Public Environment Report

Gregory Crinum Mine M-Block Extension

PREPARED FOR Sojitz Blue Pty Ltd | July 2023 Rev. No. 7

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Abbreviations

Abbreviation	Description
3DG	3D Data Guidance Pty Ltd
ADWG	Australian Drinking Water Guidelines 6, 2011
AHD	Australian Height Datum
AHT	Ancillary Habitat Trees
ALA	Atlas of Living Australia
ANZECC	Australian and New Zealand Environment and Conservation Council
ANZG	Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2018
ADWG	Australian Drinking Water Guidelines 6, 2011
AWS	Australian weather station
BMA	BHP Mitsubishi Alliance
BOM	Bureau of Meteorology
Brigalow TEC	Brigalow (*Acacia harpophylla* dominant and codominant) Threatened Ecological Community
CHPP	Coal Handling and Processing Plant
CHMP	Cultural Heritage Management Plan
DES	Queensland Department of Environment and Science
EA	Environmental Authority - EPML00945013 (Queensland)
EC	Electrical Conductivity
EMS	Environmental Management System
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPP Water Mackenzie	Environmental Protection (Water) Policy 2009 Mackenzie River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Mackenzie River Sub-basin
EPP Water Nogoa	Environmental Protection (Water) Policy 2009 Nogoa River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Nogoa River Sub-basin
ESCP	Erosion and Sediment Control Plan
GCM	Gregory Crinum Coal Mine
GDE	Groundwater Dependant Ecosystem
GMA	Groundwater Management Area
Grassland TEC	Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Threatened Ecological Community
GTES	GTES Pty Ltd
Gregory MIA	Gregory Mine Infrastructure Area
GWDB	Groundwater database
IESC	Independent Expert Scientific Committee
KCB	KCB Australia Pty Ltd
LIKT	Locally Important Koala Trees
LOR	Limit of Reporting
mbgl	metres below ground level
ML	Mining lease

Abbreviation	Description
ML/d	Megalitre per day
ML/pa	Megalitre per annum
MNES	Matters of national environmental significance
MSES	Matters of state environmental significance
NC Act	*Nature Conservation Act 1992* (Qld)
OEMP	Operational Environmental Management Plan
PAWC	Plant available water capacity
Pbd	Late Permian German Creek Formation
Pbn	Late Permian McMillan Formation
PER	Public Environment Report
Pwt	Fort Cooper Coal Measures
RE	Regional Ecosystem
REMP	Receiving Waters Monitoring Program
Rehabilitation MP	Rehabilitation Management Plan
ROM	Run of mine
Sojitz	Sojitz Blue Pty Ltd
SPI	Standardised Precipitation Index
Subsidence MP	Subsidence Management Plan
TDS	Total Dissolved Solids
TEC/s	Threatened ecological community/s
TGDE	Terrestrial Groundwater Dependant Ecosystem
Topsoil MP	Topsoil Management Plan
TPH	Total Petroleum Hydrocarbons
TRH	Total Recoverable Hydrocarbons
Waste MP	Waste Management Plan
Water MP	Water Management Plan

Executive Summary

Introduction

Sojitz Blue Pty Ltd (Sojitz) proposes to continue the existing Gregory Crinum coking coal mine (GCM) through the development of M-Block located within mining lease (ML) 1923. GCM is located to the northeast of Emerald, Queensland. The additional coal will also be utilised for steel production only.

The proposal was submitted under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) to the Minister for the Environment (the Minister) on 20 December 2021 and validated on 24 January 2022 (2021/9127). On 23 February 2022, the delegate of the Minister decided that further assessment is required as the action has the potential to have a significant impact on the following matters of national environmental significance (MNES) that are protected under Part 3 of the EPBC Act:

- Listed threatened species and communities (sections 18 and 18A).
- A water resource, in relation to coal seam gas development and large coal mining development (sections 24D and 24E).

On that same date, the delegate of the Minister made the decision that the proposed action, the extension of the mine into M-Block, be assessed by Public Environment Report (PER). The PER guidelines were issued on 24 March 2022.

Proposed Works

Sojitz are proposing to continue mining operations at GCM with the extension into M-Block. M-Block is located wholly within ML 1923 and immediately east of the existing mining areas. ML 1923 was originally granted and approved for underground mining on 14 March 1985 with additional 'surface rights' granted under the Mineral Resources Act 1989 (Qld) between 1986 and 2014. The GCM, including M-Block, holds a Queensland Environmental Authority (EA) (EPML00945013) and water licence (577145) to enable dewatering of ML 1923.

Mining of M-Block will use conventional open-cut mining methods for the first three years, with underground access to be established from the highwall. The total area of the M-Block footprint is 2,441.3 ha. This comprises 296.4 ha of open cut impact area and 1,414.1 ha of underground mining.

GCM has substantial established infrastructure that will be used for M-Block mining activity. This includes rail loading facilities, coal handling and processing plant, tailings dams and workshops. The use of this existing infrastructure will keep the overall surface disturbance at M-Block to a minimum.

Summary of Existing Environment

TENURE AND LAND USE

M-Block encompasses four lots, with three identified as freehold and one under lease. Historically, M-Block has been used for cattle grazing and cropping. Infrastructure (access tracks and roads) were constructed between 1952 and 1966, with substantial clearing occurring between 1966 and 1973. Rail infrastructure was constructed between 1973 and 1983, with little to no change between 1983 and 2022.

LISTED THREATENED SPECIES AND ECOLOGICAL COMMUNITIES

GCM is located in the Brigalow Belt Bioregion, one of 13 bio-geographical areas of Queensland. The Brigalow Belt Bioregion extends from the Queensland – New South Wales border to Townsville. Extensive clearing has historically occurred in the Brigalow Belt for agriculture purposes.

Several ecological assessments have been previously undertaken within the current MLs, including parts of the M-Block area. Most recently Stantec conducted terrestrial ecology assessments during the Spring and Post-Wet season of 2022 to investigate the nature, extent and condition of MNES within M-Block. The area of avoidance, for impacts to MNES has been determined as 1637.8 ha.

FLORA

M-Block is mapped as containing five Regional Ecosystems (REs) and also supports Category X (non-remnant) vegetation, Category B (remnant) vegetation, Category C (high-value regrowth) and Category R (reef regrowth watercourse) vegetation.

Two Threatened Ecological Communities (TECs) and one threatened flora species, under the EPBC Act, were recorded within the M-Block extension area, specifically:

- Brigalow (Acacia harpophylla dominant and codominant), (Brigalow TEC).
- Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin (Grassland TEC).
- King Bluegrass (Dichanthium queenslandicum).

Remnant Brigalow (Acacia harpophylla) woodland and open poplar box woodland provide habitat for native flora and fauna species.

King Bluegrass is listed as endangered under the EPBC Act and Vulnerable under the Nature Conservation Act 1992 (Qld) (NC Act). Large numbers of this species were encountered in numerous locations in M-Block.

FAUNA

Past and continuing land disturbing activities within M-Block impact the availability and quality of fauna habitat within the area. Some of these ongoing impacts include clearing of native vegetation, invasion by weed and pest fauna species, and grazing impacts. It is noted that there are areas of higher habitat value within M-Block, and these are typically associated with the grassland and woodland communities within and adjoining M-Block.

The dominant habitat types identified during the ecological investigations can be broadly described as:

- Woodlands to Open Forest.
- Grasslands – native and introduced pasture.
- Natural and man-made watercourses and waterbodies.

Threatened fauna species known to use these key habitat areas, the Brigalow woodland and open forest include:

- Short-beaked Echidna (Tachyglossus aculeatus).
- Squatter Pigeon (Geophaps scripta scripta).

Earlier assessments concluded that the following threatened fauna species had the potential to occur:

- Yakka Skink (Egernia rugosa).
- Dunmall's Snake (Furina dunmalli).
- Ornamental Snake (Denisonia maculata).
- Koala (Phascolarctos cinereus).

There have been no records of the Yakka Skink, Dunmall's Snake or Ornamental Snake within M-Block or in close proximity. The habitat quality for these reptiles was relatively low and the Project is unlikely to result in impact to these species.

No Koalas were recorded, and no Koala scat was identified. M block lacks the presence of suitable habitat such as locally important Koala trees. M-Block might provide movement or resting opportunities for koalas due to the presence of Ancillary Habitat Trees. Offset sites are to be established on neighbouring areas on the mine site and these sites have been selected to also provide connectivity between habitats. It was concluded that the mining of M-Block is unlikely to result in a significant residual impact to the Koala.

M-Block does not provide suitable habitat resources or an abundance of eucalypt species which is required for foraging for the Greater Glider (Petauroides volans). Despite not being recorded by any surveys within M-Block or in proximate environments, it is recognised that both the Grey-headed Flying Fox (Pteropus poliocephalus) and the Red Goshawk (Erythrotriorchis radiatus) may potentially occur in the broader locality as part of seasonal movements.

Most of M Block is underground mining and this does not impact on fauna resting opportunities or movement of fauna through the broader landscape. Underground mining has minimal impacts on dispersal, isolation of populations, genetic fragmentation and increase in habitat degradation from edge effects.

HABITAT ASSESSMENTS

Bio-Condition assessments were conducted according to the Queensland Herbarium's Bio-Condition Assessment Manual (Eyre et al. 2015). The average Bio-Condition score for both regrowth and remnant Brigalow TEC and Grassland TEC within M-Block was 0.64 and 0.56 respectively, giving both a Bio-Condition class of '2', indicating a functional biodiversity condition. The Bio-Condition score for Grassland TEC has been used to assess the quality of King Bluegrass also giving it a Bio-Condition class of '2'.

The average habitat quality score for the Squatter Pigeon within regrowth and remnant vegetation was '4' indicating medium quality habitat. The average habitat score within remnant RE 11.8.5 (Eucalyptus orgadophila open woodland on Cainozoic igneous rocks - regrowth) was '3' indicating low quality habitat.

Habitat Assessments also determined that there is limited connectivity between the ecological communities present within M-Block and areas of adjoining remnant and regrowth vegetation in the surrounding landscape.

GROUNDWATER DEPENDENT ECOSYSTEMS

The mapped Terrestrial Groundwater Dependent Ecosystems (TGDEs) within M-Block are considered unlikely to be dependent on groundwater for their survival, based on the results of the desktop and field based GDE assessments (Stantec 2022 and 3D Environmental, 2023). Consequently, it is unlikely that the predicted groundwater drawdown will result in a significant impact to the Brigalow TEC that are mapped as a potential GDE within M-Block.

STYGOFAUNA

A desktop review and a pilot survey for stygofauna (i.e. subterranean aquatic fauna) was conducted. Stygofauna samples were collected from existing bores within and surrounding the M-Block area. A single species of stygofauna was found during the most recent surveys completed by 4T in a bore that is located outside the M-Block zone of influence. No other bores sampled supported stygofauna. The absence of stygofauna in the samples collected does not necessarily indicate they are absent from M-Block.

Summary of Potential MNES Impacts and Mitigation

LISTED THREATENED SPECIES AND ECOLOGICAL COMMUNITIES

The Project has the potential to directly and indirectly impact on listed threatened species and ecological communities. Potential direct impacts are detailed below:

Brigalow (Acacia harpophylla dominant and co-dominant) ecological community:

- 58.7 ha of Brigalow TEC will be directly impacted by the Project by habitat removal or degradation.

Natural grasslands of the Queensland Central Highlands and northern Fitzroy Basin ecological community:

- 133.5 ha of this community will be directly impacted by the mining operations by habitat removal or degradation.

King Bluegrass (Dichanthium queenslandicum):

- Impacts to known and likely King Bluegrass habitat will occur; high abundance confirmed habitat – 144.5 ha, low abundance confirmed habitat – 10.3 ha, and likely habitat – 20.1 ha.

Squatter Pigeon (Geophaps scripta scripta):

- 58.7 ha of Brigalow TEC will be directly impacted by the Project which has been recognised as potential Squatter Pigeon habitat.

MNES OFFSETS

An Offset Area Management Plan has been prepared to offset residual and unavoidable impacts on the MNES through direct offsets, calculated in accordance with the Offsets Assessment Guide. To maintain or improve the viability of the impacted MNES, the following offset areas are required:

- 165 ha of Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community.

- 375 ha of Natural grasslands of the Queensland Central Highlands and northern Fitzroy Basin ecological community.
- 495 ha of King Bluegrass (*Dichanthium queenslandicum*) habitat, which can be co-located with the 250 ha of Natural grasslands of the Queensland Central Highlands and northern Fitzroy Basin ecological community.
- 95 ha of Squatter Pigeon (southern) (*Geophaps scripta scripta*) habitat.

Within 12 months of commencing the Action, Sojitz will legally secure the chosen offset sites. It is expected that this will be in the form of a statutory environmental covenant or Voluntary Declaration. This will provide ongoing and enduring protection for the offset areas against development incompatible with conservation.

Water Resources

GROUNDWATER

The groundwater table ranges between 210 and 190 m AHD in M-Block, with the flow direction from north to southwest across area. The depth to groundwater in M-Block ranges between 7 and 30 m below ground surface.

Due to the south westerly dip of the target coal seam, the underground workings within M-Block will be located at a depth of up to 370 m. The use of the bord-and pillar mining method will ensure that cracking above the mined longwall panels and into the overlying units within the Permian coal measures is minimised.

Impacts from de-watering

A numerical groundwater model was developed from the conceptual groundwater regime and used to predict the effects of the development of M-Block on the groundwater regime during and post-mining. The numerical model also incorporates the neighbouring Kestrel Mine.

The mining activity will involve dewatering the underground workings, which will result in depressurisation of the overlying and surrounding strata. Groundwater is not interpreted to be in direct hydraulic connection with surface watercourses. Surface water interactions are not affected by M-Block dewatering operations.

The potential water level decline is predicted to be greater than 5 m at one bore. Dewatering undertaken as part of the M-Block operations will result in a change in the groundwater table levels, however, recovery is predicted post-closure as groundwater levels rebound.

Recharge in M-Block will occur as diffuse recharge with rainfall infiltration occurring at outcropping aquifers. Recharge in the form of leakage from one formation to another will also occur, although this is expected to be minor due to the interbedded nature of the strata.

Connectivity between groundwater aquifers

Site-specific testing has been conducted within the Tertiary basalt, basal sand and Permian coal measures and identified:

- The hydraulic conductivity within the Tertiary basalt is dependent on the connectivity of fractures and vesicular zones. Due to the nature of the Tertiary clay, it is estimated to have persistently low hydraulic conductivity.
- The transmissivity of the basal sand is reported as ranging between 19 and 129 m2/day, with hydraulic conductivity values of 0.7 to 26 m/day.
- The hydraulic conductivity calculated from the testing ranges from a minimum of 0.001 m/day to a maximum of 34 m/day, with a median value of 0.02 m/day. Hydraulic conductivity within the Permian coal measures decreases with depth due to increased lithostatic pressure compressing the coal seams, thus reducing fracture aperture and the ability for fractures to transmit flow.

The use of bord and pillar mining ensures that cracking will be minimised. In addition, due to low hydraulic conductivity, different groundwater aquifers are not expected to be interconnected due to the underground mining operations.

The Ecohydrological Conceptual Model (Stantec 2023) identified potential impacts to one landholder due to water quality and groundwater drawdown. Sojitz will enter into “make-good” agreements with the landholder/owner of the impacted water supply bore.

Groundwater Monitoring

The GCM groundwater monitoring network includes monitoring within M-Block. It targets the regional groundwater table within the Tertiary basalt and monitors groundwater pressure in deeper strata within the basal sand and Permian coal measures. This monitoring network is suitable for monitoring the effects of M-Block on the groundwater regime and will continue to be used throughout the life of the project.

Mine Affected Water (MAW)

Based on the water balance model, the M Block development will result in an increase in the Mine Affected Water (MAW) generated. The predicted increase of the volume released is only 2% difference in the total cumulative volume released throughout the 11-year simulation period. All potential releases will meet the criteria specified in the current Environmental Authority (EA).

An existing active pit will be assigned for MAW storage to mitigate risks associated with the management of increased MAW generation.

Final Voids

No voids are proposed for M-Block. Voids located on other areas of GCM would not, however, result in adverse environmental impacts on surrounding aquifers as groundwater hydraulic gradients are expected to be maintained in the long term towards each of the voids. Residual void low walls shall be reshaped above the high-water level and rehabilitated and revegetated in accordance with the GCM Rehabilitation Management Plan (Rehabilitation MP).

SURFACE WATER

M-Block is located within the Fitzroy Basin and is at the headwaters of two sub-basins, specifically the Mackenzie River and the Nogoa River. The Mackenzie River sub-basin is on the far eastern boundary of M-Block with the Nogoa River sub-basin is on the western boundary of M-Block. This also corresponds with the sub catchments for the site, the Upper Mackenzie is on the far eastern boundary and the Nogoa is on the western boundary of the site.

The M-Block open cut area does not currently contribute to the Mackenzie River Catchment, rather it flows into the Crinum Creek Catchment and ultimately the Nogoa River Catchment. Therefore, the M-Block extension has no influence on the magnitude, duration and timing of flows within the Mackenzie River Catchment. There are no proposed ground surface disturbances within the Mackenzie River Catchment, and it is therefore not anticipated that the M-Block operations would have any impact on the flow regime within this catchment. The location of M-Block footprint is in the headwaters of both catchments and forms a significantly small portion of both catchments. It is highly unlikely that any rainfall falling on this location of the catchment would have any quantifiable impact on the timing and or persistence of flows in any downstream tributaries.

There are three unmapped watercourses under the Water Act 2000 (Qld) that flow into M-Block. Of these unmapped watercourses, two are unnamed watercourses with the remaining watercourse being Cooroora Creek. It is expected that the two unnamed watercourses, are potentially ephemeral tributaries of Crinum Creek, especially during wet weather events.

There are also a number of unmapped watercourses surrounding the area including one watercourse to the south of the site which runs into Crinum Creek, one watercourse to the south of the site which runs into Cooroora Creek. Cooroora Creek ultimately runs into the Mackenzie River approximately 45 km east of the site and Crinum Creek ultimately runs into Nogoa River approximately 21 km south of M-Block.

Impacts on water releases

Surface water monitoring (mine water releases and background water quality) has been undertaken for the GCM, with data from 2010 assessed as part of this PER. Key findings include:

- There are five monitoring locations which are used to monitor upstream environments and six monitoring locations which are used to monitor the potential impacts of the mining activity, i.e. from mine releases. One current monitoring location is located in the vicinity of M-Block, Transmission Line Creek U/S (Telegraph Creek).
- All watercourses within the site are ephemeral, with flows typically of short duration (and may be localised), interspersed with long no-flow periods and hot, dry climatic conditions leading to relatively rapid drying and evaporation of pools. The episodic patterns of stream flow are not

conducive to the development of permanent aquatic environments, nor for flow through or replenishment of pools.

The additional volume of water from the M-Block extension will be managed in accordance with the existing EA, which has criteria around the magnitude, timing and quality of water released into the Crinum Creek Catchment.

Subsidence impacts

Subsidence associated with the proposed Project is not anticipated due to the use of the bord-and pillar mining method and hence additional ponding and enhanced flooding are unlikely to occur. M-Block operations will not include the interception or diversion of surface water flows. There are no changes to stream alignments proposed.

It is also not anticipated that recharge rates will be significantly modified given the limited areal extent of infrastructure that will influence recharge. Changes to groundwater or surface water quality are not anticipated as a result of the proposed activities associated with the activities proposed for M-Block, therefore:

- No changes to habitat or lifecycle of a native species dependent on a water resource are expected.
- No changes to the water resource that may cause the establishment of an invasive species (or the spread of an existing invasive species) are expected.
- No significant worsening of local water quality is anticipated.
- No changes to ecosystem water qualities are anticipated.
- No changes to the water resource that may cause the establishment of an invasive species (or the spread of an existing invasive species) are expected.

Therefore, there will be no discernible impacts to the surface water system as a result of the mining operation proposed for M-Block. It is also not likely that M-Block operations would result in a risk to human or animal health, or to the condition of the environment as a result of a change in water quality.

Surface water is not predicted to be impacted based on the predicted drawdown of groundwater resulting from the proposed mining operations. Therefore, any surface water systems and species that may potentially be dependent on these surface water resources are not predicted to be impacted.

CUMULATIVE IMPACTS

The Project is in the vicinity of other resource tenures, including:

- Kestrel Mine, located immediately southwest of M-Block, on an adjoining ML.
- Oaky Creek Mine, located approximately 4 km northeast of M-Block.
- Ensham Mine, located approximately 14 km southeast of the M-Block,

Kestrel Mine is the nearest operations to M-Block and includes mining that could contribute to cumulative impacts with the predicted depressurisation from the Project. No additional cumulative impacts to the basalt aquifer are attributed to the proposed M-Block extension when combined with the approved Kestrel operation.

There is expected to be little change to surface water flows associated with the cumulative impacts as M-Block is the top of the catchment and the watercourses are ephemeral with minimal flow. The operation of M-Block will not include any abstraction from, or discharges to surface water or watercourses.

Potential MAW related to the proposed M-Block extension will be managed in accordance with existing water management plans. Incremental, cumulative impacts are not anticipated from the proposed Project.

Management and Mitigation

Mitigation has the primary aim of avoiding significant impacts and should be applied in the following order:

1. Avoid impacts – preserve important habitat and prevent further habitat loss.
2. Mitigate impacts – minimise habitat degradation and retain habitat function.

3. Monitor effectiveness of mitigation – ensure mitigation is effective and feeds back into an adaptive management plan.

Sojitz operate under an Environmental Management System (EMS) that details environmental measures to be implemented during the operation of GCM. As GCM is operational with activities conducted under an EA, there are on-going management and monitoring requirements to address potential environmental impacts. Sojitz will review and update the current management plans to address and include all specific requirements associated with the proposed M-Block operation.

Climate Change

The M block expansion project produces coking coal which is used in the manufacture of steel and not thermal coal as used for the generation of power. There are alternative coking coal resources globally producing lower grade coals which would be developed to feed existing steel mills instead. If M block coal was not made available, the steel makers would need to source similar coal (high fluidity) from other countries. Similar high fluidity/low ash premium coking coal sourced from countries like Russia are significantly higher in methane emissions and sulphur content and therefore increase overall fugitive emissions. Should that occur, it is estimated that the amount of CO2 produced from blast furnaces that currently use Australian coking coals may increase by 7 to 25 million tonnes per annum or 0.8 to 2.8 per cent.[1]

Conclusion

The assessment undertaken for the proposed operations on M-Block and detailed in this PER show that the operational methodology, proposed management, and mitigation measures including ongoing monitoring requirements and offset provisions, will mitigate the potential impacts on MNES.

[1] *Minerals Council of Australia, 2020. Best In Class: Australia's Bulk Commodity Giants. Australian Metallurgical Coal: Quality Sought Around the World.*

1 Introduction

1.1 Overview

Sojitz Blue Pty Ltd (Sojitz) proposes to continue the existing Gregory Crinum coking coal mine (GCM) through the development of M-Block located within mining lease (ML) 1923. GCM is located to the northeast of Emerald, Queensland (Figure 1-1). The additional coal will also be utilised for steel production only.

The proposal was submitted under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) to the Minister for the Environment (the Minister) on 20 December 2021 and validated on 24 January 2022 (2021/9127). On 23 February 2022, the delegate of the Minister decided that further assessment is required as the action has the potential to have a significant impact on the following matters of national environmental significance (MNES) that are protected under Part 3 of the EPBC Act:

- Listed threatened species and communities (sections 18 and 18A).
- A water resource, in relation to coal seam gas development and large coal mining development (sections 24D and 24E).

On that same date, the delegate of the Minister made the decision that the proposed action, the extension of the mine into M-Block, be assessed by Public Environment Report (PER). The PER guidelines were issued on 24 March 2022, and are attached as Appendix A.

This PER has been prepared to address the requirements detailed in the PER Guidelines issued for the project by the Department of Agriculture, Water and the Environment, now the Department of Climate Change, Energy, the Environment and Water and with consideration of the comments received from the Independent Expert Scientific Committee (IESC).

1.2 General Information

An overview of the project is provided in Table 1-1.

Table 1-1: General project information

Action	Gregory Crinum Coal Mine (GCM) M-Block Extension Project
Proponent	Sojitz Blue Pty Ltd Level 27, 345 Queen Street, Brisbane, 4000, Queensland
Objective	Extension of the existing GCM into M-Block located within ML 1923 to maintain commercial viability of the mine beyond 2022.
Location	The GCM is an existing underground and open cut coal mine located approximately 250 km west of Rockhampton in the Bowen Basin, Central Queensland 50 km northeast of Emerald, Queensland at 2993 Lilyvale Rd, Lilyvale (Figure 1-1).
Tenement and Property Description	The M-Block component of the GCM, subject to this assessment will occur over: • Lot 7 TT376 • Lot 4 CP843145 • Lot 3 RP616357 • Lot 1 SP258941 • Lot 45 CP883753 • Lot 14 RP855491 • Lot 20 SP129967 • Lot 4 CP843145
Project Background	The GCM was initially registered as an open-cut mining operation on 23 April 1979, with the addition of underground mining at Crinum Mine registered on 26 June 1993. In March 2019, Sojitz purchased the mine from BHP Mitsubishi Alliance (BMA) and restarted operations. The mine currently produces about 2 million tonnes per annum of premium hard coking coal for export to steel manufacturers. Sojitz is proposing to continue the GCM to an area known as 'M-Block' (the Project), located directly east of the existing mining area. M-Block is located on ML 1923 which was originally granted and approved for underground mining on 14 March 1985 with additional

Action	Gregory Crinum Coal Mine (GCM) M-Block Extension Project
	'surface rights' granted under the *Mineral Resources Act 1989* (Qld) between 1986 and 2014. The Project, including M-Block, holds a Queensland EA (EPML00945013) (Appendix B) and water licence 577145 to enable dewatering of ML 1923. Mining of M-Block will use conventional open-cut mining methods for the first 3 years, with underground access to be established from the highwall. GCM has substantial established infrastructure including rail loading, Coal Handling and Processing Plant (CHPP), tailings dams and workshops that will be used for M-Block. The use of this existing infrastructure will keep the overall surface disturbance at M-Block to a minimum.
Other Actions	Kestrel Mine, located to the south of GCM, is an existing underground longwall mine that has been in operation since 1992. There have been several EPBC Act referrals made in relation to this mine. German Creek Mine is located to the northeast of GCM, with a number of mines located further north in the vicinity of Dysart and Moranbah. Valeria Coal Holdings Pty Ltd, a wholly owned subsidiary of Glencore Coal Pty Ltd are proposing a greenfield open-cut thermal and metallurgical coal mine approximately 27 km to the north-west of Emerald, and approximately 35 km to the south-west of GCM. Supporting infrastructure is also proposed as part of this project. This project is a controlled action under the EPBC Act (2021/9077) and a Queensland Coordinated Project. An environmental impact assessment has yet to be completed.
Current Status	On Friday, 12 May 2023, the public notification period for the PER commenced through to Friday 9th June 2023. This was delivered in compliance with DCCEEW requirements. Three submissions were received. These responses were submitted on Thursday, 6 July 2023.
Consequences of Not Proceeding	The continued operation of GCM is dependent on the extension into M Block. Not undertaking this action would result in the closure of the mine during 2023, as further mining in existing areas is unachievable without a dragline.

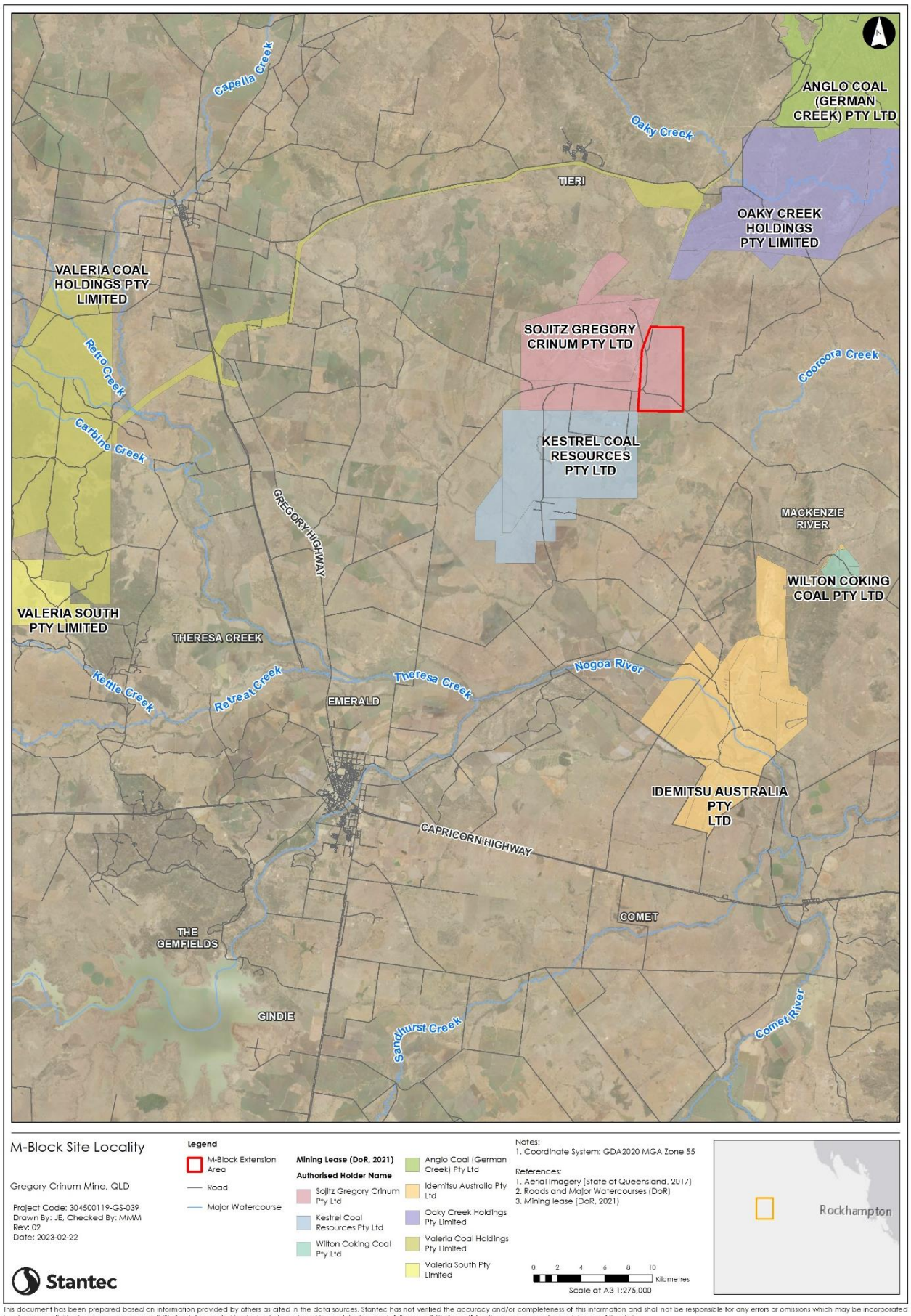


Figure 1.1: Site location

1.3 PER Structure and Content

This PER has been structured to reflect the requirements of the guidelines. A summary of the guideline requirements and the sections of this report in which they are addressed is provided in Table 1-2.

Table 1-2: PER requirements and report section

PER Section	PER Requirements	Report Section
1	Description of the Action	2
1.1	Project Details	2
	Feasible Alternatives	2.4
1.2	Description of the existing environment	3
2	Matters of National Environmental Significance	4 & 5
2.1	Listed threatened species and ecological communities	4
2.1.1	Description	4.1
2.1.2	Desktop analysis	4.2
2.1.3	Survey effort	4.3
2.1.4	Survey outcomes	4.4
2.1.5	Habitat assessment	4.5
2.1.6	Impact assessment	4.6
2.1.7	Mitigation measures	4.7
2.1.8	Residual significant impact assessment	4.8
2.2	A water resource in relation to coal seam gas development and large coal mining development	5
2.2.1	Groundwater	5.1
2.2.2	Final voids	5.2
2.2.3	Waste material	5.3
2.2.4	Groundwater dependent ecosystems	5.4
2.2.5	Stygofauna	5.5
2.2.6	Surface water	5.6
2.2.7	Cumulative impacts	5.7
3	Proposed Avoidance, Safeguards and Mitigation Measures	6
	Avoidance, safeguards and mitigation measures	6.1
	Environmental Authority – mitigation potential impacts to water resources	6.1
	Management Plans - framework for management, mitigation and monitoring of relevant impacts of the proposed action	6.2
4	Environmental Offsets	7
	Assessment of the likelihood of residual significant impacts	Appendix E
	Draft Offset Area Management Plan	Appendix J
5	Other Approvals and Conditions	8
	Details of any local or State Government planning scheme, or plan or policy that deals with the proposed action	8.2
	Description of any approval that has been obtained from a State, Territory or Commonwealth agency or authority (other than an approval under the Act), including any conditions that apply to the action	8.2
	Additional approvals that are required	8.3
	Description of the monitoring, enforcement and review procedures that apply, or are proposed to apply, to the action	8.2

PER Section	PER Requirements	Report Section
6	Consultation	9
	Consultation that has taken place	9.1
	Proposed consultation about relevant impacts of the action	9.1
	Response or result of consultation on the proposed action	9.1
	Identification of affected parties	9.1
	Consultation with traditional owners	9.2
7	Environmental Record of Person(s) Proposing to Take the Action	10
	Environmental record of the proponent – Commonwealth and State	10.1
8	Economic and Social Matters	11
	Economic and social impacts of the proposed action	11.3
9	Information Sources provided in the PER	12
	Source of information, currency, reliability, and uncertainties	12
10	Conclusion	13

1.4 PER Project Team

The project team who prepared this PER are detailed in Appendix C.

2 Description of the Action

2.1 Project Overview

The Gregory Mine was initially registered as an open-cut mining operation on 23 April 1979, with the addition of underground mining at Crinum Mine registered on 26 June 1993.

In 2012, the open cut operations at GCM were placed in care and maintenance by BMA, with the underground operations ceasing in November 2015 and the remainder of the mine placed in care and maintenance following the final load out of product coal in January 2016.

In March 2019, Sojitz purchased the mine from BMA and progressively recommissioned the site and commenced mining. The GCM currently produces about 2 million tonnes per annum of premium hard coking coal for export. Sojitz are proposing to continue mining operations at GCM which remains economic with the inclusion of the M Block coal. GCM mining infrastructure is shown on **Error! Reference source not found.**.

The GCM encompasses MLs 1789, 1923, 70061, 7007 and MDL 133. The extension area, known as M-Block, is located wholly within ML 1923 and immediately east of the existing mining areas (Figure 1-1). ML 1923 was originally granted and approved for underground mining on 14 March 1985 with additional 'surface rights' granted under the *Mineral Resources Act 1989* (Qld) between 1986 and 2014. The GCM, including M-Block, holds a Queensland Environmental Authority (EA) (EPML00945013) and water licence (577145) to enable dewatering of ML 1923.

Mining of M-Block will use conventional open-cut mining methods for the first 3 years, with underground access to be established from the highwall. The total area of the M-Block footprint is 2,441.3 ha. This comprises 296.4 ha of open cut impact area and 1,414.1 ha of underground mining.

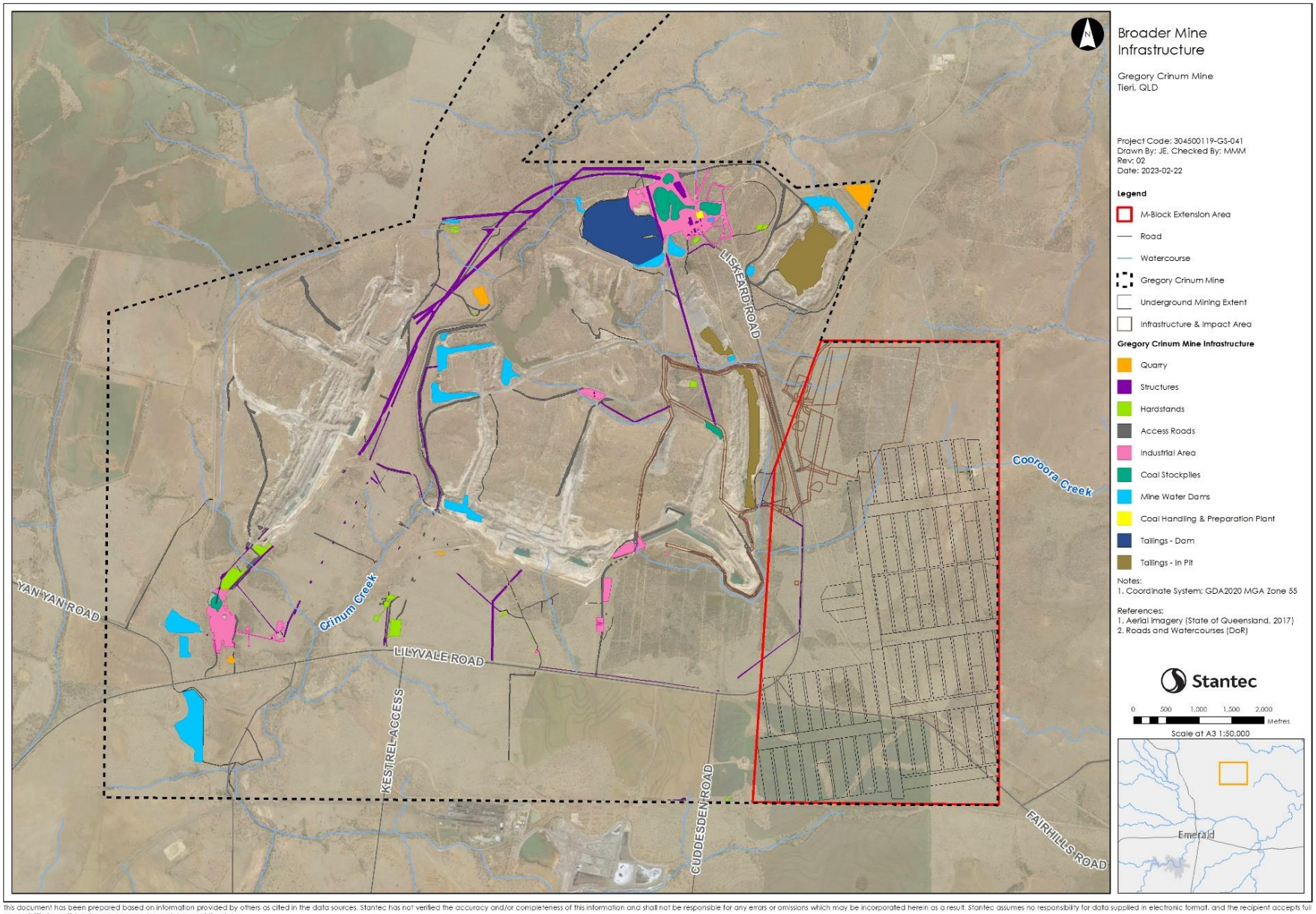
GCM has substantial established infrastructure that will be used for M-Block mining activity. This includes rail loading facilities, CHPP, tailings dams and workshops. The use of this existing infrastructure will keep the overall surface disturbance at M-Block to a minimum.

The proposed mining operations, associated infrastructure, and relationship to existing mining operations are shown on **Error! Reference source not found.**.

2.2 Project Works and Staging

The proposed action that is the subject of this PER includes the activities undertaken during the establishment and construction, operation (open cut and underground), decommissioning and rehabilitation stages of mining on M-Block.

Error! Reference source not found. shows the proposed layout of mining and associated activities on M-B lock with the key activities to be undertaken for each of project stages are detailed in Table 2-1 and the following sections.



This document has been prepared based on information provided by others as cited in the data sources. Stantec has not verified the accuracy and/or completeness of this information and shall not be responsible for any errors or omissions which may be incorporated herein as a result. Stantec assumes no responsibility for data supplied in electronic format, and the recipient accepts full responsibility for verifying the accuracy and completeness of the data.

Figure 2.1: GCM mining infrastructure

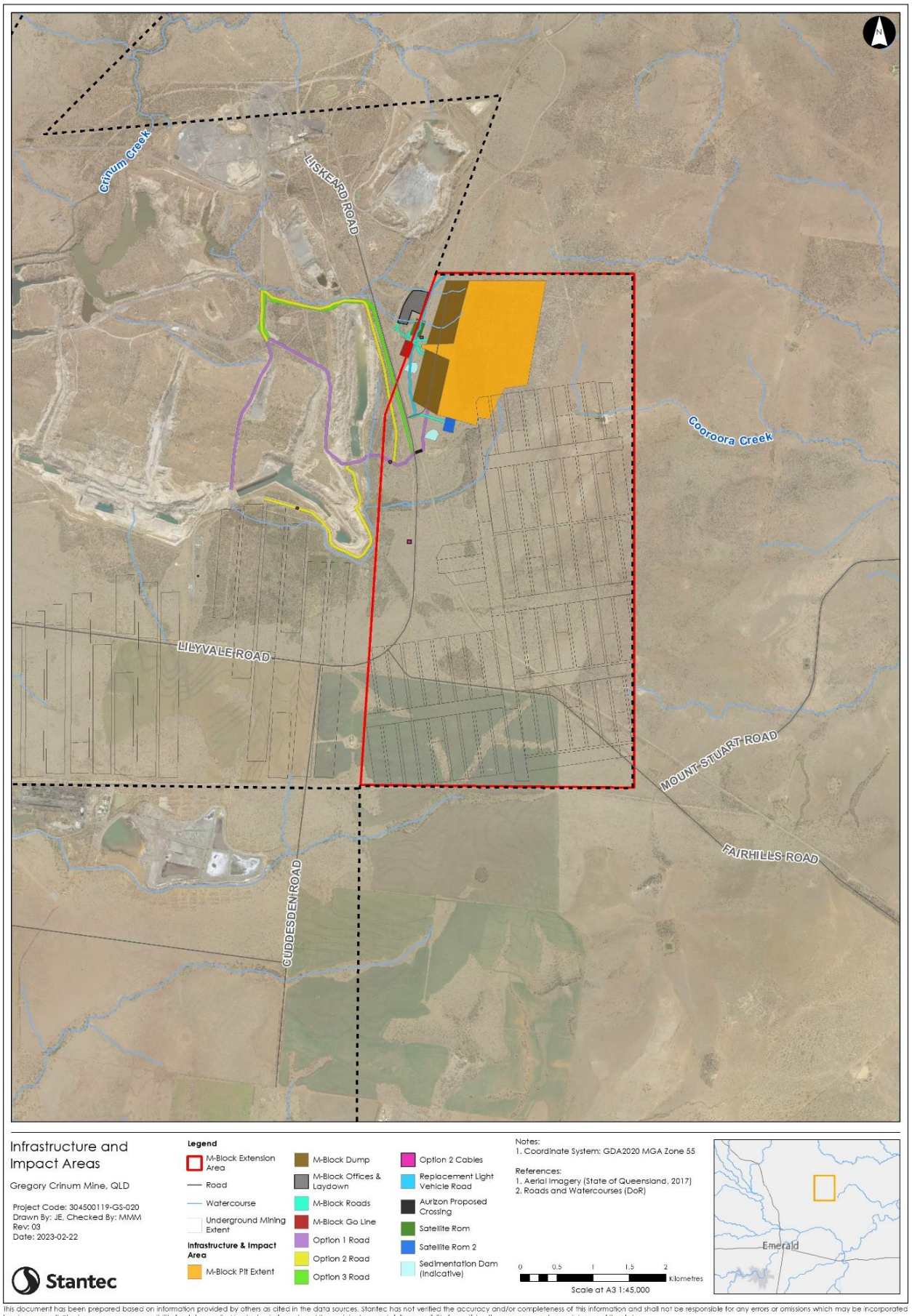


Figure 2.2: M-Block site plan

Table 2-1: Key project works and staging

Stage	Key Activity	Preliminary Timing	Equipment
Establishment and Construction	**Rail Crossing** • Improvements to current rail crossing to enable increased traffic and coal haulage. • Tender issue and awarding construction. • Construction of new crossing.	20 weeks 4 weeks 16 weeks	Civil contractor equipment
	Movement of Equipment • Development of dragline walk route. • Construction of roadways (expansion of existing roads; relocation of topsoil stockpiles). • Arrange for power line - movement / disconnection / reconnection. • Movement of equipment for preliminary works.	8 weeks 12 weeks	Mine Dozers Excavators Trucks
	Power Supply – Dragline • Substation earth pad construction. • Dragline substation and supporting electrical infrastructure. • Substation relocation.		
	Clearance • Pre-survey clearance of disturbance footprint where infrastructure and box cut is required. • Clearing and grubbing. • Topsoil pushed up into piles and salvaged - relocated into stockpiles around base of proposed out of pit dump. • Construction of first flush sediment dam/s to cater for drainage off infrastructure area.		Dozer (stick rake) D11 Excavator / Trucks Dozers, Scrapers / Rollers
	Infrastructure Limited site infrastructure is required with reliance on Gregory and Crinum Mine Infrastructure Area (MIA) for support. M-Block infrastructure will include: • Access tracks. • Vehicle parking. • Boundary fencing (cattle grade). • Ablution facilities (tanks to hold effluent – trucked out and passed through Gregory STP). • Small office building / Crib room. • Tanks to hold potable water (trucked in). • Tanks to hold mine affected water (piped in). • Fuel tanks. • Erosion and sediment control structures (appropriately sized dams). Two sediment dams are proposed to manage drainage from the out of pit dump and general runoff from the infrastructure area and the ROMs. Optimisation of the infrastructure arrangement at M Block will determine the exact location of the sedimentation dams. • Run of mine (ROM) stockpiles. • Mobile lighting plants. • Mobile pumps and pipework. • Laydown areas for mobile equipment / spares. • Workshop – container style plus igloo shade. • Communications tower (this may be satisfied with mobile units).		

Stage	Key Activity	Preliminary Timing	Equipment
	Box Cut • Free dig to hard surface using excavator and trucked to out of pit overburden location. • Surface preparation for drilling to enable blasting to occur. • Drilling and explosives loading. • Creation of spoil dump to progress towards final landform design.	Late 2023	Dragline Grader Dozer Drill Rig Loading truck
	Dragline Relocation • Walk dragline along prepared route. • Pad preparation to cross Lilyvale Road (bitumen) / vehicle bypass road construction (depending on requirements). • Road closure / disruption notifications. • Power / lines disconnection.	Late 2023	
Operation	**Open Cut Mining** • Vegetation cleared and stockpiled. • Topsoil removed and stockpiled. • Dragline to remove overburden stacking material “behind” to hard layer. • Drill and blasting of strips. • Dragline to remove overburden to coal. • Dozers to support drill and blast and dragline movements. • Coal removed by excavator into haul trucks. • Haulage to stockpile area for transport from M Block to the CHPP. • Reshaping of spoil by dozers. • Creation of highwall entry area for underground mining.	Late 2023 October 2025	Dragline Excavator / Shovel Haul Trucks Dozers
	Underground Mining • Develop mine design to optimise coal recovery using best available methods. • Construction of underground entry. • Construction of conveyor system to deposit coal at in-pit ROM for collection by haulage contractor (option). • Construction of surface infrastructure i.e. water extraction pipelines / air shafts / secondary egress.	Designs to begin in 2024	
	Coal Haulage • Load coal from ROM stockpile into road trains. • Road train haulage from M-Block to the CHPP.		Loader Road Trains
Closure and Rehabilitation	**Rehabilitation** • Reshape out of pit dumps to design. • Placement of basalt / sandstone as rock mulch to reduce erosion points. • Placement of topsoil. • Rip and seed on contour. • Closure. • Removal of infrastructure and supporting items – pipes/power/sediment dams and the rehab of these areas.	From early 2026	D11 Grader

2.2.1 Establishment and Construction

2.2.1.1 Land Clearance and Topsoil Management

Pre-surveys of the M-Block disturbance footprint where the box cut is required have been completed over various stages in the life of GCM. Surface disturbance and vegetation removal works are required to be undertaken during the establishment stage of the project. Vegetation clearing will use specific tree clearing equipment alongside fauna spotter catcher personnel and in accordance with a Vegetation and Fauna Management Plan (Vegetation and Fauna MP).

Topsoil will be stripped and stockpiled ahead of mining and where substantial disturbance is required that will impact topsoil resources. The topsoil stockpiles will be located at the edges of the open cut footprint. The quantity and location of topsoil stripping and stockpiling will be managed in accordance with the current GCM Topsoil Management Plan (Topsoil MP).

2.2.1.2 Dragline

Equipment will be relocated to M-Block pit. In particular, the dragline which is required to be moved/walked approximately 7 km one way in one session. Major power supply easements, water supply pipelines, the bitumen access road to the Gregory MIA and the rail line will be impacted by this activity. The route is currently being finalised. Relocation of the dragline is required for mining operations to commence in M-Block in 2023.

A walk route constructed to cater for the dragline and supporting equipment, will require a roadway with a width of 40-45 m and slope limited to 8%. Existing haul roads will be used where practicable. Extension of smaller existing tracks and construction of sections of new roadway will also be required.

The dragline power cables will pass through the existing culverts to facilitate walking across Liskeard Road. Walking over Liskeard Road will require the construction of a temporary earth mat to protect the bitumen and buried water pipes.

Vehicle access to the Gregory MIA will be controlled during this time and alternate routes will be arranged via on-lease roadways and/or managed with traffic control and detours.

The travelling dragline will also impact downstream electricity users when passing under power lines - local landholders for the single wire earth return line and Crinum mine infrastructure area for the 66 kV line.

To cross the rail line, a specific crossing location has been identified following engagement with the rail network provider. This designated location has existing anchor connection points making power supply disconnection and reconnection simpler (**Error! Reference source not found.**). Supporting mats are used t o protect the rail line itself which is then covered with fill material to make the surface flat.

2.2.1.3 Tracks, Access, and Services

Relocation of the existing light vehicle track, which is currently used to access a major substation, is expected to be required. There are currently several options being considered for the location of this track as detailed on **Error! Reference source not found.**. The operation of M-Block will require a power supply spur l ine and substation to be provided, with the proposed location close to the Liskeard Road and 66 kV easement.

Water will be supplied by above ground pipes from GCM, passing under Liskeard Road and the rail line in existing culverts.

Sedimentation dams will be constructed to collect and settle any runoff resulting from the disturbance. Additionally, drainage channels around the project footprint will be established to separate surface runoff from entering the pit and infrastructure area.

2.2.1.4 Other Infrastructure

Material generated from land clearance and box cut will be used to build up M-Block laydown areas and pad construction for infrastructure facilities. The entire area will be fenced to minimise access points such that all personnel at M-Block can be accounted for if an emergency incident occurs. This fencing will also indicate to the public that an active mining operation is present and restrict their access.

Demountable infrastructure will be used to reduce the extent of construction required to only that needed to support the M-Block mining operations. The demountable buildings will contain an office, a crib room, and ablution facilities. In addition, laydown areas will be established for both light and heavy vehicles, as well as ancillary equipment such as lighting plants, graders, service trucks and dozers (**Error! Reference source n ot found.**).

A standalone fuel facility will be provided and will be securely located with double skinned tanks used. A workshop capable of maintaining most M-Block equipment, with the expectation that movements of gear to the Gregory MIA will occur as required.

2.2.2 Operation

The mining of M-Block will start with open cut operations with the underground mining commencing following the clearing of the southern end wall and the face prepared such that it is available to create an entry point for underground operations. The location of the open cut and underground mining operations are shown on **Error! Reference source not found.** with the works detailed in Table 2-1.

2.2.2.1 Open Cut Mine

The preliminary works undertaken at M-Block will establish the base and arrangements for the supporting infrastructure required for the open cut operations, including diverting surface runoff around the disturbance into the sedimentation dam. The M-Block fleet of equipment will be used to begin the box cut to develop the open cut operation in 2023. It is not expected that any new equipment, or additional personnel, will be required for the operation of M-Block.

The dragline is scheduled to begin in 2023 and continue to late 2025 to reach the current economic limit of open cut mining.

A portion of the generated spoil may be used to extend the infrastructure and laydown areas however with the short life of the open cut operation, the fleet will continue to strip topsoil and pre-strip material to the limit of open cut disturbance to permit unimpeded dragline operation. It has been recognised that maximisation of the spoil placement of the pre-strip is important to optimise the final landform creation and rehabilitation process.

2.2.2.2 Underground Mine

The underground mining plan will be optimised during the period of the open cut mining. It is expected that the southern end wall strip of the open cut will be cleared, and the face prepared such that it is available to create an entry point for underground operations. Construction of development drives are expected to occur concurrently with the remaining open cut operation enabling a coal generation transition to underground operations.

The extraction of coal from the underground will be undertaken such that minimal movement of the upper strata would occur. Sufficient area within the pit floor will remain to enable supporting infrastructure to be constructed, or established, adjacent to the mine entry.

As part of the supporting infrastructure for the underground operations, construction of progressive surface infrastructure and access (maintenance) tracks will be required over the mines' life. This will include power supply and pipelines to boreholes to deliver water in and out, ventilation and potential secondary egress locations.

2.2.2.3 Coal Haulage

A satellite ROM located close to the pit entrance will store coal extracted from the M-Block pit. Road trains will be used to haul coal from M-Block to the CHPP within the Gregory MIA. The ROM stockpile will be sized to accommodate for inclement weather events, expected mining block volumes and potential haulage delays due to train loading or downtime on the rail line. It will include a turnaround point access by road haulage trucks with park up areas.

Haulage will be predominately on internal haul roads to reduce interaction between road trains and vehicles accessing the GCM. Campaign movement of coal will be determined as per coal quality criteria and the export schedule.

2.2.2.4 Processing

The CHPP within the GCM infrastructure area has been treating coal from the GCM for over thirty years with upgrades to the plant being undertaken by both BMA and Sojitz to improve efficiency (BMA 2011). No additional changes are proposed to accommodate the material from M-Block. The CHPP process was described by BMA (2011) as follows:

- The coal from each source is screened and placed through a rotary breaker to maintain a maximum plant feed top size. It passes through a series of bins and conveyors before being fed into one of the three primary (Coking Coal) modules in the plant.

- The plant feed is crushed to nominal 50 mm topsize and conveyed into the plant on three feed conveyors. The coal is deslimed at 0.5 mm wedge wire with the coarse fraction going to the primary dense medium cyclones.
- Product from the cyclones is dewatered on fed onto the main product conveyor. The deslimed fraction is floated in Microcel columns and dewatered on horizontal belt filters. The dewatered product is discharged onto the main product conveyor.
- Reject from the primary dense medium cyclones is rewashed in the secondary dense medium cyclones to recover a high ash product fraction. This fraction can be stacked separately as a thermal coal or added back into the main product. This option allows for processing difficult to wash coal.

An overview of this process is shown in **Error! Reference source not found.**.

2.2.3 Closure and Rehabilitation

The current GCM Rehabilitation Management Plan (Rehabilitation MP) reflects the rehabilitation objectives established under the EA. Sojitz, as operator of GCM, is required to rehabilitate all areas that have been substantially disturbed through its mining activities back to a stable landform with a self-sustaining vegetation cover. Further, progressive rehabilitation is required to commence within two years as, and when, areas become available within site's MLs.

Currently, more than 2,400 ha of disturbed land within the GCM leases have been rehabilitated, including 1,177 ha of subsidence area rehabilitation which was certified as progressively rehabilitated by the Queensland Department of Environment and Science (DES) in 2018.

The Rehabilitation MP will form the basis of rehabilitation for M-Block.

2.2.3.1 Open Cut Mine

Rehabilitation of the mining disturbance will be undertaken as soon as areas are available. The arrangement of the out of pit dump will be designed to reduce the need for bulk reshaping.

Following the conclusion of the underground extraction operations, rehabilitation of the remaining open cut area will be undertaken utilising bulk push dozers to create a depressed landform. Future options to optimise the next land use for this depressed landform will be assessed during the underground operation. This will include the identification of the disturbed land mining domain classification and required rehabilitation treatment.

2.2.3.2 Underground Mine

For the underground operations, the rehabilitation process will be limited until the end of the operation. The removal and recycling of surface infrastructure and access tracks will be undertaken progressively as the workings extend. At the conclusion of underground extraction operations, the drives and accesses will be closed as per safety expectations and to allow the underground to be flooded to reduce fire risks.

All remaining infrastructure will be removed and the area rehabilitated, except for the sedimentation dams which will remain until the revegetation process is sufficiently mature to prevent erosion.

2.3 Workforce and Accommodation

No changes to the current workforce at GCM will occur with the inclusion of M-Block. The current workforce comprises approximately 88% of local residents and 12% Fly In, Fly Out, accommodated in Emerald with some overflow management of contractors in Capella. GCM uses bus services from Emerald to facilitate workers commute for daily shift rotations.

2.4 Feasible Alternatives

The continued operation of GCM is dependent on the extension of operations into M-Block. M-Block is the replacement pit for the coal sourced from ABG pit with the operation of the dragline making open cut mining economically viable. The proposed mine footprint allows for possible extension to the open cut if prices make it viable i.e. take more strips until the strip ratio is uneconomic.

Not undertaking this action would result in the closure of the mine by the end of 2023.

The overall mining cost is highly affected by the use of a dragline as part of the mining fleet. Without M-Block there are no viable areas for the dragline to operate efficiently, resulting in increased mining costs and subsequently an uneconomical operation.

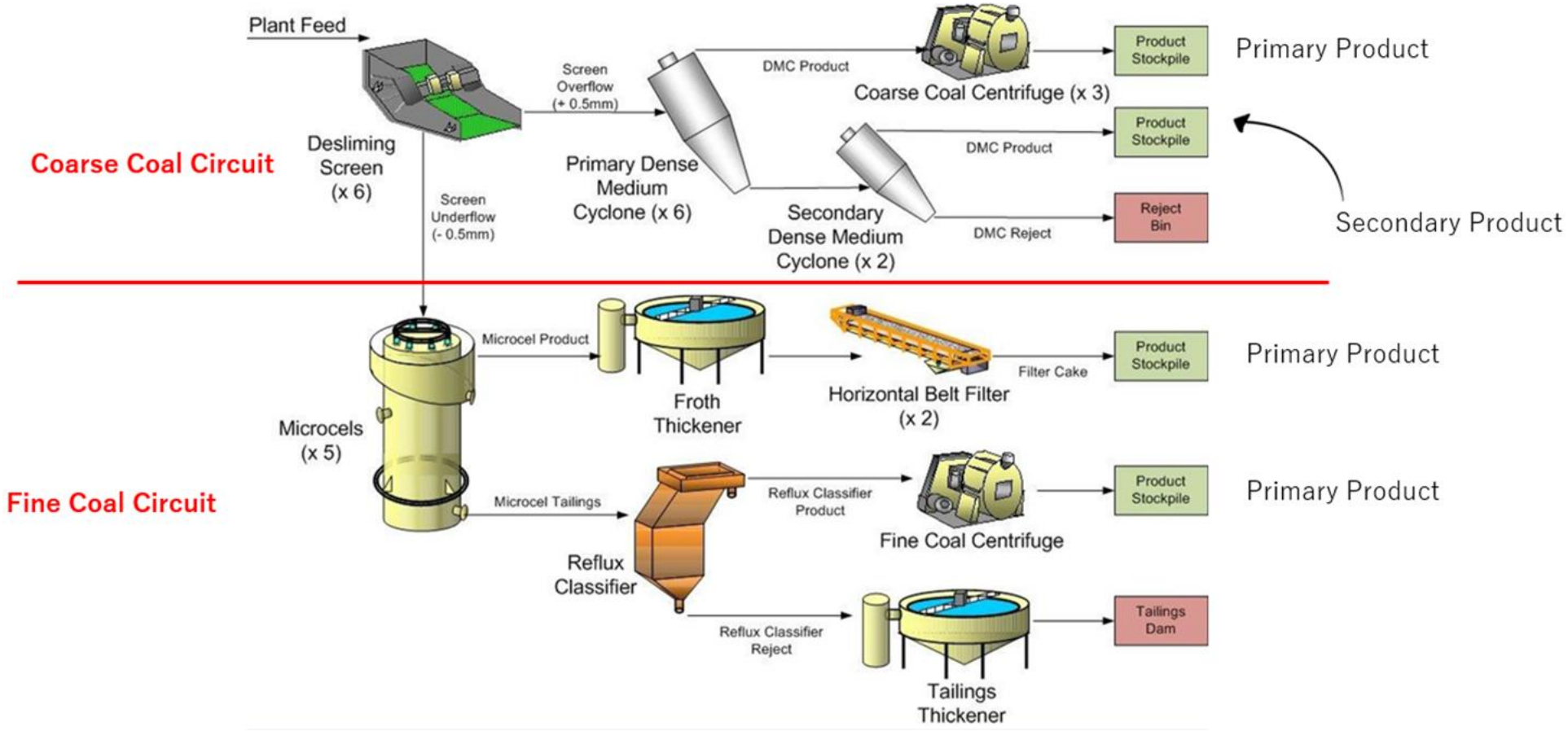


Figure 2.3: CHPP process

3 Description of the Existing Environment

3.1 Tenure

BMA operated the Gregory open cut mine between 1979 and 2012 and the Crinum underground mine between 1994 and 2015. The GCM incorporates the Crinum underground mine, Gregory open cut mine, undeveloped coal resources and on-site infrastructure including a CHPP, maintenance workshops and administration facilities. BMA sold the complex to Sojitz in 2019. The mine is currently operational.

The proposed action, located on M-Block comprises multiple MLs and lots including both freehold and lands lease tenure. M-Block incorporates four of these lots as detailed in Table 3-1 and shown on **Error! Reference source not found.**.

Table 3-1: Mining leases and land tenure

Mining Lease	Operational Land	Tenure	Activities
M-Block			
ML 1923 **Expiry: 31 March 2027**	Lot 1 SP258941	Freehold	As detailed in this PER (refer to Section 2.).
	Lot 3 RP616357	Freehold	
	Lot 7 TT376	Lands Lease	
	Lot 4 RP616357	Freehold	
	Lot 45 CP883753	Freehold	
	Lot 14 RP855491	Freehold	
	Lot 20 SP129967	Lands Leased	
	Lot 4 CP843145	Freehold	
Other GCM Lots			
ML 1789 **Expiry: 30 November 2040**	Lot 5 RP615803	Freehold	Rail loop.
	Lot 11 SP266093	Term Lease	Ramps; haul road; rehabilitation; seeded and re-contoured.
	Lot 14 RP855491	Freehold	Ramps; haul road; rehabilitation; seeded and re-contoured.
	Lot 11 SP258266	Freehold (portion of "Balmoral")	Crinum undergrounds and open cuts. Areas cleared, areas with topsoil stripped and stockpiled, mine pits, in pit spoil dumps, out of pit spoil dumps, spoil undergoing rehabilitation, mine ramps, haul roads, access roads, water management works including stream diversions, rejects dumps, raw coal stockpiles, coal preparation plant, product coal stockpiles, maintenance workshops, water and wastewater treatment plants.
	Lot 45 CP883753	Freehold	
	Lot 101 SP260668	Freehold	Areas cleared, areas with topsoil stripped and stockpiled, mine pits, in pit spoil dumps, spoil undergoing rehabilitation, mine ramps, haul roads, access roads, water management works including stream diversions, raw coal stockpiles, tailings dam, maintenance workshops.
	CCSP260668	Easement	Easement located within Lot 101 SP260668.
	CESP260668	Easement	Easement located over Liskeard Road.
	Lot 2 CP881474	Reserve	Underground development mining; Camping and Water Reserve, (Lilyvale waterhole).
	Lot 1 CP881474	Reserve	Camping and Water Reserve, (Lilyvale waterhole); Undisturbed.
	Lot 5 RP613594	Freehold ("Kevricia")	Undisturbed.
	Lot 2 RP616712	Freehold	Undisturbed.
	Lot 3 SP129968	Estate in Perpetuity	Gregory Mine Branch Railway.

Mining Lease	Operational Land	Tenure	Activities
	Lot 13 SP129969 Lot 20 SP129967		
	Lot 31 SP257924	Freehold	Norwich Park Branch passing corridor.
	Various Dedicated Road Reserves	Road Reserve	Yan Yan Road, Lilyvale Road.
ML 1923 **Expiry: 31 March 2027**	Lot 7 RP849020	Freehold	Underground mining; subsidence (Crinum South & East undergrounds).
	Lot 4 RP616357	Freehold	
	Lot 10 RP848962	Freehold	Water management works.
	Lot 11 SP258266	Freehold	Crinum undergrounds and open cuts, areas cleared, areas with topsoil stripped and stockpiled, mine pits, in pit spoil dumps, out of pit spoil dumps, spoil undergoing rehabilitation, mine ramps, haul roads, access roads, water management works including stream diversions, rejects dumps, raw coal stockpiles, maintenance workshops, water and wastewater treatment plants.
	Lot 14 RP855491	Freehold	Areas cleared; roads; rail facilities.
	Lot 42 CP864579	Freehold	Evaporation Dam; longwall mining subsidence (Crinum South).
	Lot 45 CP883753	Freehold	Areas cleared, areas with topsoil stripped and stockpiled, mine pits, in-pit spoil dumps, out of pit spoil dumps, spoil undergoing rehabilitation, mine ramps, haul roads, access roads, water management works including stream diversions, rejects dumps, raw coal stockpiles, coal preparation plant, product coal stockpiles, rail line and loop, maintenance workshops, water and wastewater treatment plants.
	Lot M AP19943	Permit to Occupy	Water pipeline along Lilyvale Road.
	Lot A AP2333	Lands Leased	Roads.
	CESP260668	Easement	Easement located over Liskeard Road.
	Lot 2 CP881474	Reserve	Camping and Water Reserve, Lilyvale waterhole.
	Lot 1 CP881474	Reserve	Camping and water reserve, (Lilyvale waterhole). Undisturbed; underground development mining.
	Lot 5 RP613594	Freehold	Undisturbed
	Lot 8 RP849020	Freehold	Kestrel Industrial Area Rail Loop
	PCP843142	Easement	
	Lot 1 RL3954	Road Licence	
	Lot 3 TT358 Lot 20 SP129967 Lot 21 SP129967 Lot 22 SP129967	Estate in Perpetuity	Gregory Mine Branch Railway
	Various Dedicated Road Reserves	Road Reserve	Yan Yan Road, Lilyvale Road, Unnamed Road, Cuddesden Road, Mt Stuart Road, Liskeard Road.
ML 7007 **Expiry: 31 January 2039**	Lot 101 SP260668	Freehold	Liskeard Pit
ML 70061 **Expiry: 31 July 2035**	Lot 101 SP260668	Freehold	Undisturbed.
	Lot 3 SP129968	Estate in Perpetuity	Gregory Mine Branch Railway Rail Loop

Mining Lease	Operational Land	Tenure	Activities
MDL 133 **Expiry: 31 March 2025**	Lot 100 SP260668	Freehold (“Kilgour”)	Exploration Resource Definition. Undeveloped.
	Lot 2 TT254	Freehold (“Lilyvale”)	
	Lot 9 CNS202	Freehold (“Crinum”)	
	Lot 1 SP291983	Freehold (“Talagai”)	

3.2 Land Use

The GCM is located within the Central Highlands Regional Council local government area. The majority M-Block is zoned Rural under the *Central Highlands Regional Council Planning Scheme 2016* with the existing rail line zoned as Community Facilities – Community Use (Queensland Rail). These also reflect the zoning of the remainder of the GCM.

The GCM supports existing mining activities as well as cattle grazing, cropping and areas of native vegetation. There are numerous access tracks, fences and dams located across the property. The historic land use of M-Block has been cattle grazing as evident in a review of historic aerial photography from QImagery (2022). Aerial photography from 1952 shows little infrastructure, with areas of sparse and dense vegetation (refer to Extract 1).

Access tracks and additional infrastructure, primarily roads and tracks are present within M-Block in 1966 (refer to Extract 2), with substantial clearing and extensive cropping being undertaken by 1973 (refer to Extract 3). In 1973, the aerial photography shows evidence of the commencement of surveys being undertaken within the GCM site prior to the commencement of mining operations.

By 1983 (refer to Extract 4) rail infrastructure is present within M-Block along with areas of native vegetation and cropping. There is an extensive track network present at this time.

Little has changed between 1983 and 2022 (Extract 4 to 7), with some exposed areas identified in 2003 (refer to Extract 6).

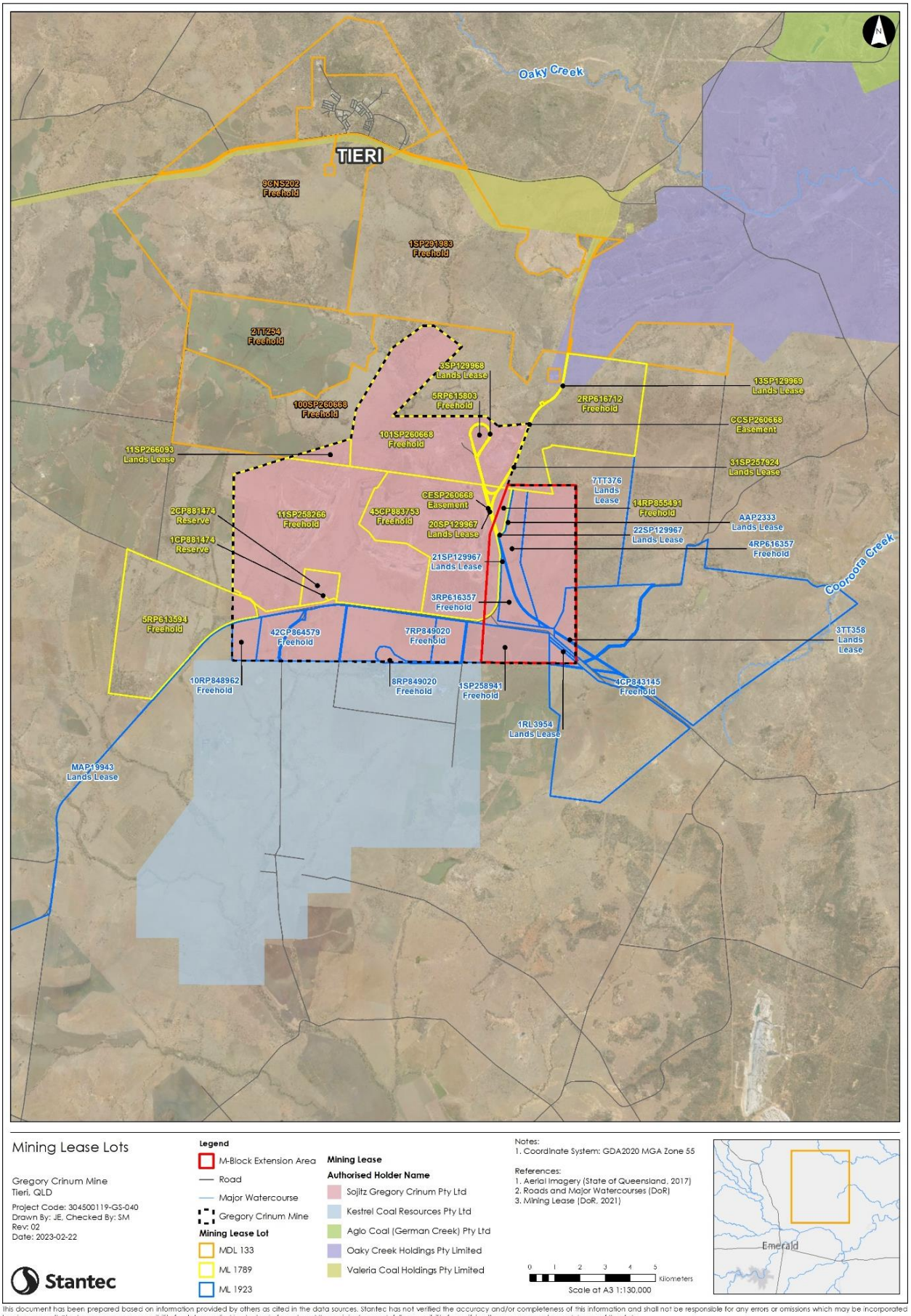
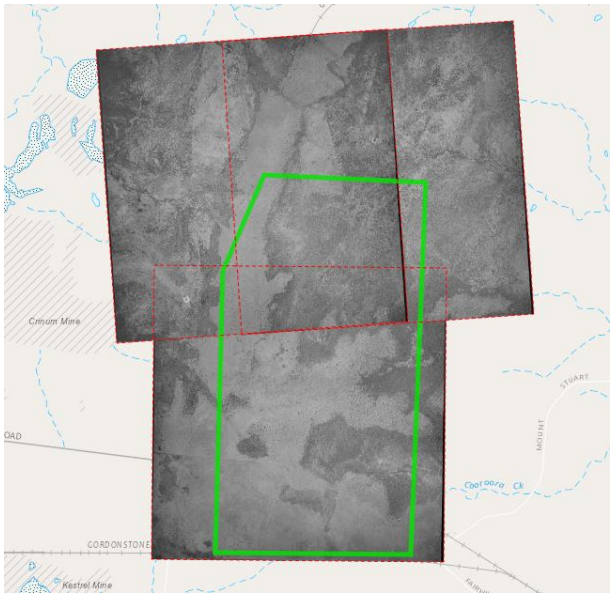
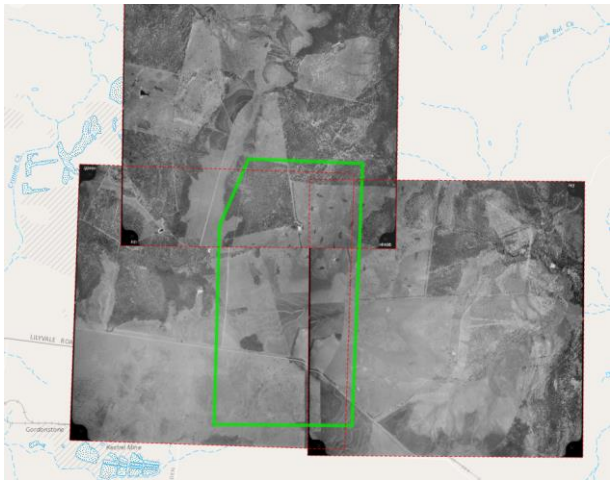


Figure 3.1: Mining leases and tenure

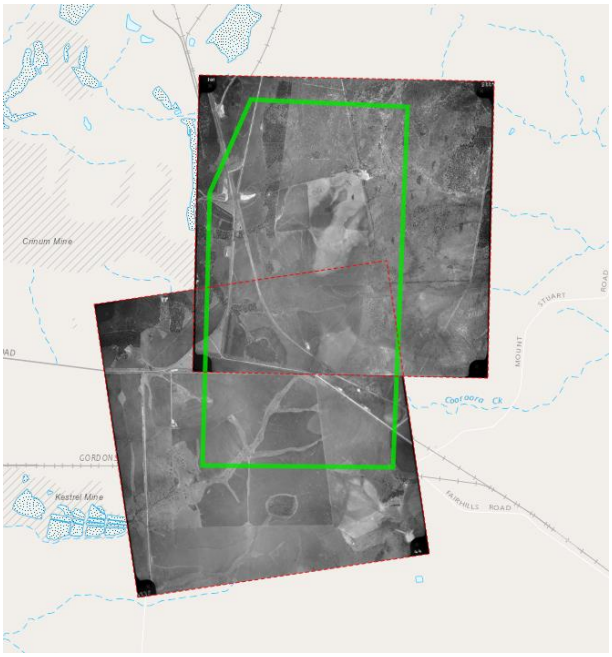


Extract 1: Historical imagery of the site in 1952

Extract 2: Historical imagery of the site in 1966



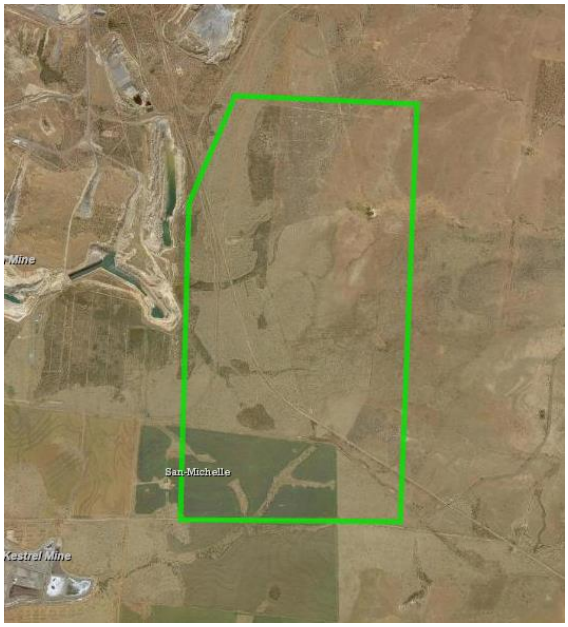
Extract 3: Historical imagery of the site in 1973



Extract 4: Historical imagery of the site in 1983

Extract 5: Historical imagery of the site in 1994

Extract 6: Historical imagery of the site in 2003



Extract 7: Imagery of the site in 2022

3.3 Climate

GCM is located within a sub-tropical, sub-humid climate with nearly half of the annual rainfall occurring in the summer months. The Bureau of Meteorology (BOM) collects climatic data across the region with the nearest Australian weather station (AWS) at the Emerald Airport (AWS 035264) located approximately 42 km from GCM. This station has data records extending from 1922 to 2022. The Average Rainfall and Maximum Temperature recorded at this AWS is provided in Figure 3.2. The average temperature varies with the highest maximum average recorded in January at 34.7□C and the lowest minimum average temperature in July at 9.1□C.

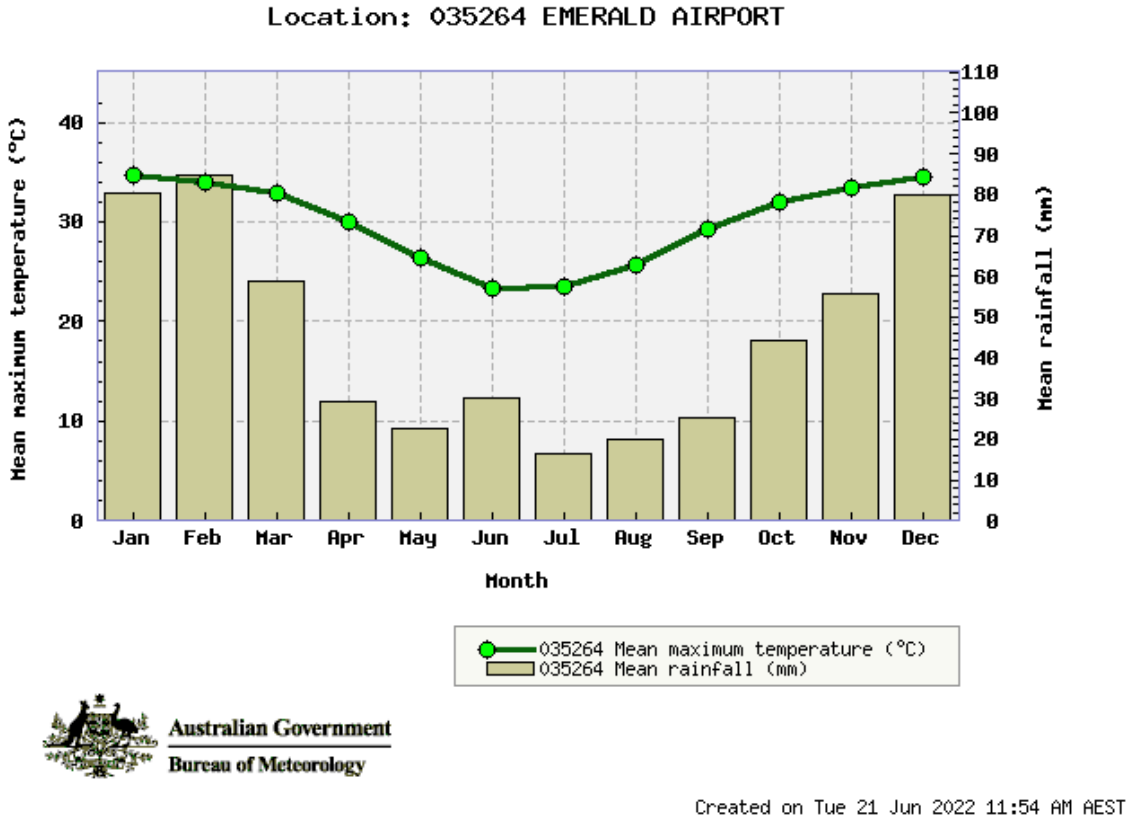


Figure 3.2: Average rainfall and maximum temperature 1922 – 2022

Overall, the annual average rainfall is 543.2 mm, the highest rainfall is seen in months December through to February, with monthly averages of over 80 mm. The average driest month is July at 16.6 mm followed by August and May, respectively. Scientific Information for Land Owners (SILO) is hosted by the Science and Technology Division of the Queensland's DES and provides a comprehensive database of Australian climate data ranging from 1889 to current. A summary of estimate average monthly rainfall and pan evaporation data from 1993 to 2022 at GCM is provide in Table 3.2. Average evaporation exceeds average rainfall in every month of the year.

Table 3.2: Average monthly rainfall and evaporation at GCM (1993 to 2022)

Month	Season	Rainfall (mm)	Evaporation (mm)
January	Wet	92	230
February	Wet	78	188
March	Wet	62	191
April	Dry	28	151
May	Dry	19	118
June	Dry	24	93
July	Dry	18	103
August	Dry	20	136
September	Dry	19	176

Month	Season	Rainfall (mm)	Evaporation (mm)
October	Wet	43	217
November	Wet	53	229
December	Wet	77	243
Annual Total		533	2,076

Modified from SILO 2023

Morning wind conditions on average are predominantly south easterly (20-30 km/hr) and easterly (10-20 km/hr). This is like the evening average which sees stronger easterly (10-30 km/hr) and some south easterly (10-20 km/hr) winds (BOM 2022) (Figure 3.1).

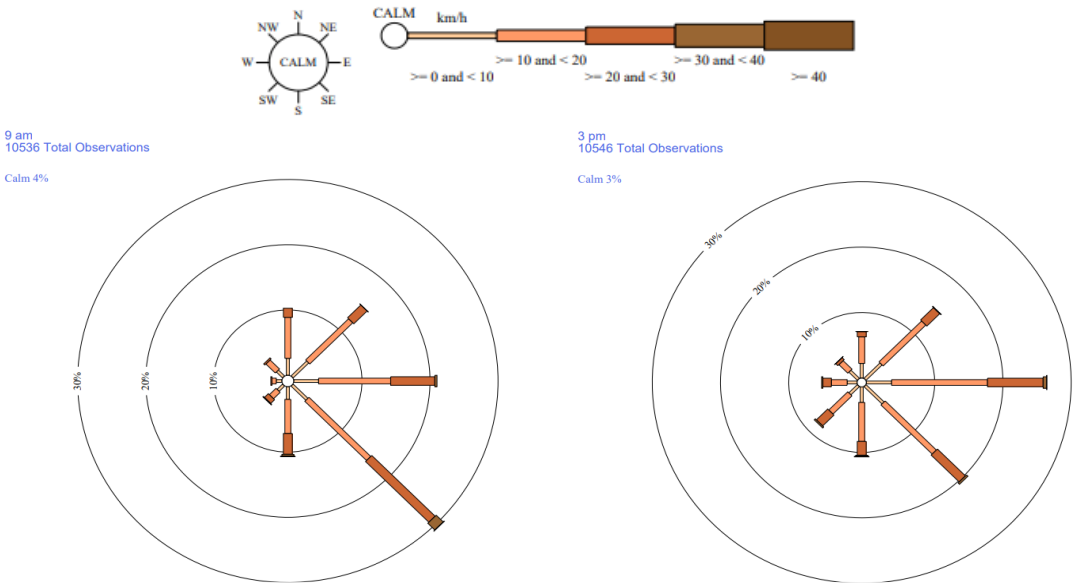


Figure 3.1: Wind conditions

3.4 Topography, Geology and Soils

3.4.1 Topography

GCM supports two predominant landforms, which include:

- Undulating Scrub Plains which are characterised by undulating plains and rises developed on sedimentary rocks, Tertiary basalt and unconsolidated sediments
- Undulating Downs which are characterised by gently undulating plains formed on Tertiary basalt, Permain shales, sandstone and unconsolidated sediments.

A ridge is present in the north-western section of M-Block that reaches a height of 240 m Australian Height Datum (AHD), with the remainder of the site ranging from 220 m AHD to 230 m AHD in elevation (GeoResGlobe, 2022). This ridge acts as a catchment divide between the Nogoa River sub-basin (western portion of M-Block) and Mackenzie River sub-basin (eastern portion of M-Block). These catchment and surface water features are summarised in Section 3.5.

3.4.2 Geology

GCM is located within the foreland, Early Permian to Middle Triassic Bowen Basin structural framework. Deposition in the Bowen Basin commenced during an Early Permian extensional phase, with the west depositing a thick succession of coals and non-marine clastics. Following rifting, there was a thermal subsidence phase extending from the mid Early to Late Permian, during which a basin-wide transgression allowed deposition of extensive coal measures. In the vicinity of the Project, sediments from the Surat Basin

have been eroded and the Bowen Basin units reside under Cenozoic cover. Sedimentation in the basin was terminated by a Middle to Late Triassic contractional event.

The Bowen Basin has vast coal resources, with major open cut and underground coal mines in the north of the basin. Large volumes of methane gas are held at shallow depths within Permian coals in the north and has potential for coal seam methane developments (Geoscience Australia, 2022).

The regional stratigraphy surrounding M-Block supports three dominant geological formations. The east and south-east are dominated by the Permian Fair Hill Formation, Fort Cooper Coal Measures (Pwt). This is a composite unit dominantly consisting of sedimentary rock with a lithology of sandstone, conglomerate, mudstone, carbonaceous shale, coal and cherty tuff. To the west and northern sections is the Late Permian German Creek Formation (Pbd), a stratified unit consisting dominantly of arenite-mudrock with a lithology of quartzose to sublabile, locally argillaceous sandstone, lithic and feldspathic sandstone, siltstone, mudstone, carbonaceous mudstone and coal. The site is traversed by stratified Late Permian McMillan Formation (Pbn) consisting dominantly of arenite-mudrock with a lithology of mudstone, siltstone and sandstone (GeoResGlobe, 2022). A figure of the surface geology and solid geology is provided in Figure 7.1 and Figure 7.2 of Appendix D.

3.4.3 Soils

The landforms discussed in Section 3.4.1 are typically associated with the following soil profiles (Department of Primary Industries, 1993):

- Undulating scrub plains
- Cracking clays
- Solodic soils
- Red brown earths
- Non-cracking clays
- Structured earths
- Undulating downs
- Black, brown and grey cracking clays
- Shallow to moderately deep cracking and non-cracking clays
- Frequently stony phases.

In 2008, GTES Pty Ltd (GTES) undertook a soil assessment of M-Block and produced report *M Block Proposed Mining Area Gregory Crinum Mine Soil and Land Suitability Study*. The sampling intensity (84 sites) of this survey as at a suitable distribution for the evaluation of topsoil resources. Prior to this survey, previous assessments applicable to the site were completed in 1991, 1997, 1999 and 2004.

The GTES survey noted that the area comprised high value agricultural land with a mixture of mid depth (60-80 cm) well-structured basaltic clay soils as well as a range of brigalow clays which include deep fertile softwood scrub soils, low lying gilgaied alluvial clays and lighter textured upland soils (GTES, 2008). It was also noted that all soil types in the area may be used for future rehabilitation. It is noted that a small proportion of the sites were mapped as Alluvial (A1 and A2).

The study described seven soil types as detailed in Table 3-3. GTES also provided recommendations regarding topsoil strip depth and preferred rehabilitation application for each of the soil types (GTES, 2008).

Table 3-3: M-Block principal soil types

Soil Type	Concept	Description of Mapping Unit	Major Soil Features
A1	ALLUVIAL Recent / active alluvial lines.	Recent alluvia mostly uniform clays with firm sandy surface with Brigalow and associated Bauhinia, Blackbutt and Leichardt Bean. Includes localised areas of thin sandy duplex with Poplar Box.	• Recent alluvia and may be quite variable • Deep, alkaline brown sandy clay • Very similar chemistry and physical attributes as A2 soil • Quite good fertility in the surface 40 cm

Soil Type	Concept	Description of Mapping Unit	Major Soil Features
			• The surface is sandy, cracking with a weak crust • Non-saline or dispersive to 40 cm depth but highly saline and sodic below 50 cm • Prone to regular erosive flooding
A2	ALLUVIAL Relic alluvial plains of Brigalow / Blackbutt with areas of Melon holes.	Flat plains of mostly cleared Brigalow and Blackbutt with some Wilga, Yellowwood and Sandalwood. A firm to hard setting sandy surface overlies stiff medium sandy clays which are coarse structured and pale coloured. Grey / brown clay in depressions of gilgai may crack.	• Deep cracking clay • The surface is cracking with a weak crust • The surface 30 cm layer is a light sandy clay which becomes coarser and heavier textured with depth • Reaction trend is neutral • Saline, sodic and dispersive by 30 cm depth • Moderate plant water storage capacity • Not very good soil for reuse in rehabilitation. Do not strip more than 20 cm
B1	BRIGALOW Lighter sandy clay soils with mixed Brigalow.	Higher lying red / brown cracking and non-cracking clay with sandy surface often with laterite gravel on firm but well drained calcium rich tertiary clay subsoils. Mixed Brigalow, Blackbutt, Bauhinia, Wilga, Poplar Box and sandalwood.	• Light sandy to medium clay to 40 cm overlies coarse brownish yellow clay • Includes a minor variant of thin red brown duplex soils along relic ridgelines • The surface is sandy, firm and may be weakly cracking • Soil reaction is alkaline • Plant available water capacity (PAWC) considered moderate (> 100 mm) • Quite good overall fertility in top 40 cm • Non saline or sodic
Ba2	BASALTIC Mid depth dark cracking clays formed on basalt.	Undulating plains up to 3% slope of mostly cleared Mountain Coolibah and Bloodwood. Soils are soft self-mulching cracking dark and red/brown clays. They have formed in-situ on basalt with a soil depth range from 50 – 80 cm to weathered basalt. Includes a variant where black basaltic clays overlain with thin sandy surface colluvial layer below red rises.	• Fertile, well structured with good soil depth • The surface is cracking with a soft granular self mulch • The entire solum to weathered basalt is good quality soil • High clay content and shrink/swell tendencies inhibits initial pasture germination • Reaction trend is alkaline • Non saline or sodic • Good PAWC (> 100 mm)
B3	BRIGALOW Dark, well-structured Brigalow softwood scrub soils.	Flat to gently undulating plains of basaltic colluvium on weathered tertiary clays. Soils are deep, well-structured and dark cracking clay of mixed Brigalow softwood scrub. Includes Yellowood and Wilga.	• Formed on basaltic colluvium over tertiary sediments • Light to medium clay to 40 cm overlies well structured dark medium heavy clay • The surface is cracking and often self mulching which may have weak crust • Soil reaction is alkaline. • PAWC considered high (> 100 mm) • Very well drained and structured soil

Soil Type	Concept	Description of Mapping Unit	Major Soil Features
B4	BRIGALOW Undulating plains of duplex and sandy noncracking clays with Brigalow, Blackbutt and Sandalwood.	Uniform non-cracking red brown clay and thin duplex with hard setting sandy clay surface overlie coarse structured sandy clays and the occasional gilgai Mostly cleared of Brigalow, Blackbutt with minor Poplar Box. Current bush and Leichhardt bean are common.	• Uniform non-cracking red brown clay and thin duplex with hardsetting sandy clay surface • Highly saline and sodic by 30 cm depth • Soil features coarse structured sandy clays and the occasional gilgai • Formed on tertiary sediments • Soil reaction is neutral becoming alkaline with depth • PAWC considered low • Fertility is reasonable
B5	BRIGALOW Melon holed Brigalow clay lowlands.	Melon holes (i.e., Gilgai > 40cm deep) make up >30% of the land surface. Depressions are dark poorly drained cracking clays which are mostly bare of vegetation. Depressions are brown noncracking clay with brigalow.	• Very poor soil in the melon holes but reasonable in areas between • Depression positions (melon holes) are > 40 cm deep and make up >30% of surface • Depressions are dark brown cracking clay, acidic, poorly drained which are mostly bare of vegetation • The mound positions are made up of lighter brown brigalow clays (B4 soil) • The depressions are highly saline and sodic from the surface and very coarsely structured • The brown non-melon hole areas are useful soil to 20 cm for rehabilitation, but depression soils are not recommended for reuse on rehabilitation due to substantial physical and chemical restrictions

Source: GETS 2008

3.5 Water Resources

M-Block is located within the Fitzroy Basin and is at the headwaters of two sub-basins, specifically the Mackenzie River and the Nogoa River (Figure 3.2). The Mackenzie River sub-basin is on the far eastern boundary of M-Block with the Nogoa River sub-basin is on the western boundary of M-Block. This also corresponds with the sub catchments for the site, the Upper Mackenzie is on the far eastern boundary and the Nogoa is on the western boundary of the site.

There are three unmapped ephemeral watercourses under the *Water Act 2000* (Qld) that run into the site. Of these unmapped watercourses, there are two standalone watercourses, however, are potentially tributaries of Crinum Creek (west of M-Block), especially during wet events and one watercourse is Cooroora Creek. There are also a number of unmapped watercourses surrounding the area including one watercourse to the south of the site which runs into Crinum Creek, one watercourse to the south of the site which runs into Cooroora Creek. Cooroora Creek ultimately runs into the Mackenzie River approximately 45 km east of the site and Crinum Creek ultimately runs into Nogoa River approximately 21 km south of the site (Figure 3.2 and Table 3.4).

The other main waterbody within M-Block is a large farm dam to the central east. This appears to have been constructed on a minor drainage line that flows to the east and now retains water for extended periods following rainfall. There are areas of extensive erosion associated with the dam wall.

The environmental values and water quality objectives for the Mackenzie River sub-basin and the Nogoa River sub-basin are detailed within the *Environmental Protection (Water) Policy 2009 Mackenzie River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Mackenzie River Sub-basin* (EPP Water Mackenzie) and the *Environmental Protection (Water) Policy 2009*

Nogoa River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Nogoa River Sub-basin (EPP Water Nogoa), respectively.

Table 3-4: Watercourse sequence (adapted from Table 6.1 of KCB 2022a)

Sub-Catchment	Watercourse	Location
Mackenzie River (Fitzroy Basin)	Cooroora Creek	Within M-Block
	Minor Watercourses and Tributaries	Within M-Block (north-east); South-east of M-Block
Nogoa River (Fitzroy Basin)	Minor Watercourses and Tributaries	Within M-Block; West, southwest of M-Block
	Crinum Creek	Within GCM, west of M-Block
	Minor Watercourses and Tributaries	Within Kestral Mine

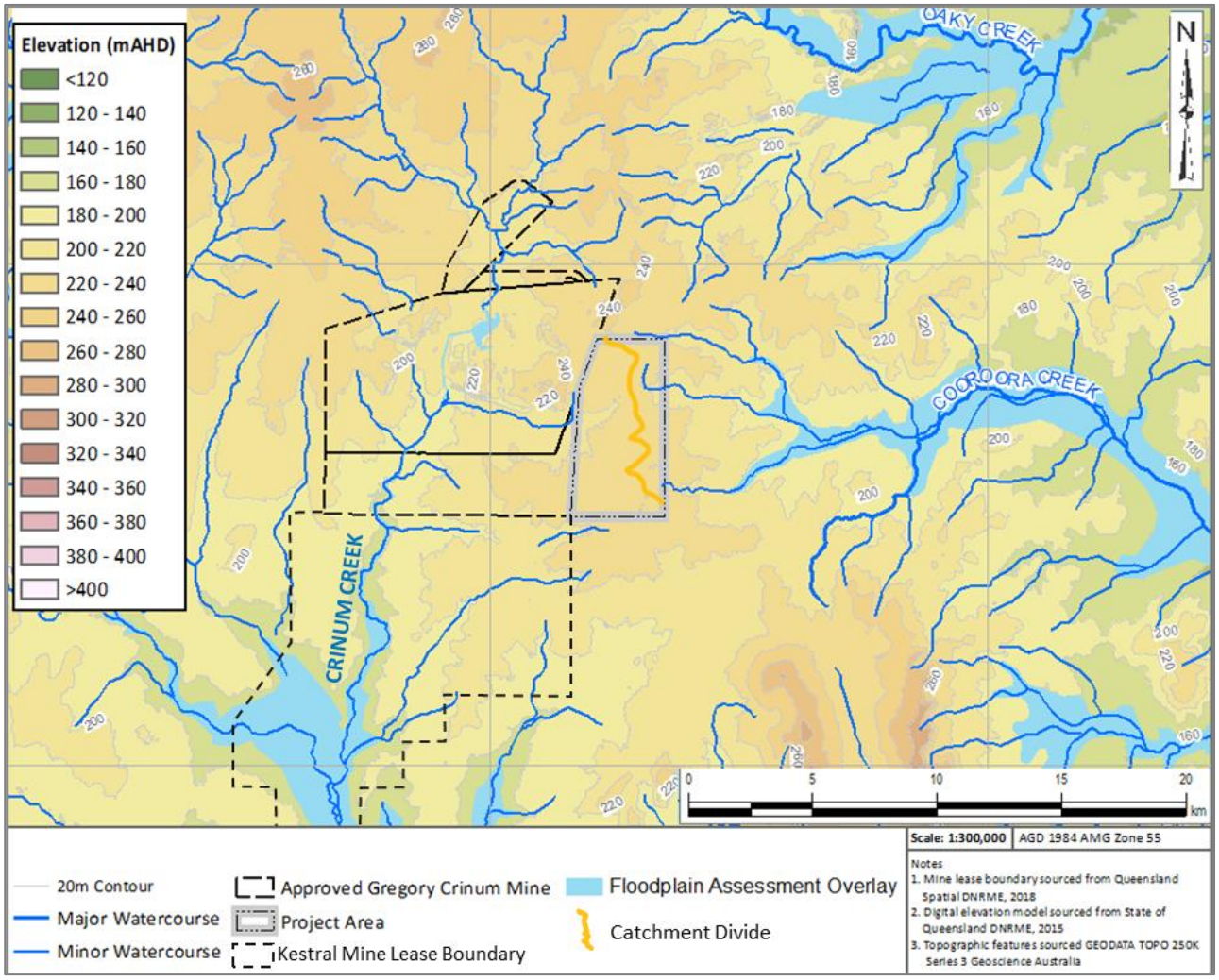


Figure 3.2: Watercourse, flood plain assessment area and catchment divide / watershed boundary

Adapted from KCB 2022a

The site is mapped 2.5 km west of the Flood Hazard Balance layer on the *Central Highlands Regional Council Planning Scheme 2016*. The layer aligns with Crinum Creek to the west and Cooroora Creek to the east. The site is also mapped within the Flood Hazard Area – local government flood mapping area, with the Flood Hazard Balance layer coinciding with the flood hazard area – level 1 – Queensland floodplain assessment overlay on the State Assessment Referral Agency Development Assessment Mapping System.

Further information on M-Block water resources, including groundwater and surface water, is provided in Section 5.

3.6 Biodiversity

3.6.1 Flora

3.6.1.1 Vegetation Communities

Two Threatened ecological communities (TECs) scheduled under the EPBC Act have been recorded within the M-Block extension area:

- Brigalow (*Acacia harpophylla* dominant and codominant), (Brigalow TEC).
- Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin (Grassland TEC).

3.6.1.2 Brigalow (*Acacia harpophylla* dominant and codominant)

Brigalow (*Acacia harpophylla*) is one of the most abundant tree species in M-Block. *A. harpophylla* is either dominant in the tree layer, or codominant with other species, notably Belah *Casuarina cristata*, other species of Acacia or Eucalyptus. The vegetation in M-Block is Brigalow regrowth with species composition and structural elements broadly typical of one of the identified Queensland RE's (although species density may be reduced). This can be assumed to be the case where it has been at least 15 years since it was last comprehensively cleared (not just thinned); unless direct evidence proves otherwise.

This community is listed as endangered under the EPBC Act and will be directly impacted by the proposed action. Further detail is provided in Section 4.1.1 and Appendix E.

3.6.1.3 Natural Grasslands of the Queensland Central highlands and Northern Fitzroy Basin

This endangered TEC is distributed largely within the Central Highlands and northern Fitzroy River Basin regions of Queensland. Occurrence is mainly associated with fine textured vertosols that are cracking or self-mulching. It usually occurs on flat ground or gently undulating rises. The ground layer is typically dominated by perennial native grasses and contains at least three of the relevant indicator native species.

The Grassland TEC will be directly impacted by the mining operations. Further information of the impact of the project on this TEC is provided in Section 4.1.2.

3.6.2 Regulated Vegetation

Five Regional Ecosystems (REs) are mapped as occurring within M-Block by the *Queensland Herbarium Regional Ecosystem Mapping* (Version 12: 2021). M-Block supports Category X (non-remnant) vegetation, Category B (remnant) vegetation, Category C (high-value regrowth) and Category R (reef regrowth watercourse) vegetation. The REs present on M-Block are detailed in Table 3-5.

Table 3-5: Regional ecosystems that occur within M-Block

Regional Ecosystem	Status*	Description
11.8.11	Of Concern	*Dichanthium sericeum* grassland on Cainozoic igneous rocks.
11.8.1	Least Concern	*Eucalyptus laevopinea* tall open forest on Cainozoic igneous rocks. Elevated plateaus.
11.8.5	No Concern	*Eucalyptus orgadophila* open woodland on Cainozoic igneous rocks.
11.9.1	Endangered	*Acacia harpophylla-Eucalyptus cambageana* woodland to open forest on fine-grained sedimentary rocks.
11.10.7	No Concern	*Eucalyptus crebr*a woodland on coarse-grained sedimentary rocks.

* *Vegetation Management Act 1999* (Qld)

3.6.3 Fauna

GCM is located in the Brigalow Belt Bioregion, one of 13 bio-geographical areas of Queensland. The Brigalow Belt Bioregion extends from the Queensland – New South Wales border to Townsville. Encompassing approximately 3.6 million hectares, this bioregion consists of sub-humid and semi-arid environments and is contained almost entirely within the 500 to 750 mm rainfall isohyets.

Extensive clearing has occurred in the Brigalow Belt for agriculture purposes. Remnant Brigalow (*Acacia harpophylla*) woodland and open poplar box woodland provide habitat for native flora and fauna species.

Several ecological assessments have been previously undertaken within the current MLs, including parts of the M-Block area. Cardno conducted terrestrial ecology assessments during the Spring and Post-Wet season of 2021 and further assessments in early 2022 to investigate the nature, extent and condition of MNES within M-Block.

3.6.3.1 Key Habitats

Past and continuing land disturbing activities within M-Block impact the availability and quality of fauna habitat within the area. Some of these ongoing impacts include clearing of native vegetation, invasion by weed and pest fauna species, and grazing impacts. It is noted that there are areas of higher habitat value within M-Block. The dominant habitat types identified during the ecological investigations undertaken can be broadly described as:

- Woodlands to Open Forest.
- Grasslands – native and introduced pasture.
- Natural and man-made watercourses and waterbodies.

Woodland and Open Forest

The Woodland and Open Forest habitat within M-Block is typically dominated by remnant and regrowth Brigalow with scattered *Eucalyptus orgadophila*, and *E. cambageana* particularly adjoining the western boundary of M-Block. The more complex and diverse fauna habitat tends to be associated with the patches and strips presently mapped as remnant or High Value Regrowth (HVR) under the Queensland *Vegetation Management Act 1999* framework. These areas also supported higher levels of micro-habitat, most particularly areas of fallen timber and hollow-bearing trees which provide potential habitat for a range of reptiles, smaller ground-dwelling mammals and hollow-dependant fauna. The open forest structure in many locations which, despite having lower habitat complexity, was still noted to provide a reasonable matrix of habitat that could be exploited by a range of birds, reptiles and the more mobile mammals.

At both local and landscape scale the patches of mapped remnant and HVR Woodland and Open Forest are quite large and, by virtue of their size, offer a valuable resource and refuge for fauna, regardless of condition. The Woodland to Open Forest habitat provides habitat that could support a range of conservation significant fauna, with the Brigalow with scattered gilgai and fallen timber providing suitable habitat resources for reptiles and ground-dwelling mammals. However, despite extensive surveys over a period of nearly 15 years there have been no sightings of conservation significant fauna, with the exception of the Squatter Pigeon, within M-Block or surrounds.

Grasslands

Areas of native grassland, including those areas mapped as supporting the Grassland TEC and grassland habitat dominated by introduced grasses such as Buffel grass all provide habitat for a high diversity of perennial grass species, including the EPBC Act listed King Bluegrass. This habitat type is widespread and occurs in a matrix with areas of sparse open woodland across much of M-Block. Despite the dominance of introduced grasses in certain locations, the Grassland habitat still provides valuable foraging and movement habitat for native fauna. Granivorous bird species were commonly observed exploiting these resources, particularly where they occur within a matrix of shrubby Acacia and Eucalypt woodland, which provides refuge from predators.

The Grassland habitat is most likely to provide some foraging resources for the conservation significant Squatter Pigeon. It has been recorded within M-Block previously and was most recently observed by Cardno, now Stantec in 2022 foraging beside an access road that traverses a portion of the Grassland TEC. For this species in particular, the Grassland habitat where it occurs in close proximity to the woodland areas surrounding ephemeral and permanent water sources are likely to be of overall greater value. These locations tend to provide a better habitat matrix in the ground layer with tussock grasses interspersed with areas of bare ground which is more suited to foraging, with the nearby woody vegetation providing cover and movement opportunities.

Watercourses and Waterbodies

The main watercourse and smaller drainage lines present within M-Block are surrounded by woody riparian vegetation with a width of approximately 100 m. This is dominated by Brigalow and occasional *Eucalyptus orgadophila* with a mixed ground layer of native and introduced grasses that has been partially impacted by grazing, resulting in predominantly bare ground. Micro-habitat in the form of woody debris and gilgai are

located throughout this area as well. During both survey periods, riparian areas supported one of the most diverse assemblages of bird species.

The large farm dam to the central east appears to have been constructed on a minor drainage line that flows to the east and now retains water for extended periods following rainfall. There is limited native vegetation, but this has not substantially reduced the value to native fauna with a wide range of waterbirds recorded here along with hollow-nesting and roosting avian species.

3.6.4 Threatened Species

Key areas of habitat are the woodlands and the fringing grassland areas particularly where they are associated with the farm dam in the central east and the ponded section of the waterway on the western part of M-Block. For Short-beaked echidna (*Tachyglossus aculeatus*) and Squatter Pigeon (*Geophaps scripta scripta*) both localities provide potentially suitable foraging and breeding habitat where it was noted the ground layer habitat matrix provides areas of tussock grass interspersed by bare ground and some gravelly soils, particularly near the farm dam. The past recorded observation of Squatter Pigeon was within the active rail corridor, which based on recent observations, should also be considered as suitable habitat as it provides the same matrix of habitat described above.

As part of the referral of the Project it was noted that the M-Block area also provides habitat resources to potentially support other conservation significant fauna. It was noted that the Brigalow woodland and open forest, particularly to the west of M-Block supports an overarching vegetation community that is known to be used by species such as the Yakka Skink (*Egernia rugosa*), Dunmall's Snake (*Furina dunmalli*) and Ornamental Snake (*Denisonia maculata*). Suitable micro-habitat also exists for these species including the presence of soil cracks, piles of woody debris and a matrix of ground habitat comprising grass, bare earth and leaf litter or other coarse litter. However, it was noted that despite repeated surveys over approximately 15 years, none of these species or signs of their occupation have been observed. As such the overall likelihood that these species occur within M-Block but have remained undetected is low.

The Koala (*Phascolarctos cinereus*) has not been recorded within M-Block, with the most proximate record made in 1996 and located approximately 25 km southeast. As such, despite some areas of suitable foraging habitat, primarily along the western and southern parts of M-Block, the overall likelihood that this species occurs within M-Block is low but remains possible. Additionally, it is noted that most of M-Block provides suitable movement habitat for this species and could provide 'stepping-stone' habitat for this species as part of movements through the broader landscape.

Notwithstanding the above, the PER Guidelines noted in Section 2.1 that further justification was required for the conclusion that they do not occur in the area and will not be impacted by the proposed Action. Cardno, now Stantec undertook further assessments in 2022, primarily focussed on detailed habitat quality assessments, supported by further targeted surveys within the M-Block area to address this requirement. The outcome of these assessments has been presented in Appendix E. These assessments did not find any further evidence of the Brigalow reptiles noted above, or the Koala, occurring within the M-Block area. Furthermore, with respect to habitat quality it was noted that:

- M-Block provides, generally, areas of Low to Medium quality habitat for all Brigalow Reptiles assessed.
- For the Koala, M-Block provides potential movement habitat of moderate quality that is dominated by Ancillary Koala Habitat trees and few to no Primary Koala food trees within the M-Block impact area.

M-Block does not provide suitable habitat resources for the Greater glider (*Petauroides volans*) as it does not provide an abundance of Eucalypt species which is required for foraging. Further, despite the presence of some hollow-bearing trees within M-Block the size and age of the trees and the overall abundance of suitable live denning trees does not meet with the expected requirements for this species, noting that in southern Queensland it has been reported that this species required at least 2 to 4 live den trees per hectare of habitat. Finally, the degree to which the immediate landscape has been fragmented and the length of time since the fragmentation has occurred greatly reduces the likelihood that this species would move from areas of potentially suitable habitat to within M-Block.

Despite not being recorded by any surveys within M-Block and a lack of proximate records for either species, it is recognised that both the Grey-headed flying fox (*Pteropus poliocephalus*) and the Red goshawk (*Erythrotriorchis radiatus*) may occur in the broader locality as part of seasonal movements (Appendix E).

Over the course of the surveys one threatened flora species was identified, the King Bluegrass (*Dichanthium queenslandicum*). This species is listed as endangered under the EPBC Act and Vulnerable under the *Nature Conservation Act 1992* (NC Act), and as such, it is considered both an MNES and a matter of state

environmental significance (MSES). Large numbers of this species were encountered in numerous locations in M-Block, particularly in the western half, mostly within the area mapped as RE 11.8.5 / 11.8.11.

Further detailed information on threatened species is provided in Section 0 and Appendix E.

The mining operation has been designed to minimise impacts on fauna and residual impacts are compensated by the provision of Biodiversity Offsets.

The *EPBC Act Environmental Offsets Policy 2012* outlines the Australian Government's approach to the use of environmental offsets under the *Environmental Protection Biodiversity Conservation Act 1999*.

The overarching test of the *EPBC Act Environmental Offsets Policy 2012* is that suitable offsets must deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environment law and affected by the proposed action. Sojitz adheres to this policy.

3.6.5 Groundwater Dependent Ecosystems

Groundwater-dependent ecosystems (GDEs) are ecosystems that rely upon groundwater for their continued existence. GDEs may be either completely dependent on groundwater or partially dependent on groundwater with only intermittent access to groundwater to supplement their water requirements.

Initial GDE desktop mapping undertaken by Klohn Crippen Berger (KCB) indicated the occurrence of potential terrestrial GDEs (TGDEs) within M-Block (refer to Section 7.11 of Appendix D). The mapped potential TGDEs occur in areas away from watercourses, around the perimeter of a change in vegetation. The TGDEs are described as sourcing groundwater from the Tertiary basalt unit.

Further desktop assessments (Cardno now Stantec 2022) and field-based assessments (3D Environmental 2023) were completed to assess the potential for potential TGDE to accessing groundwater for their water requirements. Both of these assessments, provided in Appendix G and Appendix H respectively, found that the area of mapped potential TGDE is not reliant upon groundwater for their survival.

With regards to stygofauna, the two surveys completed within and adjoining M-Block to date have found that M-Block does not appear to support significant stygofauna communities (Cardno now Stantec 2022 and 4T Consultants 2022). A single species of stygofauna was found during the most recent surveys completed by 4T in a bore that is located outside the M-Block zone of influence (Appendix N).

As identified in Stantec's Ecohydrological Conceptual Model Report (Appendix F), the predicted groundwater impacts because of mining operations are not likely to result in any significant impacts to groundwater dependent MNES or stygofauna communities.

A detailed description of the GDEs and groundwater impacts is provided in Section 5.4 of this report. Reports relating to GDE may be found in Appendix G and Appendix H and reports relating to Stygofauna in Appendix M and Appendix N.

3.7 Climate Change

Sojitz Group agree with the international consensus that greenhouse gas emissions are a global issue that require a global solution. However, the reduction of greenhouse gas emissions in one country which results in the increase in greenhouse gas emissions in another country, or carbon leakage, can result in an increase of global emissions.

Sojitz had previously committed to exiting thermal coal holdings by more than 50% by 2030. This has now been brought forward to 2025. The company is now committed to exit thermal coal and oil businesses by 2030.

The M block expansion project produces coking coal which is used in the manufacture of steel and not thermal coal as used for the generation of power. There are alternative coking coal resources globally producing lower grade coals which would be developed to feed existing steel mills instead. If M block coal was not made available, the steel makers would need to source similar coal (high fluidity) from other countries. Similar high fluidity/low ash premium coking coal sourced from countries like Russia are significantly higher in methane emissions and sulphur content and therefore increase overall fugitive emissions. Should that occur, it is estimated that the amount of CO2 produced from blast furnaces that

currently use Australian coking coals may increase by 7 to 25 million tonnes per annum or 0.8 to 2.8 per cent.[2]

Any significant habitat loss to be compensated for by the provision of Biodiversity Offsets under legislative requirements. To enable the ongoing viability and maximise the ecological gain of the offset sites, these locations have been selected on lands within the mining lease with habitat connectivity. This ensures that the MNES values being protected will benefit from and provide benefit to other areas of important habitat.

Offsets are not for short duration and in this instance have been offered on the project site. As these offsets are significantly higher than the expected loss and disturbance of habitat impacted and in the same locality these are to be effective.

[2] *Minerals Council of Australia, 2020. Best In Class: Australia's Bulk Commodity Giants. Australian Metallurgical Coal: Quality Sought Around the World.*

4 Listed Threatened Species and Ecological Communities

4.1 Description

The following MNES have been listed as controlling provisions due to the possible impact from M-Block activities.

4.1.1 Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community

Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community was listed as an Endangered threatened ecological community under the EPBC Act in 2001. In Queensland, the Brigalow ecological community is defined by reference to 16 RE, all of which are listed as Endangered under the Queensland *Vegetation Management Act 1999* (TSSC 2001). The Brigalow ecological community occurs over a vast area in semi-arid eastern Australia. In Queensland, this ecological community is found in the Brigalow Belt North, Brigalow Belt South, Mulga Lands, Darling Riverine Plains and Southeast Queensland IBRA bioregions (DoE 2013).

This ecological community is characterised by the presence of Brigalow (*Acacia harpophylla*) as one of the three most abundant tree species (Butler 2007). Brigalow may be dominant in the canopy layer or co-dominant with other species including Belah (*Casuarina cristata*), *Eucalyptus* species or other *Acacia* species within an open forest to open woodland (Butler 2007). In Queensland, the soils within this ecological community are generally cracking clays where Brigalow is dominant (Benson et al. 2006).

The original extent of the Brigalow ecological community in Queensland has been estimated at over 7.3 million hectares. Approximately 8% remained in 2003 (Butler 2007). Major identified threats include clearing, fire, inappropriate grazing and invasion of exotic plant species and feral animals (Butler 2007).

4.1.2 Natural grasslands of the Queensland Central Highlands and northern Fitzroy Basin ecological community

The Natural grasslands of the Queensland Central Highlands and northern Fitzroy Basin ecological community are native grasslands composed of a mix of perennial native grasses and forbs. The primary indicators are the native grasses based on their prominence and utility. This ecological community occurs on fine textured soils derived from basalt or fine-grained sedimentary rocks, on flat or undulated rises. Tree canopy is typically absent otherwise no more than 10% of projective crown cover (TSSC 2009). This ecological community is restricted to Queensland extending from Collinsville in the north to Carnarvon National Park in the south (DEWHA 2008).

Species dominance and cover may fluctuate seasonally due to climatic factors (Wilson et al 2002). Bluegrass communities have different climatic requirements to Curly Mitchell Grass and so the abundance can shift depending on which species the climate is favouring (Austin and Williams, 1988). The major identified threats to this ecological community include grazing, cropping and pasture improvement; invasive plants and animals; mining activities; road construction and other infrastructure (DEWHA 2008).

4.1.3 King Bluegrass (*Dichanthium queenslandicum*)

King Bluegrass (*Dichanthium queenslandicum*) is a perennial grass belonging to the Poaceae family. It is listed as Endangered under the EPBC Act and listed as Vulnerable under the Queensland *Nature Conservation (Plants) Regulation 2020*. King Bluegrass occurs on black cracking clay in tussock grasslands generally associated with other bluegrass species (*Dichanthium* spp. and *Bothriochloa* spp.) (TSSC 2013). Flowers have been recorded year-round particularly from March and after heavy rain. King Bluegrass is endemic to central and southern Queensland where it occurs in three distinct populations: Hughenden district (one record); from Nebo to Monto and west to Clermont and Rolleston; and Dalby district, Darling Downs. Recently, a specimen was recorded in 2018, 110 km north of Charters Towers (Queensland Herbarium 2021).

Identified threats include loss of habitat through agricultural and mining activities, road construction and other infrastructure developments (DSEWPC 2013). Further threats include grazing and invasion from weeds including Parthenium (*Parthenium hysterophorus*) and Buffel grass (*Cenchrus ciliary*). Despite its sensitivity to grazing, King Bluegrass persists in lightly grazed situations and roadsides (Fensham 1999). Only small remnants of the endangered bluegrass grasslands remain, with a 68.8% reduction in area (Accad et al. 2008).

4.1.4 Squatter Pigeon (southern) (*Geophaps scripta scripta*)

The Squatter Pigeon (southern) (*Geophaps scripta scripta*) is a medium-sized, ground-dwelling pigeon that is listed as Vulnerable under the EPBC Act. The known distribution of the Squatter Pigeon extends south from the Burdekin-Lynd divide in the southern region of Cape York Peninsula to the Border Rivers region of northern New South Wales, and from the east coast to Hughenden, Longreach and Charleville, Queensland (TSSC 2015).

The Squatter Pigeon (southern) feeds on seeds in the grassy understorey of open eucalypt woodland and is nearly always found in close proximity to permanent water bodies including waterholes and rivers. They nest on the ground and lay a clutch of two eggs under or amongst vegetation (Garnett et al. 2011). The population declined rapidly in the late 19th and early 20th centuries, with the near disappearance of the subspecies in New South Wales being attributed to overgrazing and vegetation clearing (Garnett and Crowley 2000). Further threats include predation by foxes (*Vulpes vulpes*) and cats (*Felis catus*) and the spread of exotic grasses including Buffel grass (*Cenchrus ciliaris*) which can be exacerbated by intense grazing (Garnett et al. 2011; Fensham et al. 2015).

4.1.5 Koala (*Phascolarctos cinereus*) combined populations of Queensland, New South Wales and the Australian Capital Territory

The Koala (*Phascolarctos cinereus*) is an arboreal, medium-sized marsupial with a stocky body, large rounded ears, and sharp claws. In 2012, the combined Koala populations of Queensland, New South Wales and the Australian Capital Territory (the Listed Population) were determined to be a species for the purposes of the EPBC Act. The Koala population was sub-divided due to substantial differences in conservation status and management across the species range (DAWE 2022). In February of 2022, the Koala (*Phascolarctos cinereus*) combined populations of Queensland, New South Wales and the Australian Capital Territory was listed as Endangered under the EPBC Act. The Koala is endemic to Australia and its range is widespread. The Listed Population has a patchy distribution which ranges from the coastal and inland areas of Queensland north to the Herberton area and extending westwards into the hotter and dryer semi-arid climates of central Queensland, New South Wales and the Australian Capital Territory (DAWE 2022).

Koalas are nocturnal folivores with a highly specialised diet of Eucalypt leaves from a limited variety of *Eucalyptus, Corymbia* and *Angophora* species (Melzer & Tucker 2011). This species generally occurs in forests and woodlands dominated by Eucalypt species and will spend a substantial amount of time moving along the ground between shelter and food trees, particularly during breeding season (September to February) (Melzer et al. 2000). A major identified threat to the Koala is climate change due to the increased frequency and intensity of drought, high temperatures and bushfires (DAWE 2022). Further threats include disease (koala retrovirus and chlamydia), habitat loss due to vegetation clearing, mining and fatal encounters with vehicles and dogs (DAWE 2022).

4.1.6 Yakka Skink (*Egernia rugosa*)

The Yakka Skink (*Egernia rugosa*) is a large, terrestrial skink that grows to 40 cm in length. It is currently listed as Vulnerable under the Queensland NC Act and the EPBC Act. This species is endemic to Queensland with a patchy distribution (DAWE 2014a). The core population is within the Mulga Lands and Brigalow Belt South bioregions, with other populations scattered throughout the Brigalow Belt North and Einasleigh Uplands bioregions, extending north to southern Cape York Peninsula. Recent surveys have also recorded populations along the Queensland and New South Wales border (TSN 2008).

The Yakka Skink inhabits open dry sclerophyll forest or woodland, taking refuge amongst dense ground vegetation, hollow logs, beneath rocks or other cavities formed in soil-bound root systems of fallen trees. They have also been known to excavate burrows beneath logs or low vegetation or occupy rabbit warrens in areas of cleared land (TSN 2008; Cogger 2000; Wilson and Knowles 1988). The Yakka Skink is extremely secretive and will not often travel far from their shelter site (Wilson 2003). Identified threats to the Yakka Skink includes past broadscale land clearing and degradation for agricultural use or urban development,

inappropriate roadside management, removal of woody debris and rock microhabitats, ripping of rabbit warrens and predation by feral animals (TSN 2008).

4.1.7 Dunmall's Snake (*Furina dunmalli*)

Dunmall's Snake (*Furina dunmalli*) is a small to medium sized venomous snake growing to a total length of 60 cm (Cogger 2000). This species is listed as Vulnerable under the EPBC Act and Queensland's NC Act. In Queensland, Dunmall's Snake distribution extends from Yeppoon and the Expedition Range in the north, to Oakey, Glenmorgan and Inglewood in the south (DAWE 2014b).

Dunmall's Snake occurs in open forest, particularly Brigalow (*Acacia harpophylla*) forest and woodland growing on floodplains of deep-cracking clay soils (Cogger et al. 1993). The distribution of this snake is associated with the Endangered Brigalow (*Acacia harpohylla* dominant and co-dominant) TEC (DAWE 2014b). The ecology of this species is not well known but captive populations suggest it is a nocturnal species and will use deep soil cracks and other cavities or fallen timber as refuge sites (DERM 2007). The major identified threat to Dunmall's Snake is past broadscale land clearing and habitat modification for agriculture, crop production and urban development. Overgrazing by stock is also a recognised threat as well as drainage of swamps and predation by feral animals (DAWE 2014b).

4.1.8 Ornamental Snake (*Denisonia maculata*)

The Ornamental Snake is a venomous snake growing to 50 cm in length. It is listed as Vulnerable under the EPBC Act and Queensland's NC Act. In Queensland, this species occurs within the drainage system of the Fitzroy and Dawson Rivers (Cogger et al 1993). The Ornamental Snake prefers woodlands and open forests which are associated with moist areas, particularly gilgai mounds and depressions. This species is known to inhabit floodplains, undulating clay pans and along the margins of lakes, swamps and other watercourses (DAWE 2014c). The distribution of this snake is associated with the Endangered Brigalow (*Acacia harpohylla* dominant and co-dominant) TEC.

The diet of the Ornamental Snake is almost exclusively frogs which makes them susceptible to being lethally poisoned by cane toads (Phillips et al 2003). Other identified threats include past broadscale land clearing and habitat degradation, destruction of wetland habitat by feral pigs (*Sus scrofa*), destruction of frog habitat and direct competition for their food resources (DAWE 2014c).

4.2 Desktop Analysis

Stantec completed a comprehensive review of background information prior to field surveys conducted in 2020/2021 (Appendix I) and 2022 (Appendix E). This desktop assessment involved collating and reviewing relevant information concerning threatened flora, fauna and ecological communities that are likely to occur in M-Block and surrounds. The purpose of the desktop analysis was to:

- Refine a list of threatened species/ecological communities to be targeted during the surveys to those species which had the highest likelihood of occurring in M-Block
- Source available information concerning the specific habitat requirements of the threatened species as well as to aid in identifying the target species
- Source available information concerning the key diagnostic characteristics and condition thresholds of target threatened ecological communities.

The key desktop findings are presented in

Table 4-1. See Appendix I (2021) and Appendix E (2022) for the detailed methodology and full results.

Table 4-1: Summary of desktop analysis findings

Matter	Findings
M-Block Habitat	• The study area assessed during Austecology (2009) surveys was not found to support high quality habitat or large patches of habitat in respect to fauna biodiversity and/or threatened species. • The patches of higher quality fauna habitat that do exist within the site, include: – small patches of timbered native vegetation communities, mainly within the western half of M-Block – larger patches of Brigalow (*Acacia harpophylla*) regrowth with associated gilgai relief in north-east – small stands of older Brigalow along the seasonal drainage channel in south; and – the larger patch of Brigalow and Casuarina cristata shrubby open forest within in the south-west. • The BAAM surveys in 2011 only assessed a small portion of the M-Block extension area. The survey findings suggest that this area was heavily impacted by weeds, in particular a dense ground cover of Buffel grass (*Cenchrus ciliaris*). This was found to substantially reduce the habitat values present in that portion of the site, particularly for Squatter Pigeon. • Key findings by Ecoserve and LAMR (2005) was that there is an absence or scarcity of key habitat resources throughout the GCM leases. Important microhabitat features such as thick leaf litter drifts, ground logs, trees with decorticating bark, and hollow-bearing trees are either absent, uncommon or rare.
Threatened Ecological Communities (TEC)	• Two TECs were listed as potentially occurring within or near M-Block by the EPBC Act Protected Matters Search Tool. • Cardno (2021) conducted a likelihood of occurrence assessment and determined the Brigalow (*Acacia harpophylla* dominant and codominant) ecological community is known to occur within M-Block and the Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin ecological community is likely to occur. • Both TECs are listed as Endangered under the EPBC Act.
Threatened Flora	Cardno (2021) determined three threatened flora species likelihood of occurrence within M-Block was 'possible'. This included: • King Bluegrass (*Dichanthium queenslandicum*), which is listed as Vulnerable under the NC Act and Endangered under the EPBC Act • Bluegrass (*Dichanthium setosum*), which is listed as Vulnerable under the EPBC Act • Finger panic grass (*Digitaria porrecta*), which is listed as Near Threatened under the NC Act.
Squatter Pigeon (*Geophaps scripta scripta*)	• The Squatter Pigeon was recorded within M-Block by Austecology (2009).
Yakka Skink (*Egernia rugosa*)	• There are no records of the Yakka Skink within M-Block. There are two records on ALA approximately 50 km from M-Block.
Ornamental Snake (*Denisonia maculata*)	• There are no records of the Ornamental Snake within M-Block and no proximate records exist within a 25 km radius. • Six records exist on ALA and Wildnet (2022) databases within a 50 km radius. • Staff at Kestrel Mine, approximately 10.5 km southwest of M-Block, have made an unconfirmed observation of the Ornamental Snake near the reject disposal area however no individuals were observed during AARC's targeted surveys in 2002 (AARC 2002).
Dunmall's Snake (*Furina dunmalli*)	• There are no records of Dunmall's Snake within M-Block and no proximate records exist within a 50 km radius.
Koala (*Phascolarctos cinereus*)	• There are no Koala records within M-Block. Mine staff have reported sightings along Crinum Creek, approximately 10 km to the west of M-Block. • The most proximate Wildnet Koala record is from 1992 and approximately 8.5 km east of M-Block. There is another record from 1996 approximately 10 km southeast of M-Block. • There are 11 further records on ALA and / or Wildnet within 50 km of M-Block.
Short-beaked Echidna	• In the public notification period, concerns were raised about the Short-beaked echidna

Matter	Findings
(*Tachyglossus aculeatus*)	• The short beaked Echidna (Tachyglossus aculeatus) is not listed as a Commonwealth listed species however it is listed as a Special least concern (SL) under the Queensland Nature Conservation Act 1992.

4.3 Survey Effort

A number of previous ecological field assessments have been undertaken within the GCM, including parts of the M-Block area. The survey effort of these historical assessments is summarised in Table 4-2. The survey effort from the Cardno/Stantec contemporary ecological field assessments within M-Block is also summarised in Table 4-2. The 'survey areas' assessed by other consultants as part of earlier assessments have been illustrated within Appendix E.

One public comment was concerned about the methodology, and thus authority, of the surveys, so for further clarity, these concerns are addressed here. Contemporary seasonal surveys have been completed over the project area over a number of years. Specifically, the spring surveys were completed in October 2020 and post-wet surveys were completed in April 2021. In the period between these two surveys approximately 200 mm of rainfall was recorded in Emerald, while this may be below longer-term averages it is not considered to be representative of an extended dry period.

Furthermore, the surveys completed in May 2022 which were targeted at the detection of certain species, including the Squatter pigeon, Koala and Queensland Bluegrass, were completed prior to and immediately following a period of notable rainfall in the region, with over 100mm falling over a three-day period between the surveys. Combined, the contemporary survey periods have taken into consideration both seasonality and a range of climatic conditions such that the results are expected to provide a representative sample of the species considered likely to utilise the site.

Added to this is an extensive range of surveys completed by others over the site, from 2005 to 2012. These surveys have also been completed over a range of seasons and would consider climatic variability.

Table 4-2: Historical and contemporary field assessments conducted within current mining leases and M-Block

Report	Scope	Methodology, timing and effort
EcoServe and LAMR (2005a). A Review of Habitat Values for Biodiversity and Species of Conservation Significance for BMA Coal Gregory Crinum Mine.	Unknown – reports no longer accessible and available for review.	Key findings from these reports were considered and incorporated into the later 2008 assessment by Austecology.
Ecoserve (2007). Baseline and Rare & Threatened Fauna Surveys for the Gregory Crinum Leases.	Unknown – reports no longer accessible and available for review.	Key findings from these reports were considered and incorporated into the later 2008 assessment by Austecology.
Austecology (2008). Review of Fauna and Flora Habitat Values – M Block, BMA Gregory Crinum.	Preliminary assessment of the fauna, flora and vegetation values supported within M-Block to assist in the future planning for the area.	• Field investigations undertaken on 6 and 7 May 2008 by two qualified and experienced ecologists. • Quaternary site data collection as per Queensland Herbarium methodology. • Random meander searches in likely habitats of rare and threatened taxa known from this region. • Rapid biodiversity assessment approaches in conjunction with habitat suitability assessments in regards to rare and/or threatened species assessments.

Report	Scope	Methodology, timing and effort
		• Rapid assessment of flora and fauna values of the survey area by traverse of most available formed tracks with specific sampling sites located.
Austecology (2009). Biodiversity Management Plan BMA Gregory Crinum.	This plan was developed to support the ongoing efforts to conserve and enhance the biodiversity values of non-mining areas within GCM.	• Field assessments were conducted during the period 3 to 7 November 2008. • Rapid biodiversity assessments in the field. • Targeted survey approaches. • Quaternary site data. • Random meander searches.
Austecology (2009). Rare & Threatened Fauna & Flora Surveys and Fauna Biodiversity Inventory of M Block, BMA Gregory Crinum.	This report addresses the further assessment recommendations detailed in Austecology's (2008) report including developing an inventory of fauna, clarifying extent of grasslands and conducting targeted surveys for rare and/or threatened fauna and flora.	• Field investigations undertaken in February and March 2009 by two qualified and experienced ecologists. • Brief random meander method for possible presence of threatened flora and fauna species. • Preparation of a large-scale base map to locate known extent of all discrete native grasslands. • Plotting locations of any rare or threatened species encountered during survey, any distinct vegetation communities and any new weeds. • Rapid biodiversity assessments and target species surveys covering full extent of remnant, remnant regrowth and cleared habitats occurring throughout extent of survey area. • Fauna surveys undertaken as two discrete events. First survey conducted 13-16 February 2009, which immediately followed a period of sustained and heavy late summer rainfall. This survey focused on target reptile species, including the Ornamental Snake, and involved spotlighting, nocturnal ground searches, driving spotlight surveys, early morning bird surveys and ground searches. Second survey conducted 13-18 March 2009. Assessed target species and biodiversity and included Elliott box trapping, pitfall trapping, diurnal ground searches, morning/afternoon bird surveys, call playback, anabat ultrasonic call detection, driving and walking spotlighting and inferential evidence.
Biodiversity Assessment and Management Pty Ltd (2011). Targeted EPBC Fauna and Flora Assessment within a component of M Block Geological Exploration Site, Gregory Crinum Mine, Emerald.	Targeted assessment to determine the presence/absence of selected threatened fauna and flora within an area of regrowth Brigalow within a component of the M-Block geological exploration site.	• Field surveys were conducted from 9-12 December 2011 by two qualified and experienced ecologists. • Methodology follows the survey effort requirements outlined in the Commonwealth's *Survey Guidelines for Nationally Threatened Species*. • Squatter Pigeon, Brigalow scaly-foot and native grasses were targeted but incidental species observations also recorded. • Native grasses were surveyed by random meanders. Flower heads were used to identify. • Squatter Pigeon survey effort was 15 hours over three days conducted morning and evening in 2.5 hour blocks. Assessment conducted in

Report	Scope	Methodology, timing and effort
		grassy understorey of Brigalow woodland and Brigalow regrowth. • Meandering transects conducted over four days and two nights. Eight hours of spotlighting conducted over two nights. 18 transects over four days resulting in 18 hours total meandering.
Cardno (2021) Ecological Assessment Report – Gregory Crinum M-Block Expansion **Attached as Appendix I**	Seasonal ecological assessments to inform the referral of the proposed 'M-Block' extension of the Gregory Crinum Mine to the Commonwealth Department of Climate Change, Energy, the Environment and Water to be assessed and approved under the EPBC Act.	• Field surveys conducted during the period 6-12 October (Spring Survey Period) and 21-26 April (Post-Wet Survey Period). • Survey sites were chosen based on consideration of areas that had not been previously subject to adequate surveys. • Fauna survey effort resulted in over 120 hours of active survey. • 79 Quaternary plots, 21 Grassland plots and five Grassland transects were undertaken across the survey period. Flora: • Quaternary assessments as described within the Methodology for surveying and mapping Regional Ecosystems and vegetation communities in Queensland (Version 5.1). • Verification of presence of TEC within listed REs using quaternary data, grassland plots and transects where appropriate. Fauna: • Surveys completed by foot and by vehicle. • Survey techniques included: spotlighting, active diurnal searches, camera traps, hair tube traps, pitfall traps, unattended and attended bat detector, harp traps, funnel traps, pest animal assessment, wildlife corridors, habitat features and assessments, dawn/dusk surveys. • Two KRAM assessments conducted to target the presence of Koalas.
Stantec (2022) Supplementary Ecological Assessment Report – Gregory Crinum M-Block Extension **Attached as Appendix E**	Targeted ecological assessments to provide further justification that the Koala, Yakka Skink, Dunmall's Snake and Ornamental Snake are unlikely to occur within M-Block and thus, unlikely to be impacted.	• Field investigations undertaken from 3-6 May 2022 and 23-27 May 2022 by four qualified and experienced ecologists. • 11 BioCondition assessments were conducted according to the Queensland Herbarium's *BioCondition Assessment Manual* (Eyre et al. 2015). • Supplementary quaternary level assessments were completed to streamline the number of full BioCondition assessment sites where an assessment unit contained multiple discrete polygons that are uniform or in the same general condition. • 11 habitat assessments were conducted for each target species according to the Queensland Government Guide to determining terrestrial habitat quality: A toolkit for assessing land based offsets under the Queensland Environmental Offsets Policy (2022). • Survey effort resulted in over 90 hours of active survey and involved spotlighting, indirect detection, camera traps, two acoustic recorders, pest animal assessment, habitat features assessment.

Report	Scope	Methodology, timing and effort
		• 11 KRAM assessments conducted to target the presence of Koalas.
Stantec (2022) Biodiversity Offsets Strategy Report - Gregory Crinum M-Block Extension	The M-Block extension will result in residual significant impacts on the following MNES: • Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community • Natural grasslands of the Queensland Central Highlands and northern Fitzroy Basin ecological community • King Bluegrass • Squatter Pigeon (southern) This report details how Sojitz will compensate for these impacts through direct offsets.	• Field investigations undertaken from 3-6 May 2022 and 23-27 May 2022 by four qualified and experienced ecologists. • 11 BioCondition assessments were conducted according to the Queensland Herbarium's *BioCondition Assessment Manual* (Eyre et al. 2015) within the proposed impact area. • A further 27 BioCondition assessments were conducted within the potential offset areas. • Supplementary quaternary level assessments were completed to streamline the number of full BioCondition assessment sites where an assessment unit contained multiple discrete polygons that are uniform or in the same general condition. • 11 habitat assessments were conducted for the Squatter Pigeon within the proposed impact area according to the Queensland Government *Guide to determining terrestrial habitat quality: A toolkit for assessing land based offsets under the Queensland Environmental Offsets Policy* (2022). • A further 27 habitat assessments were conducted for the Squatter Pigeon within the potential offset areas. • Offset requirements were calculated according to the *EPBC Act Environmental Offsets Policy* accompanied by the *Offsets Assessment Guide.*
Stantec (2022) Offset Area Management Plan - Gregory Crinum M-Block Extension **Attached as Appendix J**	The M-Block extension will result in residual significant impacts on the following MNES: • Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community • Natural grasslands of the Queensland Central Highlands and northern Fitzroy Basin ecological community • King Bluegrass • Squatter Pigeon (southern) This report details how Sojitz will compensate for these impacts through direct offsets.	• Field investigations undertaken in October and December 2022 by three qualified and experienced ecologists. • Methodology and results from the Biodiversity Offset Strategy were built upon for the chosen offset sites. • 10 BioCondition assessments were conducted according to the Queensland Herbarium's *BioCondition Assessment Manual* (Eyre et al. 2015) within the chosen offset sites. • Supplementary quaternary level assessments were completed to streamline the number of full BioCondition assessment sites where an assessment unit contained multiple discrete polygons that are uniform or in the same general condition. • 10 habitat assessments were conducted for the Squatter Pigeon within the proposed impact area according to the Queensland Government *Guide to determining terrestrial habitat quality: A toolkit for assessing land based offsets under the Queensland Environmental Offsets Policy* (2022). • Offset requirements were calculated according to the *EPBC Act Environmental Offsets Policy* accompanied by the *Offsets Assessment Guide.*

4.4 Survey Outcomes

4.4.1 Threatened Ecological Communities

Cardno (2021) identified the presence of two endangered TECs within M-Block:

- Brigalow (*Acacia harpophylla* dominant and codominant), (the Brigalow TEC).
- Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin (the Grassland TEC).

The location of these TECs within M-Block is shown in Figure 4.1.

4.4.2 Threatened Flora

Cardno (2021) identified one threatened flora species:

- King Bluegrass (*Dichanthium queenslandicum*).

The locations of King Bluegrass individuals and clusters observed during the survey period is presented in Figure 4.1. King Bluegrass has been confirmed within M-Block area by previous ecological assessments (Austecology 2008 & 2009).

The investigations undertaken by Austecology in 2009 also identified an additional threatened species:

- Finger Panic Grass (*Digitaria porrecta*).

This species is listed as near threatened under the NC Act. Effort was made during the Spring and Post-wet surveys to locate this species, with particular focus going to the areas where it had previously been identified. A number of specimens of Spreading Umbrella Grass (*Digitaria divaricatissima*) and Cotton Panic Grass (*Digitaria brownii*) were observed across M-Block and confirmed by the Queensland Herbarium. These species are not threatened, however look very similar to Finger Panic Grass. It is considered highly likely that the previous recording of Finger Panic Grass within M-Block was based on a misidentification of Spreading umbrella grass. No Finger Panic Grass was observed during Cardno's Spring and Post-wet surveys.

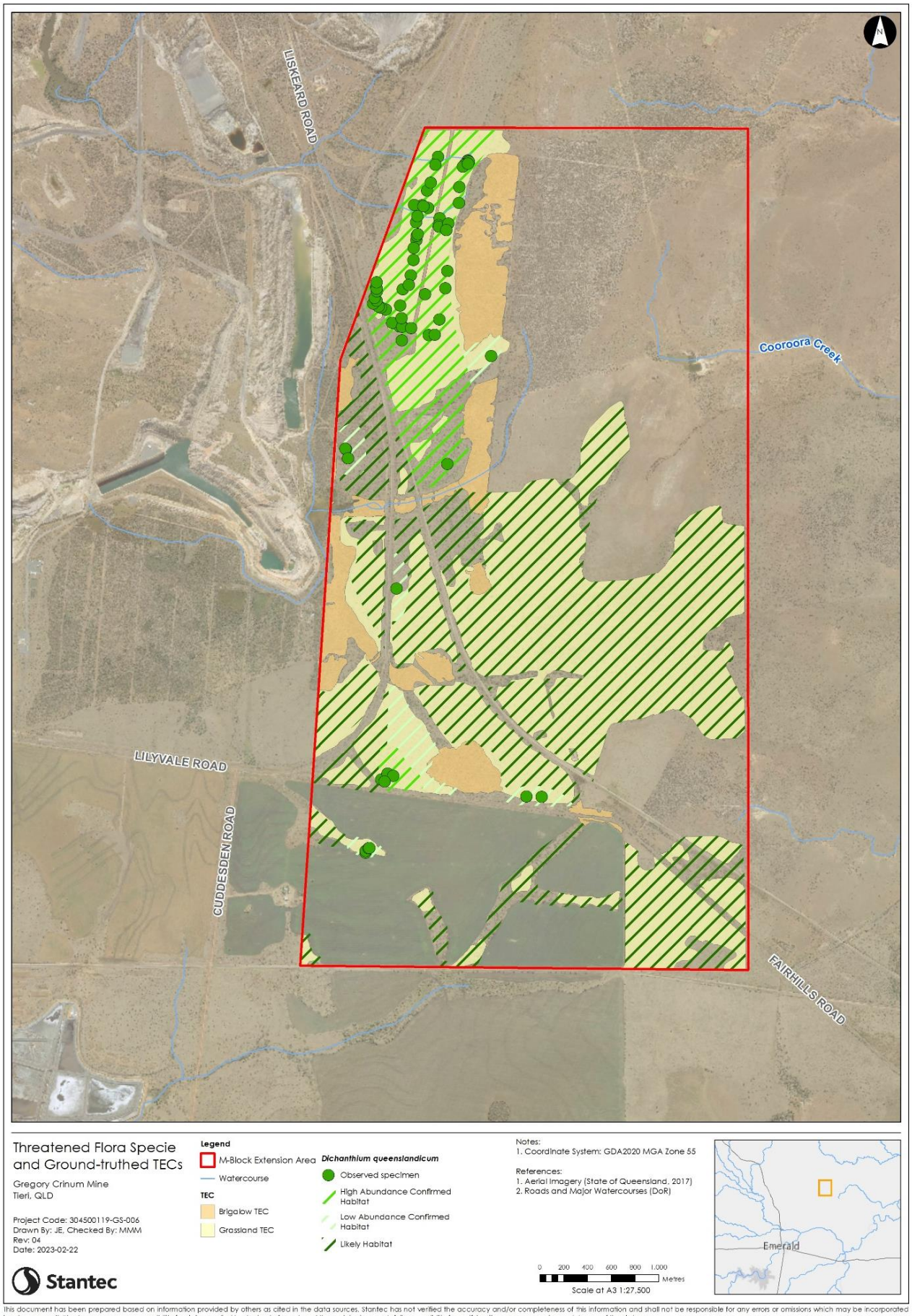


Figure 4.1: Location of TECs and King Bluegrass within M-Block

4.4.3 Threatened Fauna

The Squatter Pigeon (*Geophaps scripta scripta*), which is listed as a Vulnerable species under the EPBC Act was observed foraging along an access track in the northern portion of M-Block during Cardno, now Stantec's 2022 surveys. The Squatter Pigeon has also been observed north of GCM by mining staff. The Squatter Pigeon was previously recorded within M-Block by Austecology (2009). No other threatened fauna species were recorded within M-Block during the Cardno/Stantec assessments or historical assessments.

4.5 Habitat Assessment

4.5.1 Methodology

4.5.1.1 BioCondition Assessments

BioCondition assessments were conducted according to the Queensland Herbarium's *BioCondition Assessment Manual* (Eyre et al. 2015). BioCondition is a condition assessment framework for Queensland that provides a measure of how well a terrestrial ecosystem is functioning for biodiversity values. It is a site-based, quantitative procedure that provides a numeric condition rating of 1, 2, 3 or 4 with 1 being a 'functional' biodiversity condition and 4 being a 'dysfunctional' biodiversity condition (Eyre et al. 2015).

4.5.1.2 Habitat Quality Assessments

Habitat quality Indicators were derived for each target MNES fauna species according to the Queensland Government Guide to determining terrestrial habitat quality: A toolkit for assessing land based offsets under the *Queensland Environmental Offsets Policy* (2022). These indicators were used in the field to determine the quality of habitat available within M-Block for each target species. The full list of Habitat Quality Indicators used can be found in Appendix E, however the indicators were broadly sorted into four categories:

- Quality and availability of food and habitat required for foraging.
- Quality and availability of habitat required for shelter and breeding.
- Quality and availability of habitat required for mobility.
- Absence of threats.

The assessment of these attributes resulted in a habitat quality score out of 10, with 10 indicating a fully intact system. Scores of 4 to 6 indicate good quality regrowth or medium value habitat, and a minimum score of 0 would indicate a totally cleared or uninhabitable area. For the purpose of this assessment, these have been broadly categorised as follows, scores of:

- 10 to 7 – High Quality Habitat.
- 6 to 4 – Medium Quality Habitat.
- 1 to 3 – Low Quality Habitat.

4.5.2 Results

4.5.2.1 Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community

The location of Brigalow TEC within M-Block is shown in Figure 4.1. The vegetation was ground-truthed as remnant and regrowth RE 11.9.1 during field assessments. There is approximately 156.4 ha of Brigalow TEC within M-Block.

The average BioCondition score for both regrowth and remnant Brigalow TEC within M-Block was 0.64 giving it a BioCondition class of '2', indicating a functional biodiversity condition. Four of the survey sites scored '0' for connectivity meaning there is no connection to adjacent native vegetation. The remaining two sites scored '2' meaning ecological connectivity is connected to some native vegetation but ecological connectivity remains minimal. All sites scored low for native perennial grass cover and native grass species richness. The proposed M-Block extension and surrounds has been historically cleared for agriculture or current mining operations which has degraded the quality of habitat allowing a dense cover of invasive grasses, such as Buffel grass (*Cenchrus ciliaris*) which is likely to have been planted as part of pasture improvements across the area. Some sites were subject to recent heavy grazing which may also contribute to a low native perennial grass cover. The full BioCondition assessment methodology and results are provided in Appendix J.

4.5.2.2 Natural grasslands of the Queensland Central Highlands and northern Fitzroy Basin ecological community

The location of Grassland TEC is shown in Figure 4.1. The vegetation was ground-truthed as regrowth RE 11.8.11 during field assessments. There is approximately 819. 6 ha of Grassland TEC within M-Block.

The average BioCondition score for Grassland TEC within M-Block was 0.56 giving it a BioCondition class of '2', indicating a functional biodiversity condition. All survey sites scored '0' for connectivity meaning there is no connection to adjacent native vegetation. Two survey sites had less than 5% of non-native vegetation cover and the remaining two sites had less than 25% of non-native vegetation cover meeting the Grassland TEC condition thresholds. Overall, the Grassland TEC within M-Block was in moderate condition. The full BioCondition assessment methodology and results are provided in Appendix J.

4.5.2.3 King Bluegrass (*Dichanthium queenslandicum*)

The location of King Bluegrass is shown in Figure 4.1. There is approximately 1029.1 ha of King Bluegrass habitat within M-Block. In addition to the points showing the locations of confirmed sightings of this species, known and potential habitat of King Bluegrass is shown in Figure 4.1, based on the following categories:

- **High abundance confirmed habitat** – based on multiple confirmed specimens occurring in a location.
- **Low abundance confirmed habitat** – based on isolated single specimens observed in the field.
- **Likely habitat** – based on presence of potential habitat (i.e. 11.8.5/11.8.11). These areas were either (a) traversed and specimens were not observed and therefore potentially occur at undetectable levels or (b) they were not traversed and are assumed to be present.

The approved conservation advice for this species states the distribution of King Bluegrass overlaps with both Brigalow TEC and Grassland TEC. The BioCondition score for Grassland TEC has been used to assess the quality of King Bluegrass habitat as all of the records were from this ecological community. The average BioCondition score for Grassland TEC within M-Block was 0.56 giving it a BioCondition class of '2', indicating a functional biodiversity condition. All survey sites scored '0' for connectivity meaning there is no connection to adjacent native vegetation. Overall, the Grassland TEC within M-Block was in moderate condition. The full BioCondition assessment methodology and results are provided in Appendix J.

4.5.2.4 Squatter Pigeon (southern) (*Geophaps scripta scripta*)

The 2021 assessment confirmed that there will be impacts to habitat that is likely to be used for Squatter Pigeon foraging, breeding and movement. For the purpose of this impact assessment, the habitat requirements as outlined within the Threatened Species Scientific Committee's Species Profile and Threats Database has been adopted, specifically:

- Open-forests to sparse, open-woodlands and scrub
- Mostly dominated in the overstorey by Eucalyptus, Corymbia, Acacia or Callitris species
- Remnant, regrowth or partly modified vegetation communities
- Within 3 km of water bodies or courses.

In the context of M-Block this roughly approximates with the areas of regrowth and remnant woodland and Brigalow. Based on this there is approximately 164.8 ha of likely Squatter Pigeon habitat within the M-Block area.

The average habitat quality score for the Squatter Pigeon within regrowth and remnant RE 11.9.1 was '4' indicating medium quality habitat. The average habitat score within remnant RE 11.8.5 was '3' indicating low quality habitat. The Squatter Pigeon prefers to forage on bare ground under an open canopy of trees which is described as 'patchiness' within Cardno's habitat assessments. The proposed M-Block extension and surrounds has been historically cleared for agriculture or current mining operations which has degraded the quality of habitat allowing a dense cover of invasive grasses, such as Buffel grass (*Cenchrus ciliaris*), to establish across the area. This has decreased the level of patchiness across M-Block decreasing the foraging, shelter and mobility habitat value for the Squatter Pigeon.

Known predators to the Squatter Pigeon including the feral cat (*Felis catus*) and wild dog (*Canis familiaris*) were common across M-Block and frequently captured by camera traps. The decline of this species has been attributed to overgrazing and trampling of nests by livestock. Cattle (*Bos taurus*) were common across M-Block which has contributed to the lower habitat score. The full habitat assessment methodology and results are provided in Appendix J.

4.5.2.5 Koala (*Phascolarctos cinereus*) combined populations of Queensland, New South Wales and the Australian Capital Territory

In a report prepared for the then Department of Agriculture, Water and the Environment, entitled *A Review of Koala Habitat Assessment Criteria and Methods* (Youngentob et al. 2021) it was noted that consideration of the presence and abundance of Locally Important Koala Trees (LIKT) and Ancillary Habitat Trees (AHT) may be used to assist in determining the likely presence of Koala and the potential value of a community to the Koala.

- A LIKT is defined as: A tree from a species that is regularly browsed by koalas in a particular Koala Management Bioregion, such that it could be considered a substantial portion of the koala's diet.
- Conversely AHT's are not commonly recognised as important food trees but may still be essential for Koala survival due to the shelter or other resources they provide.

M-Block falls within the Brigalow Belt Koala Management Bioregion (KMB). Based on the list of LIKT and AHT in Yougentob *et al.* 2021, none of the assessment sites within the M-Block support any LIKTs. However, it is known that *Eucalyptus orgadophila* does occur in low abundance to the immediate west of M-Block, while *Eucalyptus populnea, Eucalyptus tereticornis, Eucalyptus camaldulensis* and *Eucalyptus melanophloia* occur in the broader locality.

The following local AHTs were identified within the assessment sites: *Acacia harpophylla, Acacia salicina* and *Melaleuca bracteata.* The cover of these AHT within the assessment sites ranged from 6.50% in regrowth RE 11.8.5 to 30.50% in regrowth RE 11.9.1.

In addition to the above, targeted KRAM assessments, as described in Appendix E were conducted at each BioCondition assessment site and no Koala scats were found.

Based on the results of all contemporary and historical assessments, which have not observed Koala and the findings of the Habitat Assessments which have found that M-Block provides low value movement or steppingstone habitat, it is considered unlikely that this species occurs regularly or permanently within the proposed impact area. Despite this, there remains a low likelihood that the species may move through M-Block as part of movements through the broader landscape. However, it is expected that, were this to occur, the likely direction of any such movement would be north – south and associated with the vegetation on and to the west of M-Block – consequently any impacts as a result of the Project are not considered likely to be significant. The full habitat assessment methodology and results are provided in Appendix E.

4.5.2.6 Yakka Skink (*Egernia rugosa*)

The conservation advice describes the Yakka Skink's habitat as open dry sclerophyll forest or woodland. Due to the discrete nature of the Yakka Skink and there being no previous records from within M-Block, a habitat assessment was conducted at each survey site. The average habitat assessment score for regrowth RE 11.8.11 was '1', with mobility and shelter and breeding receiving a score of 0 at each site. RE 11.8.11 is described as *Dichanthium sericeum* grassland on Cainozoic igneous rocks. The Yakka Skink requires microhabitat features such as log piles and dense vegetation that grasslands generally do not provide. This low score is likely reflective of the unsuitable vegetation and lack of microhabitat features present across this RE.

The average habitat assessment score for both regrowth and remnant RE 11.9.1 was '3' and the average habitat assessment score for regrowth RE 11.8.5 was '1'. Overall, the habitat quality within the proposed impact area is low for the Yakka Skink. The Yakka Skink can grow up to 40 cm and requires microhabitat features that allow it to shelter and hide throughout the day. Across M-Block, log piles and large hollow logs were present but due to the modified nature of this area these were generally artificial and have come about from past land clearing. Known predators to the Yakka Skink, including the feral cat (*Felis catus*) and wild dog (*Canis familiaris*), were common across M-Block captured by camera traps. Past broadscale land clearing and degradation for agricultural use is a major threat to the Yakka Skink due to the removal of important microhabitat features. The proposed M-Block extension and surrounds has been historically cleared for agriculture or current mining operations which has degraded the quality of habitat. Based on the results of all contemporary and historical assessments, which have not observed Yakka Skinks and the findings of the Habitat Assessments, it is considered unlikely that this species occurs within the proposed impact area and is unlikely to be impacted by the proposed M-Block extension. The full habitat assessment methodology and results are provided in Appendix E.

4.5.2.7 Dunmall's Snake (*Furina dunmalli*)

The conservation advice describes Dunmall's Snake habitat as open forest, particularly Brigalow (*Acacia harpophylla*) forest and woodland growing on floodplains of deep-cracking black clay and clay loam soils. Due to the discrete nature of Dunmall's Snake and there being no previous records from within M-Block, a habitat assessment was conducted at each survey site.

The average habitat assessment score for regrowth RE 11.8.11 and regrowth RE 11.9.1 was '5' indicating medium quality habitat. The average habitat assessment score for remnant RE 11.9.1 was '6'. The average habitat assessment score for regrowth RE 11.8.5 was '2' indicating low quality or nearly uninhabitable area. This low score was driven primarily by a lack of fallen timber and deep soil cracks. The area was also 40-60% cleared land. Overall, most of M-Block is considered to provide Medium Quality Habitat for Dunmall's Snake, with the areas of endangered Brigalow (*Acacia harpophylla* dominant and co-dominant) community providing better quality habitat areas. Dunmall's Snake requires microhabitat features that allow it to shelter and hide throughout the day. Across M-Block, log piles and large hollow logs were present but not common. Due to the modified nature of this area these features were generally artificial and have come about from past land clearing.

Known predators to Dunmall's Snake including the feral cat (*Felis catus*) and wild dog (*Canis familiaris*) were common across M-Block and frequently captured by camera traps. Past broadscale land clearing and degradation for agricultural use is a major threat to the Dunmall's Snake. M-Block and surrounds have been historically cleared for agriculture or current mining operations reducing the quality of habitat for Dunmall's Snake. Cattle (*Bos taurus*) were common across M-Block, captured on camera traps. Overgrazing by stock is a recognised threat to Dunmall's Snake and so this has contributed to the lower habitat value.

M-Block ranges from low habitat quality to medium value. The lack of microhabitat features and percentage of cleared land from past disturbance means M-Block is not optimal habitat for Dunmall's Snake. Based on the results of all contemporary and historical assessments, which have not observed Dunmall's Snake and the findings of the Habitat Assessments, it is considered unlikely that this species occurs within the proposed impact area and is unlikely to be impacted by the proposed M-Block extension. The full habitat assessment methodology and results are provided in Appendix E.

4.5.2.8 Ornamental Snake (*Denisonia maculata*)

The conservation advice describes the Ornamental Snake's habitat as floodplains, undulating clay and margins of swamps, lakes and watercourses. It may also occur on adjoining areas of elevated ground or woodlands of Coolabah, Poplar box and Brigalow. Due to the discrete nature of the Ornamental Snake and there being no previous records from within M-Block, a habitat assessment was conducted at each survey site.

The average habitat assessment score for regrowth RE 11.8.11 was '3', with foraging receiving a score of '0' at each site. There was no aquatic vegetation present and no discernible gilgai, ephemeral wetlands or waterways and therefore no habitat available for the Ornamental's snake main food source – frogs. The average habitat assessment score for regrowth RE 11.9.1 was '4' and the average habitat assessment score remnant RE 11.9.1 was '5' indicating medium value habitat. Foraging received a score ranging from 0 to 12.5 out of 25 across RE 11.9.1. This low score is associated again with little habitat availability for frogs, particularly in the patch of Brigalow in the north of M-Block. There was also a lack of deep soil cracks, although observations of these cracks may have been reduced due to the extreme wet weather that occurred in between survey periods. The Ornamental Snake is known to seek refuge in grass tussocks or log piles when soil cracks are unavailable which there was generally a lack of across RE 11.9.1. The average habitat assessment score for regrowth RE 11.8.5 was '3' indicating low quality habitat. This site had no fallen timber or deep soils cracks and limited frog habitat. Cane toads were common across M-Block, which are a known threat to the Ornamental Snake. Feral pigs were also common, which are known to degrade wetland habitat and therefore frog habitat. Generally, the habitat quality across M-Block is assessed as being Low to Medium quality.

Based on the results of all contemporary and historical assessments, which have not observed Ornamental Snake and the findings of the Habitat Assessments, it is considered unlikely that this species occurs within the proposed impact area and is unlikely to be impacted by the proposed M-Block extension. The full habitat assessment methodology and results are provided in Appendix E.

4.6 Impact Assessment

The direct and indirect impacts expected to occur with the approval of M-Block are detailed in Table 4-3. The expected area of impact is shown in Figure 4.2.

Table 4-3: Direct and indirect impact assessment of M-Block on controlling provisions

Matter	Direct Impacts	Indirect Impacts
Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community	Based on the proposed impact area associated with the open cut operations 58.7 ha of Brigalow TEC will be directly impacted by the Project by habitat removal or degradation.	• Areas over underground operations are expected to remain un-impacted as this community is not considered to be a GDE (refer to Section 5.4 for justification). • Introduction of non-native grasses and shrubs out competing native species.
Natural grasslands of the Queensland Central Highlands and northern Fitzroy Basin ecological community	133.5 ha of this community will be directly impacted by the mining operations by habitat removal or degradation.	• Areas over underground operations are expected to remain un-impacted as this community is not considered to be a GDE. • Introduction of non-native grasses and shrubs out competing native species.
King Bluegrass (*Dichanthium queenslandicum*)	Based on the proposed impact footprint of the mining operations impacts to known and likely King Bluegrass habitat will occur, specifically: • High abundance confirmed habitat – 144.5 ha. • Low abundance confirmed habitat – 10.3 ha. • Likely habitat – 20.1 ha.	• Areas over underground operations are expected to remain un-impacted as this community is not considered to be a GDE. • Introduction of non-native grasses and shrubs out competing native species.
Squatter Pigeon (*Geophaps scripta scripta*)	• Based on the proposed impact area associated with the open cut operations 58.7 ha of Brigalow TEC will be directly impacted by the Project which has been recognised as potential Squatter Pigeon habitat. • Habitat loss and fragmentation which could restrict dispersal, isolate populations, result in genetic fragmentation and increase habitat degradation from edge effects. • Habitat degradation reducing habitat quality and function. • Death or injury.	• Introduction of non-native grasses and shrubs out competing native species or important food sources for the Squatter Pigeon. • Increase of feral predators, particularly the feral cat and wild dog.

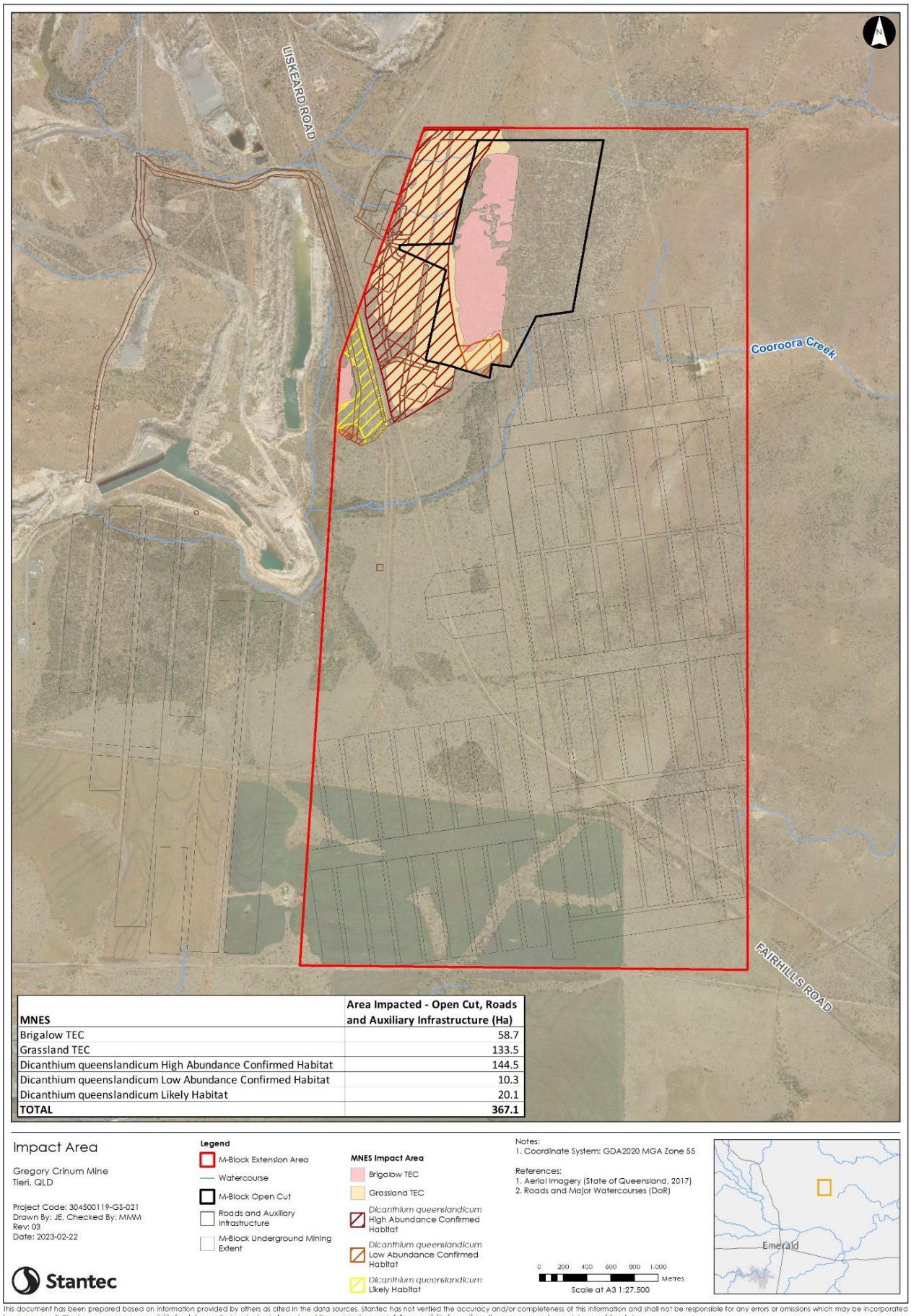


Figure 4.2: M-Block expected impact areas

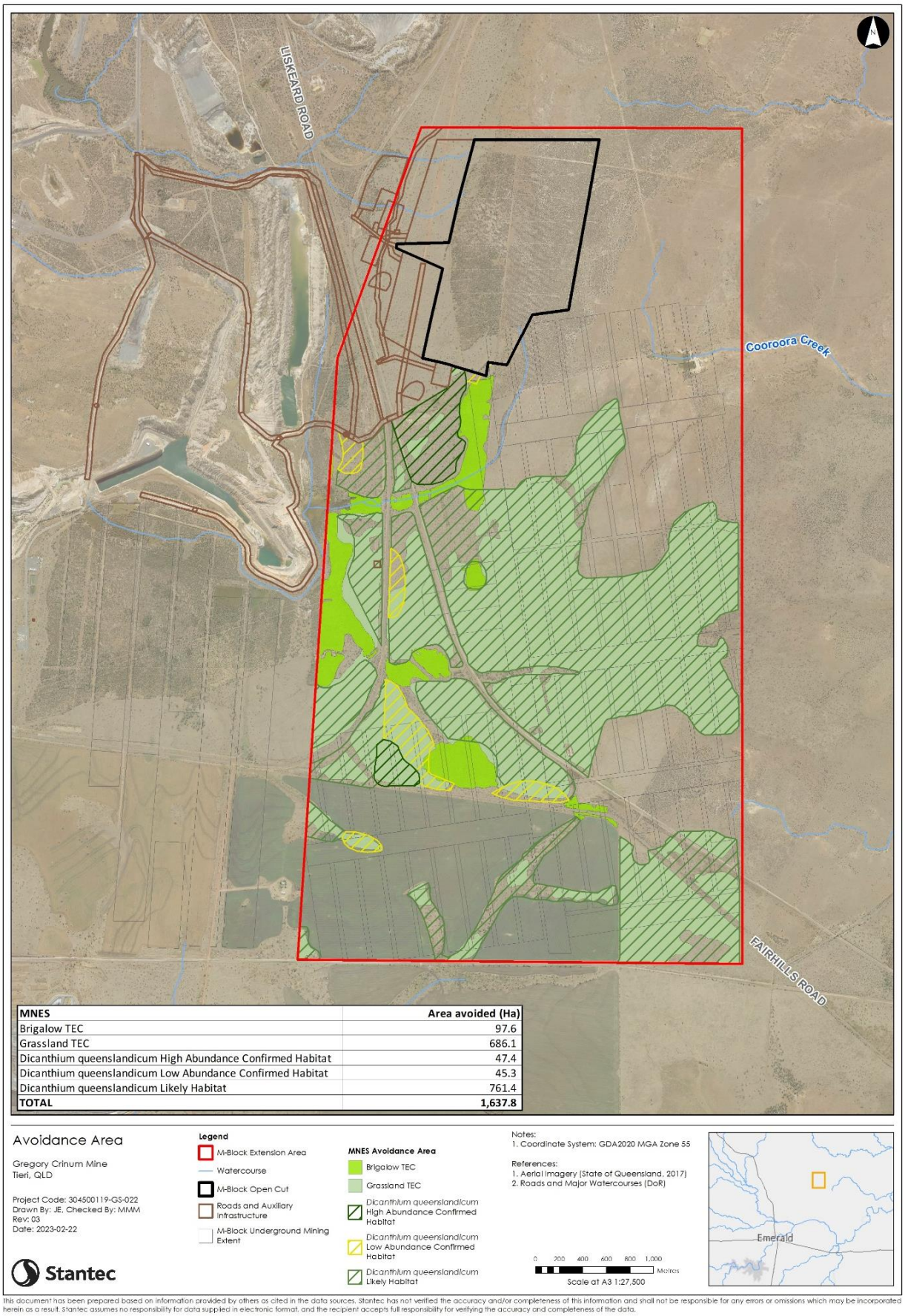


Figure 4.3: M-Block expected avoidance areas

4.7 Mitigation Measures

Mitigation has the primary aim of avoiding significant impacts and should be applied in the following order:

- Avoid impacts – preserve important habitat and prevent further habitat loss.
- Mitigate impacts – minimise habitat degradation and retain habitat function.
- Monitor effectiveness of mitigation – ensure mitigation is effective and feeds back into an adaptive management plan.

With respect to avoidance of impacts it is relevant to note that impacts to MNES occurring within M-Block have been avoided. Specifically:

- 97.7 ha of Brigalow TEC – which also provide suitable Squatter Pigeon habitat.
- 686.1 ha of Grassland TEC.
- 854.2 ha of confirmed and likely *D. queenslandicum* habitat.
- 106.1 ha of Squatter Pigeon habitat.

The impact avoidance areas have been illustrated on Figure 4.3.

There are a number of ecological impacts associated with the extension of the GCM through extended operations into M-Block. Table 4-4 outlines these potential impacts and threats to the target species and Table 4-5 outlines the associated recommended mitigation measures.

Table 4-4 Potential ecological impacts associated with the construction and operation of M-Block

Impact	Description	Project Phase
Clearing of vegetation	Destruction of habitat, including impacts to foraging resources	Pre-construction, Construction and Operation
	Destruction or disturbance of the following MNES – 58.7ha of Brigalow TEC, 133.5ha of Grasslands TEC, 174.9ha of King Bluegrass habitat and 58.7ha of Squatter Pigeon habitat	
	Destruction and/or degradation of breeding places (e.g. trees containing nests or hollows, and breeding places of more cryptic species)	
	Adverse indirect impacts on breeding animals associated with noise, dust and vibration impacts	
	Fragmentation and edge effects to areas of habitat;	
	Degradation of aquatic habitat and water quality through erosion and sedimentation	
	Reduction in connectivity of biodiversity corridors	
	Altered vegetation composition, particularly fuel characteristics and ignition sources, could increase fire frequency and intensity impacting retained Brigalow TEC	Construction, Operation
Dust emissions	Photosynthetic abilities of plants within the Brigalow and Grassland TEC adjacent to Project activities may be impacted due to an increase in dust emissions	Construction and Operation
Increasing anthropogenic activity	Impacts to water quality and degradation of aquatic habitat by pollution from human and vehicular traffic (e.g. oil, fuel, and litter);	Pre-construction, Construction and Operation
	Injury to fauna by litter (e.g. by ingestion, entanglement, or indirectly by providing resources for pest species);	
	Disruptions to fauna behaviour in response to human presence in the form of: • Avoidance behaviour; • Habituation; and • Disruption of ecological behaviour (e.g. predator prey interactions).	

Impact	Description	Project Phase
Weed and pest species	Establishment of pest fauna species, in areas of intact vegetation through clearing and fragmentation	Pre-construction, Construction and Operation
	Introduction and/or spread of existing weed species in construction zones through movement and disturbance of soil and attachment of fertile plant material to vehicles, machinery and human vectors	
	Increased dispersal of pest fauna species, including predatory species (e.g. foxes and cats) into impact area and surround as a result of clearing and human disturbance	

Table 4-5 Summary of the recommended mitigation measures

Project Phase	Mitigation Measures
Pre-construction	A Vegetation and Fauna Management Plan (Vegetation and Fauna MP) has been prepared (Appendix K). This document will be used to guide initial tree clearing and construction works to help minimise impacts to native fauna and areas of any retained vegetation adjoining the M-Block open and infrastructure areas. The Vegetation and Fauna MP includes but is not limited to the following: • Set and identify clear boundaries for clearing works. • Identify and mark any large, mature trees adjoining / in close proximity to clearing footprint. • Identify and use existing access tracks and disturbed areas for areas of temporary disturbance where possible. • Establish and identify adequate buffer zones to protect sensitive habitats. Sensitive habitats include areas with MNES. The size of the buffer will generally be 20m but may be adjusted if appropriate and approved by fauna spotter catcher during pre-clearance surveys. • Clear requirements regarding weed management and weed monitoring. In addition to the Vegetation and Fauna MP the following pre-construction mitigation measures will be undertaken: • Site inductions for all staff and contractors to inform them of their obligation to protect ecological values. • Prior to the proposed works, identify the nearest licenced wildlife rescue operation or vet clinic to which any fauna seriously injured during the proposed works can be transported for rehabilitation. • Final planning of works seeks to minimise clearing footprints wherever possible. • Plan works to maintain connectivity within and between mapped areas of higher value habitat. • Devise and implement water management, sediment erosion and pollution control/monitoring plans as required to minimise impacts as a result of proposed works on downstream environments. The Vegetation and Fauna MP includes: • SMART goals. • An assessment of predicted effectiveness outcomes, referencing SPRAT database and conservation advices. • Details of ongoing management and the timing, frequency and duration of mitigation measures to be implemented.
Construction	• Staff and contractors made aware of their environmental duties and minimise their environmental impacts wherever possible, including putting in place measures to reduce the risks associated with pollution, erosion and sedimentation. • A suitably qualified fauna spotter catcher should be present during all habitat removal works. • Directional felling should occur which directs the fall of vegetation away from areas of retained vegetation and away from recognised fauna habitat features. • Disturbance footprints for proposed works should be clearly defined to all staff; preferably visibly marked on-site using flagging tape or similar. • Staff and contractors should carry out their work in a manner that minimises interference and disturbance of native flora and fauna. • Sequential clearing should occur where large areas of vegetation require removal.

Project Phase	Mitigation Measures
	• Adequately check pipeline trenches and / or exposed pits for trapped reptiles and mammals prior to commencing work. • Monitor and maintain all erosion and sediment control devices to ensure they continue to function as designed. • Continue to implement management measures to prevent and minimise the spread and / or introduction of biosecurity matter (weeds/ pests) within the M-Block footprint. Monitoring of same to continue in accordance with the Vegetation and Fauna MP. • Manage waste generation – particularly putrescible waste – to reduce risk of attracting pest animals / predators to construction site.
Post-construction	• Carry out rehabilitation of disturbed areas. • Implement measures to exclude cattle from sensitive habitats (e.g. gilgai habitats during the wet season). • All spotter / catcher records and reporting to be supplied to Sojitz and regulators as required.
Operations	• Maintain a record of incidental observations of fauna and any interactions with same. • Continue to implement the requirements of the Rehabilitation Management Plan and the Offset Area Management Plan (Offset Area MP) including monitoring against performance objectives.

4.8 Residual Significant Impact Assessment

Most of M Block is underground mining and this does not impact on movement of fauna through the broader landscape and resting opportunities. Underground mining has minimal impacts on dispersal, isolation of populations, genetic fragmentation and increase in habitat degradation from edge effects.

There have been no records of the Yakka Skink, Dunmall's Snake or Ornamental Snake within M-Block or in close proximity. The habitat quality for these reptiles was relatively low and it was concluded that the M-Block operation is unlikely to result in a significant residual impact to these species. The full significant impact assessment for each species is detailed in Cardno, now Stantec's 2022 Supplementary Ecology Assessment Report which is attached as Appendix E.

No Koala were recorded and no Koala scat was identified. It remains unlikely that a Koala population exists within M-Block due to a lack of Locally Important Koala Trees. The area could provide movement habitat through the broader landscape or resting opportunities as many sites had Ancillary Habitat Trees (AHT). AHT are specific to the Bowen Basin, and support the Koala habitat predominately for movement and resting, and to a smaller degree for food. However, it was concluded that the M-Block extension is unlikely to result in a significant residual impact to the Koala. The full significant impact assessment for the Koala is detailed in the Cardno, now Stantec 2022 Supplementary Ecology Assessment Report which is attached as Appendix E.

The remaining MNES: Brigalow TEC, Grassland TEC, King Bluegrass and Squatter Pigeon all occur within M-Block and will be directly and indirectly impacted by the works. It has been determined that a significant residual impact to these MNES will remain following all avoidance and minimisation actions. To compensate for the residual impacts on these MNES an Offset Area Management Plan (Appendix J) has been prepared. Further details are provided in Section 7 of this PER.

5 A water resource in relation to coal seam gas development and large coal mining development

5.1 Groundwater

A Water Assessment (Appendix D) was carried out by KCB Australia Pty Ltd (KCB) to assess the potential impact to groundwater and groundwater-dependent assets under the EPBC Act from the proposed action. An overview of the outcomes of the desktop and field assessment is outlined in the following sections with the full report attached as Appendix D. A supplementary report prepared by KCB to address the IESC advice (dated 9 October 2022) provided to the Department of Climate Change, Energy, the Environment and Water is provided as Appendix L.

5.1.1 Geology

The regional stratigraphy surrounding M-Block includes several dominant geological formations. A summary of the major regional and site geological units and descriptions is provided in Table 5-1.

Table 5-1: Regional and site surface geology

Age	Lithology	Description	Identified on Surface within M-Block
Quaternary	Alluvium	Clay, silt, sand, gravel, flood-plain alluvium	No
Tertiary	Basalt	Olivine basalt flows	Yes
	Sediments	Duricrusted palaeosols at the top of deep weathering profiles	Yes
	Emerald Formation	Deeply weather fluviatile and lacustrine claystone and siltstone, sandstone, gravel and interbedded basalt	No
Triassic	Ewan Group	Lithic sandstone, pebbly lithic Sandstone, mudstone and pebble conglomerate	No
Permian	Rangal Coal Measures	Calcareous sandstone, calcareous shale, mudstone, coal, concretionary limestone	No
	Burngrove Formation	Mudstone, siltstone, sandstone, coal, tuff	Yes
	Fair Hill Formation	Sandstones, mudstones, volcanic and coal	Yes
	Macmillan Formation	Mudstone, siltstone, sandstone	Yes
	German Creek Formation	Sandstones, mudstones, volcanic and coal	Yes
	Maria Formation	Siltstone, mudstone, shale and sandstones	No
	Back Creek Formation	Siltstone, mudstone, shale, minor coal, sandstones and sandy coquinite	No

Adapted from Table 7.1, KCB 2022a

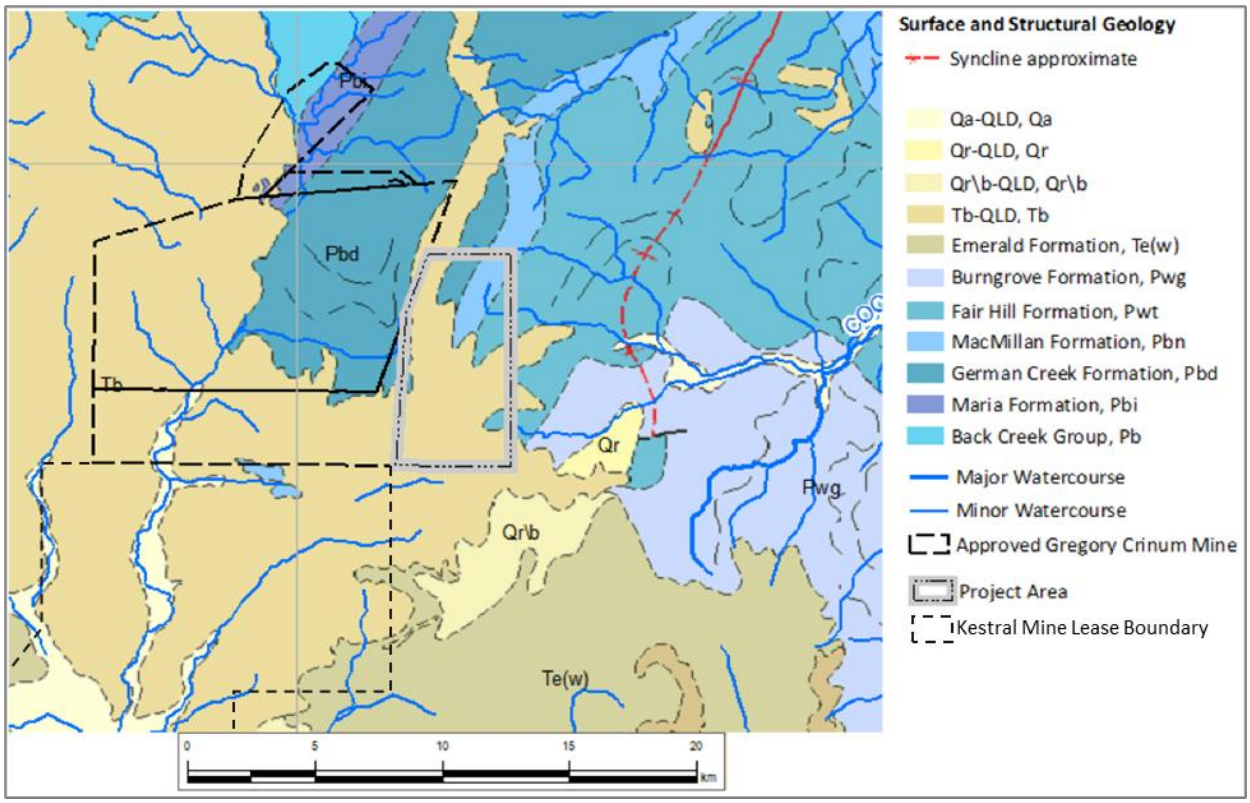


Figure 5.1: Surface geological units

Adapted from KCB 2022a

5.1.2 Structural Features and Faults

Several faults have been identified within the vicinity of M-Block, through exploration drilling and intersection during mining. The mapped location of the structures is shown on Figure 5.2, with a cross section shown on Figure 5.3. The key observations are:

- Fault displacements are greater at the top of the stratigraphy, (i.e., in Canis-Lepis seam than in the German Creek seam).
- Steep-angled fault plane angles of 65 to 80° have been interpreted in the Kestrel area. The greatest number of fault intersections in boreholes is recorded in the Tieri Seam.
- The Boundary Fault is located along the western margin of M-Block. The Boundary Fault was intersected and mapped by historical exploration drilling at both the GCM and neighbouring Kestrel Mine. The fault is a normal fault, trending north south and is downthrown >25 m to the west.
- The TiTree Fault Zone consists of 11 thrust faults, trending NW-South with the sense of displacement downthrown 2 to 15 m predominantly to the east, but with some western dipping faults. The southern extent of the TiTree Fault Zone is poorly defined.
- The Crinum Fault zone is a series of five north-westerly striking thrust faults, as part of the Northern TiTree Fault Zone.
- The Windmill Fault zone consists of five thrust faults trending northwest-southeast with displacement downthrown 1 to 3 m to the west. Faults have been inferred by Kestrel in LW403 to LW405.

Two distinct zones are associated with the Woolshed Fault. The northern zone consists of five thrust faults. The faults trend north south, and the sense of displacement are downthrown 1 to 10 m to the west. The Woolshed Fault Southern zone consists of three normal faults and two reverse faults. These faults are low in confidence and the dip plane is currently inferred as vertical, while the displacement ranges from 0.5 to 4 m.

Interpretation of the underground mapping data of the characteristics of the faulting (strike, dip, displacement, location) shows that most of the faults have displacement less than 0.1 m), dominated by normal faults that dip to the east at 60 to 65° and a strike of 070. Minor normal faults dipping to the west are also encountered, as well as rarer reverse faults dipping to the west.

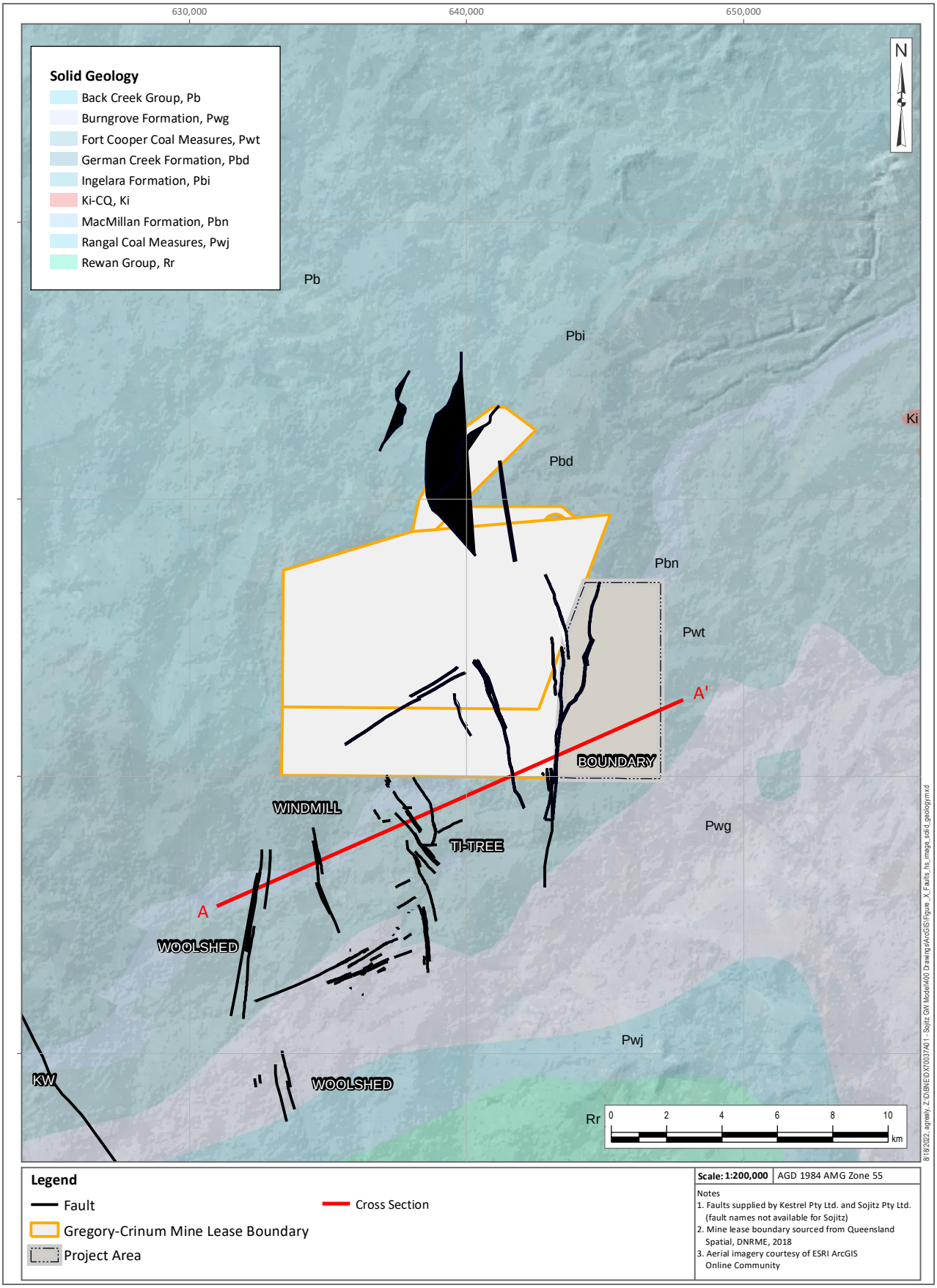


Figure 5.2: Inferred faults of the GCM and M-Block

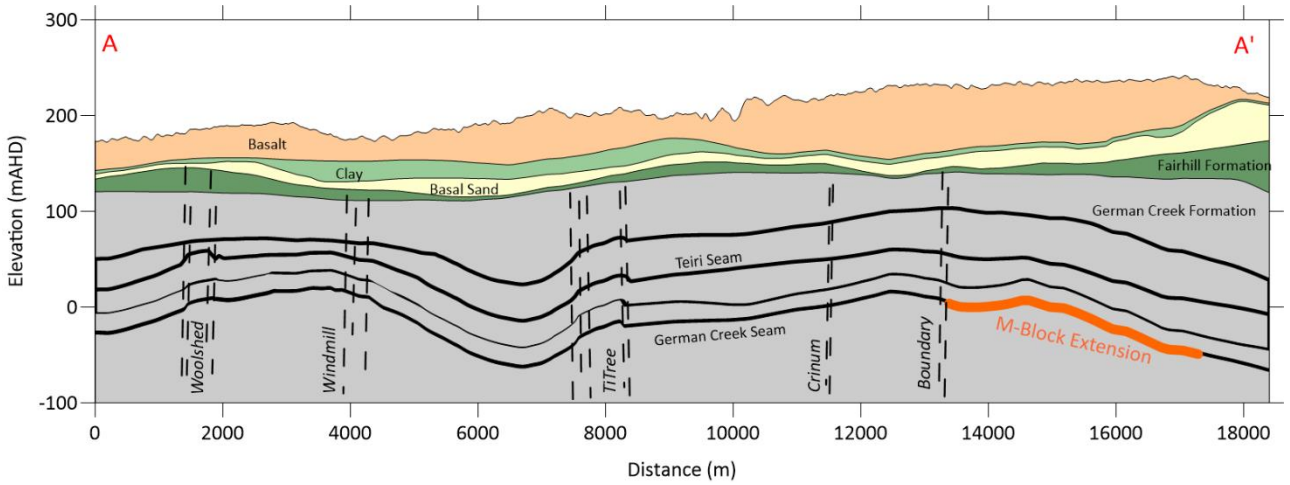


Figure 5.3: Geological section showing inferred faults of the GCM and M-Block

5.1.3 Hydrogeology

The relevant hydrogeological units in the vicinity of M-Block and its surrounds broadly comprise:

- Quaternary alluvium – localised deposits associated with minor ephemeral creeks such as Cooroora Creek and Crinum Creek.
- Tertiary basalt – comprises of multiple basalt flows with flow events separated by clay horizons representing weathered material between events.
- Tertiary clay – occasionally present underlying the basalt, forming an aquitard.
- Tertiary basal sand – occasionally present and comprises highly weathered sandstone that, where laterally continuous, can form a productive aquifer.
- Permian interburden – includes sandstone, siltstone and mudstone that are typically 'tight' and low yielding (except when affected by goafing).
- Permian coal seams – form low to moderate yielding aquifers confined by overlying interburden units.

A summary of each of these hydrogeological units is provided in the following sections. A cross-section of the hydrogeological units; Tertiary units and the Permian sequence including the German Creek seam (target for mining), and the overlying coal seams and interburden, through M-Block is shown in Figure 5.4 and Figure 5.5.

5.1.3.1 Quaternary Alluvium

Quaternary-age alluvium is not present within the boundaries of M-Block. The nearest occurrence of alluvium is to the east and west of M-Block and consists of clay, silt, sand and gravel and are associated with Cooroora Creek and Crinum Creek. South of M-Block, alluvium deposits are associated with the Nogoa River and its flood plains while to the east they are associated with Crinum Creek directly overly the Tertiary basalt.

5.1.3.2 Tertiary Basalt

The tertiary basalt outcrops at surface in M-Block bisecting it, running from the north to south along the western boundary, splaying out to overlie the majority of M-Block in the south. The tertiary basalt typically occurs as a single composite unit comprising massive and vesicular lava, tuff and ash flows.

An outcrop of tertiary basalt extensive flow of basalt occurs to the west of GCM but is absent to the east except for two discrete areas situated approximately 5 km to the northeast. Locally, the thickness of the tertiary basalt is highly varied due to being subjected to varying degrees of weathering with an overall regional trend of increased thickness to the south.

Figure 7.5 in Appendix D presents the thickness of Tertiary basalt within the vicinity of M-Block. Drilling records indicate that the basalt is up to 65 m thick within M-Block, thinning to the south and north.

5.1.3.3 Tertiary Sediments (Clay and Basal Sand)

The tertiary sediments consist of duricrust palaeosols at the top of the deep weathering profiles. The sediments occur in the east M-Block, underlying the tertiary basalt and overlying the Permian beds beneath. The sediments are divided into two distinct hydrogeological units, the Tertiary clay unit and the basal sand unit.

The tertiary clay unit varies in thickness between 5 and 40 m and comprises of weathered basaltic sediments, silt and clay.

The basal sand is typically between 2 and 20 m and comprises of highly weathered Permian sandstone and/or tertiary stream deposits; the basal sand unit is absent in some areas (Figure 7.6 of Appendix D). The basal sand is a productive groundwater bearing formation but often limited in its potential as a productive aquifer due to insufficient lateral connectivity.

5.1.3.4 Permian Coal Measures (Interburden and Coal Seams)

The Permian coal measures include all the formations within the Blackwater Group and the Back Creek Groups, which outcrop and subcrop across M-Block. The Permian coal measures comprise alternating layers of fine to medium grained siltstone, sandstone, and interbedded coal. The German Creek seam is the target for mining at the GCM. Figure 7.7 of Appendix D shows the stratigraphic sequence of the Permian, including the German Creek seam and overlying coal seams. The coal seams vary in thickness, with the maximum thickness of the German Creek seam being approximately 4 m.

5.1.3.5 Permian Coal Measures Stratigraphic Column

The Permian coal measures subcrop under the tertiary sediments and tertiary basalt and outcrop within the northeastern and far western extents of M-Block. The Permian coal measures outcrop across much of the GCM and from Lilyvale Road to Oaky Creek in the north. Figure 7.8 within Appendix D presents the top elevation of the German Creek coal seam, which is the target for mining, occurring at 175 m AHD to -125 m AHD.

The coal seams, including the German Creek seam, Corvus seam and Tieri seams, are the primary groundwater bearing units, and are confined by hydrogeologically tight, interbedded sedimentary units, which act as aquitards. Reported airlift yields from the Permian strata average 2 L/s, with some higher yields up to 6.3 L/s recorded (Douglas Partners 2006). Groundwater flow and storage within the coal seams are a function of cleating. The spacing and nature of cleating are the primary controls on hydraulic conductivity within the coal seams.

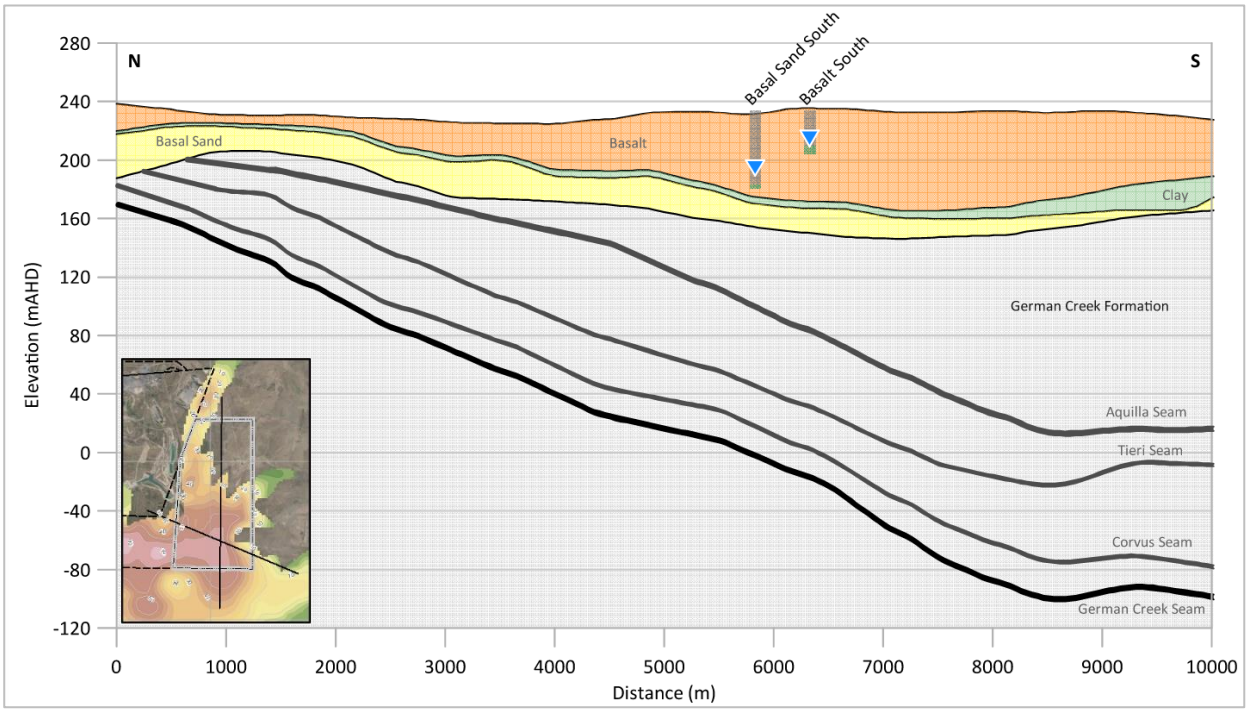


Figure 5.4: North-south cross section

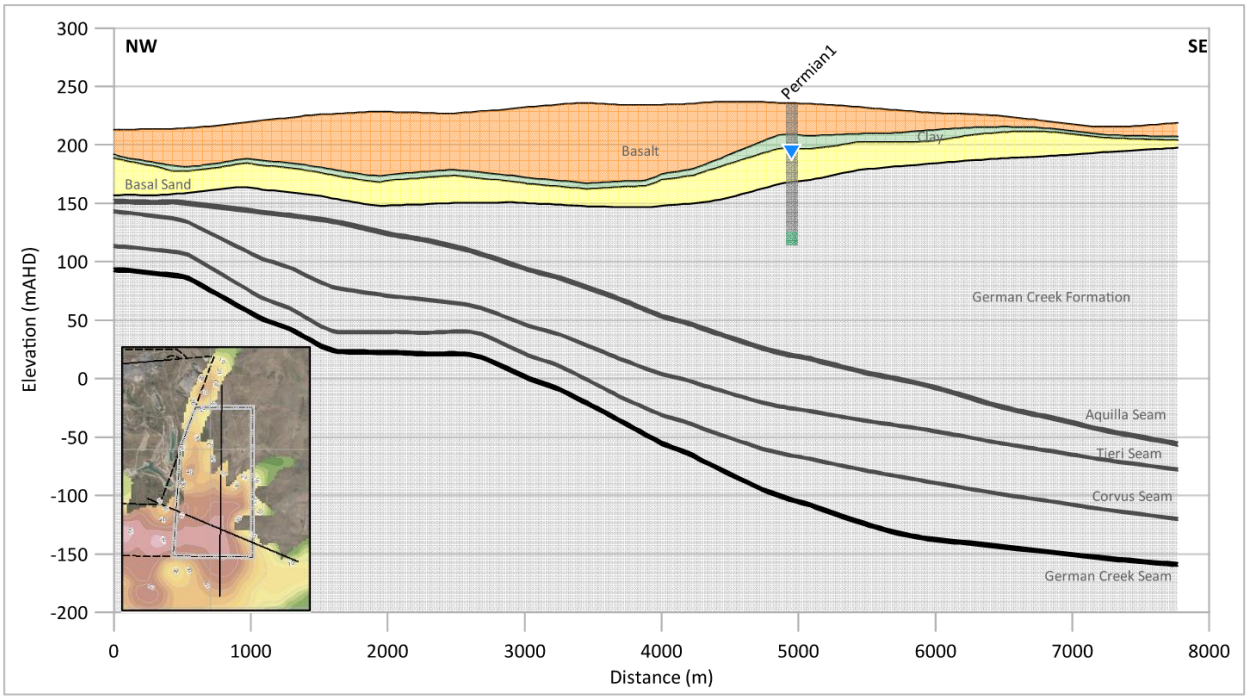


Figure 5.5: Northwest-southeast section

5.1.4 Hydraulic Conductivity

Site-specific testing has been conducted within the Tertiary basalt, basal sand and Permian coal measures. A total of 42 values exist for these units, with 19 values obtained directly on GCM from pumping tests and falling head tests. The remainder of the values were estimated from bores on the neighbouring Kestrel and Grasstree Mines, which have the same geological units present. The available values by hydrostratigraphic unit are presented on Figure 7.11 within Appendix D, with reference values from Driscoll (1986) also provided. A summary of the individual units is provided below.

5.1.4.1 Alluvium

There are no site-specific values measured for alluvium. Alluvium does not occur directly within M-Block.

5.1.4.2 Tertiary Basalt

The hydraulic conductivity within the Tertiary basalt is dependent on the connectivity of fractures and vesicular zones. The degree of weathering will also influence the hydraulic conductivity of the basalt; the weathering of basalt results in an increased clay content thus resulting in a reduction of hydraulic conductivity. As a result of the combination of these processes, there is a high degree of lateral and vertical heterogeneity on a local scale. Transmissivity values from pumping tests have estimated values ranging between 13 and 1,720 m^2/day (Coffey 1991; Golder 1984; AGE 2002; DRDMW 2021).

5.1.4.3 Tertiary Clay

There is no site-derived hydraulic conductivity available for the Tertiary clay aquitard. Due to the nature of clay, it is estimated to have a persistently low hydraulic conductivity. Literature values range between 1 x 10-8 to 10-2 m/day (Kruseman and de Ridder 1994).

5.1.4.4 Basal Sand

The transmissivity of the basal sand is reported as ranging between 19 and 129 m^2/day, with hydraulic conductivity values of 0.7 to 26 m/day (AGE 2017). The range in hydraulic conductivity values is likely due to a high lateral variation in bed thickness and the occurrence of ferricrete and silcrete within pore spaces.

5.1.4.5 Permian Coal Measures

Hydraulic conductivity within the Permian coal measures is typically associated with secondary porosity through fractures and cleats within the coal seams. Thick sequences of sandstone, siltstones and mudstones are typically ‘tight’ and low yielding and make up the interburden. The interburden sediments form confining aquitards within the coal measures (AGE 2017). Hydraulic conductivity within the Permian coal measures

decreases with depth due to increased lithostatic pressure compressing the coal seams, thus reducing fracture aperture and the ability for fractures to transmit flow. Data is available from 25 tests (pumping, packer, and falling head tests) conducted at the GCM, Kestrel Mine and nearby Grasstree Mine (KCB 2018; Coffey 1991; AGE 2002; Golder 1984). The hydraulic conductivity calculated from the test ranges from a minimum of 0.001 m/day to a maximum of 34 m/day, with a median value of 0.02 m/day.

5.1.5 Groundwater Recharge

The general processes of groundwater recharge include localised recharge, preferential pathway flow and diffuse recharge:

- Localised recharge occurs beneath drainage features including rivers, and free-draining unconsolidated sedimentary cover, such as alluvium.
- Preferential pathway flow arises from changes in permeability within aquifers and in overlying regolith, providing conduits for water to infiltrate. Zones of higher permeability may include fissures, faults, joints, tree roots and high-permeability beds within individual formations and along bedding planes (Kellett et al. 2003; Sucklow et al. 2016).
- Diffuse recharge is the process by which rainfall infiltrates directly into outcropping hydrostratigraphic units (Kellett et al. 2003).

Recharge in M-Block will occur as diffuse recharge with rainfall infiltration occurring at outcropping aquifers. Recharge in the form of leakage from one formation to another will also occur, although this is expected to be minor due to the interbedded nature of the strata.

5.1.6 Registered Groundwater Bores

There are 264 registered groundwater bores recorded in the Groundwater Database (GWDB), as of July 2021, within 10 km of M-Block (DRDMW 2021). Of the registered groundwater bores, 249 are listed as existing and include water supply and monitoring bores, with the remainder either abandoned, decommissioned or destroyed. A summary of registered bores is presented in Table 5-2, with their status, as derived from GWDB. All registered bores are described as sub-artesian facilities.

Table 5-2: GWDB registered bores- M-Block and 10 km buffer

Purpose	Abandoned and destroyed	Abandoned but usable	Existing	Total
Abandoned	12	2	0	14
Mineral Exploration	0	0	1	1
Mine Monitoring	0	0	189	189
Sub-Artesian Monitoring	0	0	18	18
Water Supply	0	0	15	15
No purposes Listed	0	0	26	26
Total	12	2	246	263

Source: DRDMW 2021

The nearest potential water supply bore is located 2.3 km from M-Block, with one other water supply bore located 9.6 km east. There are also six registered bores that have no purpose listed. These range in distance from 1.2 km to 4.6 km from M-Block and are inferred to be screened within the upper Permian units.

There are no recent details in the GWDB to verify whether these bores are currently used for water supply or still in use. Table 5-3 provides details of each of the bores, with the information sourced from the GWDB. These bores will be considered as ‘receptors’ in the impact assessment.

Table 5-3: Groundwater bores in the vicinity of M-Block

RN	Drilled Year	Easting (m)	Northing (m)	Purpose	Screen Details	Screened Unit	Distance from M-Block
57667	1991	649129	7429352	Water supply	12-15 mbgl	Basalt	2.3 km
57668	1991	651460	7436221	No purpose listed	57-63 mbgl	Upper Permian	4.4 km
62769	1899	650574	7431738	No purpose listed	30-39 mbgl	Upper Permian	3.5 km
62771	1899	651383	7432912	No purpose listed	No details	No details	4.3 km
62772	1899	647782	7429035	No purpose listed	Bore depth 42 mbgl	No details	1.2 km
89346	1992	649498	7436738	No purpose listed	24-36 mbgl	Upper Permian	2.5 km
89347	1992	656726	7432113	Water supply	14-20 mbgl	Upper Permian	9.6 km
89405	1993	641716	7431736	No purpose listed	27-36 mbgl	Upper Permian	4.6 km

mbgl – metres below ground level

5.1.7 Baseline Groundwater Monitoring

Sojitz maintains a groundwater monitoring network as part of its operations and for compliance with EA conditions. The network comprises 65 monitoring bores screened across the key hydrostratigraphic units (Figure 5.6). The network also historically included an additional 52 monitoring bores. Groundwater data collected from the active and historical monitoring network has been compiled and assessed as part of this reporting. This data is considered baseline data for the M-Block extension.

A numerical groundwater model was developed from the conceptual groundwater regime and supported by the collated dataset. The numerical model was used to predict the effects of the development of M-Block on the groundwater regime during and post-mining. The numerical model also incorporates the neighbouring Kestrel Mine. The data provided by Kestrel Mine is discussed as part of the conceptual hydrogeology as well as being used in the calibration of the numerical model. The collated local groundwater dataset includes the following relevant measurements:

- Geological data collected from the GCM and neighbouring Kestrel Mine's geology database of over 10,000 exploration drill holes within M-Block and its surrounds, lithological logs from 314 Groundwater database (GWDB) records and records from 15 gas wells, sourced from the Queensland Government GeoRes Globe.
- Groundwater level data collected from 83 bores screened across the main hydrostratigraphic units within M-Block and its surrounds.
- Hydraulic testing results collected from 42 tests conducted at the GCM and the adjacent Kestrel Mine
- Groundwater quality data collected from 51 bores, including detailed field measurements and laboratory results for each of the main hydrostratigraphic units within and surrounding M-Block.

The modelling results were used to inform assessments of the impacts on groundwater users and the surrounding environment, and the cumulative groundwater impacts of M-Block and other nearby mining projects.

All relevant data was collated and analysed to develop a conceptual understanding of the groundwater regime, including the key geology, groundwater flow and groundwater quality characteristics. The collated data is summarised below. The conceptualised groundwater regime is discussed further in Sections 7 and 8 of Appendix D.

5.1.7.1 Baseline Groundwater Levels and Flow

Spatially distributed groundwater level data were used to characterise groundwater flow directions and gradients. In addition, time-variant groundwater level fluctuations were used to interpret the rate and distribution of recharge/discharge, depressurisation influence from surrounding mining activities and pre-development/seasonal variability in groundwater levels.

Figure 7.12 within Appendix D provides an overview figure of the monitoring locations by hydrostratigraphic unit, with labelled maps of the individual hydrostratigraphic units detailed in the following sections.

Section 7.7 of the Water Assessment (Appendix D) provides a detailed description of the transient groundwater elevation hydrograph responses. A summary of the groundwater elevation response is provided below:

Permian:

- The groundwater elevations monitored in the Permian strata have been substantially altered by mining activities.
- Monitoring of the LW100/200/300 series at Kestrel Mine has the longest records for the Permian and shows the drawdown in preparation and during mining, then the recovery post-mining. Impacts from Crinum South are also evident in the monitoring bores on the neighbouring Kestrel Mine, although there are no monitoring bores for the Permian in the same period at Crinum to correlate responses.
- Recovery responses are also noted in the monitoring record.

Basal Sand:

- Monitoring of the basal sand unit shows substantial variation, with influence from climate trends at several monitoring bores, and an influence from mining on groundwater levels in some locations.
- For bores located in areas where the interburden (between coal seam and base of basal sand) is thinner, there has been a breakthrough of fracturing into the basal sand, and an increased influence from mining activities. In some locations where this has occurred the groundwater elevation indicates that the unit has moved from confined to unconfined conditions as the groundwater elevation has drawdown below the top of the basal sand unit.

Basalt:

- There is variation in the response in the basalt monitoring bores across the two mines and regionally to the west, where a number of basalt monitoring bores are located. The variation is broadly grouped as follows:
  - Basalt monitoring bores, which are highly responsive to rainfall recharge and follow annual seasonality as well as the long-term climate trend.
  - Basalt monitoring bores, which are responsive to only large rainfall events (e.g., 2010), but show limited annual seasonality, however, these generally correlate with the long-term climate trend.
  - Basalt monitoring bores, which show limited response to rainfall, however correlate with the overall climate trend.
- Reponses to mining are observed at a limited number of monitoring bores and in general those impacts are where the interburden thickness between the mined coal seams is less than 105 m.

5.1.7.2 Baseline Groundwater Table Contours

The groundwater table ranges between 210 and 190 m AHD in M-Block, with the flow direction from north to southwest across area. The depth to groundwater in M-Block ranges between 7 and 30 m below ground surface. Figures 7.35 and 7.36 within Appendix D show the groundwater table contours for 2020, produced from the numerical groundwater model and the depth to groundwater, which has been generated using the 2020 groundwater table contours and the topographic surface.

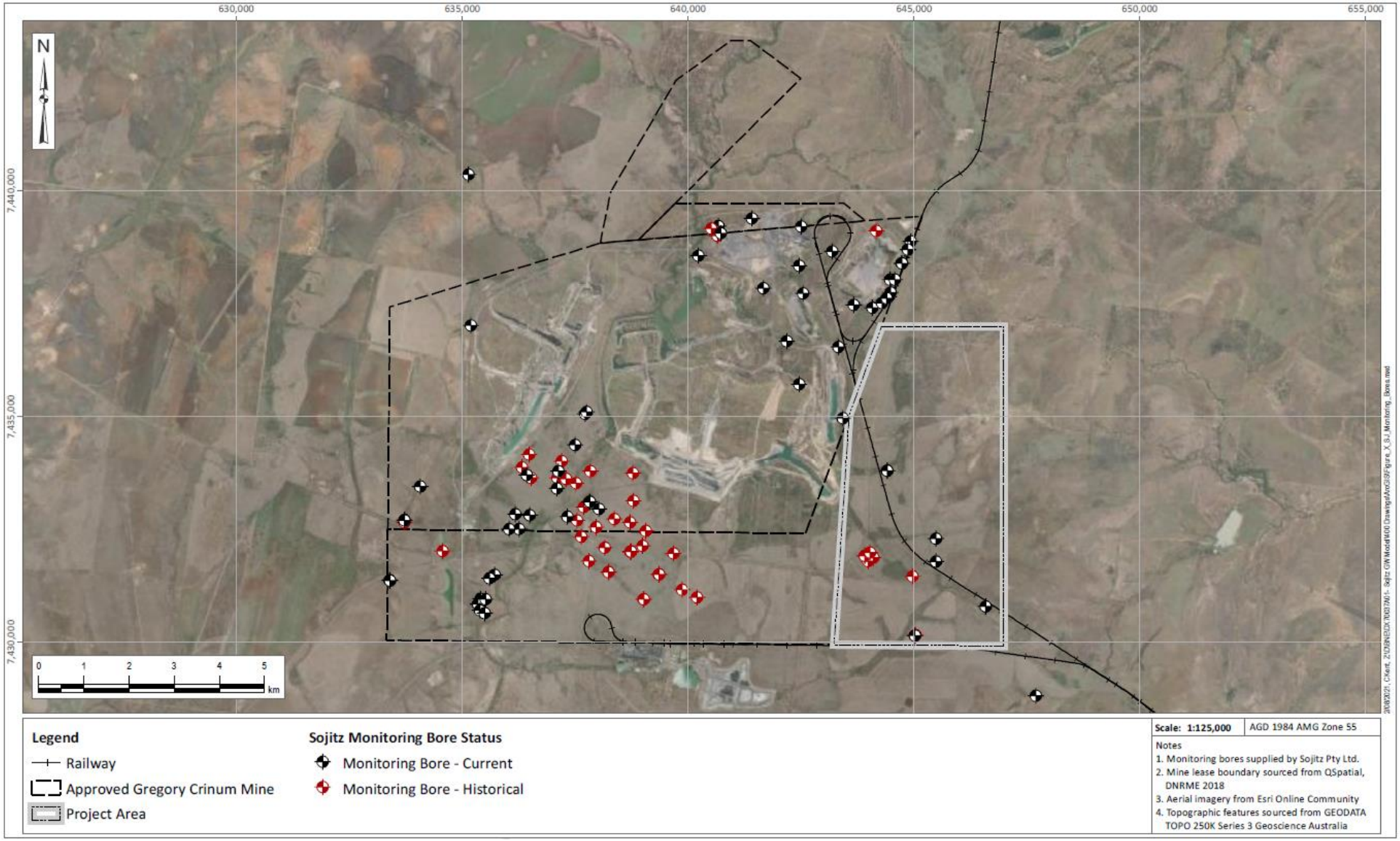


Figure 5.6: Groundwater monitoring bores

5.1.7.3 Baseline Groundwater Quality

The GCM groundwater monitoring network (Figure 5.6) includes monitoring within M-Block and targets the regional groundwater table within the Tertiary basalt, and monitors groundwater pressure in deeper strata within the basal sand and Permian coal measures. This monitoring network is suitable for monitoring the effects of M-Block on the groundwater regime and will continue to be used throughout the life of the project. Groundwater quality data provides useful information on the hydrogeological regime, as it is influenced by interaction with the aquifer matrix, and groundwater recharge/discharge processes.

Salinity is a key constraint to the usability of groundwater resources for productive applications such as potable supply, irrigation, stock watering and industrial applications. If groundwater with elevated salinity levels is used for incompatible purposes or applications it may result in impacts to agricultural productivity, health, and the environment. A categorisation scheme for salinity (FAO 1992) is presented in Table 5-4. Piper and Durov plots of the collated groundwater samples was undertaken to understand the major ionic proportions of the groundwater regime. Hydrochemical diagrams, such as Piper and Durov diagrams are useful for assessing groundwater mixing and evolution (e.g., through water rock interaction) and identifying potential zones of groundwater recharge and discharge.

Table 5-4: Salinity classification scale

Salinity	Electrical Conductivity (µS/cm)	Salt Concentration (mg/L)
Fresh (Non-Saline)	<700	<500
Brackish (Slightly Saline)	700 to 2,000	500 – 1,500
Moderately Saline	2,000 to 10,000	1,500 – 7,000
Highly Saline	10,000 to 25,000	7,000 – 15,000
Very Highly Saline	25,000 to 45,000	15,000 – 35,000
Brine	>45,000	>35,000

Source: FAO, 1992

Groundwater quality within the vicinity of M-Block has been considered using available data collected from the GCM monitoring network. The geochemistry of the water-bearing hydrostratigraphic units is summarised in Table 5-5.

Table 5-5: Summary of the groundwater chemistry in the vicinity of M-Block

Hydrostratigraphic Unit	pH (pH units)	Salinity (TDS mg/L)
Tertiary basal sand	Range between 7 – 12.7Average of 9.7	Range between 303 – 6,230 – Average of 1,446 Salinity: brackish to moderately saline
Tertiary basalt	Range between 7 – 12 Average of 8.0	Range between 413 – 20,800 – Average of 1,574 Salinity: brackish to highly saline
Permian Coal sub-unit	Range between 6.8 – 12.4 Average of 8.9	Range between 689 – 11,000 – Average of 3,53 Salinity: brackish to saline
Permian Sandstone sub-unit	Range between 6.7 – 8.0 Average of 7.3	Range between 1,660 – 23,100 – Average of 13,843 Salinity: highly saline to brine

Piper and Durov diagrams of the hydrogeochemical data from Sojitz monitoring bores are shown in Figure 7.37 and Figure 7.38 within Appendix D. Based on these diagrams, the following observations can be made:

- Groundwater within the Tertiary basalt shows a bicarbonate magnesium and calcium type, this is characteristic of waters within mafic igneous aquifers such as basalt. Groundwater within the Tertiary basalt also shows sulphate enrichment; this is indicative of recharge water and confirms that the basalt aquifer is being recharged via rainfall infiltration.
- Groundwater within the basal sand shows a sodium and chloride enrichment type. This is likely to be due to a combination of both cation exchange with the overlying Tertiary clay units and dewatering activities at the GCM Complex.

- Groundwater within the Permian coal measures, shows a sodium and chloride enrichment typical of groundwater at depth in the Permian sequence.

5.1.8 Impact Assessment

The assessment criteria used to consider the groundwater drawdown impacts associated with M-Block refers to the Queensland *Water Act 2000*, trigger thresholds:

- Bore trigger threshold, represents the maximum allowable groundwater level decline in a groundwater bore, due to petroleum tenure holders' activities, prior to triggering an investigation into the water level decline.
- For a consolidated aquifer – 5 m.
- For an unconsolidated aquifer – 2 m.
- Spring trigger threshold represents the maximum allowable groundwater level decline in the water level of an aquifer in connection with a spring, at the spring location, prior to triggering an investigation into the water level decline.
- Spring – 0.2 m.

Potential impacts have been assessed using the predicted drawdown from the numerical model with consideration to hydrogeological conceptual understanding of the system. Groundwater and surface water interactions have also been considered through the conceptual understanding of the system.

A detailed explanation of the potential impacts to groundwater is detailed within Section 8 of Appendix D, with a summary of potential impacts provided below.

5.1.8.1 Zone of Depressurisation

The mining activity will involve dewatering the underground workings, which will result in depressurisation of the overlying and surrounding strata. Due to the south westerly dip of the target coal seam, the underground workings within M-Block will be located at a depth of up to 370 m.

Underground mining may reduce the water pressure within the rock mass beyond the zone directly mined. The extent and magnitude of this pressure decrease is controlled by the hydraulic properties of the rock mass. The zone in which a pressure decrease occurs is known as the zone of depressurisation.

The pressure decrease within the zone of depressurisation is greatest adjacent to the active working face where active dewatering and excavation occur. Depressurisation decreases away from mined areas, with the rate of change and extend of impact controlled by the formation and boundary conditions associated with the groundwater flow system. Section 8.2.1 within Appendix D presents the zone of depressurisation that is predicted to occur due to the operation of M-Block.

5.1.8.2 Summary of Groundwater Modelling

The calibrated groundwater model was used to predict groundwater inflows and changes in groundwater levels in response to the operation of M-Block, including simulation of longwall mining in areas of longwall mining (historical areas in both the Kestrel Mine and GCM). The modelling approach included the simulation of subsidence-induced fracturing above the longwall panels in the historical areas (and approved future operations). Further details of the groundwater model are included in Appendix II of Appendix D.

Continuous cracking is expected to extend above mined longwall panels and into the overlying units within the Permian coal measures. Continuous cracking increases the vertical hydraulic conductivity throughout the affected zone, with the magnitude of the increase likely to be less with increasing height above the mined seam.

The sensitivity of the model predictions to the input hydrogeological parameters was tested and involved varying key model parameters in isolation and assessing the influence the change made on predictions of drawdown and mine inflow. Key model parameters were selected based on their potential to most influence model predictions.

The analyses found that predicted groundwater inflows and extent of depressurisation were most sensitive to changes in the hydraulic conductivity of the German Creek seam.

5.1.8.3 Groundwater Drawdown

Figure 8.1 of Appendix D shows the predicted maximum depressurisation within the target German Creek seam.

The operation will locally depressurise the German Creek seam within M-Block and its surrounds by up to 320 m. Depressurisation is greatest in the southern portions of M-Block, where the depth of mining is greatest, and therefore the groundwater pressure is greatest.

Depressurisation of up to 2 m (unconsolidated bore trigger threshold) of the German Creek seam due to the operation of M-Block extends approximately 6 km south, west and east from M-Block.

Depressurisation predictions for the basal sand and basalt units are shown in Figure 8.2 and Figure 8.3 of Appendix D. Up to 26 m of localised depressurisation is predicted for the basalt, which occurs towards the southeast of M-Block. Depressurisation mostly occurs within M-Block, extending ~3 km to the north, south and west. Up to 48 m of depressurisation is predicted to occur in the basal sand unit, occurring towards the south of M-Block. Depressurisation mostly occurs within M-Block, extending ~4 km to the south and west.

The coal seam (and overlying strata) in these areas have already been impacted as a result of the approved mining activities at the GCM and the neighbouring Kestrel Mine.

A public comment was made regarding concerns about groundwater drawdown affecting groundwater over the long term in the vicinity of M-Block. It is expected that whatever impacts they would have, probably already occurred – as a combination of the historic Crinum and Sojitz mining.

The Assessment of the M-Block shows that the basalt aquifer over surrounding properties will not have a lot of extra impact (Using a relatively recent water level contour (Dec 2020) as a reference condition).
The additional impact will probably start in 2045 and will reach between 2 and 5 m extra drawdown in 2050.

The cumulative predictions for Sojitz and Kestrel showed no additional impact for surrounding groundwater than shown in Figure 5.7.

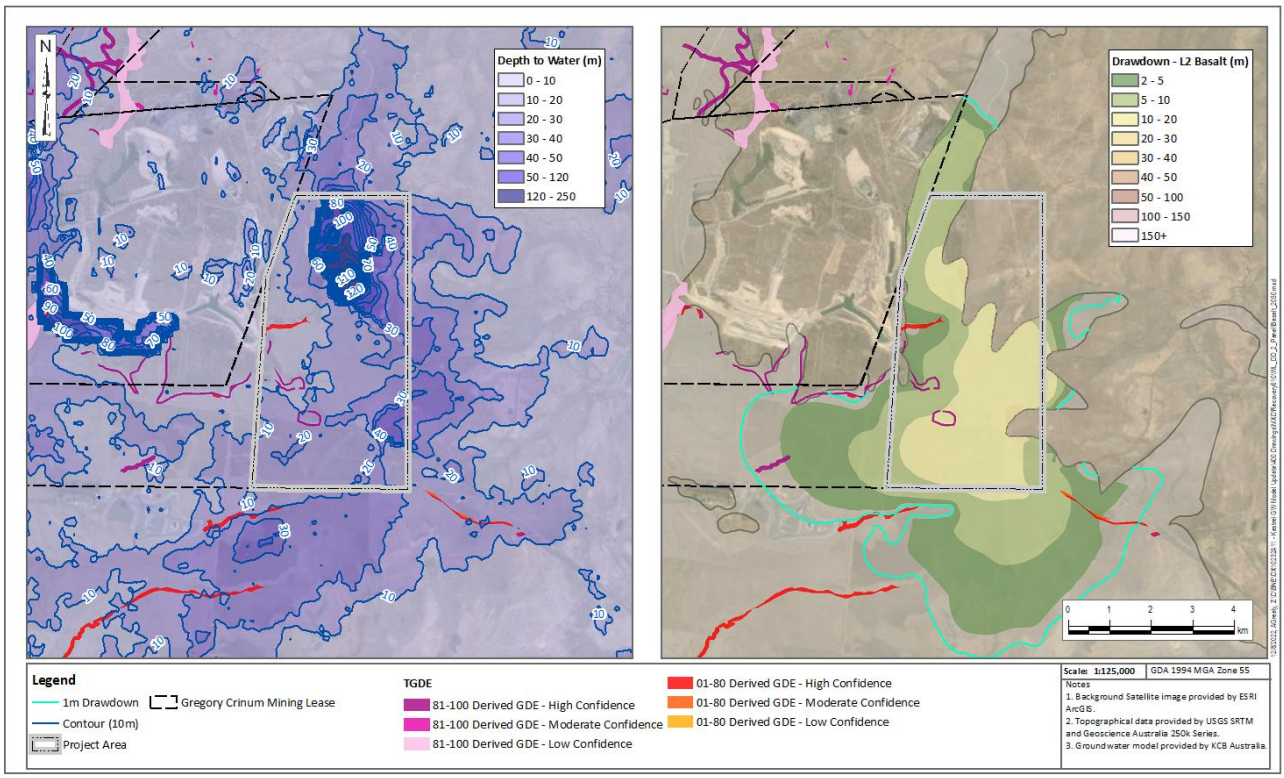


Figure 5.7: GCM groundwater drawdown 2050

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5.1.8.4 Groundwater Inflow to Underground Operations

Modelled groundwater inflow rates to the proposed mining operation are presented in Figure 8.4 of Appendix D.

The predicted rate of groundwater inflow is controlled by factors such as mining depth and extent, the thickness and hydraulic conductivity of mined and overlying strata, the hydraulic gradients induced by depressurisation and drawdown from nearby mines.

The predicted inflows from M-Block gradually increase as mining progresses south and the German Creek seam becomes deeper. The predicted inflow rate peaks at approximately 6.9 ML/d (2,523 ML/pa).

The predicted groundwater inflow rates represent the total volume of groundwater that will be removed from the groundwater regime. The actual volume of groundwater pumped from the mining area will be less that that predicted by the numerical model, as a component of the groundwater will be lost to wetting of surfaces, ventilation and retained moisture within the coal. The inflow rates presented in Figure 8.4 of Appendix D do not account for the abovementioned losses that will occur when converting groundwater inflow rates to mine dewatering rates and are therefore conservative.

5.1.8.5 Impact to Groundwater Resources

GCM is located in the Highlands Groundwater Management Area (GMA) under Schedule 3 of the *Water Plan (Fitzroy Basin) 2011* area. The Highlands GMA comprises two groundwater units, Highlands Groundwater Unit 1, containing the aquifers of the Quaternary alluvium, and Highlands Groundwater Unit 2, containing all sub-artesian aquifers within the Highlands GMA other than the aquifers included in Highlands Groundwater Unit 1.

There is no drawdown within the alluvium as a result of the proposed M-Block operations. There will be no groundwater take from the alluvium (i.e. Groundwater Unit 1) and therefore, no impact on this groundwater resource.

Figure 8.4 within Appendix D shows the predicted groundwater take from Groundwater Unit 2. The operation of M-Block will result in a total additional groundwater take of up to ~ 2,525 ML/pa from Groundwater Unit 2 due to inflows to M-Block.

Post-mining, the underground workings will be allowed to flood, and the groundwater level will recover. The final open-cut void will be designed and incorporated into future updates of Sojitz's Progressive Closure and Rehabilitation Plan, which is a requirement of the Queensland *Environmental Protection Act 1994* (Queensland Government 2022e), and the *Mined Land Rehabilitation Policy* (Queensland Government 2021b).

Sojitz will consult with DES in relation to its obligations for groundwater take, as necessary.

5.1.8.6 Impact on Groundwater Users

As discussed in Section 5.1.4, there are eight potential water supply bores in the vicinity of M-Block. Potential long-term impacts to groundwater bores have been assessed against the *Water Act 2000* bore trigger threshold of 5 m for a consolidated aquifer using the outputs and drawdown predictions from the numerical model. The predicted drawdown in 2050 has been used for this assessment. A summary of the impacts to groundwater bores is presented in Table 5-6.

Table 5-6: Potential water supply bores in the vicinity of M-Block

RN	Purpose	Screen Unit	Distance from M-Block Area	Model Layer Assessed	Drawdown at 2050 (m)
57667	Water supply	Basalt	2.3 km	Layer 2	1.4
57668	No purpose listed	Upper Permian	4.4 km	Layer 5	0.5

62769	No purpose listed	Upper Permian	3.5 km	Layer 5	4.0
62771	No purpose listed	No details	4.3 km	Layer 5	2.0
62772	No purpose listed	No details	1.2 km	Layer 5	14.6
89346	No purpose listed	Upper Permian	2.5 km	Layer 5	1.2
89347	Water supply	Upper Permian	9.6 km	Layer 5	0.1
89405	No purpose listed	Upper Permian	4.6 km	Layer 5	1.6

The results indicate that drawdown is observed in bores attributed to both the bores screened in the basalt and the upper Permian, with only one bore assigned to model layer 5 potentially impacted above the *Water Act 2000* trigger threshold of 5 m. This bore has no purpose listed, or geological information available and was assigned to layer 5 for the purposes of impact assessment based on neighbouring bores.

The *Water Act 2000* outlines requirements for make good obligations of a resource tenure holder for a bore located in immediately affected areas. Tenure holders must carry out a bore assessment and enter into a make good agreement with the bore owner if the bores are located within an immediately affected area. Any required bore assessments will be undertaken in accordance with the DES 'Bore Assessment Guideline' (DES 2021).

The results of the impact assessment to bores indicate that there would be one bore that may potentially experience water level decline greater than 5 m as a result of the development of M-Block.

5.1.8.7 Impact on Groundwater Quality

M-Block is an extension of an existing mining area that will be operated as part of the approved GCM and use existing infrastructure at the GCM for processing coal and storage of rejects associated with coal processing. Therefore, there is limited potential for contamination from new surface infrastructure areas.

The storage of hydrocarbon and chemicals will continue to be managed in accordance with the existing GCM management practices, including the use of bunding and immediate clean-up of spills which are standard practice and a legislated requirement at mine sites that will prevent the contamination of the groundwater regime.

All vehicles are serviced regularly in appropriately bunded and lined workshops to ensure that oils and hydraulics fluid leaks if any from plant and machinery are contained. These areas are fitted with triple interceptor traps or equivalent so that leaks and spills are captured and treated.

In the instance of a spill occurring, the impact would be minor and localised, Hydraulic oils and fuels are stored in appropriately bunded and lined areas to prevent soil and groundwater contamination from leaks and spills.

Should leaks of oils occur in the unlikely events of accidents or equipment failure, oil spill response kits are used to clean up any localised environmental impacts on adjacent soils and to eliminate potential impacts on nearby watercourses in accordance with the Gregory Crinum Mine Oil Spill Response Procedure.

Given the limited activities proposed, and the controls that will be adopted, M-Block has a very limited potential to give rise to groundwater contamination as a result of hydrocarbon and chemical contamination.

5.2 Final Voids

Condition F6 of the EA relating to residual void outcome requires that:

Residual voids must not cause any serious environmental harm to land, surface waters or any recognised groundwater aquifer, other than the environmental harm constituted by the existence of the residual void itself and subject to any other condition within this environmental authority.

As part of the *Gregory Crinum Mine Residual Void Investigation Report,* updated in 2021, Sojitz commissioned 3D Data Guidance Pty Ltd (3DG) to undertake a conceptual final landform design, which was prepared based on the expected pit and dump surface configuration to end of mine life. This report was provided to, and accepted by, DES.

As part of the assessment of M-Block, KCB were commissioned to prepare a three-dimensional numerical groundwater flow model using MODFLOW-USG. The model was developed to represent the key hydrogeological units within 15 model layers, covering an area of approximately 2,000 km^2.

5.2.1 The final M-Block pit will be reshaped to form a depressed landform with no residual void remaining on the void partially backfilled to cover groundwater level (

).

5.2.2 Void Design

When undertaking the final landform design for the GCM voids, 3DG adopted the following design criteria:

- Unrehabilitated spoil and low wall batter slopes greater than 25% shall be reshaped to a maximum slope of 25%.
- Weathered highwalls shall be reshaped to a maximum slope of 25% and un-weathered highwalls remain.
- Slopes below long-term final void high water levels will be left at angle of response.
- A 5 m angle of repose batter will be left down to G North Wetlands water level.
- Rephased 25% slopes shall be capped with 0.5 m of basalt rock mulch.
- A 30 m running surface shall be provided for basalt and topsoil haulage (3DG 2021).

The 3DG designs show that the landform in M-Block can be constructed with the available material located within the M-Block boundary. The final landform design represents the final design surface and may require additional blending of the surfaces at the edges of the design to tie into the existing landscape. Further work on the design may be required if the predicted swell ratios are found to be different in the field.

5.2.3 Residual Voids

The optimised final landform design results in 17 residual voids across GCM, the areas and volumes of which are provided in Table 5-7 and shown on Figure 5.8. As agreed with DES, the M-Block void is planned to be partially backfilled higher than the final groundwater elevation. Sojitz will continue to look for post mining uses for final voids that will reduce any potential impacts.

It is noted that while one void is referenced as ‘M Block’ is it located to the west of the M-Block extension area. There will be no residual voids located within M-Block.

Table 5-7: Final void areas and volumes

Final Void	Surface Area* (ha)	Void Volume* (Mm^3)	Relevant Void Water Level (mRL)
M Block	16.3	2.24	188.2
J Block Ramp 7	12.1	1.30	191.9
J Block Ramp 8	9.3	0.87	173.8
J Block Ramp 9	27.5	5.04	167.8
F Block	8.2	0.90	193.8
ASE Block - A	7.2	0.99	176.3
ASE Block - B	12.3	2.11	176.3
ASE Block - C	3.6	0.61	176.3
ASE Block - D	7.3	1.50	176.3
ASE Block - E	2.8	0.15	176.3
G Block Central	45.6	10.89	167.5
ABG Block - West	0.7	0.03	176.2
ABG Block - East	31.2	5.30	176.2
G Block North - A	2.4	0.06	183.3
G Block North - A	0.7	0	183.3
Ramp 4	2.0	0.17	183.1
Liskeard	5.2	0.19	183.1
Total	194.4		

*Subject to some change as design is refined and physical works progress

5.2.4 Residual Void Hydrological Studies

Residual void hydrological studies have been undertaken by Sojitz (2021) to:

- Calculate future groundwater inflow rates into residual voids.
- Determine long-term water balance in the voids (including the long-term equilibrium water level and potential interactions with surrounding aquifers).
- Estimate long-term void water quality.

A summary of the results is provided in the following sections with further detail is provided in Section 8.5 of Appendix D.

5.2.5 Water Balance Modelling

The water balance model for the water level in each residual void is predicted to rise towards an equilibrium over a period of about 50 years. Water level fluctuations within each void of about 5 m over decadal scales are expected. The modelled long-term high-water level (i.e., the modelled average daily maximum water level) for each void is calculated and compared to the surface elevations. The maximum water level does not the spill elevation for any of the 17 voids. No overtopping and no adverse environmental impact is expected to be caused to adjacent surface waters or adjacent land. Groundwater modelling results over the simulation period indicate that:

- Groundwater inflows will continue to the voids, with the highest rates of groundwater flows in the first 50 years after operations have ceased.
- The groundwater system has recovered within 100 years.
- Over the entire 600-year simulation period, groundwater gradients remain toward the voids, with the voids acting as localised groundwater sinks due to evaporation losses.

The modelling results suggest that it is unlikely that void water will migrate away from the voids to impact on the regional groundwater quality. Short-lived, transient periods of outflow would occur in periods of very high rainfall when the void water levels are temporarily higher than the groundwater elevations but the general gradients towards the voids re-establish after these events.

The shallow aquifer groundwater high associated with the southern portion of the M-Block is an area that is not impacted by the deeper mining. No impacts are therefore expected from this area irrespective of the flow direction.

Snapshots of the groundwater table contours over time have been provided as Figure 2.6 of Appendix L.

5.2.6 Groundwater Sinks

The long-term groundwater simulations indicate that post-closure, the voids will continue to function as local groundwater sinks. This will encourage flow toward the final voids and will act to prevent the high salinity water in the voids from migrating away from the mining area. Short-term transient reversals of flow will occur in periods of high rainfall/run-off into the voids when void water levels are temporarily higher than the equilibrated groundwater levels. During these short-lived periods, the higher salinity void water will be able to migrate into the groundwater immediately adjacent to each void, however, the gradients toward the voids will rapidly re-establish and the groundwater will again flow toward the voids.

The groundwater flow within the M-Block deeper mining area will report to the open pit area to the north of the M-Block extension showing deeper groundwater levels due to the evaporation creating the groundwater sink. Other voids in the historic Sojitz mined out areas will create passive sinks due to evaporation. Each of these voids acts as a local groundwater sink.

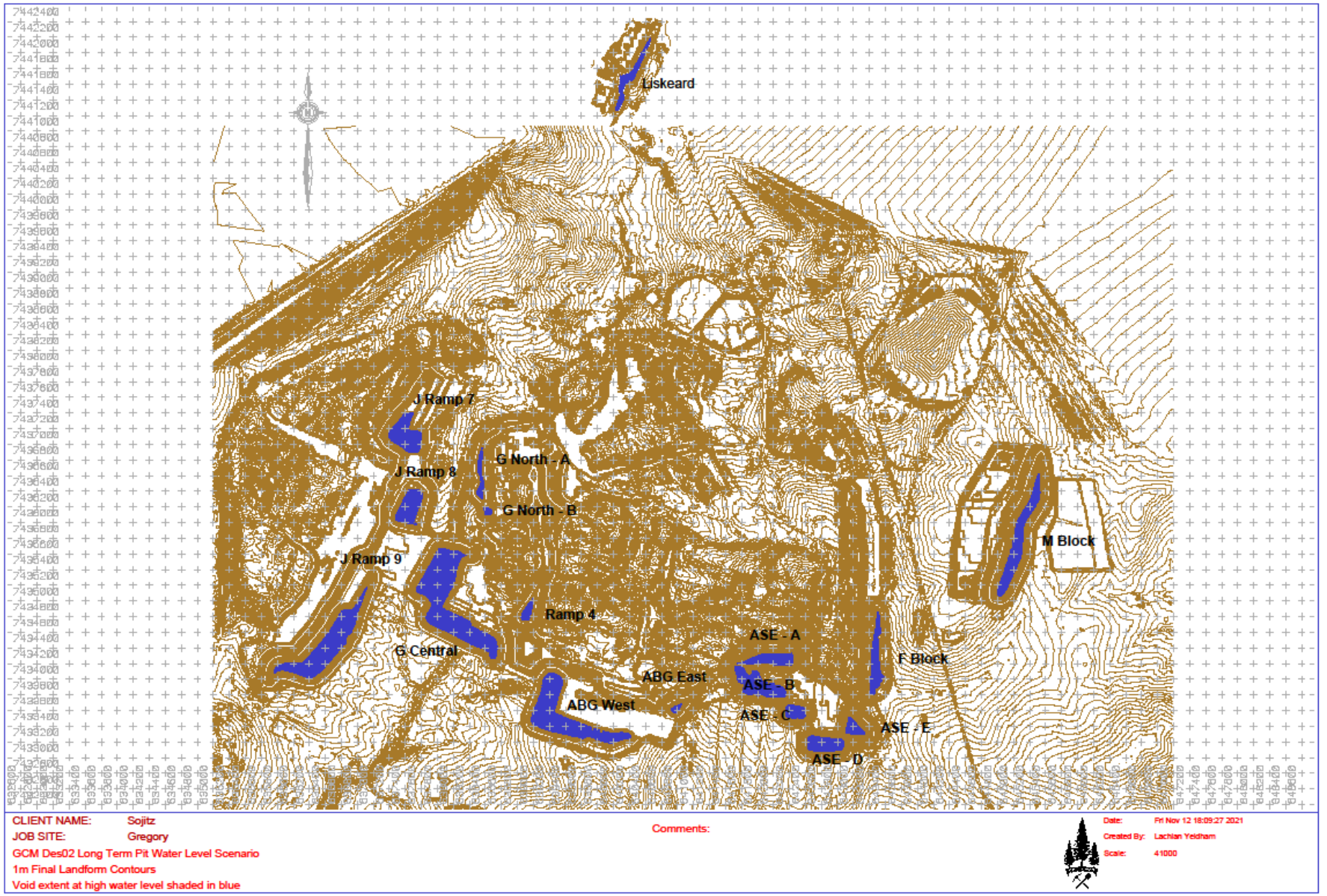

Figure 5.8: GCM final voids

5.2.7 Salinity

As previously mentioned, the water quality assessment suggests that the voids will be unsuitable for stock watering or irrigation purposes after closure. It can be expected that with the voids acting as groundwater sinks that the water quality will become saline.

The salinity results from this long-term water and salt balance provide an indicative assessment of void water quality undertaken using the range of groundwater qualities, potential groundwater inflows and run-off salinities in the voids. The site-wide water and salinity balance indicate that extremely high TDS values can be expected in these voids after closure, because of evaporation exceeding inflows expect in the short periods of rainfall events. The result from the continuous input of salt and negative water balance produces continuously increasing salinity in the majority of the GCM voids in the 600 years simulation after closure.

The modelling results suggest that it is unlikely that saline void water will migrate away from the voids to impact on the regional groundwater quality. Short period of outflow would occur in periods of very high rainfall, when the void water levels are temporarily higher than the groundwater elevations, but the general gradients towards the voids re-establish after these events. The post-closure groundwater simulations indicate that the void water quality would be unlikely to impact on regional groundwater users. The Residual Void Investigation Report (3DG 2021) identifies that the maximum water level does not reach a level where any of the voids would spill and therefore adverse environmental impacts are not expected to be cased to adjacent surface waters or land.

5.2.8 Residual Void Management and Rehabilitation

The rehabilitation criteria applicable to the residual voids is detailed in Table 5-8 (3DG 2021). The criteria are implemented through the:

- Water Management Plan
- Erosion and Sediment Control Management Plan
- Rehabilitation Management Plan.

Table 5-8: Residual void rehabilitation criteria

Objective	Indicator	Criteria
Safety hazards minimised	Hazard assessment of access	• No public access to highwalls/end walls (bunding/fencing as required)
Final voids are geotechnically stable	Factor of safety	• ≥1.5 (unless an alternative is justified by an appropriately qualified person).
	Wall slope and area	• Maximum slope in competent rock 275% (70^{o})* • Maximum slope in incompetent rock 65% (angle of repose). • Maximum total void surface area 200 ha (measured at high water level)
	Condition assessment by an appropriately qualified person	• Assessment report by a Registered Professional Engineer of Queensland (RPEQ) on the geotechnical stability of final voids.
Maintenance of surface and groundwater quality	Water quality	• Surface water and groundwater quality of receiving waters meets the requirements of Schedule W of the EA. • Voids have no adverse environmental impacts on surrounding aquifers • Final voids do not spill to surface waters

* Subject to completion of geotechnical evaluation

The GCM Rehabilitation Management Plan identifies voids as a mine domain with the post-mining land use being non-use management area. For the low walls and weathered highwalls the detailed rehabilitation method is:

- Pending spoil balance and basalt rock mulch stockpile location, margins are either:
  (i) regraded to ≤ 25% and capped with 0.5 m basalt rock mulch, or
  (ii) regraded to ≤10% and if spoil not supportable (see section 5.3) capped with 0.5 m of competent Permian sandstone.
- Reshaped-treated surfaces topsoiled, deep ripped.
- All slopes seeded with 'open woodland' post-mining land use seed mix.
- Safety fencing/bunding as required.

5.2.8.1 Monitoring Program

The rehabilitation monitoring program for GCM is outlined in Table 11 of the Rehabilitation Management Plan. For the final voids the following monitoring is undertaken:

- Geotechnical stability of walls (field inspections and aerial imagery) - At cessation of mining, then 5-yearly intervals until relinquishment.
- Water levels and quality (pH and EC) – annual sampling and analysis.

5.3 Waste Material

Waste material generated by the mining operation proposed for M-Block will comprise:

- Overburden. This material will be reused to shape the site to its final landform prior to revegetation or pending spoil balance assessment, used for capping purposes as related to tailings / rejects storage facilities.
- Putrescible and other similar waste from crib room. This will be collected in suitable receptacles and deposited to an off-site landfill via JJ Richards collection.
- Mine affected water. This water will be reused in dust suppression activities or pumped to the current storage area on F-Block immediately to the west of M-Block.

Waste management associated with M-Block will be undertaken in accordance with the current GCM Waste Management Plan (Waste MP) and the GCM Water Management Plan (Water MP), amended as required to reference M-Block. The implementation of these plans is to maintain compliance with the applicable conditions of the EA.

Tailings and rejects generated as part of processing will be deposited into the I-Block tailings storage facility and available dedicated voids.

The preliminary calculation of tailings/rejects for the proposed open cut and underground mining operations are as follows:

- Open Cut - commencing 2023 and ending in 2025.
  - 2,965,500 tonnes of coal.
  - 39,851,000 bcm of overburden.
  - 75% yield.
  - 1.4 Relative Density.

  Estimated 529,500 bcm of rejects/tailings
- Underground – commencing 2028 and ending December 2039.
  - 19,917,000 tonne of coal.
  - 75% yield.
  - 1.4 Relative Density.

  Estimated 3,556,600 bcm of rejects/tailings.

5.3.1 GCM Spoil/Waste Materials Classification

In 2012 B.R. Emmerton Pty. Ltd. (B. R. Emmerton 2013) undertook a survey of spoil/waste materials in the mined area, to classify and map the materials into broad categories which would have relevance in terms of physical attributes (salinity, plant growth and erosion/stability characteristics) and possible elemental enrichment (waste or contamination characteristics). This was partly intended, prior to planning for mine closure, to map spoil and waste materials into broad categories and appraising their quality and characteristics. The survey examined spoil and coal waste material from 248 sites over the full extent of GCM and classified the spoil/waste into fifteen Spoil/Waste Mapping Categories.

The analysis of the samples was undertaken by B.R. Emmerton (2013) in two stages:

- Stage 1 Field testing.

  248 samples collected were screened for pH, electrical conductivity (EC) and slaking/dispersion characteristics pH and E.C. analysis, and slaking/dispersion characteristics.

- Stage 2 Salinity, physical, geochemical and leachate analysis.
  - Salinity and physical analysis.

    A total of 65 samples (20 samples from the contaminant source study, eight samples from the Crossbed Creek substrate study and 37 samples from the current spoil/waste mapping study) were analysed for salinity and physical characteristics.

    - pH, EC, chloride and sulphate.
    - exchangeable calcium, magnesium, potassium and sodium.
    - cation exchange capacity.
    - particle size analysis and R1 dispersion index.
    - 1/3 and 15 bar moisture contents.
  - Geochemical analysis.

    A total of 67 spoil samples (20 samples from the contaminant source study, 10 samples from the Crossbed Creek substrate study and 37 samples from the current spoil/waste mapping study) as well as seven background soil samples were analysed for geochemistry, testing for a range of 44 elements to determine if elements in the spoil/waste materials were elevated above natural background levels, and whether the presence of these elements may have implications in terms of contaminated land legislation.
  - Leach analysis.

    A total of 67 spoil samples, 10 samples from the Crossbed Creek substrate study and 37 samples from the current spoil/waste mapping study) as well as seven background soil samples were subjected to 1:2 leach tests to analyse for the majority of potential contaminants listed in the Water Section of EA.

Following the analysis of materials they were grouped into five groups with broadly similar analytical and behavioural characteristics as well as treatment recommendations (B.R. Emmerton 2013). B.R. Emmerton (2013) detailed that the groupings and recommendations are broad by necessity, to simplify interpretation of treatments required for overall planning purposes, and further that individual areas needing rehabilitation should be assessed on an area-by-area basis. It is anticipated by Sojitz that these findings will be reflective of spoil/waste material generated from M-Block. Further geochemical analysis of spoil will be undertaken by Sojitz as exposed in M-Block to inform waste management methods and rehabilitation. The spoil/waste generated by the project will be managed through the Waste Management Plan and the Rehabilitation Management Plan which will be updated to incorporate any M-Block specific requirements.

The five spoil/waste types of GCM and their broad characteristics and associated treatment recommendations as described by B.R. Emmerton (2013) are detailed in Table 5-9.

Table 5-9: Functional material rating and broad rehabilitation/treatment for material encountered at GCM

Functional Material Rating	Spoil/Waste Mapping Categories and broad characteristics and treatment recommendations
Hostile/potentially toxic materials **(15% of the area of spoil/waste classified and mapped)**	*Acid-forming sedimentary rocks (Pas), Carbonaceous materials (Dark, carbonaceous Permian siltstones and shales (Pcb) and coal enriched spoil/waste products (Crt) materials* Acid producing materials (which with the exception of the Pas materials, are carbonaceous) with elevated to high, or sometimes extreme salinity (often exhibiting significant elemental enrichment and extremely poor leachate characteristics), which generally leach (with the exception of the impounded tailings materials, which have a high water table and extreme surface salinity) but which have some areas which are acid generating and develop extremely low pH and high salinity. The materials are difficult to effectively rehabilitate due primarily to the presence of areas of extremely low pH for plant growth, but also due to low to marginal plant water holding capacity in the materials. The materials should be preferentially buried (optimally in pit). If not able to be buried in pit or moved to an in pit location, capping will usually be required for adequate rehabilitation.
Extremely hostile materials **(16% of the area of spoil/waste classified and mapped)**	*Highly weathered Permian derived fine sandy clays and/or unconsolidated fine sandy/clayey Cainozoic sediments (Bcz), Pallid or mottled (white, red, purple) insitu, strongly kaolinitic Tertiary clays (Tci) and weathered Permian and/or unconsolidated Cainozoic sediments (Btc) materials* High clay content materials generally with high or extreme salinity, and occasionally with low pH, which have restricted rooting depth for groundcover species, are highly/extremely sodic and dispersive and are prone to rehabilitation failure where conventional/traditional rehabilitation methods involving relatively thin topsoil cover are used. Where exposed, the materials exhibit capillary rise of salts and have poor prospects for long term leaching, even where topsoiled. The materials are not a desirable subsoil material and would only be considered to support a limited range of resilient salt tolerant ephemeral shrub or woody species. Surface placement of these materials should be avoided at all costs, especially in elevated dumps. Effective rehabilitation of these materials will usually require cladding with competent/resilient cover material to act as a surface erosion control and to also act as a less hostile subsoil (where slopes are almost flat, a reduced thickness of cladding material may suffice).
Hostile/difficult materials **(6% of the area of spoil/waste classified and mapped)**	*Recent sandy or silty alluvium (Bqa), unconsolidated calcareous sediments and/or basaltic reactive clays (Btq) and predominantly fresh, labile, very fine grained Permian sedimentary rocks (mudstones, siltstones and/or shales) (Pls) materials (also includes areas of mixed materials, mainly moderately to highly weathered, fine to medium grained, Permian lithic sandstones, siltstones and shales (Bpw)/ highly weathered Permian derived fine sandy clays and/or unconsolidated fine sandy/clayey Cainozoic sediments (Bcz) materials as a secondary grouping of spoil types)* In the single primary Spoil/Waste Mapping Categories materials, clay content ranges from low (Recent sandy or silty Quaternary alluvium associated with current streams (Qas) materials) to sometimes high (Btq materials) and salinity is elevated to high. Some areas are prone to rehabilitation failure (where slopes are elevated well above background slopes, or where the materials have higher clay contents (some Btq materials) or high fine sand and silt contents (Pls materials)), however, the majority of materials appear to be capable of leaching and this will be improved with low slope and adequate soil cover. The materials are highly prone to piping and gully erosion in rehabilitated landforms. The lighter textured materials have marginal moisture holding capacity for shallow rooted species and all materials are considered to be highly erosive and therefore are better suited to the growth of more resilient deep rooted woody species than to groundcover species. (The group also includes a mixed secondary grouping of Spoil/Waste Mapping Categories materials, which are mainly areas of mixed Bpw/Bcz spoil (of Permian origin) where the inclusion of the Bcz material downgrades the mapping units from the “Supportable” category of the Bpw material, but also includes a small area of mixed Bcz/Btb material where the inclusion of basaltic material upgrades the poorer Bcz material from the “Extremely hostile” category).

Functional Material Rating	Spoil/Waste Mapping Categories and broad characteristics and treatment recommendations
	The materials are only suited to rehabilitation at moderate/gentle slopes. Above these slope angles, cladding with competent/resilient cover material will generally be required. Placement in surface or batter positions in elevated prestrip dumps should be avoided as this will add to rehabilitation complexity and cost.
Supportable materials **(59% of the area of spoil/waste classified and mapped)**	*Predominantly fresh, relatively stable, grey Permian siltstones and interbedded fine to medium grained, lithic, semi-competent sandstones (Pss) and Bpw materials* Marginal to moderate clay content materials generally with relatively low salinity (salinity is occasionally high where leaching has not taken place), which appear to usually have good long-term prospects for leaching. Sodicity is elevated to high (however reduction to low levels generally occurs in materials exposed for a long time). The fines have elevated to extreme dispersion and the rock materials are prone to fretting/breakdown in the short to medium term. The materials have erosive characteristics but the presence of some resilient rock material slows erosion processes. Rehabilitation outcomes (land use options) are generally restricted to passive/woodland uses by lower than desirable moisture holding capacity for shallow rooted species (and also by the risk of erosion with disturbance or removal of cover), but the materials appear better suited to rehabilitation at elevated slopes (determined by the degree of competent material present) than the more erosive Quaternary/Cainozoic/Tertiary/Permian materials discussed previously. There is considerable scope for improvement in long term rehabilitation stability outcomes if these materials can be selectively handled in the mining or rehabilitation process and placed onto final surface landforms. They are still not considered to be capable of stabilising steeper/higher prestrip dump batters but will give superior rehabilitation outcomes than the more erosive Quatenary/Cainozoic/Tertiary/Permian materials discussed previously.
Preferred materials **(4.5% of the area of spoil/waste classified and mapped)**	*Insitu fresh or only slightly weathered Tertiary basalt ± minor weathered regolith material (Tbi) and boxcut type materials dominated by similar competent basaltic substrate but with a mix of weathered Permian and/or unconsolidated Cainozoic sediments (Btb) materials* Generally marginal or low clay content materials with low salinity which generally appear to leach readily. The weathered basaltic materials are prone to rock fretting and some breakdown, however the fresh basalt materials are extremely hard and competent and do not fret. The materials have a sand matrix (high coarse sand which assists infiltration) and although the fines materials appear to have erosive characteristics, the presence of higher levels of resilient rock markedly slows erosion processes. Rehabilitation outcomes (land use options) are generally restricted to passive/woodland uses by lower than desirable moisture holding capacity, but the materials appear much better suited to rehabilitation at elevated/steeper slopes than other materials (determined by the degree of initially competent material present and its long term resilience). Areas of these types of materials on site are limited and where identified should be preserved, as they will provide a future rehabilitation resource of materials required for eventual mine closure (in particular to stabilise, steeper/higher spoil batters, creek diversions and recontoured lowwalls and highwalls).

5.3.2 Waste Management and Rehabilitation

The Rehabilitation MP details the procedure for the rehabilitation of the above ground tailings dams, all of which are outside M-Block and relate to the whole of the GCM operation. The dams will be de-watered and capped to be geotechnically and is stable in accordance with the EA and Rehabilitation MP. The rehabilitation strategy method includes cover the tailings with 3 m of benign spoil with a maximum final surface slope of 3%. Pending the spoil balance and basalt rock mulch stockpile location, in-pit margins are to be either:

- Regraded to ≤ 25% and capped with 0.5 m basalt rock mulch, or
- Regraded to ≤10% and capped with 0.5 m of competent Permian sandstone.

The resulting surfaces will be topsoiled and deep ripped, with slopes ≤ 5% seeded with a grazing post-mining land use mix or open woodland post-mining land use seed mix (selection dependent on post-mining land use of adjacent areas) and slopes > 5% seeded with open woodland post-mining land use seed mix.

The quantification of waste material volumes and storage in final landforms and voids will be reflected in the Waste MP and Rehabilitation Management Plan to be updated to incorporate the requirements associated with M-Block. This will detail the monitoring requirements to ensure that post-operations the landscape is safe, stable and non-polluting.

The analysis of materials across GCM identifies sufficient benign material exists on the MLs to cater for rehabilitation activities which will be undertaken as part of the GCM progressive rehabilitation process.

5.4 Groundwater Dependent Ecosystems

A Groundwater Dependant Ecosystem (GDE) assessment was completed by Cardno, now Stantec for M-Block (Appendix G) largely through interrogation of desktop resources. However, as part of other detailed ecological investigations completed for the M-Block extension, BioCondition assessment plots, completed in accordance with *BioCondition - A Condition Assessment Framework for Terrestrial Biodiversity in Queensland Assessment Manual* (Eyre *et al.* 2015), were undertaken in vegetation communities that are predicted terrestrial GDE and would also have been subject to historical groundwater drawdown due to past mining activities.

This initial GDE assessment found that there are a number of mapped potential GDEs with M-Block, however, the potential for a vegetation community to be reliant upon groundwater and thus potentially impacted by groundwater drawdown will be influenced by:

- The potential for the root structure of species to access groundwater (i.e. rooting depth).
- The nature of the geology and soils.
- The modelled groundwater levels.

Based on the initial desktop and field-based assessments, the vegetation communities mapped as being potential GDE within M-Block are dominated by *Acacia harpophylla* that has a dominant horizontal root system and were considered unlikely to be dependent on access to groundwater for long-term survival. They occur on deep self-mulching clays that have low permeability are not conducive to deep tap root development and are mapped by DES as ‘exclusion zones’ where GDE do not occur. As a result of this assessment, it was concluded that with the exception of the northern patch, they are located in areas where existing groundwater levels are typically in excess of 20 mbgl and as such occur where reliance on groundwater is expected to have a low likelihood of occurring.

A further field-based assessment was completed by 3D Environmental in December 2022 (early wet season) to ground-truth potential terrestrial GDEs within M-Block (Appendix H), including Brigalow communities, identify areas of groundwater seepage and conduct biophysical assessments (leaf water potential (LWP) and soil moisture potential (SWP)). The key conclusions from the 3D Environmental assessment were:

- Brigalow predominantly draws moisture from the soil profile between depths of 0.6 and 1.5 mbgl which may not always correspond to the zone of the seasonally highest moisture availability. This represents the zone where soil moisture is most consistently available across all seasons including periods of drought, supported by both LWP and SMP.
- There is no evidence from LWP measurement recorded in Brigalow that trees have any reliance on permanent or seasonal groundwater sources, supported by the observed susceptibility of the species to droughting.
- Dry rainforest species, such as *Brachychiton rupestris*, show higher water availability than the Brigalow, this moisture availability is accounted for in the upper 60 cm of the soil profile.

5.4.1 Ecohydrological Conceptual Model

Stantec developed an ecohydrological conceptual model (ECM) providing a qualitative description of the relationships between surface water, ground water and ecological components of an ecosystem (Appendix F). Taken from the ECM, Figure 5- illustrates a localised drainage channel within M-Block where potential terrestrial GDEs were identified, providing the basis for conceptualising the vegetation communities, relative to groundwater levels.

No alluvial deposits have been identified within M-Block and groundwater levels within the basalt aquifer are below the deepest root system, therefore the Brigalow communities are not considered dependent on groundwater as a permanent of seasonal source of water supply.

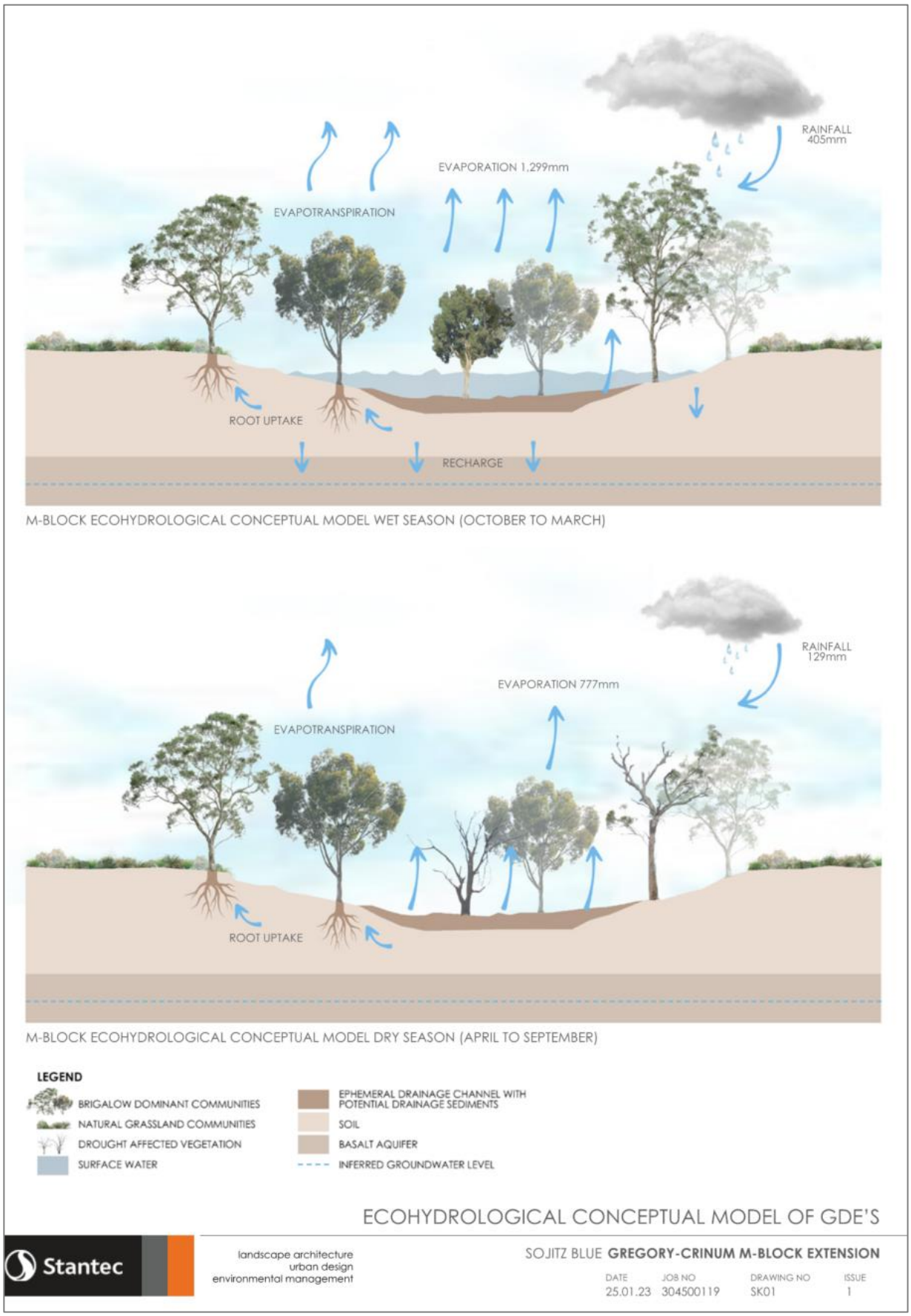

Figure 5.9: Ecohydrological conceptual model of GDEs

5.5 Stygofauna

The assessment of stygofauna was undertaken in two parts. A desktop review and a pilot survey was completed in accordance with *'Guideline for the Environmental Assessment of Subterranean Aquatic Fauna'* (DSITIA 2015), and using field sampling protocols consistent with the *Queensland Monitoring and Sampling Manual* (DES 2018) was completed in May-June 2022 (Appendix M). The initial assessment recommended that the sampling program be continued with this being completed by 4T Consultants in October 2022 (Appendix N), taking samples from eight bores which aligned with the original survey locations.

The intent of the May-June 2022 assessment was to:

- Assess the suitability of local habitat for stygofauna based on the hydrogeology within and surrounding the M-Block.
- Assess the likely presence and composition of stygofauna within and surrounding M-Block.
- Support the groundwater impact assessment for GDE under the EPBC Act.

Stygofauna samples were collected from 10 existing bores within and surrounding the M-Block area. Sampling at five additional bores was not possible due to a combination of access issues (outside the mine lease), dry and/or decommissioned bores. The bores selected contained water from alluvial, basalt and Permian aquifers to provide an adequate representation of potential groundwater stygofauna and intended to collect information on distribution of stygofauna distribution within and surrounding M-Block. The location of the sampled bores is provided in **Error! Reference source not found.**.

Static water quality monitoring completed at the same time as the stygofauna assessment found that:

- The pH of sampled groundwater ranged between 7.4 and 12.53, noting diversity of stygofauna have been found to be highest with pH values ranged from 6.5 and 7.5 (Hancock & Boulton 2008) but that generally, the pH of groundwater of the bores is suitable to support stygofauna.
- While stygofauna can tolerate a range of EC values, two recent studies have found that EC values greater than 3,000 µS/cm (Hose et al. 2015) and greater than 9,975 µS/cm (Hancock & Boulton 2008) do not support habitat typically considered to be suitable for stygofauna (Cardno now Stantec 2022).

With respect to stygofauna sampling, none of the bores sampled supported stygofauna. However, it was noted that the absence of stygofauna in the samples collected does not necessarily indicate they are absent from M-Block.

The following findings may have contributed to the lack of stygofauna in the sampled bores:

- The relatively high values of pH and EC recorded in some of the bores, particularly the Basalt Sand and South, Permian, Permian Coal aquifers, suggest these aquifers would provide sub-optimal, at best, habitat for stygofauna.
- Favourable conditions for stygofauna (Hancock & Boulton 2008, Tomlinson & Boulton 2010) are typically present at all alluvial bore sites accessing shallow aquifers with low conductivity and near neutral pH. Alluvial aquifers were not available for sampling in the present survey. Alluvial aquifers are not present within the boundaries of M-Block.
- The frequency and timing of bore purging prior to sampling may also have limited the capture of stygofauna. Bores sampled were purged on the 13 and 14 April 2022 for groundwater monitoring, 2 months before samples were collected. Ideally, bores should be left for a minimum of 3 months after the last purge before sampling for stygofauna (WA EPA 2007)
- Stygofauna generally occur at low densities in aquifers unless there are localised and abundant resources, such as alluvium of larger river systems and near phreatophytic trees (i.e. with deep roots penetrating the saturated water of groundwater systems (Dole-Olivier et al. 2009, Hancock & Bolton 2008). This suite of characteristics are absent from M-Block and hence, the low natural density of stygofauna inherently reduces the chance that they would be found given the sampling effort.

Figure 5.10: Stygofauna assessment sampling program

The second sampling program undertaken by 4T Consultants in October 2022 (Appendix N), involved taking samples from eight bores which aligned with the original program conducted by Stantec (Appendix M). Sampling at three bores previously assessed by Stantec was not possible due to access issues. This assessment found:

- Two individuals from a single taxon (*Syncarida parabathynellidae*) in Bore Basalt 11 which is screened within a Tertiary Basalt aquifer.
- There was no further detection of stygofauna in the remaining bores.

As part of the second sampling program, static water quality monitoring was completed on a different day of sampling, so the bores were not disturbed prior to collecting. Of the bores with repeat sampling, most results are consistent between sampling events. Exceptions were the EC at Basalt South (lowered from 4563 µs/cm to 1554 µs/cm) and the pH in both Basal 10 and Basalt 11 (1 pH unit lower). The Syncardia species found is indicative of very good water quality and low EC which is consistent with the water quality collected in July 2022 (4T Consultants 2022).

5.6 Surface Water

The site is located within the Fitzroy basin and is at the headwaters of two sub-basins, specifically the Mackenzie River and the Nogoa River (Figure 5.11). The Mackenzie River sub-basin is on the far eastern boundary of M-Block with the Nogoa River sub-basin is on the western boundary of M-Block. This also corresponds with the sub-catchments for the site.

The sub-catchment on the far eastern boundary of M-Block reports southeast into a series of un-named creeks before entering Cooroora Creek located some 35 km downstream of M-Block. The other sub-catchment is on the western boundary of M-Block and reports south into Telegraph Creek and ultimately Crinum Creek.

There are no named watercourses within M-Block, however it is within the headwaters of three 1st order streams, unmapped watercourses under the *Water Act 2000*, two of which are associated with the western catchment draining to Crinum Creek (Figure 5.11). Crinum Creek ultimately runs into Nogoa River approximately 21 km south of the site.

The third first order stream within M-Block, associated with the eastern catchment, drains to Cooroora Creek (Figure 5.11). Cooroora Creek ultimately runs into the Mackenzie River approximately 45 km east of the site.

The environmental values and water quality objectives for the Mackenzie River sub-basin and the Nogoa River sub-basin are detailed within the EPP Water Mackenzie and the EPP Water Nogoa, respectively.

The environmental values for the two sub-basins are detailed in Table 5-10. The Receiving Waters Monitoring Program (REMP) for the GCM details that the environmental values associated with the site (local environ) are aquatic ecosystems (slightly to moderately disturbed) and stock water (beef cattle), with some primary and visual recreation associated with the Lilyvale Waterhole, these are detailed in Table 5-10.

Table 5-10: Environmental values for the Mackenzie River Sub-basin, Nogoa River Sub-basin environ

Environmental Values	Mackenzie north-western tributaries—developed areas	Lower Nogoa / Theresa Creek tributaries—developed areas	Local Environs
Aquatic ecosystems	✓	✓	✓
Irrigation		✓	
Farm supply/use		✓	
Stock water	✓	✓	✓
Aquaculture			
Human Consumer	✓	✓	
Primary Recreation	✓	✓	✓ (Lilyvale)
Secondary recreation	✓	✓	
Visual recreation	✓	✓	✓ (Lilyvale)
Drinking water	✓	✓	

Environmental Values	Mackenzie north-western tributaries—developed areas	Lower Nogoa / Theresa Creek tributaries—developed areas	Local Environs
Industrial use	✓	✓	
Cultural and spiritual values	✓	✓	

The site is mapped 2.5 km west of the Flood Hazard Balance layer on the *Central Highlands Regional Council Planning Scheme 2016*. The layer aligns with Crinum Creek to the west and Cooroora Creek to the east. The site is also mapped within the Flood Hazard Area – local government flood mapping area, with the Flood Hazard Balance layer coinciding with the flood hazard area – level 1 – Queensland floodplain assessment overlay on the State Assessment Referral Agency Development Assessment Mapping System. M-Block is not mapped as being subject to flooding.

Using the Queensland Future Climate Dashboard (Queensland Government 2021a), the change in the annual frequency of wetness (average number of wet events per year in the 20-year period where SPI-12 is greater than the severity threshold - moderate, severe or extreme) can be projected. The projections took into consideration various years and using the representative concentration pathways of 8.5 (the worst case scenario) (Table 5-11). The wetness matrix uses the Standardised Precipitation Index (SPI) approach when presenting the data, the SPI for 12 months relates to soil moisture and provides an indication of floods.

The change in frequency of wetness within M-Block ranges between -1.1 (moderate / 2090) to 0.36 (severe / 2030) (Table 5-11). Based on the modelled data, the frequency of wet vents will reduce in each time period for the moderate and extreme scenarios. The frequency of wet events will increase in the severe scenario for 2030 and 2070 and in 2090 will decrease.

Table 5-11: Frequency of annual wetness projections for the site (change in number of events)

Frequency of wetness	Years			
	2030	2050	2070	2090
Moderate	-0.82	-0.55	-0.91	-1.1
Severe	0.36	0	0.18	-0.36
Extreme	-0.27	-0.55	-0.55	-0.27

5.6.1 Water Levels and Storage

5.6.1.1 Initial Water Balance Assessment

The locations of water storages at GCM and the respective purpose for each is shown in Appendix O. Water levels for selected pits for 2021, where measured, range between 225 m AHD and 172 m AHD, depending on location and operational status.

A water balance report was prepared by KBR in 2018 (KBR 2018) for the open cut areas of GCM for a 5-year period from 2019. The water balance modelling and assessment was undertaken using the OPSIM forecast assessment. A forecast assessment uses long-term historical rainfall data and cycles through the rainfall (125 times) for a specific time period (5 year in this case) (KBR 2018). The likely climate change and variability outcomes were then assessed against a percentile confidence range to identify the envelope of potential operational water volumes over the next 5 years.

M-Block was assessed with two other operational areas (i.e., Rail Loop Pit, Rail/Industrial Pit). Figure 3.4 within Appendix D presents the water balance results. The report indicates that the pits are generally able to be kept operational and dewatered over the 5-year period with a 90% confidence that the mine water inventory would not exceed 150 ML and potentially under extreme rainfall conditions access to the pits would be limited as additional mine water storage to receive pumped dewatering would be limited.

5.6.1.2 Subsequent Water Balance Assessment

A subsequent Water Balance Assessment (Appendix O) was completed by Stantec in 2022 to address the advice provided by the IESC. This assessment investigates the influence that the M-Block extension (particularly the realise of Mine Affected Water (MAW)) may have on the downstream waterways' riparian zone vegetation and/or aquatic biota.

Based on the latest available data, it appears that the M-Block surface disturbance is contained to the Crinum Creek Catchment, which is a tributary of the Nogoa River Catchment. The disturbed area catchment reports south to Telegraph Creek. The area of M-Block surface disturbance is less than 0.01% of the Mackenzie River Catchment and 0.005% of the Nogoa River Catchment.

The water balance model was simulated for 11 years in forecast mode, to investigate the changes to mine water inventory with, and without M-Block. The major changes to the model generally include the movement of underground operations from the currently modelled operational GCM underground area to the M-Block bord and pillar in the future.

A comparison between the baseline and M-Block scenarios will demonstrate whether the site can accommodate water from M-block, while maintaining compliant containment standards. The model used for the 2022 WAF/ROWIT assessment has been used as the baseline scenario as it represents the best understanding of current site operations, catchments and storages, and has been validated to current MAW inventory/operations on site. As it is anticipated that open-cut mining operations will decline in the coming years, maintaining the 2022 scenario throughout the duration of the assessment will provide a conservative estimate of the site water inventory for the next 11 years. The water balance modelling objectives and methodology overview is provided in Section 5 of Appendix O.

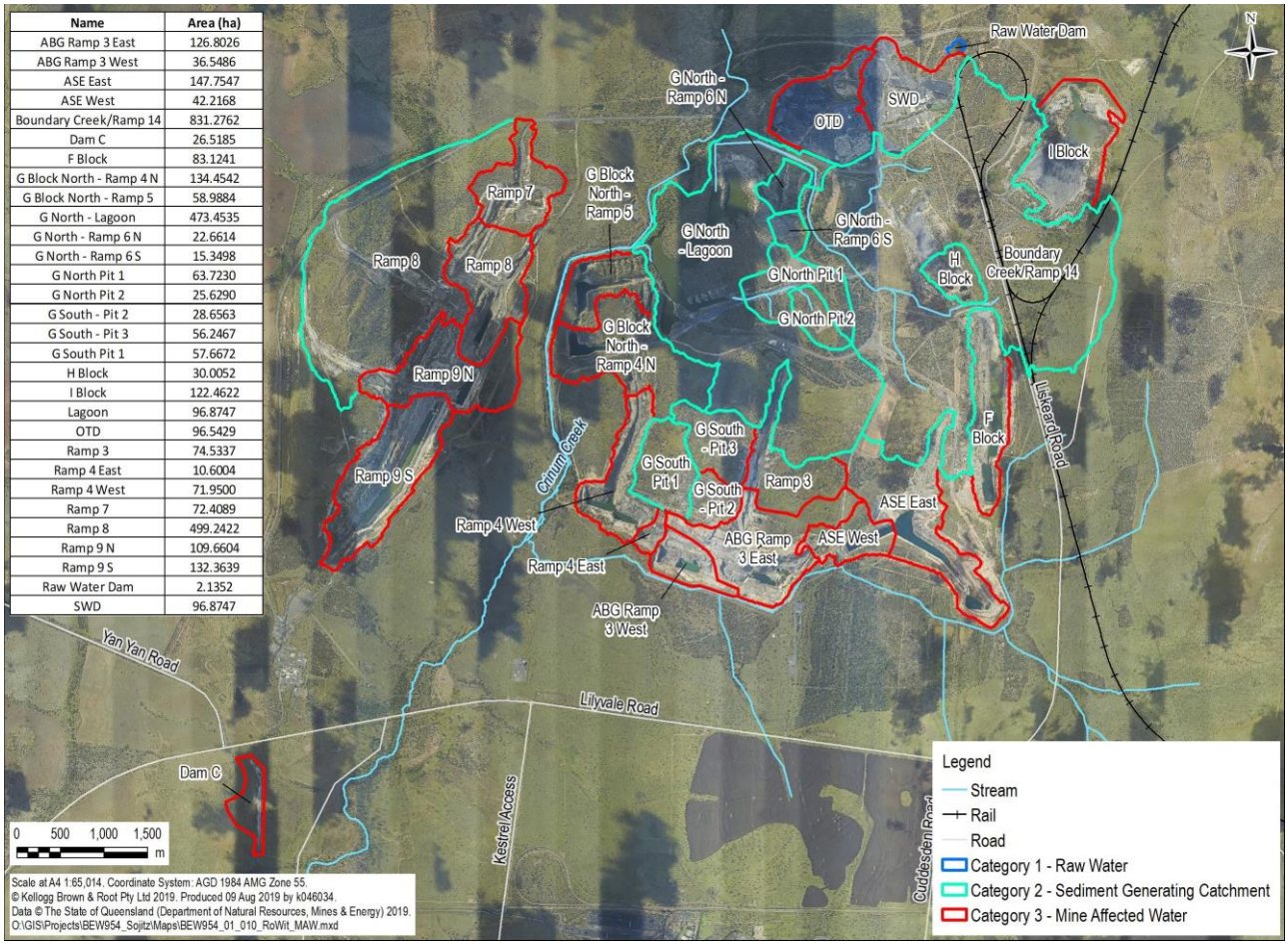

Figure 5.11: GCM water management

Source: KBR 2018

This assessment considered the composition of MAW, the EA discharge limits, groundwater inflows, piping and operation configurations, haul road water estimates, coal feed rate and raw water usage (refer to Section 3.3 to Section 3.8 of Appendix O, respectively).

The baseline results show that the total MAW inventory remains below the total on-site storage of 16,590 ML (Table 5-12). This indicates that there are no anticipated uncontrolled releases from the GCM site up to the 10% wettest conditions. The volume of water released to the downstream waterways was also tracked, with Table 5-13 showing the accumulated volume of release for the 10%, 50%, 90% and confidence levels throughout the 11 years.

The MAW inventory appears to increase at a similar rate to the baseline scenario when compared to the M-Block scenario. From 2030 onwards, there appears to be occurrences in the 10% wettest conditions, where the inventory slightly exceeds the available on site storage of 16,590 ML (refer to Table 5-12). This can likely be attributed to the slightly higher groundwater inflow rates in the M-Block bord and pillar operations when compared to the modelled flow from the baseline scenario.

The M-Block scenario results in a higher MAW inventory then the baseline, with the volume not being contained within the allowable MAW storages during the bord and pillar operations phase. For the M-Block scenario, the total volume of MAW inventory on site is anticipated to increase by 2% in the 10% of wettest years when compared to the baseline. In the 10% of wettest years, the MAW Inventory was modelled to exceed the available on-site storage capacity for the M-Block scenario (Table 5-12). This indicates that there is a risk of un-controlled releases occurring in the M-Block scenario, if operations and containment transfers are not managed appropriately.

Table 5-12: Maximum MAW inventory comparison

Replicate	Baseline scenario (% of 16,590 ML available)	M-Block extension (% of 16,590 ML available)	% Difference
10% Confidence	13,101 ML (79%)	14.550 ML (88%)	11
50% Confidence	12,793 ML (89%)	15,100 ML (91%)	2
90% Confidence	16,290 ML (98%)	16,627 ML (100%)	2

Review of the volume released by controlled environment release procedure, show there is only 2% difference in the total cumulative volume released throughout the 11 year simulation period in the 10% confidence results (Table 5-13). For the 50% and 90% replicas, there is little to no change recorded in released volumes. Of importance to note is that all releases are in accordance with the criteria of the current EA, ensuring that all controlled releases from site are compliant from both a volumetric and quality perspective. As such, although there is a 2% increase in the total volume release over the 11 year period, this volume is still within the acceptable thresholds of the approved EA, which have been pre-determined to ensure that environment flow objectives are satisfied.

Table 5-13: Environmental release volumes to downstream waterways

Replicate	Cumulative Release Volume (ML) - Baseline	Cumulative Release Volume (ML) – M--Block	% Difference
10% Confidence	8,760	8,954	2
50% Confidence	6,632	6,633	0
90% Confidence	5,132	5,132	0

5.6.2 Baseline Water Quality Monitoring

Surface water monitoring has been undertaken for the site under the requirements of the EA which requires the monitoring of both mine water releases and background water quality and for other environmental values. A REMP is produced which details the surface water quality data. A monitoring program collecting samples from various release points has been regularly undertaken with data from 2010 assessed as part of this PER.

The monitoring locations, both upstream and downstream of the mine are detailed in Table 5-14 and shown in Figure 5.11 (the delineation between upstream and downstream is shown as the orange line). There are five monitoring locations which are used to monitor upstream environments and six monitoring locations which are used to monitor the potential impacts of the mining activity, i.e. from mine releases (Figure 5.11). Over the life of M-Block, there have been sixteen release points, with, six no longer active (these are shown in Figure 5.11).

One current monitoring location is located in the vicinity of M-Block, Transmission Line Creek U/S. Although Transmission Line Creek U/S is within the Telegraph Creek, for the purpose of this PER, it will be referred to as Transmission Line Creek U/S onwards. To understand the temporal and spatial trends in water quality all current monitoring locations were reviewed as part of this PER.

Table 5-14: Surface water monitoring locations

Monitoring Points	Location Description	Easting (GDA94)	Northing (GDA94)	Sampling Years
Upstream				
MP 1	Crinum Creek - 0.4km upstream of mining activity. Represents the sum of upstream influences (agriculture, roads, Tieri township) prior to the mine on the mainstream.	640195	7439383	2010, 2011, 2012, 2015, 2016, 2017 2020, 2021 – dry
REMP S1	Crinum Creek - upstream of Balmoral Haul Road Crossing - at power line easement	640163	7439201	2010
Crossbed Creek U/S	Crossbed Creek - upstream of the Crossbed Creek diversion. Highly ephemeral site with only brief flows.	636974	7438587	2012, 2018
Balmoral Creek U/S	Balmoral Creek, upstream of diversion (Balmoral and Crossbed Creeks) and mining activity, and prior to discharge to Crinum Creek.	635071.2	7434590.8	2010, 2012. 2013
Transmission Line Creek U/S	Transmission Line Creek, upstream of the mining activity. Highly ephemeral site with only brief flows. Currently this water ponds at the junction of HSE pit and F Block. Water also ponds on Crinum East subsidence. Sojitz are currently looking at options to again reach Crinum Creek.	644135.3	7434029	2010, 2012
Downstream				
MP 2	Crinum Creek, mid-ML at Lilyvale waterhole. The only natural, permanent water body in the area. Located downstream of the confluence of Balmoral Creek.	636791	7432655	2010, 2011, 2012, 2018, 2021
CRINUM01	Crinum Creek, mid-ML after diversion. Provides data to show incremental changes in water quality throughout the ML.	638300	7434766	2010, 2012, 2019, 2020
Balmoral Creek D/S	Balmoral Creek, downstream of the creek diversion (Balmoral and Crossbed Creeks) and mining activity. This tributary enters Crinum Creek mid-lease after MP 2 and before REMP S5. Highly ephemeral site with only brief flows.	635789	7433676	2010, 2012, 2016, 2017, 2018
MP 3	Crinum Creek, downstream lease boundary prior to discharge to Kestrel lease. Represents the sum of influences in the reach located on the ML (including mining, agriculture and roads) and upstream of the ML.	635324	7430102	2010, 2011, 2012, 2015 – dry, 2018, 2020, 2021- dry
REMP S2	Crinum Creek, downstream of Balmoral haul Road Crossing	640078	7438616	2010, 2012
REMP S5	Crinum Creek, located on Myuna Road, approximately 15 km downstream of MP 3.	636437	7432101	2010, 2012
WETLAND01	G North Wetland - southern edge monitoring point	639479	7436319	2019, 2020

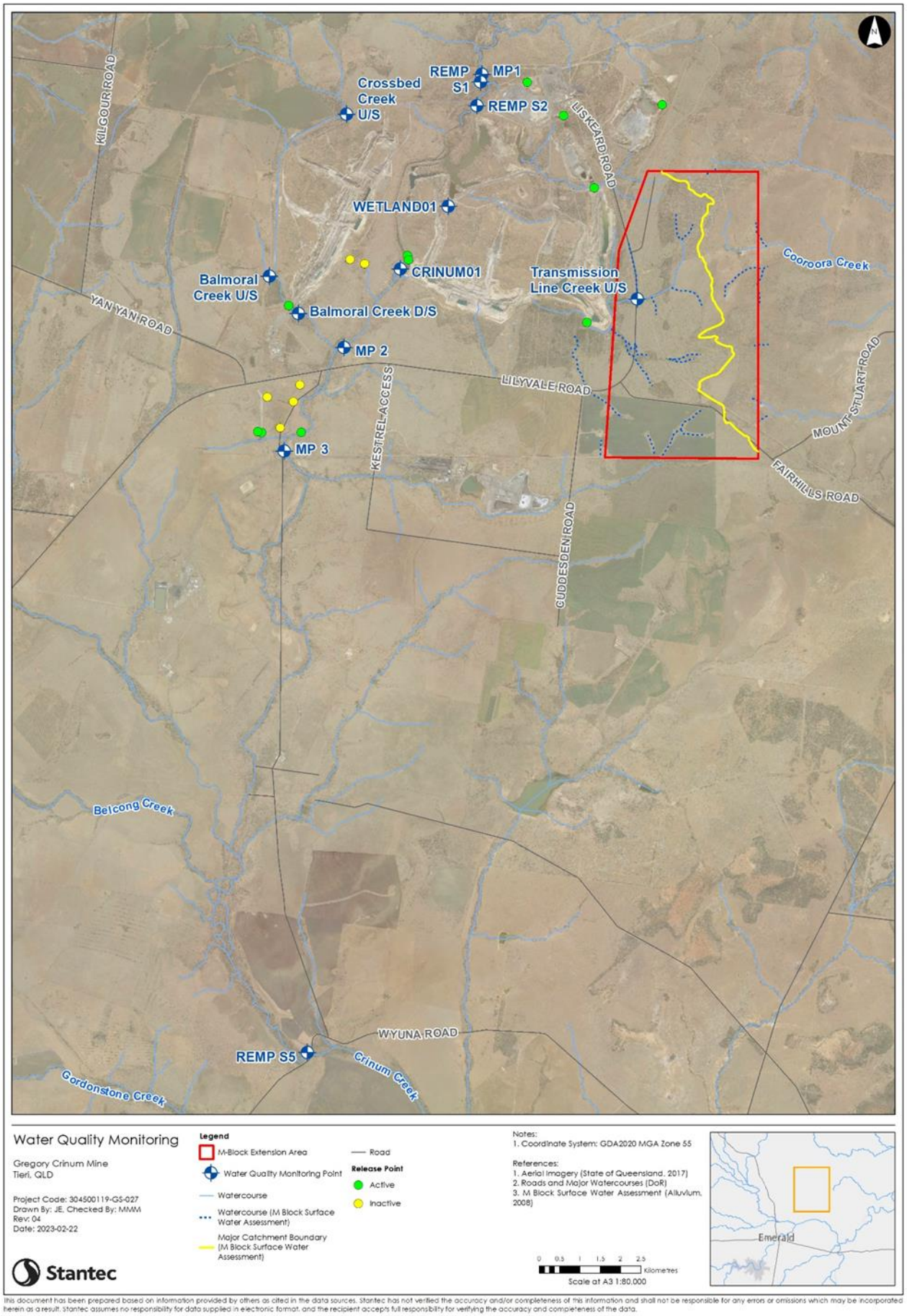

Figure 5.12: Surface water monitoring locations

The EA for the site stipulates the frequency and parameters to be monitored, as detailed in Table 5-15. Additional parameters are monitored throughout the surface water monitoring program and include general parameters (i.e. temperature, suspended solids and turbidity), nutrients, and inorganics. Due to the high frequency of monitoring, the REMP annual water quality data was used to inform the surface water assessment for this PER.

Table 5-15: Frequency of surface water monitoring

Parameters	Monitoring Frequency	
	Release or Mine Affected Water	Receiving Environment
EC	Real time telemetry for EC and pH with grab samples at commencement and weekly thereafter when safe to do so and access permits	Real time telemetry for EC and pH with grab samples at commencement and weekly thereafter when safe to do so and access permits
pH	Daily grab samples if telemetry not available	Daily grab samples if telemetry not available
Aluminium	Commencement of release and thereafter weekly during release when safe to do so and access permits	-
Cadmium		
Chromium		
Copper		
Mercury		
Nickel		
Zinc		
Boron		
Petroleum Hydrocarbons (C6-C9)		
Petroleum Hydrocarbons (C10-C36)		

The assessment criteria used to evaluate the surface water analytical results were chosen with regard to the environmental values identified in Table 5-10 and based on the following guidelines:

- The EA.
- EPP Water Nogoa. Noting that no water quality monitoring sampling has been undertaken by Sojitz for watercourses within the Mackenzie River sub-basin.
- The Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2018 (ANZG) for freshwater aquatic ecosystems, stock water (beef cattle & general use), and irrigation (cotton) – long term value and general use, recreational use and raw water supply.
- Australian Drinking Water Guidelines 6, 2011 (ADWG).

The water quality objectives from these guidelines are presented in Table 5-16. The water quality objectives for the Mackenzie River sub-basin has been included within Table 5-16, as watercourses in this sub-basin are located within M-Block.

The surface water monitoring results documented within the REMPs were extracted and tabulated to determine the water quality of the watercourses adjacent the M-Block extension area. These are presented in full in Appendix P. For the purpose of this assessment, data collected between 2010 to 2021 was used to compare against the assessment criteria. The assessment also compared the difference between the upstream and downstream monitoring results.

Table 5-16: Adopted water quality objectives for the site

Parameter	EA – EML00945013 (mg/L)	ANZG 2018					ADWG	EPP Water Mackenzie	EPP Water Nogoa
		Aquatic Ecosystems		Stock water (beef cattle) & general use (mg/L)	Irrigation (cotton) Long term value (mg/L)	General use, recreational & raw water supply (mg/L)	Drinking water (mg/L)		
		99% Protection (mg/L)	95% Protection (mg/L)						
pH (pH units)	6.5-9.0* 6.5-8.5**	-	-	6-9	-	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5
Electrical Conductivity (µS/cm)	10,000* 1,500** 5,000***	-	-	5970	3700	-	400	Base flow: <310 High flow: <210	Lower Nogoa: < 340 Theresa Creek: < 720
Aluminium pH>6.5	0.1	0.027	0.055	5	5	0.2	-	-	-
Cadmium	0.0002	0.00006	0.0002	0.01	0.01	0.005	0.002	-	-
Chromium (VI)	0.001 (total)	0.00001	0.001	1	0.1 (total)	0.052	0.05	-	-
Chromium (III)			0.0033					-	-
Copper	0.002	0.001	0.0014	1	0.2	1	2	-	-
Mercury (inorganic)	0.0002	0.00006	0.0006	0.002	0.002	0.001	0.00001	-	-
Nickel	0.001	0.008	0.011	1	0.2	0.1	-	-	-
Zinc	0.370	0.0024	0.008	20	2	5	-	-	-
Petroleum Hydrocarbons (C6-C9)	0.02	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons (C10-C36)	0.1	-	-	-	-	-	-	-	-

Note: Green highlighted cells are the most accurate aquatic ecosystem criteria to use for a moderately disturbed environment.

* Mine affected water release

** Receiving waters, stock water release and irrigation water release

*** Stock water release

As discussed in Section 3.1, the surrounding environment of the mine and M-Block is rural, comprising cattle grazing and some cropping. Rural properties can potentially impact water quality due to agricultural practices through the release nutrients, sedimentation or chemical contamination (i.e. due to the use of pesticides, use of fertilisers, processing, etc.). Therefore, there is the potential that the water quality upstream of the mine is impacted by current land uses.

The results from the assessment of the surface water monitoring data are summarised in Table 5-17 with the full suite of results included as Appendix P.

Table 5-17: Surface water monitoring – assessment of results

Analyte	Comment
General Parameters	**pH** **Upstream** The pH within the upstream environmental was within the water quality guidelines for all monitoring events, ranging between 6.69 to 8.4 pH units. This indicates that the surface water is generally neutral to slightly alkaline. **Downstream** The pH was generally within the water quality guidelines for all monitoring events, ranging between 6.69 to 9.38 pH units. This indicates that the surface water is generally neutral to slightly alkaline. Two sampling locations, specifically WETLAND01 and MP 3 exceeded the water quality guidelines in 2010 (MP3 only), 2018 (MP3 only), 2019 (WETLAND 01 only) and 2020 (WETLAND 01 only). Sampling in 2020 for MP 3 indicated the pH was within the water quality guidelines. pH was generally consistent for the upstream and downstream locations and over the monitoring events.
	Electrical Conductivity **Upstream** In 2010 and 2011, majority of the upstream locations reported EC results which were less than the quality objectives, however, the one sample for Balmoral Creek U/S in 2010 exceeded the water quality objectives for the EPP Water Nogoa. Majority of the upstream monitoring locations from 2012 onwards were below the water quality objectives, except for Balmoral Creek U/S in 2012 which exceeded the water quality objectives for the EPP Water Nogoa and the EA. This could potentially indicate a source upstream of Balmoral Creek U/S. From 2015 to 2020, MP 1 had fluctuation of EC results, with the water quality objectives being exceeded in 2015 and 2016, with the location not sampled within 2018, 2019 or 2021 (dry). **Downstream** In 2010, majority of the downstream locations reported EC results which exceeded the water quality guidelines for the EPP Water Nogoa, except for REMP S2. Four downstream locations, MP2, MP 3, Balmoral Creek D/S and REMP S5, reported results which also exceeded the EA, with MP 3 and Balmoral Creek also exceeding the ANZG for irrigation. The exceedance all occurred around the same March to September period with the highest result (8,180 µS/cm) occurring in September for Balmoral Creek D/S. Mine discharge points (Figure 5.11) are located upstream of these locations which may explain the increase, however the upstream Balmoral Creek U/S, reported an exceedance of the water quality objectives for the EPP Water Nogoa during the one monitoring period in December 2010. During this sampling it was also higher than the downstream locations during the same period. Therefore, a source upstream of Balmoral Creek U/S and the site can be potentially impacting on water quality at these locations rather than from mining activities. This is also evidenced with the exceedance of the upstream monitoring location, Balmoral Creek U/S, in 2012 and the downstream locations exceeding the water quality objectives for the EPP Water Nogoa, however at a lower result than the upstream location. Subsequent monitoring events between 2011 and 2021 reported results declining in both locations to be consistent with the other downstream results, however, still exceeding the water quality objectives for EPP Water Nogoa. Upstream monitoring locations were not assessed to compare against the respective downstream locations, so determination of the cause is not possible.

Analyte	Comment
	Turbidity **Upstream** Turbidity exceeded the water quality objectives, specifically the EPP Water Nogoa and the ANZG for aquatic ecosystems in majority of the samples in 2010, except for the one location, Balmoral Creek U/S. The high turbidity may be due to the high rainfall which occurred in 2010. The nearest AWS is at the Emerald Airport (AWS 035264) which is located approximately 42 km from the GCM and reported 1099.2mm of rainfall in 2010, compared to the 30 year (1992 to 2022) average of 548.7mm. Turbidity was generally consistent over the monitoring events, with a decrease seen in 2012, with half of the upstream monitoring locations only exceeding the water quality guidelines for ANZG for freshwater aquatic ecosystems. **Downstream** Turbidity exceeded the water quality objectives, specifically the EPP Water Nogoa and the ANZG for freshwater aquatic ecosystems in majority of the samples in 2010, except for the two locations, Balmoral Creek D/S and REMP S2 which also exceeded the water quality guidelines for the EPP Water Nogoa. Turbidity was generally consistent over the monitoring events, however, the turbidity results for the downstream locations were generally lower than the upstream locations.
	Suspended Solids Suspended solids were not analysed in the 2012, 2016 and 2017 monitoring periods. **Upstream** Majority of the upstream monitoring locations consistently exceeded the water quality objectives for the EPP Water Nogoa. **Downstream** Majority of the upstream monitoring locations consistently exceeded the water quality objectives for the EPP Water Nogoa. The results are generally consistent between the upstream and downstream locations.
Inorganics	Majority of inorganics, apart for sulfate, reported concentrations below the water quality guidelines for all samples during the monitoring events. Fluoride is below the water quality objectives for both upstream and downstream monitoring locations. **Upstream** Majority of the upstream monitoring locations sampled in 2010 were below the water quality objectives. An increase in sulfate can be seen in 2012, with the upstream locations, excluding Crossbed Creek U/S, exceeding the water quality objectives the EPP Water Nogoa. Limited upstream monitoring of sulfate occurred post 2012. **Downstream** Majority of the downstream locations exceeded the water quality objectives for the EPP Water Nogoa throughout the monitoring events, i.e. from 2010 to 2020. As limited upstream monitoring of sulfate occurred post 2012, subsequent comparison to the upstream environmental is not achievable.
Nutrients	**Ammonia** **Upstream** Majority of samples collected within 2010, 2015, 2018, 2020 and 2021 exceeded the water quality objectives for the EPP Water Nogoa. Ammonia concentrations were generally consistent between the monitoring events, except in 2012 where majority of the samples were below the laboratory's Limit of Reporting (LOR), with approximately one quarter of samples exceeding the LOR and therefore the water quality objectives for the EPP Water Nogoa. **Downstream** Majority of samples collected within 2010, 2015, 2018, 2019, 2020 and 2021 exceeded the water quality objectives for the EPP Water Nogoa. Ammonia concentrations were generally consistent between the monitoring events, except in 2012 where majority of the samples were below the laboratory's Limit of Reporting (LOR), with approximately one quarter of samples exceeding the LOR and therefore the water quality objectives for the EPP Water Nogoa. The concentrations were consistent between the upstream and downstream locations, with the downstream environment often reporting marginally lower concentrations.
	Nitrate and Nitrite Nitrite concentrations were analysed in 2015, 2017, 2018, 2019, 2020 and 2021, with concentrations either below the LOR or marginally above.

Analyte	Comment
	Upstream Nitrate concentrations exceeded the water quality objectives, specifically the ANZG for freshwater aquatic ecosystems in approximately half of the samples in 2010, with the remainder of the results in 2010, either below the LOR or marginally above. In 2012, majority of nitrate results exceeded the ANZG for freshwater aquatic ecosystems. In 2015, 2017, 2018, 2020 and 2021, majority of the samples are either below the LOR or marginally above. **Downstream** Nitrate concentrations exceeded the water quality objectives, specifically the ANZG for freshwater aquatic ecosystems in approximately half of the samples in 2010, with the remainder of the results in 2010, either below the LOR or marginally above. In 2012, majority of nitrate results exceeded the ANZG for freshwater aquatic ecosystems. In 2015, 2017, 2018, 2019, 2020 and 2021, majority of the samples are either below the LOR or marginally above. The concentrations were consistent between the upstream and downstream locations.
Metals	Majority of the metals, specifically aluminium, chromium, copper, nickel and zinc exceed the water quality objectives in all years, with total metals generally one order of magnitude higher than dissolved metals. Total metals account for both dissolved metals and particulates in the water, therefore, should always be greater or equal to dissolved metal results.
	<u>Aluminium</u> **Upstream** Majority of total aluminium concentrations in 2010 exceeded the water quality objectives, specifically the EA, the ANZG for freshwater aquatic ecosystems, general use, recreation and raw water supply and the ADWG, with half of samples for MP 1 and REMP S1 also exceeding the ANZG for stock water and irrigation. The two upstream locations, MP 1 and REMP S1 generally reported the highest total aluminium concentration throughout 2010. Dissolved aluminium concentrations were generally one order of magnitude lower than total aluminium concentrations. In 2012, total aluminium concentrations were either below the LOR or marginally above. The dissolved aluminium concentrations generally an order of magnitude higher than the total aluminium, with half results exceeding the water quality objectives for the EPP Water Nogoa. Majority of the samples between 2015 to 2021 exceeded the water quality objectives for either the EA, the ANZG for freshwater aquatic ecosystems, general use, recreation and raw water supply and the ADWG. **Downstream** Majority of total aluminium concentrations in 2010 exceeded the water quality objectives, specifically the EA, the ANZG for freshwater aquatic ecosystems, general use, recreation and raw water supply and the ADWG. One location REMP S2 which is downstream of MP 1 and REMP S1 also consistently exceeded the ANZG for stock water and irrigation. Therefore, a source upstream of MP 1 is likely to have impacted on water quality at these locations. In 2012, total aluminium concentrations were either below the LOR or marginally above. The dissolved aluminium concentrations generally an order of magnitude higher than the total aluminium, with half of the results exceeding the water quality objectives for the EPP Water Nogoa. The concentrations were consistent between the upstream and downstream locations. Majority of the samples between 2015 to 2021 exceeded the water quality objectives for either the EA, the ANZG for freshwater aquatic ecosystems, general use, recreation and raw water supply and the ADWG. As limited upstream monitoring of sulfate occurred post 2012, subsequent comparison to the upstream environmental is not achievable.
	<u>Boron</u> All samples reported total and dissolved boron concentrations below the water quality objectives.
	<u>Cadmium</u> **Upstream** All of the upstream monitoring results reported cadmium concentrations below the LOR. This remained consistent until 2016, where MP 1 exceeded the water quality objective for the EA, ANZG for aquatic ecosystems, irrigation, stock water, general use, recreational and raw water supply and the ADWG. Downstream

Analyte	Comment
	Majority of downstream monitoring locations cadmium concentrations were below the laboratory's LOR, except two sampling events for MP 2 reporting results above the LOR, and therefore exceeding the water quality criteria for the EA and the ANZG for aquatic ecosystems. This location, MP 2, also exceeded the water quality objectives for the EA and the ANZG for aquatic ecosystems in 2011 and 2012, however, this only occurred for one sample in each year. CRINUM 01 also reported an exceedance of these water quality guidelines for the same month as MP 2 in 2012. MP 3 reported dissolved cadmium concentrations which exceeded all of the relevant water quality objectives the EA, ANZG for aquatic ecosystems, irrigation, stock water, general use, recreational and raw water supply and the ADWG in 2012. As MP 2 (an upstream location of MP 3) results were below the LOR for the same period, it likely indicates that the source was due to a mine release as these are located upstream of MP 3 (Figure 5.11). In a subsequent monitoring event, 2018, cadmium results were below LOR for MP 3. **Downstream** In 2016, the downstream monitoring locations (Balmoral Creek D/S) reported exceedance of the water quality for the EA, ANZG for aquatic ecosystems, irrigation, stock water, general use, recreational and raw water supply and the ADWG. As no upstream surface water monitoring locations were sampled in the same time period, no comparison on upstream locations can be made. In a subsequent monitoring event, 2018, cadmium results were below LOR for MP 3.
	Chromium **Upstream** Total chromium concentrations for majority of the upstream samples exceeded the water quality objectives for the EA and ANZG for freshwater aquatic ecosystems in 2010, with the Transmission Line Creek U/S and Balmoral Creek U/S locations only exceeding the water quality objectives for the EA. Majority of total chromium concentrations exceeded the water quality objectives for the EA and the ANZG for freshwater aquatic ecosystems in 2012. Dissolved chromium concentrations are approximately one order of magnitude lower than total chromium concentrations. Slightly under half of the samples in 2015, 2016 and 2020 reported total chromium concentrations above the water quality objectives for the EA and the ANZG for freshwater aquatic ecosystems, with the remainder below the LOR. In 2018, the upstream sample reported total chromium concentrations above the water quality objectives for the EA and the ANZG for freshwater aquatic and for irrigation. **Downstream** Majority of the downstream locations reported total chromium concentrations below the LOR, with the remainder exceeding the water quality objectives for the EA and the ANZG for freshwater aquatic ecosystems. In 2012 the majority of total chromium concentrations exceeded the water quality objectives for the EA and the ANZG for freshwater aquatic ecosystems. Dissolved chromium concentrations are approximately one order of magnitude lower than total chromium concentrations. The concentrations within the upstream monitoring locations were marginally higher than the downstream locations. Slightly under half of the samples in 2015, 2016, 2019 and 2020 reported total chromium concentrations above the water quality objectives for the EA and the ANZG for freshwater aquatic ecosystems, with the remainder below the LOR. In 2018, one samples reported total chromium concentrations above the water quality objectives for the EA and the ANZG for freshwater aquatic ecosystems, with Balmoral Creek D/S also exceeding the water quality objective for ANZG for irrigation. As limited upstream monitoring locations were sampled between 2015 and 2020, subsequent comparison to the upstream environmental is not achievable.
	Copper **Upstream** Approximately three quarters of the samples reported dissolved concentrations which exceeded the water quality objectives for the EA and the ANZG for freshwater aquatic ecosystems in 2010, with half of the total copper concentrations exceeding these water quality objectives and the remainder below the LOR. In 2012, 2015, 2016, 2017, 2018 and 2021 majority of total copper concentrations exceeded the water quality objectives for the EA or the ANZG for freshwater aquatic ecosystems. The concentrations were consistent between the upstream and downstream locations.

Analyte	Comment
	In 2020, the upstream monitoring location results for total and dissolved copper concentrations exceeded the water quality objectives for the EA and the ANZG for freshwater aquatic ecosystems. **Downstream** Approximately half of the samples report dissolved concentrations which exceeded the water quality objectives for the EA and the ANZG for freshwater aquatic ecosystems in 2010, with half of these only exceeding the water quality objectives for the ANZG for fresher aquatic ecosystems. A quarter of the total copper concentrations exceeded these water quality objectives with the remainder below the LOR. The concentrations were generally lower within the downstream monitoring locations than those upstream of the mine. In 2012, 2015, 2016, 2017, 2018 and 2021 majority of total copper concentrations exceeded the water quality objectives for the EA or the ANZG for freshwater aquatic ecosystems. The concentrations were consistent between the upstream and downstream locations. In 2019, majority of the samples reported total and dissolved copper concentrations below the LOR. In 2020, one of the downstream monitoring location results for total and dissolved copper concentrations exceeded the water quality objectives for the EA and the ANZG for freshwater aquatic ecosystems.
	Mercury **Upstream** Majority of total mercury concentrations were below the LOR in 2010, with a few samples marginally above and therefore exceeding the water quality objectives for the EA, the ANZG for freshwater aquatic ecosystems and the ADWG. In 2011, 2019, 2020 and 2021 total and dissolved concentrations were below the LOR. Mercury was not monitoring in 2012 to 2018. **Downstream** Majority of total mercury concentrations were below the LOR in 2010, with a few samples marginally above and therefore exceeding the water quality objectives for the EA, the ANZG for freshwater aquatic ecosystems and the ADWG. The concentrations were consistent between upstream and downstream locations. In 2011, 2019, 2020 and 2021 total and dissolved concentrations were below the LOR. Mercury was not monitoring in 2012 to 2018
	Nickel Total nickel concentrations were fairly consistent between the upstream and downstream locations through the monitoring events, with majority of total nickel concentrations exceeding the water quality objectives for the EA and the ANZG for freshwater aquatic ecosystems. Majority of dissolved nickel concentrations only exceeded the water quality objectives for the EA, however, the concentrations were still consistent between the upstream and downstream locations and throughout the monitoring events. In 2016, and 2018, the water quality results also exceeded the water quality objectives for the ADWG.
	Zinc Zinc concentrations were fairly consistent between the upstream and downstream locations through the monitoring events, with majority of total zinc concentrations exceeding the water quality objectives for the ANZG for freshwater aquatic ecosystems. Half of the samples throughout the monitoring events reported dissolved zinc concentrations either below the LOR or marginally above, with the other half exceeding the water quality objectives for the EA and the ANZG for freshwater aquatic ecosystems.
Total Petroleum Hydrocarbons / Total Recoverable Hydrocarbons	In 2010, majority of samples reported concentrations of Total Petroleum Hydrocarbons (TPH) and Total Recoverable Hydrocarbons (TRH) below the LOR. The remaining results are slightly above the LOR. Although majority of the TPH (C10 to C36 Fraction) concentrations were below the LOR (200µg/L), some results exceeded the water quality objectives for the EA as the individual fractions were above the guideline of 100µg/L. From 2011 to 2021, except for 2020, the results were either below the LOR or below the water quality objectives. One downstream result reported TPH concentrations above the water quality objectives for the EA.

5.6.3 Baseline Surface Water Flow Regimes

All watercourses within the site are highly ephemeral, with flows typically of short duration (and may be localised), interspersed with long no-flow periods and hot, dry climatic conditions leading to relatively rapid drying and evaporation of pools (4T Consultants 2020). The episodic patterns of stream flow are not conducive to the development of permanent aquatic environments, nor for flow through or replenishment of pools (i.e. improved permanency) (4T Consultants 2020).

The flows within the watercourses are greatest during the summer period from October to March. This coincides with the wet season for this area, which is typically during December through to February, with monthly averages of over 80 mm (refer to Section 3.3). The 2020 report identified that most of the streams flowed during the wet season (4T Consultants 2020). These flows contribute to pools particularly in Crinum Creek, but few of these pools persist year-round, with most of the pooling not persisting longer than one month after the wet season.

4T Consultants assessed discharge data from four gauging stations that are situated onsite, specifically at Balmoral Creek, Crinum Creek at Lilyvale Waterhole, Crinum Creek upstream, Crinum Creek upstream crossing and Crinum Creek downstream. Four of the five gauging stations reported no discharge flow rate, with the Balmoral Creek gauge the only site discharging minimal volumes during February and March 2021. This site was the last to report no flow. The Crinum Creek at Lilyvale Waterhole did not receive sufficient flow to register any level rise for the duration of the 2020 – 2021 period. The Crinum Creek Upstream and Crinum Creek Downstream gauge seem to have collected unreliable data, with extreme discharge and flow values recorded. The report indicated that the data from these gauges have some uncertainty and whether there is any impact downstream at the Crinum Creek at Lilyvale Waterhole.

5.6.4 Groundwater – Surface Water Interactions

Groundwater-surface water interaction within the Project area may occur as a result of two key processes: discharge of groundwater to watercourses as baseflow; and recharge to aquifers as leakage from watercourses.

As discussed in Section 5.1.3.1, there is no alluvium mapped directly within the Project area. Outside of the Project area, where the alluvium is associated with watercourses, recharge to groundwater will occur through infiltration of stream flow. It is unlikely that groundwater discharge is occurring as baseflow to any of the watercourses directly within the Project and the near surrounds, as the watercourses are characteristically ephemeral and only flow in response to major rainfall events.

There are no reported springs within a 10 km buffer of the Project.

5.6.5 Impacts to Surface Water Resources

The Water Balance Assessment (Appendix O) noted from the available data that it appears the current mine plan for the M-Block open cut area (i.e. the area that will be subject to surface disturbance) does not currently contribute to the Mackenzie River Catchment, rather it flows into the Crinum Creek Catchment and ultimately the Nogoa River Catchment. Therefore, it is not anticipated that the M-Block operations would have any impact on the magnitude, duration and timing of flows within this catchment.

The location of the entire M-Block footprint is in the headwaters of both catchments and forms a significantly small portion of either catchment, i.e. M-Block is less than 0.01% of the Mackenzie River Catchment and 0.005% of the Nogoa River Catchment. If the M-Block extension mine plan extends beyond the current mine plan and surface disturbance occurs within the Mackenzie River Catchment, given M-Block's relative area within this catchment, it is highly unlikely that any surface disturbance or rainfall falling would have any quantifiable impact on the timing and or persistence of flows in any downstream tributaries.

The additional volume of water from the M-Block extension will be managed in accordance with the existing EA, which has criteria around the magnitude, timing and quality of water released into the Crinum Creek Catchment. Details around how the additional volume of water will be managed within the current GCM operation is provided in Section 5.6.2.

The operation of M-Block does not include any discharges to surface water or interaction with surface water bodies (that do not comply with the existing EA) and therefore direct impacts to surface water are not anticipated. Additional approvals will be sought if discharge to surface waters will be required in the future.

The extension of the mine into M-Block would include a number of activities that would disturb the surface including open cut mining, excavation, supporting infrastructure such as tracks, and vegetation removal. The ground disturbing activities, associated with the M-Block extension, have the potential to expose soils,

increasing the risk of erosion and sediment loss and the release of sediment laden run-off which may result in increased turbidity, decreased light levels for submerged aquatic vegetation, and smothering of benthic organisms.

During mining operations there is the potential exists for spills of hydraulic oil and fuels from plant, equipment or vehicles, potentially impacting on adjacent soils and nearby watercourses. In the instance of a spill occurring, the impact would be minor and localised as the quantity of hydraulic oil and fuels would be kept to a minimum and would be stored in a suitably bunded and covered area.

Any surface water runoff or overtopping of tailing dams or other contaminated water bodies can adversely impact water quality.

Mining operations also have the potential to create cracks and subsidence in the ground beneath and surrounding watercourses and waterbodies which can lead to the water draining from the surface into the ground. This can impact the water levels of both the surface water and groundwaters and can lead to the creation of additional ponding, enhanced flooding and changes to stream alignments. There is also the potential for an increase in the exchange of surface water and groundwater leading to the deterioration of water quality.

The extension of mining operations into M-Block will be undertaken under the conditions of the current EA and as such the monitoring and water quality requirements will also apply to these operations. In addition, no watercourse diversions are required for M-Block operations.

With the implementation of the current requirements and the additional measures proposed for M-Block as outlined in Section 1, potential construction, operation and mine closure impacts relating to surface water, drainage and water quality would be appropriately managed and are anticipated to be minor.

5.7 Ecohydrological Conceptual Model

Stantec developed an initial ecohydrological conceptual model (ECM) to evaluate potential effects attributable to the planned M-Block extension (Appendix F). The ECM took into consideration climate, topography, GDEs, stygofauna, catchments, watercourse and waterbodies, surface water flows and quality, groundwater – surface water interactions, geology, hydrogeology, groundwater recharge and quality, and groundwater bore users.

The key risk drivers that pose potential impacts to water resources or water dependent assets are:

- Direct and cumulative groundwater drawdown on GDE communities and nearby groundwater users – impacts accessibility to groundwater resources.
- Altered drainage features affecting flow regimes and increased sedimentation – impacts surface water availability and water quality.
- MAW breach of containment into surface water or seepage into groundwater aquifers – impacts on surface water and groundwater quality.

An evaluation of the risks and potential impacts associated with water resources and water dependent assets is provided in Section 7.2 to Section 7.4 of Appendix F.

The ECM identified the following water resources and water dependent assets that were potentially at risk of developing impact pathways:

- Subterranean groundwater dependent ecosystem risks related to direct water quality and drawdown impacts.
- One groundwater user where direct drawdown impacts was predicted to be greater than the *Water Act 2000* trigger threshold.

Field mapping indicated that potential TGDEs within the proposed M-Block extension area are not dependent on groundwater. Based on the ECM and groundwater modelling results, potential GDEs that have been identified outside the M-Block boundary are also unlikely to be dependent on groundwater. Potential TGDEs such as the Brigalow communities identified within and nearby the site are therefore not anticipated to be affected by direct cumulative impacts resulting from the proposed M-Block extension.

Key identifiable gaps were related to the:

- Spatial distribution of monitoring locations where potential subterranean GDEs could be located if the current bore designs were adequate to capture habitat types and if potential subterranean GDEs were located in areas outside of the Study Area where predicted drawdown effects may occur.

- Evaluation of potential surface water – groundwater interactions outside of the Study Area and potential risks associated with short-term MAW migration down hydraulic gradient.
- Absence of baseline water quality data for locations along Cooroora Creek and associated tributaries, which are outside the expected impact area.
- The presence of identifiable riparian ecological communities and the presence or absence of alluvial channels with areas along Crinum Creek and Cooroora Creek have not been confirmed.

A summary of the key data gaps is provided in Section 8 of Appendix F.

5.8 Cumulative Impacts

5.8.1 Groundwater

M-Block is located in the vicinity of other resource tenures, including:

- Kestrel Mine, located immediately southwest of M-Block, on an adjoining ML.
- Oaky Creek Mine, located approximately 4 km northeast of the M-Block.
- Ensham Mine, located approximately 14 km south east of the M-Block.

The potential impacts of the mining operations on the groundwater environment in the region has been considered in relation to potential cumulative impacts they may have with the operation of M-Block. The numerical groundwater model included approved operations at Kestrel Mine. This is the nearest operations to M-Block and includes mining that could contribute to cumulative impacts with the predicted depressurisation from the operation of M-Block.

More distant mining operations including Oaky Creek and Ensham are beyond the 8 km limit of predicted depressurisation from the operation of M-Block. These mines are therefore unlikely to generate cumulative impacts with M-Block.

The numerical groundwater model was used to assess the cumulative groundwater impacts associated with M-Block during mining and post-closure. The maximum predicted extents of drawdown for M-Block and the relevant operations were compared in order to determine whether any areas could potentially be cumulatively impacted.

Cumulative drawdown is discussed in Section 8.4.3 of Appendix D and details that there are no additional cumulative impacts to the basalt unit. Cumulative drawdown in the basal sand and German Creek seam is predicted, noting that recovery at 2050 has already occurred in some areas of the Kestrel mine following cessation of mining. The cumulative drawdown for the three key hydrostratigraphic units (basalt unit, basal sand and German Creek seam) are represented within Figure 8.5 to 8.7 within Appendix D. Drawdown effects in the basal sand and German Creek seam aquifers are unlikely to result in ecohydrological impacts.

The drawdown results for the cumulative assessment are included in Appendix II of Appendix D.

Field assessments showed that the mapped potential TGDEs in the M-Block extension are not dependent on groundwater (3D Environmental 2023). No additional cumulative impacts to the basalt aquifer are attributed to the proposed M-Block extension when combined with the approved Kestrel operation.

Dewatering undertaken as part of the M-Block operations will result in a change in the groundwater table, however, recovery is predicted post-closure as groundwater levels rebound. Potential Terrestrial Groundwater Dependent Ecosystems (TGDEs) within the proposed M-Block extension area are not dependent on groundwater.

Potential TGDEs such as the Brigalow communities identified within and nearby the site are therefore not anticipated to be affected by direct or cumulative impacts resulting from the proposed M-Block extension.

No additional cumulative impacts to the basalt aquifer are attributed to the proposed M-Block extension when combined with the approved Kestrel operation.

5.8.2 Surface Water

Watercourses in the vicinity of M-Block are ephemeral and only flow during, and immediately following prolonged rainfall events. Flow events in the watercourses are typically experienced during the wet season. Further, the operation of M-Block will not include any abstraction from, or discharges to surface water or watercourses. Notwithstanding minor / localised erosion and sediment controls, the M-Block operations will not include the interception or diversion of surface water flows. Subsidence associated with the M-Block extension is not anticipated due to the use of the bord-and pillar mining method. There is expected to be little

change to surface water flows associated with the cumulative impacts as M-Block is the top of the catchment and the watercourse are ephemeral with minimal flow.

Potential MAW related to the proposed M-Block extension will be managed in accordance with existing water management plans. Incremental, cumulative impacts are not anticipated due to the proposed Project.

5.9 Residual Significant Impact Assessment

There will be no discernible significant residual impacts to the surface water system as a result of the mining operation proposed for M-Block.

Groundwater and surface water interactions are not interpreted to be affected by M-Block operations given that groundwater is not interpreted to be in direct hydraulic connection with surface watercourses.

Dewatering undertaken as part of the M-Block operations will result in a change in the groundwater table, however, recovery is predicted post-closure as groundwater levels rebound.

Subsidence associated with the mining of M-Block underground mining is not anticipated as the bord-and-pillar method is proposed to be used rather than longwall mining.

M-Block is located in an area where Tertiary basalt and Permian units outcrop at surface. These outcrop areas are considered to be the location where diffuse rainfall recharge occurs. It is also not anticipated that recharge rates will be significantly modified as a result of the M-Block operations given the limited areal extent of infrastructure that will influence recharge; limited to no modification of the characteristics of surface watercourses that may also contribute to recharge and the relatively short duration of the M-Block operations

Changes to groundwater or surface water quality are not anticipated as a result of the proposed activities associated with the activities proposed for M-Block, therefore:

- No changes to habitat or lifecycle of a native species dependent on a water resource are expected.
- No changes to the water resource that may cause the establishment of an invasive species (or the spread of an existing invasive species) are expected.
- No significant worsening of local water quality is anticipated.
- No changes to ecosystem water qualities are anticipated.
- No changes to the water resource that may cause the establishment of an invasive species (or the spread of an existing invasive species) are expected.

Groundwater inflow into the pit will be managed using sump-pumping techniques with the water to be used as part of the M-Block mining operations, including dust suppression.

It is also not likely that the M-Block operations would result in a risk to human or animal health, or to the condition of the environment as a result of a change in water quality.

Groundwater in the vicinity of the M-Block has been identified to be potentially used by eight third-party groundwater users. Groundwater level drawdown associated with the operation of M-Block is predicted to impact one of the groundwater users that is inferred to be sourcing groundwater from a bore screened in the Permian units located approximately 1.2 km from M-Block. The predicted drawdown at the location of this bore will be gradual for the duration of the operation of M-Block, with a predicted maximum drawdown of 14 m.

It is anticipated that Sojitz will enter into agreements with the landholder/owner of the impacted water supply bore, which will include the addressing this water supply bore impacts through “make-good” arrangements.

Surface water is not predicted to be impacted based on the conceptual understanding of M-Block and predicted drawdown of resulting from the operation of M-Block. Therefore, any surface water systems and species that may potentially be dependent on these surface water resources are not predicted to be impacted.

6 Proposed Avoidance, Safeguards and Mitigation Measures

6.1 Proposed Avoidance, Safeguards and Mitigation Measures

This section outlines the avoidance strategies, safeguards, and mitigation and management measures developed for the potential GCM impacts to listed threatened species and communities and water resources, in relation to coal seam gas development and large coal mining development.

A summary of the proposed mitigation measures that will be implemented for the development of M-Block are detailed in Table 6-1.

Where possible, the mitigation measures implemented by Sojitz are continuously improved upon through review and update of management plans and implementation documentation. As an example, Sojitz is working proactively to manage the excess mine water more sustainably and is working with the University of Queensland to improve water quality by trialling the use of algae as a treatment. The trial so far, has indicated positive results, with Sojitz considering processing and selling the treated water for innovative farming projects, hydrogen production and other uses.

Table 6-1: Proposed mitigation measures

Aspect	Proposed Safeguards and Mitigation Measures	Timing	Relevant Approval Body	Statutory or Policy Basis	Effectiveness
Biodiversity	Section 4.7 details the proposed mitigation measures relating to biodiversity. Safeguards and Mitigation Measures: • Implement a Vegetation and Fauna MP (Appendix K). • Site inductions for all staff and contractors to make them aware of environmental obligations. • Spotter catcher to be present for all clearing and disturbance of habitat. • Progressive rehabilitation of disturbance areas. • On-going monitoring as required by the Offset Area MP and Rehabilitation MP. • Continuation of the stygofauna sampling program to determine if stygofauna are present and, if so, to estimate their abundance and composition in aquifers. • Installation of new bores to assess for stygofauna (refer to Section 4.2 of Appendix M).	• Pre, post and during construction. • Operational requirements will commence following completion of construction.	Department of Climate Change, Energy, the Environment and Water	EPBC Act Approval	Effective – ensures a suitable management and monitoring framework is in place to identify any potential impact to land and water resources. The existing suite of management plans also include monitoring and inspection requirements to monitor effectiveness.
Rehabilitation	A Rehabilitation MP has been prepared for the mine operations and will be implemented by Sojitz to mitigate the potential impacts to land and water as a result of mining operations.	• Following temporary disturbance during construction. • Progressive rehabilitation of mining extent in line with Life of Mine Plan.	Rehabilitation MP – approval by DES		Effective – ensures a suitable management and monitoring framework is in place to identify any potential impact to land and water resources. The existing suite of management plans also include monitoring and inspection requirements to monitor effectiveness.
Water Resources	A Water MP, an overarching Erosion and Sediment Control Plan (ESCP), Subsidence Management Plan	• Prior to the commencement of activities on M-Block	Rehabilitation MP – approval by DES	EA: EPML00945013	Effective – ensures a suitable management and monitoring

Aspect	Proposed Safeguards and Mitigation Measures	Timing	Relevant Approval Body	Statutory or Policy Basis	Effectiveness
	(Subsidence MP) and a Rehabilitation MP have been prepared for the mine operations and are implemented by Sojitz to mitigate the potential impacts to water resources (refer to Section 6.2.2). Safeguards and Mitigation Measures: • Review existing management plans and update, as required, for inclusion of M-Block activities. • Site-specific ESCPs will be developed and implemented for M-Block. • Inclusion of management requirements for the storage of fuels and chemicals. • An existing active pit is assigned for MAW storage in wet years, to ensure that uncontrolled release does not occur. • A trigger level is to be set for MAW inventory to assign the additional MAW storage, and to enact necessary containment transfers. • Prepare a mine-water management strategy for the site to include regular monitoring of storages and timely implementation of containment transfers.	addressed by the management plans. • Prepare site-specific ESCPs prior to land disturbance. • Implementation and review of management plans throughout the life of the M-Block operations.		Conditions W1, W36, W37, F8, F9, S3, S4 and F5.	framework is in place to identify any potential impact to water resources. The existing suite of management plans also include monitoring and inspection requirements to monitor effectiveness.
Surface Water	A REMP is undertaken by Sojitz as part of the EA requirements. The review of surface water quality monitoring sites and data provided in this PER, has identified mitigation measures required for the operation of M-Block. Safeguards and Mitigation Measures:	Update to the REMP to include the additional monitoring locations and events associated with M-Block.	N/A	EA: EPML00945013 Condition W21	Effective – ensures suitable management and monitoring will accurately measure the potential impacts from the M-Block mining activities and will also determine if any upstream sources are impacting on surface water quality.

Aspect	Proposed Safeguards and Mitigation Measures	Timing	Relevant Approval Body	Statutory or Policy Basis	Effectiveness
	• Speciation of Chromium, to provide understanding of the potential impacts for this heavy metal. • Review the sensitivity of the chemical analysis to ensure the analysis can accurately be compared against the relevant water quality objectives, i.e. Cadmium and Mercury. • Review the chemical analysis to ensure the appropriate chemicals of concern are being assessed within the surface water monitoring program. • Implementation of monitoring of M-Block activities. This includes the continuation of water quality monitoring as per the REMP and the inclusion of additional surface water monitoring locations within the Mackenzie catchment.				
Groundwater	A Groundwater Monitoring and Management Plan (GMMP) (Appendix III of Appendix D) has been prepared for the M-Block extension to assess the effects of abstraction of groundwater and to further refine and validate the groundwater flow model used to assess impacts. Safeguards and Mitigation Measures: • Implement the GMMP for the life of the project. • Installation of new groundwater monitoring bores as per Section 2.18 of Appendix L.	Pre, post and during construction.	N/A	EA: EPML00945013 Condition W44	Effective – ensures suitable management and monitoring will accurately measure the potential impacts from the M-Block mining activities and validate groundwater model.
Subsidence	A Subsidence MP and a Rehabilitation MP has been prepared for the mine operations (refer to Section 6.2.2) to	• Updates (as required) to the Subsidence MP and Rehabilitation MP to be undertaken prior to	N/A	EA: EPML00945013	Effective – ensures suitable management and monitoring framework to identify any potential

Aspect	Proposed Safeguards and Mitigation Measures	Timing	Relevant Approval Body	Statutory or Policy Basis	Effectiveness
	manage the environmental impacts from subsidence. Safeguards and Mitigation Measures: • Review and update (as required) the Subsidence MP and Rehabilitation MP to include any additional requirements specific to M-Block.	commencement of applicable activities on M-Block. • Implementation and review of management plans throughout the life of the M-Block operations.		Conditions F8, F9, S3, S4 and F5.	subsidence impacts and rehabilitation requirement. The existing suite of management plans also include monitoring and inspection requirements to monitor effectiveness.
Voids	A residual void investigation study has been undertaken. The study modelled void long-term water balances and long-term Total Dissolved Solids concentrations (as an indicator of water quality) for the final voids. Safeguards and Mitigation Measures: • Backfilling the final void to cover the groundwater level post underground mining	Review of potential land uses	N/A	EA: EPML00945013 Condition F7.8, F9, S3, S4 and F5. F7	Creation of depressed landform
Waste	A Waste MP has been prepared for GCM (refer to Section 6.2.2) to manage waste. This will apply to M-Block. Safeguards and Mitigation Measures: • Review and update (as required) the Waste MP to include any additional requirements specific to M-Block.	• Updates (as required) to the Waste MP prior to commencement of applicable activities on M-Block. • Implementation and review of Waste MP throughout the life of the M-Block operations.	N/A	EA: EPML00945013 Condition E5 *Waste Resource and Recovery Act 2011* (Qld)	Effective – ensures suitable management and monitoring framework to identify any potential waste management impacts. The existing suite of management plans also include monitoring and inspection requirements to monitor effectiveness.

6.2 Management Plans

6.2.1 Environmental Management System Manual

Sojitz operate under an Environmental Management System (EMS) that outlines environmental measures to be implemented during the operation of GCM. An Operational Environmental Management Plan (OEMP) has been developed to fulfil this purpose and aligns with Sojitz Environmental and Sustainability Policy and standards and *ISO 14001 Environmental Management Systems*. The OEMP incorporates the requirements of the EA for the mine.

An Environmental Aspects and Impacts Register was developed to identify and document the significant environmental aspects for the operation, and to inform the development of the OEMP. Section 7 of the OEMP details the minimum management requirements for the mine, including references to other management plans.

6.2.2 Management Plans

A suite of management plans has been developed under the EMS to manage potential impacts from the GCM and to satisfy the conditions of the EA. These plans will apply to the operation of M-Block and will be reviewed and updated as required to accommodate the mining of M-Block and to reflect approval condition requirements.

A summary of the management plans is provided in Table 6-2.

Table 6-2: GCM management plans

Management Plan	Overview	Applicable EA Condition
Water Management Plan	A Water MP has been developed for GCM with its primary purpose being to identify the potential risks to the environment from the mine operation and specify the controls necessary to mitigate any potential impacts. The Water MP aims to minimise the release of contaminants to the receiving environment and ensure mine-affected water, or its use, does not adversely impact the local and regional environment. The Water MP is reviewed on an annual basis and includes requirements for monitoring, reporting and event investigations. The monitoring program includes: • Water storage water quality and Reduced Level (RL) monitoring (i.e. monitoring of water levels). • Creek and river water quality monitoring. • Monitoring climatic conditions through the site's weather stations (rainfall volume and intensity). • Release monitoring.	Condition W31
	Receiving Environment Monitoring Program Sojitz implements a REMP at GCM in accordance with the conditions of its EA. The EA requires periodic monitoring, identification, and description of any impacts to the environmental values, quality and flows observed in the receiving environment due to the mine's operation. The EA states the monitoring requirements including assessment of background reference water quality, the condition of downstream water quality compared against water quality objectives, and the suitability of current discharge limits for protection of downstream environmental values. An annual report is prepared that outlines the findings of the REMP. All water quality data is stored in the GCM EMS and reported to the Administering Authority (DES) as requested.	Condition W21 Condition W22 Condition W23
Groundwater Monitoring and Management Plan	A GMMP has been prepared (refer to Appendix III of Appendix D) for M-Block to assess the effects of abstraction of groundwater and to further refine and validate the groundwater flow model used to assess impacts. • The GMMP details:	Condition W44 Condition W45 Condition W46 Condition W47

Management Plan	Overview	Applicable EA Condition
	• The monitoring program for groundwater including sampling methodology and laboratory requirements. • The investigation trigger values, including requirements for investigation of exceedances. • Actions to minimise impacts. • Notification and reporting requirements.	Condition W48 Condition W49 Condition W50 Condition W51
Waste Management Plan	A Waste MP has been developed to manage the waste generated by the operation of GCM. The Waste MP details the waste streams that are likely to be produced from operations and details the management measures to be implemented which align with the waste hierarchy of avoid, reuse, recycle, recovery and disposal. The Waste MP also details segregation methods, storage details, transport offsite, monitoring and reporting requirements. Additional requirements associated with the hazardous or registered wastes produced by the operation are also included. The following procedures that include a component of waste management are also implemented by Sojitz: • Housekeeping Procedure • Environmental Inspection	Condition E5
Erosion and Sediment Control Plan	An overarching ESCP has been developed for the site outlining Sojitz's strategy to manage its onsite erosion and sediment control requirements. The ESCP details the erosion and sediment controls that are intended to minimise erosion and sedimentation. The ESCP includes requirements for inspections, monitoring (including event-based inspection) and maintenance (including maintenance regimes) and incident investigation and reporting, performance indictors and requirements for monitoring. To supplement the overarching ESCP site specific ESCPs will be prepared and implemented for M-Block.	Condition W36 Condition W37
Topsoil Management Plan	The GCM Topsoil MP details Sojitz's strategy to manage topsoil during its mining process. The Topsoil MP details the different topsoil types for the mine and includes controls and actions to be implemented, which include administration tasks (i.e. permits to disturb), requirements for topsoil stripping, inventory, reconciliation, recovery and placement. It also includes requirements for monitoring and inspections and for incident investigation and corrective actions. The plan will be updated, as required, and implemented on M-Block.	Condition F1
Subsidence Management Plan	The Subsidence MP details the strategy and procedures to manage the environmental impacts from subsidence. The Subsidence MP covers operations where subsidence can or has historically occurred. The Subsidence MP details that any impact assessments must include cumulative impacts, groundwater impacts, infrastructure impacts and a risk assessment which covers any potential environmental impacts predicted. The impact assessment will then make recommendations as required for ongoing additional monitoring and / or mitigation measures for subsidence impacts. Annual monitoring is also conducted by Sojitz under the plan and any issues identified during this routine monitoring addressed. The Subsidence MP also details the monitoring programs, subsidence rehabilitation, reporting and maintenance requirements.	Condition F8 Condition F9 Condition S3 Condition S4
Rehabilitation Management Plan	The GCM Rehabilitation MP addresses the requirement that Sojitz rehabilitate, back to a stable landform with a self-sustaining vegetation cover, all areas that have been substantially disturbed through its mining activities. Progressive rehabilitation shall commence within two years as and when areas become available within the GCM site. The Rehabilitation MP details rehabilitation methods that can be implemented to achieve the site's post-mining land use, general rehabilitation goals, objectives, indicators and completion criteria and requirements for monitoring, maintenance and final landform planning.	Condition F5

Management Plan	Overview	Applicable EA Condition
	The Rehabilitation MP is updated every three years, or as industry or operational changes dictate.	
Community Engagement Plan	The community engagement plan is part of the EMS suite of management plans. Its purpose is to outline Sojitz's strategy to manage its community engagement requirements. The plan identifies stakeholders and details associated engagement activities, their frequency and responsibility. A complaints procedure is also detailed in this plan. Community Engagement records are in site's EMS.	Condition H1

6.3 Summary of Mitigation Measures

A summary of the mitigation measures detailed above is provided in 0.

Table 6-3: Summary of mitigation measures

Aspect	Mitigation Measure
Biodiversity	Section 4.7 details the proposed mitigation measures relating to biodiversity. Some of the key actions include: • Implementation of the Vegetation and Fauna MP, including the Pest and Weed Management Plan that details how pest and weeds will be managed for the duration of the project. • Site inductions for all staff and contractors to make them aware of environmental obligations. • Spotter catcher to be present for all clearing and disturbance of habitat. • Progressive rehabilitation of temporary disturbance areas. • On-going monitoring as required by the Offset Area MP and Rehabilitation MP. • Continuation of the stygofauna sampling program to determine if stygofauna are present and, if so, to estimate their abundance and composition in aquifers. • Installation of new bores to assess for groundwater invertebrate (refer to Section 4.2 of Appendix M).
Rehabilitation	• A Rehabilitation MP has been prepared for the mine operations and will be implemented by Sojitz to mitigate the potential impacts to land and water as a result of mining operations. • Review and updated this plan as required for the inclusion of M-Block activities.
Water Resources	• A Water MP, an overarching Erosion and Sediment Control Plan (ESCP), Subsidence Management Plan (Subsidence MP) and a Rehabilitation MP have been prepared for GCM mine operations and are implemented by Sojitz to mitigate the potential impacts to water resources (refer to Section 6.2.2). • Review existing management plans and update, as required, for inclusion of M-Block activities. • Inclusion of management requirements for the storage of fuels and chemicals. • Site-specific ESCPs will be developed and implemented for M-Block. • An existing active pit is assigned for MAW storage in wet years to ensure that uncontrolled release does not occur. • A trigger level is to be set for MAW inventory to assign the additional MAW storage, and to enact necessary containment transfers. • Prepare a mine-water management strategy for the site to include regular monitoring of storages and timely implementation of containment transfers.
Surface Water	A REMP is undertaken by Sojitz as part of the EA requirements. The review of surface water quality monitoring sites and data provided in this PER, has identified mitigation measures required for the operation of M-Block. These include: • Speciation of Chromium, to provide understanding of the potential impacts for this heavy metal.

Aspect	Mitigation Measure
	• Review the sensitivity of the chemical analysis to ensure the analysis can accurately be compared against the relevant water quality objectives, i.e. Cadmium and Mercury. • Review the chemical analysis to ensure the appropriate chemicals of concern are being assessed within the surface water monitoring program. • Implementation of monitoring of M-Block activities. This includes the continuation of water quality monitoring as per the REMP and the inclusion of additional surface water monitoring locations within the Mackenzie catchment.
Groundwater	• A GMMP (refer to Appendix III of Appendix D) has been prepared for the M-Block extension to assess the effects of abstraction of groundwater and to further refine and validate the groundwater flow model used to assess impacts. • Implementation of the GMMP for the life of the project. • Installation of new groundwater monitoring bores as per Section 2.18 of Appendix L.
Subsidence	• A Subsidence MP and a Rehabilitation MP has been prepared for the mine operations (refer to Section 6.2.2) to manage the environmental impacts from subsidence. • Review and update (as required) the Subsidence MP and Rehabilitation MP to include any additional requirements specific to M-Block.
Voids	A residual void investigation study has been undertaken. The study modelled void long-term water balances and long-term Total Dissolved Solids concentrations (as an indicator of water quality) for the final voids. No additional measures proposed.
Waste	• A Waste MP has been prepared and are in operation for GCM (refer to Section 6.2.2) to manage waste. • Review and update (as required) the Waste MP to include any additional requirements specific to M-Block.

7 Environmental Offsets

This section summarises the findings from Stantec's Offset Area Management Report (2023) which is attached as Appendix J.

7.1 MNES Requiring Offsets

It has been determined that the proposed action will likely result in residual significant impacts on the following MNES:

- Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community.
- Natural grasslands of the Queensland Central Highlands and northern Fitzroy Basin ecological community.
- King Bluegrass (*Dichanthium queenslandicum*).
- Squatter Pigeon (southern) (*Geophaps scripta scripta*).

Table 7-1 summarises the expected impact area of the above MNES. Further details are provided in the Offset Area MP which is attached as Appendix J.

Table 7-1: Estimated MNES offset requirements

Threatened Ecological Community	Total Area of Habitat (ha)	Direct Impact Area (ha)	Indirect Impact Area (ha)	Total Disturbance Estimate (ha)	Total Area of Habitat Avoided (ha)
Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community	156.4	58.7	0	58.7	97.6
Natural grasslands of the Queensland Central Highlands and northern Fitzroy Basin ecological community	819.6	133.5	0	133.5	686.1
King Bluegrass (*Dichanthium queenslandicum*)	1,029.1	174.9	0	174.9	854.1
Squatter Pigeon (southern) (*Geophaps scripta scripta*)	164.8	58.7	0	58.7	106.1

7.2 Proposed Offset Strategy

The *EPBC Act Environmental Offsets Policy - 2012* outlines the Australian Government's approach to the use of environmental offsets under the EPBC Act. The overarching test of the *EPBC Act Environmental Offsets Policy* is that suitable offsets must deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environment law and affected by the proposed action. Sojitz intends to offset residual and unavoidable impacts on the MNES identified above through direct offsets. This strategy is considered to be the most effective, reliable and efficient approach to achieve the offsets required for the M-Block extension while meeting the requirements of the *EPBC Act Environmental Offsets Policy.* All unavoidable impacts and loss of biodiversity from the M-Block operations will be compensated by the implementation of this offset strategy.

7.2.1 BioCondition and Habitat Quality Assessments

The quantification of the ecological condition of both impact and potential offset sites is based on the execution of field and desktop methodologies outlined in the Queensland Herbarium's *BioCondition Assessment Manual* (Eyre et al. 2015).

Habitat Quality Indicators were derived for the Squatter Pigeon (*Geophaps scripta scripta*) according to the Queensland Government Guide to determining terrestrial habitat quality: A toolkit for assessing land-based offsets under the Queensland Environmental Offsets Policy (2022). These indicators were used in the field to determine the quality of habitat available within M-Block.

7.2.2 Calculation of Offset Area

The *EPBC Act Environmental Offsets Policy* is accompanied by the *Offsets Assessment Guide* which has been developed in order to give effect to the requirements of the policy, utilising a balance sheet approach to estimate impacts and offsets for threatened species and ecological communities.

The proposed offset areas detailed in this assessment were calculated in accordance with the offsets assessment guide. The inputs used to assess the offset area required for each MNES are provided in the Offset Area MP attached as Appendix J.

7.3 Environmental Offset Sites

Stantec conducted BioCondition Assessments and Squatter Pigeon habitat quality assessments at three Offset Sites, all located within the Gregory Crinum mining lease (Figure 7.1). Details of each site and the results of these assessments are described below and also detailed in full in the Offset Area MP attached as Appendix J. The location of Offset Sites mapped with Brigalow and Grassland TECs and potential habitat for the Squatter Pigeon and King Bluegrass is shown in Figure 7.3.

7.3.1 Offset Site One

Offset Site One is located within Gregory Crinum's current mining operations (Figure 7.1). The current land use is mapped as Mining and Other Minimal Use. The surrounding land has been largely cleared for mining operations, however, the potential offset sites have areas of intact vegetation.

The vegetation across the site and immediate surrounds is mapped as non-remnant vegetation and regrowth RE 11.9.1 (*Acacia harpophylla-Eucalyptus cambageana* woodland to open forest on fine-grained sedimentary rocks) which was ground-truthed during Stantec's assessments in 2022. Based on the field assessments completed by Stantec, this site supports approximately 119 ha of this community with a BioCondition Class of '3' indicating a moderately functional biodiversity condition.

The vegetation community met the key diagnostic characteristics and condition thresholds to be considered a Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community making it an appropriate location to offset the Brigalow TEC that will be impacted by the proposed action. The location of the TEC is shown in Figure 7.3.

This area also contains appropriate habitat features for the Squatter Pigeon according to the description outlined within the Threatened Species Scientific Committee's Species Profile and Threats Database, specifically:

- open-forests to sparse, open-woodlands and scrub.
- mostly dominated in the overstorey by Eucalyptus, Corymbia, Acacia or Callitris species.
- remnant, regrowth or partly modified vegetation communities.
- within 3 km of water bodies or courses.

Stantec completed habitat surveys in the area and found Offset Site One had a Squatter Pigeon habitat quality score of '6', indicating a medium quality habitat. Although Squatter Pigeon have not been observed within this area yet, records exist within 1.5 km – 2.5 km from the site (Figure 7.3). The Squatter Pigeon is considered sedentary where water and food resources are reliable in the local region. However, when these resources are unavailable the subspecies may disperse along vegetated corridors to access permanent water sources elsewhere in the region (Squatter Pigeon Workshop 2011). Due to this mobility, Offset Site One makes an appropriate offset location providing the habitat requirements necessary for the survival of the species. This property is therefore an appropriate site to offset the Squatter Pigeon habitat that will be impacted by the proposed action. The potential Squatter Pigeon habitat is shown in Figure 7.3**.**

7.3.2 Offset Site Two

Offset Site Two is located within Gregory Crinum's current mining operations (Figure 7.1). The current land use is mapped as Other Minimal Use and Grazing Native Vegetation. The surrounding land has been largely cleared for mining operations, however, the potential offset sites have areas of intact vegetation.

The vegetation across the site and immediate surrounds is mapped as non-remnant vegetation and remnant RE 11.4.9 (*Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains) which was ground-truthed during Stantec's assessments. Based on the field assessments completed by Stantec,

this site supports approximately 30 ha of this community with a BioCondition Class of '2' indicating a moderately functional biodiversity condition.

The vegetation community met the key diagnostic characteristics and condition thresholds to be considered a Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community making it an appropriate location to offset the Brigalow TEC that will be impacted by the proposed action. The location of the TEC is shown in Figure 7.3**.**

7.3.3 Offset Site Three

Offset Site Three is located on the Gregory Crinum mining lease approximately 2.5 km to the west of the southern end of M-Block (Figure 7.1). The current land use of this site is mapped as Grazing Native Vegetation and Cropping. To the north is Gregory Crinum's current mining operations and to the south is the Kestrel Mine. There has been historical clearing through past agricultural practices, however, tracts of remnant vegetation and high-quality regrowth vegetation remains.

The vegetation across the site is mapped predominately as non-remnant vegetation with patches of remnant RE 11.3.37/11.3.3/11.3.2 and RE 11.8.11/11.8.5 to the western edge of the property and RE 11.8.5 to the eastern edge of the property. Cardno, now Stantec (2022) ground truthed the area as:

- 29.59 ha of regrowth RE 11.4.9 – consistent with the Brigalow TEC.
- 619.83 ha of regrowth RE 11.8.11 – consistent with the Grassland TEC.

The BioCondition class ranges from '2' to '3' across the area indicating a functional biodiversity condition to moderately functional biodiversity condition.

The area containing RE 11.4.9 met the key diagnostic characteristics and condition thresholds to be considered the Brigalow TEC making it an appropriate location to offset the Brigalow TEC that will be impacted by the proposed action. The location of the TEC is shown in Figure 7.3**.**

The assessment sites containing RE 11.8.11 met the key diagnostic characteristics and condition thresholds to be considered Natural grasslands of the Queensland Central Highlands and northern Fitzroy Basin ecological community making it an appropriate location to offset the Grassland TEC that will be impacted by the proposed action. Surveys completed by Stantec in 2022 also confirmed the presence of King Bluegrass (*Dichanthium queenslandicum*) on this site, making it a suitable location to offset the Projects impact on this MNES. The location of the TEC and potential habitat is shown in Figure 7.3**.**

7.3.4 Potential Offset Areas and Habitat Connectivity

To enable the ongoing viability and maximise the ecological gain of the offset sites it is necessary that the locations have habitat connectivity with habitat on adjoining land. All of the offset sites have some degree of habitat connectivity helping to ensure that the MNES values being protected and enhanced will benefit from and provide benefit to other areas of important habitat. As shown in Figure 7.2, the Offset Sites chosen are connected to or in close proximity to areas of potential MNES habitat as defined by the Regional Ecosystem mapping.

Minor non-perennial watercourses run through these offset sites which connect to reservoirs within the mining lease. The offset sites are strategically located around Crinum Creek which is an important riparian corridor in the locality providing critical north – south connectivity between the Nogoa River riparian zone and the larger areas of native remnant vegetation to the north of Tieri.

Due to historical land use and other man-made barriers such as existing mining there are presently only sparse and 'unprotected' stepping stones and corridors in this area – particularly to the west of the Crinum Mine. Formalising the protection of these areas will consolidate and expand the ecological connectivity in this region and provide connection within the mining operations to outer more contiguous areas of habitat.

Further, Offset Site One and Offset Site Two currently fall within the active mining lease, Offset Site Three falls within the mining lease but not within the active mining operation area. With appropriate management and rehabilitation of these sites, a higher quality corridor from the mining operations to larger areas of more contiguous habitat could be established allowing movement in and out of areas with high disturbance from mining activities. Sojitz has already begun progressive rehabilitation, as detailed in their Rehabilitation Management Plan, within the broader area (Figure 7.2). The offset sites are in close proximity to areas already subject to rehabilitation which will enhance ecological linkages throughout and out of the mining area. Further, these Offset Sites are already owned and managed by Sojitz. This allows management procedures to be implemented without negotiations with additional land owners meaning management measures can be acted on more efficiently.

The connecting habitats, biodiversity corridors and current progressive rehabilitation in relation to the offset sites are shown in Figure 7.2.

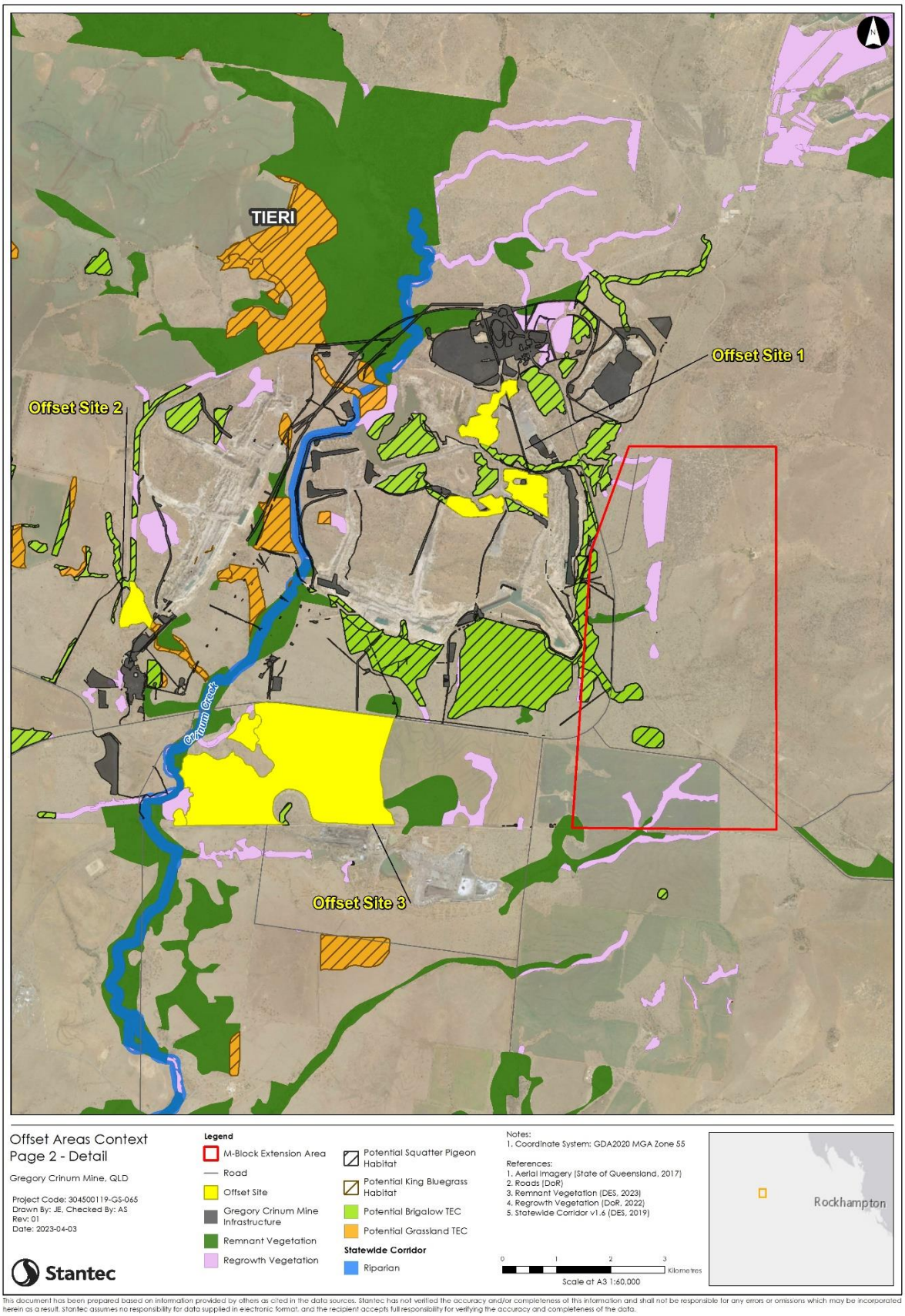

Figure 7.1: Offset locations in relation to M-Block

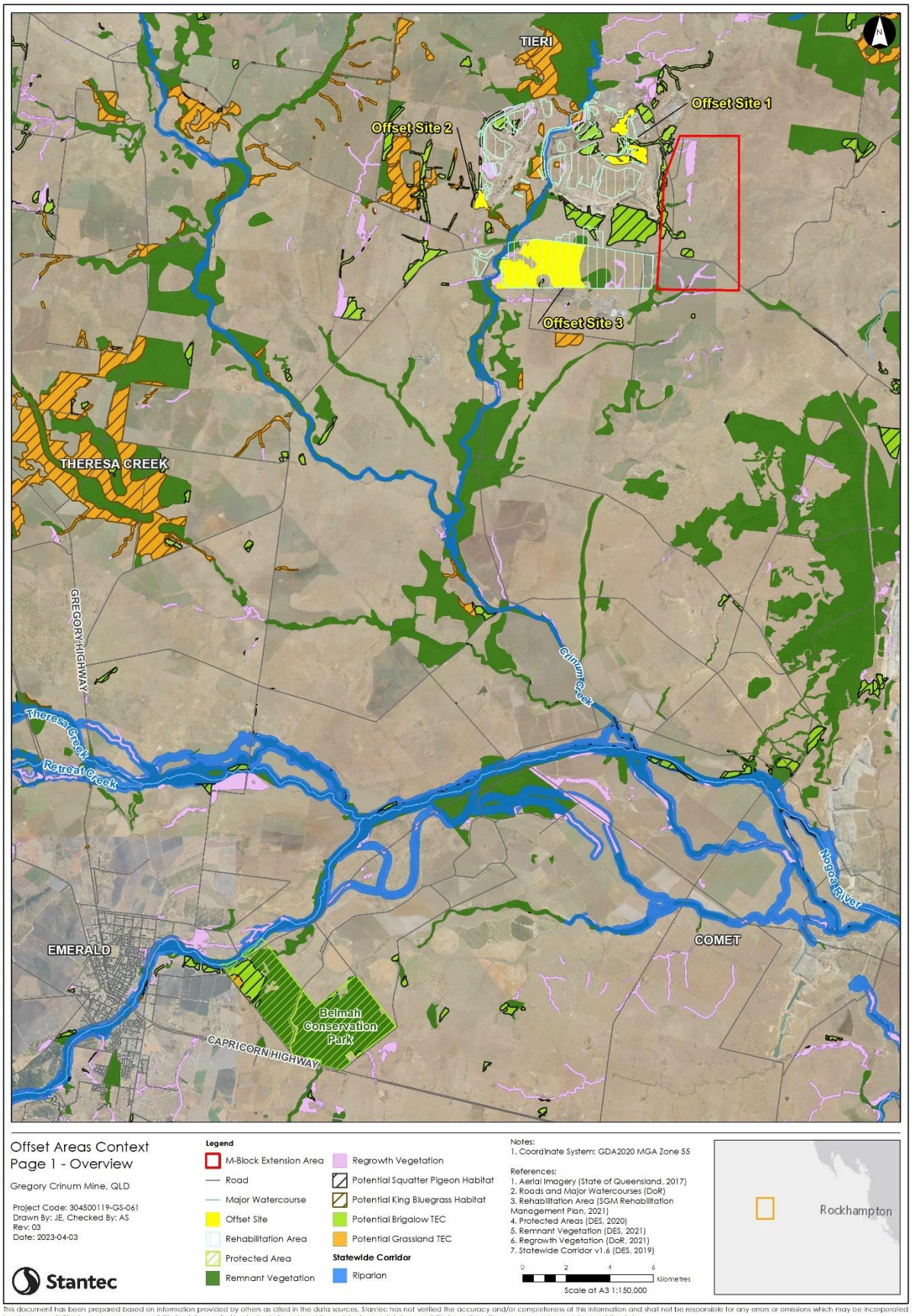

Figure 7.2: Offset locations with connecting habitats and biodiversity corridors

7.3.5 Assessment of Offset Site Habitat Quality

Table 7-2 summarises the BioCondition assessment results and Squatter Pigeon habitat quality results from each offset site and the environmental values present.

Table 7-2: Summary of offset sites and MNES present

Offset Site	Regional Ecosystem	Class	MNES Present	Habitat Area (ha)	BioCondition Score	BioCondition Class	Squatter Pigeon Habitat Quality Score
One	11.9.1	Regrowth	Brigalow TEC Squatter Pigeon Habitat	119 ha	0.57	3	6
Two	11.4.9	Remnant	Brigalow TEC	30 ha	0.6	2	N/A
Three	11.4.9	Regrowth	Brigalow TEC	29.59 ha	0.55	3	N/A

7.4 Offset Area Calculation Results

Data from the project BioCondition and habitat quality assessments was used to justify the existing habitat quality inputs in to the *EPBC Act Offsets Assessment Guide* (the Guide). In order to maintain or improve the viability of the impacted MNES, the following offset areas are required:

- 165 ha of Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community.
- 375 ha of Natural grasslands of the Queensland Central Highlands and northern Fitzroy Basin ecological community.
- 495 ha of King Bluegrass (*Dichanthium queenslandicum*) habitat, which can be co-located with the 250 ha of Natural grasslands of the Queensland Central Highlands and northern Fitzroy Basin ecological community.
- 95 ha of Squatter Pigeon (southern) (*Geophaps scripta scripta*) habitat.

The combined hectares of Offset Site One, Offset Site Two and Offset Site Three provide the required offset areas.

Table 7-3 provides a reconciliation of the proposed action's offset requirements in order to satisfy the *EPBC Act Environmental Offsets Policy* requirements. A summary of the inputs for each MNES and justification to inform the inputs is provided in the Offset Area MP attached as Appendix J.

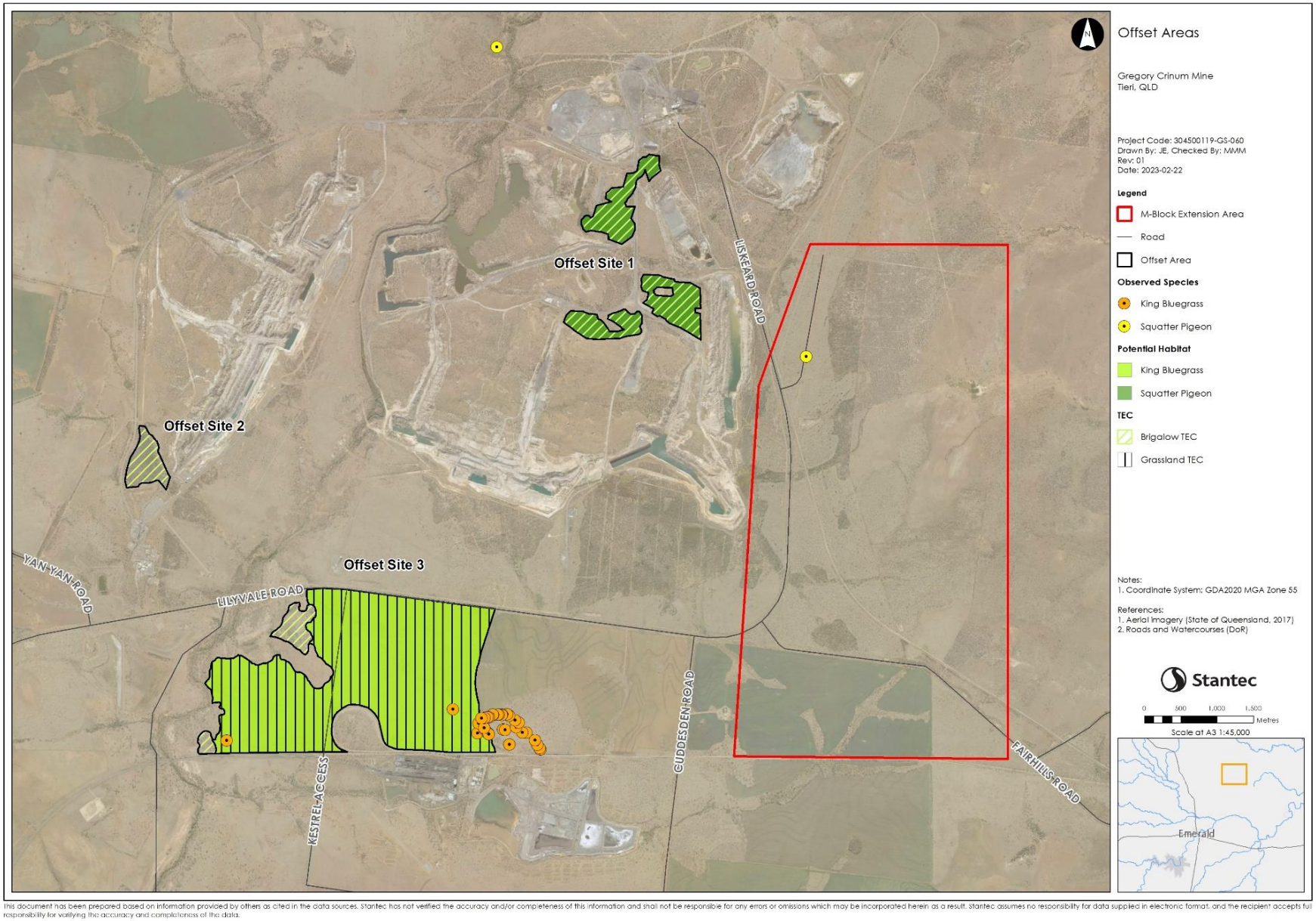

Figure 7.3: Offset areas with location of TECs and potential habitat for the Squatter Pigeon and King Bluegrass

Table 7-3: Offset requirements for each relevant MNES for the proposed M-Block extension

Matter of National Environmental Significance	M-Block Extension Impact Area (ha)	Habitat Quality Impact Area	Area within Potential Offset Area (ha)	Habitat Quality Offset Area	Future Habitat Quality with Offset	Offset Liability Satisfied (%)	Offset Requirement Satisfied?
Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community	58.7	6	165	6	8	102.63	Yes
Natural grasslands of the Queensland Central Highlands and northern Fitzroy Basin ecological community	133.5	6	375	5	7	101.97	Yes
King Bluegrass (*Dichanthium queenslandicum*)	174.9	6	495	5	7	102.73	Yes
Squatter Pigeon (southern) (*Geophaps scripta scripta*)	58.7	4	95	6	8	105.31	Yes

7.5 Legal Entitlement to Offset Site

Within 12 months of commencing the Action, Sojitz will legally secure the chosen offset sites. It is expected that this will be in the form of a statutory environmental covenant or Voluntary Declaration. The environmental covenant is a legally binding written agreement entered into between a Covenantor (Sojitz) and the Covenantee (Government body). A covenant is registered against the title and survey plan of a property and administered under the *Land Titles Act 1994* (Qld). This will provide ongoing and enduring protection for the offset areas against development incompatible with conservation.

7.6 Offset Area Management Plan

The conservation objective for the Offset Area MP (Appendix J) is to protect and enhance the condition and extent of the biodiversity values of the offset sites within 20 years.

The key conservation outcomes from the long term management and protection of the offset sites are:

- Increased extent, condition and value of Brigalow TEC and Grassland TEC.
- Increased extent, condition and value of King Bluegrass habitat.
- Improved fauna movement and flora dispersal opportunities within the surrounding disturbed landscape.
- Increased condition and area of refuge for the Squatter Pigeon and other local fauna populations.

Table 7-4 outlines the key biodiversity values for each offset area, with their corresponding key performance indicators.

Table 7-4 Values within offset sites and completion criteria

Offset Area	Regional Ecosystem	Nested Values	Key Performance Indicators	Completion Criteria
Offset Site One	RE 11.9.1 Regrowth vegetation	Brigalow TEC	• Interim performance targets outlined in Table 7-5 are achieved. • BioCondition score increases by 2 points in 20 years.	• Observed and measured increase to a BioCondition score of 8 in 20 years.

Offset Area	Regional Ecosystem	Nested Values	Key Performance Indicators	Completion Criteria
		Squatter Pigeon habitat	• Interim performance targets outlined in Table 7-5 are achieved. • Squatter Pigeon observed in Offset Area One within first 5 years of site being secured. • Habitat quality score increased by 2 points in 20 years	• Observed increase in species usage over 20 years. • Observed and measured increase to a habitat quality score of 8 in 20 years.
Offset Site Two	RE 11.4.9 Remnant vegetation	Brigalow TEC	• Interim performance targets outlined in Table 7-5 are achieved. • BioCondition score increases by 2 points in 20 years.	• Observed and measured increase to a BioCondition score of 8 in 20 years.
Offset Site Three	RE 11.4.9 Regrowth vegetation	Brigalow TEC	• Interim performance targets outlined in Table 7-5 are achieved. • BioCondition score increases by 2 points in 20 years.	• Observed and measured increase to a BioCondition score of 8 in 20 years.
	RE 11.8.11 Regrowth vegetation	Grassland TEC	• Interim performance targets outlined in Table 7-5 are achieved. • BioCondition score increases by 2 points in 20 years.	• Observed and measured increase to a BioCondition score of 7 in 20 years.

Table 7-5 outlines the specific completion criteria and interim performance targets needed to reach the final habitat quality goal within the 20-year timeframe.

Table 7-5 Interim performance targets

Offset Site	Starting Habitat Quality Score	Interim Performance Targets			Final Habitat Quality (Year 20) Completion Criteria
		Year 5	Year 10	Year 15	
Offset Site One RE 11.9.1 - Brigalow TEC	6	6.5	7	7.5	8
Offset Site One RE 11.9.1 - Squatter Pigeon habitat	6	6.5	7	7.5	8
Offset Site Two RE 11.4.9 - Brigalow TEC	6	6.5	7	7.5	8
Offset Site Three RE 11.4.9 - Brigalow TEC	6	6.5	7	7.5	8
Offset Site Three RE 11.8.11 - Grassland TEC King Bluegrass habitat	5	5.5	6	6.5	7

7.7 Specific Management Actions

The objectives of each completion criteria will be achieved through the implementation of a range of specific management actions to be performed by the Landholder. The Offset Area MP (Appendix J) is written for the management of clearly defined offset sites however the outcome and general contextual improvement will be achieved through the management of the broader property as a whole. The continued progressive rehabilitation throughout the broader property as outlined in the GCM Rehabilitation Management Plan and the implementation of actions outlined in the Offset Area MP will help improve the overall outcome and will reduce the likelihood of edge effects, weed invasion and enhances habitat connectivity.

With improved and active management of the offset sites, it is anticipated that an improvement in the condition of the offset sites and the completion criteria can be achieved within 20 years, with 5-yearly interim milestones to help ensure the active management actions are having the desired effect. The specific management actions consist of a range of on-ground management regimes designed to be consistent with the national recovery plan or conservation advice for that species or community.

The management actions and monitoring methods for each offset site generally as well as specific actions for each MNES are detailed in Table 12 of Appendix J.

7.8 Monitoring, Evaluation, Reporting and Adaptive Management

As part of the plan to improve the baseline condition of TECs, King Bluegrass and Squatter Pigeon habitat within the offset sites, a monitoring plan will be implemented to assess the success of the management activities. Monitoring will be statistically robust and quantify the change in condition of the offset sites. This monitoring program will include control sites and periodic ecological surveys to be undertaken by a suitable qualified ecologist.

The monitoring program will include the following items and detailed in full in Table 12 of the Offset Area MP (Appendix J).

- Quarterly checklist completed by the Land Manager.
- Photo point monitoring to be conducted at intervals.
- BioCondition assessments.

8 Other Approvals and Conditions

8.1 Planning Provisions and the Action

The M-Block extension will be undertaken in accordance with all applicable Commonwealth and Queensland State legislative requirements. This includes compliance with current approvals, authorities and permits under which the mine operates, as detailed in Table 8.1.

8.2 Current Approvals, Authorities and Permits

8.2.1 Overview of Approvals, Authorities and Permits

The operation of GCM is subject to a range of approvals, permits and authorities, some of which are applicable to the proposed M-Block operations. An overview of all approvals permits and authorities relating to the operation of the mine and those which are applicable to M-Block are detailed in Table 8-1.

Each of those applicable to M-Block are detailed further in the following sections.

Table 8-1: All approvals, authorities and permits

Approval, Authority or Permit	Issuing Authority	Applicability to M-Block
Federal Government		
EPBC Act Referral 2012/6268 Controlled Action	Department of Sustainability, Environment, Water, Population and Communities	M-Block 3D Seismic Exploration Program. Exploration program was not undertaken. Lapsed.
Queensland State Government		
Environmental Authority EPML00945013	Department of Environment and Science	Activities applicable to ML1923 which included M-Block: • Resource Activity, Schedule 2A, 13: Mining black coal. • Resource Activity, Ancillary 31 - Mineral processing, 2: Processing, in a year, the following quantities of mineral products, other than coke, (b) more than 100,000t • Resource Activity, Ancillary 08 - Chemical Storage, 3: Storing more than 500 cubic metres of chemicals of class C1 or C2 combustible liquids under AS 1940 or dangerous goods class 3 under subsection (1)(c). • Resource Activity, Ancillary 56 - Regulated Waste Storage, Receiving and storing regulated waste. Resource Activity, Ancillary 63 - Sewage Treatment, 1: Operating sewage treatment works, other than no release works, with a total daily peak design capacity of, (b-i) more than 100 but not more than 1500EP if treated effluent is discharged from the works to an infiltration trench or through an irrigation scheme.
Suitable Operator RSO002020	Department of Environment and Science	Registered suitable operator under the *Environmental Protection Act 1994*. Relates to operation of the EA which includes M-Block.
Damage Mitigation Permit WA0044494	Department of Environment and Science	Permit for 12 months – expiry date 28 June 2023. Includes M-Block.
Progressive certification of an Environmental Authority EPML00945013	Department of Environment and Science	This does not include M-Block. Progressive rehabilitation is proposed for M-Block.

Approval, Authority or Permit	Issuing Authority	Applicability to M-Block
Road Corridor Permit - Operation and Maintenance of pipeline within state-controlled road reserve **RCP-1849**	Department of Transport and Main Roads	Applicable to M-Block as it is part of the wider GCM operations.
Water Licence – Diverting the Flow of Water **41312F**	Department of Resources	Interfering with the flow of water in Crinum Creek by changing the course of flow on or adjoining land described as ML 1789. Does not directly relate the activities proposed for M-Block.
Water Licence – Diverting the Flow of Water **45241F**	Department of Resources	Interfering with the flow of water in Crossbred Creek by changing the course of flow on or adjoining land described as ML 1789. Does not directly relate the activities proposed for M-Block.
Water Licence – Diverting the Flow of Water **404300** **Development Permit # 404301**	Department of Resources	Interfere with the flow of water in Crinum Creek by changing the course of flow on or adjoining land described as ML 1789. The works associated with this interference are those authorised by Development Permit No. 404301. Crinum Creek Stage 2 Diversion Channel. Does not directly relate the activities proposed for M-Block.
Water Licence – Dewatering **577145** **Expiry 30/06/2111**	Department of Resources	The taking of underground water from Tertiary – Undefined with the point of take under ML 1923 and ML 1789. The water taken under this licence from the tertiary-undefined formation includes water originating from the Tertiary Basalt Formation and the German Creek coal measures. M-block is located with ML 1923.
Local Government - Central Highlands Regional Council		
Nil		

8.2.2 EPBC Act

In 2012, BM Alliance Coal Operations Pty Ltd, referred their proposal to undertake a mining exploration program on the M-Block (2012/6268). The proposal was determined to be a controlled action with assessment via preliminary documentation. A Declaration of a Lapsed Proposal of an Action Under the *Environment Protection and Biodiversity Conservation Act 1999* was made on 15 September 2020.

8.2.3 Environmental Authority (Queensland)

EA EPML00945013 is held by Sojitz Gregory Crinum Pty Ltd for the operation of a resource activity and ancillary environmentally relevant activities on MDL133, ML1789, ML1923, ML70061, ML7007 (Appendix B). M-Block is located within ML1923 and the operation of the following environmentally relevant activities are permitted, subject to the conditions detailed in EPML00945013.

- Resource Activity, Schedule 2A, 13: Mining black coal.
- Resource Activity, Ancillary 31 - Mineral processing, 2: Processing, in a year, the following quantities of mineral products, other than coke, (b) more than 100,000t.
- Resource Activity, Ancillary 08 - Chemical Storage, 3: Storing more than 500 cubic metres of chemicals of class C1 or C2 combustible liquids under AS 1940 or dangerous goods class 3 under subsection (1)(c).
- Resource Activity, Ancillary 56 - Regulated Waste Storage, Receiving and storing regulated waste.

- Resource Activity, Ancillary 63 - Sewage Treatment, 1: Operating sewage treatment works, other than no release works, with a total daily peak design capacity of, (b-i) more than 100 but not more than 1500EP if treated effluent is discharged from the works to an infiltration trench or through an irrigation scheme.

The conditions of the EA that are applicable to the activities of this action, and the current compliance activities undertaken by the proponent is detailed in Table 8-2.

Table 8-2: EA conditions and compliance activities

Conditions Applicable to the Action	Compliance Activities
General	
A1 and A2 **Financial Assurance**	A financial assurance is held by the administering authority and will remain in force until satisfied that no claim on the assurance is likely. This covers activities such as rehabilitation.
A3 **Prevent and / or minimise likelihood of environmental harm**	Sojitz has developed a site-specific Environment and Sustainability Policy that is applies to the whole operation, including M-Block, and states Sojitz's broad commitment to the environment, including: • Accountability of Management with the support of all Personnel to ensure that the Workplace and the practices comply with statutory and license conditions; • The Company will strive to implement leading industry practices and environmental management systems at all levels including exploration, development, operations, decommissioning, closure and rehabilitation; • Regular assessment of the environmental performance of the Company's activities will be undertaken to comply with the Company's commitments and conditions and to report findings to stakeholders, the community and regulatory authorities; • Continually striving to identify opportunities to effectively manage energy and water whilst minimizing waste and reducing our environmental footprint; • Increasing awareness of Personnel on the potential environment impacts of activities in which we are involved and how those impacts can be minimised; • We undertake to maintain appropriate emergency and response programs and to notify the relevant authority in the event of any reportable environmental incident; and • Contribute to conservation of biodiversity and integrated approaches to land use. GCM operates under an OEMP providing guidance primarily to Sojitz employees and direct contractors on the environmental aspects of the Gregory Crinum operation. Contractors and contracting companies are required to comply with the standards, procedures, regulations and targets identified within the OEMP and as they relate to their specific work areas and work programs. In addition, major contractors may be required to develop a supplementary environmental management plan in relation to their specific work program and associated risks. The OEMP is supported by a suite of documents including the following required by this EA: • Receiving Environment Monitoring Program • Water Management Plan • Release Event Procedure • Erosion and Sediment Control Plan • Groundwater Monitoring Program • Waste Management Plan Housekeeping Procedure Environmental Inspections • Topsoil Management Plan • Permit to disturb Procedure • Rehabilitation Management Plan • Residual Void Outcomes Report • Subsidence Management Plan

Conditions Applicable to the Action	Compliance Activities
	• Regulated Structures System Design Plan • Community Engagement Plan. • Along with: • Risk Management Procedure • Risk Management Tools and Matrix Guide • Hazardous Chemicals SOP • Hazardous Chemicals WRAC • Contractor Management Plan • These are addressed in greater detail under the applicable conditions included in this table.
A4 **Maintenance of measures, plant and equipment**	The OEMP details that haul-trucks and other vehicles and equipment, are serviced and maintained in onsite workshops. Workshops are located at Gregory and Crinum (South). Servicing of mobile equipment and maintenance of large mining equipment (i.e. draglines) also occurs periodically in the field. Underground equipment is to be serviced at the Crinum workshop or in pit where appropriate controls are in place to manage hazards associated with hydrocarbons. As required mobile equipment and maintenance of large mining equipment (i.e. draglines) will occur periodically on M-Block under the same procedures which apply to the other parts of the mine.
A5 and A6 **Monitoring and records** **A7, A8, A9, and A10** **Notification of emergencies, incidents and exceptions**	These are addressed in the OEMP along with other applicable systems, standards, procedures and manuals.
Air	
B1, B2, B3 **Dust nuisance** **B4, B5 and B6** **Odour Nuisance**	The principal objectives of air quality management onsite is to: • Protect the wider environment and nearby residents from the potential impacts of increased dust and particulates. • Assist in the protection of the health of employees. • Comply with these Schedule B conditions of the EA. • Gregory Crinum is required to comply with the specific requirements of these EA conditions and have installed six depositional dust gauges across the lease area. These are monitored on a quarterly basis.
Water	
W1 – W7 **Contaminant Release** **W8 – W13** **Mine Affected Water Release Events** **W14 – W18** **Notification of Release Event** **Release notification – potentially affected stakeholder** **Notification of Release Event Exceedance** **W19 and W20** **Receiving Environment Monitoring and Contaminant Trigger Levels**	GCM has developed the Water MP, ESCP and Receiving Environment Monitoring Program to detail the systems and processes in place to manage onsite water, potential releases and monitor the effects on the nearby environment. The principal objectives of these management plans are to: • Identify, describe and manage risks associated with water management to an acceptable level at the operation. • Identify opportunities for improvement water management, including improving water quality and efficiency of use. • Assist in maintaining compliance with these Schedule W conditions of the EA. Additional procedures have also been developed, by third parties where works are completed by them, then adopted by GCM, to assist in monitoring ground and surface waters and to aid field compliance related to water management on the site. In addition, water releases onsite are managed by the Release Event Procedure Monitoring is undertaken by Sojitz and specialist contractors. Further detail is provided in Section 6.2.2.

Conditions Applicable to the Action	Compliance Activities
W21 – W23 **Receiving Environment Monitoring Program** **W27** **Water general**	In accordance with the requirements of this EA, a REMP is implemented for the mine. This program of monitoring incorporates: • Seasonal aquatic ecosystem monitoring specifically examining potential impacts of mine-affected water released from site into the receiving environment upstream, adjacent and downstream of the mine, including aquatic habitat and aquatic macroinvertebrates. • Water quality. • Stream flow. • Sediment quality. Further detail is provided in Section 6.2.2
W24 – W26 **Water reuse**	Mine affected water generated by M-Block will be used for dust suppression during mining activities or pumped to the current storage voids. It will not be reused in a way that contravenes these conditions.
W29 **Annual Water Monitoring Reporting**	Water quality monitoring is undertaken in accordance with this EA. Further detail is provided in Section 6.2.2.
W30 **Temporary Interference with waterways**	The mine has obtained water licences for watercourse diversions and approvals for associated works. These are obtained in accordance with applicable state legislative requirements. No water licences or approvals associated with the temporary interference of waterways are required for operations associated with M-Block.
W28 **W31 – W33** **Water Management Plan**	A Water MP has been prepared and is implemented as part of mining operations. Its primary purpose is to identify the potential risks to the environment from operations at GCM and details the controls necessary to mitigate any impacts. The plan aims to minimise the release of contaminants to the receiving environment and ensure mine-affected water or its use does not adversely impact the local and regional environment. This plan is reviewed on an annual basis.
W34 **Saline drainage** **W35** **Acid rock drainage**	Potential sources of contamination and management measures are addressed in the Water MP. An assessment of spoil characteristics across the GCM has been undertaken. This can be related to the same geological conditions associated with M-Block.
W36 – W39 **Stormwater and water sediment controls**	The management of stormwater, the implementation of sediment and erosion control and the management of spillage of wastes, contaminants and other materials are addressed through a range of management plans implemented as part of the EMS suite of documents. The applicable plans are: • Erosion and Sediment Control Management Plan. • Waste MP. • These will be reviewed and updated as required as required to ensure that there are no changes required with the commencement of operations in M-Block.
W40 – W43 **Sewage effluent**	Cribb and ablution facilities are proposed for the operators working at M-Block. Management of sewage will be in accordance with the requirements of these conditions and the Waste MP prepared under condition E5 of the EA.
W44 – W49 **Groundwater** **W50 and W51** **Background groundwater monitoring program**	Groundwater monitoring is undertaken at GCM in accordance with this condition. This will not change from the commencement of operations in M-Block.
W52 – W56 **Lilyvale waterhole** **Lilyvale Waterhole Quality Monitoring**	M-Block is upstream of Lilyvale waterhole. Water quality monitoring is currently undertaken in accordance with EA. This will not require amendment due to mining operations commencing at M-Block.

Conditions Applicable to the Action	Compliance Activities
W57 **Regional groundwater model**	This is currently reviewed as required by this condition. The impacts of the underground operations and open cut will be considered as part of the review.
Noise	
D1 – D15 **Noise** **Vibration** **Airblast overpressure nuisance**	These conditions of EA detail the requirements associated with noise generation, vibration generation, airblast overpressure, and associated monitoring requirements. For both noise and vibration monitoring is required to be undertaken when request by the administering authority.
Waste	
E5 – E11 **Waste Management**	Gregory Crinum is required to comply with Schedule E Waste of the EA, which details requirements for the management of non-mineral wastes on the site. Gregory Crinum has developed the Waste MP, which details the amount and types of waste expected to be generated by the operation, segregation methods, storage details, transport offsite, monitoring and reporting requirements. The program also details additional requirements associated with the hazardous or registered wastes produced by the operation. The site has procedures that include a component of waste management: • Housekeeping Procedure. • Environmental Inspections.
Land	
F1 and F2 **Topsoil**	The topsoil stripping required for the operation of the mine are undertaken in accordance with the Topsoil MP. This applies across all of the site and will be applicable to the operation proposed for M-Block. This plan is reviewed and updated as required to reflect operational changes. In addition, a Safe Work Instruction – Ground Disturbance is also in place for vegetation clearance and topsoil disturbance activities.
F3 – F5 **Rehabilitation landform criteria**	A Rehabilitation MP is operational for mine activities. The purpose of the plan is to meet the requirements of this condition and rehabilitate all areas that have been substantially disturbed through its mining activities back to a stable landform with a self-sustaining vegetation cover. Further, progressive rehabilitation shall commence within two years as and when areas become available within site's MLs. The Rehabilitation MP is reviewed and updated every three years, or as industry or operational changes dictate. Further information on site rehabilitation is provided in Section 2.2.4.
F6 and F7 **Residual void outcome**	A residual void investigation study has been undertaken in accordance with EA Condition F7. The study modelled void long-term water balances and long-term Total Dissolved Solids concentrations (as an indicator of water quality) for the final voids. The management of voids is addressed further in Section 5.1.8.
F8 and F9 **Subsidence**	A Subsidence MP is operational for the mine. The scope of this management plan covers where subsidence can or has historically occurred. If additional underground mining is planned, such as that proposed for M-Block, and subsidence is identified as a risk, this management plan will be updated.
F10 – F16 **Preventing contaminant release to land** **Storage and handling of flammable or combustible liquids** **Storage and handling of chemicals**	Gregory Crinum recognises that hazardous materials management is a significant environmental aspect for the operation. Additionally, transport of hazardous materials for use on the site as part of the processing, and transport of either product or hazardous wastes off site is recognised as a significant environmental aspect for the operation. A series of procedures and responses to manage potential risks from both the storage of hazardous materials onsite and potential incidents that may occur during the transport of hazardous materials to site have been development and implemented on site. These comprise: • Hazardous Chemicals SOP. • Hazardous Chemicals WRAC.
Community	
H1 – H4 **Community Engagement**	The mine operates under a Community Engagement Plan in accordance with these conditions of the EA. The plan includes stakeholder consultation requirements,

Conditions Applicable to the Action	Compliance Activities
Complaint response	community engagement projects and procedures for incident reporting. This plan will be applicable to the proposed M-Block activities and updated if required.
Subsidence	
S3 – S5 **Subsidence Management Plan** **S6 – S10** **Annual Inspection** **S11** **Remedial Works**	A Subsidence MP is operational for the mine. The scope of this management plan covers where subsidence can or has historically occurred. If additional underground mining is planned, such as that proposed for M-Block, and subsidence is identified as a risk, this management plan will be updated.

8.2.4 Water Licences (Queensland)

Sojitz holds five water licences addressing the diverting the flow of water, and dewatering. Water Licence – Dewatering (577145) permits the taking of underground water from Tertiary – Undefined with the point of take under ML 1923 and ML 1789.

8.3 Required Approvals, Authorities and Permits

The approvals, authorities and permits required for the extension of the Sojitz mining operations into M-Block are detailed in Table 8-3.

Table 8-3: M-Block required approvals, authorities and permits

Required Approval, Permit or Licence	Issuing Authority	Trigger	Applicability
Federal Government			
Approval - Gregory Crinum Coal Mine M-Block Extension Project (2021/9127)	Department of Climate Change, Energy, the Environment and Water	Significant impact on MNES	**Required** Approval to which this PER relates.
Queensland State Government			
Regional interests development approval (RIDA) ***Regional Planning Interests Act 2014***	Department of State Development, Infrastructure, Local Government and Planning	Conducing a Resource Activity on Strategic Cropping Land	**Not Required** The act provides an activity is an exempt resource activity for SCL if the EA was granted before 30 January 2012. The proposed mining activity for M-Block does not require a RIDA.
Water Licence ***Water Act 2000***	Department of Resources	Dewatering Watercourse Diversion	**Not Required** Sojitz holds water licence 5777145, that authorises dewatering of two MLs including the M-Block ML, and is valid until 30 June 2111 under the *Water Act 2000* No watercourse diversions are required for the proposed works on M-Block
Operational Works – Waterway Barrier Works ***Planning Act 2016*** ***Fisheries Act 1994***	Department of Agriculture and Fisheries	Constructing or raising of a waterway barrier	**Not Required** M-Block is within an area that is traversed by waterways under the *Fisheries Act 1994*. The proposed action will however not require the construction of a waterway

Required Approval, Permit or Licence	Issuing Authority	Trigger	Applicability
			barrier and operation works approval is therefore not required.
Operational Works – Clearing of Native Vegetation ***Planning Act 2016*** ***Vegetation Management Act 1999***	Department of Resources	Clearing of regulated vegetation	**Not Required** Not applicable to activities authorised under an ML.
Species Management Program ***Nature Conservation Act 1992***	Department of Environment and Science	Tampering with Protected Animal Breeding Places	**Not Required** The Action is authorised via EA EPML00945013 under the EP Act with ML 1923 originally approved in March 1984 under the *Mineral Resources Act 1979* (Qld). Consequently, Sojitz are exempt from the provisions of the *Nature Conservation Act 1992*.
Clearing Permit ***Nature Conservation Act 1992***	Department of Environment and Science	Clearing of Protected Vegetation	
Local Government- Central Highlands Regional Council			
Nil			

9 Consultation

9.1 Landholders and Community

The M-Block coal resource has been known about for a substantial period of time with the ML granted since 1985. The owners of the GCM have progressively purchased the land underlying the ML and/or added surface rights. Sojitz now has surface rights to all of the land that underlies M-Block and agists the land to neighbouring landholders who farm cattle. No cropping currently occurs within M-Block open cut impact area with viable cropping areas located to the south.

Commercial arrangements are in place with all potentially affected landholders that support the M-Block extension. Consultation with neighbouring landholders on this PER was conducted in accordance with the Stakeholder Engagement Plan. The landholders will continue to be consulted with prior to the commencement of works and during the life of the project in accordance with the Stakeholder Engagement Plan which is updated as required.

As per the GCM Community Consultation Log, neighbours are consulted with regularly to discuss future mine planning, mine land use and other common interests.

9.2 Traditional Owners

Indigenous Land Use Agreement (s) are in place between native title parties and the mine about the use and management of areas of land and/or waters. The traditional owners have been extensively consulted as part of the on-ground assessments targeting items of significant cultural heritage within M-Block.

The Western Kangoulu have been extensively consulted including as part of the on-ground assessments targeting items of significant cultural heritage within M-Block. Extensive heritage survey works have been undertaken over several years, and mitigation of impacts to heritage will be completed in accordance with the processes of the Cultural Heritage Management Plan (CHMP) that has been in place since 8 April 2006 (Appendix Q).

The CHMP is registered with the Queensland Department of Seniors, Disability Services and Aboriginal and Torres Strait Islander Partnerships and meets the Duty of Care Requirements of the Aboriginal Cultural Heritage Act 2003 (Qld) for the M-Block extension. The CHMP details the agreements in place for the GCM and includes requirements for aboriginal cultural heritage investigations, managing impacts on Aboriginal cultural heritage (which includes a disturbance matrix detailing the relevant management procedures) and consultation.

A desktop search identified three mapped Artefact Scatters and one Landscape Feature within the locality. On-ground assessments have been completed within the M-Block area and one scarred tree has been identified, the management of which is currently under discussion with the traditional owners. The location and extent of the proposed action has considered the consultation that was undertaken with the traditional owners and seeks to minimise potential impacts to heritage.

While a large portion of the site has been subject to historic clearing and disturbance due to agriculture, there are limited areas of the site that have remained undisturbed. Surface disturbance will continue to be managed in accordance with the CHMP. The CHMP will be updated to reflect the development of M Block, if approved.

9.3 Public Notification

On Friday, 12 May 2023, the public notification period commenced through to Friday, 9th June 2023. This was delivered in compliance with DCCEEW requirements. Three submissions were received. In summary, their concerns are outlined below.

Public comments were concerned that the project would exacerbate global climate change and its impacts on Central Queensland's environment and people's wellbeing through increased temperatures, bushfires, storms, and coral bleaching events.

The Sojitz Group is committed to exiting thermal coal holdings by 2030. It has set targets, that M Block would also be accountable for, to reduce carbon emissions by 60% by 2030. This is double the current Queensland target. The operation is transitioning to renewable power through Sojitz's 50% share in, and PPA agreements with, the Edenvale Solar Farm. The company is working on reducing diesel consumption

through improved management, recycling, and exploring diesel alternatives. The transition towards underground mining will also significantly reduce diesel consumption.

Two of the submissions raised concerns over the project's greenhouse emissions.

Sojitz Group agree with the international consensus that greenhouse gas emissions are a global issue that require a global solution. However, the reduction of greenhouse gas emissions in one country which results in the increase in greenhouse gas emissions in another country, or carbon leakage, can result in an increase of global emissions.

The M block expansion project produces coking coal which is used in the manufacture of steel only. The lease does not produce the thermal coal that is used in power generation. M Block's coking coal is among the lowest fugitive methane emitting coal in Australia. Currently, there are no viable alternatives for steel production, so other coking coal resources would be required to feed existing steel mills' demand.

If M block coal was not made available, the steel makers would need to source similar coal (high fluidity/low ash) from other countries. Similar premium coking coals, sourced from countries like Russia, are significantly higher in methane emissions and sulphur content and therefore increase overall fugitive emissions. Should that occur, it is estimated that the amount of CO2 produced from blast furnaces that currently use Australian coking coals may increase by 7 to 25 million tonnes per annum or 0.8 to 2.8 per cent.[3]

Sojitz is investing in two leading edge research projects into carbon sequestration projects in Central Queensland with Tokyo University and the Queensland University of Technology. The company is also committed to creating robust and ethical Australian Carbon Credit Units to offset carbon emissions.

Two public notices raised their fears around further degradation of the local habitats and biodiversity of state and national significance through the mining operation and climate change.

Special mention was made of the fauna: Koala (Phascolarctos cinereus), Short-beaked Echidna (Tachyglossus aculeatus), Squatter Pigeon (Geophaps scripta scripta), Yakka Skink (Egernia rugosa), Dunmall's Snake (Furina dunmalli), Ornamental Snake (Denisonia maculata), Grey-headed Flying Fox (Pteropus poliocephalus) and the Red Goshawk (Erythrotriorchis radiatus); and flora: Brigalow (Acacia harpophylla) and King Bluegrass (Dichanthium queenslandicum).

Detailed impact studies have been undertaken to identify the cumulative impacts of the removal of habitat impacting species. The relevant studies include:

- EcoServe and LAMR (2005a). A Review of Habitat Values for Biodiversity and Species of Conservation Significance for BMA Coal Gregory Crinum Mine.
- Ecoserve (2007). Baseline and Rare & Threatened Fauna Surveys for the Gregory Crinum Leases.
- Austecology (2008). Review of Fauna and Flora Habitat Values – M Block, BMA Gregory Crinum.
- Austecology (2009). Biodiversity Management Plan BMA Gregory Crinum.
- Austecology (2009). Rare & Threatened Fauna & Flora Surveys and Fauna Biodiversity Inventory of M Block, BMA Gregory Crinum.
- Biodiversity Assessment and Management Pty Ltd (2011). Targeted EPBC Fauna and Flora Assessment within a component of M Block Geological Exploration Site, Gregory Crinum Mine, Emerald.
- Cardno (2021) Ecological Assessment Report – Gregory Crinum M-Block Expansion as attached as Appendix I to PER
- Stantec (2022) Supplementary Ecological Assessment Report – Gregory Crinum M-Block Extension as attached as Appendix E to PER
- Stantec (2022) Biodiversity Offsets Strategy Report - Gregory Crinum M-Block Extension
- Stantec (2022) Offset Area Management Plan - Gregory Crinum M-Block Extension as attached as Appendix J to PER

[3] Minerals Council of Australia, 2020. *Best In Class: Australia's Bulk Commodity Giants. Australian Metallurgical Coal: Quality Sought Around the World.*

Management of habitat, offsets, and safer passages of each of the vulnerable flora and fauna mentioned are described above in the PER.

In addition, most of M Block is underground mining and this does not impact on movement of fauna through the broader landscape and resting opportunities. Ancillary Habitat Trees are present in areas overlying the underground operations. Further, offset sites are to be established on neighbouring areas on the mine site and these sites have been selected to also provide connectivity between habitats. By keeping offsets on Sojitz land, there will be ongoing accountability in alignment with the site's Offset Management Plan.

Two public comments were concerned with the impacts of ground disturbance, potential contamination of soils and waterways, and subsidence.

An Erosion and Sediment Control Plan (ESCP) has been prepared to mitigate and minimise erosion and sediment deposition in watercourses. The ESCP ensures the release of sediment laden run-off is minimised. A Surface Water Management Plan has also been prepared which ensures that any unexpected sediment laden run-off is captured before it can impact on receiving water bodies.

Sojitz implements a Receiving Environment Monitoring Program (REMP) at the mine in accordance with the conditions of its Environmental Authority (EA). The REMP requires periodic monitoring, identification, and description of any impacts to the environmental values, quality and flows observed in the receiving environment due to the mine's operation. The REMP ensures that impacts such as increased turbidity, decreased light levels which may impact on submerged aquatic vegetation, or the smothering of benthic organisms are identified and mitigated should these occur.

One submission was worried about the increased exchange between surface water and groundwater, and the possible deterioration in water quality from this.

The external consultants have found that the groundwater is not in direct hydraulic connection with surface watercourses. This will avoid any changes to groundwater and surface water quality, ensure that native species dependent on ground or surface waters will not be impacted, and avoid the changing conditions that could promote the invasion or spread of unwanted species. It is unlikely that M-Block operations would result in significant impacts to water resources or flora and fauna, including Matters of National Environmental Significance (MNES) due to changes in water quality.

Two submissions explained their concerns with the effectiveness of offsets to address cumulative impacts from the loss and disturbance of habitat in this area.

The EPBC Act Environmental Offsets Policy 2012 outlines the Australian Government's approach to the use of environmental offsets under the Environmental Protection Biodiversity Conservation Act 1999.

The overarching test of the EPBC Act Environmental Offsets Policy 2012 is that suitable offsets must deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environment law and affected by the proposed action. Sojitz adheres to this policy.

The offsets will be carefully planned and managed to minimise further habitat loss, degradation and fragmentation which could restrict dispersal and further isolate populations. Sojitz is very conscious of genetic fragmentation and the possible habitat degradation from edge effects. Sojitz will be guided by the OAMP (Appendix J), developed by Stantec in 2022, if the project is approved. Within Sojitz's Offsets Management Plan, the aim is to increase biodiversity and sustainable habitats. Ongoing monitoring is done throughout the life of the offset to ensure that these goals are achieved.

One public comment questioned the methodology, and thus authority, of the flora and fauna surveys.

Ecological surveys have been conducted on the Gregory Crinum site since 2005, across various seasons, weather patterns and consultancies. The information has been thoroughly cross examined and the methodology is sound for the findings in this report.

Two submissions expressed their concerns about the impacts on First Nations people, including those not recognised by the Native Title System. They were worried that Indigenous opinions were not considered.

Indigenous Land Use Agreement(s) are in place between native title parties and the mine about the use and management of areas of land and/or waters. The traditional owners have been extensively consulted as part of the on-ground assessments targeting items of significant cultural heritage within M-Block.

A large portion of the site has been subject to historic clearing and disturbance due to agriculture, there are limited areas of the site that have remained undisturbed. The Cultural Heritage Management Plan (CHMP) will be updated to reflect the development of M Block. Surface disturbance will continue to be managed in accordance with the CHMP.

The Cultural Heritage Management Plan (CHMP) will be updated to reflect the development of M Block, if approved. Surface disturbance will continue to be managed in accordance with the CHMP.

One submission raised concerns over the impact the project will have upon groundwater in the vicinity.

This has been researched substantially and the findings are included in this report. Ongoing monitoring of groundwater drawdown and characterisation will be conducted throughout and beyond the life of the mine. A 'make good' agreement or suitable alternative will be considered especially if the groundwater is impacted. Further information is outlined in Section 5.1.8.3.

A public notice stated that local residents received no communication or consultation regarding the project.

As per Sojitz's Community Consultation Log, company personnel met with landholders and key local stakeholders to discuss future mine planning, mine land use and other common interests. Sojitz personnel met with key stakeholders in October 2022, February and May 2023. Further, there were opportunities to review the PER at the local Library, the Department of Environment and Science, and at the Crinum Hub. An electronic version was available on the Sojitz Blue website during the Public Notification period. An overview and mention of where to view the documents was advertised in The Australian, The Courier Mail and the Central Queensland Times on Friday 12th May 2023.

Two submissions expressed their concerns about social and economic impacts for the local communities through the project's material and avoidable contribution to climate change.

The township of Emerald is currently economically dependent on the coal industry, which includes mines such as Gregory Crinum, Ensham and Kestrel. Without M-Block's approval, an estimated 300 people will lose their jobs. Sojitz is committed to renewable energy, extensive and effective rehabilitation, and carbon credit creation. Sojitz expects to help in the transition towards a more diverse economy in the Central Highlands.

The mine will contribute to carbon emissions, however by utilising existing infrastructure and a coking coal with extremely low methane emissions, Sojitz is confident that this coking coal asset will contribute to less emissions intensive steel manufacturing.

10 Environmental Record of Person(s) Proposing to Take the Action

10.1 Proponent Environmental Record

Sojitz Blue Pty Ltd has a satisfactory record of responsible environment management. The Proponent has adhered to its regulatory responsibilities in association with its construction and development of its projects.

Sojitz seeks to ensure that it continues to improve its environmental performance through the prevention and reduction of impacts to the environments within which it operates and complies with applicable regulatory and permitting requirements.

The Proponent has not been the subject of any environmental legal proceedings that have resulted in fines or prosecution.

Sojitz has not had any proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources against either:

- The person proposing to take the action, or
- If a permit has been applied for in relation to the action – the person making the application.

10.2 Environmental Policy

As a global company, the Sojitz Group considers environmental issues a crucial management topic. The Sojitz Environmental Policy, attached as Appendix R, has the following key outcomes:

1. Comply with environmental laws and regulations.
2. Continuously improve our environmental management system.
3. Minimise environmental burden.
4. Conserve resources and reduce/recycle waste.
5. Consider the environment in new businesses.
6. Pursue sustainable resources.
7. Educate and promote awareness on the environment.

11 Economic and Social Matters

11.1 Existing Social and Economic Environment

A review of the 2021 Australia Census data indicated the following (Australia Bureau of Statistics, 2021a/b):

- The Crinum postal area has a recorded population of 1,596, while the town of Emerald has a population of 14,904 and the Isaac Regional Council area population is 22,046.
- In Emerald, 51.1% of the population are male, which is less than the average proportion in the region at 56.2%.
- The median age in Emerald is 32, younger than the Queensland and Australian medians which are 38.
- The Indigenous population in Emerald was 744 persons or 5% of the total population. In the region, 5.3% of the population also identified as Indigenous compared to 4.6% in the state.
- The average household size was 2.7, with the median weekly household income being $2,202.
- 50.1% of people classified themselves as a couple-family with children, and 13.8% classified themselves as one-parent families. This is compared with 40.3% and 16.8% in Queensland.
- No employment data is currently available for the 2021 Census, however on the 2016 Census 7,450 people reported being in the labour force, of these 63.3% were employed full time, 25.9% were employed part-time and 5.5% were unemployed.
- Without M-Block, an estimated 300 people would lose their jobs.
- Currently, the township of Emerald is economically dependent on the coal industry, which includes mines such as Gregory Crinum, Ensham and Kestrel.

11.2 Workforce

The current workforce at GCM will be used at M-Block, providing continuity of employment. No additional workforce will be required. The current workforce comprises approximately 88% of local residents and 12% Fly In - Fly Out accommodated in Emerald.

GCM uses a bus service from Emerald to facilitate workers commute for shift rotations.

11.3 Potential Social and Economic Impacts

The proposed continuation of mining at GCM will impact on the Australian and Queensland economies by contributing to Gross Domestic Product and Gross State Product, and through the payment of royalties and company taxes. The development of M-Block will provide economic benefit through continued employment for the mine workforce and associated economic activity.

The social impacts from the M-Block extension are likely to include:

- Construction impacts on existing landholder activities.
- Impacts to landholders and utility provides who use the current access track through M-Block. Consultation will be required to update access points.
- Service and supply opportunities during construction and operational phases.
- Minimal cumulative impacts on community services, such as, educational facilities, medical practices and social and community services can be expected as there is no increase in the workforce numbers.
- The impact to sensitive receptors is considered to be minimal due to physical distance and rural locality of M-Block. Any impacts are expected to be localised and short term.
- A complaints management protocol including a register to ensure any issues and/or complaints received are recorded and addressed appropriately is implemented as currently required by the EA.
- Develop and implement policies relating to service provision and purchasing hierarchies that prioritise local personnel and businesses first if suitably qualified and commercially competitive.

- Ongoing community engagement to maintain good relationships during the proposed development activities.

Sojitz owns and operates a number of mines located within the Central Highlands community and has been influential in the region's economy for over a decade. Sojitz has existing and continued working partnerships with local contractors and suppliers, with a focus on locally based employees. This employment focus positively contributes to direct regional services, with Sojitz also being supporters of local business and programs outworked through residential bases.

It is proposed that the social and cultural values in the local region will be improved by the overall liveability and support for profitable local business. Sojitz will continue to support and develop social and community services, as well as infrastructure in the region.

11.4 Consultation

Community consultation has been initiated and is currently ongoing. This is detailed further in Section 9.

12 Information Sources Provided in the PER

Information sources used in the preparation of this PER, along with their reliability and associated uncertainties are detailed in Table 12-1.

Table 12-1: PER information sources

Information Source	Date	Reliability	Uncertainties
3D Environmental (2023) Summary Assessment: Investigation of Potential Groundwater Dependent Ecosystems – Gregory Crinum Mine M-Block Extension Project.	2023	High	None known
3D Data Guidance Pty Ltd (2021). *Gregory Crinum Mine Residual Void Investigation Report*	2021	High	None known
4T Consultants Pty Ltd (2020). *Gregory Crinum Mine - Annual REMP Monitoring Report, April 2020*. Prepared for Sojitz Blue Pty Ltd.	2020	High	None known
4T Consultants Pty Ltd (2022). *2022 Stygofauna Assessment*.	2022	High	None known
AustralAsian Resource Consultants (AARC) (2002). *Kestrel Coal Project Flora Fauna and Biodiversity Report,* prepared for Pacific Coal Pty Ltd.	2002	High	None known
Accad A, Neldner VJ, Wilson B and Niehus RE (2008). Remnant vegetation in Queensland: analysis of remnant vegetation 1997-1999-2000-2001-2003-2005, including regional ecosystem information. Queensland Herbarium, Environmental Protection Agency, Brisbane.	2008	High	None known
AGE (2002). Hydrogeological Study, Kestrel Mine Extension	2002	Moderate	Age of publication
AGE (2017). *Mining Lease 70481 - Kestrel Mine, Associated Water Licence Application Groundwater Model Report*. Prepared for Rio Tinto Coal Australia.	2017	High	None known
ANZECC & ARMCANZ (now ANZG) (2000). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand*. Canberra.	2000	High	None known
Austecology (2008). Review of Fauna and Flora Habitat Values – M Block, BMA Gregory Crinum. An unpublished report for BMA Gregory Crinum.	2008	High	None known
Austecology (2009a). Rare and Threatened Fauna and Flora Surveys and Fauna Biodiversity Inventory of M Block, BMA Gregory Crinum. An unpublished report for BMA Gregory Crinum.	2009	High	None known
Austecology (2009b). BMA Gregory Crinum Biodiversity Management Plan.	2009	High	None known
Austin MP and Williams OB (1988). Influence of climate and community composition on the population demography of pasture species in semi-arid Australia. Vegetatio 77, 43–9.	1988	Moderate	Age of publication
Australian Bureau of Statistics (2021a). *Quick Stats - Crinum*. https://www.abs.gov.au/census/find-census-data/quickstats/2021/SAL30751.	2021	High	None known
Australian Bureau of Statistics (2021b). *Quick Stats - Emerald*. https://www.abs.gov.au/census/find-census-data/quickstats/2021/308011192 .	2021	High	None known
Benson JS, Allen CB, Togher C and Lemmon J (2006). *New South Wales Vegetation Classification and Assessment: Part 1 Plant communities of the NSW Western Plains*. Cunninghamia 9: 383–450.	2006	High	None known
Biodiversity Assessment and Management (BAAM) (2011). Targeted EPBC Fauna and Flora Assessment within a component of M Block Geological Exploration Site, Gregory Crinum Mine, Emerald. An unpublished report for BMA Gregory Crinum.	2011	High	None known

Information Source	Date	Reliability	Uncertainties
BMA (2011) Crinum M-Block Selection Phase Study – Chapter 4 Processing	2011	High	None known
B.R. Emmerton Pty Ltd (2013) Gregory Mine, Review and Mapping of Spoil Type and Quality (Post Mining at June 2012)	2013	High	None known
Bureau of Meteorology (2022). Australian Government. http://www.bom.gov.au/?ref=logo.	2022	High	None known
Bureau of Meteorology (2022). *Climate Statistics for Australian Locations – Emerald Airport*. Australian Government. http://www.bom.gov.au/climate/averages/tables/cw_035264.shtml.	2022	High	None known
Butler DW (2007). Recovery plan for the "Brigalow (*Acacia harpophylla* dominant and codominant" endangered ecological community (draft of 1 May 2007). Report to the Department of the Environment and Water Resources, Canberra. Qld National Parks and Wildlife Service, Brisbane.	2007	High	None known
Central Highlands Regional Council (2016). *Central Highlands Regional Council Planning Scheme 2016*. https://eplan.chrc.qld.gov.au/planningscheme	2016	High	None known
Coffey (1991). *Crinum Mine Hydrogeological Study*. Report No. G277/1-AB.	1991	Moderate	Age of publication
Cogger, H.G. (2000). Reptiles and Amphibians of Australia - 6th edition. Sydney, NSW: Reed New Holland.	2000	High	None known
Cogger, H.G., E.E. Cameron, R.A. Sadlier & P. Eggler (1993). The Action Plan for Australian Reptiles. Canberra, ACT: Australian Nature Conservation Agency. http://www.environment.gov.au/biodiversity/threatened/action/reptiles/index.html.	1993	Moderate	Age of publication
Commonwealth of Australia (2012) Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy October 2012	2012	High	None known
Department of Agriculture, Water and the Environment (DAWE) (2014a). Approved Conservation Advice for *Egernia rugosa* (Yakka Skink). Canberra: Department of the Environment. http://www.environment.gov.au/biodiversity/threatened/species/pubs/1420-conservation-advice.pdf. In effect under the EPBC Act from 29-Apr-2014.	2014	High	None known
Department of Agriculture, Water and the Environment (DAWE) (2014b). Approved Conservation Advice for *Furina dunmallii (*Dunmall's Snake*).* Canberra: Department of the Environment. http://www.environment.gov.au/biodiversity/threatened/species/pubs/1420-conservation-advice.pdf. In effect under the EPBC Act from 29-Apr-2014.	2014	High	None known
Department of Agriculture, Water and the Environment (DAWE) (2014c). Approved Conservation Advice for *Denisonia maculata* (Ornamental Snake). Canberra: Department of the Environment. http://www.environment.gov.au/biodiversity/threatened/species/pubs/1420-conservation-advice.pdf. In effect under the EPBC Act from 29-Apr-2014.	2014	High	None known
Department of Agriculture, Water and the Environment (2022). Conservation Advice for *Phascolarctos cinereus* (Koala) combined populations of Queensland, New South Wales and the Australian Capital Territory. Canberra: Department of Agriculture, Water and the Environment. http://www.environment.gov.au/biodiversity/threatened/species/pubs/85104-conservation-advice-12022022.pdf. In effect under the EPBC Act from 12-Feb-2022.	2022	High	None known
Department of Climate Change, Energy, the Environment and Water (2023) *Offsets Assessment Guide*.	2023	High	None known

Information Source	Date	Reliability	Uncertainties
https://www.dcceew.gov.au/environment/epbc/approvals/offsets/guidance/offsets-assessment-guide			
Department of Environment and Heritage. (2011). *Environmental Protection (Water) Policy 2009 Mackenzie River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Mackenzie River Sub-basin*. https://environment.des.qld.gov.au/__data/assets/pdf_file/0031/89068/fitzroy_mackenzie_river_wqo_290911.pdf	2011	High	None known
Department of Environment and Heritage. (2011). *Environmental Protection (Water) Policy 2009 Nogoa River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Nogoa River Sub-basin.* https://environment.des.qld.gov.au/__data/assets/pdf_file/0026/88802/fitzroy_nogoa_river_wqo_290911.pdf	2011	High	None known
Department of Environment and Resource Management, Queensland (DERM) (2007). Dunmall's Snake *Furina dunmalli* Species Information Sheet. Available on the Internet at: http://www.derm.qld.gov.au/wildlifeecosystems/wildlife/az_of_animals/dunmalls_snake.html	2007	High	None known
Department of Environment and Science (2018b). *Queensland Monitoring and Sampling Manual*. https://environment.des.qld.gov.au/__data/assets/pdf_file/0031/89914/monitoring-sampling-manual-2018.pdf			
Department of Environment and Science (2020). *Guide to determining terrestrial habitat quality Methods for assessing habitat quality under the Queensland Environmental Offsets Policy. Version 1.3 February 2020*. https://environment.des.qld.gov.au/__data/assets/pdf_file/0017/102833/habitat-quality-assessment-guide-v1-3.pdf	2020	High	None known
Department of Environment and Science (2021). *Bore Assessment: Guideline. ESR/2016/2005 Version 5.03*. State of Queensland.	2021	High	None known
Department of Environment and Science (2022). *Queensland Environmental Offsets Policy*. Version 1.13. https://environment.des.qld.gov.au/__data/assets/pdf_file/0018/293400/offsets-policyv1-13.pdf	2022	High	None known
Department of Primary Industries (1993), *Central Highlands Land Resource Areas*. Queensland Government.	1993	High	None known
Department of Science, Information, Technical and Innovation (2015). *Guidelines for the Environmental Assessment of Subterranean Aquatic Fauna*	2015	High	None known
Department of Sustainability, Environment, Water, Population and Communities (DSEWPC) (2013). Approved Conservation Advice for *Dichanthium queenslandicum* (king blue-grass). Canberra, ACT: Department of Sustainability, Environment, Water, Population and Communities. http://www.environment.gov.au/biodiversity/threatened/species/pubs/5481-conservation-advice.pdf. In effect under the EPBC Act from 26-Feb-2013.	2013	High	None known
Department of the Environment (DoE) (2013). Approved Conservation Advice for the Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community. Canberra: Department of the Environment. http://www.environment.gov.au/biodiversity/threatened/communities/pubs/028-conservation-advice.pdf. In effect under the EPBC Act from 17-Dec-2013.	2013	High	None known
Department of the Environment, Water, Heritage and the Arts (DEWHA) (2008). Approved Conservation Advice for Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin. Canberra: Department of the Environment, Water, Heritage and the Arts. http://www.environment.gov.au/biodiversity/threatened/communities/pubs	2008	High	None known

Information Source	Date	Reliability	Uncertainties
/99-conservation-advice.pdf. In effect under the EPBC Act from 07-Jan-2009.			
Dole-Oliver M, Malard F, Martin D, Lefebure T & Gibert J. (2009). *Relationships between environmental variables and groundwater biodiversity at the regional scale*. *Freshwater Biology* 54. pp.797-813.	2009	High	None known
Douglas Partners (2006). *Hydrogeological Studies for Kestrel Coal Mine – Series 300, 400 & 500 Panels – Data & Literature Review*. Project reference 33945.	2006	Moderate	Age of publication
DRDMW (2021). *Groundwater Database*. State of Queensland, Department of Regional Development, Manufacturing and Water. http://qldglobe.information.qld.gov.au.	2021	High	None Known
Driscoll, Fletcher G (1986). *Groundwater and Wells*. 2nd Edition. St. Paul, Minn: Johnson Division	1986	Moderate	Age of publication
Ecoserve (2007). Baseline and Rare & Threatened Fauna Surveys for the Gregory Crinum Leases. An unpublished report for BMA Gregory Crinum.	2007	High	None known
EcoServe and LAMR (2005). A Review of Habitat Values for Biodiversity and Species of Conservation Significance for BMA Coal Gregory Crinum Mine. An unpublished report prepared for BMA Coal Gregory Crinum Mine.	2005	High	None known
EPA. (2007). Mesa A/Warramboo Iron Ore Project. Bulletin 1251. Environmental Protection Authority, Perth.	2007	High	None known
Eyre, T.J., Kelly, A.L, Neldner, V.J., Wilson, B.A., Ferguson, D.J., Laidlaw, M.J. and Franks, A.J. (2015). BioCondition: A Condition Assessment Framework for Terrestrial Biodiversity in Queensland. Assessment Manual. Version 2.2. Queensland Herbarium, Department of Science, Information Technology, Innovation and Arts, Brisbane.	2015	High	None known
FAO (1992). *Water, Soil and Crop Management Relating to the Use of Saline Water*. Food and Agriculture Organisation of the United Nations. http://www.fao.org/3/T0667E/t0667e00.htm#Contents.	1992	High	None known
Fensham, R. J. et al. (2015) The relative impacts of grazing, fire and invasion by buffel grass (*Cenchrus ciliaris*) on the floristic composition of a rangeland savanna ecosystem. The Rangeland journal. [Online] 37 (3), 227–237.	2015	High	None known
Garnett ST and Crowley GM (2000). The Action Plan for Australian Birds 2000. Environment Australia, Canberra.	2000	High	None known
Garnett ST, Szabo JK and Dutson G (2011). The Action Plan for Australian Birds 2010. Birds Australia, CSIRO Publishing, Melbourne.	2011	High	None known
Geoscience Australia (2022). *Bowen Basin*. Australian Government. https://www.ga.gov.au/scientific-topics/energy/province-sedimentary-basin-geology/petroleum/onshore-australia/bowen-basin.	2022	High	None known
Golder (1984). Gregory South Coal Project, Geotechnical Investigations for Underground Mining. Report No. 8363-0022.	1984	High	None known
GTES Pty Ltd (2008). *M Block Proposed Mining Area Gregory Crinum Mine Soil and Land Suitability Study*.	2008	High	None known
Hancock PJ & Boulton AJ. (2008). Stygofauna biodiversity and endemism in four alluvial aquifers in eastern Australia. Invertebrate Systematics 22, pp.117-126.	2008	High	None known
Hose GC, J Sreekanth, Barron O & Pollino C. (2015). Stygofauna in Australian Groundwater Systems: Extent of knowledge. CSIRO, Australia.	2015	High	None known
KBR (2018). Gregory Crinum Mine Development – Water Balance Model Development and Outcomes. BEW861-TD-WR-REP-001 Rev A.	2018	High	None known
KCB (2018). *Grasstree Extension Project Environmental Assessment Report (Groundwater Report)*. http://epbcnotices.environment.gov.au/_entity/annotation/8c190395-1620-	2018	High	None known

Information Source	Date	Reliability	Uncertainties
e811-886f-005056ba00a8/a71d58ad-4cba-48b6-8dab-f3091fc31cd5?t=1520899200369			
KCB (2022a). *M-Block Expansion – Public Environment Report – Water Assessment*. Prepared for Sojitz Blue Pty Ltd.	2022	High	None known
KCB (2022b). M-Block Extension - Public Environment Report Water Assessment - Response to IESC Comments. Prepared for Sojitz Gregory Crinum Pty Ltd	2022	High	None known
Kellett, JR., Ransley, TR., Coram, J., Jaycock, J., Barclay, D., McMahon, G., Foster, L., and Hillier, J (2003). *Groundwater Recharge in the Great Artesian Basin Intake Beds, Queensland*. NHT Project# 982713. Bureau of Rural Science, Natural Resources and Mines, Queensland.	2003	High	None known
Kruseman, GP, and de Ridder, NA (1994). *Analysis and Evaluation of Pumping Test Data. Second.* International Institute for Land Reclamation and Improvement.	1994	High	None known
Melzer A & Tucker G (2011). Koalas of the St Lawrence region of Central Queensland. Report 1: Defining the population. This report was prepared for the Queensland Department of Transport and Main Roads.	2011	High	None known
Melzer A, Carrick F, Menkhorst P, Lunney D & John BS (2000). Overview, critical assessment, and conservation implications of koala distribution and abundance. Conservation Biology 14,619-628.	2000	Moderate	Age of publication
National Health and Medical Research Council (2022). *National Water Quality Management Strategy. Australian Drinking Water Guidelines 6 2011. Version 3.8 Updated September 2022*. file:///C:/Users/trent.passfield/Downloads/Australian_Drinking_Water_Guidelines_ADWG_V3-8_Sep2022.pdf	2022	High	None known
Phillips, B.L., G.P. Brown & R. Shine (2003). Assessing the potential impact of cane toads on Australian snakes. Conservation Biology. 17(6):1738-1747.	2003	High	None known
Queensland Government (2019). *Vegetation Management Act 1999*. https://www.legislation.qld.gov.au/view/html/inforce/current/act-1999-090	2019	High	None known
Queensland Government (Department of Environment and Science) 2022. Wildnet Records Updated data available at http://qldspatial.information.qld.gov.au/catalogue//.	2022	High	None known
Queensland Government (2021a). *The Long Paddock – Queensland Future Climate Dashboard*. https://www.longpaddock.qld.gov.au/.	2021	High	None known
Queensland Government (2021b). *Mined Land and Rehabilitation Policy*. https://environment.des.qld.gov.au/__data/assets/pdf_file/0035/87659/mined-land-rehabilitation-policy.pdf.	2021	High	None known
Queensland Government (2022a). *GeoResGlobe*. https://www.business.qld.gov.au/industries/mining-energy-water/resources/minerals-coal/online-services/georesglobe.	2022	High	None known
Queensland Government (2022b). *QImagery* https://qimagery.information.qld.gov.au/	2022	High	None known
Queensland Government (2022c). *Queensland Globe* https://qldglobe.information.qld.gov.au/	2022	High	None known
Queensland Government (2022d). *Scientific Information for Land Owners.* https://www.longpaddock.qld.gov.au/silo/	2022	High	None known
Queensland Government (2022e). *Environmental Protection Act 1994*. https://www.legislation.qld.gov.au/view/pdf/inforce/current/act-1994-062.	2022	High	None known
Queensland Government (2022f). *Water Plan (Fitzroy Basin) 2011*. https://www.legislation.qld.gov.au/view/html/inforce/current/sl-2011-0283	2022	High	None known
Queensland Herbarium (2021). Specimen label information. Queensland Herbarium. Accessed 27/04/2022.	2021	High	None known

Information Source	Date	Reliability	Uncertainties
Squatter Pigeon Workshop (2011). Proceedings from the workshop for the Squatter Pigeon (southern). 14-15 December 2011. Toowoomba Office of the Queensland Parks and Wildlife Service.	2011	High	None known
Stantec Australi**a** Pty Ltd (2022). *GCM M-Block Extension Water Balance Assessment*. Prepared for Sojitz Blue Pty Ltd.	2022	High	None known
Stantec Australia Pty Ltd (2022). *Biodiversity Offsets Strategy Gregory Crinum M-Block Extension*. Prepared for Sojitz Blue Pty Ltd.	2022	High	None known
Stantec Australia Pty Ltd (2023). *Ecohydrological Conceptual Model – Gregory Crinum Mine M-Block Extension*. Prepared for Sojitz Blue Pty Ltd.	2023	High	None known
Sucklow, A., Taylor, A., Davies, P., and Leaney, F. (2016). *Geochemical Baseline Monitoring. Final Report*. Gas Industry Social and Environment Research Alliance, CSIRO, Australia. https://gisera.org.au/wp-content/uploads/2012/06/Project-4-Geochemical-Baseline-Report-201602.pdf.	2016	High	None known
Threatened Species Network (TSN) (2008). Yakka Skink; *Egernia rugosa*; National Threatened Species Day Information Sheet. World Wildlife Foundation; Threatened Species Network; Department of the Environment, Water, Heritage and the Arts. http://www.environment.gov.au/biodiversity/threatened/publications/tsday08-skink.html.Statement Assessment Report. An unpublished report for Wesfarmers Curragh Pty Ltd.	2008	High	None known
Threatened Species Scientific Committee (2009). Commonwealth Listing Advice on Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin. Department of the Environment, Water, Heritage and the Arts. http://www.environment.gov.au/biodiversity/threatened/communities/pubs/99-listing-advice.pdf. In effect under the EPBC Act from 07-Jan-2009.	2009	High	None known
Threatened Species Scientific Committee (2015). Conservation Advice *Geophaps scripta scripta* Squatter Pigeon (southern). Canberra: Department of the Environment. http://www.environment.gov.au/biodiversity/threatened/species/pubs/64440-conservation-advice-31102015.pdf. In effect under the EPBC Act from 27-Oct-2015.	2015	High	None known
Threatened Species Scientific Committee (TSSC) (2001). *Commonwealth Listing Advice on Brigalow* (*Acacia harpophylla dominant and co-dominant)*. http://www.environment.gov.au/biodiversity/threatened/communities/brigalow.html. In effect under the EPBC Act from 04-Apr-2001.	2001	High	None known
Threatened Species Scientific Committee (TSSC) (2013). Commonwealth Listing Advice on *Dichanthium queenslandicum* (king blue-grass). Department of Sustainability, Environment, Water, Population and Communities. Canberra, ACT: Department of Sustainability, Environment, Water, Population and Communities. http://www.environment.gov.au/biodiversity/threatened/species/pubs/5481-listing-advice.pdf. In effect under the EPBC Act from 26-Feb-2013.	2013	High	None known
Tomlinson M & Boulton AJ. (2010). Ecology and management of subsurface groundwater dependent ecosystems in Australia - a review. Marine & Freshwater Research 61, pp. 936-949.	2010	High	None known
Wilson BA, Neldner V.J. and Accad A. (2002). The extent and status of remnant vegetation in Queensland and its implications for statewide vegetation management and legislation. Rangelands Journal 24 (1), 6–35.	2002	Moderate	Age of publication
Wilson S (2003). Reptiles of the Southern Brigalow Belt. WWF-Australia.	2003	High	None known
Wilson, S.K. & D.G. Knowles (1988). Australia's Reptiles: A Photographic Reference to the Terrestrial Reptiles of Australia. Australia: Collins Publishers.	1988	Moderate	Age of publication

Information Source	Date	Reliability	Uncertainties
Youngentob, K.N, Marsh, K.F., Skewes, J., (2021) A review of koala habitat assessment criteria and methods, report prepared for the Department of Agriculture, Water and the Environment, Canberra, November. CC BY 4.0.	2021	High	None known

13 Conclusion

Sojitz proposes to continue the existing GCM through the development of M-Block located within ML 1923.

The proposal was submitted under the EPBC Act to the Minister on 20 December 2021 and validated on 24 January 2022 (2021/9127). On 23 February 2022, the delegate of the Minister decided that further assessment is required as the action has the potential to have a significant impact on the following MNES that are protected under Part 3 of the EPBC Act:

- Listed threatened species and communities (sections 18 and 18A); and
- A water resource, in relation to coal seam gas development and large coal mining development (sections 24D and 24E).

This PER describes the M-Block extension, the existing environmental values for the M-Block extension, the potential impacts the operation may have on relevant MNES and details the proposed avoidance, safeguards and mitigation measures to be implemented.

Detailed assessments have been undertaken to evaluate the nature and scale of the potential impacts, against the EPBC Act significant impact guidelines.

The PER concluded the following:

- There have been no records of the Yakka Skink, Dunmall's Snake or Ornamental Snake within M-Block or in close proximity. The habitat quality for these reptiles was relatively low and it was concluded that the operation of M-Block is unlikely to result in a significant residual impact to these species.
- No Koala were recorded and no Koala scat was identified. It remains unlikely that a Koala population exists within M-Block due to a lack of Locally Important Koala Trees. M-Block might provide movement habitat through the broader landscape or resting opportunities as many sites had Ancillary Habitat Trees. However, it was concluded that the operation of M-Block is unlikely to result in a significant residual impact to the Koala.
- The remaining MNES: Brigalow TEC, Grassland TEC, King Bluegrass and Squatter Pigeon all occur within M-Block and will be directly and indirectly impacted by the works. It has been determined that a significant residual impact to these MNES will remain following all avoidance and minimisation actions. To compensate for the residual impacts on these MNES, Stantec has produced an Offset Area Management Plan (Appendix J).
- As identified in Stantec's Ecohydrological Conceptual Model Report (Appendix F), the predicted groundwater impacts as a result of mining operations are not likely to result in any significant impacts to groundwater dependent MNES. This includes Brigalow TEC which has been assessed as not being reliant on ground water (Appendix H).
- Stygofauna sampling found two individuals from a single taxon (*Syncarida parabathynellidae*) identified in one bore which is not located within M-Block (Appendix N). The absence of stygofauna in the samples collected from the other bores does not necessarily indicate they are absent from M-Block (Appendix M).
- Watercourses in the vicinity of M-Block are ephemeral and flow during, and immediately following prolonged rainfall events. Flow events in the watercourses are typically experienced during the wet season. The operation of M-Block does not include any abstraction from, or discharges to surface water or watercourses. Notwithstanding minor / localised erosion and sediment controls, the project does not include the interception or diversion of surface water flows. Therefore, there will be no discernible impacts to the surface water system as a result of the Project.
- The M-Block scenario results in a higher MAW inventory then the baseline, with the volume not being contained within the allowable MAW storages during the bord and pillar operations phase. Mitigation measures have been added to mitigation this risk including assigning an existing active pit for MAW storage.
- Review of the volume released by controlled environment release procedure, show there is only 2% difference in the total cumulative volume released However, this volume is still within the acceptable thresholds of the approved EA, which have been pre-determined to ensure that environment flow objectives are satisfied.
- Subsidence associated with the M-Block underground mining is not anticipated as the bord-and-pillar method is proposed to be used rather than longwall mining.

- It is also not anticipated that recharge rates will be significantly modified given the limited areal extent of infrastructure that will influence recharge.
- Dewatering undertaken for the operation of M-Block will result in a change in the groundwater table, however, recovery is predicted post-closure as groundwater levels rebound.
- Groundwater and surface water interactions are not interpreted to be affected by the Project development given that groundwater is not interpreted to be in direct hydraulic connection with surface watercourses.
- Changes to groundwater or surface water quality are not anticipated as a result of the proposed activities associated with the activities proposed for M-Block, therefore:
- No changes to habitat or lifecycle of a native species dependent on a water resource are expected.
- No changes to the water resource that may cause the establishment of an invasive species (or the spread of an existing invasive species) are expected.
- No significant worsening of local water quality is anticipated.
- No changes to ecosystem water qualities are anticipated.
- It is also not likely that the M-Block operations would result in a risk to human or animal health, or to the condition of the environment as a result of a change in water quality.
- The ECM identified the potential risk to subterranean groundwater dependent ecosystems and one groundwater user due to water quality and groundwater drawdown.
- It is anticipated that Sojitz will enter into agreements with the landholder/owner of the impacted water supply bore, which will include the addressing this water supply bore impacts through “make-good” arrangements.
- Surface water is not predicted to be impacted based on the conceptual understanding of M-Block and predicted drawdown of resulting from the Project. Therefore, any surface water systems and species that may potentially be dependent on these surface water resources are not predicted to be impacted.

The assessment undertaken for the proposed operations on M-Block and detailed in this PER show that while construction and operation activities have the potential for environmental impacts, the operational methodology, proposed management and mitigation measures including ongoing monitoring requirements and offset provisions, will mitigate the potential impacts on MNES.

As GCM is currently operational with activities conducted under an EA, there are on-going management and monitoring requirements to address potential environmental impacts. Sojitz will review and update the current management plans to address and include all specific requirements associated with the proposed M-Block operation.

Appendices

We design with community in mind

Appendix A PER Guidelines

Appendix B EA-EPML00945013

Appendix C PER Project Team

Team Member	Project Role	Work Undertaken
3D Environmental	GDE Assessor	• GDE assessment and report
4T Consultants	Stygofauna Assessor	• Stygofauna assessment and report
Anthony Densten	Discipline Lead – Coastal & Flooding	• Water balance assessment
Cameron Love	Senior Hydrogeologist	• Ecohydrological conceptual model
Daniel Pygas	Principal – Aquatic Ecology	• Stygofauna assessments and report
David Wassman	Senior Principal - Ecology	• Ecology field assessments • Supplementary Ecology report • Biodiversity Offset Strategy report • Groundwater Dependent Ecosystems report • PER reporting – Ecology sections
KCB Australia Pty Ltd	Hydrology and water specialists	• Hydrology and water assessment and report
Kimberley Riddell	Ecologist	• Ecology field assessments
Leonard Ainsworth	Graduate Ecologist	• Ecology field assessments • Stygofauna field assessments
Melissa Osborne	Graduate Ecologist	• Ecology field assessments • Supplementary Ecology report • Biodiversity Offset Strategy report • Offset Area Management Plan • Groundwater Dependent Ecosystems report • PER reporting – Ecology sections
Sarah Johnston	Graduate Environmental Scientist	• PER reporting • Review and summation of surface water monitoring data
Sarah Kirsch	Senior Water Resources Engineer	• Water Balance Assessment
Sophie Delzoppo	Ecologist	• Ecology field assessments • BioCondition and Habitat Quality calculations
Tracey Hooper	Senior Principal – Environmental Planning	• PER reporting
Trent Passfield	Senior Environmental Scientist	• PER reporting • Review and summation of surface water monitoring data
Walter Weinig	Discipline Lead – Hydrology	• Ecohydrological conceptual model
Yesmin Chikhani	Environmental Scientist	• Stygofauna assessments and report

Appendix D Water Assessment

Appendix E Ecological Report 2022

Appendix F Ecohydrological Conceptual Model

Appendix G Groundwater Dependent Ecosystem Report (Stantec)

Appendix H Groundwater Dependent Ecosystem Report (3D Environmental)

Appendix I Ecological Report 2021

Appendix J Offset Area Management Plan

Appendix K Vegetation and Fauna Management Plan

Appendix L KCB Supplementary Report

Appendix M Stygofauna Assessment (Stantec)

Appendix N Stygofauna Assessment (4T Consultants)

Appendix O Water Balance Assessment

Appendix P Surface Water Monitoring Results

Appendix Q CHMP

Appendix R Sojitz Environmental Policy

CREATING COMMUNITIES

Communities are fundamental. Whether around the corner or across the globe, they provide a foundation, a sense of belonging. That's why at Stantec, we always **design with community in mind**.

We care about the communities we serve—because they're our communities too. We're designers, engineers, scientists, and project managers, innovating together at the intersection of community, creativity, and client relationships. Balancing these priorities results in projects that advance the quality of life in communities across the globe.

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