creek downstream of the Sylvania pits (Section 5.16.3.4). This approach maintains the overall flow to Copper Creek. The basic creek geometry of the diversion should be suitable for closure but will be upgraded for closure based on the risk assessment processes discussed in Section 7.5.3.
- The western margins of the East Jimblebar pit area fall within the modelled 0.01% (1 in 10,000) AEP pre-development floodplain, however, this floodplain is associated with a tributary of Jimblebar Creek (with a small catchment), and the flood modelling does not consider the reduction in catchment area resulting from the pit excavation. Flood bunding is not expected to be required at this location for closure, but this will be re-reviewed closer to the time of closure. The East Jimblebar OSAs are also located outside the Jimblebar Creek 10,000-year flood extent. The eastern portion of the OSAs lie directly south of an area of Mulga identified from aerial photography and have the potential to block flows to this area of vegetation from the south. The OSAs have been designed with gaps between them that maintain the natural flow paths north (Map 7-3 and Figure 7-4) (BHP, 2023b).

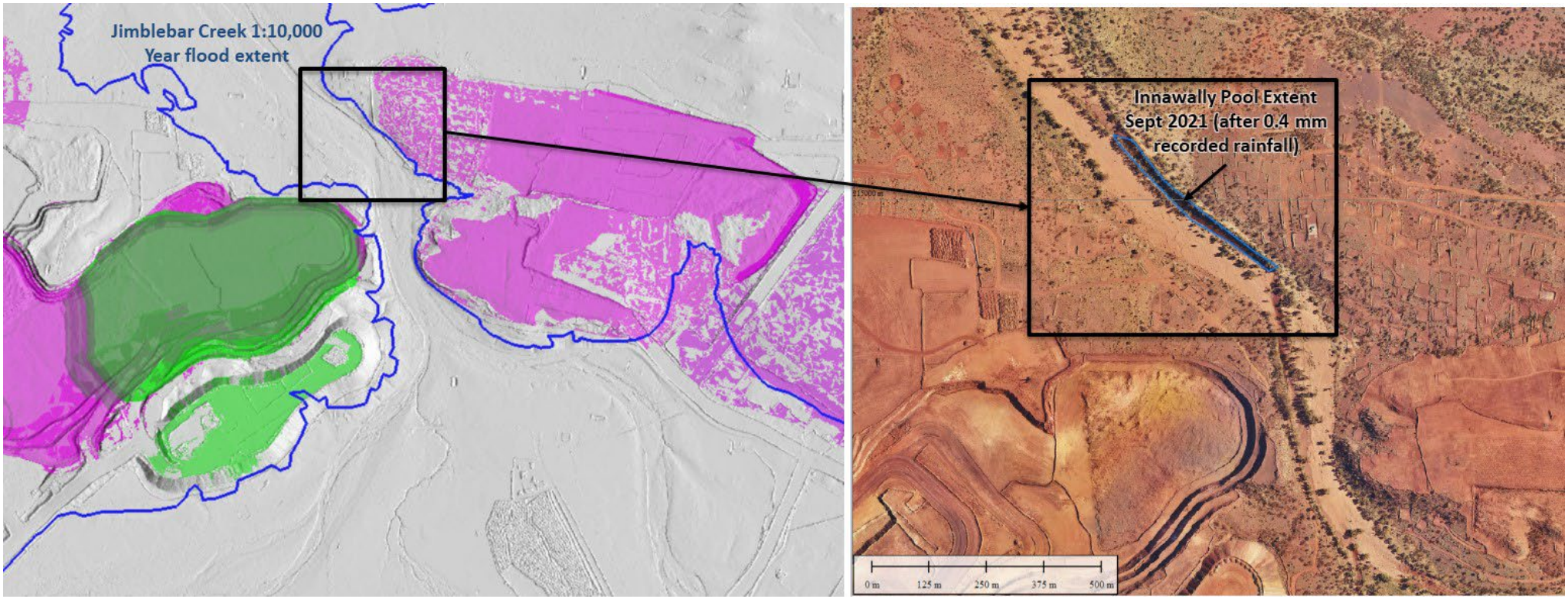
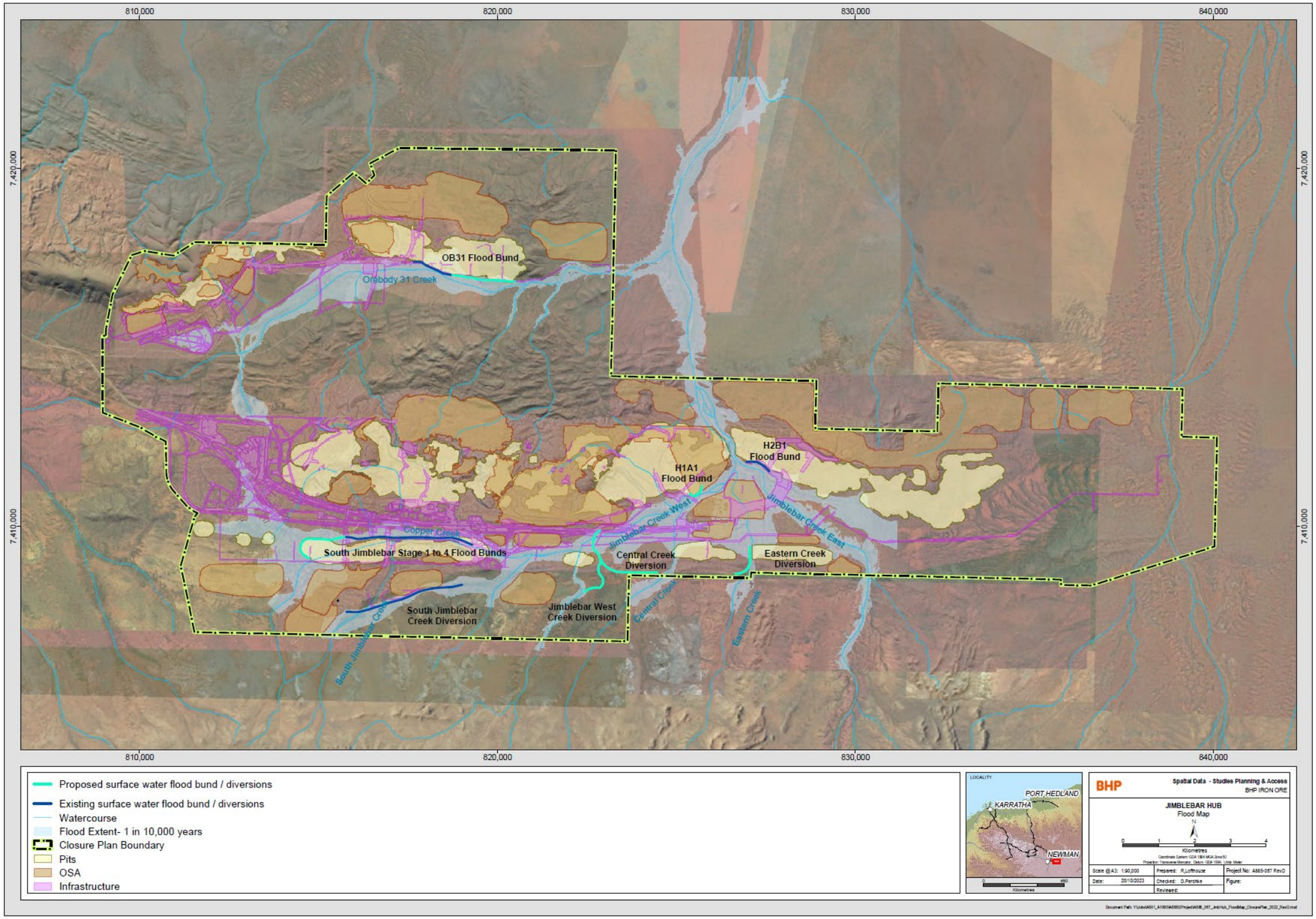


Figure 7-3 1 in 10-000-year flood interaction with WHASH and H2/3 pits



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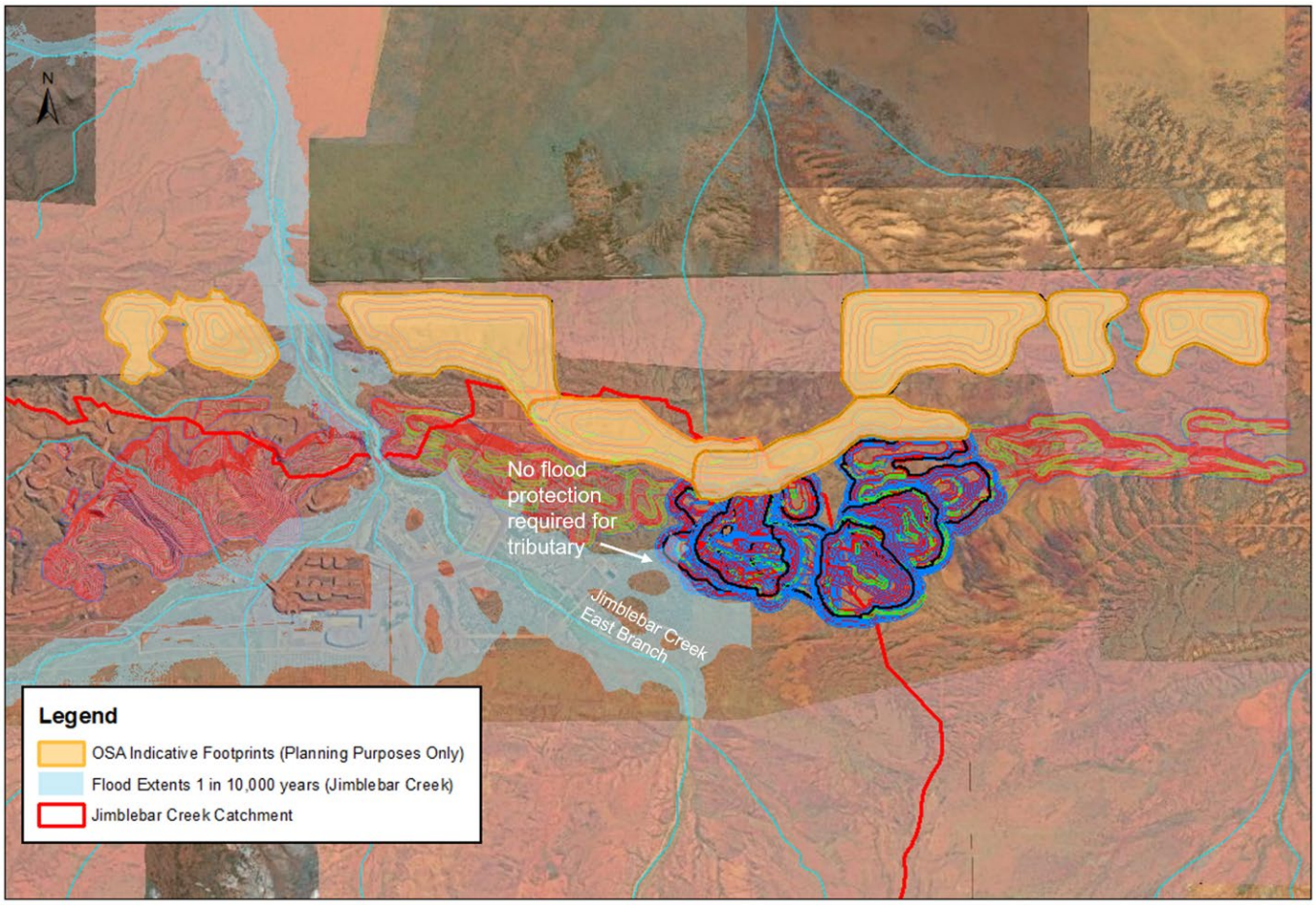
Map 7-3 Locations of existing and currently proposed flood bunds in relation to 1 in 10,000-year flood modelling



Source: BHP (2023b)

Figure 7-4 1:10,000-year flood interaction with East Jimblebar

Changes to catchment areas

Table 7-1 shows the estimated reductions in surface water catchment areas due to the combined operations at OB17/18/31 and Jimblebar (including the proposed East Jimblebar development). This reduction is not considered significant on a local or regional scale, particularly given the highly seasonal nature of streamflow in the Pilbara, as well as the annual variability of rainfall. Most of this reduction has already been approved via MS 1126 and a further reduction is subject to approval via the Jimblebar Hub Significant Amendment ERD (BHP, 2019a; BHP, 2023a).

Table 7-1 Estimated reductions in surface water catchment areas (assessed via the Jimblebar Hub ERD)

Catchment[1]	Catchment area (km^2)	Approved Proposals: Reduction in catchment area (km^2)	Proposal: Reduction in catchment area (km^2)	Combined Proposal: Reduction in catchment area (km^2)	Combined Proposal: Reduction in catchment (%)
Jimblebar Creek (upstream of Innawally Pool)	340	62.5	16.9	79.4	23.3%
Jimblebar Creek (upstream of Fortescue River confluence)	761	77.8	16.9	94.7	12.4%
Caramulla Creek	1,131	0	4.7	4.7	0.42%
Shovelanna Creek	246	0.1	0	0.1	0.06%
Upper Fortescue River	**29,751**	**80.7**	**21.6**	**102.3**	**0.34%**

Source: BHP (2023a)

Discharge of surplus mine water to creeks

The Orebody 31 Creek, Copper Creek, Jimblebar Creek and Caramulla Creek discharges have the potential to change creek vegetation due to increased availability of water, however, the discharges are not continuous and are only used to reduce pressure on Ophthalmia Dam and / or when the MAR schemes are unavailable. At closure, the discharges of surplus mine water will cease. Operational monitoring and management of the riparian vegetation along the creek lines is conducted in accordance with the Jimblebar Flora and Vegetation Management Plan (BHP, 2020a) which has been developed to meet the requirements of MS 1126

and Eastern Pilbara Water Resource Management Plan (BHP, 2021g) which has been developed to meet the requirements of MS 1021. To date no impacts have been identified that require management at closure.

Discharge of surplus mine water to Ophthalmia Dam

Surplus mine water from Jimblebar and other mines is discharged to Ophthalmia Dam as approved via various Ministerial Statements issued under Part IV of the EP Act. These cumulative surplus water discharges to the dam are managed during operations through the Eastern Pilbara Water Resources Management Plan (BHP, 2021g) and reported in AERs. Closure of Ophthalmia Dam itself is outside the scope of this plan as the dam services multiple mines.

Impacts to surface water quality

Sediment from OSAs has the potential to impact surface water quality, however, the residual impacts are expected to be low as the OSAs are generally planned to avoid 10,000-year flood plains (Map 5-14, Section 5.11.1). Where this is not possible, controls include flood bunds, diversions and erosion protection of landforms likely to be impacted by floods (Sections 7.5.4 and 9.2.2).

The potential for AMD seepage from OSAs is described in Section 7.3.2.2.

Surface discharge of surplus dewater has the potential to change the quality of water in the creek if the quality of the water in the dewatered groundwater is different to the creek water quality. As discussed in Section 5.11.1.5, the water quality in the creek lines around Jimblebar Hub is generally fresh with a pH of 6 to 8. The groundwater at Jimblebar Hub is fresh to brackish, with a pH primarily between 7.0 and 8.0. Infiltration of the mine surplus water discharges may temporarily increase the salinity of the Tertiary alluvium (shallow) aquifer units, but impacts are unlikely to occur as aquifer recharge following rainfall / flood events would be expected to periodically lower TDS concentrations in these aquifer units (Aquaterra, 2010a). Operational monitoring and management of the riparian vegetation along the creek lines is conducted in accordance with the Jimblebar Flora and Vegetation Management Plan (BHP, 2020a) which has been developed to meet MS 1126 and Eastern Pilbara Water Resource Management Plan (BHP, 2021g) which has been developed to meet the requirements of MS 1021. To date no impacts have been identified that require management at closure.

7.3.2.2 Groundwater

Potential impacts to groundwater include:

- Changes to local groundwater levels due to interaction with mine voids;
- Seepage of contaminated water from pits, in-pit TSFs, ISAs and OSAs into the surrounding groundwater.

Change to groundwater levels

OB17/18/31

As discussed in Section 5.16.5.1, the backfill strategy for OB31 is under review, but based on our current (updated) understanding of the conceptual model, even if left as a residual void, drawdown would not be expected to impact Ethel Gorge TEC.

There may be localised mounding of groundwater from the in-pit TSFs during operations, but once deposition ceases, the main inflows to the TSFs would cease, and any mounding would be expected to dissipate. Post-closure, direct precipitation over the final landform is expected to be controlled by the low permeability of the tailings and pit walls (and the fact that no large hydraulic gradients due to permanent ponding will be generated within the final landform) (Section 5.16.4.3).

The OB18 / Ninga MAR scheme will result in localised mounding during operations, however, the scheme is operated in accordance with the EP Act Part V Licence L5415/1988/9 which sets water level and quality triggers to mitigate localised impact to subterranean fauna identified near OB18. Given that there are operational controls to manage potential impacts during injection, and mounding will dissipate on cessation of discharge, no impacts are expected to require management post-closure.

Jimblebar

While drawdown is predicted to remain 80 to 120 m below pre-mining groundwater levels (depending on the backfill scenario) in the vicinity of the pits, drawdown at the end of operations (worst case, prior to groundwater level recovery) is not predicted to migrate west of the Wheelarra Fault, south into the granite bedrock, or east of the hydraulic barrier that is situated to the east of the Caramulla deposits. The future migration and magnitude of drawdown to the north is uncertain and requires further assessment based on monitored groundwater responses to dewatering (Section 5.16.5.1).

The Caramulla MAR scheme is expected to result in localised mounding of water during operations. However, this scheme is operated in accordance with Licence L5415/1988/9 and the Jimblebar Water Management Plan (BHP, 2020b) which has been developed to prevent impacts to environmental values during injection to meet Condition 7 of Ministerial Statement 1126. Given that there are operational controls to manage potential impacts during injection, and mounding will dissipate on cessation of discharge, no impacts would be expected to require management post-closure.

Change to groundwater quality

OB17/18

Impacts from PAF material

PAF exposed in the walls and floors of the De Grey pit and western end of Swan pit has the potential to give rise to AMD. However, the proposed deposition of tailings in these pits would cover these exposures and minimise the potential for impacts. A cover system would prevent erosion of the tailings (Section 5.16.4.3).

If the pits are not used for tailings deposition, then they will be backfilled with overburden to 5 m above the pre-mining water level which will limit the potential for PAF oxidation. Some PAF wall exposures may remain in the De Grey pit above the level of backfill, however, the De Grey pit is hydraulicly isolated from the regional aquifer and any changes to groundwater quality would be localised (Section 5.11.2.2). Nevertheless, further backfill or buttressing may be considered if a risk assessment indicates that PAF wall exposures above the backfill in De Grey may result in significant impacts.

Impacts to groundwater are not expected to occur as a result of contaminated seepage from PAF overburden as this material has been encapsulated with NAF material within ISAs constructed within mined-out above water table voids (refer to Section 5.16.1 for information on PAF cover design trials and Section 7.5.1 for BHP's approach to PAF overburden management). As discussed above, any seepage would be unlikely to impact sensitive receptors (Ethel Gorge TEC) as the revised conceptual model indicates there is no direct connection between the regional aquifer in the OB17/18/31 area and the TEC (Section 5.11.2.2).

Impacts from tailings

Post-closure impacts associated with seepage from tailings are expected to be low as:

- Analysis of the tailings and supernatant shows the tailings are NAF and both the tailings leachate and supernatant have low salinity, nutrients and metal(oid)s (Section 5.4.1).
- 90% of inflows to the in-pit TSFs would cease at the end of deposition. Surface water run-off from East OSA would be directed away from the TSFs and direct precipitation over the final landform is expected to be controlled by the low permeability of the tailings and pit walls (and the fact that no large hydraulic gradients due to permanent ponding will be generated within the final landform) (Section 5.16.4.3).
- De Grey pit is hydraulicly isolated from the regional aquifer.
- Any seepage from Swan pits would be captured by the residual drawdown from the OB31 pit if the pit remains a void. If the OB31 pit is backfilled and groundwater levels recover, regional flow towards the Ethel Gorge TEC is constrained by at least two partial flow barriers and the regional aquifer does not lead directly into the Ethel Gorge TEC (Section 5.11.2.2).

Impacts from OB18 / Ninga MAR

The quality of water injected into the OB18 / Ninga MAR is considered consistent with the groundwater, and Licence L5415/1988/9 contains requirements for monitoring and water quality triggers to manage the potential impacts of injection during operations. No specific closure management activities are, therefore, expected to be required for the OB18 / Ninga MAR scheme.

OB31

Impacts from PAF material

BHP (2022i) concluded that identified AMD hazards at OB31 present a low risk to receptors even prior to controls. An insignificant area of AMD 1 is predicted to be exposed on the OB31 pit wall but would not be expected to significantly impact pit lake quality or groundwater.

Less than 0.1% of the overburden at OB31 is predicted to be PAF (AMD 1, 2 or 3). Any PAF overburden mined will be managed generally in accordance with BHP's PAF overburden management procedures (Section 7.5.1) and the risk to groundwater is, therefore, expected to be low. In addition, the revised conceptual model indicates there is no direct connection between the regional aquifer in the OB17/18/31 area and Ethel Gorge TEC (Section 5.11.2.2).

Impacts from tailings

The geochemical hazard associated with tailings is low (Section 5.4.1) and seepage volumes from Swan pit are also likely to be low post-closure due to the low permeability of the tailings and pit walls (and the fact that no large hydraulic gradients due to permanent ponding will be generated within the final landform). However, should OB31 be left as a void, a pit lake risk assessment will be conducted to determine whether any controls are required post-closure as a result of the groundwater connection with the Swan pit.

Jimblebar

Impacts from PAF material

BHP (2022i) concluded that:

- Identified AMD hazards for the W4, H234, and South Jimblebar deposits present a low risk, even prior to controls.
- Overburden from the WH123, WHASH and East Jimblebar deposits presents a moderate risk without controls and a low risk with controls. The volumes of overburden classified as PAF at each of these deposits are as follows:

- WH123, approximately 1.1% of overburden is classified as AMD 2.
- WHASH, approximately 1.2% of overburden is classified as AMD 1.
- East Jimblebar approximately 1% of overburden is classified as AMD 1.

PAF overburden mined will be managed generally in accordance with BHP's PAF overburden management procedures (Section 7.5.1) and the risk to groundwater is, therefore, expected to be low.

- Pit wall exposures of PAF material within WH123, WHASH and East Jimblebar pits were identified as having moderate to high source hazards, but pit lakes are predicted to be sinks and, therefore, no impacts to groundwater quality would be expected. As the backfill / in-pit tailings deposition strategy for Jimblebar evolves, the potential impacts of pit wall exposures of PAF material to pit lake / groundwater quality will be assessed and managed, if required.

Impacts from Caramulla MAR

The Caramulla Valley aquifer is considered consistent with the quality of the Jimblebar groundwater and injection is managed during operations in accordance with Licence L5415/1988/9 and the Jimblebar Water Management Plan (BHP, 2020b). No specific closure management activities are, therefore, expected to be required for the Caramulla MAR scheme (BHP, 2019a).

7.3.2.3 Air

If tailings surfaces are frequently disturbed following cessation of deposition, or the materials do not form a physical crust, then they can be subject to wind erosion and have the potential to generate dust. However, if left undisturbed, tailings surfaces tend to form crusts and hence, their susceptibility to wind erosion is low. A cover is proposed to be constructed over the Swan and De Grey in-pit TSFs at closure which would prevent dust emissions from the tailings surface post-closure. During the period between closure and covering, the tailings surfaces would be expected to remain undisturbed and fugitive dust generation is expected to be controlled by (WSP, 2023):

- Moisture reaching the surface through consolidation.
- Crusting due to evaporation.
- The elevation of the tailings surface becoming progressively lower than the pit crest as consolidation proceeds, reducing wind exposure.

A tailings management plan will be in place to manage the in-pit TSFs between cessation of deposition and execution of closure. Should dust be identified to be an issue during this time, appropriate remedial measures will be implemented.

7.3.3 Implications of changes for receptors

This section summarises the potential impacts of the changes outlined in Section 7.3.2 to the eco-hydrological assets described in Section 5.11.3.

7.3.3.1 Ethel Gorge TEC

Habitat for stygofauna is considered to be maintained by zones of permanent saturation in the shallow alluvial groundwater system. Over 40 years of monitoring data demonstrates that groundwater levels in this area fluctuate by up to 6 m in response to seasonal rainfall and run-off variations, and that water quality has historically varied up to 2,500 mg/L TDS. Current operational thresholds in the Eastern Pilbara Water Resources Management Plan (BHP, 2021g) have been based on these ranges (Table 7-2) and are considered precautionary.

Table 7-2 Ethel Gorge TEC operational management trigger and threshold values

Receptor	Aspect	Monitoring and management values		
		Investigate (early warning trigger)	Action (trigger)	Mitigate (threshold)
Ethel Gorge Primary habitat monitoring zone	TDS	>2,500 mg/L.	3,000 mg/L	4,000 mg/L
	Change in water level	Aquifer water levels change 5 m[1] or a rate of 4 m/year.	Water levels change >6 m[1] or a rate of >4 m/year.	Water levels change >12 .m[1] or a rate of 8 m/year.
Early warning monitoring zone	TDS	Statistically significant increase by 20% from the interpreted seasonal baseline.	Statistically significant increase by 50% from the interpreted seasonal baseline.	-

Source: WAIO (BHP, 2021g)

[1]Note: interpreted as the statistically significant aquifer response and change to water level in the Ethel Gorge primary habitat monitoring zone. Water level responses greater than the above thresholds may result from localised bore abstraction and these localised responses shall not bias the overall thresholds.

Change to groundwater levels

The presence of the Wheelarra Fault means Ethel Gorge TEC is hydraulically disconnected from the Jimblebar deposits and, therefore, drawdown from these areas is not predicted to extend west towards the TEC. The revised conceptual model for

OB17/18/31 also indicates that drawdown would be unlikely to impact the TEC (Sections 5.11.2.2, 5.16.5 and 7.3.2). Further monitoring will be conducted during operations and should future model revisions indicate that there is a risk to the Ethel Gorge TEC, appropriate void management strategies (such as backfill) will be implemented.

Change to groundwater quality

There would be no impacts to the groundwater quality at Ethel Gorge TEC from the Jimblebar deposits as the mining area is hydraulically disconnected from the TEC by the Wheelarra Fault.

Any seepage from the Swan in-pit TSF would be captured by the drawdown from OB31 if the pit remains an open void at closure. If OB31 is backfilled and groundwater levels are restored, the risk to Ethel Gorge TEC is considered to be low due to the:

- Updated conceptual model that indicates, with recharge in the Ethel Gorge area, flow from OB17/18/31 passes to the north and does not interact with the TEC (Section 5.11.2.2).
- The significant distance between the OB17/18/31 area and Ethel Gorge TEC (>12 km), low inferred pre-mining hydraulic gradient (~ 2 m over ~ 12 km) and high aquifer storage, which means that both natural attenuation and dilution of seepage will be high by the time it travels to that area (Section 5.11.2.2).

The De Grey in-pit TSF is not connected to the regional aquifer and consequently no impacts would be expected to the Ethel Gorge TEC (Section 5.11.2.2).

7.3.3.2 Riparian vegetation

There are two potential impacts to riparian vegetation from hydrological processes. The first is drawdown of the water table, which impacts tree species which are groundwater dependent; and the second is waterlogging, which impacts riparian species needing 'air' in the root zone (BHP, 2021g).

If not managed, discharges during operations could result in changes to the composition and / or density of riverine vegetation due to the increased and availability of water to vegetation. However, discharges are not continuous, and regular tree health monitoring is conducted. Discharges and impacts are managed during operations through Licence L5415/1988/9, the Jimblebar Water Management Plan (BHP, 2020b), Jimblebar Flora and Vegetation Management Plan (BHP, 2020a) and Eastern Pilbara Water Resource Management Plan (BHP, 2021g). The risk of long-term vegetation change is low due to the intermittent and short duration nature of discharges, unlike a permanently operating creek discharge system that is seen at other operations in the Pilbara. Some minor change to vegetation may occur following cessation of mining, however, it is expected that the vegetation would naturally re-equilibrate as the intermittent and short duration of the discharge means that large-scale change to riparian vegetation should not occur and require management post-closure.

The groundwater at Jimblebar is too deep (Section 5.11.2) to support groundwater dependent vegetation, therefore, no impact would be expected as a result of a reduction in groundwater levels due to the Jimblebar mine. The 2015 Environmental Referral Document (BHPBIO, 2015), identified the potential for drawdown from OB31 to impact a small area of facultative vegetation located along Orebody 31 Creek to the west of the Wheelarra fault. However, it was noted that no phreatophytic species had been identified, and that the drainage line supported the vadophytic tree species *Eucalyptus victrix* and vegetation that had also been recorded in other areas with a groundwater level greater than 20 m outside of the Development Envelope. No impacts beyond those identified in the Environmental Referral Document and approved via MS 1021 would be expected at closure.

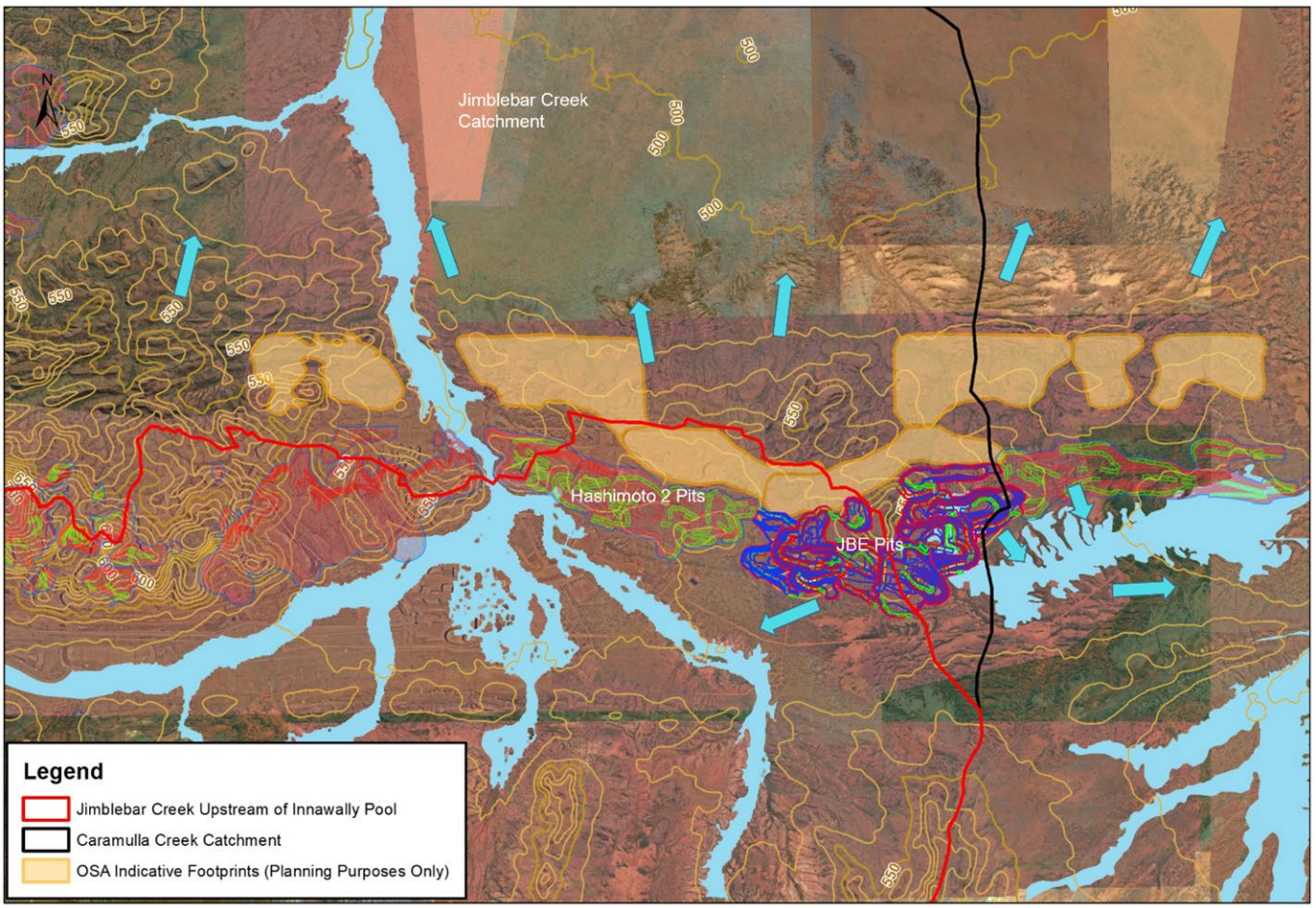
Flood bunds and a creek diversion have been constructed (or are planned) at Jimblebar and OB31 to prevent creek capture and maintain surface water flows to support riparian communities. The cumulative change to catchment area (Section 7.3.2.1) is addressed in the Jimblebar Hub Significant Amendment ERD.

7.3.3.3 Sheet-flow dependent Mulga

The areas of Mulga identified as sheet-flow dependent, are in the eastern portion of the closure planning area. The western extent of these associations is located within the proposed East Jimblebar pit and associated processing plant (discussed in the Jimblebar Hub Significant Amendment ERD), and the eastern extent is located within the area approved for the development of Caramulla MAR (approved via MS 1126). The ERD predicts that 231 ha (of a total area of 1,258 ha) will be directly impacted by clearing and that significant indirect impacts are unlikely as the (BHP, 2023a):

- East Jimblebar pits are located on a ridgeline and flow travels away from the pits (to the north and the south) (Map 7-4). The areas of sheet-flow dependent Mulga remaining within the closure planning boundary lie adjacent to the eastern perimeter of the East Jimblebar pit and surface water flow in this area is away from the proposed pit into minor tributaries that join the main channel of Caramulla Creek (Map 7-4).
- OSAs to the south of the area of Mulga identified (from aerial photography) outside the northern boundary of the closure planning area have been designed to maintain as much of the natural flow in the area as possible (i.e., with gaps between the OSAs to accommodate the natural drainage flow paths to the north) (Map 7-4).
- Surplus water infrastructure (i.e., MAR pipelines as approved via MS 1126) has been constructed to minimise impacts (i.e., by burial of pipelines, raising pipelines above ground level where burial is not suitable, and / or placement of culverts designed to maintain sheet-flow).

Unanticipated impacts to sheet-flow dependent communities arising during operations will be reported and managed via existing AER processes. Closure planning will consider the potential impacts of closure designs to these sheet-flow dependent communities and / or any mitigations that can only be implemented at closure (Section 7.5.3). Section 9.1.3 outlines how baseline vegetation data and landform are used to inform seed lists appropriate to closure of each domain.



Source: BHP (2023b)

Map 7-4 Local surface water flow

7.3.3.4 Innawally Pool

Regional groundwater levels are in currently excess of 80 m below the base of the pool (see Figure 5-54, Section 5.11.3.2) and as such, the pool and associated fringing vegetation are considered to be hydraulically disconnected from the regional groundwater system and are not expected to be affected by mining-related drawdown.

Run-off from the OB17/18/31 area will enter Jimblebar Creek approximately 4 km downstream from Innawally Pool. Therefore, the pool will not be affected by OB17/18/31 during operations or post-mining.

Innawally Pool is fed by surface flows, which implies that changes in surface water flow patterns could potentially affect the function of the pool. However, the mine only impacts a small proportion of the Jimblebar Creek catchment upstream of the pool (as discussed in the ERD for a significant amendment to the Jimblebar Hub Iron Ore Mining Operations) and flood bunds and diversions have been constructed, or are proposed, to prevent creek capture and maintain flows to the pool post-closure. The WHASH and Hashimoto pit designs have been developed to so that they are outside the 1 in 10,000-year flood plain and consequently are not expected to impact flows in Jimblebar Creek and Innawally Pool or recharge to the surficial alluvial aquifer that feeds Innawally Pool (Section 7.3.2.1).

Dewatering discharges flowing as surface water down the Jimblebar Creek system are managed via the Jimblebar Water Management Plan (BHP, 2020b) to prevent impacts to Innawally Pool. No impacts are, therefore, expected to require management during closure.

7.3.3.5 Jinerabar Pool

There are no groundwater-surface water interactions in the Jimblebar area owing to the deep groundwater levels in the region. Mine surplus water discharges to Caramulla Creek are managed via the Jimblebar Water Management Plan (BHP, 2020b) to limit the extent of surface water flow and prevent impacts to Jinerabar pool. No impacts are, therefore, expected to require management at closure.

7.3.3.6 Temporary surface water features

None of the water features discussed in Section 5.11.3.4 are located in the indicative mine footprint, and therefore are unlikely be directly impacted and require management post-closure (BHP, 2023a).

7.3.3.7 Third party groundwater users

Newman Water Reserve

Drawdown from dewatering at the Jimblebar mining area is not predicted to migrate west across the Wheelarra Fault and as such there is no potential impact on the Newman drinking water supply.

Drawdown from OB31 may extend into the Priority 1 protection zone, however, the recent conceptual model has indicated that if drawdown does reach all the way to the west, it is unlikely to impact Ophthalmia borefield because flow passes just to the north (Section 5.11.2.2). Strategies to protect water security at the borefield have been built into the Newman Potable Source Protection Plan (BHP, 2017), which defines measures to protect the drinking water source.

Pastoral bores

If pastoral bores are impacted by residual drawdown, BHP will work with the pastoral land manager to maintain water supply.

Jigalong Aboriginal Reserve

Drawdown from Jimblebar dewatering is not predicted to migrate south across the granite bedrock and consequently no potential impact on the Jigalong Aboriginal Reserve is expected.

Mining company users

There is some uncertainty as to whether dewatering activities may have an impact on the Atlas Iron bore located to the north of the Jimblebar Hub (Section 5.16.5.1). During active dewatering, a drawdown of about 2 m could occur in this area and operational monitoring will determine whether any action is required to mitigate impacts. No impacts are expected on the Rio Tinto and unknown bores located to the south.

7.3.4 Knowledge gaps & forward work program

The backfill strategy (including in-pit tailings storage) for Jimblebar Hub continues to evolve with updates to mine plans and any changes and implications for ecohydrological receptors will be reported in future iterations of this MCP.

7.4 Risk assessment

A closure planning risk assessment has been conducted for the Jimblebar Hub (Table 7-3). Participants included stakeholders within BHP with expertise in technical closure disciplines. In accordance with DMIRS guidance (DMIRS, 2020b), the risks outlined in Table 7-3 only consider environmental risks. Within the definition of environment, BHP has incorporated consideration of potential impacts to the community (e.g., in relation to post-mining land uses, safety of the site post-closure and impacts to sites of cultural significance). The risk matrix used to assess and prioritise risks is provided in Appendix G. Closure risks are reviewed annually at a minimum (BHP, 2022b).

Following the Western Australian Biodiversity Science Institute (WABSI) guidance for completion criteria (Young, et al., 2019), column 3 of Table 7-3 identifies those performance indicators / completion criteria (detailed in Section 8.3.1) that are relevant to each risk, to assist in identifying the importance of each set of criteria.

Responsibilities for closure risk mitigation and management are addressed in WAIO's internal processes and procedures. The Planning function (including; Mine Planning, Resource Modelling, Water and Closure Planning teams) in conjunction with the Environment function's Rehabilitation and Biodiversity team, would lead integration of closure management requirements into the Jimblebar Hub mining operations plans as part of the business planning process (as outlined in Section 1.3). Implementation of the risk mitigation measures incorporated into the closure plan is the responsibility of the Jimblebar Hub operations team.

Section 7.5 provides an overview of the management approaches for key closure issues. Management measures will be refined progressively (in line with the adaptive management approach).

Table 7-3 Jimblebar Hub closure planning risk assessment

Risk ID	Risk Event (Source & Pathway)	Domain / Feature	Causes	Impact to Receptors	Inherent Risk			Controls (Treatment)	Residual Risk			Completion criteria	Improvement Activity
					Consequences	Likelihood	Risk		Consequences	Likelihood	Risk		
R1	Erosion or weathering event exposes buried overburden and releases overburden and / or sediment onto downslope areas.	OSAs - Brockman out of flood plain	• Inadequate overburden characterisation. • Mine planning schedules do not consider overburden destination based on overburden material characteristics. • Competent material is not identified and segregated for use in rehabilitation, where required. • Final landform design is not suited for the materials from which it is constructed or confined by operational constraints. • Parameters used in surface water controls / erosion modelling do not reflect post-mining conditions. • Landform is not constructed to design. • Landform is constructed in a flood plain.	**Context - Brockman OSAs - Risk R1** Erosion modelling has shown that several of the Brockman lithologies are erosionally stable (R1) (Section 5.3.3). OB18 South OSA erosion trials indicate that after an initial period of armouring (from consolidation and rainfall), erosion rates were relatively low (R1) (Section 5.3.3.3). **Context - Marra Mamba OSAs - Risk R2** The Marra Mamba lithologies of the South Jimblebar deposits are known to be prone to erosion and competent overburden will need to be transported from the Brockman orebodies (R2) (Sections 5.3.3 and 5.3.4). **Context - OSAs in flood plain - Risk R2** Most of the South Jimblebar OSAs lie in the 1:10,000-year flood plain, as do the PC03 ROM, BB06, BC06 and BN07 OSAs, and some areas of WHASH OSAs (R2) (Sections 5.11.1.4 and 7.5.3.1). **Impacts** • Failure of vegetation on eroded OSA areas (R1 & R2). • Sediment impacts local downgradient vegetation, with potential impacts to priority species at OB17/18/31, WH123, BC06 and WHASH (R1 & R2) (Section 5.8.3). • Impact to visual amenity (R1 & R2). • Sediment load enters Orebody 31 / Copper / Jimblebar creeks or Innawally Pool (WHASH) (R1 & R2) (Section 5.11.1). The likelihood of erosion occurring and sediment entering creek lines is higher for OSAs in flood plains (R2). Sediment may have localised minor impacts to riparian vegetation in creek lines, but no significant impact would be expected to the Fortescue River. Sediment from WHASH OSA could impact the function of Innawally Pool which is a site of cultural significance (R2).	3	Possible	Moderate	• Inert overburden class coding is included within the mining model (Section 5.3.1). • Materials characterisation (Section 5.3.3) and competent overburden balance (Section 5.3.4). • Segregation and stockpiling of competent overburden for use in rehabilitation (Section 5.3.4). • Backfill strategy and use of ISAs where possible (Sections 7.5.4 and 9.2.2) minimises ex-pit OSA footprints and facilitates the management of overburden more susceptible to erosion. • Flood modelling is conducted (and updated as the mine footprint changes) to inform landform placement and design (Section 5.11.1.4). • Flood bunds and diversions prevent flood waters from impacting OSAs (Section 5.16.3 and 9.2.3.4). • WHASH and H234 OSAs adjacent to Innawally Pool are located outside the 1:10,000-year flood plain (Section 7.3.2.1). • The Mines Closure Design Guidance Procedure (WAIO, 2022f) informs OSA design (Section 7.5.4). • Landform design is based on materials characterisation and the outcomes of erosion modelling. Erosion protection is provided to the toes of those OSAs that may be impacted by extreme flood events post-closure (Sections 5.3.3 and 9.2.2). • Master Area Design Review process (Section 7.5.4) enables verification that closure design guidance has been incorporated into mine plans. • Assessment of compliance to plan (Section 7.5.4). • Rehabilitation works include construction supervision and post-construction inspections (Section 7.5.4). • Monitoring results determine future management and maintenance requirements.	2	Unlikely	Very low	C3.4	• Conduct additional materials characterisation and erosion modelling, as required, to inform landform designs, and update the competent overburden balance. • Continue to refine the backfill strategy to optimise closure outcomes, including reducing the risks associated with landforms constructed of material that is prone to erosion, or adjacent to flood plains. • Monitor the performance of rehabilitated landforms to validate design assumptions and inform future rehabilitation practice during the operational life of mine.
R2		OSAs - Marra Mamba or Brockman in flood plain			3	Likely	High		2	Unlikely	Very Low		
R3	Dust emissions from tailings surface post-deposition impacts adjacent vegetation.	In-pit TSFs	• Dry tailings surface is frequently disturbed. • Tailings do not form a crust post-deposition. • Wind erosion.	**Context** If left undisturbed, tailings surfaces tend to form crusts and hence, their susceptibility to wind erosion is low. In addition, the level of tailings becomes progressively lower below the pit crest as consolidation occurs, reducing wind exposure. **Impacts** Dust deposition on surrounding vegetation with impacts to visual amenity. Dust would be removed in the following wet season.	2	Possible	Low	• A tailings management plan provides for active management between the end of deposition and closure (Sections 7.3.2.3 and 9.2.1.3). • Overburden cover of suitably competent material constructed over the tailings at closure (Sections 5.16.4 and 9.2.1.3).	1	Unlikely	Very Low	C3.1	Progressive review and refinement of closure designs for the De Grey and Swan in-pit TSFs based on: • Consolidation modelling for the DPS (in progress) and subsequent monitoring and model validation during operations. • Review of options to enhance tailings settlement and drainage to reduce the timeframe over which closure works can be safely executed. • Cover material characteristics.

Risk ID	Risk Event (Source & Pathway)	Domain / Feature	Causes	Impact to Receptors	Inherent Risk			Controls (Treatment)	Residual Risk			Completion criteria	Improvement Activity
					Consequences	Likelihood	Risk		Consequences	Likelihood	Risk		
R4	Geotechnical instability causes failure of OSA into pit or to adjacent land area.	OSAs	• Inadequate overburden characterisation. • Mine planning schedules do not consider overburden destination based on overburden material characteristics. • OSA is located within the zone of instability (ZOI) of the pit. • Landform is not constructed to design. • Failure modes not assessed or inadequately assessed. • Flood waters undermine the toe of the OSA and cause slumping.	**Context** East OSA is in the ZOI of the Swan pit. Most of the South Jimblebar OSAs lie in the 1:10,000-year flood plain, as do the PC03 ROM, BB06, BC06 and BN07 OSAs, and some areas of WHASH and H234 OSAs (Sections 5.6.2 and 5.11.1.4). **Impacts** • Visual impact of failed area. • Failure of OSA compromises measures for preventing inadvertent access and leads to third party injury or fatality. • Failed landform impacts on surrounding vegetation or rehabilitation area. • Failed area impedes flow or changes surface flows. • Sediment from failed landform is transported to receptors (Orebody 31 / Copper / Jimblebar creeks / Innawally Pool). *Note: the potential for fatalities or injury has been assessed under Risk R18 and is excluded from this assessment.*	3	Possible	Moderate	• Pit wall stability assessments (Section 5.6). Where failure of pit walls may impact nearby infrastructure (e.g., abandonment bunds / OSAs / flood bunds), buttressing or backfill may be considered. Consideration may also be given to relocation of the impacted landform (Section 7.5.4and 9.2.2). • OSAs are designed to achieve a FoS ≥1.5. • Use of ISAs, where possible (Sections 7.5.4 and 9.2.2), minimises failure risk associated with ex-pit OSA footprints. • Flood modelling is conducted (and updated as the mine footprint changes) to inform landform placement and design. Flood protection is provided if required (Sections 5.11.1.4, 5.16.3 and 9.2.3.4). • Geological model (highlights fault zones) and geotechnical model informs pit design (Section 7.5.4). • The Master Area design review process identifies pit setbacks and enables verification that closure design guidance has been incorporated into mine plans (Section 7.5.4). • Compliance to plans is assessed and rehabilitation works include construction supervision and post-construction inspections (Section 7.5.4).	3	Unlikely	Low	C3.2	As the site approaches closure, conduct detailed mine void stability analysis to: • Identify the need for controls such as buttressing or backfill. • Inform the location of abandonment bunds. • Determine the final location of permanent infrastructure.

Risk ID	Risk Event (Source & Pathway)	Domain / Feature	Causes	Impact to Receptors	Inherent Risk			Controls (Treatment)	Residual Risk			Completion criteria	Improvement Activity
					Consequences	Likelihood	Risk		Consequences	Likelihood	Risk		
R5	AMD release from PAF within OSAs and low-grade stockpiles remaining at closure impacts groundwater and / or surface water quality.	OSAs at OB17, OB18, OB31, WH4, H234, South Jimblebar	• Inadequate overburden characterisation. • Mine planning schedules do not consider overburden destination based on overburden material characteristics. • Final landform design is ineffective (e.g., encapsulation, store-and-release system does not perform as anticipated. Causes could include cover inadequately limits airflow and water infiltration, climate change affects performance, landform erodes or there is foundation failure). • Landform and PAF placement are not substantially in accordance with designs. • Failure of the constructed landform.	**Context OB17/18/31 - Risk R5** There are no ex-pit PAF storage cells at OB17/18 and one at OB31. However, the OB31 AMD source hazard is low; less than 0.1% of the overburden is predicted to be PAF (AMD 1, 2 or 3) (Sections 5.3.2 and 7.5.1.1). **Context Jimblebar - Risks R5 and R6** The source AMD hazards associated with WH4, H234 and South Jimblebar are low (R5) and WH123, WHASH and East Jimblebar moderate or high (R6) (Section 5.3.2). There is a designated ex-pit PAF storage location at WH123 (Section 7.5.1.1) (R6). **Context all - Risks R5 and R6** The potential for saline and neutral metalliferous drainage has been assessed as low (R5 & R6) (Section 5.3.2). **Impacts** • Impacts to groundwater and surface water quality from low source hazard OSAs (R5) are expected to be localised and minor. • Moderate to high source hazard OSAs (R6) could cause: - Low impacts (minor decline in population numbers) on local stygofauna in the immediate vicinity of the mine, although given the depth to groundwater, the Jimblebar Hub does not represent a significant habitat for stygofauna (Section 5.9.3.2). - Potential localised impacts to Jimblebar Creek (e.g., minor pH drop, weakly elevated metals and salinity (sulphates)). - Some localised degradation of vegetation along drainage lines from the toes of OSAs containing PAF material. • Should PAF material be stored in the WHASH W55 OSA (not currently constructed), AMD could impact Innawally Pool (R6). • Regionally, groundwater and surface water would not be expected to show a decrease in pH or elevated metals due to attenuation and neutralisation. Moderate to high source hazard OSAs (R6) are located at Jimblebar where regional groundwater flows to the west are constrained by the Wheelarra Fault (Section 5.11.2.3).	2	Unlikely	Very low	• Materials characterisation information is incorporated into mining models (Section 5.3.1). • Geochemical testing and AMD risk assessment conducted (Section 5.3.2). • Management of PAF material within designated locations in OSAs using suitable techniques to minimise the potential for AMD generation (Section 7.5.1). • PAF cover trials and research (Section 5.16.1). • WAIO standards and procedures (Section 7.5.1). - AMD Management Standard (WAIO, 2022a). - BHP Global Mined Materials Management Standard (BHP, 2021a). - Reactive Ground and AMD Potential: Mining Design and Dumping Procedure (WAIO, 2021). - Reactive Ground and Associated Gases Procedure 0129611 (WAIO, 2020d). - Mines Closure Design Guidance Procedure (WAIO, 2022f) outlines the framework for reactive overburden management. - Preliminary AMD Risk Assessment Procedure 0132980 (WAIO, 2017b). - Rehabilitation Planning and Execution Procedure (WAIO, 2023c). • Assessment of compliance to plan (Section 7.5.1). • Conceptual and numerical groundwater modelling, calibrated with observations of groundwater behaviour during dewatering (Sections 5.11.2 and 5.16.5). • Pre-closure monitoring including monitoring of surface water and groundwater (Sections 10.1.5, 10.1.7 and 10.1.8).	2	Highly unlikely	Very low	C3.3 C5.2 C5.4	• As part of a BHP-wide geochemical program, further investigations will be conducted into the geochemical hazards associated with: - AMD 2 and 3 materials. - Leach test wok to assess metal mobilisation under variable environmental conditions. • BHP is reviewing OSAs / ISAs across the Pilbara based on storage of AMD 1 overburden to identify priorities for monitoring.
R6		OSAs at WH123, WHASH and East Jimblebar			3	Possible	Moderate		3	Unlikely	Low		

Risk ID	Risk Event (Source & Pathway)	Domain / Feature	Causes	Impact to Receptors	Inherent Risk			Controls (Treatment)	Residual Risk			Completion criteria	Improvement Activity
					Consequences	Likelihood	Risk		Consequences	Likelihood	Risk		
R7	AMD release from PAF within ISAs remaining at closure impacts groundwater.	ISAs at OB31, H234, South Jimblebar	• Inadequate overburden characterisation. • Mine planning schedules do not consider overburden destination based on overburden material characteristics. • Final landform design is ineffective (e.g., encapsulation, store-and-release system does not perform as anticipated. Causes could include cover inadequately limits airflow and water infiltration, climate change affects performance, landform erodes or there is foundation failure). • Landform and PAF placement are not substantially in accordance with designs. • PAF material is incorrectly placed with respect to groundwater level, or groundwater level predictions are inaccurate. • Failure of the constructed landform.	**Context OB17/18/31 - Risk R7** AMD source hazard at OB31 is low (R7). The AMD source hazard associated with the OB17/18 operations is low (R7). PAF material has been stored in designated areas Above Water Table (AWT) in Avon and Blackwood pits (Sections 5.3.2 and 7.5.1.1). **Context Jimblebar - Risks R7 and R8** There are currently designated PAF storage locations AWT in WH4 and WH123 pits (R8) (Section 7.5.1.1). WH123, WHASH and East Jimblebar represent moderate or high source hazards (R8) (Section 5.3.2). The source hazards associated with overburden from WH4, H234 and South Jimblebar are low (R7) (Section 5.3.2). **Context all - Risks R7 and R8** The potential for saline and neutral metalliferous drainage has been assessed as low (R7 & R8) (Section 5.3.2). **Impacts - Risks R7 and R8** • Impacts to groundwater from low source hazard areas would be expected to be localised and minor (R7). • Moderate to high source hazard ISAs could cause low impacts (minor decline in population numbers) on local stygofauna in the immediate vicinity of the mine, although given the depth to groundwater, the Jimblebar Hub does not represent a significant habitat for stygofauna (R8) (Section 5.9.3.2). • Impacts to Ethel Gorge TEC would not be expected due to: - Distance, low hydraulic gradient and flow barriers between OB17/18/31 and the TEC (R7) (Sections 5.11.2, 7.3.2.2 and 7.3.3). - Wheelarra Fault which acts as a flow barrier between Jimblebar and the TEC (R7 & R8) (Sections 5.11.2, 7.3.2.2 and 7.3.3). • The depth to groundwater means no connection with surface water or Innawally Pool (R7 & R8) (Sections 5.11.2, 7.3.2.2 and 7.3.3).	2	Unlikely	Very Low	• Materials characterisation information is incorporated into mining models (Section 5.3.1). • Geochemical testing and AMD risk assessment conducted (Section 5.3.2). • Storage of PAF material (Section 5.3.1) in designated locations above the water table to minimise the potential for AMD generation (Section 7.5.1). • PAF cover trials and research (Section 5.16.1). • WAIO standards and procedures (Section 7.5.1). - AMD Management Standard (WAIO, 2022a). - BHP Global AMD Management Standard (BHP, 2021a). - Reactive Ground and AMD Potential: Mining Design and Dumping Procedure (WAIO, 2021). - Reactive Ground and Associated Gases Procedure 0129611 (WAIO, 2020d). - Mines Closure Design Guidance Procedure (WAIO, 2022f) outlines the framework for reactive overburden management. - Preliminary AMD Risk Assessment Procedure 0132980 (WAIO, 2017b). - Rehabilitation Planning and Execution Procedure (WAIO, 2023c). • Assessment of compliance to plan (Section 7.5.1) • Conceptual and numerical groundwater modelling, calibrated with observations of groundwater behaviour during dewatering (Sections 5.11.2 and 5.16.5). • Pre-closure monitoring including monitoring of groundwater (Sections 10.1.5 and 10.1.8).	2	Highly unlikely	Very low	C3.3 C5.4	• As part of a BHP-wide geochemical program, further investigations will be conducted into the geochemical hazards associated with: - AMD 2 and 3 materials. - Leach test wok to assess metal mobilisation under variable environmental conditions. • BHP is reviewing OSAs / ISAs across the Pilbara based on storage of AMD 1 overburden to identify priorities for monitoring.
R8		ISAs at OB18, WH123, WH4, WHASH and East Jimblebar			2	Possible	Low		2	Unlikely	Very Low		

Risk ID	Risk Event (Source & Pathway)	Domain / Feature	Causes	Impact to Receptors	Inherent Risk			Controls (Treatment)	Residual Risk			Completion criteria	Improvement Activity
					Consequences	Likelihood	Risk		Consequences	Likelihood	Risk		
R9	Impact to groundwater quality from in-pit TSFs	TSF	• Inadequate characterisation of tailings. • Tailings characteristics change over time. • PAF wall rock remains exposed in De Grey pit following tailings deposition and consolidation. • Ponding of water on the tailings and interaction with tailings / PAF wall rock and seepage to groundwater.	**Context** • The tailings are NAF and both the tailings leachate and supernatant have low salinity, nutrients and metal(oid)s (Section 5.4.1). • The PAF wall rock in the Swan pit would be submerged by tailings during operations and post-settlement, thereby reducing the potential for oxidation. Wall rock in the De Grey pit would also be submerged by tailings during operations, and post-settlement, the final tailings level at the deepest part of the pit will be below PAF wall exposures, but a layer of low permeability tailings will remain on the pit walls and benches and cover these exposures (Section 5.16.4.3). **Impacts** • The De Grey pit is not connected to the regional aquifer (Section 5.11.2). There is some connection between the Swan pit and OB31 and any seepage would be captured by the residual drawdown from the OB31 pit (assuming it remains a void). • Should OB31 be backfilled, impacts to Ethel Gorge TEC would not be expected due to the distance, low hydraulic gradient and lack of direct flow path between OB17/18/31 and the TEC (Sections 5.11.2 and 5.16.5.1). • There is the potential for low impacts (minor decline in population numbers) on local stygofauna in the immediate vicinity of the pits. However, the stygofauna population in this area is naturally depauperate (Section 5.9.3).	2	Possible	Low	• Geochemical characterisation of tailings (Section 5.4.1). • Groundwater assessments, calibrated with observations of groundwater behaviour during dewatering and TSF operation (Section 5.11.2, 5.16.4 and 5.16.5). • Monitoring of groundwater during tailings deposition (Section 10.1.11). • Tailings cover PAF wall rock exposures. The tailings cover design prevents erosion of tailings layer covering these exposures (Section 5.16.4). • Closure design of surrounding landforms reduces the catchment for run-off onto the tailings, thereby preventing permanent ponding on the closed TSF landform (Section 5.16.4).	2	Possible	Low	C3.3 C5.4	• Updates to consolidation modelling (DPS in progress) and subsequent monitoring and model validation during operations. • Seepage modelling (in progress) and pre-closure monitoring of groundwater to confirm / refine groundwater impact assessment. • Review of alternate cover systems to investigate the impacts of different designs and material characteristics on final closure outcomes.

Risk ID	Risk Event (Source & Pathway)	Domain / Feature	Causes	Impact to Receptors	Inherent Risk			Controls (Treatment)	Residual Risk			Completion criteria	Improvement Activity
					Consequences	Likelihood	Risk		Consequences	Likelihood	Risk		
R10	AMD release from pit wall exposures of PAF material impacts pit lake or groundwater quality.	Low source hazard pits - OB17, OB31, WH4, H234	• Inadequate characterisation of wall rock. • PAF wall rock management measures are not constructed as designed. *Note, the risk of a pit lake becoming a temporary through-flow system is addressed in risk R14.*	**Context OB17/18/31 - Risks R10 and R11** The pit wall AMD source hazards at OB17 and OB31 are low (R10). The source hazard at OB18 is high (~5% of total wall rock is PAF) (R11) pre-backfilling (Section 5.3.2). **Context Jimblebar - Risks R10 and R11** Wall rock source hazards are low at WH4, H234 and South Jimblebar (R10), and moderate or high at WH123, WHASH and East Jimblebar (R11) (Section 5.3.2). **Context all - Risks R10 and R11** Acidity generation rates from wall rock are low (Section 5.3.2.2). **Impacts - Risk R11** • In a pit lake scenario for moderate or high source hazard pits (R11), pit lakes may show a pH drop, and / or elevated metals and / or salinity (sulphates) and: - May have a minor impact on migratory fauna that have been detected in the area (Section 5.9.2) and may use anthropogenic water bodies. - Would not be expected to impact surrounding groundwater as pits are predicted to be terminal sinks (Section 5.16.5.2). • In a scenario where high source hazard pits are backfilled, but not to above the AMD 1, 2 or 3 exposures (R11), there may be ongoing production of solutes which enter the local groundwater system: - There may be impacts to adjacent stygofauna, although given the depth to groundwater, the Jimblebar Hub does not represent a significant habitat for stygofauna (Section 5.9.3.2). - Regionally, groundwater and surface water would not be expected to show a decrease in pH or elevated metals due to attenuation and neutralisation and low acidity generation rates from wall rock. - Impacts to the Ethel Gorge TEC would not be expected due to: ▪ Distance, low hydraulic gradient and partial flow barriers between OB17/31 and the TEC (Section 5.11.2). ▪ Isolation of De Grey pit from the regional aquifer (Section 5.11.2). ▪ Wheelarra Fault which acts as a flow barrier between Jimblebar and the TEC (Section 5.11.2). - The depth to groundwater means no connection with surface water or Innawally Pool (Section 7.3.3.4).	2	Unlikely	Very Low	• Geochemical testing and AMD risk assessment conducted (Section 5.3.2). • Below water table voids at OB17/18 will be backfilled with overburden (to 5 m above the water table), or tailings and no pit lake will persist (Section 7.3.2.2). • If the Swan and De Grey pits are used for in-pit storage of tailings, PAF wall rock exposures will be covered by tailings and associated cover system (Sections 5.16.4 and 9.2.1.3). If backfilled with overburden to 5 m above the pre-mining water table (instead of tailings), PAF wall rock exposures may remain above the level of backfill in De Grey pit. Further backfill or buttressing to cover these exposures may be considered if assessments indicate that there may be impacts that require management (Section 7.5.1.2). • The backfill strategy for Jimblebar is continually reviewed with the progressive closure philosophy focusing on progressively backfilling into mined out voids with overburden or tailings which is expected to minimise pit lakes (Section 9.2.1.1). • WAIO standards and procedures (Section 7.5.1): - AMD Management Standard (WAIO, 2022a). - BHP Global AMD Management Standard (BHP, 2021a). - Reactive Ground and Associated Gases Procedure 0129611 (WAIO, 2020d). - Mines Closure Design Guidance Procedure (WAIO, 2022f). - Preliminary AMD Risk Assessment Procedure 0132980 (WAIO, 2017b). • Conceptual and numerical groundwater modelling, calibrated with observations of groundwater behaviour during dewatering (Section 5.11.2 and 5.16.5). • Pre-closure monitoring including monitoring of groundwater (Sections 10.1.5 and 10.1.8).	2	Unlikely	Very low	C3.3 C4.6 C5.4	• Further assessment will be conducted of the short- and long-term risks associated with wall rock exposures of PAF material above the level of backfill / to pit lakes, and implications for closure including the need to manage PAF wall rock exposures. • As the backfill strategy for Jimblebar evolves, assess the potential impacts of pit lakes that may remain post-closure.
R11		High to moderate source hazard pits - OB18, WHASH, East Jimblebar			2	Possible	Low		2	Possible	Low		

Risk ID	Risk Event (Source & Pathway)	Domain / Feature	Causes	Impact to Receptors	Inherent Risk			Controls (Treatment)	Residual Risk			Completion criteria	Improvement Activity
					Consequences	Likelihood	Risk		Consequences	Likelihood	Risk		
R12	Mine voids have unacceptable impacts on groundwater levels at key receptors.	BWT Pits	• Evaporation from open voids draws down groundwater levels. • Inadequate understanding of hydrogeology and / or inadequate sensitivity testing within predictive assessments (e.g., climate scenarios, regional cumulative impacts).	**Context OB17/18/31** OB17/18 will be backfilled with overburden or tailings to above the pre-mining groundwater level and consequently groundwater levels are predicted to recover. If OB31 remains a pit lake at closure, the groundwater level will be significantly lower (tens of metres) than the pre-development groundwater level at this location (Section 5.16.5). Groundwater mounding will occur in the vicinity of the TSFs, however, the mounding will dissipate following cessation of operations (Section 7.3.2.2). **Context Jimblebar** Groundwater levels are expected to remain 100 to 200 m below pre-mining levels in the vicinity of the pits following groundwater recovery (Section 5.16.5). **Impacts** • No impacts to Innawally Pool are predicted from regional groundwater drawdown as the perched aquifer feeding the pool is recharged from surface water flows and is hydraulically disconnected from the regional groundwater system (Sections 5.11.3.2 and 7.3.3.4). • The Jimblebar pits will not impact on Ethel Gorge TEC due to the Wheelarra Fault flow barrier and there is not expected to be a material impact to third party groundwater users (Section 7.3.2.2). • Drawdown from OB31 is unlikely to impact Ethel Gorge TEC given the leaky flow barriers and rate of recharge in the Ethel Gorge area (Section 5.16.5.1).	3	Unlikely	Low	• Below water table voids at OB17/18 will be backfilled with overburden (to 5 m above the water table) or tailings (Section 7.3.2.2). • Other pits will be backfilled to above the water table if unacceptable impacts are identified from groundwater modelling (Section 7.5.2). • East OSA adjacent to the Swan and De Grey in-pit TSFs would be shaped to direct run-off away from the TSFs to prevent permanent ponding on the closed landforms (Sections 5.16.4 and 9.2.1.3). • Conceptual and numerical groundwater modelling inform the pit closure strategy and assessment of impacts on ecohydrological receptors (Sections 5.11.2, 7.3.2.2 and 7.5.2). • Modelling includes sensitivity testing (Section 5.16.5). • Eastern Pilbara Water Resource Management Plan and Jimblebar Water Management Plan (Section 7.5.2). • Pre-closure monitoring of groundwater enables groundwater modelling to be refined (Sections 10.1.5 and 10.1.8).	3	Unlikely	Low	C5.3	• The closure strategies for below water table pits will be reviewed in the light of future operational decisions and refinements in groundwater modelling as new information becomes available through the pre-closure groundwater monitoring program. • The closure strategy for the in-pit TSFs will be reviewed and refined based on pre-closure monitoring of groundwater.

Risk ID	Risk Event (Source & Pathway)	Domain / Feature	Causes	Impact to Receptors	Inherent Risk			Controls (Treatment)	Residual Risk			Completion criteria	Improvement Activity
					Consequences	Likelihood	Risk		Consequences	Likelihood	Risk		
R13	Impact to groundwater quality from open mine void that becomes a temporary groundwater through-flow system.	Pits within floodplains - South Jimblebar, H234, WHASH, East Jimblebar, OB31	• Failure of operational surface water controls or pit walls results in creek capture and surface water run-off to pit that cause pit lake levels to rise to the level of surrounding groundwater allowing temporary through-flow. • Inadequate understanding of hydrogeology and / or inadequate sensitivity testing within predictive assessments (e.g., climate scenarios).	**Context OB17/18/31** The OB31 footprint intersects the OB31 Creek floodplain and, without controls, portions of the creek may be captured. Flood bunds have been constructed (and will be extended) for operations. OB31 pit represents a minor AMD source hazard. **Context Jimblebar** Without controls, several South Jimblebar pits, and small areas of WHASH and H234 pits intersect floodplains. East Jimblebar intersects a tributary of Jimblebar Creek with a small catchment area. Except for East Jimblebar, flood bunds / diversions will be constructed for operations. South Jimblebar and H234 pits are low AMD source hazards. WHASH and East Jimblebar pits are high source hazards. **Impacts** • The pit lakes are expected to remain sinks with no impacts to surrounding groundwater quality (Section 5.16.5.2). If the pit lakes become temporary or permanent through-flow systems, there is the potential for localised impact to groundwater (e.g., minor pH drop, some weakly elevated metals and / or salinity). Any temporary through-flow would be expected to be re-captured by the drawdown from the pits once pit lake levels recede. Regionally, groundwater would not be expected to show an increase in pH or elevated metals due to attenuation and neutralisation. • There may be low impacts (minor decline in population numbers) on local stygofauna, but the Jimblebar Hub does not represent a significant habitat (Section 5.9.3). • Impacts to Ethel Gorge TEC would not be expected due to distance, low hydraulic gradient and partial flow barriers between OB31 and the TEC (Section 5.11.2) and Wheelarra Fault flow barrier between Jimblebar and the TEC (Section 5.11.2). • The depth to groundwater means no connection with surface water or Innawally Pool (Section 7.3.3.4).	2	Unlikely	Very Low	• Pit wall stability assessments inform closure designs (Sections 5.6 and 7.5.4). • Flood bunds / diversions will be located outside the ZOI of the pits, or pits will be backfilled / buttressed to achieve an appropriate Factor of Safety (FoS) (Sections 7.5.3 and 7.5.4). • Closure is considered during the operational design of flood bunds / diversions. These features will be upgraded for closure (Sections 5.16.3.2, 7.5.3 and 9.2.1). • Surface water assessment and modelling to inform closure strategy (Sections 5.16.3.2 and 7.3.2.1). • Geochemical testing and AMD risk assessment conducted (Section 5.3.2).	2	Very Unlikely	Very low	C3.2 C5.4	As the site approaches closure: • Conduct detailed mine void stability analysis to identify the need for additional controls such as buttressing or backfill. • Develop closure designs for flood bunds and diversions.

Risk ID	Risk Event (Source & Pathway)	Domain / Feature	Causes	Impact to Receptors	Inherent Risk			Controls (Treatment)	Residual Risk			Completion criteria	Improvement Activity
					Consequences	Likelihood	Risk		Consequences	Likelihood	Risk		
R14	Post-closure landform impacts surface water flows beyond the parameters accepted by project approvals.	Surface water management infrastructure, OSAs, mine voids	• Inadequate flood protection results in creek capture due to: - Failure to upgrade operational bund / diversion for closure conditions. - Ineffective closure flood bund / diversion design arising from inadequate modelling of post-closure flood conditions (e.g., regional cumulative influences poorly accounted for) or inadequate sensitivity testing (e.g., to accommodate climate change). - Flood bund / diversion is not constructed in accordance with design. - Failure of the flood bund / diversion due to erosion caused by selection of inappropriate construction materials or inadequate materials characterisation. - Failure of the flood bund / diversion due to pit wall instability. • Closure landforms reduce: - Creek flows beyond approved levels, and alluvial recharge that supports riparian communities and Innawally Pool. - Sheet-flow to Mulga communities beyond that approved.	**Context** The estimated reduction in Jimblebar Creek catchment upstream of Innawally Pool due to the combined operations at OB31 and Jimblebar (including the proposed East Jimblebar development), is ~23% and is not considered significant on a local or regional scale given the highly seasonal nature of streamflow in the Pilbara (Section 7.3.2.1). Several operational flood bunds / creek diversions have been constructed or are proposed to prevent flood waters from entering pits during operations. **Impacts** Creek capture by mine voids or reduction in surface water flows and alluvial recharge due to other mine landforms has the potential to impact: • Riparian vegetation communities (Section 5.11.3.5). • Sheet-flow dependent Mulga communities (Section 5.11.3.6). • Innawally Pool which is a place of cultural significance (Section 5.11.3.2).	4	Possible	High	• Surface water assessment and modelling to inform closure strategy and post-closure surface water management designs (Sections 5.16.3.2 and 7.3.2.1). • Modelling includes sensitivity testing and consideration of climate change (Section 7.5.3). • Flood bunds and diversions are constructed to prevent creek capture by mine voids and to maintain flows of significant creek lines around mine infrastructure / landforms (Sections 5.16.3 and 7.3.2.1). • Closure is considered during the operational design of flood bunds / diversions which will be upgraded to accommodate closure conditions in accordance with the risk associated with each structure (Sections 5.16.3.2, 7.5.3 and 9.2.3.4). • The Hashimoto 2/3 and WHASH pits have been designed to avoid the 1:10,000-year flood plain (Section 7.3.2.1). • Significant creek realignments will be designed to achieve comparable hydraulic and geomorphological characteristics to the original creek systems (Section 7.5.3 and 9.2.3.4). • Materials characterisation informs construction materials selection (Section 5.3.3). • Flood bunds / diversions will be located outside the ZOI of the pits, or pits will be backfilled / buttressed to achieve an appropriate Factor of Safety (FoS) (Sections 7.5.3 and 7.5.4). • Master Area design review process to verify that closure design guidance has been incorporated (Section 7.5.3).	4	Unlikely	Moderate	C3.2 C5.1	As the site approaches closure: • Conduct detailed mine void stability analysis to identify the need for additional controls such as buttressing or backfill. • Develop closure designs for flood bunds and diversions. As mining progresses and further creek diversions are required, hydrological studies will be carried out, impacts assessed, and appropriately designed infrastructure developed.

Risk ID	Risk Event (Source & Pathway)	Domain / Feature	Causes	Impact to Receptors	Inherent Risk			Controls (Treatment)	Residual Risk			Completion criteria	Improvement Activity
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R15	Rehabilitation values do not achieve ecological criteria.	OSAs, pits backfilled to surface, infrastructure, surface water management infrastructure, TSF	• Lack of topsoil or suitable alternate growth medium for establishing and sustaining native vegetation. • Incorrect species selection or viable provenance seed unavailable for seeding at completion of earthworks. • Limited seed available in growth media applied to project area. • Poor or no germination / establishment following seeding. • Climate change and prolonged periods of drought during crucial growth phases or above average fire frequency post establishment. • Excessive weed infestation displaces native species. • Feral animals. • Return of fauna habitat is not considered in rehabilitation plans. • Rehabilitation earthworks are not executed to standard or as defined in the project work pack. • Landform failure or AMD (see Risks R1 to R6). • Third party activities on the land are outside the closure design parameters.	• Impact to surrounding native vegetation communities through uncontrolled weed spread (invasive species). • Potential impact to post-mining land use capacity or capability. • Minor visual amenity impacts e.g., dust or bare areas. • Return of fauna delayed due to lack of habitat.	3	Possible	Moderate	• Topsoil reconciliation and overburden characterisation for use as growth media (Section 5.5). • Progressive rehabilitation and associated monitoring and feedback loops (Sections 7.5.6and 9.3.1). • Growth media trials (Appendix F). • Rehabilitation (Sections 7.5.6 and 9.1) implemented generally in accordance with: - Rehabilitation Standard (WAIO, 2020a). - Rehabilitation Planning and Execution Procedure (WAIO, 2023c). - Management of Growth Media for Rehabilitation Procedure (WAIO, 2020c). - Seed Management Procedure (WAIO, 2022e). - Weed Management Procedure (WAIO, 2020b). • Research on rehabilitation (Section 5.16.6 and Appendix F). • Use of local provenance seed (Sections 7.5.6 and 9.1.3). • Opportunities to provide habitat for fauna are considered during rehabilitation (Sections 7.5.6 and 9.2.2.1).	2	Unlikely	Very low	C4.1 C4.2 C4.3 C4.4 C4.5	• Ongoing identification of potential growth media sources to address the topsoil deficit as landforms are progressively rehabilitated. • Utilise the results of seed and tube stock research / trials and work with the Nyiyaparli rehabilitation team to inform the revegetation strategy. • Identify appropriate species for use in rehabilitation of pits with backfill to surface. • Watching brief on research associated with the appropriate use of out of provenance seed sources to increase genetic diversity to provide resilience to climate change. • Investigate locations which may be available for a minimum of 5 years for use in rehabilitation / landform trials. • Continue to review and refine completion criteria and integrate findings from ongoing research and development programs including landform trials, rehabilitation monitoring programs, and consultation with stakeholders. • Review: - Opportunities for providing habitat for conservation significant species during rehabilitation. - Early opportunities to rehabilitate the northern side of the OB31 OSA to minimise impacts to the adjacent Priority 1 flora species.
R16	Impact to visual amenity post-mining.	All	• Key stakeholders are not identified and included in consultation program. • Post-mining visual performance objectives and completion criteria are not informed by key stakeholders or unrealistic completion criteria are defined. • Landform failure (see Risks R1 to R4). • Vegetation fails (see Risk R15). • Rehabilitation earthworks not executed to standard or as defined in the project work pack.	• Visual impact assessments indicate that the visual impacts of Jimblebar Hub would be low to negligible (Section 5.13). However, these assessments have not considered how the context of a closed site might change perceptions. *Note: visual amenity impacts to Traditional Owner values are rated as risk R17.*	2	Possible	Low	• Visual impacts, design constraints and solutions will be discussed with stakeholders, where visual impact is a key concern (Section 7.5.4). • WAIO Rehabilitation Strategy (Section 7.5.6). • WAIO Rehabilitation Standard (WAIO, 2020a). • Infrastructure will be removed, and the footprint rehabilitated unless transferred to a third party post-closure.	2	Unlikely	Very low	C3.1	• Consultation with stakeholders. • Consider the visual impacts of post-closure landforms during the detailed design phase.

Risk ID	Risk Event (Source & Pathway)	Domain / Feature	Causes	Impact to Receptors	Inherent Risk			Controls (Treatment)	Residual Risk			Completion criteria	Improvement Activity
					Consequences	Likelihood	Risk		Consequences	Likelihood	Risk		
R17	Traditional owner values not achieved post-mining.	All	• Traditional Owners are not identified or consulted. • Earthworks on closure landforms impact heritage sites. • Visual aspects of landforms or other aspects of closure designs impact on cultural values. • Access to key areas of country post-mining, including to significant sites, is not possible or has not been adequately considered in closure designs. • Landform failure (see Risks R1 to R4). • Vegetation fails (see Risk R15). • Vegetation does not include species of cultural significance. • Return of fauna habitat is not considered in rehabilitation plans. • Unusable pit lakes remain at closure. • Rehabilitation earthworks not executed to standard or as defined in the project work pack. • Excessive weed infestation displaces native species (see Risk R15). • Cultural Heritage Management Plan commitments (e.g., repatriation of cultural artefacts) are not adequately met at closure.	• Impact to Traditional Owner values.	3	Possible	Moderate	• Consultation with Traditional Owners to develop closure strategies to address heritage and cultural values which could include, but not necessarily be limited to (Sections 4.2, 7.5.8 and 9.1.4): - Closure landform designs. - Pit closure strategies. - Maintaining access to sites of significance. - Repatriation of artefacts. - Post-closure land uses and creation of special places in rehabilitation. • WAIO Rehabilitation Strategy (Section 7.5.6). • WAIO Rehabilitation Standard (WAIO, 2020a). • Seed mixes contain culturally significant species (Section 7.5.6 and Appendix J). • Backfill strategy and post-mining land use planning (Sections 6, 7.5.8 and 9.2.1.1). • Archaeological and ethnographic surveys (Sections 5.14 and 7.5.8). • Consultation program (Sections 4.2 and 7.5.8) • Disturbance for closure execution activities to be approved through Project Environmental and Aboriginal Heritage Review (PEAHR) process (Sections 7.5.8 and 9.1.4).	2	Unlikely	Very low	C7.1	• Consultation with Traditional Owners. • Assess options for post-mining uses of pit lakes. • Consider the Nyiyaparli people's principles for closure in the development of the backfill strategy for Jimblebar Hub and landform designs. • Utilise the results of seed and tube stock research / trials and work with the Nyiyaparli rehabilitation team to inform the revegetation strategy. • Research program to investigate fauna habitat and the return of fauna to rehabilitated areas, including consideration of key species of significance to the Nyiyaparli people.

Risk ID	Risk Event (Source & Pathway)	Domain / Feature	Causes	Impact to Receptors	Inherent Risk			Controls (Treatment)	Residual Risk			Completion criteria	Improvement Activity
					Consequences	Likelihood	Risk		Consequences	Likelihood	Risk		
R18	Site safety measures fail or are inadequate at closed site or pit.	All	• Public curiosity / interest in closed mine sites results in the deliberate breach of well controlled security measures. • Security measures are not in place (fence, gate, signage, abandonment bunds) or are not inspected and maintained prior to relinquishment. • Security measures are inadequate or ineffective. • Inadequate community engagement. • Inadequate infrastructure removal planning and / or execution to plan. • Leaving behind attractive features (e.g., pit lakes, high walls, tyre dumps, scrap metal yards) not planned for public access. • Abandonment bund failure caused by: - Incorrect location (e.g., near pit wall unconsolidated material) which is inconsistent with DEMIRS Guidelines. - Inappropriate design (e.g., climate change or closure time frames not considered, or pit wall not geotechnically stable due to a negative influence of the pit lake water level). - Final pit wall and abandonment bund not built to design or plan. • Uncontrolled access to potential hazards such as AMD or fibrous material (e.g., fibrous or PAF materials are released due to erosion).	• Minor environment impacts from illegal dumping of materials / items (e.g., abandoned vehicles etc). • Community injury or fatality arising from uncontrolled access to mine void or other hazardous area.	4	Possible	High	• Design and install reasonable duty of care control measures such as fencing, signage and abandonment bunds conforming to DEMIRS guidance (DoIR, 1997) and the outcomes of recent consultation with DEMIRS on abandonment bunds (Section 7.5.4, 9.1.7 and 9.2.3). • Overburden characterisation information is incorporated into mining models (Sections 5.3 and 7.5.7). • Pit wall stability assessments inform abandonment bund locations (Sections 5.6.2 and 7.5.7). Where pit walls do not allow abandonment bunds to be located outside the ZOI, buttressing may be considered (Section 7.5.7). • Geological model (highlights fault zones) (Section 7.5.7). • Geotechnical pit model informs pit design (Section 7.5.7). • Regular monitoring and maintenance of security measures during the post-closure monitoring and maintenance period (Section 10.1.12). • If not being transferred to a third party post-closure, infrastructure will be removed to a depth of 0.6 mbgl unless a risk assessment indicates that removal to a greater depth is required, or a different standard is agreed with stakeholders (Sections 7.5.7 and 9.2.3). • Final landform design engineering to allow for sustainable safe access to places of agreed Traditional Owner significance and to accommodate the post-mining land use (Section 7.5.7 and 9.1.7). • Mines Closure Design Guidance Procedure (WAIO, 2022f) includes guidance on abandonment bunds and fibrous materials (Section 7.5.4). • Master Area Design Review Process (Section 7.5.4). • Assessment of compliance to plan (Section 7.5.4). • AMD is controlled as outlined in Risks R5 to R8 and R10 to R11. • Fibrous material will be covered by 1 m of inert (non-fibrous) overburden (Section 7.5.7).	4	Highly unlikely	Low	C2.1 C3.2	• Detailed slope stability analysis and assessment of potential interactions with flood bunds / diversions will inform final abandonment bund locations for mine voids remaining at closure (Sections 7.5.7 and 9.2.1.2). • Consultation with stakeholders on post-mining land uses and safe access (Sections 4.2 and 7.5.7). • Development of detailed decommissioning and demolition plans (Section 7.5.7).

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R19	Land / infrastructure condition is not suited to the post-closure land use.	All	• Post-mining land use performance objectives and completion criteria are not supported by key stakeholders. • Unrealistic completion criteria. • Infrastructure transferred to third parties does not meet agreed condition. • The long-term active management requirements for the site are beyond those required to manage adjacent land with a similar land use.	Potential to impact viability of defined post-closure land use. *Note: risks above identify risks to specific closure objectives (e.g., revegetation, stability, water quality). This risk is specifically focused on impacts likely to arise as a result of failing to consult, remaining infrastructure condition and post-relinquishment active management requirements.*	3	Possible	Moderate	• Consultation with key stakeholders to inform post-mining land use performance objectives and completion criteria (Sections 4.2 and 7.5.8). • Assessment of infrastructure condition and the condition of the infrastructure to be transferred documented in transfer agreements (Section 7.5.7). • Identification of land management requirements through post-closure monitoring and maintenance program (Section 10).	2	Unlikely	Very low	C1.1 C1.2 C1.3	Consultation with post-mining landowners / managers (Sections 4.2 and 6).
R20	Identified areas of contamination have not been managed during operations or the contaminated sites classification under the CS Act is not suitable for the agreed post-mining land use.	Infrastructure	• Contaminated sites are not identified, assessed and remediated during operations. • Incomplete recovery of known contamination or ineffective remedial measures. • Poor hydrocarbon / chemical management during closure execution. • CS Act classification obtained during operations is not suitable for the post-mining land use	• Potential for localised soil, groundwater and surface water contamination. • Regionally groundwater would not be expected to show an increase in contaminants due to attenuation. Impacts to Ethel Gorge TEC are not expected due to distance and low hydraulic gradient between OB17/18 and the TEC and Wheelarra Fault flow barrier (Section 5.11.2). • Potential minor impacts on local stygofauna (minor decline in populations numbers) in the immediate vicinity of the mine. It should be noted that given the depth to groundwater, the Jimblebar Hub does not represent a significant habitat for stygofauna (Section 5.9.3) • Potential to impact viability of defined post-closure land use.	2	Possible	Low	• WAIO Contaminated Sites Register and risk-based schedule for investigation including PSIs and DSIs (Sections 5.12 and 9.1.5). • Pre-closure monitoring enables groundwater and surface water contamination to be identified and remediated if required (Sections 10.1.5 and 10.1.8). • Remediation of known contamination (including PFAS) as required (Sections 5.12 and 9.1.5). • Earthworks for Regrade procedure (WAIO, 2022b) addresses hydrocarbon management. • Demolition and decommissioning plan addresses management of hydrocarbons / chemicals and discovery of unknown contamination during closure execution (Section 9.2.3).	2	Unlikely	Very low	C6.1	• Investigation of suspected contamination targets (Section 5.12). • Remediate known contamination (including PFAS) as required (Sections 5.12 and 9.1.5).

7.5 Management of identified issues

This section summarises the key measures in place to manage the risks outlined in Section 7.4. The closure implementation section (Section 9) describes closure approaches and designs in more detail.

7.5.1 Acid and metalliferous drainage

AMD is a consideration for mine closure if concentrated levels of acidic, metalliferous or saline drainage may be released. Drainage that contains elevated concentrations of sulphuric acid, salts or toxic metals can present a risk to aquatic life, riparian vegetation, ground and surface water or users of these e.g., stock and humans. If the AMD risk is not managed during the life of the mine, it may arise post-closure. In BHP operations, potential sources of AMD include OSAs, ISAs, exposed pit walls and other disturbances.

BHP is committed to managing and mitigating AMD risk using a structured approach, consistent with global leading practice guidelines including International Network for Acid Prevention (INAP) (2014) and Department of Industry, Science and Resources (DISR) (2016c). Management of materials with the potential for AMD across BHP's Pilbara sites is outlined at a high-level in the WAIO AMD Management Standard (WAIO, 2022a). The overall strategy for AMD management is illustrated in Figure 7-5 and considers the full mine life cycle.

The approach shown in Figure 7-5 is a risk-based approach that is refined with increasing knowledge of the geochemical characteristics of overburden material. Specifically, the characterisation stage (Stage 1) informs Stages 2 through 5 which result in OSA designs and mine void management practices aimed at minimising the potential risks associated with AMD.

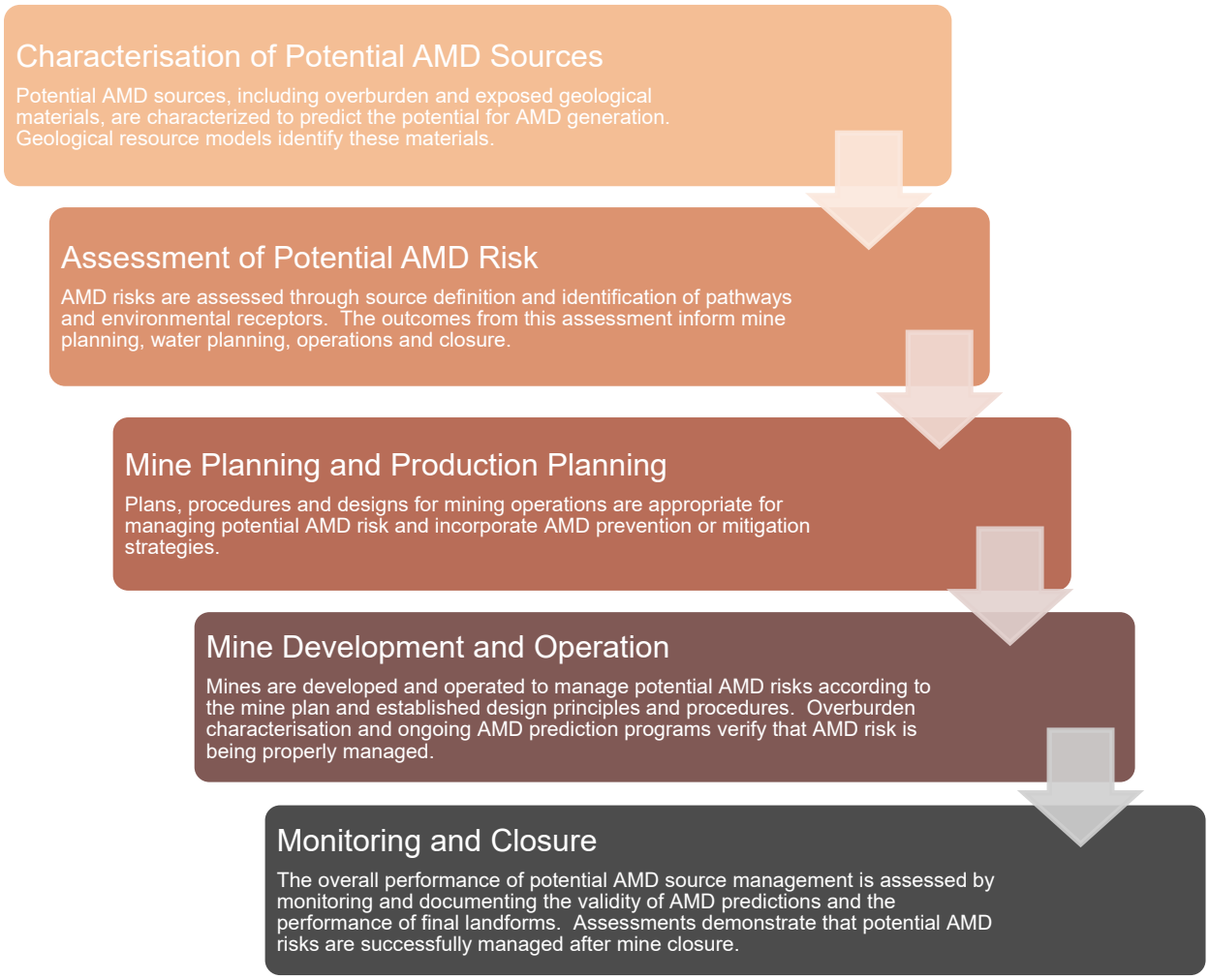


Figure 7-5 WAIO's AMD management process

BHP's process for characterising PAF material and incorporating this into mine planning is outlined in Figure 7-6. Historically, PAF was identified in geological and mine planning block models based on total sulphur content, degree of weathering and lithology, and the focus was on material known to have a high acid generating potential (i.e., unweathered black shales). Improvements have been made to procedures for identifying and coding PAF and other material that may contribute to AMD in geological and mine planning block models. This results in the more accurate documentation of AMD risk and facilitates improvements in tracking and managing overburden material as well as residual risks from material exposed in mine voids.

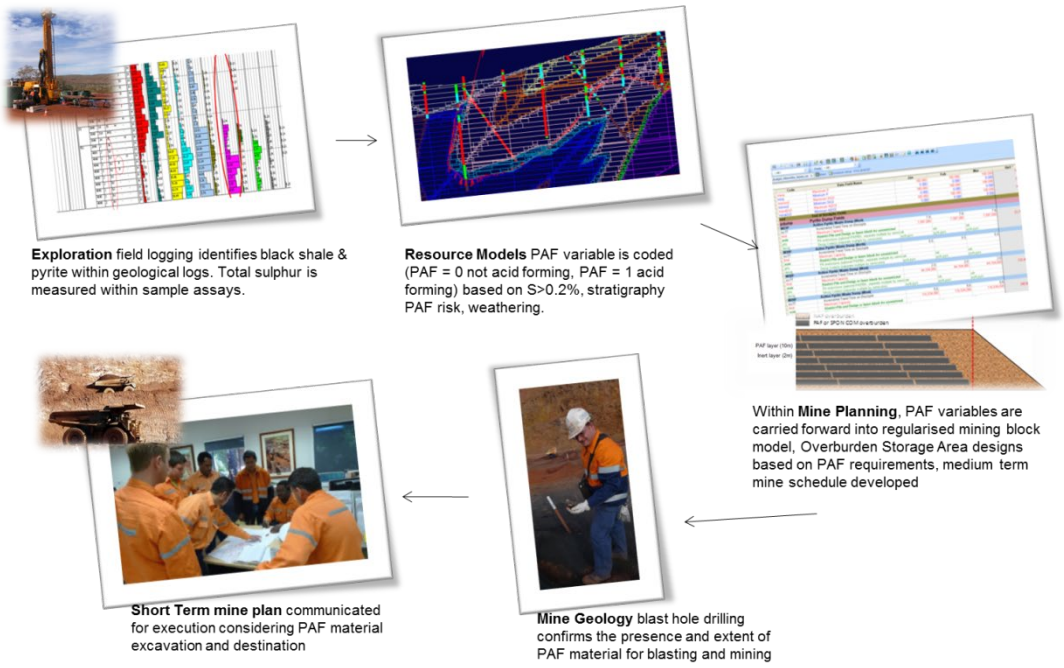


Figure 7-6 PAF management process flow (WAIO's Elearning tool)

BHP utilises the following tools, as required, to characterise and assess AMD risk:

- Exploration resource definition chemical characterisation data.
- Grade control overburden characterisation, verification and sampling.
- Hyperspectral scan mineralogical data.
- Targeted environmental geochemical characterisation programs (exploration phase, resource definition, short term geological drilling, grade control drilling, as applicable).
- AMD risk assessment.
- Hydrogeochemical predictive modelling.

There are a variety of overburden management and mitigation options available for higher risk stratigraphies that have AMD generation potential. Material can be encapsulated, co-disposed with inert or acid neutralising material, disposed sub-aqueously or a combination of options can be applied (Figure 7-7). These options are evaluated on a site-specific basis following the completion of appropriate material characterisation, risk assessment and modelling.

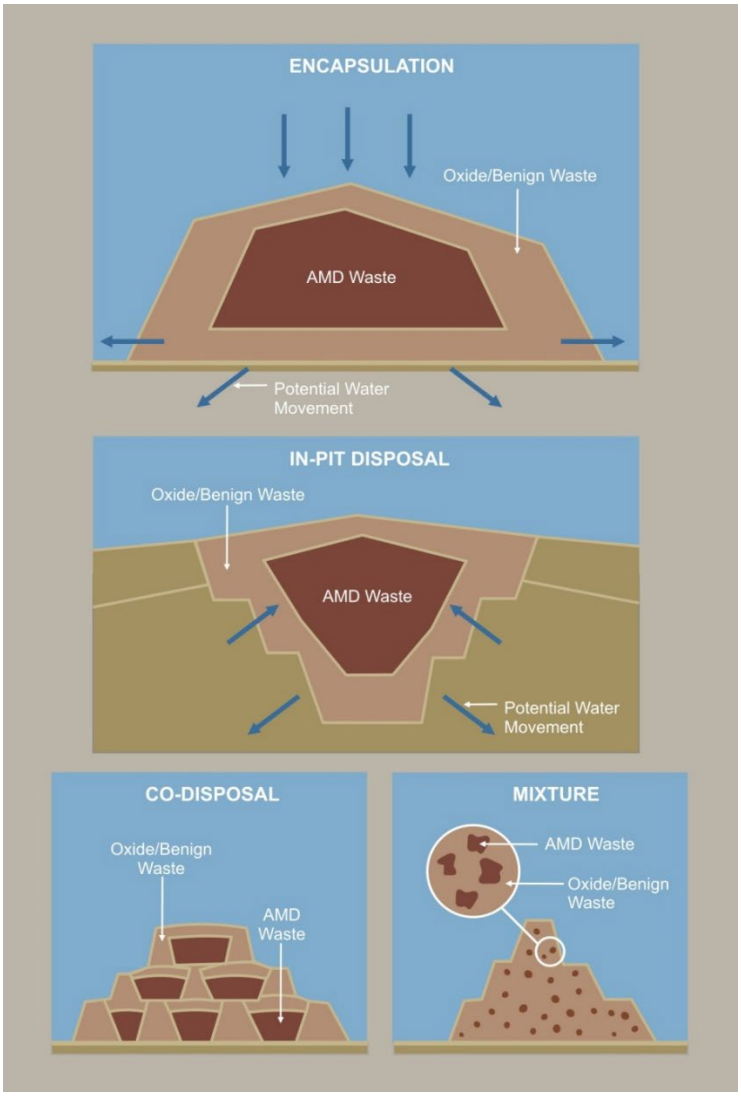


Figure 7-7 WAIO's PAF overburden management strategies (following DISR (2016c))

Based on the findings of the AMD source hazard assessments (Section 5.3.2), the management measures for overburden and wall rock at Jimblebar Hub are described below.

7.5.1.1 Overburden

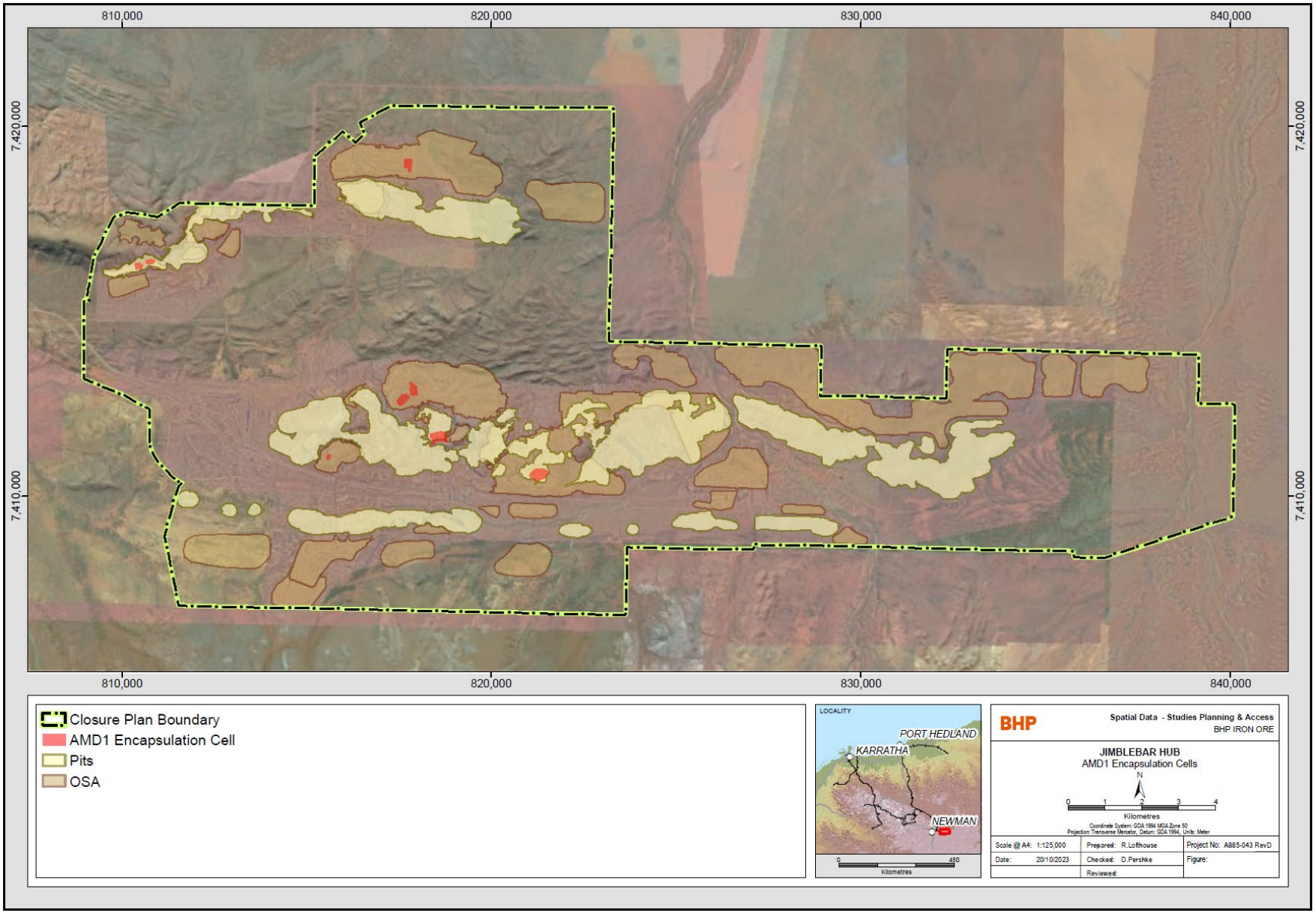
Designated locations for PAF material storage are identified as part of the mine planning process and, if PAF material is confirmed through the Mine Geology blast hole drilling, the short term mine plan directs the PAF material to a designated location.

PAF material mined at Jimblebar Hub has been stored in the following locations (Map 7-5):

- ISAs within the Avon and Blackwood pits at OB18. These pits were mined above the water table.
- OB31 OSA.
- AX12 and AU09 OSAs.
- W33E ISA which is above water table at WH123 and WH4 ISA (BF07) which is also above water table.

AMD 1 material is stored in locations contained toward the centroid of OSAs or ISAs. This is so that there will be sufficient clean inert overburden above any PAF material once the slopes of an OSA / ISA have been regraded. The AMD 1 cells are designed and constructed generally in accordance with leading practice guidance to limit oxygen and water ingress. AMD 1 overburden is paddock dumped in 2 m layers with 2 m of inert material between each layer and 5 m of inert overburden between the AMD 1 cell and surface of the OSA / ISA (Figure 7-8). Where AMD 1 is placed in above water table ISAs, a 5 m buffer of AMD 0 overburden is placed between the AMD 1 materials and the pit walls and floor. These approaches are based on the results from monitoring PAF placement techniques and cover designs at Whaleback since 1997, as described in Section 5.16.1.

AMD 2 and AMD 3 materials are managed according to risk, but are generally placed within OSAs or ISAs such that there is 10 m of inert overburden between these materials and the surface of the OSA / ISA. This depth of inert overburden prevents exposure of the AMD 2 / AMD 3 materials during any re-profiling activities.



Refer to Appendix Q for pdf version

Map 7-5 PAF material storage locations

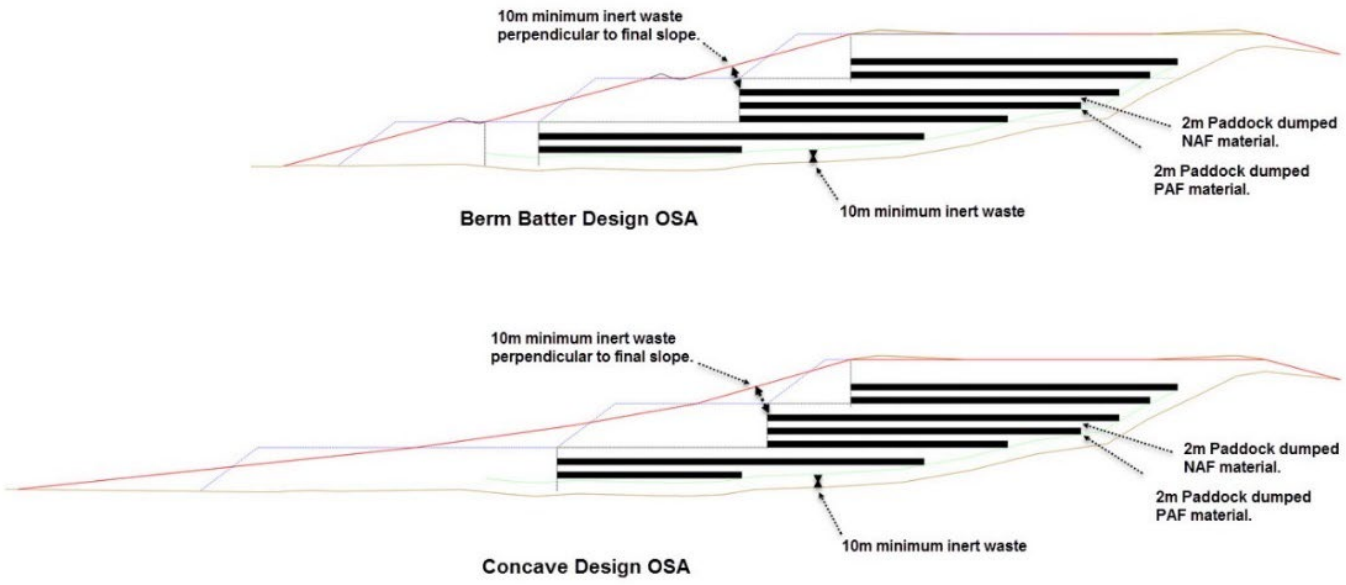


Figure 7-8 Conceptual OSA with PAF storage

7.5.1.2 Wall rock

Recent studies have found that wall rock appears to contribute only a small proportion of in-pit acidity generation (Section 5.3.1). Several possible causes of observed acidity have been identified and a range of management options could be considered including methods for:

- Adjusting drill and blasting techniques to minimise fracturing of sulphidic overburden;
- Removal of talus / scree piles containing sulphidic overburden and / or any blasted sulphidic overburden within the pit floor; and
- Using rock with neutralising capacity in strategic locations.

Backfill or buttressing can also be used to mitigate the potential for AMD by covering exposed wall rock with AMD 0 or ANC material.

Moderate and high wall rock AMD source hazards (from exposed PAF) have been identified:

- On the walls and floor of De Grey pit and the western end of the Swan pit (Figure 5-12, Section 5.3.2). These exposures will be managed by:
  - Using the voids for in-pit storage of tailings which will result in full coverage of the PAF exposures (Section 5.16.4) during inundation and include coverage by the conceptual closure capping design post settlement; or
  - Backfilling the mining voids to 5 m above the pre-mining groundwater level (502 mRL). Backfilling the De Grey pit to this level will still leave some wall rock exposures of unweathered PAF up to 520 mRL. One option that may be considered is covering the remaining exposed PAF material on the western wall (e.g., to 520 mRL) with inert overburden. However, the De Grey pit is largely hydraulically isolated from the regional aquifer, and therefore, impacts to receptors are unlikely (Section 5.11.2.2). Any options for covering the remaining wall rock exposures will be based on risk.
- At WH123, WHASH and East Jimblebar. Targeted backfill / buttressing will be considered, if required based on risk and taking into account the potential risks associated with pit lake quality post-closure.

7.5.1.3 Summary of management measures

Based on the current state of knowledge, AMD risk for Jimblebar Hub will be managed as outlined in Table 7-4.

Table 7-4 AMD management actions, tools and forward actions

Management Actions (Physical actions undertaken during operational and during closure phase to enable closure outcomes)	• Management of PAF material within designated locations in OSAs / ISAs to minimise the potential for AMD generation. • Backfill the De Grey and Swan pits with tailings or overburden (to 5 m above pre-mining water table). • Significant wall rock exposures of AMD 1 material will be managed based on risk. Backfill or buttressing of exposures may be considered to minimise the potential for AMD generation, if required.

Tools (Processes, procedures, plans used to guide and inform the planning of management actions)	• Materials characterisation information is incorporated into mining models (Section 5.3.1). • Geochemical testing and AMD risk assessment conducted (Section 5.3.2). • WAIO standards and procedures: - AMD Management Standard (WAIO, 2022a). - BHP Global Mined Materials Management Standard (BHP, 2021a). - Reactive Ground and AMD Potential: Mining Design and Dumping Procedure (WAIO, 2021). - Reactive Ground and Associated Gases Procedure 0129611 (WAIO, 2020d). - Mines Closure Design Guidance Procedure (WAIO, 2022f) outlines the framework for reactive overburden management. - Preliminary AMD Risk Assessment Procedure 0132980 (WAIO, 2017b). - Rehabilitation Planning and Execution Procedure (WAIO, 2023c). • Assessment of compliance to plan. • Pre-closure monitoring including monitoring of surface water and groundwater (Sections 10.1.5, 10.1.7 and 10.1.8).
Forward actions (Further studies based on knowledge gaps)	• As part of a BHP-wide geochemical program: - Further investigations will be conducted into the geochemical hazards associated with: ▪ AMD 2 and 3 materials. ▪ Targeted leach test work to assess metal mobilisation under variable environmental conditions. - OSAs / ISAs will be assessed across the Pilbara based on storage of AMD 1 overburden to identify priorities for monitoring. - Further assessment will be conducted of the short- and long-term risks associated with any wall rock exposures of PAF material above the level of backfill and to pit lakes, and the implications for closure, including the need to manage PAF wall rock exposures. • Further geochemical testing will be undertaken of material from the East Jimblebar and South Jimblebar (Sylvania and Capricorn) deposits. • Jimblebar tailings will be further tested during operations to confirm physical and geochemical characteristics.

7.5.2 Groundwater

Should pits be left as open voids at the completion of below water table mining, they will result in the development of pit lakes that reach equilibrium on a balance of pit inflows and evaporation, which have the potential to impact local and regional groundwater and surface water resources.

BHP uses hydrogeological conceptual and predictive modelling to inform closure planning. Groundwater flow modelling is undertaken to predict the range of possible outcomes for mine voids post-closure, which guides further technical studies and site-specific closure plans to focus on key uncertainties. Groundwater flow models provide predictions for water level recovery rates and equilibrium levels for mine void closure options. The conceptual and numerical models are updated and calibrated throughout the life of mine as more data becomes available. Such updates inform closure strategies and designs (from conceptual through to detailed), thereby reducing risk and increasing confidence.

As discussed in Section 5.11.2, the groundwater systems at OB17/18/31 and Jimblebar are separate. The management measures for each mining area are, therefore, discussed separately in Sections 7.5.2.1 and 7.5.2.2, respectively.

7.5.2.1 OB17/18/31

The current mine plan assumes that below water table pits at OB17/18 will be backfilled to above the pre-mining water table either with overburden or tailings. The mine void closure strategy for OB31 is yet to be finalised. Hydrogeological assessments predict that:

- The planned backfill of the OB17/18 below water table pits with tailings or overburden means that groundwater levels will recover. As discussed in Section 7.5.1, backfill with tailings or overburden will also minimise the potential for AMD.
- Groundwater levels at OB31 will remain depressed post-closure if the pit is left open (Section 5.16.5). However, residual drawdown is not expected to impact the Ethel Gorge TEC and so no specific management measures are expected to be required. If completely backfilled, it is predicted that groundwater levels would recover in the long term.

If left as a void, a pit lake would form in the OB31 pit and solutes would accumulate in the water as a result of evapo-concentration. As the pit would be a groundwater sink at closure, impacts to groundwater quality would not be expected, but there may be risks associated with poor quality water in the pit lake. A pit lake risk assessment will inform the need for management measures.

The OB31 pit is located within the flood plain of the OB31 Creek and if the proposed flood bund fails, creek flow would enter the pit and may cause the open void to become a temporary through-flow system releasing solutes to the local groundwater. Management measures to prevent the failure of flood bunds are discussed in Section 7.5.3.

7.5.2.2 Jimblebar

The backfill strategy (including consideration of in-pit tailings storage) for Jimblebar facilitates groundwater level recovery and minimises the extent of pit lakes post-closure. While groundwater levels are predicted to remain below pre-mining levels post-closure, impacts to receptors are not expected as a result of this level change. No specific management measures are, therefore, anticipated to be required to prevent impacts from changes to groundwater levels.

To address feedback from the Nyiyaparli people, the backfill / tailings storage strategy will aim to minimise pit lakes, and options will be reviewed for post-mining beneficial uses of any pit lakes remaining.

Residual pit lakes are predicted to be sinks post-closure and will become more saline over time. If PAF material remains exposed within mined out pit voids, it is possible for AMD to be generated (see Section 7.5.1) and impact pit lake quality. Wildlife could potentially be exposed to water containing metals. Refinement of the backfill strategy will be informed by future pit lake risk assessments.

7.5.2.3 Summary of management measures

Based on the current state of knowledge for Jimblebar Hub, groundwater closure risk will be managed as outlined in Table 7-5.

Table 7-5 Groundwater management actions, tools and forward actions

Management Actions (Physical actions undertaken during operational and closure phases to enable closure outcomes)	• Backfill De Grey and Swan pits with tailings, or with overburden (to 5 m above the pre-mining groundwater level). • Continue Jimblebar closure philosophy of backfilling mined out pits with overburden or tailings to minimise pit lakes post-closure. • Pits will be backfilled to above the water table if unacceptable impacts are identified from groundwater modelling.
Tools (Processes, procedures, plans used to guide and inform the planning of management actions)	• Conceptual and numerical groundwater modelling inform pit closure strategy and assessment of impacts on ecohydrological receptors (BHP, 2023c). • Modelling includes sensitivity testing (BHP, 2023c). • Jimblebar Water Management Plan (BHP, 2020b) and Eastern Pilbara Water Resource Management Plan (BHP, 2021g). • Pre-closure monitoring including monitoring of groundwater enables groundwater modelling to be refined (Sections 10.1.5 and 10.1.8).
Forward actions (Further studies based on knowledge gaps)	• Refinement of conceptual and numerical groundwater models as new data becomes available and the backfill strategy evolves, and further analysis of: - Post-closure groundwater levels. - Residual pit lake quality, including the potential impacts of the in-pit TSFs on the OB31 pit lake quality. - The impacts / risks associated with pit lakes. • Revision of backfill scenarios, if required, based on the outcome of modelling. • As the backfill strategy for Jimblebar evolves, update groundwater modelling and conduct an assessment of the potential impacts of pit lakes. • Assess options for post-mining uses of pit lakes.

7.5.3 Surface water

The surface water system at closure will be designed to meet the closure principle of no significant impact on baseline surface water quality and flow regimes in nearby waterways beyond the levels accepted by project approvals. Key considerations will include an assessment of the likelihood that mine voids will 'capture' creek lines, or that major climatic events will result in damage to surface water controls (including those on constructed landforms) that may in turn impact future groundwater / surface water interactions and hence, long term water balances.

The flood protection works required for closure will be designed and constructed to achieve stable, maintenance-free, freely draining landforms and may be different to operational flood protection works. Options, which would be considered for closure include additional rock armouring, changes to the elevation and slope of flood protection bunds and stream management to locally reduce velocities at critical locations.

The design of surface water management infrastructure for the operations phase addresses closure requirements where possible or includes a conceptual assessment of the upgrades necessary to accommodate closure requirements so that appropriate planning can be integrated into closure plans (Sections 5.16.3.2, 7.5.3.2 and 7.5.3.3). The executed operational designs will then be revisited 5 years prior to the closure of the site when the detailed closure design will be developed. The development of this design near to the end of the pit life will permit the closure design to benefit from the data captured through the operational period as well as the increased certainty around final landforms.

Surface water management post-closure will focus on achieving long term stability of OSAs, creek diversions and pit walls adjacent to natural creek sections. Closure designs will consider:

- Surface water run-off from OSAs;
- Natural creek sections adjacent to pits;

- Design of diversions and flood bunds; and
- The potential impact of climate change on flood events and closure designs.

Consideration will also be given to the impacts of final landform drainage on ecosystems sensitive to changes in surface water flows such as riparian vegetation and sheet-flow dependent Mulga.

Closure designs for surface water management are based on an assessment of risk which considers catchment size, the sensitivity of the receiving environment and likely impact from a change in flows, and the risks of permanent creek capture or compromising the stability of post-closure landforms such as OSAs (Table 7-6). The design event for each surface water management feature constructed for closure would be considered on a case-by-case basis using the guidance provided in Table 7-6. The element in Table 7-6 that has the highest risk drives the flood event to be used as the basis for the design of surface water management infrastructure. For high risk surface water management structures, modelled 1 in 10,000-year ARI events are typically used to inform designs. Probable Maximum Floods (PMF) have been calculated for comparison, however, are not used by BHP as a basis of design. This is due to the very large extrapolation and uncertainties involved in their estimates. Furthermore, the PMF method produces flood estimates significantly larger when adjusted for catchment area than any contained in the paleo record of any Australian River (Appendix I-1). The 10,000-year event estimates generally result in a flow rate several times larger than the 1% (100-year) AEP event and are considered an appropriately conservative basis for a closure design for a high risk structure.

Table 7-6 Guidance for selection of design events for surface water management infrastructure

Catchment Size	Design ARI Applicable (Years)					
	Risk of Creek Capture or to Stability of Post-closure Landform			Sensitivity of Receiving Environment & Potential Impact		
	Low	Moderate	High	Low	Moderate	High
Small (<10 km^2)	100	1,000	1,000	100	1,000	10,000
Medium (10 - 100 km^2)	1,000	1,000	10,000	1,000	1,000	10,000
Large (100 - 1,000 km^2)	1,000	10,000	10,000	1,000	10,000	10,000
Very Large (>1,000 km^2)	10,000	10,000	10,000	10,000	10,000	10,000

Based on current mine designs and our understanding of the surface water system and associated receiving environment, the guidance in Table 7-6 would be applied for the following key creeks at the Jimblebar Hub as follows:

- Orebody 31 creek has a medium sized catchment. The risk of creek capture is moderate as the creek does not have a well-defined channelised flow. The sensitivity and impact to the receiving environment would be low as there are several drainage lines feeding the Orebody 31 creek from the south. A design ARI of 1,000 years would, therefore, be selected for the Orebody 31 flood bund at closure.
- Copper Creek has a medium sized catchment. The risk of creek capture would be moderate as the creek has a shallow gradient which results in low creek flow velocities and a wide floodplain. The sensitivity of the receiving environment would be rated as moderate; the creek feeds into Jimblebar Creek which supplies Innawally Pool, but the contribution of Copper Creek to Innawally Pool flows is relatively small. An ARI of 1,000 years would, therefore, be selected for the closure designs for surface water management infrastructure associated with this creek.
- Jimblebar Creek West and East branches both have large catchments, and both have a significant influence on the flows at Innawally Pool which is a site of high ecological and cultural value. The sensitivity of the receiving environment is, therefore, high and the appropriate design ARI for closure infrastructure associated with this creek is 10,000 years.

7.5.3.1 Impact of floods on OSAs

The impact of floods on OSAs will be managed so that landforms are stable in the long term. OSA footprints at OB17/18/31 are outside the 0.01% (1 in 10,000-year) AEP flood extent of Orebody 31 Creek. Most of the Brockman OSAs at Jimblebar lie outside the 1:10,000-year floodplain, but the PC03 ROM, BB06, BC06 and BN07 OSAs, and some areas of WHASH and H234 OSAs intersect the floodplain, as do most of the South Jimblebar OSAs. These OSAs are protected by a combination of flood bunds, diversions and rock armouring to prevent erosion. The closure design for OSAs and ISAs is further discussed in Sections 7.5.4, 9.2.2 and 9.3.1.

7.5.3.2 Flood protection bunds

As discussed in Section 5.16.3, flood protection bunds have been designed to maintain surface water flows around pits and OSAs at:

- OB31 pit to prevent capture of the Orebody 31 Creek
- Stages 1 to 4 of the South Jimblebar pits to prevent capture of Copper Creek. Bunds for Stages 1 to 3 of the pits have been constructed and Stage 4 is in the design phase. A Stage 5 extension to the bunds is proposed but has not yet progressed to design.
- WHASH and H2/3 pits to prevent capture of the Jimblebar Creek.

The operational flood bunds have been designed / constructed to accommodate 1% (1 in 100) AEP flood depths and flood velocities. However, designs have considered the upgrades required to accommodate post-closure conditions (Section 5.16.3), and bunds will be upgraded at closure to achieve stable, maintenance-free landforms that can withstand the closure design flood

event selected as described above. As described in Section 9.2.3.4, these upgrades may include additional rock armouring and changes to the elevation and slope of the bunds.

7.5.3.3 Creek diversion

The closure design AEP for diverted creek sections is selected on a case-by-case basis. Consideration is given to the fate of flood events exceeding the design AEP so that the system is stable in the long term. This may include the use of spill out structures to divert an increasing proportion of the flow above the design AEP event into mine voids. Design features of spill out structures may include heavy rock armouring and include features such as launching aprons, baffles and weirs to improve stability.

Creek diversions have been constructed, or are proposed for:

- A tributary of Copper Creek (South Jimblebar Creek) that intersects the Stage 3 pit and South Jimblebar OSAs AV05 and BE04.
- The Jimblebar Creek West Branch to divert flows around the South Jimblebar Capricorn pits (SJG2 and SJH2) to maintain flows along Jimblebar Creek to Innawally Pool.
- Eastern and Central creeks (minor diversions) to allow mining of South Jimblebar Capricorn pits.

These diversions have been designed to accommodate a 1% (1 in 100-year) AEP event, however, consideration has been given to post-closure conditions (Section 5.16.3.4). The basic geometries of the significant diversions (South Jimblebar and Jimblebar Creek West Branch) have been designed to be suitable for closure, and as a goal, support an eco-hydrological environment comparable with the natural creek. All the creek diversions will need to be modified to accommodate design flood levels / flows selected as described above.

7.5.3.4 Summary of management measures

Based on the current state of knowledge, the management of surface water at Jimblebar Hub for closure will be undertaken as outlined in Table 7-7.

Table 7-7 Surface water management actions, tools and forward actions

Management Actions (Physical actions undertaken during operational and during closure phase to enable closure outcomes)	• Flood bunds will be upgraded to accommodate closure conditions (based on risk) to prevent uncontrolled release of surface water to mine voids. • Significant creek diversions will be designed to achieve comparable hydraulic and geomorphological characteristics to the original creek systems. • Rock armouring or other erosion protection measures will be provided to OSAs that lie within the 1:10,000-year flood plain. • Where pit walls will not allow surface water control infrastructure to be located outside the ZOI, buttressing may be considered.
Tools (Processes, procedures, plans used to guide and inform the planning of management actions)	• Surface water assessment, baseline data and modelling to inform closure strategy (Sections 5.11.1 and 5.16.3). • Modelling includes sensitivity testing. • Mines Closure Design Guidance procedure (WAIO, 2022f). • Master area design review process to verify that closure design guidance has been incorporated. • Surface water monitoring network (water quantity and quality) (Sections 10.1.6 and 10.1.7).

Forward actions
(Further studies based on knowledge gaps)
	• As the site approaches closure:
	  - Detailed mine void stability analysis will be conducted to identify the need for additional controls such as buttressing or backfill.
	  - Flood modelling will be updated for closure conditions, as required to inform the closure designs for surface water management infrastructure.
	  - Closure designs will be developed for flood bunds and diversions.
	• As mining progresses and further creek diversions are required, hydrological studies will be carried out, impacts assessed, and appropriately designed infrastructure developed.
	• The surface water (and riparian vegetation) monitoring program for Jimblebar Hub will be reviewed, and if appropriate revised, to assess its suitability to inform closure and assess achievement of completion criteria.

7.5.4 Landforms

The development of the post mining landform design is an iterative process, integrating all the closure domains. BHP follows the adaptive management framework, with the mine plan and closure landform designs evolving over the life of mine as constraints, information and knowledge become available over time.

Critical to the transfer of the operational domains, particularly OSAs, to successful and sustainable post-closure landform designs is a fundamental understanding of the chemical and physical properties of the soil and / or overburden material used to construct the final landform (Section 5.3.3). In particular, the surface materials must be appropriate to withstand erosive forces and sustain vegetation growth in the long term. Inherent in this consideration is the water and nutrient holding capability of the growth media (Section 5.5). Similarly, its chemical properties must have low AMD (Section 5.3.2) and dispersivity / sodicity risk (Section 5.3.3).

Further to these materials characterisation, selection and placement requirements, the final landform design must incorporate slopes that will result in minimal rilling as this minimises the opportunity for accelerated erosional forces to develop within channel flows. Such slopes will have minor potential to become heavily gullied, and any interill erosion that occurs will be insignificant relative to potential rates of erosion that could develop as a result of rilling on long steep, slopes. If riling and gullying is avoided, the slope should be stable.

Visual impacts of the final landform, design constraints and solutions will also be discussed with key stakeholders, where visual impact is a key concern. Safety and access considerations for the landform design are discussed in Section 7.5.7.

BHP undertakes a suite of work to inform and guide the landform design process including:

- **Resource sterilisation assessment**: which is an assessment of resource or potential mineralisation beneath an area typically selected for proposed OSA construction. This assessment also applies to mine voids where backfill is proposed as part of the operations and / or closure strategy. It adds to the spatial dataset which assists with OSA positioning at the conceptual stage.
- **The resource block model**: which contains geological resource information for planned and operational mines. The model contains, amongst other things, relevant stratigraphies and associated physical and geochemical properties of the rock mass which allow for the identification of ore and appropriate classification of overburden material.
- **Overburden characterisation**: identifies material suitable for use on final slopes and problematic material (e.g., PAF, sodic) which should be buried within an OSA or mine void as appropriate.
- **Mine plan optimiser**: Mine planning software is used to assist in generating an optimal pit design based on financial and geotechnical parameters, assuming an appropriate risk level. The mine planning software is also used to schedule multiple deposits based on optimal maximised net present value (in consideration of operational and environmental constraints). Schedules provide the necessary information to develop optimal overburden strategies and are an iterative process. This influences OSA designs and backfill strategies.
- **Numerical erosion potential modelling**: Surface erosion modelling can be undertaken as part of the detailed OSA design stage to evaluate the predicted rates and locations of erosion on a final landform. This process is supported by numerical inputs obtained from the material characterisation programs. This activity supports planning considerations around final landform design and overburden scheduling objectives.
- **Physical erosion potential modelling**: An examination of overburden that forms the outer surfaces of OSA landforms is undertaken to determine the key erosion characteristics of the overburden material. This is conducted under laboratory conditions using predicted rainfall events using local rainfall data. It provides validated data for the numerical modelling on how well a specific overburden type behaves in surface flow conditions and informs detailed OSA design such as stable slope angles and material use. In addition, field trials are utilised where appropriate, to validate laboratory findings.

The Jimblebar Hub closure final landform design will require integration of all the domains listed in Table 2-1 (Section 2.2) and summarised below:

- OSAs, ISAs, ROM pads and stockpiles (discussed in Section 7.5.4.1);
- In-pit TSFs (discussed in Section 7.5.4.2);
- Mine voids (above and below water table) (discussed in Section 7.5.4.3);
- Infrastructure including:
  - Surface water management and flood protection works (discussed in Section 7.5.3); and
  - Roads and post-closure access (discussed in Section 7.5.7).

Some areas of the Jimblebar Hub are at a greater maturity than others in terms of landform design. This reflects the history of different areas within the Hub and future operational plans. As operations / landforms in certain areas approach completion, closure designs are progressively developed and implemented. The final landform design for Jimblebar Hub will, therefore, continue to evolve over the life of mine. The designs that have already been implemented are summarised in Section 9.3.1, and those that have yet to be implemented in Section 9.2.2. Designs are based upon multi-disciplinary inputs including for example:

- Exploration data;
- Overburden characterisation;
- Hydrology, hydrogeology, and hydro-geochemistry information;
- Post-mining land use and tenure considerations;
- The physical footprint;
- Cumulative impacts;
- Visual impact considerations;
- Mine planning, scheduling, and overburden volumes;
- Flora, fauna and heritage issues; and
- Stakeholder inputs.

7.5.4.1 OSAs and ISAs

Potential requirements for OSA designs are integrated into the Master Area Design for a mine and are refined throughout the mine planning process (Figure 7-9). During the early stages of mine planning (see 'Range Analysis' and 'Development Strategy' on Figure 7-9), conceptual OSA landform designs are used to delineate OSA locations and disturbance extents for approval purposes. In these strategic planning stages, the overall landform extent and conservative assessment of slope angle is used to estimate a final disturbance extent. As more localised information becomes available and knowledge improves, a final landform design will be developed (see 'Engineering' stage on Figure 7-9) which will transition into an executable design. During construction, assessments are undertaken of compliance to plans based on survey data.

Erodible overburden is backfilled into pits (sometimes as constructed ISA landforms) or placed in ex-pit OSAs which have appropriate geometries and are sheeted with competent material defined through materials characterisation studies. OSAs are generally located outside the Zone of Instability (ZOI) of pits, but where this is not possible, pit walls will be buttressed through backfill of the pit to increase stability, or the ex-pit overburden material will be transferred to an alternative location. OSAs will also typically be located outside the 1 in 10,000-year flood plain. However, where the 1:10,000 floodplain intersects OSAs, consideration will be given to additional rock armouring or toe protection bunds or diversions to minimise the potential for erosion in a post-closure flood event.

The final shape of OSAs and ISAs will be designed to maintain surface stability. Erosion of OSAs will be minimised by managing surface water run-off (Section 9.2.2). Where berms are deemed necessary in design due to overall landform geometry, berm cross-sectional water holding storage is based on 200-year 72 hr event with 300 mm freeboard from top of crest embankment. Berm design includes engineered features to contain or direct slope run-off above 200-year events up to a 10,000-year event.

Opportunities to minimise the size of the OSAs by increasing the amount of overburden material used to infill final voids will be explored as part of ongoing operational planning (Section 9.2.1.1).

Potential fibrous overburden in OSAs

Fibrous overburden encountered during mining is placed 1 m below the surface of an OSA / ISA / backfill. Where, due to historic practices, there is an absence of detailed destination information for materials placed in OSAs, any potentially fibrous materials encountered during recovery for mine void backfill (Section 7.5.4.3), will be placed at least 1 m below the final backfill surface.

Waste Resource Planning Knowledge Map

Purpose: To layout the waste planning activities and study levels during the various stages of project development, from early Range Analysis to execution by Operations. By detailing the study/management level, risks can be identified and separate management plans to manage the risks can be developed.

Scope: This document covers the management of waste material at WAIO sites. Waste generated at WAIO sites includes:
1. Non-mineralised waste rock (mining overburden).
2. Mineralised waste rock (Low/Blend Grade).
3. Quarried rock used for construction.

LoA Waste Knowledge Understanding

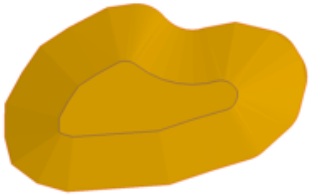
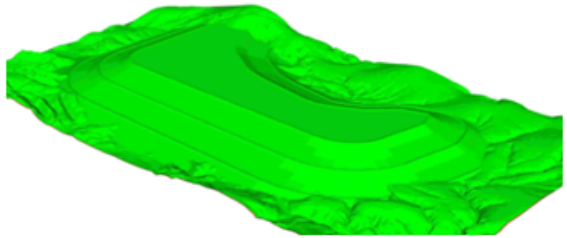
	Range Analysis	Development Strategy	Engineering	Implementation
OVERVIEW	The waste and landform considerations will generally be at a high level due to a limited waste understanding caused by the model maturity.	A conceptual 9 degree OSA final design with no ramps developed for extents that considers preliminary geochemistry and landform requirements. Assumes all waste/LG/BG dumped ex-pit.	Executable rehabilitated designs are developed to inform the as-tipped designs. The design is to consider the material properties of the waste and physical environmental conditions of the area.	Mine Operations execute the OSA and landform structure in accordance with the approved as-tipped design. Waste schedule optimises waste placement objectives to minimise haulage and rehabilitation costs.
OSA LANDFORM REQUIREMENT				
KNOWLEDGE LIMITATIONS	*Initial drilling program that has broadly defined a known mineral deposit. Footprint of conceptual OSA should consider drainage alignments and future pit and infrastructure footprints.*	*Infill drilling has allowed for the development of resource models that consider the waste risks of the deposit.*	*Infill drilling completed, resource and mining models available with a good understanding of lithologies and PAF potential. Site specific material characterisation work may not yet have been completed but reviews of adjacent studies has been undertaken.*	*Monthly review of compliance to plan undertaken to ensure compliance with design during execution of landforms. As material competency investigations are completed, mine plans are amended to optimise waste placement objectives if possible.*

Figure 7-9 OSA landform development stages during mine planning

7.5.4.2 In-pit TSFs

Cover systems for in-pit TSFs are developed with consideration of the:

- Potential for dust and seepage from the TSF.
- Final ZOI of the pit in relation to nearby infrastructure including abandonment bunds.
- Fate of surface water captured by the pits.
- Consolidation / settlement of the tailings surface and final closure outcomes to be achieved.

A conceptual cover system has been developed for the Swan and De Gray in-pit TSFs (Sections 5.16.4 and 9.2.1.3). This will be reviewed in the light of further studies, data collected during operations and stakeholder consultation. As the locations for additional in-pit TSFs are confirmed, appropriate design studies will be conducted to inform the closure strategies for these TSFs.

7.5.4.3 Mine voids

The mine void closure strategy will consider the post-closure influence of the Jimblebar Hub mining areas on groundwater and associated receptors (refer to Section 7.5.2) as well as opportunities for reducing the ex-pit footprint of OSAs. Following the confirmation of the preferred mine void closure strategy (e.g., whether they will be backfilled or used for tailings storage) and final pit shells, pit wall stability will be assessed and the potential for the ZOI of the pits to impact on infrastructure (such as abandonment bunds and surface water management infrastructure) will be assessed. Where post-closure infrastructure falls within the ZOI of pits (i.e., within areas that do not achieve a FoS ≥1.5) pit walls may be buttressed to improve stability.

Geotechnical and hydrological assessments will be used to inform pit designs and pit wall stabilities, with surveys being undertaken to check final pit walls against designs.

At closure, abandonment bunds will be located outside the ZOI of the pits in line with DMIRS guidelines (DoIR, 1997), and designs (Section 9.2.1.2) will take into account the outcomes of recent consultation with DEMIRS (Section 4.3). Consideration will also need to be given to how the abandonment bunds interact with surface water management infrastructure remaining post-closure (e.g., flood bunds and diversions).

7.5.4.4 Summary of management measures

Based on the current state of knowledge, the final landform design for Jimblebar Hub will be undertaken as outlined in Table 7-8.

Table 7-8 Landform management actions, tools and forward actions

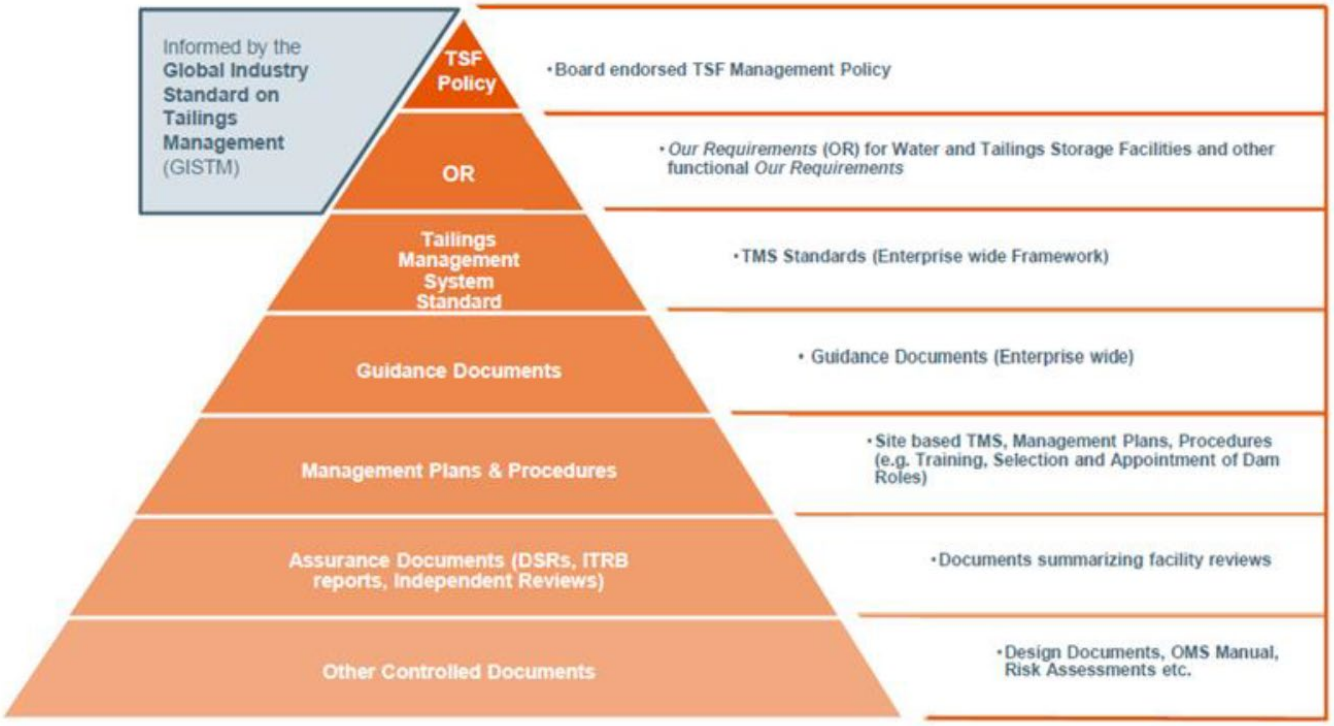
Management Actions (Physical actions undertaken during operational and during closure phase to enable closure outcomes)	• Overburden will be progressively backfilled into pits, where practical. • Closure designs for landforms will be developed and implemented progressively as operations / landforms in certain areas approach completion. • Final landform designs will be informed by overburden characterisation, erosion modelling and integrated landform considerations. • WMAT 1 overburden will be segregated and stockpiled for use in rehabilitation. • Where landforms may be impacted by flood waters, erosion protection measures may include rock armouring, flood bunds and / or diversions. • Where the stability of pit walls will not allow abandonment bunds, surface water infrastructure or OSAs to be located outside the ZOI, buttressing may be considered, or landforms may be redesigned / relocated to fall outside the ZOI. • TSF cover designs will be refined during operations based on an understanding of risk, tailings behaviour and information from stakeholder consultation.
Tools (Processes, procedures, plans used to guide and inform the planning of management actions)	• Materials characterisation information is incorporated into mining models (Section 5.3). • Materials characterisation and erosion modelling (WEPP, SIBERIA) inform final landform designs (Sections 5.3, 5.16.2, 9.3.1 and Appendix L). • Mine planning optimisation review for opportunities to place overburden into mined out voids (Section 9.2.1). • Surface water modelling informs landform designs (Section 5.11.1.4). • Mines Closure Guidance Design document (WAIO, 2022f). • Master Area Design Review Process to verify that closure design guidance has been incorporated. • Geological model (highlights fault zones). • Geotechnical pit model informs pit design. • Compliance to plans is assessed and rehabilitation works include construction supervision and post-construction inspections.

Improvement Activities (Further studies based on knowledge gaps)	• Conduct additional materials characterisation and erosion modelling, as required, to inform landform designs and update the competent overburden balance. • Continue to refine the backfill strategy to optimise closure outcomes, including reducing the risks associated with landforms constructed of material that is prone to erosion, or adjacent to flood plains and considering the Nyiyaparli people's principles for closure, future plans for in-pit tailings storage, and the outcomes of groundwater modelling, AMD studies and pit lake assessments. • Progressively develop final landform designs considering erosion modelling outputs, historical performance of comparable areas, Nyiyaparli people's principles for closure and following consultation with stakeholders, options for safe access post-closure and visual characteristics. • Monitor the performance of rehabilitated landforms to validate design assumptions and inform future rehabilitation practice during the operational life of mine. • As the site approaches closure, conduct detailed mine void stability analysis to: - Identify the need for controls such as buttressing or backfill. - Inform the location of abandonment bunds. - Determine the location of permanent infrastructure.

7.5.5 Tailings storage facilities

BHP has committed to conform with the Global Industry Standard for Tailings Management (ICMM, 2020) and the key requirements have been embedded into BHP's internal standards. The management of tailings dams is reviewed against the Global Industry Standard requirements and any identified improvement actions are publicly reported.

Closure of TSFs is carried out generally in accordance with the board endorsed TSF policy, Our Requirements for Water and Tailings Storage Facilities (BHP, 2023i) and supporting guidance materials (Figure 7-10).



Source: BHP (2021j)

Figure 7-10 BHP tailings standards and guidelines hierarchy

As outlined in BHP's Guidance for Tailings Governance (BHP, 2021j), closure planning for TSFs incorporates a risk assessment of each facility. These risk assessments inform closure design criteria and any long-term management requirements. The post-closure hazard assessment considers potential future downstream development (including populations at risk). The potential for failure modes to be created during the execution of closure works is also considered.

There are a number of studies that inform the risk assessment including failure mode assessment of the final TSF and associated components including, for example covers, water treatment plants and spillways. These are conducted generally in accordance with relevant BHP guidelines (BHP, 2020c; 2020d; 2019b; 2021d).

Design and performance assessments are conducted during operations, closure planning and, where required, post-closure as guided by:

- Our Requirements for Water and Tailings Storage Facilities (BHP, 2023i).
- Dam Integrity Management Standard (BHP, 2021c).

Dam Safety Reviews are conducted generally in accordance with the Guidance for Dam Safety Reviews (BHP, 2020f) at all stages in the life of a TSF once in operation through to closure. Reviews may also be conducted post-closure if a TSF still operates as a dam in that it is retaining water (including saturated tailings) where failure of the containment could result in runout of tailings and / or water.

Independent Peer Reviews (BHP, 2021e) conduct a cross-check of relevant design documents and systems to assess whether the key components of dam safety have been adequately addressed by the design for closure, with additional focus on the transition between current conditions and the proposed end-state of the facilities (i.e., post-closure state where the landform is permanent, or closure state where the facility is not permanent). The components assessed encompass:

- Governance: which includes a review of whether appropriate governance mechanisms have been applied, including appropriate change management processes.
- Design criteria: which reviews the documentation of criteria and assessments which have informed them.
- Geotechnical: which includes an assessment of tailings characterisation.
- Hydrotechnical: which assesses meteorological conditions, water balance, freeboard, conveyance, etc.
- Environment: which considers the geochemical characterisation of tailings and groundwater conditions.
- Risk Assessment: including the results of failure modes effects analysis / potential failure modes assessment.
- Closure: design for physical and chemical stability post-closure.

Dam Safety Reviews and Independent Peer Reviews completed during the design and operation of a dam, together with the required documents for all active and inactive dams, are a source of baseline knowledge that can be utilised to inform closure planning.

7.5.5.1 Summary of management measures

Based on the current state of knowledge of the proposed Jimblebar Hub in-pit TSFs, closure and rehabilitation will be undertaken as outlined in Table 7-9.

Table 7-9 TSF and water storage facility management actions, tools, improvement activities

Management Actions (Physical actions undertaken during operational and during closure phase to enable closure outcomes)	The current concept for closure of the Swan and De Grey in-pit TSFs is as follows: • Placement of a 1 to 2 m pioneer layer. • 1 to 5 m thick cover of NAF overburden from East OSA. • Re-profile East OSA so that surface water run-off is directed away from the in-pit TSFs.
Tools (Processes, procedures, plans used to guide and inform the planning of management actions)	• BHP Guidance for Tailings Governance (BHP, 2021j). • Dam Integrity Management Standard (BHP, 2021c). • Dam Safety Review (BHP, 2020f). • Independent Peer Review (BHP, 2021e). • Routine pre-closure and post-closure water quality monitoring (Section 10.1.11).
Improvement Activities (Further studies based on knowledge gaps)	• Jimblebar tailings will be further tested during operations to confirm physical and geochemical characteristics. • Swan and De Grey pit wall stabilities will be further assessed during DPS (in progress). • The closure designs for the De Grey and Swan in-pit TSFs will be progressively reviewed and refined based on: - Consolidation modelling for the DPS (in progress) and subsequent monitoring and model validation during operations. - Review of options to enhance tailings settlement and drainage to reduce the timeframe over which closure works can be safely executed. - Seepage modelling (in progress) and pre-closure monitoring of groundwater to confirm / refine groundwater impact assessments and identify any impacts to OB31 pit lake quality that may need to be addressed through closure planning. - Cover material characteristics. • As locations for new in-pit TSFs are confirmed, studies will be progressed to develop conceptual designs for closure. These will include: - Consideration of the tailings characteristics (geochemical and physical) and pit wall exposures of PAF material. - Surface water catchments impacting on TSFs and need for surface water management measures. - Consideration of the outcomes of detailed design studies for De Grey and Swan in-pit TSFs and the monitored behaviour of the tailings in these pits during deposition. - Consolidation behaviour and implications for placement of any cover systems. - Material types and volumes required for any cover systems. - Consultation with Nyiyaparli people regarding the final landform design, acknowledging the Nyiyaparli people's preference to backfill to surface or create water gaining sites.

7.5.6 Rehabilitation

7.5.6.1 Revegetation

The revegetation program has been designed to establish native vegetation that blends with the surrounding areas and provides habitat and foraging areas for native fauna, while taking into consideration any constructed landform and the overburden material characteristics within the potential root zone.

The establishment of a robust soil profile is critical for the successful establishment of vegetation and achievement of relevant completion criteria (see Section 8.3.1). Prior to use in rehabilitation, topsoil is stripped and stored (if required) generally in accordance with the procedures outlined BHP's Management of Growth Media for Rehabilitation Procedure (WAIO, 2020c). Where there is insufficient topsoil, alternate growth media are investigated (Section 5.5.4).

The Rehabilitation Standard (WAIO, 2020a) requires that revegetation be conducted to establish plant species that will support the approved post-mining land use. The plant species included in revegetation are selected from the species lists generated from baseline surveys and include a range of typical vegetation assemblages suited to the post-mining landform (see Appendix J for seed mix). Based on the, assumed post-mining land use (Section 6), target revegetation assemblages will typically be consistent with vegetation associations recorded in the mine area prior to mining, however some domains (e.g., backfilled pits) may require the return of novel ecosystems, and further work is required to define appropriate species for use in revegetation of these areas.

Several of the species identified as of cultural significance in the Nyiyaparli People and Country Plan (KNAC, 2023), and BHP's ethnobotanical database have been incorporated into BHP's seed mix (as shown in Appendix J). BHP is commencing a program with the Nyiyaparli people focused on rehabilitation which could include sourcing seed for species that are not commercially available, propagating tube stock for species that do not establish well from seed, and trialling rehabilitation techniques including tube stock planting. It is anticipated that this program would enhance the re-establishment of culturally significant species.

Revegetation at Jimblebar Hub will use local provenance native seed (from the local area, but as a minimum from within 100 km of site within the Pilbara Biogeographic Region).

Based on the available climate change predictions, BHP considers that the most appropriate revegetation approach is to select native species based on the current climatic conditions. If there were to be an effect on revegetation from climate change, those changes would reasonably be expected to be gradual and would be experienced across the entire region, including adjoining unmined areas. Major differences between regional and post-mining vegetation will be managed by providing sufficient diversity of species within rehabilitated sites, so that the natural adjustments to a changing climate will be accommodated within the local species pool. However, BHP is currently conducting research at Yandi to assess whether out of provenance seed sources can be used to increase genetic diversity and provide resilience to climate change. The outcomes of this research will be incorporated into future MCPs as they become available.

A Priority 1 flora species (*Acacia corusca*) is located adjacent to the OB31 OSA footprint (see Map 5-6, Section 5.8.3). In line with the Biodiversity Management Plan (BHP, 2018c) (Section 3.2.2), WAIO will consider early opportunities to rehabilitate the northern side of the OB31 OSA to minimise potential impacts to this species.

BHP manages introduced flora species at Jimblebar Hub with reference to the Environmental Management Plan for OB17/18 (BHPBIO, 2014a), Biodiversity Management Plan for OB31 (BHP, 2018c), Jimblebar Flora and Vegetation Management Plan (BHP, 2020a) and WAIO's Weed Management Procedure (WAIO, 2020b).

7.5.6.2 Fauna habitats

Rehabilitation plans address the return of fauna habitat through selection of target vegetation communities and / or specialised constructed habitat features. Establishment of specialised fauna habitats is considered during the development of landform designs and associated work packs for execution. Rock habitat structures (Section 9.2.2.1) provide gaps and voids to allow species such as quolls and pebble mound mice to gain entry. Landform designs typically require a higher percentage of rock on slopes for stability, but the surfaces of OSAs may contain less rock and, therefore, are of greater suitability for species that require less rocky habitat.

BHP is in the process of planning a research program on fauna habitat, including consideration of key species of importance to Traditional Owners, and the return of fauna to rehabilitated areas. This will inform future rehabilitation practices.

7.5.6.3 Summary of management measures

Based on the current state of knowledge, the rehabilitation of disturbed areas of the Jimblebar Hub operations will be consistent with the Rehabilitation Standard (WAIO, 2020a) and will be undertaken as outlined in Table 7-10. Note specific improvements aimed at addressing matters of interest to Traditional Owners are outlined in Table 7-12, Section 7.5.8.

Table 7-10 Rehabilitation management actions, tools and forward actions

Management Actions (Physical actions undertaken during operational and during closure phase to enable closure outcomes)	• Growth media management generally in accordance with the Management of Growth Media for Rehabilitation Procedure (SPR-IEN-LAND-009) (WAIO, 2020c). • Seed collection, storage, testing, treatment and data management generally in accordance with the Seed Management Procedure (WAIO, 2022e). • Rehabilitation generally in accordance with the Rehabilitation Standard (WAIO, 2020a). • Use of local provenance native seed (from the local area, but as a minimum from within 100 km of the site and within the Pilbara Biogeographic Region). • Consider opportunities for providing habitat for fauna during rehabilitation planning, including for conservation significant species and species of significance to Nyiyaparli people.
Tools (Processes, procedures, plans used to guide and inform the planning of management actions)	• Rehabilitation Standard (WAIO, 2020a). • Rehabilitation Planning and Execution Procedure (WAIO, 2023c). • Management of Growth Media for Rehabilitation Procedure (WAIO, 2020c). • Seed Management Procedure (WAIO, 2022e). • Weed Management Procedure (WAIO, 2020b). • Topsoil reconciliation and overburden characterisation for use as growth media (Section 5.5). • Growth media trials (Appendix F). • Seeding and rehabilitation trials (Section 5.16.6 and Appendix F). • Progressive rehabilitation and associated monitoring (Section 9.3) and adaptive management feedback loops. • OB17/18 Environmental Management Plan (BHPBIO, 2014a), OB31 Biodiversity Management Plan (BHP, 2018c), Jimblebar Flora and Vegetation Management Plan (BHP, 2020a). • WAIO Weed Management Procedure (WAIO, 2020b).
Improvement Activities (Further studies based on knowledge gaps)	• Ongoing characterisation of overburden for use as growth media in rehabilitation. • Consider early opportunities to rehabilitate the northern side of the OB31 OSA to minimise impacts to the adjacent Priority 1 flora species and for providing habitat for conservation significant species during rehabilitation. • Utilise the results of seed and tube stock research / trials and work with the Nyiyaparli rehabilitation team to inform the revegetation strategy. • Keep a watching brief on research associated with the appropriate use of out of provenance seed source to increase genetic diversity to provide resilience to climate change. • Identify appropriate species for use in rehabilitation of pits with backfill to surface. • Research program to investigate fauna habitat and the return of fauna to rehabilitated areas, including consideration of key species of significance to the Nyiyaparli people. • BHP is in the process of reviewing its rehabilitation monitoring procedures to determine how fauna use of rehabilitated areas can be integrated into the monitoring program. • Locations which may be available for a minimum of five years will be investigated for rehabilitation / landform trials and incorporated into the 5-year plan. • Monitor the performance of rehabilitated landforms to validate design assumptions and inform future rehabilitation practice during operational life of mine.

7.5.7 Site safety and security

BHP's standard site safety and security measures are outlined in Section 9.1.7. Key considerations would include:

- Construction of abandonment bunds. At closure, abandonment bunds would be located outside the ZOI of the pits in accordance with DEMIRS guidelines (DoIR, 1997) and designs would take into account the outcomes of recent consultation with DEMIRS (Section 4.3). Consideration would also need to be given to how the abandonment bunds interact with surface water management infrastructure remaining post-closure (e.g., flood bunds and diversions).
- Fencing and signage, where appropriate.
- Requirements for safe access to areas of the mine post-closure. Provisions for safe access to the closed mine would be made in consultation with key stakeholders to accommodate the post-mining land use and enable Traditional Owners to access places of importance.
- Placement of fibrous material beneath at least 1 m of inert (non-fibrous) overburden cover.
- Management of AMD generally in accordance with the measures outlined in Section 7.5.1 to prevent hazards such as release of asphyxiating gases / vapour (e.g., CO_2).
- Decommissioning and removal of infrastructure that will not be transferred to a third-party post-mining.

7.5.7.1 Summary of management measures

Site security and safety management measures at Jimblebar Hub will be as outlined in Table 7-11.

Table 7-11 Site safety and security management actions, tools and forward actions

Management Actions (Physical actions undertaken during operational and during closure phase to enable closure outcomes)	• For mine voids that will not be backfilled to surface, the final pit design will include abandonment bunds conforming to DEMIRS guidance (DoIR, 1997), and the outcomes of recent consultation with DEMIRS on abandonment bunds. • Pit wall stability assessments inform abandonment bund locations. Where pit walls do not allow abandonment bunds to be located outside the ZOI, buttressing may be considered. • AMD will be controlled generally in accordance with the procedures outlined in Section 7.5.1. • Fibrous material will be placed beneath at least 1 m of inert (non-fibrous) overburden cover. • Reasonable duty of care safety control measures (such as fencing and signage) will be installed. • Infrastructure that will not be transferred to a third-party post-closure will be decommissioned and removed to a depth of 0.6 m below ground level unless a risk assessment indicates that removal to a greater depth is required, or a different standard is agreed with stakeholders. • Security measures will be regularly monitored and maintained during the post-closure monitoring and maintenance period.
Tools (Processes, procedures, plans used to guide and inform the planning of management actions)	• Materials characterisation information is incorporated into mining models (Section 5.3). • Mines Closure Design Guidance Procedure (WAIO, 2022f). • Master Area Design Review Process. • Pit wall stability assessments inform abandonment bund locations. • Geological model (highlights fault zones). • Geotechnical pit model informs pit design. • Assessment of compliance to plan.
Improvement Activities (Further studies based on knowledge gaps)	• Options for safe access post-closure will be considered in closure designs following consultation with stakeholders. • Detailed slope stability analysis and assessment of potential interactions with flood bunds and diversions will inform final abandonment bund locations for mine voids remaining at closure. • Decommissioning and demolition plans will be developed towards the end of the mine life.

7.5.8 Cultural values / post-closure land use

7.5.8.1 Cultural values

Cultural Heritage Management at BHP is driven by the Sustainable Cultural Heritage Framework. The framework is underpinned by four initiatives – legal compliance, scientific research, indigenous engagement, and cultural heritage education – with three key objectives:

- Comply with the current Aboriginal Heritage legislation and internal BHP standards.
- Guide the heritage approvals process by addressing key gaps in the knowledge base.
- Create a positive heritage legacy for future generations.

Comprehensive archaeological and ethnographic surveys are undertaken to identify sites of cultural significance prior to ground disturbing activities (Section 5.14).

There is the potential for closure works to impact on sites of cultural significance via direct or indirect disturbance (e.g., erosion). All activities that require land disturbance, including during decommissioning and rehabilitation, will be authorised by BHP (currently via the Project Environmental and Aboriginal Heritage Review (PEAHR) procedure (WAIO, 2023b)). For each planned disturbance area, the following details are addressed in the PEAHR form:

- A summary of the proposed disturbance activities;
- A plan showing the location of the proposed works;
- The anticipated environmental, land access and Aboriginal heritage impacts; and
- Specific management measures, where necessary.

The primary mechanism for protection of cultural heritage sites identified as being significant at Jimblebar Hub will be avoidance of identified sites. Any post-closure issues (including ongoing management) relevant to these sites will be determined in consultation with the relevant Nyiyaparli people through the stakeholder engagement process (Section 4). Discussions will also include:

- The opportunity to repatriate artefacts that have been collected and stored during the mining process, if required.
- Options for closure designs to provide safe access to sites of importance post-closure.
- Cultural values and potential closure designs to incorporate / retain these values.

All work will be conducted in compliance with the current Aboriginal Heritage legislation and in accordance with BHP's comprehensive agreement with the Nyiyaparli people.

7.5.8.2 Post-closure land use

As discussed in Section 6, stakeholder views and the appropriateness / feasibility of different land uses will change over time and requires further investigation over the life of mine. BHP's ongoing stakeholder consultation program will enable future land use

options to be identified and studied in further detail throughout the mine's life, and detailed land use-specific performance objectives and completion criteria to be developed.

As the site approaches closure, discussions will be held with key stakeholders to determine whether they have a requirement for site infrastructure post-closure. In the event that infrastructure is to be transferred to third parties, a condition assessment of the infrastructure will be conducted, and the condition of the infrastructure to be transferred will be agreed in writing. Following agreement, the infrastructure (including responsibilities for ongoing management and maintenance) will be formally transferred to its new owner.

7.5.8.3 Summary of management measures

Based on the current state of knowledge, heritage and post-closure land use considerations for Jimblebar Hub will be managed as outlined in Table 7-12

Table 7-12 Cultural value and post-closure land use management actions, tools and forward actions

Management Actions (Physical actions undertaken during operational and during closure phase to enable closure outcomes)	• Consultation with Traditional Owners (as part of the program outlined Section 4.2) to inform the development of closure strategies and associated completion criteria to address heritage and cultural values which could include, but not necessarily be limited to: - Closure landform designs. - Pit closure strategies. - Maintaining access to sites of significance. - Repatriation of artefacts. • Consultation with post-mining landowners / managers to inform post-mining land use objectives and completion criteria. • Where infrastructure is to be transferred to a third party, condition assessments will be conducted, and the condition of the infrastructure to be transferred will be agreed in writing.
Tools (Processes, procedures, plans used to guide and inform the planning of management actions)	• Archaeological and ethnographic surveys (Section 5.14). • PEAHR procedure (WAIO, 2023b). • Consultation program (Section 4.2). • Post-closure monitoring and maintenance program (Section 10) confirms post-closure land management requirements.
Improvement Activities (Further studies based on knowledge gaps)	• Consultation with Traditional Owners. • Consultation with post-mining landowners / managers. • Assess options for post-mining uses of pit lakes. • Refinement of post-mining land use objectives (including creation of special places) and completion criteria following stakeholder consultation. • Consider the Nyiyaparli people's principles for closure in the development of the backfill strategy for Jimblebar Hub and landform designs.

7.6 Forward work program

Section 7.5 provides an overview of closure issues, modelling and assessment and management initiatives which BHP will undertake to progress closure planning during the life of the Jimblebar Hub. Section 5 discusses the baseline knowledge that BHP currently has regarding the Jimblebar Hub and relevant closure design studies, it also discusses the knowledge gaps which have been identified. Based on the knowledge gaps and improvement activities identified in these sections, Table 7-13 summaries the activities we will undertake to fill gaps in the existing knowledge base and further define the closure methodology.

Table 7-13 Forward work program

Technical Area	Knowledge gap	Proposed improvement activity	Indicative timing	Justification for timing
CONSULTATION				
Government and stakeholder consultation	Stakeholder views	Consultation will continue to be undertaken with identified stakeholders in line with the broader stakeholder consultation program. Information sought will include over time: • Post mining land use performance objectives and requirements for safe access. • Requirements for infrastructure post-closure. • Visual amenity.	Ongoing	Ongoing consultation as outlined in Section 4.2 aligns with DMIRS (2020b) guidelines that advocate early and continuous engagement with stakeholders. The socio-economic and environmental issues that are required to be addressed in closure, and the views of stakeholders change over time. Failure to consult means that stakeholder views on the protection of cultural values, post-mining land use, and associated completion criteria may not be recognised. Given the long mine life and established stakeholder engagement strategy (Section 4.2), these knowledge gaps are considered low risk.
	Nyiyaparli people's views	Consultation will continue with Traditional Owners as part of the broader Stakeholder Consultation Program. Information sought will include over time: • Cultural values. • Requirements for protection, management and post-closure access to sites of cultural significance. • Management of cultural artefacts. • Nyiyaparli people's views of rehabilitation and post-mining land use. • Landform and rehabilitation designs including creation of special places.	Ongoing	
COMPLETION CRITERIA				
Completion Criteria	Measurable metrics based on site specific data.	Continue to review and refine completion criteria and integrate findings from ongoing research and development programs including landform trials, rehabilitation monitoring programs, and consultation with stakeholders.	Ongoing	This timing aligns with the DMRS (2020b) guidelines which state that completion criteria should be reviewed and refined throughout the development and operation of the project to respond to monitoring, research and trial information. The Jimblebar Hub is a long-lived operation and there is significant knowledge that may be obtained over this time which can inform completion criteria. Given the progress to date, and the long mine life, the risk associated with this data gap is considered to be low.

Technical Area	Knowledge gap	Proposed improvement activity	Indicative timing	Justification for timing
MATERIALS CHARACTERISATION				
Physical Characterisation	Erosion characteristics of key lithologies and competent overburden balance.	Further investigations will be conducted over the life of mine to assess the erosion characteristics of key lithologies at Jimblebar Hub and the volumes of competent overburden available for use in rehabilitation.	Ongoing	The timing of this program is appropriate as: • Some lithologies may only be accessed for bulk sampling and testing at certain times during mining. • The final landforms remaining post-closure will be influenced by refinements to mine plans and the backfill strategy.
	Tailings physical characteristics and settlement / consolidation behaviours	Jimblebar tailings will be further tested during operations to confirm physical characteristics.	Ongoing	The timing of this program is dependent on the commissioning of the full-scale beneficiation plant and is appropriate to enable any changes in assumed properties to be identified.
Geochemical Characterisation	Refine understanding of hazards associated with AMD 2 and 3 materials and mobility of metals under variable environmental conditions.	As part of a BHP-wide geochemical program: • Further assessments will be conducted into the geochemical hazards associated with AMD 2 and 3 materials. • Targeted leach test work will be conducted to assess metal mobility under variable environmental conditions.	Next scheduled statutory MCP update	Sample availability will dictate when these tests can be implemented. BHP collects samples from exploration / infill drilling activities. As drilling occurs, appropriate samples will be selected for test work. In addition, to enable progress against the proposed work plan, geochemical samples from similar stratigraphies, sulphur / acid neutralising capacity as those expected to be mined from Jimblebar Hub, will be sourced from other drilling programs across other Pilbara sites. The mineralogy and geochemical behaviour of mine overburden from similar geological formations are not expected to have material differences. Thus, BHP will leverage data and sampling opportunities from analogue sites.
	Priorities for monitoring OSAs / ISAs storing AMD 1.	BHP is reviewing OSAs / ISAs across the Pilbara based on storage of AMD 1 materials to identify priorities for AMD monitoring.	Next scheduled statutory MCP update	The assessment of high risk OSAs is in progress.
	Refinement of understanding of AMD from wall rock exposures of PAF material.	Further assessment of the short- and long-term risks associated with wall rock exposures of PAF material above the level of backfill and to pit lakes, and implications for closure including the need to manage PAF wall rock exposures.	Next scheduled statutory MCP update	Work to date has shown that the acidity generation rates from wall rock are low. The risk associated with this data gap is, therefore, considered to be low.
	Further characterisation of South Jimblebar and East Jimblebar deposits.	Additional geochemical testing of material from the East Jimblebar and South Jimblebar (Sylvania and Capricorn) deposits.	Ongoing	WAIO's mine planning processes characterise overburden as part of the ongoing resource drilling and mine planning processes. The timing of this study is driven by the resource drilling programs. Given WAIO's embedded processes, the risk associated with this data gap is considered low.
	Confirmation of geochemical characteristics of tailings	Jimblebar tailings will be further tested during operations to confirm geochemical characteristics.	Ongoing	The timing of this program is dependent on the commissioning of the full-scale beneficiation plant and is appropriate to enable any changes in assumed properties to be identified.

Technical Area	Knowledge gap	Proposed improvement activity	Indicative timing	Justification for timing
LANDFORMS				
Landform design	Mine void closure strategy	Review and optimisation of the backfill strategy to reduce the risks associated with landforms constructed of material that is prone to erosion, or adjacent to flood plains and consider: • The future use of pits for storage of tailings. • Outcomes of groundwater modelling. • AMD studies. • Pit lake assessments. • Nyiyaparli people's principles and preferences for closure.	Next scheduled statutory MCP update	The backfill strategy requires continual review based on the outcomes of studies into the future requirements for tailings storage, and groundwater, surface water and AMD studies. The backfill strategy can impact post-closure groundwater levels, pit lake formation and pit lake quality. BHP acknowledges the Nyiyaparli people's stated preference for the avoidance of pit lakes and has placed a high priority on progressing this study.
	Final landform designs	Progressively develop final landform designs considering erosion modelling outputs, historical performance of comparable areas, Nyiyaparli people's principles for closure, and following consultation with stakeholders, options for safe access post-closure and visual characteristics.	Progressively during operations and prior to final executable design for each area	WAIO's mine planning processes characterise overburden at a high level as part of the ongoing resource drilling and mine planning processes. The outcomes of this process are integrated into the Master Area Design (Sections 5.3 and 7.5.4). The final landforms remaining post-closure will be influenced by refinements to mine plans and the backfill strategy. Given the long life of the Jimblebar Hub, the timing for this program is therefore appropriate.
	Conceptual design studies for new proposed in-pit TSFs.	As locations for new in-pit TSFs are confirmed, studies will be progressed to develop conceptual designs for closure. These will include: • Consideration of the tailings characteristics (geochemical and physical) and pit wall exposures of PAF material. • Surface water catchments impacting on TSFs and need for surface water management measures. • Consideration of the outcomes of detailed design studies for De Grey and Swan in-pit TSFs and the monitored behaviour of the tailings in these pits during deposition. • Consolidation behaviour and implications for placement of any cover systems. • Material types and volumes required for any cover systems. • Consultation with Nyiyaparli people regarding the final landform design, acknowledging the Nyiyaparli people's preference to backfill to surface or create water gaining sites.	Update to be provided in the next scheduled statutory MCP update	The timing for this program is appropriate as additional pits (to Swan and De Grey) to be used for in-pit storage of tailings have not yet been confirmed. Initial deposition into the proposed De Grey and Swan in-pit TSFs will occur for 3 to 5 years, and an update of the MCP will be submitted prior to the commissioning of any new in-pit TSFs and will include relevant design information arising from this forward work program.

Technical Area	Knowledge gap	Proposed improvement activity	Indicative timing	Justification for timing
Landform design continued	Refinement of De Grey and Swan in-pit TSF closure designs	Progressively review and refine closure designs for the De Grey and Swan in-pit TSFs based on: • Consolidation modelling for the DPS (in progress) and subsequent monitoring and model validation during operations. • Review of options to enhance tailings settlement and drainage to reduce the timeframe over which closure works can be safely executed. • Seepage modelling (in progress) and pre-closure monitoring of groundwater to confirm / refine groundwater impact assessment. • Cover material characteristics.	Over life of asset	The timing for this program is appropriate as the behaviour of tailings during deposition is required to inform the detailed cover design. New information will be incorporated into future iterations of this MCP as it becomes available.
Stability	Slope stability of residual voids remaining post-closure.	Detailed slope stability analysis of final mine voids to inform final abandonment bund locations and the placement of permanent infrastructure, and identify the need for backfilling or buttressing. Abandonment bund design will also consider interaction with flood bunds.	5 years prior to completion of mining	The timing for this study is appropriate given that final pit designs will not be known until closer to closure. The risk associated with failing to identify this data gap in the early stages of the Jimblebar Hub's mine life is low.
		Swan and De Grey pit wall stabilities will be further assessed as part of the tailings storage DPS.	Update to be provided in the next scheduled statutory MCP update	The timing of this program is linked to the completion of the DPS and was in-progress at the time of writing.
WATER				
Hydrogeology	Refine understanding of long-term groundwater and pit lake behaviour.	Refinement of conceptual and numerical modelling as new data becomes available and the backfill strategy evolves, and further analysis of: • Post-closure groundwater levels. • Residual pit lake quality, including the potential impacts of the in-pit TSFs on the OB31 pit lake quality. • The impacts / risks associated with pit lakes.	In accordance with Groundwater Licence requirements	The timing for the update of the conceptual and numerical groundwater models is appropriate, as groundwater is routinely monitored during dewatering and conceptual and numerical modelling is updated as required by groundwater licences when new information becomes available.
Surface water hydrology	Flood characteristics of final landform	Update flood modelling for closure conditions, as required to inform the closure designs for surface water management infrastructure.	5 years prior to completion of mining	There are likely to be changes to mine infrastructure and the final mine landform design over the life of mine. The timing of this work program is, therefore, appropriate to take account of these changes.
	Flood bund / diversion designs for closure.	Complete detailed closure designs for the flood bunds and diversions.	5 years prior to completion of mining	The timing of this task is dependent on the final mine footprint and location and performance of the operational flood bunds / diversions.

Technical Area	Knowledge gap	Proposed improvement activity	Indicative timing	Justification for timing
Surface water hydrology continued	Surface water monitoring data	The surface water (and riparian vegetation) monitoring program for Jimblebar Hub will be reviewed, and if appropriate revised, to assess its suitability to inform closure and assess achievement of completion criteria	2027	This timing will enable the collection of sufficient data to inform closure planning and completion criteria.
REHABILITATION				
Progressive rehabilitation	Sources of growth media to address topsoil deficit.	Identification of appropriate growth media and research on methods to address topsoil deficit as rehabilitation of landforms progresses.	Ongoing	The potential for overburden materials to be used as growth media is assessed as part of materials characterisation assessments informing landform designs at both Jimblebar Hub and other mines. These assessments have provided a database of knowledge that can be drawn on for rehabilitation programs. Progressive rehabilitation monitoring also provides data on the suitability of different growth media types. Some site-specific assessment of potential alternative growth media has been conducted at Jimblebar Hub on a range of materials and all have been assessed as benign from a plant growth perspective (Section 5.5.4). In addition, BHP has been conducting rehabilitation research across its Pilbara operations (Appendix F) and is continuing to research options for addressing topsoil deficits (Section 5.5.4). The timing of this program is, therefore, considered to be appropriate.
	Opportunities for reducing potential impacts to conservation significant species.	Review: • Opportunities for providing habitat for conservation significant species during rehabilitation. • Early opportunities to rehabilitate the northern side of the OB31 OSA to minimise impacts to the adjacent Priority 1 flora species.	Ongoing	The timing of this program is necessarily driven by the availability of sites for progressive rehabilitation and the development timeframe of OB31 OSA. BHP has significant rehabilitation experience and research to draw on from its Pilbara mining operations (Appendix F). The timing of this program is therefore considered to be appropriate.
	Opportunities for encouraging fauna return to rehabilitation	Research program to investigate fauna habitat and the return of fauna to rehabilitated areas including consideration of key species of significance to the Nyiyaparli people. BHP is in the process of reviewing its rehabilitation monitoring procedures to determine how fauna use of rehabilitated areas can be integrated into the monitoring program.	Update to be provided in the next scheduled statutory MCP update.	The research program is currently being developed and the timing is driven by the completion of the planning and implementation of the program. Updates will be provided as elements of the program are completed.

Technical Area	Knowledge gap	Proposed improvement activity	Indicative timing	Justification for timing
Progressive rehabilitation continued	Optimising revegetation establishment.	Use the results of research to inform future rehabilitation including: • Utilise the results of seed and tube stock research / trials and work with the Nyiyaparli rehabilitation team to inform the revegetation strategy. • Conduct a review to identify appropriate species for use in pits with backfill to surface. • Keeping a watching brief on research associated with the appropriate use of out of provenance seed source to increase genetic diversity to provide resilience to climate change.	Update to be provided in the next scheduled statutory MCP update.	This work is part of ongoing research programs. The timing is driven by the completion of these programs. Updates will be provided as programs are completed.
	Progressive rehabilitation	Locations which may be available for a minimum of five years will be investigated for rehabilitation / landform trials and incorporated into the 5-year plan.	Ongoing	The timing of this program is necessarily driven by the availability of sites for progressive rehabilitation. WAIO has significant rehabilitation experience to draw on from its Pilbara mining operations (Appendix C and Appendix F), including rehabilitation sites at Jimblebar Hub (Section 9.3.1). The risk associated with this data gap is, therefore, considered to be low.
		Monitor the performance of rehabilitated landforms to validate design assumptions and inform future rehabilitation practice during operational life of mine.	Ongoing	Continual review of the performance of rehabilitated landforms is part of BHP's adaptive management approach (Appendix C).
CONTAMINATED SITES				
Potentially contaminated sites	Contamination assessment and remediation is incomplete for known and suspected contaminated sites.	Contamination assessments are undertaken as per BHP's contaminated site management strategy including assessment and remediation of known contamination (including PFAS).	In accordance with the risk-based schedule agreed with DWER (see Section 5.12)	BHP prioritises and agrees the investigation and remediation of sites with DWER according to risk. The timing of this study is, therefore, considered appropriate.
POST-CLOSURE LAND USE AND DECOMMISSIONING				
Post-closure land use	The post-mining land use has yet to be confirmed. Assumed land uses have been proposed in Section 6.	Consultation with post-mining landowners / managers to inform post-mining land use objectives and completion criteria. Assess options for post-mining uses of pit lakes.	Ongoing	The provisional post-mining land use reflects that of the underlying tenure and the surrounding area. The Jimblebar Hub is a long-lived operation and consequently the socio-economic context of the area is likely to change over this time. BHP has developed a strategic plan for the ongoing investigation of post-mining land uses during the life of mine. As potential productive post-mining land uses emerge, these will be investigated and incorporated into the MCP, as appropriate.

Technical Area	Knowledge gap	Proposed improvement activity	Indicative timing	Justification for timing
Decommissioning plans	Detailed decommissioning and demolition plans for site infrastructure not required to be transferred to third parties.	Decommissioning and demolition plans will be developed towards the end of the mine life.	Within 5 years of closure	The Jimblebar Hub is a long-lived operation. BHP conducts regular reviews of closure demolition requirements to update the closure provision. The timing for more detailed planning is, therefore, appropriate.

8 Closure outcomes and completion criteria

In line with BHP's Charter, we demonstrate environmental responsibility by minimising environmental impacts and contributing to enduring benefits to biodiversity, ecosystems and other environmental resources.

8.1 Closure and rehabilitation standards

BHP employs its Closure and Rehabilitation Standards (WAIO, 2020a; BHP, 2021b) across its Pilbara sites. The Closure Standard provides the overarching framework for the development of the mine closure strategy and supporting closure provision. The Rehabilitation Standard provides the overarching framework for successful rehabilitation of areas impacted by BHP operations in the Pilbara.

The Standards provide a consistent approach for closure and rehabilitation across BHP's Pilbara operations.

8.2 Closure outcomes and guiding principles

The BHP closure and rehabilitation objective is to:

Develop a safe, stable, non-polluting and sustainable landscape that is consistent with key stakeholder agreed social and environmental values and aligned with creating optimal business value.

To guide the development and implementation of mine closure and rehabilitation, BHP has established a set of guiding closure principles which are applied to the Jimblebar Hub mining operations. These are outlined below and future iterations of the MCP will incorporate a review against the Nyiyaparli closure principles

- **Informed planning and design**: rehabilitation and decommissioning requirements are considered at a mine deposit and regional scale, upfront and integrated into mine plans to achieve optimal business value and a sustainable post-mining land use.
- **Sustainable post-closure land use**: post-mining land use and rehabilitated areas meet stakeholder expectations and consider the following:
  - Local land management practices;
  - Ongoing management requirements (e.g., roads and tracks);
  - Closure landform integration, including visual impacts, landform stability (physical and geochemical) and hydrological regimes;
  - Local baseline conditions (e.g., flora, vegetation, fauna and fauna habitat);
  - Ecosystem resilience in terms of flora, vegetation, fauna, and surface and groundwater conditions;
  - Infrastructure transfer or decommissioning;
  - Management or remediation of contaminated sites; and
  - Amenity.
- **Safety**: all mine rehabilitation and decommissioning is planned so that the risks to health and safety of people within BHP's area of influence are minimised. Unauthorised public access risk would be managed through the implementation of controls in accordance with regulatory requirements and consideration of industry guidance.
- **Effective stakeholder engagement**: transparent and proactive stakeholder engagement occurs for all planned activities that may impact surrounding communities, including consideration of communities impacted by closure.

Rehabilitation and revegetation activities undertaken at Jimblebar Hub will be targeted at the post closure land uses described in Section 6 and developed to function in line with the two or three star outcomes as described in SERA (2021), meaning the rehabilitation outcome will: *reinstate a level of ecosystem functionality on degraded sites where ecological restoration is not the aspiration, as a means of enabling ongoing provision of ecosystem goods and services*. This is consistent with the SERA (2021) definition of a rehabilitated outcome and the level of landscape disturbance at Jimblebar.

The objective and guiding closure principles provide the foundation for developing site specific completion criteria for the Jimblebar Hub operations as outlined in Section 8.3.

8.3 Completion criteria

Completion criteria are defined in the DMIRS (2021) Mine Closure Completion Guideline as *providing the basis on which successful rehabilitation and mine closure are determined* and so enable formal acceptance that rehabilitation and closure obligations agreed to in an approved MCP have been met. The DMIRS guideline has been developed for rehabilitation and closure obligations under the Mining Act 1978. However, in the absence of specific guidance for rehabilitation and closure obligations arising from a Part IV EP Act approval, it can provide a general template for achieving completion of these sites and be submitted in support of a request for withdrawal of a Ministerial Statement under Section 47A of the EP Act.

The process of 'completion' is a pre-cursor to, but separate from, the process to relinquish or surrender tenure (discussed further in Section 10.4). Once completion has been achieved, monitoring, inspection and any maintenance activities can be reduced from those necessary to achieve and demonstrate completion, and would be commensurate with those required post-

relinquishment. Following completion or withdrawal of a Ministerial Statement under the EP Act, DEMIRS / DWER can also determine that submission of AERs and MCPs is no longer required. The DMIRS (2021) guideline provides for progressive completion reporting and sign-off as portions of mine disturbance are rehabilitated and completion criteria achieved. Given the long life of the Jimblebar Hub, the timeframe between completion of certain areas and relinquishment of tenure may be significant if mining activities are still occurring on parts of the tenure. Section 10.4 deals with completion reporting and relinquishment and the intervening period (referred to as post-completion).

Several terms have been used in this section to define the time between operations and completion as follows:

- Operations refers to the time when active mining or processing operations are occurring. Most of the planning for closure occurs during this time.
- Execution refers to the phase where closure and rehabilitation activities are conducted. Progressive closure execution may occur during the operational phase following cessation of mining / processing in a particular area.
- Post-closure refers to the time following execution of closure and rehabilitation where the success of closure and rehabilitation is being monitored and maintenance / rectification of areas not on track to meet completion criteria might occur.
- Completion refers to the time where achievement of completion criteria can be demonstrated and sign-off achieved.
- Post-completion refers to the period following completion but prior to relinquishment of tenure.

Completion criteria are the measures against which implementation of the closure objective and guiding principles can be assessed. BHP continues to actively review and improve its completion criteria based on new information and techniques. Recent studies informing completion criteria include a review of vegetation completion criteria by Syrinx Environmental (2019; 2023) and guidance on acceptable erosion rates for landforms in the Pilbara by Landloch (2018). The criteria developed by Syrinx and Landloch have been incorporated into those presented in Section 8.3.1. The full suite of criteria will be further refined based on new knowledge gathered during the life of the mine, and these refinements will be presented in future iterations of this plan.

In recognition that progressive closure is desirable to reduce the impacts of mining, BHP closes and rehabilitates landforms where this is practical and can be accommodated within mine plans. As discussed above, completion criteria will be refined over the life of mine. The completion criteria applicable to landforms rehabilitated at various times may, therefore, be different as criteria change in response to new knowledge.

8.3.1 Approach

BHP recognises that closure outcomes are controlled by planning, design and execution activities. BHP's criteria, therefore, include both leading indicators describing the activities and designs necessary to achieve desired outcomes (e.g., landforms have been designed and constructed to take account of overburden characteristics affecting stability), as well as lagging indicators (completion criteria) which describe closure outcomes to be achieved (e.g., total hummock grass cover to be 14-25%).

Closure and rehabilitation objectives and criteria are based on the land uses applicable to a particular area, in recognition of the fact that the land is altered fundamentally from its pre-existing condition. The completion criteria for the Jimblebar Hub operations are based on an assumed outcome of a combination of *'natural environments for managed resource protection*' and '*relatively natural environment for pastoral grazing purposes'* (Section 6.2).

The purpose of completion criteria is to provide clarity on the characteristics that will make it suitable for the post-mining land use and give Government regulators confidence that, to the maximum possible extent, the land can be managed in the long term according to the intended land use (or uses), using normal management practices without the input of additional resources.

The criteria outlined in Section 8.3.1 apply to the most common rehabilitated landforms, they do not apply in some specific or unusual circumstances, or where post-closure land uses other than natural environments for managed resource protection and / or grazing are required. Circumstances may arise whereby unusual landforms are constructed that may require additional completion criteria or different thresholds. These include instances where impacts encroach on unique vegetation and hydrologic systems (e.g., riparian areas, Mulga woodlands) or specially valued ecological communities (e.g., TECs, PECs). Many impacts by BHP's Pilbara mining operations avoid these requirements.

Criteria have been defined based on successive stages of closure; the criteria outlined in Section 8.3.1 have been divided into three stages. The first two stages are performance indicators that are aimed at providing assurance that completion criteria will be met and guide appropriate planning and execution of closure:

- **Stage 1 Planning**: describes a level of performance that will assure BHP that the necessary planning and operating procedures have been developed and supported by regulators and other relevant stakeholders.
- **Stage 2 Execution**: describes criteria that must be met to confirm that rehabilitation operations have been substantially implemented according to the plans and operating procedures developed during Stage 1. The assessment method for this would be by reviewing and auditing closure execution records and site inspections, as required.

The **Stage 3 Completion Criteria** are the criteria which, when met, indicate that closure and rehabilitation has achieved an acceptable standard and is suitable for the defined post-closure land use. These are the criteria that would be measured to support a completion report.

In line with the WABSI completion criteria framework (Young, et al., 2019), BHP has correlated the inherent risk ratings relevant to each set of criteria to assist in prioritising focus on those criteria of most importance.

Completion criteria standards and milestones will be formally reviewed every five years and, where necessary, they will be revised to integrate findings from ongoing research and development programs including landform trials, rehabilitation monitoring

programs, and consultation with stakeholders. Future revisions of the criteria will focus on developing and refining measurable metrics based on site specific data.

8.3.2 Completion criteria and performance indicators

The completion criteria for Jimblebar Hub are presented in Table 8-1. For clarity, column headings are designed to broadly align with WABSI guidelines for completion criteria (Young, et al., 2019) and are defined as follows:

- **Aspect:** A key theme or element of rehabilitation that needs to be addressed in order to meet closure objectives.
- **Criterion Objective**: The purpose or objective of the particular criterion. As defined in Young et. al, (2019) the closure objective provides a clear indication on what the proponent commits to achieve at closure.
- **Risk ID:** Refers to the Risk ID in Table 7-3, Section 7. Where more than one risk relates to a particular set of criteria, this has been shown in the Risk ID column, and the specific domains to which each risk relates are outlined in the adjacent domain column. The colour coding relates to the colour coding used in Table 7-3 for the inherent risk rating, i.e.,

High	Moderate	Low	Very Low	Risk Currently N/A

- **Domain**: Areas of similar operational land uses that have similar closure requirements and to which a particular completion criterion relates. Additional information relating to closure implementation for each closure domain is provided in Section 9.2.
- **Performance Indicator**: A level of performance through planning and execution that provides assurance that completion criteria will be met.
- **Completion Criterion**: A defined standard or level of performance that can be objectively verified and demonstrates successful closure of a site for a particular objective.
- **Verification Procedure**: The method used to confirm that the identified standard for the criterion has been achieved. As outlined by DMIRS (2021), verification may rely on quantitative measurements or could be a process of certification, for example, compliance with an approved design. Verification processes have been identified for the planning, execution and completion phases of closure. The completion phase is the phase during which a completion report would be developed to support sign-off against completion criteria in accordance with DMIRS (2021).

Consistent with the WABSI completion criteria guidance (Young, et al., 2019), completion criteria can incorporate qualitative measures as well as quantitative numerical targets. Young et. al (2019) identifies three types of criteria which have been used in the development of the criteria outlined in Table 8-1:

- P - installed / built as planned. For example, habitat features have been installed / constructed as planned / designed.
- C - categorical - a feature is present or absent, or an activity has been achieved or not. For example, overburden materials with adverse geochemical properties are not exposed on OSAs.
- Q - quantitative - the attribute can be measured and compared against a numerical target. For example, total hummock grass cover to be 14-25%.

The qualitative categorical and installed / built as planned criteria can be measured by audit, inspection or survey whereas quantitative criteria would typically be measured through a specific environmental monitoring program. These monitoring and measurement / verification programs are described in Section 10.

Table 8-1 Jimblebar Hub completion criteria

Aspect	Criterion objective	Risk ID	Domain	Performance indicators[38]		Completion (Stage 3)[38]	Verification procedure	MCP section
				Planning (Stage1)	Execution (Stage 2)			
C1 Post-closure land use								
C1.1 Post-mining Land Use	Post-mining land use has been informed by consultation with relevant stakeholders	R19	All	Post-completion land use has been informed by consultation with key stakeholders (C). Specific rehabilitation objectives, including requirements for safe access, have been developed so that, when met, areas will fulfil the post-completion land use requirements (C). Rehabilitation objectives have been informed by consultation with post-mining land users / owners (C). Mine closure designs have been developed to meet rehabilitation objectives (C).	Mine closure execution is conducted substantially in accordance with designs (P).	Monitoring, inspection and / or survey reports demonstrate that the rehabilitation objectives have been substantially met. These are the measures that the post-mining land use has been met (C). The current assumed post-mining land use is related to underlying tenure (pastoral and unallocated crown land) and achievement of the criteria for land management (C1.3), stability (C3.2- C3.4), revegetation (C4.1 to C4.5) and water (C5.1 to C5.4) will indicate that this criterion has been met (C).	**Planning** Documented approval of land use performance objectives from end landowners / managers and administering authority. Mine closure design review. **Execution** As-constructed report, or post-construction survey or inspection report. **Completion** Post-closure monitoring and survey reports. Landowner / manager provides written acknowledgement that rehabilitation objectives and completion criteria have been met.	6.2 Post-closure land use 7.5.8 Cultural values / post-closure land use 10.1.1 Closure completion audit and inspection
C1.2 Infrastructure	Infrastructure has been decommissioned and removed where transfer to a third party is not agreed.	R19	All where infrastructure exists	Agreement has been reached with government and other stakeholders (including post mining landowner / land manager) regarding the infrastructure to remain post-mining (C). The agreement includes condition of infrastructure at transfer (C). The depth of removal of in-ground infrastructure has been informed by the risks to post-mining land uses and consultation with the landowner / land manager and is specified in demolition plans (C). Waste disposal requirements and locations have been informed by consultation with key stakeholders and incorporated into decommissioning and demolition programs (C).	Unless otherwise agreed with stakeholders, infrastructure has been removed to 0.6 mbgl (C). Infrastructure removal is generally in accordance with demolition specifications (P). Remaining infrastructure condition has been assessed and referenced in stakeholder agreements (P). Waste disposal plans have been implemented (P).	Stakeholders agree to the transfer of infrastructure ownership and accept ongoing responsibility for maintenance of the infrastructure (C). In-ground infrastructure has been removed to 0.6 mbgl unless (C): • An alternate standard has been agreed with the post-mining landowner / manager. • Risk assessment indicates that a different specification is required.	**Planning** Demolition plan outlining infrastructure to be removed and standard of demolition (including extent to which concrete foundations and buried services will be removed). Documented agreement on infrastructure to remain and condition of infrastructure at transfer. **Execution** Demolition contractor's report against agreed standard. Condition assessment report of remaining infrastructure. Waste disposal records. **Completion** Completion audit of demolition contractor's report against agreed standard. Site inspection report following demolition. Documented transfer of infrastructure to stakeholders.	7.5.7 Site safety and security 9.2.3 Infrastructure, road and rail 10.1.1Closure completion audit and inspection
C1.3 Land Management	Long-term management requirements have been addressed.	R19	All	The long-term management requirements of the closure strategy and alignment with the post-mining land use have been considered (C). Post-completion land management requirements have been defined through the post-closure monitoring and maintenance program and contaminated sites assessment (C). Where active management is likely to be required, land use representatives agree on the level of effort required to actively manage the site post-completion (C).	Post-completion land management plan has been developed (C).	At the time mine closure is considered complete, site land management requirements are aligned to the post-completion land use and / or approved closure strategy (C). If additional management actions are required post-completion, these will have been agreed with the landowner / manager (C).	**Planning** The final closure strategy has been informed by consultation with post-mining land managers / owners. Report of the monitoring and maintenance activities required during the post-closure phase. **Execution and Completion** Closure strategy achieved as demonstrated by achievement of post-mining land use criterion C1.1 Post-completion land use management plan. Documented agreement of additional active management measures required post-completion.	10.1.1Closure completion audit and inspection 10.4 Completion and relinquishment

[38] Letters in brackets refer to the attribute types identified in Young et. al. (2019): P (installed / built as planned); C (categorical – the feature is present or absent or the activity has been achieved or not); Q (quantitative, the attribute can be measured and compared against a numerical target).

Aspect	Criterion objective	Risk ID	Domain	Performance indicators[38]		Completion (Stage 3)[38]	Verification procedure	MCP section
				Planning (Stage1)	Execution (Stage 2)			
C2 Safety								
C2.1 Safety	There are no unsafe areas where members of the general public could gain inadvertent access.	R18	All	**All** A hazard assessment of aspects of the closed site that could endanger the safety of any person or animal has been conducted (C). Designs have been developed to eliminate or mitigate identified hazards (C). Decommissioning and demolition plans have been developed for all infrastructure not required by third parties post-mining (C). **Mine void** Pit wall stability assessments inform the location of abandonment bunds (C). **OSAs / ISAs** Materials characterisation has been conducted and any PAF or fibrous materials identified (C).	Abandonment bunding which meets the DEMIRS guidelines (DoIR, 1997) is in place to prevent inadvertent access to mine voids (P). All infrastructure is de-energised and inadvertent access controlled following cessation of operations, and prior to demolition (C). Mine closure and demolition execution are conducted substantially in accordance with designs / plans (P). Fibrous material has been covered with 1 m of non-fibrous inert material (C). The geochemical execution performance indicators (C3.3) have been met (C).	Residual safety and health hazards have been identified and controlled in accordance with regulatory requirements and consideration of industry guidance and are acceptable to the District Mines Inspector (C). The geotechnical and geochemical stability criteria (C3.2 and C3.3) have been met.	**Planning** Mine closure design hazard assessment. Decommissioning and demolition plans. Fibrous materials identified in mining models. DEMIRS endorsement via MCP updates. **Execution** As-constructed report, or post-construction / demolition survey or inspection report. Survey reports / mining records of fibrous and PAF material placement. Audit showing that the geotechnical and geochemical stability execution performance indicators (C3.2 and C3.3) have been met. **Completion** All sites are assessed as acceptable with regards to safety by the District Mines Inspector following execution. Audit showing that the geotechnical and geochemical stability criteria (C3.2 and C3.3) have been met.	7.5.7 Site safety and security 9.1.7 Site security 10.1.1Closure completion audit and inspection 10.1.12 Public safety monitoring
C3 Landforms								
C3.1 Visual Amenity	Visual amenity of constructed landforms is compatible with that of local Pilbara landforms.	R3 R16	All	Within the constraints imposed by aspects such as the physical nature of the materials available, tenement boundaries, and proximity to water courses, landforms have been designed to blend into the surrounding landscape (C). Visual impacts, design constraints and solutions have been discussed with stakeholders, where visual impact is a key concern (C).	Mine closure execution is substantially in accordance with designs (P).	Landforms meet visual design criteria (P).	**Planning** Mine closure design review. Stakeholder consultation records where visual impact is a key concern. **Execution** Report on rehabilitation works confirms landform has been substantially constructed according to design. **Completion** Rehabilitation inspections following execution confirm earthworks have substantially met visual impact design criteria.	7.5.4 Landforms 9.1 Standard closure and rehabilitation strategies 10.1.1 Closure completion audit and inspection
C3.2 Geotechnical Stability	Constructed landforms are safe and geotechnically stable.	R4 R8 R13 R14	OSAs ISAs Mine void Surface water infrastructure	**OSAs** Post-mining landforms have been designed to: • Account for overburden characteristics affecting stability (physical and chemical) and the ZOI of the void (C). • Achieve a Static FoS of ≥1.5 (C). **ISAs** • The stability of ISAs has been designed according to the risk posed by that ISA (C). **Mine voids** • Pit walls have been designed to achieve a static FoS of ≥1.5 where failure to meet this criterion could impact infrastructure designed to remain post-mining (e.g., surface water controls, abandonment bunds) (C). **Surface water infrastructure** • Flood bunds / diversions have been designed to fall outside the ZOI of the pit(s) (C).	Mine closure execution is conducted substantially in accordance with designs (P).	OSAs and mine voids conform to DMIRS (2019) guidelines for structural stability and achieve design FoS criteria (C). Unless otherwise designed, there is no significant slumping or failure of accessible ex-pit constructed slopes or berms (C).	**Planning** Mine closure design review against DMIRS (2019) guidelines. Overburden characterisation and OSA landform design shows target FoS will be achieved. Pit wall stability modelling reports show that the target FoS will be met where post-mining landforms and infrastructure may be impacted by the ZOI of the pit. DEMIRS endorsement via MCP updates. **Execution** Report on landform construction methods following execution confirms construction has substantially met relevant design criteria. **Completion** Results of inspections of the rehabilitated landforms conducted to completion. Report on performance in relation to design criteria and DEMIRS guidelines.	7.5.4 Landforms 9.2.1 Mine voids 9.2.2 OSAs 10.1.1 Closure completion audit and inspection 10.1.10 Landform and erosion monitoring

Aspect	Criterion objective	Risk ID	Domain	Performance indicators[38]		Completion (Stage 3)[38]	Verification procedure	MCP section
				Planning (Stage1)	Execution (Stage 2)			
C3.3 Geochemical Stability	Materials with poor chemical properties do not compromise rehabilitation (landform stability and revegetation) or water quality.	R5 R6 R7 R8 R10 R11	OSAs ISAs Mine voids	**All** Geochemical overburden / tailings characterisation and an AMD risk assessment have been conducted (C). **OSAs and ISAs** PAF material placement practices within OSAs / ISAs have been developed to control the risk of AMD (C). **ISAs** The height of the water table has informed the location of designated AMD 1 cells (C). **Mine voids** Closure designs have been developed to manage PAF wall rock exposures on the basis of risk (C). Where there is potential for the quality of pit lakes to be impacted, a pit lake assessment will be conducted to identify potential impacts and requirements for mitigation measures (C). **In-pit TSF** Cover designs have been developed to control potential impacts of TSF seepage (if required) (C).	**OSAs and ISAs** All PAF material placement has been undertaken generally in accordance with the mine plan, Mines Closure Design Guidance Procedure and landform designs to control the risk of AMD (P). **Mine voids** Overburden or wall rock exposures likely to give rise to AMD have been appropriately managed in accordance with designs (P). **All** Mine closure execution is substantially in accordance with designs (P).	**OSAs / ISAs / TSFs** No evidence of mineral scalds within rehabilitation areas (C). No exposed overburden or tailings with adverse geochemical properties (C). **OSAs** Surface water and groundwater quality completion criteria (C5.2 and C5.4) are met (C). **Mine voids / ISAs / in-pit TSFs** Groundwater quality completion criteria (C5.4) are met (C). **Mine voids:** Pit lake water quality aligns with modelling trajectory, where modelling is required (C)	**Planning** Geochemical overburden and tailings characterisation and risk assessment reports are available for review. OSA and ISA design guidance defines acceptable locations for PAF overburden. Pit lake assessment (where required). Tailings cover design reports. **Execution** Operational survey reports and mining records show PAF overburden has been substantially placed in designated locations and pit wall exposures of PAF material have been managed, if required. Report on tailings cover construction following execution confirms construction to relevant design criteria. **Completion** Visual inspections to completion identify no adverse materials at the surface of OSAs / ISAs or TSFs. Pit lake monitoring to validation of modelled quality. Water quality monitoring to completion.	7.5.1 Acid and metalliferous drainage 9.2.1 Mine voids 10.1.7 Surface water monitoring 10.1.8 Ground water monitoring 10.1.10 Landform and erosion monitoring
C3.4 Surface Stability	The constructed surface is stable and showing no signs of significant erosion or release of sediment causing adverse impacts to drainage lines.	R1 R2 R14	OSAs Surface water infrastructure	Post-mining landform designs have been informed by, and take account of, the following, as appropriate to the landform: • Overburden characteristics (physical and chemical) (C). • Erosion modelling. Modelled average annual erosion rates for OSAs are ≤6 t/ha/yr and maximum erosion rates ≤12 t/ha/yr (Q). • Design rainfall events. OSA landforms are designed to retain the 1 in 200-year rainfall event on the landform and allow the controlled discharge of higher rainfall events to erosion resistant areas (C). • Flood modelling. OSAs are located outside the 1 in 10,000-year flood plain, or designs include appropriate erosion protection (C). Surface water infrastructure has been designed on the basis of hydraulic modelling (C). Appropriate surface treatments have been identified given landform design, post-closure hydrology and available construction materials (C).	Mine closure execution is substantially in accordance with designs (P). Surface treatments (including ripping) have been undertaken to rehabilitated surfaces, if required, to maximise water infiltration, reduce erosion potential, and support establishment of vegetation (P). Overburden likely to provide a poor growth medium (e.g., dispersive and incompetent material), has been placed appropriately in OSAs or backfilled pits (P). Rock armouring is present as required, and no areas are exposed to the risk of significant unplanned erosion (P).	OSA slope surfaces do not show significant unplanned erosion which may be defined as having (C): • Channelised flow resulting in extensive active gullies; • Failure of banks, berms or bunds; and • Evidence of ongoing significant sheet erosion (including large accumulation of silt at base of slope, exposed subsoil, poor seedling establishment). By completion: • The annual average rate of erosion of slopes, flats and crests of OSAs is ≤6t/ha/yr (Q). • The erosion rate at any point on an OSA slope does not exceed the target threshold average rate by more than 100% (Q). Surface water management structures are performing as designed (P). Geotechnical stability completion criterion (C3.2) is met, where applicable (C).	**Planning** Mine closure design review. DEMIRS endorsement via MCP updates. Overburden characterisation and erosion modelling reports. Surface water modelling reports. Surface water management infrastructure design reports including hydraulic modelling and construction material characterisation. **Execution** Report on landform construction, and any additional maintenance works confirm earthworks have substantially met final landform designs. **Completion** Visual assessment and rehabilitation monitoring to completion indicate: • Gullies and rills have stabilised. • There is no evidence of significant sheet erosion. • Average and maximum erosion rates have been achieved. • Surface water management structures are performing as designed.	7.5.4 Landforms 7.5.6 Rehabilitation 9.1 Standard closure and rehabilitation strategies 9.2.3.4 Water management infrastructure 10.1.2 Rehabilitation monitoring methodology 10.1.10 Landform and erosion monitoring
C4 Revegetation								
C4.1 Growth Media	A suitable growth medium has been identified to facilitate plant establishment and growth.	R15	All where revegetation is planned	Topsoil stockpiles have been mapped, volumes calculated, and the relevant plans and databases have been prepared, updated and maintained (C). Available topsoil is assessed against topsoil required for rehabilitation and alternate sources of growth media have been identified where there is a deficit of topsoil (C). Material identified for placement on the outer surface of landforms has been assessed for its suitability as a growth medium and takes into consideration characteristics required to support sustainable vegetation development including structure, water holding capacity, and elements that might affect plant growth or survival (C).	Soil stripping and management have been undertaken generally in accordance with the relevant WAIO Rehabilitation Standards and Procedures (P). Where available and appropriate to meet the landform design requirements, topsoil has been used to provide a suitable medium for plant establishment and a source of propagules (P). Topsoil / growth medium has substantially been placed in accordance with rehabilitation plans (P).	Achievement of vegetation development criteria (C4.2) (C).	**Planning** Topsoil reconciliation information. Growth media characterisation reports. Rehabilitation monitoring results and / or trials provide feedback to determine the suitability of growth medium. **Execution** Report on landform construction. Rehabilitation inspections confirm earthworks have met final landform designs. **Completion** Rehabilitation monitoring results to completion.	7.5.6 Rehabilitation 9.1 Standard closure and rehabilitation strategies 10.1.2 Rehabilitation monitoring and methodology

Aspect	Criterion objective	Risk ID	Domain	Performance indicators[38]		Completion (Stage 3)[38]	Verification procedure	MCP section
				Planning (Stage1)	Execution (Stage 2)			
C4.2 Vegetation Development	Vegetation is suited to the final landform and post-mining land use.	R15	All where revegetation is planned in pastoral lease areas (infrastructure footprints, OSAs, pits backfilled to surface)	Rehabilitation plans and target seed mixes are designed to return target vegetation communities (C).	Rehabilitation is substantially executed in accordance with plans (P).	**Land use: Relatively natural environments for pastoral grazing purposes** • % bare ground (Q): - Hills, slopes, dry plains ≤50%. - Drainage lines and floodplains (excluding channel bed) ≤20%. • Perennial native species richness recorded in aggregated 50 x 50 m plot achieves target % for each target vegetation type (see Appendix K) (Q). • At least one dominant species from each stratum present (Appendix K) (Q). • >50% common species for the target vegetation type present (Q). • Plant cover achieves target % for each stratum and vegetation type (see Appendix K) (Q).	**Planning** Review of rehabilitation monitoring results, and related rehabilitation monitoring procedures. Research reports and findings from trials. **Execution** Rehabilitation execution completion report. Site inspection to confirm rehabilitation has been substantially conducted in accordance with the plan. **Completion** Monitoring of vegetation re-establishment using WAIO rehabilitation monitoring procedures until monitoring shows that the vegetation is on trajectory towards meeting completion criteria.	7.5.6 Rehabilitation 9.1.3 Revegetation 10.1.2 Rehabilitation monitoring methodology
		R15	All where revegetation is planned in areas of unallocated crown land (infrastructure footprints, OSAs, pits backfilled to surface)			**Land use: Natural environments for managed resource protection** • % bare ground (Q): - Hills, slopes, dry plains ≤50%. - Drainage lines and floodplains (excluding channel bed) ≤20%. • Perennial native species richness recorded in aggregated 50 x 50 m plot achieves target % for each target vegetation type (see Appendix K) (Q). • At least one dominant species from each stratum present (see Appendix K) (Q). • >70% common species for the target vegetation type present (Q). • Plant cover achieves target % for each stratum and vegetation type (see Appendix K) (Q).		
C4.3 Resilience	Demonstrated capacity of the site to recover from fire, drought and other disturbances.	R15	All where revegetation is planned (infrastructure footprints, OSAs, pits backfilled to surface)	Seeds to be used in rehabilitation reflect a range of species found in the bioregion (C). Seed requirements for rehabilitation have been identified and appropriate quantities of seed collected from local provenance areas, within the Pilbara IBRA region, to support the five-year rehabilitation plan (C). Rehabilitation techniques are informed by trials, research and monitoring of rehabilitated areas (C).	Rehabilitation is substantially executed in accordance with plans (P). Revegetation has used local provenance native seed from the Pilbara IBRA region (C).	• Flowering and seed production observed in more than one native lifeform (Q). • Different aged plants observed for more than one native species and for all lifeforms (Q).	**Planning** Review of progress and performance from rehabilitation monitoring results, and related rehabilitation monitoring procedures. Research findings from trials on representative rehabilitated areas investigating post-disturbance recovery of revegetation. **Execution** Rehabilitation execution completion report. **Completion** Monitoring of vegetation re-establishment using WAIO rehabilitation monitoring procedures until monitoring shows that the vegetation is on trajectory towards meeting completion criteria.	7.5.6 Rehabilitation 9.1.3 Revegetation 10.1.2 Rehabilitation monitoring methodology

Aspect	Criterion objective	Risk ID	Domain	Performance indicators[38]		Completion (Stage 3)[38]	Verification procedure	MCP section
				Planning (Stage1)	Execution (Stage 2)			
C4.4 Weeds	DBCA priority list weed species to be managed so as not to cause unacceptable risk to surrounding environments.	R15	All where revegetation is planned	Weeds have been monitored and risk-based control plans developed which are compatible with the defined post-mining land use (C).	The requirements of the WAIO Weed Management Procedure have been substantially implemented as demonstrated by reports that populations of weeds have been monitored and controlled based on risk (P).	Priority alert weed species are not present (C), or if present, cover is less than or equal to the surrounding areas (regional baseline) (Q). No new priority alert weed species introduced (C).	**Planning** Review of weed monitoring and control. **Execution** Report on weed monitoring and control records. **Completion** Measurement of weed abundance to completion. Surveys and comparison of priority weed species with regional baseline data.	7.5.6 Rehabilitation 10.1.3 Weed monitoring
	Total weed cover to be typical for each site and landform and reflect post-mining land use.	R15	All where revegetation is planned in pastoral lease areas (infrastructure footprints, OSAs, pits backfilled to surface)			**Land use: Relatively natural environments for pastoral grazing purposes** Total weed cover: • Drainage lines, floodplains <20%. • Upland hills, slopes and flats <10%. Buffel grass cover: • Drainage lines, floodplains <10%. • Upland hills, slopes and flats <10%.		
			All where revegetation is planned in areas of unallocated crown land (infrastructure footprints, OSAs, pits backfilled to surface)			**Land use: Natural environment for managed resource protection** Total weed cover: • Drainage lines, floodplains <15%. • Upland hills, slopes and flats <5%. Buffel grass cover: • Drainage lines, floodplains <10%. • Upland hills, slopes and flats <5%.		
C4.5 Fauna Habitat	Vegetated areas provide fauna habitat	R15	All where revegetation is planned (infrastructure footprints, OSAs, pits backfilled to surface)	Rehabilitation plans consider return of fauna habitat through selection of target vegetation communities and / or constructed habitat features (C). Constructed fauna habitat designs are based on the results of research and trials (C).	Rehabilitation is substantially executed in accordance with plans (P).	Achievement of vegetation development criterion (C4.2).	**Planning** Rehabilitation plans incorporate creation of fauna habitat. Review of research and trials. **Execution** Report on habitat construction. **Completion** Monitoring of vegetation re-establishment using WAIO rehabilitation monitoring procedures until monitoring shows that the vegetation is on trajectory towards meeting completion criteria.	7.5.6 Rehabilitation 9.2.2 Overburden storage areas 10.1.1 Closure completion audit and inspection
C4.6 Impact to Fauna	No significant adverse impact to fauna from pit lakes	R10 R11	Mine voids In-pit TSFs	The planning criteria have been met for geochemical stability (C3.3) (C). Pit lake quality assessments have been conducted (C). A pit lake risk assessment has been conducted and mitigation measures identified, if required (C).	Identified mitigation measures are substantially implemented in accordance with designs (P).	The pit lake risk assessment shows no significant impact to native terrestrial fauna (C). Monitoring shows that pit lake quality aligns with closure risk assessment assumptions (Q).	**Planning** Refer to geochemical stability criteria (3.3). Pit lake quality and risk assessment reports. Risk mitigation design review. **Execution** Refer to geochemical stability criteria (3.3). **Completion** Post completion report on pit lake monitoring and validation of risk assessment assumptions.	9.2.1 Mine voids 10.1.4 Fauna inspection of rehabilitation areas

Aspect	Criterion objective	Risk ID	Domain	Performance indicators[38]		Completion (Stage 3)[38]	Verification procedure	MCP section
				Planning (Stage1)	Execution (Stage 2)			
C5 Water								
C5.1 Surface Water Flows	Rehabilitation drainage patterns have been established and impacts on natural surface water flows are acceptable at key receptors.	R14	Surface water management infrastructure, OSAs, mine voids	Surface water management infrastructure has been provided around closure landforms (OSAs, mine voids) that may capture or significantly impede flow (C). Surface water modelling shows downstream flows are within parameters accepted via project approvals, following implementation of surface water management measures for closure (Q). Hydraulic modelling shows that surface water management infrastructure designs can withstand selected closure design flood events (C).	Mine closure execution is substantially in accordance with designs (P).	Flows at downstream environmental receptors are within model predictions and the parameters accepted via project approvals (Q). Impacts to downstream environmental receptors are within the parameters accepted via project approvals (Q).	**Planning** Surface water assessment and modelling reports. Design review. **Execution** Report on landform construction. **Completion** Surface water flow monitoring to calibration of model predictions. Calibration reports for model predictions. Monitoring of ecohydrological receptor condition to calibration of model. Site inspection to verify no unplanned impacts on surrounding natural drainage patterns or landform failures.	7.5.3 Surface water 7.5.4 Landforms 9.2.1 Mine voids 9.2.2 OSAs 9.2.3.4 Water management infrastructure 10.1.7 Surface water monitoring
C5.2 Surface Water Quality	Surface water quality is acceptable at key receptors.	R2 R5 R6	OSAs	The planning criteria for surface stability (C3.4) have been met (C). The planning criteria for OSA geochemical stability (C3.3) have been met (C).	Mine closure execution is substantially in accordance with designs (P).	Water quality (sediment and chemical) at downstream creek locations (Orebody 31 Creek, Jimblebar Creek, Copper Creek and Innawally Pool) is within limits (Q): • Defined, through the detailed analysis of pre-closure monitoring data from appropriate reference sites, to represent no significant impact to downstream ecohydrological receptors; and / or • Accepted via project approvals or other regulatory processes.	**Planning** Refer to surface stability and OSA geochemical stability criteria (3.4 and 3.3). **Execution** Refer to surface stability and OSA geochemical stability criteria (3.4 and 3.3). **Completion** Surface water quality monitoring to completion. Site inspection to verify that there have been no unplanned impacts associated with sediment transport. Audit of the achievement of contaminated sites criterion C6.1.	7.5.1 Acid and metalliferous drainage 7.5.3 Surface water 7.5.4 Landforms 9.2.1 Mine voids 9.2.2 OSAs 9.2.3.4 Water management infrastructure 10.1.7 Surface water monitoring
C5.3 Groundwater Levels	Groundwater levels are acceptable at key receptors.	R12	Mine voids	Groundwater modelling has been conducted to identify impacts to groundwater levels post-mining (C). Where unacceptable impacts have been identified at key receptors, closure designs, including backfilling if required, have been developed to mitigate these impacts (C).	Mine closure execution is substantially in accordance with designs (P).	Groundwater levels at key receptors are at acceptable levels, defined as closure thresholds in the Eastern Pilbara Water Resource Management Plan[39], and meet land use criteria supported by key stakeholders (Q).	**Planning** Groundwater assessment and modelling reports. Design review **Execution** Report on landform construction. **Completion** Groundwater monitoring to validation of groundwater model and groundwater model validation report.	7.5.2 Groundwater 9.2.1 Mine voids 10.1.8 Ground water monitoring
C5.4 Groundwater Quality	Groundwater quality is acceptable at key receptors.	R5 R6 R7 R8 R9 R13	OSAs ISAs In-pit TSF Mine voids	The planning criteria have been met for geochemical stability (C3.3) (C).	Mine closure execution is substantially in accordance with designs (P).	Groundwater quality is within limits (Q): • Defined, through the detailed analysis of pre-closure monitoring data from appropriate reference sites, to represent no significant impact to downgradient ecohydrological receptors; and / or • Accepted via project approvals or other regulatory processes.	**Planning** Refer to geochemical stability criteria (3.3) **Execution** Refer to geochemical stability criteria (3.3) **Completion** Groundwater quality monitoring to completion. Audit of the achievement of contaminated sites criterion C6.1.	7.5.1 Acid and metalliferous drainage 10.1.8 Ground water monitoring

[39] Current thresholds are:
- Trigger > 6 m or a rate of > 4 m/year - interpreted as the statistically significant aquifer response and change to water level in the Ethel Gorge primary habitat monitoring zone. Water level responses greater than the above thresholds may result from localised bore abstraction and these localised responses shall not bias the overall criteria.
- Response >12 m or a rate of > 8 m/year.

Thresholds may be revised as the Eastern Pilbara Water Resources Management Plan is revised and where there is a difference in the criteria presented in this MCP and the Eastern Pilbara Water Resources Management Plan, the criteria in the Eastern Pilbara Water Resources Management Plan take precedence.

Aspect	Criterion objective	Risk ID	Domain	Performance indicators[38]		Completion (Stage 3)[38]	Verification procedure	MCP section
				Planning (Stage1)	Execution (Stage 2)			
C6 Contaminated sites								
C6.1 Contaminated Sites	Contaminated sites have been documented and managed to achieve a classification commensurate with the post-mining land use	R20	All where relevant	Contaminated sites have been identified and, where required, remediation action plans developed (C). Remediation action plans have been approved by a contaminated sites auditor, where required (C).	Implementation of the approved remediation action plan (P).	Validation sampling shows remediation has achieved remediation criteria (Q).	**Planning** Preliminary Site Investigation (PSI), Sampling and Analysis Plan (SAP), Detailed Site Investigation (DSI) and Remediation Action Plan (RAP) – produced by a contaminated site consultant and reviewed by an independent auditor. **Execution** Reports produced by remediation contractor including validation sampling and waste disposal records. **Completion** Contaminated sites auditor produces Voluntary Audit Report (VAR) or Mandatory Audit Report (MAR).	9.1.5 Site contamination 10.1.1 Closure completion audit and inspection
C7 Cultural heritage & values								
C7.1 Cultural Heritage & Values	Protection of cultural values, and access to sites of cultural importance has been incorporated into mine closure planning following consultation with the Traditional Owners.	R17	All where relevant	In consultation with the Nyiyaparli people: • Cultural values associated with final landforms have been identified and addressed in designs (C). • Provisions for safe access to sites of importance have been incorporated into closure designs (C). • Requirements for repatriation of cultural artifacts have been identified (C).	Mine closure execution is substantially in accordance with designs for the protection of cultural values (P). Cultural artifacts have been repatriated generally in accordance with stakeholder requirements (P).	Performance indicators for Execution (Stage 2) have been met.	**Planning** Mine closure designs have addressed cultural values and incorporated safe access to sites of cultural importance identified during consultation. Documented agreement regarding the repatriation of cultural artefacts. **Execution and Completion** As constructed report. Confirmation by Nyiyaparli people representative that artefacts have been repatriated.	7.5.8 Cultural values / post-closure land use 9.1.4 Cultural values and heritage 9.1.7Site safety and security 10.1.1Closure completion audit and inspection

9 Closure implementation

Taking into account the identified closure issues and acknowledging the further studies, investigations and design work that will occur during the life of the mine, this section describes how Jimblebar Hub will be rehabilitated and closed in a manner that satisfies the objectives, guiding principles and completion criteria outlined in Section 8, and addresses the DMIRS guidelines (2020a; 2020b). Closure implementation strategies defined below are based on the studies outlined in Section 5, experience across BHP's Pilbara operations and on the WAIO Closure and Rehabilitation Standard (WAIO, 2020a).

Rehabilitation of disturbed areas will be conducted progressively during the mine life with complete closure of the mine not expected to occur until ~2053.

9.1 Standard closure and rehabilitation strategies

BHP will implement its Rehabilitation Standard 0001074 (WAIO, 2020a) which covers all procedures relevant to rehabilitation works including rehabilitation planning, growth media, earthworks for rehabilitation, audit and inspection, seed management, rehabilitation data management and rehabilitation monitoring. This rehabilitation standard is used across BHP's Pilbara mine sites and other areas where appropriate. Further details of various aspects of the standard are provided in the subsections below.

The internal procedures and standards referenced may be amended or replaced from time to time in accordance with BHP's adaptive management approach (Section 7.1).

9.1.1 Earthworks

The Earthworks for Rehabilitation Procedure (WAIO, 2022b) has been prepared to provide a consistent methodology for rehabilitation earthworks across BHP's operations. The procedure has been based on previous rehabilitation success and to manage identified issues. The results of rehabilitation monitoring are used to adjust and refine this methodology in accordance with BHP's adaptive management approach (Section 7.1).

Rehabilitation earthworks aim to re-profile the land surface to create landforms that are consistent with the surrounding landscape, within the constraints imposed by the physical nature of the materials. Earthworks consist of reshaping the slope to a profile suited to the nature of the material used (determined by overburden characterisation studies and modelling of erosion potential) and constructing surface water controls (see Section 7.5.4). At the end of each earthworks phase, a rehabilitation inspection is conducted generally in accordance with WAIO's Rehabilitation Inspection and Sign-off procedure (WAIO, 2022d) to confirm conformance to the work pack / scope of work for that area.

The Earthworks for Rehabilitation Procedure (WAIO, 2022b) addresses the safe handling of chemicals and hydrocarbons during the closure execution period.

9.1.2 Surface treatment

A number of surface treatments may be used, depending on the size and nature of the rehabilitated area. The proposed surface treatments for rehabilitation areas at Jimblebar Hub have been developed to satisfy the stated closure objectives and may consist of one or more of the following:

- Deep ripping of compacted surfaces, and cross ripping if clod size is greater than 150 mm.
- Selective application of topsoil material (or alternative growth media) to provide a medium to support plant growth.
- Application of inorganic or organic amendments informed by assessment of the growth media and research findings (refer to Appendix F).
- Surveyed contour ripping or scarifying of surfaces following the application of soils, to maximise water infiltration and enhance revegetation success (Figure 9-1). When scarifying on the contour is not appropriate due to physical constraints (such as narrow areas or areas constrained by infrastructure or natural features), a herringbone technique may be used (Figure 9-2). Where there is high rock content and natural surface roughness of the final designed surface, contour ripping may not be required. Based on the outcomes of research and trials across BHP's operations, a no-rip approach is the preferred approach, where possible. This can be achieved through deep ripping to treat compacted areas being undertaken prior to the spread of armouring material / growth media.
- Selective placement of logs or smaller woody debris across the re-profiled surface (Figure 9-3) and / or constructing rocky habitat features (where potential exists) to provide additional habitat areas for fauna species recorded prior to mining.

The Management of Growth Media for Rehabilitation Procedure (WAIO, 2020c) provides general information on soils of the Pilbara region and methods for soil stripping, stockpiling and use in rehabilitation, and has been informed by the results of the research discussed in Section 7.1.1.

Direct placement of topsoil onto rehabilitation areas is preferable. If direct placement is not possible, soil should be stockpiled in flat topped low mounds to minimise water holding and weed growth, and ideally should be no more than 3 m high to maintain biological activity. Compaction of the topsoil stockpiles should be minimised by building from the edge (rather than the top of the stockpile), deep ripping and spreading stripped plant material to encourage revegetation.

Figure 9-1 Contour ripping

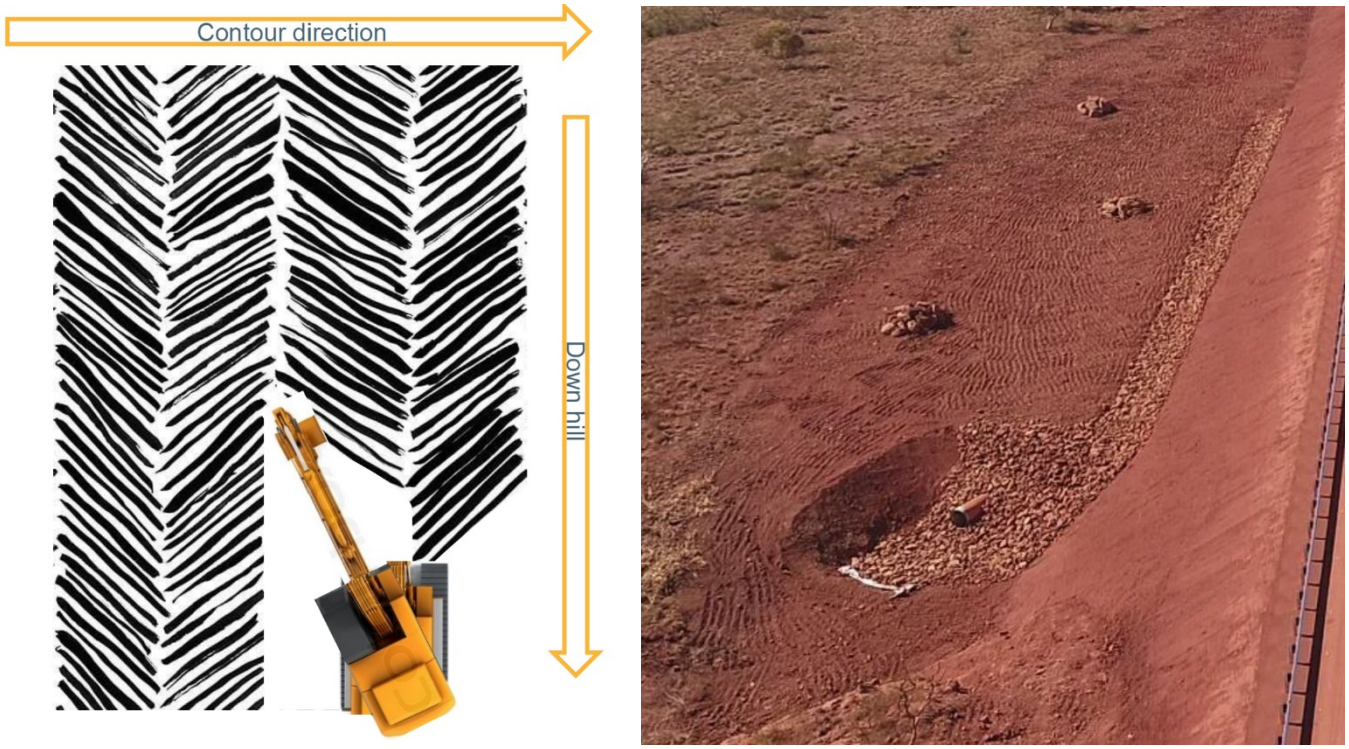


Figure 9-2 Herringbone scarification

Figure 9-3 Example of placement of logs & branches as fauna habitat

At the completion of works, a rehabilitation inspection is conducted generally in accordance with WAIO's Rehabilitation Inspection and Sign-off procedure (WAIO, 2022d) to confirm conformance to the work pack / scope of work for that area.

9.1.3 Revegetation

As discussed in Section 7.5.6, the Rehabilitation Standard (WAIO, 2020a) requires that revegetation be conducted so as to establish plant species that will support the approved post-mining land use and that local provenance seed will be sourced from within 100 km of the site and within the Pilbara Biogeographic Region. Plant species lists for the different domains will be generated, using the baseline vegetation data, to include a range of typical vegetation assemblages that will be suited to the post-mining landform and provide fauna habitat (Appendix J). The seed list for the Jimblebar Hub incorporates several species of cultural significance to the Nyiyaparli people.

The Seed Management Procedure (WAIO, 2022e) describes the types of seed species mixes and seeding rates that BHP uses at its Pilbara mining operations. This mix can be adapted to suit the particular characteristics of the site through BHP's adaptive management approach (refer Section 7.5.6). Seed mixes and methods of seed handling, assessment of seed viability and seeding rates will continue to be improved and informed by ongoing monitoring results, and research. All seed collections are recorded in BHP's seed collection database (developed as part of the Restoration Seedbank initiative research program). This database records information for each seed batch such as provenance zone, seed test data, and landform position and aspect preferred by each species.

Through BHP's adaptive management approach (refer Section 7.1), seed mixes and methods of seed handling, assessment of seed viability, seed treatment and seeding rates will continue to be improved and informed by ongoing monitoring results and research.

Where monitoring results indicate vegetation establishment may not meet required standards, (vegetation density, species diversity and plant age heterogeneity), additional seeding (in subsequent years) may be undertaken.

Two rainfall periods occur at Jimblebar Hub; one from January to March and the other from May to August. The most reliable rainfall period occurs from January to March. Accordingly, revegetation activities will be completed during November and December where practicable. Work completed as part of the Restoration Seedbank Initiative research program has highlighted the significance of sowing time (in relation to expected rainfall events) to the success of seed germination.

9.1.4 Cultural values and heritage

As discussed in Section 7.5.8, there is the potential for closure works to impact on sites of cultural significance via direct or indirect disturbance (e.g., erosion).

A number of sites of cultural value have been identified at Jimblebar Hub in consultation with the Nyiyaparli people. The primary mechanism for protection of cultural heritage sites identified as being significant at Jimblebar Hub will be avoidance of these sites, and mine designs are developed to accommodate these requirements. In general, this means that closure activities are unlikely to impact these sites, however, to confirm that there will be no impacts to identified sites, any activities that require new land disturbance (e.g., for reprofiling landforms), will be authorised by BHP via the PEAHR procedure (WAIO, 2023b).

Final landform designs (including requirements for safe access to sites of significance) and management of cultural artefacts post-closure will be discussed with the relevant Nyiyaparli people through the stakeholder engagement process along with other closure

planning matters that may influence cultural values (Sections 4.2 and 5.14). All work will be conducted in compliance with the current Aboriginal Heritage legislation, and in accordance with BHP's comprehensive agreement with the Nyiyaparli people.

9.1.5 Site contamination

In areas where the potential for soil contamination has been identified, assessment and remediation are generally managed in accordance with the CS Act and DWER requirements (including sampling / analysis and remediation / management) during a site's operational life and not left unresolved at the time of closure. As a site approaches closure, investigation and remediation of any remaining contamination is considered during BHP's closure study phases (refer to the introduction to Section 5). This includes consideration of whether the contamination land use classification of sites previously investigated / remediated is commensurate with the agreed post mining land use.

Remaining surfaces will be reshaped to conform with surrounding landforms, with surface treatment and revegetation implemented as outlined in Sections 9.1.2 and 9.1.3.

9.1.6 Dust emissions

Dust has the potential to be emitted during decommissioning and bulk earthworks activities during closure. Dust control measures will be implemented during closure e.g., regular watering of unsealed roads, exposed surfaces and active earthwork areas. Following closure, dust generation from the rehabilitated surfaces is expected to be similar to other nearby natural landforms.

9.1.7 Site safety and security

Site security measures will be implemented to prevent inadvertent access including abandonment bunds, signage and, where appropriate, fencing and locked gates. Relevant security measures will take into account the location of the site relative to public access routes and any agreements made with post-mining landowners / land managers or Traditional Owners for safe access to various site areas post-closure.

9.2 Closure strategies for specific domains

This section outlines the closure strategies for each domain. Where designs have been developed for certain landforms and have not yet been implemented, these are described in the relevant sections below. Where designs remain at concept level, the concepts are shown in visualisations provided in Section 9.2.4. Section 9.3.1 summarises closure designs that have already been implemented as part of progressive rehabilitation.

9.2.1 Mine voids

Closure and rehabilitation design considerations for mine voids at Jimblebar Hub include:

- Backfill strategy (Section 9.2.1.1).
- Management of surface water to prevent unnecessary capture of surface water within pits. Closure designs for surface water management infrastructure are discussed in Section 9.2.3.4.
- Measures for managing inadvertent access (abandonment bunds) to mine voids (Section 9.2.1.2).
- Closure designs for ISAs (including AMD 1 encapsulation cells). These elements are considered separately with OSAs in Section 9.2.2.
- Closure of in-pit TSFs (Section 9.2.1.3).

9.2.1.1 Backfill strategy

BHP acknowledges the Nyiyaparli people's stated preference for the avoidance of pit lakes. The backfill strategy for the Jimblebar Hub is continually reviewed as the mine plan is updated. Several backfill scenarios were run in 2019 to assess the backfill that could be achieved for Jimblebar. The scenarios indicated that between 40% and 60% of overburden can be backfilled. Table 9-1 shows our current understanding of the backfill strategy, and Figure 9-26 (Section 9.2.4) provides an indication of where pit lakes may remain, based on current mine plans. Where backfill / tailings storage has the potential to sterilise a pit, BHP will consult with the DEMIRS Geological Survey and Resource Strategy Division where resource is present and reported (DMIRS, 2018).

Table 9-1 Mine void closure strategy

Pit	Status	Considerations	Closure Strategy
Avon (western end)	Inactive	AWT	Open void
Avon (eastern end)	Inactive	AWT	Backfilled with ISA which includes an AMD 1 encapsulation cell (refer to Section 9.2.2 for design)
Blackwood	Inactive	AWT	Backfilled and OSA constructed over the void which includes an AMD 1 encapsulation cell (refer to Section 9.2.2 for design)

Pit	Status	Considerations	Closure Strategy
De Grey	Inactive	BWT, PAF pit wall exposures	Partial fill with tailings (if approved) or backfill to at least 5 m above the pre-mining water table. Additional measures may be considered to minimise the exposure of PAF material in pit walls, if required.
OB17 - Swan (eastern end)	Inactive	AWT	Partial fill with tailings (if approved) or backfill to at least 5 m above the pre-mining water table which will cover PAF wall rock exposures. Further backfill may be considered (if required) to address the encroachment of East OSA within the ZOI (Section 9.2.2.2).
Swan (western end)	Inactive	BWT, PAF pit wall exposures	
OB31	Active	BWT, very small AMD 1 exposure at toe of the southen wall of the eastern section of the pit that is not expected to require specific management.	Backfill strategy under review, including potential future use for tailings storage. If unacceptable groundwater impacts are predicted to occur as a result of residual groundwater drawdown associated with the open void or the remaining pit lake, then the pit will be backfilled, as required to mitigate these impacts.
WH123	Active	AWT / BWT mining. Mined out void infilling planned with extent to be confirmed. Opportunity to minimise WH123 NE ex-pit OSA rehabilitation extent.	Open void with partial backfill. Tailings storage may also be considered in the future.
WH4	Active	AWT mining. Mined out void infilling underway since early 2000s with additional infilling planned from adjacent WH56 and South Jimblebar.	Backfilled pit with rehabilitated surface.
WHASH	Active	AWT / BWT mining. Mined out void infilling planned with extent to be confirmed (potential opportunity for further pit infilling).	Open void with partial backfill and some pit lakes.
H234	Active	AWT / BWT mining. Mined out void infilling planned with extent to be confirmed (potential opportunity for further pit infilling).	Open void with partial backfill and potentially a small pit like (but could be dry).
East Jimblebar	Inactive	AWT / BWT mining	Open void with partial backfill and some pit lakes.
South Jimblebar (Mindoona)	Active	AWT / BWT mining. Mined out void infilling planned with extent to be confirmed.	Open void with partial backfill and pit lakes.
South Jimblebar (Sylvania)	Active	AWT / BWT mining	Open void with partial backfill and a pit lake.
South Jimblebar (Capricorn)	Inactive	AWT / BWT mining	Open dry void with partial backfill. Pits may be considered for tailings storage in the future.
Pain Killer	Inactive	AWT / BWT mining	Open dry void.

Notes: AWT – Above Water Table; BWT – Below Water Table

9.2.1.2 Abandonment bunds

Abandonment bunds will be constructed around mine voids in accordance with DEMIRS recommended practice (DoIR, 1997) and the outcomes of recent consultation (Section 4.3). The bunds will be a minimum 2 m high with a base width of minimum 5 m and constructed at least 10 m away from the edge of the area known to contain potentially unstable rock mass as per recommended practice.

Final locations for abandonment bund placement will be determined once closure designs have been finalised, to allow consideration of the effects of backfill on pit wall stability and any slopes that are reprofiled. Consideration will also be given to how the bunds interact with surface water flows and surface water management infrastructure.

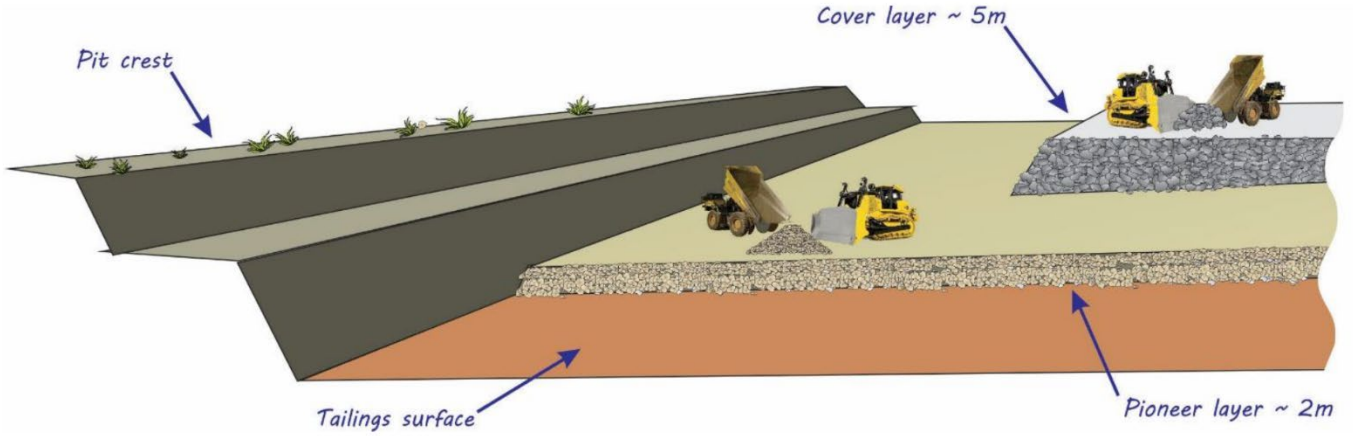
Where appropriate, final pit designs may include ramps and sloped areas to facilitate safe entry to the pit areas (e.g., for post-closure monitoring).

9.2.1.3 In-pit TSFs

In accordance with BHP's standards for the management of TSFs (Section 7.5.5), a management plan will be developed and implemented for the active management of the in-pit TSFs between cessation of deposition and closure.

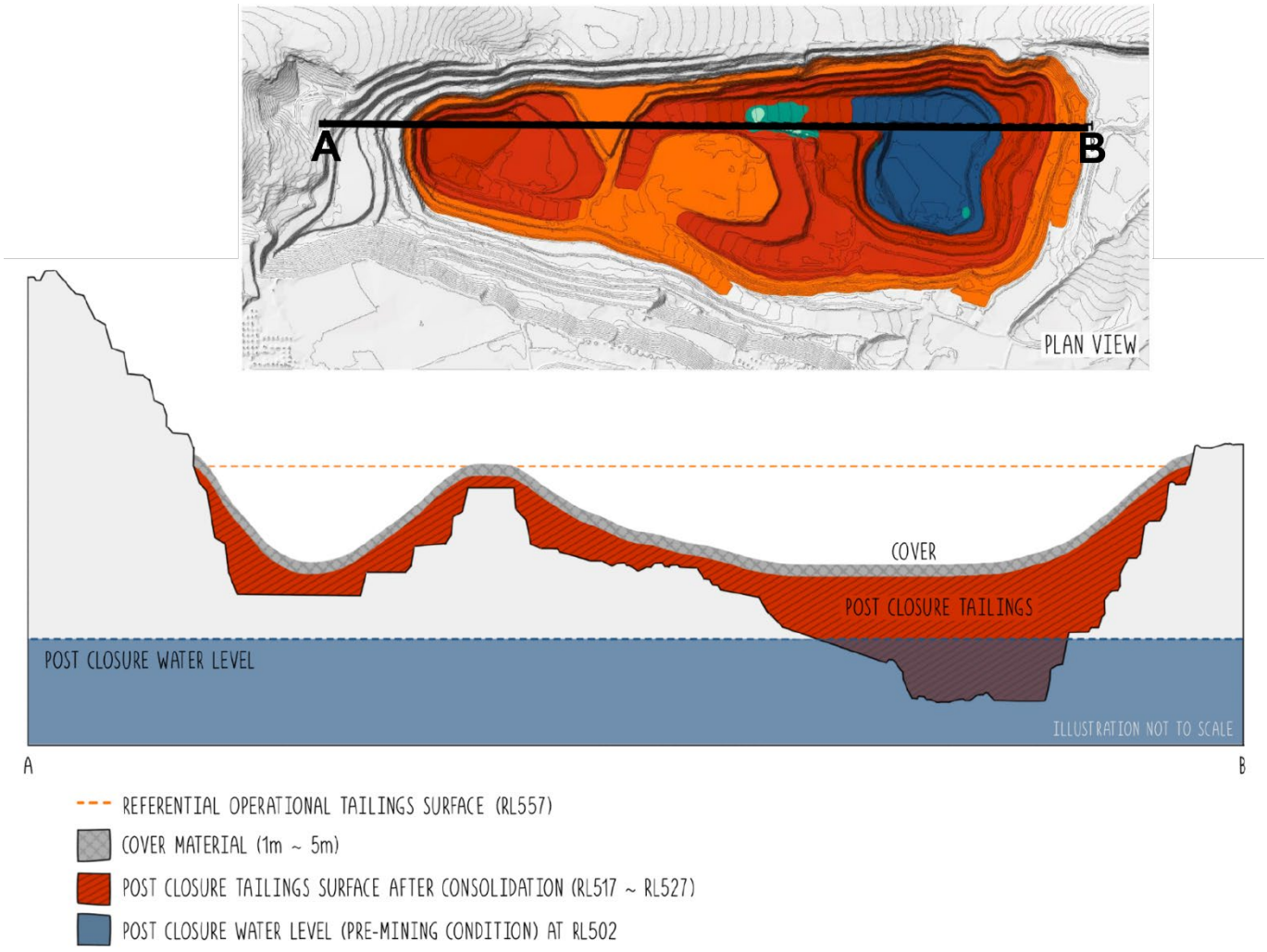
As discussed in Section 5.16.4, a conceptual cover design has been developed for the Swan and De Grey in-pit TSFs. This will be reviewed and refined as additional information becomes available over the life of the assets. The concept design comprises:

- A pioneer layer of 1 to 2 m thick (Figure 9-4) placed with smaller lower ground pressure equipment to allow access for larger equipment for the remaining cover works.
- 1 to 5 m thick cover depending on differential settlements (Figure 9-5 and Figure 9-6).
- The overburden to be used to construct the pioneering layer and final cover will be sourced from the East OSA and screened to confirm that it is NAF and that layers used at the surface are suitably resistant to erosion.
- Re-profiling of East OSA as material is being extracted for the cover so that surface water run-off drains away from the in-pit TSFs.



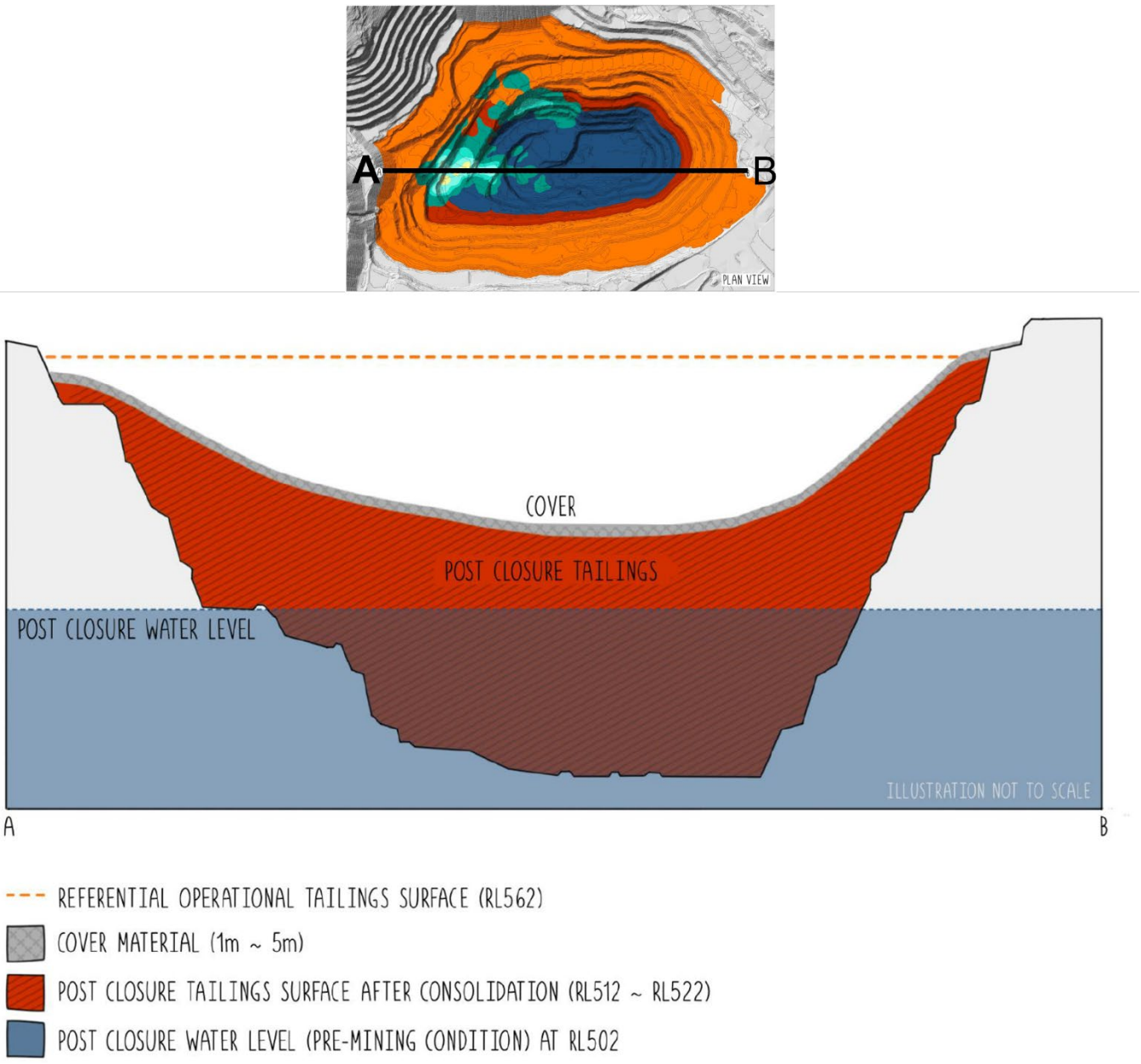
Source: WSP (2023)

Figure 9-4 Conceptual cover layer construction (for illustrative purposes only)



Source: WSP (2023)

Figure 9-5 Swan in-pit TSF cover concept



Source: WSP (2023)

Figure 9-6 De Grey in-pit TSF cover concept

Knowledge gaps & forward work program

Cover designs for future in-pit TSFs will be informed by the detailed design studies conducted for the Swan and De Grey in-pit TSFs and the monitored behaviour of the tailings during deposition. Designs for future TSFs will be incorporated into updates of this MCP.

9.2.2 OSAs and ISAs

There are several OSAs and ISAs at the Jimblebar Hub which are at different stages of design. As discussed in Section 7.5.4, conceptual landform designs are developed for ex-pit OSAs and integrated into the Master Area Design for a mine. Designs are refined throughout the mine planning process. In an operation with a long life (such as Jimblebar Hub), requirements for overburden storage change throughout the life of mine based on changes to the mine plan. OSA designs, therefore, remain in a conceptual form until close to the time of progressive closure execution.

Section 9.2.2.1 provides an overview of the general approach to OSA closure, and the designs for OSAs and ISAs that are approaching progressive closure, or have only been partially rehabilitated are discussed in Sections 9.2.2.2 to 9.2.2.8. The designs for OSAs which have been already rehabilitated are summarised in Section 9.3.1 with supporting information provided in Appendix L.

The status of the OSAs / ISAs at the Jimblebar Hub is provided in Table 9-2.

Table 9-2 Jimblebar Hub OSA / ISA status

OSA / ISA name	Status	Comments
OB17/18/31		
South OSA	Rehabilitated 2018/19	Refer to Section 9.3.1.2 for summary of landform design.
North OSA	Rehabilitated 2016/17	Refer to Section 9.3.1.1 for summary of landform design.
East OSA	Active	The toe of the East OSA is located within the possible ZOI of the Swan pit. If the De Grey and Swan in-pit TSFs are approved, overburden from this OSA will be used to cover the facilities and material will be moved from the ZOI. A significant quantity of overburden is predicted to be required which will change the final geometry of the landform. A preliminary design based on current overburden volumes and excluding consideration of the proposed in-pit TSFs is provided in Section 9.2.2.2. A low-grade stockpile is located adjacent to this landform and the current design allows for the stockpiled material to be incorporated into the landform at closure if it is not processed. The external faces will be re-profiled to between 15˚ and 20˚ based on the outcomes of materials characterisation. Final designs for the East OSA will progress once there is clarity on the likely volume of cover material required for the in-pit TSFs.
Blackwood OSA / ISA	Active	Contains an AMD 1 encapsulation cell. Landform design provided in Section 9.2.2.4.
OB31 OSA / ISA	Active	With a long life, the final design and footprint of the OB31 OSA will be periodically reviewed to take into account recommended slope profiles (Section 5.16.2.1) based on materials characterisation data and environmental, social and mine planning considerations. Options are being explored for reducing the volume of overburden stored ex-pit through backfilling of the mined-out void.
Avon ISA	Active	Contains an AMD 1 encapsulation cell. Landform design provided in Section 9.2.2.3.
Jimblebar		
WH123 (AX12) OSA	Inactive	Design is currently under review with a concave option (see Section 5.16.2.1 for example of a concave landform) being considered.
WH123 (AU09)	Reprofiling of top lifts in progress	Refer to Section 9.2.2.5 for summary of landform design.
WH123 AU12 ISA	Active	Closure strategy to be defined.
WH123 ISA W33E	Active	Contains PAF material storage cell. Closure strategy to be defined.
Jimblebar South OSA	Rehabilitated 2017/18	Refer to Section 9.3.1.3 for summary of landform design,
BB06 OSA	Inactive	This OSA is constructed of Marra Mamba materials and located within the 1:10,000-year flood plain. The OSA will be relocated prior to closure.
BC06 (BD06) OSA	Reprofiled & partially seeded	Refer to Section 9.3.1.4 for summary of landform design.
BN07 OSA	Inactive	Refer to Section 9.2.2.7 for summary of landform design.
WH4 BB09 ISA	Active	Design to be developed to take into account overburden characteristics. Concave or stacked linear profiles (refer to Section 5.16.2.1 for examples) to be analysed.
WH4 BF07	Active	Contains PAF material storage cell. Refer to Section 9.2.2.6 for summary of landform design. Review of design in progress.
WHASH OSA 1-4	Active	Design to be developed to take into account overburden characteristics. Concave or stacked linear profiles (refer to Section 5.16.2.1 for examples) to be analysed.
WHASH OSA W55	Not yet developed	
WHASH BN10 OSA	Active	
H234	Active	Design to be developed to take into account overburden characteristics. Concave or stacked linear profiles (refer to Section 5.16.2.1 for examples) to be analysed.
Jimblebar South AV05	Active	Marra Mamba Overburden. Given the Marra Mamba material type, landforms will require sheeting with a minimum of 1 m WMAT 1 overburden for stability. Analysis of competent overburden source options and preliminary erosion modelling will be conducted.
Jimblebar South A005, BE04, BH04 & Painkiller	Not yet developed	
East Jimblebar	Not yet developed	Design to be developed to take into account overburden characteristics. Concave or stacked linear profiles (refer to Section 5.16.2.1 for examples) to be analysed.

9.2.2.1 General approach to OSA closure

Final OSA landform designs are informed by:

- Final contours of an 'as tipped' OSA;
- Surface water assessments including an assessment of the catchments that impact on the OSA and potential for run-off from the OSA;
- Materials characterisation (Section 5.3.3); and
- Modelling of erosion (Section 5.3.3).

There are several standard design elements that are typically integrated into most landform designs. These comprise:

- Frontal crest bunds to control surface water run-off down slopes (Figure 9-7). A typical cross section is shown in Figure 9-8.
- Inter-bunds to control surface water movement across landform surfaces (Figure 9-9). Cells generally run perpendicular to the frontal crest bunds. A typical cross section is shown in Figure 9-10. Finished cell surfaces are deep ripped. The top RL of inter-bunds is required to be a minimum of 300 mm below the frontal crest bunds.
- Fauna habitat. Large rocks (with a minimum of 500 mm diameter) are used to create fauna habitats. The rock habitats are formed with a wide base, often sunk into the ground, with multiple layers of rocks to 2.5 m high (Figure 9-11). Topsoil is pushed back in / around the lower section of the rock stack.

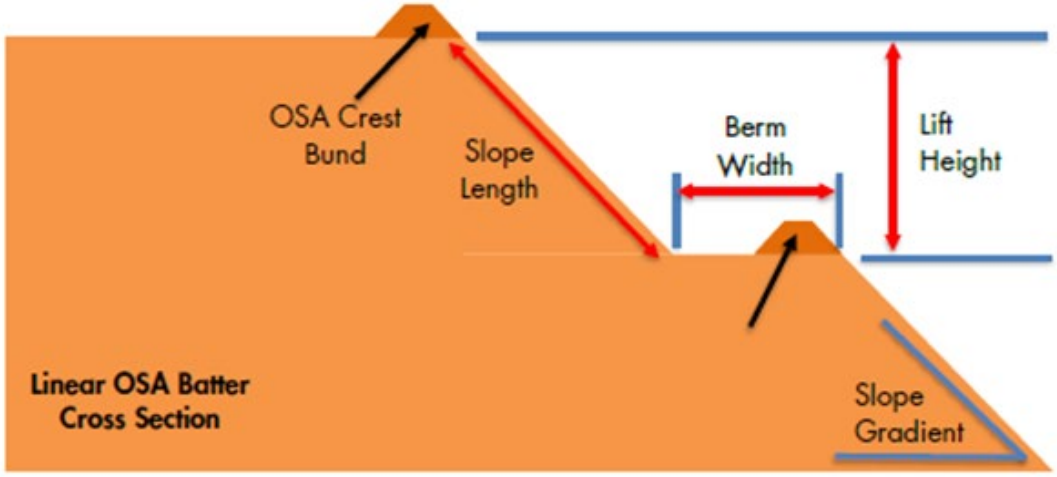


Figure 9-7 Linear OSA batter cross section showing location of crest bunds

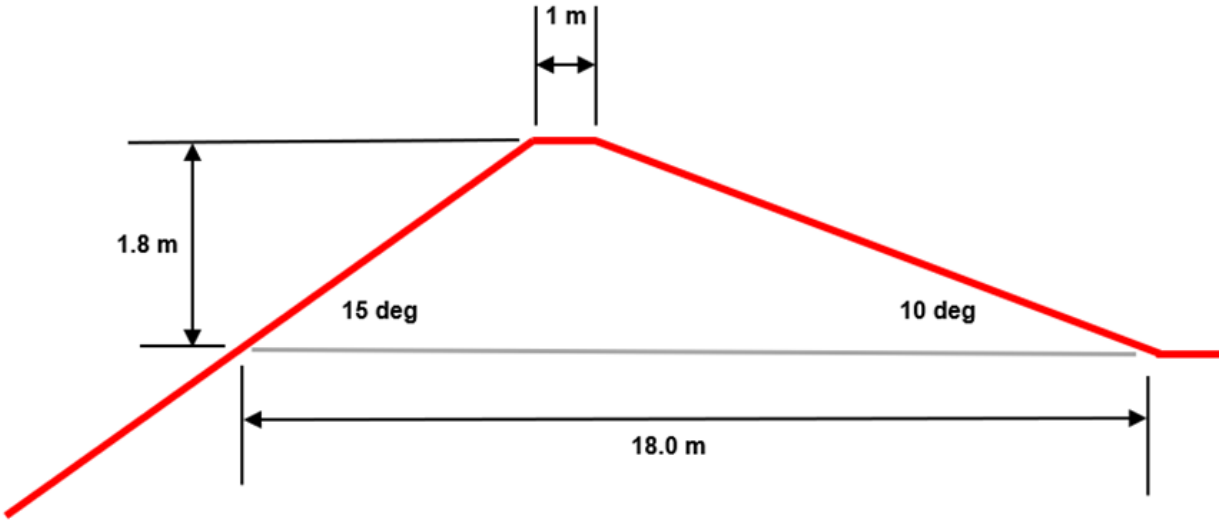


Figure 9-8 Typical frontal crest bund cross section

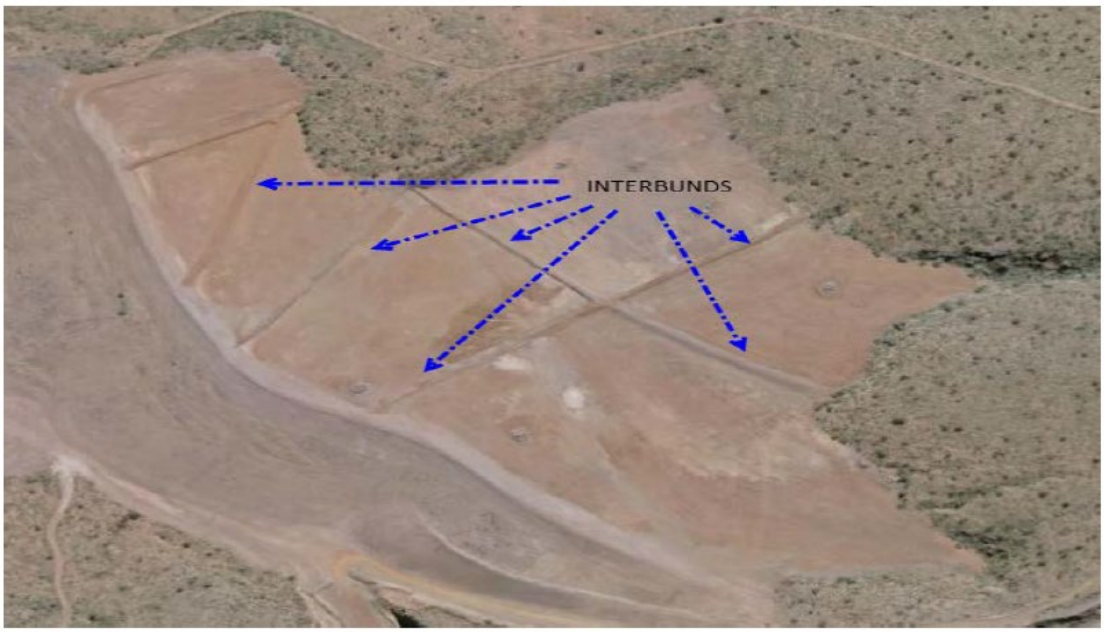


Figure 9-9 Example inter-bund configuration

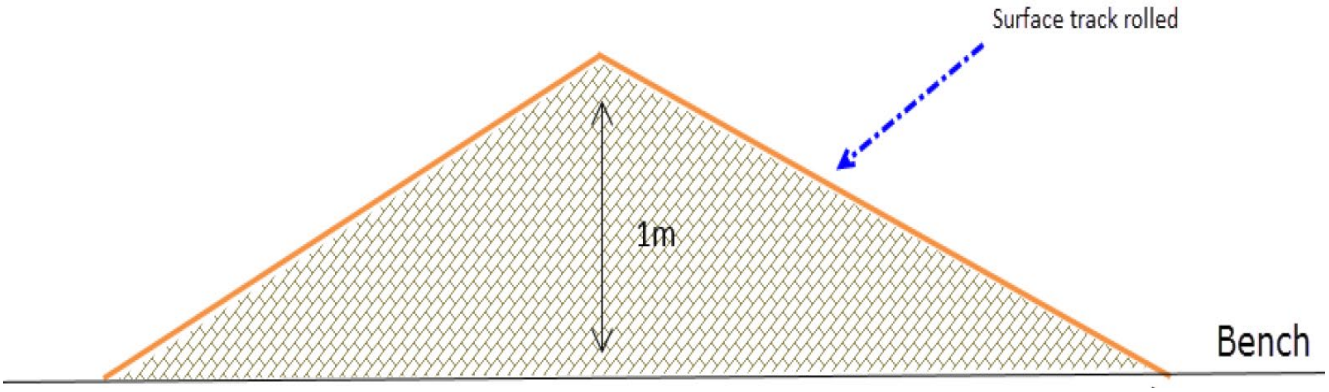


Figure 9-10 Typical inter-bund cross section

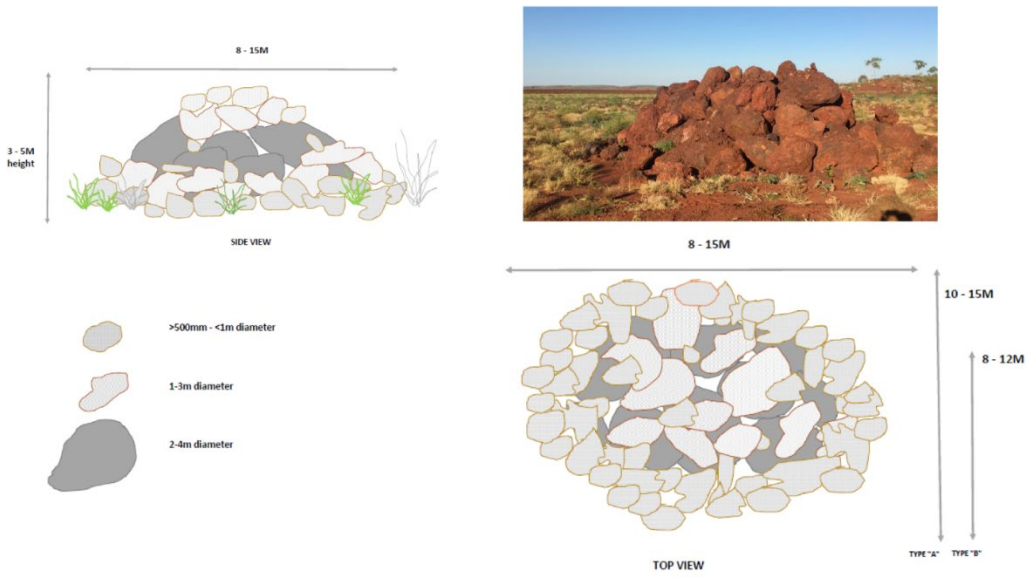


Figure 9-11 Fauna habitat

9.2.2.2 East OSA

The toe of the East OSA is located within the possible ZOI of the Swan pit. The red line on Figure 9-12 shows the extent of the OSA within this zone. If the in-pit TSF is approved, the material within the ZOI of the pit will be used as a cover for the tailings. The consolidated tailings and cover system will also have the effect of buttressing the pit wall. The final landform design for East OSA will depend on the quantity of material that may be used in the cover of the proposed Swan and De Grey in-pit TSFs. If the in-pit TSFs are approved, the OSA will be re-profiled to reduce run-off from the OSA catchment into the in-pit TSFs.

Figure 9-13 and Figure 9-14 show the landform design options for East OSA if the Swan pit is not used for tailings storage. In this case, the Swan pit may be backfilled (to a level beyond 5 m above the water table) to buttress the pit walls so the OSA falls outside the ZOI (Figure 9-13) or the East OSA material located within the possible ZOI will be relocated (Figure 9-14).

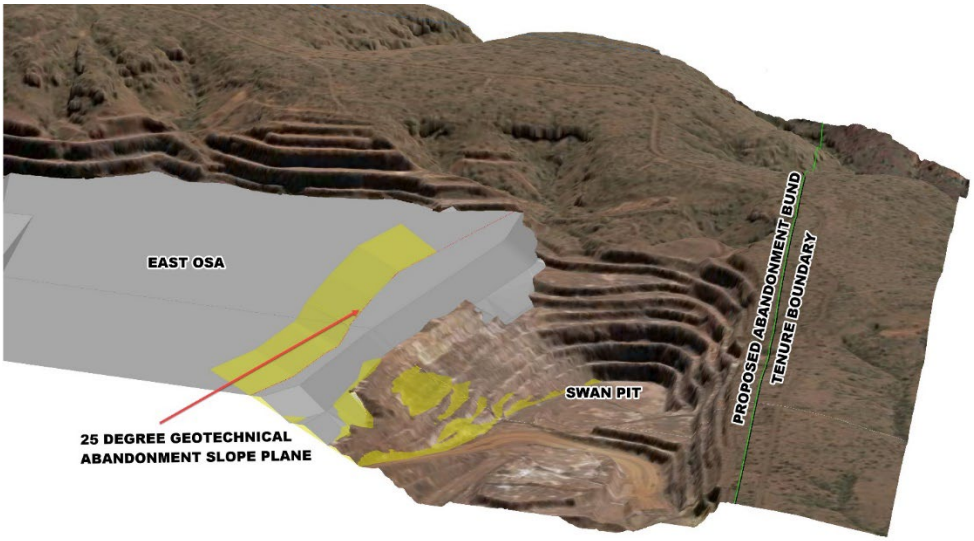


Figure 9-12 Extent of East OSA located within the possible ZOI of Swan pit

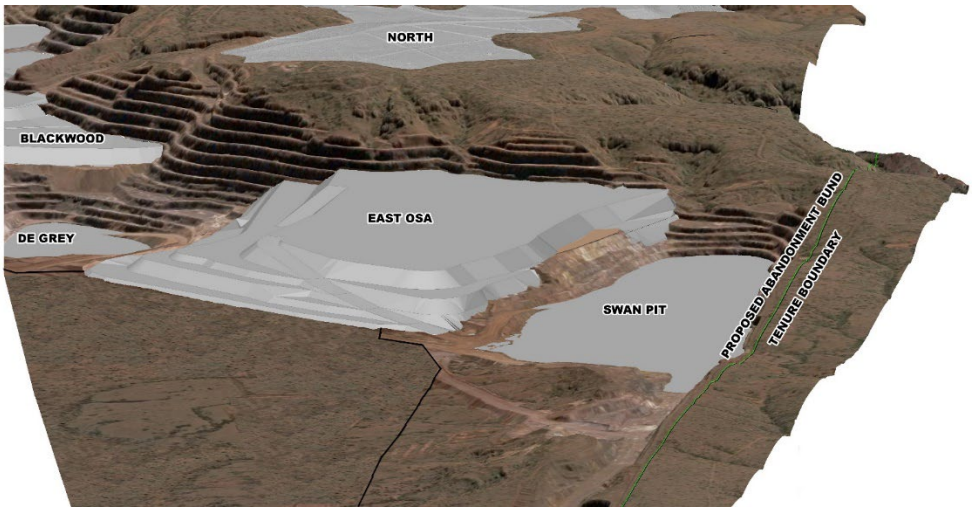


Figure 9-13 Backfill of Swan pit to buttress pit walls

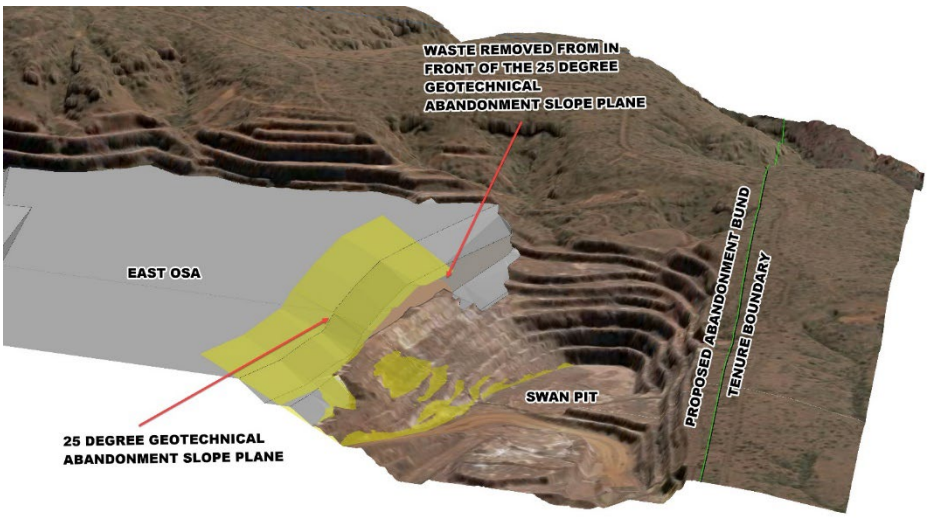


Figure 9-14 Potential removal of East pit OSA material within the possible ZOI of Swan pit

9.2.2.3 Avon ISA

The Avon ISA contains an AMD 1 encapsulation cell as described in Section 7.5.1.1. The design philosophy for this area is, therefore, to regrade it into a water shedding landform, and to capture water before it runs onto the landform so that the potential for infiltration of water into the AMD 1 encapsulation cell is minimised.

The Avon ISA is designed to provide 17 to 20 m of cover over the AMD 1 cell, and survey data from July 2021 shows final cover levels have been achieved (Figure 9-15 and Figure 9-16).

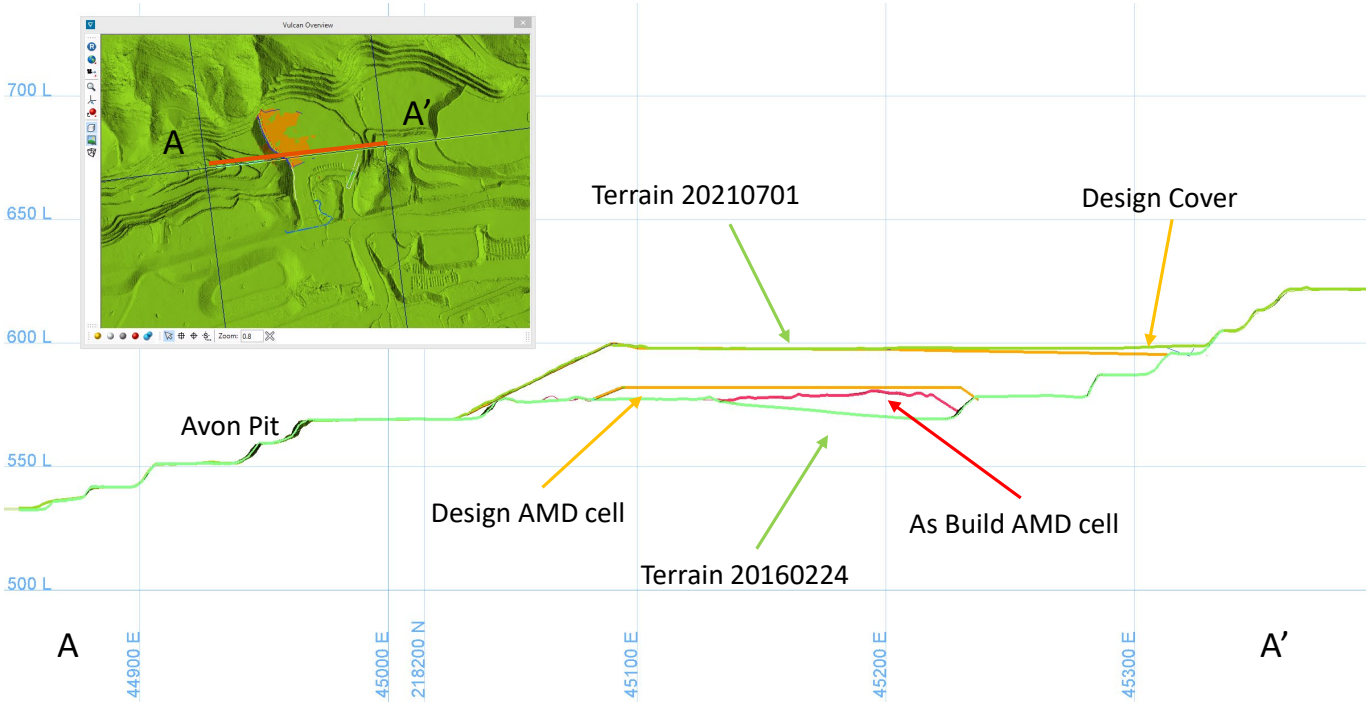


Figure 9-15 Avon ISA cross section looking north

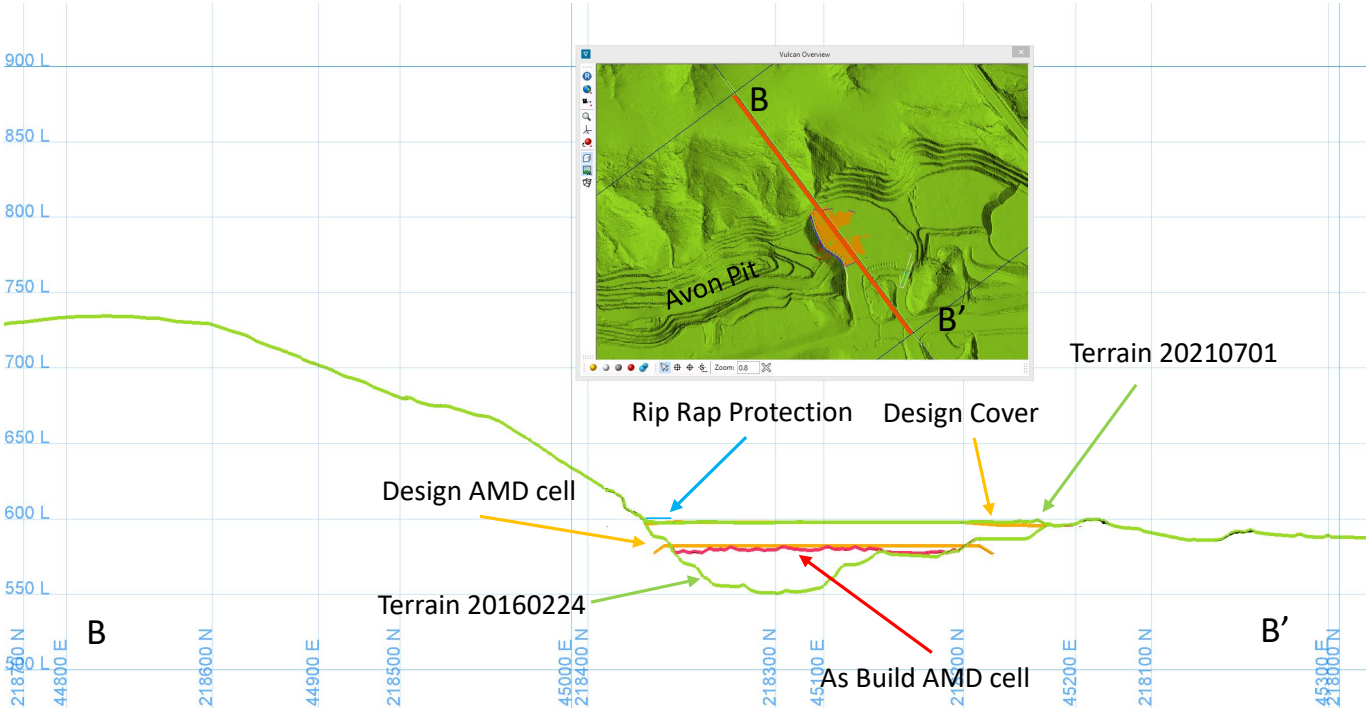


Figure 9-16 Avon ISA cross section looking east

The Avon ISA surface receives a point source discharge onto the north-western corner of the final landform surface from the 6 ha catchment upstream (Figure 9-17). This inflow will be managed by constructing an area of rip rap (Figure 9-16 and Figure 9-18) to reduce the potential for accelerated erosion of the final cover system. Appendix L provides the calculations for peak flows generated from the catchment in a 1 in 10,000-year event. Current design recommendations are that:

- The external rocks used in this area should be no smaller than 300 mm in diameter and should be selected from WMAT 1 competent overburden.
- The internal areas of this structure should be coarse rubble.

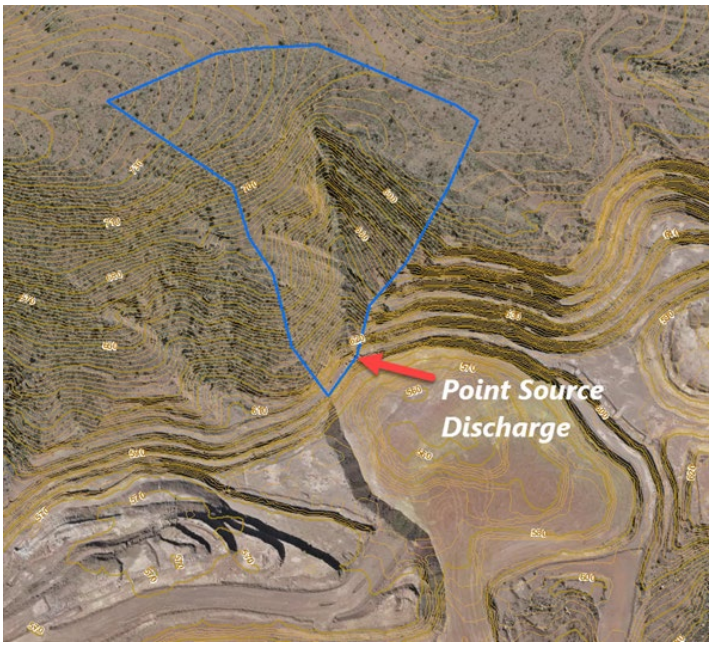


Figure 9-17 Catchment above Avon ISA & point source discharge

The drainage from the landform and its upper catchment will be directed into a 'V' drain constructed on the 596 RL bench of the Avon pit wall (Figure 9-18). This will be sized for a 1 in 10,000-year event (Appendix L) and will direct surface water drainage from the Avon OSA and its upper catchment away from the final regraded surface and will reduce the volumes of water available for infiltration into the AMD 1 encapsulation cell. The 'V' drain is predominantly located on a natural ground surface to maximise stability. Final profiling of the ISA and construction of rip rap and drainage have yet to be completed.

A crest bund has been provided on the west side of the OSA (Figure 9-15 and Figure 9-18) to maintain drainage toward the 'V' drain located on the east side of the landform.

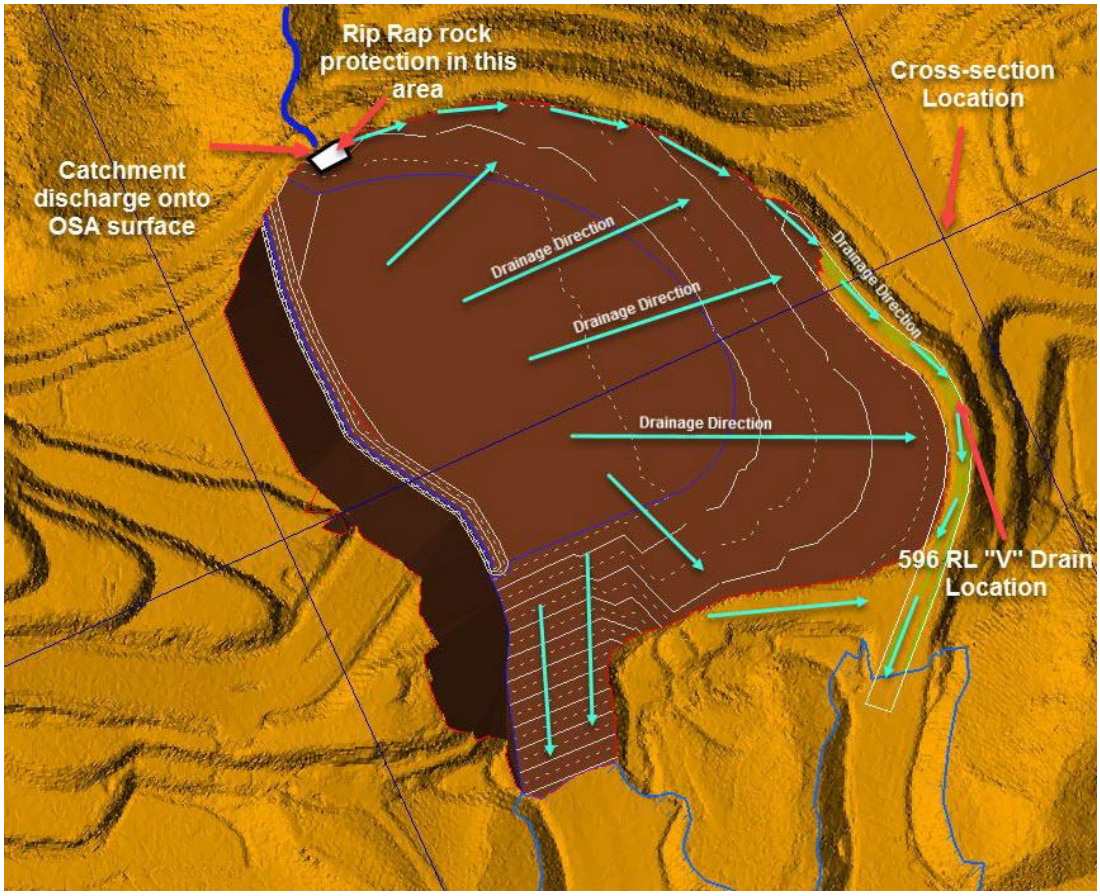


Figure 9-18 Avon ISA water management landform design

9.2.2.4 Blackwood ISA / OSA

Similar to the Avon ISA, the Blackwood ISA / OSA includes an AMD 1 encapsulation cell and will be regraded to a water shedding landform. There is a natural drainage line between the North OSA and Blackwood OSA which is currently used as an access route between the two landforms (Figure 9-19). At closure, the ramp in this drainage line will be removed and the natural drainage line will be reinstated. The timing of these works is dependent on the decommissioning of a radio tower which is currently accessed via this ramp and will nominally be required for the next 10 years. Further study is required to develop the final drainage design, however, in concept (Figure 9-19), the design will:

- Consider opportunities for landform works that can be implemented in the upper catchment to reduce the effective catchment area draining to the Blackwood OSA.
- Include an attenuation structure on the surface of the Blackwood OSA, at the point that the ramp discharges to the OSA, to dissipate the energy of the flow from the drainage line and minimise the potential for erosion.
- Direct water away from the area of the OSA that has been used to store AMD 1 and discharge it into the same natural drainage line as the Avon ISA. A crest bund will prevent discharge of water from the Blackwood OSA on to the Avon ISA.
- The AMD 1 storage area will be regraded to shed water and will also discharge water into the natural drainage line.

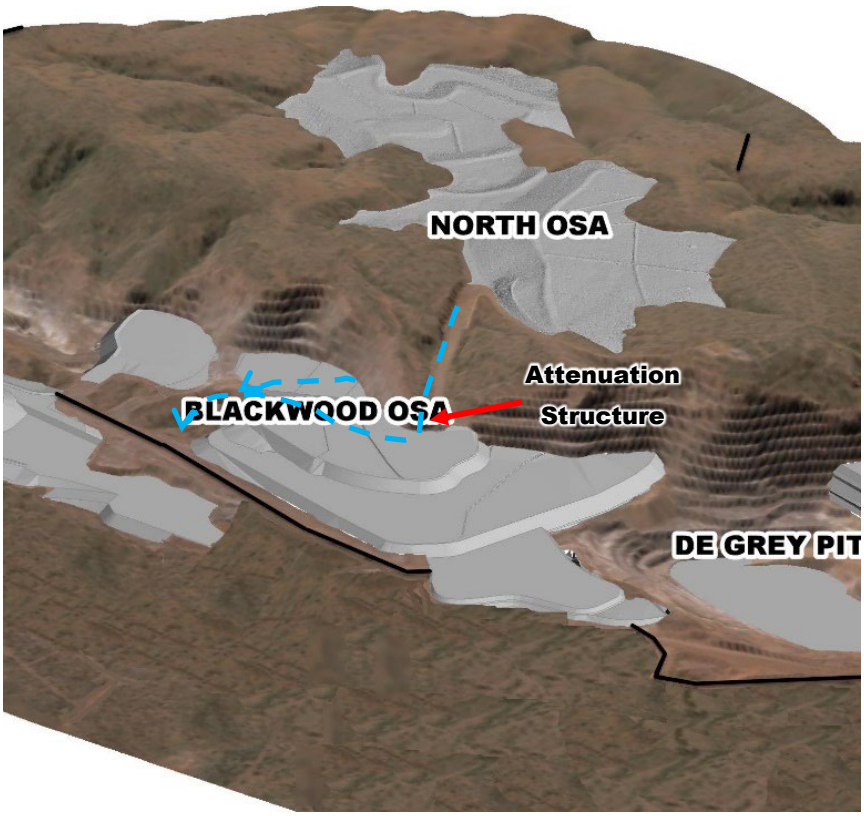


Figure 9-19 Blackwood OSA / ISA drainage design

9.2.2.5 WH123 (AU09)

The WH123 (AU09) landform is a multiple lift OSA that extends to a height of 70 m. The surface of the OSA has been predominantly constructed of weathered BIF overburden. Both Dales Gorge D3 and Joffre J2 materials have been mined from WH123. Using the erosion characteristics of Jimblebar D3 materials (Section 5.3.3.2), the concept design shown in Figure 9-20 has been developed and comprises:

- Top lift (636 mRL to 616 mRL) with a linear slope of 15°.
- Concave slope comprising:
  - 16° slope from 616 mRL to 596 mRL.
  - 10° slope from 596 mRL to 576 mRL.
  - 8° slope from 576 mRL to 556 mRL.

A detailed design has been developed for the top lifts only (Figure 9-21) as the western side will not be rehabilitated until the proposed adjacent pit has been mined out and backfilled, and rehabilitation of the bottom lift of the eastern and southern faces will only take place once the haul road is no longer required.

The top lifts of the landform (Figure 9-21) were being re-profiled at the time of writing this MCP. Crest bunds (yellow line on Figure 9-21) will be installed along the crest of the 636 mRL lift and the southern and eastern perimeters of the 616 mRL lift. Crest bunds will be constructed generally in accordance with the design principles outlined in Section 9.2.2.1 and will be 1.8 m high with the outer slopes to be consistent with the designed batter slope and the internal sections sloped at 10°. Inter-bunds will be installed on the top surface and 616 mRL berm of the landform (see yellow lines on Figure 9-21) in general conformance to the design principles detailed in Section 9.2.2.1. The slopes of the top lifts will be covered by 1 m rock armour.

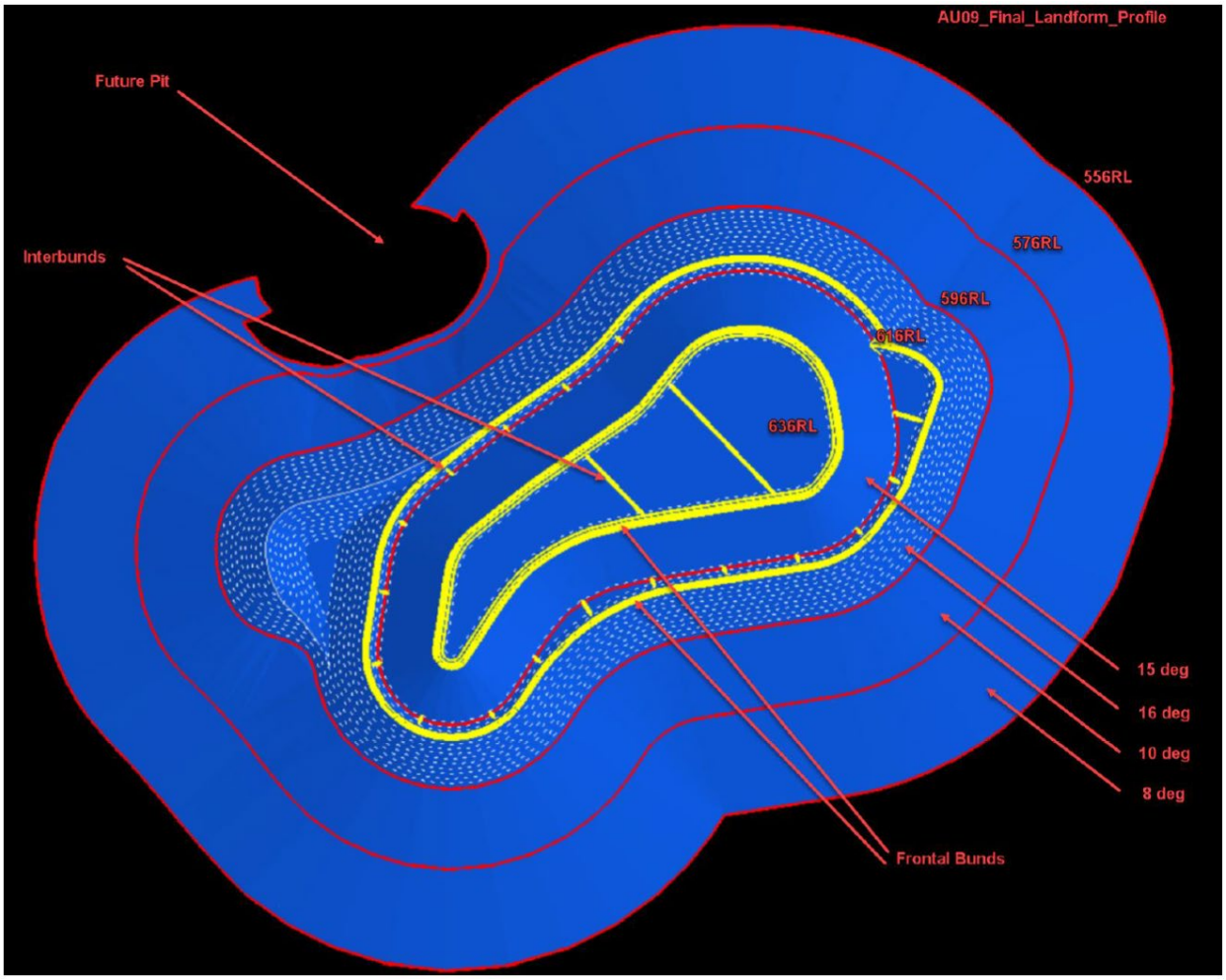


Figure 9-20 WH123 (AU09) final landform design showing interaction with future pit

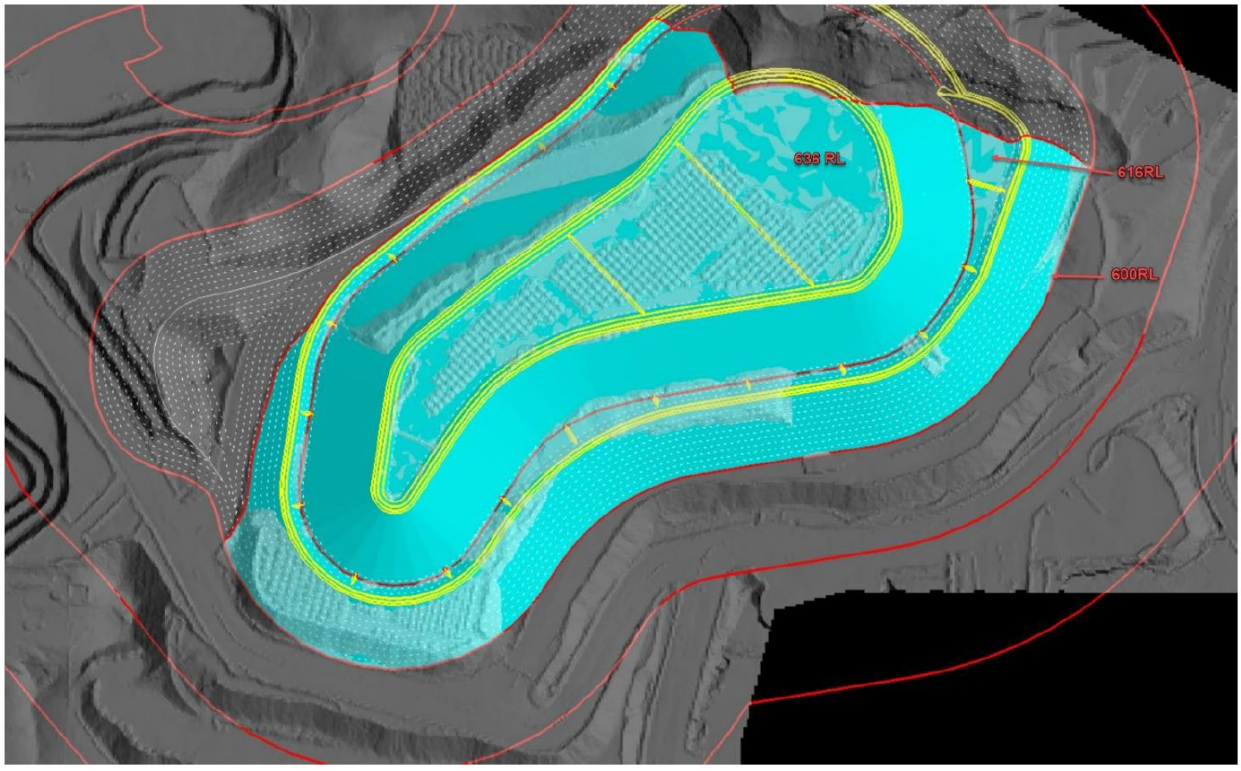
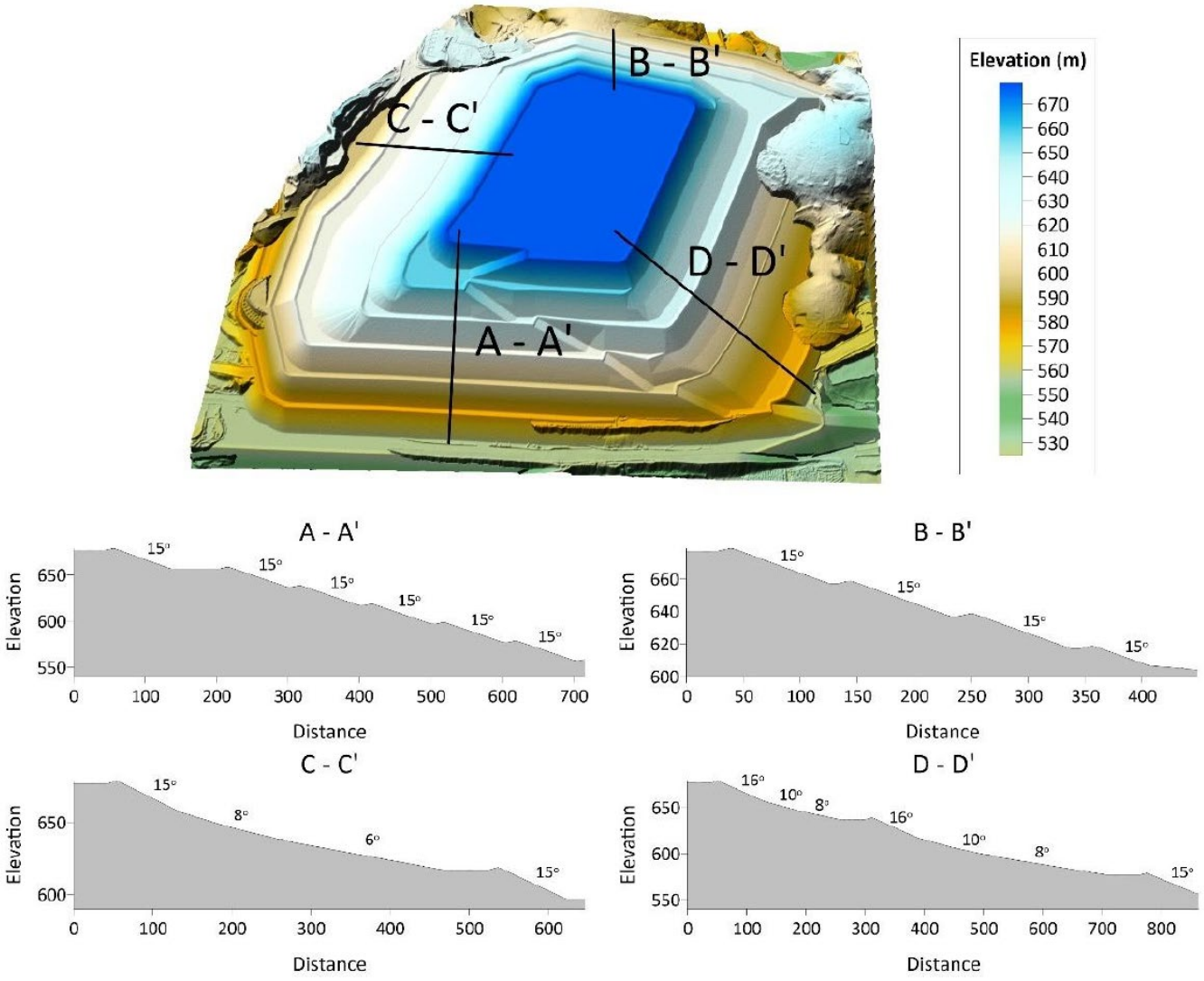


Figure 9-21 Design of top lifts showing crest and inter-bund locations

9.2.2.6 BF07

The design selected for BF07 from the design options analysis outlined in Section 5.16.2.2 is the concave landform (Figure 9-22) which was predicted to be the most erosionally stable. As outlined in Section 5.16.2.2, the design comprises:

- Two concave slopes on the eastern face separated by a 50 m wide bench. The top concave is 40 m high with a 20 m slope at 16°, and 2 x 10 m slopes at 10° and 8° respectively. The lower concave is 60 m high with slopes of 20 m at 16°, 10° and 8°.
- A 60 m concave slope on the western face (with 20 m high slopes of 15°, 8°, 6°) with a 75 m wide bench separating a 20 m high linear batter with a 15° gradient.
- Linear batters with ramps on the northern and southern faces. Each ramp extends from the crest to toe of a lift with a gradient of 5°. A crest bund (2 m) is included at the top and bottom of each ramp segment.
- Crest bunds (2 m high) on each bench and at the surface of the OSA.



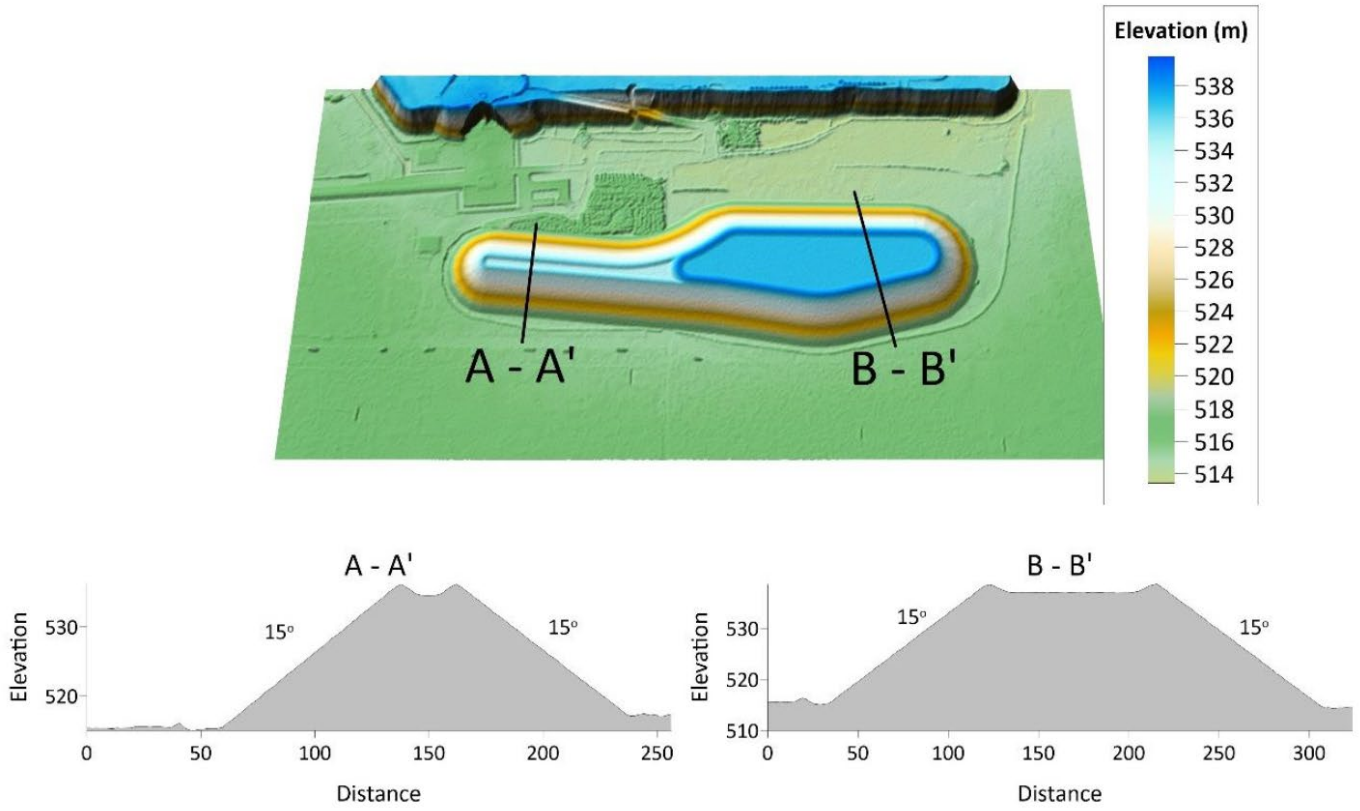
Source: Landloch (2021a)

Figure 9-22 BF07 selected landform design

9.2.2.7 BN07

The design selected for BN07 from the design options analysis outlined in Section 5.16.2.3 is the linear landform with a 25 m wide western section and crest bunding (Figure 5-59) which had the lowest predicted annual average erosion rates compared to the other design options. As outlined in Section 5.16.2.3, the design comprises:

- Linear batters 20 m and 25 m high in the western and eastern sections, respectively.
- Batter gradient of 15°.
- Crest bunds located on the outer edge of the top surface:
  - 1.5 m high, 15 m wide at base with a 13° backslope on western section.
  - 2 m high, 20 m wide at base with a 10-11° backslope on eastern section.
- Top surface flat with a maximum width of 25 m in the western section and 130 m in the eastern section



Source: Landloch (2021b)

Figure 9-23 BN07 selected landform design

9.2.2.8 BB06

BB06 is constructed of Marra Mamba materials and is located within the 1:10,000-year floodplain. It is, therefore, proposed that this OSA be removed prior to closure and the material placed in a location where the potential for erosion of the Marra Mamba materials can be managed (e.g., through backfill of pits, or by covering with erosion resistant overburden).

9.2.3 Infrastructure

The following sub-sections describe the key activities associated with the decommissioning and closure of the infrastructure domain. Following the removal of infrastructure, road and rail facilities, the land surface will be re-profiled and additional surface treatments and revegetation works will be implemented generally in accordance with the standard rehabilitation procedures described in the Rehabilitation Standard (WAIO, 2020a) (Section 9.1).

9.2.3.1 Process, supporting and transport infrastructure

As required by the State Agreement Acts, prior to removing the rail rolling stock, equipment and removable buildings, BHP will notify the State in writing giving the option for the State to purchase the infrastructure subject to valuation. Other stakeholders including adjacent landholders will also be consulted regarding infrastructure decommissioning as part of the post mining land use consultations.

Where infrastructure is transferred to a third party, transfer agreements will detail the condition of infrastructure at transfer and responsibilities for ongoing maintenance of the infrastructure, for signed acceptance by all parties.

In the event the State or other stakeholders do not take up the infrastructure ownership, decommissioning plans will be prepared to guide the decommissioning, demolition and removal of all fixed site assets at closure. Plans will include provisions for:

- Safe removal of residual hydrocarbons and chemicals, and de-energising and cleaning equipment prior to demolition.
- Demolition / removal of:
  - Ore processing facilities.
  - BHP's office buildings and minor equipment.
  - All above-ground power generation and supply infrastructure.
- Break up and removal of concrete slabs, foundations and footings to a depth of 600 mm below ground surface (to a maximum of 1000 mm below ground surface), to allow for grading of the site to a self-draining condition.

- Removal of underground services to a depth of 600 mm below ground surface unless a risk assessment indicates otherwise, or a different agreement is made with the post-mining landholder.
- Removal of bitumen from sealed roads and disposal to an appropriate landfill.
- Removal of rail infrastructure, including lines and sleepers in accordance with the *Rail Safety National Law WA (2015) Act* and associated regulations:
  - Rail ballast and sleepers will be managed during closure in a similar manner to how used ballast and sleepers removed during operational maintenance activities are managed. As outlined in BHP's Code of Practice for Track Maintenance Standard (BHP, 2018d), this includes testing for contamination prior to identifying an appropriate management strategy. The management strategy at closure will be informed by the waste classification guidelines in force at the time of decommissioning (currently DWER (2019)). Other materials will be broken up / placed within areas of general backfill or buried in-situ to a minimum depth of 1.5 m below the rehabilitated surface.
  - Rail corridors will be reprofiled to blend in with surrounding topography and will include removal of portions of rail embankments and culverts where necessary. The decommissioning of rail corridors will involve consideration of the design discharge, durability and long-term stability of culverts and other surface water management measures. Rail embankments will be removed, or surface water management measures enhanced if the existing embankment would result in significant adverse impacts on surface water drainage or quality in the long term.

Waste management facilities including the putrescible landfills, inert landfills and tyre dumps will be closed and rehabilitated. Details of the closure treatments (e.g., depth of cover material) will be developed over the life of mine.

9.2.3.2 Borefields

Subject to consultation with stakeholders, borefields and dewatering infrastructure will be removed, and water bores capped in accordance with the requirements of NUDLC (2020).

9.2.3.3 Borrow pits

Borrow pits will be closed generally in accordance with the Borrow Pit Management and Rehabilitation Procedure (WAIO, 2019a), provided as Appendix O, which broadly requires:

- Borrow pit walls to be battered to blend with the surrounding environment.
- Straight edges to be avoided and edges to be blended with the surrounding environment.
- Borrow pits to be free draining.
- Compacted areas to be deep ripped prior to topsoil return.
- Light scarification of topsoil and seeding

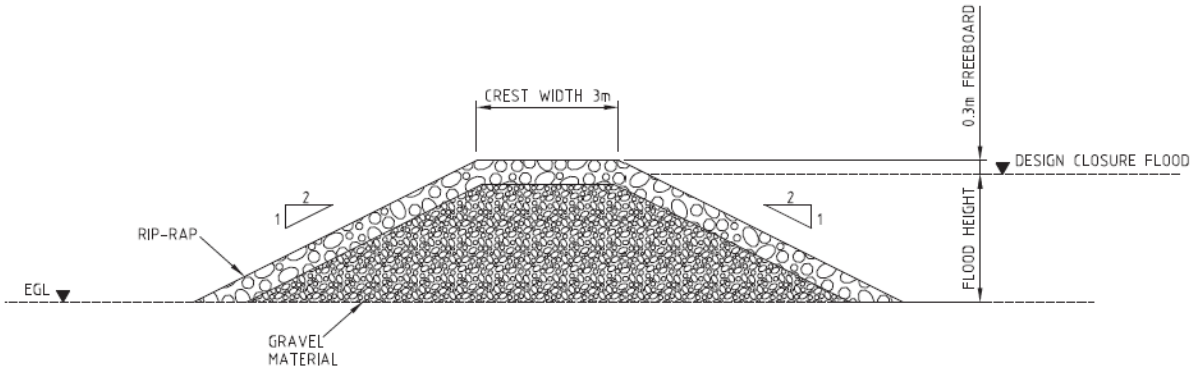
9.2.3.4 Surface water management infrastructure

As discussed in Section 5.16.3, flood bunds and minor creek diversions have been designed for operational conditions (1 in 100-year floods). A review will be conducted closer to the time of closure to determine the upgrades required for these structures once the final mine footprint and backfill levels are known. Similarly, while significant diversions have been designed to broadly mimic the natural creek conditions, and the basic diversion geometry should be suitable for closure, a review will be required of the upgrades required to accommodate selected closure design events closer to the time of closure. The sections below provide information on closure concepts, based on currently available information.

Closure options for flood bunds

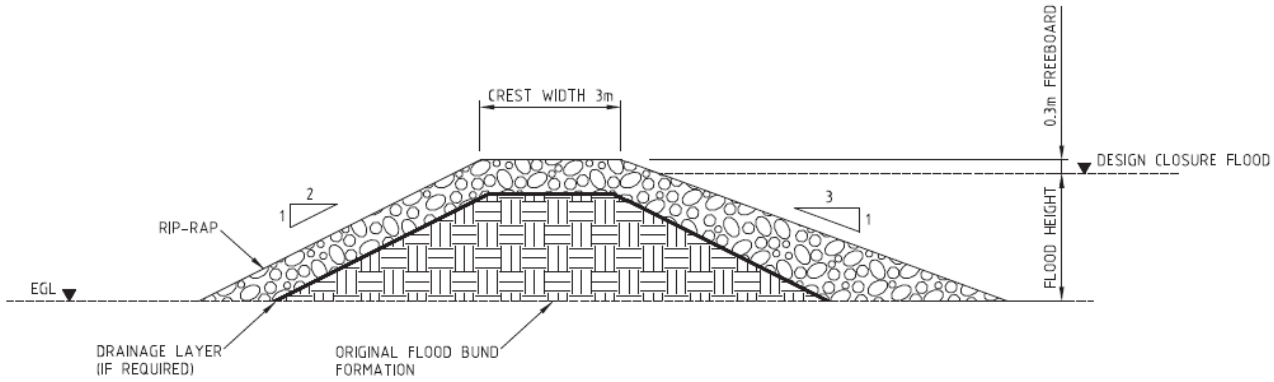
Two options have been proposed for closure of flood bunds and could be considered for the permanent flood bunds constructed at the Jimblebar Hub (RPS, 2019a; 2019b). The selected option for each pit would need to consider the flood characteristics associated with each creek line and the role of different creek flood events in supporting ecohydrological receptors. The options that could be considered are:

- **Option 1** which comprises replacing the existing bund with a bund that would act as an abandonment bund and "flow through" rock fill dam (Figure 9-24). RPS (2019b) considered that this option would provide a high level of robustness. This bund would be of large dimensions and made up of coarse material to prevent washout of fines over time. Ideally, the closure bund material would be made up of predominantly fine gravel.
- **Option 2** which would involve designing a modification of the existing flood bund to last for the long term (Figure 9-25). To obtain long term slope stability, the faces of the bund would be rolled, and the slope on the flood face widened to a flatter slope (such as 3:1) using rock armour. The two main mechanisms of degradation the bund would experience would be erosion due to flood flows along the face of the bund and disturbance of particles within the bund structure due to long term physical and chemical weathering. To prevent erosion during flood flows, the structure would be rock armoured along the faces of the bund. Long term weathering could be decreased by reducing the amount of precipitation that could infiltrate by providing a layer of material (such as gravel or geomembrane) between the existing bund and rock armour to drain water away from the surface.



Source: RPS (2019b)

Figure 9-24 Flood bund closure Option 1: through-flow rockfill dam / abandonment bund



Source: RPS (2019b)

Figure 9-25 Flood bund closure Option 2: upgrade operational flood bund

Specific considerations for each creek are outlined below and have nominally been based on 1 in 10,000-year events. As discussed in Section 7.5.3, the design flood event for the final design of each structure will be defined in accordance with the risk posed by that structure based on the final mine footprint and backfill:

- **OB31** - based on the modelling conducted for a 1 in 10,000-year event (Section 5.16.3.2), the height of the operational OB31 flood bund would need to be increased to 2 m. Velocities may reach up to 2 m/s at the eastern end of the bund and may require rock protection for long term stability (RPS, 2019a).
- **South Jimblebar flood bunds** - based on current 1 in 10,000-year modelling (Section 5.16.3.3), the closure bund would need to be 1 m higher than the constructed operational bund (which has 1 m freeboard for the 1 in 100-year event) without allowing freeboard for the 1 in 10,000-year event. The bund would need to withstand flow velocities of around 1.5 - 2.0 m/s.
- **H1A1 flood bund** - the closure design for the flood bund will be dependent on the final backfill design of the H1A1 pit and the final PC03 ROM landform.
- **H2B1 flood bund** - based on 1 in 10,000-year modelling, post development flood levels are 1.3 m higher than the operational (1 in 100-year) flood level.

Creek diversions

The closure options for the creek diversions will be influenced by the final mine landform and the performance of the operational creek diversions which would be monitored during operations to inform the final closure design.

As discussed in Sections 5.16.3.4 and 5.16.3.5, the basic diversion geometry for the major permanent creek diversions is expected to be suitable for closure. As a goal, the closure diversion design should perform and function similarly to the existing creek. Alluvial creeks operate on a bank “undermine and collapse” method to produce sediment and provide diversity of habitat.

For the South Jimblebar Creek diversion, the design assumes that the diversion will attain its own mobile bed and revegetate itself. This requires the low stream power (as designed) but can take a very long time in supply limited creeks (this can be assisted by importing alluvium from the natural creek). If required, construction of a shallow alluvial aquifer in the channel could assist the re-establishment of riparian vegetation. Overshot blasting in a rocky channel base and sides can produce material similar to the natural alluvium (and possibly substitute for natural alluvials, particularly in weathered rock), improve the creek ecology and replicate natural aquifer conditions with full saturation. The diversion flood bund would need to be modified to increase longevity by placing rip rap on the exterior (RPS, 2020).

The operational design for the Jimblebar Creek West Branch includes a hyporheic layer (Section 5.16.3.5) and it is expected that the basic design would be suitable for closure, however a review will be required closer to the time of closure to determine what upgrades might be required.

Designs for minor creek diversions will be developed once the final mine footprint is understood. The designs for these diversions will be based on risk, and the principle of maintaining flows to sensitive receptors.

9.2.4 Visualisations

Figure 9-26 provides a visualisation of the conceptual final Jimblebar Hub landforms and likely locations of pit lakes based on current mine plans for backfill.

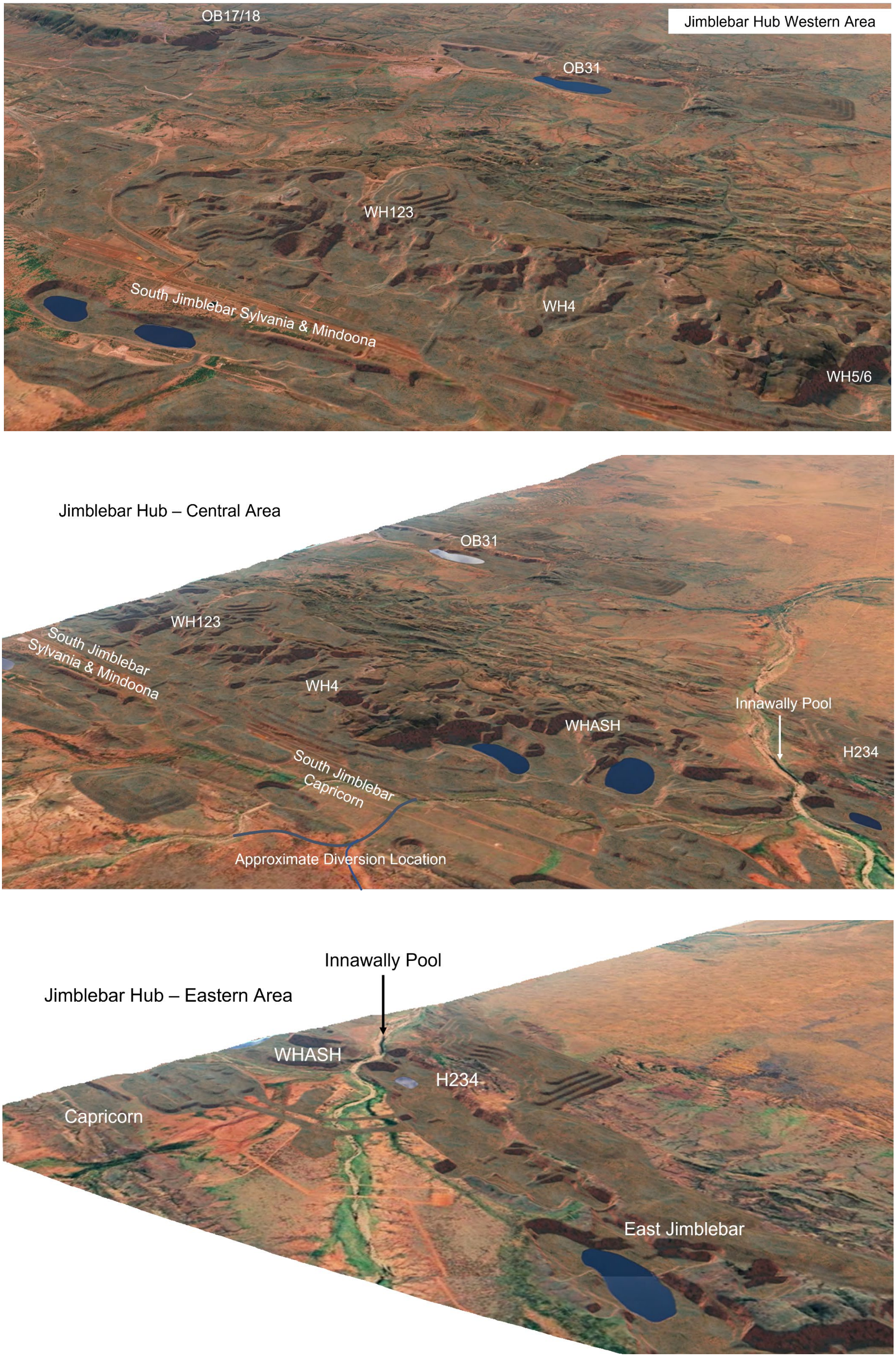


Figure 9-26 Jimblebar Hub Visualisations

9.3 Progressive rehabilitation

Progressive rehabilitation and ongoing performance assessment are carried out in areas where mining operations have been completed and further disturbance is unlikely.

The main components of the progressive rehabilitation program are described in the Rehabilitation Standard (WAIO, 2020a) and reported annually within the Annual Environmental Report (AER).

This section provides a brief overview of rehabilitation that has been conducted to date (Section 9.3.1) and the results of rehabilitation monitoring (Section 9.3.2).

9.3.1 Existing rehabilitation

Map 2-1 (Section 2.2) shows the areas that have been rehabilitated to date at Jimblebar Hub which include:

- OB18 North OSA (Section 9.3.1.1).
- OB18 South OSA (Section 9.3.1.2).
- Jimblebar South OSA (Section 9.3.1.3).
- Several borrow pit and infrastructure areas (Section 9.3.1.5).

Sections 9.3.1.1 to 9.3.1.5 outline key aspects of the designs for each of these landforms and supporting information is provided in Appendix L. Closure planning practices have evolved over time and:

- The data and studies that might be expected to inform contemporary closure designs may not be available for some of the older landforms that have been rehabilitated.
- The designs for older landforms may not reflect current practices.

The data arising from the monitoring program outlined in Section 10 will measure of the success of rehabilitation based on the Stage 3 completion criteria outlined in Section 8.3.1. Sections 9.3.1.1 to 9.3.1.5 provide a brief overview of monitoring results to date at each of the rehabilitated areas and compares the results to interim internal performance targets that have been developed to inform the management of rehabilitated sites. These targets are not formal trajectory performance indicators as these are still under development and, together with the Stage 3 completion criteria, will be the future measures of success.

9.3.1.1 OB18 North OSA

OSA description

The North OSA is located in a gully system on the northern side of Shovelanna Hill. Between 2016 and 2017, it was regraded to a series of linear and concave slopes and revegetated.

OSA design

Landloch (2013a) conducted erosion modelling for the range of materials which may be present at the North OSA (Section 5.3.3.2). This was supplemented with erosion testing and modelling of bulk samples of materials taken from the surface of the OSA (Landloch, 2015a) (Appendix L-1). These studies were used to guide the North OSA landform design shown in Figure 9-27.

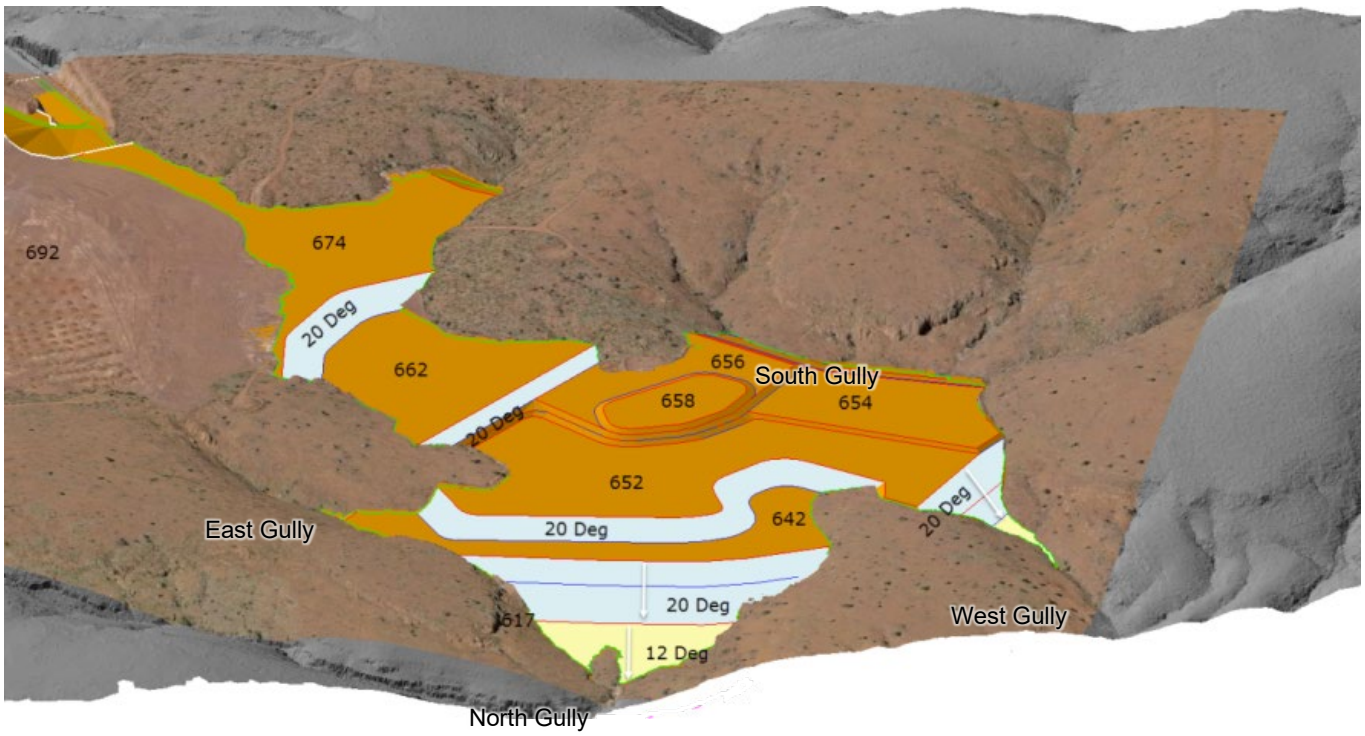


Figure 9-27 Design of lower North OSA showing slope angles and RL

Potential impacts associated with rainfall catchment flow onto or away from the OSA were taken into account during the design development (refer to Appendix L for initial catchment calculations used to inform the design) and, where required, additional competent overburden was placed in these areas to provide a suitable armoured surface. Additional erosion protection measures (riprap with rocks of approximately 400 mm minimum diameter) were provided at the intersection of the OSA with the south gully (Figure 9-28) as high velocity flows would be expected to impact this area during rainfall events because:

- The area receives flows from two relatively large catchments.
- There is an average gradient of 18% within the drainage gully.

Figure 9-28 Placement of rip rap at intersection of OSA with South Gully

Crest bunds and inter-bunds were constructed on each bench in general accordance with the design principles outlined in Section 9.2.2.1. Inter-bunds, designed to contain a 72-hour 1 in 200 rainfall event, were installed with their crests at a minimum of 300 mm below the crest bunds.

After regrading:

- Cell surfaces (excluding windrows and bunds) were deep ripped to 500 mm and cross ripped if necessary to reduce clod size to <300 mm in diameter.
- Fauna habitats were constructed of rocks 500 mm in diameter or larger, placed in a wide strip with multiple layers to approximately 2.5 m tall.
- 100 mm of topsoil was applied to cell surfaces (excluding windrows and bunds).
- The area was scarified and seeded. Seed treatments were guided by seed research (Appendix F).

A photograph of the rehabilitation in 2018 is shown below (Figure 9-29).

Figure 9-29 Photograph of rehabilitated North OSA in 2018

Rehabilitation monitoring results

Remote sensing conducted by Spectrum (2022) indicated that OB18 North OSA met the interim internal target for total weed / hummock grass cover ratio in all but one location but did not meet the internal target for hummock grass / native cover ratio at any locations. No on-ground monitoring has yet been conducted on this landform to ground truth remote sensing data, however, there have been recent photographs of the rehabilitation and visual evidence of Quolls in fauna habitat areas Figure 9-30 and Figure 9-31).

Figure 9-30 Photographs of North OSA rehabilitation 2021 & 2023

Figure 9-31 Quoll scat photographed in fauna habitat on North OSA

Remedial action

Given the young age of the rehabilitation, no remedial action is considered required at this time.

9.3.1.2 OB18 South OSA

OSA description

The southern OSA is located on the southern side of the OB18 mining area and comprises a single, 35 m high landform.

Rehabilitation design

Re-profiling works at the South OSA to achieve the final landform design (Figure 9-32 and Figure 9-33) and subsequent seeding were completed in FY18 and FY20 respectively (Figure 5-84, Section 5.16.6.1). Based on guidance from Landloch (2013a), slopes were re-profiled to between 10° and 20° (see Appendix L-2 for example sections) with each level designed to contain the rainfall captured by that catchment.

Crest bunds (~1.8 m) were installed across the top of the OSA to capture rainfall and prevent it from draining down the OSA slopes (Appendix L-2). Bunds and fauna habitat were constructed in general alignment with the design principles outlined in Section 9.2.2.1. All final slopes were surfaced with WMAT 1 overburden materials (i.e., competent rock) to a depth of ~1 m.

After regrading:

- Cell surfaces (excluding windrows and bunds) were deep ripped to ~500 mm and cross ripped if necessary to reduce clod size to <300 mm in diameter.
- Fauna habitats were constructed of rocks 500 mm in diameter or larger, in general accordance with the principles outlined in Section 9.2.2.1.
- ~100 mm of topsoil was applied to cell surfaces (excluding windrows, bunds and slopes) (see Appendix L-2 for locations).
- The area was scarified.
- Erosion trial plots were installed as described in Section 5.3.3.
- Seeding trials were completed as described in Section 5.16.6.1.

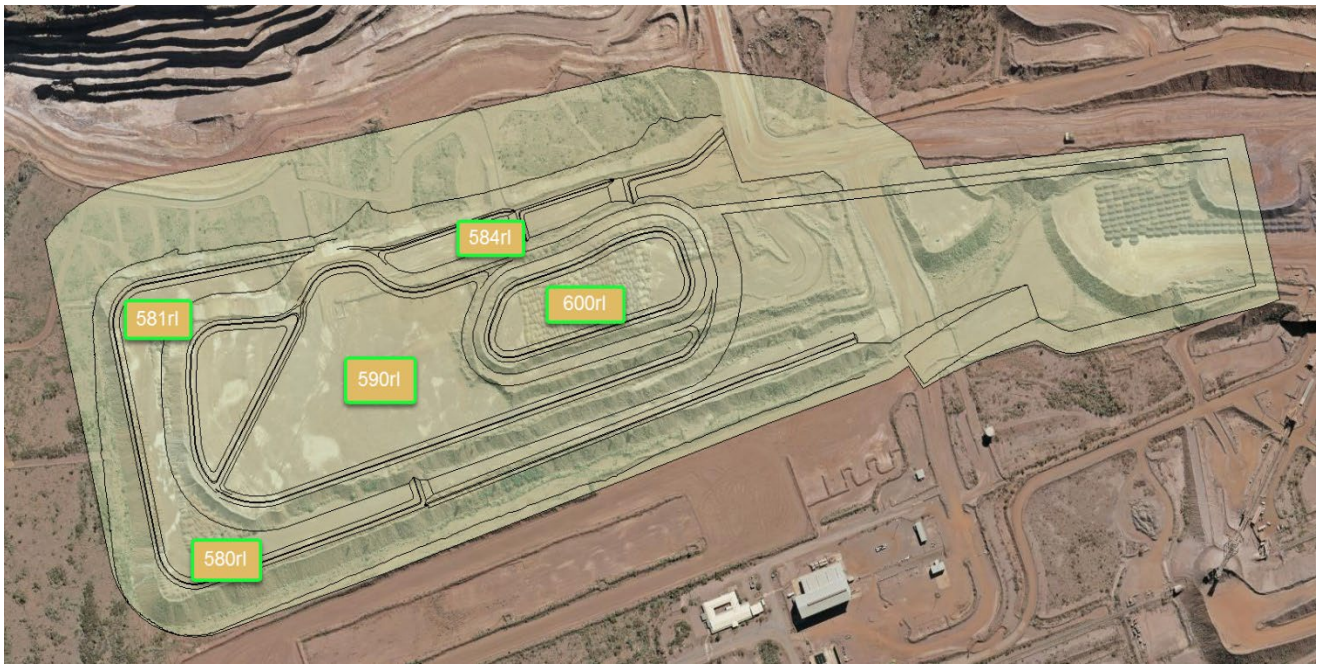


Figure 9-32 OB18 South OSA final landform design

Note the erosion trials at the western end

Figure 9-33 OB18 South OSA as constructed

Rehabilitation monitoring results

Remote sensing conducted by Spectrum (2022) indicated that OB18 South OSA met the interim internal target for total weed / hummock grass cover ratio at 4 out of 6 locations but did not meet the internal target for hummock grass / native cover ratio at any location. No on-ground monitoring has yet been conducted on this landform to ground truth remote sensing data, however, a recent photograph of rehabilitation at South OSA is provided in Figure 9-34.

Figure 9-34 Recent photograph of South OSA rehabilitation

Remedial action

Given the young age of the rehabilitation, no remedial action is considered required at this time.

9.3.1.3 Jimblebar South OSA

OSA description

South OSA is constructed from Marra Mamba overburden and was re-profiled in 2017 and revegetated in 2018.

Rehabilitation design

The South OSA closure landform design was based on the erosion modelling recommendations made by Landloch (2016b) in relation to Marra Mamba landforms sheeted with Jimblebar hard cap material (Appendix L-4). The design incorporates a concave slope of approximately 18° and 15° (see Appendix L-4 for cross sections). The slopes of the entire landform have been sheeted with competent Jimblebar hard cap material to a depth of ~1 m (Figure 9-35). Increased percentages of rock have also been provided around the lower northwest slopes of the OSA to protect the landform against erosion from water draining through the adjacent gully (Figure 9-35). In general accordance with the design principles outlined in Section 9.2.2.1:

- Frontal crest bunds have been installed around the perimeter of the OSA (see Appendix L-4 for locations).
- Inter-bunds have been installed perpendicular to the frontal bunds to control surface water on the surface of the landform.
- Fauna habitats were installed in cells between inter-bunds.

Figure 9-36 shows the OSA after completion of earthworks. Topsoil was applied to the top surfaces of the landform (shown in orange in Figure 9-35), to a depth of 100 mm, and scarified A mixture of hard seed and *Triodia* grass seed were spread at rates of 2.5 kg/ha and 6.5 kg/ha respectively.

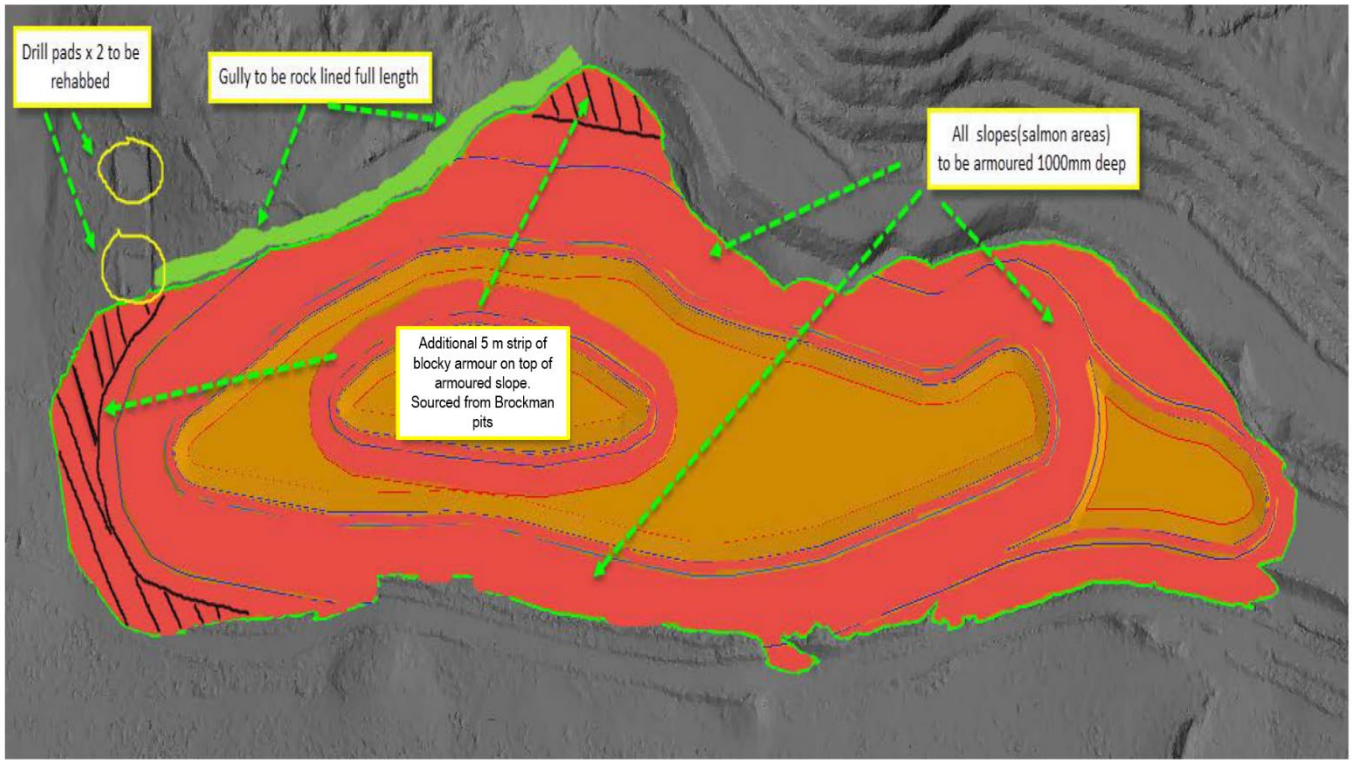


Figure 9-35 Jimblebar South OSA rock armour and topsoil strategy

Figure 9-36 South Jimblebar OSA following completion of earthworks

Rehabilitation monitoring results

Remote sensing conducted by Spectrum Ecology (2022) indicated that South OSA met the interim internal rehabilitation targets for native cover and total weed / *Triodia* cover ratio, but not the *Triodia* / shrub cover ratio for young rehabilitation (<5 years old). An on-ground site inspection was conducted in 2021 to confirm remote sensing results and identified that there was some *Triodia* recruitment present and that this had improved since the 2020 monitoring program. Figure 9-37 shows photographs of the rehabilitation taken in 2023.

Figure 9-37 Photographs of South Jimblebar OSA rehabilitation 2023

Remedial action

Given the young age of the rehabilitation, and the improvement in *Triodia* recruitment since 2020, no remedial action is considered necessary at this stage. Further monitoring will assess progress towards completion criteria and trajectory performance indicators as these are developed.

9.3.1.4 BC06 (BD06)

OSA description

The BC06 landform (also referred to as BD06) is constructed of Marra Mamba overburden. The as-tipped OSA comprised a single lift to a height of 20 m.

Rehabilitation design

The landform was regraded in FY22 and was partially seeded in February 2023. Seeding will be completed in FY24. The final landform design comprises slope profiles of 18° to 20° with approximately 1 m competent rock armouring applied to the slopes to provide erosional stability (Figure 9-38). An additional 0.7 m layer of blocky WMAT 1 rock armour with a D_{50} of 300 mm has been placed to a height of 2 m around the eastern, southern and western slopes of the OSA to stabilise those areas of the landform that encroach into the floodplain. About half of the ramp has been removed to create a stormwater storage on the 535 mRL (Figure 9-39).

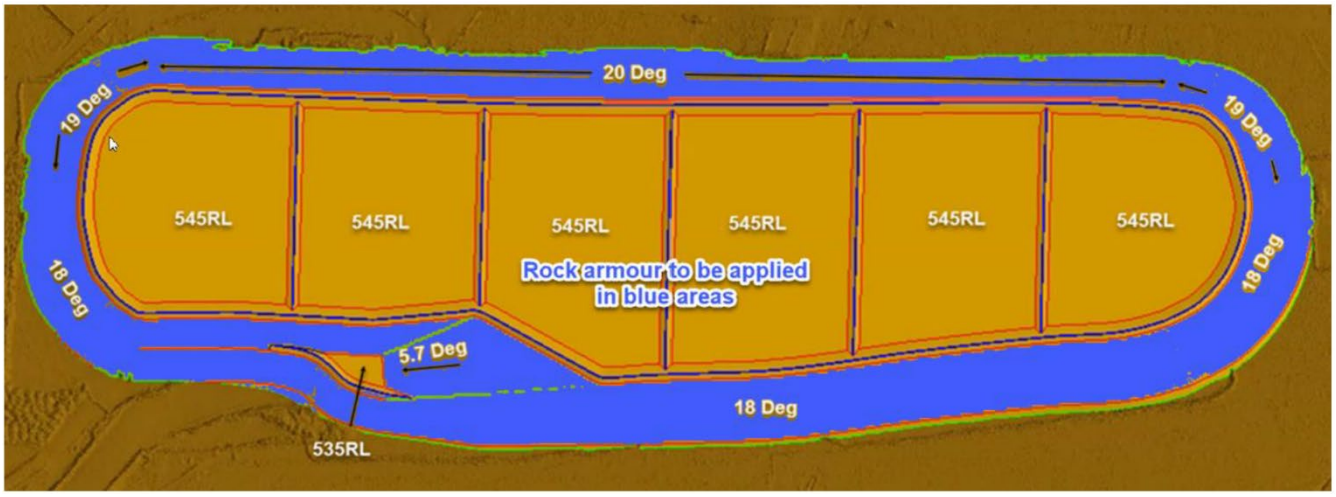


Figure 9-38 BC06 landform design

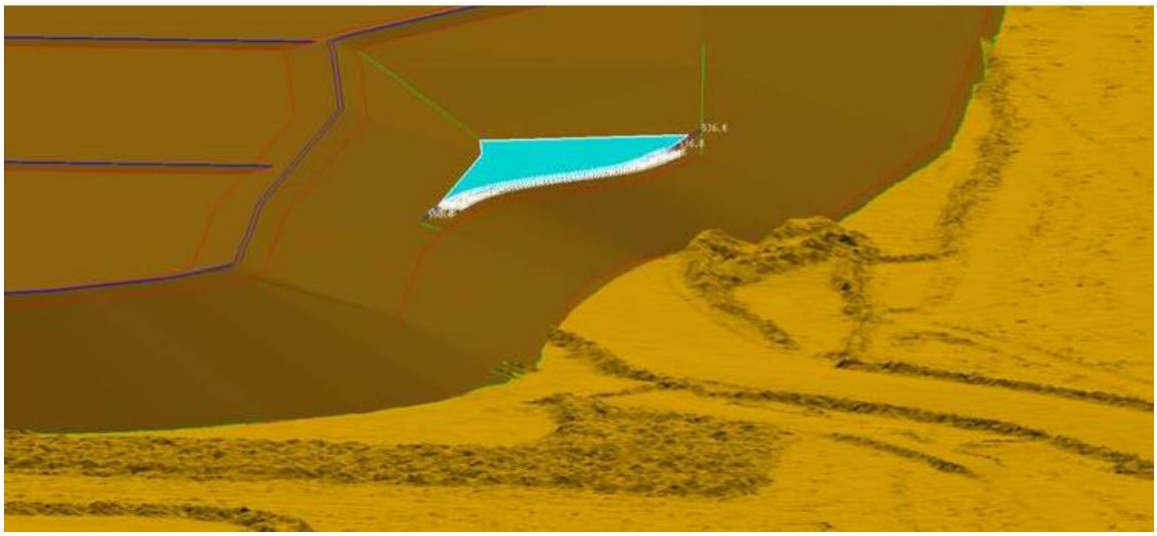


Figure 9-39 Stormwater storage on 535 mRL

The design incorporates a frontal bund constructed along the crest of the OSA and inter-bunds across the top surface (Figure 9-40) in general accordance with the design principles outlined in Section 9.2.2.1. The external faces of the crest bunds have been designed to be continuous with the designed batter slope. The backslope of the crest bunds on the 545 mRL have been designed to slope at 10° towards the internal section of the OSA, and the backslope of the bund on the 535 mRL at 15°. Fauna rock habitats have been installed on the surface of the OSA (approximately 1 habitat per 3 ha) in general accordance with the specifications outlined in Section 9.2.2.1.

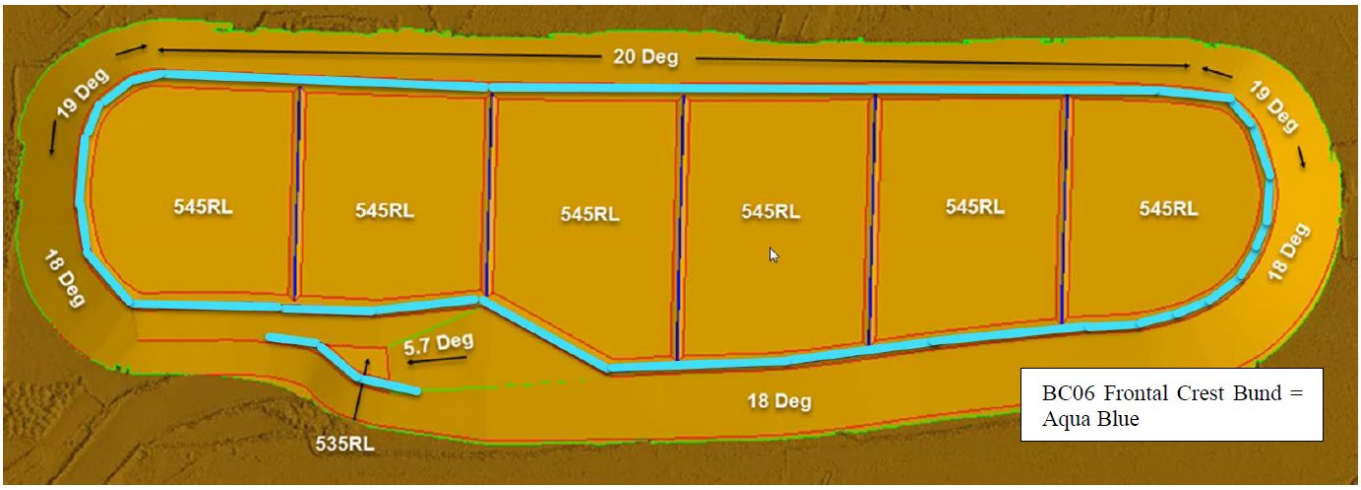


Figure 9-40 BC06 crest bund locations

Deep ripping (to remove compaction) or cross ripping (to reduce clod size) was conducted where required. Topsoil (100 mm) was applied to the flat areas and southern 18° slope (Figure 9-41). Following topsoiling, the areas were scarified.

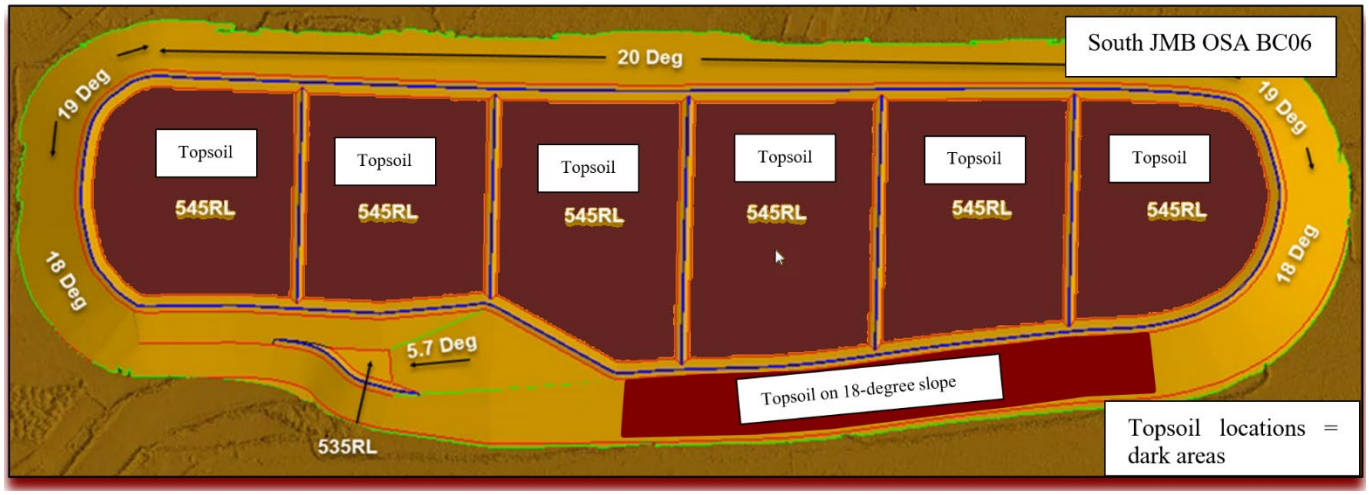


Figure 9-41 BC06 topsoil locations

Rehabilitation monitoring results

There are no revegetation monitoring results to date as seeding will not be completed until FY24. However, an inspection in December 2023 identified two bush turkeys utilising the top of the OSA (Figure 9-42).

It has also been noted that topsoil erosion occurred on the southern face in March 2023 following heavy rainfall as it was not fully integrated into the rock armour during project execution.

Figure 9-42 Bush turkeys recorded in December 2023

Remedial action

Eroded topsoil accumulated at the base of the landform will be recovered for re-use. The face will continue to be monitored to determine whether remedial action is required.

9.3.1.5 Borrow pit and infrastructure areas

Several borrow pit and infrastructure areas have been rehabilitated since 1990. Some of these have been re-disturbed as a result of subsequent mining operations. The available information on rehabilitation of those areas that remain undisturbed is summarised in Table 9-3. Given the age of some of these sites, there is limited information available on rehabilitation techniques, however, monitoring of these areas is conducted and the results are summarised in Section 9.3.2 and Appendix M-3.

Table 9-3 Summary of borrow pit / infrastructure rehabilitation that remains undisturbed

Area rehabilitated	Date	Details
OB18 - 17 borrow pits	1998	Ripped with grader and smoothed to blend with landscape (0-5° slope). Topsoil replaced within a year before wet season. Remnant vegetation material scattered.
	2011 - 2013	Undulating flat surface, ripped and topsoiled.
Jimblebar – borrow pits along rail spur	1990	Ripped with grader and smoothed to blend with landscape.
	2009	Flat or gently sloping surface contour ripped and spread with log-mulch.
Jimblebar CSI Crusher	2014-2015	Refer to Appendix L-7 for location. Windrows, stockpiles and any other outlying mounds of material were levelled to enable sheet-flow water to flow undisturbed across the rehabilitated landscape. Slopes were reprofiled to ~15° and crest bunds installed in general accordance with the design principles outlined in Section 9.2.2.1 with the outer slope 15° and inner slope 5°. Deep ripping of the upper surface to 500 mm and cross ripping conducted if necessary to reduce clod size to <300 mm diameter prior to the application of 100 mm of Topsoil
OHP East Laydown	2014-2015	The area comprised five work zones (refer to Appendix L-9). Zone 1 and Zone 2 were open areas surrounding a topsoil stockpile and rehabilitation works comprised: • Pushing out stockpiles of overburden until blended in with current ground level. • Deep ripping to ~1 m depth. • Cross ripping. • Final surface scarification. Zone 3 was a laydown area. Rehabilitation comprised: • Deep ripping all areas (excluding the white cross hatch shown in Appendix L-9) to ~1 m depth. • Cross ripping to achieve final clod size of less than 100 mm. • Pushing out topsoil stockpile (orange shape) across rehab project area until all material was blended in with the ground level. • Final scarification of all areas (including white cross hatch). • The area of white cross hatch was disturbed but not completely cleared or used as a laydown area. This area only required a light scarification across any bare areas and light vehicle tracks. Zone 4 was a laydown area. Rehabilitation comprised: • Reprofiling ramp and exposed faces (see Appendix L-9) to as low of an angle as practical (less than 1:3 slope angle). • Deep ripping to ~1 m depth. • Cross ripping to achieve a final clod size of less than 100 mm. • Final scarification of all areas. Zone 5 was a laydown area. Rehabilitation works comprised: • Pushing out windrows and blending into rehabilitation surface. • Deep ripping to 1 m depth. • Cross ripping to achieve final clod size of less than 100 mm. • Final scarification of all areas.

Area rehabilitated	Date	Details
Jimblebar – various infrastructure areas	Circa 2014-2015	Areas rehabilitated are shown in Appendix L-5. Rehabilitation comprised: • Levelling and final trim activities including filling in low points / holes. • Construction of fauna habitats in areas 51520 and 27186. • Deep-ripping to ~500 mm. • Scarification of the surface to ~200 mm. Final scarification was not possible at areas 51520 and 27186 due to the amount of rock in the soil. However, there was sufficient surface roughness without scarification as the two areas are on flat sections with little to no erosion risk. • Topsoil was not considered necessary at any of the project areas as the in-situ overburden was generally suitable as growth media. • Vegetation was allowed to recolonise naturally for most areas, with hand-seeding conducted in larger sections of rehabilitation, namely 51520, 14891, and 27186 and 1157.
Jimblebar Geotech Village	2014-2015	Graded to integrate with natural topography, ripped and topsoiled.
Warrawandu WWTP and Irrigation Zones	2014-2015	Soil and vegetation (acacia and spinifex) were stripped from the evaporation pond and relocated to rehabilitation areas and spread across the site as evenly as possible using a dozer.
Jimblebar East Regrade	2017	Area with undulating flats and crests. Ripped and seeded.
Jimblebar Calibration Pad	2017-2018	Rehabilitation works comprised: • Recovery of overburden and topsoil from windrows and spreading in adjacent open areas to a depth of ~150 mm (Appendix L-11). • Reinstatement of creek line (Appendix L-11) and spreading removed material to an undulating level merging with the surrounding natural surface. • Deep ripping to ~1,000 mm on contour (where possible). • Cross ripping if necessary to reduce clod size to <300 mm. • Seeding with 2 kg/ha hard seed and 6 kg/ha grass seed (*Triodia*).
OB18 Rail Loop	2018	Flat surface, ripped and topsoiled.
Jimblebar CSI Stockpile	2018	Rehabilitation works comprised: • Re-profiling to allow surface water to flow across the project area unimpeded (Appendix L-6). • Recovery of overburden, topsoil and vegetation from windrows and spreading in adjacent open areas to a depth of ~150 mm. • Deep ripping to ~500 mm. • Cross ripping if necessary to reduce clod size to <300 mm. • Application of 100 mm of topsoil to all open areas. • Scarification to 100 mm deep.
Dead Dead Stockpile	2018-2019	Rehabilitation works comprised: • Re-profiling to allow surface water to flow across the project area unimpeded (Appendix L-8). • Recovery of overburden, topsoil and vegetation from windrows and spreading in adjacent open areas to a depth of ~150 mm. • Deep ripping to 500 mm on contour (where possible). • Cross ripping if necessary to reduce clod size to <300 mm. • Application of 100 mm of topsoil to all open areas. • Scarification of all areas after topsoil spreading.
Jimblebar PC1 ROM	2018	Contour ripping to approximately 300-400 mm and seeding with 6.5 kg/ha *Triodia* and 2.5 kg/ha hard seed.
OB31 flood bund	2022	Floor of borrow area contoured to avoid water ponding and promote drainage to natural ground falls. Edges blended into the surrounding topography 3:1 (18°, 33%). Ripped to 1 m across majority of the site and 0.1 m in northern portion where caprock encountered. No topsoil or seeding as borrow area is located in a future pit area.

9.3.2 Rehabilitation monitoring

Since 2020, BHP has been using remote sensing in its rehabilitation monitoring program to assess rehabilitation performance against interim internal targets and completion criteria developed by Syrinx (2019; 2023) (see Section 8.3.1). The interim internal targets are designed to help gauge whether rehabilitation less than 15 - 20 years old is likely to be successful in the future, and to indicate where intervention may be necessary, to improve the likelihood of future rehabilitation success. These targets are applied to young rehabilitation (< 5 years old) and progressive rehabilitation (5 - 15 years old) and are derived from an analysis of relationships between early-stage metrics with later rehabilitation success evident in historical rehabilitation datasets. Overall, the

analysis indicates that *Triodia* cover, *Triodia* density, shrub cover, and weed cover are key targets. Relative abundance is important and differs at different points in time. Relative abundance can be represented as ratios since this better represents the dynamics of developing sites and is instantly informative in terms of flagging remedial actions. The metrics of these internal targets continue to be refined based on analysis and review of rehabilitation monitoring.

On-ground monitoring was not conducted in 2020 due to site access restrictions (COVID 19), but in 2021 two rehabilitated sites were selected for a quadrat assessment, in general accordance with the procedures outlined in Section 10.1.2, and six rehabilitated sites were selected for inspection to determine possible drivers of failure. No on-ground monitoring was conducted in 2022 as it was not considered necessary based on the results of the 2021 remote sensing assessment (Spectrum Ecology, 2022).

The results of remote sensing are summarised below. A summary of recent on-ground monitoring at rehabilitation sites is provided in Appendix M-3.

Mean native cover across all rehabilitated sites at Jimblebar was 40.1% and ranged between 0.7% and 81.1%. Rehabilitated crest, flat, and slope sites had an average native cover of 34.5%, 41.0%, and 40.2%, respectively. On average, native vegetation cover consisted of 9.9% hummock grass (*Triodia* spp.), 14.7% other grass, 10.1% shrub, 0.8% Mulga (*Acacia aneura* complex), 0.4% herb, and 1.3% tree cover. Mean hummock grass cover was lowest at crest sites (2.7%), relative to flat (11.1%), and slope (9.7%) landforms. The composition of native lifeforms was similar between the different landforms. Across Jimblebar, mean bare area cover was 9.0% and mean introduced cover was 1.1%. Bare areas ranged between 0.0% and 91.4% and did not vary substantially between crest (average 12.3%), flat (average 7.4%), and slope (average 11.7%) landforms. Weed cover was highest across flat landforms (1.3%) compared to slopes and crests (Spectrum Ecology, 2022).

Remote sensing metrics indicated 7.3% of the 303.6 ha of rehabilitated land met all Low Woodland completion criteria that could be evaluated with the monitoring method, regardless of age. All rehabilitated land was established less than 15 years ago and likely has not had adequate time to develop and achieve completion criteria. Sites rehabilitated between 5 and 15 years ago, or with no accurate date information, were assessed against interim internal performance targets. A total of 14.2% (38.6 ha) of the 272.1 ha of rehabilitated land met interim internal performance targets. None of the 31.6 ha of rehabilitated land less than 5 years old met all interim internal performance targets for 'Young' rehabilitation (Spectrum Ecology, 2022).

9.4 Implementation schedule

The schedules outlined in this section relate to areas that have not yet been rehabilitated. Map 2-1 (Section 2.2) shows areas that have been disturbed to date, and those that have been rehabilitated.

9.4.1 Life of asset overview

The current life of the Jimblebar Hub operations is until ~2053. Given the long life of the asset, mine plans can change according to a range of factors including market conditions and technology and several mining areas may be used over a long period of time to achieve appropriate blends to meet customer demand. A broad schedule is identified for progressive closure based on the predicted life of each orebody (Table 9-4). As the mine life progresses, areas available for rehabilitation can be factored into the five-year plan (Section 9.4.2). Rehabilitation trials may be conducted on areas that have been confirmed as not being required for at least five years, BHP prefers to conduct full scale rehabilitation once it has been confirmed that an area will no longer be required for mining. This is because re-disturbance of an area results in some losses of valuable rehabilitation materials (such as topsoil) and can negatively impact the structure of these materials by subjecting them to additional handling.

Table 9-4 Jimblebar Hub closure implementation schedule

Domain	Feature	Indicative Timing[40]	Commentary
OSA	OB18 East OSA	2051 to 2071	East OSA required as a source of materials for covering Swan and De Grey in-pit TSFs.
	OB18 Blackwood ISA / OSA	2029	-
	OB18 Avon ISA	2041	-
	OB18 South OSA (east side)	2029	-
	OB31 OSA	2030 - 2048	Opportunities for progressive rehabilitation will be identified and integrated into the rolling 5-year plan (Section 9.4.2). Final rehabilitation from 2048.
	WH123 OSA / ISAs	2040 - 2044	Opportunities for progressive rehabilitation will be identified and integrated into the rolling 5-year plan (Section 9.4.2). Final rehabilitation from 2044.
	WH4 ISA	2041 - 2044	Opportunities for progressive rehabilitation will be identified and integrated into the rolling 5-year plan (Section 9.4.2). Final rehabilitation from 2044.
	WHASH OSAs	2044 - 2050	Opportunities for progressive rehabilitation will be identified and integrated into the rolling 5-year plan (Section 9.4.2). Final rehabilitation from 2050.
	H234 OSAs	2050	Opportunities for progressive rehabilitation will be identified and integrated into the rolling 5-year plan (Section 9.4.2). Final rehabilitation from 2050.
	East Jimblebar OSAs	2051	Opportunities for progressive rehabilitation will be identified and integrated into the rolling 5-year plan (Section 9.4.2). Final rehabilitation from 2051.
	South Jimblebar ex-pit OSAs	2027 - 2049	Opportunities for progressive rehabilitation will be identified and integrated into the rolling 5-year plan (Section 9.4.2). Final rehabilitation from 2049.
Mine Voids	Swan & De Grey in-pit TSFs	2061 to 2071	Subject to approval of Jimblebar Beneficiation Project. Timeframe takes account of the need for tailings to consolidate to allow vehicle access.
	OB31	2048	Opportunities for progressive fill to be identified and included in the mine plan. Final closure from 2048.
	WH123	2040	Opportunities for progressive fill to be identified and included in the mine plan. Final closure from 2040.
	WH4	2044	Progressive infill underway since early 2000's. Final design and rehabilitation from 2044.

[40] Timing reviewed annually with directional and 5-year mine plans

Domain	Feature	Indicative Timing[40]	Commentary
Mine Voids Continued	WHASH	2050	Opportunities for progressive fill to be identified and included in the mine plan. Final closure from 2050.
	East Jimblebar	2051	Opportunities for progressive fill to be identified and included in the mine plan. Final closure from 2051.
	H234	2050	Opportunities for progressive fill to be identified and included in the mine plan. Final closure from 2050.
	South Jimblebar	2049	Opportunities for progressive fill to be identified and included in the mine plan. Final closure from 2049.
Infrastructure	Hub processing, mining support, roads and rail	2053	Opportunities for progressive demolition and rehabilitation will be identified and integrated into the life of asset and rolling 5-year plans. Final decommissioning and rehabilitation from 2053.

9.4.2 Five-year plan

The Jimblebar Hub five-year rehabilitation plan is developed annually as part of the CAP process (BHP, 2022c), outlined in Section 1.4. It is developed to align with the five-year mining plans and identifies areas available for final landform earthworks and rehabilitation within the next five-year period.

Rehabilitation planned in the next five years is summarised in Table 9-5. It should be noted that the potential to use the De Grey and / or Swan pits for tailings storage impacts the progressive rehabilitation program at OB17/18/31 due to the need to use some of the material in OSAs to cover the in-pit TSFs.

Table 9-5 Progressive rehabilitation schedule (FY24 5-year plan)

Activity	Approximate Area
OB31 • AW24 (regrade to seed)	35 ha
Jimblebar • Progressive backfill as pit pushback sequence allows • BD06 (seed) • AU09 (regrade to seed) • Hashimoto Creek area (seed) • AX12 (regrade and AMD rehandle to backfill) • BB06 (rehandle to backfill)	86 ha

9.5 Unplanned or unexpected closure

BHP is required to review a range of risks associated with the closure of its facilities annually as assessed using the risk processes described in Our Requirements: Risk Management (BHP, 2022b). One of these risks is unexpected or unplanned closure. In the event that unplanned or unexpected closure occurs, the site will be decommissioned and rehabilitated in line with the objectives and strategies outlined in this document. In the absence of more detailed information (as planned in Section 7.5.4), the overall objective under this scenario will be to make landforms such as OSAs secure and non-polluting following decommissioning and decontamination activities, with application of topsoil prioritised for these areas.

In the rare event of unplanned closure, existing OSAs would be assessed on a case-by-case basis to develop a final design commensurate with the incomplete geometry and available overburden on site to re-contour within acceptable erosion requirements. Given the overburden balance provided in Section 5.3.4.2, it is expected that existing stockpiles of competent overburden can be used to stabilise landforms to acceptable levels. Where there is a shortfall, alternative landform geometries may be considered, or portions of OSAs may be rehandled into mined-out voids subject to consultation with the DEMIRS Geological Survey and Resource Strategy Division where resource is present and reported.

Should closure occur before in-pit TSFs have been completed, a review would be conducted of the risks associated with incomplete deposition (compared to a full deposition scenario) and closure strategies would be refined / revised, as required. Material to be used in tailings closure is already stored in East OSA and consequently would be available in an unplanned closure scenario.

Annual cost provisioning for closure in line with the closure cost estimating methodology outlined in Section 11 provides an understanding of the current closure liability, with present closure obligation costs representing an unplanned or unexpected closure scenario.

10 Closure monitoring and maintenance

10.1 Monitoring program overview

Across its Pilbara mining operations, BHP has implemented monitoring programs to evaluate the performance of rehabilitated mine landforms and to assess whether they have either met the site completion criteria or are showing satisfactory progress towards meeting these criteria. These programs will be expanded as new areas of the mine are rehabilitated and will be refined based on monitoring results and rehabilitation success.

Monitoring events will be undertaken in line with the process outlined in this section, and the outcomes will inform rehabilitation strategies, facilitate refinement of completion criteria, direct maintenance and remedial action plans consistent with the adaptive management approach (Section 7.1), and demonstrate performance against completion criteria in preparation for rehabilitation sign-off.

In some instances, achievement of completion criteria will be verified by audit or inspection rather than by monitoring over a period of time. Section 10.1.1 provides further details of the means to verify achievement of these criteria.

10.1.1 Closure completion audit and inspection

Table 10-1 outlines those completion criteria (Table 8-1) that would be verified through a completion audit and inspection rather from the monitoring processes discussed in Sections 10.1.2 to 10.1.12. This section focuses only on completion criteria. Other interim audits and inspections would be conducted to confirm that planning and execution performance indicators were met.

Table 10-1 Completion audits and inspections

Category	Completion Criteria	Means of Verification
C1.1 Post-closure land use	Monitoring, inspection and / or survey reports demonstrate that the rehabilitation objectives have been substantially met.	Completion audit of: • Post-closure monitoring and survey reports. • Written acknowledgement from post-closure land user / owner that completion criteria have been met.
	The current assumed land use is related to underlying tenure (pastoral and unallocated crown land) and achievement of the criteria for land management (C1.3), stability (C3.2- C3.4), revegetation (C4.1 to C4.5) and water (C5.1 to C5.4) will indicate that this criterion has been met.	Completion audit of achievement of land management (C1.3), stability (C3.2- C3.4), revegetation (C4.1 to C4.5) and water (C5.1 to C5.4) criteria.
C1.2 Infrastructure	Stakeholders agree to the transfer of infrastructure ownership and accept ongoing responsibility for maintenance of the infrastructure. In-ground infrastructure has been removed to 0.6 mbgl unless: • The post-closure landowner / manager requires infrastructure to remain. • Risk assessment indicates that a different specification is required.	Completion audit of: • Demolition contractor's report against agreed standard. • Site inspection report following demolition. • Documented transfer of infrastructure to stakeholders.
C1.3 Land management	At the time mine closure is considered complete, site land management requirements are aligned to the post-completion land use and / or approved closure strategy. If additional management actions are required post-completion, these will have been agreed with the landowner / manager.	Completion audit of: • Achievement of the closure strategy, as demonstrated by achievement of post-mining land use criterion C1.1 • The post-completion land use management plan. • The documented agreement of additional active management measures required post-completion.
C2.1 Safety	Residual safety and health hazards have been identified and controlled in accordance with regulatory requirements and consideration of industry guidance, and are acceptable to the District Mines Inspector The geotechnical and geochemical stability criteria (C3.2 and C3.3) have been met.	Site inspection by the District Mines Inspector following execution and all sites are assessed as acceptable. Completion audit of the achievement of the geotechnical and geochemical stability criteria (C3.2 and C3.3).
C3.1 Visual amenity	Landforms meet visual design criteria.	Inspection and audit confirm earthworks have substantially met visual impact design criteria.

Category	Completion Criteria	Means of Verification
C3.2 Geotechnical stability	OSAs and mine voids conform to DMIRS (2019) guidelines for structural stability and achieve design FoS criteria. Unless otherwise designed, there is no significant slumping or failure of accessible ex-pit constructed slopes or berms.	Completion audit of: • Construction records against designs. • Landform inspection reports.
C4.6 Impact to fauna	The pit lake risk assessment shows no significant impact to native terrestrial fauna.	Completion audit of report on pit lake monitoring and validation of risk assessment assumptions.
C6.1 Contaminated sites	Validation sampling shows remediation has achieved remediation criteria.	Completion audit of contaminated sites auditor VAR or MAR.
C7.1 Cultural heritage & values	Performance indicators for Execution (Stage 2) have been met.	Completion audit of: • As constructed report of designs developed to protect cultural values. • Confirmation by Nyiyaparli people representative that artefacts have been repatriated.

10.1.2 Rehabilitation monitoring methodology

10.1.2.1 Monitoring objective

Monitoring will be used to assess whether initial vegetation establishment has been successful, rehabilitation is developing satisfactorily and is ready for signoff. Rehabilitation monitoring will be used to assess achievement of completion criteria outlined in Table 10-2.

Table 10-2 Rehabilitation completion criteria

Criteria	Domain	Completion criteria
C4.1 Growth media. C4.2 Vegetation development. C4.5 Fauna	All where revegetation is planned in areas of unallocated crown land (infrastructure footprints, OSAs / ISAs).	**Land use: Natural environments for managed resource protection** • % bare ground: - Hills, slopes, dry plains ≤50%. - Drainage lines and floodplains (excluding channel bed) ≤20%. • Perennial native species richness recorded in aggregated 50 x 50 m plot achieves target % for each target vegetation type (see Appendix K). • At least one dominant species from each stratum present (Appendix K). • >50% common species for the target vegetation type present. • Plant cover achieves target % for each stratum and vegetation type (see Appendix K).
	All where revegetation is planned in pastoral lease areas (infrastructure footprints, OSAs / ISAs).	**Land use: Relatively natural environments for pastoral grazing purposes** • % bare ground: - Hills, slopes, dry plains ≤50%. - Drainage lines and floodplains (excluding channel bed) ≤20%. • Perennial native species richness recorded in aggregated 50 x 50 m plot achieves target % for each target vegetation type (see Appendix K). • At least one dominant species from each stratum present (see Appendix K). • >70% common species for the target vegetation type present. • Plant cover achieves target % for each stratum and vegetation type (see Appendix K).
C4.3 Resilience (Reproductive Capacity).	All domains where revegetation is planned.	• Flowering and seed production observed in more than one native lifeform. • Different aged plants observed for more than one native species and for all lifeforms.

10.1.2.2 Monitoring method and frequency

Rehabilitation monitoring post-closure would be generally in accordance with the Rehabilitation Standard (001074) and the Rehabilitation Monitoring Procedure (SPR-IEN-LAND-012) (Appendix M-2). BHP implements an adaptive approach to rehabilitation monitoring that is continually developed as new knowledge and technologies become available, such as the implementation of remote sensing. BHP will continue to implement this approach and pioneer new methodologies to support the achievement of completion criteria outcomes. The Rehabilitation Monitoring Procedure is currently under review and the updated version will be incorporated into the next iteration of this MCP.

Previous rehabilitation monitoring used Ecosystem Function Analysis. A review of BHP's Pilbara rehabilitation monitoring system was undertaken during 2011. This resulted in the establishment of a three-stage monitoring process:

- **Rehabilitation establishment assessment**: 3 to 24 months of age. Rehabilitation establishment assessment provides feedback on the stability and erosion of rehabilitation areas and an assessment of vegetation establishment.
- **Rehabilitation development monitoring**: Years 3, 5, 7, 9, 12, 15. Rehabilitation development monitoring is an in-depth assessment of rehabilitation involving Landscape Function Analysis, erosion monitoring and quadrat vegetation monitoring using existing monitoring transects. It is applied to maturing rehabilitated areas.
- **Rehabilitation landform appraisal:** Years 3, 7, 12 and thereafter if required. Rehabilitation landform appraisal provides a summary of the status of large-scale rehabilitated landforms and areas not covered by rehabilitation development monitoring.

BHP currently uses annual remote sensing to gain a broad understanding of rehabilitation performance across the Jimblebar Hub and to inform the on-ground monitoring program. On-ground rehabilitation monitoring and analogue sites for Jimblebar Hub are shown in Appendix M-1. Quadrat monitoring comprises 50 x 50 m quadrats with two nested 5 m x 5 m quadrats. The following are recorded within each quadrat:

- Flora species, number of individuals, estimated total % cover, lifeform, and average height.
- Photo from each corner of quadrat.

Relevé transects are used to record:

- Dominant and supplementary flora species.
- All weed species.
- Any erosion (including wind) and disturbances.
- Representative photographs.

To maintain quality control at all stages of the rehabilitation processes (e.g., execution of rehabilitation works, maintenance and monitoring), activities will be completed generally in line with BHP's suite of procedures which provide guidance on aspects such as:

- Rehabilitation audit and inspection;
- Rehabilitation data capture; and
- Rehabilitation monitoring.

10.1.2.3 Corrective action

Should ongoing monitoring indicate that completion criteria cannot be met, the appropriate maintenance and / or remedial work would be undertaken. Depending on the cause of the deficiency, remedial actions could include, but not be limited to, reseeding, application of ameliorants / fertiliser and / or rework of an area. Further monitoring would be subsequently undertaken on repaired areas to demonstrate achievement of relevant criteria.

10.1.3 Weed monitoring

10.1.3.1 Monitoring objective

To assess weed populations in relation to completion criterion C4.4 targets (Table 10-3) and the effectiveness of weed control measures.

Table 10-3 Weed completion criteria

Criteria	Domain	Completion criteria
C4.4 Weeds	All where revegetation is planned in areas of unallocated crown land (infrastructure footprints, OSAs / ISAs).	**Land use: Natural environment for managed resource protection** Total weed cover: • Drainage lines, floodplains <15%. • Upland hills, slopes and flats <5%. Buffel grass cover: • Drainage lines, floodplains <10%. • Upland hills, slopes and flats <5%.
	All where revegetation is planned in pastoral lease areas (infrastructure footprints, OSAs / ISAs).	**Land use: Relatively natural environments for pastoral grazing purposes** Total weed cover: • Drainage lines, floodplains <20%. • Upland hills, slopes and flats <10%. Buffel grass cover: • Drainage lines, floodplains <10%. • Upland hills, slopes and flats <10%.
	All where revegetation is planned (infrastructure footprints, OSAs / ISAs).	• Priority alert weed species are not present, or if present, cover is less than or equal to the surrounding areas (regional baseline). • No new priority alert weed species introduced.

10.1.3.2 Monitoring method and frequency

Monitoring and weed management will be conducted generally in accordance with the Weed Management Procedure (WAIO, 2020b) and Jimblebar Flora and Vegetation Management Plan (BHP, 2020a) until the weed cover objective is met. These documents require annual monitoring and treatment of introduced species and weed cover within the Development Envelope and biennial monitoring of reference sites.

10.1.3.3 Corrective action

Where weed cover is not meeting objectives, weed control measures will be implemented generally in accordance with the Weed Management Procedure (WAIO, 2020b). Post-mining weed control measures and monitoring programs will be refined in consultation with the relevant authorities. Approved changes to the monitoring programs and control measures will be documented in the AER, revisions of the Jimblebar Flora and Vegetation Management Plan (BHP, 2020a) and weed management procedure (WAIO, 2020b).

10.1.4 Fauna monitoring

10.1.4.1 Monitoring objectives

We recognise that fauna have an intrinsic value to key stakeholders and natural processes within rehabilitation, however, the transient nature of fauna makes it difficult to consistently capture data that can be compared to a quantitative target. The objectives of fauna monitoring are therefore to:

- Provide information to key stakeholders on observed use of rehabilitation areas by fauna; and
- Inform management of the impacts of feral animals and pests on rehabilitation.

10.1.4.2 Monitoring method and frequency

Damage to rehabilitation from feral animals / pests is currently recorded during on-ground rehabilitation monitoring and inspections. BHP is in the process of reviewing its rehabilitation monitoring procedures to determine how fauna use of rehabilitated areas can be integrated into the monitoring program.

10.1.4.3 Corrective action

Implement feral animal and pest controls, if required.

10.1.5 Regional water monitoring network

From a closure perspective, it is necessary to have an understanding of:

- Pre-mining conditions and acceptable levels of change so that appropriate completion criteria can be developed.
- The changes that occur during mining so that conceptual and numerical models can be refined to facilitate:
  - Prediction of impacts at closure; and
  - The development of a post-closure monitoring regime that would enable model predictions to be validated over time.
- The changes that occur post-closure to enable models to be calibrated and provide an acceptable level of certainty in model predictions.

A regional monitoring network has been installed at an operational and catchment scale, and a monitoring program collects important information for compliance reporting and to improve the capacity to estimate receptor response to changing hydrological conditions and natural climatic variations and stresses (Figure 10-1). It is used to develop an understanding of the baseline conditions (prior to BHP operations) and current conditions (with BHP operations), to:

- Define the natural variance in hydrological conditions;
- Underpin adaptive management and modelling processes; and
- Be consistent with the threshold variables being used to assess significance of impacts to receiving receptors.

The regional monitoring network and monitoring is used to support and inform closure assessments, enabling progressive improvement in understanding and confidence in the achievement of the stated closure objectives related to the hydrological regime.

The regional monitoring network – hydrological enables time-variant data collection from various hydrological systems, including:

- Groundwater aquifer water levels and quality;
- Surface water drainage feature and creek flow volumes;
- Spring discharges, seepages, waterholes and marsh zones; and
- Weather and climatic conditions.

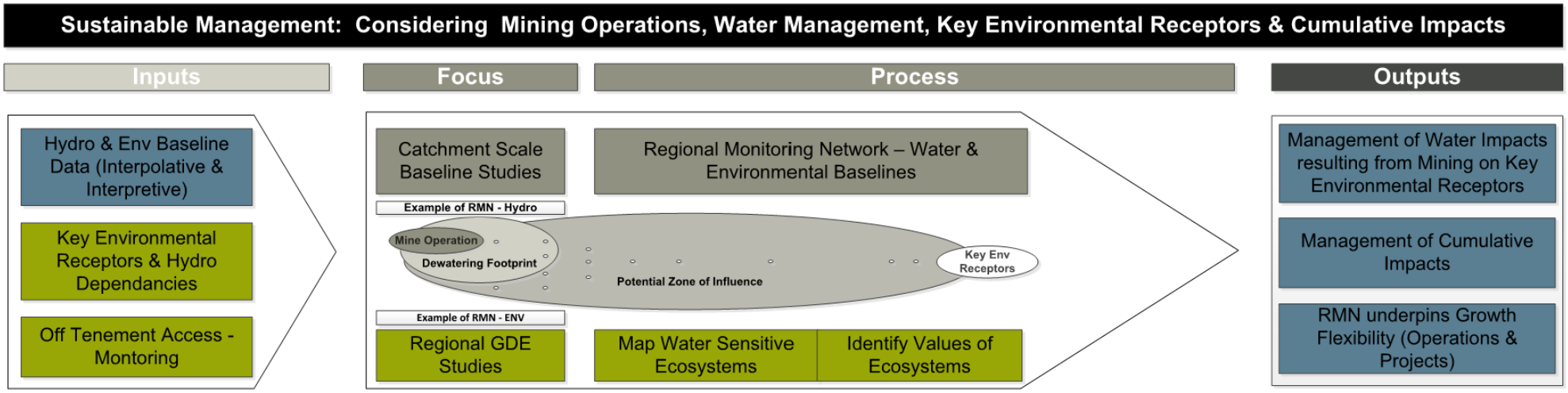


Figure 10-1 Regional Groundwater Monitoring Network overview

The data from the regional monitoring network - hydrological would be supplemented by data collected on:

- Vegetation assemblages;
- Significant biodiversity, flora and fauna values;
- Tree health monitoring, including lead indicators such as leaf moisture, sap flow and trunk / stem growth gauges or satellite / aerial photography-based vegetation condition; and
- Hydrological dependence of receiving receptors on surface water, groundwater or soil moisture.

10.1.6 AMD monitoring

10.1.6.1 Monitoring objective

To assess the effectiveness of PAF material management measures (completion criterion C3.3) (Table 10-4).

Table 10-4 Geochemical stability completion criteria

Criteria	Domain	Completion criteria
C3.3 Geochemical stability	OSAs ISAs In-pit TSFs Mine voids	**OSAs / ISAs / TSFs** • No evidence of mineral scalds within rehabilitation areas. • No exposed overburden or tailings with adverse geochemical properties. **OSAs** • Surface water and groundwater quality completion criteria (C5.2 and C5.4) are met (refer to Sections 10.1.7 and 10.1.8, respectively). **Mine voids / ISAs / in-pit TSFs** • Groundwater quality completion criteria (C5.4) are met (refer to Section 10.1.8).

10.1.6.2 Monitoring method and frequency

AMD monitoring will be integrated with the regional monitoring network (Section 10.1.5) as required based on progressive refinement of the assessment of AMD risk following mine closure.

Surface water and groundwater monitoring are currently the primary methods for assessing impacts from AMD. In addition, visual inspections will be conducted of:

- The integrity of landforms that are constructed to prevent AMD generation and release.
- Rehabilitated landforms to identify any areas exhibiting mineral scalds.
- Surface water courses for signs of AMD discharge.

As identified in Section 7.6, BHP is conducting a review of the OSAs / ISAs across the Pilbara based on storage of AMD 1 materials to identify priorities for additional AMD monitoring. The results of this review will be incorporated into future iterations of this MCP.

10.1.6.3 Corrective action

Where AMD is detected in the receiving environment, an investigation into the cause of the release will be conducted, and remedial measures defined in consultation with appropriate regulatory authorities.

10.1.7 Surface water monitoring

10.1.7.1 Monitoring objectives

The objectives of surface water monitoring are to:

- Assess the quality of water in drainage lines to identify any releases of AMD, inform completion criteria and enable achievement of completion criterion C5.2 to be demonstrated (Table 10-5).
- Measure flow rates to assist in the validation of surface water modelling and assess achievement of completion criterion C5.1 (Table 10-5).

Table 10-5 Surface water completion criteria

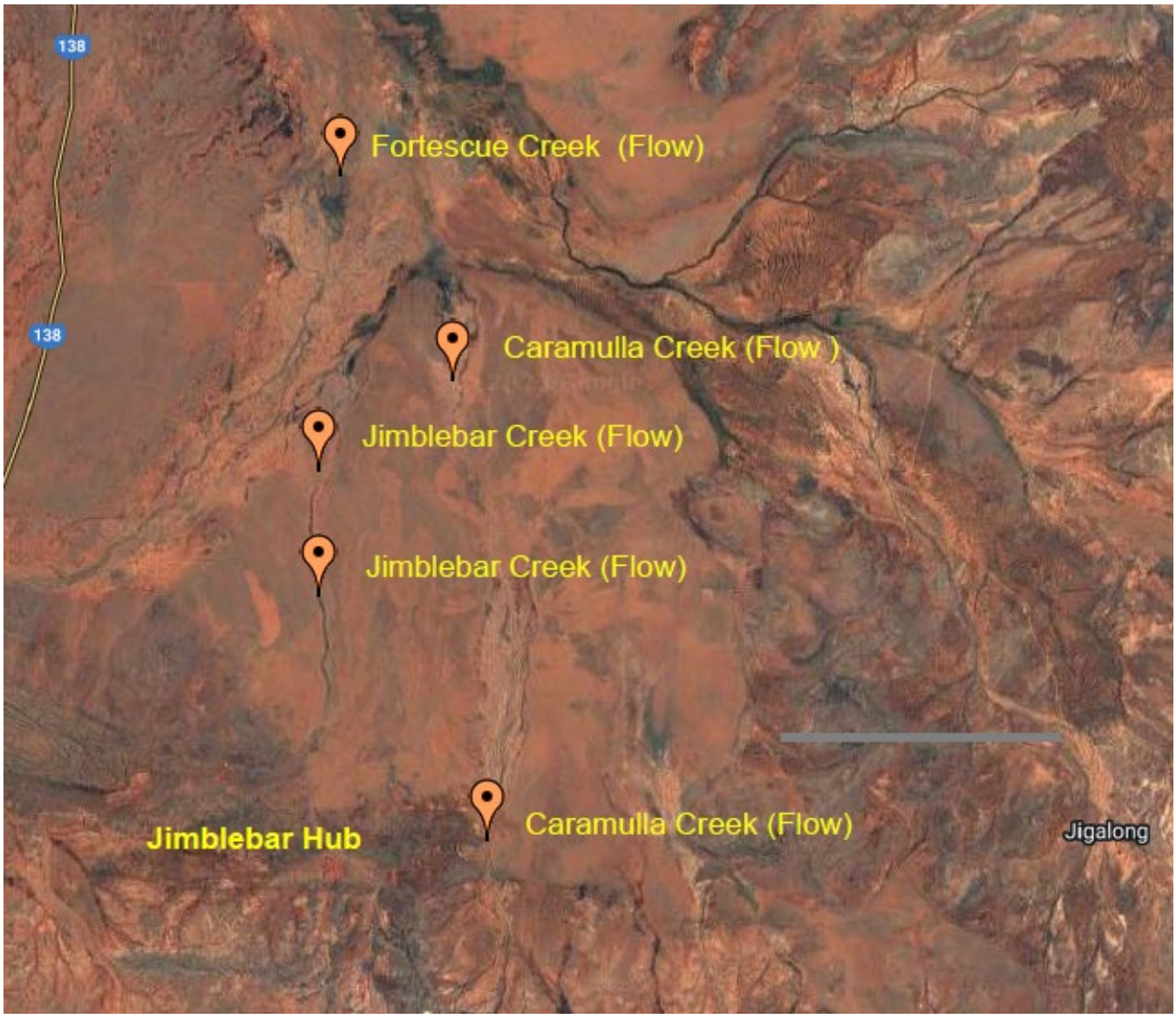
Criteria	Domain	Completion criteria
C5.1 Surface water flows	Surface water management infrastructure, OSAs, mine voids	• Flows at downstream environmental receptors are within model predictions and the parameters accepted via project approvals. • Impacts to downstream environmental receptors are within the parameters accepted via project approvals.

Criteria	Domain	Completion criteria
C5.2 Surface water quality	OSAs, in-pit TSF	• Water quality (sediment and chemical) at downstream creek locations (Orebody 31 Creek, Jimblebar Creek, Copper Creek and Innawally Pool) is within limits: - Defined, through the detailed analysis of pre-closure monitoring data from appropriate reference sites, to represent no significant impact to downstream ecohydrological receptors; and / or - Accepted via project approvals or other regulatory processes.

10.1.7.2 Monitoring method and frequency

Surface water flows

Data collected during operations helps to refine and calibrate surface water models which will in-turn inform the locations and frequencies of a post-closure surface water monitoring program designed to validate model predictions of changes to flows arising from Jimblebar mine infrastructure. BHP has installed several flow gauges within the Jimblebar Creek catchment to assist in calibration of surface water modelling (Map 10-1).



Map 10-1 Surface water flow gauging stations

In addition to monitoring of surface water flows, BHP has an operational monitoring program for monitoring impacts to riparian vegetation from creek discharges in accordance with the Jimblebar Flora and Vegetation Monitoring Plan (BHP, 2020a) and the Eastern Pilbara Water Resource Management Plan (BHP, 2021g). As outlined in Section 7.6, BHP intends to conduct a review of riparian vegetation monitoring programs to identify whether amendments to operational monitoring programs are required to inform closure planning and completion assessments.

Surface water quality

Surface water quality sampling is currently conducted in accordance with L5415/1998/9 (Table 10-6) and is focused on monitoring surface water in the vicinity of discharges to creek lines.

As outlined in Section 7.6, BHP intends to conduct a review of its surface water and riparian vegetation monitoring programs for Jimblebar Hub to assess their suitability to inform closure and assess achievement of completion criteria. Recommendations arising from this review will be incorporated into future revisions of this MCP.

Table 10-6 Surface water quality monitoring program

Monitoring point reference and location (refer to Appendix N-3 for locations)	Parameter	Units	Averaging period	Frequency
• Copper Creek downstream (JBSW003) • Jimblebar Creek upstream (JBSW004) • Jimblebar Creek upstream (JBSW0010) • Jimblebar Creek downstream (JBSW005) • Jimblebar Creek downstream (JBSW009) • Orebody 31 discharge downstream (JBSW011)	pH[1]	pH units	Spot sample	Quarterly when flowing
	Total dissolved solids, total suspended solids, aluminium, arsenic, boron, barium, hardness ($CaCO_3$), cadmium, calcium, chloride, chromium, copper, fluoride, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, nitrate, potassium, selenium, silica, sodium, sulphate, zinc	mg/L		

Note 1: pH in-field non-NATA accredited analysis permitted

10.1.7.3 Corrective action

Post-mining monitoring programs will be developed and / or refined during the mine life in consultation with the relevant authorities. Approved changes to the monitoring programs and control measures will be documented in the AER and this MCP. If monitoring indicates that completion criteria will not be achieved, an investigation into the cause of the exceedance will be conducted, and remedial measures defined in consultation with appropriate regulatory authorities.

10.1.8 Groundwater monitoring

10.1.8.1 Monitoring objective

The monitoring objectives are to:

- Confirm conceptual and numerical model assumptions[41]; and
- Assess achievement of completion criteria C5.3 and C5.4 (Table 10-7).

Table 10-7 Groundwater completion criteria

Criteria	Domain	Completion criteria
C5.3 Groundwater Levels	Mine voids	Groundwater levels at key receptors are at acceptable levels, defined as closure thresholds in the Eastern Pilbara Water Resource Management Plan (refer to Section 8.3.1 for current thresholds), and meet land use criteria supported by key stakeholders.
C5.4 Groundwater Quality	Mine voids OSAs ISAs	Groundwater quality is within limits (Q): • Defined, through the detailed analysis of pre-closure monitoring data from appropriate reference sites, to represent no significant impact to downgradient ecohydrological receptors; and / or • Accepted via project approvals or other regulatory processes.

10.1.8.2 Monitoring method and frequency

In addition to the Regional Monitoring Network (Section 10.1.5), ambient groundwater monitoring is conducted in accordance with Environmental Licence L5415/1998/9 and the Groundwater Operating Strategies (GWOS) for Shovelanna (BHP, 2018b) and Jimblebar (BHP, 2018a) which outline the management and monitoring of groundwater abstraction at OB18/31 and Jimblebar, respectively (Table 10-8). The operating strategies form part of the conditions of groundwater licences GWL156786(10), GWL181025(4) and GWL 158795(11), and are approved by DWER. The strategies are periodically reviewed and revised to incorporate changes in operations and / or knowledge of groundwater responses to dewatering stresses. They also specify internal water quality trigger levels that are used to manage potential impacts from dewatering during operations.

41 Monitoring data is collected during operations to enable groundwater models to be calibrated (i.e., adjust various parameters in the groundwater model until the model outputs reflect data observed over time). Following calibration, monitoring data will be used to validate groundwater models by comparing model predictions of groundwater recovery to observed data (i.e., checking that groundwater is behaving as predicted following mining).

The operational monitoring program is designed to measure potential impacts of the dewatering program by determining the hydraulic connectivity between the major orebodies and regional units through the monitoring of regional drawdown propagation pathways and water quality trends. The results will help to refine and calibrate the conceptual and numerical groundwater models for the Jimblebar Hub. These models will be used to inform pit backfill strategies and identify the locations and frequencies of monitoring post-closure to enable predictions of groundwater recovery levels to be validated.

Table 10-8 Operational groundwater monitoring program

Monitoring Type	Borefield or Source	Bore (refer to Appendix N for locations)	Monitoring Parameters	Minimum Monitoring Frequency
Operational				
Production bores (dewatering and water supply)	OB18 & OB31	HMG0051P, HMG0052P, HMG0054P, HMG0055P Two operational dewatering bores per deposit All sumps	Field EC and pH	Monthly when operating
		HMG0051P, HMG0052P, HMG0054P, HMG0055P Two operational dewatering bores per deposit All sumps	Hydrochemistry[2].	Quarterly when operating
	Jimblebar & Wheelarra	Any two operational dewatering bores and active sumps per deposit	Field EC and pH	Monthly
			Hydrochemistry[2].	Biannually
Monitoring bores	OB18, OB31 and Jimblebar Source	Any 2 in-pit monitoring bores	Water level	Monthly
	Pathway (regional)	HMG0058M, HMG0103M, HMG0111M1, HMG0111M2, HMG0125M, HMG0126M, HMG0127M, HMG0128M, HFG0035M, HFG0042M, HSJ0173M, HSJ0104M		
DWER License (L5415/1998/9[1])				
Ambient monitoring bores	Jimblebar, OB18 & OB31	HSJ0073M, HSJ0081M, HSJ0117M, SJ0435RM, HMG0109M, HMG0115M, HMG0119M, HMG0121M, HSJ0083M, SJ0571RM, HMG0103M, HMG0111M1, HEOP0828M, HEOP0838M, HCM0043M, HCM0044M, HCM0045M, HCM0046M2, HCM0047M, HCM0059M, HCM0019M	Depth to groundwater	Spot sample monthly when re-injecting or discharging
		HSJ0081M, HSJ0115M, HMG0109M, HMG0115M, HMG0119M, HMG0121M, HSJ0083M, SJ0571RM, HMG0103M, HMG0111M1	Field pH[1], EC and TDS	Spot sample quarterly (when reinjecting)
		HSJ0081M, HSJ0115M, HMG0109M, HMG0115M, HMG0119M, HMG0121M, HSJ0083M, SJ0571RM, HMG0103M, HMG0111M1, HCM0008M, HCM0017M	Total Suspended Solids, Al, As, B, Ba, $CaCO_3$, Cd, Ca, Cl, Cr, Cu, F, Fe, Pb, Mg, Mn, Hg, Mo, Ni, NO_3, K, Se, SiO_2, Na, SO_4, Zn	

Source: WAIO (2018b); EP Act Part V Licence L5415/1988/9

Notes:

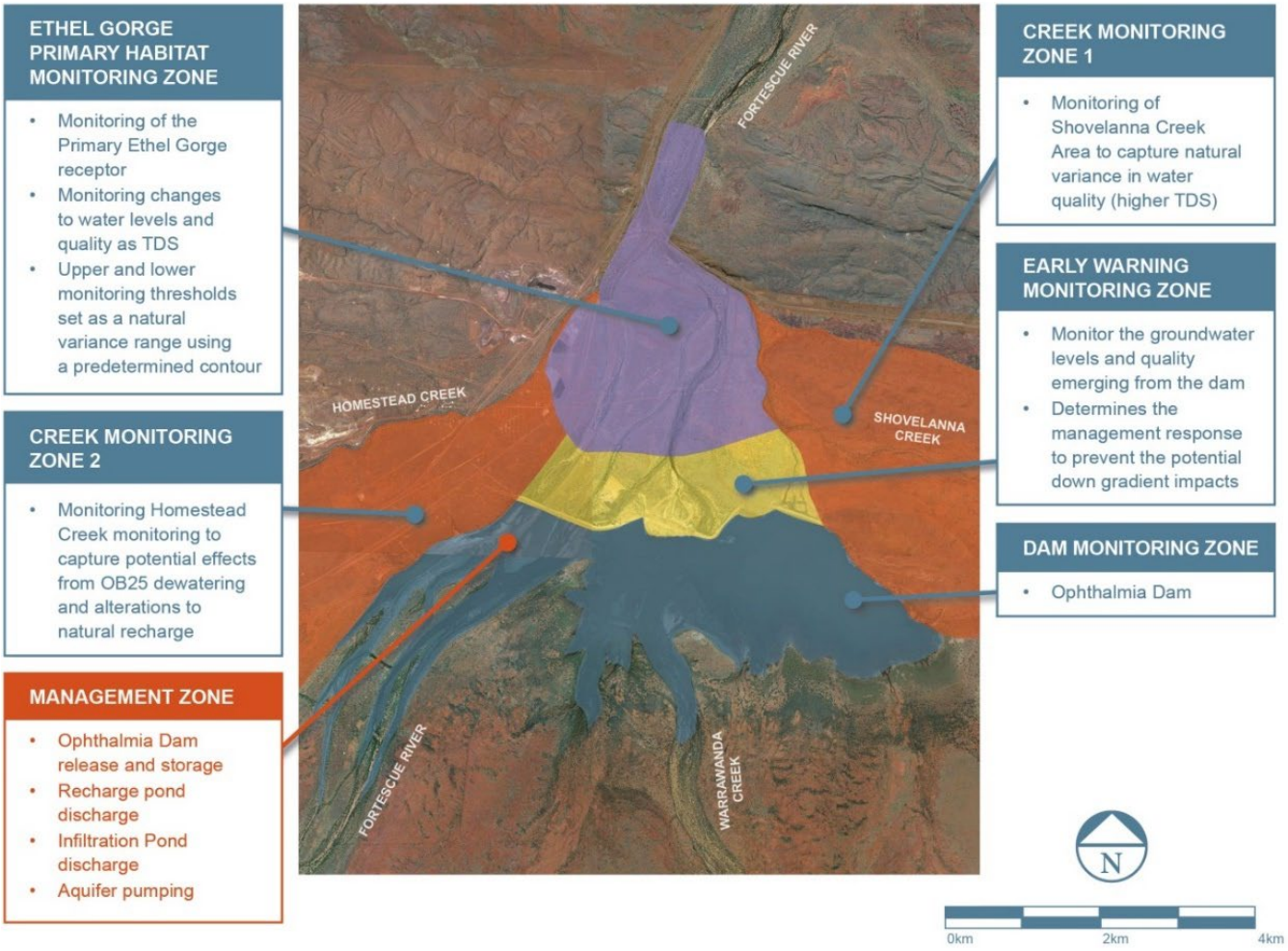
1: pH in-field non-NATA accredited analysis permitted.

2: Standard hydrochemistry suite: pH, EC, Total dissolved solids, total suspended solids, aluminium, alkalinity, arsenic, bicarbonate, boron, barium, hardness ($CaCO_3$), cadmium, calcium, chloride, chromium, copper, fluoride, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, nitrate, potassium, selenium, silica, sodium, sulphate, zinc. New production bores to be sampled for comprehensive suite as provided in Appendix G of WAIO (2018b).

In addition to the GWOS monitoring programs, the Jimblebar Water Management Plan requires groundwater level at Caramulla MAR to be monitored and the Eastern Pilbara Water Resources Management Plan (BHP, 2021g) provides an overarching monitoring and management program that is focused on the protection of the Ethel Gorge TEC. Monitoring zones have been established that reflect the main sources of influence on the Ethel Gorge aquifer (Figure 10-2) which include inflows from adjacent river valleys, Ophthalmia Dam, and surplus water inputs from surrounding mines and any closure related activities. Monitoring associated with the Eastern Pilbara Water Resources Management Plan is designed to compare changes in the water level and quality against thresholds that protect key receptors in the system, namely the Ethel Gorge Aquifer Stygobiont Community and

riparian vegetation associated with the creeks. Under the Eastern Pilbara Water Resources Management Plan, changes in aquifer condition outside the nominated ranges will trigger management responses designed to mitigate impacts at key receptors.

Post-mining monitoring programs will be developed and / or refined during the mine life in consultation with the relevant authorities and will include consideration of monitoring required to calibrate groundwater modelling. The forward work program includes an action to review existing groundwater monitoring programs in terms of their suitability for developing completion criteria. Approved changes to the monitoring programs and control measures will be included in future iterations of this MCP.



Source: BHP (2021g)

Figure 10-2 Ethel Gorge TEC monitoring zones

10.1.8.3 Corrective actions

Post-mining monitoring programs will be developed and / or refined during the mine life in consultation with the relevant authorities. Approved changes to the monitoring programs and control measures will be documented in future iterations of this MCP. If monitoring indicates that completion criteria will not be achieved, an investigation into the cause of the exceedance will be conducted, and remedial measures defined in consultation with appropriate regulatory authorities.

10.1.9 Pit lake monitoring

10.1.9.1 Monitoring objective

Pit lake monitoring will be conducted to validate pit lake risk assessment assumptions and assess achievement of completion criteria C3.3 and C4.6 outlined in Table 10-9.

Table 10-9 Pit lake completion criteria

Criteria	Domain	Completion criteria
C3.3 Geochemical stability	Mine voids	• Pit lake water quality aligns with modelling trajectory, where modelling is required
C4.6 Impact to fauna		• Monitoring shows that pit lake quality aligns with closure risk assessment assumptions

10.1.9.2 Monitoring method and frequency

Depending on the final backfill strategy, a pit lake monitoring program will be implemented once pit lakes form. The program will include an assessment of pit lake levels and water quality.

10.1.9.3 Corrective actions

If pit lake monitoring shows significant departures from modelling results or risk assessment assumptions, an investigation will be conducted, and modelling / risk assessments revised. If revised modelling / assessments indicate that remedial actions are required, these will be defined in consultation with relevant regulators.

10.1.10 Landform erosion monitoring

10.1.10.1 Monitoring objective

The monitoring objectives are to:

- Assess landform surface stability against completion criterion C3.4 outlined in Table 10-10.
- Identify any obvious sources of off-site impact.

Table 10-10 Surface stability completion criteria

Criteria	Domain	Completion criteria
C3.4 Surface stability	OSAs Surface water infrastructure	• Slope surfaces do not show significant erosion which may be defined as having: - Channelised flow resulting in extensive active gullies; - Failure of banks, berms or bunds; and - Evidence of ongoing significant sheet erosion (including large accumulation of silt at base of slope, exposed subsoil, poor seedling establishment). • The average rate of erosion of slopes, flats and crests of OSAs measured at completion is <6t/ha/yr. • The erosion rate at any point on a slope does not exceed the target threshold average rate by more than 100%. • Surface water management structures are performing as designed.

10.1.10.2 Monitoring method and frequency

Monitoring methods may include:

- Visual inspections and / or photographic review of rehabilitated landforms including surface water management structures during public safety inspections or after significant rainfall events.
- LiDAR, INSAR data, photogrammetry surveys and / or comparative assessment at established survey points.

10.1.10.3 Corrective action

Where unacceptable erosion or threats to geotechnical stability have occurred, maintenance works will be undertaken to improve performance.

10.1.11 In-pit TSFs

10.1.11.1 Monitoring objective

Pre-closure monitoring will be used to confirm tailings characteristics, in-pit TSF consolidation modelling and groundwater impact assessment. The outcomes of monitoring will be used to inform the final cover strategy. Post-closure monitoring will be conducted to confirm that the tailings cover is performing in accordance with design criteria.

10.1.11.2 Monitoring method and frequency

The following pre-closure monitoring programs will be implemented:

- Monitoring of tailings settlement using:
  - LiDAR surveying to establish actual settlement rates (and available storage volume for tailings and storm water).
  - Vibrating Wire Piezometers to track reduction of excess pore-water pressures with time (i.e., progress of settlements).
  - Drone survey imagery to provide regular measurements of the beach development and pond size.
- Groundwater monitoring during and after deposition of tailings.
- Periodic sampling and analysis of tailings to confirm / track any changes in geochemical and physical characteristics.

Based on the data arising during pre-closure, monitoring programs will be reviewed and refined to programs suitable for post-closure monitoring.

Following cover placement, the cover layer will be monitored to check whether differential settlements cause deformation or cracking to occur.

10.1.11.3 Corrective action

Should pre-closure monitoring indicate the potential for potential significant impacts post-closure and / or requirements for a revised cover design, the cover strategy for the in-pit TSF will be reviewed and revised.

Should deformation or cracking of the cover occur following placement, then remedial works may be undertaken if considered necessary.

Following closure, if groundwater monitoring indicates a potentially significant impact, a review of the cause of the impact will be conducted and remedial measures will be defined in consultation with relevant regulators.

10.1.12 Public safety monitoring

10.1.12.1 Monitoring objective

To confirm the integrity of public safety measures.

10.1.12.2 Monitoring method and frequency

Monitoring will be conducted during the post-closure monitoring and maintenance period and will include:

- Periodic visual inspection of safety bunds and other safety measures including fencing and signage. Records will be kept of these inspections.
- Inspection and audit by District Mines Inspector to confirm the site is acceptable with respect to safety at completion.

10.1.12.3 Corrective action

Maintenance will be conducted where the integrity of the bunds or other safety measure has been compromised to the extent that inadvertent public access could occur.

10.2 Reporting

The following information will be reported in the AER which covers all of BHP's operations:

- Progress and performance of rehabilitation including a summary of the rehabilitation monitoring results for the reporting period, maintenance / remedial actions completed or planned;
- New rehabilitation activities conducted including the area and nature of the rehabilitation;
- Research and development activities; and
- Rehabilitation activities planned for the future reporting period which will continue to be reported as environmental initiatives on an annual basis.

Reporting results will be made available to the relevant authorities on request.

10.3 Maintenance

The monitoring program will provide feedback on the performance of the site rehabilitation to identify any issues and inform maintenance activities. Examples of remedial maintenance activities that may occur during the post-closure phase include:

- Minor earthworks:
  - Repair erosion or stability issues identified during landform monitoring.
- Maintenance and repair:
  - Fences, signage etc.
  - Monitoring networks.
  - Any retained infrastructure assets.
- Infill planting or reseeding:
  - Based on failing to maintain development trajectory, additional tube stock may be planted, or reseeding undertaken to improve density or species diversity.
- Weed control:
  - Weed control may be required to manage weed species that may compete with planted rehabilitation species, increase fire risk or as required under regulation.
- Fire management:
  - Fire is part of traditional land management practices but is a risk to initial development of rehabilitation, and therefore, would be controlled.
  - Fire will be excluded from rehabilitation areas for a nominal period until framework species have achieved the required parameters (to be determined from research). Following this establishment phase, cool season burns will be promoted to build resilience in the rehabilitation landscape.

- Application of fertiliser:
  - Some growth media used in rehabilitation may require fertiliser to create optimal growing conditions, however due to losses from volatilisation (from heat) and leaching (from rainfall) much of the fertiliser is unavailable to plants. Based on monitoring results for plant health and nutrient cycling, reapplication of fertilisers may be required.
- Pest control:
  - Insect damage and grazing by native and feral vertebrate fauna can impact rehabilitation success. Monitoring results will be used to determine impact vectors and appropriate management actions.
- Water management:
  - Irrigation established to support rehabilitation growth, if required, will be removed when no longer required.
  - If passive water / sediment structures are established for closure, these structures will be removed when no longer required.

Triggers for maintenance activities will be developed via the adaptive management process and will be based on measured deviation away from the completion criteria.

10.4 Completion and relinquishment

As discussed in Section 8.3, the DMIRS (2021) guideline provides for progressive completion and, given the long life of the Jimblebar Hub, there may be a considerable time between completion of some areas, and completion and relinquishment of the whole site. During the time between completion and relinquishment, completed areas may still be managed by BHP, but differently to areas that are still subject to the post-closure monitoring and maintenance phase. This section outlines key steps in completion reporting, post-completion management and relinquishment.

10.4.1 Completion reporting

As areas of the Jimblebar Hub approach completion, BHP will prepare completion reports in accordance with the Mine Closure Completion Guideline (DMIRS, 2021). With reference to the guideline requirements, BHP will consult with DEMIRS and DJTSI regarding the eligibility of the area for evaluation prior to submission of a completion report.

Completion reports will collate evidence that the completion criteria, outlined in Section 8.3, have been achieved using the data collected from the monitoring programs outlined in Section 10. The reports will also include:

- Details of how the closure risks identified in the MCP have been managed and an assessment of any residual post-closure risks requiring management by the post-mining land manager.
- A post-completion land management plan where there are residual post-closure risks that require management.
- Relevant information on consultation with stakeholders including:
  - Documented acknowledgement of landowners / managers that rehabilitation objectives and completion criteria have been met.
  - Documented infrastructure transfer agreements where infrastructure has been transferred.
  - Documented agreements with post-mining land managers on implementation of any post-closure management activities (including the post-relinquishment land management plan).

10.4.2 Post-completion management

Following completion and prior to relinquishment, BHP will maintain tenure over the Jimblebar Hub area. During this period, the land will be managed in accordance with the post-completion management plan, either by BHP, or by arrangement with the landowner / manager. As detailed in the completion criteria in Section 8.3, land management requirements will be typical for the agreed post-completion land use unless otherwise specified in the post-completion management plan agreed with the landowner / manager.

10.4.3 Relinquishment

At relinquishment, land management responsibilities will be transferred to the landowner / manager, with adequate provisions for management requirements beyond those normally associated with the agreed post-completion land use.

11 Financial provisioning for closure

BHP considers specifics of the closure cost estimate (provision) to be commercially sensitive information. This section outlines the general process used to develop the closure cost estimate.

11.1 BHP principles for closure cost estimation

The financial provision preparation is undertaken in accordance with Our Requirements: Closure (BHP, 2023h), and the associated BHP accounting and cost estimation standards. Closure cost estimates are updated annually.

BHP ensures costs included in the provision encompass all closure and rehabilitation activities (for areas disturbed as at balance sheet reporting date) expected to occur progressively over the life of the operation, at the time of closure and during the post-closure period (e.g., monitoring). This includes all expected indirect costs, such as project management costs, statutory reporting fees and technical support costs.

In some cases, substantial judgements and estimates are involved in forming expectations of future activities and the amount and timing of the associated cash flows. These expectations are based on existing environmental and regulatory requirements and / or company standards or policies as outlined in this MCP.

Adjustments to the estimated amount and timing of future closure and rehabilitation cash flows are a normal occurrence in light of the substantial judgements and estimates involved. Factors influencing those changes include:

- Revisions to estimated site life;
- Developments in technology or improvements to existing practices;
- Regulatory requirements and environmental management strategies;
- Changes in the estimated extent and costs of anticipated activities; and
- Movement in economic input assumptions (interest rates, inflation).

For Jimblebar Hub, the provision is made up of:

- Three iterative phases of closure studies (refer to the introduction of Section 5).
- Landform earthworks and general land disturbance rehabilitation including:
  - Reshaping of OSAs and sheeting with competent material.
  - Topsoil growth media haulage and spreading.
  - Ripping, scarifying as required and seeding.
  - Construction of abandonment bunds.
  - Upgrade of flood bunds and diversions.
  - Backfill of pits where there are specific commitments to do so, and where this cannot be achieved through productive movement.
  - Haulage and placement of TSF cover material.
- Decommissioning and demolition of infrastructure (based on independent engineering contractor estimate) including:
  - Removal of all buildings and structures.
  - Removal of in-ground infrastructure and services to 0.6 mbgl, or otherwise agreed based on risk or stakeholder requirements.
  - Waste management.
- A provision for remediation of any remaining contamination.
- Post-closure monitoring and maintenance costs for up to 20 years.
- Stakeholder engagement.
- Allowance for failed rehabilitation.
- A contingency factor.
- Human resources allowances.

11.2 Closure cost estimation methods

The closure cost estimation process is conducted in accordance with BHP Our Requirements: Closure (BHP, 2023h) and the associated BHP accounting and cost estimation standards. The level of accuracy increases as the site approaches closure. The closure cost estimate is:

- An expected cost, based on best available information at a point in time;
- Reflective of the class of estimates appropriate for the proximity in time to the commencement of closure activities; and
- Inclusive of uncertainty and reflective of the maturity of the estimate using methods such as sensitivity analysis, weighted scenarios, range analysis, risk events and / or contingency.

Closure cost estimates are developed within the BHP business and include input from specialists in closure planning, rehabilitation, contamination, risk, finance, engineering (mining, civil, mechanical), water planning, and, where necessary, external consultants.

The closure cost estimate is developed from the activities required to close each domain. The closure cost estimate uses internal BHP costs and / or external third-party rates, as appropriate for the activity. Selected costs are benchmarked against third party rates to provide confidence in the quantum of the estimate. The cost estimate for each activity is developed using the method that is considered by BHP to provide the most reasonable estimate. Methods include cost estimates built up by BHP from first principles, factorisation based on BHP's experience at its WAIO sites, or cost estimates provided by specialist third-party consultants for specific studies such as engineering studies, demolition studies and / or detailed execution planning. BHP maintains sufficient closure input assumption documentation to support the closure model financial provision outcomes. The closure cost estimate is updated annually to account for incremental changes to disturbance during the year and to capture changes to the cost basis for execution activities. The provision process and outcomes are subject to internal and external audit on an annual basis.

For commercial reasons BHP does not document the actual estimate in this MCP.

12 Data management

BHP will collect, store and manage closure data in line with its existing data management procedures, including the Rehabilitation Data Capture Work Instruction (001006) (WAIO, 2022c).

The MCP and related information will be managed by BHP. All data will be stored in a central and readily accessible location in accordance with existing BHP standards and procedures. After lease relinquishment, BHP will transfer the MCP and all associated completion relevant information to the DEMIRS for its files.

BHP will progressively update this MCP over time to capture and summarise current closure planning information associated with:

- Closure planning prior to cessation of operations;
- Implementation of the closure program of works; and
- The post-closure monitoring and reporting period.

BHP will communicate closure planning progress to the regulators via updates to the MCP as knowledge gaps are filled and closure plans are refined.

13 Reviewed mine closure plans

This MCP is the first revision of the combined Jimblebar and OB17/18.31 MCPs. This section, therefore, provides commentary on:

- The key changes between this plan and the last plans submitted to government for OB17/18/31 (Revision 1 - January 2022) and Jimblebar (Revision 3 - March 2021) (Section 13.1).
- Regulator comments provided on previous plans and how these have been addressed in this update (Section 13.2).
- Progress made to address knowledge gaps and implement improvement activities outlined in both previous plans. It also summarises the new knowledge gaps identified during the development of this MCP (Section 13.3).

13.1 Changes to this revision of the MCP

The key changes between this MCP (Jimblebar Hub Revision 0) and Revision 1 (January 2022) of the OB17/18/31 and Revision 3 (March 2021) of the Jimblebar MCPs are summarised below and in Table 13-1:

- The OB17/18/31 and Jimblebar MCPs have been combined into one hub-wide MCP in line with the Significant Amendment ERD which includes the use of the De Grey and Swan pits for deposition of tailings from the Jimblebar beneficiation plant. The timing of the overall closure of the combined OB17/18/31 and Jimblebar operations has therefore been adjusted in recognition of the links between these two areas.
- The document includes information relevant to the use of Swan and De Grey pits for in-pit tailings deposition including:
  - Geochemical and physical characteristics of tailings (including preliminary consolidation modelling).
  - Stability of the Swan and De Grey pit walls.
  - Conceptual cover design study.
- The stakeholder engagement register has been updated to incorporate consultation that has occurred since the last MCP.
- The AMD risk assessment for Jimblebar and OB31 has been updated and incorporates the new East Jimblebar mining area.
- The outcomes of a new study on NMD hazard have been summarised in the geochemical characterisation section.
- New monitoring data from the OB18 South OSA erosion trials has been incorporated into the physical material characterisation section.
- The overburden balance has been updated to reflect changes in the mine plan and the overburden needed for a cover over the Swan and De Grey in-pit TSFs.
- Additional baseline soils information has been added for Jimblebar and the topsoil balance has been updated.
- Vegetation and weed mapping has been updated as has information on SRE species and subterranean fauna.
- Baseline information on surface water has been updated to incorporate new / additional information on creek geomorphology, flood modelling and surface water quality.
- The conceptual groundwater models for OB17/18/31 and Jimblebar have both been updated and new numerical modelling conducted for Jimblebar.
- An analysis of baseline monitoring data has been provided for Innawally Pool.
- The site contamination section has been revised to reflect investigations completed since the last MCP.
- The cultural values and heritage section has been updated to incorporate relevant information from the Nyiyaparli Caring for Country Plan, the Nyiyaparli people's baseline closure principles / preferences (Appendix B-2) and feedback from the Jimblebar Hub Significant Amendment social surrounds consultation process. Several sections of the MCP have also been revised to respond to KNAC's comments on behalf of the Nyiyaparli people on a draft version of this (2023) MCP and the OB17/18/31 (2018) MCP and Jimblebar MCP (2021).
- The outcomes of several design studies have been incorporated into the plan including:
  - Studies informing OSA designs for BF07 and BN07 OSAs and berm widths for OSAs.
  - Flood bund and creek diversion studies for South Jimblebar flood bund and creek diversion, SJG2 / SJH2 creek diversions, and H1A1 and H2B1 flood bunds.
- The risk assessment has been updated to reflect updates to the knowledge base, new mine plans and the in-pit TSFs.
- There have been minor amendments to completion criteria.
- The closure implementation section has been updated to reflect changes to mine plans and integrate new information on:
  - OSA / ISA closure designs.
  - Closure of water management infrastructure (creek diversions / flood bunds).
  - Closure of in-pit TSFs.
  - Closure visualisations.
  - Progressive closure / rehabilitation.
- The implementation and progressive rehabilitation schedules have been updated to reflect changes to the mine plan.
- The monitoring section has been updated to incorporate the in-pit TSFs.

Table 13-1 Summary of key changes between the OB17/18/31 2022 (Rev 1) and Jimblebar 2021 (Rev 3) MCP and this MCP for Jimblebar Hub (Rev 0)

Mine Closure Plan checklist	Y / N / NA	Section No.	Changes from previous revision (Y / N)	Section No.	Summary
Has the Checklist been endorsed by a senior representative within the tenement holder/operating company?	N/A	No longer a requirement.			
Public Availability					
Are you aware that all approved MCPs will be made publicly available?	Y	N/A			
Is there any information in this MCP that should not be made publicly available?	Y	N/A			Commercially sensitive information
If 'Yes' to Q3, has confidential information been submitted in a separate document/section?	Y	Appendix F Appendix H-1 Appendix P			Commercially sensitive information
Cover Page, Table of Contents					
Does the cover page include; • title; • site name and code (environmental group site name and code from EARS2 system or note if this is a greenfields or new site); • version number; • date; • tenement(s); and • tenement holder or authorised company/person.	Y	Cover, Page ii			
Project Summary					
Does the project summary include; • Description of the mining operation • Map of the location of the mining operation showing all relevant mine activities, land disturbances, tenements and other land tenure. • Estimated project completion date.	Y	Sections 1 & 2	Y	Section 2	Updated to address: • New proposed mining areas and OSAs. • In-pit storage of tailings at Swan and De Grey pits. • Amendment to completion date to reflect current mine plans. • Details of the closure features and domains including disturbance areas.
Legal Obligations and Commitments					
Does the MCP detail all legal obligations for rehabilitation and closure that will affect the post-mining land use and closure outcomes?	Y	Section 3	Y	Section 3	Elements of the Rail Safety National Law WA (2015) Act have been summarised where potentially relevant to closure.

Mine Closure Plan checklist	Y / N / NA	Section No.	Changes from previous revision (Y / N)	Section No.	Summary
Stakeholder Consultation					
Does the MCP include: • Information on the engagement that has been undertaken with stakeholders relevant to rehabilitation and mine closure • A record of the engagement undertaken to date • A strategy for ongoing engagement.	Y	Sections 4.2, 4.3 & Appendix B	Y	Section 4.3	Updated to include consultation since last closure plan.
Collection and Analysis of Closure Data					
Does the MCP include: • baseline data that: - informs successful rehabilitation and closure; - identifies the issues to be managed through the mine closure process and the environmental closure risks; - informs the development of criteria or indicators for closure monitoring and performance; - informs the establishment of achievable closure outcomes and goals in a local and regional context; and - establishes baseline conditions for closure monitoring programs. • an analysis of the baseline data that describes how the wider receiving environment, receptors and exposure pathways have been considered; • an analysis of the baseline data that identifies the knowledge gaps and the risk of not having that information; and • details of the methodology of analysing the baseline data.	Y	Sections 5 and 7	Y	Sections 5 and 7	Information has been updated to incorporate new / additional information on: • Geochemical overburden characterisation (updated AMD risk assessment for Jimblebar and OB31 and new information on NMD hazard); • OB18 South OSA erosion trials; • Overburden balances (competent material / backfill volumes); • Topsoil baseline data and balances; • Swan and De Grey pit wall stability assessments; • Vegetation and weed mapping; • Geomorphology, flood modelling and surface water quality; • Groundwater conceptual and numerical modelling; • Innawally Pool volumes correlated with rainfall; • Contaminated sites and status of investigations and remediation. • Cultural values derived from publicly available plans and feedback from KNAC on behalf of the Nyiyaparli people. • Design studies for OSAs / ISAs, flood bunds / diversions and in-pit TSFs.
Have all relevant technical reports been attached as appendices?	Y	Appendix P	Y	Appendix P	Technical appendices have been revised to reflect updated information
Post-Mining Land Use(s) and Closure Objectives					
Does the MCP include the post-mining land use(s) that has been proposed or agreed with key stakeholders, including regulators.	Y	Section 6.2	N		

Mine Closure Plan checklist	Y / N / NA	Section No.	Changes from previous revision (Y / N)	Section No.	Summary
Does the MCP describe how the post-mining land use(s) is: • relevant to the environment in which the mine will operate or is operating; • achievable in the context of post-mining land capability; • acceptable to the key stakeholders; and • ecologically sustainable in the context of the local and regional environment.	Y	Section 6	Y	Section 6	Provides further description of Nyiyaparli people's values and clearly links land use to tenure.
Identification of Management of Closure Issues					
Does the MCP include an environmental closure risk assessment that: • identifies all the environmental closure risk pathways; • evaluates these risks to derive an inherent risk rating, prior to the application of treatments; • identifies appropriate risk treatments, using the hierarchy of control; and • re-evaluates the risk pathways to derive a residual risk rating; and • demonstrates that all residual risks are as low as reasonably practicable (ALARP).	Y	Section 7	Y	Section 7	The risk assessment and risk management sections have been updated to take account of new information and provide further details of the rationale to justify the risk ratings and management of issues.
Does the MCP include information on the processes and methodologies undertaken to identify the closure risks and their potential environmental impacts post-mining, including a description of the risk assessment criteria and risk evaluation techniques.	Y	Section 7 & Appendix H	Y	Section 7	The risk assessment and risk management sections have been updated to take account of new information and provide further details of the rationale to justify the risk ratings and management of issues.
Development of Closure Criteria					
Does the MCP include: • Site-specific closure outcomes consistent with the post-mining land use(s) that are realistic and achievable based on the closure risk assessment. • Completion criteria that are specific, measurable, achievable, relevant and time-bound, and will demonstrate the achievement of the closure outcomes and monitoring.	Y	Section 8	Y	Section 8	There have been minor amendments to completion criteria to incorporate consideration of the in-pit TSFs and updated risk assessment.

Mine Closure Plan checklist	Y / N / NA	Section No.	Changes from previous revision (Y / N)	Section No.	Summary
Closure Implementation					
Does the MCP include: • a closure work program for achieving the closure outcomes, with implementation strategies and timeframes for each domain and/or feature of the mining operations; • closure designs for landforms; and • contingencies for premature or early closure or suspension of operations.	Y	Sections 9.2, 9.3.1, 9.4 and 9.5	Y	Sections 9.2, 9.3.1, 9.4 and 9.5	The closure implementation section has been updated to reflect changes to mine plans and integrate new information on: • OSA / ISA closure designs. • Closure of water management infrastructure (creek diversions / flood bunds). • Closure of in-pit TSFs. • Closure visualisations. • Progressive closure / rehabilitation.
Closure Monitoring and Maintenance					
Does the MCP include: • a monitoring framework to monitor the progress of the closure implementation strategies for achieving closure outcomes and completion criteria; • description of proposed post-closure monitoring; and • a description of the monitoring methodology.	Y	Section 10	Y	Section 10	The monitoring and maintenance programs have been updated to include consideration of the monitoring required for the in-pit TSFs.
Closure Financial Provisioning					
Does the MCP include details of closure costing methodology, including clearly documented assumptions and uncertainties?	Y	Section 11	Y	Section 11	Minor updates to description of items included in the provision to incorporate closure of in-pit TSFs.
Management of Information and Data					
Does the mine closure plan include a description of data management strategies, including systems and processes for the retention of mine records and all information and data relevant to mine closure?	Y	Section 12	N		

Mine Closure Plan checklist	Y / N / NA	Section No.	Changes from previous revision (Y / N)	Section No.	Summary
Reviewed Mine Closure Plans					
If the mine closure plan is reviewed under s84AA of the Mining Act or included in a revision to an approved mining proposal, has the reviewed MCP included: • A revision summary table that clearly outlines all changes made in the reviewed mine closure plan. • A summary table documenting how the aspects identified by the department for improvement in the prior revision of the mine closure plan have been addressed. • A table documenting how the knowledge gaps identified in the prior revision of the mine closure plan have been addressed, as well as any new gaps identified.	Y	This section (Section 13)	Y	This section (Section 13)	Refer to remainder of table for a summary of changes. Tables detailing responses to regulator comments and progress against knowledge gaps are detailed in Sections 13.2 and 13.3 respectively.

13.2 Feedback on recent closure plans & response in this MCP

This section summarises the response to regulator feedback on the OB17/18/31 and Jimblebar MCPs. No feedback has yet been provided on the 2022 OB17/18/31 MCP. A summary of this MCP's response to the comments provided on the 2018 MCP is, therefore, provided in Section 13.2.1. Section 13.2.2 summarises this MCP's response to comments provided on the 2021 Jimblebar MCP.

13.2.1 Response to comments on the 2018 OB17/18/31 MCP

Table 13-2 summarises the feedback provided by regulators on the 2018 revision of the MCP and how this MCP has responded to the feedback.

Table 13-2 Feedback on 2018 OB17/18/31 MCP

Section MCP 2018 (Section No. this plan)	DWER Feedback	Closure Plan Response
General Comment	Given that the site has been operating for many years (mining at Orebody 17/18 was approved in 1997), it is expected that the Mine Closure Plan (MCP) would be more advanced than it currently is. There are several sections which require further refinement (as detailed below). As part of this process, the MCP needs to be updated to meet the requirements of DMIRS 2020 Statutory Guidelines for Mine Closure Plans (the current MCP is dated July 2018 and understandably was submitted in accordance with DMIRS 2015 Mine Closure Plan Guidelines). It is also understood from a recent conversation with BHP, that BHP WA Iron Ore's overall closure criteria have been refined since submission of this MCP in 2018. This indicates that this MCP may not contain the most current information on closure strategies.	The estimated completion date for the Jimblebar Hub operations is 2053. The previous OB17/18/31 MCP (Revision 1) noted that mining operations were scheduled to cease at OB17/18 in June 2020, but this timeframe has been extended and mining of the final blocks of De Grey pit is ongoing. There is also potential to move overburden between OB17/18 and OB31. Furthermore, this MCP accompanies the ERD requesting a significant amendment to the Jimblebar Hub operations which includes the use of the De Grey and Swan pits for storage of tailings produced by beneficiation of Jimblebar ore. The closure timeframe, therefore, reflects the timeframe for closure across the Jimblebar Hub. This revision to the MCP aligns with the DMIRS Mine Closure Guidelines (2020a; 2020b). Revision of completion criteria to reflect the WABSI guidance (Young, et al., 2019) and the results of recent studies including Landloch (2018) and Syrinx (2019; 2023) is addressed in more detail below.
Maps	It is requested that maps are provided in a larger scale (e.g., 1:30,000) using satellite imagery to enable the Department of Mines, Industry Regulation and Safety (DMIRS) to clearly see the extent of the disturbance and location of permanent features, as well for a better understanding and assessment of closure risks. Please provide spatial data (if available).	Refer to Appendix Q.
Stakeholder consultation (Section 4)	The stakeholder engagement register generally meets the requirements of the guidelines, however, it appears to have many gaps. Keeping accurate records of stakeholder engagement is important to ensure that stakeholder's requirements for closure are met. Table 4-2 only describes consultation undertaken with government agencies and one meeting with the Native Title group in 2015. There is no indication of consultation with other key stakeholders listed in section 4.2. It is recommended that a robust document search be completed to identify any missing stakeholder correspondence and all future correspondence should be stored in a fashion to allow easy recall when required. DMIRS expects that further engagement with key stakeholders occurs prior to re-submission of the MCP, particularly when refining post-mining land use and closure outcomes / criteria.	The level of stakeholder consultation completed to date reflects the estimated completion date for the Jimblebar Hub of 2053. The Nyiyaparli people (through KNAC) were invited to comment on the 2019 Jimblebar and 2022 OB17/18/31 draft MCPs and have also been invited to comment on this draft MCP (Section 4.3 and Appendix B-3 and B-4). Furthermore, prior to submission of the draft Jimblebar Hub MCP to KNAC / Nyiyaparli people for review, there have been several engagements on the proposed Jimblebar Hub Significant Amendment as part of the social surrounds process. These engagements have included discussions on closure (Section 4.3). Also note that pre-2013 engagement is provided in Appendix B.

Section MCP 2018 (Section No. this plan)	DWER Feedback	Closure Plan Response
Post-closure land use (Section 6)	The MCP states that the proposed post mining land use (PMLU) is yet to be determined through stakeholder consultation. BHP assumes a native pastoral ecosystem capable of supporting low intensity grazing as the provisional post mining land use. In the early stages of a mining project, it may be acceptable for provisional or proposed PMLU to be identified; however, mining at Orebody 17/18 was approved in 1997 and is now near to closure. As the PMLU is the guiding factor in the development of closure outcomes and associated completion criteria, it should be already well refined and agreed upon. This was an issue that was raised in the assessment of the previous OB17/18 MCP. DMIRS also notes that the underlying tenure is mostly Vacant Crown Land with a small portion of disturbance areas intersecting pastoral land. DMIRS expects, at this stage, in the absence of agreement with key stakeholders and future land managers, the disturbed land is reinstated to natural ecosystems to be as similar as possible to the original ecosystem (in accordance with the post-mining land use hierarchy referenced in the guidelines). DMIRS would expect that post-mining land use is discussed with key stakeholders prior to re-submission of the MCP.	Section 2.3 has been updated to reflect that, although mining operations are more advanced at OB17/18, the closure date for these orebodies is influenced by the estimated life of operations across Jimblebar Hub due to ongoing overburden and tailings movement between the sites. As discussed above, the level of stakeholder consultation about the post-mining land use reflects this estimated completion date. Section 6 has been updated to incorporate post-closure land use classifications consistent with the Australian Land Use and Management Classifications (ABARES, 2016) and the underlying tenure. A post-mining land-use of 'natural environments for managed resource protection' has been included to apply where the underlying tenure is UCL.
Collection and analysis of closure data (Section 5)	Overall, the MCP demonstrates a lack of transparency in the presentation of baseline, closure data and modelling. DMIRS will not be able to make an informed assessment of the statements made in the MCP and determine the adequacy of the proposed management with the absence of technical reports. All technical reports referenced in the document should be attached as appendices.	We note that the 2018 MCP was developed in accordance with the 2015 DMIRS guidelines that did not require technical documents to be appended. Additional detail has been provided within the body of this MCP and technical appendices for baseline data and studies relevant to closure are provided as Appendix P.
Materials characterisation (Section 5.2.2)	Comprehensive characterisation of materials (including soils and mine waste) is critical to effective closure planning and successful progressive rehabilitation. **Overburden characteristics** - the MCP refers to a preliminary geochemical assessment undertaken by Earth Systems in 2014 (for OB31) and 2015 (for OB17/18). These reports are required to be appended to the MCP. It is unclear what studies have been undertaken since 2015 to refine data from preliminary assessment and further inform the block model and selective placement of waste. There is limited information in the MCP to inform risks of generation of acidic drainage from overburden. **Storage Areas (OSAs**). Lack of specific detail regarding acid mine drainage (AMD) management was raised in the previous OB17/18 MCP. DMIRS seeks clarification on whether hydrogeochemical modelling and monitoring of the performance of the encapsulation cell has been undertaken to further inform closure risks and determine whether management strategies are effective.	As discussed above, the 2018 MCP was developed in accordance with the 2015 DMIRS guidelines that did not require technical documents to be appended. The AMD risk assessments have been provided in Appendix P and further detail on the assessments has been provided in Section 5.3.2. As discussed in Section 5.3.1, BHP has developed an overburden classification system that has been developed based on extensive data across its Pilbara operations. The AMD risk assessments have confirmed that this classification system appropriately classifies overburden according to its hazard. An updated risk assessment has been conducted for OB31 and Jimblebar (including East Jimblebar) (BHP, 2022i) and the results are presented in Section 5.3.2. BHP has conducted extensive research on AMD 1 encapsulation techniques at its Whaleback site since 1997. A brief summary of the outcomes of the research is provided in Section 5.16.1, and a more detailed report developed by O'Kane (2020) is provided in Appendix P. Following this research, the WAIO AMD management standard requires that AMD 1 materials (higher risk overburden) are stored in a paddock dumped configuration, layered with inert overburden, to limit oxygen ingress into reactive overburden. BHP is currently in the process of reviewing OSAs / ISAs across its Pilbara operations and ranking them based on storage of AMD 1 materials to identify priorities for monitoring. A monitoring program to test the effectiveness of AMD management measures necessarily requires encapsulation cells to have been completed to a sufficient level of maturity (i.e., cover system installed) before commencing. Monitoring of the OB17/18 encapsulation cells will be considered as part of this review.

Section MCP 2018 (Section No. this plan)	DWER Feedback	Closure Plan Response
Materials characterisation (Section 5.2.2) *Continued*	**Pit walls** – based on preliminary assessment, potentially acid forming (PAF) material will be exposed on some parts of pit walls. It was estimated that, without treatment, total acidity loads post-closure could potentially be in the order of 100-200 tonnes of hydrogen sulphate (H_2SO_4) 5 years after mining ceases. Backfilling of pits 5 metres above pre-mining groundwater levels is proposed, however PAF exposure is still expected (management to be investigated). DMIRS expects that progress is made on the closure of knowledge gaps associated with risks of contamination of water resources due to AMD generation from pit walls prior to re-submission of the MCP.	A more recent study into the potential for release of AMD from wall rock has been conducted by Earth Systems (2018) (Section 5.3.2) and concludes that wall rock is a small component of in-pit acidity generation. The De Grey and Swan pits are proposed to be used for in-pit tailings storage and PAF wall rock exposures will be covered by tailings and associated cover (Sections 5.16.4 and 9.2.1.3). The forward work program includes further assessment of the short- and long-term risks associated with wall rock exposures of PAF material and the need for management (Section 7.6).
	Neutral mine drainage (NMD) (for OSA's and pit walls) – no information is provided regarding potential for generation of NMD within OSA's and pits. It is unclear whether any waste or exposed surfaces contain metals / metalloids at concentrations that exceed environmental investigation levels and what analysis has been undertaken to determine that NMD / saline drainage is not a risk. The occurrence of only low concentrations of sulphide minerals, or indeed the absence of sulphides, does not mean that mined materials will not produce drainage, such as NMD that could be of risk to the receiving environment.	The potential for NMD has been considered in the recent updated AMD risk assessment, and this information, along with information from a new study targeting the potential for NMD has been summarised in Section 5.3.2.4.
	Physical characteristics of waste – analysis of materials seems to be only provided for OB18. Availability of competent material (e.g., scree) versus volumes required for rehabilitation should be detailed in the MCP and implications for closure risk assessment discussed. There is insufficient information on asbestiform materials present at the site (only mentioned in Table 7-6) to inform closure risks and management. Further detail is expected in the next revision of the MCP. Current calculations indicate that a topsoil deficit is predicted at closure. It is understood that the OB31 footprint is still under review, and there is ongoing identification of potential growth media sources. This section should better discuss implication for closure risks and strategies.	The OB17/18/31 orebodies are all part of the same stratigraphic sequence. Materials characterisation studies across BHP's Pilbara operations have indicated that the competency of different overburden materials can be broadly categorised by stratigraphy. While there appears to be some variability of the D3 unit in the OB17/18/31 and Jimblebar area, the most recent overburden balance shows that there is likely to be adequate competent overburden to support rehabilitation (Sections 5.3.3 and 5.3.4). Further work to quantify available volumes of competent material has been incorporated into the forward work program (Section 7.6). Furthermore, material characterisation studies conducted to inform the closure designs for specific landforms are outlined in Appendix L. All of the overburden materials characterised for erosion (Section 5.3.3) were benign from a plant growth perspective and the low fertility of materials could be addressed through application of fertilisers (Section 5.5.4). The management of potential fibrous materials is addressed in Section 7.5.4.1.
Hydrology Section 5.11.1	Flood maps showing areas prone to flooding (including height and flow velocities) under different rainfall scenarios (extreme events, e.g., 1 in 10,000-year rainfall event and Probable Maximum Precipitation (PMP)) in relation to permanent features should be provided and used to inform closure risks. Designs for permanent features are expected to also consider extreme rainfall events. Limited information regarding the proposed diversion bund at OB31 is provided. Technical reports used to inform proposed final bund designs must be provided for assessment. Limited information regarding risks posed by catchment discharge into the Avon PAF OSA is provided in the MCP. Data to inform risks is expected to be provided in the baseline section with management of risks addressed in the risk assessment and detailed in the implementation section.	Section 5.11.1 has been updated to include flood modelling results and maps for a 1 in 10,000-year rainfall event. Section 7.5.3 and Appendix I-1 provide a description of BHP's process for defining appropriate closure design events and the rationale for the use of a 1 in 10,000-year event as a design event for high risk infrastructure. Progress on the design of the OB31 flood bund has been provided in Section 5.16.3.2 with relevant technical reports provided in Appendix P. Section 9.2.2.3 describes the catchment upstream of the Avon PAF OSA. The risks associated with management of surface water flows onto this storage facility are captured in Risk R7 (Table 7-3) and addressed in Section 9.2.2.3.

Section MCP 2018 (Section No. this plan)	DWER Feedback	Closure Plan Response
Geotechnical matters	Geotechnical advice has not been sought from DMIRS Mines Safety division at this stage as limited geotechnical information (i.e., technical reports) has been provided within the document. The East OSA is located within the possible zone of instability of the Swan pit. BHP identifies general options for addressing the risk, however the options are still being evaluated. Any geotechnical and hydrological assessments used to inform the final pit design / backfilling options and reduce instability issues should be provided for DMIRS assessment. Design and characteristics of proposed diversion bunds or any other significant surface water infrastructure must be provided for DMIRS geotechnical assessment.	Stability assessments of Swan and De Grey pit walls have been conducted as part of the assessment of in-pit tailings deposition and are summarised in Section 5.6.2 with supporting documents provided in Appendix P. Sections 5.16.3.2 and 9.2.3.4 describe the approach to the flood bund installation at OB31. A bund designed to meet operational requirements will be upgraded for closure. The geotechnical assessment of the operational design is summarised in Section 5.16.3.2. Design reports are provided in Appendix P. The closure design for the OB31 flood bund will be considered during future operational design stages, but until the final pit footprint is established, and the performance of the operational flood bund has been monitored, closure designs will not be progressed to further detail.
Identification and management of closure issues Section 7.4	A complete risk assessment is not provided in Appendix F as stated in the MCP. This is a requirement of DMIRS MCP guidelines and essential for DMIRS assessment. A review of this section is limited without the supporting information. A clear description / definition of consequences and likelihood considered relevant to the project also must be provided. Consequence descriptions need to be specific to each environmental factor / receptor at risk at closure. It was highlighted in the assessment of the previous OB31 MCP that more clarity was needed around the management of identified closure risks. The MCP also needs to clearly indicate how uncertainties and knowledge gaps have been considered in risk assessment.	A complete risk assessment for OB17/18/31 is provided in Table 7-3 and includes: • Descriptions of likelihood and consequence specific to each environmental receptor. • Breakdown of the risks (generally by domain) to reflect the risk pathway and potential receptor. A column has been added to Table 7-3 to summarise the knowledge gaps associated with each risk / control in the table. Risk controls and knowledge gaps are further summarised in Sections 7.5 and 7.6. The Risk Matrix is provided in Appendix H along with the severity rating guidance table in Appendix H-1.

Section MCP 2018 (Section No. this plan)	DWER Feedback	Closure Plan Response
Closure objectives and completion criteria Section 8	DMIRS comments on the 2013 and 2015 MCPs raised that completion criteria were not adequately specific or measurable. This version of the MCP is still trailing behind where it is expected to be given the stage of the mine life. Generally, the completion criteria lack firm commitments and do not set a firm end point. BHP need to revise the completion criteria using SMART criteria (specific, measurable, achievable, realistic, and time-bound). The completion criteria are milestones that when met collectively indicate that the closure objectives have been achieved. Therefore, each completion criteria needs to directly relate to one or more closure objective(s). In turn, completion criteria data needs to be informed by monitoring, therefore monitoring should be able to identify trends towards the completion criteria. Much of the monitoring outlined does not allow tracking of performance to identify if completion criteria are being met. There is also limited consideration of performance of permanent landforms or rehabilitated land in the long term. For example, DMIRS recommends that Landform evolution modelling for high-risk landforms and hydro geochemical modelling is undertaken to demonstrate that final landforms will be safe, stable, non-polluting and sustain an agreed post mining land-use in the long term (~300 years or longer). The environmental risk assessment will determine which risk pathways require development of closure criteria and outcomes, thus there needs to be a clear link between risk assessment and closure outcomes / criteria. Refinement of the following Criterion Objective is recommended: Materials with poor chemical properties do not compromise rehabilitation (landform stability and revegetation). DMIRS expects that all final landforms and rehabilitated land are non-polluting / non-contaminating post-closure and do not compromise rehabilitation, or negatively impact any sensitive receptors. The rationale behind criterion objectives and criteria should also be provided and it should be demonstrated that they are based on risk and continuously informed by scientific studies and / or trials. Domains where revegetation is planned should also be specified in completion criteria table. Refinement of proposed closure objectives and criteria in consultation of key stakeholder is critical at this stage of mine life for Orebody 17/18.	As discussed above, the OB17/18/31 and Jimblebar operations are managed as one operation and consequently the closure date for the site is 2053. The criteria in Section 8.3.1 have been refined with consideration to the SMART principle and the WABSI guidance on completion criteria presented in Young et al. (2019). In some instances, the criteria rely on the outcomes of well-established processes to define acceptability (e.g., contaminated site assessment, audit and classification under the Contaminated Sites Act). In these instances, where the site has been deemed acceptable under these processes, then this will be taken to be an acceptable mine closure outcome. Table 8-1 outlines the refined completion criteria and identifies: • The closure risk(s) driving each closure objective and completion criterion (Column 3). • The domain(s) to which the criteria apply (Column 4). • The monitoring and audit program(s) that will be implemented to demonstrate performance and ultimately achievement of each of the completion criterion (Columns 8 and 9). Former completion criterion "*Materials with poor chemical properties ….*" has been refined and split into Completion Criteria: (3.3) Geochemical stability and (3.2) Geotechnical Stability. Note, the geochemical stability criterion includes the objective of not compromising water quality. Water quality objectives are also captured by Completion Criteria 5.1 (Surface Water) and 5.3 (Groundwater) Section 10 has been updated to describe the various monitoring programs that will be implemented to demonstrate that the site is on an appropriate trajectory towards, and ultimately achieves, the completion criteria outlined in Table 8-1. In line with the WABSI guidelines (Young, et al., 2019), some criteria are measurable by audit i.e., criteria defined in the guidelines as: • **P:** installed / built as planned – a process for emplacing these attributes is approved initially and then assessed when constructed. • **C:** categorical – the feature is required to be present or absent.

Section MCP 2018 (Section No. this plan)	DWER Feedback	Closure Plan Response
Closure implementation Section 9	The closure implementation section of the MCP provides a very high-level view of what is required without providing much detail. The design philosophy for each of the landforms is described in section 9.2.2. Technical reports to support proposed OSA's closure designs need to be provided for assessment. Hydrology assessment undertaken to inform catchment discharge into Avon OSA surface for example and proposed management should be clearly presented. Results of studies or monitoring being undertaken to demonstrate that encapsulation strategies are effective needs to also be described. The following is required to be provided for each domain: • indicative final footprint and updated closure designs (relevant technical reports attached). • domain specific closure tasks. • domain specific knowledge gaps and proposed timeframe to address these. • domain specific rehabilitation timeframes. • domain specific rehabilitation materials volume requirements. Detailed information regarding strategies for suspended operations under care and maintenance should be provided in the MCP. Backfilling of pits: it is unclear if BHP has consulted with DMIRS Geological Survey and Resource Strategy Division to determine if the State is satisfied that no future resources will be sterilised through backfilling. It is recommended that BHP do this if not undertaken already.	Design studies for closure landforms that have yet to be implemented are summarised in Section 5.16. Designs that have been implemented as part of progressive closure are summarised in Section 9.3.1 with supporting information provided in Appendix L. The information in Appendix L includes stormwater volume assessments for the Avon catchment. Monitoring of rehabilitation outcomes achieved to date is provided in Section 9.3 and Appendix M. Studies completed to support encapsulation strategies are discussed in Section 5.16.1 and provided in Appendix P. Appendix P also includes erosion modelling reports used to support landform designs, and flood bund / diversion design studies. The current and indicative final footprints of all domains is provided in Section 2.2. Knowledge gaps and timeframes to address them are provided in Section 7.6. This encompasses knowledge gaps identified for specific domains. Rehabilitation timeframes are provided by domain in Section 9.4. Materials balances are provided in Section 5.3.4. Further information on strategies for suspended operations under care and maintenance has been provided in Section 9.5. The requirement to consult with the DEMIRS Geological Survey and Resource Strategy Division has been added to the mine void closure section (Section 9.2.1).
Closure monitoring and maintenance Section 10	A monitoring framework to monitor progress of the closure implementation strategies for achieving closure outcomes and completion criteria is generally provided but it is not clearly linked to the completion criteria table. This needs to be refined with more detailed methodology, including contingency strategies. Details of any analogue or reference sites used for monitoring needs to be provided.	Section 10 expands on the monitoring programs proposed to meet the completion criteria. Corrective actions are described for each aspect being monitored. Each monitoring program is cross-referenced with the criteria in Table 8-1. Section 10.1.1 details the completion criteria that will be assessed through an inspection and audit program rather than quantitative monitoring. Analogue sites established for rehabilitation monitoring are shown in Appendix M-1.
Financial provisioning for closure Section 11	It is a requirement of the MCP Guidelines to include details of closure costing methodology in the MCP, including clearly documented assumptions and uncertainties. This has not been provided in this iteration of the MCP.	The closure cost estimate is developed from the activities required to close each domain. The closure cost estimate uses internal BHP costs and / or external third-party rates, as appropriate for the activity. The cost estimate for each activity is developed using the method that is considered by BHP to provide the most reasonable estimate. Methods include cost estimates built up by BHP from first principles, factorisation based on BHP's experience at its WAIO sites, or cost estimates provided by specialist third-party consultants for specific studies such as engineering studies, demolition studies and / or detailed execution planning. Section 11 has been updated accordingly.

13.2.2 Response to DWER feedback on the 2021 Jimblebar MCP

Table **13-3** summarises the feedback provided by DWER on the 2021 revision of the MCP and how this MCP has responded to the feedback.

Table 13-3 **Feedback on 2021 Jimblebar MCP**

Item	MCP section	DWER comments	Closure plan response
1.	All – document readability	Issue: • The PDF document cannot be printed. Submitted e-documents should be searchable, printable and be able to be saved for optimum efficiency of review. • Technical appendices were difficult to find and were not listed in the Mine Closure Plan (MCP). It is difficult to know what supporting studies have been included when reading the MCP. Please ensure clear referencing is included so technical reports provided in appendices can be easily found. ACTION • Ensure the PDF is searchable and printable. • Ensure clear referencing is included so technical reports provided in appendices can be easily found.	The pdf settings have been amended to allow printing. The pdf for both this document and the 2021 document have been set up to be searchable. Instructions on navigating via bookmarks have been provided in Section 1.4. The technical reports in the separate Appendix file were supplied as searchable and indexed documents in the 2021 version of the plan and a similar approach has been taken to the pdf for this Jimblebar Hub 2023 MCP as follows: • The cover page for the technical appendix clearly lists the technical appendices included in the document. • The separate appendix pdf is set up with bookmarks that can be used to navigate immediately to the document of interest (refer to Section 1.4 for instructions). Bookmarks match the order of documents shown on the cover page of the technical appendix document. • Each technical report within the technical appendix is supplied with a cover page and each report listed in the index on the cover page of the technical appendix is hyperlinked to the cover page of the relevant report. It should be noted that for some older technical report, no digital record exists as the reports pre-date digital technology and scanned copies have been supplied.
2.	Tenure	Issue: The document references dead tenements (e.g. G52/08). ACTION Remove references to dead tenements (e.g.G52/08) and applicable liabilities referenced against live tenure.	At the time of drafting the MCP in H1 2021 the tenure had not been reported as converted, and the MCP in Section 2.4 stated that the MCP recognised that the conversion was underway. Section 2.4 has been amended to reflect the tenements current at the time of writing.
3.	Stakeholder consultation	Issue: • Earliest stakeholder consultation noted is in 2016, however operations have been ongoing under State Agreement prior to this. • Table 4-2 – it is stated that a site visit was scheduled with the Nyiyaparli people in 2019 to discuss any concerns with MCP but was cancelled due to COVID restrictions. ACTION • Provide an overview of pre-2016 engagement and consultation undertaken or explain why this has not been provided. • Ensure that all stakeholder responses and concerns are provided, as well as how BHP are managing/addressing the responses and concerns. • Please check the dates as this abovementioned date occurrence predates COVID.	The 2021 MCP provided an overview of historical engagement, and this has been repeated in this version of the plan (Section 4.3), see paragraph 2 "*Key themes arising from previous stakeholder engagement*". Consultation after 2013 is summarised in Table 4-2 of this MCP and consultation prior to 2013 is included in Appendix B. It should be noted that the current Jimblebar operations only ramped up after expansions in 2010. Prior to 2014 and the development of the Indigenous Land Use Agreement with the Nyiyaparli people, consultations with Traditional Owners were less formal than in the current day.
4	5.2 Overburden	Issue: Maps 5-1, 5-2 and Figures 5-1, 5-2, 5-3 are low quality (blurry, low resolution) ACTION Resubmit the maps in a higher quality to ensure readability.	Appendix Q provides the original pdf maps which preserves their resolution. Pictures of the maps are provided within the text of the MCP to enhance the readability of the document.
5.	Physical characteristics	General comment: Waste materials availability and rehabilitation requirements for rock armour will need to be regularly reviewed in future MCP revisions to ensure adequate resources for rehabilitation are identified and secured, or alternative sources found.	The overburden balance (Section 5.3.4) has been updated for this MCP revision and updates to the physical characteristics knowledge base and overburden balance form elements of the forward work program in Section 7.6.
6.	Collection and analysis of closure data	General comment: The baseline data presented has been recently assessed by DWER and is acceptable at this time. DWER recommends the focus of future MCP revisions needs to shift from operations to closure, to enable keeping the 'big picture' whole-of-site closure in mind.	The Jimblebar Hub mine is a long-lived mine (estimated completion date for mining is 2049). The knowledge base of the MCPs is continually updated over time. The new knowledge incorporated into this MCP is summarised in Section 13.1 and includes several closure design studies. As outlined in Section 5, the knowledge base associated with areas approaching closure / rehabilitation is more mature than newer areas, or areas that have not yet been mined. As areas progress through operations to closure, additional studies will be conducted to help inform the closure and rehabilitation of these areas.
7.	5.8 Hydrology	Issue: Operations flood protection is generally described, however discussion on planning for diversions (considering post closure landscape) is needed – mine and divert with a view to closing. ACTION Provide a discussion on planning for diversions, catchment-scale processes and their interactions with the final landscape.	Section 7.5.3 describes key processes and principles involved in surface water planning for closure. Section 5.16.3 summarises the surface water management infrastructure design studies conducted to date, noting that closure is only considered conceptually due to the likely changes in post-closure flood characteristics. The forward work program (Section 7.6) includes studies required to progress designs for closure.
		Issue: Tables 5-21 and 5-22, whilst useful, are mostly operationally focused. ACTION • The potential pathways and impacts (relevant to closure) would be well-placed in the risk assessment with emphasis on closure, and / or temporary suspension of operations. • Please provide all relevant technical refences to support the MCP.	Change assessments and the implications of changes to receptors have been moved to Section 7.3 and updated. The assessments draw on information in Section 5, including the design studies in Section 5.16. The risk assessment in Section 7 follows a source pathway receptor approach relevant to closure and links to information contained in the knowledge base. All relevant technical documents were supplied to EPA at submission with the 2021 MCP either embedded in the MCP pdf file or in the separate technical appendix pdf file that was indexed and searchable. A similar approach has been followed for this 2023 MCP.
		Issue: Ongoing collection of hydrological (surface water) baseline in creeks is expected during operations to inform future closure studies. Hydrological measurements in as yet undisturbed catchments must commence well-in-advance of future mining operations to establish a clear baseline understanding of (sub-) catchment hydrology. ACTION • Discuss hydrological monitoring in the MCP baseline data, including water quality and stream flow. • Further studies to validate assumptions in groundwater conceptual and numerical model in relation to other groundwater users/receptors (e.g. Newman water supply, Jigalong Aboriginal community, Ethel Gorge Threatened Ecological Community, post-mining users) needs to be developed in future MCP revisions. Where knowledge gaps exist, groundwater investigations and monitoring may be required. • Further work is required to test hydraulic connection and inform estimation of groundwater levels recovery post mining.	The surface water monitoring program for Jimblebar is described in Section 10.1.7, and has been updated to discuss surface water flow and quality monitoring. Surface water quality data are discussed in Section 5.11.1.5. The design studies discussed in Section 5.16.3 have used flow gauging data relevant to the study. As outlined in Section 7.6, BHP has a forward work program to conduct a more detailed analysis of existing data and review the suitability of the current surface water quality sampling program to inform closure and completion criteria. As discussed in Sections 3.4.7 and 10.1.8, dewatering at Jimblebar is conducted in accordance with the groundwater operating strategy (GWOS) which forms part of the conditions for Groundwater Licence GWL 158795(8) and is approved by DWER. The strategy is periodically reviewed and revised to incorporate changes in operations and / or knowledge of groundwater responses to dewatering stresses. The data collected through the GWOS monitoring program helps to refine and calibrate the conceptual and numerical groundwater models for the Jimblebar operations including closure (Sections 5.11.2 and 5.16.5). The Annual Aquifer Reviews (AARs) / Triennial Aquifer Reviews (TARs) report on observed groundwater responses. The MCPs progressively include updates to the conceptual and numerical groundwater models as they are refined based on observed groundwater responses. This MCP (Sections 5.11.2 and 5.16.5) incorporates the results of work completed since the last MCP revision. The forward work program (Section 7.6) reflects the progressive nature of model updates.

Item	MCP section	DWER comments	Closure plan response
7.	*5.8 Hydrology continued*	Issue: The Central Fault acts as a barrier, which limits the extent of reinjection mounding impacts for the proposal. As detailed in the MCP, the Managed Aquifer Recharge scheme is expected to result in localised mounding of water during operations. ACTION • DWER requires further information on mining of the Central Fault including: • Timing of when the cut/removal of the Central Fault will occur. • Clarity on how the removal of the Central Fault will influence the potential reinjection mounding impacts. • Further groundwater investigations and studies may be required if the change to the groundwater regime is significant. • Investigations are to be scoped and undertaken to support the claim that mounding will not be an issue at closure, please submit with the next iteration of the MCP.	Prior to mining, the groundwater levels across the Jimblebar mining area were very flat with similar levels either side of the Central Fault. Removal of the Central Fault will replicate this situation post-closure. The main control on groundwater levels to the west of the Jimblebar mining area is the Wheelarra Fault and effectively provides a flow barrier between Jimblebar and areas west of the fault. Current mine plans do not intersect the Central Fault below the water table. The Caramulla MAR was approved via Ministerial Statement 1126 which was issued following submission of the "*Jimblebar Optimisation Project: Jimblebar Iron Ore Mine Revised Proposal*" which contains details of relevant modelling. The MAR is operated in accordance with Condition 7 of Ministerial Statement 1126 which requires *inter alia* that the hydrological regimes of groundwater are maintained so that environmental values are protected, and that the Jimblebar Water Management Plan (BHP, 2020b) be implemented. The current version of this plan (approved by DWER) sets a groundwater rise threshold of 25 mbgl with an early warning trigger of 29 mbgl to protect environmental values. Given that there are operational controls to manage potential impacts during injection, and mounding will dissipate on cessation of discharge, no impacts would be expected to require management post-closure.
		Issue: Mining of the Hashimoto orebodies will occur on both sides of the Jimblebar Creek. ACTION Provide results of the mine design review and the review of potential impacts and the management of the Innawally Pool prior to mining in this area.	As discussed in Section 7.3.2.1, The WHASH and Hashimoto 2/3 pit shells have been designed so that the pit walls are located outside the 1:10,000-year flood plain of Jimblebar Creek in this area, and avoid intersecting alluvium under the flood plain which is regularly recharged by streamflow and which feeds Innawally Pool.
8	5.11 Cultural heritage	Issue: Consideration of Aboriginal heritage places, cultural and site values, post-mining access (safety, rehabilitation of access tracks) is limited throughout the document. ACTION • The above information should be discussed in the MCP (noting confidentiality limitations). • Site specific risk assessment for potential impacts on heritage during decommissioning / rehabilitation / closure are required in the MCP.	BHP does not agree with the recommendation to detail site specific impact mitigations in the MCP, as this is managed confidentially under the Aboriginal Heritage Act and remains separate to the MCP. BHP is committed to working with Traditional Owners under our Comprehensive Agreements and Heritage Protocols to ensure that cultural heritage is protected and managed as far as possible.
		Issue: Closure-related stakeholder engagement with the Nyiyaparli Traditional Owners is expected to support ongoing refinement of closure outcomes and completion criteria. ACTION Further discussion on how Aboriginal stakeholders are engaged in closure planning is required in the MCP. Please consider the EPA's expectations regarding consultation with Aboriginal groups and Traditional Owners as set out in the EPA's Interim Technical Guidance EIA of Social Surroundings – Aboriginal Cultural Heritage.	We note that the referenced technical guidance document was published 2 years after the MCP under assessment was written. The social surroundings process as detailed in the Interim Technical Guidance is an EIA process. Nevertheless, since this MCP is supporting the Jimblebar Hub Significant Amendment submission, a social surroundings process has been undertaken, and the outcomes relevant to closure are summarised in Sections 4.3 and 5.14. BHP is committed to ongoing consultation with the Nyiyaparli people (Section 4) and both this (2023) and the Jimblebar 2021 and OB17/18/31 2018 MCPs were provided to KNAC for review. BHP has incorporated responses to KNAC comments on the MCPs into this version (refer to Appendices B-3 and B-4). This plan also acknowledges the Nyiyaparli Closure Principles that were communicated to BHP following KNAC review of the 2021 MCP, but which were received after submission to government.
9.	Assessment and management of risk	Issue: Risks are to be informed by analysis of the baseline data, also considering knowledge gaps. In turn, the risk assessment informs the decision to develop closure outcomes. ACTION Consider the above and consider how this can be demonstrated / improved within the MCP.	Table 7-3 in Section 7.3 has been revised to provide a greater level of granularity on the risk assessments with references to knowledge base and risk management sections (where more detailed data / analysis can be found) provided within the table. Improvement activities for knowledge gaps are also linked to each risk.
		Issue: Consideration of how operational planning impacting on closure outcomes (e.g. changed mine layout, inappropriate placement of overburden storage areas or potentially acid forming materials, poor management of erodible waste, poor progressive rehabilitation due to mine schedule not prioritising backfill) is required in the risk assessment. ACTION • Given the long-duration of this project, clarify how risk management will be integrated where mine planning decisions impact mine closure risk. • All risks need to be presented in the MCP (can be in appendix) including those with a "Low" inherent risk.	**Noted:** Both the 2021 MCP and this version have outlined the contributing causes to closure risks including the examples provided in the comment (refer to Column 4 for Risks R1 and R2 in Table 7-3). BHP has a suite of procedures to control risks during all stages of mining from planning to execution and closure as outlined in both the 2021 MCP and this (2023) MCP (Column 9, Table 7-3). Further information on these controls is provided in Section 7.5. The controls in this (2023) version of the MCP include additional information on closure designs (with references to sections where further detail can be found) as well as procedural controls. The current risk table includes a greater level of risk granularity, however, we note that splitting out multiple low inherent risks (e.g., one risk per causal factor) does not add value when each causal factor contributes to a higher-level amalgamated risk (i.e. this approach can result in a false picture of risk across the site as each risk in its own right may be low, but when the causal factors are considered cumulatively, the overall risk is likely to be higher).
		Issue: Table 7.1 requires risk consequences, likelihoods to be included. ACTION • Inherent and residual risk are not specified (only coloured cells), please define the risk ratings (represented by colours). • Closure-related environmental and stability risks during care and maintenance/unplanned closure and decommissioning phases are also required in the risk assessment.	Table 7-3 in Section 7.4 includes the likelihood and consequence descriptors as well as the risk rank descriptor / colour. Generally, BHP does not see a different set of risks to closure outcomes in unplanned or early closure scenarios. As detailed in Section 9.5, depending on the site status the risks would need to be reassessed based on the conditions present at the time – e.g., has progressive backfill progressed sufficiently to manage geotechnical or geochemical risks. The risk status may be different, but the impacts and control process will be similar and will need to be adjusted according to actual conditions – that is the adaptive management process as described in the MCP. If there are any issues that would specifically need to be managed in early closure (e.g., insufficient competent materials), then these are highlighted in Section 9.5 along with management actions. The application of the adaptive management process will ensure changes to risk status is identified and controls are updated. BHP considers populating a table with a wide range of "What If" risks will not inform the reader (DWER, DEMIRS or the public) to any greater level of detail than the current format.

Item	MCP section	DWER comments	Closure plan response
9.	*Assessment and management of risk continued*	Issue: • Risk Rows 1 & 2 (landform stability) • Risk Row 5 (surface water) • Risk Row 7 (Completion criteria - achieving post-mining land use) ACTION: • Landform stability – how is post-closure hydrology (creeks, floodplains) impacting on landform stability / abandonment bunding design being risk assessed and addressed in MCP? • Surface water – consideration of impacts are predominantly to Innawally Pool, however the closure risk assessment must consider the whole catchment. Early identification of risks associated with rare to extreme hydrological events will improve closure outcomes through informed mine planning. • Completion criteria for achieving post-mining land use - This risk category captures a range of potential risks that ideally need to be individually assessed for environmental impact, with closure outcomes and completion criteria developed where the level of risk requires it.	Risks R1 and R2 capture impacts to landforms from post-closure hydrology. The results of 10,000 AEP flood modelling are outlined in 5.11.1.4 along with more detailed flood studies conducted for specific areas of the mine with the potential to interact with surface drainage. These studies have informed the risk assessments in Section 7.4 and the design studies in Section 5.16.3 for mitigating impacts arising from interaction with surface drainage. Section 7.3 summarises the areas of the mine that interact with surface drainage and Section 7.5.3 outlines the approach to managing risks from surface water. Risk R14 considers the impacts of changes surface water flows across Jimblebar Hub catchment, with the key receptors being riparian vegetation communities and sheet-flow dependent Mulga as well as Innawally Pool. Design studies (Section 5.16.3) consider closure, and the approach to managing risks associated with surface water is outlined in Section 7.5.3. The results of extreme event flood modelling (Section 5.11.1.4) have been used to inform design studies. The completion criterion risk has been sub-divided into several risks (R15, R16, R17, R19) in Table 7-3 (Section 7.4) .
10.	7.5 Closure improvement	General comment: • This section appears similar to knowledge gaps (MCP Section 13). Please consider rationalising to ensure consistency and remove duplication. Improvements identified in Table 7-1 need to be stated in the knowledge gaps (Table 13-2). • Please note, when scheduling final pit void and landform planning, design, and implementation, timing of review by regulatory agencies must be factored in. These reviews can occur through the MCP revisions submitted to EPA.	Under the DMIRS 2020 Statutory Guidelines, Section 13 must present: • A table documenting how knowledge gaps identified in the **prior revision** of the mine closure plan have been addressed. • Any new gaps identified. Table 13-4 in Section 13.3 of this MCP outlines the data gaps and improvement activities in the **2018 OB17/18/31** (since feedback on the 2022 MCP has not yet been received) and **2021 Jimblebar** closure plans and provides commentary on the current status of those improvement activities. The 2021 Jimblebar MCP outlined the data gaps and improvement activities from the **2016** MCP and provided commentary on progress towards these activities. Table 13-5 outlines the new knowledge gaps identified in this MCP (i.e., only those actions that are different from those that have carried forward from the 2021 MCP). The risk assessment (Table 7-3 in this MCP) provides a linkage between risk and current identified knowledge gaps that are leading into forward work plans. The wording of knowledge gaps and forward work programs may be different between Table 13-5 and Table 7-3 due to the space available in Table 7-3 and the specific risk being discussed.
11.	Closure outcomes and completion criteria	Issue: • The “closure criteria” table (Table 8-1) is well presented and articulates relevant information well. However it uses non-standard terminology for closure outcomes (BHP uses criterion objective) and completion criteria (BHP uses completion (stage 3)) in the MCP. ACTION • Revise Section 8 and MCP text to be consistent with standard terms, so it is clear what the closure outcomes and completion criteria are.	The terms used in Section 8.3 of the updated MCP are consistent with those used in the WABSI guidance on completion criteria. As defined in Young et. al.: • The closure objective provides a clear indication on what the proponent commits to achieve at closure (in other words, outcomes). • Completion criteria are defined standards or level of performance that can be objectively verified and demonstrates successful closure of a site for a particular objective.
		Issue: • Risk to key environmental values at Jimblebar (as identified by the EPA or key stakeholders) need to be included with relevant closure outcomes and completion criteria developed. ACTION • The MCP needs to demonstrate the objectives set by EPA have been achieved in closure (in addition to other outcomes). • Completion criteria don’t always follow the S.M.A.R.T. principles – see DMIRS’ Statutory Guidelines for Mine Closure Plans - March 2020 particularly when it comes to being timebound.	Criterion objective in Table 8-1 describes the purpose or objective (i.e., the outcomes to be achieved) of a particular criterion. Each criterion in Table 8-1 is linked to a specific risk number and domain. Completion is assessed in three stages with the first two stages (Planning and Execution) measured via internal performance indicators and the third stage, Completion, measured via *Completion Criteria*. Timing is built in via the 3-stage process. Completion is not defined as 1 year or 10 years etc. as, based on historical experiences within BHP in the Pilbara, trajectories of rehabilitation success are variable, and it would be erroneous to predict when rehabilitation meets all completion outcomes. BHP’s point of view is that when we apply for surrender or relinquishment, all criteria must be met. Some criteria may be met earlier in the post closure phase, however many, especially the vegetation criteria, may take 15-30 years to achieve success, based on historical performance. Jimblebar is a long-lived mine and completion criteria are being refined based on collection of data and interpretation during the life of mine.
		General comment: Ongoing development of the outcomes and completion criteria are expected in future MCP revisions, and outcomes are intended to be informed by the risk assessment for activities or events with higher risk.	Each criterion in Table 8-1 is linked to a specific risk number and domain.
12.	Closure Implementation	General comment: • Closure implementation is acceptable at this time. Future MCP revisions are expected to progressively refine the planned approach to closure implementation. • Indicative landform designs must be included in the MCP including maximum height, slope angle / profile shape, disturbance area, materials and methods used in rehabilitation of the final landform surface, armouring requirements, and plans for revegetation. • Future supporting studies, geotechnical assessments, and ongoing waste materials characterisation are also required to demonstrate acceptable landform design (informing refined closure outcomes and completion criteria). • Are there provisions for acid mine drainage material and other potentially hazardous / contaminating waste to be backfilled into pit voids to ensure they remain in situ? Management strategies for these materials need to be developed in closure implementation.	Noted. As outlined in Section 9.2.2 there are several OSAs and ISAs at the Jimblebar Hub which are at different stages of design. As discussed in Section 7.5.4, conceptual landform designs are developed for ex-pit OSAs and integrated into the Master Area Design for a mine. Designs are refined throughout the mine planning process. In an operation with a long life (such as Jimblebar Hub), requirements for overburden storage change throughout the life of mine based on changes to the mine plan. OSA designs, therefore, remain in a conceptual form until close to the time of progressive closure execution. A significant amount of additional information has been added to this MCP to reflect the outcomes of studies that have been progressed since the last MCP revision. As outlined in Section 13.1, this includes materials characterisation and landform design studies. Section 7.5.1 describes the strategies used to manage PAF material and provides a diagram to show the designated PAF material storage locations (as did the 2021 MCP).

Item	MCP section	DWER comments	Closure plan response
13.	Knowledge gaps	Issue: Knowledge gaps have been commented on in baseline data that require further information in future MCP revisions. There are knowledge gaps in the text that aren't carried over into tables. ACTION Please check all tables and the methodology for tracking, risk assessing, prioritisation to ensure that all knowledge gaps are addressed and managed. Rationalise the information provided in Table 7-1 (risk assessment), Table 7-7 (improvement activities) and Tables 13-2/13-3 (knowledge gaps) to remove duplication and ensure consistency in future MCPs.	Please refer to the previous comment on the information that should be presented in Section 13 according to DMIRS 2020 Guidelines. Table 7-13 (forward work program) is the defined program of work for the MCP. Improvement activities outlined in Section 5 are incorporated into the table. Some knowledge gaps / programs outlined in Section 5 are combined into one forward work action in Table 7-13 for ease of tracking and management. Summaries of forward works have been included in Table 7-3 to help make it clear that further work is required to more fully define a risk or control. Given the available space in this table, some forward work actions have necessarily been shortened. The improvement actions are reiterated in Section 7.5 (Management Identified Issues) to summarise the pathway forward in the context of the MCP section. Given the timing of receipt of DWER comments, a restructure of the MCP was not feasible prior to submission. Future MCPs will consider structural improvements.

13.3 Progress to address knowledge gaps & improvement activities

In line with the DMIRS (2020a) guidelines, this section provides:

A table documenting how the knowledge gaps identified in the prior revision of the mine closure plan have been addressed (Table 13-4), *as well as any new gaps identified* (Table 13-5).

Table 13-4 summarises the progress made against improvement actions identified in the forward work programs of the 2021 Jimblebar MCP and the 2018 OB17/18/31 MCP since formal feedback on the 2022 OB17/18/31 has not yet been received. New knowledge gaps identified in the completion of this plan and the 2022 OB17/18/31 MCPs (compared to the 2021 Jimblebar and 2018 OB17/18/31 MCPs) are summarised in Table 13-5. In some instances, the knowledge gaps and forward work programs identified in the 2018 OB17/18/31 and 2021 Jimblebar MCPs have been reworded slightly in Section 7.6 to accommodate the current context of the MCP, but fundamentally relate to the same issue / work program. In these cases, the forward works have not been identified as new knowledge gaps / forward works in Table 13-5.

Table 13-4 Progress against improvement activities from the 2022 OB17/18/31 and 2021 Jimblebar MCPs

Technical Area	Knowledge gap	Proposed Improvement activity	Indicative timing	Progress since 2018 / 2021 MCP
Government and stakeholder consultation	Stakeholder views (OB17/18/31 & Jimblebar).	Consultation will continue to be undertaken with identified stakeholders in line with the broader stakeholder consultation program.	Ongoing	Consultation with key stakeholders has progressed (Section 4.3), however, due to significant remaining life of Jimblebar Hub (>20 years), further consultation with stakeholders is required throughout the life of the mine (Section 4.2).
Completion Criteria	Conceptual criteria (OB17/18/31 & Jimblebar).	Review and refine completion criteria taking into consideration improved knowledge to develop more measurable metrics and the WABSI framework for completion criteria.	Ongoing	A review of ecological completion criteria by Syrinx (2019; 2023) and assessment of erosion rates by Landloch (2018) has resulted in measurable metrics that have been incorporated into the completion criteria presented in Section 8.3.1.
Sustainability				
Progressive rehabilitation	Opportunities for reducing potential impacts to conservation significant species (OB17/18/31).	Review of: • Early opportunities to rehabilitate the northern side of the OB31 OSA to minimise impacts to the adjacent Priority 1 flora species. • Opportunities for providing habitat for conservation significant species during rehabilitation.	Ongoing	Rehabilitation of the OB18 South OSA has been completed since submission of the 2018 MCP and included return of fauna habitat as detailed in Section 9.3.1.2. OB18 North OSA also includes return of fauna habitat (Section 9.3.1.1). Opportunities for rehabilitation at the OB31 OSA will be investigated when planned materials deposition is complete along the northern boundary of the landform.
	Progressive rehabilitation	Locations which may be available for a minimum of five years will be investigated for rehabilitation/ landform trials and incorporated into the 5-year plan.	Ongoing	Many of the areas at Jimblebar Hub are still active. However, several areas have been rehabilitated as described in Section 9.3.1. This includes BC06 (BD06) OSA which has been rehabilitated since the last MCP updates (regrade in FY22 and partial seeding in FY23),
Soils	Sources of growth media to address topsoil deficit (OB17/18/31 & Jimblebar).	Characterisation of appropriate growth media to address topsoil deficit as rehabilitation of OSAs progresses.	Ongoing	This work is ongoing across BHP Pilbara sites and this activity has been carried over to the forward work program (Section 7.6). Work completed in this area to date is outlined in Section 5.5.4.
Landforms				
Overburden characterisation	Overburden characterisation (physical and chemical) modelling and analysis (OB17/18/31 & Jimblebar).	Characterisation of overburden to inform final landform designs, as required.	Ongoing	Overburden characterisation has been completed as detailed in Section 5.3. Further work has been carried over to the forward work program in Section 7.6.

Technical Area	Knowledge gap	Proposed Improvement activity	Indicative timing	Progress since 2018 / 2021 MCP
Stability	East OSA lies within the possible ZOI of Swan pit (OB17/18/31).	Determination of the best option for managing the interaction of the East OSA with the possible ZOI of the Swan pit.	By next closure plan update	Recent stability assessments have shown that the Swan pit wall will achieve a FoS >2 at the end of tailings deposition, if approved. Material from East OSA will be used as cover for the Swan in-pit TSF. The ZOI relative to the East OSA will be further considered as closure designs for the in-pit TSF progress. This action has been captured in the forward work program (Section 7.6) as the analysis of the Swan pit wall stability as part of the in-pit TSF DPS.
	Pit void stability and abandonment bund placement (Jimblebar)	Slope stability analysis to inform final abandonment bund locations for mine voids remaining at closure.	5 yrs prior to mine completion	Given the current life of mine, this action has been carried through to the forward work program in Section 7.6.
Landform design	OB31 OSA footprint and backfill strategy (OB17/18/31).	Establishment of the backfill strategy for the OB31 mine void and confirmation of the preferred conceptual design for the OB31 OSA.	By next closure plan update	The backfill strategy for OB31 is still under review and considers the potential to use the pit for storage of tailings, and for movement of overburden between OB31 and OB17/18 to optimise closure outcomes. This has been captured in the forward work program (Section 7.6) within the action to optimise the Jimblebar Hub backfill strategy.
	Backfill strategy (Jimblebar).	Review and optimisation of backfill strategy to take into account the outcome of groundwater modelling, post-closure surface water flows and AMD studies.	2024	The backfill strategy for Jimblebar is under continual review and the most recent results have been incorporated into this closure plan (Section 9.2.1.1). Further assessment, including the potential to use other pits for tailings storage, is underway and consequently, this action has been carried forward to the forward work program outlined in Section 7.6 and is captured within the action to optimise the Jimblebar Hub backfill design.
	Progressively develop final landform designs based on local overburden characteristics and schedule for closure (Jimblebar).	Final landform designs confirmed through erosion modelling or comparable assessments of historical performance.	Prior to final executable design	Materials characterisation and erosion assessments have been conducted for several materials at Jimblebar (Section 5.3.3). Erosion modelling has also been conducted to support several design studies for OSA closure. The outcomes of these studies are summarised in Section 5.16.2 and Appendix L. Further characterisation and modelling studies will be conducted to support landform designs for other OSAs as they approach completion. A number of design studies have progressed to execution (Section 9.3.1). New designs will be incorporated into this MCP as they are developed (refer to the action to progressively develop final landform designs in Section 7.6.
		WH123 NE OSA design review considering erosion modelling outcomes. WH56 / H1OSA design review considering erosion modelling outcomes.	Two years prior to commencing rehabilitation	

Technical Area	Knowledge gap	Proposed Improvement activity	Indicative timing	Progress since 2018 / 2021 MCP
Hydrology				
Hydrogeology	Risk of impacts from a pulse of poor-quality water (from PAF oxidation) following groundwater recovery of backfilled voids (OB17/18/31).	Assessment of the degree of hydraulic connection of the Swan and De Grey pits to the underlying dolomite via faults and the significance of this pathway in terms any release of poor-quality water from AMD.	By next closure plan update	The conceptual model for OB17/18/31 and the pathway between this mining area and Ethel Gorge TEC has been updated and is reported in Section 5.11.2.2. The revised change assessment based on this updated model is provided in Section 7.3.2.2.
	Post-closure impacts resulting from depressed water levels (OB17/18/31).	Investigation of the appropriate closure scenario for OB31 to mitigate any potential post-closure impacts of groundwater drawdown from dewatering of OB31.	By next closure plan update	
	Potential change to Innawally perched aquifer systems via Wheelarra and Hashimoto development (Jimblebar).	Hydrological studies will be carried out to update the conceptual model of Innawally Pool and to delineate potential impacts to the pool from nearby mining related activities.	Update provided in 2024 or the next revision of the MCP	The current conceptualisation of Innawally Pool is provided in Section 5.11.3.2 along with a recent analysis of pool volumes compared to rainfall. The Hashimoto and WHASH pits have been designed so they fall outside the 1 in 10,000-year flood plain in the vicinity of Innawally Pool (Section 7.3.2.1).
	Groundwater and pit lake modelling (Jimblebar).	Calibration of numerical groundwater model and modelling to conduct a more detailed analysis of post-closure groundwater levels and residual pit lake quality.	2024	The conceptual and numerical groundwater models have been updated with results reported in Sections 5.11.2 and 5.16.5. The Jimblebar backfill strategy is evolving (including consideration of in-pit storage of tailings) and further work to refine the strategy and define pit lakes remaining post-closure has been incorporated into the forward work program outlined in Section 7.6.
Surface water hydrology	Post-closure drainage design (OB17/18/31).	Investigation of the suitability of operational surface water controls for closure and upgrade to meet closure standards if required.	Within 5 years of closure	The operational design of the OB31 flood bund and conceptual assessment of required upgrades for closure, including flood assessments have been completed, as described in Sections 5.16.3.2 and 9.2.3.4. The forward work program in Section 7.6 maintains an action to complete detailed designs for surface water management infrastructure closer to the time of closure.
	South Jimblebar creek diversions (Jimblebar).	Hydrological studies will be carried out and appropriately designed infrastructure will be developed where mining plans indicate the need for surface water realignment.	Aligned with approvals	The design studies for South Jimblebar Creek and Jimblebar Creek West Branch diversions are reported in Section 5.16.3. The forward work program in Section 7.6 maintains an action to complete detailed designs for surface water management infrastructure closer to the time of closure.
	South Jimblebar flood protection bund post-closure design (Jimblebar).	For the existing flood protection bund, additional targeted hydrological design studies will be carried out to assess the suitability of the existing structures for the post closure phase	5yrs prior to mine completion	There has been initial consideration of closure requirements for the South Jimblebar permanent flood bunds and creek diversion (Sections 5.16.3 and 9.2.3.4). The forward work program in Section 7.6 maintains an action to complete detailed designs for surface water management infrastructure closer to the time of closure.

Technical Area	Knowledge gap	Proposed Improvement activity	Indicative timing	Progress since 2018 / 2021 MCP
Inland environmental quality				
AMD	Potential for AMD impacts from De Grey and Swan pit wall rock (OB17/18/31).	Kinetic testing to assess the potential for wall rock material above the planned level of backfill in the De Grey pit to release AMD. Determination of the optimal backfill levels for the De Grey pit to manage AMD. Assessment of the need for artificial groundwater recharge to accelerate groundwater recovery, or other measures to manage potential risks associated with AMD from the backfilled De Grey and Swan pits.	By next closure plan update	A study into the potential for release of AMD from wall rock has been conducted by Earth Systems (2018) (Section 5.3.2.2) and concludes that wall rock is a small component of in-pit acidity generation. An approval is being sought for use of the Swan and De Grey pits to store tailings. A layer of tailings over the PAF exposures will minimise oxygen ingress and thus AMD generation. An overburden cover will minimise erosion of this tailings layer (Section 5.16.4). The conceptual model for OB17/18/31 and the pathway between this mining area and the Ethel Gorge TEC has been updated and is reported in Section 5.11.2.2. The revised change assessment based on this updated model is provided in Section 7.3.2.2. Given the proposal to use Swan and De Grey pits to store tailings, the low potential for wall rock to generate acidity, and the updated conceptual model described in Section 5.11.2, artificial recharge of groundwater does not require further investigation at this time.
	AMD potential from pit wall exposure (Jimblebar).	Further geochemical studies and field trials to assess AMD risk from wall rock and develop Wheelarra and Hashimoto PAF management controls including mine planning design and schedule.	2024	The AMD risk assessment for Jimblebar has been updated and a review has been conducted of pit wall acidity generation rates (Section 5.3.2.2). The Jimblebar backfill strategy is still under review (Section 7.6). As described in Section 5.3, WAIO has an ongoing program of testing linked to resource drilling activities, and manages PAF in accordance with its AMD management standard (WAIO, 2022a) as summarised in Section 7.5.1. The Jimblebar AMD risk assessment has been updated and is reported in Section 5.3.2. Further sampling and analysis has been carried through to the forward work program in Section 7.6.
	Characterisation of South Jimblebar deposits (Jimblebar).	Characterise material from the South Jimblebar Sylvania and Capricorn deposits to identify PAF	12 months prior to mining	
Potentially contaminated sites	Contamination assessments are incomplete for known and suspected contaminated sites (OB17/18/31).	Contamination assessments will be undertaken for any potential contaminated site, in accordance with the requirements of DWER and relevant technical guidelines. Preparation and implementation of a remediation plan, as appropriate.	Ongoing	The contaminated sites section has been updated to incorporate information from recent studies (Section 5.12). Further investigation of potential PFAS sources of contamination have been included in the forward work program (Section 7.6).
	Presence / severity of contamination (Jimblebar)	Conduct contaminated sites investigation at sites with suspected contamination.	In accordance with contaminated sites investigation schedule	

Technical Area	Knowledge gap	Proposed Improvement activity	Indicative timing	Progress since 2018 / 2021 MCP
Final land use and decommissioning				
Land use	Final-land use yet to be confirmed (Provisional use is currently low intensity grazing) (OB17/18/31).	Final land use planning study to be undertaken. Stakeholders to agree and endorse the final land use for OB17/18/31 operations.	Within 5 yrs of closure	Section 2.3 has been updated to reflect that, although mining operations are more advanced at OB17/18, the closure date for these orebodies is influenced by the estimated life of operations across the Jimblebar Hub (2053) due to in-pit tailings deposition and ongoing overburden material movement between the sites. The level of stakeholder consultation about post-mining land use reflects this estimated completion date. Section 6 has been updated to incorporate post-closure land use classifications consistent with the Australian Land Use and Management Classifications (ABARES, 2016) and the underlying tenure. A post-mining land-use of 'natural environments for managed resource protection' has been included to apply where the underlying tenure is UCL and the land use on pastoral tenure remains 'relatively natural environments for pastoral grazing purposes'. A preliminary study has been conducted to inform post-closure land use planning (Section 6) and there is an ongoing process to investigate post-closure economic opportunities. Consultation with the Nyiyaparli people is ongoing (Section 4) and further work is required to determine how traditional uses can be factored into the land use classifications. This action has been .carried through to the forward work program in Section 7.6
	Post-closure-land use yet to be confirmed (provisional use is currently relatively natural environment for pastoral grazing purposes)	Review and define post closure land use options following consultation with stakeholders.	5 years prior to completion of mining	
Decommissioning Plans	No detailed decommissioning plans (OB17/18/31).	Development of detailed decommissioning plans for site infrastructure	Within 5 yrs of closure	Not yet required given the estimated completion date of 2053 (and use of OB17/18 facilities for OB31 operations). Carried over to the forward work program in Section 7.6.

Table 13-5 New knowledge gaps and improvement activities identified in this MCP

Technical Area	Knowledge gap	Proposed improvement activity	MCP Section
CONSULTATION			
Stakeholder consultation	Nyiyaparli people views	Consultation will continue with Traditional Owners as part of the broader Stakeholder Consultation Program. Information sought will include, over time: • Requirements for protection, management and post-closure access to sites of cultural significance. • Management of cultural artefacts. • Nyiyaparli people views of rehabilitation of OB17/18/31. • Landform and rehabilitation designs including creation of special places.	Section 4.2 Section 7.5.8.3
LANDFORMS			
Physical characterisation	Tailings physical characteristics and settlement / consolidation behaviours	Jimblebar tailings will be further tested during operations to confirm physical characteristics.	Section 5.4.3
Geochemical characterisation	Priorities for monitoring OSAs / ISAs storing AMD 1.	BHP is reviewing OSAs / ISAs across the Pilbara based on storage of AMD 1 overburden to identify priorities for AMD monitoring.	Section 5.16.1
	Further assessment of the hazards associated with AMD 2 and 3 materials and mobility of metals under variable environmental conditions.	As part of a BHP-wide geochemical program: • Further assessments will be conducted into the geochemical hazards associated with AMD 2 and 3 materials. • Targeted leach test work will be conducted to assess metal mobility under variable environmental conditions.	Section 5.3.5
	Confirmation of geochemical characteristics of tailings	Jimblebar tailings will be further tested during operations to confirm geochemical characteristics.	Section 5.4.3
LANDFORMS			
Landform design	Progress conceptual design studies for new proposed in-pit TSFs.	As locations for new in-pit TSFs are confirmed, studies will be progressed to develop conceptual designs for closure. These will include: • Consideration of the tailings characteristics (geochemical and physical) and pit wall exposures of PAF material. • Surface water catchments impacting on TSFs and need for surface water management measures. • Consideration of the outcomes of detailed design studies for De Grey and Swan in-pit TSFs and the monitored behaviour of the tailings in these pits during deposition. • Consolidation behaviour and implications for placement of any cover systems. • Material types and volumes required for any cover systems. • Consultation with Nyiyaparli people regarding the final landform design, acknowledging the Nyiyaparli people's preference to backfill to surface or create water gaining sites.	Section 9.2.1.3

Technical Area	Knowledge gap	Proposed improvement activity	MCP Section
Landform design continued	Refine De Grey and Swan in-pit TSF closure designs	Progressively review and refine closure designs for the De Grey and Swan in-pit TSFs based on: • Consolidation modelling for the DPS (in progress) and subsequent monitoring and model validation during operations. • Review of options to enhance tailings settlement and drainage to reduce the timeframe over which closure works can be safely executed. • Seepage modelling (in progress) and pre-closure monitoring of groundwater to confirm / refine groundwater impact assessment. • Cover material characteristics.	Section 5.16.4
Stability	Slope stability of residual voids remaining post-closure.	Swan and De Grey pit wall stabilities will be further assessed as part of the tailings storage DPS.	Section 5.6.3
WATER			
Surface water hydrology	Surface water monitoring data	The surface water (and riparian vegetation) monitoring program for Jimblebar Hub will be reviewed, and if appropriate revised, to assess its suitability to inform closure and assess achievement of completion criteria.	Section 5.11.4 Section 7.5.3.4
REHABILITATION			
Progressive Rehabilitation	Optimising revegetation establishment.	Use the results of research to inform future rehabilitation including: • Utilise the results of seed and tube stock research / trials and work with the Nyiyaparli rehabilitation team to inform the revegetation strategy. • Conduct a review to identify appropriate species for use in pits with backfill to surface. • Keeping a watching brief on research associated with the appropriate use of out of provenance seed source to increase genetic diversity to provide resilience to climate change.	Section 5.16.6.1 Section 7.5.6.3
	Progressive rehabilitation	Monitor the performance of rehabilitated landforms to validate design assumptions and inform future rehabilitation practice during operational life of mine.	Section 7.5.6.3
	Opportunities for encouraging fauna return to rehabilitation	Research program to investigate fauna habitat and the return of fauna to rehabilitated areas including consideration of key species of significance to the Nyiyaparli people. BHP is in the process of reviewing its rehabilitation monitoring procedures to determine how fauna use of rehabilitated areas can be integrated into the monitoring program.	Section 5.9.5 Section 7.5.6.3

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Appendix A. Closure-relevant statements in submissions to State Government

Reference	Applicable Area	Obligation Description	Section
1987 State Agreement Proposal for the Development of McCameys Monster (now Jimblebar)	Wheelarra Hill W4 (Ferro Gully)	**Decommissioning & demolition** Remove all Temporary Works and Construction and Plant from the work site and leave the work site in a clean condition free of all waste and make good all disfigurement of the environment to the specified condition all to the satisfaction of the Superintendent.	Section 2.13
		Upon decommissioning all equipment machinery and buildings, etc. will be removed, rubbish burned, and ash and non-combustible rubbish buried, and the area left clean and tidy.	Section 5.2.1, 5.2.9
		Remove all facilities and the process plant installation upon completion of the mining contract, including the demolition and removal of concrete foundations and the treatment of the site area as described in the summary of environmental commitments.	Section 3 Clause A13, A29
		All sewage holes, pits, trenches, boreholes, etc. will be filled or capped.	Section 5.2.9
		Topsoil Strip topsoil from the open pit areas as directed and stockpile in designated areas.	Section 3 Clause A15
		Haul road: • Topsoil shall be stripped to a minimum depth of 100mm below natural surface level. Stripped topsoil shall be stockpiled at areas nominated by the Superintendent or windrowed to the limits of the works. • On completion of the roadworks, topsoil shall be respread on cut and fill batters and to the sides of the roadway within the road reserve.	Section 1.5
		Kalgan Rail Siding: • Topsoil shall be stripped to a minimum depth of 100mm below the natural surface level. Stripped topsoil shall be spread within areas nominated by the Superintendent.	Section 2.3
		Topsoil shall be stripped from selected areas of the [Process Plant] Works where directed by the Superintendent but to a maximum depth of 150mm. The topsoil shall be hauled to adjacent locations, approved by the Superintendent, and stockpiled.	Section 3.7.3
		Topsoil may be required to be removed from areas where it occurs as an identifiable layer over the scree. The extent shall be as directed by the Superintendent. Topsoil to be stripped shall be stockpiled in locations approved by the Superintendent for subsequent respreading.	Section 4.4.2
		Topsoil and vegetation stripped during operations will be replaced as soon as practicable onto areas to be rehabilitated.	Section 5.2.8
		Borrow pits On completion of the works the Contractor shall reinstate all borrow pits and temporary access roads in accordance with Mt Newman Mining Co (Walker) Borrow Pit Development and Rehabilitation.	Section 1.7, 2.4, 5.2.3
		Borrow pits will be ripped and battered	Section 5.2.8
		Mine voids Surface scree: • When mining has been completed in successive areas, the final pit walls shall be battered at a slope of 1 vertical: 2 horizontal. Any slope that is higher than 2.0 metres shall have a bund constructed, adjacent to the top of the batter and to a height of not less than 600mm. • The finished surface level of the area after mining shall in general follow the original natural surface level such that major diversions of surface runoff shall not occur.	Section 4.4.4.1

Reference	Applicable Area	Obligation Description	Section
1987 State Agreement Proposal for the Development of McCameys Monster (now Jimblebar) continued	*Wheelarra Hill W4 (Ferro Gully) continued*	Deep Scree: • When mining has been completed, the final pit walls shall be trimmed to a batter slope of not more than 1 vertical: 1. 5 horizontal. Any slope that is higher than 2.0 metres shall have a bund constructed adjacent to the top of the batter and to a height of not less than 600mm. The design of the pit walls and adjacent berms shall be such as to divert surface water away from the pit and towards the nearest natural watercourse. • The floor of the pit shall be graded so that runoff water is directed towards the nearest natural watercourse.	Section 4.4.4.2
		All faces on the mine, borrow pits, etc., will be battered if low and benched if high.	Section 5.2.8
		The existing landscape will be preserved as much as possible, within the constraints of the actual mining operation.	Section 5.2.1
		Overburden Waste stockpiles will be regularly shaped and of low profile to reduce obtrusiveness.	Section 5.2.1
		Waste dumps will be irregularly shaped to be unobtrusive.	Section 5.2.8
		Rehabilitation All compacted surfaces will be ripped.	Section 5.2.8
		Fertiliser applications or seeding will be used on rehabilitation areas as required.	Section 5.2.8
State Agreement Proposal 1988	Jimblebar	Rehabilitation required pursuant to any environmental commitments shall be carried out as soon as practicable after the final finished surface profile has been achieved.	
		Rehabilitation • Topsoil and vegetation stripped during operations will be replaced as ‘soon as practicable onto areas to be rehabilitated. • All faces on the mine, borrow pits, etc., will be battered if low and benched if high. • Waste—dumps will be irregularly shaped to be unobtrusive. • Borrow pits will be ripped and battered. • All compacted surfaces will be ripped. • Fertiliser applications or seeding will be used on rehabilitation areas as required.	
		Decommissioning • All equipment, machinery, rubbish, the camp, etc., will be removed upon completion of operations. Combustible debris will be burned, and ash and non-combustible rubbish buried. • All sewage holes, pits, trenches, boreholes, etc. will be filled or capped. • The area will be left clean and tidy.	
1990 A Proposal for the Further Development of McCameys Monster Iron ore Deposit Stage 2 Bedrock Mining at Ferro Gully	Wheelarra Hill W4 (Ferro Gully)	Waste material will be placed in the existing dump locations or mined out areas of the existing pit as applicable.	
		Overburden consists of scree iron ore, which is being removed, also as part of the scree mining operations, and waste and fines will be stockpiled at the designated dumps	
		Waste from the bedrock mining will be hauled to existing dumps or to areas of the scree mine where mining has been completed.	
		Rehabilitation will comply with the Mt Newman Mining Co Pty Ltd.’s policy document entitled "Borrow Pit Development and Rehabilitation" in the sense that it applies to Open Cut Mining Operations.	

Reference	Applicable Area	Obligation Description	Section
1990 A Proposal for the Further Development of McCameys Monster Iron Ore Deposit Stage 2 Bedrock Mining at Ferro Gully continued	*Wheelarra Hill W4 (Ferro Gully) continued*	Environmental Commitments: • Waste stockpiles will be regularly shaped and of low profile to reduce obtrusiveness. • Upon decommissioning all equipment and buildings, etc. will be removed, rubbish burned or buried, and the area left clean and tidy. • All boreholes and costeans will be capped or filled when no longer required. • Topsoil and vegetation stripped during operations will be replaced as soon as practicable onto areas to be rehabilitated. • All faces on the mine, borrow pits, etc., will be battered if low and – benched if high. • Waste-dumps will be irregularly shaped to be unobtrusive. • Borrow pits will be ripped and battered. • All compacted surfaces will be ripped. • Fertiliser applications or seeding will be used on rehabilitation areas as required. • All equipment, machinery, rubbish, the camp, etc., will be removed upon completion of operations. Combustible debris will be burned and ash and non -combustible rubbish buried. • All sewage holes, pits, trenches, boreholes, etc. will be filled or capped. • The area will be left clean and tidy.	
1990 Supplementary Information for Stage 2 Bedrock Mining at Ferro Gully	Wheelarra Hill W4 (Ferro Gully)	**Rehabilitation** All compacted surfaces, the mine floor, etc, will be ripped and contoured to facilitate water retention and penetration. Waste material dumps will be contoured to a low profile and any banks or steep slopes will be battered to a low angle and contoured if necessary. Natural regeneration of all these slopes and ripped areas is expected to be rapid but will be enhanced by a light application of suitable fertiliser. The haul road will regenerate naturally and will require no special treatment although windrows may be pushed back onto the road. Borrow pits on the haul road will be ripped and the banks battered. All rehabilitation works will follow the document "Guidelines and objectives for borrow · pit development and rehabilitation" prepared by Mt Newman Mining (Walker, 1986).	Attachment E
1992 State Agreement Proposal to Extend Mining of Stage II Development	Wheelarra Hill W4 (Ferro Gully)	The overburden material mined from the pit will continue to be placed into worked out areas of the scree pit or backfilled into excavated areas of the current bedrock pit.	
		No mining is conducted below the water table.	
		The overburden that is placed in worked out areas of the scree pit / will be positioned in such a way as not to interfere with naturally occurring water courses.	

Reference	Applicable Area	Obligation Description	Section
1992 State Agreement Proposal to Extend Mining of Stage II Development continued	*Wheelarra Hill W4 (Ferro Gully) continued*	Rehabilitation • All boreholes and costeans will be capped or filled when no longer required. • The existing landscape will be preserved as much as possible, within the constraints of the actual mining operation. • Topsoil will first be removed from areas to be disturbed. • Topsoil and vegetation stripped during operations will be replaced as 'soon as practicable onto areas to be rehabilitated. • Overburden will be rehabilitated on a progressive basis. • All faces on the mine, borrow pits, etc., will be battered if low and benched if high. • Overburden stockpiles will be of low profile to reduce obtrusiveness. • Overburden will be irregularly shaped to be unobtrusive. • Borrow pits will be rehabilitated to the standards set out in Walker (1986). • All compacted surfaces will be ripped. • Fertiliser applications or seeding will be used on rehabilitation areas as required. • Monitoring of rehabilitation success will be undertaken. • Rainfall measurements will be taken in the area to assist in the gauging of success of rehabilitation.	
		Decommissioning • All equipment, machinery, rubbish, the camp, etc., will be removed upon completion of operations. Combustible debris will be burned, and ash and non-combustible rubbish buried. • All sewage holes, pits, trenches, boreholes, etc. will be filled or capped. • The area will be left clean and tidy.	
State Agreement Proposal 1991	Jimblebar	The method of rehabilitation of the pit will be unchanged. Bund wall around the top of the completed pit will be in accordance with the recommendations of the "Guidelines on Safety Bund Walls around Abandoned Open Pits". The additional pit floor area will not require treatment. Rehabilitation of the waste dump will be carried out as outlined in our Rehabilitation Concept Plan as originally submitted to the Department in February 1991, and as is currently being undertaken for the Scree waste dumps. Rehabilitation of the proposed waste dump in the gully to the Northeast would be carried out as soon as it was completed, and according to the appropriate seasonal timing. Surface drainage of the hill slope to the east will be diverted to the existing gullies by the provision of bund walls. Therefore, the water flows in the gullies during rainfall events will be virtually unchanged. The commitments on rehabilitation for Stage I (Scree Mining) and Stage II remain. Reporting will continue as required in accordance with the requirements of the McCameys Agreement Act	

Reference	Applicable Area	Obligation Description	Section
1994 Jimblebar Proposal for the Development of Wheelarra Hill Iron Ore	Jimblebar Wheelarra Hill Scree W3 to W6 (formerly Ferro Gully) & Wheelarra 4 Bedrock	**Overburden** The overburden from the bedrock pit will be backfilled into mined out scree or bedrock areas where practicable. If no mined-out areas are available for backfilling, the overburden will be hauled to nominated storage areas where it will be formed to blend with the surrounds and rehabilitated.	Executive Summary Section 3.3
		Fines will be returned to mined out areas where possible or alternatively it will be placed into storage areas where it will be formed to blend with the surrounds and rehabilitated.	Section 3.3
		Overburden will be positioned in such a way so that the naturally occurring water courses will not be obstructed. All exposed areas will be rehabilitated	Section 3.3
		Where practical, the overburden material is backfilled into the existing mined out scree and bedrock pits, and due to the low stripping ratio, these areas can be blended into the existing topography limiting visual impact. The overburden placed into / storage areas will have all exposed faces battered to an angle of 20° or less, appropriately landscaped, dressed with topsoil where available and revegetated.	Sections 3.3 & 8.1
		The overburden storage sites will be designed to be low profile and to blend with the surrounding landforms. The sites will be designed to be stable and to resist erosion. The surface of the overburden will be progressively rehabilitated as specific areas become inactive.	Section 9.5
		Water table No mining will take place below the water table. As a result, there will be no impacts on the local water table or any surface discharges.	Executive Summary & Sections 3.2 & 8.3
		Topsoil Topsoil will first be removed to a depth of 200mm. before the commencement of scree mining in any new area and where possible in the bedrock area. This topsoil will be stored in windrows no higher than 2 metres adjacent to the mining area.	Section 3.3
		Where practicable, topsoil (to a depth of 200 mm) and vegetation on most areas to be disturbed will be stripped and stored for later use in rehabilitation. At the end of mining activities, all areas will be contoured (where necessary), topsoiled (where soil is available) and contour ripped or scalloped. Where necessary, areas will be seeded with a mixture of local species.	Sections 8.7 & 9.1
		Mine void Mining of ore from the W4 bedrock pit will result in the formation of a side hill slope with 12 metre benches, 5 metre berms and a nominal slope of 45°. The vertical height of this slope is around 100 metres and will run for some 1000 metres along the slope. To improve on the visual effects, any accessible benches will be ripped and seeded with native species.	Section 8.1
		Any scree areas that have not been backfilled to the original landform will be left so that the disturbed area is free draining. The slopes will be battered out to an angle no greater than 20° and rehabilitated as for the overburden dumps. Rehabilitation will be monitored to assess success.	Section 8.1
		Rehabilitation The overall object of the Jimblebar rehabilitation programme is to ensure that at the end of the project, disturbed surfaces (with the exception of the mined bedrock pit) are returned to a stable condition with flora approaching that which occurred in the area prior to mining.	Sections 8.7 & 9.12
		BHP Iron Ore will continue research to improve rehabilitation techniques and apply successful procedures as they emerge. BHP Iron Ore will also return to areas that require further remedial work to establish a stable and vegetated landform to the satisfaction of the appropriate regulatory authority.	Section 9.12

Reference	Applicable Area	Obligation Description	Section
1994 Jimblebar Proposal for the Development of Wheelarra Hill Iron Ore continued	*Jimblebar Wheelarra Hill Scree W3 to W6 (formerly Ferro Gully) & Wheelarra 4 Bedrock continued*	BHP Iron Ore feels it is premature at this time to propose completion criteria for rehabilitation areas. The Company is presently undertaking extensive assessments of major rehabilitation programs at Goldsworthy, Koolan Island and Newman. This work is designed to assess various slope stabilisation techniques including scalloping and drainage control through contour drains. A wide range of parameters are being examined which effect the slope stabilisation techniques used on overburden storage areas. These include slope length, slope angle, physical and chemical properties of the overburden as well as rainfall intensity and duration. Additionally, many aspects still need to be researched in connection with mine rehabilitation such as grasses and the merits of using pasture species verses using native grasses in areas that are difficult to stabilise. BHP Iron Ore is committed to this research and will apply successful techniques as they emerge.	Section 8.7
		BHP Iron Ore will return to areas requiring further remedial work to establish a stable and vegetated landform to the satisfaction of the appropriate regulatory authority.	Section 8.7
		Rainfall measurements will be taken in the area to assist in the gauging of the success of rehabilitation.	Section 9.12
		Decommissioning & demolition Following the completion of mining, all buildings and other infrastructure no longer required for other ongoing mining activities will be removed. Concrete slabs will be broken up and buried and the rehabilitation of all disturbed areas will be completed using techniques standard at the time of decommissioning. The rehabilitation of the overburden will be completed. Remaining borrow pits will be rehabilitated. All unwanted bare or compacted areas will be contoured (where necessary), ripped and seeded, Monitoring of the rehabilitated areas will be undertaken to gauge success.	Section 8.7 & 9.13
		Erosion Erosion around roads and building areas will be controlled by minimisation of clearing, rehabilitation, proper drainage and bunding where necessary. Monitoring will take place where disturbance occurs near creek drainage and appropriate silt traps installed where seen as necessary to minimise siltation.	Section 9.4
1999 Proposal for an Extension of Mining at Wheelarra Hill W4 (Jimblebar)	Jimblebar Wheelarra Hill W4	**Groundwater impacts** Mining will not take place below the water table. As a result, there will be no impact on the local water table. An ongoing monitoring program exists for this area, and this will be maintained to detect any significant changes to the hydrologic balance	Executive summary Sections 3.5 & 4.3
		Surface water impacts The proposed Wheelarra Hill W4 mine extension would be primarily inward draining as it is situated on the southern slopes of the Ophthalmia Range. No impact to the surrounding drainage patterns is anticipated. No surface water discharges are planned. An ongoing monitoring program exists for this area, and this will be maintained to detect any significant changes to the hydrologic balance	Sections 3.4 & 4.3
		Overburden Approximately 26Mt of overburden is required to be moved for the recovery of the high-grade ore in the pit extension. This material will be placed into storage areas as shown on Figure 2.1. Where possible during the mining programme, overburden will be directly infilled into mined out areas of the pit. The remaining overburden will be placed in an overburden storage area as shown on Figure 2.1. These sites are considered to have least visual and environmental impacts. Overburden placed in storage areas will be profiled to blend with the existing topography, stabilised to resist erosion and · revegetated with native species common to the area. Progressive rehabilitation will occur where possible.	Sections 2.4 & 4.1
		The final pit walls will have benches with a maximum height of 24 metres and 14 metre berms. The final overall slope angle will be between 30° to 45°. At the end of mining, berms within the pit will be rehabilitated.	Section 4.1
		Erosion The rocky soils of the upland areas should not require any special erosion control measures. Drainage lines will be avoided where possible. Adequate sedimentation measures will be provided, if required, to prevent sedimentation of drainage lines downstream of the mine.	Section 4.2

Reference	Applicable Area	Obligation Description	Section
1999 Proposal for an Extension of Mining at Wheelarra Hill W4 (Jimblebar) continued	*Jimblebar Wheelarra Hill W4 continued*	**Waste** Non- toxic solid wastes are disposed in a landfill in the W4 scree pit.	Section 4.6
		Rehabilitation and Decommissioning Following the completion of mining, all buildings and other infrastructure will be removed. Concrete slabs will be broken up and buried and the rehabilitation of disturbed areas will be completed using techniques standard at the time of decommissioning. BHPIO has developed rehabilitation procedures through its experience in the Pilbara region. The overall objective of the rehabilitation program is to return disturbed surfaces to a stable condition, with flora and fauna approaching that which occurred in the area prior to mining. Where available and practicable, topsoil and vegetation are stripped and stored for later use in rehabilitation. At the end of mining activities, areas will be contoured as necessary, topsoiled and surface treated by ripping or other techniques. Where necessary, the area will by seeded with a mixture of local species. To minimise the impact from habitat loss, BHPIO is committed to a policy of minimum disturbance with rehabilitation to occur as soon as practicable following mining. Fauna enhancement techniques may also be utilised in the rehabilitation of this area.	Sections 4.4 & 4.7
		Commitments BHPIO will comply with all existing commitments with respect to the management of environmental impacts and all associated undertakings.	Section 4.8
2005 Wheelarra Hill Extension Project Environmental Protection Statement	Jimblebar Wheelarra Hill W1, W2, W3, W4, W5 & W6	**Groundwater impacts** The proposed open pits are above the groundwater level at the Wheelarra Hill Ridge and as a result no pit dewatering has or would be required. Consequently, no operational or post-closure impacts on the groundwater (i.e., permanent pit lakes and groundwater sinks) are expected in the mine areas.	Executive Summary Sections 1.3.1, 2.4.1 & 3.6.2
		The Groundwater Management Programme would describe how the Jimblebar Wellfield would be developed and operated in a manner that minimises potential impacts on existing and potential beneficial uses during operations and post-closure.	Section 3.6.2
		Soils Once planned land disturbance activities have been authorised, the following specific soil resource management practices are used at the Jimblebar Mine to minimise soil loss through erosion and to maximise the potential for re-using stripped materials in rehabilitation programmes. • Vegetation, topsoil, subsoil materials and other identified suitable growth medium material would be stripped prior to the commencement of mining activities in accordance with procedures described in the Environmental Management Programme (EMP). • Where mine scheduling allows, stripped topsoil and other materials are re-used as quickly as possible by directly transferring them to areas that are being rehabilitated at the time. Where this is not possible, stripped materials are stored in separate stockpiles for later use. The stockpiles (both long and short-term) are constructed and managed in a manner that encourages the continuation of the soil's biological activity. • Where practicable, the storage and reuse of topsoil is conducted in a manner that minimises the potential for significant changes to the structure and chemical properties of the soil, and allows natural soil evolutionary processes to continue once the soil is replaced in rehabilitated areas. • The locations of soil stockpiles are planned so that potential sites for future mine and infrastructure disturbance areas are taken into consideration. • Stockpiles are clearly identified on the relevant site plan and where appropriate, signposted in the field. • Plans and databases that record the location and volume of topsoil and other materials stockpiled are maintained.	Executive Summary Sections 2.4.1 & 3.3.2

Reference	Applicable Area	Obligation Description	Section
2005 Wheelarra Hill Extension Project Environmental Protection Statement continued	*Jimblebar Wheelarra Hill W1, W2, W3, W4, W5 & W6 continued*	The Topsoil Management Manual describes the overall objectives and strategies relating to the four main components of soil management at BHPBIO's Pilbara operations. These components are centred on the following directives: • stripping of soil resources should be to appropriate depths and at appropriate times; • stripped soils should be stockpiled in an appropriate manner; and • appropriate planning should be undertaken so that stripped topsoil can be efficiently and effectively used during rehabilitation.	Section 3.3.2
		Erosion Erosion from cleared areas is managed through the minimisation of land clearing, progressive rehabilitation, and installation of runoff controls where necessary. Water monitoring is undertaken where necessary if land disturbance occurs near creek drainage lines. Sediment reduction controls would continue to be installed downstream of active mine areas, OSAs and other disturbance areas as required in order to minimise the potential for erosive sheet-flow and / or the development of gullies.	Executive Summary, Sections 3.3.2 & 3.5.2
		Mine void The project would lower the height of sections of the Wheelarra Hill by up to 150 m. In particular the W1 and W3 pits would alter the shape and height of McCamey's Monster and Wheelarra Hill.	Executive Summary
		Residual pit voids would be left as run-of-mine (ROM) where geotechnically stable.	Section 6.3.2
		Once mining in the detrital mining areas is completed, the voids would be reprofiled and smoothed to blend in with the adjoining unmined areas.	Section 3.4.2
		At the completion of the Project the perimeter of the final voids would be bunded to a height of 2 m to prevent unauthorised access in accordance with the DOIR guideline Safety Bunds Around Abandoned Open Pit Mines (DME, 1997).	Section 6.3.4
		Overburden The DRP describes how BHPBIO would: • Design final landforms (e.g., OSAs) to blend in with the surrounding hills and be similar to existing regional landforms, within the constraints imposed by the physical nature of the materials. • Develop low energy, shallow slopes that are consistent with the surrounding naturally occurring landforms. • Minimise disturbance footprints (number and size of ex-pit OSAs) by storing overburden within the open pits where possible. • Define drainage routes on final landforms to minimise impacts from surface water and erosion. • Create climax vegetation that is generally similar to surrounding areas (local native vegetation suitable to the characteristics of the area).	Sections 6.1.2 & 6.3.2
		The following environmental considerations have been incorporated into the conceptual designs of the Project out-of-pit OSAs: • minimisation of additional land disturbance; • creation of stable final landforms that incorporate appropriate surface water controls to maximise infiltration and minimise runoff; • construction of the final landforms in a manner that integrates with the local topography, minimises impacts on visual amenity and is compatible with natural landforms found in the Wheelarra Hill area; and • effective use of soil resources and appropriate revegetation strategies.	Section 2.4.1
		The location and design of infrastructure and mine landforms are and would be optimised throughout the mine planning process to ensure that environmental impacts are minimised.	Executive summary
		Out-of-pit OSAs would be designed and constructed to be stable, have a maximum height that is not greater than the natural escarpment features, and have a final rehabilitated profile that is compatible with the surrounding naturally occurring landforms. The final landforms would retain the key features of the existing landforms (i.e., low rise, rounded hills) to minimise visual impacts and resemble the naturally occurring hills that occur in the area. Vegetation communities would be consistent with local native vegetation.	Executive Summary Sections 2.4.1, 3.4.2 & 6.5

Reference	Applicable Area	Obligation Description	Section
2005 Wheelarra Hill Extension Project Environmental Protection Statement continued	*Jimblebar Wheelarra Hill W1, W2, W3, W4, W5 & W6 continued*	Rehabilitation and mine closure requirements would be integrated with mine planning during the life of the Project. Landforms such as the proposed OSAs and detrital mining areas would be designed with due consideration of the current DOIR guidelines (DME, 1996; EA, 1998; MCA, 1998). OSAs would be designed to blend in with the surrounding landforms. It is not proposed to modify the slopes of final voids. *Guidelines* *Slope, rock type, slope length and rainfall generally determine the physical stability of mine landforms. The current DOIR [DME] guidelines recommend slopes of no greater than 200 with back sloped benches 4 to 5 m wide every 7 to 10 m of vertical height. Properly constructed and revegetated, the final surface should be self-sustaining and able to resist the natural force of erosion.* *In arid areas where mine waste dumps are constructed of competent (non-erosive) rock, steeper slopes may be used (MCA, 1998; EA, 1998).*	Section 6.3.1
		Earthworks would be used to re-profile the final batters. This would generally involve pushing down the individual batters as required (i.e., minor cut and fill) to produce an overall final slope of approximately 15°. Prior to re-profiling of batter slopes the berms would be approximately 30 m wide. Re-profiling of the batters would reduce the final width of the berms or remove them completely depending on their original size and the final length of slope. Drainage channels would be established on berms where concentrated runoff is expected and would be armoured with oversize material (+300 mm). Stockpiled topsoil and subsoil materials would be used where available to cover the top surface and/or batters of the OSAs. Deep ripping would be used where appropriate. Seeding with local native seed mixes would be undertaken on prepared rehabilitation surfaces. The species mix would aim to be consistent with vegetation associations found in the equivalent pre-mining area and would be selected in consultation with CALM. Species selection would consider the impacts of climate change on rehabilitation.	Section 6.3.3
		BHPBIO would evaluate options for reducing the area of disturbance by infilling previously mined pits and using existing OSAs. Where mine scheduling allows, overburden and/or fines from the scree deposits would continue to be used to partially infill the mined-out pits or continued placement of in existing W4 OSAs plus new OSAs located adjacent to the new W1, W2, W3, W5 and W6 pits.	Section 1.3.1, Section 1.6.2 (Table 1-2), 2.4.1
		The additional overburden materials that would be generated by the Project are from the same rock units that are currently being mined at the W4 deposit and are expected to have similar inert geochemical characteristics. No potentially acid forming (PAF) material (i.e., pyritic shale) has been mined at the Jimblebar Mine to date, and the exploration programme for the Project has not intersected any in the proposed mining areas. Notwithstanding, BHPBIO would continue to periodically review the acid forming potential of overburden materials during the life of the mine. In the event that potentially acid forming (PAF) materials are identified through exploration or waste classification programmes, management procedures would be developed and implemented to minimise potential impacts.	Section 1.6.2 (Table 1-2), 2.4.1
		The new out-of-pit OSAs would be constructed in existing valleys and on the slopes of the Wheelarra Hill ridge rather than new standalone emplacements on the valley floor. They would be predominantly located on the northern side of the range where the natural topography is more dissected and where the visual impact of the final landforms is likely to be less due to the restricted number of access tracks in this area. Notwithstanding, the OSAs would be designed to have final slopes and shapes that are compatible with the surrounding naturally occurring landforms.	Section 3.4.2
		Long-term visual impacts would be minimized through the rehabilitation of the slopes and top surfaces of the OSAs with local native plant species which would soften the overall effect of the land disturbance	Section 3.4.2
		Decommissioning and demolition Mine infrastructure areas (e.g., access tracks, borrow pits, topsoil stockpiles, buildings, etc.) that are no longer required would be decommissioned and removed (unless otherwise agreed with the administering authority), and the disturbed area re-contoured to blend with the surrounding topography, topsoiled, contour ripped (or equivalent) in preparation for seeding with local native species as necessary.	Executive Summary Section 3.4.2

Reference	Applicable Area	Obligation Description	Section
2005 Wheelarra Hill Extension Project Environmental Protection Statement continued	*Jimblebar Wheelarra Hill W1, W2, W3, W4, W5 & W6 continued*	Rehabilitation works would include: • Application of local native seeds. • Erection of sediment fences to reduce potential migration of sediments.	Section 6.3.5
		Surface water impacts The project would not directly affect any named surface water courses or water bodies. However, mining has the potential to result in localised impacts on surface water by changing local flow patterns (e.g., from construction of pits & OSAs) or by affecting surface water quality as a result of erosion.	Executive Summary Section 3.5.2
		The size of mine landforms and infrastructure areas would be restricted to the practicable minimum in order to minimise potential impacts on ephemeral flows within the localised gullies and minor drainage lines that drain from the Wheelarra Hill ridge.	Executive Summary Section 3.5.2
		Rehabilitation BHPBIO would undertake progressive and appropriate rehabilitation of areas disturbed by the Project. BHPBIO's principle rehabilitation objective is to rehabilitate sites as close as possible to their original state in order to minimise long term environmental impacts.	Sections 4.1.2, 6.1 & 6.3.1
		Weed management Specific management measures that would be undertaken at the Project to minimise the potential for the spread of the five previously recorded weed species (plus other species that may be introduced in the future) are listed below. • Areas of known weed infestation would be shown on mine plans and marked on the ground in order to minimise the potential for inadvertent access and spread of weeds. • Mobile machinery and equipment would be cleaned on a regular basis, with particular attention being given to machinery that operates in areas of known weed infestation. • Topsoil that is stripped from areas known to be infested with weeds would be treated before use. • Regular inspections for the presence of weeds within areas of disturbance would be conducted. • Treatment programmes for weed infested areas would be developed and implemented in consultation with CALM. These programmes may include, but are not restricted to, the application of herbicides and pre-emergent treatments.	Executive Summary Section 3.7.2
		As part of a weed management initiative for all of its Pilbara mining operations, and in order to address the site-specific recommendation made by ecologia (2004a), BHPBIO has developed a Weed Control Work Instruction to provide guidance for the management of particular weed species that are currently problematic or have the potential to be problematic at some of its mine sites. The work instruction is subject to periodic review. It currently provides guidance for managing Ruby Dock (*Acetosa vesicarius*) and Kapok (*Aerva javanica*).	Section 3.7.2
		Fauna Cleared vegetation would be stockpiled for re-use during rehabilitation. Areas would be rehabilitated in a manner that encourages the return of fauna species through the provision of habitat, shelter and food sources.	Executive Summary
		BHPBIO's overall guiding principles for managing the potential impacts of its Pilbara operations on fauna are documented in its Land Management Manual (BHPBIO, 2003b) and include the following: • fauna monitoring sites should be established during operations; and • the return of fauna to rehabilitated areas should be promoted.	Section 3.8.2
		Should any Declared' feral species listed under the *Agriculture and Related Resources* Protection Act, 1976 be identified in the Project area during the mine life, suitable control measures would be developed in consultation with CALM to eradicate, reduce or contain the species.	Executive Summary Section 3.8.2

Reference	Applicable Area	Obligation Description	Section
2005 Wheelarra Hill Extension Project Environmental Protection Statement continued	*Jimblebar Wheelarra Hill W1, W2, W3, W4, W5 & W6 continued*	**Post mining land use** While the post mining land use is likely to revert to low intensity grazing on the underlying Pastoral Lease, the land would be rehabilitated to bushland and may also have significant nature conservation values. It is envisaged that the final land use of the mine area would not conflict with those values. However, this would be determined in consultation with stakeholders, and approved by the administering authority during the life of the mine.	Sections 6.3.2, 6.5
		Completion criteria BHPBIO's Land Management Manual (BHPBIO, 2003b) describes a number of broad completion criteria which are applied to the rehabilitation of the BHPBIO's mine sites including: • No significant, physical off-site impacts. • Post-mining landform should be geotechnically stable and responsive to erosion agents in a similar manner to naturally occurring landforms. • Surface water quality should fall within guidelines for specific-end land use (e.g., stock watering requirements). • Established vegetative cover should be self-sustaining and similar to the surrounding undisturbed vegetation in terms. • Landforms remaining after mining should be consistent with others in the region.	Section 6.1.1
		Environmental monitoring Environmental monitoring results (water quality, flora, fauna, erosion, etc.) would be assessed on an ongoing basis and the findings used to refine the design of subsequent OSAs. This approach would facilitate adaptive management and continuous improvement in mine planning.	Section 3.4.2
		BHPBIO would progressively develop and implement its rehabilitation monitoring programmes with the objective of evaluating the performance of rehabilitated mine landforms to assess whether they have met its guiding closure principles or are showing satisfactory progress towards meeting these principles. It is expected that the following areas would be monitored during the life of the Project: • biological processes in rehabilitated areas (flora and fauna), including weeds; • surface water quality and flows within the area; • groundwater levels and quality in the underlying aquifer; • public safety; • off-site impacts; and • stability of mine landforms.	Section 6.4
		During the life of the mine, additional flora and fauna monitoring locations would be established on rehabilitated landforms and in undisturbed areas as required. Biological monitoring results would be recorded every five years (monitoring may be more frequent depending on environmental conditions). Ecosystem Function Analysis (EFA) or an equivalent long-term systems-based monitoring approach would be used to track the trajectory of rehabilitated areas towards self-sustaining status.	Sections 6.3.2, 6.4
		The condition of safety bunds erected around the perimeter of final voids would be inspected on a regular basis. Bund maintenance would be performed as required.	Section 6.4
		Rehabilitated landforms would be inspected after significant rainfall to assess stability and to monitor for areas where unacceptable erosion has occurred. Where necessary, maintenance works would be performed to improve performance.	Section 6.4
		Monitoring of surface water quality and quantity occurs at Jimblebar Creek and Copper Creek. As mining moves to other areas on the lease, the surface water monitoring locations would be reviewed and revised with additional sites being installed as necessary.	Section 7.4

Reference	Applicable Area	Obligation Description	Section
2005 Wheelarra Hill Extension Project Environmental Protection Statement continued	*Jimblebar Wheelarra Hill W1, W2, W3, W4, W5 & W6 continued*	The groundwater monitoring locations would be reviewed and revised as the Project mining footprint moves further to the east and west of the current mining area.	Section 7.4
		A weather station, located in the vicinity of the administration buildings, was established at the Jimblebar Mine in 2000. Parameters recorded include temperature, wind direction, wind speed and rainfall. These would continue to be recorded for the life of the Project.	Section 7.4
		Fauna monitoring would be conducted in rehabilitated areas, and where required, as part of species-specific management plans/programmes for fauna of conservation significance (as agreed with CALM).	Section 7.4
State Agreement Proposal 2005	Jimblebar Wheelarra 3	4.3 Environmental impacts and Management Where practicable, topsoil and other identified suitable growth medium material (e.g., alluvial and gravel material from creek beds) are stripped prior to the commencement of mining activities. Where mine scheduling allows, stripped topsoil and other materials are applied to areas being rehabilitated. Where this is not possible, stripped materials are stored in separate stockpiles for later use. Where necessary, drainage features such as cut-off drains are to be incorporated onto the tops of cuts to stop water running down the sides and causing erosion. The Decommissioning and Final Rehabilitation Plan (DRFP) will be reviewed at intervals of no more than 5 years during operations. The DFRP will be prepared in consultation with and to the requirements of agencies including DoIR. The plan will detail specific management plans and final void strategies and will be made available for stakeholder review and comment as part of the EPS environmental approval process under Part IV of the EP Act. A plan will be developed and implemented which addresses rehabilitation during the mining phases. It will outline how disturbed areas will be rehabilitated and will consider future decommissioning alternatives. Where possible, areas of disturbance will be progressively rehabilitated as they become available. Further disturbance to these areas will not be permitted without the approval of the Environmental Department. All mine infrastructure areas (e.g., access tracks, borrow pits, topsoil stockpiles, buildings etc.) will be re- contoured to blend with the surrounding topography, top soiled, contour ripped (or equivalent) in preparation for seeding with native species as necessary. Infilling of mined out pits will be undertaken, where practical. An overburden storage plan for any new OSA is developed and incorporated into the life of mine plan prior to the commencement of out-of-pit dumping activities. All overburden placement in the new OSAs is undertaken in accordance with this plan. OSAs are constructed in a manner that is sympathetic with the surrounding landforms and consistent with rehabilitation objectives. The OSAs are managed to minimise the effect on surface water quality consistent with regulatory requirements. Materials are to be selected and drainage designed to minimise erosion of cuts and fills. Materials that have a low resistance to erosion are generally not used in fill batters. The OSAs will be constructed to be stable, and surfaces will be battered to an angle of 20° or less. Topsoil, where available, will be replaced and the surface shaped for water harvesting and stability. If necessary, seeding using local species will occur. With respect to the mined pit, seeding of the berms will be undertaken to minimise the remaining visual impact. Research will be undertaken to continually improve rehabilitation techniques. The object of the rehabilitation will be to ensure that, at the end of the project, all disturbed surfaces are returned to a stable condition with a flora and fauna which approaches the natural condition of the site.	

Reference	Applicable Area	Obligation Description	Section
2009 Wheelarra Hill Mine Modification ARI	Jimblebar rail spur, rail loop, train load-out, ore handling plant (OHP), overland conveyor, Wheelarra Hill W1, W2, W3, W4, W5, and W6	**Guiding principles** The Guiding Closure Principles would also remain the same: • [There will be no significant, physical off-site impacts. • Baseline surface water quality and flow regimes in Copper Creek and Jimblebar Creek will be maintained. • The established vegetative cover will be self-sustaining and show progression towards the surrounding undisturbed vegetation in terms of species diversity and plant density. • The post-mining landform will be stable and respond to erosive forces in a similar manner to equivalent naturally occurring landforms composed of similar rock types. • There will be no unsafe areas where members of the general public could inadvertently gain access. Access to potentially unsafe areas will be impeded by safety bunds built to comply with the applicable DMP guidelines. • Future mine plans will examine opportunities to minimise the number and size of out-of-pit OSAs and changes to the water flow pattern by increasing the amount of overburden material used to infill final voids as void areas become available and/or as resources are mined out. • Residual pit voids will be left as run-of-mine (ROM) where geotechnically stable and profiled as necessary to achieve long-term closure objectives. • Final landform designs will be similar to the existing regional landforms, within the constraints imposed by the physical nature of the materials. • Revegetation of mine landforms will aim to establish local native vegetation appropriate for the area. • Ecosystem Function Analysis (EFA) or an equivalent long-term systems-based monitoring approach will be used to track the trajectory of rehabilitated areas towards self-sustaining status. • The end land use for the area will be determined in consultation with stakeholders and agreed with the administering authority ongoing during the life of the mine.]	Section 3.1
		Decommissioning & demolition All mine infrastructure areas (e.g., access tracks, borrow pits, topsoil stockpiles, buildings, etc.) that are no longer required would be decommissioned and removed (unless otherwise agreed with the administering authority), and the disturbed area re-contoured to blend with the surrounding topography, topsoiled, contour ripped (or equivalent) in preparation for seeding with native species as necessary.	Section 3.3.1
		Borrow pits Borrow pits used for the construction-related activities will be designed so that they are self-draining on completion.	Section 3.3.1
		Topsoil Where practicable, topsoil and other identified suitable growth medium materials would be stripped prior to the construction of infrastructure. Where mine scheduling allows, stripped topsoil and other materials would be directly applied to areas being rehabilitated. Where this is not possible, stripped materials would be stored in separate stockpiles for later use. The stockpiles (both long and short-term) would be constructed and managed in a manner that encourages the continuation of the soil's biological activity. Where practicable, the storage and reuse of topsoil would be conducted in a manner that minimises the potential for significant changes to the structure and chemical properties of the soil and allows natural soil evolutionary processes to continue once the soil is replaced in rehabilitated areas.	Section 3.3.2
		Erosion Erosion from cleared areas would be managed through the minimisation of land clearing, progressive rehabilitation and installation of runoff controls where necessary.	Section 3.3.2

Reference	Applicable Area	Obligation Description	Section
2009 Wheelarra Hill Mine Modification ARI continued	*Jimblebar rail spur, rail loop, train load-out, ore handling plant (OHP), overland conveyor, Wheelarra Hill W1, W2, W3, W4, W5, and W6 continued*	**Weeds** Management measures that would be undertaken to minimise the potential for the spread of weed species include the following: • Areas of known weed infestation would be shown on mine plans and marked on the ground in order to minimise the potential for inadvertent access and spread of weeds. • Mobile machinery and equipment would be cleaned on a regular basis, with particular attention being given to machinery that operates in areas of known weed infestation. • Regular inspections for the presence of weeds within areas of disturbance would be conducted.	Section 3.2.1
		Surface water impacts The DFRP describes the Guiding Closure Principles and design of final mine landforms, which aim to maintain water quality and flow regimes in Copper Creek. Guiding Closure Principles relevant to the proposed modification include: • There will be no significant, physical off-site impacts. • Baseline surface water quality and flow regimes in Copper Creek and Jimblebar Creek will be maintained. The final designs of rehabilitated landforms take into account the hydrological effects of the infrequent, high intensity rainfall events that occur in the area. The Guiding Closure Principles and design of final landforms described in the DFRP would be implemented for the proposed modification.	Section 3.2.5
2009 Jimblebar Hub Mining Proposal L52/108 and L52/109	Jimblebar train load-out, rail loop, rail spur and associated infrastructure	**Guiding principles** BHPBIO would adopt the following Guiding Closure Principles for the proposed Project: • There will be no significant, physical off-site impacts. • Baseline surface water quality and flow regimes in Copper Creek and Jimblebar Creek will be maintained. • The established vegetative cover will be self-sustaining and show progression towards the surrounding undisturbed vegetation in terms of species diversity and plant density. • The post-mining landform will be stable and respond to erosive forces in a similar manner to equivalent naturally occurring landforms composed of similar rock types. • There will be no unsafe areas where members of the general public could inadvertently gain access. Access to potentially unsafe areas will be impeded by safety bunds built to comply with the applicable DMP guidelines. • Future mine plans will examine opportunities to minimise the number and size of out-of-pit OSAs and changes to the water flow pattern by increasing the amount of overburden material used to infill final voids as void areas become available and/or as resources are mined out. • Residual pit voids will be left as run-of-mine (ROM) where geotechnically stable and profiled as necessary to achieve long-term closure objectives. • Final landform designs will be similar to the existing regional landforms, within the constraints imposed by the physical nature of the materials. • Revegetation of mine landforms will aim to establish local native vegetation appropriate for the area. • Ecosystem Function Analysis (EFA) or an equivalent long-term systems-based monitoring approach will be used to track the trajectory of rehabilitated areas towards self-sustaining status. • The end land use for the area will be determined in consultation with stakeholders and agreed with the administering authority ongoing during the life of the mine.	Section 6.1

Reference	Applicable Area	Obligation Description	Section
2009 Jimblebar Hub Mining Proposal L52/108 and L52/109 continued	*Jimblebar train load-out, rail loop, rail spur and associated infrastructure continued*	**Decommissioning & demolition** All infrastructure areas (e.g., access tracks, borrow pits, topsoil stockpiles, buildings, etc.) that are no longer required would be decommissioned, and the disturbed area re-contoured to blend with the surrounding topography, topsoiled, contour ripped (or equivalent) in preparation for seeding with native species as necessary.	Section 5.3
		Rehabilitation Where disturbance is unavoidable, it is undertaken in a manner which uses rehabilitation to promote the natural return of vegetation and fauna consistent with agreed closure criteria and commitments.	Section 4.7
		Erosion from cleared areas would be managed through the minimisation of land clearing, progressive rehabilitation and installation of runoff controls where necessary.	Section 4.7
		BHPBIO has developed and implemented standard rehabilitation procedures for 'Earthworks', 'Surface Treatments' and 'Revegetation'. Rehabilitation and revegetation of final mine landforms and infrastructure and support facilities will be conducted in accordance with these procedures, which are described in the PRMP	Section 6.2
		Topsoil Where practicable, topsoil and other identified suitable growth medium materials would be stripped prior to the construction of infrastructure.	Section 4.7
		Where construction scheduling allows, stripped topsoil and other materials would be directly applied to areas being rehabilitated. Where this is not possible, stripped materials would be stored in separate stockpiles for later use. The stockpiles (both long and short-term) would be constructed and managed in a manner that encourages the continuation of the soil's biological activity. Where practicable, the storage and reuse of topsoil would be conducted in a manner that minimises the potential for significant changes to the structure and chemical properties of the soil and allows natural soil evolutionary processes to continue once the soil is replaced in rehabilitated areas.	Section 4.7
		Weeds Management measures that would be undertaken to minimise the potential for the spread of weed species are described in the Weed MP (Appendix E) and would include the following: • Areas of known weed infestation would be shown on mine plans and marked on the ground in order to minimise the potential for inadvertent access and spread of weeds. • Mobile machinery and equipment would be cleaned on a regular basis, with particular attention being given to machinery that operates in areas of known weed infestation. • Regular inspections for the presence of weeds within areas of disturbance would be conducted.	Section 4.1
		Post-mining land use The post-mining land use would be determined through on-going consultation with the administering authority and relevant stakeholders during the remaining life of the mining operations. Notwithstanding, the most likely final land use for the lease areas would be low intensity cattle grazing (which is the current land use for areas not directly affected by mining activities).	Section 6.4
		Monitoring Fauna activity on rehabilitated sites would be monitored in accordance with the EMP	Section 6.6.2
		Weed monitoring and control would be conducted in accordance with the Weed MP.	Section 6.6.3
		Rehabilitated landforms would be inspected after significant rainfall to assess stability and to monitor for areas where unacceptable erosion has occurred. Where necessary, maintenance works would be performed to improve performance.	Section 6.6.4

Reference	Applicable Area	Obligation Description	Section
2010 Jimblebar Iron Ore Project EPS	Wheelarra Hill, South Jimblebar (SJ West, SJ Central, SJ East); and Hashimoto (H1 West, H1 East; H2; H3; and H4).	**Guiding principles** The guiding closure principles for the Project include the following: • There will be no significant, physical off-site impacts. • The established vegetative cover will be self-sustaining and show progression towards the surrounding undisturbed vegetation in terms of species and plant diversity. • The post-mining landform will be stable and respond to erosive forces in a similar manner to equivalent naturally occurring landforms composed of similar rock types. • Mine plans will examine opportunities to minimise the number and size of out-of-pit OSAs and changes to the water flow pattern by increasing the amount of overburden material used to infill final voids as void areas become available and/or as resources are mined out. • The batters of residual pit voids will be left where geotechnically stable, or re-profiled as necessary to achieve long-term closure objectives. • Final landform designs would be similar to existing regional landforms, within the constraints imposed by the physical nature of the materials. • Re-vegetation of mine landforms would establish local native vegetation suitable to the characteristics of the area. • Ecosystem Function Analysis (EFA) or an equivalent long-term systems-based monitoring approach would be used to track the trajectory of rehabilitated areas towards self-sustaining status. • The end land use for the area will be determined in consultation with stakeholders and agreed with the administering authority ongoing during the life of the mine.	Section 5.1
		Surface water management infrastructure Surface water control measures would be installed during the Project life to manage the flow of water off and around the OSAs and pits during operations and post-closure.	Section 4.3.2
		The proposed Project would require temporary and/or permanent diversion of sections of Jimblebar Creek and Copper Creek. The permanent creek diversions would be designed to continue to operate after mine closure and would therefore be designed to have equivalent sediment transport capacity and transport rates under conditions comparable to those experienced in the existing creek sections. Similar natural processes of erosion (i.e., bed loss and loss of fringing vegetation during large flood events) are also expected to continue. The permanent creek diversions would be designed so that their overall integrity would be maintained during flow events.	Executive summary Section 3.4.5
		Alluvial and bank soil material would be recovered separately and used in the permanent diversions to replicate the existing creek ecosystems. It is expected that this material would contain both organic matter and seeds, which would germinate and grow once placed in the appropriate part of the diversion system. In addition, it is expected that surface water flows through the permanent diversion would deposit new sediment, organic matter and seeds transported from upstream areas. The actual location and design of the creek diversions associated with South Jimblebar deposit would be subject to mine planning, feasibility studies and monitoring of key hydrogeological characteristics prior to construction.	Executive summary Sections 3.4.5, 4.3.3, 4.6.2
		Sediment control measures would be designed and implemented on major watercourses downstream of active mine areas, OSAs and other disturbance areas as required in order to minimise the potential for erosive sheet-flow and/or the development of gullies.	Section 4.3.3
		Mine voids The proposed open pits would create permanent excavations which would cause localised effects on visual amenity and surface water drainage paths (i.e., the final profile of the Wheelarra Hill ridge when viewed from a distance would include new stepped features where the final pit walls are visible in profile). The South Jimblebar pits are likely to be much less visible from a distance as the existing topography is considerably lower and less pronounced.	Section 4.3.2

Reference	Applicable Area	Obligation Description	Section
2010 Jimblebar Iron Ore Project EPS continued	*Wheelarra Hill, South Jimblebar (SJ West, SJ Central, SJ East); and Hashimoto (H1 West, H1 East; H2; H3; and H4) continued*	Residual batters in the pit voids would be left as run-of-mine (ROM) where geotechnically stable and profiled as necessary to achieve long-term closure objectives.	Section 4.3.3
		The final voids at Wheelarra Hill and Hashimoto that extend below the water table are not proposed to be backfilled, although BHPBIO may infill these areas and/or other parts of the pits where mine scheduling allows.	Section 1.6.2 (Table 1-3), 3.5.1, 4.3.2
		BHPBIO is planning to conduct further feasibility and groundwater assessments of post-closure options for South Jimblebar, including the option of not backfilling all or parts of the South Jimblebar pits to above the pre-mining water table. The South Jimblebar pit infill evaluation would be used to evaluate whether leaving the South Jimblebar pits open below the water table would have a significant post-closure impact on the beneficial use of groundwater resources and/or other relevant environmental values in the Project area and surrounds. The results of the South Jimblebar pit infill evaluation would be incorporated into a revised DFRP to be prepared to the satisfaction of the DMP and DEC within 5 years of Project approval if no backfill option is to be used at South Jimblebar. BHPBIO has included in this EPS (i.e., Proponent Commitment No. 8) a commitment to undertake the South Jimblebar pit infill evaluation, and if the results indicate that beneficial use and relevant environmental values will be significantly impacted, a new revision of the DFRP will be prepared which describes how the South Jimblebar pits will be rehabilitated and closed with backfilling to at least two metres above the pre-mining water table.	Executive summary Section 1.6.2 (Table 1-3), 3.5.1, 4.3.2, 4.5.3, 5.1
		Overburden In the 2005 and 2006, BHPBIO conducted studies across its WA Iron Ore operations to assess the physical and chemical nature, and susceptibility to erosion of waste and topsoil materials. Similar studies would be carried out during the life of the Project to characterise the overburden and topsoil materials from the South Jimblebar and Hashimoto deposits and to enable BHPBIO to use them effectively for rehabilitation within their natural physical and chemical constraints.	Section 4.12.1
		BHPBIO would continue to periodically review the acid forming potential of overburden materials during the life of the mine. In the event that PAF materials from the Mt McRae Shale are identified within the planned pit areas through exploration or waste classification programmes, management procedures would be developed and implemented to minimise potential impacts.	Section 3.5.2
		BHPBIO recognises the opportunity to conduct further study into the geochemical nature of the Marra Mamba ore type and waste rock in the South Jimblebar deposit, and in particular studies to investigate the potential for metals and metalloids to accumulate in final mine void lakes that may form post-closure at South Jimblebar. BHPBIO proposes to conduct a study in parallel with mining activities at Jimblebar that includes geochemical modelling and leachate testing as part of the South Jimblebar Pit Infill and Mine Closure Evaluation. The scope of this study will be developed with technical input from DEC to ensure the study delivers the outcome required. These studies would be extended and applied to other BHPBIO Marra Mamba deposits in the Pilbara.	Section 1.6.2 (Table 1-3), 3.5.2, 4.2.2
		BHPBIO would develop and implement management measures for PAF material if it is to be mined (i.e., if Mt McRae Shale, Nammuldi member or Roy Hill Shale material with a sulphur content equal or greater than 0.5% is intercepted during exploration or pit definition drilling for the Wheelarra Hill, Hashimoto or South Jimblebar deposits and the material is within the pit boundaries). The measures may include, but are not necessarily limited to: • further analysis of acid forming potential (e.g., static acid base account test work, Net Acid Generation [NAG] test work, kinetic test work); • operational procedures that would be used to identify PAF material during mining operations; • operational procedures for selectively mining and transferring the PAF material to nominated encapsulation areas; • operational procedures for encapsulating and rehabilitating the PAF material, and • monitoring and reporting measures that would be used to control implementation of the plan.	Section 4.2.2

Reference	Applicable Area	Obligation Description	Section
2010 Jimblebar Iron Ore Project EPS continued	*Wheelarra Hill, South Jimblebar (SJ West, SJ Central, SJ East); and Hashimoto (H1 West, H1 East; H2; H3; and H4) continued*	Specific control measures for the management of fibrous material mined from the South Jimblebar deposits will be incorporated into the revised version of the EMP. These measures pertain to the identification and delineation of fibrous material within South Jimblebar deposit; procedures for entering and existing areas where fibrous material has been identified; requirements for drilling, blasting and mining within designated fibrous material areas; and disposal methods for mined fibrous materials.	Section 4.2.2
		Overburden would be placed in out-of-pit OSAs and would be used to backfill mined-out pits where mine scheduling allows.	Section 3.5.1
		The life of mine planning approach has been developed and implemented to allow a degree of flexibility in the final siting of mine landforms such as OSAs, as long as they are constructed within the area defined by the nominated 'Maximum Disturbance Boundary', and they are rehabilitated in a manner that satisfies agreed 'Guiding Closure Principles'.	Section 3.3
		An overburden storage construction plan for new OSAs would be developed and incorporated into the life of mine plan prior to the commencement of out-of-pit dumping activities. All overburden placement in the new OSAs would be undertaken in accordance with this plan.	Section 4.3.3
		Materials would be selected, and drainage designed to minimise erosion from mine landforms and from cuts and fill areas associated with mine infrastructure (e.g., Primary Crusher pads and railway embankments). Overburden materials that have a low resistance to erosion would be identified and would generally not be used on outer slope batters.	Section 4.3.3
		BHPBIO intends to adopt this approach of determining OSA lift heights on a case by case basis at the Jimblebar Project. The new OSAs would generally be constructed in 10 to 20 m high lifts, with angle of repose batters and wide berms. As sections of the dumps are completed the batters would be progressively re-shaped (i.e., flattened) to their final angle (ideally between 15° and 18°) prior to them being revegetated. The final heights of these OSAs would range from approximately 30 m to 80 m above the existing ground level when viewed from south of M266SA. These OSAs would represent permanent new landform features in the local environment, and post-closure they would ultimately appear as flat-topped mesas vegetated with local plant species.	Section 1.6.2 (Table 1-3), 4.3.2
		Where necessary, drainage features such as cut-off drains and bunds would be incorporated onto the tops of cuts and dumps to prevent water filtering down the sides of drains/bunds and causing erosion.	Section 4.3.3
		The rehabilitated OSAs associated with the Wheelarra Hill and Hashimoto H1 deposits would be designed to integrate and blend in with the Wheelarra Hill ridge as much as practicable, and would be consistent with the relevant Guiding Closure Principles	Section 4.3.3
		The rehabilitated out-of-pit OSAs associated with the South Jimblebar deposit and the Hashimoto H2/H3/H4 deposits would be designed as standalone 'new' mine landforms that would be rehabilitated to resemble flat-topped mesa-like landforms on the adjoining plains.	Section 4.3.3
		The following visual impact management measures would be implemented where appropriate: • designing OSAs to integrate and blend in with the surrounding topography; • progressive rehabilitation of mine landforms; • visual screens using vegetation and/or earth and rock bunds;	Section 4.3.3
		Topsoil Prior to ground disturbance works, vegetation, topsoil and other identified suitable growth medium material (e.g., subsoil, and deeper alluvial and gravel material from drainage line areas) would be stripped, where practicable (i.e., subject to the operating constraints of the equipment used), and either temporarily stored separately in nearby stockpiles or used immediately in the rehabilitation programme. Temporary soil stockpiles would be located adjacent to the disturbance areas and would be separated into the major topsoil types.	Section 3.4.2, 4.12.3
		Where mine scheduling allows, stripped topsoil, subsoil and other materials would be applied to areas being rehabilitated. Where this is not possible, stripped materials would be stored in separate stockpiles for later use. The stockpiles (both long and short-term) would be constructed and managed in a manner that encourages the continuation of the soil's biological activity.	Section 4.12.3

Reference	Applicable Area	Obligation Description	Section
2010 Jimblebar Iron Ore Project EPS continued	*Wheelarra Hill, South Jimblebar (SJ West, SJ Central, SJ East); and Hashimoto (H1 West, H1 East; H2; H3; and H4) continued*	Topsoil details will be recorded and stored in a central database or spreadsheet. Locations of topsoil storage stockpiles would be recorded on BHPBIO's GIS System Regular inspections would be undertaken to assess erosion and sediment migration from topsoil stockpiles. Where unacceptable rates of erosion are identified, remedial works would be undertaken, or the stockpile will be relocated. The management measures provided above would be used throughout the life of the Project in order to minimise potential impacts on soil resources.	Section 4.12.3
		Stockpile heights would be kept as low as practicable (i.e., less than 2 m in height) to maintain biological activity and viable seed reserves. Stockpiles would be seeded as soon as practicable following deposition and would preferentially be deposited by trucks rather than scrapers. Subsoil would be stockpiled separately to topsoil	Section 4.12.3
		Weeds Management measures that would be undertaken to minimise the potential for the spread of weed species include the following: • Areas of known weed infestation would be shown on mine plans and marked on the ground in order to minimise the potential for inadvertent access and spread of weeds. • Mobile machinery and equipment would be cleaned on a regular basis, with particular attention being given to machinery that operates in areas of known weed infestation. • Regular inspections for the presence of weeds within areas of disturbance would be conducted.	Section 4.6.3
		Fauna BHPBIO's overall guiding principles for managing the potential impacts of its WA Iron Ore operations include "the return of fauna to rehabilitated areas should be promoted".	Section 4.7.3
		Rehabilitation Progressive rehabilitation of OSAs and infill areas as they become available	Section 3.3 (Table 3-3)
		All employees and contractors involved in establishing and rehabilitating borrow pits would use BHPBIO's Borrow Pit Progressive Checklist.	Section 4.3.3
		Where disturbance is unavoidable, it is undertaken in a manner which uses rehabilitation to promote the natural return of vegetation and fauna consistent with agreed closure criteria and commitments.	Section 4.12.3
		BHPBIO has developed and implemented standard rehabilitation procedures for 'Earthworks', 'Surface Treatments' and 'Revegetation'. Rehabilitation and revegetation of final mine landforms and infrastructure and support facilities will be conducted in accordance with these procedures	Section 5.2
		Strategic placement of salvaged soils in 'similar' areas of final mine landforms would be a key aspect of successful rehabilitation. For example, the surface soils from the hill crests and rocky scree slopes, which are typically well 'armoured' with a high percentage of coarse material, would be utilised to rehabilitate the top surfaces and upper slopes of waste landforms. Finer textured soils from the flats and minor drainage lines would generally not be used as an outer surface rehabilitation medium for steeply sloping landforms.	Section 4.12.3
		Decommissioning & demolition Mine infrastructure areas (i.e., access tracks, borrow pits, topsoil stockpiles, buildings, etc.) that are no longer required would be decommissioned, and the disturbed area re-contoured to blend with the surrounding topography, topsoiled, contour ripped (or equivalent) in preparation for seeding with native species as necessary.	Section 4.3.3
		Post-closure land use The post-mining land use of the area would be determined through ongoing consultation with the administering authority and relevant stakeholders during the remaining life of the mine. Notwithstanding, the most likely final land use for the lease area is either low intensity cattle grazing (which is the current land use for areas not directly affected by mining activities) or inclusion in some form of natural conservation area.	Section 5.6

Reference	Applicable Area	Obligation Description	Section
2010 Jimblebar Iron Ore Project EPS continued	*Wheelarra Hill, South Jimblebar (SJ West, SJ Central, SJ East); and Hashimoto (H1 West, H1 East; H2; H3; and H4) continued*	**Surface water impacts** There is a low risk of significant loss of downstream flow (including Innawally Pool) as a result of the Project. The potential reduction in runoff to Jimblebar Creek as a result of the Project is not considered to be significant to the overall hydrological system, particularly in comparison to the natural seasonal variations in catchment runoff.	Section 1.6.2 (Table 1-3)
		The Wheelarra Hill & Hashimoto developments may potentially reduce the quality and quantity of runoff draining to the existing natural downslope drainage systems.	Section 4.2.2
		The proposed mining of the South Jimblebar deposits and the development of their associated OSAs would impact several tributaries of Jimblebar Creek, including Copper Creek. Excavating through, or depositing overburden in the creek channel may potentially impact on runoff from this creek system	Section 4.2.2
		Where possible, the location and layout of infrastructure areas and mine landforms would be designed in a manner such that environmental impacts (including potential changes to existing landforms and surface water drainage lines) are kept to a minimum.	Section 4.3.3
		Runoff volume is likely to decrease from areas containing pits and OSAs where the upstream catchments are blocked or intercepted by these works. Runoff volumes from upstream flow paths diverted through or around planned mine development works would be unchanged	Section 4.2.2
		The groved Mulga adjacent to the proposed disturbance areas is unlikely to be affected by changes in surface water flow as the surface water flow direction is generally in a northerly direction.	Section 4.6.2
		Groundwater impacts Groundwater levels at South Jimblebar would be expected to recover by some 50% to 60% within five years of the cessation of mining, and to within 70% to 95% after approximately 250 years. Full recovery to pre-mining groundwater levels would eventually be reached for the option of infilling the pits to 5 m above the pre-mining water table.	Section 4.5.3
		None of the pit lakes that would develop in the Wheelarra Hill and Hashimoto pits would recover to pre-mining groundwater levels. Aquaterra (2009) predict that the equilibrium pit lake levels would be some 30 m to 60 m below the pre-mining water table. Mine voids are likely to form 'groundwater sinks' which, although they would gradually become saline over time, would not result in significant environmental impacts or adversely affect the beneficial use of groundwater in the region and no outflow of saline water and impacts to surface water are expected to occur. The likelihood that fauna would be impacted by the saline mine water is considered low given more suitable permanent and semi-permanent water resources are available in the surrounds (such as Ophthalmia Dam, Innawally Pool and Jimblebar Creek)	Section 1.6.2 (Table 1-3), 3.5.1, 4.5.3
		Monitoring Monitoring of potential impacts on the local surface water and groundwater and environmental values such as Innawally Pool should be conducted during the mine life. BHPBIO would install and monitor paired monitoring bores at several locations adjacent to Jimblebar Creek, Caramulla Creek and of Innawally Pool (and adjacent to existing/planned vegetation monitoring sites) to assess seasonal water table (perched and permanent) fluctuations and potential Project-related effects.	Section 1.6.2 (Table 1-3)
		BHPBIO has implemented monitoring programmes to evaluate the performance of rehabilitated mine landforms and assess whether they have met the Guiding Closure Principles or are showing satisfactory progress towards meeting these principles. These programmes will be expanded as new areas of the mine are rehabilitated and will be refined based on monitoring results and rehabilitation success.	Section 5.5
		Rehabilitated areas at the Jimblebar Mine are monitored using Ecosystem Function Analysis (EFA),	Section 5.5.1
		Fauna activity on rehabilitated sites would be monitored	Section 5.5.2
		Weed monitoring and control would be conducted progressively as part of the rehabilitation programme in accordance with the Weed MP. Post-mining control measures and monitoring programmes would be developed and/or refined during the mine life in consultation with the relevant authorities. Approved changes to the monitoring programme and completion criteria would be documented in the relevant management plans, where necessary.	Section 5.5.3

Reference	Applicable Area	Obligation Description	Section
2010 Jimblebar Hub Mining Proposal Addendum L52/108 and L52/109	Rail line duplication & associated infrastructure	Weeds Management measures that would be undertaken to minimise the potential for the spread of weed species are described in the Weed MP (Appendix E) and would include the following: • Areas of known weed infestation would be shown on mine plans and marked on the ground in order to minimise the potential for inadvertent access and spread of weeds. • Mobile machinery and equipment would be cleaned on a regular basis, with particular attention being given to machinery that operates in areas of known weed infestation. • Regular inspections for the presence of weeds within areas of disturbance would be conducted.	Section 3.2
2015 Jimblebar Mining Operations Northern Overburden Storage Area Extension S45C Application	Wheelarra Hill W1 to W3	**Overburden** BHPBIO has committed to ensure that rehabilitation achieves specific outcomes so that at closure, OSAs and other disturbed areas are left in a safe, stable and non-polluting condition. The out-of-pits OSAs and pit infill areas would be rehabilitated to be similar to the existing regional landforms, in accordance with guiding closure principles. The final shape of the OSAs would be designed to minimise erosion by creating a bund along the crest of the OSA to prevent surface water runoff from the crest down the slopes.	Section 3.1.4
		Surface water impacts It is predicted that no significant detrimental environmental effects to inland water environmental quality will occur from the proposed change.	Section 3.2.3
2019 Jimblebar Optimisation Project: Jimblebar Iron Ore Mine Revised Proposal	South Jimblebar, Hashimoto	**Surface water management infrastructure** To construct the new southern OSAs, a minor drainage line diversion is required.	Section 5.4.1
		Management approaches identified in the MCP relating to water for the Project include: • Design and construct drainage line realignments to achieve comparable hydraulic and geomorphological characteristics to the original systems. • Design and construct flood protection to reduce the likelihood of creek capture post-closure and prevent flood events from impacting the integrity of post-mining landforms. • Design and construct OSAs to minimise erosion based on waste characteristics and control of surface water. • Contain Potentially Acid Forming (PAF) material within OSAs to minimise oxidation and the potential to generate AMD.	Section 5.6.3
		Overburden The MCP addresses the potential impacts on soils (structure, stability and quality) and details how constructed landforms (principally OSAs) will be constructed and rehabilitated, to ensure they are safe, stable and non-polluting.	Section 5.6.3, 8
		Although the AMD risk is low at South Jimblebar, the MCP includes potential management strategies and processes for monitoring of risk indicators for AMD. BHP has existing management measures to ensure erosion and AMD is considered in the design, scheduling and construction of overburden storage areas and other waste landforms. BHP continues to undertake studies of the geochemical and physical properties of Brockman Iron and Marra Mamba Iron waste material to confirm the appropriate erosion and AMD management requirements.	Sections 5.6.3, 8
		The updated Mine Closure Plan addresses the potential impacts on natural landforms. This includes interface with constructed landforms and managing surface water flows to limit sheet and rill erosion from rehabilitated constructed landforms.	Section 8
		The Project will not be in the viewshed of locations with high amenity values (panoramic viewpoints, lookouts, gorges and rockpools). The Mine Closure Plan details how new landforms (principally overburden storage areas) will be constructed and rehabilitated, including contouring, incorporation of screening structures and revegetation of waste rock landforms	Section 8

Reference	Applicable Area	Obligation Description	Section
2019 Jimblebar Optimisation Project: Jimblebar Iron Ore Mine Revised Proposal continued	*South Jimblebar, Hashimoto continued*	**Rehabilitation** Implement the Jimblebar Mine Closure Plan so that the Project is rehabilitated in an ecologically appropriate and sustainable manner.	Section 6.7
		The revised MCP addresses the rehabilitation of the additional areas that will be disturbed. Management approaches relating to flora and vegetation for the Project include: • Review and optimise pit backfill strategy to minimise disturbance, particularly for OSAs. • Progressively rehabilitate OSAs. • Design the revegetation program to establish native vegetation that blends with the surrounding areas. • Undertake growth media management in accordance with standard business procedures. • Use specified seed mix, including the use of local provenance native seed.	Section 6.6.3
		The revised MCP addresses the rehabilitation of the additional areas that will be disturbed. Management approaches relating to terrestrial fauna for the Project, particularly in relation to fauna habitat (and in addition to those for flora and vegetation (Section 6.6.3)), include: • Integrate fauna habitats (e.g., large rocks) into landform design. • Design the revegetation program to establish native vegetation that blends with the surrounding areas and will provide habitat and foraging areas for native fauna. • Choose appropriate surface treatments, including selective placement of logs or smaller woody debris and/or boulders (if available) across the re-profiled surface and/or constructing rocky cliff features (where potential exists) to provide additional habitat areas for fauna species.	Section 7.6.3
		Traditional Owners As the Project is located within the Nyiyaparli native title determination area, BHP recognises that the Nyiyaparli people have a strong interest in closure and the post-mining landscape when mining at Jimblebar is finished. Consultation with the Nyiyaparli people on closure and post-closure land-use is undertaken through the ongoing stakeholder engagement process.	Section 8
		Surface water & groundwater impacts The cumulative loss of Jimblebar Creek Catchment upstream of the confluence with Fortescue River (and hence potential decrease in runoff volume) at the Jimblebar Hub (including from Orebody 31 and Orebody 18) is estimated to be up to 3% which is within the natural variation of seasonal runoff. Therefore, the disruption to natural surface flows and reduction in the availability of surface water downstream will be minimal. The changes to surface water regimes from the construction of infrastructure are not considered to be significant.	Sections 5.4.1, 5.5.1
		There is unlikely to be a significant change to water quality from the Project.	Section 5.5.3
		BHP considers that: • There is no significant residual impact to Inland Waters from the Project, as there will be no impacts to significant wetlands, waterways and TECs. • The predicted outcome in relation to the EPA's objective for Inland Waters is that hydrological regimes and quality of groundwater and surface water will be maintained so that environmental values are protected.	Section 5.7
		Discharging surplus water has the potential to cause localised changes to the composition and/or density of vegetation within the wetting front (e.g., increase in weed species). The potential impact from inundation is approximately 12% (71 ha) of the area of riparian vegetation mapped along the main channel of Caramulla Creek. There are unlikely to be impacts to the riparian vegetation on the banks	Section 6.4.2, 7.4.2
		BHP has proposed to control groundwater mounding so that groundwater does not rise within 25 mbgl, and therefore will not impact on vegetation.	Section 6.4.2

Reference	Applicable Area	Obligation Description	Section
2019 Jimblebar Optimisation Project: Jimblebar Iron Ore Mine Revised Proposal continued	*South Jimblebar, Hashimoto continued*	The Project has the potential to impact sheet-flow dependent Mulga from the disruption of natural sheet-flow resulting from the construction of surplus water infrastructure (i.e., pipelines). To mitigate this impact, infrastructure through areas identified as sheet-flow dependent Mulga will be constructed to maintain sheet-flow and minimize potential impacts to Mulga.	Section 6.6.2
		There will be no directs impacts on the identified river pools - Innawally Pool and Jinerabar Pool	Section 8
		Weed impacts The presence of introduced flora species within the proposed Development Envelope is not expected to impact on any significant vegetation (as none occur within or adjacent to the proposed Development Envelope), or the regional representation of conservation significant flora species.	Section 6.4.4
		Monitoring BHP commits to monitoring the health of the riparian vegetation along Caramulla Creek to ensure actual impacts are not greater than predicted	Section 6.6.2
State Agreement Proposal 2015	Jimblebar Expansion	5 CLOSURE AND REHABILITATION The Jimblebar Mine Closure Plan (Revision 7, August 2012) was submitted to the OEPA in August 2012. The 2012 Closure Plan aligns with Ministerial Statements 683, 809 and 857 and represents a conceptual plan given the completion of mining is beyond 2035. The mining operations described within the Closure Plan directionally align with the Jimblebar Expansion footprint. The 2012 Closure Plan will be updated (based on 2012 regulator feedback) in 2017, as per the routine update process agreed with the regulator	
State Agreement Proposal 2017	McCameys Pipeline	6 CLOSURE AND REHABILITATION Rehabilitation of the disturbed area will be undertaken in accordance with the conditions included in BHPBIO's whole-of-site Mine Closure Plan for Jimblebar and NVCP 3609/4.	
State Agreement Proposal 2018	65Mtpa	Closure and rehabilitation will be undertaken in accordance with the Jimblebar Mine Closure Plan (MCP) (MCP Revision No. 1 dated June 2016) which was approved by the EPA on 14 October 2016. BHPBIO have committed to review and revise the MCP over the life of the mine in accordance with the DMP/EPA 2015 Guidelines for Preparing Mine Closure Plans. The updates will occur at five yearly intervals or as otherwise agreed by the EPA.	
1996 Orebody 18 Consultative Environmental Review	Orebody 18	**Overburden** Overburden storage areas will be contoured and rehabilitated, and areas will be designed to be consistent with the surrounding landform. They will be designed to blend with the surrounding topography and contoured, stabilized and revegetated during and after mining.	Executive Summary Section 3.3.3
		Overburden will be stored outside the pit, either on the plain or in a gully. The height of the storage areas will vary at the end of mine life. The eastern area will be approximately 50 m in height, the western area (located in a gully to the north-west of the pit) will be 30 - 40 m in height, and the smaller western area will be 10 m in height. The overburden storage area located in the gully to the north-west will be below the skyline when viewed from the main access road to the mine. The two overburden storage areas on the plain will have a maximum height lower than the natural ridgelines to the immediate west and will therefore not appear inconsistent with the natural topography in this part of the Range.	Executive Summary Sections 2.1 (Table 2.1), 3.2.2
		Final surfaces will be formed as early as possible and slopes will be progressively battered to an overall angle of approximately 20° or less, spread with topsoil (where available) and stabilised to prevent erosion and encourage vegetation establishment. Erosion control and water harvesting techniques will be applied to the slopes. Where necessary, the slopes will be seeded using a mixture of local species. The long-term goal of the rehabilitation programme will be the re-establishment of Eucalyptus trees over Triodia basedowii to create suitable local habitats similar to the surrounding tree-steppe.	Sections 3.3.3, 3.7.5

Reference	Applicable Area	Obligation Description	Section
1996 Orebody 18 Consultative Environmental Review continued	*Orebody 18 continued*	There are currently no firm plans detailing overburden return to the pit.	Section 2.2.2
		As a result of its depth, the pyritic material will not be intercepted by the pit. Dewatering will not occur below the level at which the McRae shale occurs either. Therefore, the pyritic shale should not be disturbed or exposed to oxygen, avoiding the potential for acid production.	Section 3.4.1
		Mine void Residual impacts at the completion of mining will include the mine pit. Evapo-concentration of salts will occur over time in the waterbody.	Executive Summary
		Safety bund walls will be constructed around the decommissioned pits and their design will comply with guidelines established by the Department of Mines	Section 4.5.2
		Borrow pits will be rehabilitated in accordance with BHP Iron Ore guidelines (Walker, undated). Shallow scree mined areas will be recontoured, stored topsoil spread, and the areas ripped, in a similar way to borrow pits, to promote revegetation. Deeper scree pits will be used as repositories for waste rock, wherever possible, and then rehabilitated.	Section 4.5.2
		Decommissioning & demolition Unwanted project infrastructure will be removed after the completion of mining. The resulting disturbed areas will be rehabilitated once facilities are removed.	Section 3.2.2
		At the completion of mining, all infrastructure will be removed. Concrete footings will be excavated and buried. Remaining surfaces of borrow pits or overburden storage areas that have not previously been rehabilitated will be battered to an angle of 20" or less. Top-soil which was stripped and stored prior to the commencement of mining will be returned for use in areas to be rehabilitated. Stabilisation techniques will be applied to exposed surfaces and local native seed applied where necessary.	Executive Summary Section 4.5.2
		Topsoil Topsoil and vegetation will be stripped and used immediately for rehabilitation or stored for later use	Section 3.3.3, 3.7.5
		Rehabilitation Disturbed surfaces will be progressively rehabilitated to a self-sustaining condition and re-establish plant communities and fauna habitats similar to the existing associations. Progressive rehabilitation to meet the requirements of the post-mining land use.	Executive Summary Section 3.7.5
		Revegetation activities will continue beyond the mine closure to enable final overburden storage areas to be contoured and stabilised.	Executive Summary Section 4.5.2
		All areas no longer required, such as borrow pits, temporary access roads and hardstand areas, will be contoured as necessary, topsoiled (where soil is available) and ripped. If required, areas will then be seeded with a mixture of local species according to the approved rehabilitation procedure documented in the Environmental Management Programme.	Section 3.7.5
		All compacted surfaces resulting from the operation of the mine will be ripped to promote water penetration and the catchment of windblown seed. Where necessary, reseeding will take place using species present in the area.	Section 4.5.2
		Fauna Re-creation, of faunal habitats will coincide with revegetation of disturbed areas.	Executive Summary Section 3.8.8
		Once disturbance ends, it is expected that the rehabilitated areas be recolonised from surrounding areas.	Executive Summary
		Post-mining land use End use to be landforms and vegetation. similar to the surrounding area.	Executive Summary

Reference	Applicable Area	Obligation Description	Section
1996 Orebody 18 Consultative Environmental Review continued	*Orebody 18 continued*	**Surface water impacts** The mine will reduce the catchment area for local drainage lines to the south, thereby potentially reducing surface runoff. However, there will be little impact on downstream vegetation as existing drainage flows infiltrate the porous scree deposits at the base of the slope and there is no phreatophytic vegetation (vegetation dependent on groundwater) in this area.	Executive Summary
		The overburden storage areas to the south-east of the pit-will not disrupt surface flows as they occur at the head of the catchment. The overburden storage areas in the gully to the north-west of the pit will alter surface flows within that drainage -channel	Executive Summary Section 3.5.2
		Diversion works will be constructed to minimise the impacts on existing drainage	Executive Summary
		Vegetation in downstream areas will not be impacted by potentially reduced surface flows since flows infiltrate through scree deposits and do not generally persist beyond the base of the slope. Water levels within the scree are generally more than 40 m below ground level and phreatophytic vegetation does not occur in the drainage channels in this area.	Section 3.5.2
		Significant sediment loads will therefore not migrate downstream to Shovelanna or Jimblebar Creeks. As no potential pollutants occur in the overburden, other water quality parameters in the drainage lines downstream will remain unchanged.	Section 3.5.3
		In order to leave the site in a condition that will minimise the impact caused by erosion in ensuing years, pre-existing drainage networks will be re-established where required.	Section 4.5.2
		Groundwater impacts Due to the limited hydraulic connection between the orebody aquifer and other local aquifers, the dewatering activities will have a negligible impact on other aquifers	Executive Summary
		A waterbody with a surface area of approximately 8 ha will form in the decommissioned pit. It is estimated that pit water levels would stabilise at about 1 to 5 m below the regional water table. Other than periods when rainfall/runoff results in temporarily elevated pit water levels, groundwater will flow towards and into the pit rather than away from it. The waterbody will become saline in time.	Executive Summary Section 3.6.2
		Saline pit water is not expected to migrate from the pit until such time as there develops a sufficient density contrast between saline pit water and fresher groundwaters. This may start to happen at salinities in excess of 10,000 mg/L, when the denser saline pit water could migrate to the base of the aquifer under the influence of gravity rather than hydraulic gradient. However, due to the low permeabilities of the surrounding and underlying shales, it is expected that the saline water would be contained within the orebody aquifer and have little to no impact on adjacent aquifers (valley sediments etc).	Executive Summary Section 3.6.2
		The water table at the borefield site is 36 m below ground level and does not support phreatophytic vegetation. Therefore, any drawdown will not affect vegetation in the area.	Section 3.6.2
		Completion criteria Proposed rehabilitation criteria for overburden storage areas: • Final landform – flat topped spurs, 20° scree outer slopes, stabilised, rounded forms like existing hills. • Final vegetation – early successional species first, final objective is scattered eucalypts over spinifex	Section 3.3.3 (Table 3-2)
		Proposed rehabilitation criteria for open pit: • Final landform - open pit to DOME [now DMIRS] safety standards with occasional open water or partially filled with overburden. • Final vegetation - accessible internal benches and pit floors will be ripped and seeded	Section 3.3.3 (Table 3-2)
		Proposed rehabilitation criteria for scree mining: • Final landform – shallow areas recontoured to blend with surroundings. Deep areas filled or treated similarly to main pit. • Final vegetation - early successional species first, final objective is scattered eucalypts over spinifex, where appropriate	Section 3.3.3 (Table 3-2)

Reference	Applicable Area	Obligation Description	Section
1996 Orebody 18 Consultative Environmental Review continued	*Orebody 18 continued*	Proposed rehabilitation criteria for process plant, powerline, borefield: • Final landform – consistent with existing. All infrastructure removed. • Final vegetation – site ripped and seeded with species consistent with the vegetation type on the outwash plains	Section 3.3.3 (Table 3-2)
		Proposed rehabilitation criteria for road / rail spurs: • Final landform – consistent with existing. All infrastructure removed. Formation retained. • Final vegetation – site ripped and seeded with species consistent with the vegetation type on the outwash plains	Section 3.3.3 (Table 3-2)
		Monitoring Monitoring following decommissioning will consist of periodic site visits to assess the progress of revegetation. Parameters to be monitored will include the establishment and growth of plants; the species composition; evidence of land degradation; and evidence of the return of fauna species. Sites requiring remedial work will be repaired. Water quality will be monitored in the pit and surrounding aquifers. Environmental monitoring and ongoing research studies to be undertaken through the life of the mining operation at Orebody 18, and at other BHP Iron Ore mining operations, will assist in refining environmental management practices to minimise longer-term impacts.	Executive Summary Sections 3.3.3, 4.5.2
		Monitoring and maintenance of the rehabilitated areas will continue until the vegetation is seen to be progressing towards a stable condition.	Section 3.3.3
1996 State Agreement Proposal for Mining at Orebody 18	Orebody 18	**Mine voids** The opportunity will arise in the latter part of the orebody's life to directly infill some overburden into mined out areas. This practice will be prioritised where options in the mining sequence exist. If scree ore is recovered, the pit areas will be directly infilled with overburden once mining is complete.	Section 2.2
		Safety bund walls will be constructed around the decommissioned pits and their design will comply with guidelines established by the Department of Mines (1991).	Section 4.9
		Overburden Overburden storage areas positioned so as to blend with the surrounding landforms. Remaining surfaces of overburden storage areas that have not previously been rehabilitated will be battered to an angle of 20° or less.	Sections 4.5, 4.9
		Access road It is proposed that the northern [site access] road be degazetted and the southern road be used by the public. Access to the Jigalong Aboriginal Mission and Sylvania pastoral station will be maintained.	Section 2.10
		Decommissioning & demolition Removal of infrastructure no longer required. At the completion of mining, all infrastructure will be removed. Concrete footings will be excavated and buried.	Sections 4.5, 4.9
		Topsoil Recovery and storing of topsoil in areas to be disturbed for later use in rehabilitation.	Section 4.5
		Rehabilitation Progressive rehabilitation of disturbed areas throughout the project's life and completion of rehabilitation at the conclusion of mining. Revegetation activities will continue beyond the mine closure to enable final overburden storage areas to be stabilised.	Section 4.5
		Any remaining topsoil which was stripped and stored prior to the commencement of mining will be returned for use in areas to be rehabilitated. Stabilisation techniques will be applied to exposed surfaces and local native seed applied where necessary.	Section 4.9
		Borrow pits will be rehabilitated in accordance with BHP Iron Ore guidelines (Walker, undated). Remaining surfaces will be battered to an angle of 20° or less.	Section 4.9

Reference	Applicable Area	Obligation Description	Section
1996 State Agreement Proposal for Mining at Orebody 18 continued	*Orebody 18 continued*	All compacted surfaces resulting from the operation of the mine will be ripped to promote water penetration and the catchment of windblown seed. Where necessary, reseeding will take place using species present in the area.	Section 4.9
		Surface water impacts The proposed mine pit will intercept minor drainage lines. Vegetation downstream however will not be impacted since surface flows already infiltrate scree deposits at the base of the slope. The water levels within these deposits are then 40 m below ground level, well beyond the reach of phreatophytic vegetation.	Section 4.6
		The overburden storage areas are located on top of the ridge or at the head of the water catchment area on the plain. Their position will have little impact on surface flows. The presence of the storage areas could however increase sediment load downstream. Surface flows infiltrating scree slopes will filter suspended sediment naturally. If natural filtration is not occurring in any areas, settling ponds will be installed to eliminate sediment from reaching the local creek system.	Section 4.6
		In order to leave the site in a condition that will minimise the impact caused by erosion in ensuing years, pre-existing drainage will be re-established where required.	Section 4.9
		Groundwater impacts Dewatering of a small area of the pit will take place. At the completion of mining this area is expected to recharge with water. The pit water salinity will increase with time due to evaporative concentration. The higher saline water will however be restricted to the orebody aquifer and will not permeate to adjacent aquifers found in the valley sediments and basement lithologies.	Section 4.6
		Monitoring Monitoring following decommissioning will consist of periodic site visits to assess the progress of re vegetation.	Section 4.9
2007 Orebody 18 Mine Modification S45C Application	Orebody 18	**Overburden** Disposal of the majority of the overburden from the open pit in adjacent out-of-pit OSAs, with the possibility of some in-pit disposal of overburden in the later stages of mining. The proposed changes to the OB18 Mine would allow for more opportunity for pit infilling, particularly in the North Pit/East Pit area. The designs of the three planned out-of-pit overburden storage areas (OSAs) would be adjusted, but they would remain in their same general positions on the OB18 ridgeline. The planned OSAs would occupy a smaller area than that proposed in the original CER (i.e., 127 ha rather than 154 ha), and would continue to have maximum heights lower than the height of the natural ridgeline: • East (max height 630 mRL; same as 1996 CER) • North-West (Max. height 682 mRL; reduced from 730 mRL in 1996 CER) • West – (Max. height 611 mRL; increased from 590 mRL in 1996 CER). However, the top surface would still be more than 130 m lower than the height of the ridgeline located immediately to the north.	Executive Summary Section 2.1, 2.2.1 (Table 2-2), 2.2.3, 3.3
		DoIR raised a general (i.e., Pilbara-wide) concern regarding placement of OSAs and stockpiles within a potential zone of instability around pits at BHPBIO's operations. BHPBIO explained that it would conduct geotechnical investigations prior to siting OSAs where necessary, and in accordance with its Mine Planning Flowsheet for Major Mine Landforms	Section 1.4 (Table 1-1)
		BHPBIO will endeavour to sell and remove all material in the low-grade stockpiles prior to, or at the end of the mine life. In the event that this material is not able to be sold, BHPBIO would re-profile the stockpiles and rehabilitate them in accordance with the Guiding Closure Principles for the OB18 Mine.	Section 2.2.4
		The planned landform designs shown in this document (e.g., Figure 2-3) are indicative only, and may be adjusted through the use of the Life of Mine Planning Process.	Section 2.2.6

Reference	Applicable Area	Obligation Description	Section
2007 Orebody 18 Mine Modification S45C Application continued	*Orebody 18 continued*	Where necessary, drainage features such as cut-off drains and bunds would be incorporated onto the tops of cuts and dumps to prevent water filtering down the sides of drains/bunds and causing erosion. Materials would be selected, and drainage designed to minimise erosion of cuts and fills. Materials that have a low resistance to erosion would generally not be used in outer slope fill batters.	Section 3.3
		BHPBIO has sought and obtained Ministerial approvals for its expanded Yandi, Wheelarra Hill, Goldsworthy and OB25 mining operations in recent years. A key component of these approvals has been the adoption of a life-of-mine planning approach. This approach has been developed to allow some flexibility in the final siting of mine landforms, as long as they are constructed within a nominated 'Maximum Disturbance Boundary', avoid significant sites/ environmental aspects, and satisfy agreed 'Guiding Closure Principles'. BHPBIO intends to adopt the same approach at the OB18 Mine and is seeking to formalise it via the 45C application. Where possible, the location and layout of infrastructure areas and mine landforms would be designed in a manner such that environmental impacts (including potential changes to existing landforms and drainage channels) are kept to a minimum.	Executive Summary Section 1.2, 2.2.6, 3.3
		BHPBIO manages the potential risk for pyritic shale being intersected during mining by conducting detailed geological modelling using available data. The present model indicates that pyritic black shale is present at depth, but is below the existing pit design, with the exception of a small quantity (less than 100,000 t), which is predicted to occur at the base of the North Pit. Mt McRae Shale is predicted to be exposed in the pit walls only in its oxidised form and to date no fresh Mt McRae Shale has been exposed due to mining. The proposed final design for the North and South Pits would extend 18 m and 72 m, respectively below the water table however it is not predicted to intersect fresh pyritic shale, as the base of oxidation profile is situated below the final design. The potential impacts of the PAF material will be minimised by selectively mining and placing it in a designated encapsulation cell(s) within a mined-out portion of the open pit, and/or OSA. BHPBIO will develop and implement a management plan for PAF material at OB18 in consultation, and to the satisfaction of the DoIR and DEC.	Section 1.4 (Table 1-1), 3.2.1
		Mine voids Residual batters in the pit voids would be left as ROM where geotechnically stable and profiled as necessary to achieve long-term closure objectives.	Section 3.3
		All parts of the pits that extend below the water table would be backfilled to have a final pit surface that is above than the pre-mining groundwater level.	Section 1.4 (Table 1-1), 3.3, 3.4.1
		Pit infilling would be used to dispose of overburden material where practicable as described in the OB18 EMP and the DRP.	Section 1.4 (Table 1-1)
		Rehabilitation DoIR indicated that the use of non-local provenance seed in BHPBIO's rehabilitation programmes is not acceptable. BHPBIO is investigating options to address the issue raised by DoIR by appointing a dedicated Rehabilitation Co-ordinator in 2007. Part of this role will be to identify how BHPBIO would secure local provenance seed for all its rehabilitation requirements. If necessary, the Purchase of Seed Manual would be revised to reflect changes to procedures that are considered necessary to manage the use of non-local provenance seed.	Section 1.4 (Table 1-1)
		DoIR requested that BHPBIO consider revegetation of pit benches in its closure planning. BHPBIO explained that it has rehabilitated benches and upper pit batters at some of its other mines (e.g., OB25), and that it would consider revegetation of pit benches at OB18 to minimize visual impacts.	Section 1.4 (Table 1-1)
		BHPBIO explained that it would commence progressive rehabilitation as soon as possible at OB18 following completion of disturbance in parts of OSAs, open pits and other mine areas that are no longer required.	Section 1.4 (Table 1-1)
		All mine infrastructure areas (i.e., access tracks, borrow pits, topsoil stockpiles, buildings, etc.) that are no longer required would be decommissioned, and the disturbed area re-contoured to blend with the surrounding topography, topsoiled (or alternative media applied), contour ripped (or equivalent) in preparation for seeding with native species as necessary.	Section 3.3

Reference	Applicable Area	Obligation Description	Section
2007 Orebody 18 Mine Modification S45C Application continued	*Orebody 18 continued*	**Surface water impacts** The modified open pit would affect an additional two or three minor drainage lines in the vicinity of the East Pit, and possibly one more on the western-most end of the South Pit, however these changes would not result in significant additional detrimental environmental effects. The proposed changes to the OSAs and ore stockpiles would not result in significant additional impacts on surface water features in the area.	Section 3.4.1
		BHPBIO would use progressive rehabilitation and life of mine planning at the OB18 Mine to minimise the effect of BHPBIO's operations on surface water during operations and following mine closure.	Section 3.4.1
		Groundwater impacts At the completion of mining and dewatering pumping (and infilling of the pits by overburden to above the pre-mining water table), groundwater inflows would start to saturate the infill material. Groundwater levels within the infilled pit voids should fully recover to pre-mining water table levels within three years (Aquaterra, 2007). The impact on local/regional groundwater resources during these recovery periods would be less than the impact during mining and active dewatering.	Section 3.4.1
State Agreement Proposal April 2009	OB17	Closure reference to OB18 Mine EMP	MN34
State Agreement Proposal April 2009	OB18	Closure reference to OB18 Mine EMP	MN34
2014 Orebody 18 Hub Mine Modification S45C Application	Orebodies 17 & 18	Maximum height of overburden storage areas 730 mRL	Appendix B
State Agreement Proposal March 2015	OB17	Closure reference to Mine Closure July 2013	MN84
State Agreement Proposal November 2015	OB31	N/A	MN91
2015 Orebody 31 Environmental Referral	Orebody 31	**Overburden** Overburden will be stockpiled in approved Overburden Storage Areas (OSAs). Where possible, overburden may also be placed back into the pit void/s at either Orebody 31 or nearby Orebody 17 to reduce the impact of OSAs on existing landforms and assist in achieving closure objectives for various sites. Where [backfill] this is not possible, any required OSAs will be designed to blend with the natural landforms.	Section 2.3.3, 6.2 (Table 11)
		Various options are being explored to mitigate post-closure residual impacts including backfilling depleted mine pits at the Orebody 18 Mine Hub and/or the Proposal with waste material where practicable. Waste categorization studies are currently considering a range of options which include the potential to backfill depleted pits at the adjacent Orebody 18 Mine Hub, in order to reduce the amount of waste being directed to the Proposal OSAs and impacts to final landforms.	Section 6.2 Table 10
		Modify the Proposal footprint to avoid the majority of identified habitat containing *Acacia* sp. *East Fortescue* through modifying the OSA design. BHPBIO is continuing to reduce the indicative OSA designs to exclude impact on the western recorded population of this species within the Development Envelope.	Section 6.2 Table 6
		Segregation of PAF overburden, construction of PAF OSA's in accordance with leading practice to minimise AMD generation and treating pit water during operations, if required, to protect receiving receptors.	Section 6.2 Table 12

Reference	Applicable Area	Obligation Description	Section
2015 Orebody 31 Environmental Referral continued	*Orebody 31 continued*	**Topsoil** Topsoil, where recoverable, will first be removed and placed into stockpile areas for later use in rehabilitation	Section 2.3.3
		Groundwater impacts A number of closure scenarios are currently being considered as part of a proposed Mine Closure Plan. Post-closure impacts of the mine, particularly formation of pit lakes in mine voids (as a worst-case scenario) are discussed further in the Mine Closure Plan.	Section 6.2 Table 10
		Visual impacts Through the Landscape and Visual Impact Assessment, it has been determined that the Proposal is expected to have little to no impacts on viewsheds	Section 6.2 Table 16
State Agreement Proposal February 2016	OB31	Closure reference to Mine Closure Plan (MCP Revision No 1 dated August 2015)	MN94
State Agreement Proposal March 2017	OB31	Rehabilitation of the road will be undertaken in accordance with the conditions of the NVCP under Part V of the EP Act with the addition of a commitment that the closure works undertaken in accordance with this proposal will be included within BHPBIO's whole-of-site closure plan during the next 5-year update.	Clause 5 of MN104

Appendix B. Stakeholder engagement - further information

B-1. Stakeholder engagement with implications for closure conducted prior to 2013

Date (s)	Orebody	Description of Engagement	Stakeholders	Stakeholder comments / issue	Proponent response and / or resolution
8 June 04	Wheelarra Hill	Site visit of proposed Wheelarra Hill mining areas and disturbance footprints	Representatives from the Nyiyaparli Aboriginal Group	Heritage sites identified.	Sites documented. Approval sought for disturbance of selected sites.
1 June 04	Wheelarra Hill	Presentation of Wheelarra Hill extension project	Newman Community Consultative Interactive Forum	No specific technical issues raised.	-
27 July 04 and 2 Sept 04	Wheelarra Hill	Presentation of Wheelarra Hill extension project	Department of Environment (DoE) (now DWER) Karratha and CALM (now DBCA) Karratha	Potential impacts on biophysical values.	Disturbance would be conducted progressively. BHP's mine planning process has been documented in the EPS and BHP has committed to following this process.
3 September 04	Wheelarra Hill	Presentation of Wheelarra Hill extension project	Department of Industry and Resources (DoIR) (now DMIRS)	No specific technical issues raised.	-
6 October 04	Wheelarra Hill	Presentation of Wheelarra Hill extension project	Representatives from the Nyiyaparli Aboriginal Group	Potential impact of the extension on recorded heritage sites in the area.	Approval sought for disturbance of selected sites.
21 October 04	Wheelarra Hill	Updated presentation of Wheelarra Hill extension project	DoE Karratha (now DWER) CALM Karratha (now DBCA)	No specific technical issues raised.	-
22 October 04	Wheelarra Hill	Updated presentation of Wheelarra Hill extension project	East Pilbara Shire	No specific technical issues raised.	-
5 November 04	Wheelarra Hill	Update on Wheelarra Hill extension project	DoE (now DWER) / EPA	Mine closure planning should be considered up front and as an integral part of the mine planning process.	BHP's mine planning process has been documented in the EPS and BHP has committed to following this process.
19 November 04	Wheelarra Hill	Comments on the EPS	CALM (now DBCA)	Queried whether a more detailed and developed mine-sequencing plan could be used to reduce the total area of disturbance.	The proposed increased disturbance area for the project is based on the current life of mine plan and is subject to more detailed mine planning. As part of this planning process, BHPBIO would evaluate options for reducing the area of disturbance by infilling previously mined pits and using exiting OSAs. BHP's mine planning process has been documented in the EPS and BHP has committed to following this process.
24 November 04	Wheelarra Hill	Updated presentation of the proposal and finding of environmental studies	Representatives from the Nyiyaparli Aboriginal Group	Further discussion regarding heritage sites to be disturbed.	Relevant information incorporated into the EPS.
26 November 04	Wheelarra Hill	Site visit of existing mine and proposed project areas	EPA Services Unit	EPA environmental objectives relevant to the project. Mine closure strategy to be incorporated in the EPS. Evaluate potential impacts of the project on landscape values (including visual amenity) and demonstrate how they will be protected and / or impacts mitigated. Characterisation and management of overburden materials.	The EPS describes how potential impacts would be managed to satisfy EPA objectives. A conceptual decommissioning and rehabilitation plan has been prepared and includes measures to minimise effects on landscape values. No PAF material (i.e., pyritic shale) has been mined at the Jimblebar mine to date, and the exploration program for the project has not intersected any in the proposed mining areas. In the unlikely event that it is required, BHP would implement appropriate management strategies so that PAF waste does not adversely affect environmental values.
2 December 04	Wheelarra Hill	Comments on the EPS	DoE (now DWER) Karratha	No specific issues raised.	-
25 January 05 and February 05	Wheelarra Hill	Comments on the EPS	EPA Services Unit	EPS should include a discussion of lessons learnt from mine closure and rehabilitation in the area.	Information included in the EPS.
8 Oct 07 12 Nov 07 Jan 08	OB17/18	Meeting to discuss Life of Mine planning and disturbance areas	Department of Environment and Conservation (DEC) (now DWER / DBCA)) DoIR (now DMIRS) Environmental Protection Authority Service Unit	DEC (now DWER /DBCA) queried whether an area limit for disturbance (i.e., in hectares) would be imposed within the Maximum Disturbance Area boundary to prevent the possibility of the whole area being cleared. DoIR (now DMIRS) requested more detail on how the life of mine process would prevent BHP from making significant changes to the mine plan without consultation and approval by Government agencies.	BHP explained that the use of the life of mine planning process would provide it with some flexibility to adjust mine landform designs during the mine life if necessary. However, adjustments would be subject BHP using the life of mine planning procedure, BHP meeting the various operating commitments made in the Environmental Management Plan, the Significant Species Management Plan, and BHP satisfying the Guiding Closure Principles contained in the Decommissioning and Rehabilitation Plan. Consultation with Government agencies would be via phone / email, site visits, meetings, and the revision processes for the Environmental Management Plan, and Decommissioning and Rehabilitation Plan. During the Environmental Management Plan, and Decommissioning and Rehabilitation Plan revision process, the nominated Decision Making Authorities would be able to review drafts of the documents and work with BHP so that the finalised documents were to their satisfaction. It is expected that the Decision Making Authorities would carefully review whether any proposed changes to mine landform designs are consistent with the 'Guiding Closure Principles', and other operational conditions and undertakings
31 May 07 13 April 07	OB17/18	Meeting to discuss landforms - Overburden management using pit infilling	DoIR (now DMIRS) DEC (now DWER / DBCA)	DOIR (now DMIRS) and DEC (now DWER / DBCA) inquired into the use of pit infilling as part of overburden management.	BHP explained that pit infilling would be used to dispose of overburden material where practicable as described in the OB18 Decommissioning and Rehabilitation Plan

Date (s)	Orebody	Description of Engagement	Stakeholders	Stakeholder comments / issue	Proponent response and / or resolution
31 May 07	OB17/18	Meeting	DoIR (now DMIRS)	Seed availability and revegetation DoIR (now DMIRS) indicated that the use of non-local provenance seed in BHP's rehabilitation programs is not acceptable.	BHP explained that the OB18 Environmental Management Plan describes how it uses its 'Purchase of Seed and Formulation of Seed Mixes for Rehabilitation Manual' across its Pilbara mining operations. The Manual outlines a basic seed mix to be used at BHP's Pilbara operations. However, it explains that this mix can be adapted to suit the particular characteristics of the site through BHP's adaptive management approach. The manual also lists seed vendors which collect seed from the Pilbara region and requires the Environmental Officer to plan for the purchase of seed well in advance of use in rehabilitation activities. Notwithstanding the above, BHP is investigating options to address the issue raised by DOIR (now DMIRS) by appointing a dedicated Rehabilitation Co-ordinator in 2007. Part of this role will be to identify how BHP would secure local provenance seed for all its rehabilitation requirements. If necessary, the Purchase of Seed Manual would be revised to reflect changes to procedures that are considered necessary to manage the use of non-local provenance seed.
				Current condition to backfill pits DOIR (now DMIRS) inquired as to whether BHP has a current condition to backfill pits at OB18.	BHP explained that it has committed to backfill to at least the pre-mining groundwater level.
31 May 07	OB17/18	Meeting	DOIR (now DMIRS)	Closure planning in regard to pit faces DOIR (now DMIRS) requested that BHP consider revegetation of pit benches in its closure planning.	BHP explained that it has rehabilitated benches and upper pit batters at some of its other mines (e.g., Orebody 25), and that it would consider revegetation of pit benches at OB18 to minimise visual impacts.
31 May 07 8 Oct 07	OB17/18	Meeting to discuss rehabilitation techniques and strategies	DOIR (now DMIRS) DEC (now DWER / DBCA)	Timing of rehabilitation Monitoring of rehabilitation DoIR (now DMIRS) raised a general (i.e., Pilbara-wide) concern that rehabilitation works are not being conducted at BHP's operations soon enough following completion of disturbance. DEC (now DWER /DBCA requested that BHP deliver rehabilitation Assessment Reports to Department of Environment and Conservation for advice during the rehabilitation of the OB18 mine.	BHP explained that it would commence progressive rehabilitation as soon as possible at OB18 following completion of disturbance in parts of OSAs, open pits and other mine areas that are no longer required. The OB18 Decommissioning and Rehabilitation Plan describes rehabilitation procedures that are/would be used at the mine. BHP indicated it has an existing Ecosystem Function Analysis program for rehabilitation monitoring and prepares annual reports that document the results. A summary of these reports is provided in the Annual Environmental Report. This mechanism for tracking BHP's rehabilitation progress and reporting results for all of its Pilbara mines has been in place for many years. The Annual Environmental Report provides a summary of areas that have been rehabilitated over the previous reporting period. It is also used to describe the timing and nature of planned rehabilitation activities scheduled for the upcoming reporting period. Broader mine rehabilitation and closure objectives and implementation strategies are described in the Decommissioning and Rehabilitation Plan.
13 Apr 07	OB17/18	Meeting	DEC (now DWER / DBCA)	Development of completion criteria DEC (now DWER / DBCA enquired about the timing for BHP developing completion criteria for the OB18 mine.	BHP explained that Guiding Closure Principles for mine closure would be included in the Decommissioning and Rehabilitation Plan, and that these would provide the broad criteria for closure, which is appropriate for the stage of the mine, plus outline the process for developing more quantitative criteria as the mine progresses.
				Risk assessment DEC (now DWER / DBCA) requested a risk assessment of key impacts to be included as part of the assessment.	BHP explained that a risk assessment would be included in the 2008 Section 45C Application.
28 June 07	OB17/18	Meeting to discuss landscape and visual impact	Wildflower Society of WA Conservation Council of WA (Perth)	Landscape/Visual impacts Conservation Council and Wildflower Society raised concern regarding visual impacts.	BHP explained that the proposal would involve the same types of activities in the same area as the approved mine. As a result, no additional detrimental visual impacts are expected to occur
5 November 2009	Jimblebar	Consultation in relation to Jimblebar EPS	Department of Mines and Petroleum (DMP) (now DMIRS)	Rehabilitation and Dump Profile of the OSAs DMP requested that BHP Billiton Iron Ore consider adopting 10m high lifts, as it is easier for the batters to be re-shaped and flattened to their final angle.	BHP Billiton Iron Ore uses OSA lifts of between 10 and 20 m at its existing Pilbara operations, with the actual height used dependant on the characteristics of the overburden, location of the stockpile, operational requirements at the mine, and the sites rehabilitation and mine closure objectives. In general terms BHP Billiton Iron Ore agrees that it is easier for batters to be re-shaped and flattened to their final angle if OSA lifts are 10 m high, and as a result, where practicable OSA lifts at BHP Billiton Iron Ore's contemporary Pilbara mining areas are on the lower end of the range. There are however occasions where higher lifts are suitable and can still be successfully and progressively rehabilitated. The height of OSA lifts is therefore decided on a case by case basis as part of the Life of Mine (LOM) planning process. BHP Billiton Iron Ore intends to adopt this approach of determining OSA lift heights on a case by case basis at the Jimblebar Project.

Date (s)	Orebody	Description of Engagement	Stakeholders	Stakeholder comments / issue	Proponent response and / or resolution
17 November 2009	Jimblebar	Consultation in relation to Jimblebar EPS	DEC (now DWER / DBCA)	Management of Impacts on Shallow Perched Aquifers DEC (now DWER / DBCA) requested that BHP develop a monitoring program to detect potential impacts of altered hydrology on groundwater dependent ecosystems, in consultation with DEC. DEC suggested that this could be achieved by monitoring groundwater in the relevant superficial aquifers	BHP concurs that monitoring of potential impacts on the local surface water and groundwater and environmental values such as Innawally Pool should be conducted during the mine life. BHP will install and monitor paired monitoring bores at several locations adjacent to Jimblebar Creek, Caramulla Creek and of Innawally Pool (and adjacent to existing/planned vegetation monitoring sites) to assess seasonal water table (perched and permanent) fluctuations and potential Project-related effects.
				Final Void Water Quality DEC requested that BHP Billiton Iron Ore provides further information on the closure risks (e.g., final void water quality and native fauna) and gives consideration to backfilling pit voids to at least 2 m above the level of the pre-mining water table.	The final voids at Wheelarra Hill and Hashimoto that extend below the water table are not proposed to be backfilled. Similar to existing Orebody 18 Mine (Johnson and Wright, 2003), the Wheelarra Hill and Hashimoto mine voids are likely to form 'groundwater sinks' and no outflow of saline water is expected to occur (Aquaterra, 2009). BHP Billiton Iron Ore is planning to conduct further feasibility and groundwater assessments of post-closure options for the Project, including the option of not backfilling all or parts of the South Jimblebar pits to above the pre-mining water table. The likelihood that fauna would be impacted by the saline mine water is considered low given more suitable permanent and semi-permanent water resources are available in the surrounds (such as Ophthalmia Dam, Innawally Pool and Jimblebar Creek). BHP has considered the backfilling of pit voids. The Project Groundwater Assessment by Aquaterra (2009) included evaluation of post-mining water level recovery through the South Jimblebar pits based on the option of all parts of the pits that extend below the water table being filled to at least 5 m above the pre-mining water table. As part of the proposed Project, BHP is planning to conduct further feasibility and groundwater assessments of post-closure options for the Project, including the option of not backfilling all or parts of the South Jimblebar pits post-closure. The results of these assessments would be used to evaluate whether leaving the pits open post-closure would have a significant post-closure impact on the beneficial use of groundwater resources and / or other relevant environmental values in the Project area and surrounds. A commitment has been made to undertake the South Jimblebar pit infill evaluation, and if the results indicate that beneficial use and relevant environmental values will be significantly impacted, a new revision of the DFRP will be prepared which describes how the South Jimblebar pits will be rehabilitated and closed with backfilling to at least two metres above the pre-mining water table.
10 March 2010	Jimblebar	Consultation in relation to Jimblebar EPS	Office of the Environmental Protection Authority (OEPA), (now DWER)	Groundwater Drawdown Contour Extent OEPA queried why the minimum groundwater drawdown contour shown on Figure 4-12 of the EPS is 5 m.	A regional groundwater model was prepared as part of the Hydrogeological Assessment for the Project (Aquaterra, 2009). The accuracy of the model allowed for predicted groundwater drawdown contours to be generated at minimum intervals of 5 m. The groundwater model would be validated against the results of ongoing investigations and operational performance data and the model modified and re-calibrated as required to maintain the highest possible predictive reliability.
				PAF Material Management OEPA requested that a PAF management plan be included in the EMP document.	BHP Billiton Iron Ore has revised the draft EMP to include specific measures for the management of PAF material.
				Fibrous Material Management OEPA requested that measures for the management of fibrous material be included in the EMP document.	BHP Billiton Iron Ore has revised the draft EMP to include specific measures for the management of fibrous material.
				Creek Diversions – South Jimblebar Deposit Provide details of where creek diversions will be located, should the South Jimblebar pits not be backfilled, following completion of the South Jimblebar pit infill evaluation.	BHP has committed to undertake the South Jimblebar pit infill evaluation, and if the results indicate that beneficial use and relevant environmental values will be significantly impacted, a new revision of the DFRP will be prepared which describes how the South Jimblebar pits will be rehabilitated and closed with backfilling to at least two metres above the pre-mining water table. Should the South Jimblebar pits not be backfilled following completion of the South Jimblebar pit infill evaluation, BHP Billiton Iron Ore would provide detail for the relocated South Jimblebar pit creek diversions in a new revision of the DFRP.
10 March 2010	Jimblebar	Consultation in relation to Jimblebar EPS	OEPA (now DWER)	Backfilling of Below Water Table Mining Areas OEPA recommended that mine voids be backfilled to at least 2 m above the pre-mining water table, consistent with best practice Pilbara Iron ore mining, to avoid potential long-term impacts on the quality of groundwater resources and local fauna. OEPA suggested that backfilling will reduce the area required for waste dumps. OEPA requested that a justification be provided, should the pits not be proposed to be backfilled.	The final voids at the Wheelarra Hill and Hashimoto deposits that extend below the water table would not be backfilled. Aquaterra (2009) has assessed the potential impacts of leaving these voids open and has concluded that they would form localised groundwater sinks, which although they would gradually become saline over time, would not result in significant environmental impacts or adversely affect the beneficial use of groundwater in the region. This assessment is consistent with the neighbouring approved OB18 Mine (located approximately 5 km to the north-west) (Johnson and Wright, 2003). The hydrogeological conditions at the South Jimblebar deposit differ from the Wheelarra Hill and Hashimoto deposits in that the iron mineralisation is primarily hosted within Marra Mamba Iron Formation (rather than the Brockman Iron Formation) and there is more potential for connectivity with the Wittenoom Formation and overlying alluvium / colluvium. The Project Groundwater Assessment by Aquaterra included evaluation of post-mining water level recovery through the South Jimblebar pits based on the option of all parts of the pits that extend below the water table being filled to at least 5 m above the pre-mining water table. As part of the proposed Project, BHP is planning to conduct further feasibility and groundwater assessments of post-closure options for South Jimblebar, including the option of leaving the South Jimblebar pits open post-closure. The South Jimblebar pit infill evaluation would be used to evaluate whether leaving the South Jimblebar pits open post-closure would have a significant post-closure impact on the beneficial use of groundwater resources and / or other relevant environmental values in the Project area and surrounds. The results of the South Jimblebar pit infill evaluation would be incorporated into a revised DFRP to be prepared to the satisfaction of the OEPA, on advice from the DMP and DEC, within 5 years of Project approval. BHP has made a commitment to undertake the South Jimblebar pit infill evaluation, and if the results indicate that beneficial use and relevant environmental values will be significantly impacted, a new revision of the DFRP will be prepared which describes how the South Jimblebar pits will be rehabilitated and closed with backfilling to at least two metres above the pre-mining water table.
10 March 2010	Jimblebar	Consultation in relation to Jimblebar EPS	DEC (now DWER / DBCA)	Surface Water Contamination and Erosion and Sedimentation Control	The Jimblebar Hub Water Management Plan and include numerous measures for the management of potential surface water contamination, and erosion and sediment control.

Date (s)	Orebody	Description of Engagement	Stakeholders	Stakeholder comments / issue	Proponent response and / or resolution
10 March 2010	Jimblebar	Consultation in relation to Jimblebar EPS	Department of Indigenous Affairs	Surface Water Diversions and Cultural Heritage Values of Innawally Pool, Jimblebar Creek and its Tributaries Investigate the potential ethnographic values of Innawally Pool (and Jimblebar Creek) to determine if the potential loss of water to the pool would impact upon cultural values within it. Consult with local Aboriginal people regarding surface water diversions and any proposed. Decommissioning and Final Rehabilitation Plan.	Most of the additional disturbance area associated with the Project naturally drains to Jimblebar Creek upstream (south) of Innawally Pool, with only a small portion draining to Jimblebar Creek downstream of Innawally Pool. The risk assessment for the Project determined that there is a low risk of significant loss of downstream flow (including Innawally Pool) as a result of the Project. The potential reduction in runoff to Jimblebar Creek as a result of the Project is not considered by Aquaterra to be significant to the overall hydrological system, particularly in comparison to the natural seasonal variations in catchment runoff. BHP has consulted widely with the Nyiyaparli people regarding the Project and will continue to do so. The Nyiyaparli people provided no specific comments regarding the proposed disturbance of tributaries of Jimblebar Creek, or proposed surface water diversions during consultation for the EPS. BHP is satisfied that any cultural values will not be significantly impacted as a result of the Project.
5 May 2010	Jimblebar	Consultation in relation to Jimblebar EPS	OEPA (now DWER)	Impact of final voids on Fauna Assess the long-term impacts of contaminants and toxicants such as cadmium and selenium which have the potential to concentrate in the final voids and impact local fauna. Conduct leachate testing and geochemical modelling to determine the likely concentrations of metals and metalloids in the final voids and assess the associated potential impacts on local fauna.	BHP proposes to conduct a study in parallel with mining activities at Jimblebar that includes geochemical modelling and leachate testing as part of the South Jimblebar Pit Infill and Mine Closure Evaluation. The scope of this study will be developed with technical input from DEC to ensure the study delivers the outcome required. These studies would be extended and applied to other BHP Marra Mamba deposits in the Pilbara.

B-2. Nyiyaparli people's baseline closure principles / preferences

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Nyiyaparli Baseline Closure Principles/Preferences

At this preliminary stage, the comments, and recommendations below are an initial response only. This letter provides a preliminary summary of the main concerns Nyiyaparli people have raised in response to mine closure in a broad sense. The principles and concerns will be refined and revised in an on-going consultative process.
The chief preferences/concerns of Nyiyaparli people to date include:

- Safe and culturally appropriate access protocols post mine closure including the ability to continue to exercise native title rights.
- Primary preference for post closure land design (use) is for a landscape resembling (as close as possible) pre mining conditions
- Backfilling to ground level, especially if pit voids are in a highly visible area and/or require permanent creek diversions. If unavoidable, pit void design needs to take into consideration not only basic human safety but also, in relation to a healthy country, animals moving around country etc, try and maintain safe access and rehabilitation of voids if possible, consideration of alternative use eg solar farms etc if possible.
- Water management – long term impacts and management of both surface and ground water systems – need to make sure that natural systems are self-sustaining and nonpolluting.
- The group have a very strong aversion to pit lakes – this links to both water management and safety, all efforts should be made to avoid them. If they are completely unavoidable, then the number should be limited and consideration given to i) water quality of the pit lake e.g aim to meet recreation standard (or other standard if another use is agreed upon) – basically aim for an asset not a liability, and ii) direct and indirect impacts on surrounding water systems eg contamination risks, stygofauna, source vs sink dynamics etc
- Waste rock landform designs – consideration needs to be given to how these look and function long term - this is the country that Nyiyaparli are left with and they do not want a manicured landscape – preference is for them to look as natural as possible eg the inclusion of 'nice places' in design plans such small water holes – these are nice 'camping spots' and they support healthy country more generally by providing habitat and food sources for other animals etc
- Consideration of cumulative impacts – this includes the number of pit voids, changing landscape, creek diversions, etc
- Potential long term impacts upon places of outstanding cultural importance and repatriation of artefacts - requires transparency in terms of minerology
- Drone footage of the proposed mine and infrastructure area pre, during and post mining (eg projected 10 years time, 50 years, 100 years), visual impact assessments; images of what their country looked like before impact for longevity
- Ongoing consultation on mine closure design and rehabilitation work, including the opportunity for involvement in monitoring activities, onsite workshops and review of, and input into, MCP's. Requires the provision of easy to understand summaries on closure topics and mine closure plans
- Rehabilitation work – Baseline ethnoecological surveys are important as they can assist rehabilitation species composition planning etc. Consideration should be given to business tenders, employment and training opportunities

It is hoped that the above information can assist in establishing a baseline of Nyiyaparli expectations for closure design and therefore feed into basic discussions for future consultations.

Kind regards,
Michelle Gardner
Environmental Advisor, KNAC

B-3. KNAC's comments on draft Jimblebar Hub MCP & ERD (2023)

This appendix records this MCP's response to KNAC's comments on the draft Jimblebar Hub MCP and closure relevant comments on the ERD.

Response to KNAC comments on closure statements in draft Jimblebar Significant Amendment documents

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Page number	**Document content**	**KNAC comment/query**	**BHP response**
xvi (Executive Summary: Table 2 Proposal content elements)	Mine pit voids and pit lakes	Acknowledging that some voids must be left, Nyiyaparli do not support mining companies leaving abandoned voids or pit lakes - particularly if they cannot serve a post-mining land use or purpose. Pit lakes with a long-term deterioration in water quality represent an ongoing liability that is not supported, and if unavoidable, must be borne by the Company.	BHP acknowledges the Nyiyaparli people's stated preference for the avoidance of pit lakes and the MCP includes a forward work program for reviewing the backfill strategy. Given the Nyiyaparli people's views, a high priority has been assigned to progressing this study (Section 7.6). The MCP re-iterates BHP's SCHMP commitment to continue to consult on closure and rehabilitation matters (Section 4.2), which will include post-mining land uses (encompassing consideration of the potential for beneficial uses of mine voids and pit lakes) (Section 6.2) and post-mining access (Section 7.5.8).
xix (Executive Summary: Table 2 Proposal content elements)	Any permanent pit lake that forms following the permanent cessation of dewatering (if backfilling above the water table cannot be achieved) will be designed and managed to be safe and non-polluting.	It is not clear what is meant by being "managed to be safe". If it means that people will be excluded from the unsafe areas, then that is what it should say. Although pit voids may be groundwater sinks and hence be considered "non-polluting", they are not able to support any post-mining land use and as above represent an ongoing, permanent liability that the Company must be accountable for.	BHP acknowledges Nyiyaparli's preference for avoidance of pit lakes and ongoing access post-closure. BHP has a forward work plan for reviewing the backfill strategy for Jimblebar Hub and will continue to consult with Nyiyaparli people on mine closure, rehabilitation and post-mining land uses. Regulatory requirements for safe access will also need to be met.

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7 Inland Waters			
60 (Section 7.4.3.1)	The assessment for OB31 (BHP Billiton 2015c) predicted that the backfilled void scenario would recover to a pre-mining hydrological condition; however, it increased the risk of downstream impact through the potential transport of any potential AMD associated with mine waste). Conversely, the pit lake would not result in a pre-mining hydraulic condition with the pit void remaining a groundwater sink. The risk of downstream impact was low, due to the reversal of hydraulic gradient of groundwater flow towards the void and AMD likely being localised to the pit lake. BHP committed to backfill the below water table voids for that OB17/18 Approved Proposal (BHP Billiton 2007) so that no pit lakes will permanently form.	It is not clear what is proposed here. OB31 will have a pit lake, but OB 17 and 18 will not? What pH is predicted for OB31?	Further information is outlined in Sections 5.16 and 9.2.1 of the MCP: • The closure options for the OB17/18 below water table voids (Swan and De Grey) are to backfill with tailings or overburden to above the pre-mining water table (i.e., no pit lake). • The backfill strategy for OB31 is still under review and may include in-pit storage of tailings. The MCP discusses scenarios where OB31 remains a void and where it is backfilled. As described in Section 5.3.2.2 of the MCP, there is a very small (negligible, ~5,000 m^2) exposure of AMD 1 at the toe of the southern wall of the eastern section of the OB31 pit which represents <0.1% of the total pit shell surface area. Acidity generation from wall rock is low (Section 5.3.2.2) and the AMD 1 exposure would not be expected to significantly impact pit lake or groundwater quality (Section 7.3.2.2). BHP acknowledges the Nyiyaparli people's stated preference for the avoidance of pit lakes and has placed a high priority on progressing a backfill study in the MCP forward work program (Section 7.6).
8 Flora and Vegetation			
145	at closure, fauna habitats will be constructed into rehabilitated areas, where practicable	Not clear exactly what BHP is committed to here.	As outlined in Section 7.5.6.2 of the MCP, rehabilitation plans address the return of fauna habitat through selection of target vegetation communities and / or specialised constructed habitat features. Establishment of specialised fauna habitats is considered during the development of landform designs and associated work packs for execution. Rock habitat structures (described in Section 9.2.2.1 of the MCP) provide gaps and voids to allow species such as quolls and pebble mound mice to gain entry. BHP is in the process of planning a research program on fauna habitat and the return of fauna to rehabilitated areas. This will inform future rehabilitation practices.

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148	9.6.3 Impacts to species from mining activities The potential indirect impacts of mining activities and mining equipment and infrastructure (i.e. vehicles) on terrestrial fauna are typically non-lethal and generally take the form of changes to behaviour, resulting in avoidance of an area. These impacts are often temporary.	The direct impacts from mining are removal of habitat and there is little information about fauna return. There is concern amongst Traditional Owners that the rehabilitated land may never support the return of some species.	Section 10.1.4 of the MCP (fauna monitoring) has been updated as follows: We recognise that fauna have an intrinsic value to Traditional Owners however, the transient nature of fauna makes it difficult to consistently capture data that can be compared to a quantitative target. The objectives of fauna monitoring are therefore to: • Capture information on observed use of rehabilitation areas by fauna; and • Inform management of the impacts of feral animals and pests on rehabilitation. BHP is in the process of reviewing its rehabilitation monitoring procedures to determine how fauna use of rehabilitated areas can be integrated into the monitoring program.
175	Of special value is the Hill Kangaroo (understood to be the Euro). Nyiyaparli representatives have expressed concern about the loss of habitat for the Hill Kangaroo across their country and are interested in the recreation of suitable habitats post-closure and during rehabilitation.	Yes, and also Wallabies, Emus, Dingos, Goannas, birds, etc. (see Trip 2 report). The Hill Kangaroo was given as an example to outline that rehabilitation needs to support practical land uses. Rehabilitation of hills to re-create habitat for the Hill Kangaroo also requires re-creating or integrating into suitable surrounding landscapes that support a healthy ecosystem and habitat corridors.	The full list of species with cultural value provided in the Trip 2 report has been incorporated into Section 5.14 of the MCP. A research program is being developed for fauna habitat, including consideration of culturally significant species. This will be referenced in Section 7.5.6.2 of the MCP and incorporated into the forward work program.
175	Water is a key value of Nyiyaparli Traditional Owners and the management of water is a key interest. This includes in relation to the ephemeral creeks and temporary surface water features.	And groundwater. Nyiyaparli are also interested in water impacts from abstraction, injection, and discharge, and how these activities directly or indirectly impact environmental values.	Section 5.14 of the MCP has been updated to incorporate the following statement: *Discussion of the importance of the management of water including ephemeral creeks, temporary water features and impacts from abstraction / drawdown.*

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175	Several surface water features have been identified in the vicinity of the Jimblebar Hub. Those that are of most significance to the Nyiyaparli Traditional Owners are: • Innawally Pool • Jinerabar Pool	This is limiting what Nyiyaparli consider significant surface water features to Innawally Pool and Jinerabar Pool. These are key locations, but during trip 1, Nyiyaparli representatives outlined how water travels between the traditional country of several groups and each groups responsibility to manage it for the next (the picture of the shield). Management of water is significant on a regional scale for Nyiyaparli and other traditional owner groups and is not restricted to two locations.	Comment noted. Text modified to acknowledge that surface water moves across different groups and each group is responsible for managing it for the next. Section 5.14 of the MCP has been updated to incorporate the following statement: *Both Innawally Pool and Jinerabar Pool are significant heritage places for the Nyiyaparli Traditional Owners. However, management of water more broadly on a regional scale is also important to the Nyiyaparli people and other Traditional Owner groups, and it is each group's responsibility to manage water on their country as it travels to the next group.*
176	Nyiyaparli representatives through KNAC have expressed interest in rehabilitation and closure including final landforms, the types of plant species to be used in seeding for revegetation, changes to surface and groundwater regimes following cessation of mining and dewatering and safety.	The Nyiyaparli interest in rehabilitation and closure is to create a post-mining landscape and land use suitable for future generations to use and learn from. Nyiyaparli also want BHP to recognise the intrinsic value of the pre-mining ecosystem to reflect their care for country ethos.	Section 5.14 of the MCP has been updated to incorporate the following statement: *The Nyiyaparli people have expressed a strong interest in rehabilitation and closure with the aim of creating a post-mining landscape and land use which is suitable for future generations to use and learn from. This includes final landforms, the types of plant species to be used in seeding for revegetation, changes to surface and groundwater regimes following cessation of mining and dewatering, and safety. BHP is committed to working with the Nyiyaparli people to investigate how they might be engaged in rehabilitation and land management activities.* Section 4.3 includes the following reference in Table 4-2: *The pre-mining ecosystem is of intrinsic value to the Nyiyaparli people and reflects their care for country ethos.*
180	Pits that are not backfilled to above the water table are expected to be terminal sinks and as such are not expected to impact the water quality of surroundings groundwater.	The water quality of surrounding groundwater is important to Nyiyaparli, but so is the creation of an ongoing source of groundwater loss, evaporation and concentration of contaminants and salt in a pit void. The statement mentions only the upside of creating a groundwater sink.	If backfilling above water table is not possible due to lack of backfill material, a pit lake is expected to form and this will be a terminal sink such that water does not flow out of the pit. Therefore, this is not predicted to result in contamination of the surrounding groundwater or environment.

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MCP		The MCP is generally of good quality and is comprehensive. The surface water section appears to be unclear about small surface water features – how many and where? Completion criteria were not reviewed. Specific comments on the MCP are listed in Table 2 below.	The surface water section has been amended to reference the temporary surface water features that are discussed in further detail in Section 5.11.3 (ecohydrological assets) and aligns with information in the ERD.
vi	The mine operates on the lands of the Nyiyaparli people and copies of this plan have been provided to the Karlka Nyiyaparli Aboriginal Corporation (KNAC) for their review and comment on behalf of the Nyiyaparli people. BHP takes into consideration the views and feedback of the Traditional Owners as part of the closure planning process.	Note that the review of the MCP was based on the brief consultation process completed for the BHP Jimblebar Hub Significant Amendment environmental impact assessment documentation. It does not constitute a review based on mine closure specific consultation	The executive summary has been updated to include the following statement: *Closure was considered as part of the Social Surrounds consultation process for the Jimblebar Hub significant amendment, however, consultation on closure and rehabilitation is an ongoing process and further closure-specific consultation is required, as outlined in the Jimblebar Social and Cultural Heritage Management Plan (BHP, 2023).*
vii	Executive Summary Table 1 – Summary of Key Risks and Management Approaches Further consultation with key stakeholders (including Traditional Owners) is required to obtain more information on their views of: - Post-mining land use performance objectives and requirements for safe access. - Visual amenity. • Further consultation with the Nyiyaparli people is required in relation to: - Requirements for protection, management and post-closure access to sites of cultural significance. - Management of cultural artefacts. - Landform and rehabilitation designs	Post mining land use definitions do not adequately address Native Title rights. Land uses are related to underlying tenure rather than use. Appropriate species for use in backfilled pits is listed as a knowledge gap. Good to see that BHP is planning to establish vegetation in backfilled pits. Backfilled pits may represent an opportunity to create water-gaining sites that may become 'special places' in the future – nice places to camp, hunt etc. Nyiyaparli have a particular interest in identifying and capitalising on such opportunities to turn liabilities into assets. It can be difficult for Traditional Owners to envisage what can be achieved through the rehabilitation process – so the feedback is often simplified to 'put it back like it was'.	BHP acknowledges that further consultation is required with the Nyiyaparli people to define post-mining land uses and this is detailed in Section 6.2 (post-mining land use) which states: *"The post mining land use will be informed by stakeholder consultation. In advance of the final post mining land use being defined for the Jimblebar Hub mines, BHP has adopted post mining land uses consistent with the Australian Land Use and Management Classifications (ABARES, 2016) and the underlying tenure (Section 2.4) to guide the closure and rehabilitation of the site (Table 6-1 and Map 6-1). These provide an interim target to which closure and rehabilitation planning can work. However, we also recognise that the Nyiyaparli people will be custodians of the land post-closure, and further consultation is required to determine how traditional uses may be factored into these land use classifications."* This detail was not clear in the executive summary of the draft provided to KNAC for review and the executive summary in the revised version of the MCP has been updated accordingly.

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vii	Executive Summary Table 1 – Summary of Key Risks and Management Approaches Knowledge Gaps and Forward Work Program	Knowledge gaps include how to get recalcitrant species back in rehabilitation, developing seed mixes that generate useful populations of culturally significant species, creation of special places (e.g. water gaining sites). Pleasing to see Nyiyaparli Closure Principles mentioned.	BHP is commencing a program with the Nyiyaparli people focused on rehabilitation. It is anticipated that this program would enhance the re-establishment of culturally significant species. This program has been referenced in the executive summary of the MCP along with BHP's plans to improve rehabilitation through seed and tube stock research / trials and work with the Nyiyaparli rehabilitation team. The knowledge gaps around culturally significant species and creation of special places have been made more explicit.
1	1.1 Purpose of the plan	Nyiyaparli support the preparation of an integrated MCP for all of Jimblebar operations.	No action required.
4	Closure and Legacy Management – as stewards of the land on which we operate and members of the communities which host us, we have a responsibility to leave a sustainable, positive legacy for host communities, the environment and future land users.	KNAC looks forward to working with BHP to develop the concepts and processes to deliver on this requirement.	Noted.
10	Map 2-2	This map reinforces the small aperture for Jimblebar Creek to transit between future pits and the need for careful planning and controls to ensure that this feature is planned and implemented to succeed as a permanent walk away solution.	Noted.
17	Table 3-2 Management plan commitments with relevance to closure and rehabilitation	SCHMP should be included as it has obligations for closure and rehabilitation.	The SCHMP has been included in Table 3-2 – noting that at the time of providing the draft MCP to KNAC for review, the SCHMP had not been finalised or endorsed.
23	Table 4-1 Stakeholder consultation program	Include SCHMP commitment to ongoing communication on closure.	The SCHMP commitment to ongoing communication on closure will be referenced in Table 4-1 of the MCP. Table 4-2 (Sept 2023 review of MCP) also reiterates BHP's commitment to ongoing consultation on closure and rehabilitation matters and to understanding how cultural values can be integrated into mine closure and rehabilitation plans.

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43	Table 5-10 East Jimblebar overburden material proportions by stratigraphy Table 5-15 Volume of Jimblebar overburden & low-grade ore by AMD class	Significant quantities of shale are noted and presumably indicate ARD risk. Concerned that poor management or leaving a pit lake may lead to very poor water quality. 1,782,400 BCM of AMD1 indicated for East Jimblebar reinforces the above.	Concerns regarding pit lakes, and poor water quality within the lakes are noted and acknowledged in several areas of the MCP including Sections 4.3, 5.14 and 7.6. The forward work program (Section 7.6) includes a requirement to continually review the backfill strategy. It acknowledges the Nyiyaparli people's stated preference for the avoidance of pit lakes and has placed a high priority on progressing this study. Not all shale represents PAF material. While the mining model indicates that there is 1,782,400 BCM of AMD1 at East Jimblebar, this represents <1% of the total overburden at East Jimblebar.
94	BHP has committed to backfilling the Swan and De Grey pits to 5 m above the water table. The current plan for these pits is to use them for storage of tailings which will meet this commitment.	Nyiyaparli would like to continue to engage with BHP on these plans as backfilling to surface, or creation of water gaining sites may lead to better outcomes than just backfilling to 5m above water table	This has been noted in Table 4-2 (Section 4 - consultation) and Section 5.16.4 (Swan & De Grey in-pit tailings closure studies) as a forward work program.
116	5.5.5 Knowledge gaps & forward work program Ongoing identification of potential growth media sources to address the topsoil deficit is required as landforms are progressively rehabilitated.	It is not clear how BHP plans to address the growth media shortfall	Appendix E of the MCP provides a summary of growth media trials and research which includes an assessment of soil quality indicators and methods for improving the fertility of overburden materials. Research is ongoing and includes research on approaches to rehabilitation that can enhance soil function in the absence of topsoil, and seed enhancements with the potential to reduce topsoil requirements. Reference will be made to these programs in Sections 5.5.4 and 5.5.5, and the forward work program will be updated to reference growth media research.

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125	5.8 Vegetation Summary of key points	Key point and knowledge gap is how to establish vegetation with a more complete re-instatement of species (no mention of recalcitrant species). Also integration of culturally significant species and habitat for key fauna species for Traditional Owners should be mentioned.	The vegetation section has been updated to acknowledge: • The vegetation species of significance to Traditional Owners discussed in Section 5.14. • Vegetation communities' roles in providing habitat for key fauna. Appendix I (seed lists) have been updated to highlight those species that have been identified as of cultural significance. The knowledge gaps in Section 5.8 refer to gaps in baseline knowledge. Section 7.5.6 has been updated to include information on the program currently being commenced with the Nyiyaparli people which focuses on rehabilitation. It is anticipated that this program would enhance the re-establishment of culturally significant species. The associated forward work program has been amended to reference this program as follows: *Utilise the results of seed and tube stock research / trials and work with the Nyiyaparli rehabilitation team to inform the revegetation strategy.*
136	5.9 Fauna Summary of key points	No mention of significant species to Traditional Owners. It is important that key species are returned to the landscape.	The fauna section has been updated to reference the fauna identified as of significance to Traditional Owners in Section 5.14 (cultural values and heritage) which, in turn, has been updated to include the full list of fauna provided in the Trip 2 report.

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224	5.16.5 Summary of key points If OB31 remains an open void, then a pit lake will form. Based on the current mine plan, pit lakes would also be expected to form at WH123, WHASH, East Jimblebar, Sylvania and Mindoona pits. A small pit lake may form at Hashimoto, but this pit is more likely to remain dry. The pits at OB31 and Jimblebar would be expected to remain sinks (i.e., the pit lake levels would be lower than the surrounding water table and groundwater would discharge to the pits). Pit lake water quality would be expected to deteriorate as a result of evapo-concentration of naturally occurring salts and metals in groundwater	This is a key point in the summary and the number of pit lakes and their potential implications is problematic to Nyiyaparli who reiterate the Closure Principles prepared for BHP in the social surroundings workshops.	Noted. The forward work program includes a requirement to continually review the backfill strategy. It acknowledges the Nyiyaparli people's stated preference for the avoidance of pit lakes and a high priority has been placed on progressing this study.
224	An insignificant area of AMD 1 exposure in the OB31 pit wall would not be expected to represent a significant hazard to pit lake quality. There are AMD 2 (sparingly soluble) wall rock exposures in WH123 and minor exposures of AMD 1. South Jimblebar also has minor exposures of AMD 1. WHASH and East Jimblebar have larger exposures. However, studies have shown that acidity generation rates from wall rock are low (Section 5.3.2.2). An assessment of the impacts to pit lake quality will be con	As above.	Noted. The forward work program includes a requirement to continually review the backfill strategy. It acknowledges the Nyiyaparli people's stated preference for the avoidance of pit lakes and a high priority has been placed on progressing this study.

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252	7.3.3.3 The remaining areas of sheet-flow dependent Mulga are not expected to be impacted as the direction of surface flow in this area is away from the proposed pit; specifically, it flows away from the southern perimeter of the pits towards a branch of Jimblebar Creek, and the eastern pit perimeter flows northeast into minor tributaries that join the main channel of Jimblebar Creek (BHP, in-prep). Surface water management measures for closure will consider potential impacts to these sheet-flow dependent communities (Section 7.5.3).	It is difficult to verify this statement – it doesn't reference a map or other source of information.	The assessment of potential indirect impacts from the alteration of surface water regimes on banded Mulga communities within and adjacent the Development Envelope has been updated within the revised version of the *Jimblebar Hub Significant Amendment* ERD. Further details on the potential indirect impacts from alterations of sheet-flow has been provided with references to the *East Jimblebar: Surface Water Environmental Impact Assessment* (BHP 2023d) (ERD Appendix 3). This impact assessment includes figures showing the surface water flow through the areas where banded Mulga has been identified. The revised information in the ERD concluded that based on the direction of the surface water flow in relation to the Proposal footprint and banded Mulga communities, it is considered unlikely that the surface water sheet-flow would be reduced to an extent that would impact on the Mulga community of the area. The MCP summarises the impact assessment in the ERD (Section 7.3.3.3) and provides a map showing surface water flows for context. Unanticipated impacts to sheet flow dependent communities arising during operations will be reported and managed via existing AER processes. Closure planning will consider the potential impacts of closure designs to these sheet-flow dependent communities and / or any mitigations that can only be implemented at closure.
275	7.5.3.3 Creek diversion	Nyiyaparli expect to be consulted about the details of creek diversions.	The SCHMP commits to ongoing engagement throughout the life of the Proposal in relation to Nyiyaparli social, cultural and heritage values and interests, in the form of annual updates on the proposal at the Implementation Committee meetings, or as requested by KNAC. It is expected that these processes would be the avenue for raising items of interest for consultation, noting that the role of the MCP is to focus on rehabilitation and closure planning rather than impact assessment.

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Page number	**Document content**	**KNAC comment/query**	**BHP response**
282	7.5.6.1 Revegetation	No mention of number of species in seed mixes, target vegetation types, recalcitrant species etc.	Appendix I provides details of seed mixes (number of species) and target vegetation types. This is referenced in Section 7.5.6.1. BHP has an ongoing program of research into improving rehabilitation which include investigations into seed dormancy and alleviation of dormancy, seed germination and seed enhancement techniques. The results of this program are summarised in Appendix E. The section has been updated to reference a program that BHP is commencing with the Nyiyaparli people which is focused on rehabilitation and could include sourcing seed for species that are not commercially available, propagating tube stock for species that do not establish well from seed, and trialling rehabilitation techniques, including tube stock planting.
283	7.5.6.2 Fauna habitats	No mention of target habitat types other than rock habitat structures to attached quolls and pebble mouse.	A research program is being developed for fauna habitat. This has been referenced in Section 7.5.6.2 and incorporated into the forward work program.
283	Table 7-9 Rehabilitation management actions, tools and forward actions Improvement Activities (Further studies based on knowledge gaps)	No mention of improvements that would address Traditional Owner concerns – although these appear to be addressed in Table 7.1.	Improvement actions in Table 7-9 will also refer to Table 7.11.
292	8.2 Closure outcomes and guiding principles	Next revision could address Nyiyaparli Closure Principles.	Section 8.2 of the MCP has been updated as follows: To guide the development and implementation of mine closure and rehabilitation, BHP has established a set of guiding closure principles which are applied to the Jimblebar Hub mining operations. *These are outlined below and future iterations of the MCP will incorporate a review against the Nyiyaparli closure principles.*
295	Table 8-1 Jimblebar Hub completion criteria	A detailed review of completion criteria has not been completed on behalf of Nyiyaparli.	Noted.

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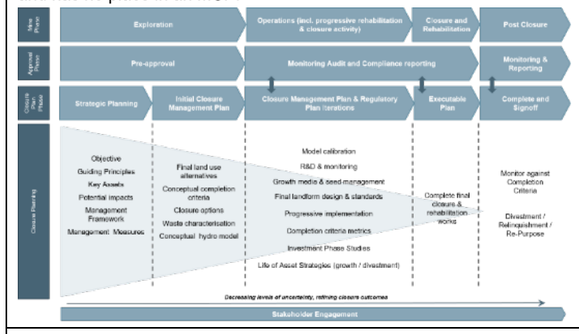
Page number	**Document content**	**KNAC comment/query**	**BHP response**
323	Visualisations	Very useful for Traditional Owners. Take care that texture of surface reflects what is likely to be achieved in terms of revegetation.	Noted. This will be considered in future visualisations.
340	Table 10-1 Completion audits and inspections	Nyiyaparli request data on return of key species such as kangaroo, emu, goanna.	Section 10.1.4 has been updated to reference BHP's review of its rehabilitation monitoring procedures to determine how fauna use of rehabilitated areas can be integrated into the monitoring program..

B-4. KNAC's comments on draft OB17/18/31 (2018) & Jimblebar (2021) MCPs

Category	KNAC Comment	BHP Action
General statement of the importance of mine closure to Nyiyaparli	Mine closure and rehabilitation are critical aspects of the mining operations for the Nyiyaparli People as they dictate what the Group will inherit to resume Native Title rights within its Determined Area.	Acknowledged in Table 4-1, Section 4.2
Combining Mine Closure Plans	KNAC is supportive of BHP preparing a combined MCP to cover the Jimblebar hub.	-
Section 2 Tenure	Tenure includes mention of underlying pastoral lease, but no mention of traditional ownership of the land via Native Title of the Nyiyaparli Determined Areas	The following statement has been included in Section 2.4: *The Jimblebar Hub is located on the land of the Nyiyaparli people (Native Title Determination [WCD2018/008] see Section 3.4.6 for further details), with their connection to the land stretching back over 40,000 years.*
Section 3 Legal obligations	The following comment is not accurate: *The Statutory Guidelines for Preparing Mine Closure Plans (2020a) require that mine closure be managed through Part IV of the EP Act on tenements subject to a State Agreement and the Mining Act 1978.*	Statement deleted.
	Add in tenement conditions for M266SA for Jimblebar	Added in Table 3-5, Section 3.4.4.
Section 4 Consultation	The group considers it important to agree on the social and environmental values to be developed as part of the safe, stable, non-polluting and sustainable landscape.	Further consultation with KNAC and the Nyiyaparli people was undertaken as part of social surrounds engagements for the Jimblebar Hub MCP in May (1-5) and August (21-25) 2023 (Table 4-2). BHP is committed to consulting further on mine closure and rehabilitation matters (Sections 4 and 7.6).
	Consultation with the Nyiyaparli People was limited to social surrounds engagements undertaken in relation to BHP project development throughout 2021 where mine closure was broadly discussed. Due to limited availability of the Nyiyaparli People throughout 2021, further and ongoing consultation will be required for the development of mine closure principles linked to the Jimblebar Hub MCP.	
	Section 4 states: *The current focus of the Jimblebar mining operations closure consultation is primarily with the key stakeholders Department of Water and Environmental Regulation (DWER), EPA and DMIRS.* The Nyiyaparli People, expect to be included in the current focus of closure consultation and note that as Traditional Owners who will inherit the outcomes of BHP rehabilitation, they see themselves as more than just stakeholders and believe there is a need for improved consultation with Traditional Owners in relation to Mine Closure and Rehabilitation.	Sentence in Section 4.2 has been amended to: In line with DMIRS guidelines (DMIRS, 2020a), BHP considers the key stakeholders for closure to be post-mining owners or managers, *including Traditional Owners*, and relevant regulators.
	Table 4-1 consultation program The focus on "progressive rehabilitation", of which there appears to be little, and "technical studies, post-closure use and access considerations" has been noted. We encourage BHP to consult with KNAC prior to planning the consultation sessions to ensure availability of key Nyiyaparli representatives and targeting of information provided/agenda items.	Further consultation with KNAC and the Nyiyaparli people was undertaken as part of social surrounds engagements for the Jimblebar Hub MCP in May (1-5) and August (21-25) 2023 (Table 4-2). BHP is committed to consulting further on mine closure and rehabilitation matters (Sections 4 and 7.6).
	Add the following concerns to the table of consultation in Section 4.3: • The impacts of dust accumulation; • Protection of heritage places during and after closure; • Access to country; • Keeping places for artefacts and cultural material; and • Involvement of Nyiyaparli People in rehabilitation activities	Added to Table 4-2.
	Table 4-2 mentions a Nyiyaparli site visit being cancelled due to COVID 19 restrictions in March 2019 – this should be 2020.	Amended in Table 4-2.
	The Nyiyaparli People would welcome the opportunity to review the rehabilitated areas of OB17/18/31 with BHP as part of our ongoing consultation regarding closure and rehabilitation. Progressive rehabilitation of these areas will help to provide confidence in the processes that BHP have identified to apply to closure and rehabilitation.	OB18 was visited during social surrounds on 4th of May 2023 and OB18 South and South Jimblebar OSAs were visited during social surrounds on 22-23 August 2023 (Table 4-2).
Section 5 Material characterisation / fauna	A key issue raised by Landloch (2016b in the MCP reference list) in using these materials in rehabilitation is the potentially hard setting surface - which may have implications for seeding OSAs at closure. The Nyiyaparli people request BHP consider the creation of suitable habitat for burrowing fauna as well as vegetation. The lack of topsoil is also a concern in relation to the ability to create suitable habitat for burrowing fauna.	Rehabilitation plans address the return of fauna habitat through selection of target vegetation communities and / or specialised constructed habitat features. Establishment of specialised fauna habitats is considered during the development of landform designs and associated work packs for execution. Rock habitat structures (Section 9.2.2.1) provide gaps and voids to allow species such as quolls and pebble mound mice to gain entry. Landform designs typically require a higher percentage of rock on slopes for stability, but the surfaces of OSAs may contain less rock and, therefore, are of greater suitability for species that require less rocky habitat (Section 7.5.6.2).
Section 5 Materials balance	Section 5.5 documents a topsoil shortfall estimated at 2.4 Mm^3. No information has been provided as to what has caused such a short fall. The development of a rehabilitation strategy that delivers appropriate outcomes on Nyiyaparli land is important to the Nyiyaparli People.	An explanation of the topsoil deficit has been provided in Section 5.5.3. BHP is committed to BHP is committed to consulting further on mine closure and rehabilitation matters (Sections 4 and 7.6) and is progressively incorporating feedback from KNAC and the Nyiyaparli people into relevant sections of the plan (e.g., Sections 5.14, 6, 7.4, 7.6, 9.2.1.1).
Sections 5 Surface Water 8 completion criteria 9 closure strategies for specific domains	Map 5-8 (JMB plan) indicates only one surface water diversion, but the figures show drainage flow paths crossing indicative pits that would presumably require diversion. It also shows indicative pits in close proximity to Jimblebar Creek just upstream of Innawally Pool. It is not clear if flood bunding will be constructed during operations or closure. The protection of Innawally Pool from impacts during both mining and closure is important.	The footprints of mining areas and OSAs are confirmed during the design process as each area approaches disturbance. During this process, the need for flood bunds or diversions is considered. Section 5.16.3 includes information on design studies for all current / proposed flood bunds / diversions. Impacts to Innawally Pool are separately discussed in Section 7.3.3.4.
	The Nyiyaparli People are generally concerned with water flows and cumulative impacts to water balances in their country. BHP has indicated that final landforms are yet to be confirmed, the number, location and details of water diversions for closure is unclear. The Group would like to ensure that the design basis for water diversions is appropriate, and that water flows through the landscape will be re-instated and sustained post-mining.	Section 5.16.3 outlines the design studies for all current / proposed flood bunds / diversions. Section 7.5.3 outlines the general design principles for surface water management infrastructure and Section 9.2.3.4 describes conceptual closure designs and design considerations.
Section 5 Surface Water	Section 5.1.1 describes the installation of water quality monitoring in Jimblebar and Copper Creeks with data (to date) provided in Table 5-20. No interpretation of the data is provided, and it appears that there is a pH drop downstream at both locations. No definition of TSS is provided, it is unclear if the TDS represents all dissolved solids or only salinity and Table 10.1 does not list upstream pH monitoring of Copper Creek.	Section 5.11.1.5 has been updated with data from recent water quality monitoring (2019 - 2022). The data is limited but includes one round of sampling at Innawally Pool. A brief discussion of the monitoring results has been provided, but a more detailed analysis of monitoring data is planned as part of the forward work program (Section 7.6).

Category	KNAC Comment	BHP Action
Section 5 Groundwater – change assessment	The need to dewater pits to allow mining to proceed safely is understood by the Nyiyaparli People. The post-mine recovery of aquifers and implications of post-mine changes is not well understood, and the Group is seeking re-assurance that BHP will continue to manage these implications post-closure until equilibrium conditions are demonstrated.	The modelling of aquifer recovery as described in the MCP is conceptual, and will continue to be refined through adaptive management processes as new information is obtained. BHP recognises that the presence of pit lakes in the closure strategy will impact on the recovery timeframes and outcomes. The backfill strategy including opportunities to progressively backfilling during the life of the operation will help to reduce timeframes for aquifer recovery. BHP commits to improving the understanding of aquifer performance post closure to inform decision making and planning for post closure management. Monitoring data will be used to validate groundwater models by comparing model predictions of groundwater recovery to observed data (i.e., checking that groundwater is behaving as predicted following mining) (Section 10.1.8).
	Table 5-22, Map 5-9 and the supporting text does not explain what the implications may be from cutting through the central fault that is currently separating two of the aquifers. More detail is required to understand the implications of the planned mining for mine closure, pit lakes and long-term outcomes.	Under dewatering conditions, these western and eastern compartments on either side of the Central Fault can be thought of as separate entities. Current mine plans do not intersect the Central Fault below the water table. However, if the fault were to be removed, groundwater levels would be similar in the eastern and western compartments post-closure. This is similar to the pre-mining condition where the groundwater levels across the Jimblebar mining area were very flat with similar levels either side of the Central Fault (Section 5.11.2.3).
	BHP notes that "there are no groundwater fed pools or springs owing to the deep regional groundwater levels". In Section 5.8.4 BHP states that "while groundwater drawdown of the deep aquifer is not likely to impact Innawally Pool, adjacent mining of the Hashimoto ore bodies could impact on the perched groundwater systems that support the pool. As mining progresses towards Jimblebar Creek, assessment of the potential impacts on the perched aquifers and Innawally Pool will be required to inform final mine design." These two statements appear to be at odds with each other. Clarification on groundwater systems and cumulative impacts in these regions is required.	Groundwater fed pools / springs refers to regional groundwater, however, to avoid confusion, this statement has been removed from the MCP.
	Recovery time frames for the long-term drawdown levels, long-term changes to surface and groundwater quality are of significant concern.	Table 4-2, Section 4.3 has been updated to reflect these matters of interest.
Section 5 Contaminated sites	Suspected contamination by Hydrocarbons at JB-10 Jimblebar – Fuel Farm, investigation is only scheduled to commence in 2051 – is this a mistype? If not, why is there such a delay in investigations?	In areas where the potential for soil contamination has been identified, assessment and remediation are generally managed in accordance with the CS Act and DWER requirements (including sampling / analysis and remediation / management) during a site's operational life and not left unresolved at the time of closure. As a site approaches closure, investigation and remediation of any remaining contamination is considered during BHP's closure study phases (refer to the introduction to Section 5). This includes consideration of whether the contamination land use classification of sites previously investigated / remediated is commensurate with the agreed post mining land use (Section 9.1.5). An inspection schedule is maintained across site to inspect targets on a periodic basis (the frequency determined by risk posed) and the contamination is controlled. Should any further suspected contaminated targets be identified in future, investigation will be prioritised based on risk, as discussed with the DWER in regular meetings. In some instances, final investigation and remediation can only be conducted once infrastructure has been removed (Section 5.12).
Section 5 Local land use	It is disappointing to note that the sections on post-mining land use do not consider the resumption of Native Title rights when BHP has finished mining. There is no mention of the Nyiyaparli people in the local land use sections.	Traditional uses of the land have been acknowledged in both Section 5.15 and Section 6.
Section 5 Visual amenity	The visual amenity work completed by Urbis (2009) and 360 Environmental (2014) pre-dates consideration of Indigenous use of the land or sites of Indigenous significance for visual amenity. The Group looks forward to seeing what visual aids BHP can bring to the post-mine landscape and encourages engagement on post-mine land use, landscapes and visual impact. The visual amenity work was based on publicly accessible potential vantage points that presumably did not consider landscape views relevant or significant to the Traditional Owners.	Section 5.13 has been updated to acknowledge that 2009 and 2014 visual assessments did not consider views of importance to the Nyiyaparli people. A Jimblebar Hub visualisation was presented at the August Social Surrounds and screenshots have been included in the MCP (Section 9.2.4).
Section 6 Post-mining land use	It is disappointing to note that the sections on post-mining land use do not consider the resumption of Native Title rights when BHP has finished mining.	Traditional uses of the land have been acknowledged in both Section 5.15 and Section 6.
	Map 6-1 shows the disturbance areas that may not support a specific post-closure land-use due to ingress/egress restrictions. The high proportion of areas with access restrictions is of concern.	BHP acknowledges concerns raised by KNAC on behalf of the Nyiyaparli people about the restricted post-closure access to pits and will continue to optimise pit closure strategies, including backfill designs, that may, in some instances allow for safe access, however, regulatory requirements for managing access will also need to be met (Table 6-1, Section 6.2).
Section 7 Risk identification & management	Divestment is identified in Figure 7-1 in both operational and post-closure phases. The Nyiyaparli People would like to point out that divestment does not represent a risk management option in relation to managing Project closure risk for any parties other than BHP and has no place in an MCP. 	Noted.
	In section 7.1.1 rehabilitation trials and research are addressed by cross reference to Annual Environmental Reports and Appendix F, neither of which are included in the document	Appendix F provides a summary of growth media trials and research but is commercially sensitive. Some research that has been conducted at the Jimblebar Hub is outlined in Section 5.16.6.

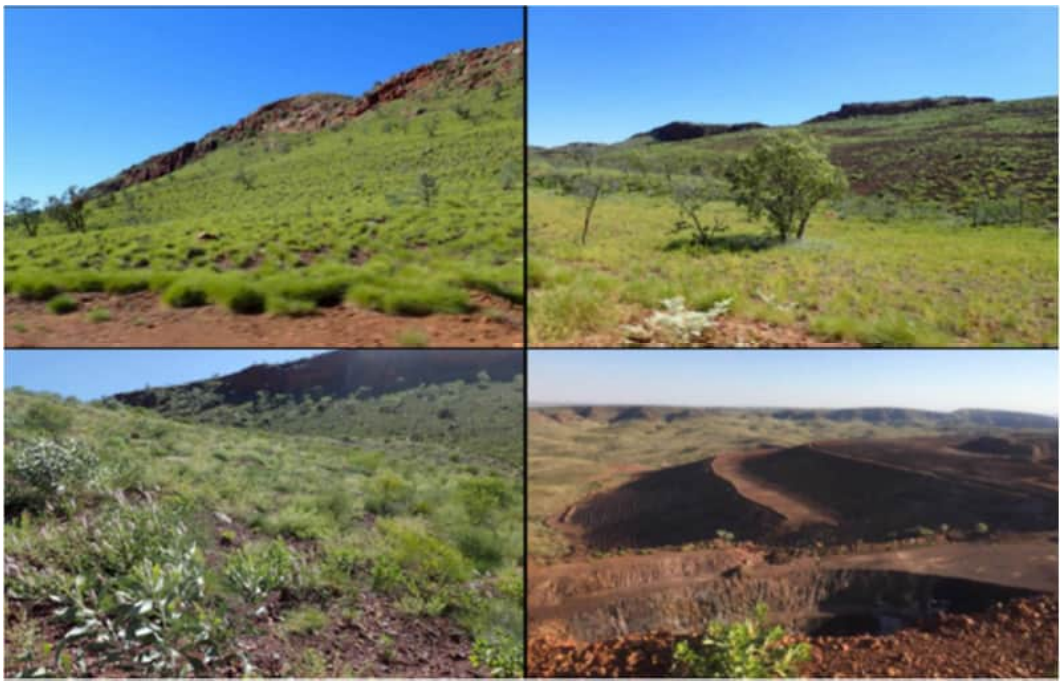
Category	KNAC Comment	BHP Action
Section 7 Risk identification & management – rehabilitation	The section states: *"During rehabilitation works, suitable material will be identified for use in the creation of landforms that mimic those of surrounding areas, with natural drainage lines being restored where practicable. Specialised fauna habitats will be established if available resources can be identified, however there are currently no plans to disturb new areas to source these materials."* If suitable materials are only being identified during rehabilitation works, it does not suggest any real planning for rehabilitation. Similarly, the establishment of specialised fauna habitats (no definition provided for specialised fauna habitat) is only established if "available resources can be identified". These statements do not give confidence to the Nyiyaparli People that they will be inheriting best practice rehabilitation from BHP.	Section 7.5.6.2 specifically addresses fauna habitat and has been amended to read: *Rehabilitation plans address the return of fauna habitat through selection of target vegetation communities and / or specialised constructed habitat features. Establishment of specialised fauna habitats is considered during the development of landform designs and associated work packs for execution. Rock habitat structures (Section 9.2.2.1) provide gaps and voids to allow species such as quolls and pebble mound mice to gain entry. Landform designs typically require a higher percentage of rock on slopes for stability, but the surfaces of OSAs may contain less rock and, therefore, are of greater suitability for species that require less rocky habitat.* There is a forward work program (Section 7.6) to investigate fauna habitat and the return of fauna to rehabilitated areas, including consideration of key species of significance to the Nyiyaparli people.
Section 7 Risk identification & management	The impact of dust from the many mining operations around Newman has been an area of concern for the Nyiyaparli People for many years. For example, people have noticed that unwillingness of small birds to drink from water pools that have a thin layer of dust on the surface. Whilst this is an operational issue, the continuous nature of dust emissions to the atmosphere and cumulative deposition of this material may be an issue for closure. Historically, EPA assessments of dust have focused only on sensitive premises and not considered cumulative impacts on vegetation, fauna, waterways or heritage sites. The Nyiyaparli People are concerned about the implications of dust emissions on their country and request BHP consider addressing this concern through further investigations and assessments, monitoring and consultation with the Nyiyaparli People.	Dust was discussed in the August Social Surrounds and is addressed in the SCHMP for the Jimblebar Hub.
Section 8 completion criteria	Completion criteria were specifically raised in relation to the weed comments, below, but applied more broadly. As with many completion criteria, these may require further consultation and development.	Completion criteria are reviewed and updated as new information becomes available (Section 8.3). BHP is committed to consulting further on mine closure and rehabilitation matters (Sections 4 and 7.6).
Sections 9.1 and 9.3 Rehabilitation	Despite Mulga vegetation types being noted as ecosystems at risk in section 5.6.7, there appears to be no mention of rehabilitation of Mulga.	Section 9.1.3 outlines how baseline vegetation data and landforms are used to inform seed lists appropriate to closure of each domain. Seed lists are provided in Appendix J
	The Nyiyaparli people request BHP consider the creation of suitable habitat for burrowing fauna as well as vegetation	Landform designs typically require a higher percentage of rock on slopes for stability, but the surfaces of OSAs may contain less rock and, therefore, are of greater suitability for species that require less rocky habitat (Section 7.5.6.2). In addition to the rocky fauna habitat discussed in Section 9.2.2.1, Section 9.1.2 discusses other means of creating fauna habitat considered in rehabilitation planning. Section 7.6 includes a forward work program to further investigate fauna habitat, including consideration of key species of significance to the Nyiyaparli people.
	Table 9-3 provides a rehabilitation summary for Jimblebar. The oldest rehabilitation areas are associated with rail and show a range of results, but with many sites showing a difficulty in re-establishing *Triodia* (spinifex hummock) grasses. It is important to the Group to understand and participate in the development of rehabilitated landscapes that they will inherit. BHP is encouraged to take into consideration rehabilitation of, and access to, culturally significant species, to effectively do so the following activities are requested: • Inclusion into the rehabilitation prescription of plant species with tucker, medicinal or other cultural significance to the Nyiyaparli People, inclusive of vegetation that is of broader ecological importance; • Research into the biology of those species (where little is known); • Creation of habitat to encourage culturally significant species to re-occupy rehabilitation areas; • Consideration of access for Traditional Owners post-mining; and • Creation of places that the Traditional Owners can conduct cultural activities to replace those that have been lost through mining.	BHP is in the process of establishing a Nyiyaparli rehabilitation group. Appendix J contains the seed list for Jimblebar and has highlighted those species identified as of cultural significance in the *Nyiyaparli People and Country Plan* (KNAC, 2023) and / or BHP's internal ethnobotanical database. It is envisaged that the activities of the Nyiyaparli rehabilitation group could include sourcing seed for species that are not commercially available, propagating tube stock for species that do not establish well from seed, and trialling rehabilitation techniques including tube stock planting. BHP has an ongoing research program focused on improving rehabilitation success which includes research on seeds and growth media. A research program on fauna habitat, including consideration of key species of importance to Traditional Owners, and the return of fauna to rehabilitated areas, is currently in the planning phase. Section 6 (post-mining land use planning) acknowledges the need to consider: • Plant species with tucker, medicinal or other cultural significance to the Nyiyaparli people. • Creation of habitat to encourage culturally significant species to re-occupy rehabilitation areas • Creation of places where the Traditional Owners can conduct cultural activities to replace those that have been lost through mining. • Beneficial use of pit lakes (comes from KNAC mine closure principles). Post-mining access is considered in Section 7.5.8 and the forward work program in Section 7.6.
	The rehabilitation schedule for Jimblebar indicates that no areas will be fully rehabilitated until 2055 – only "opportunities will be identified and integrated into rolling 5 year plan". This delay in rehabilitation is confusing given Table 3-4 [*NVCP conditions*] indicates that revegetation and rehabilitation of areas needs to occur within 12 months – and in s10.1.1.2 it states that rehabilitation should only take a maximum of 15yrs [*Not sure where this statement comes from. The only reference to 15 is year 15 of rehabilitation development monitoring*]. Further confusion arises given existing rehabilitation areas listed in 9.3.1. Clarification needed in this area. The above schedule does not provide the Nyiyaparli People with confidence that progressive rehabilitation has been or will be implemented at Jimblebar – given approvals were given in 2005 for the Project to proceed.	To make BHP's rehabilitation intent clearer, the following amendments have been made: • Planned rehabilitation has now been moved from progressive rehabilitation to a subsection in implementation schedule (Section 9.4.2) and renamed five year plan. • The broad closure implementation schedule (Section 9.4.1) is now called life of asset overview and includes the following explanation of the closure schedule. *The current life of the Jimblebar Hub operations is until ~ 2053. Given the long life of the asset, mine plans can change according to a range of factors including market conditions and technology and several mining areas may be used over a long period of time to achieve appropriate blends to meet customer demand. A broad schedule is identified for progressive closure based on the predicted life of each orebody (Table 9-4). As the mine life progresses, areas available for rehabilitation can be factored into the five-year plan (Section 9.4.2). While rehabilitation trials may be conducted on areas that have been confirmed as not being required for at least five years, BHP prefers to conduct full scale rehabilitation once it has been confirmed that an area will no longer be required for mining. This is because re-disturbance of an area results in some losses of valuable rehabilitation materials (such as topsoil) and can negatively impact the structure of these materials by subjecting them to additional handling.* The NVCPs apply to clearing for specific uses (e.g., exploration, transmission line, rail infrastructure, haul roads) and the 12 month timeframe relates to rehabilitation of an area when it is no longer required for the purpose for which it was cleared.
	We encourage BHP to: • Complete trial work and progressive rehabilitation to continue to develop best practice rehabilitation processes for the Pilbara; • Improve the implementation of progressive rehabilitation to ensure that liabilities are not deferred; and • Involve the Nyiyaparli People in the above to ensure that they have an understanding of how their country will be shaped and rehabilitated, and the opportunity for input into the outcomes and objectives of such rehabilitation.	Section 5.16.6 summarises the outcomes of rehabilitation trials conducted at Jimblebar and the forward work program includes the following: • Locations which may be available for a minimum of five years will be investigated for rehabilitation / landform trials and incorporated into the 5-year plan. • Consultation will continue with Traditional Owners including landform and rehabilitation designs.
9.2 Closure strategies for specific domains (mine voids)	No commitment to backfill below water table pit voids exists, however backfilling mined out pit voids is a priority focus." The Nyiyaparli People do not support the creation of pit lakes.	Nyiyaparli principles for closure are summarised in Section 5.14 and provided in full in Appendix B-2. BHP acknowledges the Nyiyaparli people's stated preference for the avoidance of pit lakes and a high priority has been placed on a review of the backfill strategy in the forward work program in Section 7.6.
	The pit lakes are expected to be permanent features post-closure and require careful consideration to ensure that the risks of them becoming a liability for future generations is minimised.	
	The presence of potentially acid forming (PAF) materials is noted. The Nyiyaparli People do not support mine closure that leaves acid or saline pit lakes. Consideration should be given to the design and ongoing standards for pit lake areas and safety as described above. Innovative mine closure approaches that avoid the need for pit lakes and do not create long term liability are required.	

Category	KNAC Comment	BHP Action
9.2 Closure strategies for specific domains (mine voids) & now also 7.5 Site safety and security	It is not clear how BHP intends to ensure a walk-away solution for post-mining features that will require maintenance such as signs, fences and gates. The creation of significant areas around mine voids that are no longer safely accessible during mine closure is of concern. The Nyiyaparli People seek a solution to this problem that allows safe access in the future.	Safe access is addressed in Section 7.5.7 and still includes fencing / signage as these may be required in places. As discussed in Section 10.4, land management requirements post-completion will be typical for the agreed post-completion land use unless otherwise specified in the post-completion management plan agreed with the landowner / manager. At relinquishment, land management responsibilities will be transferred to the landowner / manager, with adequate provisions for management requirements beyond those normally associated with the agreed post-completion land use. Provisions for safe access to the closed mine would be made in consultation with key stakeholders to accommodate the post-mining land use and enable Traditional Owners to access places of importance (Section 7.5.8).
9.2 Closure strategies for specific domains (mine voids)	the use of “trim shots” is identified to reduce the potential for pit wall failure post-closure. This term is not defined. Map 9-2 is very difficult to interpret [*example of mine planning output to progressively backfill voids*].	Reference to both Map 9-2 and “trim shots” have been removed from the MCP.
9.2 Closure strategies for specific domains (OSAs)	In Table 9-1 OSA closure strategies are provided with cross reference to Map 2-1. The Table refers to concave, concave stacked and stacked linear landform design features which don’t appear to have been defined. As these will be key features of the closed mine landscape, the Nyiyaparli People seek input into the landform designs and encourage BHP to pursue backfilling strategies.	Section 5.16.2 and Appendix L summarise the design studies conducted for landforms. Section 5.16.2 includes a brief precis of SIBERIA modelling of representative concave and linear landforms. A series of example cross sections and isometric views of single linear / concave slopes and stacked linear / concave slopes have been provided in Figure 5-55. Table 9-2 in Section 9.2.2 either refers to a landform specific design in Section 9.2.2, or refers back to the example landforms in Section 5.16.2 where no landform specific design exists yet. A high priority has been placed on a review of the backfill strategy in the forward work program in Section 7.6. BHP is committed to consulting further on mine closure and rehabilitation matters (Sections 4 and 7.6).
9.2 Closure strategies for specific domains (surface water)	The MCP notes a number of operational surplus dewatering options including creek discharge (several locations) and managed aquifer recharge (MAR). Where creek discharge is the only or best option, in addition to monitoring the downstream impacts during discharge, consideration also needs to be given to the timing and implications of slowing and ceasing the quantities as mine dewatering requirements reduce. This is briefly mentioned in section 7.4.3 but more detail is needed on how rehabilitation activities and monitoring plans will be prepared and implemented for each location.	Discharges and impacts are managed during operations though Licence L5415/1988/9, the Jimblebar Water Management Plan, Jimblebar Flora and Vegetation Management Plan and Eastern Pilbara Water Resources Management Plan. The risk of long-term vegetation change is low due to the intermittent and short duration nature of discharges, unlike a permanently operating creek discharge system that is seen at other operations in the Pilbara. Some minor change to vegetation may be occur following cessation of mining, however, it is expected that the vegetation would naturally re-equilibrate as the intermittent and short duration of the discharge means that large-scale change to riparian vegetation should not occur and require management post-closure (Section 7.3.3.2).
	The Nyiyaparli People seek to maintain the integrity of all surface water systems during operations and post-mining. Impacts to Innawally Pool during mining and closure are of particular concern. Table 5-22 notes that modified flow patterns, volumes and velocities in drainage represents a low to moderate change during closure. The design and design standards for any permanent diversions and flood protection structures requires careful consideration.	Section 5.16.3 outlines the design studies for all current / proposed flood bunds / diversions. Section 7.5.3 outlines the general design principles for surface water management infrastructure and Section 9.2.3.4 describes conceptual closure designs and design considerations.
Noted in Section 5 (visual assessment) but relevant to Section 9.2 Closure strategies for specific domains	Waste rock landforms (OSA in BHP nomenclature) will be a significant residual feature of mine rehabilitation that will be inherited by the Nyiyaparli People when BHP have finished mining and rehabilitation. It is noted that ERM completed a landform design and opportunities assessment for BHP in 2014 (Section 7.10). The MCP states that “analysis supported the application of WAIO’s standard landform design practice to the OB17/18/31 area. This practice develops designs for ex-pit OSAs which are based upon existing geometry (i.e., no major earthworks are required beyond reshaping to achieve closure objectives) and includes controls for local surface water drainage (e.g. slope crest bunding) and material stability.” It is not clear whether this review included any consultation with the Nyiyaparli People (no appendices were provided).	Section 5.13 acknowledges that previous visual assessments did not consider views of importance to the Nyiyaparli people and the forward work program includes an action to consider the visual characteristics of landforms that have not yet been rehabilitated during the detailed design phase, including consultation with the Nyiyaparli people.
Sections 5 (weeds) 7.5 (rehabilitation) 10 (weed monitoring) 10.3 (maintenance)	A previous KNAC query: What is BHP’s responsibility if an introduced weed takes hold? While they have a spraying program, weeds are still found there. What happens when they leave? Are they responsible to make sure all weeds are removed after leaving? BHP responded to clarify that it is responsible for removing weeds introduced by the Proposal, noting that it does spray for weeds annually subject to access. KNAC notes that the 2005 EPS states that only five environmental or otherwise recognised weed species were recorded previously in the Project area or along the Wheelarra Hill rail spur line (i.e., *Cenchrus ciliaris, Malvastrum americanum, Sonchus oleraceus, Lactuca serriola*, and *Acetosa vesicarius*). It appears likely the mine disturbance has increased the number of species growing in the area. In addition, Map 5-6 suggests introduced species are widespread throughout the disturbed areas. The response also refers to the application of completion criteria for mine closure. Completion criteria are provided in Table 8-1 of the Jimblebar MCP. As with many completion criteria, these may require further consultation and development.	Monitoring and weed management will be conducted generally in accordance with the Weed Management Procedure (WAIO, 2020b) and Jimblebar Flora and Vegetation Management Plan (BHP, 2020a) until the weed cover objective is met. These documents require annual monitoring and treatment of introduced species and weed cover within the Development Envelope and biennial monitoring of reference sites (Section 10.1.3). Where weed cover is not meeting objectives, weed control measures will be implemented generally in accordance with the Weed Management Procedure (WAIO, 2020b). Post-mining weed control measures and monitoring programs will be refined in consultation with the relevant authorities. Approved changes to the monitoring programs and control measures will be documented in the AER, revisions of the Jimblebar Flora and Vegetation Management Plan (BHP, 2020i) (BHP, 2020a) and weed management procedure (WAIO, 2020b) (Section 10.1.3).
Section 10 (water monitoring)	BHP outlines regional monitoring network for water. Such a network is supported by the Nyiyaparli People who see water as an integral part of the land.	No action required in MCP.

Appendix C. Analysis of rehabilitation across WAIO sites

BHP Pilbara Expansion Strategic Proposal

Rehabilitation Report FY2021



January 2023

Authorisation

Version	Description	Position	Date
Rev 0	Initial version – for OB32 Below Water Table Derived Proposal	Manager Environment WA Iron Ore	July 2022
Rev 0.1	Addition of Western Ridge Derived Proposal	Manager Environment WA Iron Ore	January 2023

Glossary

Term	Meaning
Allelopathic species	Plant species which chemically inhibit another plant due to the release into the environment of substances acting as germination or growth inhibitors
Baseline data	Regional or local data (from reference sites) from a point in time used to compare data at rehabilitation sites
Completed rehabilitation	Rehabilitation areas where the revegetation phase of rehabilitation is at a stage where it can be assessed for completion (rehabilitation generally greater than 15 to 20 years old)
Completion criteria	Agreed standards or levels of performance that indicate the success of completed rehabilitation (DMIRS 2020)
Disturbed land	Total land area that is physically impacted by the activities of the business (including cleared areas)
Domain	A group of landform(s) or infrastructure that has similar rehabilitation and closure requirements and outcomes (DMIRS 2020)
Future rehabilitation activities	Rehabilitation areas where rehabilitation activities have not yet commenced, i.e areas that have been cleared or areas planned and proposed to be cleared
Post-mining land use	The outcome environment that is established for disturbed land after mining ceases (from Syrinx 2020)
Progressive criteria	Criteria developed for this report to measure how rehabilitation underway is progressing and whether it is likely to be successful (at completion)
Reference site	Location that has not been subject to mine-related disturbance that is monitored (landform and vegetation) as part of BHP's rehabilitation monitoring program
Rehabilitation	A process, which improves a degraded environment toward an agreed goal (Syrinx 2020)
Rehabilitation area	Area where rehabilitation activities have been undertaken and revegetation phase has begun
Rehabilitation site	Location within area under rehabilitation that is monitored as part of BHP's rehabilitation monitoring program
Rehabilitation underway	Rehabilitation areas where all rehabilitation activities have been undertaken but the rehabilitation is not at a stage where it can be assessed for completion (rehabilitation generally less than 15 years old)
Revegetation	Phase of rehabilitation, including any or all of the following activities - final trim, topsoil, ameliorant, contour ripping / scarification and seeding, to achieve rehabilitation

Abbreviations

Term	Meaning
AER	Annual Environmental Report
AWT	Above water table
BWT	Below water table
DMIRS	Department of Mines, Industry Regulation and Safety
DWER	Department of Water and Environment Regulation
EPA	Environmental Protection Authority
EP Act	*Environmental Protection Act 1986* (WA)
FY	Financial Year
ha	Hectare
IRR	Impact Reconciliation Reports
MCPs	Mine Closure Plans
MRF	Mining Rehabilitation Fund
MS	Ministerial Statement
MS1105	Ministerial Statement 1105
NA	Not applicable
NVCP	Native Vegetation Clearing Permit
OB	Orebody
OB32 BWT	Orebody 32 Below Water Table Proposal
OSA	Overburden Storage Area
Strategic Proposal	BHP Pilbara Expansion Strategic Proposal
TBA	To be advised
WA	Western Australia
WABSI	Western Australian Biodiversity Science Institute
WAIO	Western Australian Iron Ore
Western Ridge	Western Ridge Proposal
yrs	Years

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Summary

Purpose, approach and scope

The purpose of this report is to meet the requirement under the Pilbara Expansion Strategic Proposal Ministerial Statement (MS)1105 to include a report on rehabilitation with a request to declare a referred proposal to be a derived proposal (see 1(c) of the *Guidelines for submitting a derived proposal* (MS1105 Guidelines)). BHP has prepared this report to support the derived proposal requests for the following proposals:

- Newman Hub - Orebody 32 Below Water Table
- Newman Hub - Western Ridge.

This is the first report on rehabilitation that BHP has prepared to meet the MS1105 Guidelines and it is the first time that BHP has attempted to develop scientifically-based criteria and quantitative targets to systematically, consistently and transparently assess rehabilitation progress and success across its Western Australian Iron Ore (WAIO) operations. Following testing since 2019, BHP is currently undertaking a review of the rehabilitation success methodology. Therefore, the methodology presented in this report is preliminary and will be updated for future reports.

The scope of this report is the rehabilitation (revegetation) of mining-related disturbance across BHP's WAIO operations (Jimblebar, Newman, Yandi, Mining Area C, Goldsworthy and Yarrie mine hubs) on BHP's iron ore tenure.

Guidelines 1(c)(i): Types of ecosystems and total area required to be rehabilitated

BHP has defined the types of ecosystems requiring rehabilitation across their iron ore tenure based on the major vegetation types of Beard et al. (2013). These major vegetation types were chosen as they represent the dominant ecosystems present on BHP iron ore tenure, reflect the scale of rehabilitation required and also represent the likely post-mining ecosystem.

Based on data up to the end of the 2021 financial year (FY), BHP estimates that the total area of disturbance that BHP will be required to rehabilitate to the revegetation phase (i.e. excluding open pits that remain as voids) across its iron ore tenure in the designated mine hubs including the OB32 BWT and Western Ridge derived proposals, is approximately 48,764 hectares (ha), based on the total approved disturbance limit. The total actual disturbed land is approximately 26,267 ha and the total area of rehabilitation is approximately 4,564 ha, representing 17% of the total disturbed land.

Guidelines 1(c)(ii): Analysis of rehabilitation history and success

BHO has undertaken an analysis of the history of rehabilitation undertaken by BHP in the Pilbara. The key practices and outcomes include the following:

- 1980s: Rehabilitation started at Mt Whaleback (Newman hub) – rehabilitation was 'ad hoc' and poor *Triodia* recruitment, limited species diversity and high erosion were observed.
- 1990s: Rehabilitation was initiated across all WAIO operations in Pilbara – trials with different rehabilitation landforms, slope modification and contour ripping started. There were improved trials and monitoring, and less erosion and improved recruitment was noted.
- Early 2000s onwards: Landform improvements (e.g. integrating OSAs into the landscape and altering slopes to minimise erosion) were progressed and the concept of growth media was introduced. Lower erosion impacts were noted.
- 2015 onwards: Revegetation improvements were made, e.g. understanding of seed biology and improvements in collection, dormancy breaking and seeding methods. Improvements in recruitment were noted.

As part of the preliminary methodology for measuring rehabilitation success, BHP has developed scientifically verifiable success measures (criteria and targets) based on relevant contemporary scientific evidence in the Pilbara and the quantitative analysis of BHP rehabilitation data. BHP has also developed a traffic light approach to communicate the status and success of rehabilitation at the mine hub level.

BHP has developed completion criteria to use as the measure of historical rehabilitation success, when rehabilitation is considered to be complete. For the FY2021 analysis, all hubs had rehabilitation sites that were monitored and were old enough to assess against completion criteria, except Jimblebar. From the analysis at the hub level, historical rehabilitation is variable across the hubs, but was at least partially successful for all hubs. Very few rehabilitation sites did not meet all or most criteria, which suggests that most older sites are likely to reach completion and rehabilitation will be successful, but potentially over a longer timeframe. In summary, at Newman hub rehabilitation sites hub met all criteria, Yandi and Yarrie hubs met most completion criteria and rehabilitation sites at Mining Area C and Goldsworthy hubs met some completion criteria.

The most common criteria that was not met was Hummock Grasses (*Triodia*) Cover. As *Triodia* Cover is a key indicator for rehabilitation success, improving *Triodia* Cover will be a focus of BHP's improvement activities. The rehabilitation status maps reflect the relatively small areas assessed for completion. As expected, the hubs with older mines that have ceased mining activities in some/all areas (e.g. Goldsworthy and Yarrie) have a higher proportion of rehabilitation assessed for completion, as a higher proportion of the disturbed land that has been rehabilitated. Where completion criteria were not met, BHP will review whether the criteria need to be amended (e.g. for older mines where early rehabilitation practices were used) or whether intervention is required for certain rehabilitation areas to improve rehabilitation outcomes.

Schedule 1, Table 2, 2.c and Guidelines 1(c)(iii): Future rehabilitation success

For rehabilitation areas where rehabilitation is underway but not ready to be measured for success (i.e completion), BHP has developed progressive criteria and targets to assess the likely success of future rehabilitation based on the same scientifically verifiable data and approach as the completion criteria and targets for historical rehabilitation. Rehabilitation that is underway is likely to be successful (at completion) if BHP can demonstrate that rehabilitation is progressing according to an appropriate trajectory.

The FY2021 analysis shows progressing rehabilitation is variable across the hubs, but was at least partially successful for all hubs. While the supporting criteria were met for most hubs, most hubs did not meet the major criterion (*Triodia* Cover/Total Native Cover ratio) except Jimblebar and Mining Area C. This is reflected in the rehabilitation status maps which show only some areas are considered to be on track. Where progressive criteria were not met, BHP will review whether maintenance is required for certain rehabilitation areas (e.g. to address *Triodia* Cover and Weed Cover). As part of the review of the rehabilitation success methodology, BHP is currently reviewing the progressive criteria and is developing interim milestones to enable BHP to assess whether rehabilitation underway is progressing on the right trajectory. The application of the revised criteria for future assessments will help BHP confirm whether maintenance is required at sites that were not met for the FY2021 assessment.

BHP considers that future rehabilitation activities in areas where rehabilitation activities have not yet commenced will be successful if the relevant criteria targets (progressive and completion) are met. Therefore, BHP intends to apply a similar approach for future rehabilitation activities as existing rehabilitation areas (underway and completed), adapting the current approach (rehabilitation practices, monitoring and success criteria), where relevant, based on contemporary scientific evidence from BHP data and information, and broader (including Pilbara) information. BHP will also take into account the types of areas to be rehabilitated and the scale of rehabilitation activities in assessing the likely success of future rehabilitation activities.

Based on the assessment of relevant existing rehabilitation, which demonstrates that rehabilitation is at least partially successful and at least partially progressing along the appropriate trajectory for success at completion, BHP considers that it is likely that future rehabilitation activities for the OB32 BWT and Western Ridge derived proposals will be successful.

1 Introduction

1.1 Purpose of this report

BHP has prepared this Rehabilitation Report (report) for the 2020-2021 Financial Year (FY2021), to support the derived proposal requests for the following proposals:

1. Newman Hub - Orebody 32 Below Water Table (OB32 BWT) (BHP2022a)
2. Newman Hub - Western Ridge (BHP2022b).

The purpose of this report is to meet the requirement under the Pilbara Expansion Strategic Proposal (Strategic Proposal) (BHP 2016) Ministerial Statement 1105 (MS1105) to include a report on rehabilitation with a request to declare a referred proposal to be a derived proposal (see 1 (c) of the *Guidelines for submitting a derived proposal* (MS1105 Guidelines)). Table 1 outlines which sections in this report address the specific requirements of MS1105 (main section in **bold**).

Table 1: MS1105 Rehabilitation Report requirements

MS1105 reference	Rehabilitation Report requirement	Section addressed
Guidelines 1(c)(i)	The types of ecosystems and total area of rehabilitation that the proponent will be required to rehabilitate across their iron ore tenure including the derived proposal.	**Section 2**
Guidelines 1(c)(ii)	An analysis of the history of rehabilitation that the proponent has undertaken in the Pilbara and the demonstrated success of this rehabilitation.	Section 3 **Sections 4.1, 4.2** Appendices 1 to 9
Guidelines 1(c)(iii)	The likely success of future rehabilitation activities in establishing self-sustaining areas of rehabilitation, taking into account: • relevant contemporary scientific evidence • the types of area to be rehabilitated • the scale of rehabilitation activities.	Section 3 **Sections 4.1, 4.3** Section 5 Appendices 1 to 9
Schedule 1, Table 2, Column 3	2 Planned, designed and managed (demonstrated in the referral of future proposal and draft management plans submitted at the time of referral of future proposals) to ensure: c. Scientifically verifiable estimates of the likely success of future rehabilitation have been made.	

1.2 Approach for this report

In the Environmental Protection Authority's (EPA) Report 1619 on the Strategic Proposal (EPA 2018), the EPA considered that it is important that a full understanding of the status of rehabilitation in the Pilbara is achieved and included guidance on the information related to rehabilitation that it expects to see in any request to declare a proposal a derived proposal (see MS1105 Guidelines, 1(c)).This report documents the status of rehabilitation at BHP's Western Australia Iron Ore (WAIO) operations.

This is the first Rehabilitation Report for a derived proposal that BHP has prepared as a requirement of MS1105 for the Strategic Proposal. BHP monitors rehabilitation and reports on rehabilitation for other internal and regulatory requirements, including at the approval level as part of the Annual Environmental Report (AER). However, this is the first time that BHP has attempted to develop scientifically-based criteria and quantitative targets to systematically, consistently and transparently assess rehabilitation progress and success across its WAIO operations.

BHP considers that the approach for this report sets up an effective process for BHP to continue to improve the standard of rehabilitation and to demonstrate successful broadscale rehabilitation over time. Following testing the since 2019, BHP is currently reviewing the rehabilitation success methodology. Therefore, the methodology

presented in this report is considered to be preliminary and in development. While BHP will continue to use a scientifically verifiable approach for measuring rehabilitation success, the rehabilitation success methodology will be updated for future reports.

1.3 Scope of this report

The focus of this report is the success of rehabilitation, as discussed in the EPA Report 1619 on the Strategic Proposal (EPA 2018) and required by MS1105. The scope of this report is disturbed areas requiring rehabilitation under Part IV and Part V of the *Environmental Protection Act 1986* (WA) (EP Act) and State Agreements, on BHP's iron ore tenure.

1.3.1 Data

Unless otherwise specified, BHP will use disturbance (clearing) and rehabilitation data from the previous financial year to prepare rehabilitation reports. This report uses BHP data from approved projects up to the end of FY2021 (i.e. 30 June 2021). This enables the information presented in this report to be aligned with other regulatory reporting relating to disturbance/clearing and rehabilitation, e.g. Annual Environmental Reports (AERs), Mining Rehabilitation Fund (MRF) reports and Impact Reconciliation Reports (IRR).

As required by MS1105 Guideline 1(c)(i) and (iii), this report also includes relevant data and information (Sections 2 and 4.3) relating to the OB32 BWT and Western Ridge derived proposals.

1.3.2 Rehabilitation phase - revegetation

The report focuses on the revegetation phase of rehabilitation, where all other planned earthwork activities are complete and, if specified, topsoil, ameliorant, contour ripping/scarification and/or seeding have been undertaken. In EPA Report 1619, the EPA states that a consideration for environmental impact assessment (in the EPA's *Environmental Factor Guideline – Flora and Vegetation*) is whether the proposal area will be revegetated in a manner that promotes biological diversity and ecological integrity (EPA 2018). Other rehabilitation phases such as landform profiling, contouring and armouring are addressed in Mine Closure Plans (MCPs) and other Department of Mines, Industry Regulation and Safety (DMIRS) requirements.

1.3.3 Types of disturbed areas

In EPA Report 1619, the EPA states that the environmental impact of vegetation clearing has been exacerbated by the lack of successful rehabilitation of mines in the Pilbara (EPA 2018). Therefore, this report focuses on the rehabilitation (revegetation) of mining-related disturbance (clearing), including for overburden storage areas (OSAs), associated infrastructure and rail. The analysis of rehabilitation (revegetation) success in this report does not include:

- mine pits that will remain as open pit voids at closure (i.e. are not backfilled, including where pit lakes will form), as these landforms will not be revegetated
- the portions of the Chichester rail line that are not part of a mine hub
- exploration disturbance (as it will either be rehabilitated under Part V of the EP Act (Native Vegetation Clearing Permits (NVCPs)), or included as mine disturbance in the future if the orebody is approved for mining)
- BHP operations at Port Hedland.

1.4 Other rehabilitation reporting

This report complements other regulatory documents and reports relating to disturbance and rehabilitation that BHP is required to prepare including MCPs, AERs, IRRs (for biological offsets) and MRF reports.

2 BHP areas requiring rehabilitation

2.1 Mine operations required to be rehabilitated

BHP's iron ore tenure extends across the Pilbara (Figure 1). It includes existing operations and future operations identified in the Strategic Proposal. For the purposes of this report only, BHP has grouped mine operations into hubs, as the scale of BHP's WAIO mine operations across its iron ore tenure is hundreds of kilometres. The hub boundaries (Figure 2) are defined for calculation and mapping purposes only.

All of the mine hubs except for Goldsworthy and Yarrie are located in the Strategic Proposal Project Boundary (Figure 1) and are consistent with the existing mining operations identified in MS1105. The hub boundaries are arbitrary only for the purposes of grouping operations to assess rehabilitation success. As future operations are proposed (including future proposals identified in the Strategic Proposal), BHP may amend the hubs or add new hubs.

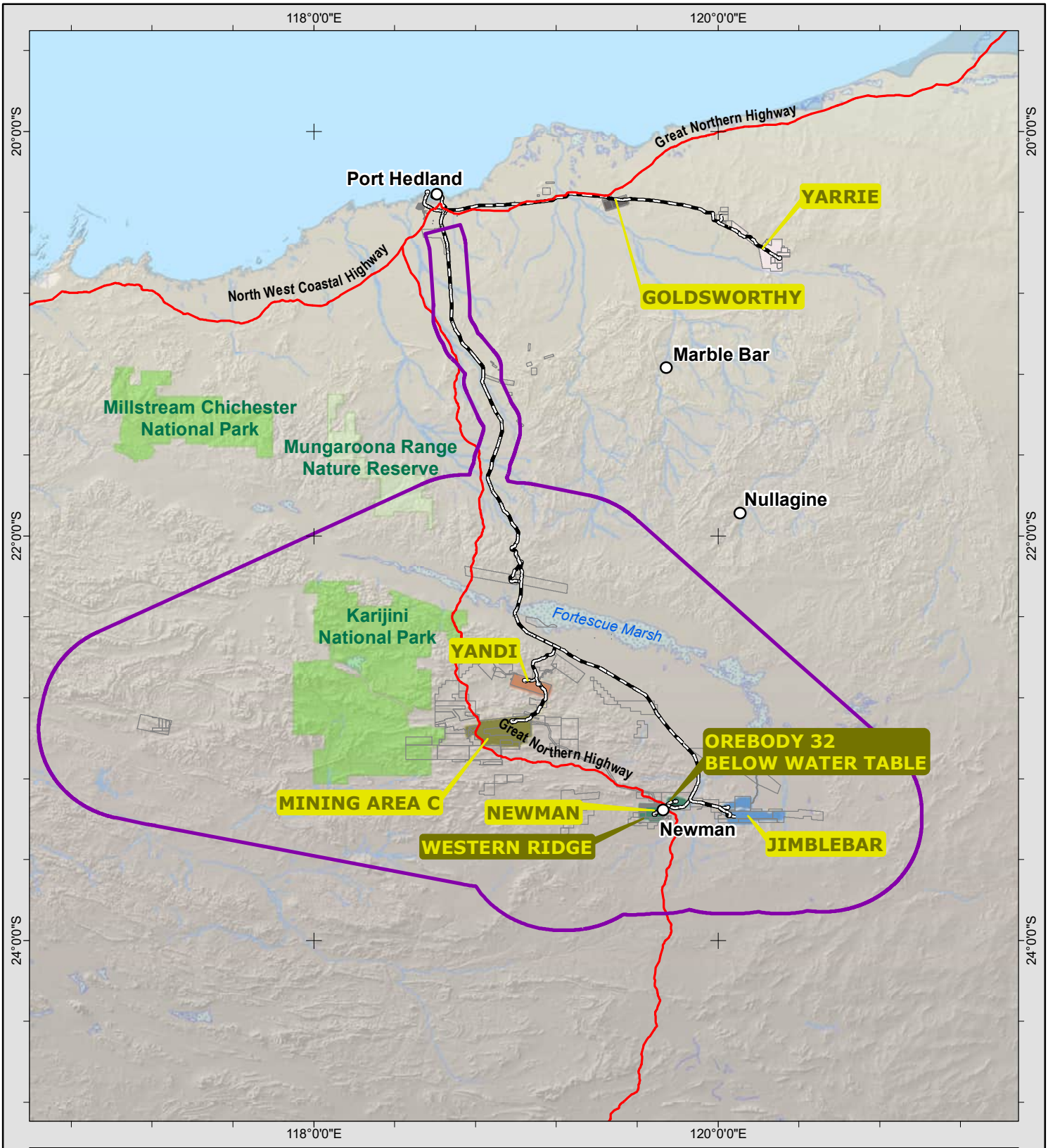
Table 2 lists the current approvals under Part IV of the EP Act (Ministerial Statements) for mines within each hub that authorise disturbance and/or require rehabilitation. There are also approvals through Part V of the EP Act (NVCPs) and State Agreements. While most mines are approved under Part IV of the EP Act, some older mines (e.g. Whaleback and Goldsworthy) or smaller mines are approved under State Agreements and/or NVCPs. Table 2 also includes the OB32 BWT derived proposal and Western Ridge derived proposal.

Table 2: Mine operations requiring rehabilitation

Mine hub	Mine	Approval status	Date original Part IV approval	Current Ministerial Statement	Operational phase	Estimated mining[1] completion date
Jimblebar	Jimblebar	Approved	2011	MS1126	Operations	2060
	Orebody 31	Approved	2015	MS1021	Operations	2069
	Orebody 17, 18	Approved	1997	MS439 (and MS1012)	Operations	
Newman	Whaleback	Approved	N/A Pre EP Act (1964)[2]	N/A	Operations	2040
	Orebody 29/30/35 Below Water Table	Approved	2014	MS963	Operations	2069
	Western Ridge	Proposed	N/A	N/A	Planning	2045
	Eastern Ridge (Orebodies 24, 25, 25W and 32[3])	Approved	2006	MS1037	Operations	2068
	Orebody 32 Below Water Table	Proposed	N/A	N/A	Planning	
	Orebody 23[4]	Approved	1998	MS478	Mining ceased	-
Yandi	Marillana Creek (Yandi)	Approved	2005	MS679 (and MS1039)	Operations	2028
Mining Area C	Mining Area C (Northern and southern flanks)	Approved	1998	MS1072	Operations	2049

Mine hub	Mine	Approval status	Date original Part IV approval	Current Ministerial Statement	Operational phase	Estimated mining[1] completion date
Goldsworthy	Goldsworthy	Approved	N/A Pre- EP Act (1964)[1]	N/A	Mining ceased	-
Yarrie	Yarrie (Y2, Y3)	Approved	1993	MS303	Suspended Operations	To be advised (TBA)
	Nimingarra (Nim 1) Yarrie (Y4A, Y7W and Y10) Cattle Gorge	Approved	2005	MS682	Mining ceased Suspended Operations Mining ceased	
	Cundaline Callawa	Approved	2009	MS814	Suspended Operations Mining not started	

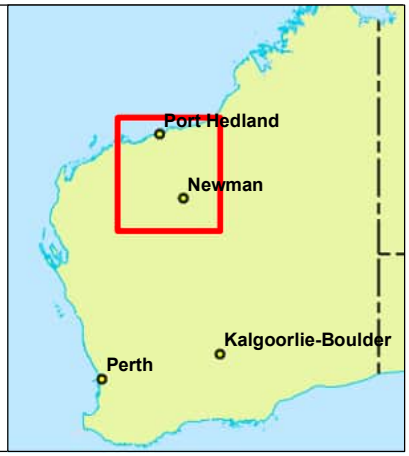
1. Latest mining completion date according to current MCPs. Decommissioning and demolition of infrastructure will occur decades later at some hubs (eg Newman and Mining Area C), where the infrastructure is used to service other operations. The estimated closure date in Appendix 3 includes removal of infrastructure.
2. Date State Agreement approval.
3. Above water table mining at Orebody 32 is approved.
4. BHP also includes Orebody 23 as part of the Eastern Ridge operations, however it was not included in the Eastern Ridge Revised Proposal approved under MS1037.



- BHP Rail
- Major Roads
- BHP Tenements
- Strategic Proposal MS1105 Project Boundary

Existing hubs in Strategic Proposal boundary

- Jimblebar
- Mining Area C
- Newman
- Yandi



BHP

Spatial Data - Studies & Access
BHP IRON ORE

REHABILITATION REPORT FY2021
BHP tenure and Strategic Proposal boundary

N

0 50 100 150
Kilometres

Coordinate System: GCS GDA 1994, Datum: GDA 1994, Units: Degree

Scale @ A4: 1:2,925,000	Prepared: J. Vis	Project No: A1079/005 REV B
Date: 12/10/2022	Reviewed: Env. Approvals	Figure: 1

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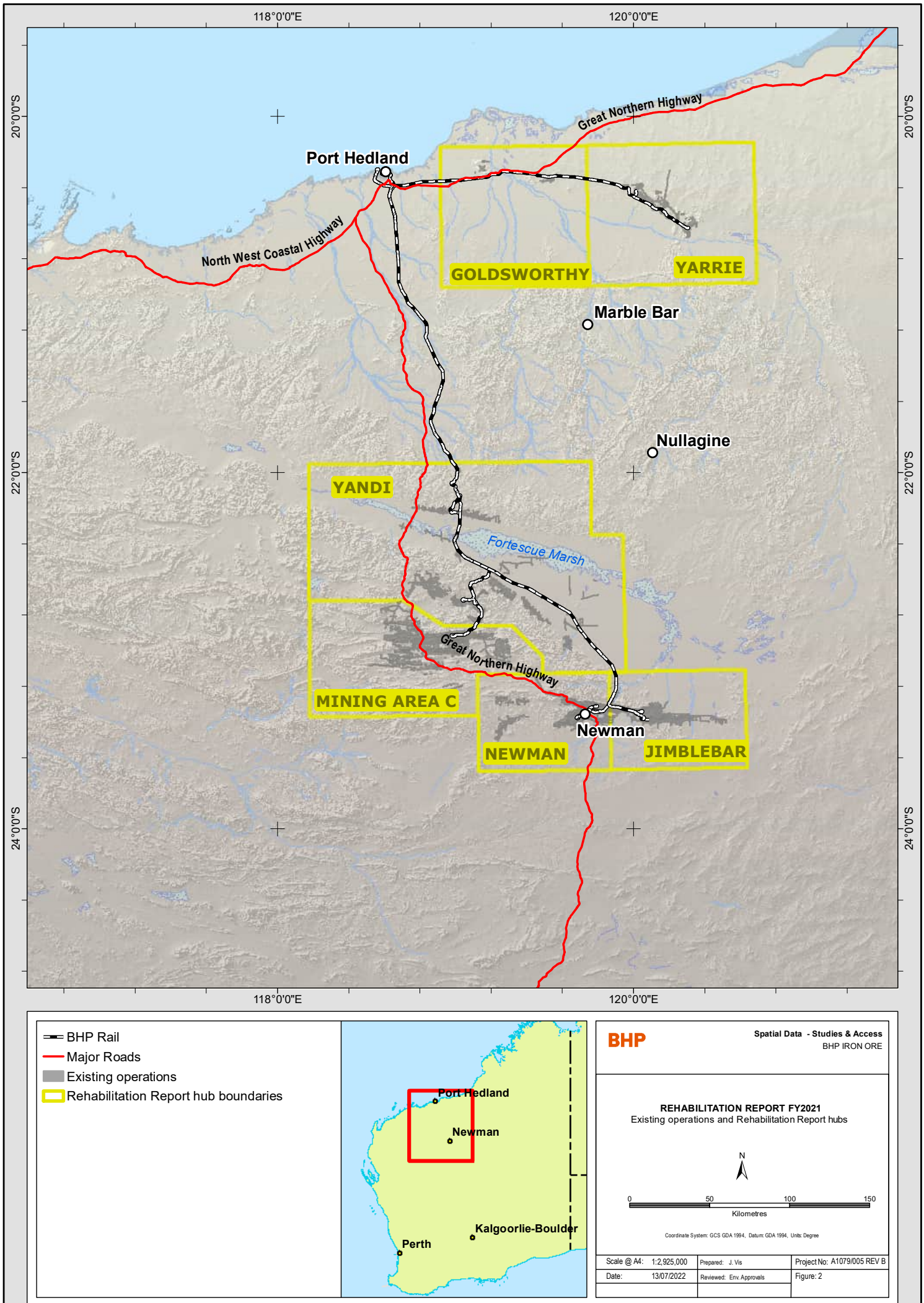

BHP Rail
Major Roads
Existing operations
Rehabilitation Report hub boundaries

BHP

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REHABILITATION REPORT FY2021
Existing operations and Rehabilitation Report hubs

N

0 50 100 150
Kilometres

Coordinate System: GCS GDA 1994, Datum: GDA 1994, Units: Degree

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Date: 13/07/2022	Reviewed: Env. Approvals	Figure: 2

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2.2 Types of ecosystems to be rehabilitated

MS1105 Guidelines (1(c)(i) requires information on '*the types of ecosystems that the proponent will be required to rehabilitate across their iron ore tenure including the derived proposal*'.

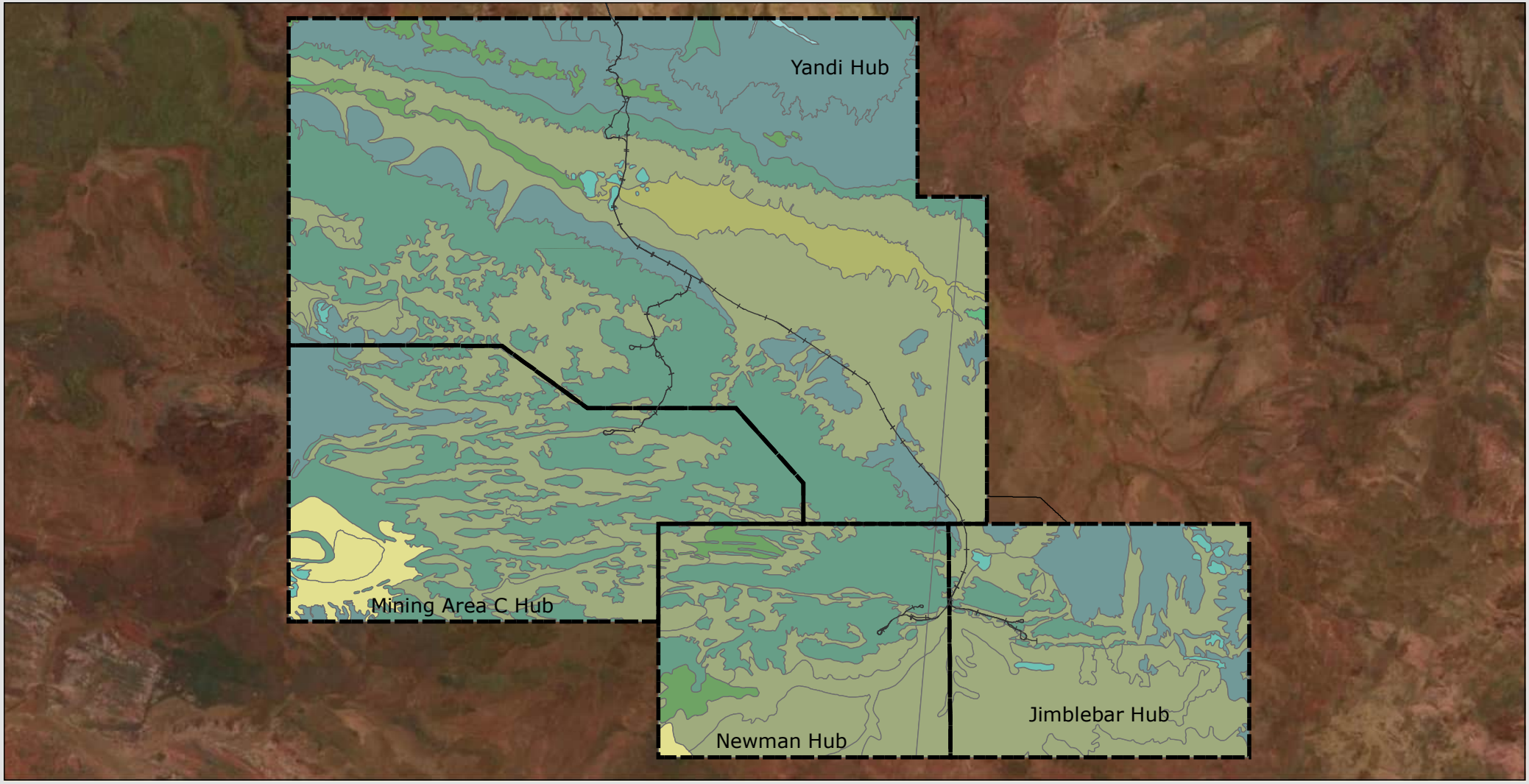
The term ecosystem is applied at various scales, and in WA has been used at the scale of a specific community (e.g. wetland communities associated with Weeli Wolli spring) as well as at the broader vegetation scale (e.g. spinifex grasslands) or geomorphic scale (e.g. claypan) (Syrinx 2020).

BHP has defined the types of ecosystems requiring rehabilitation across their iron ore tenure based on the Beard 1:3,000,000 scale major vegetation types (Beard *et al.* 2013). These major vegetation types were chosen based on the analysis undertaken by Syrinx (2020), as they represent the dominant ecosystems present on BHP iron ore tenure and reflect the scale of rehabilitation required.

The major vegetation types (Table 3, Figure 3 and Figure 4) allow for the analysis of rehabilitation (revegetation), based on vegetation attributes including indicator species, vegetation cover and species richness. The major vegetation types also represent the likely post-mining ecosystem as the pre-mining environment is generally significantly altered following mining.

Table 3: Ecosystem types

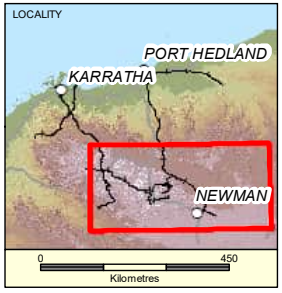
Ecosystem type	
Beard vegetation type	
Spinifex grassland	35 Low tree-steppe
	38 Shrub-steppe
	40 Grass-steppe
Low forest and woodlands	8 Low woodland, open low woodland or sparse woodland
Bunch grassland	32 Riverine sedgeland/grassland with trees



Rehabilitation Report hubs

Vegetation Structure Description (Beard et al. 2013)

- Grass-steppe
- Grasslands, short bunch-grass savanna
- Low tree-steppe
- Low woodland, open low woodland or sparse woodland
- Pindan with low trees
- Riverine sedgeland/grassland with trees
- Salt lake, lagoon, clay pan
- Samphire
- Scrub, open scrub or sparse scrub
- Short bunch-grass savanna / Grass-steppe
- Shrub-steppe
- Sparse low tree-steppe / Sparse shrub-steppe
- Tidal mud flat
- Woodland other



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REHABILITATION REPORT FY2021
Ecosystem types for the Eastern and Central Pilbara

0 5 10 15 20
Kilometres
Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator, Datum: GDA 1994, Units: Meter

N

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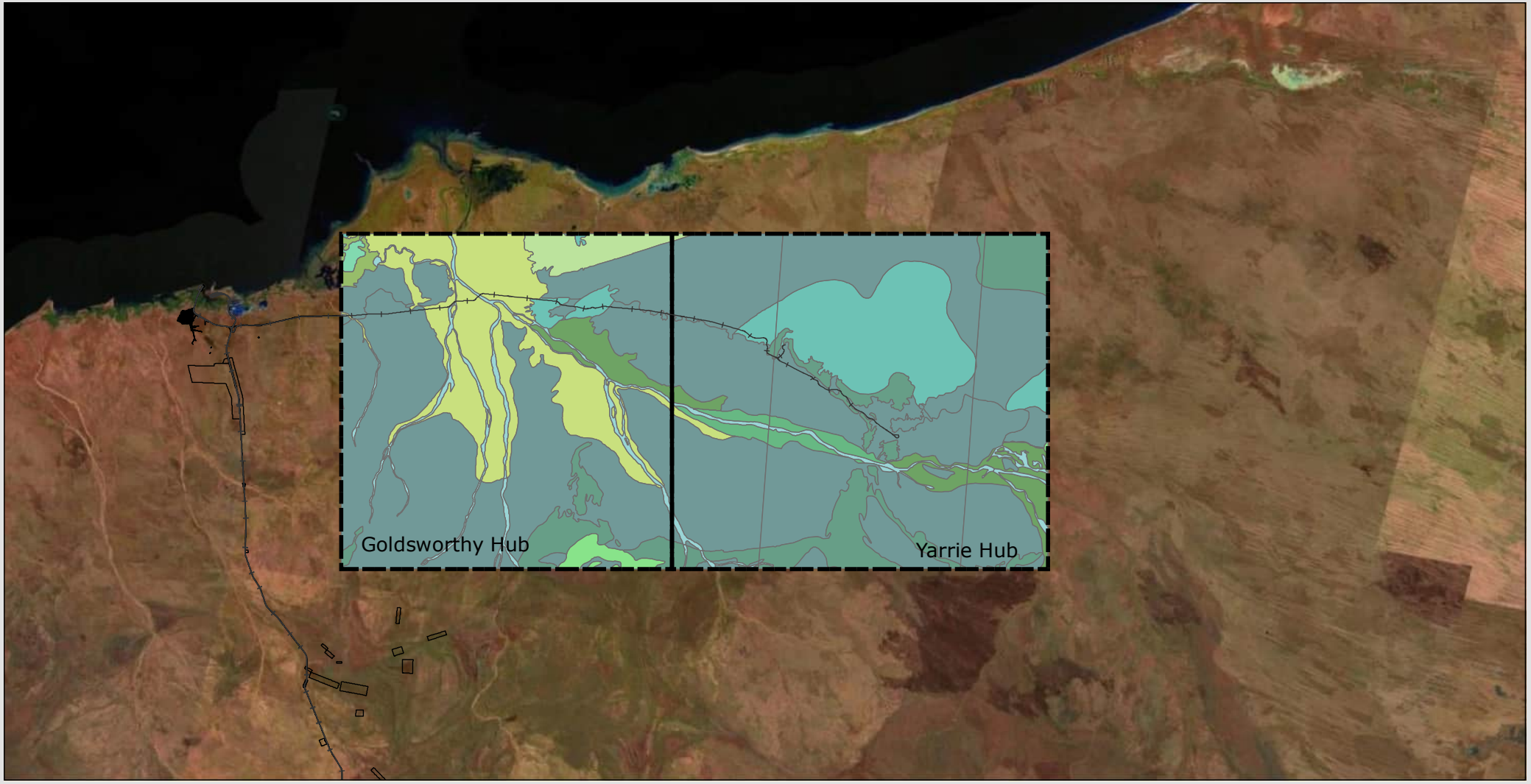
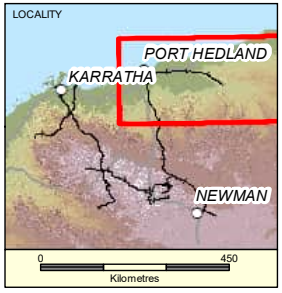


Rehabilitation Report hubs

Vegetation Structure Description (Beard et al. 2013)

- Grass-steppe
- Grasslands, short bunch-grass savanna
- Low tree-steppe
- Low woodland, open low woodland or sparse woodland
- Pindan with low trees
- Riverine sedgeland/grassland with trees
- Salt lake, lagoon, clay pan
- Samphire
- Scrub, open scrub or sparse scrub
- Short bunch-grass savanna / Grass-steppe
- Shrub-steppe
- Sparse low tree-steppe / Sparse shrub-steppe
- Tidal mud flat
- Woodland other



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Spatial Data - Studies Planning & Access
BHP IRON ORE

REHABILITATION REPORT FY2021
Ecosystem types for the Northern Pilbara

0 10 20 30 40
Kilometres
Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator, Datum: GDA 1994, Units: Meter

N

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2.3 Types of areas to be rehabilitated

MS1105 Guidelines (1(c)(iii) requires information on '*the likely success of future rehabilitation activities in establishing self-sustaining areas of rehabilitation, taking into account … the types of area to be rehabilitated*'….

The success of rehabilitation will depend to a degree on the type of landforms and/or infrastructure constructed as part of a mining operation. Consistent with DMIRS *Statutory Guidelines for mine closure plans* (DMIRS 2020), BHP considers domains, which are a group of landform(s) or infrastructure that have similar rehabilitation and closure requirements and outcomes. Rehabilitation is likely to be more successful and/or take less time to be successful in areas where there is a lower impact on the land (e.g. infrastructure areas), compared to areas where there is a higher impact (e.g. overburden storage areas (OSAs)).

BHP also reports disturbance to DMIRS for the MRF (as part of BHP's AER process) for infrastructure and land features within domains. The main domains are OSAs, infrastructure, mine voids and rail.

As discussed in Section 1.3.3, the analysis of rehabilitation (revegetation) success in this report does not include mine pits that will remain as open pit voids at closure (i.e. are not backfilled, including where pit lakes will form), as these landforms will not be revegetated. This report does include all other types of areas associated with mining operations in the mine hubs that will be rehabilitated, i.e. OSAs, infrastructure and rail.

2.4 Total area of disturbance to be rehabilitated

MS1105 Guidelines (1(c)(i) requires information on *the total area of rehabilitation that the proponent will be required to rehabilitate across their iron ore tenure including the derived proposal*.

Table 4 tabulates disturbance (clearing) data for approved operations under Part IV and Part V of the EP Act and State Agreements for each hub as at the end of FY2021 (30 June 2021). Table 4 also includes data for operations approved and Part IV proposals that BHP has progressed to the referral stage since 1 July 2021; the OB32 BWT and Western Ridge derived proposals. Table 5 does not include data for other future proposals identified in the Strategic Proposal. Table 4 shows that, assuming all approved and proposed disturbance (Approved disturbance limit) requires rehabilitation, the total area of disturbance that BHP will be required to rehabilitate across its iron ore tenure in the designated mine hubs including the derived proposals (OB32 BWT and Western Ridge) is approximately 65,500 ha. However, as stated Section 1.3.3, mine pits that will remain as open pit voids at closure (i.e. are not backfilled to pit crest, including where pit lakes will form) will not be revegetated. Based on actual disturbance data including areas classified as pits, approximately 74% of the total actual disturbance excludes pits (Table 4).

Therefore, the current total area of disturbance that BHP will be required to rehabilitate (to the revegetation phase) across its iron ore tenure in the designated mine hubs including the derived proposals is estimated to be 48,764 ha (74% of the 65,500 ha total disturbance limit). The actual area will depend on the final pit backfill strategy selected for each mine.

Table 4: Mine disturbance requiring rehabilitation

Mine hub[1]	Type of Approval	Approved disturbance limit (ha)[2]	Actual disturbance at FY21 (ha)[3]	Actual disturbance at FY21 excluding pits[4] (ha)	Disturbance excluding pits as % of actual disturbance
Jimblebar	MS	10,195	5,406	3,509	65%
	Other (NVCP, State Agreements)	1,536	1,042	1,042	100%
	Subtotal	***11,731***	***6,449***	***4,552***	***71%***
Newman	MS	3,957	1,980	1,266	64%
	Other (NVCP, State Agreements)	7,677	5,323	4,260	80%
	Proposed: (OB32 BWT)	224	-	-	-
	Proposed: (Western Ridge)	4,281	-	-	-
	Subtotal	**16,139**	***7,303***	***5,526***	***76%***
Yandi	MS	5,176	4,721	2,960	63%
	Other (NVCP, State Agreements)	3,756	2,892	2,877	99%
	Subtotal	***8,933***	***7,613***	***5,837***	***77%***
Mining Area C	MS	21,606	8,057	5,265	65%
	Other (NVCP, State Agreements)	1,130	341	341	100%
	Subtotal	***22,736***	***8,398***	***5,606***	***67%***
Goldsworthy	MS	-	-	-	-
	Other (NVCP, State Agreements)	1,303	1,303	1,239	95%
	Subtotal	***1,303***	***1,303***	***1,239***	***95%***
Yarrie	MS	1,362	926	656	71%
	Other (NVCP, State Agreements)	3,296	3,290	2,850	87%
	Subtotal	***4,658***	***4,216***	***3,506***	***83%***
Total		**65,500**	**35,282**	**26,267**	**74%**
Total area requiring rehabilitation (revegetation) [5]		**48,764**			

1. The figures for each mine hub are approximate only, as some approvals overlap more than one mine hub (especially for linear infrastructure). Where an approval overlaps more than one hub the areas have been apportioned to each hub (e.g. small proportion of MS1072 for Mining Area C extends into Yandi hub).
2. Includes disturbance (clearing) authorised through Ministerial Statements, NVCPs and State Agreements and assumes the derived proposals are approved. Excludes disturbance authorised for exploration. 'Other' also includes historical clearing other than State Agreements (including clearing from current and previous *Mining Act 1978* (WA) tenure, previous clearing from NVCPs, clearing exempt from approval, e.g. firebreaks). For historical clearing without an approved disturbance limit, it was assumed that the approved disturbance limit is the actual disturbance (see 3. below).
3. Actual disturbance is from BHP land disturbance data as at 30 June 2021. This differs from the total in the 2021 AER (BHP 2021), as the AER reports on data from Ministerial Statements and active NVCPs only, not inactive approvals or disturbance authorised only through State Agreements, e.g. Whaleback. Historical calculations exclude clearing attributed to current MS and NVCPs. Note there may be overlap where historical clearing and/or previous approval (e.g. NVCP) has been superseded by a more recent approval (e.g. MS).
4. Pit area data derived from disturbed areas classified under MRF landuse category as a pit.
5. Total area requiring rehabilitation (to revegetation phase is Total Approved disturbance limit multiplied by Disturbance excluding pits as % of actual disturbance.

3 Preliminary methodology for measuring rehabilitation success

3.1 Background

Following the publishing of EPA Report 1619 on the Strategic Proposal in July 2018, which included the guidelines for a rehabilitation report as part of the EPA's recommended conditions, BHP initiated work to develop a methodology for measuring rehabilitation success across BHP's iron ore tenure (WAIO operations). To meet the requirements of the rehabilitation report under MS1105 Guidelines 1(c) and Schedule 1, Table 2, Column 3 (see Table 1), BHP commissioned Syrinx Environmental (Syrinx) to develop rehabilitation success criteria and a methodology for measuring rehabilitation success.

The *BHP Pilbara Strategic Proposal: Inputs to Rehabilitation Report* (Syrinx 2020; Appendix 1) is a supporting document to this report. It provides the scientific detail to support the preliminary approach to measure rehabilitation success in this report, including the following:

- relevant contemporary scientific evidence in the Pilbara, including factors that influence rehabilitation success (e.g. rainfall, vegetation cover, diversity of species and growth media)
- development of scientifically verifiable success measures based on revegetation objectives, considering; post-mining land use (Pastoral or Natural System), appropriate floristic (vegetation) attributes, appropriate spatial and time scales
- development of criteria and targets using quantitative BHP reference site and baseline data compared and verified with published data specific to the Pilbara
- methodology for measuring rehabilitation success and initial testing of the methodology using BHP rehabilitation data up to FY2018.

After testing the rehabilitation success methodology since 2019, BHP is currently reviewing the methodology (including the rehabilitation monitoring approach and rehabilitation criteria). Therefore, the rehabilitation success methodology used for analysing historical and future rehabilitation success in Section 4 is considered to be preliminary and in development. Information on the reasons for reviewing and updating the methodology and work currently underway and planned is provided in Sections 4 and 5, respectively.

3.1.1 Rehabilitation standards and guidance

There are currently no adopted international, national or state standards (or criteria) for mine rehabilitation and management. The Western Australian Biodiversity Science Institute (WABSI) concluded that the most relevant and detailed sources of publicly available guidance for establishing criteria in WA were those from the EPA, Department of Water and Environmental Regulation (DWER), DMIRS, and the Australian Government Department of Industry Innovation and Science (Syrinx 2020). BHP follows internal rehabilitation standards, which align with current guidance from these departments.

3.1.2 Challenges in measuring rehabilitation success

The key challenges BHP has met in measuring rehabilitation success in the past are:

- no agreed post-mining land use
- no measurable completion criteria
- changes in rehabilitation monitoring methods
- success being measured against natural analogues (rather than likely post-mining land use)

- unrealistic measures for constructed landforms (i.e. OSAs), which represent a very different environment compared to natural landforms.

The above challenges were considered in developing the preliminary rehabilitation success methodology and criteria.

3.2 Rehabilitation criteria

BHP has developed criteria that are indicators of rehabilitation success at different points in time:

- Completion criteria: the end point criteria that measure rehabilitation success when rehabilitation is considered to be complete.
- Progressive criteria: the criteria that measure whether rehabilitation progress for rehabilitation underway is likely to be on a trajectory to achieve rehabilitation success in the future.

3.2.1 Completion criteria

Completion criteria are used to determine whether the closure revegetation objectives (naturalness, resilience, habitat connectivity etc.) for the post-mining land uses have been met and whether rehabilitation is successful. The criteria need to achieve the goal of establishing self-sustaining areas of rehabilitation that support the post-mining land use. The degree to which completion criteria are met provides a measure of historical rehabilitation success.

The development of the completion criteria considered:

- relevant contemporary scientific evidence - including a scientific literature review and recent BHP data (Syrinx 2020)
- the types of ecosystems to be rehabilitated (Section 2.2) and the types of areas to be rehabilitated (Section 2.3).

To assess appropriate timeframes for measuring rehabilitation success, Syrinx (2020) analysed *Triodia* data based on the age of rehabilitation. *Triodia* was selected as it is the major component of most of the target ecosystem (vegetation) types and has typically been considered as the most important plant genera in terms of naturalness. The likely timeframe to be able to measure rehabilitation success (i.e. when rehabilitation is considered to be completed) is 15 to 20 years, based on the strong correlation between time when rehabilitation started and *Triodia* cover Syrinx (2020).

The preliminary criteria and metrics to measure the success of each of the vegetation attributes (from Syrinx 2020) are provided in Appendix 2. The criteria targets are presented in the completion criteria summary tables in Appendix 4 to Appendix 9 for each hub.

3.2.2 Progressive criteria

As rehabilitation areas are unlikely to be ready for assessment against completion criteria for at least 15 years, interim (progressive) targets are needed to track rehabilitation progress of rehabilitation underway at certain intervals to assess whether rehabilitation is likely to be on a trajectory to achieve success. This provides a measure of the likely future success of rehabilitation and allows for early intervention if rehabilitation is not on track.

The following progressive categories were defined for measuring rehabilitation progress against criteria, based on patterns observed in the historical rehabilitation datasets to date for different ages of rehabilitation:

1. Young rehabilitation (less than 5 years) – areas where all rehabilitation activities have been undertaken, however revegetation is incomplete (seedlings still emerging or too young to monitor accurately).
2. Progressing rehabilitation (5 - 15 years) – ecological succession processes are establishing with progress made against criteria.

The key principle in deriving progressive criteria is that they should be consistent with the completion criteria, post-mining land uses and the closure revegetation objectives. To derive meaningful criteria to provide confidence that a site is progressing along the appropriate trajectory, a review of ecological thresholds was undertaken (Syrinx 2020).

The analysis indicates that *Triodia* cover, shrub cover, and weed cover are key trajectory criteria, and that relative abundance is important and differs at different points in time. Ratios represent the dynamics of developing sites and are informative in terms of identifying where intervention may be required.

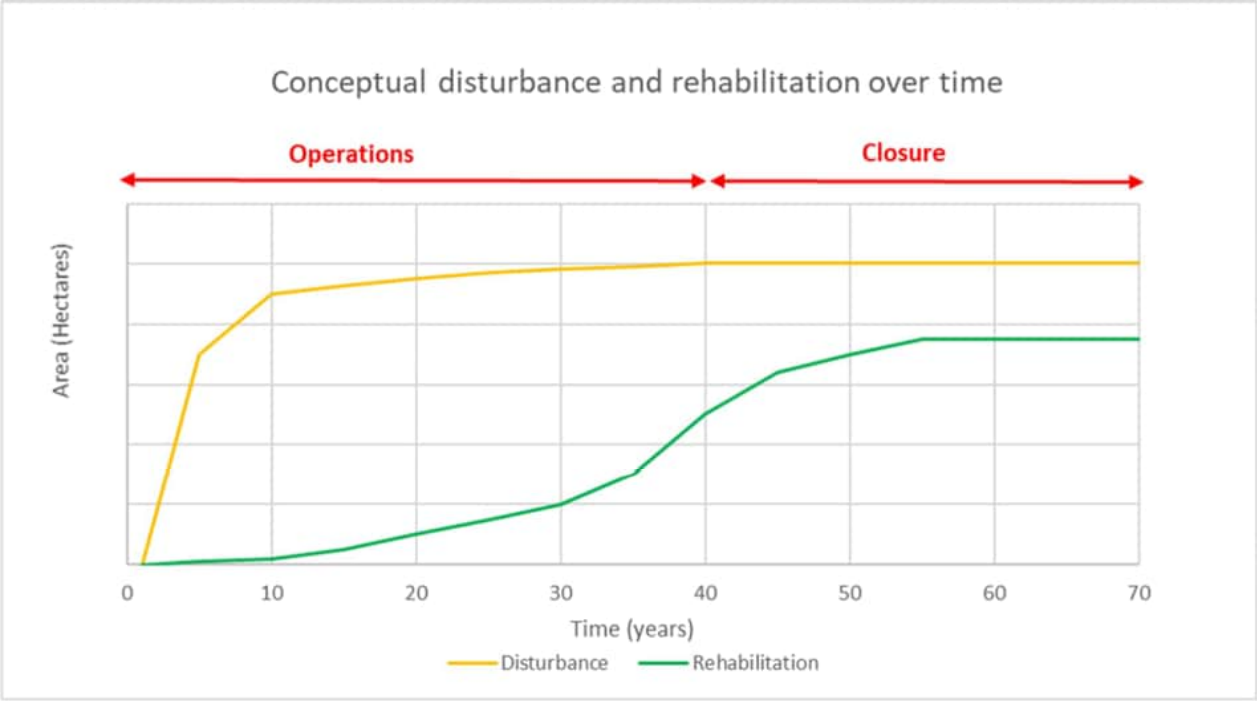
The preliminary criteria and targets to measure the progress of rehabilitation (from Syrinx 2020) are provided in Appendix 2. The FY2021 results for rehabilitation sites analysed against each target are presented in the progressive criteria output tables for each hub (Appendix 4 to Appendix 9).

BHP will assess the progress of rehabilitation at sites against progressive criteria to ensure they are at a level ready to transition into the next category, rather than specific ages as these are a guide only. However, BHP will still monitor the progress of rehabilitation sites at a minimum frequency of three years as part of the rehabilitation monitoring program to allow continuous improvement (e.g. to confirm that seed is germinating, the appropriate species are germinating and rehabilitation areas have not washed way etc.).

3.3 Quantity of rehabilitation

BHP notes the EPA's discussion in EPA Report 1619 regarding the limited evidence of large-scale rehabilitation in the Pilbara (EPA 2018). BHP measures and reports on the amount (quantity) of rehabilitation against each relevant active approval (MS, NVCP, State Agreement etc.) in its AERs. This report quantifies and reports on the cumulative amount of rehabilitation across its WAIO operations at the hub scale.

During operations, only a portion of the land disturbed is available to be rehabilitated, as many areas of the mine site are still active (e.g. mine pits, active overburden storage areas). Figure 5 shows conceptual disturbance and rehabilitation over time for a typical iron ore mine, highlighting that most of the area to be rehabilitated is only available towards the end of the mine life. Therefore, the quantity of rehabilitation relative to the area of disturbed land will be greater for older mine sites that are closer to the end of the mine life.



Note: Area rehabilitated is less that the area disturbed, as pits that remain as voids will not be rehabilitated (revegetated)

Figure 5: Conceptual disturbance and rehabilitation over time

3.4 Communicating rehabilitation success

The assessment of rehabilitation success across BHP's iron ore tenure involves the analysis of numerous rehabilitation and reference sites. This level of detail is necessary to make scientifically verifiable estimates of the success of historical rehabilitation and the likely success of future rehabilitation. However, as the scale of BHP's WAIO mine operations is hundreds of kilometres, BHP has assessed overall rehabilitation success at the hub level.

BHP has developed a traffic light approach to report the status of rehabilitation at each hub using the following categories:

- **Operations:** Disturbed land that is still required for operations and is not yet available to be rehabilitated (i.e. not assessable).
- **Progressive rehabilitation**:
  - *Young rehabilitation (<5 years)*: Areas of rehabilitation where rehabilitation activities have been undertaken within the last 5 years.
  - *Progressing rehabilitation (5 - 15 years) - on track:* Areas of rehabilitation that have progressed enough to assess rehabilitation progress and rehabilitation is on track to achieve success (all progressive criteria met).
  - *Progressing rehabilitation (5-15 years) - maintenance required:* Areas of rehabilitation that have progressed enough to assess rehabilitation progress and rehabilitation requires maintenance (one or more progressive criteria has not been met).
  - *Status unknown*: Areas where data is not suitable to assess against progressing rehabilitation criteria.
- **Completion rehabilitation**:
  - *Completion rehabilitation (>15 years) - criteria met*: Areas of rehabilitation that have progressed enough to assess whether rehabilitation is successful and have met all completion criteria.
  - *Completion rehabilitation (>15 years) - criteria not met*: Areas of rehabilitation that have progressed enough to assess whether rehabilitation is successful and one or more completion criteria has not been met that will be reviewed to determine the appropriate intervention.

BHP has used the traffic light approach for the rehabilitation status table for all hubs (Table 5) and maps for each hub (Figure 6 to Figure 11) in Section 4.1. The traffic light maps used in this report are the same as those used in the previous version of this report for the OB32 Below Water Table Derived Proposal (V.0) as both reports present rehabilitation status for the FY2021 period.

4 Rehabilitation success

This section provides the assessment of rehabilitation success across BHP's WAIO operations as at the end of FY2021 for existing areas under rehabilitation.

4.1 Rehabilitation summary

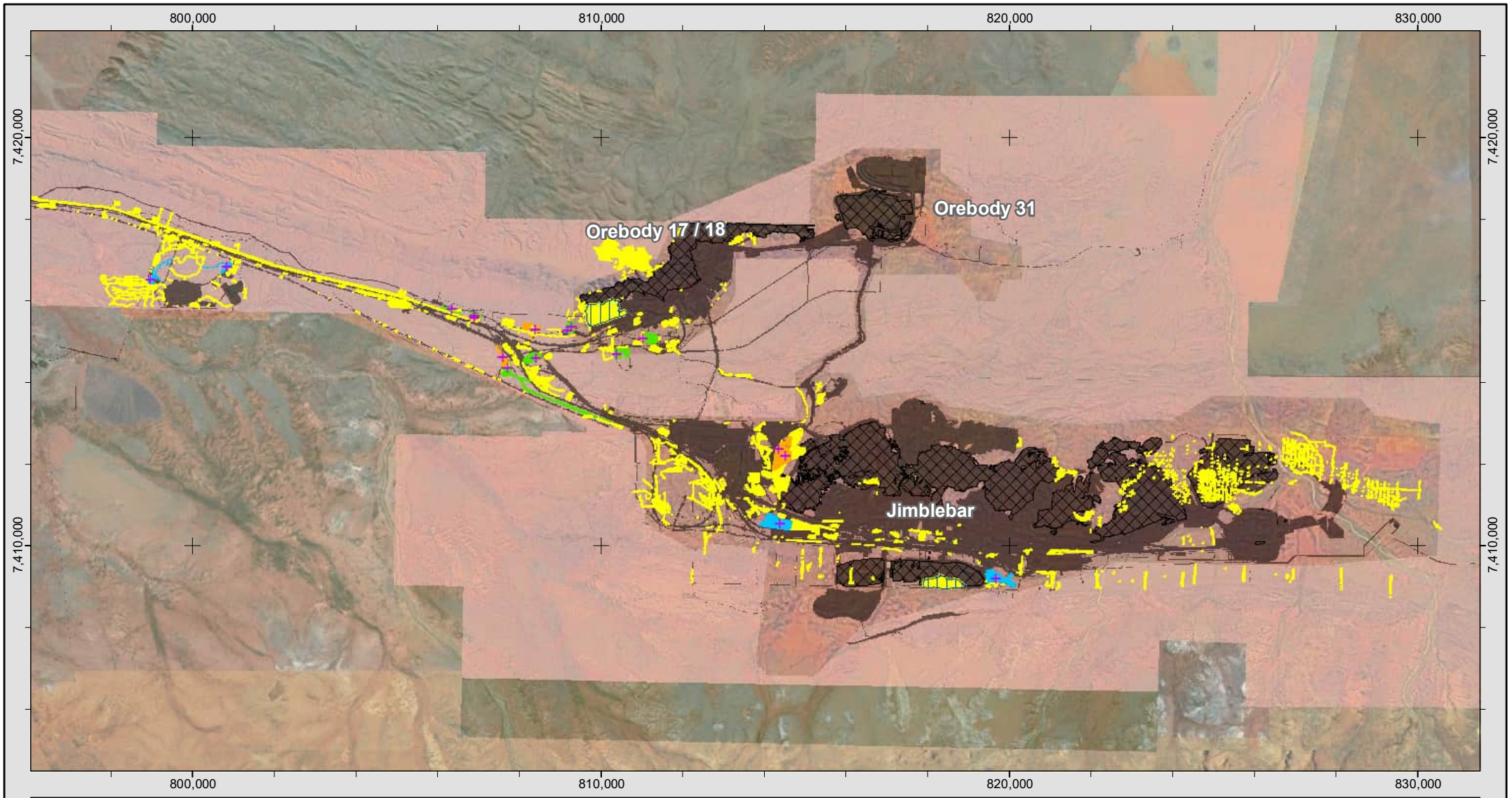
Appendix 3 summarises key information relevant to rehabilitation for each hub that may influence historical rehabilitation success and progress towards future rehabilitation success (i.e. when rehabilitation started, number of rehabilitation sites, time to closure etc.) and the target ecosystem (vegetation) type and assumed post-mining land use used for the criteria analysis.

The results of the criteria analysis are provided in Appendix 4 to Appendix 9. The results were then applied to rehabilitation areas to undertake the spatial analysis, to calculate the areas of rehabilitation status for each rehabilitation category for each hub. The summary of the status of disturbance and rehabilitation is presented in Table 5 and the status of rehabilitation for each hub is presented visually in Figure 6 to Figure 11.

Table 5: Status of rehabilitation progress and success FY2021

Rehabilitation status	Hub						
	Jimblebar	Newman	Yandi	Mining Area C	Goldsworthy	Yarrie	TOTAL
Areas under rehabilitation							
Assessment against Completion Criteria (>15 yrs)							
Criteria met (ha)	-	5	-	0	64	-	**69**
Criteria not met (ha)	-	2	53	7	280	31	**373**
Assessment against Progressing Criteria (5-15 yrs)							
On track (ha)	33	15	16	9	-	94	**167**
Maintenance required (ha)	39	184	162	11	28	429	**852**
Young rehabilitation (<5yrs)							
Young rehabilitation (ha)	39	149	3	28	-	114	**334**
Unknown areas							
Status unknown (ha)	464	625	568	536	102	473	**2,769**
Summary data							
Total disturbed land (ha)[1]	6,449	7,303	7,613	8,398	1,303	4,216	**35,282**
Total disturbed land - excluding pits (ha)[1]	4,552	5,526	5,837	5,606	1,239	3,506	**26,267**
Total rehabilitation (ha)[2]	576	980	802	591	475	1142	**4,564**
Rehabilitation as % of Total disturbed land - excluding pits	13%	18%	14%	11%	38%	33%	**17%**

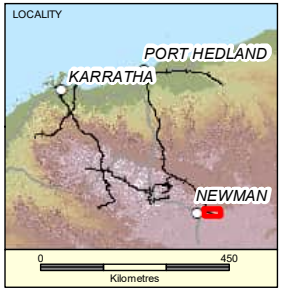
1. From Table 4. Total disturbed land (ha) = Actual disturbance at FY21. Total disturbed land - excluding pits = Actual disturbance at FY21 excluding pits. Includes Areas under rehabilitation.
2. Total rehabilitation is total of all Areas under rehabilitation



No rehabilitation
- Operations
- Pits

+ Recently monitored site (2018-2021) included in analysis

Areas under rehabilitation
- Completion rehabilitation (>15 years) – criteria met (0ha)
- Completion rehabilitation (>15 years) – criteria not met (0ha)
- Progressing rehabilitation (5-15 years) – on track (33ha)
- Progressing rehabilitation (5-15 years) – maintenance required (39ha)
- Young rehabilitation (<5 years) (39ha)
- Rehabilitation – status unknown (464ha)
- Rehabilitation – status checked



BHP

Spatial Data - Studies Planning & Access
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REHABILITATION REPORT FY2021
Jimblebar Hub

N

0 1 2 3 4
Kilometres

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator, Datum: GDA 1994, Units: Meter

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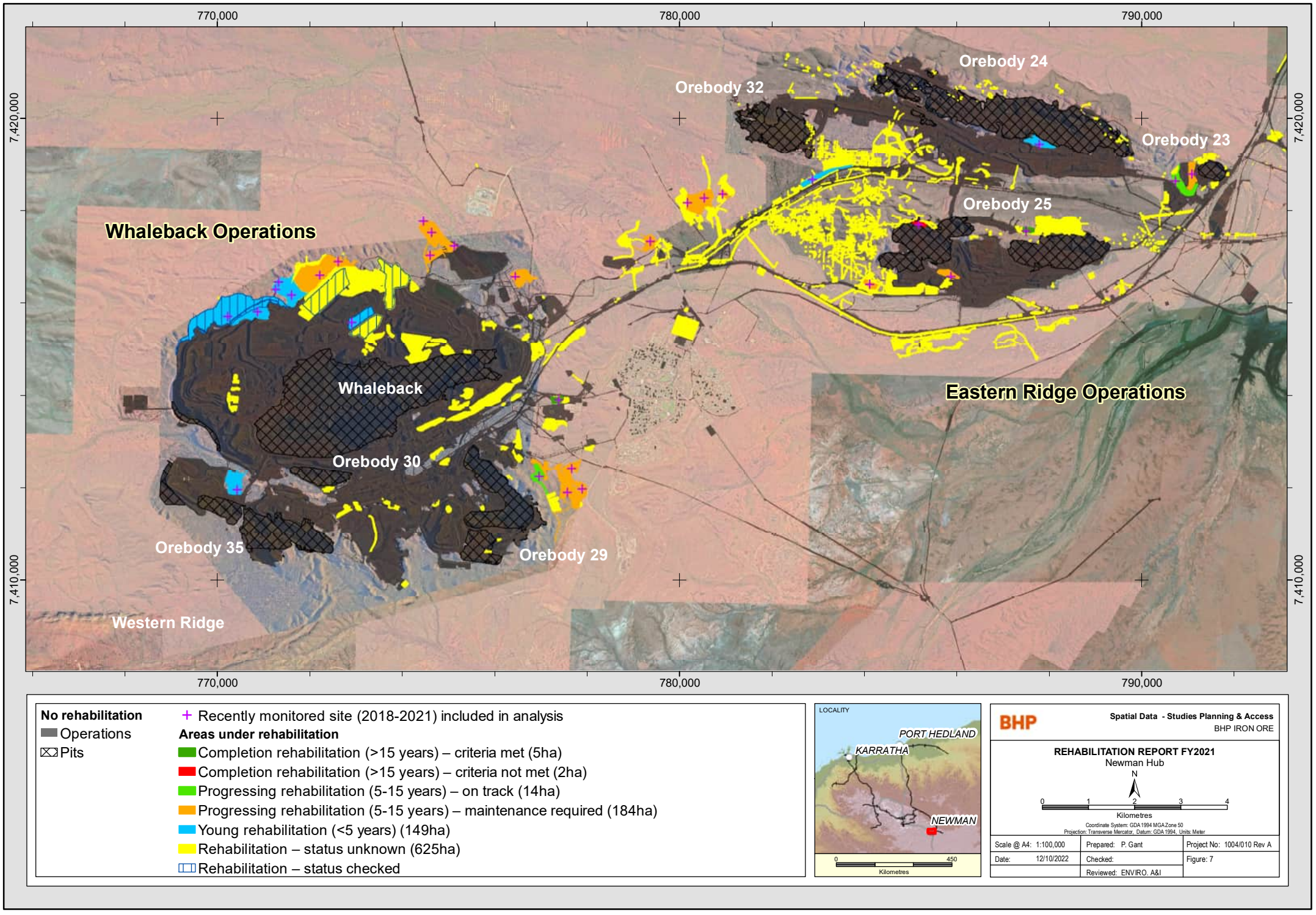

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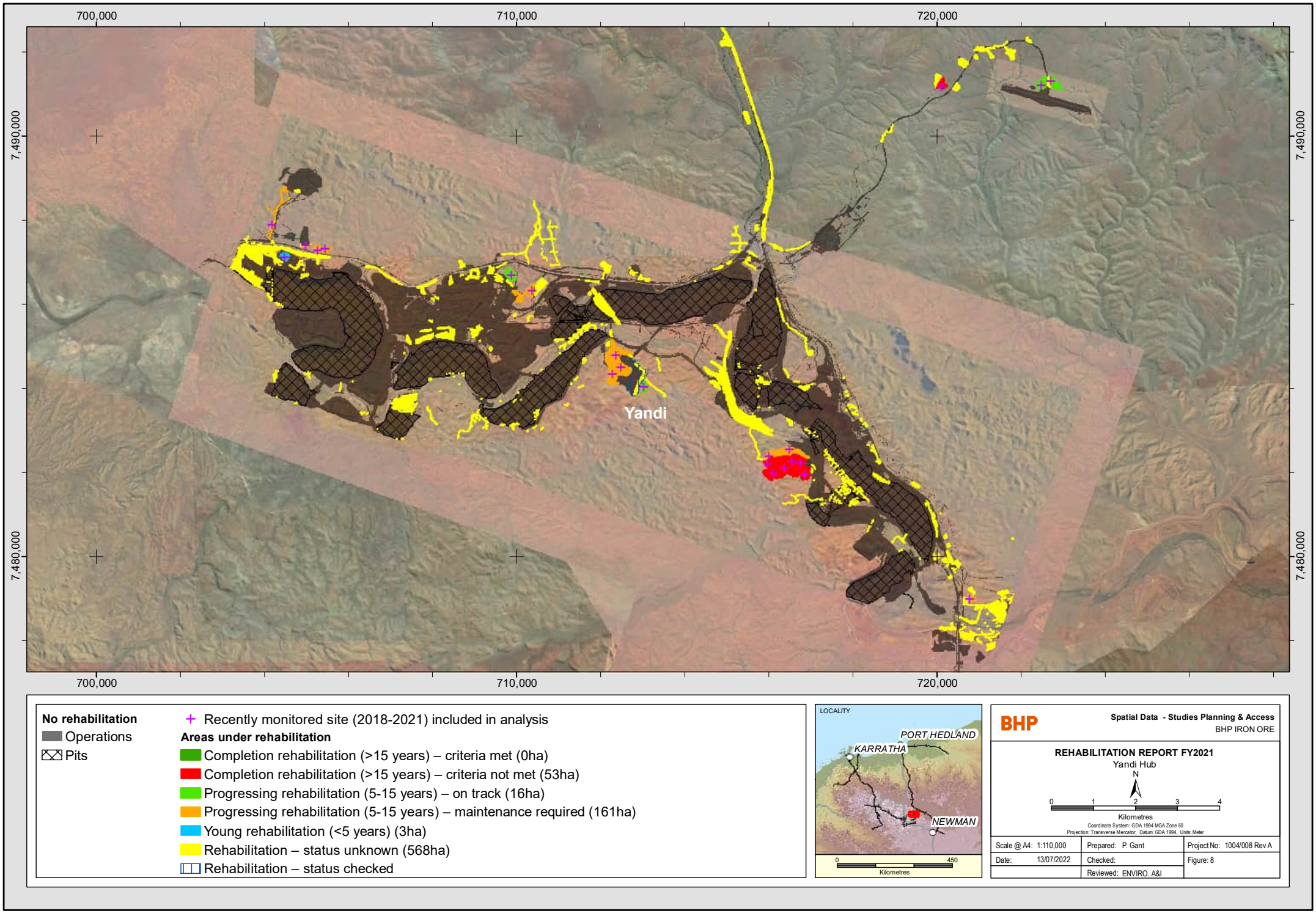
700,000
710,000
720,000
7,490,000
7,480,000
Yandi
No rehabilitation
Operations
Pits
Recently monitored site (2018-2021) included in analysis
Areas under rehabilitation
Completion rehabilitation (>15 years) – criteria met (0ha)
Completion rehabilitation (>15 years) – criteria not met (53ha)
Progressing rehabilitation (5-15 years) – on track (16ha)
Progressing rehabilitation (5-15 years) – maintenance required (161ha)
Young rehabilitation (<5 years) (3ha)
Rehabilitation – status unknown (568ha)
Rehabilitation – status checked
LOCALITY
PORT HEDLAND
KARRATHA
NEWMAN
0
450
Kilometres
BHP
Spatial Data - Studies Planning & Access
BHP IRON ORE
REHABILITATION REPORT FY2021
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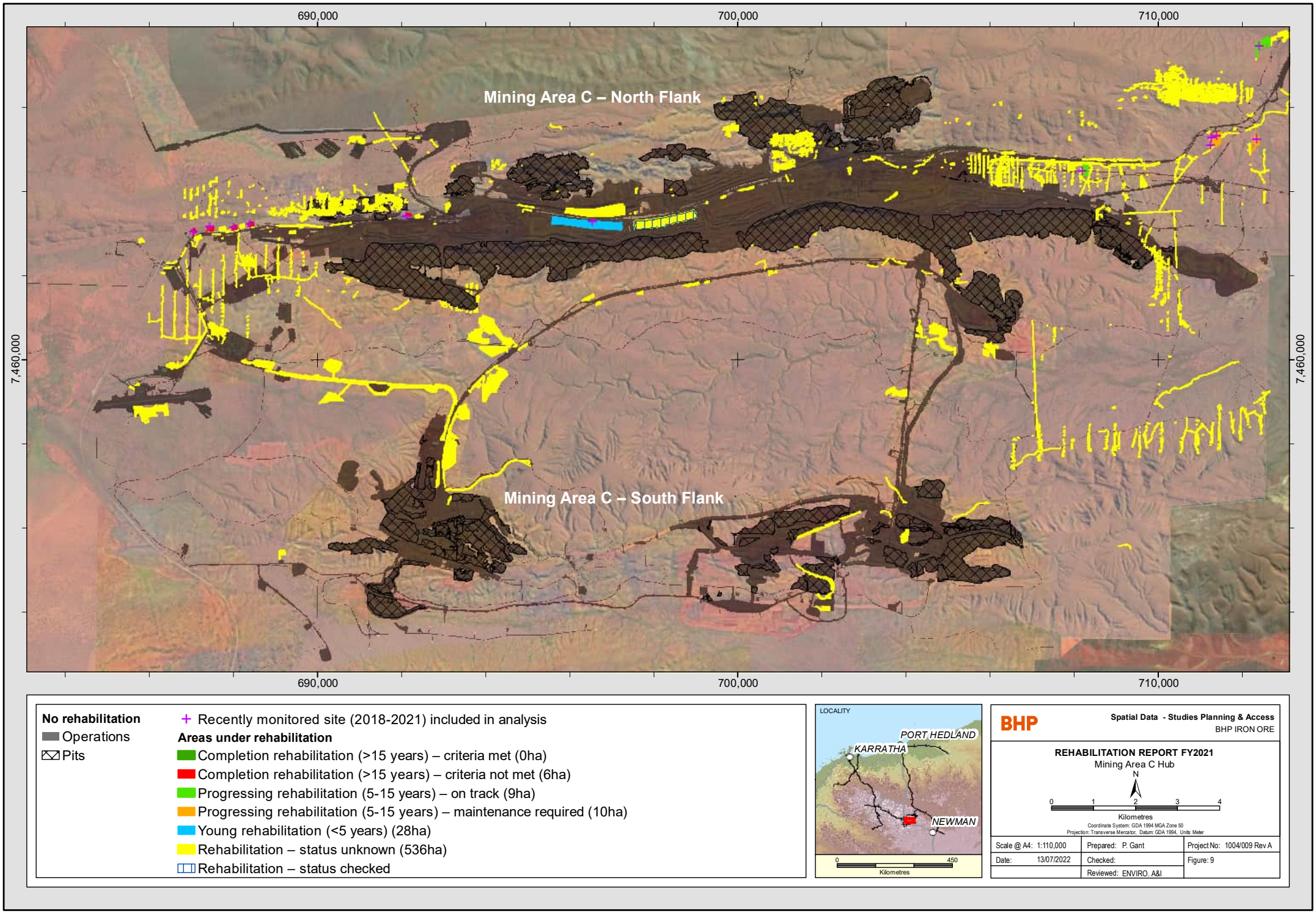

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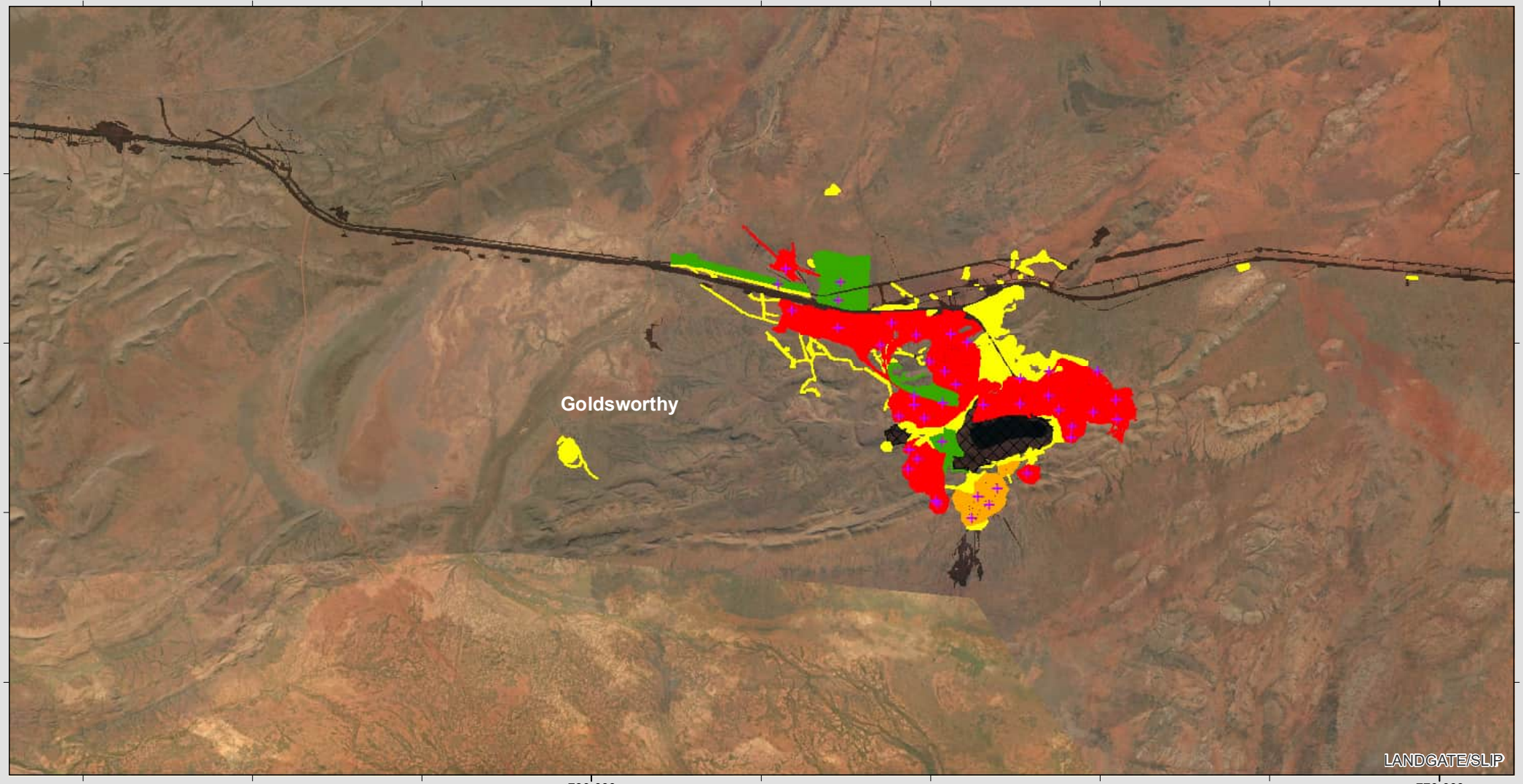


No rehabilitation

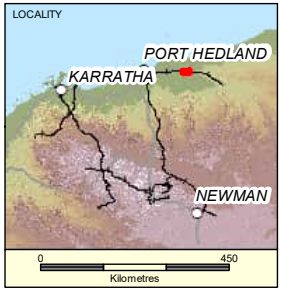
Operations

Pits

+ Recently monitored site (2018-2021) included in analysis

Areas under rehabilitation

- Completion rehabilitation (>15 years) – criteria met (64ha)
- Completion rehabilitation (>15 years) – criteria not met (280ha)
- Progressing rehabilitation (5-15 years) – on track (0ha)
- Progressing rehabilitation (5-15 years) – maintenance required (28.5ha)
- Young rehabilitation (0ha)
- Progressing rehabilitation - unknown status (101.5ha)
- Rehabilitation – status checked



BHP

Spatial Data - Studies Planning & Access
BHP IRON ORE

REHABILITATION REPORT FY2021
Goldsworthy Hub

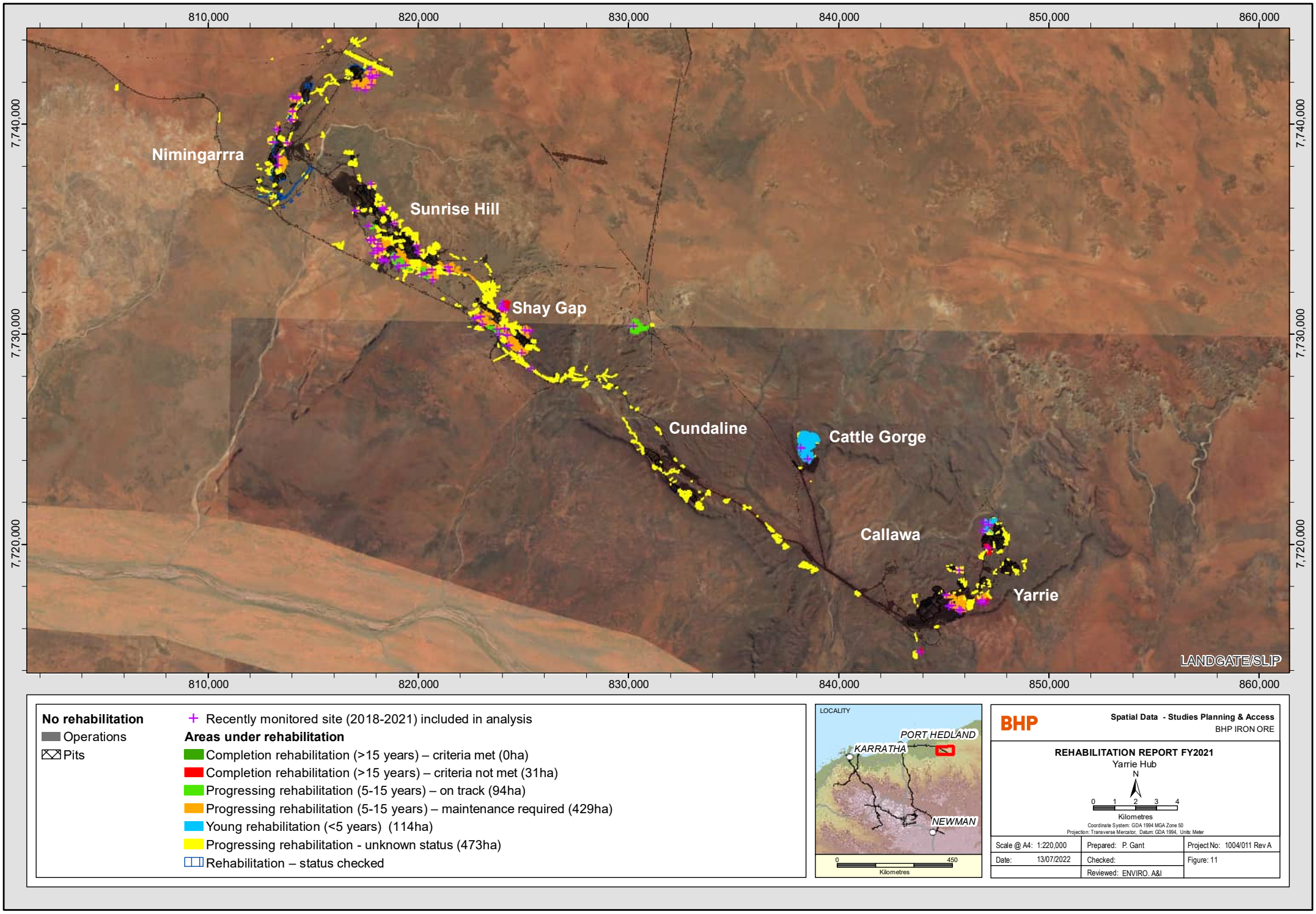
N

0 750 1,500 2,250 3,000
Meters

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator, Datum: GDA 1994, Units: Meter

Scale @ A4: 1:65,000	Prepared: P. Gant	Project No: 1004/012 Rev A
Date: 13/07/2022	Checked:	Figure: 10
	Reviewed: ENVIRO. A&I	

Document Path: Y:\Jobs\A1001_A1500\A1004\3Project\A1004_012_E_RehabReport_Goldsworthy_RevA.mxd



No rehabilitation

- Operations
- Pits

+ Recently monitored site (2018-2021) included in analysis

Areas under rehabilitation

- Completion rehabilitation (>15 years) – criteria met (0ha)
- Completion rehabilitation (>15 years) – criteria not met (31ha)
- Progressing rehabilitation (5-15 years) – on track (94ha)
- Progressing rehabilitation (5-15 years) – maintenance required (429ha)
- Young rehabilitation (<5 years) (114ha)
- Progressing rehabilitation - unknown status (473ha)
- Rehabilitation – status checked

BHP

Spatial Data - Studies Planning & Access
BHP IRON ORE

REHABILITATION REPORT FY2021
Yarrie Hub

N

0 1 2 3 4
Kilometres

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator, Datum: GDA 1994, Units: Meter

Scale @ A4: 1:220,000	Prepared: P. Gant	Project No: 1004/011 Rev A
Date: 13/07/2022	Checked:	Figure: 11
	Reviewed: ENVIRO. A&I	

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4.2 Historical rehabilitation success

MS1105 Guidelines 1(c)(ii) requires '*an analysis of the history of rehabilitation that BHP has undertaken in the Pilbara and the demonstrated success of this rehabilitation*'.

4.2.1 Analysis of rehabilitation history

BHP presented a chronology of BHP's rehabilitation and closure activities in the Pilbara since the mid-1970s (when revegetation trials were first undertaken at Mt Whaleback) in the PERSP (BHP Billiton 2016; Table 83). In EPA Report 1619, the EPA noted that these activities are of a small scale, and broadscale rehabilitation remains an area of improvement. The EPA also noted that the information provided by the small-scale activities since 1974 contribute to the knowledge base required for successful broadscale rehabilitation (EPA 2018).

Syrinx (2020; Table 12) provides an analysis of BHP's rehabilitation history (Appendix 1). A summary of this analysis is provided in Table 6.

Table 6: Summary of rehabilitation history analysis

Timeframe	Relevant hubs	Key practices	Rehabilitation outcomes
1980s	Newman	• First rehabilitation undertaken at Mt Whaleback by contractors with no specific guidelines or standards to follow. • Steep slopes and use of incompetent materials. • Seed generally limited to generic Pilbara species lists and absence of seed quality checks compromised germination success. • Rehabilitation activities were 'ad hoc' and not timed to suit recruitment.	• Poor or no records of rehabilitation works. • Poor *Triodia* recruitment, limited species diversity and high erosion were observed.
1990s (1990-2002)	Newman Jimblebar Goldsworthy Yarrie	As above and: • First 'moonscaping' (scalloping) of rehabilitation landforms to increase water harvesting potential • First trials with linear landforms, gentler slopes (20 degrees) and contour ripping • Various trials initiated to determine recruitment success/failure factors • Review of seed collection methods and quality was undertaken.	• Improved trials, audit process undertaken and improved monitoring of success across different landforms. • Less erosion and improved recruitment noted.
Early 2000s (2003 to 2013)	All hubs	• Moonscaping was abandoned, and linear landform with ripping adopted as new approach. • New OSA cover systems implemented. First use of rock armouring on OSAs to reduce erosion and mimic natural mesa formations • OSA slope profiles changed to 15-18 degrees and final landforms designed to integrate with surrounding terrain. (from 2010). • Material classification and management of rehabilitation substrates initiated across sites. Concept of 'growth media' introduced to enable use of subsoil in place of topsoil • Seed collection methods, and revegetation species lists changed. Seed quality assessment, provenance records, revegetation lists targeted to each mine region.	• Lower erosion impacts noted.

Timeframe	Relevant hubs	Key practices	Rehabilitation outcomes
		• External audits of existing practices was undertaken to develop formal standards. First closure and rehabilitation standards developed to guide future rehabilitation across sites. • Draft completion criteria developed and used to assess rehabilitation sites. • Research Strategy developed and specific rehabilitation initiatives established and funded to improve rehabilitation outcomes.	
2015 onwards	All new rehabilitation sites in all hubs	• Rehabilitation of all sites undertaken using primed seeds (*Acacia* species). • Long range data analysis used to assess rehabilitation and define gaps and future directions. • Seed sourcing strategy established to address quality control, provenance and seasonal variation. • Standardised approach to monitoring of sites introduced (2015-2016) and new survey methods (plot size etc.) rolled out (2017-2018).	• Seed technologies (pre-treatment, seeding) show improvements in recruitment in rehabilitation sites. • Growth media studies show that soil moisture and secondly carbon content, not substrate type, are the overriding factor influencing emergence of a range of Pilbara species.

4.2.2 Historical rehabilitation assessment

As discussed in Section 3.2.1, BHP considers that it is appropriate to measure rehabilitation success when the revegetation phase of rehabilitation is at a stage where it can be assessed for completion (rehabilitation generally greater than 15 to 20 years old). To assess the success of the history of rehabilitation for this report (as required by Guidelines 1(c)(ii), BHP has defined 'historical rehabilitation' as rehabilitation that is ready to be assessed against the completion criteria discussed in Section 3.2.1.

The FY2021 results for rehabilitation sites analysed are provided in the completion criteria output tables in Appendix 4 to Appendix 9. The appendices also provide a summary table for the overall performance of the hub against the vegetation attributes. A vegetation attribute is considered to be met at the hub level if the median of the results of the individual sites in the completion criteria output tables meets the target. For the FY2021 analysis, all hubs had rehabilitation sites that were monitored and were old enough to assess against completion criteria, except Jimblebar (Table 7). The low number of sites assessed for completion reflects BHP's change in sampling methods in 2017 to align with the EPA's revised technical guidance on flora and vegetation surveys in 2015 (EPA 2016) and because rehabilitation sites were monitored in 2021 using remote sensing only, as on ground monitoring was restricted due to COVID restrictions.

Table 7 presents the summary of the completion assessment for historical rehabilitation success. From the analysis at the hub level, historical rehabilitation is variable across the hubs, but was at least partially successful for all hubs. Very few rehabilitation sites did not meet all or most criteria, which suggests that most older sites are likely to reach completion and rehabilitation will be successful, but potentially over a longer timeframe. In summary:

- rehabilitation sites at Newman hub met all criteria
- rehabilitation sites at Yandi and Yarrie hubs met most completion criteria
- rehabilitation sites at Mining Area C and Goldsworthy hubs met some completion criteria.

The most common criteria that wasn't met was Hummock Grasses (*Triodia*) Cover, followed by Annual Species Richness. As *Triodia* Cover is a key indicator for rehabilitation success, improving *Triodia* Cover will be a focus of improvement activities (see Section 5).

Reasons that completion criteria weren't met across the hubs include the following:

- Poor rainfall years when rehabilitation areas are seeded. Spinifex (*Triodia*) germination is reliant on rainfall, hence many sites are not meeting Hummock Grasses (*Triodia*) Cover criteria.
- Older seeding techniques used in the past at some sites have not been conducive to *Triodia* germination or encouraging species richness (i.e. limited species seed mix). Some native species may have been used in the past which are allelopathic (i.e. plant species that produce substances that inhibit the germination or growth, survival, of other species), which may have affected hummock grasses.
- Weed infestation causing pronounced weed cover levels at some sites and in some cases restricting the growth and establishment of native species (e.g. where there are infestations of Buffel Grass (*Cenchrus cilliaris*), an allelopathic species).
- Lack of topsoil available or topsoil which cannot be used due to high weed seed loads (e.g. Whaleback in the Newman hub).
- Erosion of topsoil (e.g. Eastern Ridge in the Newman hub). Rock armour is being considered as an option to prevent future erosion.
- The past use of 'moonscaping' (from 1990 to early 2000s until it was replaced with other landforming methods) where the landform was scalloped to increase the water harvesting potential (e.g. Goldsworthy).

The rehabilitation status maps (Figure 6 to Figure 11) reflect the relatively small areas assessed for completion (442 ha). As expected, the hubs with older mines that have ceased mining activities in some/all areas (see Table 2) (e.g. Goldsworthy and Yarrie) have a higher proportion of rehabilitation assessed for completion, as a higher proportion of the disturbed land has been rehabilitated (Table 5). The maps also show large areas where the status of the rehabilitation is unknown, which is either where rehabilitation sites have not been monitored or the monitoring does not align with the preliminary methodology. Initial ground-truthing of the results of the analysis has indicated that there are additional areas of rehabilitation that are suitable to be assessed for completion (e.g. small areas at Mining Area C and Yandi that are meeting completion criteria) that are shown as 'Status Unknown' on the maps.

BHP will review areas where performance against the completion criteria was poor and the reason for low areas of rehabilitation assessed for completion. As discussed in Section 3, BHP is currently reviewing the rehabilitation success methodology, as part of BHP's Rehabilitation Improvement Program. BHP is aware that there are large areas of rehabilitation that have not been captured in the current analysis (shown as 'Status Unknown') due to data gaps and lack of alignment with the current rehabilitation monitoring approach. This is a key focus of the review of the rehabilitation success methodology (Section 5).

Where completion criteria were not met, BHP will review whether the criteria need to be amended or whether intervention is required for certain rehabilitation areas (e.g. to address *Triodia* Cover and Annual Species Richness). There are also several older mines across BHP (Whaleback in the Newman hub, Goldsworthy and Yarrie) where rehabilitation activities were undertaken using different land forming and revegetation techniques that were acceptable at that time and therefore are likely to perform poorly against the preliminary criteria used for this report. Specific completion criteria will be developed for these sites as part of the review of the rehabilitation success methodology (Section 5).

Table 7: Historical rehabilitation success – FY2021 completion criteria assessment

Mining hub	Years post-rehabilitation[1]	Target vegetation type	No. of sites assessed	Completion assessment	Summary
Jimblebar (Figure 6, Appendix 4)	Not assessed	Low Tree Steppe	0	Not assessed - no sites monitored using revised sampling methods (since 2017) were old enough to assess against completion criteria.	Not assessed - no sites monitored were old enough to assess completion.
Newman (Figure 7, Appendix 5)	20 to 30 years	Low Tree Steppe	3	Only three sites assessed. Individual sites met most targets (one site did not meet Tree Cover and one site did not meet Hummock Grasses (*Triodia*) and Weed Cover). At the hub level, targets for all vegetation attribute criteria were met.	Successful –all completion criteria met at hub level.
Yandi (Figure 8, Appendix 6)	16 to 23 years	Low Tree Steppe	7	All sites met Shrub and Other Grasses Cover, and Perennial Species Richness targets. Most sites met Tree, Herb and Weed Cover, and Perennial Species Richness. Most sites did not meet Hummock Grasses (*Triodia*) Cover target. At the hub level, targets for all vegetation attribute criteria were met except Tree and Hummock Grasses (*Triodia*) Cover.	Partially successful - most completion criteria met at hub level.
Mining Area C (Figure 9, Appendix 7)	16 to 17 years	Low Tree Steppe	5	All sites met Tree and Weed Cover and most sites met Shrub Cover targets. Most sites did not meet Hummock Grasses (*Triodia*), Other Grasses and Herb Cover, and Annual Species Richness. All sites did not meet Perennial Species Richness. At the hub level, targets for vegetation attribute criteria were met except Species Richness, and Hummock Grasses (*Triodia*), Other Grasses and Herb Cover.	Partially successful - some completion criteria met at hub level.
Goldsworthy (Figure 10, Appendix 8)	25 to 27 years	Grass Steppe	38	All sites met Tree and Shrub Cover target and most sites met Other Grasses and Weed Cover, and Perennial Species Richness targets. Most sites did not meet Hummock Grasses (*Triodia*) Cover and Annual Species Richness. At the hub level, targets for most vegetation attribute criteria were met except Annual Species Richness, Hummock Grasses (*Triodia)* and presence of Indicator Species from each Target Vegetation Type.	Partially successful - some completion criteria met at hub level.
Yarrie (Figure 11, Appendix 9)	16 – 27 years	Shrub Steppe	5	All sites met Shrub and Weed Cover, and Perennial Species Richness targets. Most sites met Tree, Other Grasses and Herb Cover. Most sites did not meet Hummock Grasses (*Triodia*) Cover and Annual Species Richness. At the hub level, targets for most vegetation attribute criteria were met except Annual Species Richness and Hummock Grasses (*Triodia).*	Partially successful - most completion criteria met at hub level.

1. For sites assessed. Years from start of rehabilitation (see Appendix 3).

4.3 Future rehabilitation success

To discuss future rehabilitation success, BHP has chosen to distinguish between areas where rehabilitation activities have been undertaken but the rehabilitation is not yet ready to be measured for success against completion criteria (rehabilitation underway) and areas where rehabilitation activities have not yet commenced, i.e areas that have been cleared or areas planned and proposed to be cleared (future rehabilitation activities).

4.3.1 Rehabilitation underway

MS1105 Schedule 1, Table 2, Column 3 2.c. requires that '*Scientifically verifiable estimates of the likely success of future rehabilitation have been made*'.

To address the requirements of MS1105 Schedule 1, Table 2, Column 3 2.c., BHP considers that 'future rehabilitation' is rehabilitation where all rehabilitation activities have been undertaken but the rehabilitation is not at a stage where it can be assessed for completion (rehabilitation generally less than 15 years old). BHP has used the assessment of rehabilitation at each hub against progressive criteria as the basis for analysing the likely success of future rehabilitation because:

- the progressive criteria and targets are based on the same scientifically verifiable data and approach as the completion criteria and targets, which BHP has used to measure historical rehabilitation success (Section 4.2.2)
- rehabilitation is likely to be successful (at completion) if BHP can demonstrate that rehabilitation is progressing according to an appropriate trajectory.

BHP has assessed the performance of 'future rehabilitation' using the progressive criteria discussed in Section 3.2.2 to understand whether rehabilitation underway that is young and progressing is likely to be successful in the future (i.e when considered to be completed).

The FY2021 results for rehabilitation sites analysed are provided in the progressive criteria output tables (Young and Progressing) in Appendix 4 to Appendix 9. For the FY2021 analysis, all hubs had rehabilitation sites that were monitored and categorised as progressing (i.e. 5 to 15 years) and young (less than 5 years), except Goldsworthy, which did not have young rehabilitation (Table 8). The Mining Area C and Yandi hubs only had one young rehabilitation site each assessed. The low number of sites assessed against progressive criteria reflects the low overall number of sites assessed and the smaller age range of young sites (5 years) compared to the other categories. As expected, the hubs with older mines that have ceased mining activities in some/all areas (e.g. Goldsworthy) have less younger rehabilitation sites.

Table 8 presents the summary of the progressive assessment for the likely future rehabilitation success. Although the data is limited, the analysis shows progressing rehabilitation is variable across the hubs, but was at least partially successful for all hubs. While the supporting criteria were met for most hubs, most hubs did not meet the major criterion (*Triodia* Cover/Total Native Cover ratio) except Jimblebar and Mining Area C. Newman hub also did not meet the supporting Weed Cover/*Triodia* Cover ratio. As discussed in Section 4.1, *Triodia* Cover is a key indicator for rehabilitation success, and improving *Triodia* will be a focus of improvement activities (see Section 5). The reasons that completion criteria weren't met are also applicable to why the progressing criteria weren't met. The results of the young rehabilitation cannot be extrapolated to the hub level as only three of the hubs had more than one rehabilitation site that was assessed.

The rehabilitation status maps (Figure 6 to Figure 11) show that of the areas assessed against progressing criteria (1,020 ha), only 16% (167 ha) is considered on track, which reflects that the major criterion was not met at most sites. The maps also show large areas where the status of the rehabilitation is unknown, which is either where rehabilitation sites have not been monitored or the monitoring does not align with the preliminary methodology. Initial ground-truthing of the results of the analysis has indicated that there are additional areas of young and progressing

rehabilitation that are shown as 'Status Unknown' on the maps, including young rehabilitation at Yandi, Yarrie, Newman and Jimblebar and progressing rehabilitation at Yandi and Jimblebar.

Where progressive criteria were not met, BHP will review whether maintenance is required for certain rehabilitation areas (e.g. to address *Triodia* Cover and Weed Cover). As discussed in Section 4.2, BHP is also currently reviewing the rehabilitation success methodology, as part of BHP's Rehabilitation Improvement Program. The progressive criteria used for the FY2021 assessment was the first attempt by BHP to develop criteria for the likely future success of rehabilitation. BHP is currently reviewing the progressive criteria to ensure that they are reflective of rehabilitation success and is developing interim milestones to enable BHP to assess whether rehabilitation underway is progressing on the right trajectory (see Section 5). The application of the revised progressive criteria for future assessments will help BHP confirm whether maintenance is required at sites that were not met for the FY2021 assessment.

Analysis of rehabilitation underway using scientifically-based targets (rather than aspirational targets) demonstrates that all hubs have met at least some progressive criteria targets. The new rehabilitation assessment approach BHP has implemented for this report (together with on-ground monitoring and remote sensing monitoring) provides BHP with early warning if sites are not progressing along the appropriate trajectory and enables BHP to undertake early maintenance work to get sites back on track to be successful at completion.

4.3.2 Future rehabilitation activities

MS1105 Guidelines 1(c)(iii) requires information on '*the likely success of future rehabilitation activities in establishing self-sustaining areas of rehabilitation, taking into account: relevant contemporary scientific evidence; the types of area to be rehabilitated; and the scale of rehabilitation activities.*'

Based on BHP's experience with rehabilitation to date and the scientific analysis undertaken by Syrinx (2020), BHP considers that the likely success of establishing self-sustaining areas of rehabilitation depends on the following elements:

- the types of areas (i.e. domains) to be rehabilitated (Section 2.3). Rehabilitation is likely to be more successful and/or take less time to be successful in areas where there is a lower impact on the land (e.g. infrastructure areas), compared to areas where there is a higher impact (e.g. OSAs)
- smaller areas of disturbance (e.g. borrow pits or laydown areas) and linear disturbance (e.g. pipelines and roads) will be easier to rehabilitate than larger areas and landforms, e.g. OSAs
- availability of growth media (and the type of waste when rehabilitating OSAs)
- realistic, scientifically-based, criteria and targets that are used to measure success (Section 3.2)
- the capacity for BHP to adapt from rehabilitation learnings, including the success of existing rehabilitation and relevant contemporary scientific evidence, e.g. to:
  - adjust the rehabilitation monitoring program if required
  - revise criteria or targets if justified from scientific evidence
  - undertake maintenance work, where appropriate, if rehabilitation progress is not on track.

While the scale of rehabilitation required is not a direct consideration for rehabilitation success, larger mines will operate for longer and larger areas will take longer to rehabilitate. Therefore, there is likely to be a longer time period from when rehabilitation activities start at a mine to when rehabilitation is complete.

BHP considers that future rehabilitation activities will be successful if the relevant criteria targets (progressive and completion) are met. Therefore, BHP intends to apply a similar approach for future rehabilitation activities as existing areas under rehabilitation (underway and completed), adapting the current approach (rehabilitation practices, monitoring and success criteria), where relevant, based on contemporary scientific evidence (BHP data and information and broader (including Pilbara) information). The relevant contemporary scientific evidence BHP has

taken into account for the current rehabilitation approach is detailed in Syrinx 2020 (Sections 2.3, 4.0, 5.0 and 9.0). A full list of the scientific reports is provided in Syrinx 2020 (References).

BHP considers that future rehabilitation activities are likely to be successful because BHP plans early for rehabilitation as part of the closure planning process, implements the latest rehabilitation techniques and incorporates learnings from the performance of existing rehabilitation. The assessment of historical rehabilitation (Section 4.2.2) and future rehabilitation (where rehabilitation is underway) (Section 4.3.1) demonstrates that rehabilitation is at least partially successful and at least partially progressing along the appropriate trajectory for success at completion, particularly for native species cover.

For the derived proposals (OB32 BWT and Western Ridge), based on relevant aspects of the completion criteria (Section 4.2.2) and progressive criteria (Section 4.3.1) analysis for the Newman Hub and the relevant considerations for the likely success of establishing self-sustaining areas of rehabilitation, BHP considers that it is likely that future rehabilitation activities for the OB32 BWT and Western Ridge derived proposals will be successful.

For the OB32 BWT derived proposal (BHP 2022a), the proposed disturbance for the construction and operation of a surplus water pipeline from the OB32 BWT mine to Ophthalmia Dam (linear infrastructure only) will be relatively small scale (224 ha). The analysis of rehabilitation sites (including the Eastern Ridge mining operation where the existing OB32 AWT mine is located and sites located on similar flat terrain where the disturbance for the OB32 BWT will occur), demonstrates a high likelihood of success. Given the larger scale and nature of proposed mining activities for the Western Ridge derived proposal, where the area of proposed disturbance is up to 4,281 ha (BHP 2022b), it is likely that it will take longer for rehabilitation to be complete. However, analysis of rehabilitation sites, particularly where rehabilitation activities have been undertaken using more recent rehabilitation techniques, demonstrates that there is also a high likelihood of success at the mine scale. BHP will also apply any relevant rehabilitation learnings when areas associated with the OB32 BWT pipeline and Western Ridge mine and associated infrastructure, are ready to be rehabilitated.

Table 8: Future rehabilitation success – FY2021 progressive criteria assessment

Mining hub	Target vegetation type	No of sites assessed	Progressive assessment	Summary
Jimblebar (Figure 6, Appendix 4)	Low Tree Steppe	Young: 3	All sites did not meet target for major criterion *Triodia* Cover/Shrub Cover ratio. Two of three sites met targets for supporting criteria Minimum Total Native Cover and one site met supporting Weed Cover/*Triodia* Cover ratio.	Most criteria not met
		Progressing: 14	Most sites met targets for major criterion for *Triodia* Cover/Total Native Cover ratio and supporting criterion Weed Cover/*Triodia* Cover ratio.	Most criteria met
Newman (Figure 7, Appendix 5)	Low Tree Steppe	Young: 5	Most sites met targets for major criterion *Triodia* Cover/Shrub Cover ratio, and supporting criteria Minimum Total Native Cover and Weed Cover/*Triodia* Cover ratio.	Most criteria met
		Progressing: 23	Most sites did not meet targets for major criterion *Triodia* Cover/Total Native Cover ratio and supporting criterion Weed Cover/*Triodia* Cover ratio.	Most criteria not met
Yandi (Figure 8, Appendix 6)	Low Tree Steppe	Young: 1	Only 1 site assessed. Did not meet target for major criterion *Triodia* Cover/Shrub Cover ratio. Met targets for supporting criteria Minimum Total Native Cover and Weed Cover/*Triodia* Cover ratio.	Only 1 site - met supporting criteria only
		Progressing: 15	Most sites did not meet target for major criterion *Triodia* Cover/Total Native Cover ratio. Most sites met target for supporting criterion Weed Cover/*Triodia* Cover ratio.	Most criteria not met
Mining Area C (Figure 9, Appendix 7)	Low Tree Steppe	Young: 1	Only 1 site assessed. Did not meet target for major criterion *Triodia* Cover/Shrub Cover ratio. Met targets for supporting criteria Minimum Total Native Cover and Weed Cover/*Triodia* Cover ratio.	Only 1 site - met supporting criteria only
		Progressing: 6	50% of sites met target for major criterion for *Triodia* Cover/Total Native Cover ratio and all sites met target for supporting criteria Weed Cover/*Triodia* Cover ratio.	Most criteria met
Goldsworthy (Figure 10, Appendix 8)	Grass Steppe	Young - 0	Not assessed - all sites old enough to assess against progressive or completion criteria.	Not assessed
		Progressing: 4	All sites did not meet target for major criterion *Triodia* Cover/Shrub Cover ratio. 50% of sites met target for supporting criterion Weed Cover/*Triodia* Cover ratio.	Most criteria not met
Yarrie (Figure 11, Appendix 8)	Shrub Steppe	Young: 4	Most sites did not meet target for major criterion *Triodia* Cover/Shrub Cover ratio. All sites met targets for supporting criteria Minimum Total Native Cover and Weed Cover/*Triodia* Cover ratio.	Met supporting criteria
		Progressing: 67	Most sites did not meet target for major criterion *Triodia* Cover/Shrub Cover ratio. Most sites met target for supporting criterion Weed Cover/*Triodia* Cover ratio.	Met supporting criteria

5 Continuous improvement and future work

Through the development of the preliminary rehabilitation success methodology (including criteria and targets), and analysis of BHP's rehabilitation data, BHP has identified areas of continuous improvement and future work.

Methodology for assessing rehabilitation success

To support the approach for assessing rehabilitation success used in this report, as part of the Rehabilitation Improvement Program, BHP will review and improve a number of standards and procedures/processes currently being used by WAIO and where necessary, address identified gaps. This includes the following:

Review of rehabilitation criteria

BHP is currently reviewing the preliminary completion criteria developed to assess rehabilitation success for completed rehabilitation. This will involve testing the criteria for both the Pastoral and Natural Vegetation post-mining land uses against additional data collected through monitoring over the past three years. BHP is reviewing the appropriateness of the criteria for use at older mines (i.e Whaleback in the Newman Hub, Goldsworthy and Yarrie) and may modify the criteria where appropriate, to recognise historical rehabilitation practices. Once the completion criteria are reviewed and updated and agreed within BHP, MCPs will be updated to reflect the revised completion criteria, where relevant. BHP has started discussions with DMIRS regarding revising the completion criteria and is currently exploring options to enable the completion criteria to be approved.

BHP has also started reviewing the progressive criteria and is developing interim milestones to enable BHP to assess whether rehabilitation underway is progressing on the right trajectory towards rehabilitation success.

Review of monitoring methodology

BHP has started to review the current rehabilitation monitoring methodology, to identify gaps in the monitoring and to better align the monitoring to the revised rehabilitation criteria. This will include reviewing the locations, frequency and method of monitoring (i.e on-ground and remote-sensing). Once the review of rehabilitation criteria is complete, BHP will revise the monitoring program to ensure appropriate data is collected to measure rehabilitation success at key development points on the rehabilitation trajectory (interim milestones) and at completion. The aim of the revised monitoring program is also to provide clear data on whether rehabilitation intervention / maintenance is required, for continuous improvement.

Review of rehabilitation status and success reporting

Once the rehabilitation criteria and monitoring program reviews are complete, BHP will review the traffic light approach for spatially presenting the status and success of rehabilitation, aligning it to any new monitoring methodology.

Rehabilitation activities

In parallel with the review of the methodology for assessing rehabilitation success, BHP will continue to ground-truth the analysis contained in this report to confirm the assessment of rehabilitation progress and success (including Status Unknown areas). This will include reviewing rehabilitation sites that are not performing against targets, or where there is variability across sites in the same hub, and decide if maintenance / intervention is required. For example, in response to poor performance against rehabilitation targets, the Buffel Grass (*Cenchrus cilliaris*) management techniques at the Newman hub are under review and a *Triodia* seeding program is commencing at areas near Yandi's putrescible landfill which has not met progressive criteria targets.

BHP will also continue to undertake progressive rehabilitation. BHP aims to complete landforming and stabilisation works within 3 years of disturbed areas becoming available for rehabilitation and complete topsoil and/or growth media spreading and revegetation works within 5 years. BHP will also align the timing of rehabilitation activities to

the optimal time of year as far as practicable. In extended drought periods, BHP will implement accelerated and/or advanced revegetation methods, to avoid extensive bare areas and to facilitate plant cover.

Investigation/research

BHP will identify work based on the outcomes of this report (e.g. where criteria have not been met - mostly Hummock Grasses (*Triodia*) criteria). Relevant investigations and research include the following:

- Jimblebar hub: Ongoing research is underway to investigate seeding placement and cover strategies to enhance rehabilitation success.
- Newman hub: Irrigation trials will commence at Whaleback rehabilitation areas with the aim of improving rehabilitation success, in particular seed germination.

6 References

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Appendices

Appendix 1 BHP Pilbara Strategic Proposal: Inputs to Rehabilitation Report

Separate document

Appendix 2 Preliminary rehabilitation criteria

Completion criteria

CLOSURE REVEGETATION OBJECTIVES: *Naturalness* (major vegetation types, characteristic (icon) species, structure, pattern), *Resilience* (vegetation cover, richness, recruitment, stability) and *Habitat Connectivity*				
Attribute	**Criteria**	**Metric**	**Rationale**	**Method of Assessment**
Bare Ground (Non-vegetated)	Bare ground to have stony/rocky cover and be typical of the regional landforms and generally evenly dispersed between vegetation	% bare ground with rock or stony cover for individual landforms (e.g. hills, slopes etc.)	Critical for achieving key attributes such as patterns, diversity, soil stability	Survey by plot or equivalent method
Species Richness	Perennial and annual native species richness to reflect each major vegetation type present within the rehabilitation	Number of perennial and annual species to be within the median range (Q1 - Q3) for each major Vegetation Type	Strong indicator of resilience in Pilbara; important for achieving diversity and vegetation cover	Survey by plot and releve (median of aggregated plots per site compared to Q1-Q3 range for natural end use, >Q1 for pastoral) Not less than 15 years post rehabilitation
Weed Invasiveness	DBCA priority list weed species to be managed so as not to cause unacceptable risk to surrounding environments	Absence of priority weed species or if present, cover not greater than in the regional surrounds No new priority species to be introduced	Critical for achieving naturalness and resilience objectives	Surveys and comparison with regional baseline data
	Total weed cover to be typical for each site and landform, and reflect final end use	% total weed cover and % buffel grass (**Cenchrus ciliaris*) cover per post-mining land use and landform		Survey by plot and releve or equivalent method
Target Vegetation Types	Vegetation types to respond to biogeographic region and finished landforms. All major vegetation types (Beard et al 2013) present at each site to be represented in post-mined landscapes	Presence of appropriate Vegetation Types	Provides variability of habitat types and is critical for achieving naturalness objective	Survey by plot or equivalent method and comparison with Beard et al 2013 Pilbara vegetation types
Indicator Species	Presence of dominant and common species from each Target Vegetation Type represented in post-mined landscapes	Presence of dominant species to reflect end use Presence of iconic species	Critical for achieving naturalness objective and ensuring required species and structure diversity	Survey by plot or equivalent method
Plant Cover	Vegetation cover for each strata to reflect major vegetation type present within the rehabilitation	% cover for each strata (e.g. trees, shrubs, grasses, etc.) to be within the median range (Q1 - Q3) for each major vegetation type	Key attribute of closure revegetation objectives (naturalness, resilience and habitat connectivity)	Survey by plot or equivalent method (median of aggregated plots per site compared to Q1-Q3 range for Natural Environment post-mining land use, >Q1 for Pastoral Environment) By plot not less than 15 years post-rehabilitation

Progressive criteria

PROGRESSIVE CRITERIA		
Young rehabilitation (< 5 years)		
	Criteria	**Targets**
Major criterion	*Triodia* cover / Shrub cover ratio	> 2
Supporting criteria	Minimum total native cover (%)	> 12%
	Weed cover / *Triodia* cover ratio	< 1
Progressing rehabilitation (5 - 15 years)		
	Criteria	**Targets**
Major criterion	*Triodia* Cover / Total Native Cover	≥ 0.32
Supporting criterion	Weed cover / *Triodia* cover ratio	< 1

Appendix 3 Hub key information

Element	Jimblebar	Newman	Yandi	Mining Area C	Goldsworthy	Yarrie
Start of disturbance (Year)	1989	1968	1991	2000	1965	1991
Start of rehabilitation (Year)	1990	1975	1998	2002	1992	1993
Start of rehabilitation monitoring (Year)	1991	1976	1999	2004	1993	1994
Number of plots with rehabilitation >= 15 years [2006 or earlier]	17	25	25	12	41	30
Number of plots with rehabilitation < 15 years [2007 onwards]	15	21	20	18	0	32
Operations status	Operations	Operations	Operations	Operations	Mining ceased	Suspended operations
Estimated closure date[1]	2069	2080	2028	2068	-	TBA
Geographic region	Eastern Pilbara, Northern Gascoyne	Eastern Pilbara	Central Pilbara	Central Pilbara	Northern Pilbara	Northern Pilbara
Target ecosystem (vegetation) type	Low tree-steppe	Low tree-steppe	Low tree-steppe	Low tree-steppe	Grass-steppe	Shrub-steppe
Assumed post-mining land use	Pastoral environment	Pastoral environment	Pastoral environment	Natural environment	Pastoral environment	Pastoral environment

1. Date when infrastructure is decommissioned and removed, according to current MCPs.

Appendix 4 Jimblebar hub: completion and progressive criteria output tables FY2021

Jimblebar hub completion criteria analysis

Note: No sites met the requirements for quantitative completion assessment

SITE:	Jimblebar
YEARS POST REHAB:	0 to 0
No. SITES ASSESSED:	0
VEG TYPE:	Low Tree Steppe
END USE:	Pastoral

ATTRIBUTE	METRIC	TARGETS		PERFORMANCE	
Bare Ground (non-vegetated)	% bare ground with rock and stony cover	Hills, slopes, dry plains	≤ 50 %		
		Drainage lines (excluding channel bed)	≤ 20 %		
		Floodplains	≤ 10 %		
Species Richness	Perennial and annual native species richness (number of species)		> **Q1**	**median**	
		Perennial native species	> 16	Sample size too small	-
		Annual native species	> 5	Sample size too small	-
Weed Invasiveness	Priority Alert weed species	Priority alert weed species presence and cover	Not present or cover ≤ regional baseline	none	√
		Introduction of new priority species	No new priority species introduced	none	√
	Percentage cover of total weeds	Total weed cover (%)			
		drainage lines, floodplains	< 20 %	Sample size too small	-
		upland hills, slopes and flats	< 10 %	Sample size too small	-
	Percentage cover of Cenchrus ciliaris	Cenchrus ciliaris cover (%)			
		drainage lines, floodplains	< 10 %	Sample size too small	-
		upland hills, slopes and flats	< 10 %	Sample size too small	-
Target Vegetation Types	Presence of appropriate vegetation types			**Low Tree Steppe**	
Indicator Species	Presence of dominant and common species from each Target Vegetation Type	All dominant species present		NO	-
		>50% of common species present		YES	-
Plant Cover	% cover for each strata Low Tree Steppe		> **Q1**	median	
		Trees	> 1 %	Sample size too small	-
		Shrubs	> 2 %	Sample size too small	-
		Hummock Grasses	> 20 %	Sample size too small	-
		Other Grasses	> 0.04 %	Sample size too small	-
		Herbs	> 0.05 %	Sample size too small	-

Jimblebar hub progressive criteria analysis

						PROGRESSING REHABILITATION (5-15 YEARS) CRITERIA	
						MAJOR	*SUPPORTING*
Transect	Location	Date of monitoring	Years post rehabilitation	Type	Terrain	Triodia cover /Total native cover ratio	Weed cover / Triodia cover ratio
					Target	≥ 0.32	< 1
BJB42	Jimblebar	2021	6	Wheelara 1/2	Flat	0.052	0.1
BJB43	Jimblebar	2021	7	Wheelara 1/2	Slope	0.288	0.0
BJB45	Jimblebar	2021	8	OB18 Rail Loop	Flat	0.470	0.0
BJB46	Jimblebar	2021	9	Unnamed Area	Flat	0.338	0.0
BJB_R01	Jimblebar	2019	7	Borrow Pit - Rail	Flat	0.528	0.0
BJB_R02	Jimblebar	2019	7	Borrow Pit - Rail	Flat	0.155	0.0
BJB_R03	Jimblebar	2019	7	Borrow Pit - Rail	Flat	0.434	0.0
BJB_R04	Jimblebar	2019	7	Borrow Pit - Rail	Flat	0.045	5.0
BJB_R05	Jimblebar	2019	7	Borrow Pit - Rail	Flat	0.579	0.0
BJB_R08	Jimblebar	2019	6	Borrow Pit - Rail	Flat	0.762	0.0
BJB_R09	Jimblebar	2019	7	Borrow Pit - Rail	Flat	0.682	0.0
BJB_R10	Jimblebar	2019	7	Borrow Pit - Rail	Flat	0.769	0.0
BJB33	Jimblebar	2019	8	Borrow Pit - Rail	Flat	0.014	0.8
BJB41	Jimblebar	2019	5	Previous Geotech - Jimblebar	Flat	0.042	12.5
% sites meeting targets						57%	86%

						YOUNG REHABILITATION (< 5 YEARS) CRITERIA		
						MAJOR	*SUPPORTING*	
Transect	Mine	Date of monitoring	Years post rehabilitation	Type	Terrain	Triodia cover /Shrub cover ratio	Minimum total native cover (%)	Weed cover / Triodia cover ratio
					Target	> 2	> 12	< 1
BJB44	Jimblebar	2019	3	West Jimblebar	Flat	0.00	12.6	21
BJB47	Jimblebar	2019	2	Jimblebar - EA Validated for .	Flat	0.01	3.1	0
BJB40	Jimblebar	2019	3	Previous Geotech - Jimblebar	Flat	0.00	13.3	20
% sites meeting targets						0%	67%	33%

Appendix 5 Newman hub: completion and progressive criteria output tables FY2021

Newman hub completion criteria analysis

Transect	Location	Date of	Years post rehabilitation	Type	Terrain	COMPLETION (>15 YEARS) CRITERIA: % Cover – Tree	Shrub	Triodia	Other grass	Herb	Weed	Species richness – Perennial	Annual
					Target	>1	>2	>20	>0.04	>0.05	<10	>16	>5
BFO03	Eastern Ridge	2021	22	OSA - OB25 Fire Trial (c	Crest	0.3	11.1	30.0	0.40	2.9	0.2	32	13
BO2-11	Eastern Ridge	2018	20	Pit 1 Face South Face, 1	Slope	2.1	17.0	1.5	2.36	0.1	10.0	36	9
BWB01	Mount Whalebac	2017	30	Borrow Pit - Security Gat	Flat	1.5	14.6	26.0	1.38	0.3	2.0	31	6
				% sites meeting targets		67%	100%	67%	100%	100%	67%	100%	100%

SITE:	Newman
YEARS POST REHAB:	20 to 30
No. SITES ASSESSED:	3
VEG TYPE:	Low Tree Steppe
END USE:	Pastoral

ATTRIBUTE	METRIC	TARGETS		PERFORMANCE	
Bare Ground (non-vegetated)	% bare ground with rock and stony cover	Hills, slopes, dry plains	≤ 50 %		
		Drainage lines (excluding channel bed)	≤ 20 %		
		Floodplains	≤ 10 %		
Species Richness	Perennial and annual native species richness (number of species)		> **Q1**	**median**	
		Perennial native species	> 16	32	√
		Annual native species	> 5	9	√
Weed Invasiveness	Priority Alert weed species	Priority alert weed species presence and cover	Not present or cover ≤ regional baseline	none	√
		Introduction of new priority species	No new priority species introduced	none	√
	Percentage cover of total weeds	Total weed cover (%)			
		drainage lines, floodplains	< 20 %	2	√
		upland hills, slopes and flats	< 10 %	2	√
	Percentage cover of Cenchrus ciliaris	Cenchrus ciliaris cover (%)			
		drainage lines, floodplains	< 10 %	0.1	√
		upland hills, slopes and flats	< 10 %	0.1	√
Target Vegetation Types	Presence of appropriate vegetation types			**Low Tree Steppe**	
Indicator Species	Presence of dominant and common species from each Target Vegetation Type	All dominant species present		YES	√
		>50% of common species present		YES	√
Plant Cover	% cover for each strata Low Tree Steppe		> **Q1**	median	
		Trees	> 1 %	1.50	√
		Shrubs	> 2 %	14.6	√
		Hummock Grasses	> 20 %	26.0	√
		Other Grasses	> 0.04 %	1.4	√
		Herbs	> 0.05 %	0.34	√

Newman hub progressive criteria analysis

Transect	Location	Date of monitoring	Years post rehabilitation	Type	Terrain	PROGRESSING REHABILITATION (5-15 YEARS) CRITERIA – *MAJOR*: Triodia cover /Total native cover ratio	*SUPPORTING*: Weed cover / Triodia cover ratio
					Target	≥ 0.32	< 1
BO2-12	Eastern Ridge	2021	13	OSA - Southern Landform	Slope	0.003	500.0
BO2-13	Eastern Ridge	2021	13	OSA - OB23 OSA	Slope	0.355	1.0
BO2-18	Eastern Ridge	2021	10	OSA - OB23 OSA	Slope	0.216	5.6
BO2-28	Eastern Ridge	2021	5	OB23 WS Dump	Crest	0.682	0.0
BO2-60	Eastern Ridge	2019	5	Unnamed Area	Flat	0.672	0.0
BO2_R01	Eastern Ridge	2019	6	Old Projects Rehab from Roac	Flat	0.010	2.0
BO2-27	Eastern Ridge	2019	7	Rail Borrow Pit	Crest	0.718	1.1
BO2-48	Eastern Ridge	2019	7	Borrow Pit	Flat	0.024	50.0
BO2-47	Eastern Ridge	2019	6	Borrow Pit	Flat	0.000	402.0
BO2-51	Eastern Ridge	2019	6	Borrow Pit	Flat	0.005	150.0
BWB51	Mount Whaleback	2021	7	-	Flat	0.512	0.0
BWB55	Mount Whaleback	2021	7	Evap Ponds	Flat	0.000	
BWB_R01	Mount Whaleback	2019	7	No name	Flat	0.000	
BWB_R02	Mount Whaleback	2019	7	No name	Flat	0.000	
BWB26	Mount Whaleback	2019	9	W41 Soak Cells (cells 1-3)	Flat	0.000	
BWB36	Mount Whaleback	2019	5	WD 41_EXTN1	Flat	0.024	62.5
BWB37	Mount Whaleback	2019	5	WD 41_EXTN2	Flat	0.107	5.6
BWB41	Mount Whaleback	2019	5	OB29 Old Town Landfill	Flat	0.000	
BWB54	Mount Whaleback	2019	7	Evap Ponds	Flat	0.000	
BWB56	Mount Whaleback	2019	7	Evap Ponds	Flat	0.000	
BWB27	Mount Whaleback	2019	8	W41 Soak Cells (cells 4-17)	Flat	0.195	4.9
BWB49	Mount Whaleback	2019	6	Old Landfill	Flat	0.321	1.0
BWB50	Mount Whaleback	2019	6	Old Landfill	Flat	0.094	7.4
				% sites meeting targets		26%	25%

Transect	Mine	Date of monitoring	Years post rehabilitation	Type	Terrain	YOUNG REHABILITATION (< 5 YEARS) CRITERIA – *MAJOR*: Triodia cover /Shrub cover ratio	*SUPPORTING*: Minimum total native cover (%)	*SUPPORTING*: Weed cover / Triodia cover ratio
					Target	> 2	> 12	< 1
BWB200	Mount Whaleback	2019	3	-	Flat	9.65	28.8	0
BWB44	Mount Whaleback	2019	4	W28 Old Topsoil storage	Slope	5.95	32.1	0
BWB45	Mount Whaleback	2019	4	W28 Old Topsoil storage	Crest	1.54	20.8	0
BWB46	Mount Whaleback	2019	4	OB35 PAF contingency dum	Flat	6.89	9.7	19
BWB52	Mount Whaleback	2019	2	SPA	Crest	0.07	5.0	77
				% sites meeting targets		60%	60%	60%

Appendix 6 Yandi hub: completion and progressive criteria output tables FY2021

Yandi hub completion criteria analysis

Transect	Location	Date of monitoring	Years post rehabilitation	Type	Terrain	COMPLETION (>15 YEARS) CRITERIA: % Cover: Tree	Shrub	Triodia	Other grass	Herb	Weed	Species richness: Perennial	Annual
					Target	>1	>2	>20	>0.04	>0.05	<10	>16	>5
BMC03	Yandi	2021	19	OSA - E20SA	Slope	0.3	7.7	6.5	11.10	1.2	25.0	24	12
BMC04	Yandi	2021	19	OSA - E20SA	Slope	2.0	9.1	32.0	1.39	2.5	12.0	37	20
BMC12	Yandi	2021	17	OSA - E20SA	Crest	3.0	19.7	0.6	12.03	0.1	0.0	84	3
BMC13	Yandi	2021	23	OSA - E20SA	Crest	8.5	2.0	12.0	1.82	0.3	0.4	52	9
BMC14	Yandi	2021	23	OSA - E20SA	Crest	0.5	12.3	35.0	2.99	1.5	0.4	76	20
BMC15	Yandi	2021	23	OSA - E20SA	Crest	1.0	23.5	2.5	11.40	0.4	0.0	73	7
BMC10	Yandi	2018	16	Borrow Pit for Barimunya	Flat	0.0	13.1	15.1	0.06	0.0	0.0	17	5
				% sites meeting targets		57%	100%	29%	100%	86%	71%	100%	86%

SITE:	Yandi
YEARS POST REHAB:	16 to 23
No. SITES ASSESSED:	7
VEG TYPE:	Low Tree Steppe
END USE:	Pastoral

ATTRIBUTE	METRIC	TARGETS			PERFORMANCE	
Bare Ground (non-vegetated)	% bare ground with rock and stony cover	Hills, slopes, dry plains	≤ 50	%		
		Drainage lines (excluding channel bed)	≤ 20	%		
		Floodplains	≤ 10	%		
Species Richness	Perennial and annual native species richness (number of species)		> **Q1**		**median**	
		Perennial native species	> 16		52	√
		Annual native species	> 5		9	√
Weed Invasiveness	Priority Alert weed species	Priority alert weed species presence and cover	Not present or cover ≤ regional baseline		none	√
		Introduction of new priority species	No new priority species introduced		none	√
	Percentage cover of total weeds	Total weed cover (%)				
		drainage lines, floodplains	< 20	%	0.35	√
		upland hills, slopes and flats	< 10	%	0.35	√
	Percentage cover of Cenchrus ciliaris	Cenchrus ciliaris cover (%)				
		drainage lines, floodplains	< 10	%	0.1	√
		upland hills, slopes and flats	< 10	%	0.1	√
Target Vegetation Types	Presence of appropriate vegetation types				**Low Tree Steppe**	
Indicator Species	Presence of dominant and common species from each Target Vegetation Type	All dominant species present			YES	√
		>50% of common species present			YES	√
Plant Cover	% cover for each strata Low Tree Steppe		> **Q1**		median	
		Trees	> 1	%	1.00	-
		Shrubs	> 2	%	12.3	√
		Hummock Grasses	> 20	%	12.0	-
		Other Grasses	> 0.04	%	3.0	√
		Herbs	> 0.05	%	0.36	√

Yandi hub progressive criteria analysis

Transect	Location	Date of monitoring	Years post rehabilitation	Type	Terrain	PROGRESSING REHABILITATION (5-15 YEARS) CRITERIA: *MAJOR*: Triodia cover /Total native cover ratio	*SUPPORTING*: Weed cover / Triodia cover ratio
					Target	≥ 0.32	< 1
BMC05	Yandi	2019	15	OSA - E20SA	Slope	0.022	0.0
BMC06	Yandi	2021	14	OSA - E20SA	Slope	0.136	0.0
BMC21	Yandi	2021	12	OSA - Central OSA	Flat	0.468	0.0
BMC247	Yandi	2021	12	OSA - Central OSA	Slope	0.260	0.6
BMC26	Yandi	2019	10	OSA - Central OSA	Crest	0.436	0.0
BMC27	Yandi	2019	10	Infrastructure - OHP2 Rail Loo	Flat	0.053	0.1
BMC62	Yandi	2019	10	Yandi 2 Rail Loop Borrow Pit	Flat	0.522	0.1
BMC67	Yandi	2019	7	Access Rd upgrade Borrow Pi	Flat	0.133	0.0
BMC_R01	Yandi	2019	7	RGP5 Spinifex Village HV Acc	Crest	0.107	0.0
BMC_R02	Yandi	2019	7	Access Rd upgrade Borrow Pi	Flat	0.067	0.0
BMC_R03	Yandi	2019	7	Access Rd upgrade Borrow Pi	Flat	0.199	0.0
BMC18	Yandi	2019	10	Borrow Pit - Marillana	Flat	0.197	8.7
BMC20	Yandi	2019	14	OSA - Central OSA East	Crest	0.525	0.1
BMC08	Yandi	2019	15	Borrow Pit for Barimunya Airp	Flat	0.342	0.0
BMC09	Yandi	2019	15	Borrow Pit for Barimunya Airp	Flat	0.658	0.0
				% sites meeting targets		40%	93%

Transect	Mine	Date of monitoring	Years post rehabilitation	Type	Terrain	YOUNG REHABILITATION (< 5 YEARS) CRITERIA: *MAJOR*: Triodia cover /Shrub cover ratio	*SUPPORTING*: Minimum total native cover (%)	Weed cover / Triodia cover ratio
					Target	> 2	> 12	< 1
BMC68	Yandi	2019	4	YNMS679	Flat	0.02	24.3	0
				% sites meeting targets		0%	100%	100%

Appendix 7 Mining Area C hub: completion and progressive criteria output tables

Mining Area C hub completion criteria analysis

						COMPLETION (>15 YEARS) CRITERIA							
						% Cover						Species richness	
Transect	Location	Date of monitoring	Years post rehabilitation	Type	Terrain	Tree	Shrub	Triodia	Other grass	Herb	Weed	Perennial	Annual
					Target	1 - 10	2 - 10	20 - 30	0.04 - 0.62	0.05 - 0.4	<5	16 - 29	5 - 11
BAC04	Area C	2018	16	Bulk sample borrow pits 11a	Flat	9.5	9.2	45.1	1.51	0.1	0.0	46	8
BAC_R04	Area C	2019	17	Bulk Sample Borrow Pit 6	Flat	4.0	8.7	10.0	3.00	0.0	0.0	12	0
BAC_R05	Area C	2019	17	Bulk Sample Borrow Pit 2	Slope	2.0	9.3	29.0	0.60	0.0	0.0	11	0
BAC_R06	Area C	2019	17	Bulk Sample Borrow Pit 1	Flat	10.0	6.6	15.0	2.00	0.0	0.0	12	0
BAC_R07	Area C	2019	17	Bulk Sample Borrow Pit 4	Flat	3.0	12.8	20.0	1.00	0.0	0.0	11	1
				% sites meeting targets		100%	80%	40%	20%	20%	100%	0%	20%

SITE:	Area C
YEARS POST REHAB:	16 to 17
No. SITES ASSESSED:	5
VEG TYPE:	Low Tree Steppe
END USE:	Natural

ATTRIBUTE	METRIC	TARGETS					PERFORMANCE	
Bare Ground (non-vegetated)	% bare ground with rock and stony cover	Hills, slopes, dry plains	≤	50	%			
		Drainage lines (excluding channel bed)	≤	20	%			
		Floodplains	≤	10	%			
Species Richness	Perennial and annual native species richness		>	**Q1**		< **Q3**	**median**	
	(number of species)	Perennial native species	>	16		< 29	12	-
		Annual native species	>	5		< 11	0	-
Weed Invasiveness	Priority Alert weed species	Priority alert weed species presence and cover	Not present or cover ≤ regional baseline				none	√
		Introduction of new priority species	No new priority species introduced				none	√
	Percentage cover of total weeds	Total weed cover (%)						
		drainage lines, floodplains	<	15	%		0	√
		upland hills, slopes and flats	<	5	%		0	√
	Percentage cover of Cenchrus ciliaris	Cenchrus ciliaris cover (%)						
		drainage lines, floodplains	<	10	%		0	√
		upland hills, slopes and flats	<	5	%		0	√
Target Vegetation Types	Presence of appropriate vegetation types						**Low Tree Steppe**	
Indicator Species	Presence of dominant and common species	All dominant species present					YES	√
	from each Target Vegetation Type	>50% of common species present					YES	√
Plant Cover	% cover for each strata Low Tree Steppe		>	**Q1**		< **Q3**	median	
		Trees	>	1	%	< 10 %	4.00	√
		Shrubs	>	2	%	< 10 %	9.2	√
		Hummock Grasses	>	20	%	< 30 %	20.0	-
		Other Grasses	>	0.04	%	< 0.62 %	1.5	-
		Herbs	>	0.05	%	< 0.4 %	0.00	-

Mining Area C Hub progressive criteria analysis

						PROGRESSING REHABILITATION (5-15 YEARS) CRITERIA	
						MAJOR	*SUPPORTING*
Transect	Location	Date of monitoring	Years post rehabilitation	Type	Terrain	Triodia cover /Total native cover ratio	Weed cover / Triodia cover ratio
					Target	≥ 0.32	< 1
BAC24	Area C	2021	10	Packsaddle Range Detritals - Rail Borr	Flat	0.733	0.0
BAC30	Area C	2021	9	Rail Borrow Pit	Flat	0.745	0.0
BAC32	Area C	2021	7	Borrow Pit Ch 335.6	Flat	0.310	0.0
BAC_R01	Area C	2019	7	Borrow Pit Ch 335.6	Flat	0.022	0.0
BAC_R02	Area C	2019	8	No name	Flat	0.242	0.0
BAC_R03	Area C	2019	8	No name	Crest	0.789	0.0
				% sites meeting targets		50%	100%

						YOUNG REHABILITATION (< 5 YEARS) CRITERIA		
						MAJOR	*SUPPORTING*	
Transect	Mine	Date of monitoring	Years post rehabilitation	Type	Terrain	Triodia cover /Shrub cover ratio	Minimum total native cover (%)	Weed cover / Triodia cover ratio
					Target	> 2	> 12	< 1
BAC31	Area C	2019	2	Regrade works Not picked up for FY1	Slope	0.32	19.9	0
				% sites meeting targets		0%	100%	100%

Appendix 8 Goldsworthy hub: completion and progressive criteria output tables

Goldsworthy hub completion criteria analysis

						COMPLETION (>15 YEARS) CRITERIA							
						% Cover						Species richness	
Transect	Location	Date of monitoring	Years post rehabilitation	Type	Terrain	Tree	Shrub	Triodia	Other grass	Herb	Weed	Perennial	Annual
					Target	>0	>0.2	>15	>0.01	>0.1	<10	>8	>6
BGW07	Goldsworthy	2020	27	Industrial area C - Light Ir	Flat	0.0	2.3	45.0	0.05	0.0	0.0	24	7
BGW09	Goldsworthy	2020	27	Airstrip - sandy soils	Flat	0.0	23.7	25.0	0.13	0.2	0.0	43	6
BGW11	Goldsworthy	2020	27	Industrial Area B - Mine C	Flat	0.0	4.4	30.0	0.15	0.4	0.9	53	11
BGW17	Goldsworthy	2018	25	Railway Waste Dump 8 -	Crest	0.0	3.1	0.0	1.03	0.8	0.3	15	6
BGW22	Goldsworthy	2020	27	Magazine Waste Dump 8	Crest	2.5	9.2	15.0	6.02	0.1	0.1	52	8
BGW28	Goldsworthy	2018	25	Goldsworthy and Erectior	Crest	0.0	6.9	0.5	2.04	0.1	0.0	24	10
BGW30	Goldsworthy	2020	27	Goldsworthy and Erectior	Crest	0.0	5.1	4.0	4.13	0.2	5.3	44	12
BGW31	Goldsworthy	2020	27	Goldsworthy and Erectior	Crest	2.5	6.0	40.0	4.13	0.3	0.2	62	12
BGW42	Goldsworthy	2020	27	Golf Course (sandy soils)	Flat	1.5	19.5	30.5	0.14	0.2	0.5	51	9
BGW43	Goldsworthy	2020	27	Golf Course (sandy soils)	Flat	1.5	4.3	25.0	0.13	0.4	0.2	52	9
BGW_R01	Goldsworthy	2019	26	Rosemary Waste Dump `	Moonscape	1.0	1.3	0.1	0.00	0.4	0.1	9	1
BGW_R02	Goldsworthy	2019	26	Rosemary Waste Dump `	Moonscape	2.0	17.6	0.5	2.00	0.0	0.0	7	1
BGW_R03	Goldsworthy	2019	26	Rosemary Waste Dump `	Moonscape	0.2	0.2	1.0	0.02	0.0	0.0	6	0
BGW_R04	Goldsworthy	2019	26	Rosemary Waste Dump `	Moonscape	2.5	5.1	3.0	0.60	0.1	0.0	11	1
BGW_R05	Goldsworthy	2019	26	Magazine Waste Dump 8	Moonscape	1.0	0.5	0.1	2.00	0.2	2.2	9	1
BGW_R06	Goldsworthy	2019	26	Railway Waste Dump 8	Moonscape	0.5	2.6	5.0	0.13	0.0	0.1	8	2
BGW_R07	Goldsworthy	2019	26	Railway Waste Dump 8	Moonscape	1.0	4.6	0.5	1.00	0.0	0.0	10	0
BGW_R08	Goldsworthy	2019	26	Railway Waste Dump 8	Moonscape	1.2	6.2	0.1	0.10	0.0	0.1	10	0
BGW_R09	Goldsworthy	2019	26	Railway Waste Dump 8	Moonscape	0.0	7.0	0.1	0.50	0.0	0.0	11	0
BGW_R10	Goldsworthy	2019	26	Railway Waste Dump 8	Moonscape	0.0	0.3	0.0	0.03	0.0	0.0	9	1
BGW_R11	Goldsworthy	2019	26	Railway Waste Dump 8	Moonscape	0	9	0.2	0.01	0.01	0	4	1
BGW_R12	Goldsworthy	2019	26	No name	Moonscape	1	7.21	0.5	3.00	0.51	0.02	12	0
BGW_R16	Goldsworthy	2019	26	Goldsworthy and Erectior	Moonscape	2.0	1.3	0.0	0.50	0.0	0.0	10	0
BGW_R17	Goldsworthy	2019	26	Goldsworthy and Erectior	Moonscape	1	2.9	0.0	0.50	0.0	0.11	8	1
BGW_R18	Goldsworthy	2019	26	Goldsworthy and Erectior	Moonscape	0.0	16.2	5.0	3.00	0.2	0.0	12	0
BGW_R20	Goldsworthy	2019	26	Bustard Waste Dump	Moonscape	4.1	3.5	1.0	1.00	0.1	0.0	12	0
BGW_R21	Goldsworthy	2019	26	Railway Waste Dump 8	Moonscape	1.0	3.5	0.0	1.01	0.0	0.2	10	0
BGW_R22	Goldsworthy	2019	26	Bustard Waste Dump	Moonscape	2	6.6	0.2	0.01	0.1	8.01	9	1
BGW04	Goldsworthy	2018	25	Town site - Mixed Road a	Flat	0.5	3.62	9	0.04	0.06	15.02	23	4
BGW05	Goldsworthy	2018	25	Town site - Mixed Road a	Flat	0.3	9.9	8.0	0.04	0.1	20.2	19	6
BGW10	Goldsworthy	2018	25	Old town site	Flat	0	13.1	40.0	0.13	0.1	11	20	8
BGW13	Goldsworthy	2018	25	Rosemary Waste Dump `	Crest	0	12.2	0.1	0.13	0.2	1	14	8
BGW21	Goldsworthy	2018	25	Water Tank Waste Dump	Crest	0	12.3	5.0	4.12	1.2	23.1	24	9
BGW26	Goldsworthy	2018	25	Billygoat Dump	Crest	0	4.7	2.0	0.24	0.7	0.1	18	9
BGW32	Goldsworthy	2018	25	Railway OSA	Crest	0.1	1.1	1.0	0.03	1.0	21.61	19	9
BGW35	Goldsworthy	2018	25	Gravel/Borrow Pit (near K	Flat	0	26.7	5.0	0.21	0.1	0	17	6
BGW40	Goldsworthy	2018	25	Sewerage Ponds	Flat	0	4.3	1.5	1.13	0.4	60	18	14
BGW45	Goldsworthy	2018	25	Borrow pit near townsite	Flat	1.5	6.0	40.0	0.02	0.1	0.1	20	3
				% sites meeting targets		100%	100%	24%	97%	55%	84%	92%	47%

SITE:	Goldsworthy
YEARS POST REHAB:	25 to 27
No. SITES ASSESSED:	38
VEG TYPE:	Grass Steppe
END USE:	Pastoral

ATTRIBUTE	METRIC	TARGETS			PERFORMANCE	
Bare Ground (non-vegetated)	% bare ground with rock and stony cover	Hills, slopes, dry plains	≤ 50 %			
		Drainage lines (excluding channel bed)	≤ 20 %			
		Floodplains	≤ 10 %			
Species Richness	Perennial and annual native species richness		> **Q1**		**median**	
		Perennial native species	> 8		15	√
	(number of species)	Annual native species	> 6		4	-
Weed Invasiveness	Priority Alert weed species	Priority alert weed species presence and cover	Not present or cover ≤ regional baseline		none	√
		Introduction of new priority species	No new priority species introduced		none	√
	Percentage cover of total weeds	Total weed cover (%)				
		drainage lines, floodplains	< 20 %		0.1	√
		upland hills, slopes and flats	< 10 %		0.1	√
	Percentage cover of Cenchrus ciliaris	Cenchrus ciliaris cover (%)				
		drainage lines, floodplains	< 10 %		0	√
		upland hills, slopes and flats	< 10 %		0	√
Target Vegetation Types	Presence of appropriate vegetation types				**Grass Steppe**	
Indicator Species	Presence of dominant and common species from each Target Vegetation Type	All dominant species present			NO	-
		>50% of common species present			YES	√
Plant Cover	% cover for each strata Grass Steppe		> **Q1**		median	
		Trees	> 0 %		0.38	√
		Shrubs	> 0.2 %		5.1	√
		Hummock Grasses	> 15 %		1.3	-
		Other Grasses	> 0.01 %		0.2	√
		Herbs	> 0.1 %		0.11	√

Goldsworthy hub progressive criteria analysis

						PROGRESSING REHABILITATION (5-15 YEARS) CRITERIA	
						MAJOR	*SUPPORTING*
Transect	Location	Date of monitoring	Years post rehabilitation	Type	Terrain	Triodia cover /Total native cover ratio	Weed cover / Triodia cover ratio
					Target	≥ **0.32**	< **1**
BGW_R13	Goldsworthy	2019	7	Billygoat Waste Dump	Moonscape	0.047	1.0
BGW_R14	Goldsworthy	2019	7	Billygoat Waste Dump	Moonscape	0.034	0.0
BGW_R15	Goldsworthy	2019	7	Billygoat Waste Dump	Moonscape	0.111	0.0
BGW_R19	Goldsworthy	2019	7	Bustard Waste Dump	Moonscape	0.017	1.0
				% sites meeting targets		**0%**	**50%**

Appendix 9 Yarrie hub: completion and progressive criteria output tables

Yarrie hub completion criteria analysis

						COMPLETION (>15 YEARS) CRITERIA							
						% Cover						Species richness	
Transect	Location	Date of	Years post rehabilitation	Type	Terrain	Tree	Shrub	Triodia	Other grass	Herb	Weed	Perennial	Annual
					Target	>1	>3	>19	>0.02	>0.1	<10	>15	>9
BYA03	Yarrie	2020	27	Borrow Pit 1	Flat	0.1	5.7	30.0	0.01	0.0	0.0	17	1
BYA07	Shay Gap	2018	23	OSA - Flying Circus	Crest	1.0	21.9	15.0	0.15	0.2	0.0	28	15
BYA08	Shay Gap	2018	23	Shay Ridge Flat	Flat	10.1	17.6	5.0	4.07	0.2	0.0	35	17
BYA31	Yarrie	2020	16	Y7D Growth Trials - Tops	Slope	2.0	5.6	15.1	0.21	0.2	0.0	84	6
BYA01	Yarrie	2019	16	OSA - Y10 Contour Ripp	Slope	0.3	13.6	5.0	3.05	0.0	0.2	36	3
				% sites meeting targets		60%	100%	20%	80%	60%	100%	100%	40%

SITE:	Yarrie
YEARS POST REHAB:	16 to 27
No. SITES ASSESSED:	5
VEG TYPE:	Shrub Steppe
END USE:	Pastoral

ATTRIBUTE	METRIC	TARGETS		PERFORMANCE	
Bare Ground (non-vegetated)	% bare ground with rock and stony cover	Hills, slopes, dry plains	≤ 50 %		
		Drainage lines (excluding channel bed)	≤ 20 %		
		Floodplains	≤ 10 %		
Species Richness	Perennial and annual native species richness		> **Q1**	**median**	
		Perennial native species	> 15	35	√
	(number of species)	Annual native species	> 9	6	-
Weed Invasiveness	Priority Alert weed species	Priority alert weed species presence and cover	Not present or cover ≤ regional baseline	none	√
		Introduction of new priority species	No new priority species introduced	none	√
	Percentage cover of total weeds	Total weed cover (%)			
		drainage lines, floodplains	< 20 %	0	√
		upland hills, slopes and flats	< 10 %	0	√
	Percentage cover of Cenchrus ciliaris	Cenchrus ciliaris cover (%)			
		drainage lines, floodplains	< 10 %	0	√
		upland hills, slopes and flats	< 10 %	0	√
Target Vegetation Types	Presence of appropriate vegetation types			**Shrub Steppe**	
Indicator Species	Presence of dominant and common species from each Target Vegetation Type	All dominant species present		YES	√
		>50% of common species present		YES	√
Plant Cover	% cover for each strata Shrub Steppe		> **Q1**	median	
		Trees	> 1 %	1.01	√
		Shrubs	> 3 %	13.6	√
		Hummock Grasses	> 19 %	15.0	-
		Other Grasses	> 0.02 %	0.2	√
		Herbs	> 0.1 %	0.15	√

Yarrie hub progressive criteria analysis

Transect	Location	Date of monitoring	Years post rehabilitation	Type	Terrain	PROGRESSING REHABILITATION (5-15 YEARS) CRITERIA — MAJOR: Triodia cover /Total native cover ratio	PROGRESSING REHABILITATION (5-15 YEARS) CRITERIA — SUPPORTING: Weed cover / Triodia cover ratio
					Target	≥ 0.32	< 1
BYA28	Yarrie	2020	10	OSA - W1 Lower batter	Slope	0.218	16.7
BYA29	Yarrie	2020	10	OSA - W1 Lower batter	Crest	0.332	3.1
BYA35	Yarrie	2020	10	OSA - W1 238 RL Batter	Slope	0.218	7.6
BYA36	Yarrie	2020	10	OSA - W1 238 RL Batter	Slope	0.131	4.3
BYA40	Yarrie	2018	9	Y6/7	Crest	0.199	0.0
BYA43	Yarrie	2018	13	Y6/7	Crest	0.719	0.0
BYA44	Yarrie	2018	6	Y10 Sisters	Crest	0.526	0.0
BYA45	Yarrie	2018	10	Yarrie 4 Crustal	Crest	0.574	0.0
BYA51	Nimingarra	2018	8	Nimingarra A	Crest	0.018	8.4
BYA52	Nimingarra	2018	8	Nimingarra A	Crest	0.108	0.1
BYA58	Shay Gap	2018	8	Lower Shay Gap	Flat	0.682	0.0
BYA60	Shay Gap	2018	6	Shay Gap 6	Crest	0.304	0.0
BYA63	Shay Gap	2018	8	Shay Gap 3 North	Crest	0.265	0.0
BYA_R01	Yarrie	2019	7	Nimingarra A	Moonscape	0.010	1.1
BYA_R02	Yarrie	2019	7	Nimingarra A	Moonscape	0.006	1.1
BYA_R03	Yarrie	2019	7	Nimingarra A	Moonscape	0.007	4.0
BYA_R04	Yarrie	2019	7	Nimingarra A	Moonscape	0.000	
BYA_R05	Yarrie	2019	7	Nimingarra A	Moonscape	0.051	2.0
BYA_R06	Yarrie	2019	7	Nimingarra A	Moonscape	0.182	0.0
BYA_R07	Yarrie	2019	7	Nimingarra A	Moonscape	0.089	0.0
BYA_R08	Yarrie	2019	7	Nimingarra A	Moonscape	0.056	1.0
BYA_R09	Yarrie	2019	7	Nimingarra A	Moonscape	0.034	0.0
BYA_R10	Yarrie	2019	7	Nimingarra A	Moonscape	0.041	0.3
BYA_R100	Yarrie	2019	7	Sunrise Hill	Flat	0.714	0.0
BYA_R101	Yarrie	2018	7	Sunrise Hill West 8	Flat	0.038	0.1
BYA_R102	Yarrie	2018	7	Sunrise Hill West 8	Flat	0.851	0.0
BYA_R103	Yarrie	2018	7	Sunrise Hill West 8	Flat	0.124	0.0
BYA_R104	Yarrie	2018	7	Sunrise Hill West 8	Flat	0.905	0.0
BYA_R11	Yarrie	2018	7	Nimingarra C	Moonscape	0.005	0.1
BYA_R110	Yarrie	2018	7	Sunrise Hill 8	Flat	0.786	0.0
BYA_R119	Yarrie	2018	7	Sunrise Hill 8	Flat	0.769	0.0
BYA_R12	Yarrie	2018	7	Shay Gap Upper	Moonscape	0.268	0.0
BYA_R14	Yarrie	2018	7	Shay Gap Upper	Moonscape	0.103	0.0
BYA_R15	Yarrie	2018	7	Shay Gap Upper	Moonscape	0.809	0.0
BYA_R16	Yarrie	2018	7	Shay Gap Upper	Moonscape	0.322	0.0
BYA_R17	Yarrie	2018	7	Shay Gap Upper	Moonscape	0.240	0.0
BYA_R20	Yarrie	2018	7	Shay Gap Upper	Moonscape	0.251	0.0
BYA_R21	Yarrie	2018	7	Shay Gap Upper	Moonscape	0.070	0.2
BYA_R22	Yarrie	2018	7	Shay Gap Upper	Moonscape	0.143	0.8
BYA_R23	Yarrie	2018	7	Shay Gap Upper	Moonscape	0.516	0.0
BYA_R24	Yarrie	2018	7	Shay Gap Upper	Moonscape	0.007	6.1
BYA_R25	Yarrie	2018	7	Sunrise Hill	Moonscape	0.053	1.3
BYA_R27	Yarrie	2018	7	Sunrise Hill	Moonscape	0.103	0.0
BYA_R28	Yarrie	2018	7	Shay Gap Upper	Moonscape	0.021	2.0
BYA_R30	Yarrie	2018	7	Shay Gap Upper	Moonscape	0.026	0.2
BYA_R31	Yarrie	2018	7	Shay Gap Upper	Moonscape	0.008	0.0
BYA_R33	Yarrie	2018	7	Shay Gap Upper	Moonscape	0.356	0.0
BYA_R35	Yarrie	2018	7	Shay Gap Upper	Moonscape	0.108	0.0
BYA_R36	Yarrie	2018	7	Shay Gap Upper	Moonscape	0.112	0.0
BYA_R37	Yarrie	2018	7	Shay Gap Upper	Moonscape	0.067	0.0
BYA_R38	Yarrie	2018	7	Shay Gap Upper	Moonscape	0.003	0.5
BYA_R39	Yarrie	2018	7	Shay Gap Upper	Moonscape	0.001	1.0
BYA_R40	Yarrie	2018	7	Shay Gap Upper	Moonscape	0.001	0.0
BYA_R41	Yarrie	2018	7	Shay Gap Upper	Moonscape	0.009	0.0
BYA_R42	Yarrie	2018	7	Shay Gap Upper	Moonscape	0.007	0.1
BYA_R43	Yarrie	2018	7	Shay Ridge Flat	Moonscape	0.016	0.0
BYA_R44	Yarrie	2018	7	Shay Ridge Flat	Moonscape	0.022	0.0
BYA_R45	Yarrie	2018	7	Shay Gap Upper	Moonscape	0.087	0.0
BYA_R46	Yarrie	2018	7	Shay Gap Upper	Moonscape	0.179	0.0
BYA39	Yarrie	2018	8	C Pit	Slope	0.240	0.0
BYA53	Nimingarra	2018	6	Nimingarra C	Crest	0.062	0.0
BYA54	Nimingarra	2018	6	Nimingarra DE	Crest	0.354	0.0
BYA55	Nimingarra	2018	6	Nimingarra DE	Crest	0.001	501.0
BYA56	Shay Gap	2018	6	Lower Shay Gap	Crest	0.421	0.9
BYA59	Shay Gap	2018	6	Shay Gap 5	Crest	0.017	3.1
BYA61	Shay Gap	2018	6	OSA - Flying Circus	Flat	0.000	0.0
BYA62	Shay Gap	2018	6	Shay Gap 2	Flat	0.721	0.1
		67					
				% sites meeting targets		31%	74%

Transect	Mine	Date of monitoring	Years post rehabilitation	Type	Terrain	YOUNG REHABILITATION (< 5 YEARS) CRITERIA — MAJOR: Triodia cover /Shrub cover ratio	YOUNG REHABILITATION (< 5 YEARS) CRITERIA — SUPPORTING: Minimum total native cover (%)	YOUNG REHABILITATION (< 5 YEARS) CRITERIA — SUPPORTING: Weed cover / Triodia cover ratio
					Target	> 2	> 12	< 1
BYA67	Yarrie	2018	3	Cattle Gorge waste dump	Crest	1.42	28.2	0
BYA69	Yarrie	2018	2	Yarrie 10 - Rehab	Crest	1.02	29.8	0
BYA70	Yarrie	2018	2	Yarrie 10 - Rehab	Slope	0.97	16.3	0
BYA66	Yarrie	2018	2	Cattle Gorge waste dump	Slope	3.35	12.4	0
				% sites meeting targets		25%	100%	100%

Appendix D. Plants of importance to Nyiyaparli people

Scientific name	Common name	Nyiyaparli name
Acacia ampliceps	Salt Wattle	Wijalpa
Acacia ancistrocarpa	Fishhook Wattle	Parlpinypa
Acacia aptaneura/ Acacia aneura	Mulga	Wirntamarra
Acacia coriacea (Sub-species pendens)	River Mulga	Warntanypa
Acacia inaequilatera	Camel Bush	Partirri
Acacia pruinocarpa	Gidgee	Pulartu
Acacia pyrifolia	Kanji Bush	Munturru
Acacia rhodophloia	Mini Ritchie	Marntarru
Acacia sclerosperma	Limestone Wattle	Pakurta
Acacia sericophylla	Desert Dogwood	Pirrkala
Acacia synchronicia	Bardi Bush	Yarrkurtu
Acacia tetragonaphylla	Dead Finish	Kurarra
Acacia trachycarpa	Sweet Scented Mini Ritchie	Parrkalyi
Acacia xiphophylla	Snakewood	Pukarti
Capparis lasiantha	Split Jack	Karnti marnarnu
Capparis spinosa	Caper Bush	Yarlunti
Capparis umbonata	Wild Orange	Kurlarnti
Corymbia aspera	Rough-leaved Ghost Gum	Malykampa
Corymbia hamersleyana	Bloodwood	Parlkarri
Cymbopogon ambiguous	Lemon Grass	Lemon Grass
Cyperus bulbosus	Bush Onion	Jakarlu
Cyperus vaginatus	Stiff-Leaf Sedge	Puwaji
Dysphania rhadinostachya	Dysphania	Yampala
Eragrostis dielsii	Mallee Love Grass	Miyiru
Eucalyptus camaldulensis	River Red Gum	Wurrangkura
Eucalyptus leucophloia	Snappy Gum	Malykan
Eucalyptus victrix	Smooth-Baked Coolibah	Piyarrpa
Gossypium robinsonii	Wild Cotton	Ngurtaya
Grevillea pyramidalis	Caustic Bush	Karranypa
Grevillea wickhamii	Wickham's Grevillea	Wickham's Grevillia
Hakea lorea	Honey Hakea	Kartanypa
Ipomoea costata	Bush Potato	Marta
Lobelia arnhemiaca	Lobelia	Lobelia (kuyu)
Maireana luehmannii	Salt Bush	Thulamarta
Melaleuca glomerata	Desert Honey Myrtle	Jalkupurta
Nicotiana heterantha	Native Tobacco	Native Tobacco
Petalostylis cassioides	Butterfly Bush (Sugar Tree)	Thanyji
Podaxis pistillaris	Black Powder Puff	Kurnmi
Pysdrax latifolia	Native Plum	Patharra
Salsola australis	Tumbleweed (Roly Poly Bush)	Thantarra
Samolous sp. Fortescue Marsh	Samolous	Gurrungali
Santalum lanceolatum	Northern Sandalwood	Nyumaru
Santalum spicatum	Sandalwood	Purtartu
Sida platycalyx	Life Saver Burr	Thapulji
Solanum diversiflorum	Bush Tomato	Kapumarta
Stemodia grossa	Vicks Plant	Vicks Bush
Triodia species – Spinifex	Hard or Soft Spinifex	Paru
Vachellia farnesiana	Prickly Mimosa Bush	Kartimpa

Source: KNAC (2023)

Appendix E. Materials characterisation data

E-1. Overburden geochemical characterisation

Summary of statistics for drillhole intervals within OB17

Rock Type	Parameter	Unit	Statistic						
			Count	Min	Max	Average	Median	90th percentile	95th percentile
Mt. McRae Shale Formation (Rx)	Total S	wt.%	1,486	<0.01	0.953	0.017	0.026	0.049	0.066
	ANC	kg/t H_2SO_4	1,486	<1	184.3	0.3	0.8	1.0	1.8
	NAPP	kg/t H_2SO_4	1,486	-184	28.8	0.2	-0.02	1.1	1.5
BIF - Dales Gorge Member (Dx)	Total S	wt.%	2,154	0.003	0.638	0.027	0.033	0.059	0.075
	ANC	kg/t H_2SO_4	2,154	<1	8.0	0.3	0.6	1.1	1.6
	NAPP	kg/t H_2SO_4	2,154	-7.2	19.2	0.4	0.5	1.4	1.7
Mt. Sylvia Formation (Sx)	Total S	wt.%	1,346	<0.01	0.473	0.008	0.012	0.021	0.030
	ANC	kg/t H_2SO_4	1,346	<1	367.5	0.5	1.5	1.2	1.5
	NAPP	kg/t H_2SO_4	1,346	-367	5.5	-0.3	-1.1	0.3	0.6
Tertiary Detritals (TD3)	Total S	wt.%	185	<0.01	0.175	0.021	0.030	0.066	0.081
	ANC	kg/t H_2SO_4	185	<1	28.0	1.3	2.1	3.7	5.5
	NAPP	kg/t H_2SO_4	185	-28	5.2	-0.7	-1.1	0.8	1.4
Wittenoom Formation (O)	Total S	wt.%	274	<0.01	0.361	0.003	0.008	0.016	0.076
	ANC	kg/t H_2SO_4	274	<1	43.6	0.9	1.5	1.6	1.7
	NAPP	kg/t H_2SO_4	274	-43	2.8	-0.8	-1.3	-0.3	1.7
Dykes / Sills (formerly Clay) (K)	Total S	wt.%	22	0.008	0.101	0.034	0.038	0.065	0.093
	ANC	kg/t H_2SO_4	22	<1	4.4	0.9	1.3	3.6	4.0
	NAPP	kg/t H_2SO_4	22	-4.0	2.2	0.1	-0.1	0.9	2.0

Source: Earth Systems (2015)

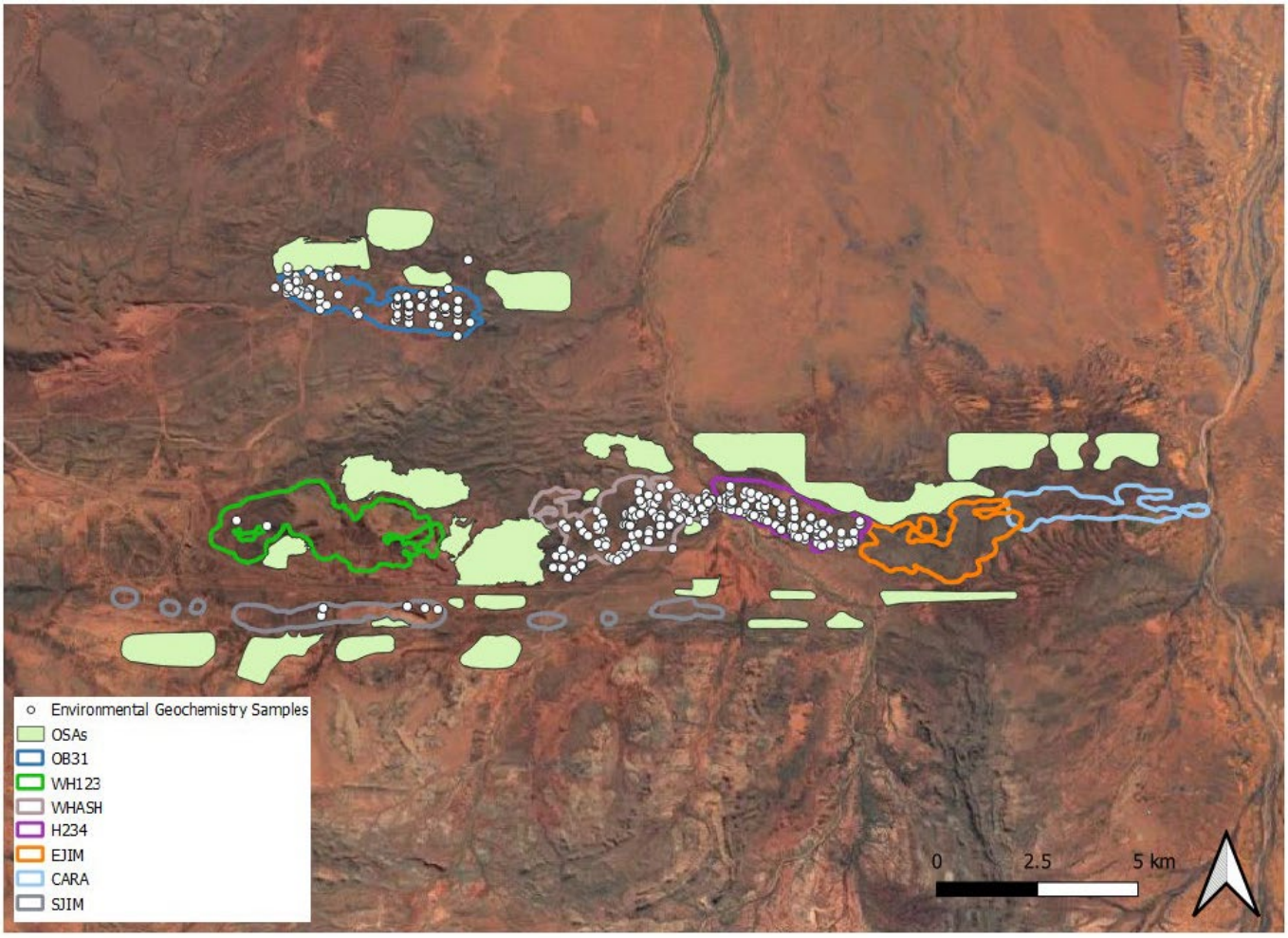
Summary of statistics for drillhole intervals within OB18

Rock Type	Parameter	Unit	Statistic						
			Count	Min	Max	Average	Median	90th percentile	95th percentile
Mt. McRae Shale Formation (Rx)	Total S	wt.%	4,083	<0.001	12.00	0.213	0.016	0.102	0.966
	ANC	kg/t H_2SO_4	4,083	0.0	399.1	1.2	0.3	1.2	2.3
	NAPP	kg/t H_2SO_4	4,083	-398.5	366.9	5.3	0.2	2.4	28.0
BIF - Dales Gorge Member (Dx)	Total S	wt.%	14,174	<0.001	1.22	0.019	0.013	0.039	0.052
	ANC	kg/t H_2SO_4	14,174	0.0	477.0	0.5	0.2	0.7	1.0
	NAPP	kg/t H_2SO_4	14,174	-476.5	36.8	0.1	0.3	1.0	1.3
BIF - Joffre Member (Jx)	Total S	wt.%	1,220	<0.001	0.54	0.016	0.008	0.038	0.050
	ANC	kg/t H_2SO_4	1,220	0.0	6.1	0.3	0.2	0.9	1.5
	NAPP	kg/t H_2SO_4	1,220	-4.5	14.1	0.1	0.1	0.9	1.2
BIF - Whaleback Shale Upper (WU)	Total S	wt.%	908	<0.001	2.19	0.035	0.016	0.059	0.098
	ANC	kg/t H_2SO_4	908	0.0	58.4	0.6	0.2	1.3	2.4
	NAPP	kg/t H_2SO_4	908	-56.6	66.5	0.5	0.4	1.6	2.5
Mt. Sylvia Formation (Sx)	Total S	wt.%	1,859	<0.001	3.88	0.021	0.009	0.026	0.039
	ANC	kg/t H_2SO_4	1,858	0.0	367.5	1.2	0.5	1.2	1.5
	NAPP	kg/t H_2SO_4	1,858	-367.1	118.2	-0.6	-0.2	0.7	1.0

Source: Earth Systems (2015)

ABA data for OB31 and Jimblebar

Location of samples with ABA data



Source: BHP (2022i)

ABA summary data

Stratigraphy		Count	Median Values								NAF	UC (NAF)	UC (PAF	PAF
			Paste pH	Paste EC	Total-S	MPA	ANC	NAPP	*NPR	NAG pH				
			pH unit	µS/cm	wt.%	kg H_2SO4/t			unitless	pH unit				
Dykes/Sills	8200 - K	2	6.9	482	0.011	0.3	2.7	-2.4	72.6		2	0	0	0
Surface Scree	8150 - SZ	3	6.6	149	0.020	0.6	4.9	-4.9	9.8	8.2	3	0	0	0
Tertiary Detritals	8130 - TD3	8	7.2	187	0.013	0.4	1.0	-0.7	2.1	6.7	8	0	0	0
	9150 - CY2	5	5.9	286	0.008	0.2	2.5	-2.4	11.4	7.0	5	0	0	0
	9130 - VB2	1	7.4	191	0.005	0.1	3.9	-3.7	25.5		1	0	0	0
	9120 - LT2	2	4.4	671	0.161	4.9	0.5	4.4	0.1	3.8	0	0	0	2
	8120 - TD2	1	6.3	6000	3.38	103.5	41.5	62.0	0.4	8.8	0	1	0	0
Weeli Wolli Formation	6120 - HE	15	7.0	205	0.005	0.1	5.4	-4.8	15.9	6.6	14	0	1	0
	6110 - HJ	6	7.1	102	0.005	0.1	2.6	-2.4	12.0	6.0	6	0	0	0
	6100 - WW	2	7.0	203	<0.01	0.2	2.6	-2.4	17.0	6.7	2	0	0	0
Brockman Iron Formation	5910 - YE	3	7.4	232	0.009	0.3	3.7	-3.7	11.9		3	0	0	0
	5900 - Y	27	6.9	229	0.007	0.2	3.3	-2.6	10.6	8.6	27	0	0	0
	5860 - J6	20	7.1	101	0.005	0.1	1.0	-0.8	5.5	6.5	20	0	0	0
	5850 - J5	7	7.2	165	0.005	0.1	0.8	-0.8	19.6	6.8	7	0	0	0
	5830 - J3	3	7.3	214	0.005	0.1	3.1	-3.0	33.7	7.6	3	0	0	0
	5820 - J2	13	7.4	88	0.004	0.1	0.6	-0.5	7.2	7.6	13	0	0	0
	5810 - J1	11	7.2	101	0.005	0.1	1.2	-0.9	8.7	7.2	11	0	0	0
	5800 - J	4	7.0	120	0.007	<0.1	4.3	-4.1	24.4	6.8	4	0	0	0
	5700 - W	46	7.2	177	0.005	0.1	1.9	-1.8	9.8	6.6	45	0	1	0
	5640 - D4	9	7.1	86	0.007	0.2	0.5	-0.3	2.3	7.0	9	0	0	0
	5630 - D3	14	7.0	104	0.005	0.1	0.8	-0.7	7.3	8.1	14	0	0	0
	5620 - D2	14	7.1	83	0.005	0.1	0.7	-0.6	6.5	7.7	15	0	0	0
	5610 - D1	30	7.2	111	0.010	0.3	1.8	-1.6	8.1		30	0	0	0
	5600 - D	4	6.9	94.5	0.004	0.1	1.7	-0.9	4.4		4	0	0	0
Mt McRae Shale	5440 - RU	51	7.4	342	0.02	0.6	3.7	-2.7	8.6	5.4	42	0	3	6
	5430 - RN	20	6.8	305	0.030	0.9	0.8	-0.3	2.1	2.6	13	0	0	7
	5420 - RC	4	6.6	119	0.018	0.5	0.7	-0.2	1.8	1.6	3	0	0	1
	5410 - RL	13	7.1	156	0.007	0.2	1.9	-1.2	6.5	2.2	11	0	0	2
	5400 - R	6	6.0	312	0.77	23.6	1.3	22.2	4.0	1.9	8	0	0	4

Stratigraphy		Count	Median Values								NAF	UC (NAF)	UC (PAF	PAF
			Paste pH	Paste EC	Total-S	MPA	ANC	NAPP	*NPR	NAG pH				
			pH unit	µS/cm	wt.%	kg H_2SO4/t			unitless	pH unit				
Mt Sylvia Formation	5300 - S	43	7.0	170	0.008	0.2	0.7	-0.5	4.1	7.2	41	1	0	1
Wittenoom Formation	4400 - OD	8	7.6	177	0.009	0.3	4.2	-4.1	25.5	2.3	7	0	0	1
	4300 - OC	3	7.0	151	0.001	<0.1	0.5	-0.5	16.3		3	0	0	0
	4200 - OB	7	9.1	567	0.03	0.9	866	-865	912	9.0	7	0	0	0
	4120 - WA2	5	6.0	326	0.009	0.3	3.6	-3.2	11.2	8.0	5	0	0	0
Marra Mamba Formation	3420 - N2	1	5.6	90	0.004	0.1	0.2	-0.1	1.6	6.5	1	0	0	0
	3300 - MM	1	5.9	106	0.271	8.3	4.6	3.7	0.5	5.2	0	1	0	0
	3200 - MU	2	5.5	60	0.013	0.4	0.3	0.0	0.9	5.9	2	0	0	0
Mixed stratigraphies		2	7.1	533	0.04	0.7	108	-107	137		2	0	0	0
Total		**423**									**391**	**3**	**5**	**24**

Source: BHP (2022i)

Multi-element analysis of OB31 and Jimblebar samples with GAI ≥3

STRAT Group		Count	As	Bi	Cd	Fe	Hg	Mn	Mo	Pb	Sb	Se
Tertiary Detritals (Clay)	9150 - CY2	5	3	1							3	5
Tertiary Detritals (Lignite Clay)	9120 - LT2	2										
Dykes/Sills	8200/8400 - K/F	1										
	8200 - K	2						1				1
Surface Scree	8150 - SZ	1										
Tertiary Detritals	8130 - TD3	4									1	4
Weeli Wolli Formation	6120 - HE	7	5					1			5	4
	6110/6120 - HJ/HE	2	1								1	1
	6110 - HJ	2	1								1	1
Brockman Iron Formation	5910 - YE	1	1								1	1
	5900 - Y	3	3			1				1	3	1
	5860 - J6	9	3									7
	5850 - J5	3	2								1	2
	5820/5830 - J2/J3	1										1
	5820 - J2	6	1									2
	5810 - J1	5	1								1	
	5700 - W	19	13			1					8	8
	5640 - D4	5	1								1	1
	5630 - D3	4	2									2
	5620/5630 - D2/D3	1									1	1
	5620 - D2	2	1									
	5610 - D1	5	4								1	1
Mt McRae Shale	5440 - RU	7	6	1				1			5	5
	5430 - RN	3	1				1				2	3
	5410/5420 - RL/RC	1	1								1	1
	5410 - RL	4	3					1	1		3	3
	5400 - R	1									1	1
Mt Sylvia Formation	5300 - S	9	6		2		2	2			5	7
Wittenoom Formation	4400 - OD	2	1								2	2
	4200 - OB	2										
	4120 - WA2	5	5					3			3	1
	3420 - N2	1										

STRAT Group		Count	As	Bi	Cd	Fe	Hg	Mn	Mo	Pb	Sb	Se
Marra Mamba Iron Formation	3300 - MM	1										
	3200 - MU	2										
Total		**128**	**65**	**2**	**2**	**2**	**3**	**9**	**1**	**1**	**50**	**66**

Source: BHP (2022i)

OB31 and Jimblebar leach test results

Deionised water (1:2) leach test results

Deposit	Orebody	Sample ID	Strat	AMD Class	Total-S	pH	EC	Acidity	ALK-OH	ALK-CO3	ALK-HCO3	ALK-TOT	Ag	Al	As	B	Ba	Be	Bi	Ca	Cd	Ce	Cl	Co	Cr	Cu	F	Fe
					wt%	pH unit	µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
HASHIMOTO	H1	HH1203DTM-04-PAF	D4	NAF	0.020	7.9	91	1.6				26	<0.01	0.45	<0.001	<0.05	0.043	<0.001	<0.001	4.5	<0.001	<0.001	2	0.006	<0.001	0.037		<0.001
HASHIMOTO	H1	N681922	RL	NAF	1.080	7.7	1,283	2.6				29	<0.01	0.44	<0.001	<0.05	0.001	<0.001	<0.001	44.88	<0.001	<0.001	17	0.003	<0.001	<0.001		<0.001
HASHIMOTO	H1	N802881	RU	NAF	0.060	8.3	387	0.4				69	<0.01	0.34	0.001	<0.05	0.001	<0.001	<0.001	17.33	<0.001	<0.001	19	<0.001	<0.001	<0.001		<0.001
HASHIMOTO	H1	N705691	S	NAF	1.080	8.6	451	<0.2				70	<0.01	0.55	<0.001	<0.05	0.001	<0.001	<0.001	31.88	<0.001	<0.001	2	<0.001	<0.001	<0.001		<0.001
HASHIMOTO	H1	N705686	S	NAF	0.370	8.7	434	<0.2				94	<0.01	0.45	<0.001	<0.05	<0.001	<0.001	<0.001	28.74	<0.001	<0.001	3	0.001	<0.001	<0.001		<0.001
HASHIMOTO	H1	N705694	S	NAF	0.420	8.9	320	<0.2				85	<0.01	<0.01	<0.001	<0.05	0.001	<0.001	<0.001	16.5	<0.001	<0.001	4	<0.001	<0.001	0.002		<0.001
HASHIMOTO	H1	N800050	S	NAF	0.200	8.0	305	1.3				61	<0.01	0.33	<0.001	<0.05	<0.001	<0.001	<0.001	10.32	<0.001	<0.001	9	<0.001	<0.001	<0.001		<0.001
HASHIMOTO	H1	N646419	S	NAF	0.010	7.6	275	2.6				34	<0.01	0.29	<0.001	<0.05	<0.001	<0.001	<0.001	3.07	<0.001	<0.001	25	<0.001	<0.001	<0.001		<0.001
HASHIMOTO	H23	N881556	D1	NAF	0.006	7.8	101	3.4				16	<0.01	<0.01	<0.001	<0.05	0.001	<0.001	<0.001	3.6	<0.001	<0.001	11	<0.001	<0.001	<0.001		<0.001
HASHIMOTO	H23	N884014	D2/D3	NAF	0.004	6.4	65	7.6				12	<0.01	<0.01	<0.001	<0.05	0.001	<0.001	<0.001	1.64	<0.001	<0.001	6	<0.001	<0.001	<0.001		<0.001
HASHIMOTO	H23	N893984	J5	NAF	<0.002	7.3	134	4				23	<0.01	<0.01	<0.001	<0.05	0.001	<0.001	<0.001	3.64	<0.001	<0.001	17	<0.001	<0.001	<0.001		<0.001
HASHIMOTO	H23	N902513	W	NAF	<0.002	7.6	228	3.8				29	<0.01	<0.01	<0.001	<0.05	0.001	<0.001	<0.001	0.95	<0.001	<0.001	27	0.001	<0.001	<0.001		<0.001
HASHIMOTO	H23	N896691	W	NAF	0.003	7.0	237	8				21	<0.01	<0.01	<0.001	<0.05	0.002	<0.001	<0.001	5.22	<0.001	<0.001	30	<0.001	<0.001	<0.001		<0.001
HASHIMOTO	H23	N906568	Y	NAF	0.020	8.0	441	5.4				35	<0.01	<0.01	0.015	<0.05	0.004	<0.001	<0.001	13	<0.001	<0.001	61	<0.001	<0.001	0.003		1.43
HASHIMOTO	H23	N882712	YE	NAF	<0.002	7.7	623	4.4				125	<0.01	0.17	<0.001	<0.05	0.002	<0.001	<0.001	1.74	<0.001	<0.001	84	<0.001	<0.001	<0.001		<0.001
HASHIMOTO	H4	N891507	S	NAF	0.615	7.3	728	7.2				36	<0.01	<0.01	0.006	<0.05	<0.001	<0.001	<0.001	28.3	0.002	<0.001	10	0.001	<0.001	<0.001		<0.001
HASHIMOTO	H4	N891678	W	NAF	0.016	7.5	153	5.4				13	<0.01	<0.01	<0.001	<0.05	<0.001	<0.001	<0.001	1.5	<0.001	<0.001	17	<0.001	<0.001	<0.001		<0.001
HASHIMOTO	H4	N891856	W	NAF	0.006	7.2	178	3.5				15	<0.01	<0.01	<0.001	<0.05	<0.001	<0.001	<0.001	2.38	<0.001	<0.001	19	<0.001	<0.001	0.003		<0.001
SHOVELANNA	31	N593723	D1	NAF	0.020	7.2	120	3.3	<2	<2	25	25		<0.01	<0.001	0.03	0.028	<0.001	<0.001	7.43	<0.001	<0.001	9	<0.001	<0.001	<0.001	<0.1	0.05
SHOVELANNA	31	N588645	D1	NAF	0.030	6.7	120	4.3	<2	<2	26	26		0.03	<0.001	0.01	0.009	<0.001	<0.001	7.18	<0.001	<0.001	12	<0.001	<0.001	<0.001	0.1	0.07
SHOVELANNA	31	N502065	D2	NAF	<0.01	6.9	69	4	<1	7	<1	7	<0.001	0.11	<0.001	<0.05	0.004	<0.001	<0.001	3	<0.001	<0.001	8	<0.001	0.001	<0.001		2.21
SHOVELANNA	31	N502486	D3	NAF	0.040	7.9	280	2	<1	81	<1	81	<0.001	0.02	<0.001	0.09	0.154	<0.001	<0.001	20	<0.001	<0.001	15	<0.001	<0.001	<0.001		<0.05
SHOVELANNA	31	N623444	D3	NAF	0.010	7.6	280	5.2	<2	<2	64	64		<0.01	<0.001	0.03	0.002	<0.001	<0.001	32.86	<0.001	<0.001	29	<0.001	<0.001	0.002	1.5	0.04
SHOVELANNA	31	N502058	D3	NAF	<0.01	7.2	154	4	<1	23	<1	23	<0.001	<0.01	<0.001	0.09	0.003	<0.001	<0.001	7	<0.001	<0.001	18	0.003	<0.001	0.002		<0.05
SHOVELANNA	31	N505655	D4	NAF	<0.01	7.0	89	2	<1	12	<1	12	<0.001	<0.01	<0.001	<0.05	0.005	<0.001	<0.001	6	<0.001	<0.001	9	<0.001	<0.001	<0.001		<0.05
SHOVELANNA	31	N502031	D4	NAF	<0.01	7.0	134	4	<1	11	<1	11	<0.001	<0.01	<0.001	<0.05	<0.001	<0.001	<0.001	7	<0.001	<0.001	22	<0.001	0.001	<0.001		<0.05
SHOVELANNA	31	N590054	D4	NAF	<0.01	6.8	100	0.5	<2	<2	22	22		0.35	<0.001	0.03	0.003	<0.001	<0.001	4.98	<0.001	<0.001	8	<0.001	<0.001	<0.001	0.1	0.01
SHOVELANNA	31	EB0794DT-09-PAF	HE	NAF	<0.01	8.2	775	2	<1	114	<1	114	<0.001	<0.01	<0.001	0.1	0.019	<0.001	0.005	36	<0.001	<0.001	118	<0.001	0.009	<0.001		<0.05
SHOVELANNA	31	N416358	HE	NAF	<0.01	8.0	599	2	<1	77	<1	77	<0.001	0.01	0.005	0.12	0.008	<0.001	<0.001	5	<0.001	<0.001	109	<0.001	<0.001	<0.001		0.12
SHOVELANNA	31	EB0794DT-04-PAF	HE	NAF	0.020	7.8	1,280	8	<1	106	<1	106	<0.001	<0.01	<0.001	0.26	0.017	<0.001	0.002	87	<0.001	<0.001	77	<0.001	0.013	<0.001		<0.05
SHOVELANNA	31	N590352	HE	NAF	<0.01	7.1	620	4.8	<2	<2	56	56		0.02	<0.001	0.07	0.019	<0.001	<0.001	22.84	<0.001	<0.001	126	<0.001	<0.001	<0.001	0.1	0.01
SHOVELANNA	31	N624584	HE	NAF	<0.01	7.6	129	5.3				22	<0.01	<0.01	<0.001	<0.05	0.003	<0.001	<0.001	2.82	<0.001	<0.001	15	<0.001	<0.001	0.003		<0.001
SHOVELANNA	31	N505856	HE	NAF	<0.01	7.5	197	4	<1	33	<1	33	<0.001	<0.01	<0.001	0.05	0.01	<0.001	0.001	10	<0.001	<0.001	29	<0.001	<0.001	<0.001		<0.05
SHOVELANNA	31	N416182	HE	NAF	<0.01	7.3	154	4	<1	21	<1	21	<0.001	<0.01	<0.001	0.06	0.006	<0.001	<0.001	6	<0.001	<0.001	29	<0.001	<0.001	<0.001		<0.05
SHOVELANNA	31	N590264	HJ	NAF	0.010	7.6	390	0.5	<2	<2	42	42		0.02	<0.001	0.13	0.017	<0.001	<0.001	11.44	<0.001	<0.001	71	<0.001	<0.001	<0.001	0.2	0.04
SHOVELANNA	31	N416289	HJ	NAF	<0.01	7.3	96	4	<1	16	<1	16	<0.001	0.02	<0.001	<0.05	0.004	<0.001	<0.001	6	<0.001	<0.001	15	<0.001	<0.001	<0.001		0.08
SHOVELANNA	31	N416293	HJ/HE	NAF	<0.01	7.3	202	6	<1	33	<1	33	<0.001	<0.01	<0.001	0.05	0.007	<0.001	<0.001	10	<0.001	<0.001	29	<0.001	0.001	<0.001		<0.05
SHOVELANNA	31	N416220	HJ/HE	NAF	<0.01	7.6	444	4	<1	32	<1	32	<0.001	0.02	0.001	0.12	0.011	<0.001	<0.001	7	<0.001	<0.001	92	<0.001	<0.001	<0.001		<0.05
SHOVELANNA	31	EB0790DT-48-PAF	J1	NAF	<0.01	7.1	80	4	<1	12	<1	12	<0.001	<0.01	<0.001	<0.05	0.003	<0.001	0.001	3	<0.001	<0.001	6	<0.001	<0.001	<0.001		<0.05
SHOVELANNA	31	N593582	J1	NAF	<0.01	6.6	320	4.8	<2	<2	13	13		0.07	<0.001	0.07	0.263	<0.001	<0.001	6.58	<0.001	<0.001	74	<0.001	<0.001	<0.001	0.1	0.01
SHOVELANNA	31	N505639	J1	NAF	<0.01	7.1	127	6	<1	12	<1	12	<0.001	<0.01	<0.001	<0.05	0.002	<0.001	<0.001	9	<0.001	<0.001	8	0.01	<0.001	<0.001		<0.05
SHOVELANNA	31	EB0790DT-15-PAF	J2	NAF	<0.01	7.2	107	4	<1	12	<1	12	<0.001	0.7	<0.001	<0.05	0.002	<0.001	<0.001	2	<0.001	<0.001	12	<0.001	<0.001	<0.001		5.26
SHOVELANNA	31	N516457	J2	NAF	<0.01	7.1	67	2	<1	10	<1	10	<0.001	<0.01	<0.001	<0.05	0.002	<0.001	<0.001	2	<0.001	<0.001	7	<0.001	0.001	<0.001		<0.05
SHOVELANNA	31	N502147	J2	NAF	<0.01	6.9	73	6	<1	7	<1	7	<0.001	<0.01	<0.001	<0.05	0.006	<0.001	<0.001	3	<0.001	<0.001	10	<0.001	<0.001	<0.001		<0.05
SHOVELANNA	31	N502364	J2	NAF	<0.01	7.3	108	4	<1	28	<1	28	<0.001	<0.01	<0.001	<0.05	0.259	<0.001	<0.001	8	<0.001	<0.001	8	<0.001	<0.001	<0.001		<0.05
SHOVELANNA	31	N590127	J2	NAF	<0.01	7.0	160	5.2	<2	<2	30	30		<0.01	<0.001	0.01	0.005	<0.001	<0.001	6.55	<0.001	<0.001	19	<0.001	<0.001	<0.001	0.1	0.08
SHOVELANNA	31	EB0790DT-08-PAF	J2/J3	NAF	0.010	7.0	150	4	<1	12	<1	12	<0.001	0.29	<0.001	0.08	0.023	<0.001	<0.001	5	<0.001	<0.001	12	<0.001	<0.001	<0.001		0.34
SHOVELANNA	31	N505729	J5	NAF	<0.01	7.6	178	6	<1	47	<1	47	<0.001	0.01	<0.001	0.05	0.166	<0.001	<0.001	8	<0.001	<0.001	16	0.001	<0.001	0.017		<0.05

Orebody	Sample ID	Strat	Hg	K	Mg	Mn	Mo	Na	Ni	NO_2	NO_3	NO_X	P	Reactive Phosphorous	Pb	S	Sb	Se	Se (low detection limit)	Si	Sn	SO_4	Sr	Th	Tl	U	V	W	Zn
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
H1	HH1203DTM-04-PAF	D4	<LOR	2.2	3.02	0.021	<0.001	4.2	0.01		0.4		<0.1		<0.001	2.6	<0.001	<0.01		4.08	<0.001	8.2	0.025	<LOR	<0.001	<LOR	<0.005	<0.001	<0.005
H1	N681922	RL	<LOR	4.7	72.56	12.5	<0.001	45.4	0.01		<0.1		<0.1		<0.001	158.7	<0.001	0.011		0.57	<0.001	455	0.133	<LOR	<0.001	<LOR	<0.005	<0.001	<0.005
H1	N802881	RU	<LOR	4.8	12.99	0.028	0.023	27.1	<0.01		<0.1		<0.1		<0.001	16	<0.001	0.155		1.31	<0.001	47.8	0.061	<LOR	<0.001	0.001	<0.005	<0.001	<0.005
H1	N705691	S	<LOR	8	20.15	0.016	0.075	4.4	<0.01		0.1		<0.1		<0.001	32.2	0.001	<0.01		0.66	<0.001	86	0.021	<LOR	<0.001	<LOR	<0.005	0.009	<0.005
H1	N705686	S	<LOR	2	24.92	0.015	0.054	5.4	<0.01		2.9		<0.1		<0.001	23.4	<0.001	<0.01		0.58	<0.001	58.5	0.013	<LOR	<0.001	<LOR	<0.005	0.016	<0.005
H1	N705694	S	<LOR	2.5	19.2	0.005	0.079	11.7	<0.01		0.2		<0.1		<0.001	18.9	<0.001	0.017		0.62	<0.001	50.1	0.017	<LOR	<0.001	<LOR	<0.005	<0.001	0.004
H1	N800050	S	<LOR	3.8	12.15	0.39	0.002	14.5	<0.01		0.2		<0.1		<0.001	12.5	<0.001	0.008		0.42	<0.001	36.5	0.021	<LOR	<0.001	<LOR	<0.005	<0.001	<0.005
H1	N646419	S	<LOR	2.6	2.64	<0.001	0.005	30.6	<0.01		0.1		<0.1		<0.001	7	<0.001	<0.01		2.26	<0.001	20.2	0.015	<LOR	<0.001	<LOR	<0.005	<0.001	<0.005
H23	N881556	D1	<LOR	1.8	1.91	<0.001	0.001	8.8	<0.01		0.6		<0.1		<0.001	3.5	<0.001	0.003		1.59	<0.001	9.6	0.014	<LOR	<0.001	<LOR	<0.005	<0.001	<0.005
H23	N884014	D2/D3	<LOR	2.6	1.21	0.001	0.005	5	<0.01		0.1		<0.1		<0.001	2	<0.001	<0.01		2.69	<0.001	4.1	0.01	<LOR	<0.001	<LOR	<0.005	<0.001	<0.005
H23	N893984	J5	<LOR	2.1	2.93	<0.001	0.003	16.7	<0.01		0.6		<0.1		<0.001	5.5	<0.001	<0.01		1.54	<0.001	9.4	0.016	<LOR	<0.001	<LOR	<0.005	<0.001	<0.005
H23	N902513	W	<LOR	2.2	0.72	0.002	0.014	36.6	0.01		0.1		3.2		<0.001	10.2	<0.001	0.003		3.25	<0.001	28.7	0.005	<LOR	<0.001	<LOR	<0.005	<0.001	0.012
H23	N896691	W	<LOR	1.9	4.86	<0.001	0.003	29.9	<0.01		0.2		<0.1		<0.001	9.3	<0.001	0.007		2.75	<0.001	25.4	0.024	<LOR	<0.001	<LOR	<0.005	<0.001	<0.005
H23	N906568	Y	<LOR	3.6	9.38	0.002	0.005	49.4	0.01		0.1		<0.1		<0.001	19.8	<0.001	0.009		1.7	<0.001	47.9	0.052	<LOR	<0.001	<LOR	<0.005	<0.001	0.009
H23	N882712	YE	<LOR	6.4	5.01	0.001	0.004	152.7	<0.01		<0.1		5.1		<0.001	44.5	<0.001	0.004		5.11	<0.001	110	0.024	<LOR	<0.001	<LOR	0.011	<0.001	<0.005
H4	N891507	S	<LOR	3.2	53.2	7	0.004	23	0.03		<0.01		<0.1		<0.001	107	<0.001	0.148		0.61	<0.001	285	0.09	<LOR	<0.001	<LOR	<0.005	<0.001	0.011
H4	N891678	W	<LOR	1.6	1.85	0.002	0.003	18.6	<0.01		0.2		<0.1		<0.001	6	<0.001	0.009		2.56	<0.001	16.6	0.012	<LOR	<0.001	<LOR	<0.005	<0.001	<0.005
H4	N891856	W	<LOR	1.8	2.85	<0.001	0.011	19.6	<0.01		0.1		<0.1		<0.001	6.2	<0.001	0.009		3.13	<0.001	16.7	0.014	<LOR	<0.001	<LOR	<0.005	<0.001	0.005
31	N593723	D1	<LOR	1.4	4.96	0.01	<0.001	5	<0.01		<0.1		<0.1	<0.005	<0.001	2	<0.001	<0.01		5.27	<0.001	5.9	0.036		0.001		<0.005	<0.001	<0.005
31	N588645	D1	<LOR	1.6	5.38	0.003	<0.001	6.1	<0.01		0.1		<0.1	<0.005	0.001	2.9	<0.001	<0.01		6.29	<0.001	8.8	0.024		<0.001		<0.005	<0.001	<0.005
31	N502065	D2	<LOR	2	2	0.014	<0.001	11	0.003	0.01	0.07	0.08	<1	0.07	<0.001	3	<0.001	<0.01	<0.2	11.8	<0.001	6	0.007		<0.001		<0.01	<0.001	<0.005
31	N502486	D3	<LOR	9	5	<0.001	0.002	31	<0.001	0.01	0.11	0.12	<1	<0.01	<0.001	8	0.001	<0.01	1.1	12.4	<0.001	24	0.113		<0.001		<0.01	<0.001	<0.005
31	N623444	D3	<LOR	1.6	3.63	<0.001	0.001	14.6	<0.01		<0.1		<0.1	<0.005	<0.001	5.9	<0.001	0.001		7.83	<0.001	17.7	0.059		<0.001		<0.005	<0.001	<0.005
31	N502058	D3	<LOR	5	6	0.008	0.004	17	0.003	<0.01	<0.01	<0.01	<1	<0.01	<0.001	5	<0.001	<0.01	<0.2	7.13	<0.001	14	0.024		<0.001		<0.01	<0.001	<0.005
31	N505655	D4	<LOR	2	4	0.003	<0.001	9	0.005	<0.01	0.01	0.01	<1	<0.01	<0.001	6	<0.001	<0.01	<0.2	3.22	<0.001	13	0.017		<0.001		<0.01	<0.001	<0.005
31	N502031	D4	<LOR	4	4	0.002	<0.001	15	<0.001	0.02	0.03	0.05	<1	<0.01	<0.001	4	<0.001	<0.01	0.2	2.95	<0.001	12	0.02		<0.001		<0.01	<0.001	<0.005
31	N590054	D4	<LOR	1	3.44	0.007	<0.001	4.9	<0.01		<0.1		<0.1	<0.005	<0.001	1.1	<0.001	<0.01		7.82	<0.001	3.2	0.016		<0.001		<0.005	<0.001	<0.005
31	EB0794DT-09-PAF	HE	<LOR	15	23	<0.001	0.001	86	<0.001	<0.01	5.94	5.94	<1	<0.01	<0.001	21	0.005	<0.01	1.3	17.5	<0.001	68	0.212		<0.001		<0.01	<0.001	<0.005
31	N416358	HE	<LOR	1	11	<0.001	0.002	105	<0.001	<0.01	0.01	0.01	<1	<0.01	<0.001	15	<0.001	<0.01	0.2	22.2	<0.001	39	0.058		<0.001		0.03	<0.001	<0.005
31	EB0794DT-04-PAF	HE	<LOR	29	33	<0.001	<0.001	136	<0.001	<0.01	3.42	3.42	<1	<0.01	<0.001	138	0.002	<0.01	1.7	16.5	<0.001	402	0.408		<0.001		<0.01	<0.001	<0.005
31	N590352	HE	<LOR	3.8	22.8	0.023	<0.001	59.1	<0.01		0.2		<0.1	<0.005	<0.001	12.3	<0.001	<0.01		5.63	<0.001	36.8	0.074		<0.001		<0.005	<0.001	<0.005
31	N624584	HE	<LOR	2.9	3	<0.001	<0.001	14.7	<0.01		0.3		<0.1		<0.001	4.6	<0.001	0.019		3.43	<0.001	12.8	0.011	<LOR	<0.001	<LOR	<0.005	<0.001	0.005
31	N505856	HE	<LOR	5	8	<0.001	<0.001	19	<0.001	0.07	0.03	0.1	<1	<0.01	<0.001	5	0.002	<0.01	<0.2	3.66	<0.001	14	0.022		<0.001		<0.01	<0.001	<0.005
31	N416182	HE	<LOR	6	6	0.001	<0.001	19	<0.001	0.05	0.05	0.1	<1	0.03	<0.001	4	<0.001	<0.01	<0.2	4	<0.001	8	0.018		<0.001		<0.01	<0.001	<0.005
31	N590264	HJ	<LOR	2.8	11.69	0.001	<0.001	41.7	<0.01		0.2		<0.1	<0.005	<0.001	6.6	<0.001	0.001		6.58	<0.001	19.8	0.054		<0.001		<0.005	<0.001	<0.005
31	N416289	HJ	<LOR	3	4	<0.001	<0.001	11	<0.001	0.02	0.02	0.04	<1	0.02	<0.001	3	<0.001	<0.01	<0.2	3.14	<0.001	8	0.017		<0.001		<0.01	<0.001	<0.005
31	N416293	HJ/HE	<LOR	5	8	<0.001	<0.001	20	<0.001	0.01	0.03	0.04	<1	0.06	<0.001	7	<0.001	<0.01	<0.2	5.58	<0.001	17	0.029		<0.001		<0.01	<0.001	<0.005
31	N416220	HJ/HE	<LOR	6	7	<0.001	0.001	75	<0.001	<0.01	<0.01	<0.01	<1	<0.01	<0.001	13	<0.001	<0.01	0.3	14.4	<0.001	33	0.054		<0.001		<0.01	<0.001	<0.005
31	EB0790DT-48-PAF	J1	<LOR	5	2	0.003	0.001	9	<0.001	0.01	0.07	0.08	<1	0.01	<0.001	3	<0.001	<0.01	<0.2	7.5	<0.001	8	0.009		<0.001		<0.01	<0.001	<0.005
31	N593582	J1	<LOR	2.8	6.42	0.003	<0.001	40.6	<0.01		0.2		<0.1	<0.005	<0.001	3.2	<0.001	<0.01		11.03	<0.001	9.7	0.046		<0.001		<0.005	<0.001	<0.005
31	N505639	J1	<LOR	3	6	0.006	<0.001	10	0.014	<0.01	<0.01	<0.01	<1	<0.01	<0.001	12	<0.001	<0.01	<0.2	5.13	<0.001	31	0.027		<0.001		<0.01	<0.001	<0.005
31	EB0790DT-15-PAF	J2	<LOR	3	2	0.018	<0.001	19	0.001	0.02	0.25	0.27	<1	0.02	<0.001	4	<0.001	<0.01	0.2	7.13	<0.001	10	0.008		<0.001		<0.01	0.002	0.005
31	N516457	J2	<LOR	3	2	0.001	<0.001	9	<0.001	<0.01	0.04	0.04	<1	<0.01	<0.001	2	<0.001	<0.01	0.4	5.42	<0.001	5	0.007		<0.001		<0.01	<0.001	<0.005
31	N502147	J2	<LOR	2	2	<0.001	<0.001	8	<0.001	0.01	0.03	0.04	<1	<0.01	<0.001	2	<0.001	<0.01	<0.2	6.08	<0.001	6	0.009		<0.001		<0.01	<0.001	<0.005
31	N502364	J2	<LOR	4	6	0.096	<0.001	8	<0.001	0.02	0.04	0.06	<1	0.02	<0.001	2	<0.001	<0.01	<0.2	3.31	<0.001	5	0.047		0.001		<0.01	<0.001	<0.005
31	N590127	J2	<LOR	2.2	5.77	0.002	<0.001	10.9	<0.01		0.1		<0.1	<0.005	<0.001	2.9	<0.001	<0.01		6.34	<0.001	8.8	0.019		<0.001		<0.005	<0.001	<0.005
31	EB0790DT-08-PAF	J2/J3	<LOR	6	2	0.001	<0.001	23	<0.001	0.01	2.79	2.8	<1	<0.01	<0.001	7	<0.001	<0.01	0.8	17.2	<0.001	21	0.028		<0.001		<0.01	<0.001	<0.005
31	N505729	J5	<LOR	6	9	0.252	0.002	17	0.002	<0.01	<0.01	<0.01	<1	0.02	<0.001	5	<0.001	<0.01	0.2	6.47	<0.001	13	0.033		<0.001		<0.01	<0.001	<0.005

Deposit	Orebody	Sample ID	Strat	AMD Class	Total-S	pH	EC	Acidity	ALK-OH	ALK-CO3	ALK-HCO3	ALK-TOT	Ag	Al	As	B	Ba	Be	Bi	Ca	Cd	Ce	Cl	Co	Cr	Cu	F	Fe
					wt%	pH unit	µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
SHOVELANNA	31	N593509	J5	NAF	<0.01	7.0	540	1	<2	<2	64	64		0.01	<0.001	0.1	0.031	<0.001	<0.001	17.88	<0.001	<0.001	119	<0.001	<0.001	<0.001	0.2	<0.01
SHOVELANNA	31	EB0793DT-23-PAF	J6	NAF	<0.01	7.5	97	2	<1	16	<1	16	<0.001	0.38	0.002	<0.05	0.004	<0.001	<0.001	<1	<0.001	0.002	12	<0.001	<0.001	<0.001		10.9
SHOVELANNA	31	EB0794DT-26-PAF	J6	NAF	<0.01	8.1	180	2	<1	42	<1	42	<0.001	<0.01	<0.001	<0.05	0.003	<0.001	<0.001	4	<0.001	<0.001	11	<0.001	0.002	<0.001		<0.05
SHOVELANNA	31	EB0793DT-32-PAF	J6	NAF	<0.01	7.4	118	2	<1	21	<1	21	<0.001	0.02	<0.001	<0.05	0.001	<0.001	<0.001	2	<0.001	<0.001	11	<0.001	<0.001	<0.001		0.38
SHOVELANNA	31	EB0793DT-12-PAF	J6	NAF	<0.01	7.4	480	4	<1	20	<1	20	<0.001	<0.01	<0.001	0.06	0.02	<0.001	<0.001	20	<0.001	<0.001	92	<0.001	<0.001	<0.001		0.08
SHOVELANNA	31	EB0793DT-14-PAF	J6	NAF	<0.01	7.2	306	4	<1	12	<1	12	<0.001	<0.01	<0.001	0.06	0.047	<0.001	<0.001	12	<0.001	<0.001	56	<0.001	<0.001	<0.001		<0.05
SHOVELANNA	31	EB0794DT-51-PAF	J6	NAF	<0.01	7.5	114	2	<1	18	<1	18	<0.001	0.04	<0.001	<0.05	<0.001	<0.001	<0.001	1	<0.001	<0.001	12	<0.001	<0.001	<0.001		1.79
SHOVELANNA	31	N416412	J6	NAF	<0.01	6.8	316	4	<1	8	<1	8	<0.001	<0.01	<0.001	<0.05	0.006	<0.001	<0.001	5	<0.001	<0.001	61	<0.001	<0.001	<0.001		<0.05
SHOVELANNA	31	N502399	J6	NAF	0.010	5.9	114	6	<1	5	<1	5	<0.001	1.33	<0.001	0.08	0.068	<0.001	<0.001	4	<0.001	0.001	12	0.001	0.001	0.001		7.52
SHOVELANNA	31	N502459	J6	NAF	<0.01	7.0	105	4	<1	11	<1	11	<0.001	<0.01	<0.001	<0.05	0.015	<0.001	<0.001	7	<0.001	<0.001	11	<0.001	<0.001	<0.001		<0.05
SHOVELANNA	31	N502473	J6	NAF	<0.01	7.0	114	4	<1	10	<1	10	<0.001	<0.01	<0.001	<0.05	0.006	<0.001	<0.001	6	<0.001	<0.001	14	0.001	<0.001	<0.001		<0.05
SHOVELANNA	31	EB0792DT-32-PAF	RU	NAF	<0.01	7.4	135	4	<1	32	<1	32	<0.001	<0.01	<0.001	0.05	<0.001	<0.001	<0.001	6	<0.001	<0.001	10	<0.001	0.003	<0.001		<0.05
SHOVELANNA	31	N505546	RU	NAF	<0.01	7.4	210	6	<1	36	<1	36	<0.001	<0.01	0.001	0.11	0.003	<0.001	<0.001	8	<0.001	<0.001	28	<0.001	<0.001	<0.001		<0.05
SHOVELANNA	31	N502086	TD3	NAF	<0.01	7.9	228	4	<1	76	<1	76	<0.001	0.02	<0.001	<0.05	0.074	<0.001	<0.001	28	<0.001	<0.001	14	<0.001	0.002	<0.001		<0.05
SHOVELANNA	31	EB0790DT-04-PAF	TD3	NAF	0.010	7.0	119	4	<1	12	<1	12	<0.001	0.87	<0.001	0.1	0.019	<0.001	<0.001	5	<0.001	<0.001	8	<0.001	0.002	<0.001		1.73
SHOVELANNA	31	N505789	TD3	NAF	<0.01	7.8	325	4	<1	70	<1	70	<0.001	0.07	0.002	0.25	0.038	<0.001	<0.001	6	<0.001	<0.001	37	<0.001	0.001	<0.001		0.06
SHOVELANNA	31	N505663	TD3	NAF	0.030	6.4	230	6	<1	4	<1	4	<0.001	0.18	<0.001	0.21	0.071	<0.001	<0.001	1	<0.001	<0.001	49	0.001	<0.001	<0.001		0.1
SHOVELANNA	31	N624585	W	NAF	<0.01	7.4	86	3				16	<0.01	0.21	<0.001	<0.05	<0.001	<0.001	<0.001	0.83	<0.001	<0.001	6	<0.001	<0.001	<0.001		<0.001
SHOVELANNA	31	N505643	W	NAF	<0.01	7.3	171	4	<1	23	<1	23	<0.001	<0.01	<0.001	0.06	0.005	<0.001	<0.001	10	<0.001	<0.001	11	0.027	<0.001	0.002		<0.05
SHOVELANNA	31	N502244	W	NAF	<0.01	7.0	103	6	<1	22	<1	22	<0.001	0.04	<0.001	<0.05	0.017	<0.001	<0.001	4	<0.001	<0.001	12	<0.001	<0.001	<0.001		0.78
SHOVELANNA	31	N505565	W	NAF	<0.01	7.3	232	4	<1	17	<1	17	<0.001	<0.01	<0.001	0.05	0.007	<0.001	<0.001	7	<0.001	<0.001	48	<0.001	<0.001	<0.001		<0.05
SHOVELANNA	31	N502014	W	NAF	0.010	7.7	267	4	<1	72	<1	72	<0.001	0.04	<0.001	0.13	0.096	<0.001	<0.001	16	<0.001	<0.001	18	<0.001	0.001	<0.001		0.07
SHOVELANNA	31	N502313	W	NAF	<0.01	7.2	119	4	<1	17	<1	17	<0.001	<0.01	<0.001	0.05	0.004	<0.001	<0.001	4	<0.001	<0.001	14	<0.001	<0.001	<0.001		<0.05
SHOVELANNA	31	EB0793DT-06-PAF	Y	NAF	0.010	7.9	963	6	<1	95	<1	95	<0.001	<0.01	<0.001	0.21	0.025	<0.001	<0.001	45	<0.001	<0.001	154	<0.001	0.003	<0.001		<0.05
SHOVELANNA	31	N590424	Y	NAF	<0.01	7.4	570	3.3	<2	<2	80	80		<0.01	<0.001	0.07	0.021	<0.001	<0.001	24.76	<0.001	<0.001	99	<0.001	<0.001	<0.001	0.3	0.01
WHEELARRA	WH56	N630965	CY2	NAF	0.030	7.6	790	6.7	<2	<2	102	102		0.02	0.001	0.23	0.017	<0.001	<0.001	22.49	<0.001	<0.001	147	0.001	<0.001	0.004	0.8	<0.01
WHEELARRA	WH56	N633238	D1	NAF	<0.01	7.1	110	2.4				31		0.04	<0.001	0.08	0.002	<0.001	<0.001	5.83	<0.001	<0.001	7	<0.001	<0.001	<0.001		0.02
WHEELARRA	WH56	N618615	D3	NAF	<0.01	7.1	240	2.4				37		<0.01	<0.001	0.13	0.008	<0.001	<0.001	8.27	<0.001	<0.001	37	<0.001	<0.001	0.001		0.01
WHEELARRA	WH56	N619931	D4	NAF	0.020	6.9	350	4.8				32		<0.01	<0.001	0.04	0.017	<0.001	<0.001	7.09	<0.001	<0.001	38	<0.001	<0.001	0.001		<0.001
WHEELARRA	WH56	N564742	J2	NAF	0.020	6.4	150	3.3	<2	<2	18	18		0.03	<0.001	0.06	0.272	<0.001	<0.001	2.16	<0.001	<0.001	19	<0.001	<0.001	0.001	0.1	0.03
WHEELARRA	WH56	P05554	K	NAF	<0.002	7.3	802	5.2				114	<0.01	0.05	<0.001	<0.05	0.001	<0.001	<0.001	5.59	<0.001	<0.001	112	<0.001	<0.001	<0.001		<0.001
WHEELARRA	WH56	P05525	OD	NAF	0.015	7.5	168	3.8				10	<0.01	<0.01	<0.001	<0.05	<0.001	<0.001	<0.001	27.94	<0.001	<0.001	21	<0.001	<0.001	<0.001		<0.001
WHEELARRA	WH56	N619571	RU	NAF	0.050	7.2	470	<0.2				74		0.64	0.001	0.11	0.003	<0.001	<0.001	3.62	<0.001	<0.001	51	<0.001	0.001	0.003		0.06
WHEELARRA	WH56	N645606	W	NAF	<0.01	7.7	221	8.1				20	<0.01	<0.01	<0.001	<0.05	<0.001	<0.001	<0.001	1.48	<0.001	<0.001	24	0.001	<0.001	0.003		<0.001
WHEELARRA	WH56	N661391	W	NAF	<0.01	7.1	138	12.3				12	<0.01	<0.01	<0.001	<0.05	<0.001	<0.001	<0.001	0.63	<0.001	<0.001	20	<0.001	<0.001	0.003		<0.001

Orebody	Sample ID	Strat	Hg	K	Mg	Mn	Mo	Na	Ni	NO_2	NO_3	NO_X	P	Reactive Phosphorous	Pb	S	Sb	Se	Se (low detection limit)	Si	Sn	SO_4	Sr	Th	Tl	U	V	W	Zn
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
31	N593509	J5	<LOR	3	17.46	0.019	<0.001	60.1	<0.01		<0.1		<0.1	<0.005	<0.001	1.7	<0.001	<0.01		9.99	<0.001	5	0.066		<0.001		<0.005	<0.001	<0.005
31	EB0793DT-23-PAF	J6	<LOR	2	<1	0.068	0.003	23	<0.001	0.02	0.28	0.3	<1	0.12	<0.001	4	<0.001	<0.01	<0.2	2.65	<0.001	9	0.002		<0.001		<0.01	<0.001	<0.005
31	EB0794DT-26-PAF	J6	<LOR	4	1	<0.001	<0.001	34	<0.001	0.02	0.11	0.13	<1	<0.01	<0.001	8	<0.001	<0.01	0.4	2.02	<0.001	21	0.009		<0.001		<0.01	<0.001	<0.005
31	EB0793DT-32-PAF	J6	<LOR	3	<1	0.003	<0.001	25	<0.001	0.01	0.08	0.09	<1	0.02	<0.001	4	<0.001	<0.01	<0.2	2.61	<0.001	13	0.004		<0.001		<0.01	<0.001	<0.005
31	EB0793DT-12-PAF	J6	<LOR	11	9	<0.001	<0.001	58	<0.001	<0.01	0.13	0.13	<1	<0.01	<0.001	19	<0.001	<0.01	2.7	11.1	<0.001	61	0.11		<0.001		<0.01	<0.001	<0.005
31	EB0793DT-14-PAF	J6	<LOR	8	6	<0.001	<0.001	38	<0.001	<0.01	0.07	0.07	<1	<0.01	<0.001	11	<0.001	<0.01	1.5	10.3	<0.001	30	0.073		<0.001		<0.01	<0.001	<0.005
31	EB0794DT-51-PAF	J6	<LOR	2	<1	0.005	<0.001	24	<0.001	0.01	0.09	0.1	<1	0.02	<0.001	4	<0.001	<0.01	<0.2	2.56	<0.001	12	0.003		<0.001		<0.01	<0.001	<0.005
31	N416412	J6	<LOR	8	8	0.002	<0.001	41	<0.001	0.02	0.02	0.04	<1	<0.01	<0.001	10	<0.001	<0.01	0.3	11.1	<0.001	28	0.023		<0.001		<0.01	<0.001	<0.005
31	N502399	J6	<LOR	6	2	0.017	<0.001	15	0.001	0.01	0.87	0.88	<1	0.02	<0.001	6	<0.001	<0.01	1.1	16.8	<0.001	<0.5	0.026		<0.001		<0.01	<0.001	<0.005
31	N502459	J6	<LOR	2	4	<0.001	<0.001	10	0.002	<0.01	0.04	0.04	<1	<0.01	<0.001	5	<0.001	<0.01	<0.2	3.09	<0.001	13	0.02		<0.001		<0.01	<0.001	<0.005
31	N502473	J6	<LOR	2	4	0.001	<0.001	12	0.002	<0.01	0.03	0.03	<1	<0.01	<0.001	4	<0.001	<0.01	<0.2	6.69	<0.001	11	0.015		<0.001		<0.01	<0.001	<0.005
31	EB0792DT-32-PAF	RU	<LOR	7	3	<0.001	<0.001	17	<0.001	<0.01	0.02	0.02	<1	<0.01	<0.001	5	<0.001	<0.01	0.3	3.26	<0.001	14	0.025		<0.001		<0.01	<0.001	<0.005
31	N505546	RU	<LOR	10	6	0.008	0.003	27	0.001	<0.01	<0.01	<0.01	<1	<0.01	<0.001	6	<0.001	<0.01	<0.2	4.46	<0.001	16	0.022		<0.001		<0.01	<0.001	<0.005
31	N502086	TD3	<LOR	10	4	<0.001	0.003	15	<0.001	0.04	0.05	0.09	<1	0.01	<0.001	4	<0.001	<0.01	0.6	18.4	<0.001	10	0.083		<0.001		<0.01	0.012	<0.005
31	EB0790DT-04-PAF	TD3	<LOR	6	2	0.005	<0.001	16	<0.001	0.03	2.19	2.22	<1	0.01	<0.001	6	<0.001	<0.01	1.9	19.2	<0.001	17	0.028		<0.001		<0.01	<0.001	<0.005
31	N505789	TD3	<LOR	14	3	0.001	0.004	55	<0.001	0.03	0.05	0.08	<1	<0.01	<0.001	8	<0.001	<0.01	0.4	19.8	<0.001	23	0.048		<0.001		<0.01	0.005	<0.005
31	N505663	TD3	<LOR	6	3	0.059	<0.001	44	<0.001	<0.01	0.11	0.11	<1	<0.01	<0.001	10	<0.001	<0.01	0.6	24.8	<0.001	26	0.022		<0.001		<0.01	<0.001	<0.005
31	N624585	W	<LOR	1.7	0.36	<0.001	<0.001	8.7	<0.01		0.1		<0.1		<0.001	1.7	<0.001	<0.01		1.97	<0.001	8.9	0.002	<LOR	<0.001	<LOR	<0.005	<0.001	<0.005
31	N505643	W	<LOR	5	8	0.03	<0.001	14	0.015	<0.01	<0.01	<0.01	<1	<0.01	<0.001	18	<0.001	<0.01	<0.2	5.5	<0.001	36	0.033		<0.001		<0.01	<0.001	<0.005
31	N502244	W	<LOR	4	3	0.011	<0.001	14	<0.001	<0.01	0.02	0.02	<1	0.02	<0.001	2	<0.001	<0.01	<0.2	13	<0.001	6	0.013		<0.001		<0.01	<0.001	<0.005
31	N505565	W	<LOR	8	6	0.002	<0.001	29	0.002	<0.01	0.01	0.01	<1	<0.01	<0.001	6	<0.001	<0.01	<0.2	6.02	<0.001	17	0.031		<0.001		<0.01	<0.001	<0.005
31	N502014	W	<LOR	16	6	<0.001	0.002	28	<0.001	0.03	1.36	1.39	<1	<0.01	<0.001	6	<0.001	<0.01	0.7	10.1	<0.001	18	0.088		<0.001		<0.01	<0.001	<0.005
31	N502313	W	<LOR	4	3	0.002	<0.001	16	<0.001	<0.01	0.01	0.01	<1	0.01	<0.001	4	<0.001	<0.01	<0.2	7.69	<0.001	11	0.012		<0.001		<0.01	<0.001	<0.005
31	EB0793DT-06-PAF	Y	<LOR	20	19	<0.001	<0.001	117	<0.001	<0.01	0.54	0.54	<1	<0.01	<0.001	40	<0.001	<0.01	5	10.4	<0.001	131	0.348		<0.001		<0.01	<0.001	<0.005
31	N590424	Y	<LOR	3.9	18.43	0.008	<0.001	55.8	<0.01		0.2		<0.1	<0.005	0.004	9.1	<0.001	<0.01		7.56	<0.001	27.3	0.113		<0.001		<0.005	<0.001	<0.005
WH56	N630965	CY2	<LOR	4.8	19.59	0.016	0.002	109	<0.01		0.4		<0.1	<0.005	<0.001	22.2	<0.001	0.001		10.63	<0.001	66.5	0.258		<0.001		<0.005	<0.001	<0.005
WH56	N633238	D1	<LOR	1.5	3.26	0.001	<0.001	10.4	<0.01		0.3		<0.1		<0.001	0.7	<0.001	<0.01		2.64	<0.001	2.2	0.029		<0.001		<0.005	<0.001	<0.005
WH56	N618615	D3	<LOR	2.2	6.3	0.007	<0.001	27.6	<0.01		0.3		<0.1		0.001	5.1	<0.001	<0.01		7.66	<0.001	15.2	0.038		<0.001		<0.005	<0.001	<0.005
WH56	N619931	D4	<LOR	1.8	18.18	0.001	<0.001	31.8	<0.01		0.3		<0.1		<0.001	21.2	<0.001	<0.01		3.18	<0.001	63.4	0.05		<0.001		<0.005	<0.001	<0.005
WH56	N564742	J2	<LOR	0.5	1.84	0.008	<0.001	19.3	<0.01		0.5		<0.1	<0.005	0.001	1.4	<0.001	0.001		9.73	<0.001	4.2	0.024		<0.001		<0.005	0.001	0.006
WH56	P05554	K	<LOR	15.6	26.67	0.047	0.004	92.3	<0.01		2.6		<0.1		<0.001	24	<0.001	<0.01		2.64	<0.001	66.9	0.134	<LOR	<0.001	<LOR	<0.005	<0.001	<0.005
WH56	P05525	OD	<LOR	6.4	1.88	0.001	0.001	18.8	<0.01		0.2		<0.1		<0.001	5.6	0.001	0.017		2.42	<0.001	16.7	0.01	<LOR	<0.001	<LOR	<0.01	<0.001	<0.005
WH56	N619571	RU	<LOR	53.2	5.16	0.032	0.006	46.3	0.01		0.2		<0.1		0.001	13.6	0.003	0.03		9.18	<0.001	40.8	0.016		<0.001		<0.005	<0.001	<0.005
WH56	N645606	W	<LOR	2.5	2.15	<0.001	0.003	28.2	<0.01		0.1		<0.1		<0.001	8.2	<0.001	0.019		3.39	<0.001	22.7	0.008	<LOR	<0.001	<LOR	<0.005	<0.001	0.005
WH56	N661391	W	<LOR	1.8	1.21	<0.001	0.003	20	0.01		0.1		<0.1		<0.001	5.6	<0.001	0.02		3.86	<0.001	15.8	0.006	<LOR	<0.001	<LOR	<0.005	<0.001	0.006

Pilbara-wide statistical summary of element concentrations in leach extracts (pH ≥5)

Parameter	All samples					Low sulphur samples (total S 0.1%)					Detection limits (mg/L)		No. of "0" values (all / low S)
	Count [1]	Dissolved concentration (mg/L)				Count [1]	Dissolved concentration (mg/L)						
		Min	P50	P95	Max		Min	P50	P95	Max	Low	High	
pH	424	5	7.3	8.4	9.5	352	5.0	7.3	8.2	9.4			
Alkalinity	399	1	25	131	319	327	1	23	112	285	1	5	
SO_4	441	0.3	25	363	3,131	362	0.3	19	135	1,400			
Cl	441	2	16	101	1,200	362	2	18	112	1,200	1	2	
F	33	0.1	0.2	1.32	2.9	31	0.1	0.2	1.0	1.5	0.1		
Na	441	0.3	19	92	964	362	0.3	19	84	964	0.1		
K	441	0.2	4	27	76	362	0.2	3	16	76	0.1	1	
Ca	441	0.01	7	64	738	362	0.01	6	36	149	1		
Mg	441	0.01	6	53	356	362	0.01	5	30	291	0.01	1	
Ag	350	0	0.001	0.01	0.01	286	0	0.001	0.01	0.01	0.001	0.01	42/35
Al	441	0	0.01	0.5	22[2]	362	0	0.01	0.5	22[2]	0.01		33/28
As	441	0	0	0.005	0.06	362	0	0	0.002	0.06	0.001		222/193
B	424	0	0.05	0.2	1.0	352	0	0.05	0.21	1.0	0.01	0.05	157/122
Ba	441	0	0.008	0.2	1.4	362	0	0.009	0.17	1.4	0.001		22/17
Be	441	0	0	0.001	0.011	362	0	0	0.001	0.011	0.001		251/207
Cd	441	0	0	0	0.007	362	0	0	0	0.001	0.001		425/358
Ce	382	0	0	0.001	0.012	317	0	0	0.001	0.012	0.001		209/171
Co	441	0	0.001	0.02	2.1	362	0	0.001	0.004	0.15	0.001		176/155
Cr	441	0.001	0.001	0.002	0.2	362	0.001	0.001	0.002	0.15	0.001		
Cu	441	0.001	0.001	0.01	0.5	362	0.001	0.001	0.005	0.16	0.001		
Fe	441	0.001	0.05	1.8	126[2]	362	0.001	0.05	2.4	126[2]	0.001	0.05	
Hg	441	0	0	0	0.013	362	0	0	0	0.013			437/359
Mn	441	0	0.01	3.8	82[2]	362	0	0.008	0.69	13[2]	0.001		25/25
Mo	424	0	0.001	0.05	0.5	352	0	0.001	0.027	0.16	0.001		134/117
Ni	441	0	0.01	0.04	2.4	362	0	0.01	0.013	0.58	0.001	0.01	4/3
NO_3	378	0	0.1	1.8	14	316	0	0.1	1.8	14	0.01	0.1	6/3
P	424	0	0.1	1	26	352	0	0.1	1.0	26	0.1	1	1/1
Pb	441	0	0.001	0.001	0.1	362	0	0.001	0.001	0.037	0.001		198/162
Sb	424	0	0	0.002	0.02	352	0	0	0.002	0.02	0.001		215/182
Se	424	0	0.01	0.04	0.16	352	0	0.007	0.02	0.16	0.001	0.01	120/113
Si	424	0.05	5.1	18	73	352	0.4	5.4	18.2	73	0.05		
Sn	424	0	0.001	0.001	0.02	352	0	0.001	0.001	0.016	0.001		75/66
Sr	382	0.002	0.02	0.2	1.6	317	0.002	0.023	0.16	1.3			
Th	181	0	0	0	0.021	143	0	0	0	0.021			179/141
U	181	0	0	0.001	0.011	143	0	0	0.0009	0.011			165/135
V	441	0.005	0.01	0.01	0.09	362	0.005	0.01	0.01	0.03	0.005	0.01	
Zn	441	0.004	0.005	0.10	9.8	362	0.005	0.005	0.06	9.8	0.005		

Notes: Green highlighting denotes a 'zero' value – assumed below detection with detection limits unknown – and grey denotes limit of detection. Zero values were included when calculating the statistical summary.

[1] Excluding duplicates

[2] Some of the maxima are unexpectedly high for neutral pH solutions, and are suspected to be outliers, possibly influenced by fine particulates present in the solution.

Source: SRK (2022)

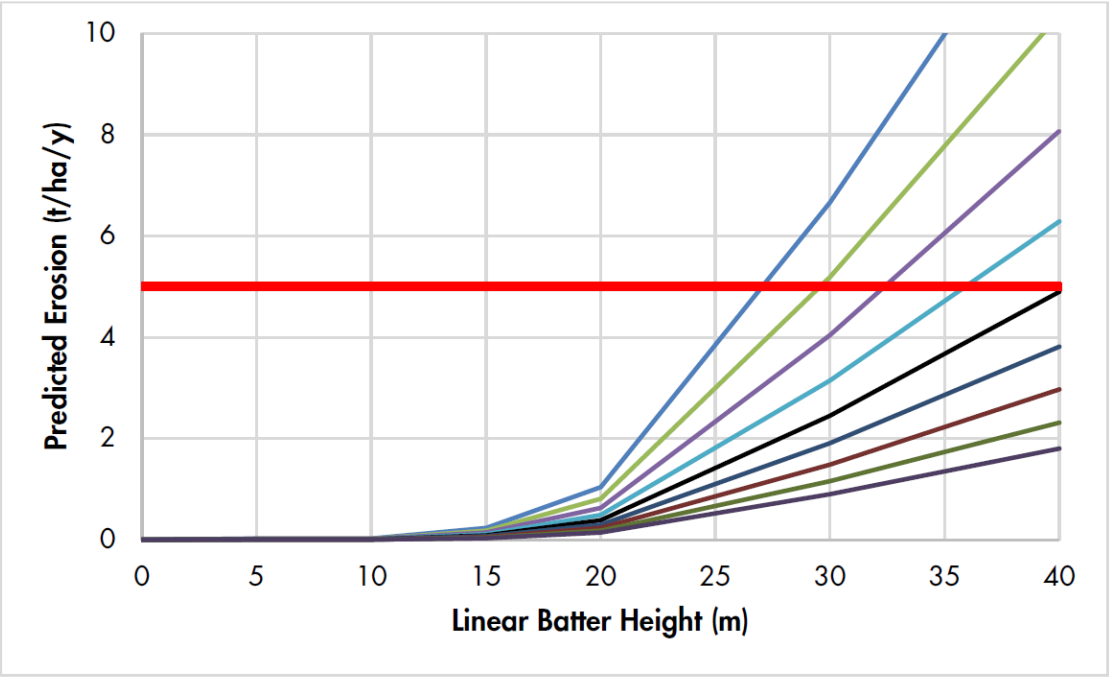
E-2. OB18 rock cover modelling

Proportion of rock cover over a surface required to reduce erosion to acceptable levels

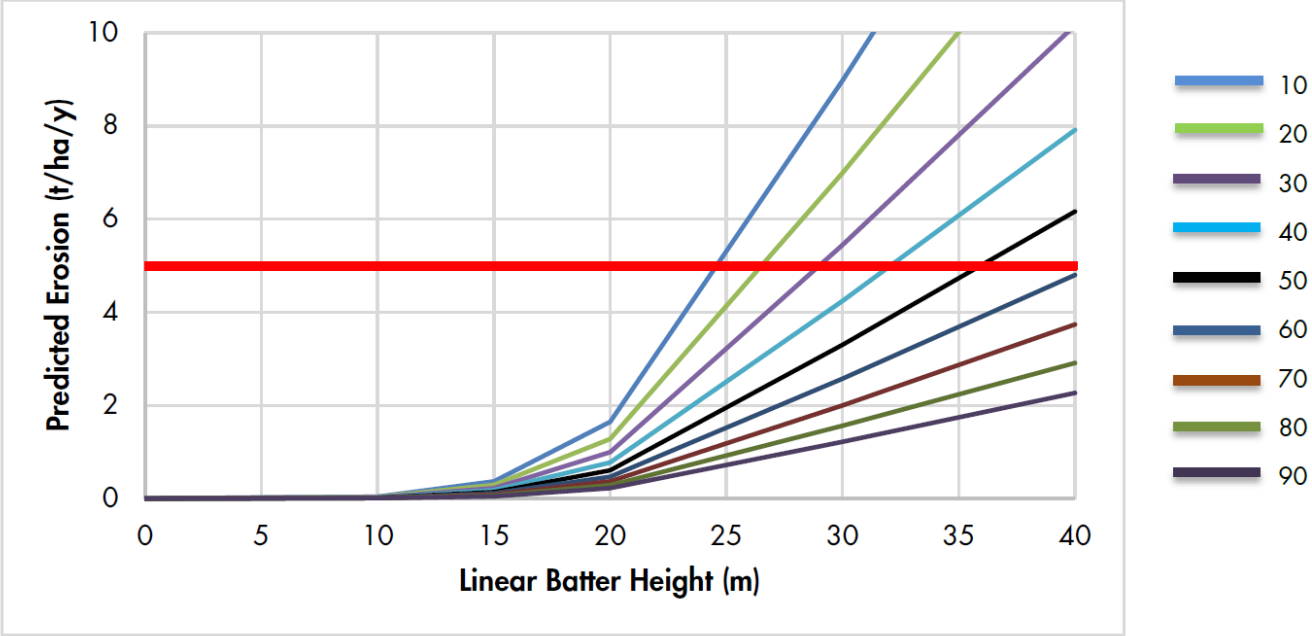
Batter Height (m)	Batter Gradient (°)	Dales Gorge 1	Dales Gorge 3A	Dales Gorge 3B	McRae Shale	Scree A	Scree B	Topsoil	Topsoil & Dales Gorge 1	Topsoil & Dales Gorge 3	Topsoil & Scree
10	12	100	90	40	80	40	45	35	50	10	45
10	15	100	100	50	90	40	45	35	60	20	45
10	18	100	100	50	90	40	45	35	60	30	45
20	12	100	100	80	100	40	45	60	90	60	50
20	15	100	100	80	100	40	45	70	90	70	60
20	18	100	100	90	100	40	45	80	100	80	60
30	12	100	100	90	100	40	45	80	100	70	60
30	15	100	100	100	100	40	45	100	100	80	70
30	18	100	100	100	100	40	45	100	100	90	80
40	12	100	100	100	100	40	45	90	100	70	60
40	15	100	100	100	100	40	45	100	100	90	70
40	18	100	100	100	100	40	45	100	100	90	80

Note: Acceptable erosion rates are considered to be an average of <5 t/ha/y and a peak rate of <10 t/ha/y
Source: Landloch (2013a)

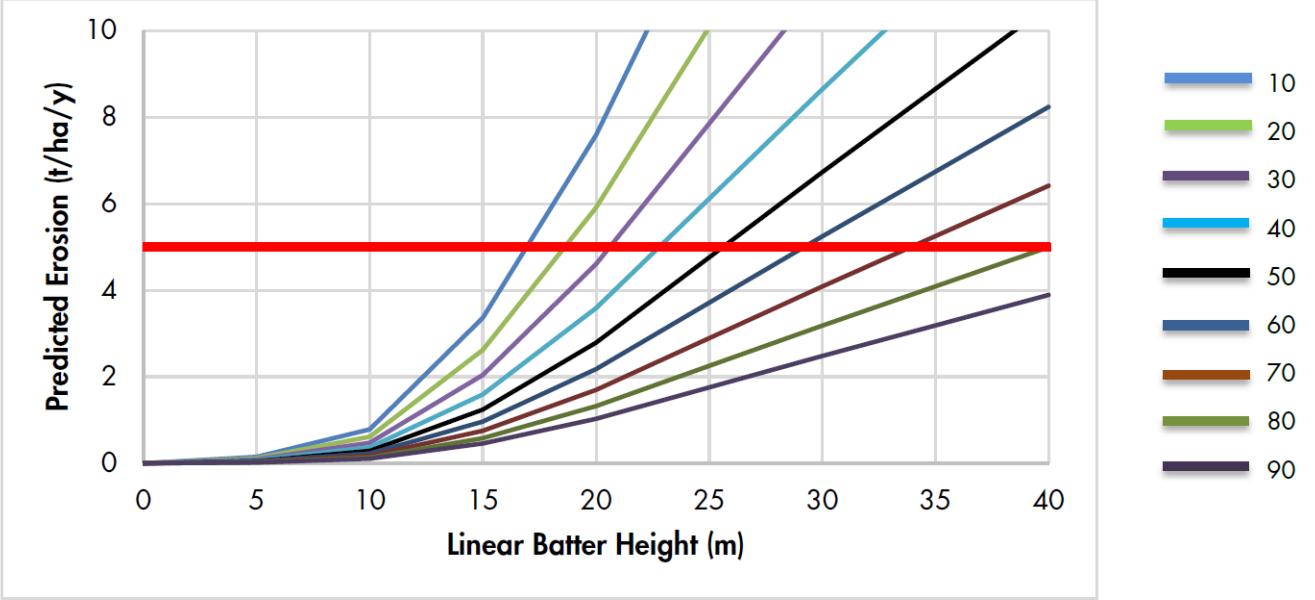
E-3. Jimblebar rock cover erosion modelling results



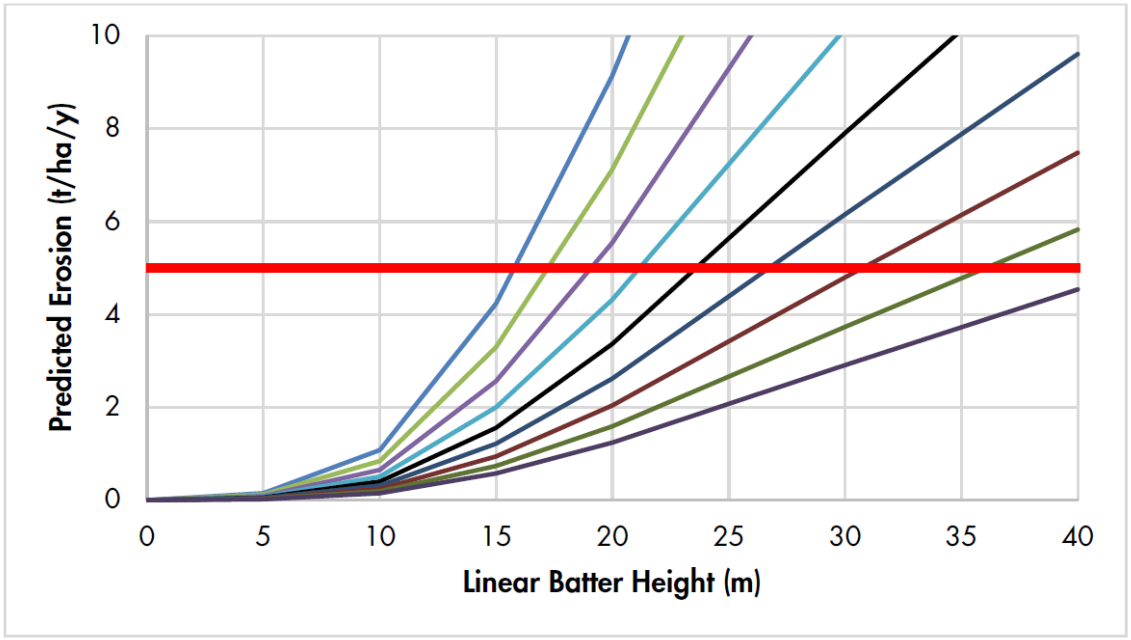
D3 material erosion results for a 15° single lineal batter slope with variable rock covers



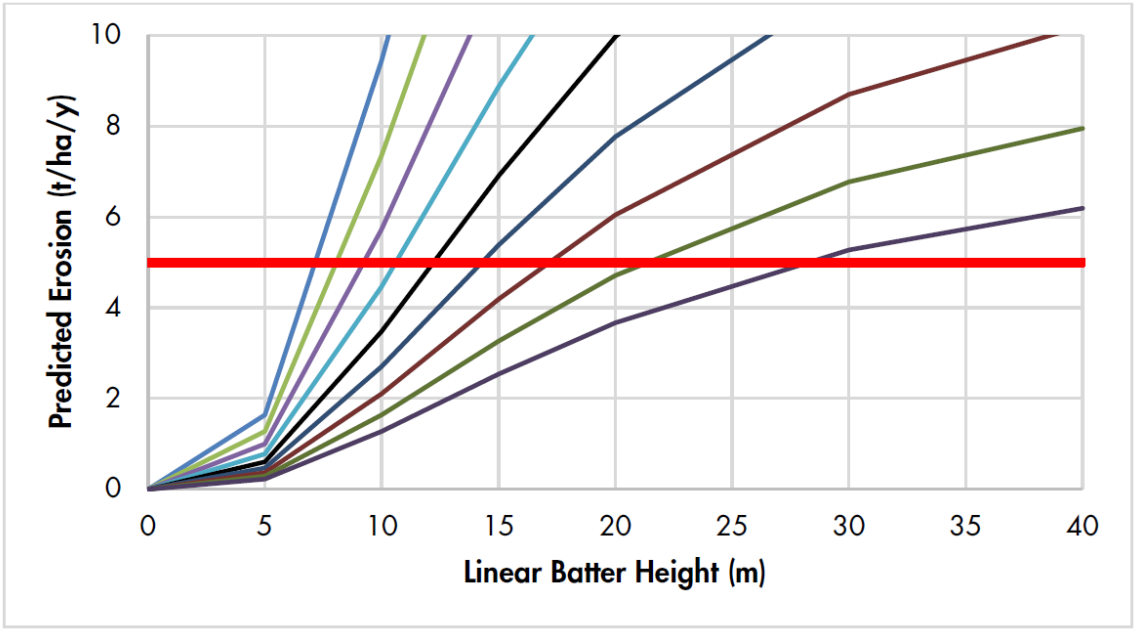
D3 material erosion results for a 18° single lineal batter slope with variable rock covers



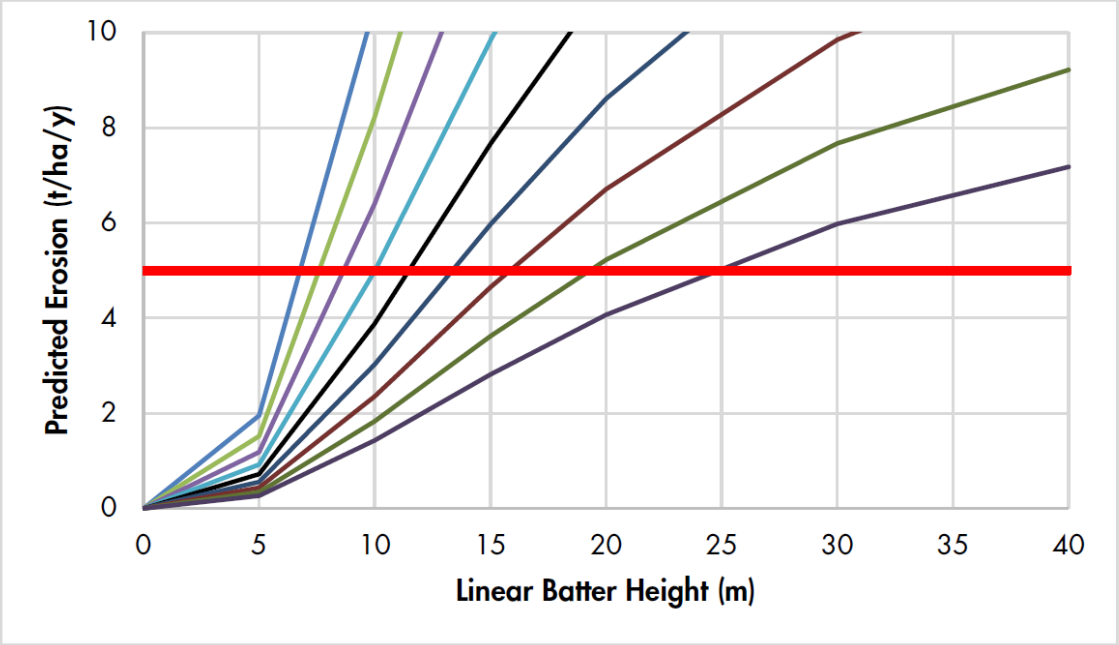
J2 material erosion results for a 15° single lineal batter slope with variable rock covers



J2 material erosion results for a 18° single lineal batter slope with variable rock covers



J6 material erosion results for a 15° single lineal batter slope with variable rock covers



J6 material erosion results for a 18° single lineal batter slope with variable rock covers

E-4. Geochemical characteristics of Jimblebar tailings

Tailings leachate and supernatant chemistry

The following pages are an extract from Golder (2022b) which record the analytical results for tailings leachate, supernatant, decant and process water.

Table D-3: Tailings leachates chemistry

Sample ID	Laboratory ID	Leaching Protocol	pH	EC	Cl	SO_4	F	Carbonate Alkalinity	Bicarbonate Alkalinity	Total Alkalinity	Ca	Mg	Na	K	NO_2 as N	NO_3 as N	NH_4 as N	TKN As N	Total N as N	Reactive P as P	Total P as P
			pH Units	µS/cm	mg/L	mg/L	mg/L	mg/L $CaCO_3$	mg/L $CaCO_3$	mg/L $CaCO_3$	mg/L	mg/L	mg/L	mg/L	mgN/L	mgN/L	mgN/L	mgN/L	mgN/L	mgP/L	mgP/L
Shovelanna Trigger Value			6.0-8.5	670-1800	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
P2 Blend	EB2226852001	1:2 (S:L) DI Water Leach	7.36	176	23	13	0.9	<1	28	28	8	3	25	3	<0.01	<0.01	<0.01	<0.1	<0.1	<0.01	<0.01
High Joffre	EB2226852002		7.48	163	21	14	0.9	<1	36	36	7	3	26	2	<0.01	<0.01	0.02	<0.1	<0.1	<0.01	<0.01
High Marra Mamba	EB2226852003		7.63	179	21	13	1	<1	32	32	8	3	26	3	<0.01	<0.01	<0.01	<0.1	<0.1	<0.01	<0.01
Average Blend	EB2226852004		7.65	164	23	13	0.9	<1	48	48	7	3	24	2	<0.01	<0.01	<0.01	<0.1	<0.1	<0.01	<0.01
High Dales	EB2226852005		7.59	165	25	13	0.9	<1	26	26	7	3	24	2	<0.01	<0.01	<0.01	<0.1	<0.1	<0.01	<0.01
P2 Blend	EB2226852008	1:2 (S:L) Saline (2 g/L) Leach	7.44	*3290*	997	16	0.7	<1	36	36	24	6	588	9	<0.01	<0.01	<0.01	<0.1	<0.1	<0.01	<0.01
High Joffre	EB2226852009		7.49	*3380*	1030	14	0.6	<1	51	51	28	8	588	9	<0.01	<0.01	0.03	<0.1	<0.1	<0.01	<0.01
High Marra Mamba	EB2226852010		7.52	*3310*	998	14	0.7	<1	37	37	24	6	574	8	<0.01	0.01	<0.01	<0.1	<0.1	<0.01	<0.01
Average Blend	EB2226852011		7.48	*3380*	1020	13	0.7	<1	39	39	26	7	577	8	<0.01	0.02	0.01	<0.1	<0.1	<0.01	<0.01
High Dales	EB2226852012		7.47	*3290*	999	14	0.7	<1	29	29	24	6	568	8	<0.01	<0.01	<0.01	<0.1	<0.1	<0.01	<0.01
P2 Blend	EB2226852013	1:2 (S:L) Saline (10 g/L) Leach	7.34	*14700*	5060	24	0.7	<1	37	37	45	9	2880	15	<0.01	0.01	0.02	<0.1	<0.1	<0.01	0.02
High Joffre	EB2226852014		7.39	*15000*	5130	16	0.5	<1	31	31	55	11	2980	17	<0.01	<0.01	<0.01	<0.5	<0.5	<0.01	<0.05
High Marra Mamba	EB2226852015		7.4	*14900*	5100	15	0.6	<1	37	37	42	8	2940	14	<0.01	<0.01	<0.01	<0.5	<0.5	<0.01	<0.05
Average Blend	EB2226852016		7.41	*15200*	5130	15	0.5	<1	32	32	49	10	3030	16	<0.01	<0.01	<0.01	<0.5	<0.5	<0.01	<0.05
High Dales	EB2226852017		7.39	*14900*	5050	18	0.6	<1	41	41	46	9	2970	14	<0.01	<0.01	<0.01	<0.5	<0.5	<0.01	<0.05
P2 Blend	EB2226852018	NAG Liquor	6.13	120	<1	1	0.3	<1	8	8	1	<1	22	<1	<1	<10	<10	<0.5	<10	<0.5	<0.05
High Joffre	EB2226852019		6.11	120	<1	2	0.3	<1	7	7	1	<1	23	<1	<1	<10	<10	<0.5	<10	<0.5	<0.05
High Marra Mamba	EB2226852020		6.18	113	<1	<1	0.4	<1	8	8	1	<1	21	<1	<1	<10	<10	<0.1	<10	<0.5	0.03
Average Blend	EB2226852021		6.09	125	<1	<1	0.3	<1	8	8	1	<1	23	<1	<1	<10	<10	<0.1	<10	<0.5	0.01
High Dales	EB2226852022		6.16	118	<1	1	0.4	<1	7	7	1	<1	22	<1	<1	<10	<10	<0.1	<10	<0.5	0.01

Note: NG = no guideline.

Values highlighted exceed the TVs.

Values in italics are expected to exceed TV due to the saline leach.

Table D-4: Tailings leachates metal(loid)s

Sample ID	Laboratory ID	Leaching Protocol	Ag	Al	As	B	Ba	Be	Bi	Cd	Co	Cr	Cu	Fe	Hg	Mn	Mo
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Shovelanna Trigger Value			0.00005	0.055	0.013	0.61	0.01	NG	NG	0.0002	NG	0.01	0.01	0.1	0.0006	1.9	NG
P2 Blend	EB2226852001	ASLP(1:2) DI Water Leach	<0.0001	<0.005	<0.0002	0.027	0.107	<0.0001	<0.00005	<0.00005	<0.0001	<0.0002	<0.0005	<0.002	<0.00004	0.0105	0.0003
High Joffre	EB2226852002		<0.0001	0.204	<0.0002	0.046	0.125	<0.0001	<0.00005	<0.00005	<0.0001	<0.0002	<0.0005	0.098	<0.00004	0.0032	0.0003
High Marra Mamba	EB2226852003		<0.0001	0.034	<0.0002	0.026	0.113	<0.0001	<0.00005	<0.00005	<0.0001	0.0009	<0.0005	0.033	<0.00004	0.0017	0.0004
Average Blend	EB2226852004		<0.0001	0.021	<0.0002	0.027	0.116	<0.0001	<0.00005	<0.00005	<0.0001	<0.0002	<0.0005	0.038	<0.00004	0.0009	0.0004
High Dales	EB2226852005		<0.0001	<0.005	<0.0002	0.026	0.104	<0.0001	<0.00005	<0.00005	<0.0001	<0.0002	<0.0005	0.013	<0.00004	0.0022	0.0004
P2 Blend	EB2226852001	ASLP(1:2) Saline (2 g/L) Leach	<0.0001	<0.005	<0.0002	0.02	0.319	<0.0001	<0.00005	<0.00005	<0.0001	<0.0002	<0.0005	<0.002	<0.00004	0.0301	0.0003
High Joffre	EB2226852002		<0.0001	0.008	<0.0002	0.028	0.361	<0.0001	<0.00005	<0.00005	<0.0001	<0.0002	<0.0005	0.005	<0.00004	0.0119	0.0003
High Marra Mamba	EB2226852003		<0.0001	<0.005	<0.0002	0.023	0.336	<0.0001	<0.00005	<0.00005	<0.0001	0.0004	<0.0005	0.004	<0.00004	0.0008	0.0004
Average Blend	EB2226852004		<0.0001	0.047	0.0007	0.035	0.365	<0.0001	0.00008	<0.00005	0.0003	0.0028	0.0042	0.059	<0.00004	0.0061	0.0006
High Dales	EB2226852005		<0.0001	0.006	<0.0002	0.028	0.315	<0.0001	<0.00005	<0.00005	<0.0001	0.0003	<0.0005	0.004	<0.00004	0.0068	0.0003
P2 Blend	EB2226852001	ASLP(1:2) Saline (10 g/L) Leach	<0.0002	<0.005	<0.0002	0.11	1.4	<0.0002	<0.00010	0.00014	<0.0002	0.0002	<0.0005	<0.002	<0.00004	0.0654	0.0002
High Joffre	EB2226852002		<0.0002	<0.005	<0.0002	<0.005	0.942	<0.0002	<0.00010	<0.00005	<0.0002	<0.0002	<0.0005	0.004	<0.00004	0.0284	0.0003
High Marra Mamba	EB2226852003		<0.0002	<0.005	<0.0002	<0.005	0.889	<0.0002	<0.00010	<0.00005	<0.0002	0.0003	<0.0005	0.011	<0.00004	0.0013	0.0004
Average Blend	EB2226852004		0.001	0.08	0.0004	<0.005	0.998	<0.0002	<0.00010	<0.00005	0.0009	0.0176	0.0007	0.158	<0.00004	0.0225	0.003
High Dales	EB2226852005		<0.0002	0.01	<0.0002	<0.005	0.846	<0.0002	<0.00010	<0.00005	<0.0002	0.0004	<0.0005	0.02	<0.00004	0.014	0.0005
P2 Blend	EB2226852001	NAG Liquor	<0.0005	<0.005	<0.0005	<0.005	0.0617	<0.0005	<0.00025	<0.00005	<0.0005	0.0499	<0.0005	0.005	<0.00040	0.0017	0.0024
High Joffre	EB2226852002		<0.0005	<0.005	<0.0005	0.061	0.0735	<0.0005	<0.00025	<0.00005	<0.0005	0.0607	<0.0005	<0.005	<0.00040	<0.0005	0.0043
High Marra Mamba	EB2226852003		<0.0001	<0.005	<0.0002	0.044	0.0551	<0.0001	<0.00005	<0.00005	<0.0001	0.045	<0.0005	0.006	<0.00004	<0.0005	0.0025
Average Blend	EB2226852004		<0.0001	<0.005	<0.0002	0.033	0.0634	<0.0001	<0.00005	<0.00005	<0.0001	0.0582	<0.0005	<0.002	<0.00004	0.0006	0.0032
High Dales	EB2226852005		<0.0001	0.008	<0.0002	0.036	0.0626	<0.0001	<0.00005	<0.00005	<0.0001	0.054	<0.0005	0.007	<0.00004	0.001	0.0027

Note: NG = no guideline

Values in exceedance of TV are highlighted.

Ba and Sr may have increased due to contaminants in saline solution

Sample ID	Laboratory ID	Leaching Protocol	Ni	Pb	Sb	Se	Si	Sr	Tl	Th	Sn	U	V	W	Zn	Zr
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Shovelanna Trigger Values			0.011	0.0034	0.001	0.011	NG	NG	NG	NG	0.001	NG	NG	NG	0.024	NG
P2 Blend	EB2226852001	$ASLP_{(1:2)}$ DI Water Leach	<0.0005	<0.0001	<0.0002	0.0004	5.33	0.048	0.00006	<0.1	<0.0002	<0.00005	<0.2	<0.001	0.001	<0.005
High Joffre	EB2226852002		<0.0005	0.0002	<0.0002	0.0005	6.98	0.049	<0.00002	<0.1	<0.0002	<0.00005	0.4	<0.001	0.028	<0.005
High Marra Mamba	EB2226852003		0.0019	0.0001	<0.0002	0.0003	5.19	0.053	0.00002	<0.1	<0.0002	<0.00005	<0.2	<0.001	0.006	<0.005
Average Blend	EB2226852004		<0.0005	<0.0001	<0.0002	0.0004	6.23	0.047	0.00002	<0.1	<0.0002	<0.00005	<0.2	<0.001	0.005	<0.005
High Dales	EB2226852005		<0.0005	<0.0001	<0.0002	0.0004	5.19	0.046	0.00003	<0.1	<0.0002	<0.00005	<0.2	<0.001	0.002	<0.005
P2 Blend	EB2226852001	$ASLP_{(1:2)}$ Saline (2 g/L) Leach	<0.0005	<0.0001	<0.0002	0.0006	5.34	0.173	0.00018	<0.1	<0.0002	<0.00005	<0.2	<0.001	0.002	<0.005
High Joffre	EB2226852002		<0.0005	<0.0001	<0.0002	0.0006	7.16	0.23	0.00007	<0.1	<0.0002	<0.00005	<0.2	<0.001	0.008	<0.005
High Marra Mamba	EB2226852003		0.0008	<0.0001	<0.0002	0.0003	5.27	0.196	0.00008	<0.1	<0.0002	<0.00005	<0.2	<0.001	0.003	<0.005
Average Blend	EB2226852004		0.009	0.0017	<0.0002	0.0005	6.46	0.222	0.00009	<0.1	<0.0002	<0.00005	0.4	<0.001	0.012	<0.005
High Dales	EB2226852005		0.0009	<0.0001	<0.0002	0.0006	5.56	0.19	0.00012	<0.1	<0.0002	<0.00005	<0.2	<0.001	0.002	<0.005
P2 Blend	EB2226852001	$ASLP_{(1:2)}$ Saline (10 g/L) Leach	<0.0005	<0.0002	<0.0002	0.0006	5.82	0.363	0.00031	<0.2	0.0003	<0.00010	<0.2	<0.001	0.154	<0.005
High Joffre	EB2226852002		<0.0005	<0.0002	<0.0002	0.0008	7.5	0.499	0.0002	<0.2	<0.0002	<0.00010	<0.2	<0.001	0.009	<0.005
High Marra Mamba	EB2226852003		0.0009	<0.0002	<0.0002	0.0004	5.61	0.379	0.00023	<0.2	0.0003	<0.00010	<0.2	<0.001	0.005	<0.005
Average Blend	EB2226852004		0.0063	0.0007	0.0062	0.0007	6.72	0.477	0.00034	<0.2	0.0006	<0.00010	0.3	<0.001	0.018	<0.005
High Dales	EB2226852005		0.001	<0.0002	<0.0002	0.0007	5.83	0.394	0.00032	<0.2	<0.0002	<0.00010	<0.2	<0.001	0.005	<0.005
P2 Blend	EB2226852001	NAG Liquor	<0.0005	<0.0005	<0.0005	<0.0005	9.18	0.008	<0.00010	<0.5	<0.0005	<0.00025	13.2	0.003	0.005	<0.005
High Joffre	EB2226852002		<0.0005	<0.0005	<0.0005	0.0006	12.1	0.012	<0.00010	<0.5	<0.0006	<0.00025	13.8	0.001	<0.002	<0.005
High Marra Mamba	EB2226852003		<0.0005	<0.0001	<0.0002	0.0003	8.76	0.009	<0.00002	<0.1	<0.0002	<0.00005	7.6	<0.001	0.004	<0.005
Average Blend	EB2226852004		<0.0005	<0.0001	<0.0002	0.0004	10.4	0.01	<0.00002	<0.1	<0.0002	<0.00005	11.5	<0.001	0.002	<0.005
High Dales	EB2226852005		<0.0005	0.0004	<0.0002	0.0003	8.09	0.009	<0.00002	<0.1	<0.0002	<0.00005	9.9	<0.001	0.003	<0.005

Notes: *NG = no guideline

Values in exceedance of TV are highlighted.

Table D-5: Tailings associated (supernatant) water, Process and Decant water total metal(loid)s

Sample ID	Al	B	Ba	Ca	Cu	Fe	K	Mg	Mn	Mo	Na	Ni	Pb	Si	Se	Sr	U	Zn
	mg/L (% inc.)	mg/L (% inc.)	mg/L (% inc.)	mg/L (% inc.)	mg/L (% inc.)	mg/L (% inc.)	mg/L (% inc.)	mg/L (% inc.)	mg/L (% inc.)	mg/L (% inc.)	mg/L (% inc.)	mg/L (% inc.)	mg/L (% inc.)	mg/L (% inc.)	mg/L (% inc.)	mg/L (% inc.)	mg/L (% inc.)	mg/L (% inc)
P2 Blend	0.010 (300%)	0.057 (-12%)	0.095 (-9%)	31 (3%)	<0.0005	0.008 (88%)	8 (-11%)	12 (-8%)	0.017 (14%)	0.0002 (-300%)	94 (-14%)	<0.0005	<0.0001	6.08 (-3%)	0.0008 (-50%)	0.177 (3%)	0.00009 (33%)	0.009 (78%)
High Joffre	0.009 (260%)	0.041 (-27%)	0.081 (-7%)	27 (8%)	0.001 (30%)	<0.002	8 (0%)	10 (0%)	0.021 (-10%)	0.0003 (0%)	95 (-12%)	<0.0005	<0.0001	6.23 (-2%)	0.0005 (-60%)	0.148 (-1%)	0.00013 (23%)	0.005 (0%)
High Marra Mamba	0.008 (220%)	0.048 (6%)	0.084 (22%)	26 (8%)	0.002 (33%)	0.011 (91%)	8 (0%)	10 (0%)	<0.0005	0.0005 (-60%)	96 (-9%)	<0.0005	0.0001 (50%)	4.58 (0%)	0.0006 (0%)	0.156 (10%)	0.00009 (11%)	0.014 (21%)
Average Blend	0.007 (180%)	0.042 (-19%)	0.080 (-10%)	27 (8%)	0.001 (75%)	<0.002	8 (0%)	10 (0%)	0.0006 (58%)	0.0005 (-40%)	97 (-9%)	<0.0005	0.0006 (92%)	5.88 (1%)	0.0005 (-80%)	0.154 (3%)	0.00033 (79%)	0.003 (33%)
High Dales	0.008 (220%)	0.046 (-17%)	0.087 (-7%)	28 (12%)	0.006 (22%)	0.003 (67%)	8 (0%)	10 (0%)	<0.0005	0.0005 (-40%)	97 (-8%)	0.0005 (-20%)	0.0004 (50%)	5.10 (-4%)	0.0006 (-67%)	0.153 (1%)	0.00013 (38%)	0.016 (6%)
Process water	0.010 (43%)	0.329 (-19%)	0.007 (-19%)	11 (10%)	0.002 (-6%)	0.006 (83%)	11 (-8%)	60 (3%)	<0.0005	0.0009 (-44%)	135 (-3%)	0.0006 (-0%)	<0.0001	6.68 (-1%)	0.0003 (-100%)	0.043 (12%)	0.00013 (8%)	0.007 (-29%)
Decanted water	0.087 (40%)	0.050 (-24%)	0.114 (-7%)	28 (8%)	0.003 (36%)	0.002 (50%)	8 (-11%)	9 (13%)	0.005 (-4%)	0.0005 (-120%)	105 (-3%)	<0.0005	<0.0001	4.59 (-4%)	0.0004 (-25%)	0.158 (1%)	0.00019 (32%)	0.005 (0%)

Note: % increase calculated from dissolved concentration (**Error! Reference source not found.**) to total concentration. Where dissolved concentration was below limit of reporting (LOR), 50% of the LOR was used to calculate % increase.

Table D-6: Results for tailings supernatant chemistry (dissolved)

Sample ID	Laboratory ID	pH	EC	Redox Potential	Cl	SO_4	F	Carbonate Alkalinity	Bicarbonate Alkalinity	Total Alkalinity	Ca	Mg	K	Na	NO_2 as N	NO_3 as N	NH_4 as N	TKN as N	Total N as N	Reactive P as P	Total P as P
		pH Units	µS/cm	mV	mg/L	mg/L	mg/L	mg/L $CaCO_3$	mg/L $CaCO_3$	mg/L $CaCO_3$	mg/L	mg/L	mg/L	mg/L	mgN/L	mgN/L	mgN/L	mgN/L	mgN/L	mgP/L	mgP/L
Shovelanna Trigger Values		**6.0-8.5**	**670-1800**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**
P2 Blend	EB2226852001	7.94	839	172	219	45	0.8	<1	64	64	30	9	13	109	<0.01	0.12	<0.01	<0.1	0.1	<0.01	<0.01
High Joffre	EB2226852002	8.03	784	191	199	39	0.9	<1	78	78	25	8	10	108	<0.01	0.09	<0.01	<0.1	<0.1	<0.01	<0.01
High Marra Mamba	EB2226852003	8	775	201	197	39	1	<1	67	67	24	8	10	106	<0.01	0.18	<0.01	<0.1	0.2	<0.01	<0.01
Average Blend	EB2226852004	8.04	780	208	194	39	1	<1	72	72	25	8	10	107	<0.01	0.14	<0.01	<0.1	0.1	<0.01	<0.01
High Dales	EB2226852005	8.03	772	210	215	40	1	<1	66	66	25	8	10	105	<0.01	0.09	<0.01	0.1	0.2	<0.01	<0.01
Process water	EB2228231006	8.35	1200	204	243	148	0.5	4	127	131	10	12	58	139	<0.01	<0.01	<0.01	0.2	0.2	<0.01	<0.01
Decanted water	EB2228231007	8.09	789	212	205	30	1	<1	63	63	26	9	8	108	0.02	0.12	<0.01	<0.1	0.1	<0.01	<0.01
Process Water		**8.30**	**-**	**-**	**350**	**378**	**-**	-	**-**	**164.46**	**95.5**	**114.31**	**9.38**	**136.77**	**-**	**-**	-	-	**11.12**	-	**2.31**

Note: NG = no guideline; Values highlighted exceed the TVs; NO_2 = Nitrite; NO_3 = Nitrate; NH_4 = Ammonia; TKN = Total Kjedahl Nitrogen; N = Nitrogen; P = Phosphorus

Table D-7: Results for tailings supernatant metal(loid)s (dissolved)

Sample ID	Laboratory ID	Ag	Al	As	B	Ba	Be	Bi	Cd	Co	Cr	Cu	Fe	Hg	Mn
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Shovelanna Trigger Values		**0.00005**	**0.055**	**0.013**	**0.61**	**0.01**	**NG**	**NG**	**0.0002**	**NG**	**0.01**	**0.01**	**0.1**	**0.0006**	**1.9**
P2 Blend	EB2226852001	<0.0001	<0.005	<0.0002	0.064	0.104	<0.0001	<0.00005	<0.00005	<0.0001	<0.0002	<0.0005	<0.002	<0.00004	0.0147
High Joffre	EB2226852002	<0.0001	<0.005	<0.0002	0.052	0.087	<0.0001	<0.00005	<0.00005	<0.0001	<0.0002	0.0007	<0.002	<0.00004	0.0231
High Marra Mamba	EB2226852003	<0.0001	<0.005	<0.0002	0.045	0.0685	<0.0001	<0.00005	<0.00005	<0.0001	<0.0002	0.0014	<0.002	<0.00004	<0.5
Average Blend	EB2226852004	<0.0001	<0.005	<0.0002	0.05	0.0897	<0.0001	<0.00005	<0.00005	<0.0001	<0.0002	<0.5	<0.002	<0.00004	<0.5
High Dales	EB2226852005	<0.0001	<0.005	0.0003	0.054	0.0937	<0.0001	<0.00005	<0.00005	<0.0001	<0.0002	0.0045	<0.002	<0.00004	<0.5
Process water	EB2228231006	<0.0001	0.007	0.0002	0.39	0.0085	<0.0001	<0.00005	<0.00005	<0.0001	0.0009	0.0017	<0.002	<0.00004	<0.5
Decanted water	EB2228231007	<0.0001	0.062	<0.0002	0.062	0.123	<0.0001	<0.00005	<0.00005	<0.0001	<0.0002	0.0016	<0.002	<0.00004	0.0047
Process Water		**0.001**	**13.0**	**0.00561**	**0.222**	**0.0340**	**0.0016**	**0.001**	**0.0001**	**0.0323**	**0.0257**	**0.0343**	**36.31**		**0.939**

Sample ID	Laboratory ID	Mo	Ni	Pb	Sb	Se	Si	Sr	Tl	Th	Sn	U	V	W	Zn	Zr
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Shovelanna Trigger Values		**NG**	**0.011**	**0.0034**	**0.001**	**0.011**	**NG**	**NG**	**NG**	**NG**	**0.001**	**NG**	**NG**	**NG**	**0.024**	**NG**
P2 Blend	EB2226852001	0.0008	<0.0005	<0.0001	<0.0002	0.0012	6.27	0.171	0.00012	<0.0001	<0.0002	0.00006	<0.0002	<0.001	0.002	<0.005
High Joffre	EB2226852002	0.0003	<0.0005	<0.0001	<0.0002	0.0008	6.37	0.15	0.00003	<0.0001	<0.0002	0.0001	<0.0002	<0.001	0.005	<0.005
High Marra Mamba	EB2226852003	0.0008	<0.0005	<0.0001	<0.0002	0.0006	4.57	0.14	0.00004	<0.0001	<0.0002	0.00008	<0.0002	<0.001	0.011	<0.005
Average Blend	EB2226852004	0.0007	<0.0005	<0.0001	<0.0002	0.0009	5.85	0.15	0.00003	<0.0001	<0.0002	0.00007	<0.0002	<0.001	0.002	<0.005
High Dales	EB2226852005	0.0007	0.0006	0.0002	<0.0002	0.001	5.31	0.152	0.00004	<0.0001	<0.0002	0.00008	<0.0002	<0.001	0.015	<0.005
Process water	EB2228231006	0.0013	0.0008	<0.0001	<0.0002	0.0006	6.77	0.048	<0.02	<0.0001	<0.0002	0.00012	0.0003	<0.001	0.009	<0.005
Decanted water	EB2228231007	0.0011	<0.0005	<0.0001	<0.0002	0.0005	4.76	0.156	0.00005	<0.0001	<0.0002	0.00013	<0.0002	<0.001	0.005	<0.005
Process Water		**0.00215**	**0.0796**	**0.00184**	**0.001**	**0.0208**	**21.016**	**0.2395**	**-**	**-**	**0.001**	**0.00438**	**0.01308**	**0.001**	**0.1527**	**-**

Notes: *NG = no guideline; Values in exceedance of TV are highlighted.

Table D-8: Results for tailings supernatant chemistry (total)

Sample ID	Laboratory ID	pH	EC	Redox Potential	Cl	SO_4	F	Hydroxide Alkalinity	Carbonate Alkalinity	Bicarbonate Alkalinity	Total Alkalinity	Ca	Mg	Na	K	NH_4 as N	NO_2 as N	NO_3 as N	NO_2+NO_3 as N	TKN As N	Total N as N	Total P as P	Reactive p as P
		pH Units	µS/cm	mV	mg/L			mg/L $CaCO_3$	mg/L $CaCO_3$	mg/L $CaCO_3$	mg/L $CaCO_3$	mg/L	mg/L	mg/L	mg/L	mgN/L	mgN/L	mgN/L	mgN/L	mgN/L	mgN/L	mgP/L	mgP/L
P2 Blend	EB2226852001	Filtered-only										31	8	94	12	Filtered-only							
High Joffre	EB2226852002											27	8	95	10								
High Marra Mamba	EB2226852003											26	8	96	10								
Average Blend	EB2226852004											27	8	97	10								
High Dales	EB2226852005											28	8	97	10								
Process water	EB2228231006											11	11	135	60								
Decanted water	EB2228231007											28	8	105	9								
Process Water		8.30	-	-	350	378	-	-	-		164.46	95.5	114.31	9.38	136.77	-	-	-	-		11.12	-	2.31

Notes: NO_2 = Nitrite; NO_3 = Nitrate; NH_4 = Ammonia; TKN = Total Kjedahl Nitrogen; N = Nitrogen; P = Phosphorus

Table D-9: Results for tailings supernatant metal(loid)s (total)

Sample ID	Laboratory ID	Ag	Al	As	B	Ba	Be	Bi	Cd	Co	Cr	Cu	Fe	Hg	Mn
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Shovelanna Trigger Values		0.00005	0.055	0.013	0.61	0.01	NG	NG	0.0002	NG	0.01	0.01	0.1	0.0006	1.9
P2 Blend	EB2226852001	<0.0001	0.01	<0.0002	0.064	0.0946	<0.0001	<0.00005	<0.00005	<0.0001	<0.0002	<0.0005	0.008	<0.00004	0.0171
High Joffre	EB2226852002	<0.0001	0.009	<0.0002	0.052	0.0808	<0.0001	<0.00005	<0.00005	<0.0001	<0.0002	0.001	<0.002	<0.00004	0.021
High Marra Mamba	EB2226852003	<0.0001	0.008	0.0004	0.045	0.0835	<0.0001	<0.00005	<0.00005	<0.0001	<0.0002	0.0021	0.011	<0.00004	<0.0005
Average Blend	EB2226852004	<0.0001	0.007	0.0008	0.05	0.0803	0.001	0.00014	0.00056	0.0002	<0.0002	0.001	<0.002	<0.00004	0.0006
High Dales	EB2226852005	<0.0001	0.008	0.0004	0.054	0.0872	<0.0001	<0.00005	<0.00005	<0.0001	<0.0002	0.0058	0.003	<0.00004	<0.0005
Process water	EB2228231006	<0.0001	0.01	<0.0002	0.39	0.0069	<0.0001	<0.00005	<0.00005	<0.0001	0.0009	0.0016	0.006	<0.00004	<0.0005
Decanted water	EB2228231007	<0.0001	0.087	<0.0002	0.062	0.114	<0.0001	<0.00005	<0.00005	<0.0001	<0.0002	0.0025	0.002	<0.00004	0.0045
Process Water		**0.001**	**13.0**	**0.00561**	**0.222**	**0.0340**	**0.0016**	**0.001**	**0.0001**	**0.0323**	**0.0257**	**0.0343**	**36.31**	**-**	**0.939**

Sample ID	Laboratory ID	Mo	Ni	Pb	Sb	Se	Sr	Tl	Th	Sn	U	V	W	Zn	Zr
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Shovelanna Trigger Values		NG	0.011	0.0034	0.001	0.011	NG	NG	NG	0.001	NG	NG	NG	0.024	NG
P2 Blend	EB2226852001	0.0002	<0.0005	<0.0001	<0.0002	0.0008	0.177	0.00015	<0.0001	<0.0002	0.00009	<0.0002	<0.001	0.009	<0.005
High Joffre	EB2226852002	0.0003	<0.0005	<0.0001	<0.0002	0.0005	0.148	0.00004	<0.0001	<0.0002	0.00013	<0.0002	<0.001	0.005	<0.005
High Marra Mamba	EB2226852003	0.0005	<0.0005	0.0001	<0.0002	0.0006	0.156	0.00005	<0.0001	<0.0002	0.00009	<0.0002	<0.001	0.014	<0.005
Average Blend	EB2226852004	0.0005	<0.0005	0.0006	0.0006	0.0005	0.154	0.00033	0.0002	<0.0002	0.00033	<0.0002	<0.001	0.003	<0.005
High Dales	EB2226852005	0.0005	0.0005	0.0004	<0.0002	0.0006	0.153	0.00006	<0.0001	<0.0002	0.00013	<0.0002	<0.001	0.016	<0.005
Process water	EB2228231006	0.0009	0.0006	<0.0001	<0.0002	0.0003	0.043	<0.02	<0.0001	<0.0002	0.00013	0.0003	<0.001	0.007	<0.005
Decanted water	EB2228231007	0.0005	<0.0005	<0.0001	<0.0002	0.0004	0.158	0.00005	<0.0001	<0.0002	0.00019	<0.0002	<0.001	0.005	<0.005
Process Water		**0.00215**	**0.0796**	**0.00184**	**0.001**	**0.0208**	**0.2395**	**-**	**-**	**0.001**	**0.00438**	**0.01308**	**0.001**	**0.1527**	**-**

E-5. BHP construction fill definitions

BHP definitions of fill types suitable for flood bund construction are provided below. Material conforming to A4 (Clayey Gravel) is the preferred material for flood bund construction due to its low erodibility (high cohesion) and low permeability.

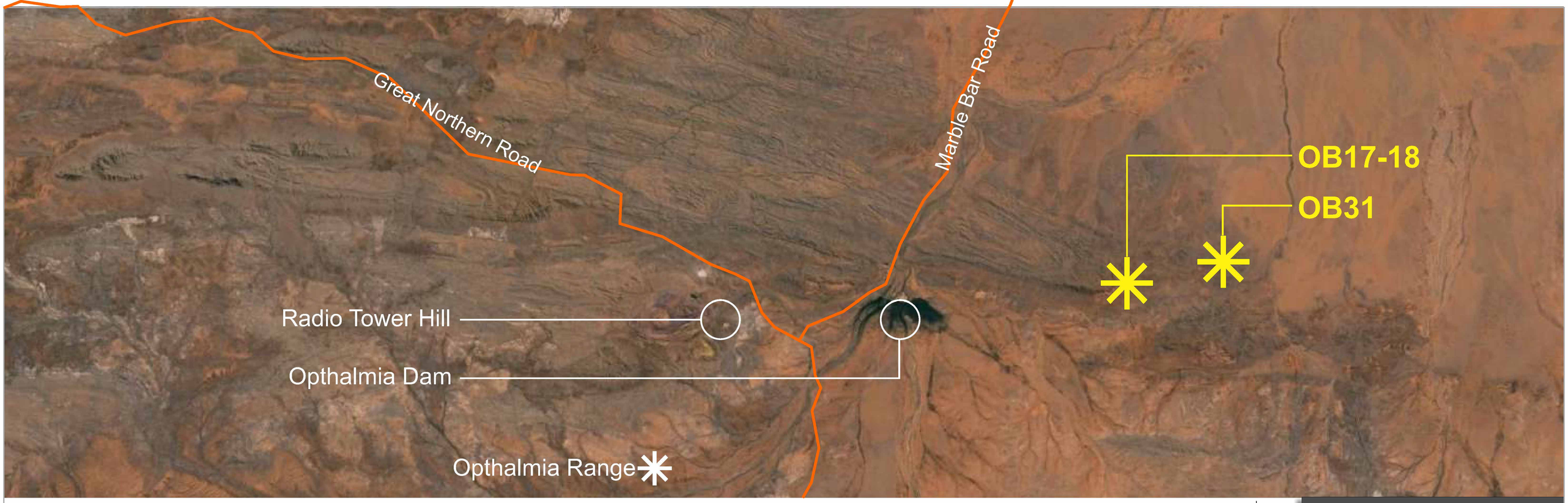
Fill Type	Definition
General C1	Includes Poorly Graded Sand (SP), Well Graded Sand (SW), Clayey Sand (SC), Silty Sand (SM), Poorly Graded Gravel (GP), Well Graded Gravel (GW), Clayey Gravel (GC) and Silty Gravel (GM). Some of these soils are more suitable than others, with GM and SM being least preferred due to higher erodibility; and GC and SC most preferred due to the clay content. General Fill (C1) also allows for some cobbles (up to 20% by weight >70 mm)
A2	Sandy gravel can be characterised as SP, SW, GP, or GW, which are coarse and have higher permeability. This material contains medium to coarse gravels, which offer good erosion resistance.
A4	Typically refers to Clayey Gravel (GC), but includes other soil types such as SC.

Source: RPS (2021)

Appendix F. WAIO closure & rehabilitation research & trials

This appendix is not publicly available. It is commercially sensitive and has been supplied separately.

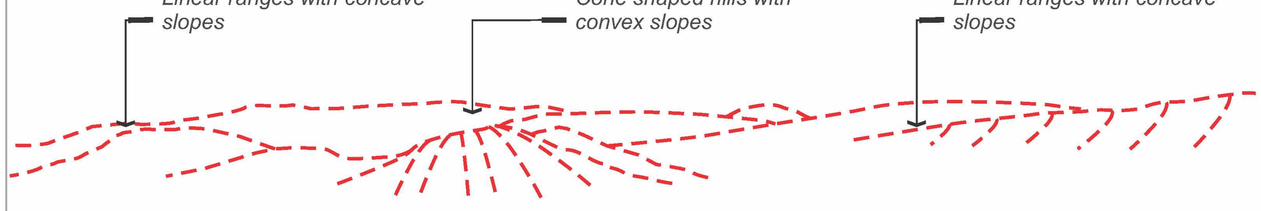
Appendix G. ERM Landform opportunities assessment



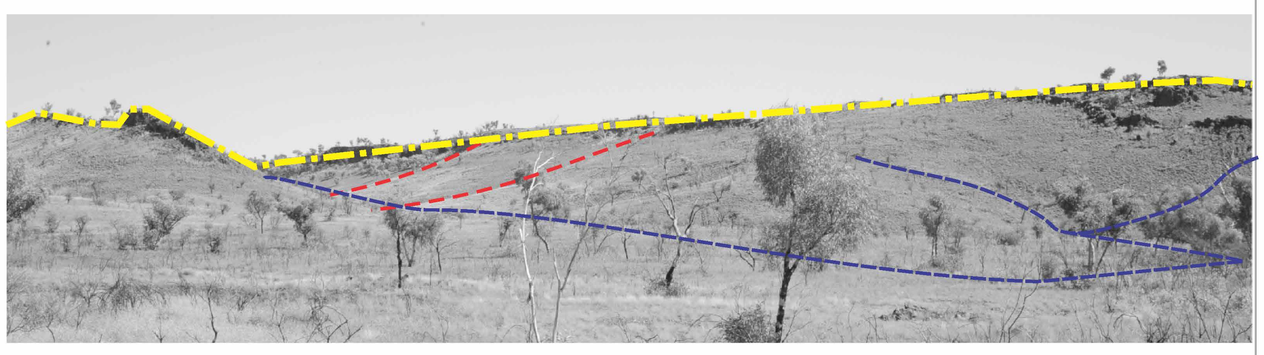
CONTEXT PLAN

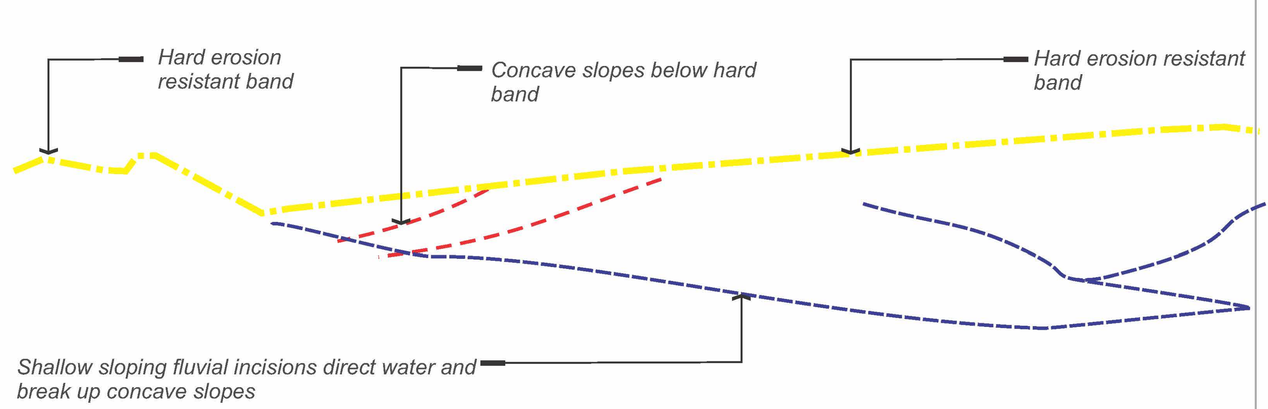
0 10 20km

Radio Tower Hill

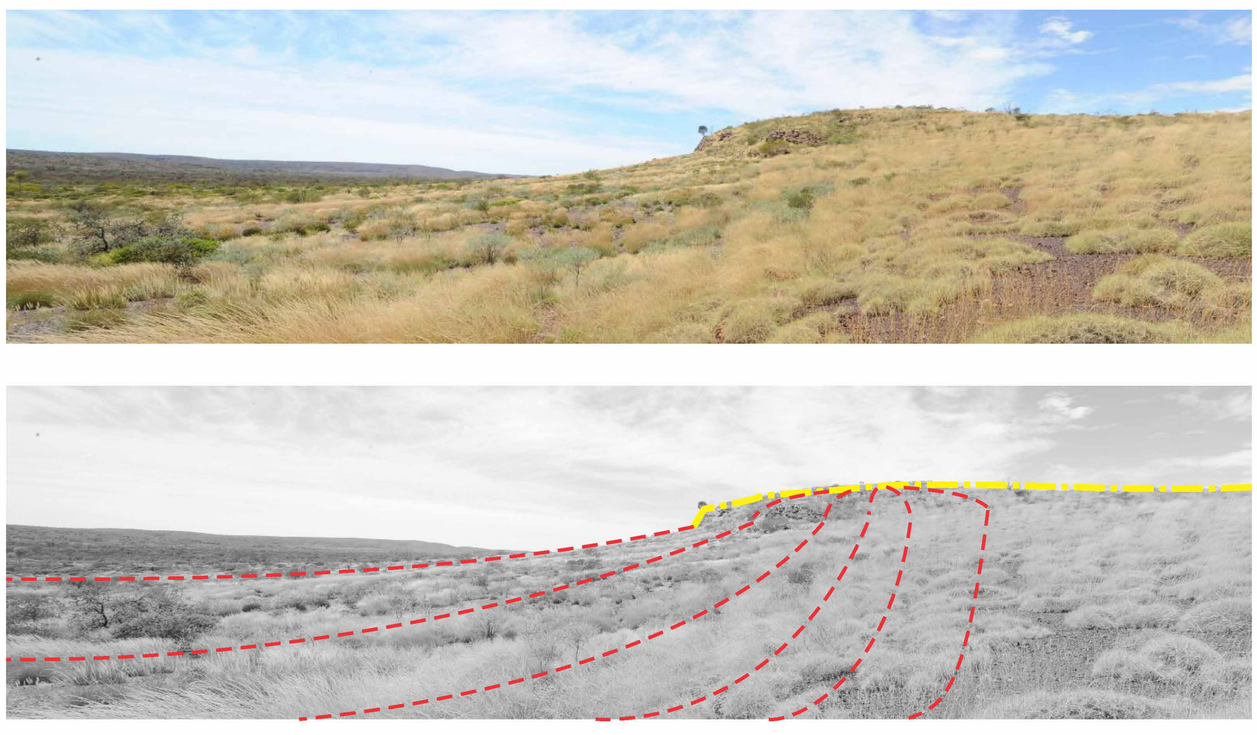


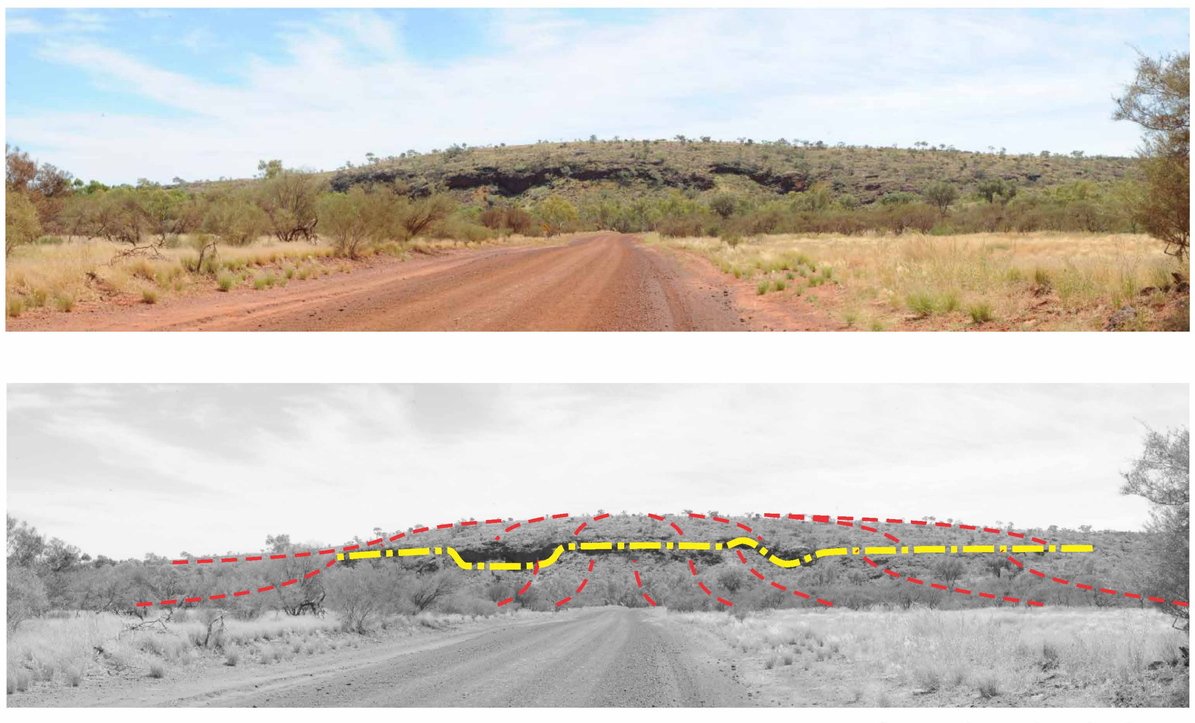
Opthalmia Range

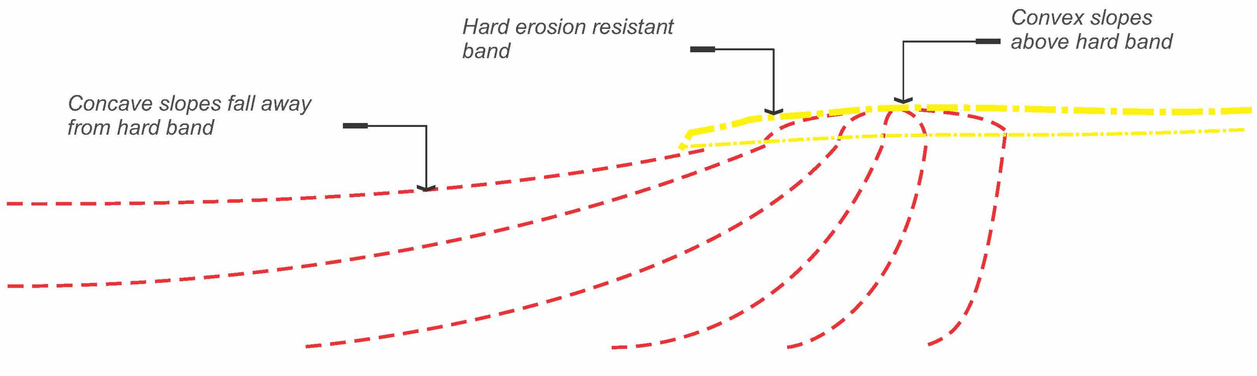


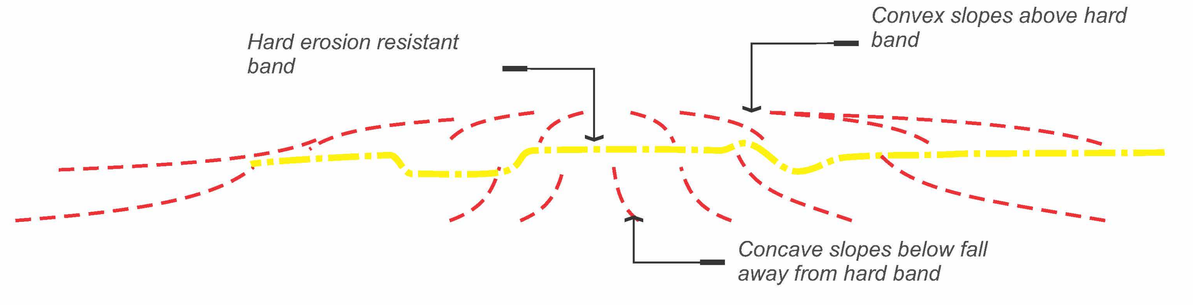


Opthalmia Dam









ANALOGUE SITES

OB17-18-31

PROJECT: BHPB IO MINE CLOSURE

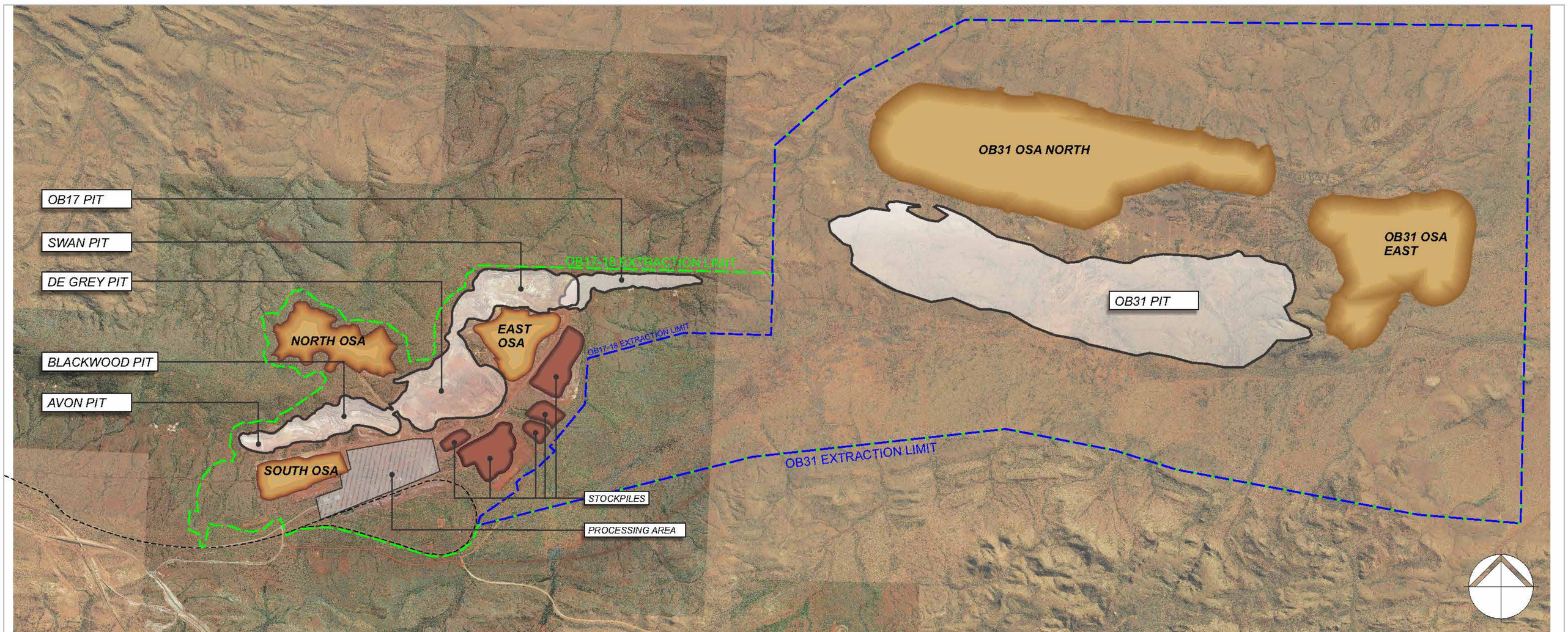
LANDFORM DESIGN

Drawn by: DC I Checked by: AW

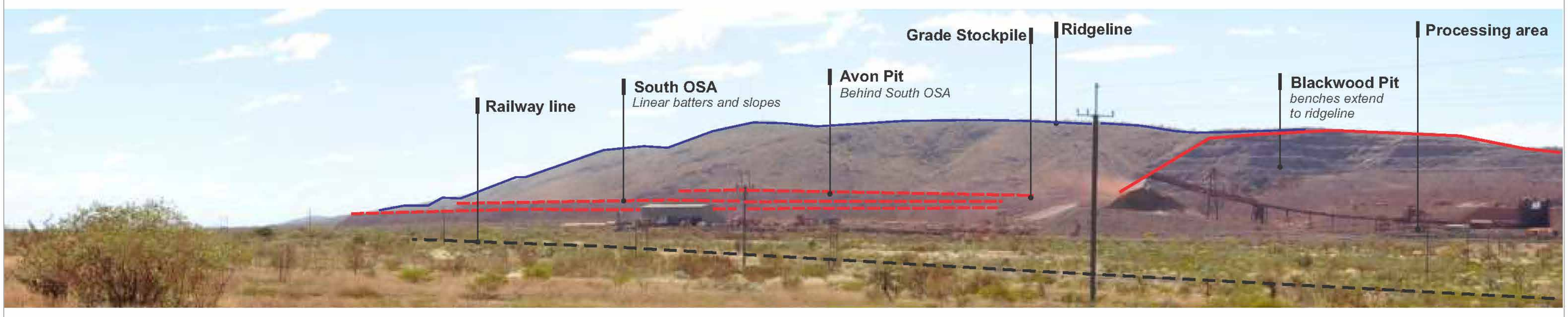
Date: November 2014 I DWG#: Ls1

bhpbilliton

ERM



South OSA



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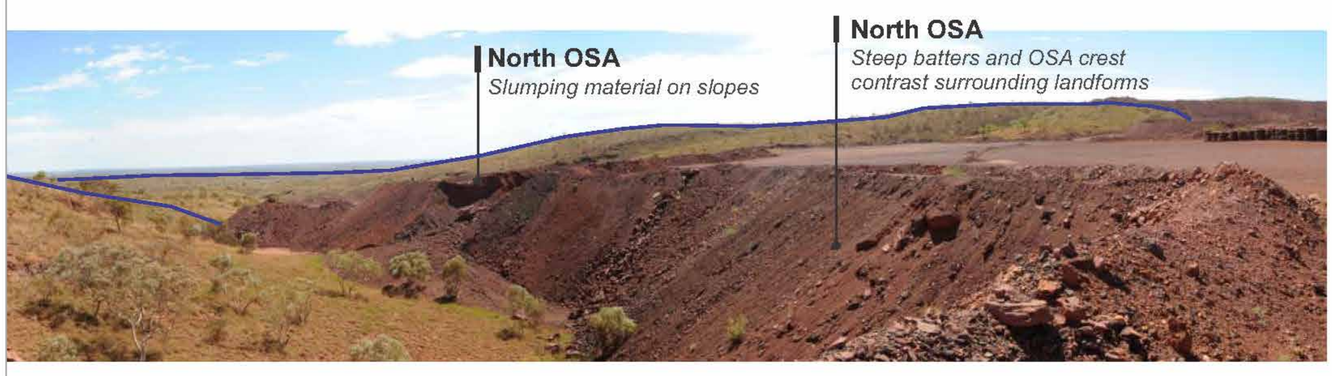
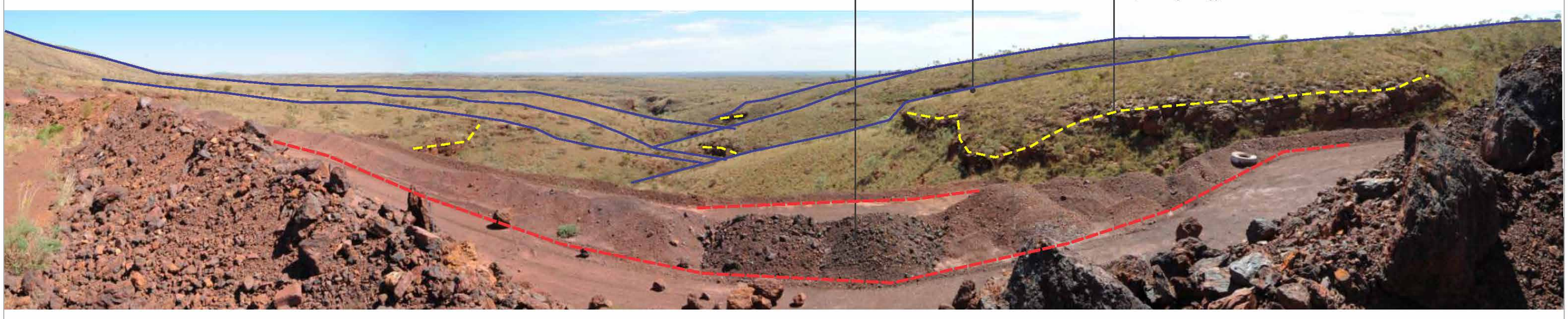
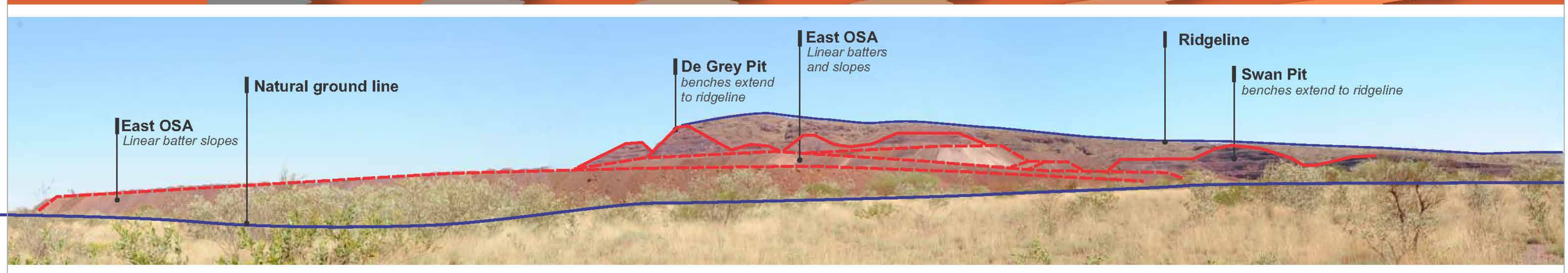




East OSA



SITE ANALYSIS - OSA's

OB17-18-31

PROJECT: BHPB IO MINE CLOSURE

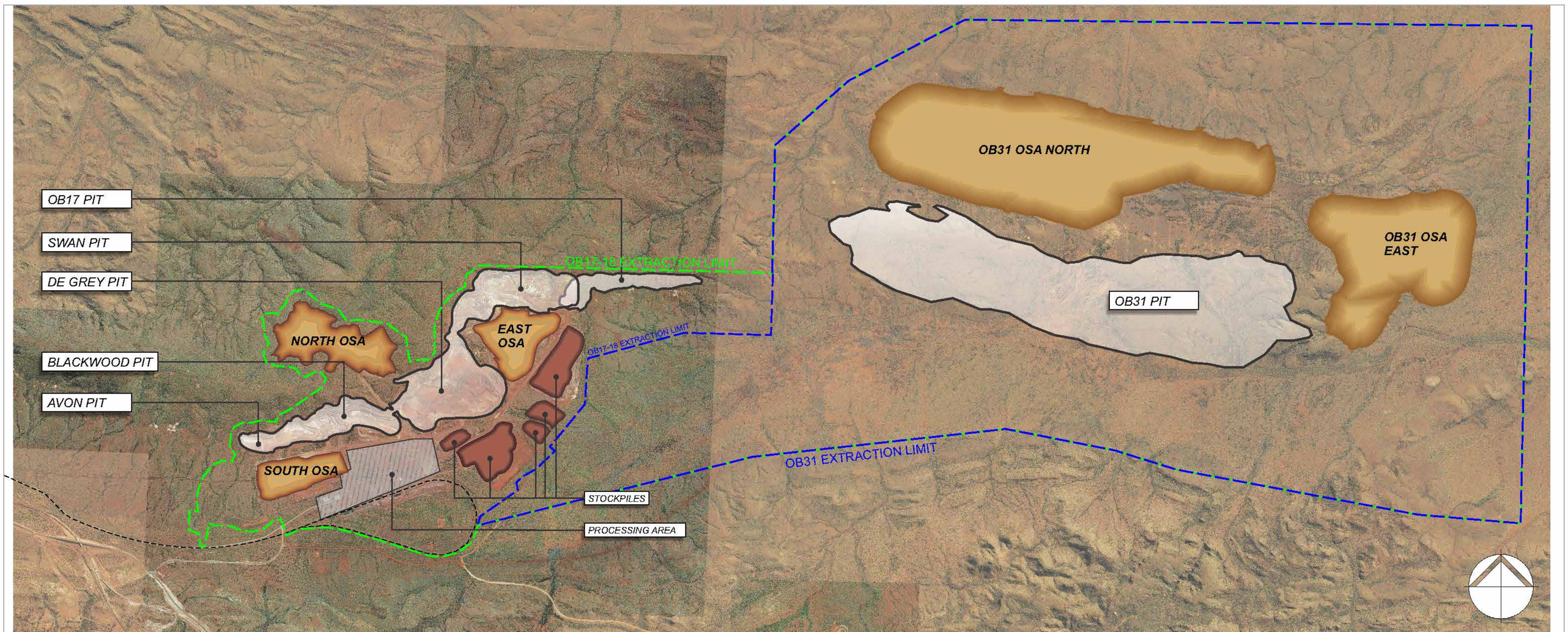
LANDFORM DESIGN

Drawn by: DC I Checked by: AW

Date: November 2014 I DWG#: Ls2

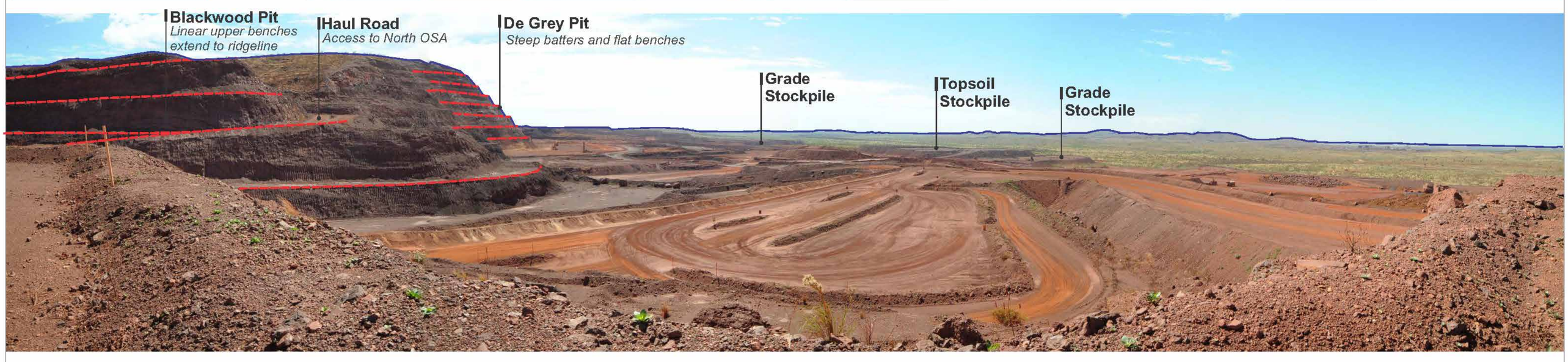
bhpbilliton

ERM

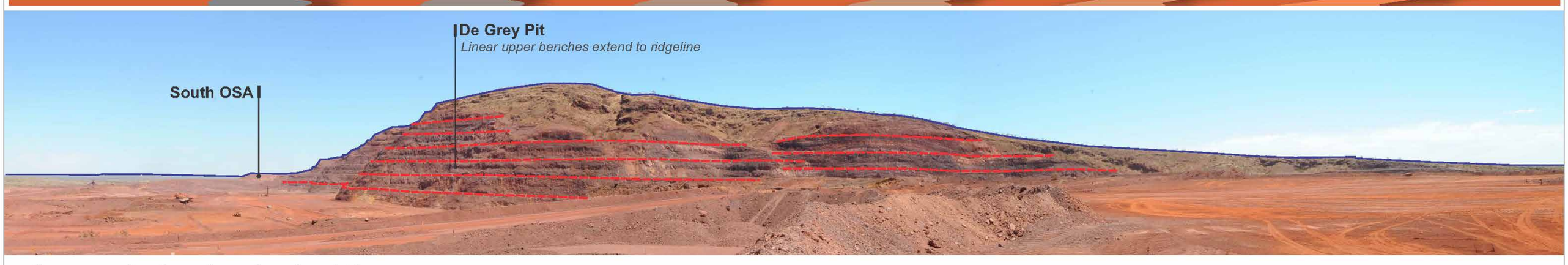


Blackwood & Avon Pit

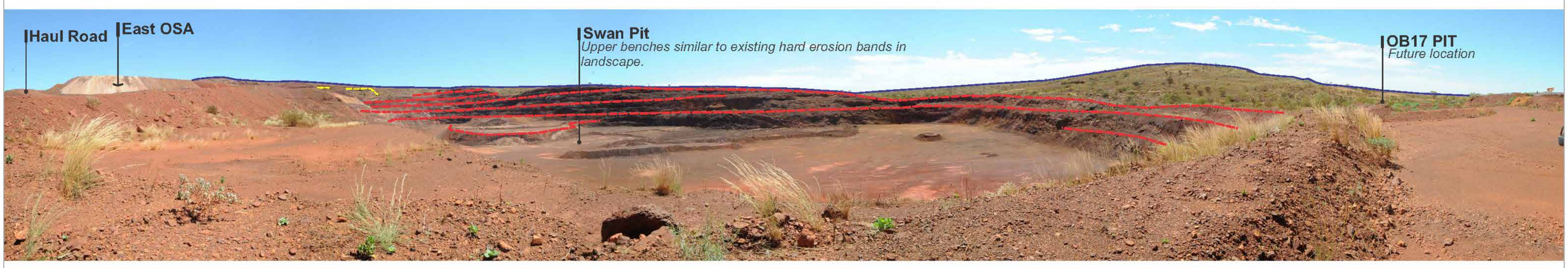
De Grey Pit



De Grey Pit



Swan & Orebody 17 Pit



SITE ANALYSIS - PITS

OB17-18-31

PROJECT: BHPB IO MINE CLOSURE

LANDFORM DESIGN

Drawn by: DC | Checked by: AW

Date: November 2014 | DWG#: Ls3

bhpbilliton

ERM

Appendix H. Closure risk matrices

Severity matrix

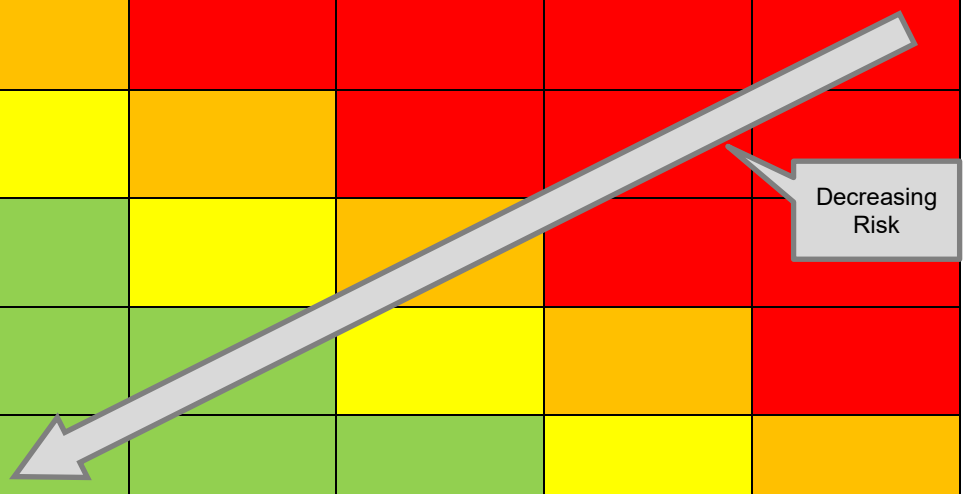
Severity Level	Descriptor
5	6 or more fatalities or 6 or more life shortening illnesses; or Severe impact to the environment and where recovery of ecosystem function takes 10 years or more; or Severe impact on community lasting more than 12 months or a substantiated human rights violation impacting 6 or more people.
4	1-5 fatalities or 1-5 life shortening illnesses; or Serious impact to the environment, where recovery of ecosystem function takes between 3 and up to 10 years; or Serious impact on community lasting 6-12 months or a substantiated human rights violation impacting 1-5 persons.
3	Life altering or long term/permanent disabling injury or illness to one or more persons; or Substantial impact to the environment, where recovery of ecosystem function takes between 1 and up to 3 years; or Substantial impact on community lasting 2-6 months
2	Non-life altering or short-term disabling injury or illness to one or more persons; or Measurable but limited impact to the environment, where recovery of ecosystem function takes less than 1 year; or Measurable but limited community impact lasting less than one month.
1	Low level impact resulting in first aid only; or Minor, temporary impact to the environment, where the ecosystem recovers with little intervention; or Minor, temporary community impact that recovers with little intervention.

Likelihood Matrix

Uncertainty	Frequency	Likelihood Factor
Highly Likely	Likely to occur within a 1-year period.	3
Likely	Likely to occur within a 1 - 5-year period.	1
Possible	Likely to occur within a 5 - 20-year period.	0.3
Unlikely	Likely to occur within a 20 - 50-year period.	0.1
Highly Unlikely	Not likely to occur within a 50-year period.	0.03

Risk Matrix

	Severity Level				
Likelihood	1	2	3	4	5
Highly Likely					
Likely					
Possible					
Unlikely					
Highly Unlikely					



H-1. Severity level guidance

This appendix is not publicly available. It is commercially sensitive and has been supplied separately.

Appendix I. Supplementary surface water information

I-1. Comparison of PMF with 1 in 10,000-year flood

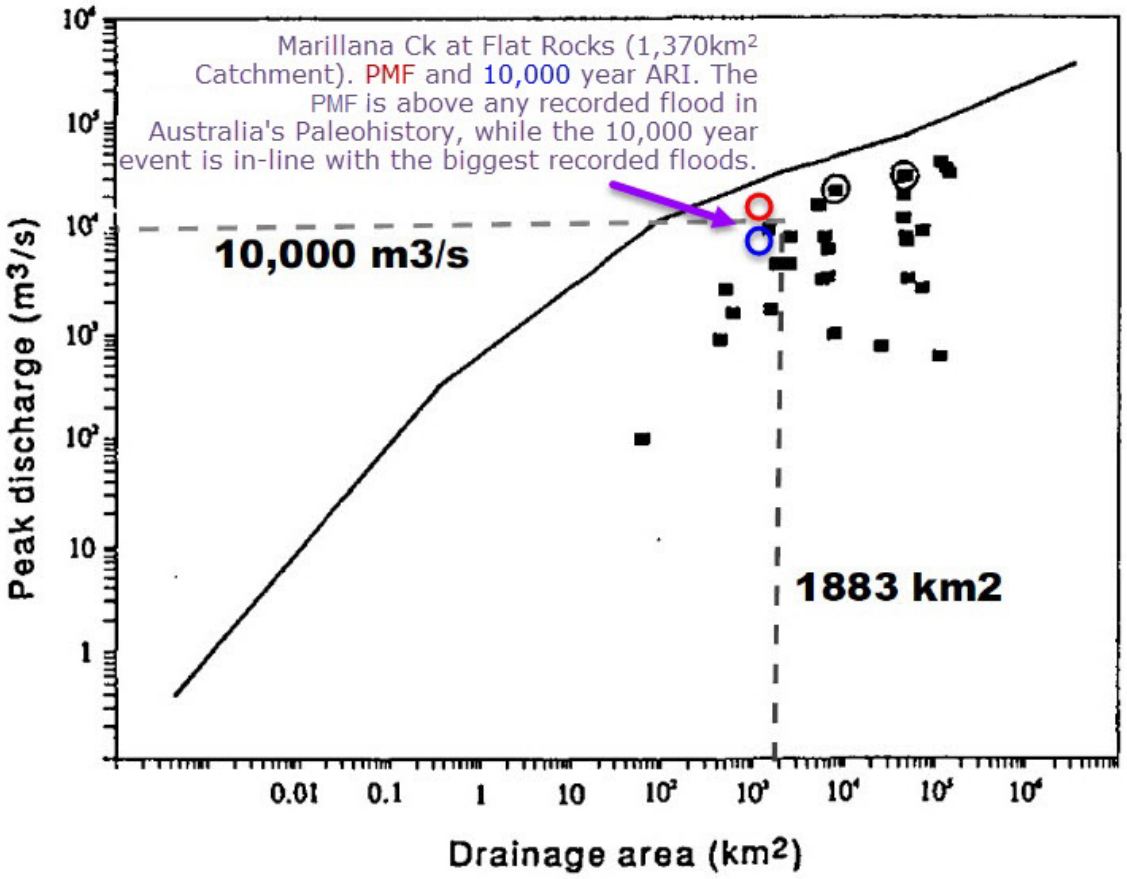


Figure 2.5: Plot of maximum rainfall-runoff floods measured world-wide and in Australia (reproduced from Fig. 5 Wohl et.al 1994). Envelope curve for world floods, shown as solid line, based on data from Costa (1987). Australian data points from Rodier and Roche (1984) and Finlayson and McMahon (1988) represent maximum floods measured in Australia north of 25° South. The largest palaeo-floods in the Fitzroy and Margaret River are circled. The peak discharge for the catchment area of Marillana Creek (1883 km²) is estimated.

I-2. Jimblebar Creek cross sections in the vicinity of Innawally Pool

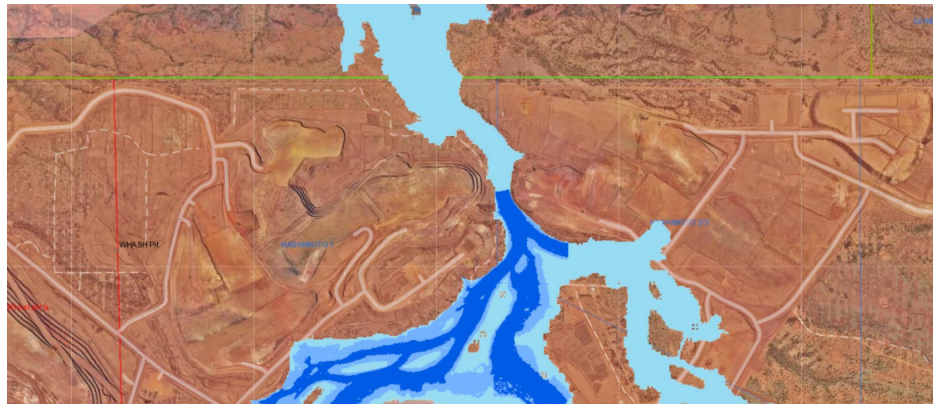
The following slides show cross sections across Jimblebar Creek between the WHASH and H234 pits in the vicinity of Innawally Pool. The sections show that the pits have been designed to fall outside the 1 in 10,000-year flood plain, and that they avoid the areas of alluvium that would be regularly recharged by creek flow.

BHP

Innawally Pool Sections

WAIO – Resource Engineering

May 2023



Area Overview

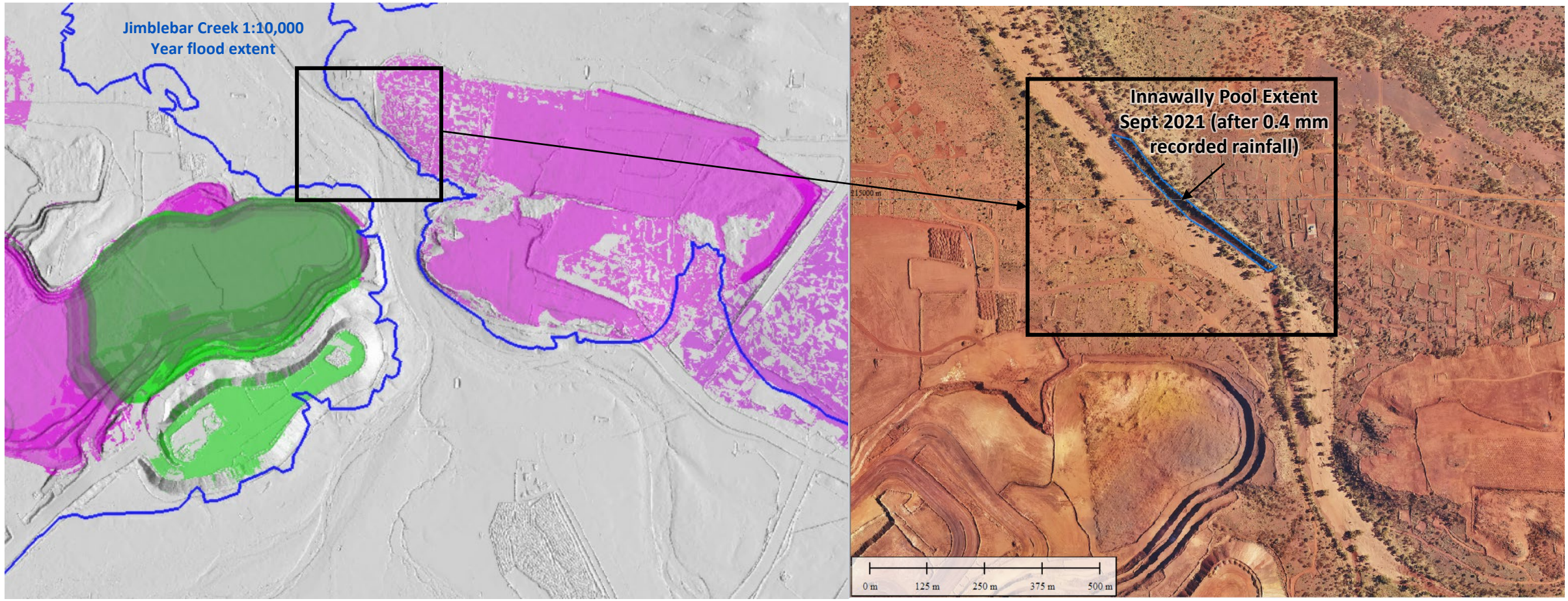
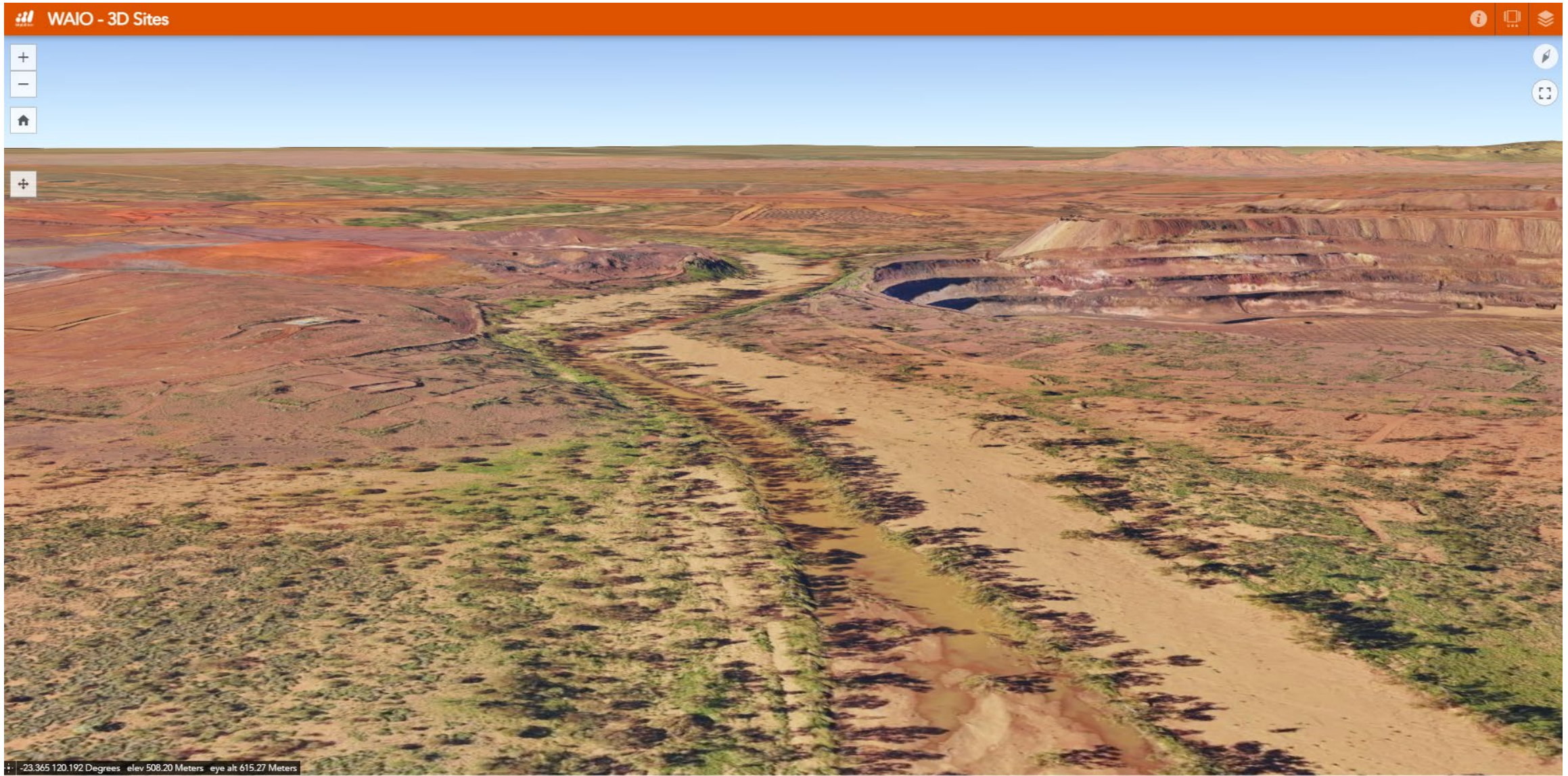


Figure 1: Innawally Pool1:10,000 years Flood Extent.

Innawally Pool – North Aspect



Innawally Pool – South Aspect

Cross Section View A’A

Planview

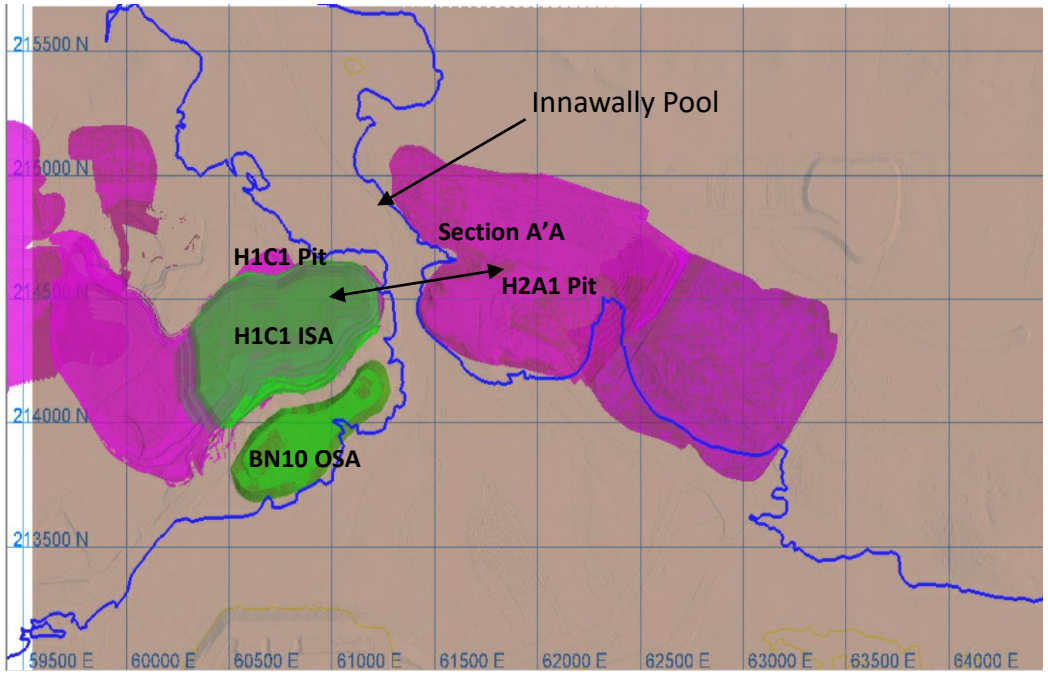
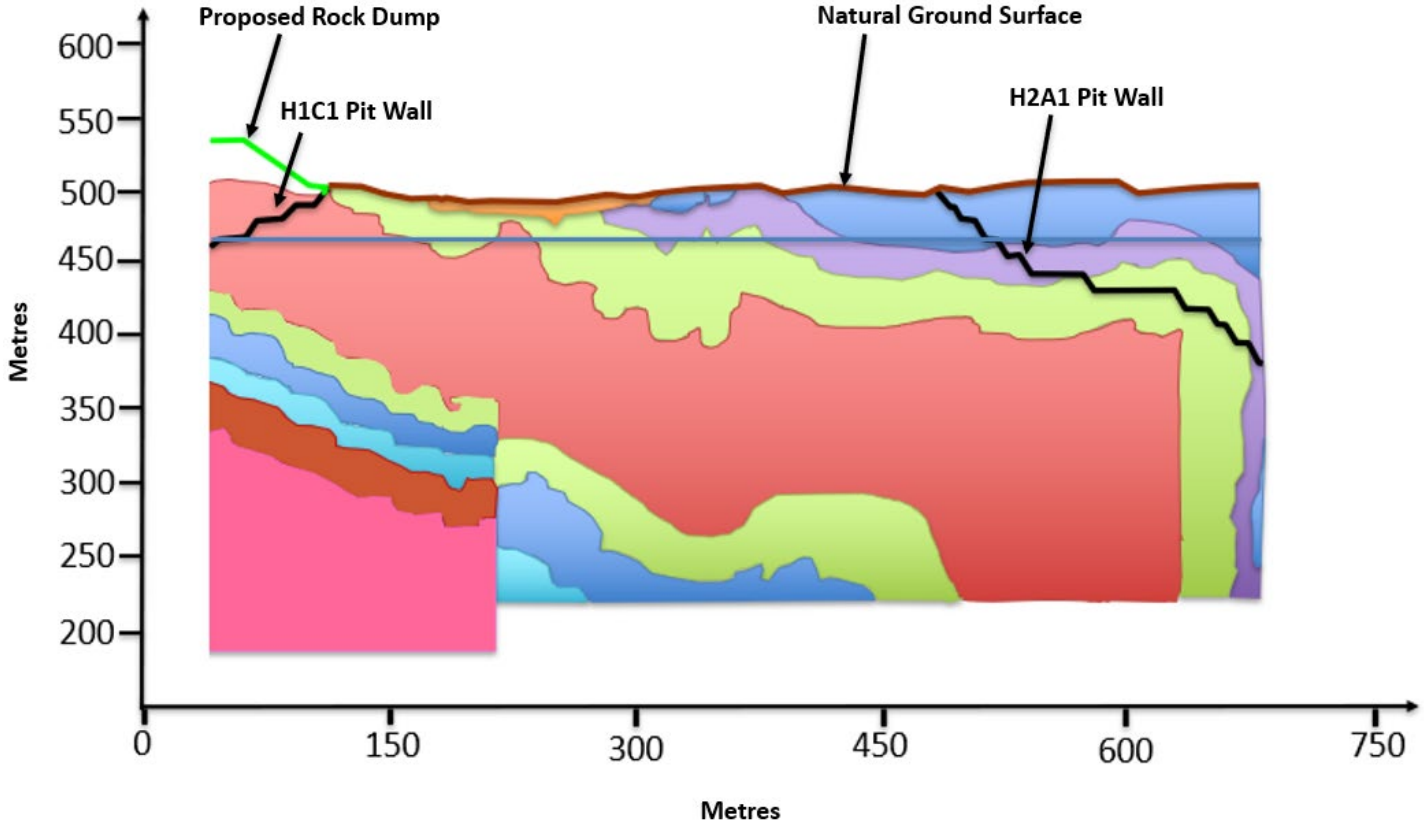
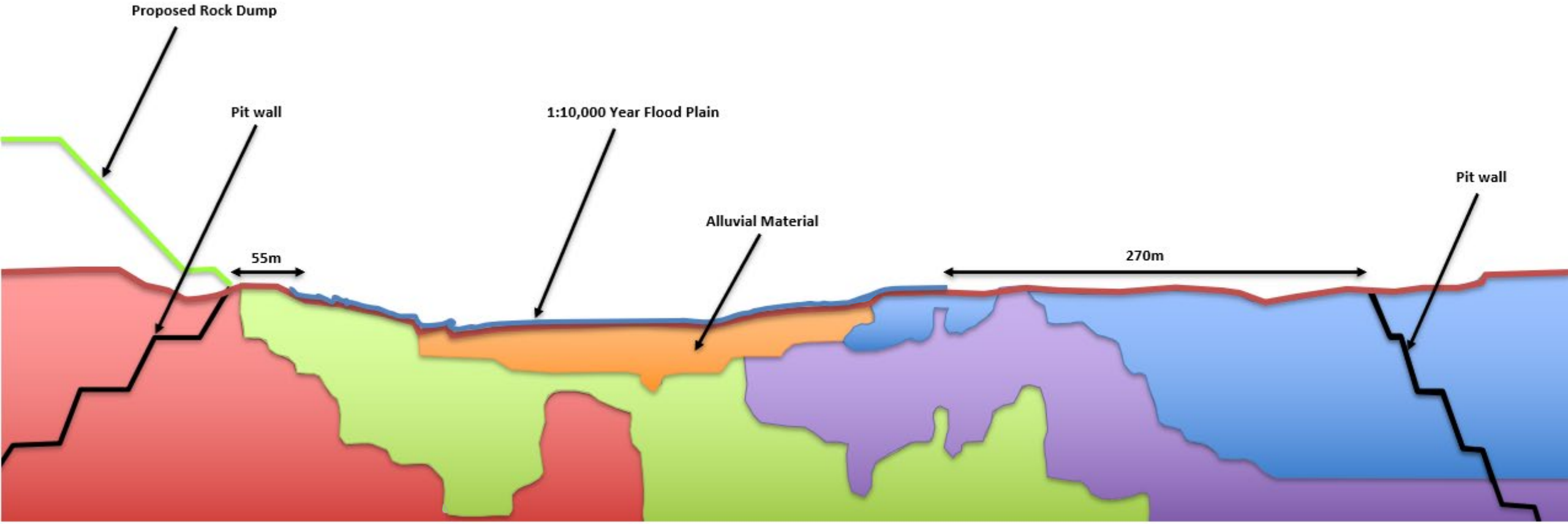


Figure 2: Cross Section of Flood Plain A’A.



Cross Section View A'A



- Alluvial Material
- Brockman Iron Formation – D4
- Brockman Iron Formation – J1 Shaly
- Brockman Iron Formation – J2
- Brockman Iron Formation – WB Shale

BHP

Cross Section View B’B

Planview

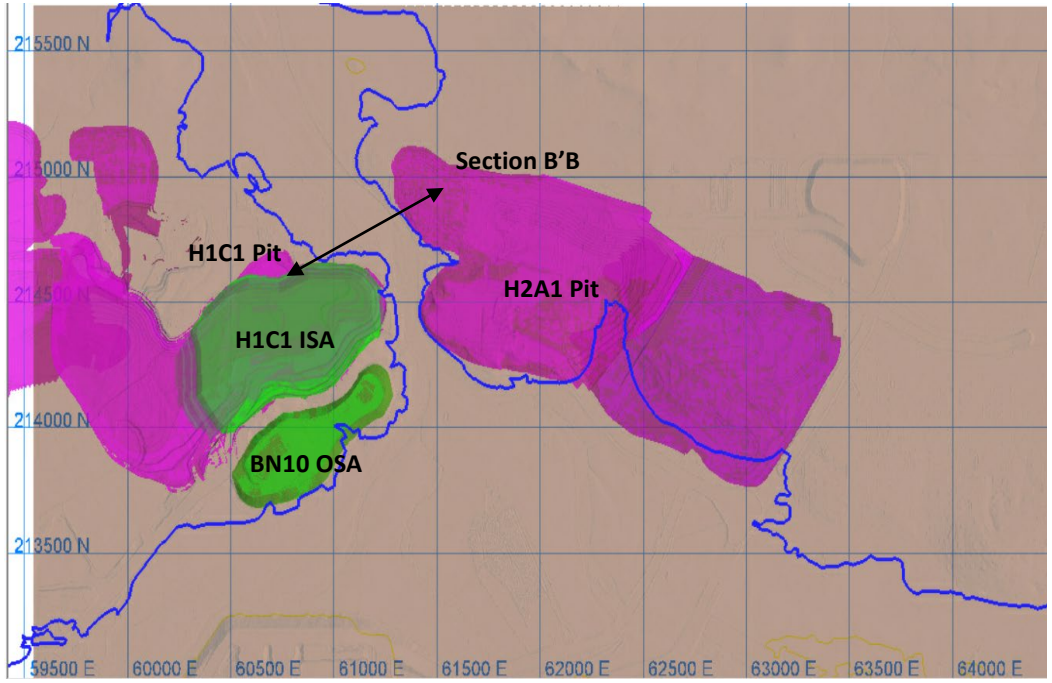
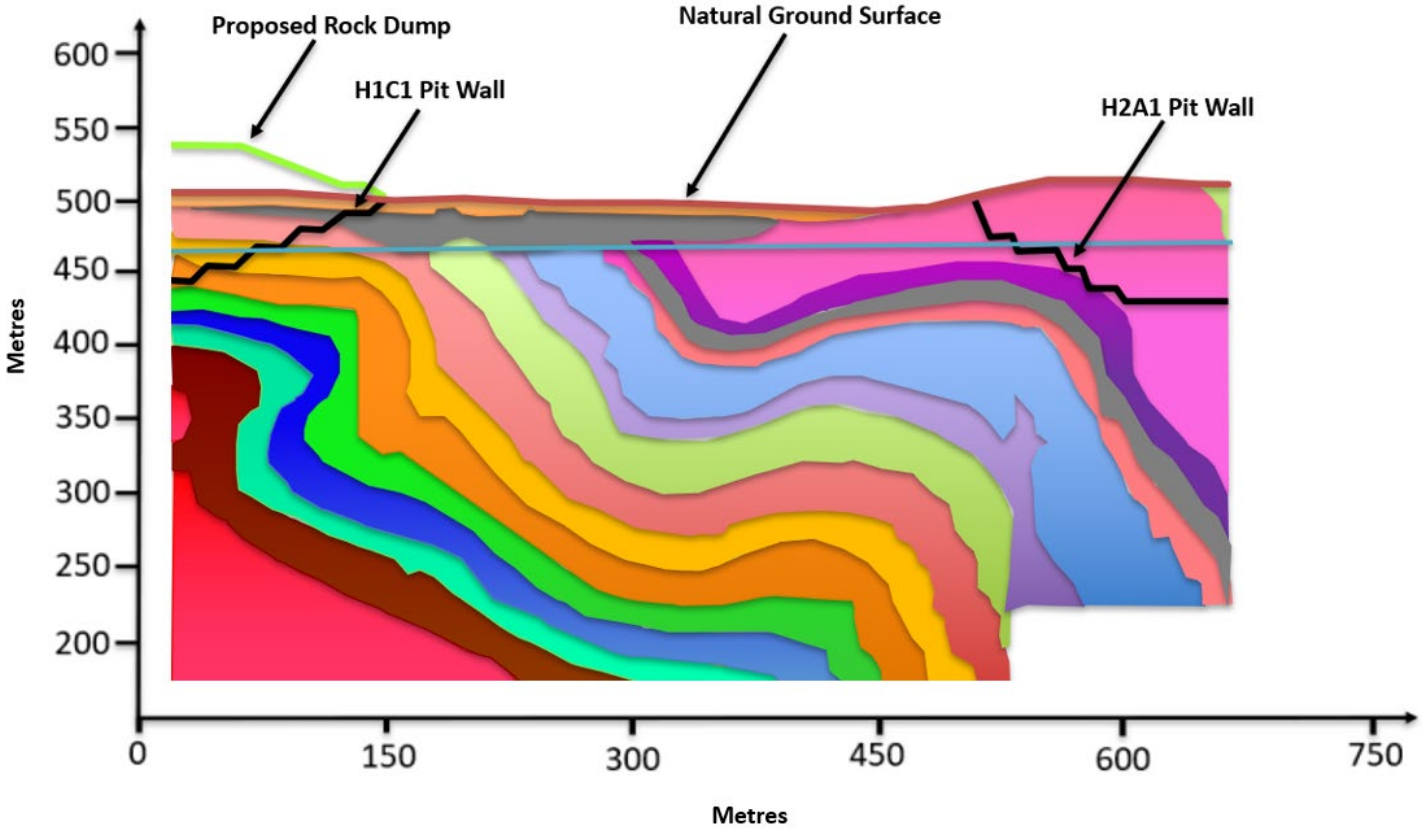
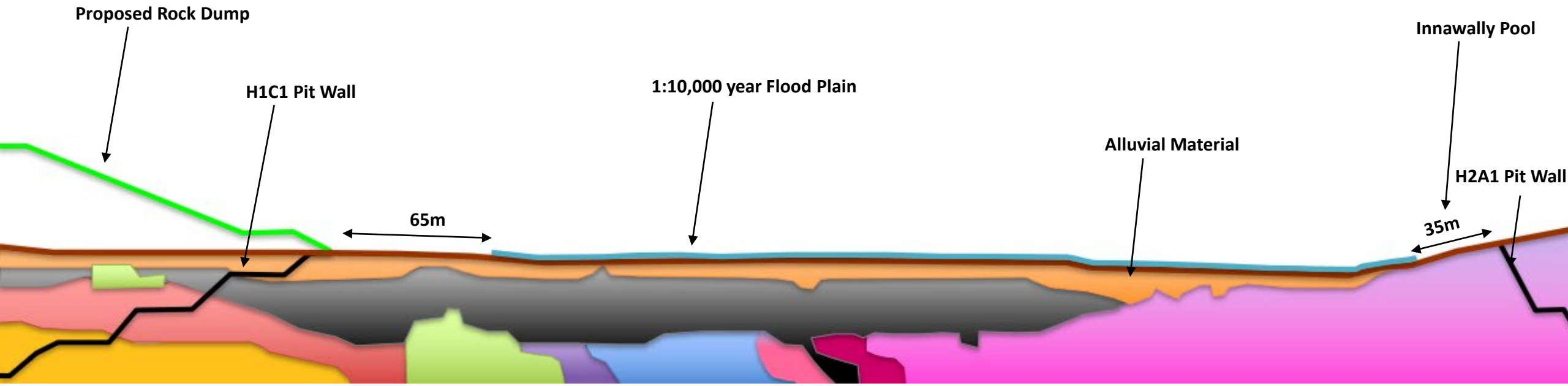


Figure 3: Cross Section of Flood Plain B’B.



Cross Section View B'B



- Alluvial Material
- Brockman Iron Formation – J2
- Brockman Iron Formation – J5 Shaly
- Brockman Iron Formation – D3
- Vuggy Breccia
- Brockman Iron Formation – D4
- Brockman Iron Formation – J3 Shaly
- Brockman Iron Formation – J6
- Brockman Iron Formation – WB Shale
- Brockman Iron Formation – J1 Shaly

BHP

BHP

Appendix J. Seed List

Common species used in rehabilitation at Jimblebar

Derived from baseline surveys. Species planted in each rehabilitation area may vary according to seed availability and include other (less common) species identified during baseline surveys

Domain	OSA			Infrastructure	Road / rail / corridors	TSF	Mine Pit		
Landform	Lower Slope /Plains	Mid Slope	Crest/Mesa	Lower Slope /Plains	Lower Slope /Plains	Lowlying floodplain	Lowlying floodplain	Major drainage line / Creek	Escarpment / steep slope into pit
Community	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Acacia Shrubland	Triodia Hummock Grassland
Species									
Abutilon cryptopetalum		P							
Abutilon lepidum									P
Acacia adoxa	P	P	P	P	P	P	P		
Acacia adoxa var. adoxa	P	**P**	P	P	P	**P**	**P**		**P**
Acacia adsurgens	P	P	P	P	P	P	P		
Acacia aff. ayersiana	P	P		P	P				
Acacia ancistrocarpa	**P**	P	P	**P**	**P**	**P**	**P**	P	
Acacia aneura	**P**	P	P	**P**	**P**	**P**	**P**	**P**	
Acacia aneura var. aneura								P	
Acacia aneura var. macrocarpa	P			P	P				
Acacia aneura var. pilbarana		P	**P**					P	
Acacia aneura var. tenuis	**P**	**P**		**P**	**P**	P	P		**P**
Acacia balsamea			P			P	P	P	
Acacia bivenosa	**P**	**P**	**P**	**P**	**P**	**P**	**P**	P	**P**
Acacia catenulata						P	P	P	
Acacia coriacea						P	P		
Acacia coriacea subsp. pendens								P	
Acacia dictyophleba			P						
Acacia eriopoda	P	P	P	P	P	P	P	P	
Acacia hilliana	P	**P**	**P**	P	P	P	P		**P**
Acacia inaequilatera	P		P	P	P				
Acacia maitlandii		P				P	P	P	
Acacia marramamba	P	P	P	P	P				
Acacia melleodora	**P**	**P**		**P**	**P**	**P**	**P**	**P**	P
Acacia monticola	P	**P**		P	P	**P**	**P**	**P**	
Acacia pachyacra	**P**	P		**P**	**P**	**P**	**P**		
Acacia paraneura		**P**	**P**					**P**	
Acacia pruinocarpa	P	P	P	P	P	P	P	P	P
Acacia pyrifolia						P	P	**P**	
Acacia pyrifolia var. morrisonii	**P**	P	P	**P**	**P**	P	P	**P**	
Acacia rhodophloia	P	P	P	P	P	P	P		
Acacia sclerosperma	P			P	P				
Acacia sclerosperma subsp. sclerosperma	P			P	P				
Acacia sibirica		P							
Acacia synchronicia		P							
Acacia tenuissima	P	P		P	P	P	P		
Acacia tetragonophylla	P	P	P	P	P	P	P	**P**	

Highlighted species of significance to Nyiyaparli people*

Approx %Cover	
<1	P
1-20	P
21-40	P
41- 60	P
61-80	P
>80	P

Domain	OSA			Infrastructure	Road / rail / corridors	TSF	Mine Pit		
Landform	Lower Slope /Plains	Mid Slope	Crest/Mesa	Lower Slope /Plains	Lower Slope /Plains	Lowlying floodplain	Lowlying floodplain	Major drainage line / Creek	Escarpment / steep slope into pit
Community	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Acacia Shrubland	Triodia Hummock Grassland
Species									
Acacia trudgeniana		P							
Acacia wanyu		P							
Amphipogon sericeus	P	P	P	P	P	P	P		
Amyema fitzgeraldii			P						
Anthobolus leptomerioides		P	P						
Aristida aff. Inaequiglumis	P			P	P	**P**	**P**	P	
Aristida contorta	**P**	P	P	**P**	**P**	**P**	**P**	**P**	P
Aristida holathera						P	P		
Aristida inaequiglumis	P			P	P	P	P		
Aristida ingrata		P	P					**P**	
Boerhavia coccinea								P	
Bonamia rosea	**P**	P		**P**	**P**	**P**	**P**		P
Calytrix carinata	P	P	P	P	P	P	P		**P**
Cassytha capillaris	P			P	P			P	
Cheilanthes sieberi subsp. sieberi	P			P	P			P	
Chrysocephalum apiculatum			P					P	
Chrysocephalum pterochaetum	P	P	P	P	P	P	P	P	
Chrysopogon fallax	P	P		P	P			**P**	
Cleome viscosa		P				P	P	P	
Codonocarpus cotinifolius	P	P	P	P	P				
Corchorus lasiocarpus subsp. lasiocarpus	P			P	P	P	P		
Corchorus sidoides subsp. sidoides	P	P	P	P	P	P	P	P	
Corymbia deserticola	P	P	P	P	P	**P**	**P**		
Corymbia hamersleyana	P	P		P	P			**P**	
Cymbopogon ambiguus	P	P	P	P	P			P	
Cymbopogon obtectus	P	**P**	P	P	P	P	P	**P**	
Cynanchum floribundum								P	
Cyperus cunninghamii subsp. cunninghamii								P	
Cyperus ixiocarpus								P	
Dicrastylis cordifolia	P	P		P	P	P	P		
Digitaria brownii	P			P	P				
Dodonaea coriacea	P	P	P	P	P	P	P	P	P
Dodonaea petiolaris	**P**	P	P	**P**	**P**	P	P	**P**	
Duperreya commixta	P	P	P	P	P	P	P	P	
Duperreya commixta alsinoides	P			P	P				
Enchylaena tomentosa var. tomentosa	P		P	P	P	P	P		
Enneapogon polyphyllus	P			P	P	P	P	P	P
Eragrostis eriopoda	P	P	P	P	P	P	P	P	P
Eragrostis exilifolia			P						
Eragrostis laniflora	P		P	P	P				

Highlighted species of significance to Nyiyaparli people*

Approx %Cover	
<1	**P**
1-20	**P**
21-40	**P**
41- 60	**P**
61-80	**P**
>80	**P**

Domain	OSA			Infrastructure	Road / rail / corridors	TSF	Mine Pit		
Landform	Lower Slope /Plains	Mid Slope	Crest/Mesa	Lower Slope /Plains	Lower Slope /Plains	Lowlying floodplain	Lowlying floodplain	Major drainage line / Creek	Escarpment / steep slope into pit
Community	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Acacia Shrubland	Triodia Hummock Grassland
Species									
Eremophila exilifolia	**P**	**P**	P	**P**	**P**				**P**
Eremophila forrestii			**P**						
Eremophila forrestii subsp. forrestii	P	P		P	P	P	P	**P**	
Eremophila fraseri	P	P	P	P	P				
Eremophila fraseri subsp. fraseri		P							
Eremophila jucunda subsp. pulcherrima	P	P	P	P	P	P	P		**P**
Eremophila lanceolata	P			P	P	P	P		
Eremophila latrobei						P	P	P	
Eremophila latrobei subsp. filiformis			P						
Eremophila latrobei subsp. latrobei	**P**	**P**	P	**P**	**P**	P	P		**P**
Eremophila longifolia	**P**			**P**	**P**	**P**	**P**	P	
Eriachne ciliata	P	P	P	P	P	P	P		P
Eriachne helmsii	P		P	P	P				**P**
Eriachne lanata			P						P
Eriachne mucronata	P	P		P	P	P	P	**P**	
Eriachne obtusa								P	
Eriachne pulchella subsp. pulchella								P	
Eucalyptus camaldulensis								**P**	
Eucalyptus gamophylla	**P**	P		**P**	**P**	**P**	**P**	P	
Eucalyptus leucophloia subsp. leucophloia		P	P						**P**
Eucalyptus odontocarpa	P	P		P	P				
Eucalyptus victrix								**P**	
Eucalyptus xerothermica	P			P	P	P	P		
Eulalia aurea	P	P	P	P	P			**P**	
Euphorbia australis	P			P	P			P	
Euphorbia coghlanii								P	
Euphorbia tannensis subsp. eremophila						P	P		
Evolvulus alsinoides var. villosicalyx	P	P	P	P	P	P	P	P	
Fimbristylis dichotoma	P			P	P				
Gompholobium karijini	P	**P**	P	P	P				**P**
Gomphrena affinis subsp. pilbarensis	P			P	P	P	P	P	
Gomphrena kanisii		P	P						
Goodenia prostrata						P	P	P	
Goodenia sp. Sandy Creek	P	P	P	P	P	P	P		
Goodenia stobbsiana	P	P		P	P				
Goodenia triodiophila	P	P	P	P	P				
Gossypium robinsonii						P	P	P	
Grevillea berryana	P	**P**	**P**	P	P				P
Grevillea juncifolia subsp. juncifolia		P							
Grevillea wickhamii	P	P	P	P	P	P	P	P	**P**

Highlighted species of significance to Nyiyaparli people*

Approx %Cover	
<1	**P**
1-20	**P**
21-40	**P**
41- 60	**P**
61-80	**P**
>80	**P**

Domain	OSA			Infrastructure	Road / rail / corridors	TSF	Mine Pit		
Landform	Lower Slope /Plains	Mid Slope	Crest/Mesa	Lower Slope /Plains	Lower Slope /Plains	Lowlying floodplain	Lowlying floodplain	Major drainage line / Creek	Escarpment / steep slope into pit
Community	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Acacia Shrubland	Triodia Hummock Grassland
Species									
Grevillea wickhamii subsp. hispidula	P	P	P	P	P				
Hakea chordophylla	P	P	P	P	P	P	P		
Hakea loranthifolia		P							
Hakea lorea	**P**	**P**	P	**P**	**P**	**P**	**P**	P	
Hakea lorea subsp. lorea		P							
Halgania gustafsenii var gustafsenii		P	P						
Halgania solanacea var. Mt Doreen	P	**P**	**P**	P	P	P	P	P	**P**
Hibiscus burtonii	P	P	P	P	P	P	P	P	
Hibiscus coatesii	P	P		P	P	P	P		
Hibiscus sturtii var. campylochlamys		P	P						
Hibiscus sturtii var. truncatus	P	P	P	P	P	P	P		
Hybanthus aurantiacus	P	P	P	P	P	P	P	P	P
Indigofera brevidens						P	P	P	
Indigofera georgei	P			P	P	P	P	P	
Indigofera monophylla	P	P	P	P	P	P	P	P	P
Ipomoea calobra			P			P	P	P	
Ipomoea polymorpha								P	
Isotropis atropurpurea	P			P	P				
Isotropis forrestii								P	
Kennedia prorepens	**P**			**P**	**P**	**P**	**P**	P	
Keraudrenia nephrosperma	P	P	**P**	P	P				P
Keraudrenia velutina subsp. elliptica	P	P		P	P	**P**	**P**	P	**P**
Keraudrenia velutina subsp. velutina	P	P		P	P	**P**	**P**		
Maireana melanocoma	P			P	P				
Maireana planifolia villosa	P			P	P				
Maireana triptera		P							
Maireana villosa		P	P			P	P		
Melaleuca glomerata								**P**	
Melhania oblongifolia						P	P		
Mirbelia viminalis		P	P			P	P		**P**
Mollugo molluginea	P			P	P				
Panicum effusum						P	P	P	
Paraneurachne muelleri	P	P	P	P	P	P	P	P	
Paspalidium clementii			P						
Paspalidium rarum								**P**	
Perotis rara		P							
Petalostylis labicheoides	P		P	P	P	P	P	**P**	
Phyllanthus maderaspatensis								P	
Pluchea dentex								P	
Pluchea dunlopii			P						

Highlighted species of significance to Nyiyaparli people*

Approx %Cover	
<1	**P**
1-20	**P**
21-40	**P**
41- 60	**P**
61-80	**P**
>80	**P**

Domain	OSA			Infrastructure	Road / rail / corridors	TSF	Mine Pit		
Landform	Lower Slope /Plains	Mid Slope	Crest/Mesa	Lower Slope /Plains	Lower Slope /Plains	Lowlying floodplain	Lowlying floodplain	Major drainage line / Creek	Escarpment / steep slope into pit
Community	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Acacia Shrubland	Triodia Hummock Grassland
Species									
Portulaca oleracea	P			P	P				
Psydrax latifolia		P							
Psydrax suaveolens		P				P	P		
Pterocaulon serrulatum			P			P	P	P	
Pterocaulon sphaeranthoides	P			P	P				P
Ptilotus astrolasius						P	P		
Ptilotus astrolasius var. astrolasius	**P**			**P**	**P**	**P**	**P**		
Ptilotus calostachyus	P	P	P	P	P	P	P		P
Ptilotus exaltatus	P			P	P				
Ptilotus exaltatus var. exaltatus			P						
Ptilotus obovatus	P	P	P	P	P	P	P	P	P
Ptilotus polystachyus var. polystachyus	P			P	P				
Ptilotus rotundifolius		P	P						
Rhagodia eremaea	P	P	P	P	P				
Rhyncharrhena linearis	P	P	P	P	P				
Rhynchosia minima						P	P	**P**	
Rulingia luteiflora	P	P		P	P	P	P	P	
Rutidosis helichrysoides subsp. helichrysoides		P							
Santalum lanceolatum	P			P	P	**P**	**P**	**P**	
Scaevola browniana		P	P						P
Scaevola parvifolia						P	P		
Scaevola parvifolia subsp. pilbarae	P			P	P	P	P		
Scaevola spinescens		P							
Senna artemisioides			P						
Senna artemisioides subsp. filifolia								P	
Senna artemisioides subsp. helmsii	P	P	P	P	P	P	P	P	
Senna artemisioides subsp. oligophylla	**P**	P		**P**	**P**	**P**	**P**	P	
Senna artemisioides subsp. oligophylla x helmsii		P	P						P
Senna glaucifolia		P							
Senna glutinosa subsp. glutinosa	P	P	P	P	P				**P**
Senna glutinosa subsp. luerssenii	P	P	P	P	P	P	P		P
Senna glutinosa subsp. oligophylla luerssenii	P			P	P				
Senna glutinosa subsp. pruinosa	P	P	P	P	P	P	P	P	
Senna sericea	P	P		P	P				
Senna sp. Meekatharra (E. Bailey 1-26)	P	P	P	P	P			P	
Senna stricta		P							
Sida arenicola	P	P	P	P	P	P	P	**P**	
Sida cardiophylla	P	P	P	P	P				
Sida clementii						P	P	P	
Sida fibulifera								P	

Highlighted species of significance to Nyiyaparli people*

Approx %Cover	
<1	P
1-20	P
21-40	P
41- 60	P
61-80	P
>80	P

Domain	OSA			Infrastructure	Road / rail / corridors	TSF	Mine Pit		
Landform	Lower Slope /Plains	Mid Slope	Crest/Mesa	Lower Slope /Plains	Lower Slope /Plains	Lowlying floodplain	Lowlying floodplain	Major drainage line / Creek	Escarpment / steep slope into pit
Community	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Acacia Shrubland	Triodia Hummock Grassland
Species									
Sida pilbarensis	P			P	P				
Sida platycalyx		P	P						
Sida sp. golden calyces	P			P	P				
Solanum centrale	P	P	P	P	P				P
Solanum lasiophyllum	P	P	P	P	P	P	P	P	
Solanum horridum	P	P		P	P				P
Solanum lasiophyllum	P	P	P	P	P				P
Stenopetalum decipiens		P							
Streptoglossa macrocephala	P			P	P				
Tephrosia rosea								P	
Tephrosia rosea var. glabrior								P	
Themeda triandra	**P**			**P**	**P**	**P**	**P**	**P**	
Trianthema glossostigma						P	P		
Tribulus suberosus	P	P	P	P	P	P	P		
Triodia basedowii	**P**	**P**	**P**	**P**	**P**	**P**	**P**	**P**	**P**
Triodia epicata	**P**	P		**P**	**P**	**P**	**P**	**P**	
Triodia pungens								**P**	
Triodia schinzii	P			P	P	**P**	**P**	**P**	
Triodia sp. Shovelanna Hill	**P**	**P**	**P**	**P**	**P**	**P**	**P**		
Triumfetta chaetocarpa									P
Waltheria virgata			P						
Wurmbea deserticola	P		P	P	P				
Yakirra australiensis						P	P		

Highlighted species of significance to Nyiyaparli people*

Approx %Cover	
<1	**P**
1-20	**P**
21-40	**P**
41- 60	**P**
61-80	**P**
>80	**P**

*Sources: KNAC (2023) Nyiyaparli People & Country Plan. Fortescue Marsh. 2023 - 2032; BHP Ethnobotanical Species Database (2023)

Common species used in rehabilitation at OB17/18/31

Derived from baseline surveys. Species planted in each rehabilitation area may vary according to seed availability and include other (less common) species identified during baseline surveys

Domain	OSA			Infrastructure	Road / rail / corridors	TSF	Mine Pit		
Landform	Lower Slope /Plains	Mid Slope	Crest/Mesa	Lower Slope /Plains	Lower Slope /Plains	Lowlying floodplain	Lowlying floodplain	Major drainage line / Creek	Escarpment / steep slope into pit
Community	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Acacia Shrubland	Triodia Hummock Grassland
Species									
Abutilon cryptopetalum		P							
Abutilon lepidum									P
Acacia adoxa	P	P	P	P	P	P	P		
Acacia adoxa var. adoxa	P	**P**	P	P	P	**P**	**P**		**P**
Acacia adsurgens	P	P	P	P	P	P	P		
Acacia aff. ayersiana	P	P		P	P				
Acacia ancistrocarpa	**P**	P	P	**P**	**P**	**P**	**P**	P	
Acacia aneura	**P**	P	P	**P**	**P**	**P**	**P**	**P**	
Acacia aneura var. aneura								P	
Acacia aneura var. macrocarpa	P			P	P				
Acacia aneura var. pilbarana		P	**P**					P	
Acacia aneura var. tenuis	**P**	**P**		**P**	**P**	P	P		**P**
Acacia balsamea			P			P	P	P	
Acacia bivenosa	**P**	**P**	**P**	**P**	**P**	**P**	**P**	P	**P**
Acacia catenulata						P	P	P	
Acacia coriacea						P	P		
Acacia coriacea subsp. pendens								P	
Acacia dictyophleba			P						
Acacia eriopoda	P	P	P	P	P	P	P	P	
Acacia hilliana	P	**P**	**P**	P	P	P	P		**P**
Acacia inaequilatera	P		P	P	P				
Acacia maitlandii		P				P	P	P	
Acacia marramamba	P	P	P	P	P				
Acacia melleodora	**P**	**P**		**P**	**P**	**P**	**P**	**P**	P
Acacia monticola	P	**P**		P	P	**P**	**P**	**P**	
Acacia oswaldii									
Acacia pachyacra	**P**	P		**P**	**P**	**P**	**P**		
Acacia paraneura		**P**	**P**					**P**	
Acacia pruinocarpa	P	P	P	P	P	P	P	P	P
Acacia pyrifolia						P	P	**P**	
Acacia pyrifolia var. morrisonii	**P**	P	P	**P**	**P**	P	P	**P**	
Acacia rhodophloia	P	P	P	P	P	P	P		
Acacia sclerosperma	P			P	P				
Acacia sclerosperma subsp. sclerosperma	P			P	P				
Acacia sibirica		P							
Acacia synchronicia		P							
Acacia tenuissima	P	P		P	P	P	P		
Acacia tetragonophylla	P	P	P	P	P	P	P	**P**	

Highlighted species of significance to Nyiyaparli people*

Approx %Cover	
<1	**P**
1-20	**P**
21-40	**P**
41- 60	**P**
61-80	**P**
>80	**P**

Domain	OSA			Infrastructure	Road / rail / corridors	TSF	Mine Pit		
Landform	Lower Slope /Plains	Mid Slope	Crest/Mesa	Lower Slope /Plains	Lower Slope /Plains	Lowlying floodplain	Lowlying floodplain	Major drainage line / Creek	Escarpment / steep slope into pit
Community	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Acacia Shrubland	Triodia Hummock Grassland
Species									
Acacia trudgeniana		P							
Acacia wanyu		P							
Amphipogon sericeus	P	P	P	P	P	P	P		
Amyema fitzgeraldii			P						
Anthobolus leptomerioides		P	P						
Aristida aff. Inaequiglumis	P			P	P	**P**	**P**	P	
Aristida contorta	**P**	P	P	**P**	**P**	**P**	**P**	**P**	P
Aristida holathera						P	P		
Aristida inaequiglumis	P			P	P	P	P		
Aristida ingrata		P	P					**P**	
Boerhavia coccinea								P	
Bonamia rosea	**P**	P		**P**	**P**	**P**	**P**		P
Calytrix carinata	P	P	P	P	P	P	P		**P**
Cassytha capillaris	P			P	P			P	
Cheilanthes sieberi subsp. sieberi	P			P	P			P	
Chrysocephalum apiculatum			P					P	
Chrysocephalum pterochaetum	P	P	P	P	P	P	P	P	
Chrysopogon fallax	P	P		P	P			**P**	
Cleome viscosa		P				P	P	P	
Codonocarpus cotinifolius	P	P	P	P	P				
Corchorus lasiocarpus subsp. lasiocarpus	P			P	P	P	P		
Corchorus sidoides subsp. sidoides	P	P	P	P	P	P	P	P	
Corymbia deserticola	P	P	P	P	P	**P**	**P**		
Corymbia hamersleyana	P	P		P	P			**P**	
Cymbopogon ambiguus	P	P	P	P	P			P	
Cymbopogon obtectus	P	**P**	P	P	P	P	P	**P**	
Cynanchum floribundum								P	
Cyperus cunninghamii subsp. cunninghamii								P	
Cyperus ixiocarpus								P	
Dicrastylis cordifolia	P	P		P	P	P	P		
Digitaria brownii	P			P	P				
Dodonaea coriacea	P	P	P	P	P	P	P	P	P
Dodonaea petiolaris	**P**	P	P	**P**	**P**	P	P	**P**	
Duperreya commixta	P	P	P	P	P	P	P	P	
Duperreya commixta alsinoides	P			P	P				
Enchylaena tomentosa var. tomentosa	P		P	P	P	P	P		
Enneapogon polyphyllus	P			P	P	P	P	P	P
Eragrostis eriopoda	P	P	P	P	P	P	P	P	P
Eragrostis exilifolia			P						
Eragrostis laniflora	P		P	P	P				
Eremophila exilifolia	**P**	**P**	P	**P**	**P**				**P**

Highlighted species of significance to Nyiyaparli people*

Approx %Cover	
<1	P
1-20	P
21-40	P
41- 60	P
61-80	P
>80	P

Domain	OSA			Infrastructure	Road / rail / corridors	TSF	Mine Pit		
Landform	Lower Slope /Plains	Mid Slope	Crest/Mesa	Lower Slope /Plains	Lower Slope /Plains	Lowlying floodplain	Lowlying floodplain	Major drainage line / Creek	Escarpment / steep slope into pit
Community	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Acacia Shrubland	Triodia Hummock Grassland
Species									
Eremophila forrestii			**P**						
Eremophila forrestii subsp. forrestii	P	P		P	P	P	P	**P**	
Eremophila fraseri	P	P	P	P	P				
Eremophila fraseri subsp. fraseri		P							
Eremophila jucunda subsp. pulcherrima	P	P	P	P	P	P	P		**P**
Eremophila lanceolata	P			P	P	P	P		
Eremophila latrobei						P	P	P	
Eremophila latrobei subsp. filiformis			P						
Eremophila latrobei subsp. latrobei	**P**	**P**	P	**P**	**P**	P	P		**P**
Eremophila longifolia	**P**			**P**	**P**	**P**	**P**	P	
Eriachne ciliata	P	P	P	P	P	P	P		P
Eriachne helmsii	P		P	P	P				**P**
Eriachne lanata			P						P
Eriachne mucronata	P	P		P	P	P	P	**P**	
Eriachne obtusa								P	
Eriachne pulchella subsp. pulchella								P	
Eucalyptus camaldulensis								**P**	
Eucalyptus gamophylla	**P**	P		**P**	**P**	**P**	**P**	P	
Eucalyptus leucophloia subsp. leucophloia		P	P						**P**
Eucalyptus odontocarpa	P	P		P	P				
Eucalyptus victrix								**P**	
Eucalyptus xerothermica	P			P	P	P	P		
Eulalia aurea	P	P	P	P	P			**P**	
Euphorbia australis	P			P	P			P	
Euphorbia coghlanii								P	
Euphorbia tannensis subsp. eremophila						P	P		
Evolvulus alsinoides var. villosicalyx	P	P	P	P	P	P	P	P	
Fimbristylis dichotoma	P			P	P				
Gompholobium karijini	P	**P**	P	P	P				**P**
Gomphrena affinis subsp. pilbarensis	P			P	P	P	P	P	
Gomphrena kanisii		P	P						
Goodenia prostrata						P	P	P	
Goodenia sp. Sandy Creek	P	P	P	P	P	P	P		
Goodenia stobbsiana	P	P		P	P				
Goodenia triodiophila	P	P	P	P	P				
Gossypium robinsonii						P	P	P	
Grevillea berryana	P	**P**	**P**	P	P				P
Grevillea juncifolia subsp. juncifolia		P							
Grevillea wickhamii	P	P	P	P	P	P	P	P	**P**
Grevillea wickhamii subsp. hispidula	P	P	P	P	P				
Hakea chordophylla	P	P	P	P	P	P	P		

Highlighted species of significance to Nyiyaparli people*

Approx %Cover	
<1	**P**
1-20	**P**
21-40	**P**
41- 60	**P**
61-80	**P**
>80	**P**

Domain	OSA			Infrastructure	Road / rail / corridors	TSF	Mine Pit		
Landform	Lower Slope /Plains	Mid Slope	Crest/Mesa	Lower Slope /Plains	Lower Slope /Plains	Lowlying floodplain	Lowlying floodplain	Major drainage line / Creek	Escarpment / steep slope into pit
Community	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Acacia Shrubland	Triodia Hummock Grassland
Species									
Hakea loranthifolia		P							
Hakea lorea	**P**	**P**	P	**P**	**P**	**P**	**P**	P	
Hakea lorea subsp. lorea		P							
Halgania gustafsenii var gustafsenii		P	P						
Halgania solanacea var. Mt Doreen	P	**P**	**P**	P	P	P	P	P	**P**
Hibiscus burtonii	P	P	P	P	P	P	P	P	
Hibiscus coatesii	P	P		P	P	P	P		
Hibiscus sturtii var. campylochlamys		P	P						
Hibiscus sturtii var. truncatus	P	P	P	P	P	P	P		
Hybanthus aurantiacus	P	P	P	P	P	P	P	P	P
Indigofera brevidens						P	P	P	
Indigofera georgei	P			P	P	P	P	P	
Indigofera monophylla	P	P	P	P	P	P	P	P	P
Ipomoea calobra			P			P	P	P	
Ipomoea polymorpha								P	
Isotropis atropurpurea	P			P	P				
Isotropis forrestii								P	
Kennedia prorepens	**P**			**P**	**P**	**P**	**P**	P	
Keraudrenia nephrosperma	P	P	**P**	P	P				P
Keraudrenia velutina subsp. elliptica	P	P		P	P	**P**	**P**	P	**P**
Keraudrenia velutina subsp. velutina	P	P		P	P	**P**	**P**		
Maireana melanocoma	P			P	P				
Maireana planifolia villosa	P			P	P				
Maireana triptera		P							
Maireana villosa		P	P			P	P		
Melaleuca glomerata								**P**	
Melhania oblongifolia						P	P		
Mirbelia viminalis		P	P			P	P		**P**
Mollugo molluginea	P			P	P				
Panicum effusum						P	P	P	
Paraneurachne muelleri	P	P	P	P	P	P	P	P	
Paspalidium clementii			P						
Paspalidium rarum								**P**	
Perotis rara		P							
Petalostylis labicheoides	P		P	P	P	P	P	**P**	
Phyllanthus maderaspatensis								P	
Pluchea dentex								P	
Pluchea dunlopii			P						
Portulaca oleracea	P			P	P				
Psydrax latifolia		P							
Psydrax suaveolens		P				P	P		

Highlighted species of significance to Nyiyaparli people*

Approx %Cover	
<1	**P**
1-20	**P**
21-40	**P**
41- 60	**P**
61-80	**P**
>80	**P**

Domain	OSA			Infrastructure	Road / rail / corridors	TSF	Mine Pit		
Landform	Lower Slope /Plains	Mid Slope	Crest/Mesa	Lower Slope /Plains	Lower Slope /Plains	Lowlying floodplain	Lowlying floodplain	Major drainage line / Creek	Escarpment / steep slope into pit
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Species									
Pterocaulon serrulatum			P			P	P	P	
Pterocaulon sphaeranthoides	P			P	P				P
Ptilotus astrolasius						P	P		
Ptilotus astrolasius var. astrolasius	**P**			**P**	**P**	**P**	**P**		
Ptilotus calostachyus	P	P	P	P	P	P	P		P
Ptilotus exaltatus	P			P	P				
Ptilotus exaltatus var. exaltatus			P						
Ptilotus obovatus	P	P	P	P	P	P	P	P	P
Ptilotus polystachyus var. polystachyus	P			P	P				
Ptilotus rotundifolius		P	P						
Rhagodia eremaea	P	P	P	P	P				
Rhyncharrhena linearis	P	P	P	P	P				
Rhynchosia minima						P	P	**P**	
Rulingia luteiflora	P	P		P	P	P	P	P	
Rutidosis helichrysoides subsp. helichrysoides		P							
Santalum lanceolatum	P			P	P	**P**	**P**	**P**	
Scaevola browniana		P	P						P
Scaevola parvifolia						P	P		
Scaevola parvifolia subsp. pilbarae	P			P	P	P	P		
Scaevola spinescens		P							
Senna artemisioides			P						
Senna artemisioides subsp. filifolia								P	
Senna artemisioides subsp. helmsii	P	P	P	P	P	P	P	P	
Senna artemisioides subsp. oligophylla	**P**	P		**P**	**P**	**P**	**P**	P	
Senna artemisioides subsp. oligophylla x helmsii		P	P						P
Senna glaucifolia		P							
Senna glutinosa subsp. glutinosa	P	P	P	P	P				**P**
Senna glutinosa subsp. luerssenii	P	P	P	P	P	P	P		P
Senna glutinosa subsp. oligophylla luerssenii	P			P	P				
Senna glutinosa subsp. pruinosa	P	P	P	P	P	P	P	P	
Senna sericea	P	P		P	P				
Senna sp. Meekatharra (E. Bailey 1-26)	P	P	P	P	P			P	
Sida arenicola	P	P	P	P	P	P	P	**P**	
Sida cardiophylla	P	P	P	P	P				
Sida clementii						P	P	P	
Sida fibulifera								P	
Sida pilbarensis	P			P	P				
Sida platycalyx		P	P						
Sida sp. golden calyces	P			P	P				
Solanum centrale	P	P	P	P	P				P
Solanum lasiophyllum	P	P	P	P	P	P	P	P	

Highlighted species of significance to Nyiyaparli people*

Approx %Cover	
<1	P
1-20	P
21-40	P
41- 60	P
61-80	P
>80	P

Domain	OSA			Infrastructure	Road / rail / corridors	TSF	Mine Pit		
Landform	Lower Slope /Plains	Mid Slope	Crest/Mesa	Lower Slope /Plains	Lower Slope /Plains	Lowlying floodplain	Lowlying floodplain	Major drainage line / Creek	Escarpment / steep slope into pit
Community	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Triodia Hummock Grassland	Acacia Shrubland	Triodia Hummock Grassland
Species									
Solanum ellipticum									
Solanum horridum	P	P		P	P				P
Solanum lasiophyllum	P	P	P	P	P				P
Stenopetalum decipiens		P							
Streptoglossa decurrens								P	
Streptoglossa macrocephala	P			P	P				
Tephrosia rosea								P	
Tephrosia rosea var. glabrior								P	
Themeda triandra	**P**			**P**	**P**	**P**	**P**	**P**	
Trianthema glossostigma						P	P		
Tribulus suberosus	P	P	P	P	P	P	P		
Triodia basedowii	**P**	**P**	**P**	**P**	**P**	**P**	**P**	**P**	**P**
Triodia epicata	**P**	P		**P**	**P**	**P**	**P**	**P**	
Triodia pungens								**P**	
Triodia schinzii	P			P	P	**P**	**P**	**P**	
Triodia sp. Shovelanna Hill	**P**	**P**	**P**	**P**	**P**	**P**	**P**		
Triumfetta chaetocarpa									P
Waltheria virgata			P						
Wurmbea deserticola	P		P	P	P				
Yakirra australiensis						P	P		

Highlighted species of significance to Nyiyaparli people*

Approx %Cover	
<1	**P**
1-20	**P**
21-40	**P**
41- 60	**P**
61-80	**P**
>80	**P**

*Sources: KNAC (2023) Nyiyaparli People & Country Plan. Fortescue Marsh. 2023 - 2032; BHP Ethnobotanical Species Database (2023)

Appendix K. Indicator species and plant cover criteria

Indicator species and plant cover targets for the land use of natural environments for managed resource protection

Target Vegetation Types			Grass Steppe	Shrub Steppe	Low Tree Steppe	Low Woodland	Riparian Woodland
Indicator Species	Presence of dominant and common species from each Target Vegetation Type *Note, if more than one type is applicable, choose the most representative for each rehabilitated area*	At least one dominant species from each strata present >70% of common species present	Dominant Trees -	Dominant Trees *Corymbia hamersleyana*	Dominant Trees *Corymbia hamersleyana* *Eucalyptus leucophloia subsp. leucophloia* *E. gamophylla*	Dominant Trees *Acacia aneura* *A. ayersiana* *A. minyura* *A. paraneura* *Corymbia hamersleyana* *Eucalyptus leucophloia subsp. leucophloia*	Dominant Trees *Eucalyptus camaldulensis var. obtusa* *E. victrix* *Melaleuca glomerata* *M. argentea*
			Dominant Shrubs *Acacia tumida var. pilbarensis* *A. eriopoda* *A. ptychophylla* *Grevillea wickhamii*	Dominant Shrubs *Acacia bivenosa* *A. aneura* *A. inaequilatera* *A. pyrifolia* *Grevillea pyramidalis subsp. Leucadendron* *G. wickhamii* *Hybanthus aurantiacus* *Senna notabilis* *S. glutinosa subsp. glutinosa*	Dominant Shrubs *Acacia ancistrocarpa* *A. atkinsiana* *A. bivenosa* *A. aneura* *A. hiliana* *Hakea lorea* *H. chordophylla* *Senna artemisioides* *S. glutinosa subsp. glutinosa* *S. pleurocarpa var. pleurocarpa* *Solanum lasiophyllum*	Dominant Shrubs *Acacia adoxa var. adoxa* *A. pruinocarpa* *A. tenuissima* *Eremophila spp. Grevillea wickhamii* *Hakea chordophylla* *Hybanthus aurantiacus* *Indigofera monophyla* *Senna artemisioides subsp. Oligophylla* *S. glutinosa subsp. glutinosa*	Dominant Shrubs *Acacia ampliceps* *A. pyrifolia var. pyrifolia* *Atalaya hemiglauca* *Crotalaria novae-hollandiae subsp. novae-hollandiae* *Cymbopogon ambiguous* *Cyperus vaginatus* *Gossypium robinsonii* *Indigofera monophyla* *Petalostylis labicheoides*
			Dominant Grasses: *Triodia basedowii* *T. epactia* *T. pungens* *T. schinzii*	Dominant Grasses: *Triodia wiseana* *T. basedowii* *T. pungens* *T. vanleeuwenii* *T. epactia*	Dominant Grasses: *Triodia wiseana* *T. basedowii* *T. schinzii* *T. vanleeuwenii* *Eriachne pulchella subsp. pulchella*	Dominant Grasses: *Triodia basedowii* *T. pungens* *T. wiseana* *Aristida spp.* *Cymbopogon spp.* *Eriachne pulchella subsp. Pulchella*	Dominant Grasses/Sedges: *Aristida spp.* *Enneapogon spp.* *Eragrostis spp.* *Eriachne mucronate* *Eriachne tenuiculmis* *Themeda triandra*

Target Vegetation Types			Grass Steppe	Shrub Steppe	Low Tree Steppe	Low Woodland	Riparian Woodland
Species Richness	Presence of perennial species	No perennial species recorded in aggregated 50 x 50 m plots	8 - 16.5	15 - 19	16 - 29	28 - 30	14 - 30
Plant Cover	% cover for each stratum and each Vegetation Type to be	Trees	0 - 1	1 - 10	1 -10	2 - 10	10 - 70
		Shrubs	0.2 - 7	3 - 7	2 - 10	2.6 - 6.8	2 -10
		Hummock Grasses	15 - 34	19 - 33	20 - 30	17 - 33	
		Other Grasses	0.01 - 0.4	0.02 - 0.16	0.04 - 0.62	0.2 - 1	
		Herbs	0.1 - 0.2	0.1 - 1	0.05 - 0.4	0.06 - 0.27	

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Indicator Species and Cover Targets for Pastoral Grazing Land uses

Target Vegetation Types			Grass Steppe	Shrub Steppe	Low Tree Steppe	Low Woodland	Riparian Woodland
Indicator Species	Presence of dominant and common species from each Target Vegetation Type *Note, if more than one type is applicable, choose the most representative for each rehabilitated area*	At least one dominant species from each strata present >50% of common species present	Dominant Trees -	Dominant Trees *Corymbia hamersleyana*	Dominant Trees *Corymbia hamersleyana* *Eucalyptus leucophloia subsp. leucophloia* *E. gamophylla*	Dominant Trees *Acacia aneura* *A. ayersiana* *A. minyura* *A. paraneura* *Corymbia hamersleyana* *Eucalyptus leucophloia subsp. leucophloia*	Dominant Trees *Eucalyptus camaldulensis var. obtusa* *E. victrix* *Melaleuca glomerata* *M. argentea*
			Dominant Shrubs *Acacia tumida var. pilbarensis* *A. eriopoda* *A. ptychophylla* *Grevillea wickhamii*	Dominant Shrubs *Acacia bivenosa* *A. aneura* *A. inaequilatera* *A. pyrifolia* *Grevillea pyramidalis subsp. Leucadendron* *G. wickhamii* *Hybanthus aurantiacus* *Senna notabilis* *S. glutinosa subsp. glutinosa*	Dominant Shrubs *Acacia ancistrocarpa* *A. atkinsiana* *A. bivenosa* *A. aneura* *A. hiliana* *Hakea lorea* *H. chordophylla* *Senna artemisioides* *S. glutinosa subsp. glutinosa* *S. pleurocarpa var. pleurocarpa* *Solanum lasiophyllum*	Dominant Shrubs *Acacia adoxa var. adoxa* *A. pruinocarpa* *A. tenuissima* *Eremophila spp. Grevillea wickhamii* *Hakea chordophylla* *Hybanthus aurantiacus* *Indigofera monophyla* *Senna artemisioides subsp. Oligophylla* *S. glutinosa subsp. glutinosa*	Dominant Shrubs *Acacia ampliceps* *A. pyrifolia var. pyrifolia* *Atalaya hemiglauca* *Crotalaria novae-hollandiae subsp. novae-hollandiae* *Cymbopogon ambiguous* *Cyperus vaginatus* *Gossypium robinsonii* *Indigofera monophyla* *Petalostylis labicheoides*
			Dominant Grasses: *Triodia basedowii* *T. epactia* *T. pungens* *T. schinzii*	Dominant Grasses: *Triodia wiseana* *T. basedowii* *T. pungens* *T. vanleeuwenii* *T. epactia*	Dominant Grasses: *Triodia wiseana* *T. basedowii* *T. schinzii* *T. vanleeuwenii* *Eriachne pulchella subsp. pulchella*	Dominant Grasses: *Triodia basedowii* *T. pungens* *T. wiseana* *Aristida spp.* *Cymbopogon spp.* *Eriachne pulchella subsp. Pulchella*	Dominant Grasses/Sedges: *Aristida spp.* *Enneapogon spp.* *Eragrostis spp.* *Eriachne mucronate* *Eriachne tenuiculmis* *Themeda triandra*

Target Vegetation Types			Grass Steppe	Shrub Steppe	Low Tree Steppe	Low Woodland	Riparian Woodland
Species Richness	Presence of perennial species	Number of perennial species recorded in aggregated 50 x 50 m plots	>8	>15	>16	>28	>14
Plant Cover	% cover for each strata and each Vegetation Type to be > Q1 for relevant reference sites	Trees	>0	>1	>1	>2	>10
		Shrubs	>0.2	>3	>2	>2.6	>2
		Hummock Grasses	>15	>19	>20	>17	
		Other Grasses	>0.01	>0.02	>0.04	>0.2	
		Herbs	>0.1	>0.1	>0.05	>0.06	

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Appendix L. Supporting information for rehabilitated landforms

L-1. OB18 North OSA

Materials characterisation and erosion modelling

A bulk sample of the materials used in the construction of the North OSA was taken by Landloch (2015a) and subjected to rainfall and overland flow simulation testing. The results of these tests were used to derive input parameters for a WEPP model. WEPP modelling was conducted for the linear slope configurations outlined in Table L 1 and identified that linear slopes up to 10 m high with slopes between 12° and 18° would have acceptable rates of erosion without the addition of rock armour. If the local competent rock were mixed with the North OSA material to achieve a D_{50} of 65 mm (assuming a specific gravity of 2.8 g/cm^3), then erosion modelling indicates that a 30 m high slope with a 12° slope would achieve acceptable erosion rates (Table L 1) (Landloch, 2015a).

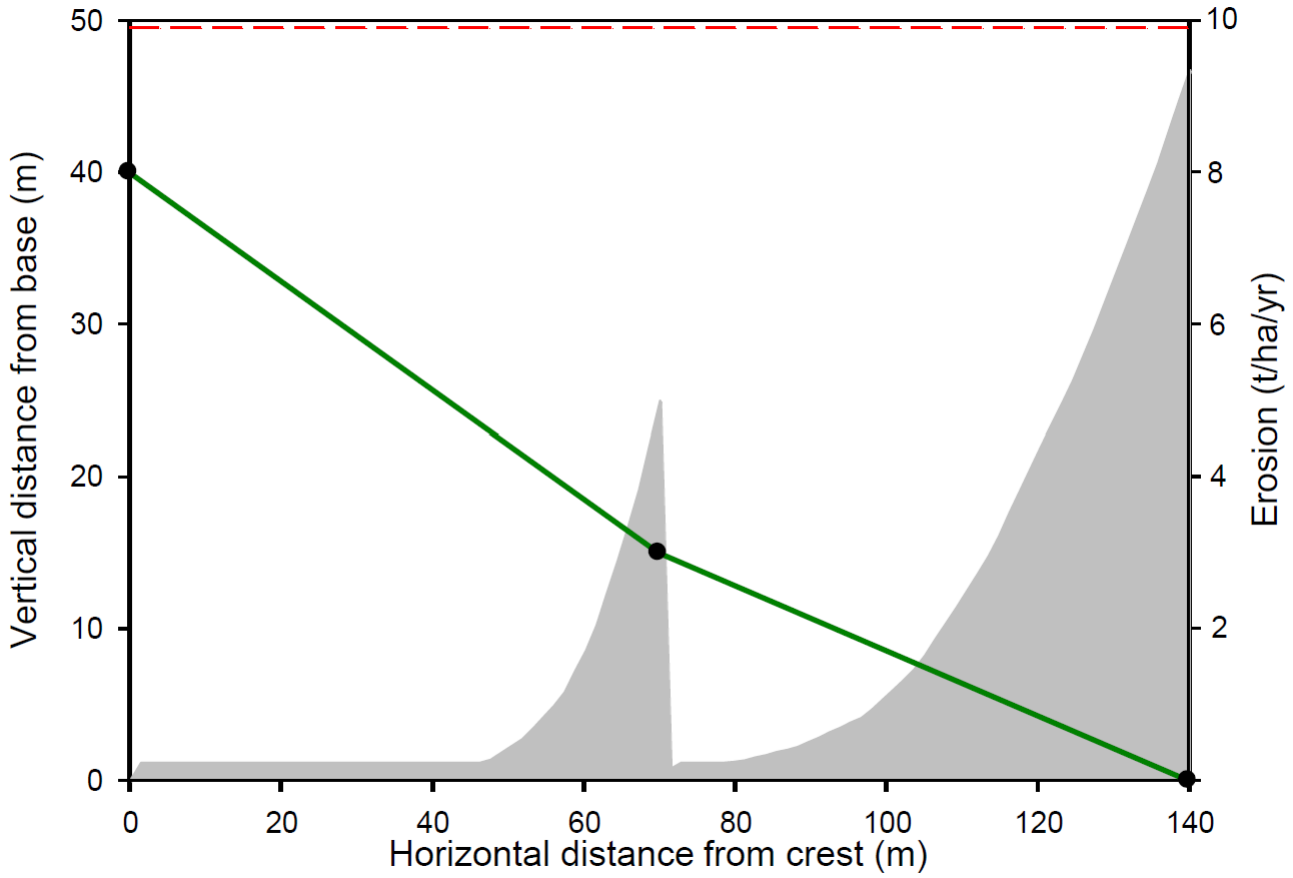
Table L 1 Erosion modelling results for North OSA

Batter Configuration			Long-term Annual Erosion Predictions (t/ha/y)			
Height (m)	Gradient (°)	Footprint (m)	No Rock Armour		With Rock Armour	
			Avg	Peak	Avg	Peak
10	12	47.0	0.9	5.2	Not analysed	
10	15	37.3	l .3	7.2		
10	18	30.8	l .7	8.7		
30	12	141.0	9.9	27.6	1.7	9.8
30	15	112.0	13.2	35.7	2.62	13.9
30	18	92.3	15.9	42	3.5	17.4
40	12	188.2	12.7	28.2	3.6	16.3
40	15	149.3	16.9	36.3	5.37	22.7
40	18	123.l	20.6	43.6	6.91	28
50	12	235.0	14.l	27	Not analysed	
50	15	187.0	18.7	34.5		
50	18	154.0	23.3	42.6		

Notes: Orange shaded cells indicate batter configurations with predicted average erosion values greater than 6 t/ha/y or maximum values greater than 12 t/ha/y. Cells shaded green indicate batter configurations with predicted erosion values less than these thresholds.

Source: Landloch (2015a)

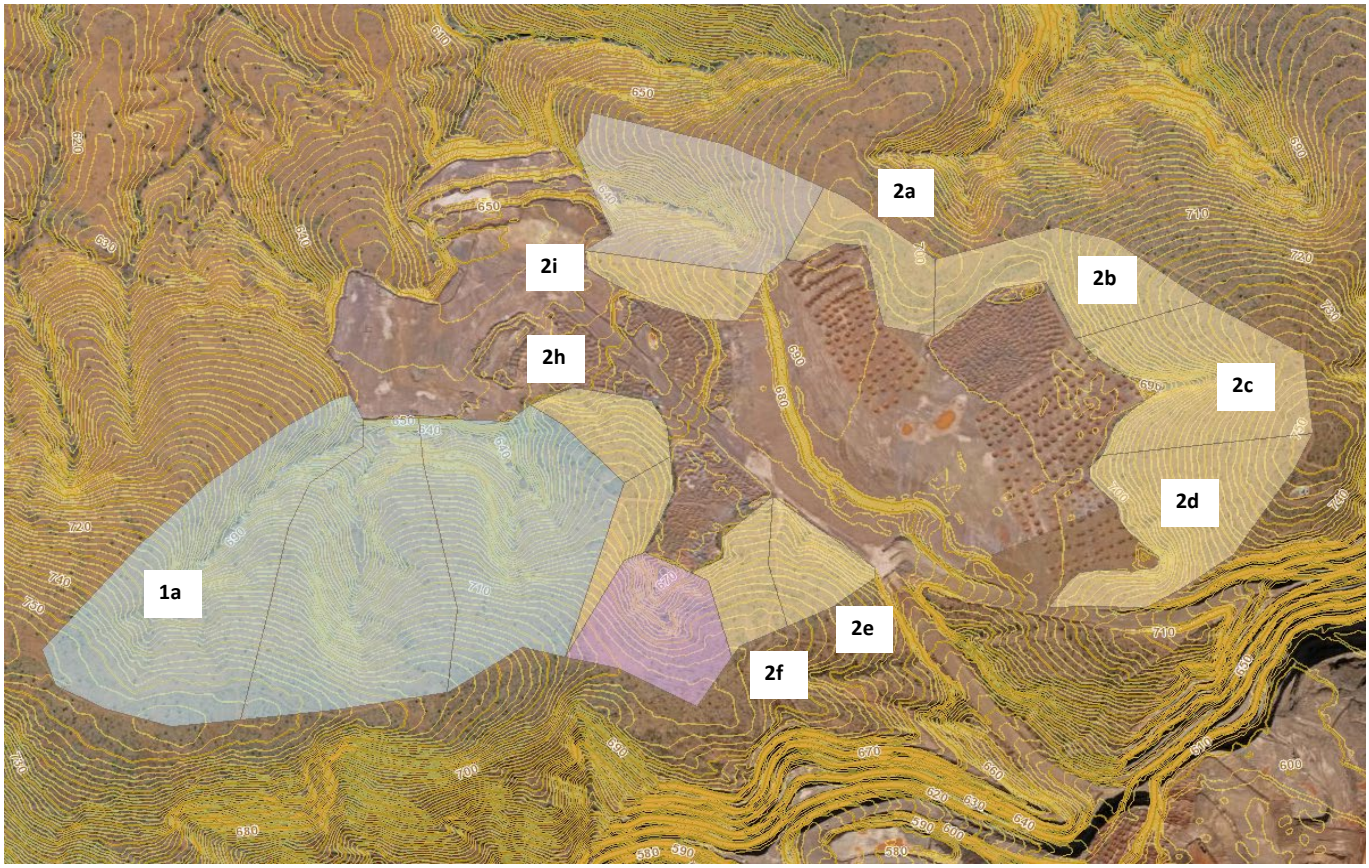
Further WEPP modelling of a two-section concave slope of 12° between 0 and 15 m and 20° between 15 and 40 m would result in an average erosion rate of 1.85 t/ha/y and a peak erosion rate of 9.4 t/ha/yr (Figure L 1) (Landloch, 2015a). This information was used to inform the design of the North OSA described in Section 9.3.1.1.



Notes: design assumes addition of competent rock (specific gravity of 2.8 g/cm^3) to achieve a D_{50} of 65 mm
Source: Landloch (2015a)

Figure L 1 Erosion rates for concave design option for North OSA concave slope with rock armour

North OSA catchments

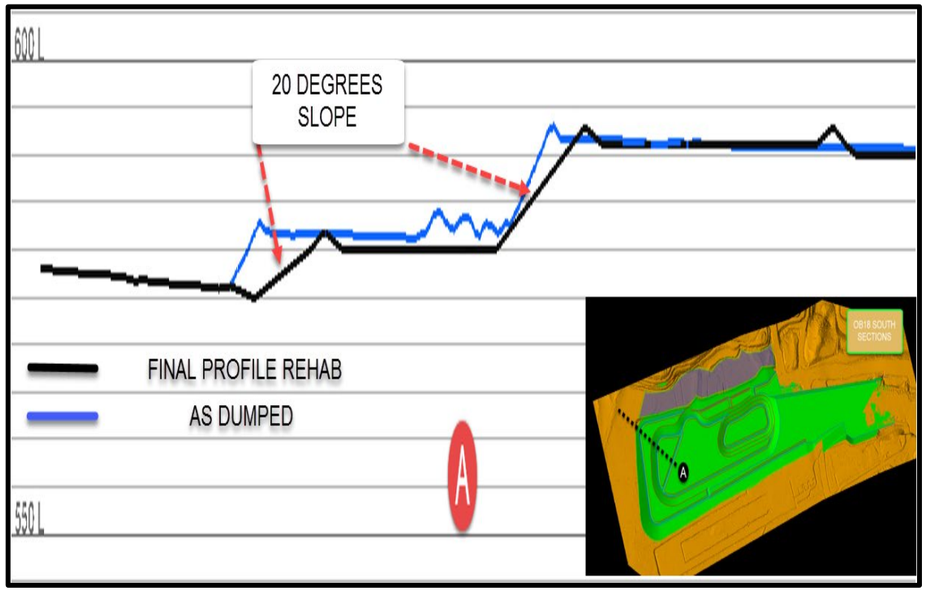


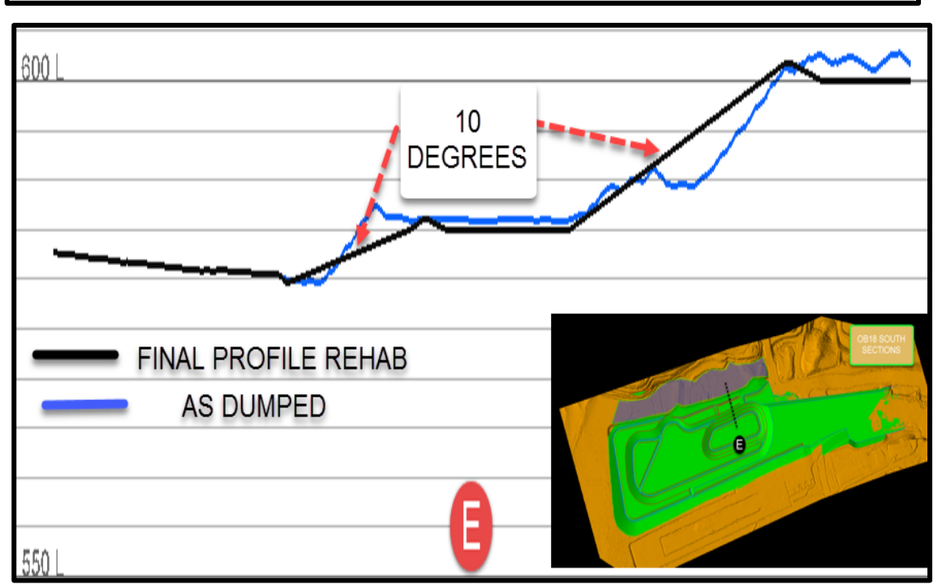
North OSA catchment volumes for 72-hour ARI events

Catchments	Discharge	Catchment Area (ha)	Q10,000 72hr Rainfall (mm)	Run-off Coefficient	Vol Runoff (m3)	Q100 72hr Rainfall (mm)	Q100 Peak Flow (m3/s)	Q10,000 Peak Flow (m3/s)	Max Vel	Size of Rip Rap
1 - blue	To sump	31.97	507	1	162,088	219	4.6	10.6	5.7	2.0 tonne
2a - yellow	To OSA	2.3	507	1	11,661	219				
2b	To OSA	4.09	507	1	20,736					
2c	To OSA	5.89	507	1	29,862					
2d	To OSA	5.7	507	1	28,899					
2e	To OSA	1.89	507	1	9,582					
2f	To OSA	1.82	507	1	9,227					
2g	To OSA	1.4	507	1	7,098					
2h	To OSA	1.85	507	1	9,380					
2i	To OSA	1.77	507	1	8,974					
3 - purple	To sump	3.71	507	1	18,810	219	2.7	6.3	5.9	4.0 tonne
4 - grey	To sump	6.55	507	1	33,209	219	4.6	10.6	5.9	4.0 tonne

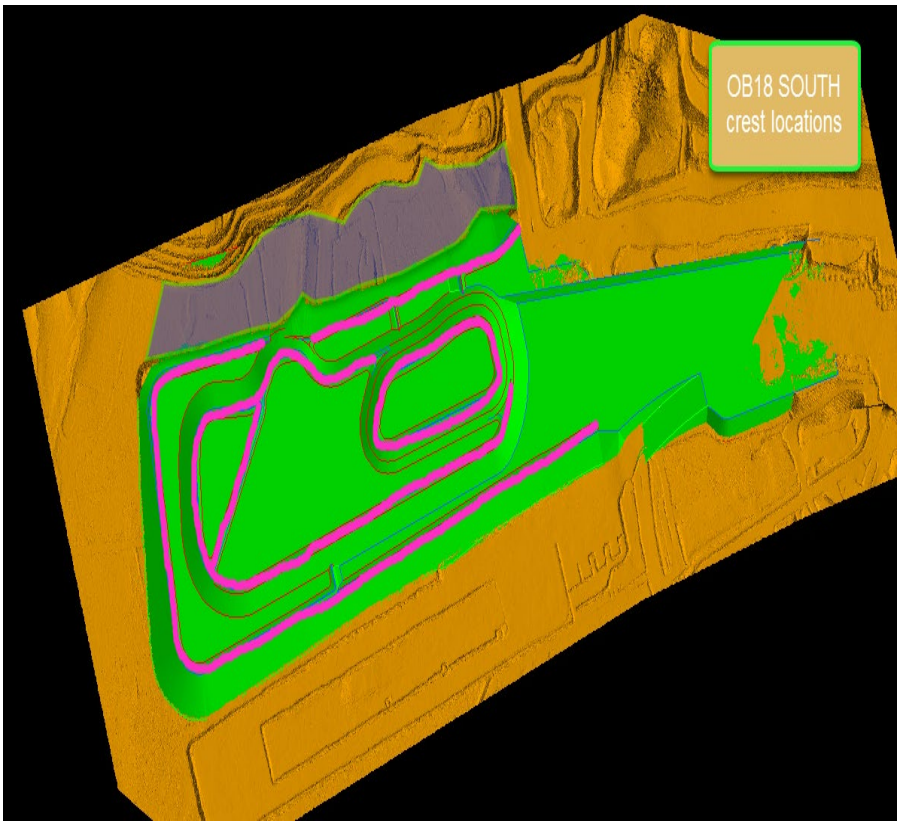
L-2. OB18 South OSA

OB18 South OSA example sections

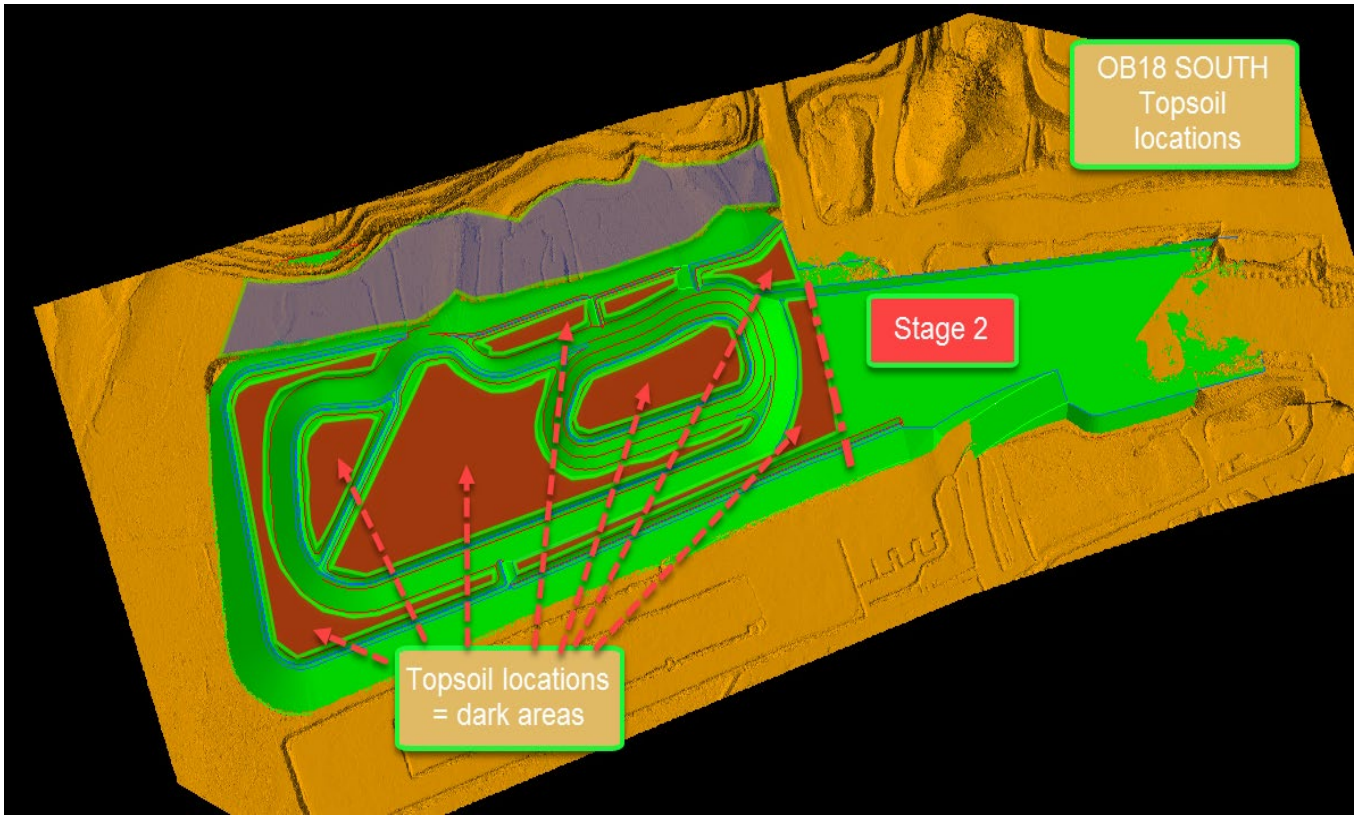




OB18 South OSA crest bund locations



OB18 South OSA topsoil application locations



L-3. Avon catchment run-off

Stormwater volumes discharging on to Avon ISA for 72-hour ARI events

ARI	Q100	Q200	Q500	Q1000	Q2000	Q5000	Q10000
Catchment area (m^2)	60,000	60,000	60,000	60,000	60,000	60,000	60,000
72 hr rainfall (mm)	289	322	365	398	431	474	507
Run-off coefficient	1	1	1	1	1	1	1
Runoff volume (m^3)	17,340	19.309	21,911	23,880	25,849	28,451	30,420

L-4. Jimblebar South OSA

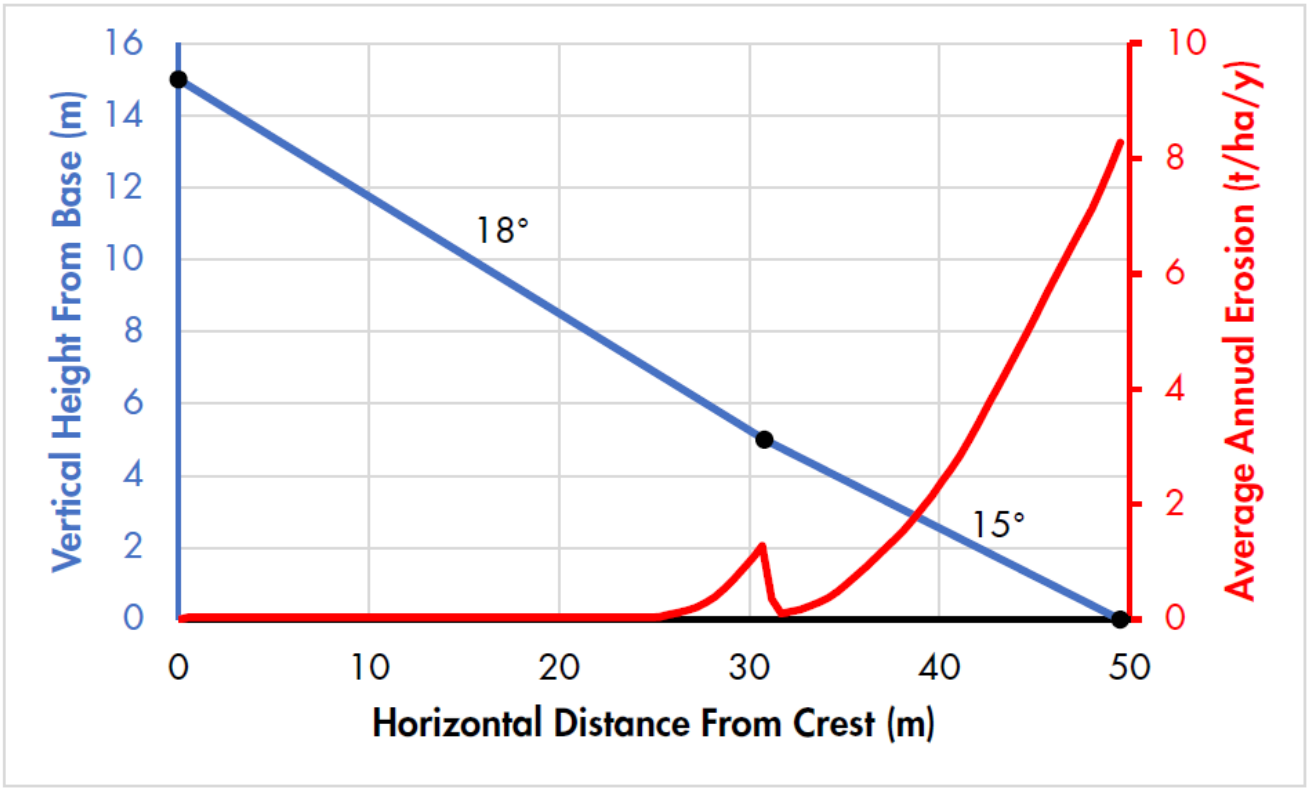
Landloch (2016b) used erosion modelling of Jimblebar hard cap material to inform the landform design for Jimblebar South OSA. The WEPP modelling results are provided in Section 5.3.3.2 and indicated that the hard cap material would be stable on a linear batter with a gradient of 12° and height of 15 m and that linear slope gradients greater than 12° would cause unacceptable[42] erosion rates at the toe of the slope. Landloch (2016b) concluded that:

- Erosion of steeper slopes could be managed by preferential placement of rockier material on the lower 3 m vertical height of the formed batter.
- If selective placement of rockier overburden on the toe of the OSA batter is not an option, a concave option could be used to achieve an acceptable batter profile. This would utilise an 18° upper section (10 m vertical interval), and a 15° lower section (5 m vertical interval) (Figure L 2). This profile is predicted to have a mean average annual erosion rate of 1.3 t/ha/y and a mean peak annual erosion rates of 8.3 t/ha/y.
- The best material for use on the batter slopes is a rocky material that contains a mixture of coarse and fine size materials. When selecting materials for use, the rocks should not all be the same size, and the size distribution should be well graded. Mean rock diameters should be approximately 40 mm. Where rockier materials are placed at the toe of the linear option, a mean rock size of 60 mm should be achieved.

As an outcome of the modelling, Landloch (2016b) recommended that batter slopes be sheeted to a depth of at least 0.5 m with the Jimblebar hard cap materials. It was also noted that:

- As a general rule, a suitable rock mulch would have no more than 10% of rock by weight with diameters exceeding 200 mm, and only 10-20% of the rock with median rock diameters less than 20 mm.
- The surface created should have a rock cover percentage greater than ~20%.

[42] Landforms designed with a predicted long-term average annual erosion rate (averaged over the whole slope) of less than 5t/ha/y, together with a predicted maximum long term average annual erosion rate (at any point on the slope) of less than 10t/ha/y exhibit a low tendency to rill. These erosion threshold values were adopted in this report to differentiate between acceptable and unacceptable slope options (Landloch, 2016b).



Source: Landloch (2016b)

Figure L 2 Concave Profile

Cross sections shown in Figure L 4 to Figure L 9 show the ‘as-dumped’ profile of each of the major OSA slope areas (green lines) along with the final design profile (red line) (see Figure L 3 for location of sections).

Figure L 3 Landform Design Section Locations

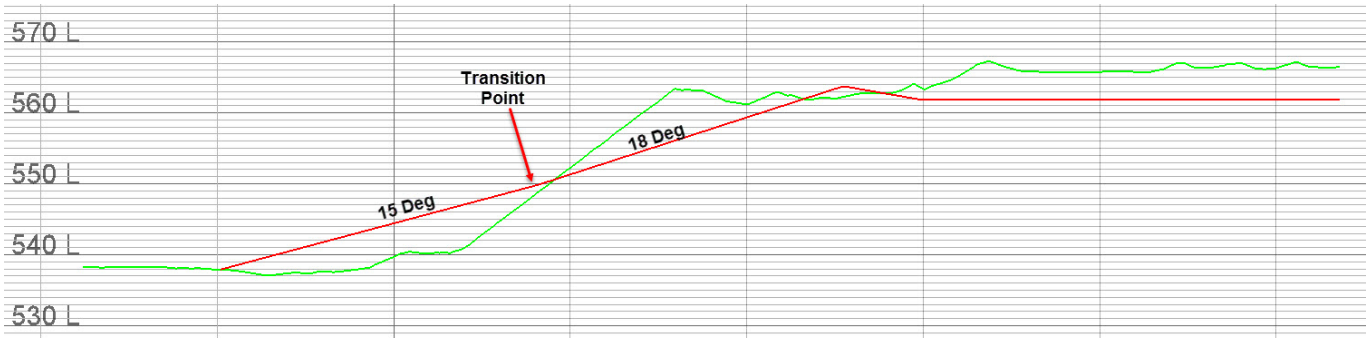


Figure L 4 Section A

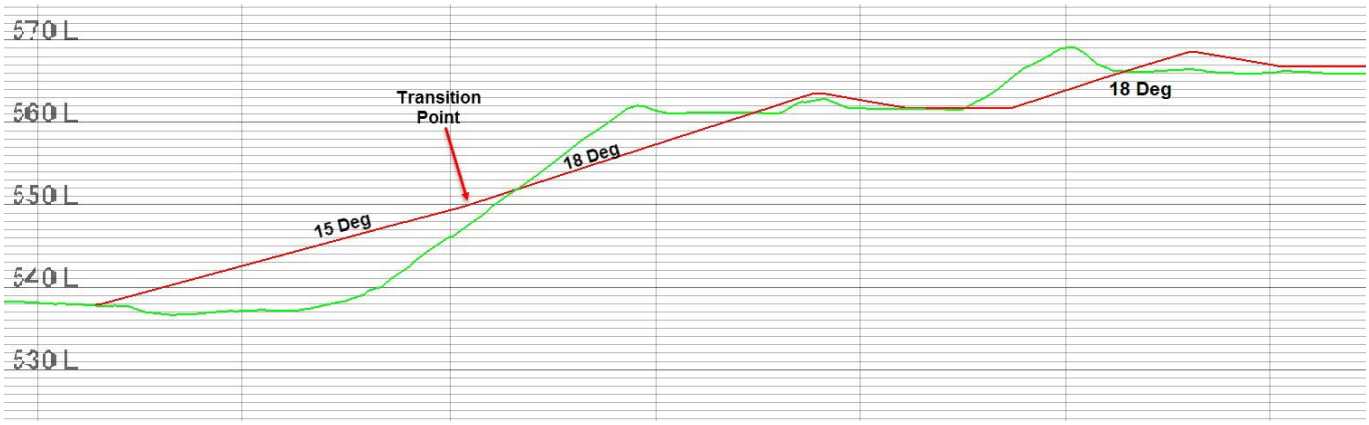


Figure L 5 Section B

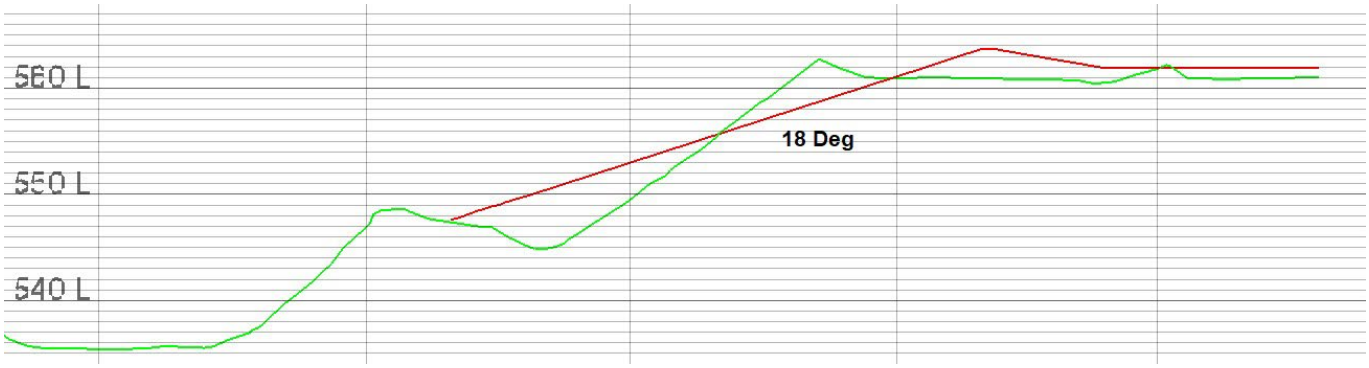


Figure L 6 Section C

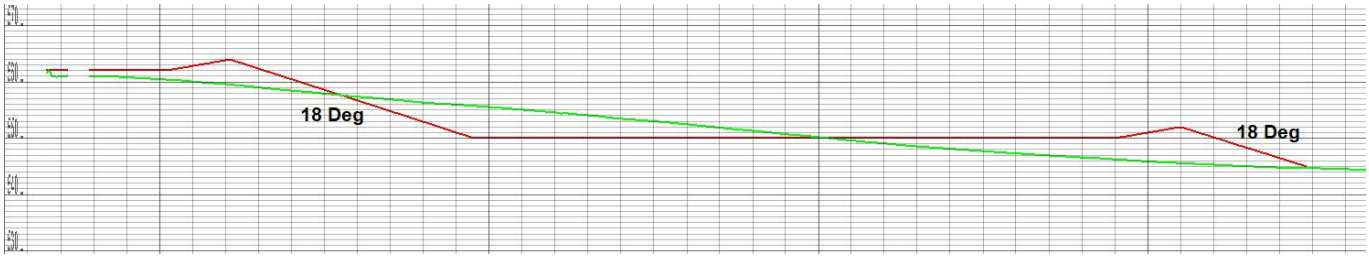


Figure L 7 Section D

Figure L 8 Section E

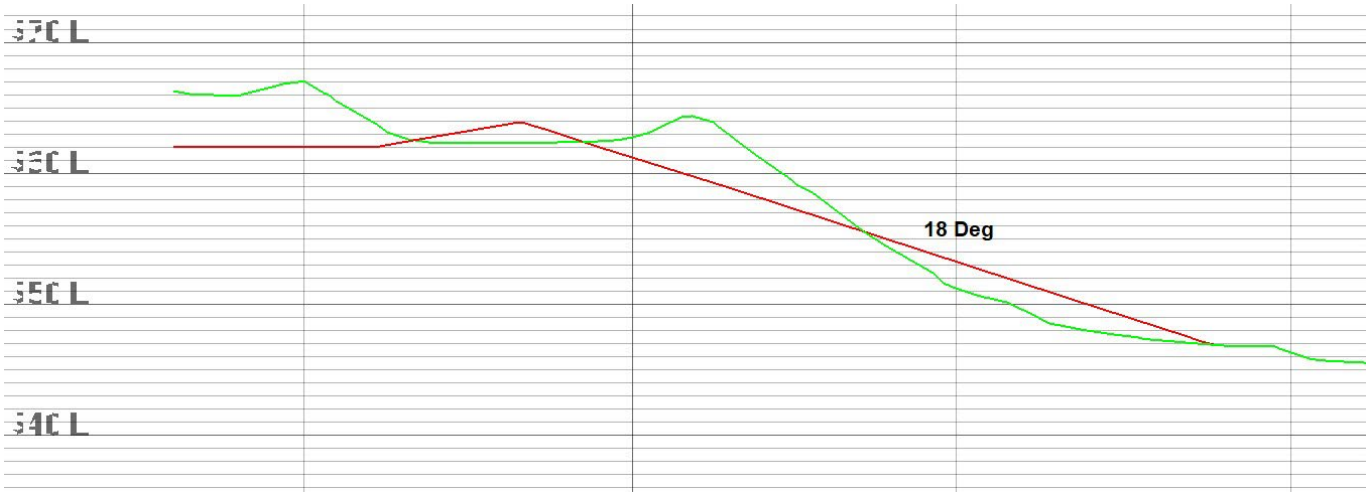


Figure L 9 Section F

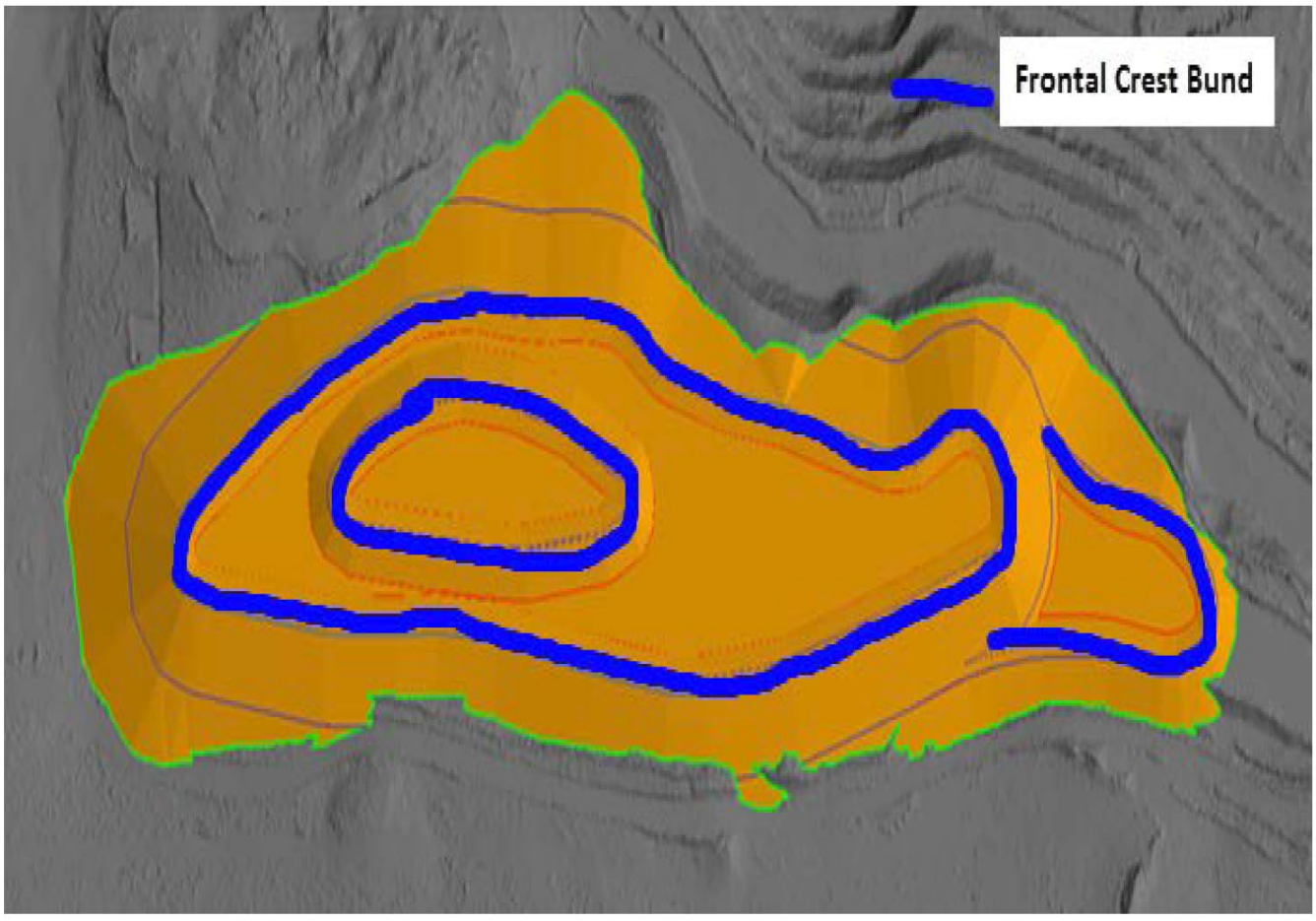
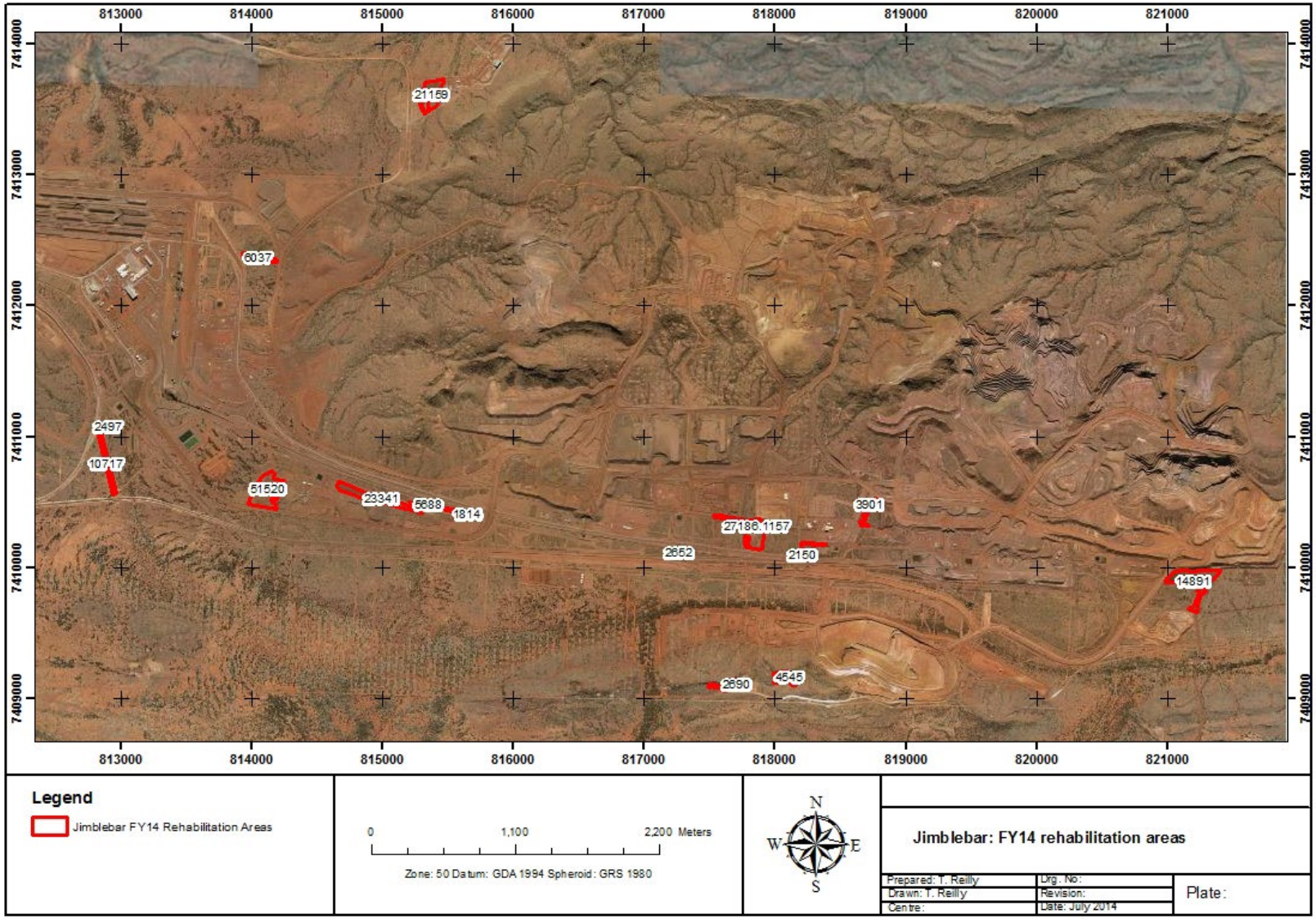
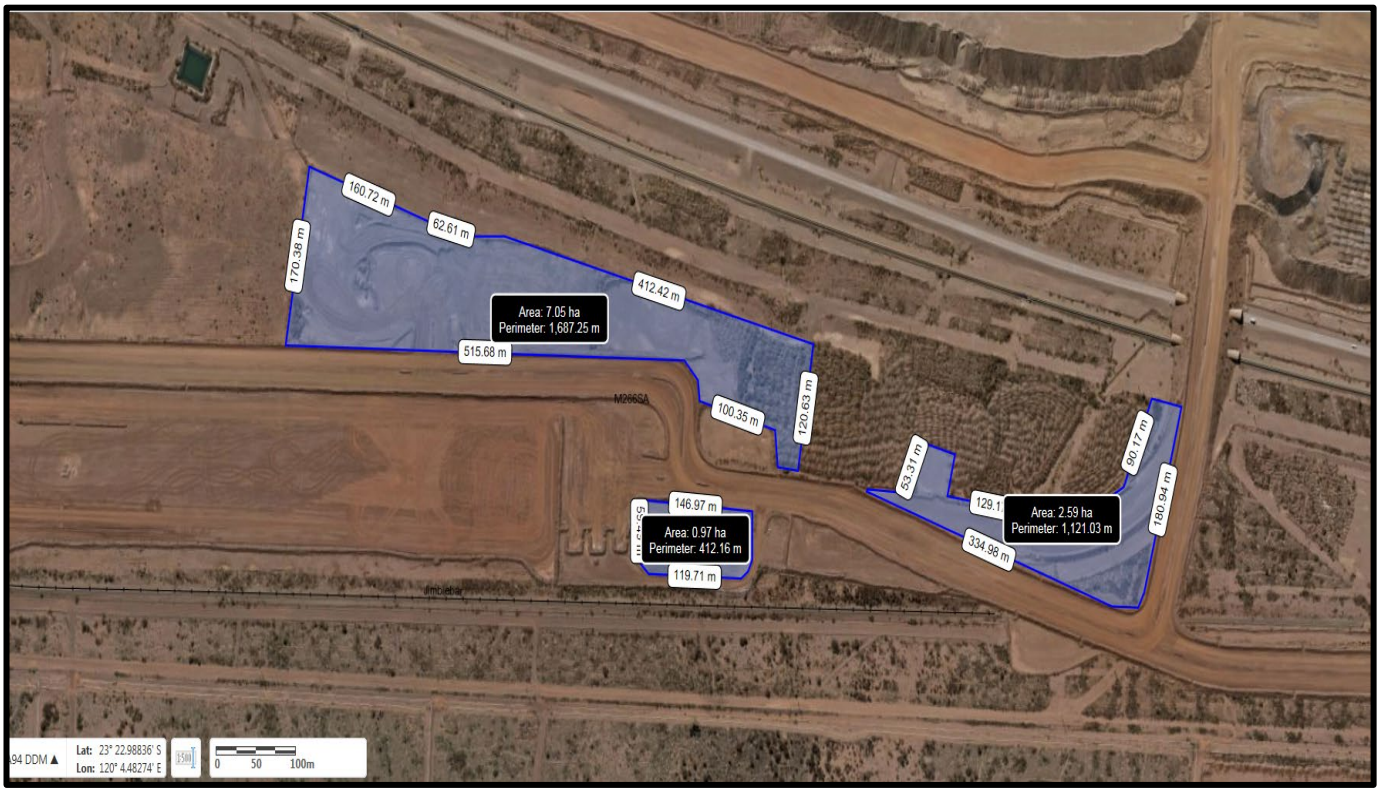


Figure L 10 Frontal crest bund locations

L-5. Location of FY14 infrastructure rehabilitation

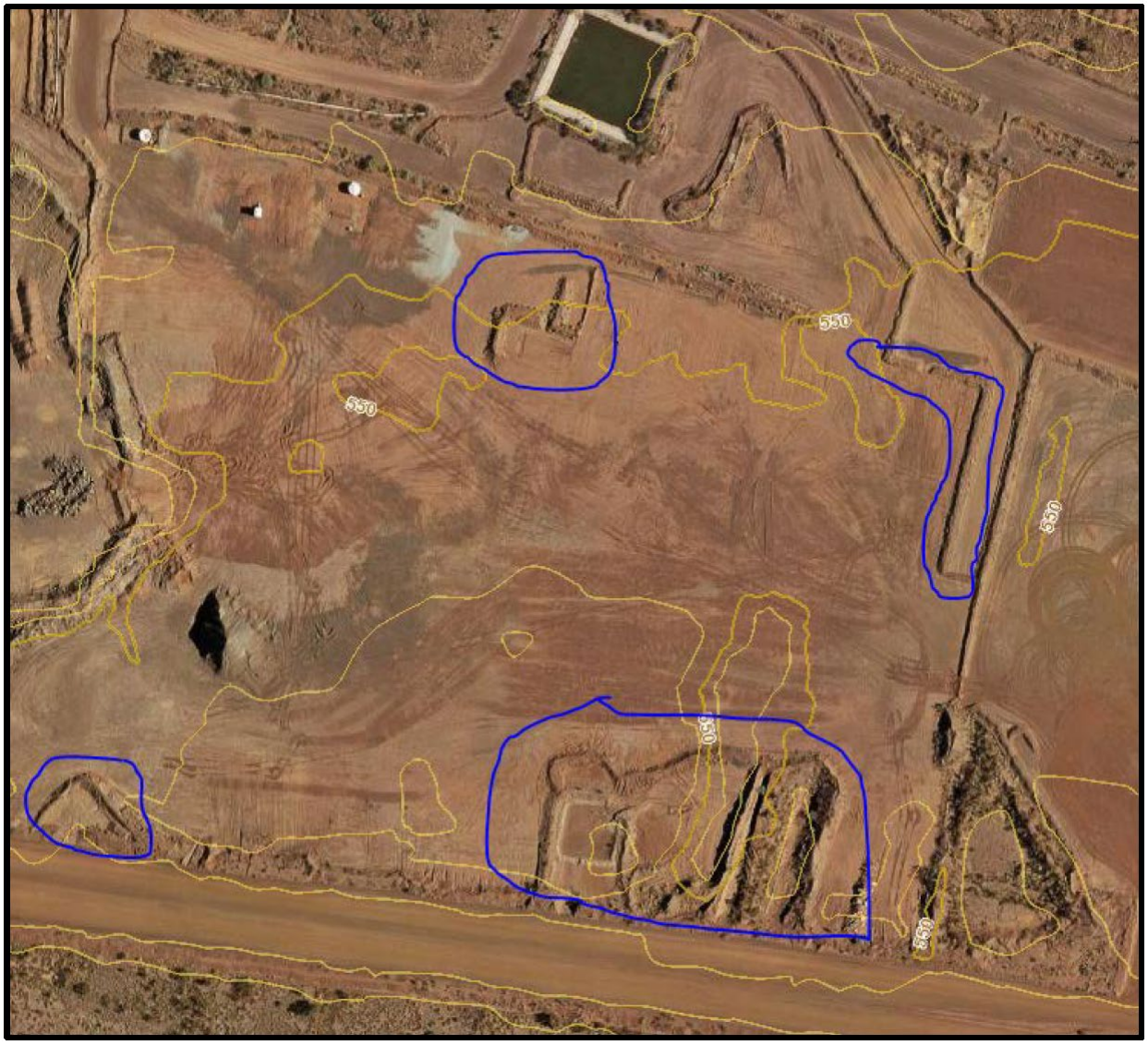


L-6. CSI Stockpile area



L-7. CSI Crusher

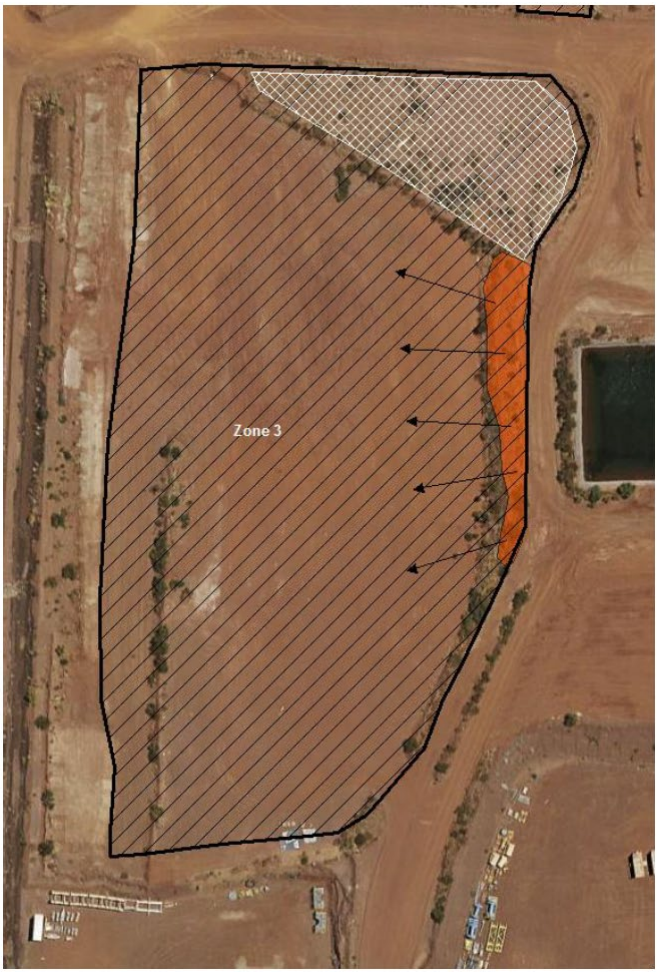
Areas requiring leveling



L-8. Dead Dead Stockpile

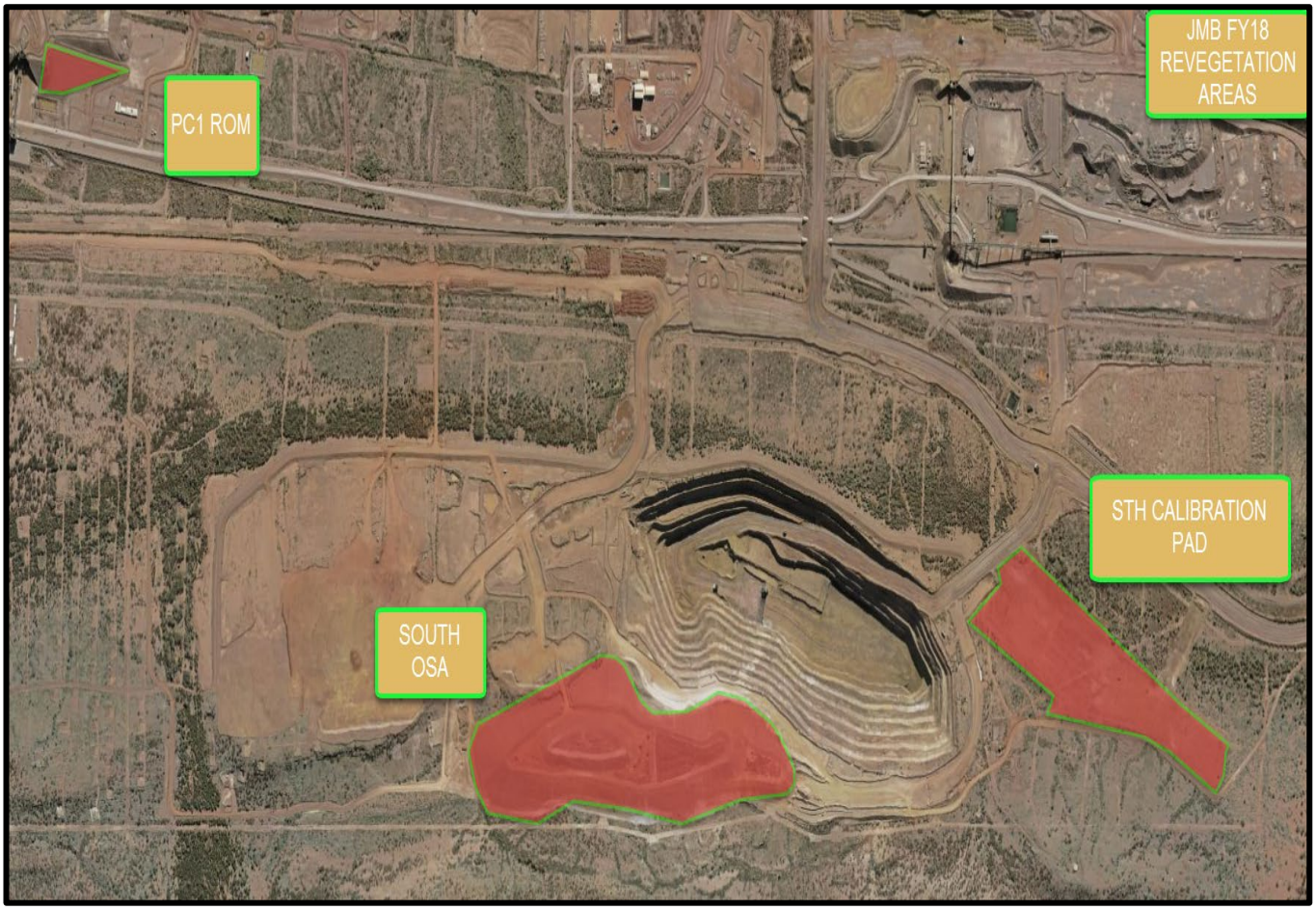
L-9. OHP Laydown area

Zone 3 work plan areas



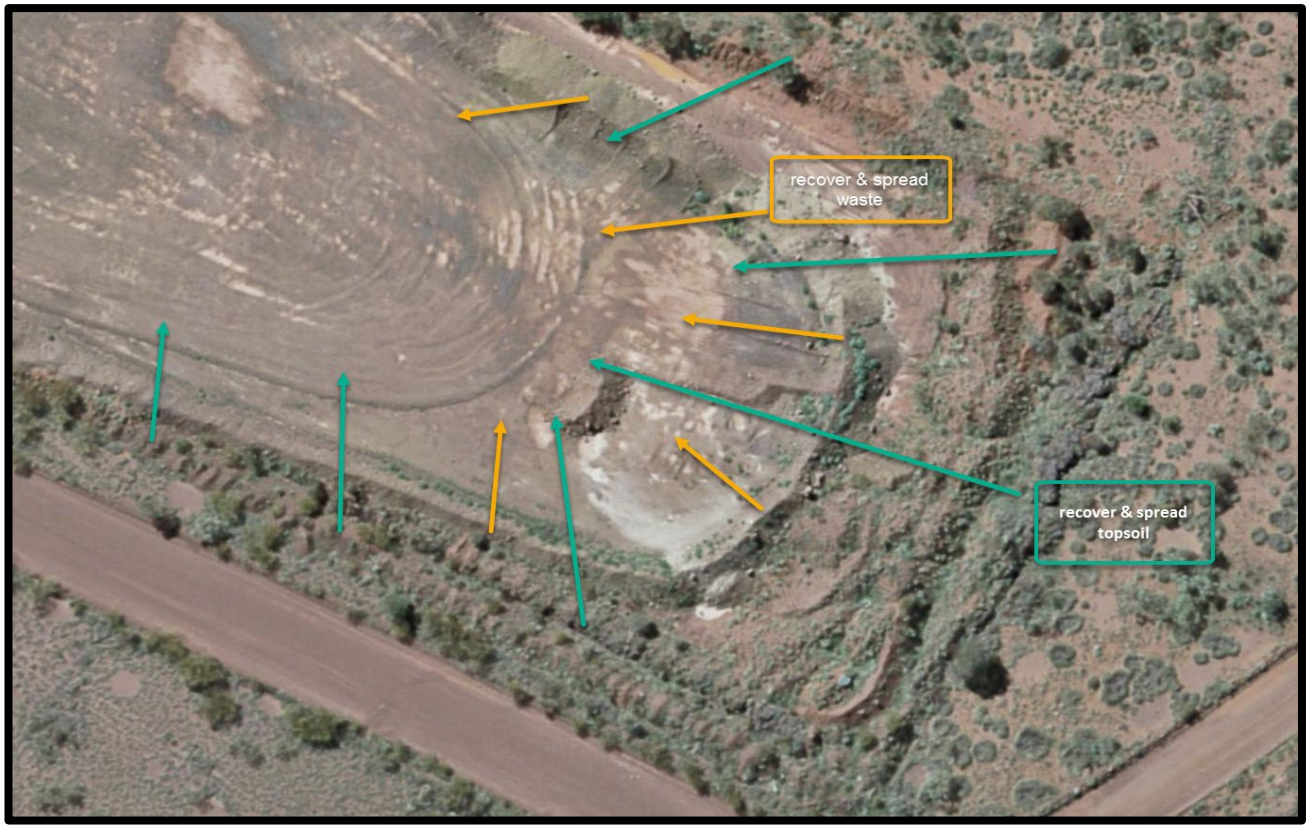
Zone 4 work plan areas

L-10. PC ROM

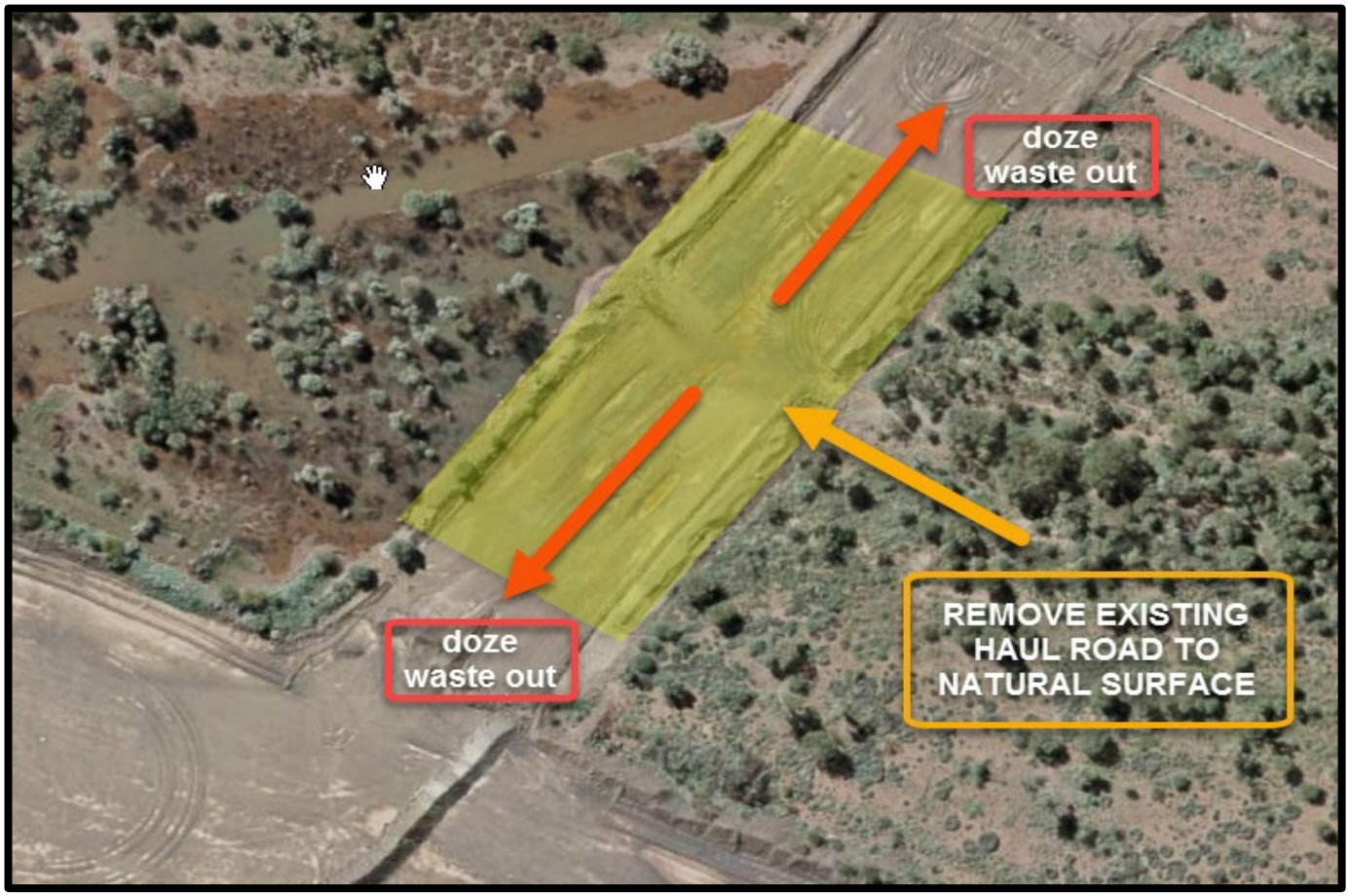


L-11. Calibration Pad

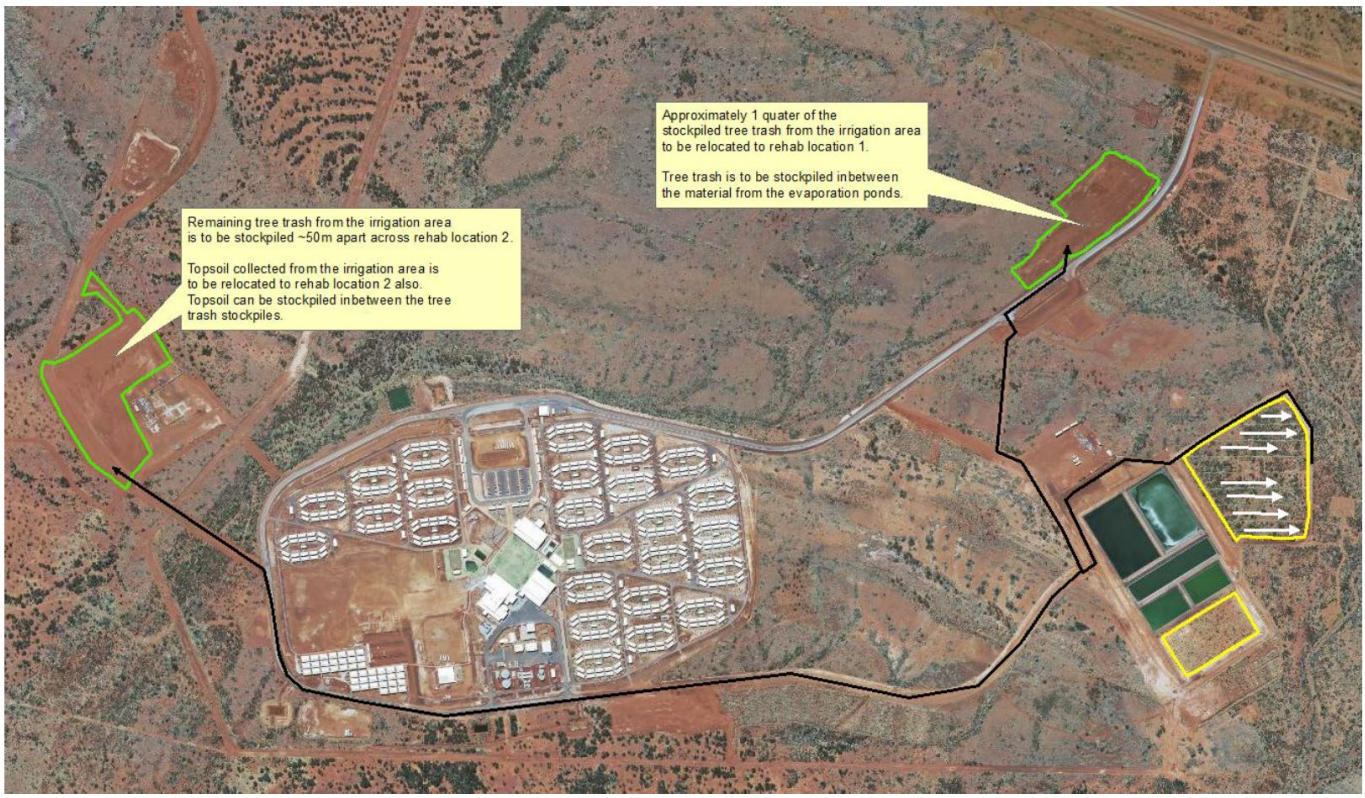
Windrow recovery



Reinstate Coopers Creek

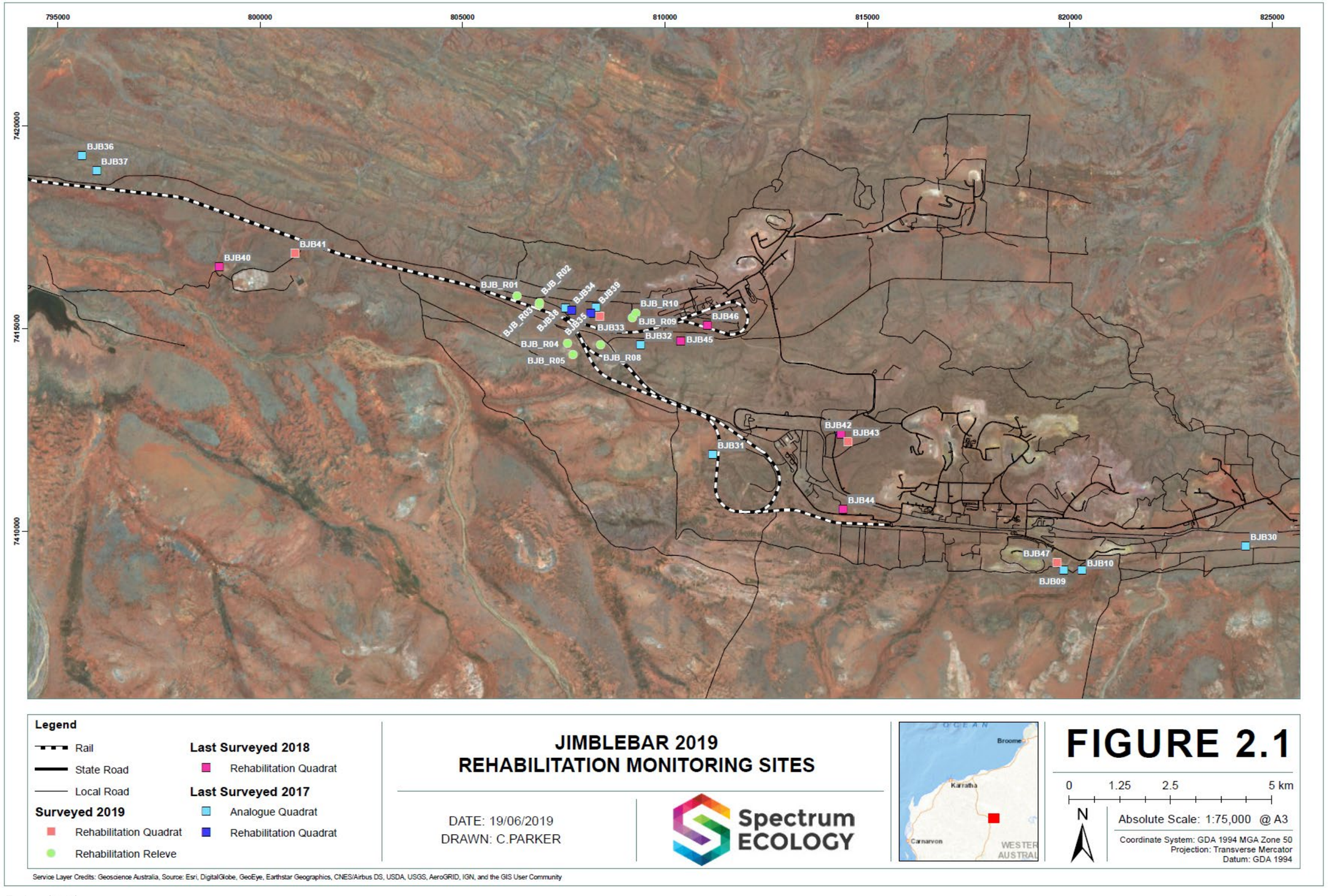


L-12. Warrawandu WWTP



Appendix M. Rehabilitation monitoring

M-1. Rehabilitation monitoring locations



Source: Spectrum Ecology (2019)

M-2. Rehabilitation monitoring procedure

BHP

Rehabilitation Monitoring
Technical Process Instruction

Document number: SPR-IEN-LAND-012
Version: 6.0

Document Control

APPROVER	DATE	CUSTODIAN	REVIEW DATE
Manager HSE Non Mining	August 2022	Superintendent Biodiversity Contamination and Rehabilitation	August 2026

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7.6. Appendix 6 – Plant Species List.....24

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Electronic Approval Record

Business Role	Name
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Document Amendment Record

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Key Stakeholders

Department	Position
HSE	Manger A & I Environment
HSE	Manager Projects Infrastructure and Planning
HSE	Manager BP HSE

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1. Introduction

1.1. Background

This document outlines the rehabilitation monitoring procedures employed at BHP Western Australia Iron Ore (BHPWAIO) rehabilitation sites. It is to be provided to WAIO staff and external consultants engaged to conduct rehabilitation monitoring on behalf of WAIO.

1.2. Objective

The objective is to provide detailed guidance on the methodologies to be used, and under which circumstances they apply. The results from this monitoring data are to be compared with established Vegetation Completion Criteria targets to determine when a rehabilitated site has reached acceptable levels of vegetation development. Vegetation Completion Criteria and its associated rationale are yet to be confirmed. The results of the rehabilitation monitoring program are also to be used to identify sites which may be at risk of not achieving the Vegetation Completion Criteria, and for which additional investigation and management intervention may be required.

1.3. Scope

This document provides a detailed description of the methods used to assess the development of vegetation on rehabilitated sites situated across WAIO's operations. Elements of landform stability and erosion monitoring are included in this procedure, but this procedure does not attempt to cover these areas fully. Fauna monitoring is also not included in this procedure. Monitoring for conservation significant species and communities in rehabilitation is also excluded from this document, as an appropriate monitoring methodology is better tailored to each species and community of interest.

2. Process

Rehabilitation monitoring at WAIO sites are completed using a combination of the following procedures:

- Landform Stability and Vegetation Establishment Inspection (LSVEI)
- Level 1 Rehabilitation Monitoring; and
- Level 2 Rehabilitation Monitoring;
- Remote Sensing

The following sections provide a detailed description of the three field procedures and reporting protocol.

2.1. Landform Stability and Vegetation Inspection

Landform Stability and Vegetation Establishment Inspection (LSVEI) is a qualitative assessment to identify rehabilitated landforms requiring remedial action to address site stability issues. It is recommended that (Landform Stability Inspection) LSI be conducted 3 to 12 months after the rehabilitation works have been completed, and again, in conjunction with the Vegetation Establishment Inspection (VEI), at 18 to 24 months post-rehabilitation. The first inspection is to be scheduled following a significant rainfall event (>100 mm) to detect any major issues related to landform stability and erosion. Information from the inspection should be recorded in the Landform Stability Inspection datasheet and uploaded into BHPWAIO's 1DOC system. (See Appendix 1 for a copy of the datasheet).

The following are to be recorded on the Landform Stability Inspection datasheet:

- Site details (including mine site, rehabilitation area, date, observer).
- At least three representative digital photographs (e.g. on a slope: looking upslope, downslope and across the slope).
- Location and size of large bare areas (defined as areas >400 m2 that contain <1 m2 of native perennial vegetation).

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- Location and size of poor drainage areas and internally draining zones (ponding).
- Location and size of areas of dispersive soil material.
- Location of any unstable or unsafe areas, broken berms, or other features of interest.
- Location, extent, and status of erosion (rills, gullies and sheet erosion) with an estimate of length, width and depth of each rill and gully. Status of erosion is defined as active or passive.
- Estimation of hummock seedling density (plants per m2) within a 'visual radius' of 50 metres.
- Estimation of total native seedling density (plants per m2) within a 'visual radius' of 50 metres.
- Estimation of weed density (plants per m2) and percentage cover of each weed species **wherever they occur in large numbers** (e.g. >5 plants per m2). The area (m2) of the infestation should be recorded.
- Where weeds listed as Declared Pests under the *Biosecurity and Agriculture Management Act 2007* (BAM Act) are encountered (e.g. *Prosopis* spp.) the location and a count of the population is required for the implementation of weed control.

2.2. Level 1 Rehabilitation Monitoring

Level 1 Rehabilitation Monitoring is aligned with the guidelines set out by the EPA for Level 1 (Reconnaissance Survey) Flora and Vegetation Surveys (EPA 2016). The purpose of Level 1 Rehabilitation Monitoring is to provide information on rehabilitated areas deemed to have a relatively low impact on the ecological connectivity of the surrounding landscape. This includes narrow corridors of rehabilitation adjacent to undisturbed vegetation and areas of rehabilitation which may be too small to accommodate a Level 2 (Detailed Survey) Rehabilitation Monitoring quadrat.

The information collected at a Level 1 site is less detailed than the information collected at a Level 2 site, and is primarily focused on ensuring adequate vegetation cover and structure are developing, and that weeds are being managed appropriately. Consistent with EPA guidelines (EPA 2016), Level 1 and Level 2 Rehabilitation Monitoring should be undertaken six to eight weeks after the wet season (March to June).

2.2.1. Level 1 Relvé Specifications

Level 1 Rehabilitation Monitoring requires a relevé and site traverse at the rehabilitated area. A relevé is a low intensity survey technique carried out within an unmarked area. The field protocol requires the assessor to first walk across the rehabilitated site to gain an appreciation of site variability. The assessor should then complete a relevé that is representative of the vegetation of the rehabilitated area. Where substantial variation in vegetation establishment exists across a rehabilitated site, additional relevés may be required. Where possible, relevés should avoid boundaries and minimise edge effects.

2.2.2. Level 1 Relvé Data

For each relevé, the following information is to be recorded:

- Site details (including: mine name, rehabilitation area, date, observer's name);
- GPS waypoint (UTM GDA94 format);
- Total percent vegetation cover (see vegetation cover estimation guide in Appendix 4);
- Total percent cover native perennial vegetation;
- Total percent cover weeds;
- Total percent cover and average height of dominant species by lifeform (tree, shrub, hummock grass, other grass and herb, as defined in Appendix 5 and weeds);
- Percent bare ground, bare rock, woody debris, leaf litter;
- Percent area affected by erosion and the type of erosion (rills, gullies, sheet erosion) and status of the erosion (i.e. passive or active) that occurs within the site;

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- At least two representative digital photographs of the entire rehabilitation area should also be taken for future reference. Additional photographs of significant features that may require remedial management should also be taken (e.g. major erosion, significant weed infestations);and
- Record general observations about evidence of grazing, fire or drought on the vegetation and soil surface conditions at the site.

2.2.3. Level 1 Traverse

In addition to the relevé, the remaining rehabilitated area is to be traversed by the assessor (Figure 1) and evidence of any of the following recorded:

- Location and size of bare areas (defined as areas >400 m2) where there is no indication of any perennial seedlings;
- Location and size of poor drainage areas and internally draining zones;
- Location and size of dispersive soil material;
- Location of weeds, where they appear to be establishing in large numbers noting the size (length and width) of the infestation;
- Location of subsidence, broken berms etc;
- Location of significant erosion (i.e. gullies >30 cm wide and deep, sheet erosion) with an estimate of length, width and depth. Where the erosion forms a significant portion of the slope (i.e. >10%) an estimate of the proportion of the slope considered eroded and type of erosion should be noted; and
- Data presentation and reporting format requirements are provided in Appendix 6.

Figure 1: Example of traverse to be conducted outside of relevé area in Level 1 assessments.

2.3. Level 2 Rehabilitation Monitoring

The purpose of Level 2 Rehabilitation Monitoring is to provide a more detailed assessment of rehabilitation areas that are deemed to potentially have a significant effect on the ecological connectivity of the surrounding landscape. These areas are identified in terms of their total area, depth of soil disturbance, and proximity to undisturbed vegetation.

Level 2 Rehabilitation Monitoring is based upon the EPA guidelines for Level 2 Flora and Vegetation Surveys (EPA 2016). The Level 2 Rehabilitation Monitoring procedure is based on the assessment of species composition and cover within 50 x 50 m quadrats. This will enable direct comparison of areas under rehabilitation with baseline datasets (Figure 2a). Consistent with EPA guidelines (EPA 2016), Level 1 and Level 2 Rehabilitation Monitoring should be undertaken six to eight weeks after the wet season (March to June) in the Pilbara.

Level 2 Rehabilitation Monitoring also includes two 5 x 5 m nested quadrats for collecting plant density data. The sum of these two 25 m2 nested quadrats enables this data to be directly compared with historical RDM (Rehabilitation Development Monitoring – See Rehabilitation Monitoring Procedure SPR-IEN-LAND-012 *V2.1*) data (also based on 50 m2). On sloped, rehabilitated landforms (i.e. OSAs), erosion transects are also to be established (Figure 2b and section 3.2.6).

In addition to assessing 50 x 50 m quadrat, the area of rehabilitation outside of the quadrat is to be traversed by the assessor and any potentially dysfunctional areas recorded (see section 3.2.3).

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2.3.1. Level 2 Quadrat Specifications

The number of Level 2 quadrats established in each rehabilitated area will be determined by the level of variation in soil type, vegetation cover, landform and rehabilitation treatment. An area with greater variability will require more sites to provide an accurate representation of the status of the rehabilitation.

The following should be considered when establishing Level 2 quadrats:

- Preferential sampling is to be used when positioning quadrats; sample sites should be placed to avoid boundaries and to minimise edge effects.
- Sampling sites should be placed at representative locations throughout the survey area considering landform, geology, elevation, slope, aspect, surface or groundwater expression, and soil type.
- Where it is safe to do so, quadrats should be positioned in the middle section of a slope (this is to ensure the results provide an accurate representation of the rehabilitated area by not focussing on the lower part of the slope that may receive more water and nutrients).
- Topographical position of the quadrat shall be noted, with naming conventions limited to:
    - Flat: flat topography, low landscape position;
    - Slope: sloping topography; and
    - Crest: flat topography, high landscape position receiving no rainfall run-on.
- The primary quadrat should measure 50 x 50 m. If the rehabilitated area does not allow for this (e.g. narrow, linear rehabilitation corridor), the quadrat dimensions may be adjusted to 25 x 100 m. Sites that are still too small to fit the quadrat are not suitable for Level 2 assessment and should be assessed using the Level 1 method.
- A 5 x 5 m nested quadrat is to be located in the SW and NE corner of the primary quadrat (Figure 2).
- Quadrats replacing existing transects should utilize the existing transects steel pickets where possible. A note of the change must be made in the field datasheet and written report.
- The four points of the quadrat are permanently marked with a steel picket and their position recorded using GPS (GDA94 UTM).

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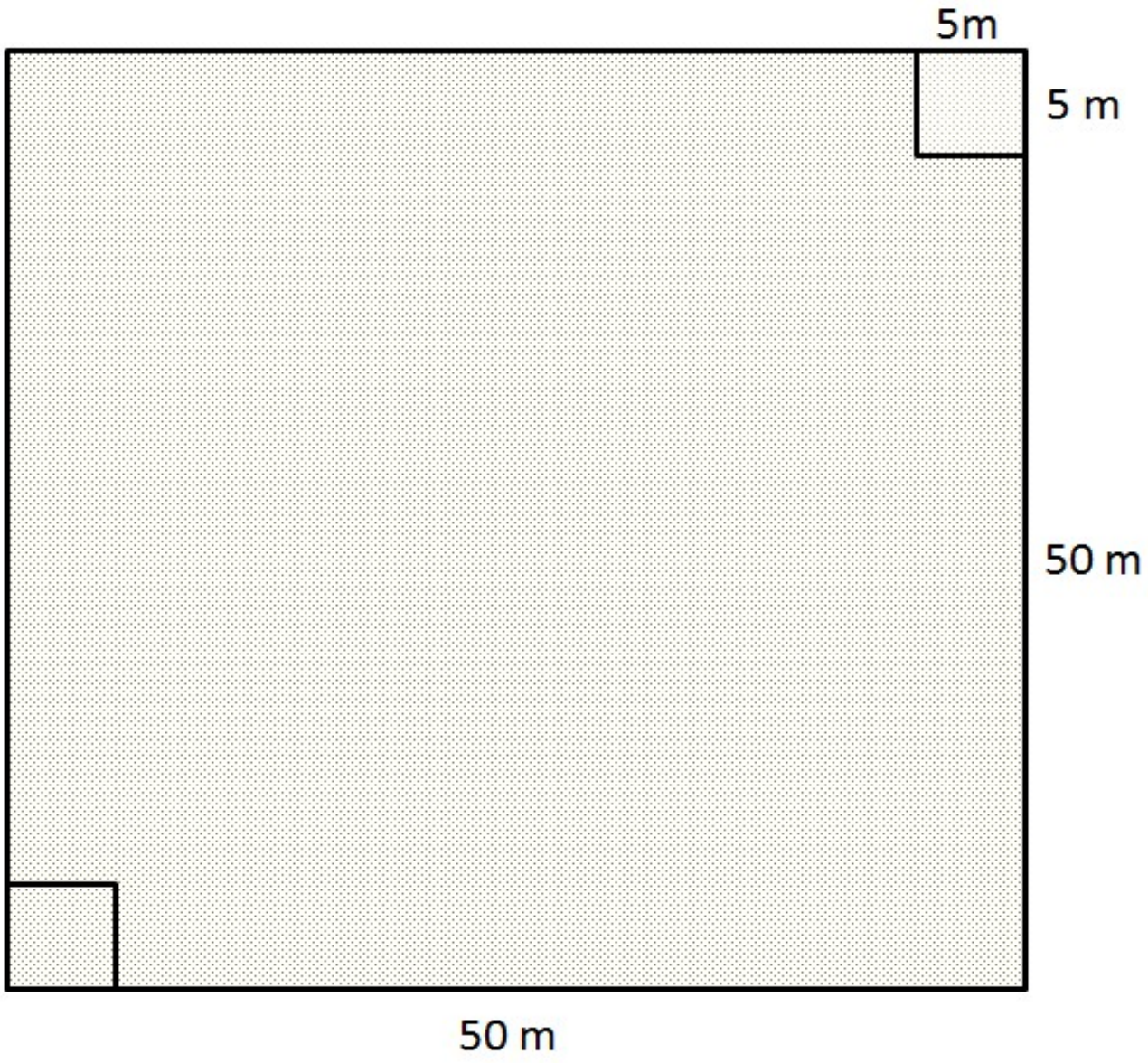

Figure 2: Level 2 50 x 50 m quadrat with two (5 x 5 m) nested quadrats. Erosion transects on sloping sites are to be established on the upper and lower lengths of the quadrat.

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2.3.2. Level 2 Quadrat Data

The following attributes are to be assessed and recorded within the primary (50 x 50 m) quadrat:

- Estimated total percent vegetation cover;
- Estimated percent cover of each individual plant species within the quadrat;
- Estimated percent cover by type (bare ground, bare rock, woody debris, leaf litter, perennial plant cover, annual plant cover).

Please see Appendix 2 for guidance in estimating vegetation cover.

The following attributes are to be assessed and recorded within each nested 5 x 5 m quadrat:

- Number of individuals of each species;
    - Numbers may be estimated when a species is abundant; and
    - A plant is only counted when more than half of the rooted potion of the plant is located within the nested quadrat (i.e. plants with only overhanging canopy are not counted).

Plant identifications should be made to species level where possible. Where this cannot be completed in the field, representative samples (flowers, fruit, leaves etc.) and photographs should be collected and identified later by a qualified botanist.

All Level 2 data should be supplied to BHPWAIO in the format stipulated in the Rehabilitation Monitoring *Spatial Data and Digital Photography Requirements*.

2.3.3. Photo-point Location for Level 2 Sites

- Photographs shall be taken diagonally across the quadrat, from quadrat post 1 to quadrat post 3, and quadrat post 4 to quadrat post 2.
- Ensure the horizon is visible in the photograph.

2.3.4. Level 2 Traverse

Outside of the detailed 50 x 50 m quadrat assessment, the remaining rehabilitated area is to be traversed by the assessor (Figure 3) and evidence of any of the following recorded:

- Location and size of bare areas (defined as areas >400 m2) where there is no indication of any perennial seedlings;
- Location and size of poor drainage areas and internally draining zones;
- Location and size of dispersive soil material;
- Location of weeds, where they appear to be establishing in large numbers noting the size (length and width) of the infestation;
- Location of subsidence, broken berms; and
- Location of significant erosion with an estimate of length, width, and depth. Where the erosion forms a significant portion of the slope (i.e. >10%) an estimate of the proportion of the slope considered eroded and type of erosion should be noted.

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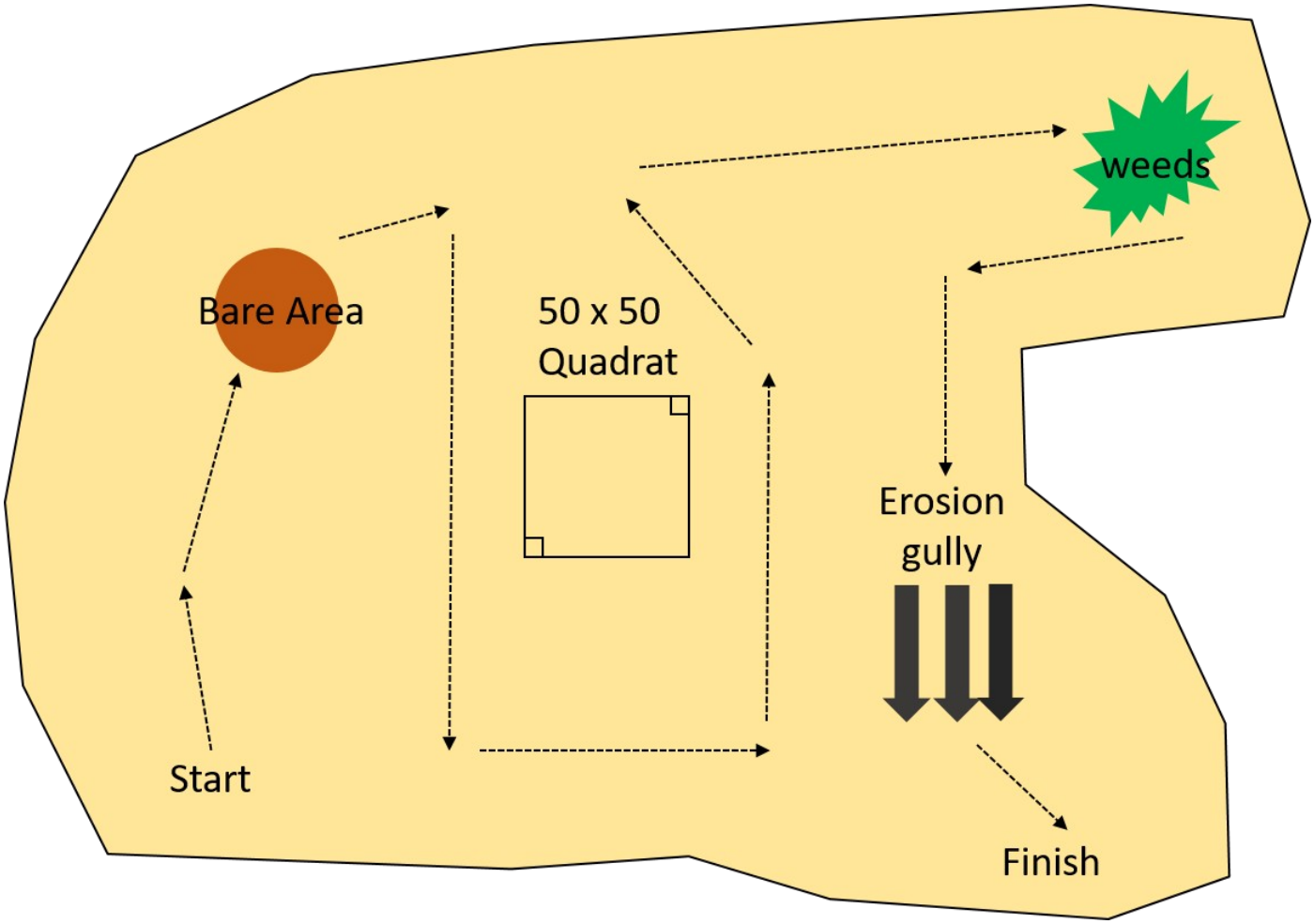

Figure 3: Example of a traverse path outside of a Level 2 Quadrat to identify site failures.

2.3.5. Remote Sensing

BHP is currently trialling custom capture of 4 band (RGBI) aerial imagery in conjunction with geodetic precise airborne DGPS from a manned aircraft at 0.10 m Ground Sample Distance (GSD).

Ground Control

Ground Control (GC) is necessary to ensure the absolute accuracy of all deliverables. BHP WAIO are required to install adequate GC at all sites prior to aerial data acquisition

Orthomosaic and Digital Surface Model (DSM)

The assessor will produce an orthorectified, mosaiced, and colour balanced image for the area of influence (AOI) at 0.1 m GSD. Imagery will be provided in tiles, according to the specifications required by BHP WAIO survey team. An associated DSM will also be produced for each AOI at 1 m GSD.

Remote Sensing Data Analysis

Areas captured in the AOI's and deemed to be suitable analogue sites for rehabilitation will be assessed using the machine learning (ML) algorithms. Analogue sites will be selected to represent crest, slope, and flat landforms. ML algorithms will be applied to each site and the following metrics recorded:

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All rehabilitated areas (as identified by BHP WAIO's rehabilitation polygon layer) will be extracted from the orthomosaic and DSM data sets. Each polygon will have a series of ML algorithms applied in order to derive the following metrics:

- Total % plant cover
- Vegetation cover by strata
- Vegetation cover by lifeform
    - Herb
    - Hummock
    - Tussock
    - Shrub
    - Tree
- Vegetation cover by target species (weed)
    - *Cenchrus ciliaris*
    - *Calatropis procera*
    - *Aerva javanica*
- Total biovolume
- Biovolume by strata
- Weed Invasiveness
- Species richness
    - Perennial
    - Annual
- Indicator Species
- Bare Ground (non-vegetated)

Following classification of the data based on existing ML algorithms, a thorough, visual quality assessment will be carried out on the outputs. Where deemed necessary, classification errors will be manually corrected and used to retrain and improve the ML algorithms, after which they will be used to classify elements of the data a second time, if required. The outputs will be delivered in the form of a GIS shapefile with an associated attribute table containing the data for each rehabilitation polygon.

2.3.6. Erosion Method

The purpose of the erosion transects are to quantify the extent and severity of erosion features on rehabilitated areas. This information can assist in identifying whether any remedial action is required to prevent erosion features from developing further.

The erosion transects are monitored using the following method:

- Erosion transects are to be established on the upper and lower lengths of the 50 x 50 m quadrat on rehabilitated slopes on waste landforms (Figure 2).
- Lay out a measuring tape perpendicular to the slope, for the width of the Level 2 quadrat, and measure the width and depth of each rill and gully that intercepts the erosion transect based on the conventions outlined in (CSIRO 2007). The difference between rills and gullies is based on the classification of < 0.3 m depth and ≥ 0.3 m depth respectively.
- Any evidence of sheet erosion, including numerous pedestals, terracettes, or large amounts of silt accumulation is also to be recorded.
- The information collected from the erosion transects should be recorded as per the Rehabilitation Monitoring Spatial Data and Digital Photography Requirements. Refer to Section 3 for guidance on data presentation and reporting of the results.

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3. Data Presentation and Reporting

The information collected from LSI and Plant Establishment Inspection) PEI assessments is to be recorded using standardised WAIO excel workbooks (Appendix 1 and 2) and uploaded to the WAIO 1Doc system. Level 1 and Level 2 rehabilitation monitoring data may be recorded in the field in a format of the consultants choosing, however all data is to be submitted to WAIO in accordance with the standards outlined in the Rehabilitation Monitoring Spatial Data and Digital Photography Requirements. All data should adhere to the following requirements:

- **Written report** (electronic format) which contains the following minimum requirements:
  - Dashboard summary of the key attributes for each site. (Refer to Appendix 7).
  - Brief summary of the rainfall received since the last reporting period;
  - Location details of the Level 1/ Level 2 sites that were assessed and/or installed and a well-presented map displaying their location;
  - Reference to this document in the methods section, and a detailed description of any changes made to the methods, including justification;
  - Detailed results section, including interpretation and possible explanations for particular findings. See Appendix 6 for presentation of figures; and
  - When a plant species recorded within a rehabilitation area is not listed from previous rehab monitoring works, then the relevant vegetation stratum and functional grouping (i.e. perennial vs annual) for that species should be sourced from the Florabase online database.
- **GIS data** of monitoring locations is to be recorded and integrated into the GIS layers used by BHPWAIO, in accordance with Rehabilitation Monitoring Spatial Data and Digital Photography Requirements (file format compatible with ArcGIS).
- **Raw field data, photos, and summary data** (electronic format) to be submitted in accordance with Rehabilitation Monitoring Spatial Data and Digital Photography Requirements.

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4. Responsibilities

Role	Description of Task
Superintendent Rehabilitation & Contaminated Sites	• Responsible for management and monitoring of contract. • Sign-off on completed rehabilitation monitoring.
Specialist Rehabilitation	• Prepare annual monitoring schedule and issue scope of works to contractor. • Maintain 5-year Monitoring Plan. • Plan and coordinate monitoring schedule and liaise with site Environmental Specialist. • Review and feedback on reports. • Data collation and analysis. • Prepare rehabilitation monitoring site summaries for AER. • Support site Environmental Specialist with contractor supervision where possible. • Revise and update rehabilitation monitoring procedure as required. • Update rehabilitation species list on an annual basis. • Undertake Rehabilitation Monitoring on new rehabilitation areas. • Prepare Rehabilitation Summary Report and submit to sites. • Provide assistance with contractor supervision where possible.
Specialist Environment	• Coordinate the execution of annual rehab monitoring works of contractor. • Review rehab monitoring annual site reports. • Review rehab monitoring site summary in AER.

5. Definitions & Abbreviations

Term	Description
AER	Annual Environmental Review
AOI	Area of Influence
BHPWAIO	BHP Western Australian Iron Ore
DRF	Declared Rare Flora
GC	Ground Control
GPS	Global Positioning System
GSD	Ground Sample Distance
ML	Machine Learning
OSA	Overburden Storage Area
REA	Rehabilitation Establishment Assessment
LSI	Landform Stability Inspection
PEI	Plant Establishment Inspection
RDM	Rehabilitation Development Monitoring

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6. Reference Table

Document Number	Reference Title
	BAM Act 2007. Biosecurity and Agricultural Management Act 2007. State of Western Australia.
	CSIRO 2007. Australian Soil and Land Survey Field Handbook (Third Edition). The National Committee on Soil and Terrain. CSIRO Publishing.
	EPA 2016. Technical Guide – Flora and Vegetation Surveys for Environmental Impact Assessment. Technical Report of the Environmental Protection Authority and the Department of Parks and Wildlife.
	BHPWAIO Rehabilitation Monitoring Data Standards

7. Appendices

Appendix 1: Landform Stability and Vegetation Establishment Inspection Data Template

Appendix 2: Estimating Vegetation Cover

Appendix 3: Defined Vegetation Strata

Appendix 4: Example of Data Presentation and Reporting

Appendix 5: Rehabilitation Site Summary Dashboard

Appendix 6: Plant Species List

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7.1. Appendix 1 – Landform Stability and Vegetation Establishment Inspection Data Template

BHP BILLITON IRON ORE LANDFORM STABILITY AND VEGETATION ESTABLISHMENT INSPECTION					
Mine Site Name					
Name of Rehabilitation Area Inspecte					
Inspection Date					
Inspected by (Company/pers. initials)					
VEGETATION ESTABLISHMENT					
Plant density may be estimated when individuals are abundant. Minimum total native plant density should be approximately 1 plant/m^2. Minimum Triodia density should be approximately 0.5 plants/m^2					
	Assessment Point 1	Assessment Point 2	Assessment Point 3	Assessment Point 4	Assessment Point 5
GPS Location (UTM GDA 94)					
Total Native Plant Density (plants/m^2)					
Triodia Density (plants/m^2)					
Weed Density (plants/m^2)					
Native species list					
Weed species list					
LANDFORM STABILITY INSPECTION					
Features to record include broken batters and/or berms, erosion rills and gullies, sheet erosion, tunnel erosion, evidence of subsidence/slumping, dispersive materials, and surface crusting. Record the GPS location (UTM GDA 94), and dimensions of each feature (width, length, depth) as appropriate.					
Feature	GPS Location	Details			
GENERAL SITE COMMENTS					
Record any additional pertinant information about the site, including comments on earthworks, rubbish, and issues that may effect the successful establishment of vegetation.					
INSPECTION OUTCOME					
Should the area be incorporated into 5-year monitoring plan					
Proposed monitoring methodology (Level 1 or Level 2)					
Proposed number of releves/quadrats to be installed					
Proposed starting year of monitoring					

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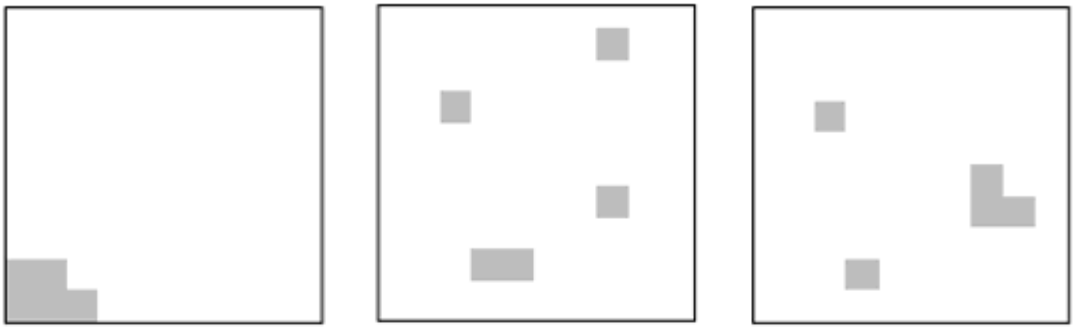
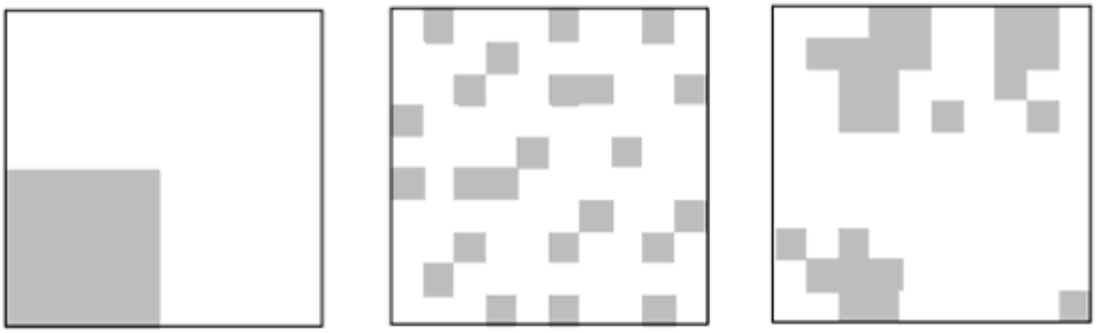
7.2. Appendix 2 – Estimating Vegetation Cover

1% to 5%: These are all 5% cover



6% to 10%: These are all 10% cover

11% to 25%: These are all 25% cover



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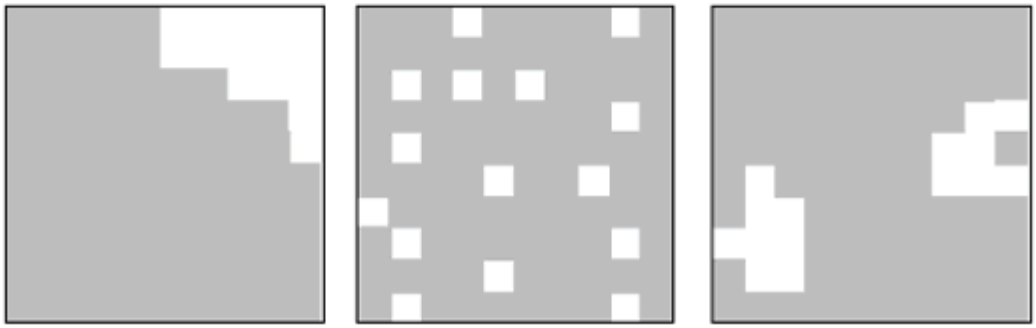
26% - 50% - These are all 50% cover

51% - 75% - These are all 75% cover

76% - 100% - These are all 85 % cover



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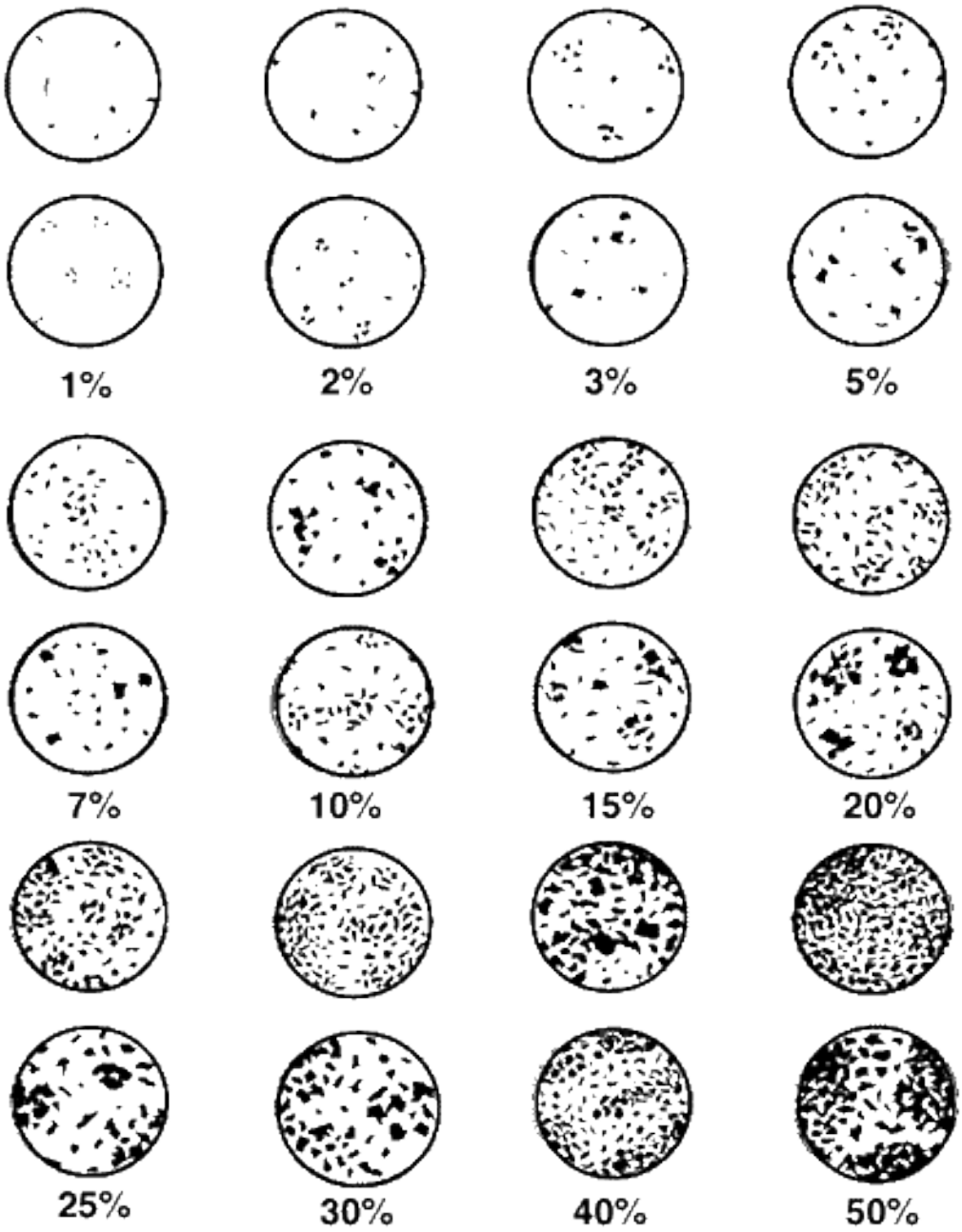

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7.3. Appendix 3 – Defined Vegetation Strata

The vegetation stratum classes are amalgamated into five stratum groupings for BHP rehabilitation reporting purposes.

Type	Vegetation Stratum Classes	Vegetation Stratum Groupings for Reporting Purposes
1	Tree > 30 m height	Tree
2	Tree 10 to 30 m height	
3	Tree < 10 m height	
4	Mallee	Shrub
5	Shrub > 2 m height	
6	Shrub 1 to 2 m height	
7	Shrub < 1 m	
8	Hummock grass	Hummock grass
9	Tussock grass	Other grass
10	Bunch grass	
11	Sedge	Herb
12	Herb	

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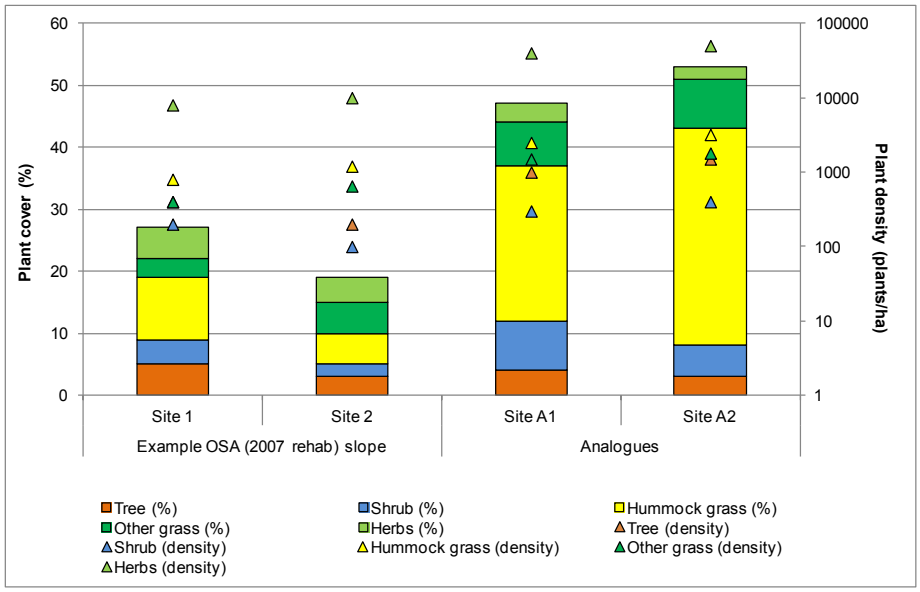
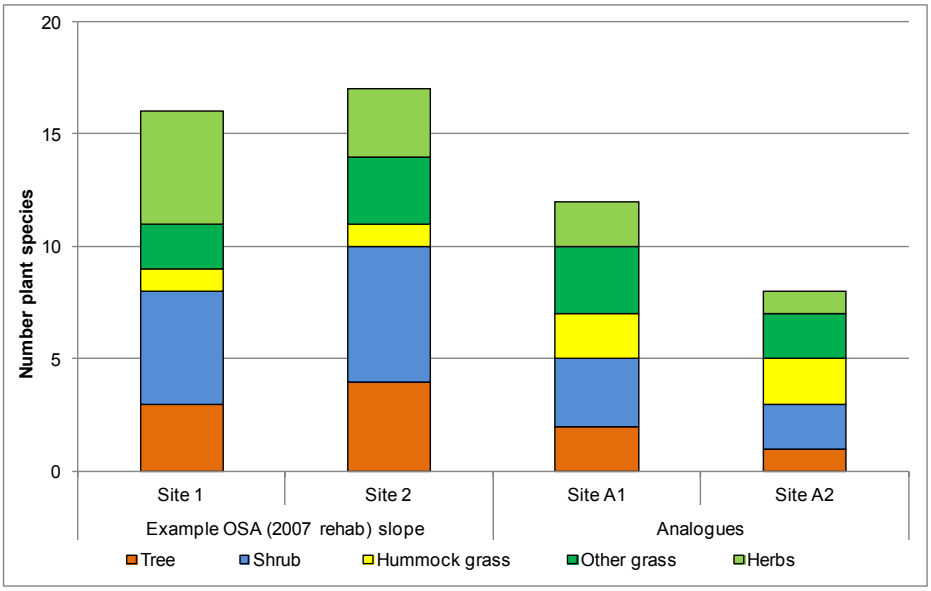
7.4. Appendix 4 – Example of Data Presentation and Reporting

For consistency across all reports and the Annual Environmental Report (AER) the following formatting guidelines apply:

- Size 10 aerial font;
- Secondary axis is to be a logarithmic scale when plant density is displayed with plant cover (%); and
- The colour scheme used for the different plant functional groups in the following Figures is to be used.



Example Figure: Plant cover and density of Example OSA (2007 rehabilitation) in 2017 compared with analogue sites



Example Figure: Species richness of Example OSA (2007 rehabilitation) in 2017 compared with analogue sites

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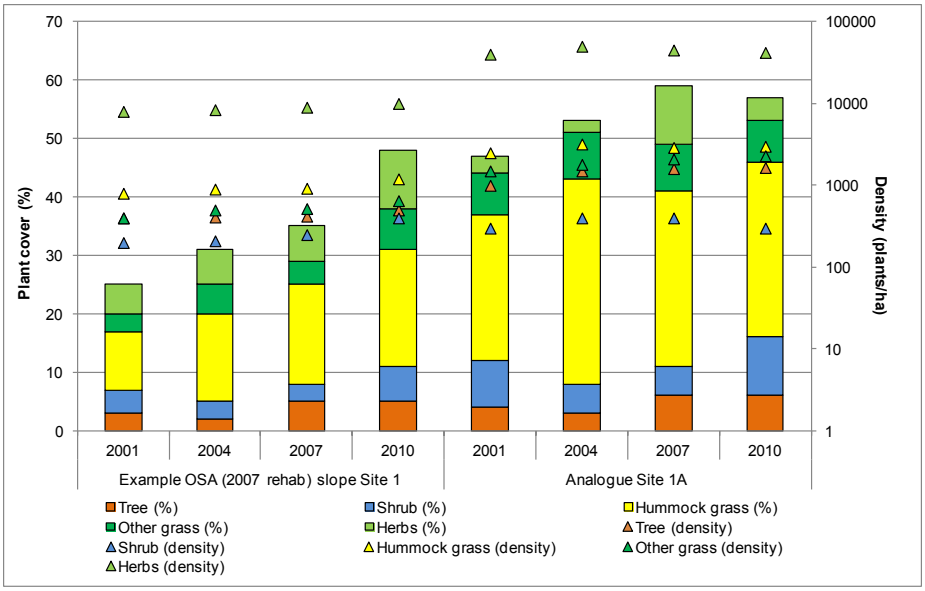
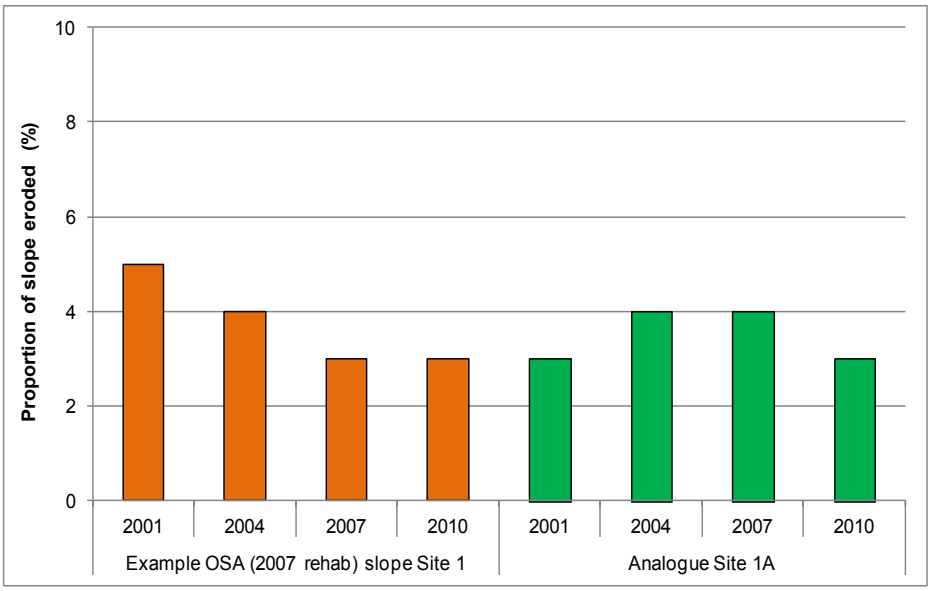


Example Figure: Change in plant cover (%) and density between 2001 and 2010 at Example OSA (2007 rehabilitation) slope Site 1 compared to analogue



Example Figure: Change in the proportion of slope eroded (%) between 2001 and 2010 at Example OSA (2007 rehabilitation) slope Site 1 compared to analogue. (NB: The values used in the Figure are for illustrative purposes only and are not to be used as a guide or expected to be measured in the field).

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7.5. Appendix 5 – Rehabilitation Site Summary Dashboard

Site	Yarrie			Region	Northern		Date	10/3/2016			
Rehab	Age	Area	Indigneous Species	Cover		Weeds	Richness	Plant Density	Bare Areas	Erosion	OVERALL
				Total	Hummock						
BYA1	22	5.5									
BYA2	22	3.2									
BYA3	18	4.6									4.6
BYA4	16	5.6									
BYA5	16	6.7									
BYA6	16	4.9									
BYA7	13	7.2									
BYA8	13	6.3									
BYA9	13	8.1									8.1
BYA10	13	3									
BYA11	7	3.91									
BYA12	7	4.82									4.82
BYA13	7	5.73									
BYA14	7	3.4									
BYA15	4	8.4									
BYA16	4	2.8									
BYA17	4	4.3									
TOTAL		88.46	88.46	88.46	164	72.46	202	70.46	78.46	50.46	**70.94**
			0	3.4	20	4.9	0	4.6	17	13	**8.1**
			0	0	4.6	0	0	0	0	25	**9.42**

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7.6. Appendix 6 – Plant Species List

Plant species name^	Vegetation stratum class	Annual (A) / Perennial (P)	Comments
**Acetosa vesicaria*	Herb	A	
**Aerva javanica*	Herb	P	
**Cenchrus ciliaris*	Other Grass	P	
**Chloris barbata*	Other Grass	A	
**Citrullus lanatus*			
**Cynodon dactylon*	Other Grass	P	
**Malvastrum americanum*	Herb	P	
**Tribulus terrestris*	Herb	A	
Abutilon otocarpum			
Acacia "aneura" group	Woody Shrub	P	The aneura variations have now been classified into separate species entities. If adequate flowering and vegetative material is available please attempt to get an Identification. Acacia aneura var. aneura is not listed as a Pilbara species on Florabase
Acacia adoxa	Woody Shrub	P	
Acacia adsurgens	Woody Shrub	P	
Acacia ancistrocarpa	Woody Shrub	P	
Acacia arida	Woody Shrub	P	
Acacia atkinsiana	Woody Shrub	P	
Acacia ayersiana	Woody Shrub	P	
Acacia bivenosa	Woody Shrub	P	
Acacia citrinoviridis	Woody Shrub	P	
Acacia colei	Woody Shrub	P	
Acacia colei var. colei	Woody Shrub	P	
Acacia coriacea	Woody Shrub	P	
Acacia cowleana	Woody Shrub	P	
Acacia dictyophleba	Woody Shrub	P	
Acacia hilliana	Woody Shrub	P	
Acacia inaequilatera	Woody Shrub	P	
Acacia incurvaneura	Woody Shrub	P	
Acacia kempeana	Woody Shrub	P	
Acacia ligulata	Woody Shrub	P	
Acacia macraneura	Woody Shrub	P	
Acacia maitlandii	Woody Shrub	P	
Acacia marramamba	Woody Shrub	P	
Acacia minyura	Woody Shrub	P	
Acacia monticola	Woody Shrub	P	
Acacia pruinocarpa	Woody Shrub	P	
Acacia ptychophylla	Woody Shrub	P	
Acacia pyrifolia	Woody Shrub	P	
Acacia pyrifolia var. pyrifolia	Woody Shrub	P	

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Plant species name^	Vegetation stratum class	Annual (A) / Perennial (P)	Comments
Acacia sibirica	Woody Shrub	P	
Acacia spondylophylla	Woody Shrub	P	
Acacia stellaticeps	Woody Shrub	P	
Acacia tenuissima	Woody Shrub	P	
Acacia tetragonophylla	Woody Shrub	P	
Acacia trachycarpa	Woody Shrub	P	
Acacia tumida	Woody Shrub	P	
Acacia victoriae	Woody Shrub	P	
Acacia wanyu	Woody Shrub	P	
Alternanthera nana	Herb		
Amphipogon caricinus	Other Grass	P	
Aristida contorta	Other Grass	A	
Aristida holathera	Other Grass	P	
Aristida holathera var. holathera	Other Grass	P	
Aristida inaequiglumis	Other Grass	P	
Aristida latifolia	Other Grass	P	
Amaranthus. sp.			
Atalaya hemiglauca	Tree	P	
Atriplex nummularia	Woody Shrub	P	
Austrostipa sp.	Other Grass	P	
Boerhavia coccinea	Herb	P	
Boerhavia repleta	Herb	P	
Bonamia alatisemina	Herb	P	
Bonamia linearis	Herb	P	
Bonamia rosea	Herb	P	
Bonamia pannosa	Herb	P	
Bonamia sp. Dampier (A.A. Mitchell PRP 217)	Herb	P	
Brachyachne convergens	Herb	P	
Cleome viscosa	Herb	A	
Corchorus incanus subsp. *lithophilus*	Woody Shurb	P	
Corchorus lasiocarpus	Woody Shrub	P	
Corchorus sidoides			
Corchorus walcottii	Woody Shrub	P	
Corymbia opaca	Tree	P	
Cullen leucanthum			
Cymbopogon ambiguus	Other Grass	P	
Cymbopogon obtectus	Other Grass	P	
Cynanchum floribundum	Herb	P	
Cyperus cunninghamii subsp. *cunninghamii*	Herb	P	
Cyperus hesperius	Herb	P	
Dactyloctenium radulans	Other Grass	A	
Dampiera candicans	Woody Shrub	P	

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Plant species name^	Vegetation stratum class	Annual (A) / Perennial (P)	Comments
Dichanthium sericeum	Herb	A	
Dicrastylis sp.	Woody Shrub	P	
Digitaria brownii	Herb	P	
Dodonaea petiolaris	Woody Shrub	P	
Dysphania rhadinostachya	Herb	A	
Dysphania kalpari	Herb	A	
Enchylaena tomentosa	Woody Shrub	P	
Enneapogon caerulescens	Other Grass	P	
Enneapogon polyphyllus	Other Grass	A	
Enneapogon robustissimus	Other Grass	P	
Eragrostis dielsii	Other Grass	A	
Eragrostis eriopoda	Other Grass	P	
Eremophila forrestii	Woody Shrub	P	
Eremophila lachnocalyx	Woody Shrub	P	
Eremophila latrobei	Woody Shrub	P	
Eremophila longifolia	Woody Shrub	P	
Eriachne aristidea	Other Grass	A	
Eriachne ciliata	Other Grass	A	
Eriachne obtusa	Other Grass	P	
Eriachne mucronata	Other Grass	P	
Eriachne puchella subsp. *dominii*	Other Grass	P	
Eucalyptus gamophylla	Tree	P	
Eucalyptus leucophloia	Tree	P	
Euphorbia australis	Herb	A	
Euphorbia drummondii	Herb	A	
Euphorbia myrtoides	Herb	A	
Evolvulus alsinoides	Herb	P	
Evolvulus alsinoides var. *villosicalyx*	Herb	P	
Gompholobium oreophilum	Woody Shrub	P	
Gompholobium polyzygum	Woody Shrub	P	
Gomphrena canescens	Herb	A	
Gomphrena cunninghamii	Herb	A	
Goodenia microptera	Herb	A	
Goodenia stobbsiana	Herb	P	
Goodenia triodiophila	Herb	P	
Gossypium australe	Woody Shrub	P	
Gossypium robinsonii	Woody Shrub	P	
Grevillea pyramidalis	Tree	P	
Grevillea wickhamii	Woody Shrub	P	
Hakea lorea	Tree	P	
Halgania solanacea	Herb	P	
Hibiscus coatesii	Woody Shrub	P	

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Plant species name^	Vegetation stratum class	Annual (A) / Perennial (P)	Comments
Hibiscus leptocladus	Woody Shrub	P	
Hybanthus aurantiacus	Woody Shrub	P	
Indigofera monophylla	Woody Shrub	P	
Indigofera rugosa	Woody Shrub	P	
Ipomoea muelleri	Herb	P	
Iseilema membranaceum	Other Grass	A	
Keraudrenia velutina	Woody Shrub	P	
Keraudrenia velutina subsp. elliptica	Woody Shrub	P	
Maireana tomentosa	Woody Shrub	P	
Maireana triptera	Woody Shrub	P	
Maireana villosa	Woody Shrub	P	
Malvaceae sp.			
Mollugo molluginea	Herb	P	
Paraneurachne muelleri	Other Grass	P	
Paspalidium basicladum	Other Grass	A	
Perotis rara	Herb	P	
Petalostylis labicheoides	Woody Shrub	P	
Pluchea tetranthera	Herb	P	
Polycarpaea longiflora	Herb	P	
Pterocaulon serrulatum	Herb	P	
Pterocaulon serrulatum var. velutinum	Herb	P	
Pterocaulon sphaeranthoides	Herb	P	
Ptilotus astrolasius	Woody Shrub	P	
Ptilotus calostachyus	Herb	P	
Ptilotus fusiformis	Herb	A	
Ptilotus incanus	Herb	P	
Ptilotus nobilis	Herb	P	
Ptilotus obovatus	Woody Shrub	P	
Rhynchosia minima	Herb	P	
Salsola australis	Herb	A	
Scaevola parvifolia	Herb	P	
Sclerolaena cornishiana	Herb	P	
Sclerolaena costata	Herb	P	
Senna artemisioides subsp. filifolia	Woody Shrub	P	
Senna glutinosa subsp. *glutinosa*	Woody Shrub	P	
Senna artemisioides subsp. helmsii	Woody Shrub	P	
Senna artemisioides subsp. oligophylla	Woody Shrub	P	
Senna artemisioides subsp. x sturtii	Woody Shrub	P	
Senna ferraria	Woody Shrub	P	
Senna glutinosa	Woody Shrub	P	
Senna glutinosa subsp. *pruinosa*	Woody Shrub	P	
Senna glutinosa subsp. x luerssenii	Woody Shrub	P	

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Plant species name^	Vegetation stratum class	Annual (A) / Perennial (P)	Comments
Senna notabilis	Woody Shrub	P	
Sida arenicola	Woody Shrub	P	
Sida calyxhymenia	Woody Shrub	P	
Sida sp. Articulation below (AA. Mitchell PRP 1605)	Woody Shrub	P	
Sida clementii	Woody Shrub	P	
Sida fibulifera	Woody Shrub	P	
Sida laevis	Woody Shrub	P	
Sida sp. dark green fruits (S. van Leeuwen 2260)	Woody Shrub	P	
Sida sp. Pilbara (AA Mitchell PRP 543)	Woody Shrub	P	
Sida sp. Golden calyces glabrous	Woody Shrub	P	
Solanum cleistogamum	Woody Shrub	P	
Solanum diversiflorum	Woody Shrub	P	
Solanum horridum	Woody Shrub	P	
Solanum lasiophyllum	Woody Shrub	P	
Solanum orbiculatum	Woody Shrub	P	
Solanum phlomoides	Woody Shrub	P	
Sporobolus australasicus	Other Grass	A	
Stemodia viscosa	Herb	P	
Tephrosia rosea	Woody Shrub	P	
Tephrosia sp. Bungaroo Creek (M.E. Trudgen 11601)	Woody Shrub	P	
Tephrosia sp. D Kimberley flora (R.D. Royce 1848)	Woody Shrub	P	
Themeda australis	Other Grass	P	
Themeda triandra	Other Grass	P	
Trachymene oleracea	Herb	A	
Trianthema pilosa	Herb		
Trianthema triquetra	Herb		
Tribulus hirsutus	Woody Shrub	P	
Tribulus platypterus	Woody Shrub	P	
Tribulus suberosus	Woody Shrub	P	
Trichodesma zeylanicum	Herb	A	
Triodia basedowii	Hummock Grass	P	
Triodia epactia	Hummock Grass	P	
Triodia pungens	Hummock Grass	P	
Triodia schinzii	Hummock Grass	P	
Triodia wiseana	Hummock Grass	P	
Yakirra australiensis			

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M-3. Summary of recent on-ground monitoring results

Site Name	Monitoring Location	Year of Rehabilitation	Year Last Monitored[43]	Monitoring Results
Rail spur borrow pit	BJB14	2009	2016	A total of 18 species were recorded. 7.6% shrub cover, particularly *Senna glutinosa* subsp. *x luerssenii, Acacia pruinocarpa* and *A. bivenosa.* <1% spinifex. Several other grass species and two annual herbs were also recorded but contributed minimal cover. Spinifex cover was considerably lower than analogue sites which was >30%. The cover of shrubs (woody plants) along the rehabilitation transect was higher than analogue sites. No herbs or other grasses were recorded from two analogue sites. No weeds were recorded in 2016, and only one weed species has been recorded over the course of the monitoring: **Cenchrus ciliaris* (in 2014).
Borrow pit – rail 1	BJB33	2011	2019	Good native vegetation cover and species richness, similar to analogue sites. Vegetation structure was similar to analogues, with shrub cover a dominant lifeform in both site types, however there was almost no hummock grass cover recorded (0.4%compared to the analogue mean of 19.0%). The rehabilitation is developing well and in time, hummock grasses are expected to establish. Native vegetation cover was 28.2%, similar to the analogue mean (28.5%). Introduced cover was low (0.3%) made up exclusively of **Cenchrus ciliaris*. There was no introduced cover recorded at analogue sites. Native species richness (40 species; 35 perennial, five annual) was similar to the analogue mean (38 species; 33 perennial and five annual). No erosion was recorded.
	BJB34	2011	2017	Total perennial cover is well-developed at all sites, and within the range of associated analogues. Rehabilitated sites were characterised by higher cover of woody shrubs and tussock grass species, and lower *Triodia* cover. *Triodia* hummock grasses, the dominant lifeform throughout Pilbara region, was at lower levels than desirable at BJB-35. Species richness in rehabilitated sites was within the range, or higher than that recorded in analogues sites. The weed, **Cenchrus ciliaris*, was recorded within all sites.
	BJB35			Surface erosion was recorded at BJB-35, however, the intersecting drainage lines and small gullies all appear to be stable.
Borrow pit - rail 2	BJB_R01	2012	2019	Native vegetation cover (13.3%) was less than half that of the analogue mean (28.5%). Vegetation structure was similar to the analogues, with hummock grass and shrub as the two most dominant lifeforms. One introduced species, **Cenchrus ciliaris*, was recorded at four of the sites as scattered individuals. There was no erosion or other disturbances recorded. The rehabilitation is developing well and on track to returning to an analogue state.
	BJB_R02			Native vegetation cover (20.0%) was close to the analogue range (20.3% to 41.5%). Vegetation structure was similar to the analogues, with shrub and hummock grass as the two dominant lifeforms. There was 0.1% introduced cover (**Cenchrus ciliaris*). The rehabilitation is developing well and on track to returning to an analogue state.
	BJB_R03			Native vegetation cover (18.4%) was close to the analogue minimum (range 20.3% to 41.5%). Vegetation structure was similar to the analogues, with shrub and hummock grass as the two most dominant lifeforms. There was no introduced cover. The rehabilitation is developing well and on track to returning to an analogue state.
	BJB_R04			Native vegetation cover (8.8%) was lower than the lowest analogue value (20.3%) by more than half. Vegetation structure was similar to the analogues with shrub as a dominant lifeform, however the hummock grass cover (0.4%) was well below the analogue mean (19.0%). There was 2.0% introduced cover (**Cenchrus ciliaris*). The rehabilitation is developing well and on track to returning to an analogue state.

[43] This table reflects on-ground monitoring conducted in accordance with BHP's rehabilitation monitoring procedure and as guided by remote sensing. Remote sensing is conducted annually.

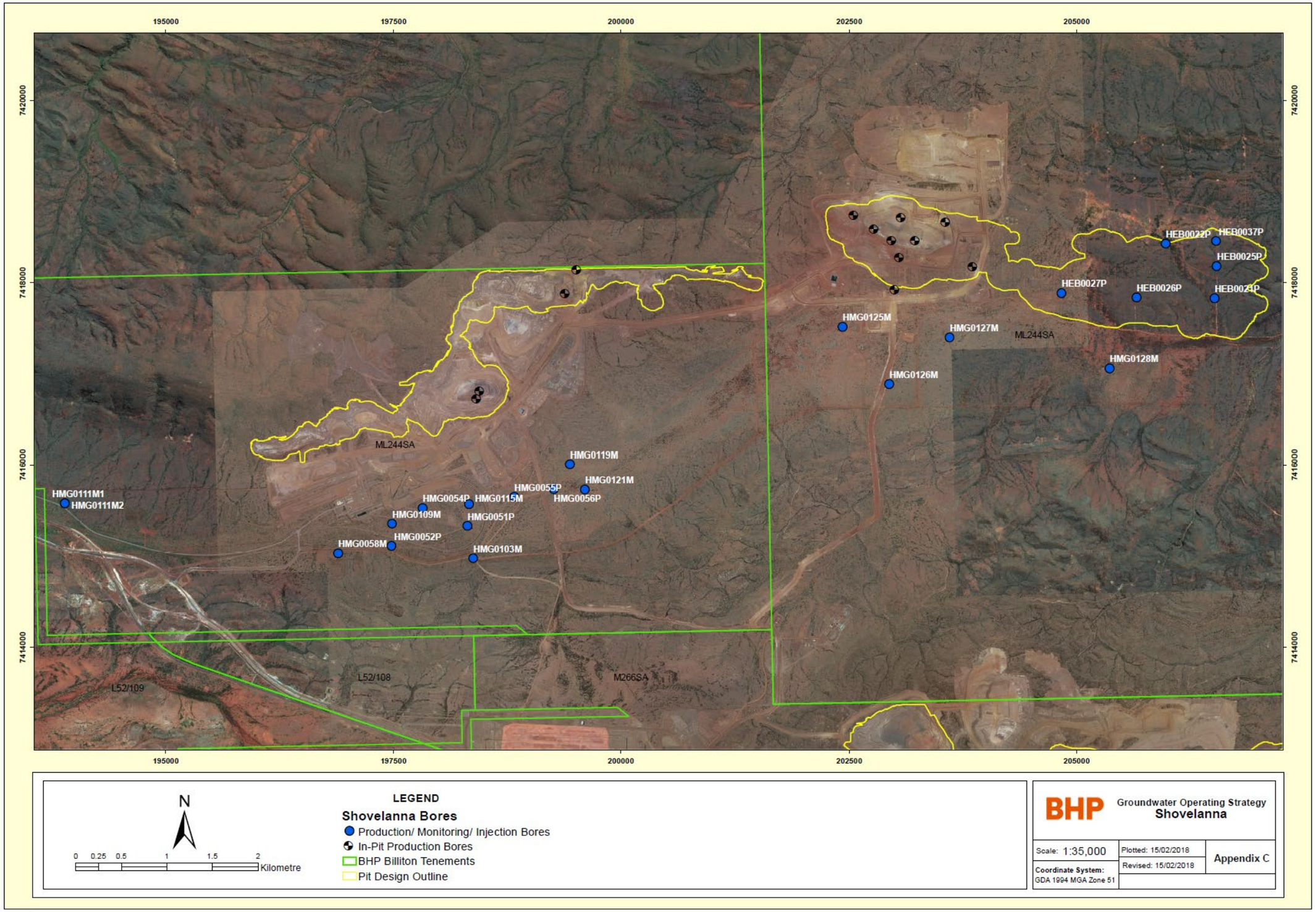
Site Name	Monitoring Location	Year of Rehabilitation	Year Last Monitored[43]	Monitoring Results
	BJB_R05			Native vegetation cover (12.6%) was lower than the lowest analogue value (20.3%). Vegetation structure was similar to the analogues, with hummock grass and shrub as the two most dominant lifeforms. There was 0.3% introduced cover (**Cenchrus ciliaris*). The rehabilitation is developing well and on track to returning to an analogue state.
Borrow pit - rail 2	BJB_R08	2012	2019	Native vegetation cover (26.6%) was within the analogue range (20.3% to 41.5%). Vegetation structure was similar to the analogues, with hummock grass and shrub as the two most dominant lifeforms. There was 0.1% introduced cover (**Cenchrus ciliaris*). The rehabilitation is developing well and on track to returning to an analogue state.
	BJB_R09			Native vegetation cover (29.3%) was within the analogue range (20.3% to 41.5%). Vegetation structure was similar to the analogues, with hummock grass and shrub as the two dominant lifeforms. There was no introduced cover. The rehabilitation is developing well and on track to returning to an analogue state.
	BJB_R10			Native vegetation cover (32.9%) was within the analogue range (20.3% to 41.5%). Vegetation structure was similar to the analogues, with hummock grass and shrub as the two most dominant lifeforms. There was no introduced cover. The rehabilitation is developing well and on track to returning to an analogue state.
WH1/2 (borrow pit)	BJB42	2012	2018	Perennial cover was good. Hummock grass cover was low at with less than 1.5% cover. Species richness was higher than in any analogue sites. Introduced cover was 0.1% (**Cenchrus ciliaris*). No erosion was recorded. Remediation recommended.
	BJB43	2012	2019	Low native cover (10.8%); more than three time less than the analogue mean (35.8%). Low hummock grass cover (3.1%); significantly less than the analogue mean of 20.0%. Native species richness (22 species; 20 perennials, two annuals) was similar to the analogue mean (27 species, 22 perennial and five annual). Similar vegetation structure to the analogues with a mid to tall shrub layer present. There was no introduced flora. Minor erosion features were recorded (two rills affecting 2.7% of the erosion transect. Remediation recommended.
OB18 borrow pit (unnamed area)	BJB46	2012	2021	*Acacia bivenosa, Acacia adsurgens,* and *Acacia dictyophleba* tall sparse shrubland, over *Triodia vanleeuwenii* and *Triodia schinzii* low open hummock grassland, over *Aristida inaequiglumis* and *Themeda triandra* mid sparse tussock grassland. Remote sensing showed total native cover of 56.0% and total introduced cover 0.2% (comprised entirely of **Cenchrus* species). Hummock grass was the dominant lifeform (32.1% cover) followed by shrubs (12.5%), trees (3.5%), herb (0.1%), and other grasses (7.6%). Bare areas were not detected. Native species richness was 56 and perennial and annual species richness were 44 and 12, respectively. No evidence of fire. Erosion and other disturbances were not recorded during the on-ground assessment.
OB18 rail loop	BJB45	2018	2021	Acacia pruinocarpa low sparse woodland with *Acacia bivenosa, Acacia* *ancistrocarpa*, and *Acacia hilliana* tall open shrubland, over *Triodia vanleeuwenii* low open hummock grassland. Remote sensing showed total native cover of 51.7%, introduced cover <0.01% (comprised entirely of **Cenchrus* species). Shrub lifeforms were the dominant cover (25.3%) followed by hummock grasses (19.7%), trees (1.2%), herbs (1.2%), and other grasses (4.1%). No bare areas were recorded. Native species richness was 52 with perennial and annual species richness 36 and 16, respectively. No evidence of fire. No introduced species recorded in the on-ground assessment. Erosion and other disturbances were not recorded in the on-ground assessment.
	BJB41	2014/15	2019	Low native cover (9.4%); less than half of the analogue mean (28.5%). Low hummock grass cover (0.4%); significantly lower than the analogue mean (19.0%). Moderate weed cover (5.0%) made up exclusively of **Cenchrus ciliaris*; higher than the analogues (no cover). Vegetation structure was similar to the analogue sites, where shrub was a dominant component. Native species richness (34 species, 29 perennials, five annuals) was similar to the analogue mean (38 species, 33 perennials and five annuals). No erosion was recorded.

Site Name	Monitoring Location	Year of Rehabilitation	Year Last Monitored[43]	Monitoring Results
West Jimblebar	BJB44	2015	2018	Perennial cover was good. Hummock grass cover was low with less than 1.5% cover. Species richness was higher than in any analogue sites. Introduced cover was 0.2%, (**Cenchrus ciliaris*). No erosion was recorded. Some water pooling (500 m^2). Inappropriate landform (floodplain) for hummock grass. Species present more appropriate for floodplain. Reassess target vegetation community.
East Jimblebar Regrade	BJB47	2017	2019	Very low native cover (3.1% compared to the analogue mean of 28.5%), however, as this area was rehabilitated in 2017, it is very young and over time native vegetation cover is expected to increase, particularly as there are no weeds or other disturbances to prevent it from doing so. Vegetation structure was not similar to the analogues, as all lifeforms had low covers. Native species richness (32 species; 24 perennial, eight annual) was similar to the analogue mean (38 species; 33 perennials, five annuals). There were no introduced flora species or erosion recorded.

Source: Spectrum Ecology (2018; 2019; 2021)

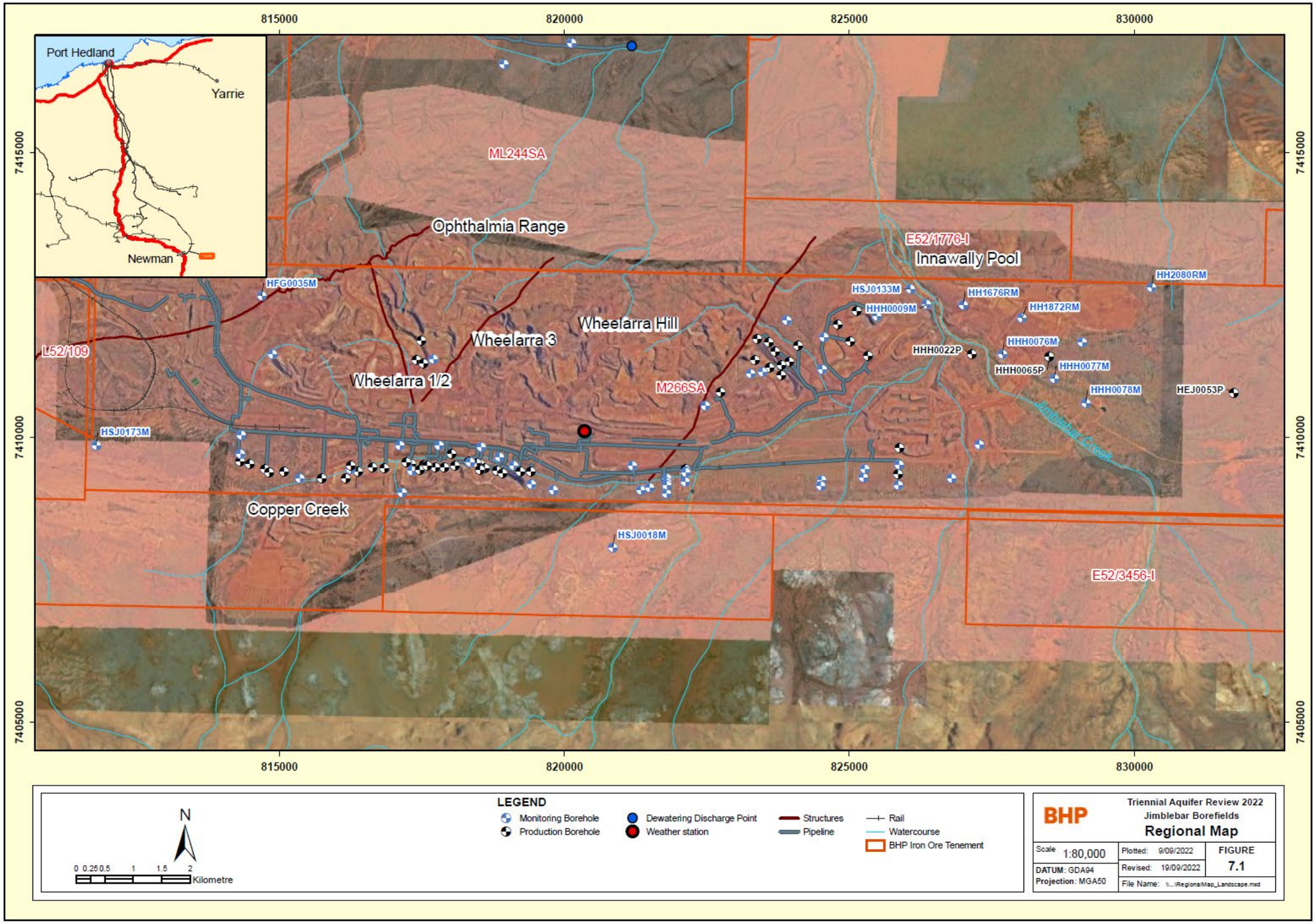
Appendix N. Water monitoring locations

N-1. OB17/18/31 groundwater operating strategy monitoring locations

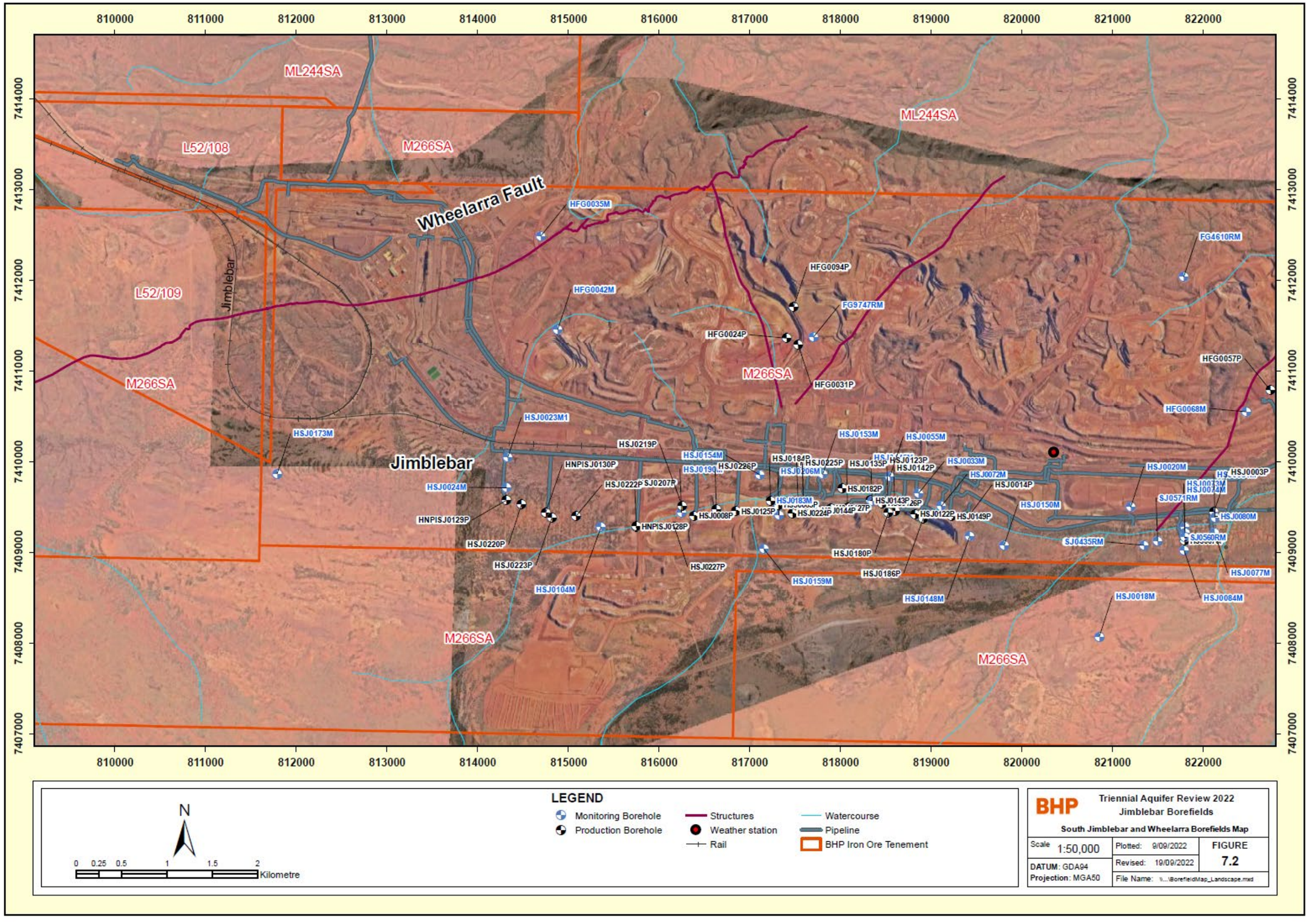


Source: WAIO (2018b)

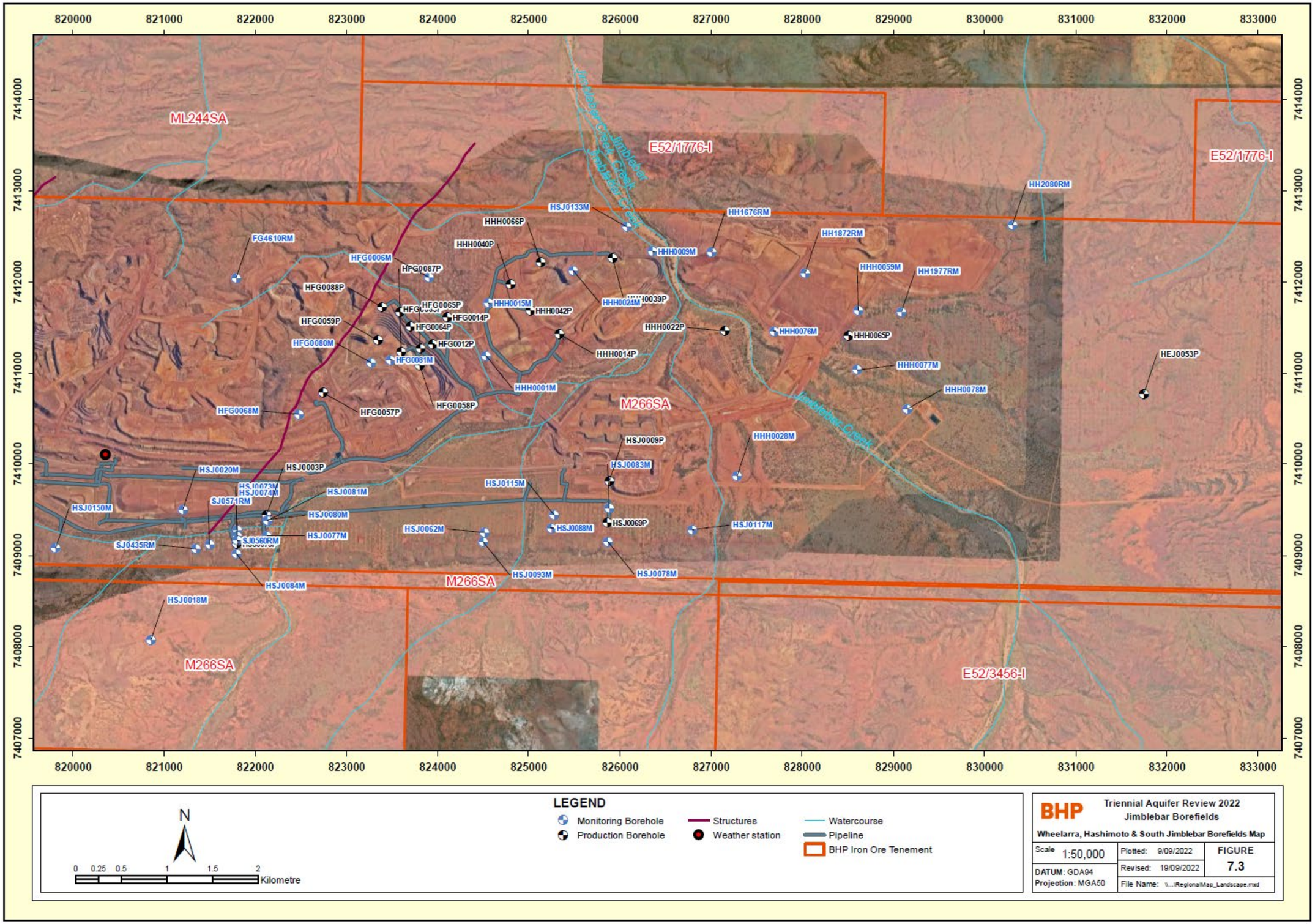
N-2. Jimblebar groundwater operating strategy monitoring locations



Source: BHP (2022l)

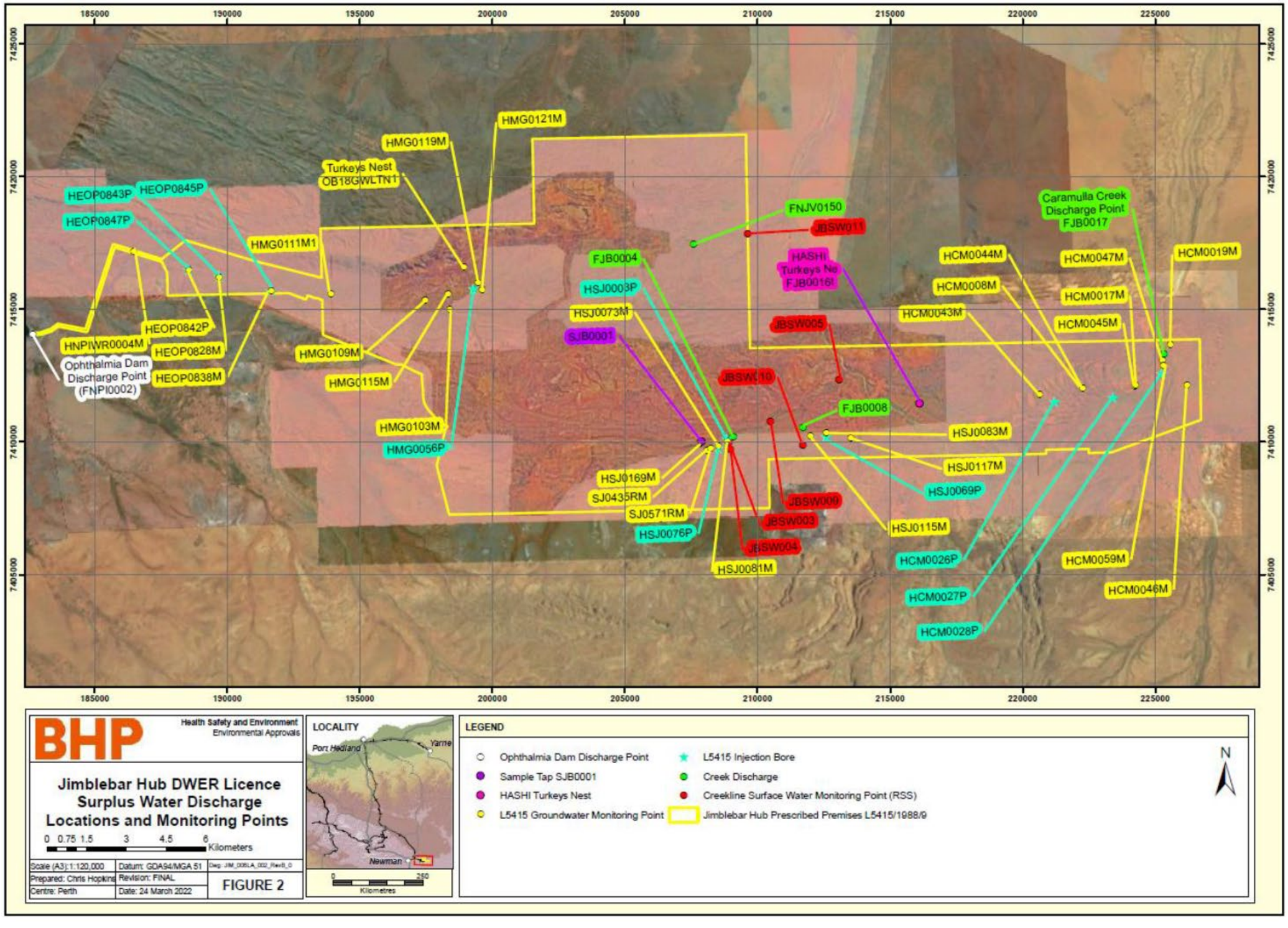


Source: BHP (2022l)



Source: BHP (2022l)

N-3. Environmental Licence L5415/1988/9 groundwater and surface water monitoring locations



Appendix O. Borrow Pit Rehabilitation Procedure

BHP

WAIO Borrow Pit Management & Rehabilitation Procedure

Document number: SPR-IEN-LAND-008
Version: 7.0

Document Control

APPROVER	DATE	CUSTODIAN	REVIEW DATE
Manager Business Partnering HSE	December 2019	Superintendent Business Partnering HSE Rehabilitation	December 2021

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Electronic Approval Record

Business Role	Name
Author Role	**Name**
Specialist Rehabilitation	Shayne Lowe
Reviewer Role	**Name**
Superintendent Business Partnering HSE	Tony Webster
Approver Role	**Name**
Manager HSE Non Mining	Emily Haley

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4.0	Multiple	24 Month review.	08/16
5.0	Multiple	Spatial requirements amendment	14/11/2017
6.0	All	Update, edit	08/18
7.0	All	Minor Edits	11/19

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1. Purpose

This document sets out the minimum standards for the planning, management and rehabilitation of borrow pits for all WAIO sites. Compliance with this document will ensure that borrow pit rehabilitation complies with WAIO standards and legal obligations.

2. Scope

This procedure covers the minimum environmental requirements for planning, management and rehabilitation of borrow pits for all sites across WAIO. It details the planning and operational requirements that are necessary to ensure compliant rehabilitation and minimize the environmental impact of borrow extraction activities.

3. Policy / Procedure Statement

Quality Message
Borrow pits shall be designed to ensure they can free drain (not hold water) when rehabilitated. If pits hold water, the rehabilitation will be compromised as plants that establish can drown after rain.
Pit design shall ensure there is sufficient backfill to achieve a free-draining condition and obvious engineered drains shall not be used.
All borrow pit rehabilitation shall have the aim of blending the pit into the surrounding landscape.

3.1. Planning & Operation of Borrow Pits

Borrow pits are generally created to source fill for areas of construction, or maintenance of roads and rail lines.

The intent of borrow pit design is that it shall:

- be free draining without construction of a formed drain;
- blend with the surrounding landscape;
- allow natural recruitment of species back into the pit;
- have reduced visual impact; and
- have reduced risk of impacting surface water flow through the landscape.

Borrow pits should be as small as possible while providing the suitable type and quantity of material required. Borrow pit design should minimize overall environmental impact.

A Borrow Pit Management Plan (BPMP – see FRM-IEN-LAND-006) shall be completed for all borrow pits, and approved prior to borrow pit disturbance commencing. The BPMP will detail how the borrow pit is to comply with the requirements of this procedure; this will include evidence of test pit results proving that a borrow resource is present, plans of the final rehabilitation of the pit showing final landform design, and demonstration that the pit can be made to free drain in compliance with this procedure.

Any significant variations to an approved BPMP, regarding the site investigation, design, construction or operation of the borrow pit, shall be updated in the BPMP and require the approval of the BHP Advisor Environment Projects or BHP Specialist Environment, and the BHP Specialist Rehabilitation.

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A photographic record shall be made to record the progress of the borrow pit, consisting of a series of photographs taken from the same location looking over the borrow pit. As a minimum photographs shall be taken:

- prior to clearing; and
- following rehabilitation of the borrow pit.

Photographs taken during the operation of the borrow pit are also of value. All photographs shall be submitted with the final BPMP documentation.

3.1.1. Selecting borrow sources

Clean fill borrow material shall be first sourced from existing stockpiles including mining waste wherever reasonable. Existing borrow pits not fully depleted of material may be re-opened where possible. If a new borrow pit is required, preference shall be given to situating it on future approved disturbance areas such as future mine voids.

Weed infested locations shall be avoided where possible. Where weed infestations are identified, they shall be managed appropriately.

Detailed testing of the in-situ materials in the proposed borrow pit needs to be undertaken to confirm suitability and extent of materials prior to clearing. Test pits must be immediately refilled if the area is shown to be unsuitable for borrow extraction. Test pit results for areas to be used as borrow must be supplied with the BPMP; results from borrow pit testing shall be used to provide a detailed plan of the borrow resource available for extraction.

3.1.2. Pit size

The size of the borrow pit and amount of material extracted shall be ample for the requirements of the project, and shall not over compensate allowing excessive clearing i.e. no more than 15% extra area should be planned.

Borrow pits shall not exceed one hectare in surface area, unless otherwise authorised by the BHP Specialist Environment. Larger pits will only be approved where a net environmental benefit exists – for instance if a greater amount of borrow can be extracted from a single larger pit than from several smaller pits, or where an improved rehabilitation outcome will be achieved by blending the edges of the borrow area with the surrounding landscape. Smaller pits are preferred as this encourages revegetation by assisting recruitment of plants from the surrounding native vegetation.

3.1.3. Roads

To reduce visual impact, borrow pits shall be kept a minimum of 50 m away from roads, with consideration given to placing the pits in locations that are not obvious from roads and other viewpoints. For private (BHP) roads, a shorter buffer is allowable provided the pit is hidden from view and access to the pit can easily be blocked after rehabilitation. Access must be blocked to rehabilitated areas.

Where possible, vehicle movement shall be confined to either existing roads or a single access track only.

3.1.4. Drainage

For the purpose of this procedure, significant water courses shall be defined as those water courses that:

- are marked on a 250,000 scale Geoscience Australia GIS layer (TOPO-250K hydrography);
- exhibit a change in vegetation that indicates a watercourse; and/or
- have a defined watercourse bed (definite bank and/or alluvial gravels present.

Significant water courses shall be avoided by a buffer zone of at least 50 m to ensure that the natural flow of water is not impeded.

Borrow pits shall not be positioned where culverts or drains have potential to drain into the pit.

Water control measures shall be implemented as required. Windrows may need to be placed on the ‘upslope’ side of the pit and / or diversion drains may need to be constructed to direct water away from the pit. If being left in place after rehabilitation, these must be designed to blend with the surrounding landscape.

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As each pit has different requirements the BHP Specialist Environment shall be consulted to advise of the most appropriate technique.

Pooling of water during extraction from the borrow pit shall be minimized, and is not permitted following rehabilitation. All borrow pits are to be free-draining after rehabilitation.

3.1.5. Design

Borrow pit shape and design shall blend with the natural contours of the surrounding landscape. A re-profiling buffer (a minimum of 10m) must be planned to allow blending of the pit edges into the surrounding area during final landscaping.

Borrow pits may be located on sloped land, and shall be designed to ensure they are free draining on completion. A survey is required during the final borrow pit stages to confirm compliance to the BPMP, that rehabilitation efforts will be able to deliver a free draining pit, and to allow estimates of fill extracted.

3.1.6. Topsoil Management

The first 150mm of soil shall be stripped as topsoil and stockpiled for use during rehabilitation of the borrow pit. Where additional Subsoil or Growth media is identified, there may be requirements to recover additional Growth Media material. Topsoil / Subsoil stockpiles are to be constructed to **3m high with a convex upper final surface** and placed parallel to the slope to reduce the risk of water pooling against the stockpile. For further information on soil management, please refer to SPR-IEN-LAND-009 Growth Media Management.

3.1.7. Weed Management

Weed hygiene procedures, site Weed Management Plan requirements and site specific approval conditions must be followed during development and utilisation of borrow pits. Equipment operating within a borrow pit shall hold a Weed and Seed certificate for the site that the borrow pit is located within. If not, equipment must be cleaned prior to arriving on site, and certified as weed and seed free before operating within the borrow pit.

3.1.8. Rail Specific

As Rail activities are constrained by tenure, special borrow pit specifications apply. Where practicable, widening or extending of rail cuttings shall be used to obtain borrow and these extended cuttings are not required to be battered to angles similar to the surrounding natural landscape. Rail borrow pits are exempt from the visual impact requirements (e.g. distance to Public Roads) but shall ensure access to borrow pits is restricted by windrowing or bunding following rehabilitation and additional signage should be used where required to ensure rehabilitated areas are not accessed. Borrow pits must still be free draining, where practicable.

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3.1.9. Summary of Specifications

Table 1: Borrow Pit Technical Specifications

HEADING	DESCRIPTION OF REQUIREMENT
Maximum size	One ha unless otherwise approved by BHP Specialist Environment responsible for the area.
Minimum distance from roads	
- Public	50 m
- BHP	50 m or hidden from view
- Rail	Can be against the road, refer **Section 3.1.8.**
Minimum distance from significant watercourses	50 m of natural vegetation shall be retained between the proposed edge of the final re-profiled borrow pit to the bank of the channel, refer **Section 3.1.4**.
Minimum distance between pits	50 m
Maximum depth of borrow pits	Must free drain with no engineered drains.
Spread depth of topsoil / subsoil	Dependent on volume stripped. Aiming for 100mm
Batter angle	Similar to surrounding natural slopes, and less than 3:1 (unless utilizing a rail cutting extension). Refer Section 2.1.8
Testing	Confirm suitability and extent of borrow materials.
Borrow Pit Management Plan	Must be approved prior to the start of clearing activities. Extraction plans to include: planned borrow pit boundary; extent of borrow resource; planned re-profile buffers; size of planned borrow pit; PEAHR Boundary; VDA boundary *(IOP only)*; any exclusion zones; creeks & drainage lines; public & private roads; planned access roads; existing natural contours. Rehabilitation plans must indicate planned contours post rehabilitation showing free draining pit; final pit boundary; PEAHR boundary; VDA boundary *(IOP only)*; and an indicative cross section of the planned final landform profile is to be provided.

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3.2. Rehabilitation of Borrow Pits

All standard rehabilitation requirements apply to borrow pits, refer SPR-IEN-LAND-010 Earthworks for Rehabilitation and 0000973 Rehabilitation Audit & Inspect. The following are additional requirements specific to borrow pits.

The Borrow Pit Completion Report shall be signed off following completion of borrow pit rehabilitation (0108012), following 0000973 Rehabilitation Audit & Inspect procedure.

Note for IOP only: all standard rehabilitation and demobilisation requirements, including the completion of a Demobilisation Audit[1], apply to all borrow pit areas. All BPMP shall be closed out with the Borrow Pit Completion Report signed off prior to demobilisation.

3.2.1. Unused Material

Any unused stockpiles of borrow pit material shall be spread back over the borrow pit floor prior to topsoil return.

3.2.2. Waste

Once extraction of material is completed all rubbish shall be removed for proper disposal. Under no circumstances will rubbish or construction waste be buried in the borrow pit.

3.2.3. Landscaping

Borrow pit walls should be battered to blend with the surrounding environment **(Figure 1)**. An exception to this exists for Rail where borrow pits are created as extensions to cuttings – see **Section 3.1.8**.

The 3:1 (18 degrees, 33%) slopes are only to be used where the surrounding topography is similarly sloped such that the re-profiled batter blends into the adjacent undisturbed landscape.

Borrow pits edges shall be blended into the surrounding topography. Straight lines are to be avoided in favour of fluid edges and pits that slope naturally. The buffer between the clearing line and the edge of extraction is to be used to create this effect. The aim in rehabilitating borrow pits is such that they cannot be easily discerned from their surroundings once vegetation has re-established. The recommended machinery for achieving this result is an excavator.

Rehabilitated borrow pits shall be free draining. That is, the pit can drain naturally from the lowest point and will not accumulate water. Where pits hold water, rehabilitation success is reduced due to death of vegetation by drowning. Drainage management systems are permitted, however they must blend in with the surrounding landscape. Surveys shall be undertaken, with a contour map produced to confirm compliance with BPMP and demonstrate final contours allow free draining.

If available, materials unused from nearby areas, such as mine waste, can be utilised to backfill deeper areas of the borrow pit, thereby increasing the amount of borrow that can be taken while still providing a final free-draining state. This must be planned for and approved as part of the BPMP.

[1] IOP procedure: FRM PP-13-003-04

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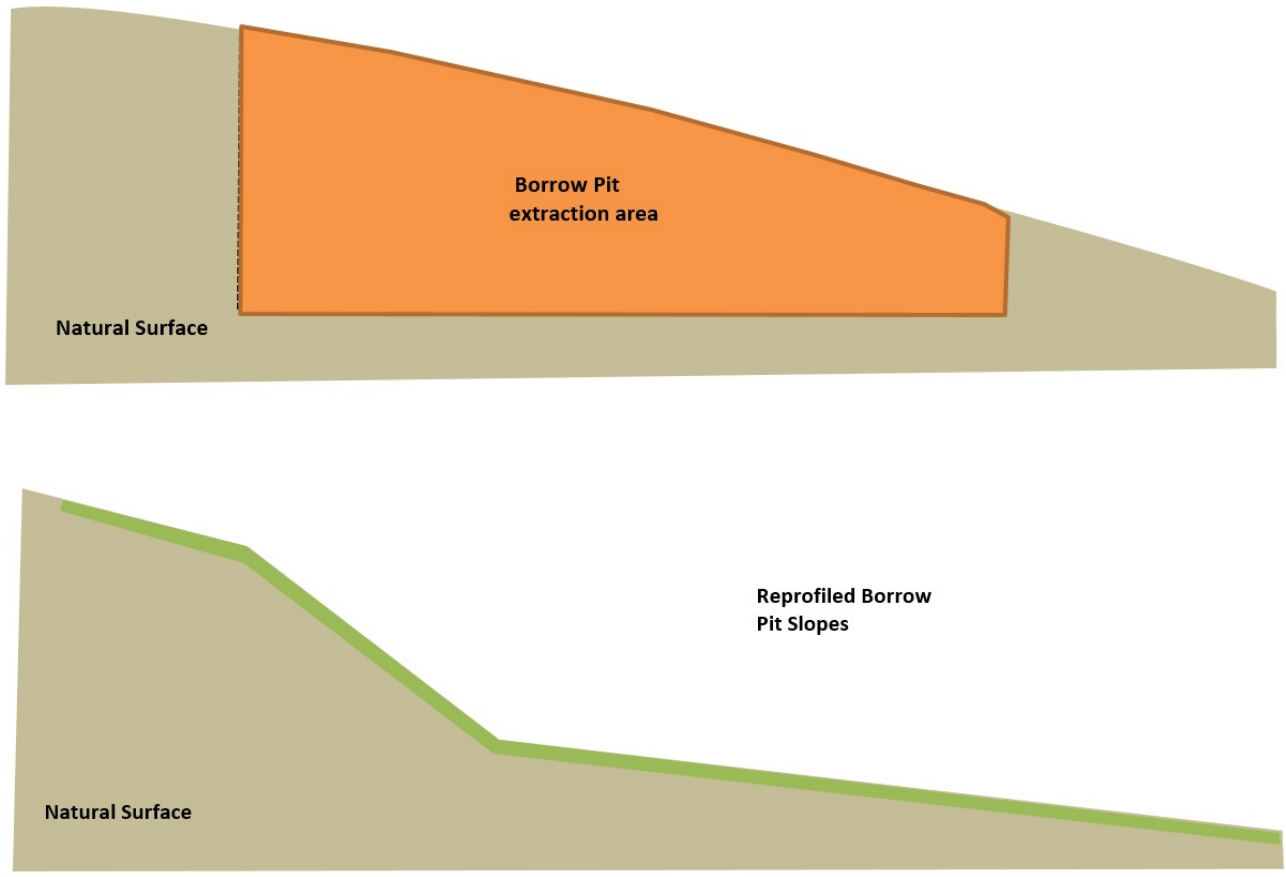

Figure 1: Slope profiling objectives are to blend the pit in with the surrounding landscape and avoid water pooling in the pit.

3.2.4. Ripping

All compacted areas / haul roads are to be deep ripped following completion of project works and prior to growth media / topsoil return. This will increase the success of the rehabilitation and assist water infiltration.

Light scarification (100mm) to be undertaken following topsoil spread. Final scarification shall be carried out in compliance with SPR-IEN-LAND-010 Earthworks for Rehabilitation.

3.2.5. Seeding

Rehabilitation Specialist to review area prior to works commencing to establish vegetation communities.

Seed shall be broadcast for revegetation if necessary – i.e. seed may be required if the borrow pit is greater than 1 ha, or the growth media / topsoil has been stockpiled > 1 year or at the advisement of the Rehabilitation Specialist following pre works site visit.

Seed will be provided by BHP Rehabilitation Team.

Consult the BHP Specialist Rehabilitation regarding seed requirements.

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3.3. Compliance with this Procedure

If an exemption to any of the requirements detailed in this procedure is required, it must be demonstrated within the BPMP that every effort has been made to follow this procedure before addressing the reasons for the variation to the procedure. The BPMP will then require approval from both the following BHP staff:

- Specialist Environment;;
- Specialist Rehabilitation.

Exemption requests shall be reviewed for compliance with environmental legal and other obligations, and for environmental impact. The reasons for approval of any request must be documented.

During review of an exemption request, no borrow pit construction or activities, including clearing and topsoil collection, shall be undertaken at that location unless under the conditions of an already existing and approved BPMP. *IOP only - allow 3-5 days for BPMP exemption reviews.*

4. Responsibilities

Position Title	Role	Description of Task
BHP Specialist Environment	Approval and advice	• Approve standard BPMPs.
BHP Specialist Environment	Approval and advice	• Approve non-standard BPMPs – for instance where the borrow pit is proposed to be larger than 1ha.
Project Manager / IOP Company Representative (generally a supervisor or engineer)	Compliance	• Develop BPMP. • Ensure that the borrow pit is developed and rehabilitated in adherence with the BPMP.
Operations Personnel / contractors	Compliance	• Follow the requirements of this procedure. • Ensure that the borrow pit is developed and rehabilitated in adherence with the BPMP.
BHP Specialist Rehabilitation	Advice	• Provide advice and assistance where required to ensure the best environmental outcome. • Provide Seed as required • Save completed BPMPs to 1Doc Rehabilitation Works under the respective site.
BHP Specialist Rehabilitation	Approval and Advice	• Approve non-standard BPMPs

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5. Definitions and Abbreviations

Term	Description
BPMP	Borrow Pit Management Plan
BHP	BHP Iron Ore
IOP	Iron Ore Projects
PEAHR	Project Environmental and Aboriginal Heritage Review
Significant watercourse	Those water courses that: □ are marked on a 250,000 scale Geoscience Australia GIS layer (TOPO-250K hydrography); □ exhibit a change in vegetation that indicates a watercourse; and/or □ have a defined watercourse bed (definite bank and/or alluvial gravels present.
VDA	Vegetation Disturbance Approval *(IOP only)*
WAIO	Western Australian Iron Ore

6. References

References	Title
FRM-IEN-LAND-006	Borrow Pit Management Plan
SPR-IEN-LAND-009	Growth Media Management
SPR-IEN-LAND-010	Earthworks for Rehabilitation
SPR-IEN-LAND-011	Seed Management
0108012	Rehabilitation Audit and Inspect Borrow Pit Form

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7. Appendices

7.1. Appendix 1 Examples of Good and Poor Borrow Pit Rehabilitation

✓ Free draining

✓ Topsoil and Spinifex re-spread over pit

✓ Good re-profile

✓ Edges blended into surrounding landscape

✘ Ripping is not on contour

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✓ Edges blended into surrounding landscape (excavator was used)

✘ Not free draining

✘ Culvert drains stormwater into pit

✘ Batters too steep; does not blend with surrounding landscape

✘ no allowance to blend into adjacent undisturbed landscape

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✓ No windrow on edge of access track

✓ Vegetation and topsoil brought back across track

✓ Edges blended into surrounding landscape

✓ Good re-profile

✓ Borrow pit situated on sloping land to allow free draining

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✘ Not blended into landscape (windrow on edges)

✓ Topsoil returned evenly

✓ Low profile rip lines on previously compacted areas

✘ Surface left too rough

✓ Well blended into landscape

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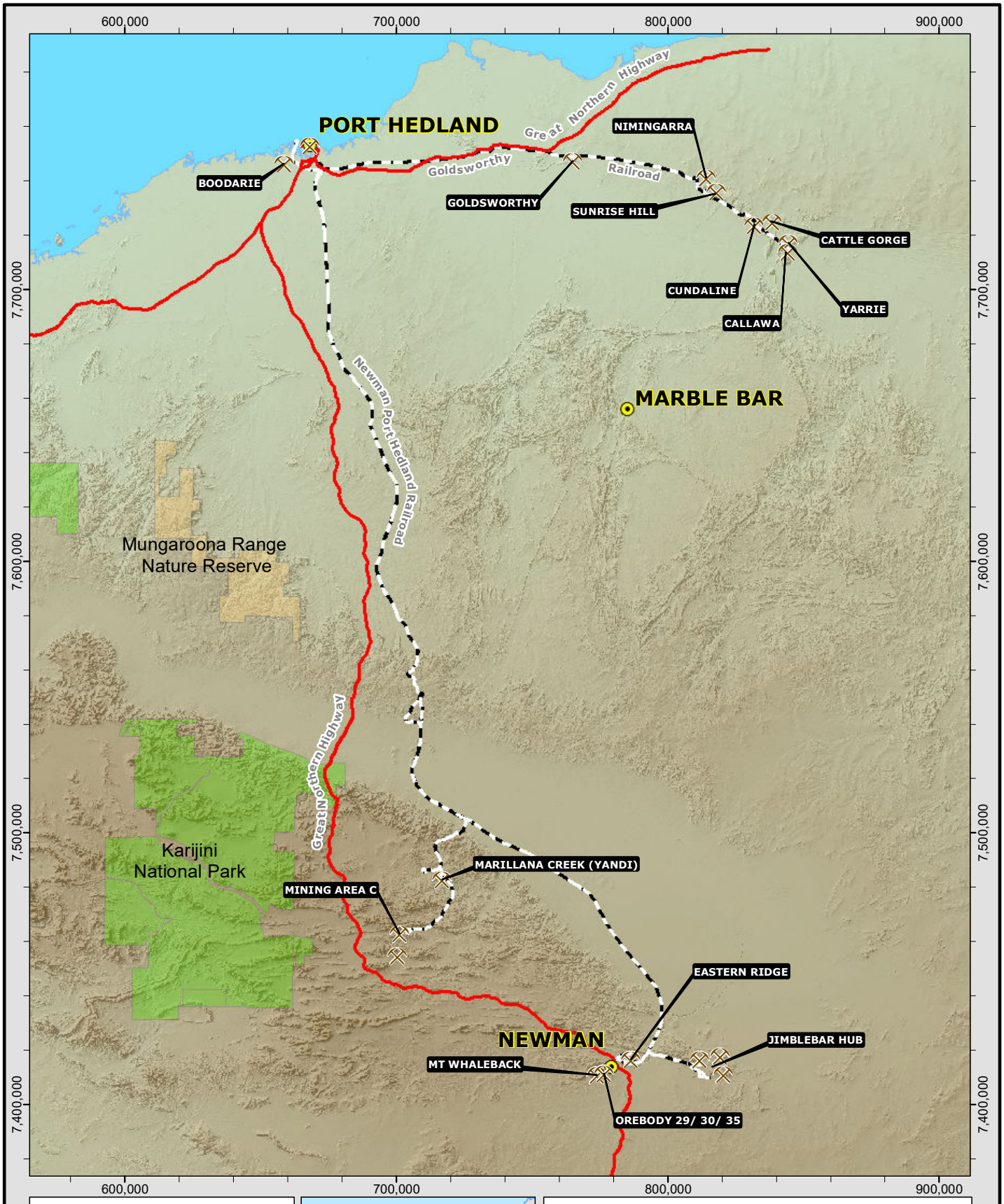
Appendix P. Relevant technical references

This appendix is not publicly available. It is commercially sensitive and has been supplied separately.

Appendix Q. PDF versions of plans

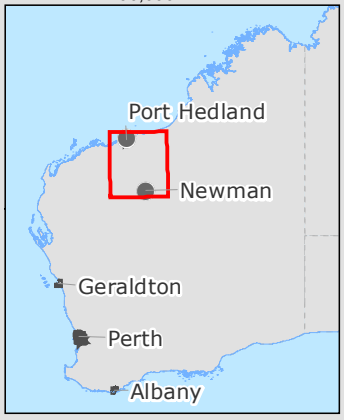


LEGEND

- BHP Operation
- Pilbara Town

N

0 20 40 60 80 km



BHP

BHP IRON ORE

WESTERN AUSTRALIAN OPERATIONS
BHP IRON ORE

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Datum: GDA 94, Projection: MGA Zone 50		

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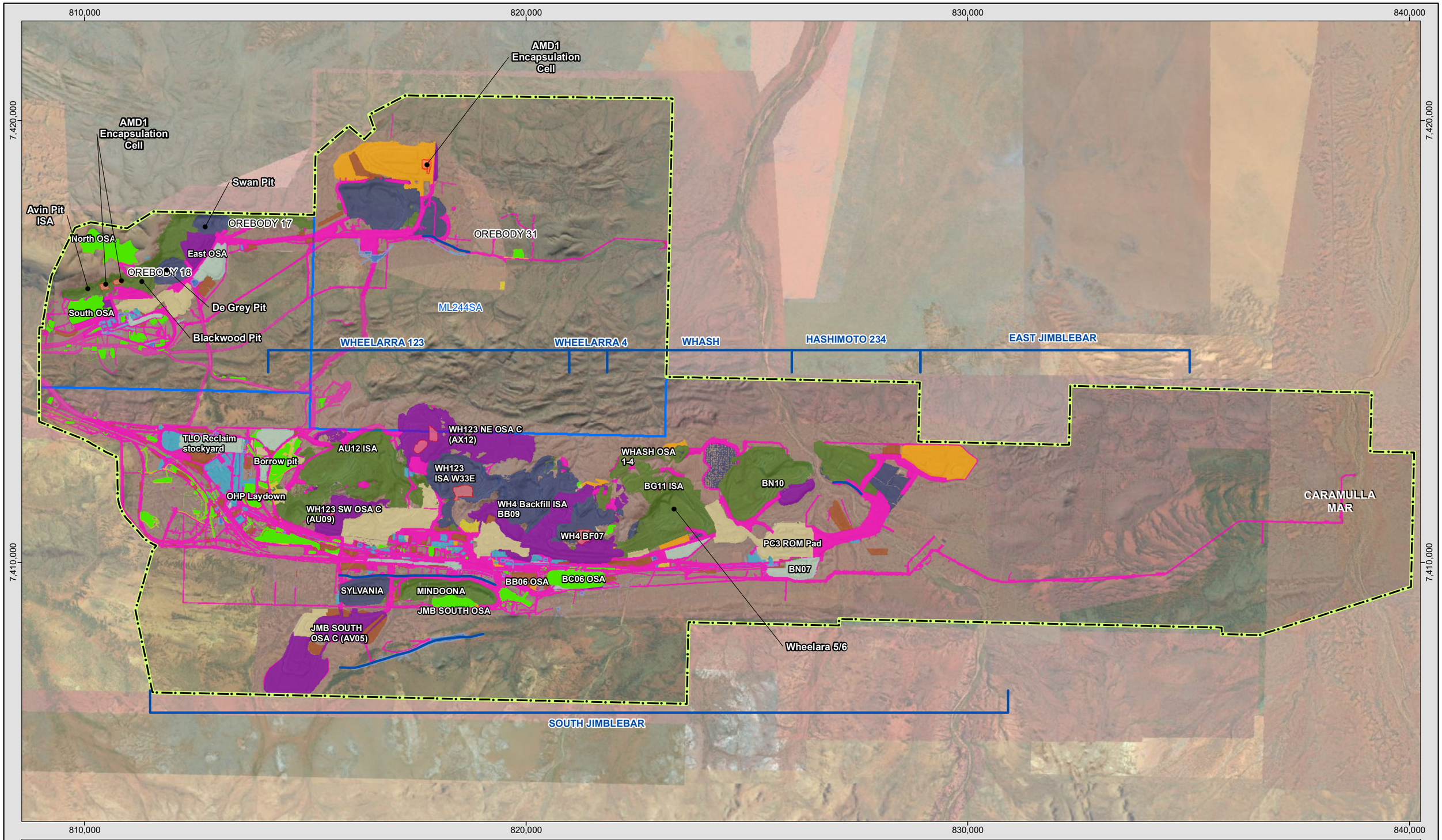
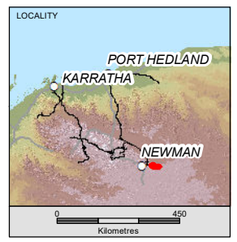


- Existing surface water flood bund / diversions
- Closure Plan Boundary
- ML244 State Agreement
- PAF encapsulation cells
- Land under rehabilitation, where the mining authorisation is not a prospecting licence or exploration licence granted under the Mining Act 1978
- Waste dump or overburden stockpile (class 1)
- Waste dump or overburden stockpile (class 2)
- Infrastucture
- Borefield
- Borrow pit (less than 5 metres)
- Dam or channel
- Low-grade ore stockpile
- Run-of-mine pad
- Topsoil stockpile
- Transport or service infrastructure corridor
- Mining void (with a depth of at least 5 metres) above ground water level
- Mining void (with a depth of at least 5 metres) below ground water level



BHP

Spatial Data - Studies Planning & Access
BHP IRON ORE

JIMBLEBAR HUB
Existing Disturbance by MRF Category

N

0 1 2 3 4
Kilometres

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator, Datum: GDA 1994, Units: Meter

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Date: 12/12/2023	Checked: D.Perske	Figure:
	Reviewed:	

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810,000
820,000
830,000
840,000
7,450,000
7,440,000

AMD1 Encapsulation Cell
Swan Pit
AMD1 Encapsulation Cell
AMD1 Encapsulation Cell
OREBODY 17
OREBODY 11
Swan OSA
East OSA
Avon Pit OSA
OREBODY 18
De Grey Pit
Blackwood Pit
Swan OSA
RAIL LOOP
WHEELARRA 122
WHEELARRA 4
WHASH
HASHIMOTO 234
EAST JIMBLEBAR
Tip Overflow West Dyke
Bore Field
WH122 NE OSA C (AA12)
AU12 ISA
WH123 ISA W3E
WHASH OSA 1/4
BO11 ISA
BN10
Dam Dry Dam
WH123 SW OSA C (AJ29)
WH4 Backfill ISA BB09
WH4 BF07
PORT HEDLAND
CARAWULLA MAIN
BN07
BB06 OSA
BO01 OSA
SYLVANIA
MINGOONA
Wheelara 5/6
JMB SOUTH OSA
JMB SOUTH (OSA C, AV05)
SOUTH JIMBLEBAR

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- Waste dump or overburden stockpile (class 2)
- Infrastructure
- Borefield
- Borrow pit (less than 5 metres)
- Dam or channel
- Low-grade ore stockpile
- Run-of-mine pad
- Topsoil stockpile
- Transport or service infrastructure corridor
- Mining void (with a depth of at least 5 metres) above ground water
- Mining void (with a depth of at least 5 metres) below ground water

LOCALITY
PORT HEDLAND
KARRATHA
ROEBUCK
0 200 400 600
Kilometres

BHP
Spatial Data - Studies Planning & Access
BHP IRON ORE

JIMBLEBAR HUB
Existing Disturbance by MRF Category

N
0 0.5 1 1.5 2
Kilometres

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator, Datum: GDA 1994, Units: Meter

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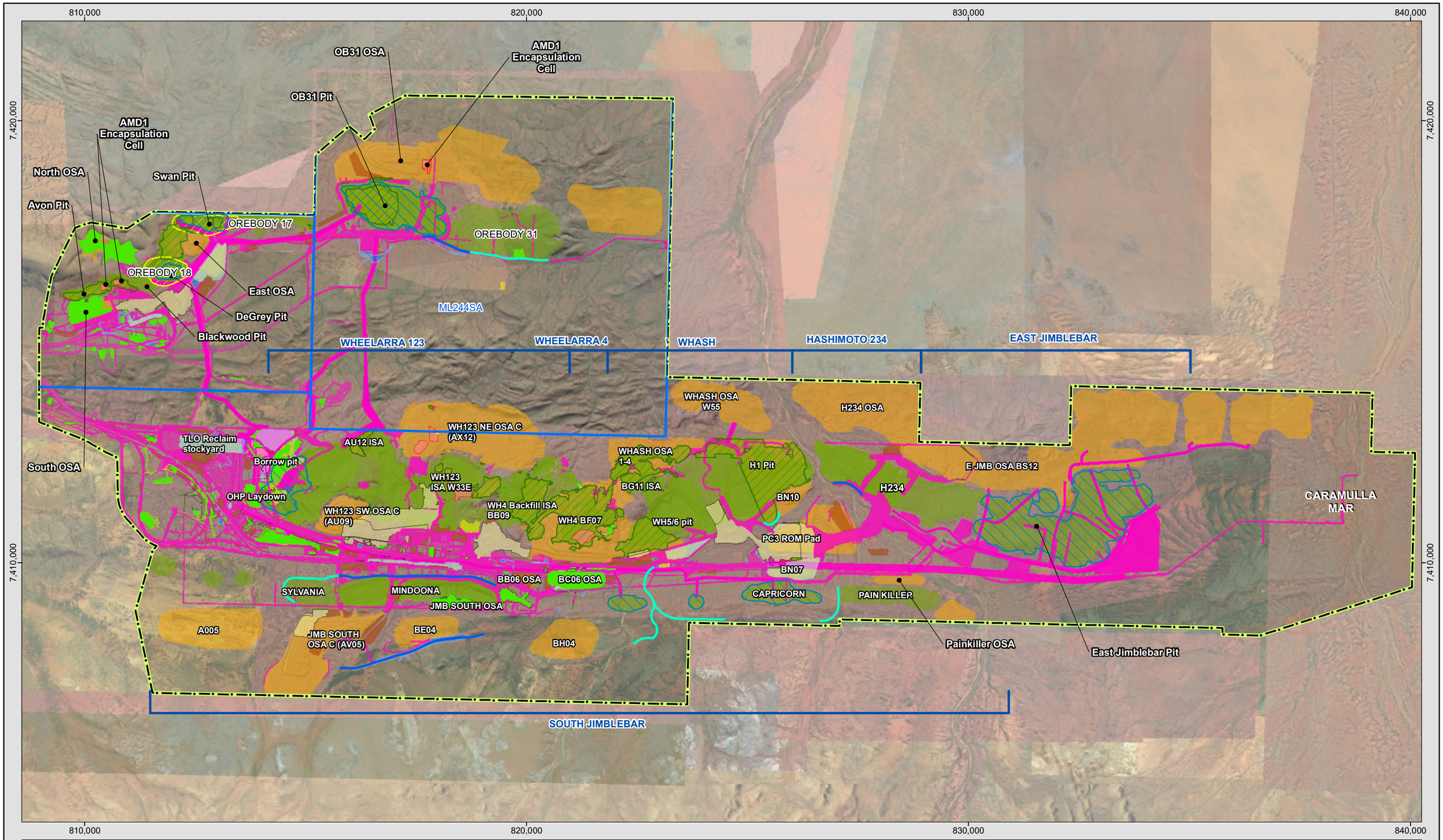
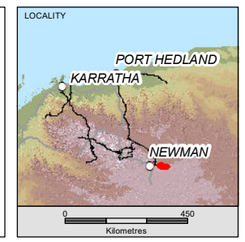


- Proposed surface water flood bund / diversions
- Existing surface water flood bund / diversions
- Closure Plan Boundary
- Potential In pit TSF (conceptual - long term)
- ML244 State Agreement
- PAF encapsulation cells
- Land under rehabilitation, where the mining authorisation is not a prospecting licence or exploration licence granted under the Mining Act 1978
- Pits
- OSA
- ISAs / backfill
- Infrastructure
- Borefield
- Borrow pit (less than 5 metres)
- Dam or channel
- Low-grade ore stockpile
- Run-of-mine pad
- Topsoil stockpile
- Tailings or residue storage facility



BHP

Spatial Data - Studies Planning & Access
BHP IRON ORE

JIMBLEBAR HUB
Domain Closure - Future Disturbance

N

0 1 2 3 4
Kilometres

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Projection: Transverse Mercator, Datum: GDA 1994, Units: Meter

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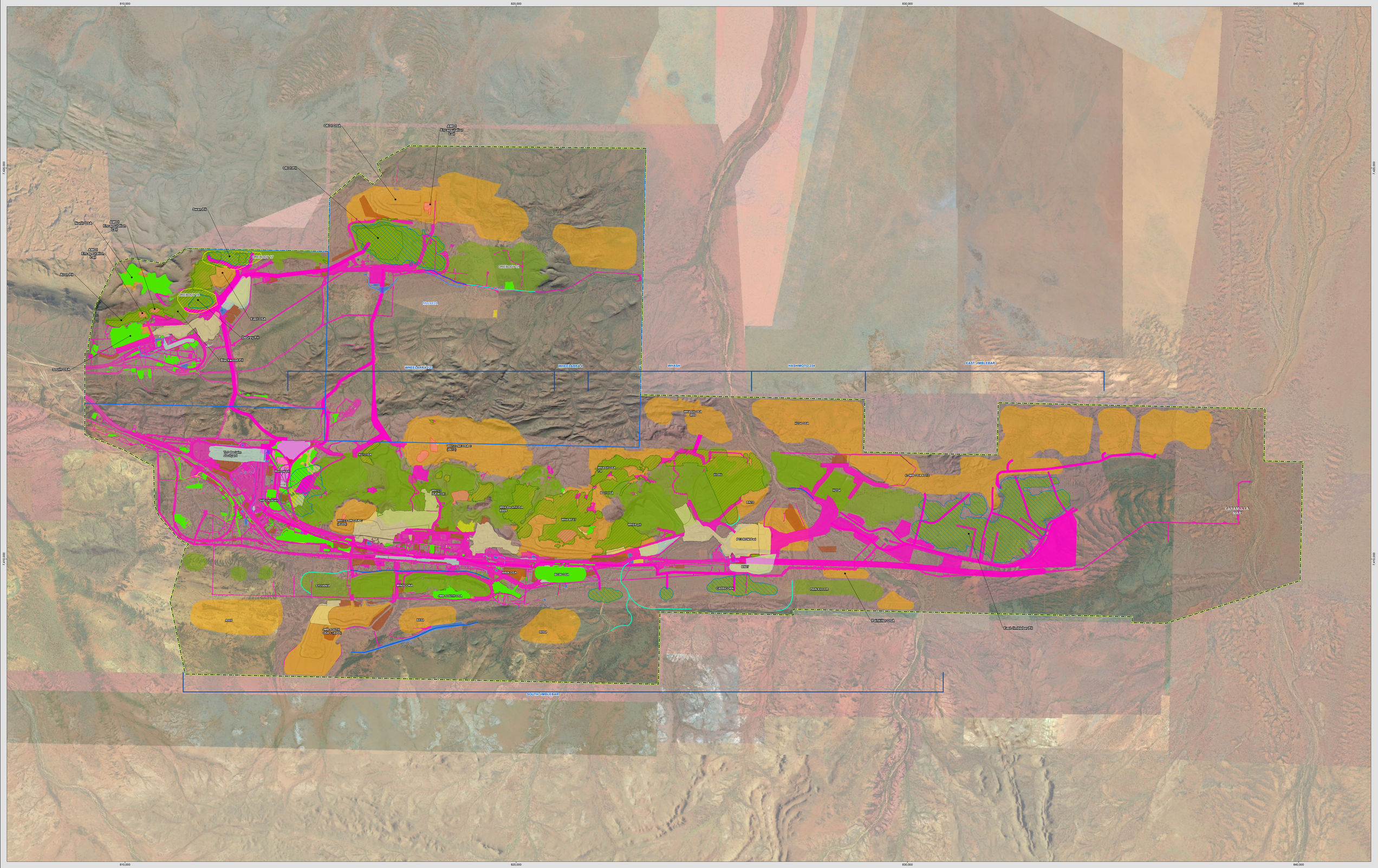

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- Low-grade ore stockpile
- Run-of-mine pad
- Topsoil stockpile
- Tailings or residue storage facility

LOCALITY

0 200 400 600
Kilometres

BHP

Spatial Data - Studies Planning & Access
BHP IRON ORE

JIMBLEBAR HUB
Domain Closure - Existing Disturbance

N
0 0.5 1 1.5 2
Kilometres

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator. Datum: GDA 1994. Units: Meter

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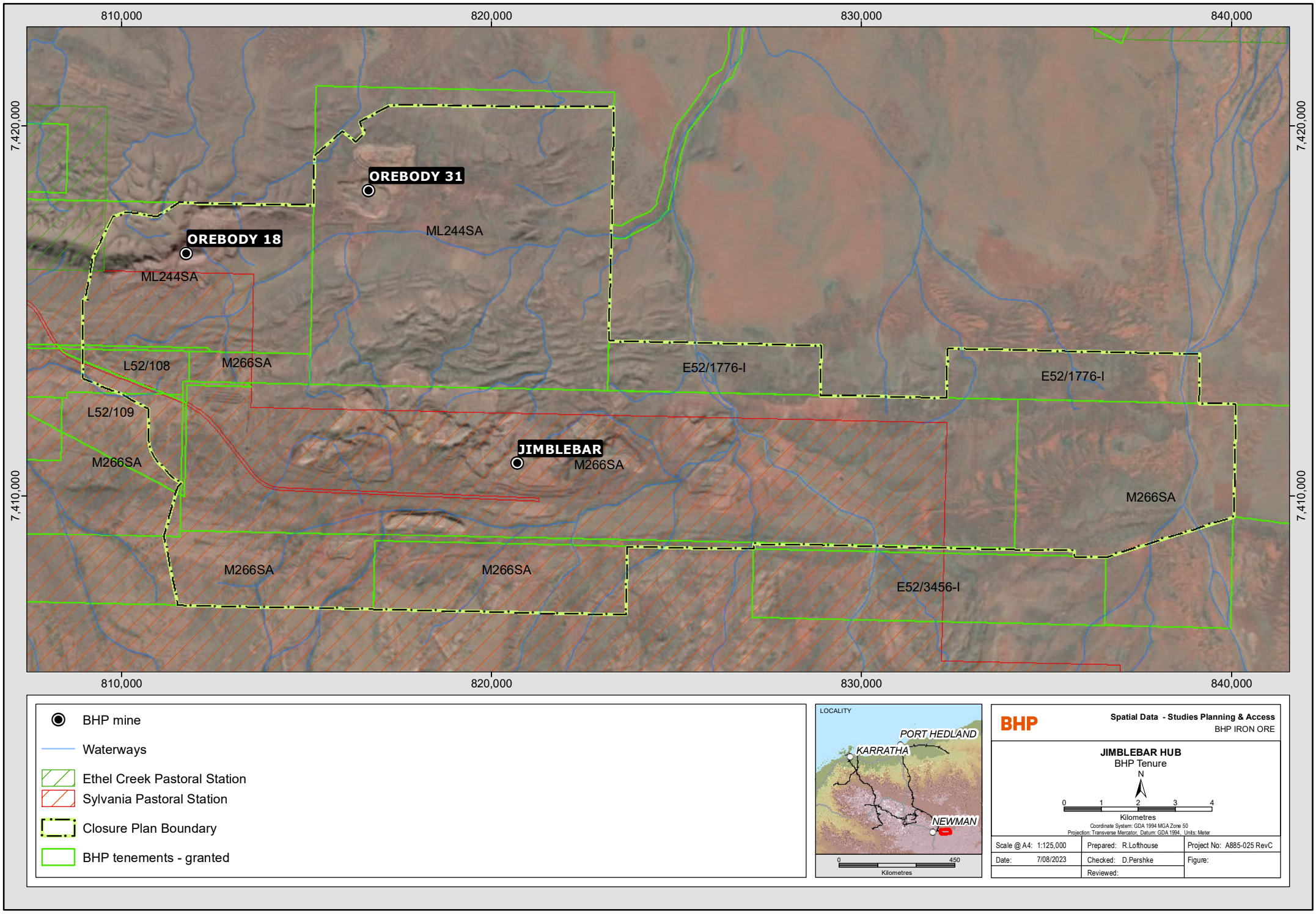

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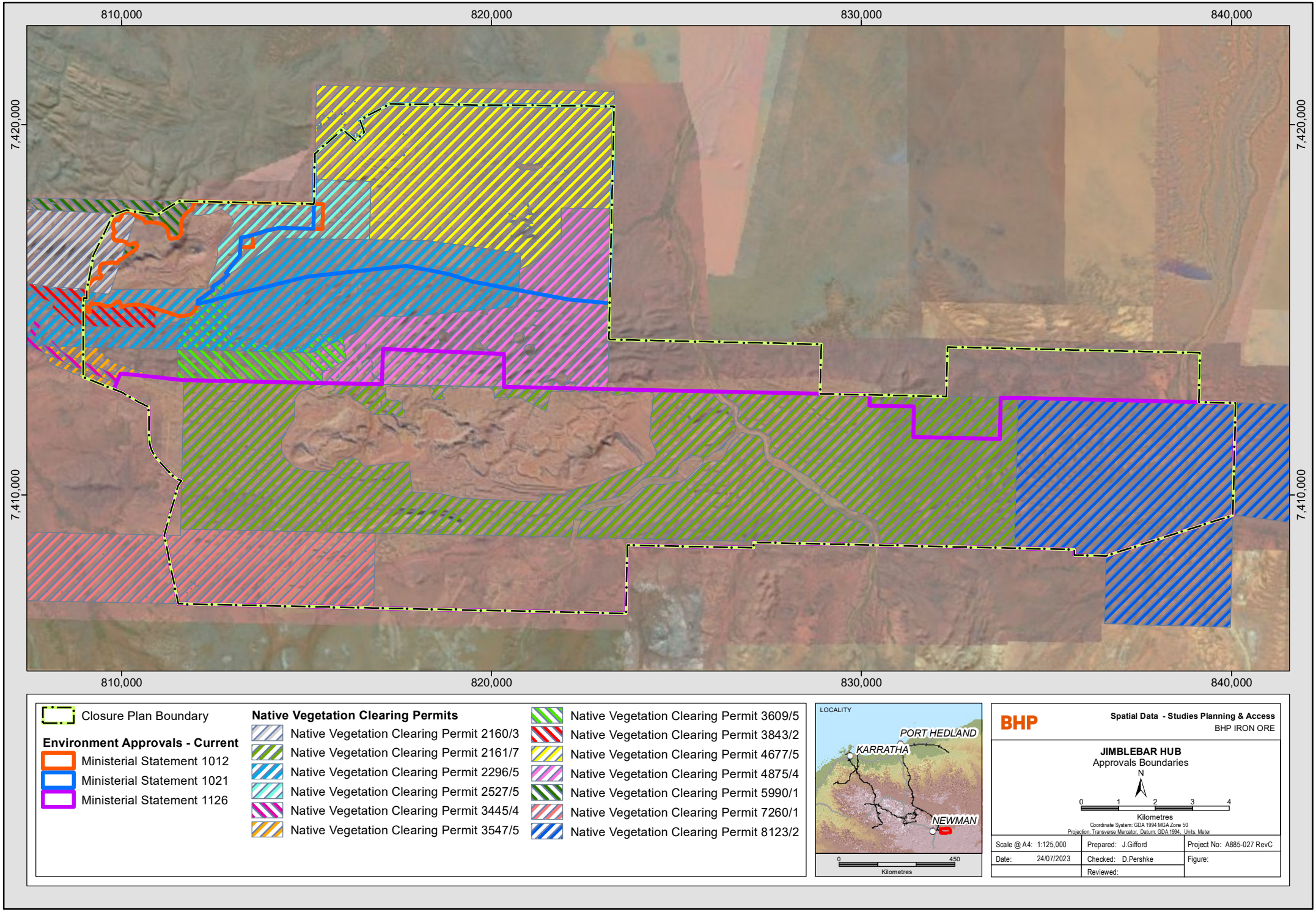

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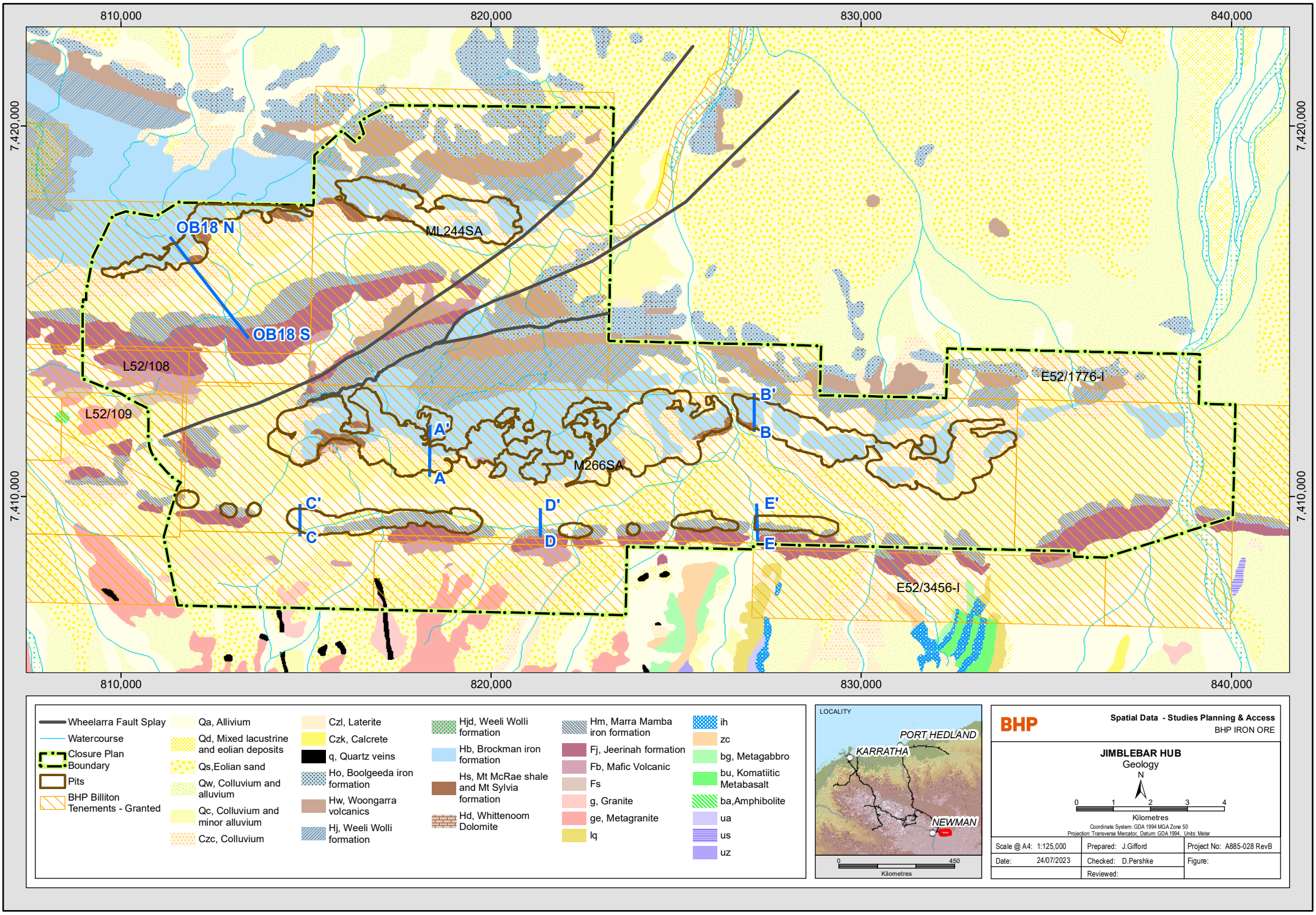

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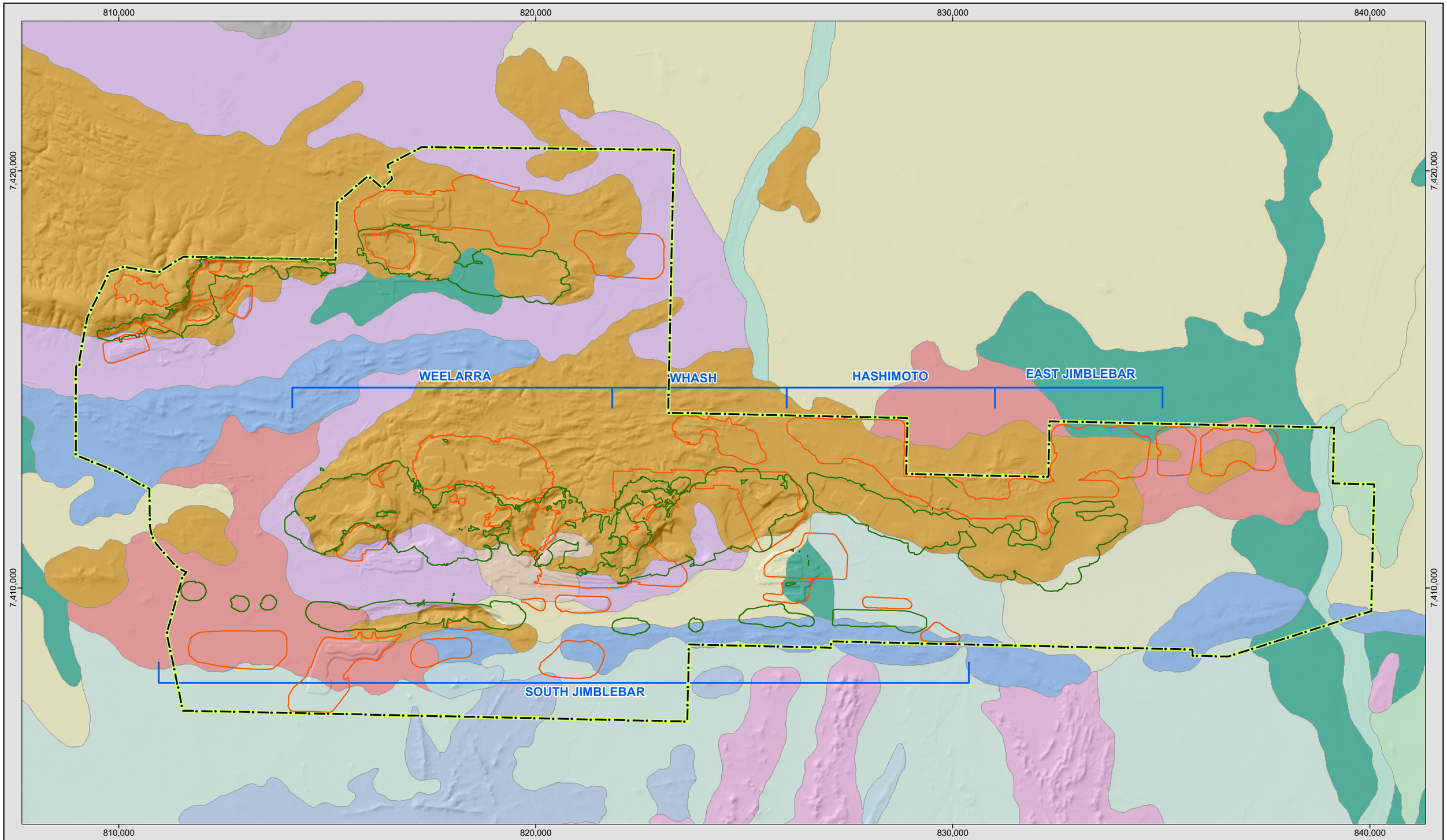
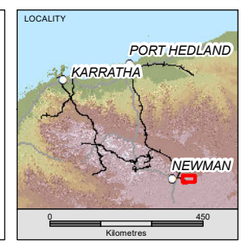


Closure Plan Boundary
Pits
OSA

Land System - Land Type

Boolgeeda
Cadgie
Disturbed Land
Divide
Fortescue
Jamindie
Laterite
McKay
Newman
Prairie
River
Sylvania
Talga
Washplain
Zebra



BHP

Spatial Data - Studies Planning & Access
BHP IRON ORE

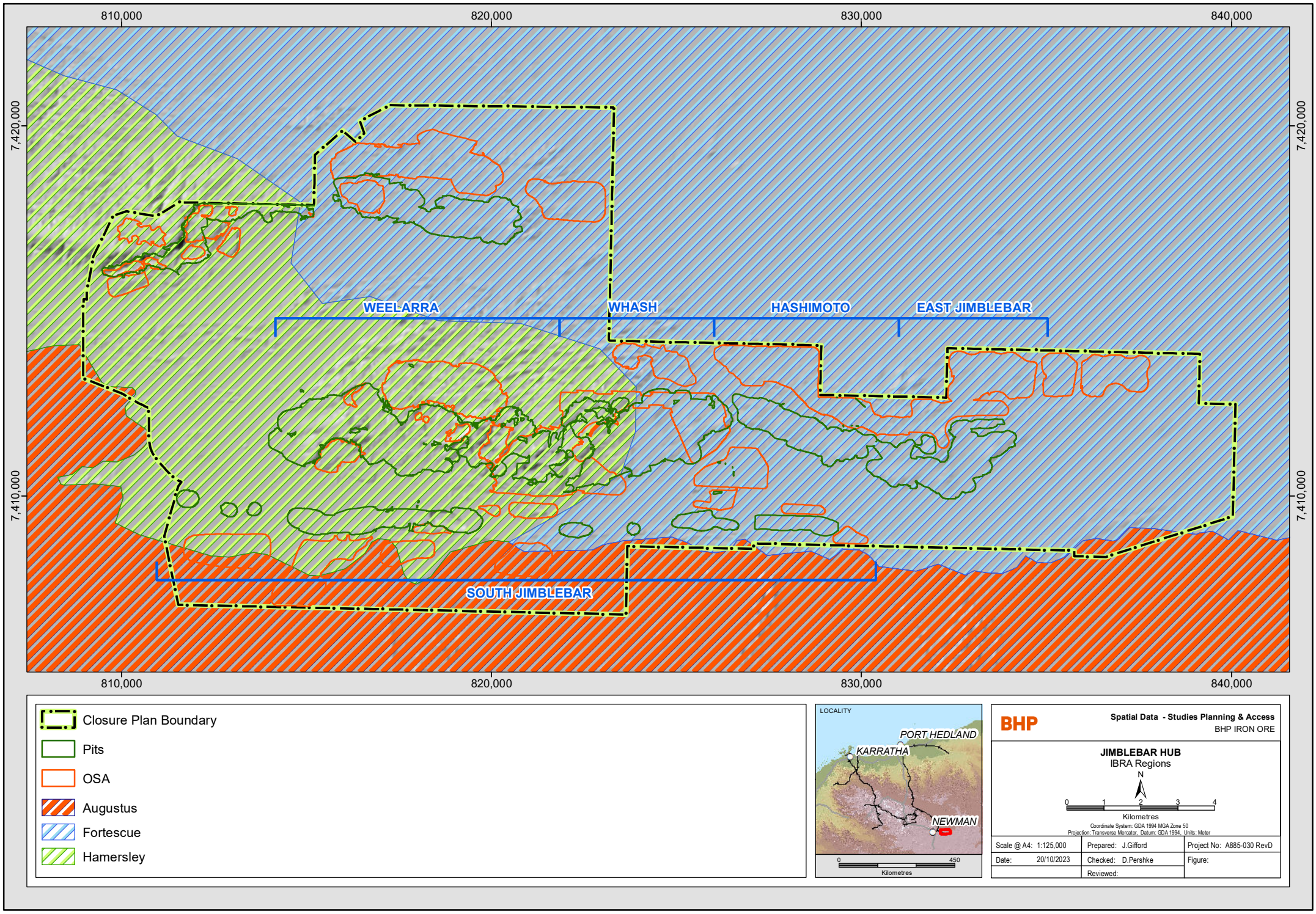
JIMBLEBAR HUB
Land Systems

N

0 1 2 3 4
Kilometres
Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator, Datum: GDA 1994, Units: Meter

Scale @ A3: 1:85,000	Prepared: R.Lofthouse	Project No: A885-029 RevD
Date: 20/10/2023	Checked: D.Pershke	Figure:
	Reviewed:	

Document Path: Y:\Jobs\A501_A1000\A885\3Project\A885_029_JmbHub_LandSystems_ClosurePlan_2022_RevD.mxd



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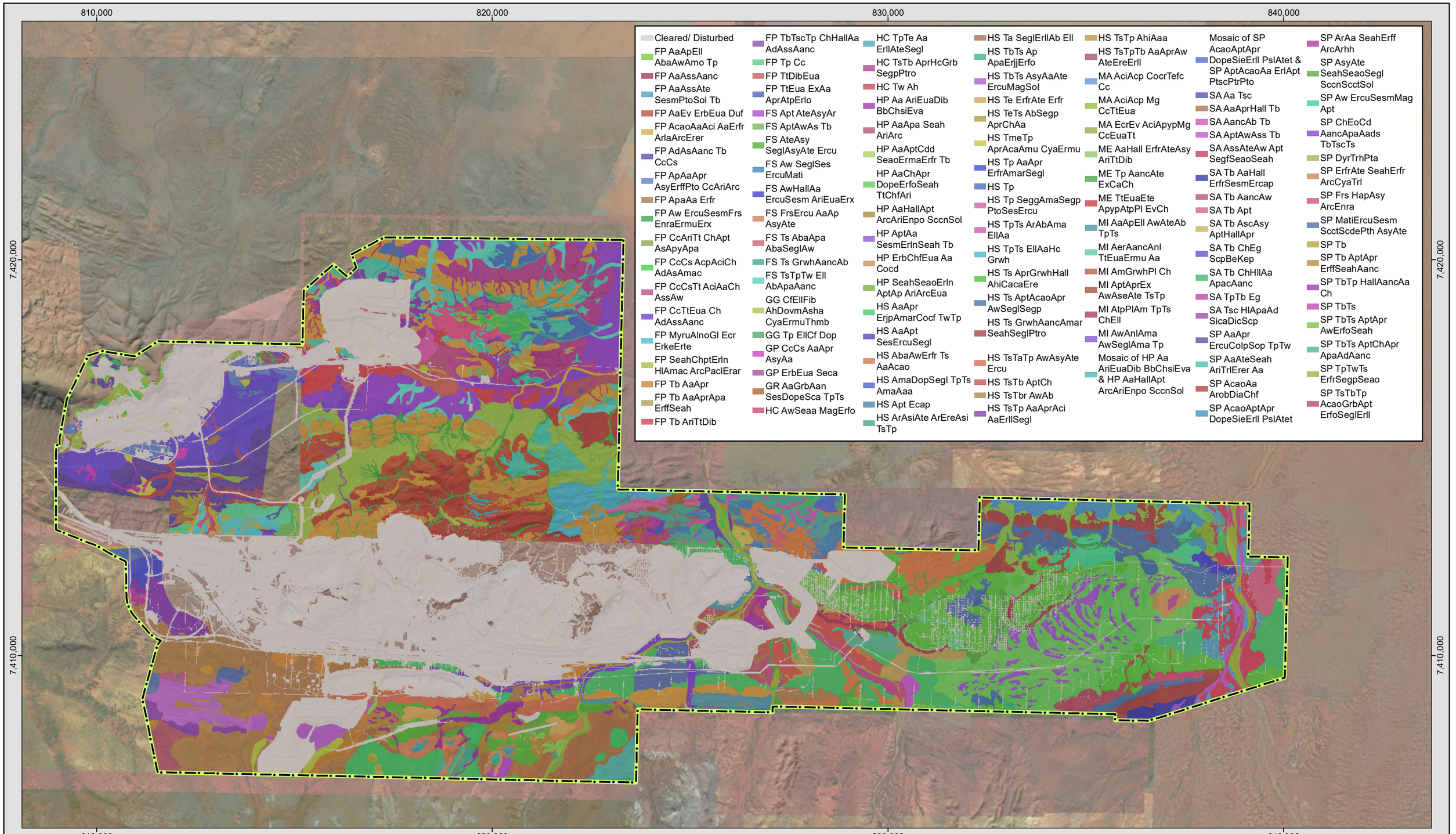
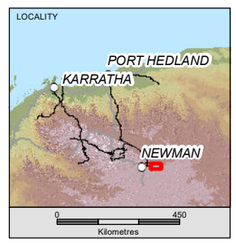


Closure Plan Boundary



BHP

Spatial Data - Studies Planning & Access
BHP IRON ORE

JIMBLEBAR HUB
Vegetation Associations

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0 1 2 3 4
Kilometres
Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator, Datum: GDA 1994, Units: Meter

Scale @ A3: 1:90,000	Prepared: J.Gifford	Project No: A885-075 RevA
Date: 5/12/2023	Checked: D.Perske	Figure:
	Reviewed:	

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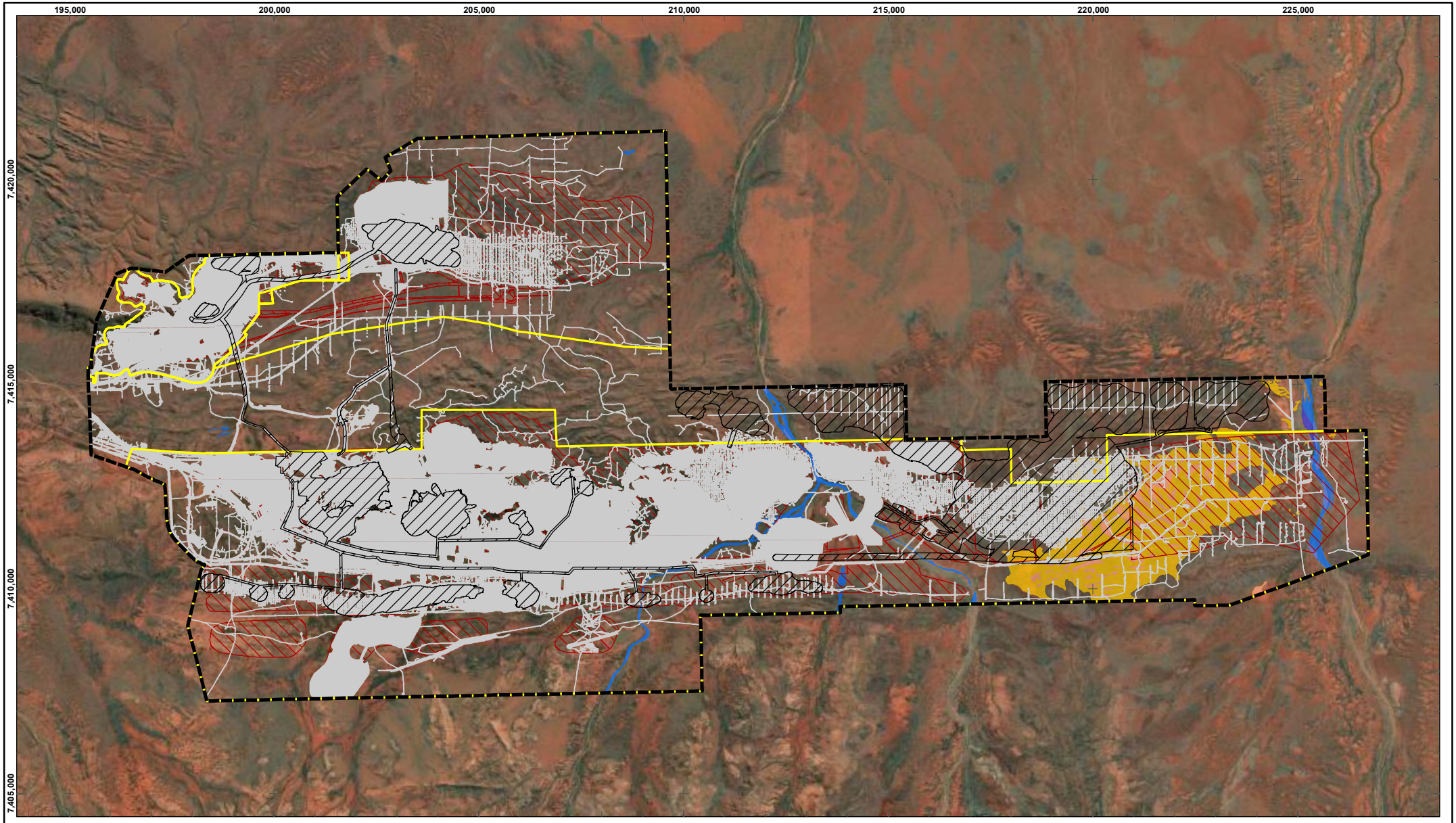

Proposed Development Envelope Indicative
Footprint Jimblebar Hub Revised Proposal
Indicative Cleared Area (as at FY22)
Previously Assessed Areas
Approved Proposal Ministerial Statement boundaries

Banded Mulga
HP AaChApr DopeErfoSeah TtChfAri
HP AptAa SesmErlnSeah Tb

Major ephemeral water course
MA AciAcp CocrTefc Cc
MA AciAcp Mg CcTtEua
MA EcrEv AciApypMg CcEuaTt

N

0 1.5 3 4.5 6
KILOMETRES
GDA 1994 MGA ZONE 51

BHP

PUBLIC

JIMBLEBAR HUB
IRON ORE MINING OPERATIONS
DBCA Ecosystems at Risk

PLANNING & STANDARDS - IRON ORE

SCALE @ A4:	1:125,000	PREPARED:	SPATIAL DATA	FIGURE:	8-5
DATE:	30/11/2023	REQUESTOR:	ENV. APPROVALS	NO:	1021/052B

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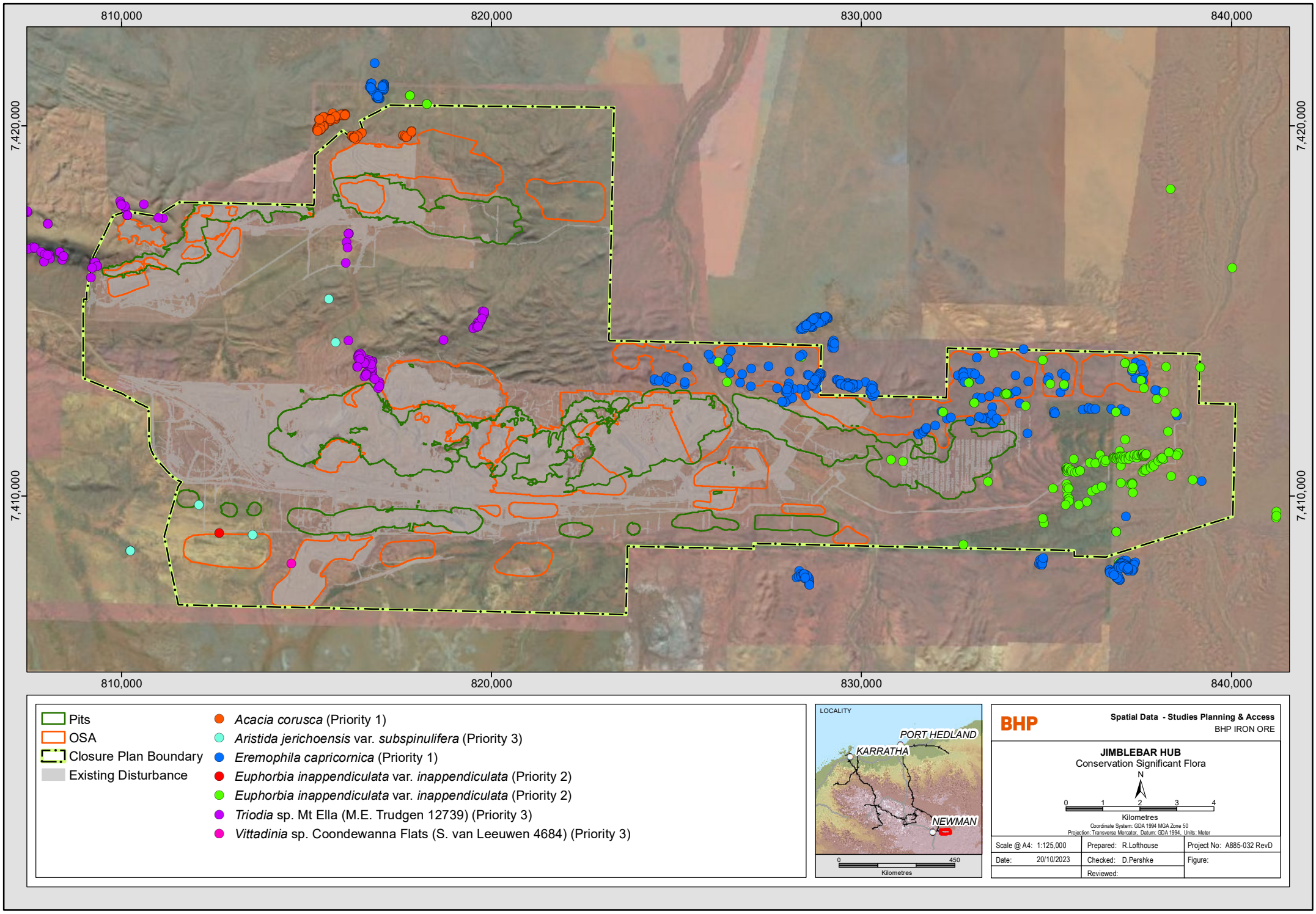

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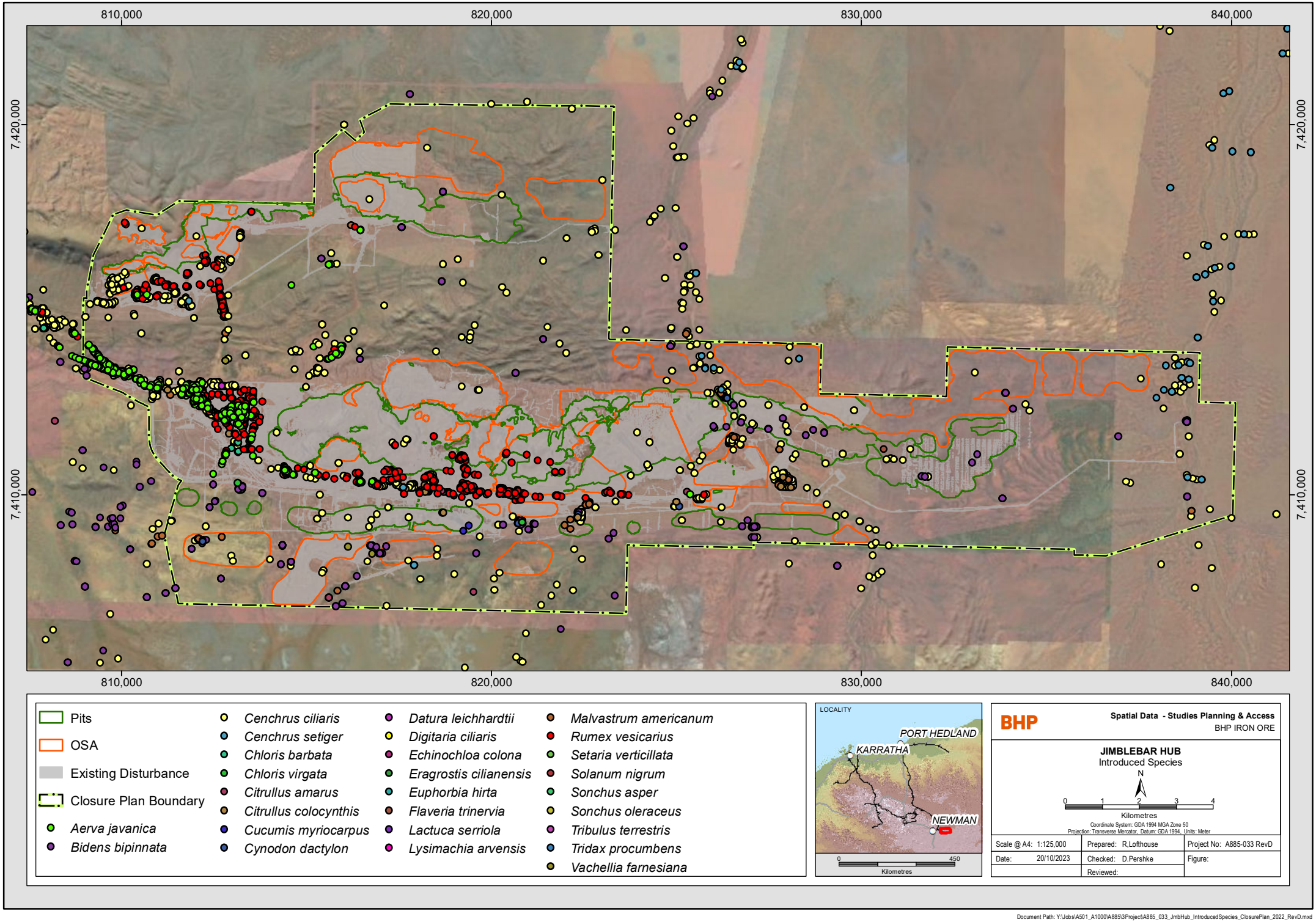

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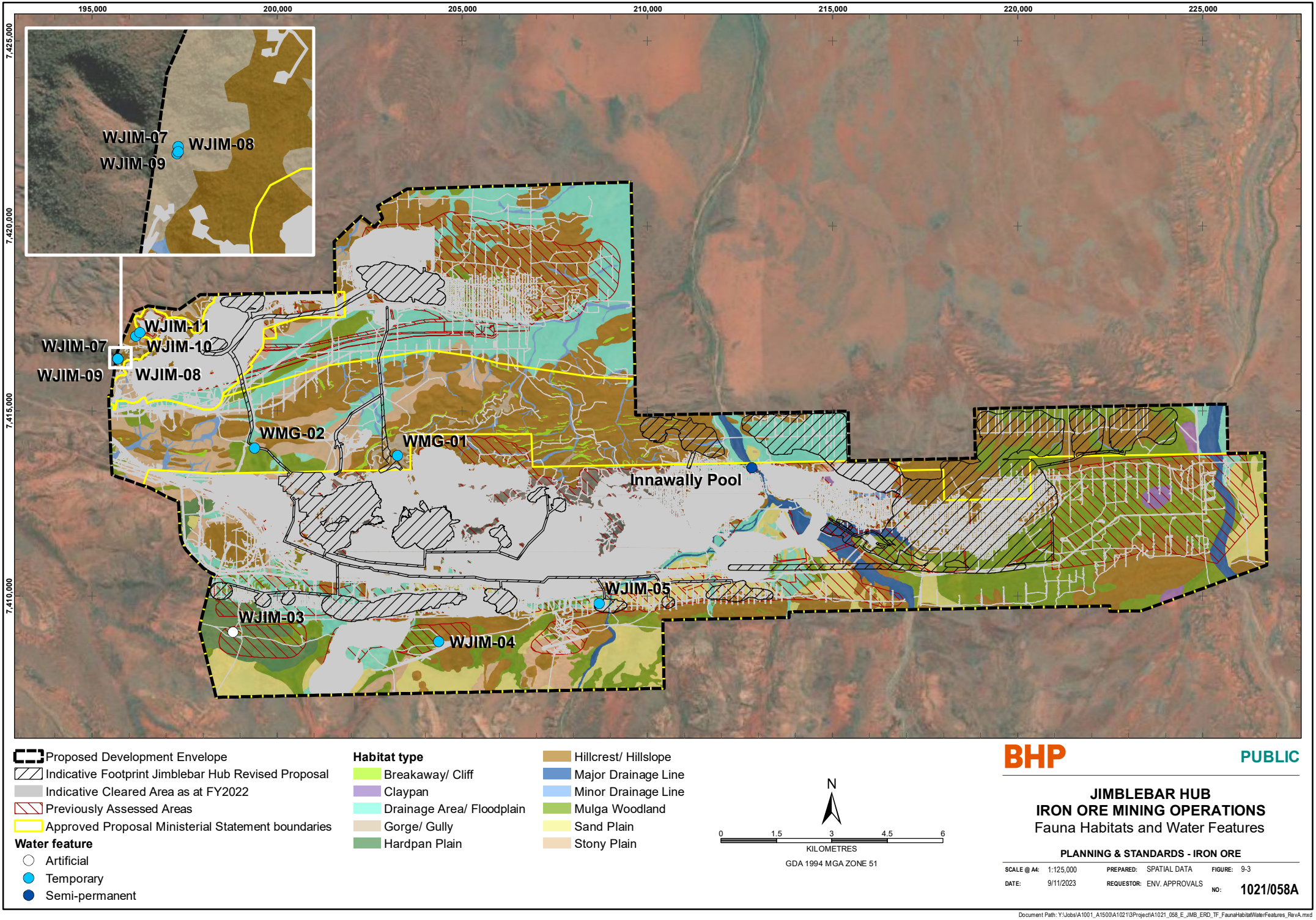


BHP

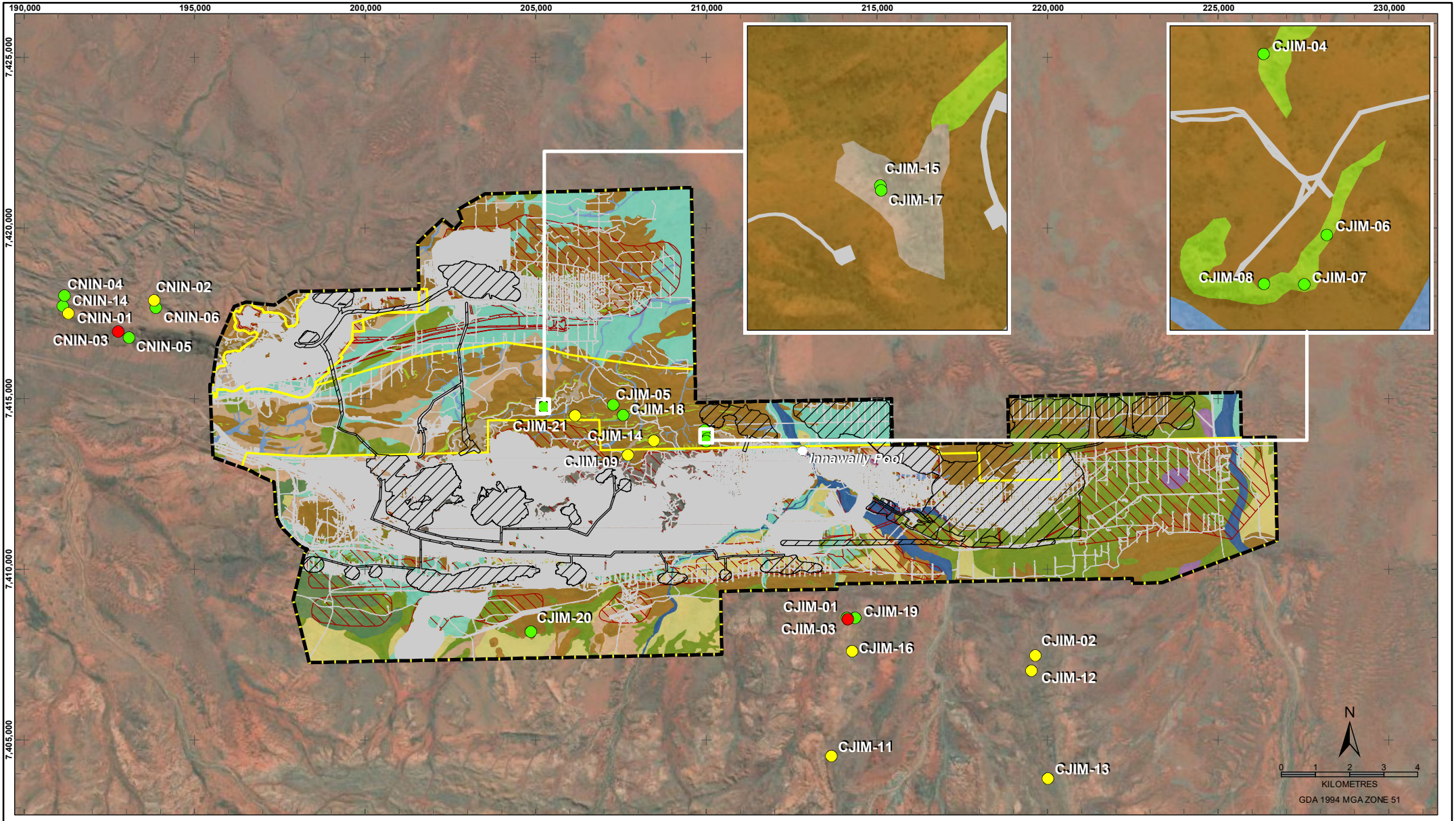
PUBLIC

JIMBLEBAR HUB
IRON ORE MINING OPERATIONS
Fauna Habitats and Water Features

PLANNING & STANDARDS - IRON ORE

SCALE @ A4:	1:125,000	PREPARED:	SPATIAL DATA	FIGURE:	9-3
DATE:	9/11/2023	REQUESTOR:	ENV. APPROVALS	NO:	1021/058A

Document Path: Y:\Jobs\A1001_A1500\A1021\3Project\A1021_058_E_JMB_ERD_TF_FaunaHabitatWaterFeatures_RevA.mxd



Proposed Development Envelope
Indicative Footprint Jimblebar Hub Revised Proposal
Approved Proposal Ministerial Statement boundaries
Indicative Cleared Area as at FY2022
Previously Assessed Areas

Ghost Bat roosts
- Category 2 Roost
- Category 3 Roost
- Category 4 Roost

Habitat type
- Breakaway/ Cliff
- Claypan
- Drainage Area/ Floodplain
- Gorge/ Gully
- Hardpan Plain
- Hillcrest/ Hillslope
- Major Drainage Line
- Minor Drainage Line
- Mulga Woodland
- Sand Plain
- Stony Plain

BHP

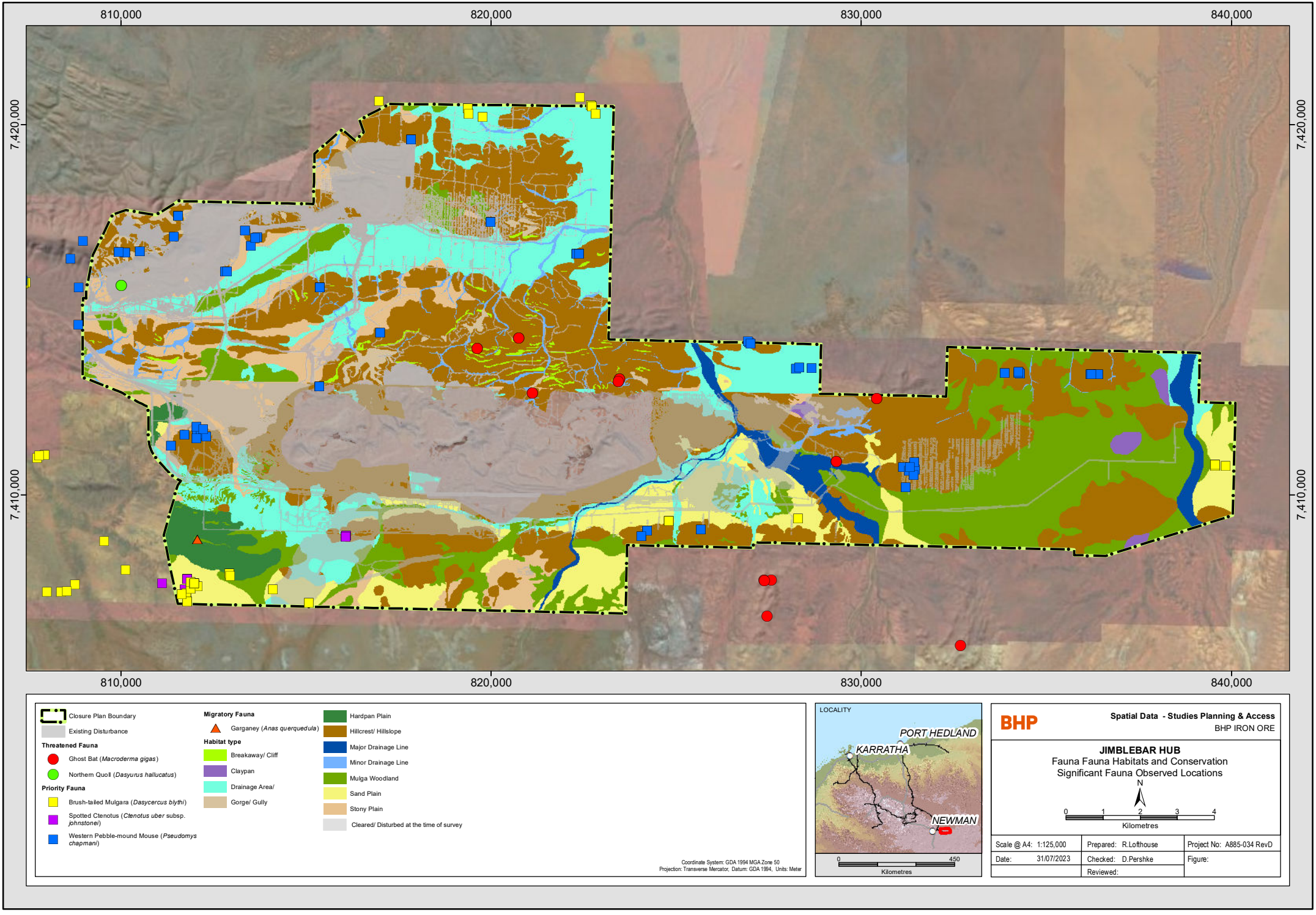
PUBLIC

JIMBLEBAR HUB
IRON ORE MINING OPERATIONS
Fauna Habitats and Cave Features

PLANNING & STANDARDS - IRON ORE

SCALE @ A4:	1:150,000	PREPARED:	SPATIAL DATA	FIGURE:	9-4
DATE:	28/08/2023	REQUESTOR:	ENV. APPROVALS	NO:	1021/059A

Document Path: Y:\Jobs\A1001_A1500\A1021\3Project\A1021_059_E_JMB_ERD_TF_FaunaHabitatCaveFeatures_RevA.mxd



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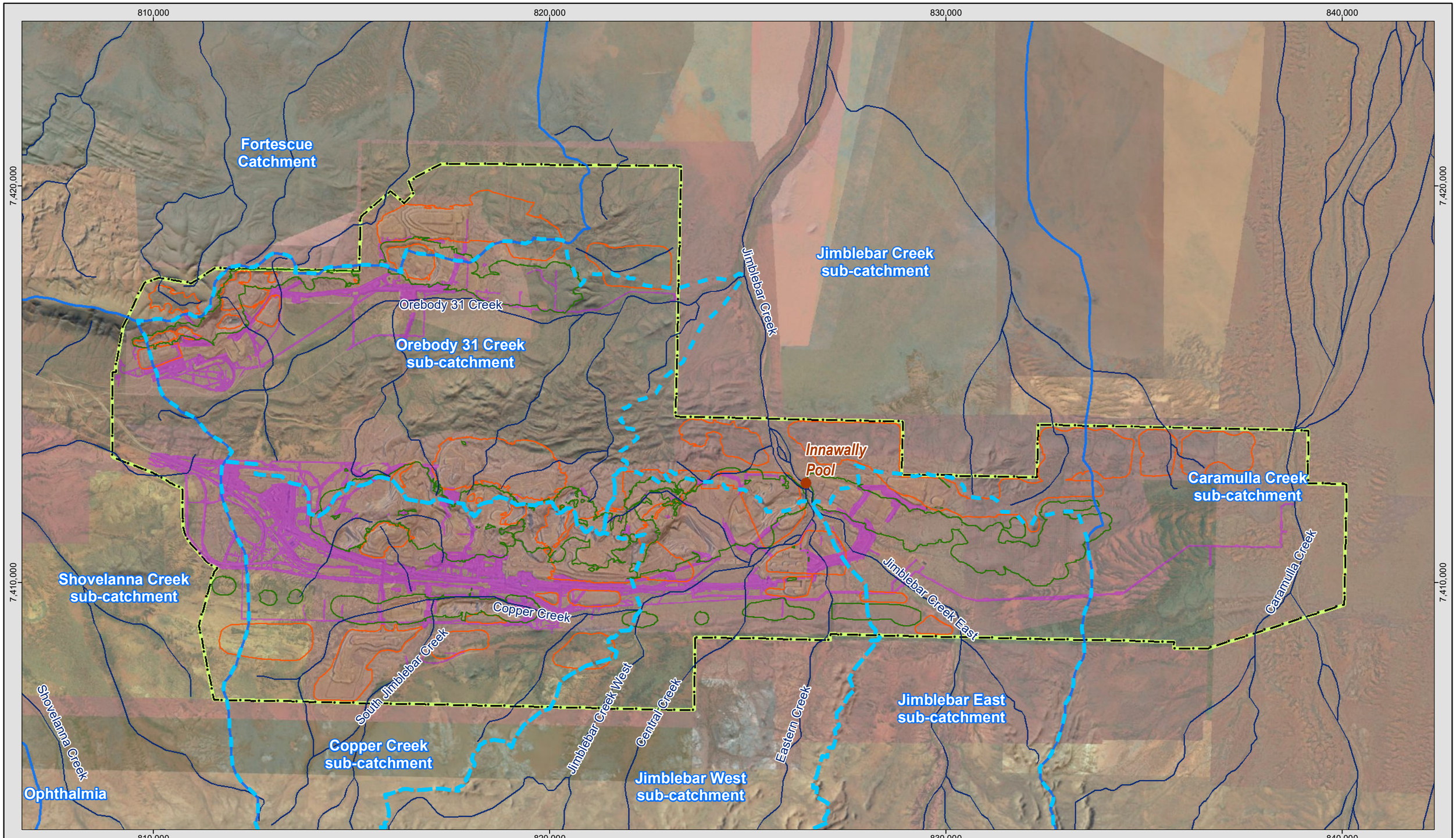
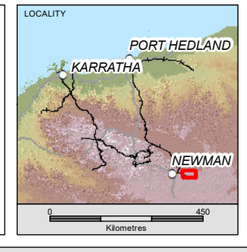


- Waterholes
- Watercourse
- Closure Plan Boundary
- Jimblebar Sub-Catchments
- WA Hydrographic Catchments - Sub Catchments
- Infrastructure
- Pits
- OSA



BHP

Spatial Data - Studies Planning & Access
BHP IRON ORE

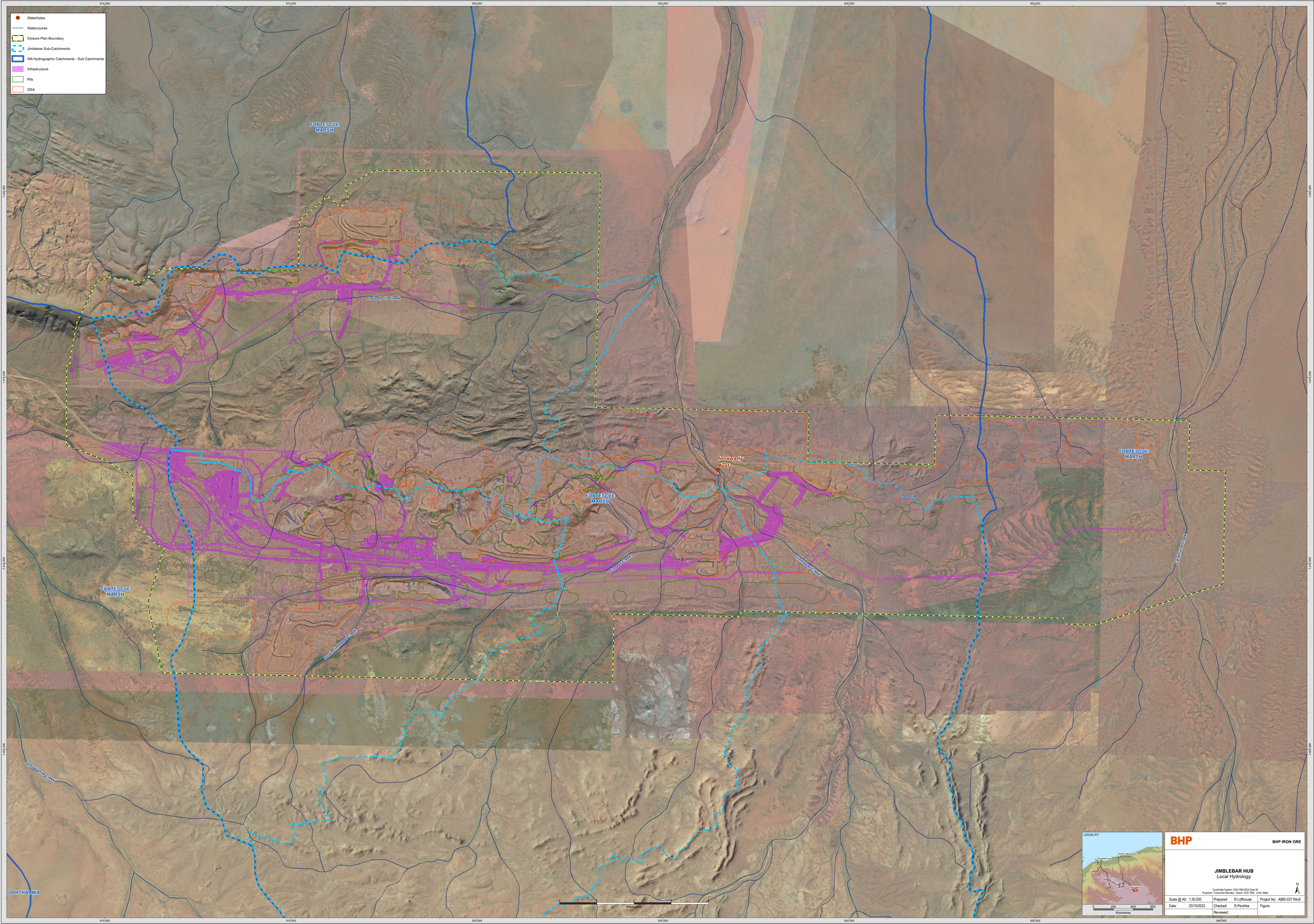
JIMBLEBAR HUB
Regional Hydrology

N

0 1 2 3 4
Kilometres
Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator, Datum: GDA 1994, Units: Meter

Scale @ A3: 1:90,000	Prepared: R.Lofthouse	Project No: A885-036 RevE
Date: 20/10/2023	Checked: D.Pershke	Figure:
	Reviewed:	

Document Path: Y:\Jobs\A501_A1000\A885\3Project\A885_036_JimbHub_RegionalHydrology_ClosurePlan_2022_RevE.mxd



BHP

BHP IRON ORE

JIMBLEBAR HUB
Local Hydrology

N

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator; Datum: GDA 1994; Units: Meter

Scale @ A0:	1:30,000	Prepared: R.Lofthouse	Project No: A885-037 RevE
Date:	20/10/2023	Checked: D.Pershke	Figure:
		Reviewed:	

Document Path: Y:\Jobs\AS01_A1000\A885\Project\A885_037_JimbHub_LocalHydrology_30k_ClosurePlan_2022_RevE.mxd

810,000 820,000 830,000 840,000

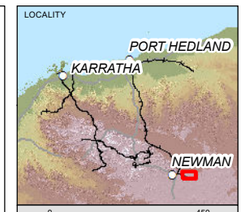
7,420,000

7,410,000

Orebody 31 Creek
Jimblebar Creek
Caramulla Creek
Copper Creek
Jimblebar Creek West
Jimblebar Creek East
Central Creek
Eastern Creek
South Jimblebar Creek

- Proposed surface water flood bund / diversions
- Existing surface water flood bund / diversions
- Watercourse
- Flood Extent- 1 in 10,000 years
- Closure Plan Boundary
- Pits
- OSA
- Infrastructure

LOCALITY



BHP

Spatial Data - Studies Planning & Access
BHP IRON ORE

JIMBLEBAR HUB
Flood Map

N

0 1 2 3 4
Kilometres

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator, Datum: GDA 1994, Units: Meter

Scale @ A3: 1:90,000	Prepared: R.Lofthouse	Project No: A885-067 RevD
Date: 20/10/2023	Checked: D.Pershke	Figure:
	Reviewed:	

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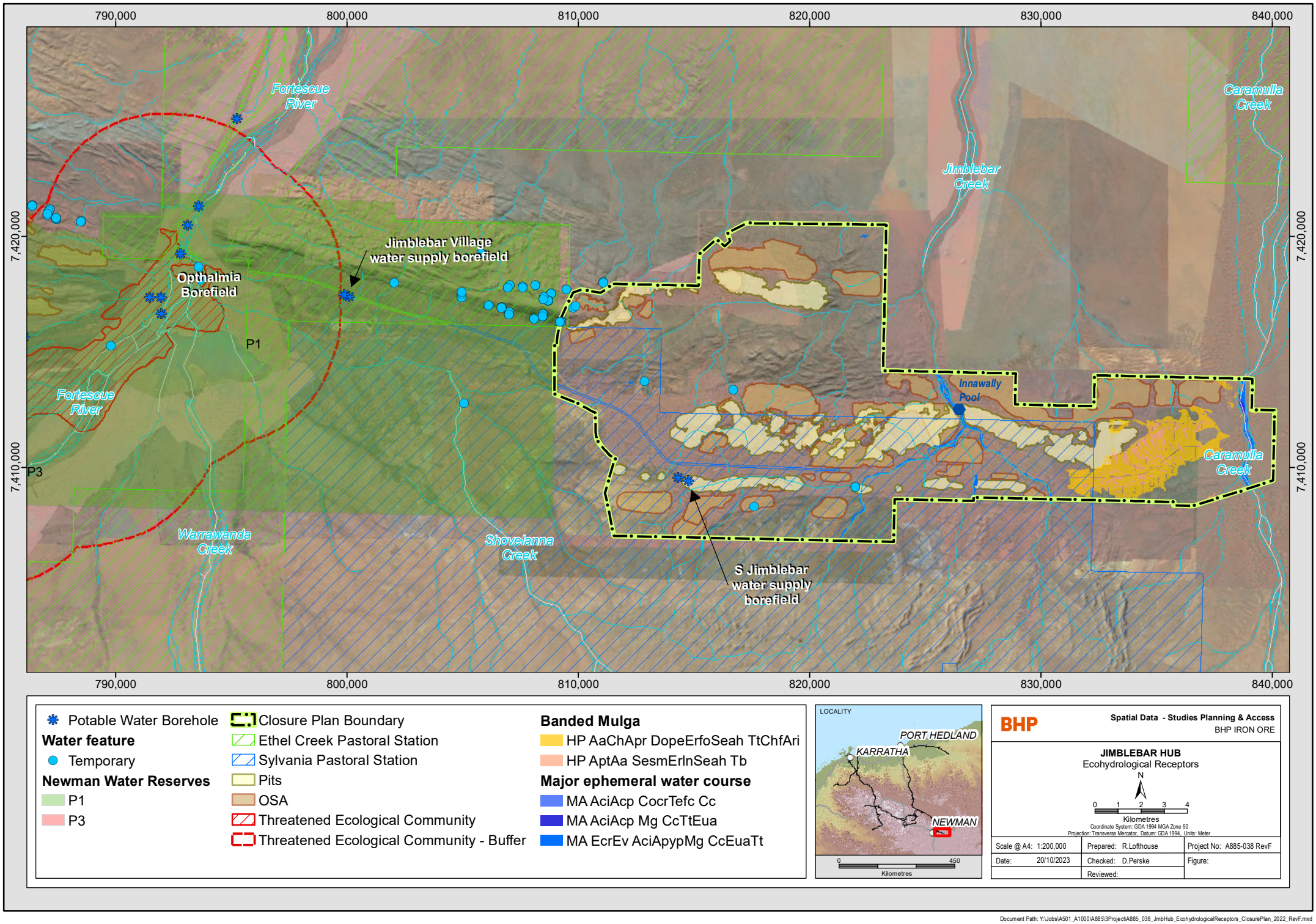


- Potable Water Borehole
- **Water feature**
  - Temporary
- **Newman Water Reserves**
  - P1
  - P3
- Closure Plan Boundary
- Ethel Creek Pastoral Station
- Sylvania Pastoral Station
- Pits
- OSA
- Threatened Ecological Community
- Threatened Ecological Community - Buffer
- **Banded Mulga**
  - HP AaChApr DopeErfoSeah TtChfAri
  - HP AptAa SesmErlnSeah Tb
- **Major ephemeral water course**
  - MA AciAcp CocrTefc Cc
  - MA AciAcp Mg CcTtEua
  - MA EcrEv AciApypMg CcEuaTt

BHP

Spatial Data - Studies Planning & Access
BHP IRON ORE

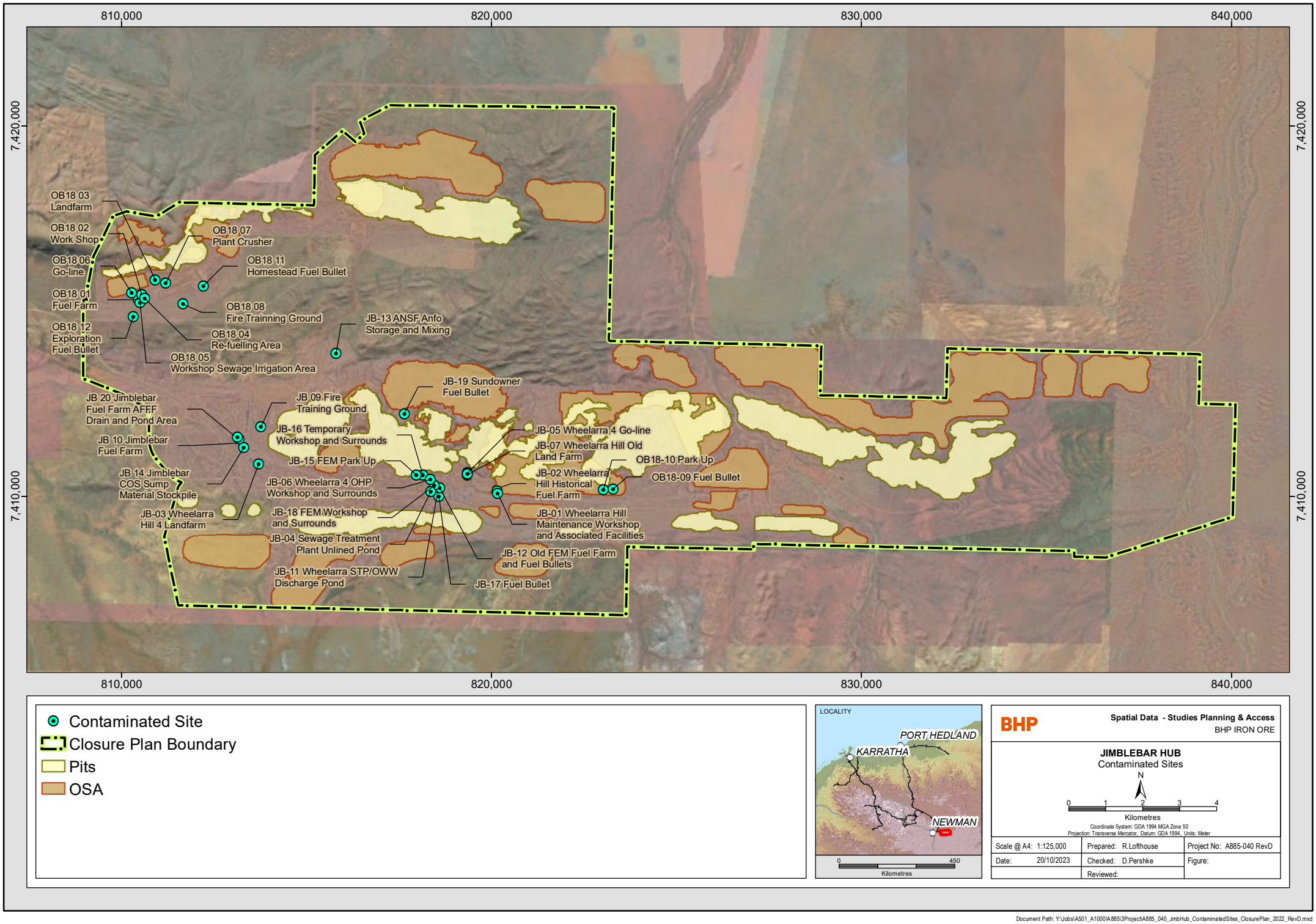
JIMBLEBAR HUB
Ecohydrological Receptors

N

0 1 2 3 4
Kilometres
Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator, Datum: GDA 1994, Units: Meter

Scale @ A4: 1:200,000	Prepared: R.Lofthouse	Project No: A885-038 RevF
Date: 20/10/2023	Checked: D.Perske	Figure:
	Reviewed:	

Document Path: Y:\Jobs\A501_A1000\A885\3Project\A885_038_JmbHub_EcohydrologicalReceptors_ClosurePlan_2022_RevF.mxd



Contaminated Site
Closure Plan Boundary
Pits
OSA

BHP

Spatial Data - Studies Planning & Access
BHP IRON ORE

JIMBLEBAR HUB
Contaminated Sites

N

0 1 2 3 4
Kilometres

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator, Datum: GDA 1994, Units: Meter

Scale @ A4: 1:125,000	Prepared: R.Lofthouse	Project No: A885-040 RevD
Date: 20/10/2023	Checked: D.Pershke	Figure:
	Reviewed:	

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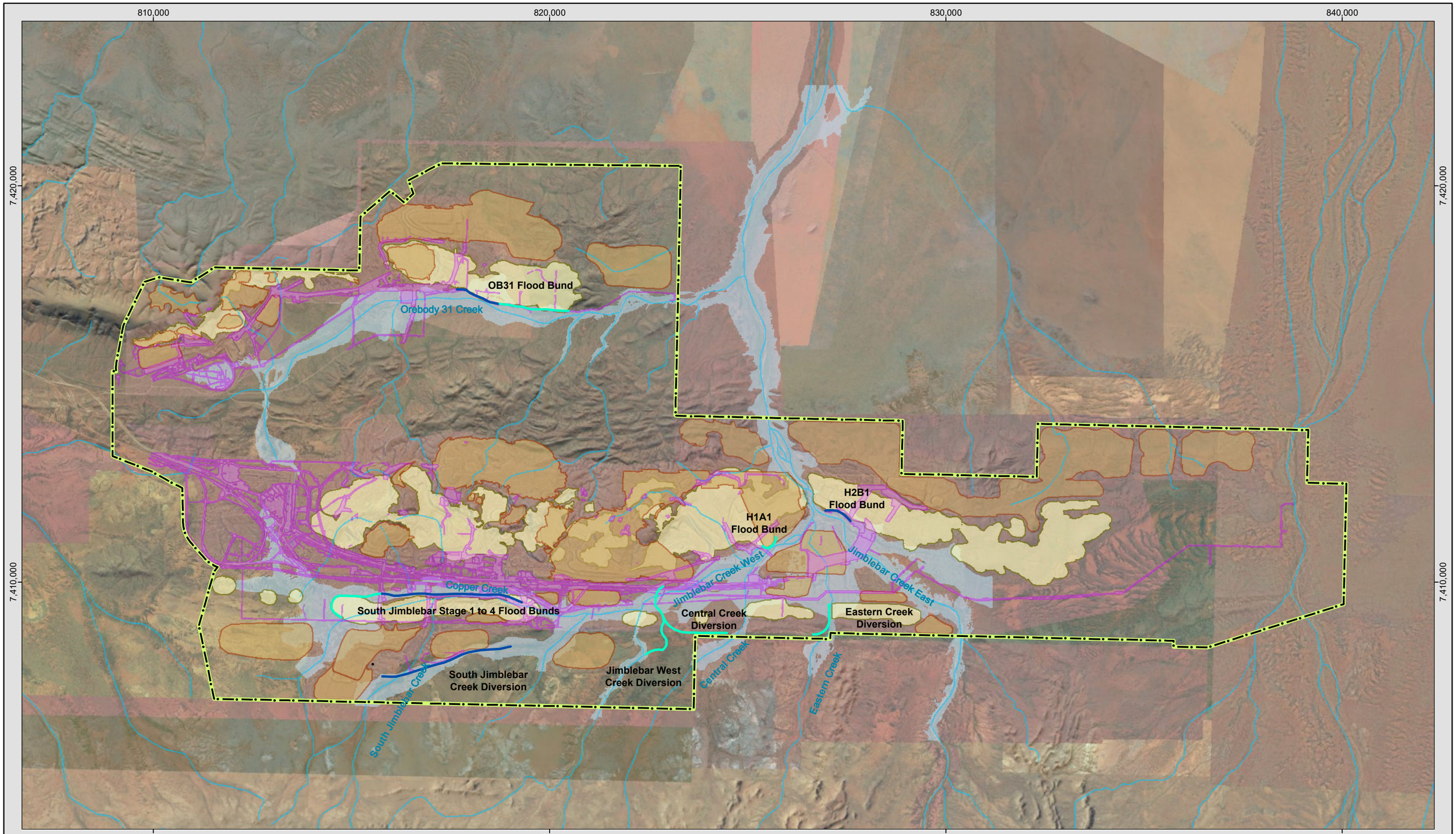
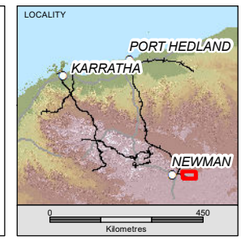


- Proposed surface water flood bund / diversions
- Existing surface water flood bund / diversions
- Watercourse
- Flood Extent- 1 in 10,000 years
- Closure Plan Boundary
- Pits
- OSA
- Infrastructure



BHP

Spatial Data - Studies Planning & Access
BHP IRON ORE

JIMBLEBAR HUB
Flood Map

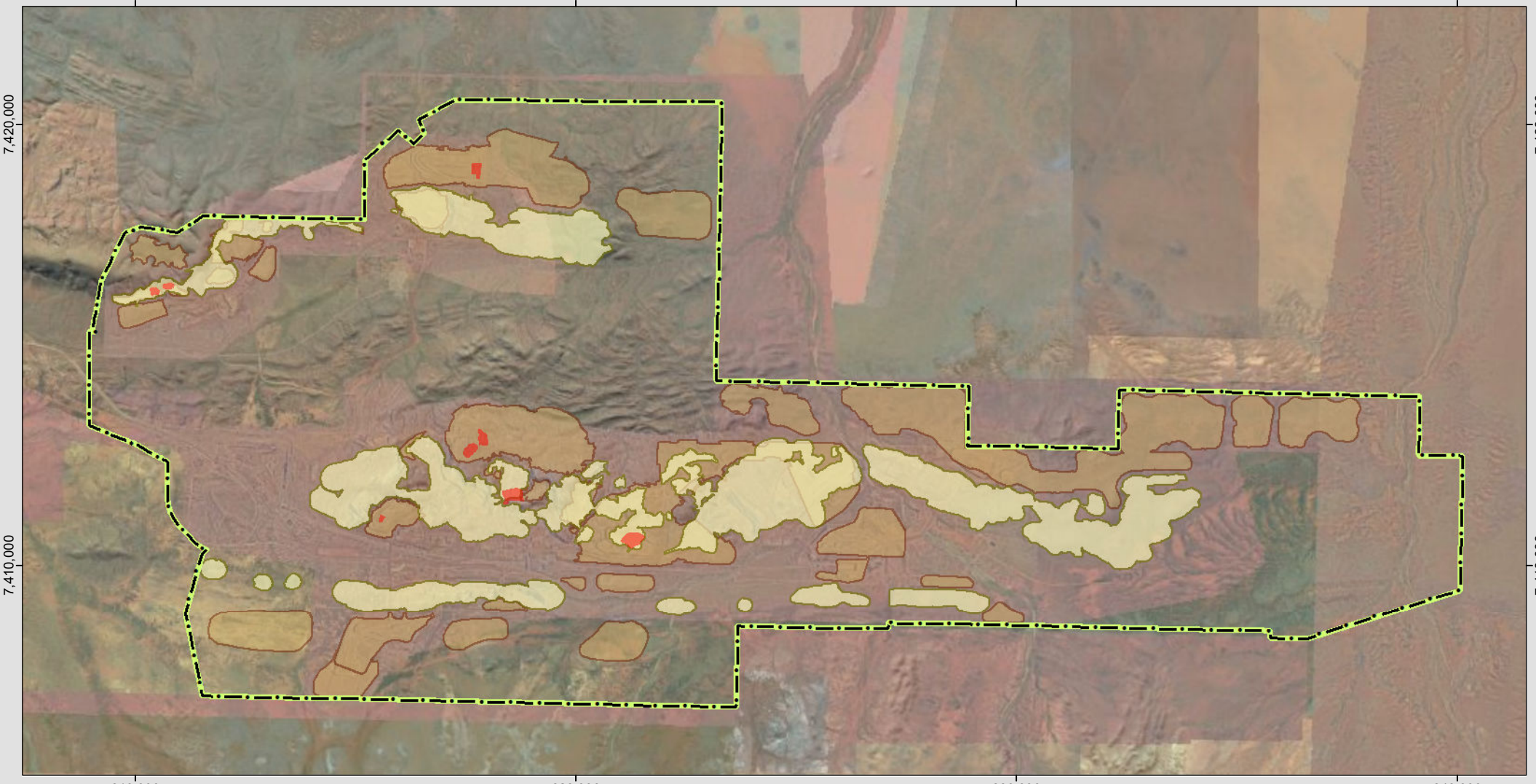
N

0 1 2 3 4
Kilometres

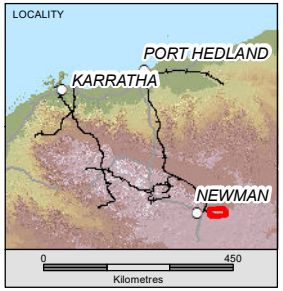
Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator, Datum: GDA 1994, Units: Meter

Scale @ A3: 1:90,000	Prepared: R.Lofthouse	Project No: A885-067 RevD
Date: 20/10/2023	Checked: D.Pershke	Figure:
	Reviewed:	

Document Path: Y:\Jobs\A501_A1000\A885\3Project\A885_067_JmbHub_FloodMap_ClosurePlan_2022_RevD.mxd



Closure Plan Boundary
AMD1 Encapsulation Cell
Pits
OSA



BHP

Spatial Data - Studies Planning & Access
BHP IRON ORE

JIMBLEBAR HUB
AMD1 Encapsulation Cells

N

0 1 2 3 4
Kilometres

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator, Datum: GDA 1994, Units: Meter

Scale @ A4: 1:125,000	Prepared: R.Lofthouse	Project No: A885-043 RevD
Date: 20/10/2023	Checked: D.Pershke	Figure:
	Reviewed:	

Document Path: Y:\Jobs\A501_A1000\A885\3Project\A885_043_JmbHub_PAF_EncapsulationCells_ClosurePlan_2022_RevD.mxd