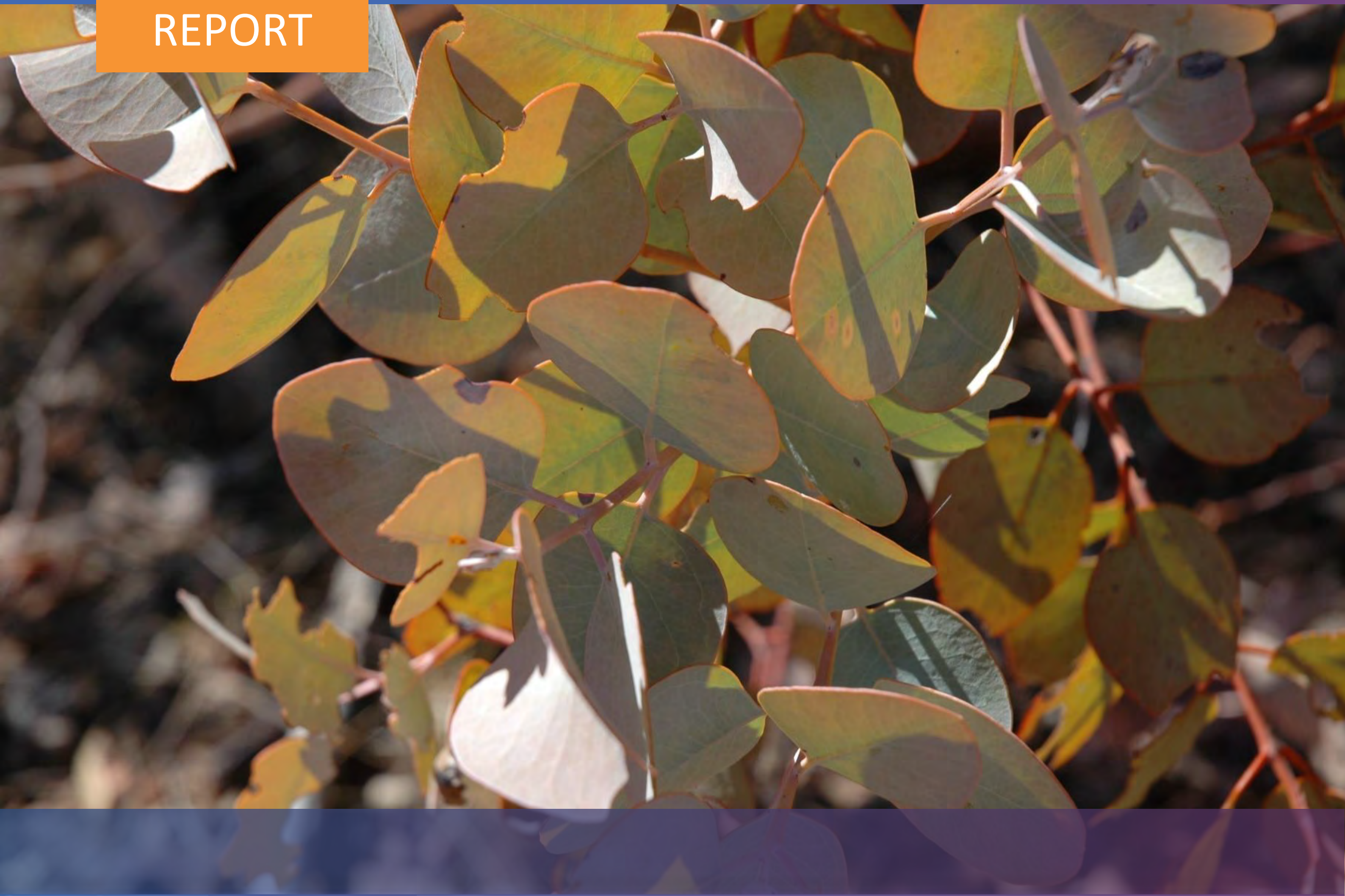
REPORT



FINAL Public Environment Report Vulcan South Coal Mine (2023/09708)

Queensland Coking Coal Pty Ltd (owned by Vitrinite Pty Ltd)

07/10/2024

Mining & Energy Technical Services Pty Ltd

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Table of Contents

TABLES

FIGURES

Executive Summary

Background

Queensland Coking Coal Pty Ltd (QCC) (a wholly owned subsidiary of 'Vitrinite Pty Ltd'), proposes to construct and operate the Vulcan South Coal Mine (the Project). The proponent is QCC, however is referred to as 'Vitrinite' throughout the PER. The Project is located 35 km south of Moranbah, Central Queensland, adjacent to several established mining operations. The Project will extract premium coking coal (steel-making coal) and will consist of an open-cut mining area, a highwall mining trial area, rail loop loading facility, Coal Handling and Processing Plant (CHPP) and ancillary infrastructure.

The Project was referred under the *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act) to the Minister for the Environment on 1 February 2024. The Minister determined on 4 March 2024 that the Project is a controlled action and approval is required as the action has the potential to have a significant impact on the following Matters of National Environmental Significance (MNES) protected under Part 3 of the EPBC Act:

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

It was also determined that the proposed action was to be assessed by a Public Environment Report (PER).

This PER has been prepared to address the requirements of the final Vulcan South PER Guidelines, issued by the Department of Climate Change, Energy, the Environment and Water (DCCEEW) on 1 May 2024.

The Project is a small-scale coal mine that will extract approximately 13.5 Mt of run-of-mine (ROM) coal, consisting predominately of hard coking coal with an incidental thermal secondary product, at a rate of up to 1.95 million tonnes per annum (Mtpa). The project will operate for approximately nine years, including primary rehabilitation works and a two-year construction period.

The land within the Project is zoned as Rural under the Isaac Regional Council Planning Scheme. It is currently primarily used for low-intensity cattle grazing.

Forty-two percent of the proposed Project footprint had been previously cleared of its natural vegetation; the remaining 58% comprises native remnant vegetation with an understorey that has been highly modified by grazing. The dominant land use adjacent to the Project (to the north and east) is coal mining.

EPBC Act Listed TECS, Threatened and Migratory Species

Five Threatened Ecological Communities (TECs) were identified by database searches as being potentially present. Further surveys confirmed that one of these, Brigalow (*Acacia harpophylla* dominant and co-dominant), is present within the Project area.

In total, fifty-one species have been identified either during the 2024 desktop review or the 2022 desktop review as potentially occurring within the Project area. Field surveys confirmed that four of these (Koala, Greater Glider, Squatter Pigeon and White-throated Needletail) are present within the Project area. No threatened species of plants were detected within the survey area or Project area. The likelihoods that the remaining species occur within the Project area were assessed by considering the proximity and recentness of records, as well as availability of potential habitat. An additional 11 species were considered likely or possibly occurring within the vicinity of the Project area.

Two listed migratory species, the Rufous Fantail and White-throated Needletail, were detected within the survey area. Two additional species (Fork-tailed Swift and Latham's Snipe) are likely visitors, and an additional six species (Sharp-tailed Sandpiper, Oriental Cuckoo, Gull-billed Tern, Black-faced Monarch, Satin Flycatcher, Glossy Ibis) are possible visitors.

Surface Water

The Project is located within the Isaac River sub-basin of the greater Fitzroy Basin. The Isaac River commences approximately 100 km to the north of the Project site within the Denham Range. It drains in a south westerly direction through the

Carborough and Kerlong Ranges before turning in a south easterly direction near the Goonyella Riverside Mine. It drains approximately 30 km to the east of the Project, and eventually flows to the Mackenzie River some 150 km to the southeast. Vulcan South is located in the headwaters of the Boomerang, Hughes, Barret and Harrow creek catchments.

Groundwater

The following geological formations within the Project area may contain groundwater:

1) Tertiary sediments and weathered regolith: Silts and clays, which comprise the bulk of the regolith overlying the coal measures, are densely compacted, hard and generally dry. Sand and gravel lenses embedded within the regolith are permeable but have low hydraulic conductivity and limited lateral and vertical extent. These have a potential to represent unconfined to confined aquifers, depending on location.

2) Permian coal measures: The ALEX and DLL coal seams are poor aquifers of low hydraulic conductivity. They are confined above and below by low-permeability regolith and sedimentary rocks. Nevertheless, these represent the largest and uppermost aquifers across most of the Project.

3) Back Creek Group: This formation of sandstones, siltstones and shale forms a largely impervious layer beneath the DLL coal seam aquifer. However, the Back Creek Group also contains narrow coal seams that can act as poor aquifers.

Recent site-specific investigation has indicated that there is no quaternary alluvium within the Project area.

Impact Assessment

Listed Threatened Species and Ecological Communities

Species that will be significantly impacted to varying degrees by the Project, following the incorporation of mitigation measures, are as follows:

- Brigalow TEC: Based on the criterion that the extent of the ecological community will be reduced by Vulcan South by 71.2 ha, the residual impacts to the Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community qualify as significant.
- Squatter Pigeon: loss of 372.5 ha of breeding and foraging habitat, 78.9 ha of foraging (but not breeding) habitat and 767.6 ha of dispersal habitat qualifies as a significant impact.
- Koala: loss of 1,166.9 ha of foraging, shelter and dispersal habitat (938.6 for combined foraging/shelter/dispersal habitat, 45.5 ha for shelter/dispersal and 182.8 ha for dispersal only).
- Greater Glider: reduction of the area of occupancy by 1,056.8 qualifies as a significant impact. Within this there is 750 ha of likely/current denning habitat, 234.6 ha of future denning habitat, 19.3 ha of foraging habitat and 52.9 ha of dispersal habitat.

Impacts on Surface Water

With appropriate mitigation measures in place, the potential impact of the proposed mining operations on surface flows and water quality in the receiving waters downstream of the Project will be insignificant.

Preliminary baseline monitoring indicates that water in the surrounding environment is of poor quality. Overall, the impact of the Project on the hydraulic characteristics of Boomerang Creek, Hughes Creek and their tributaries do not affect the existing conditions significantly. It is expected that the channel and floodplain will undergo little, if any, adjustment to the altered hydraulic conditions upstream or downstream of Vulcan South as a result of the Project.

There will be changes to the extent of floodplain inundation as a result of the development of the Project. The primary change is the introduction of diverted water drains, bunds and diversion levees, which will result the loss of channel and floodplain in one area and its replacement in another. The diversions are necessary to divert runoff from undisturbed catchments around areas disturbed by mining.

The area of surface water impact is expected to be minimal and localised.

Mine affected water from the proposed Project will be managed through a mine water management system which is designed to operate in accordance with proposed EA conditions that are based on Model Mining Conditions and incorporated into the release criteria used in modelling the mine water management system in this report.

In consideration of the already heavily disturbed nature of the surrounding catchment, it is unlikely that Project releases will have a measurable impact on receiving water quality or environmental values.

In summary, the conceptual final landform is not considered likely to have a long-term significant impact on the receiving waters.

Impacts on Groundwater

Impacts to Groundwater are considered negligible and are primarily associated with limited effects on drawdown.

Hydrogeologist.com.au (2024) (**Appendix P**) has developed a numerical groundwater flow model of the survey area and broader region to predict the effects of Vulcan South on local groundwater levels. The maximum predicted drawdown in the Tertiary / weathered zone (layer 2) is approximately 10 m in the vicinity of the Vulcan Main pit. Negligible drawdown is predicted in layer 2 in the vicinity of the Vulcan North pit and Vulcan South pit. The drawdown extent occurs some 2,200 m (from the pit crest to the 1 m drawdown contour) and the predicted drawdown preferentially propagates towards the east and the existing Saraji Mine. The maximum drawdown in the DLL coal seam (layer 10) is predicted to be larger than, but of a similar magnitude to, that predicted for layer 2. The maximum magnitude of drawdown is approximately 10 m in the vicinity of the proposed Vulcan Main pit with negligible drawdown predicted in the vicinity of the Vulcan North pit and Vulcan South pit. The drawdown extent in layer 10 occurs some 2,400 m and the predicted drawdown preferentially propagates towards the east and existing Saraji Mine. Overall drawdown is limited in magnitude and extent, and areas that extend beyond the boundary of the Project area do so into existing mines groundwater systems (which already have a significant effect on the baseline groundwater conditions for the Project). There may be some minor change to the local groundwater elevations and flow directions post closure however these are expected to be negligible and will not impact materially on the groundwater regime. As the pits will be backfilled, no residual drawdown is expected following the cessation of the project and groundwater recharge is anticipated to return to baseline conditions post-closure.

Groundwater flow into the Vulcan South and Vulcan North pits will be negligible, with the maximum at any point in time reaching 43 m^3/day within the Main pit, 4.71 m^3/day for the North pit and 2.34 m^3/day for the South Pit. Overall, the predicted groundwater seepage to the proposed pits is low and will very likely be lost through evaporation on the pit face or as entrained moisture within the mined coal. Hence seepage to the pit is very unlikely to be observed during the Project.

No impacts on groundwater quality are anticipated given there is no material inflow of groundwater within the pit. There are no surface water interactions.

Groundwater Dependent Ecosystems and Stygofauna

Based on literature reviews, depth-to-groundwater data, national GDE mapping, and water quality data, there are likely to be some Terrestrial GDEs contained within the Project area. The locations of these likely GDEs closely match that mapped within the National Atlas of Groundwater Dependent Ecosystems. Additional partly groundwater-dependent ecosystems may be located in the central and southern parts of the Project area, based on depth-to-groundwater data. No GDEs will be affected beyond the Project disturbance footprint.

No Aquatic GDEs, Subterranean GDEs or stygofauna are anticipated be impacted by the Project.

Avoidance, Minimisation, Mitigation, and Management of Impacts

Listed Threatened Species and Ecological Communities

The proposed location of infrastructure for the action has been determined to minimise the potential impacts to existing surface water drainage channels and watercourses (and therefore riparian vegetation and habitat for threatened species) in the eastern Section of the MLA. For example, large corridors have been maintained between the north pit, main pit and south pit to minimise impacts to drainage features and watercourses (as defined under the *Water Act 2000*) that exist between these pits and to reduce impacts on surface water flows. Specifically, this separated placement will avoid a tributary of Plumtree Creek (between the north and main pit) and the Hughes Creek watercourse and tributary (located between the main and south pit) that contain high value habitat for the Koala and Greater Glider. These separations have also allowed the action (construction, operation and rehabilitation) to occur in stages and therefore, the disturbance footprint at any one-point-in-time is small and there will be available habitat for native species to utilise.

Vitrinite will employ the mitigation measures to reduce the extent of impacts to threatened species through the management of: weeds, mortality during clearing and on roads, dust effects, noise effects and light effects, appropriateness of rehabilitation objectives to achieve habitat outcomes for threatened species, reduction of barbed wire entanglement, reduction in risk of fire.

The Progressive Rehabilitation and Closure Plan stipulates the achievement of rehabilitation milestone criteria for the stable, non-polluting and safe rehabilitation of habitat for reinstatement of habitat for threatened species, lost as part of the Project. These milestone criteria are legislative requirements of the Queensland Government environmental approvals process that Vitrinite must abide by.

However, following the implementation of these measures, significant residual impacts will remain for the Koala, Greater Glider, Squatter Pigeon and Brigalow TEC which will be the subject of Environmental Offsets.

Surface Water

The performance of the mine water management system in managing impacts to water has been investigated using a detailed site water balance model. The model simulated water inflows and outflows through the various stages of mine development, based on 122 realisations with different climatic sequences. The potential impacts of the Project on surface water resources will be effectively mitigated through the implementation of a mine site water management system to control the flow and storage of water of different qualities across the site. A surface water monitoring program will be implemented to monitor potential environmental impacts and ensure that the site water management system is meeting its objectives. The Approved EA stipulates the management of surface water against site specific Water Quality Objectives and approved upstream and downstream monitoring locations.

Groundwater

Impacts to groundwater were assessed to be negligible; however, monitoring and management measures will be implemented. The Project will have a groundwater monitoring program operating throughout all phases of the Project, including through rehabilitation and closure. The approved Environmental Authority stipulates the groundwater monitoring locations, water quality objectives/trigger values and the frequency of monitoring. Every three years, consideration must be given for the redevelopment and or recalibration of the numerical groundwater model to ensure accurate and contemporary impacts are assessed.

Environmental Offsets

To counter the Project's significant residual impacts to the Koala, Greater Glider, Squatter Pigeon and Brigalow TEC, Vitrinite proposes to deliver 7415 ha of suitable offset, located on Lot 3 of Plan SP314273 (Tay-Glen) via 100% direct offset. The proposed offset site is located approximately 3 km west of Dysart, Queensland and approximately 6 km southwest of the impact site. Vitrinite proposes to ensure the habitat quality gains (1/10 gain over 20 years) are achieved by reducing the threats of clearing, management of feral predators and weeds, reduction of fire risk and removal of barbed wire and by improving the habitat condition via active management measures such as, providing water points, active grazing management and potentially installation of artificial hollows. For all matters, the starting habitat quality in the candidate offset site exceeded, or with active management will exceed the quality of the habitat disturbed at the impact site, a requirement of the EPBC Act Environmental Offsets Policy. Overall, this offset site will satisfy the requirements of the EPBC Act Environmental Offsets Policy (as determined using the Offsets Assessment Guide).

An OAMP (Appendix II) has been prepared to demonstrate how the Tay-Glen offset area addresses the EPBC Act Environmental Offsets Policy. The plan utilises the findings of the ecological assessments from both the impact site and offset area to outline how the offset obligations and requirements, under the OAMP, will be addressed. The OAMP also details the management of offsets and how monitoring and reporting are to take place. Once approved by the Australian Government, the offset area is to be managed in accordance with the OAMP.

Economic and Social Impacts

A Stakeholder Engagement Plan and Social Impact Assessment was completed to determine the social and economic benefits of the Project and the pathway for ongoing stakeholder engagement. The Project is expected to result in the following benefits to the broader community:

- Construction workforce employment;
- Corporate sponsorship of local groups and services by Vitrinite;
- Indigenous employment and land access;
- Investment in housing rather than mine camps;
- Population increases in Dysart providing greater support for establishment and maintenance of local services and business; and,
- Improved utilisation of available rail and port capacity.

The Project is expected to result in the following economic benefits:

- Significant capital expenditure on infrastructure (regional and state economies);
- Significant operational expenditure;
- Offset area funding;
- Landholder compensation funding ;
- Local economic inputs from workforce and supply chain;
- Workforce wages and salaries – local increase in household income;
- Royalties; and,
- Corporate and other taxes.

Abbreviations and Glossary

Term	Definition
AEP	Annual Exceedance Probability
AMD	Acid and Metalliferous Drainage
ANC	Acid Neutralisation Capacity
AQP	Appropriately Qualified Person
AS	Australian Standard
AU	Assessment Unit
AUSRIVAS	Australian River Assessment System
BACI	Before, After, Control, Impact
Barada Barna People	The Barada Barna People (QUD380/08), represented by the Barada Barna Aboriginal Corporation RNTBC ICN 8343 (BBAC), are the native title holders for the broader Project area and the 'Aboriginal party' for the project under the *Aboriginal Cultural Heritage Act 2003* (Qld).
BBAC	Barada Barna Aboriginal Corporation
Brigalow TEC	Brigalow TEC Brigalow (*Acacia harpophylla* dominant and codominant) Threatened Ecological Community
BAL	Basic Left Turn
BAR	Basic Right Turn
BSS	Bed Shear Stress
BVG	Broad Vegetation Group
CAMBA	China-Australia Migratory Bird Agreement
CCA	Conduct and Compensation Agreement
CHPP	Coal Handling and Processing Plant
CHR	Channelised Right Turn
CSP	Corrugated Steel Pipe
DAWE	Department of Agriculture, Water and the Environment
DBH	Diameter at Breast Heigh
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DES	Department of Environment and Science
DESI	Queensland Department of Environment, Science and Innovation
DIN	Dissolved Inorganic Nitrogen
Disturbance footprint	Where project activities take place, e.g. approved infrastructure and clearing
DLL	Dysart Lower Lower coal seam
DNRM	Department of Natural Resources and Mines
DNRME	Department of Natural Resources, Mines and Energy
DRDMW GWDB	Department of Regional Development, Manufacturing and Water Groundwater Database – Queensland

Term	Definition
DSITI	Department of Science, Information Technology and Innovation
DTMR	Department of Transport and Main Roads
EA	Environmental Authority
EC	Electrical conductivity
eCEC	Effective Cation Exchange Capacity
ECM	Ecohydrological Conceptual Model
EIS	Environmental Impact Statement
EOS	Environmental Offsets Strategy
EP Act	*Environmental Protection Act 1994* (Qld)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
EPC	Exploration Permit Coal
EPO	Environmental Protection Order
EPP (Water)	*Environmental Protection (Water and Wetland Biodiversity) Policy 2019*
ERA	Environmentally Relevant Activity
ESC	Erosion and Sediment Control
ESD	Ecologically Sustainable Development
ESG	Environmental Social Governance
ESCP	Erosion and Sediment Control Plan
ESP	Exchangeable Sodium Percentage
EV	Environmental Value
EVNT	Endangered, Vulnerable, Near Threatened
FoS	Factor of Safety
FSV	Full storage volume
GBO	General Biosecurity Obligation
GDE	Groundwater Dependent Ecosystem
GHG	Greenhouse Gas
GIA	Groundwater Impact Assessment
GIS	Geographic Information System
GWDB	Groundwater Database
ha	Hectare
IBRA	Interim Biogeographic Regionalisation for Australia
IESC	Independent Expert Scientific Committee
ILUA	Indigenous Land Use Agreement
IPD	Impacts Pathways Diagram
IRC	Isaac Regional Council
JAMBA	Japan-Australia Migratory Bird Agreement
KLC	Kinetic leach column

Term	Definition
km	Kilometre
LEM	Landform Evolution Model
LFA	Land Function Analysis
LOM	Life of Mine
LoR	Limit of Reporting
mAHD	metres Australian Height Datum
MAT	Matilda coal seam
MAW	Mine affected water
mbgl	meters below ground level
MIA	Mine Infrastructure Area
ML	Mining Lease
MLA	Mining Lease Application
MNES	Matters of National Environmental Significance
MOV	Maximum operating volume
MPA	Maximum potential acidity
MSES	Matters of State Environmental Significance
Mtpa	Million tonnes per annum
NAF	Non-acid Forming
NAPP	Net Acid Producing Potential
NC Act	*Nature Conservation Act 1992* (Queensland)
NDVI	Normalised Difference Vegetation Index
NEQ	Net Explosive Quantity
NGER Act	*National Greenhouse and Energy Reporting Act 2007*
NR	Non-Remnant
NT Act	*Native Title Act 1993*
NUMA	Non-Use Management Area
NWQMS	National Water Quality Management Strategy
OAMP	Offset Area Management Plan
OPSIM	A computer-based operational simulation model
PAF	Potentially acid forming
PER	Public Environment Report
PMLU	Post-mining land use
PMST	Protected Matters Search Tool
PPP	Parcel Prospecting Permit
PRCP	Progressive Rehabilitation and Closure Plan – a requirement for the submission of an Environmental Authority application to the Queensland Department of Environment, Science and Innovation

Term	Definition
The Project	Vulcan South Coal Mine
Project area	The MLA boundary
QCA1	Ltd (QCC) and Queensland Coal Aust. No. 1 Pty Ltd
QCC	Queensland Coking Coal Pty Ltd (owned by Vitrinite Pty Ltd)
RA	Rehabilitation areas
RCP	Representative concentration pathway
RE	Regional Ecosystem
REDD	Regional Ecosystem Description Database
REMP	Receiving Waters Monitoring Program
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
ROM	Run of Mine
RPEQ	Registered Professional Engineer of Queensland
SAR	Standard Axle Repetitions
SCR	State Controlled Road
SEP	Stakeholder Engagement Plan
SIA	Significant Impact Assessment
SLATS	Statewide Landcover and Trees Study
SMU	Soil Management Unit
SP	Stream Power
SPRAT	Australian Government's Species Profiles and Threats Database
SRMS	Scaled root mean square error
SSE	Senior Site Executive
Survey Area	The MLA boundary and additional areas to the west where the flora and fauna surveys were conducted in 2019.
SWA	Surface Water Assessment
TARP	Trigger Action Response Plan
TEA	Terrestrial Ecological Assessment
TEC	Threatened Ecological Community
TDS	Total Dissolved Solids
TIA	Transport Impact Assessment
TLO	Train Load Out
TEC	Threatened Ecological Community
UWIR	Underground Water Impact Report
V	Velocity
VCM	Vulcan Coal Mine
VM Act	*Vegetation Management Act 1999*
VS	Vulcan South

Term	Definition
Vitrinite	Vitrinite Pty Ltd
WAL	Water Access Licence
WQGs	Water Quality Guidelines
WQO	Water Quality Objective
WRD	Waste rock dump

PER Requirements and Report Section

The following table outlines where the requirements of the PER Guidelines have been addressed in this report. Please refer to **Appendix A** for a copy of the complete Vulcan South Coal Mine PER Guidelines.

PER Section	Summary of requirements	Section in this Report
1	Background information	1
2	Description of the action	2
3	Feasible alternatives	3
4	Description of the environment	4
5	Matters of National Environmental Significance	5
5.1	General MNES information	5
5.1.1	Describe each listed threatened species and ecological community and water resource.	5
5.1.2	Identify and describe known historical records of protected matters in the broader region.	5 and **Appendix N**
5.1.3	Provide distinct, specific definitions for each category of habitat relevant to the MNES.	5 and subsections therein
5.1.4	Provide a habitat assessment for the relevant protected matters.	5
5.1.5	Provide detailed mapping of habitat for all listed threatened species and ecological communities, and listed migratory species likely to be impacted	5
5.1.6	Include the scope, methodology, timing and effort of field surveys to identify protected matters. Attach all referenced ecological surveys.	Section 4.7 and **Appendix M**, **Appendix Q** and **Appendix V**,
5.1.7	Provide detailed maps of survey effort.	Section 4.7.2
5.1.8	Include the total area of habitat for each relevant protected matter.	5 and subsections therein
5.1.9	Consider and assess the potential for occurrence for species in potential habitat for protected matters.	Section 5.3
5.1.10	Include an appendix of occurrence records for all listed threatened species and migratory species identified during field surveys.	**Appendix N**
5.1.11	Describe historical anthropogenic uses of the Project area (if relevant) and existing condition of the overall environment.	4
5.2	Specific Listed threatened species and ecological communities information requirements	5.5.and 5.6
Brigalow (*Acacia harpophylla* dominant and co-dominant) threatened ecological community (TEC) – Endangered		

PER Section	Summary of requirements	Section in this Report
5.2.1	A cross-reference table assessment of vegetation composition against key diagnostic characteristics and condition thresholds.	5.5.1
5.2.2	The total area of identified remnant and regrowth Brigalow TEC within the proposed action area.	5.5.1
5.2.3	Demonstrate that surveys were adequate to detect the presence and condition of Brigalow TEC.	4.7
Koala (*Phascolarctos cinereus*) (combined populations of Qld, NSW, and the ACT) – Endangered		
5.2.4	Habitat descriptions should align with those provided in the SPRAT database and relevant DCCEEW documents.	5.6.2
5.2.5	Demonstrate that surveys were adequate to detect the full extent of the species presence and abundance throughout the site.	4.7
Greater Glider (southern and central) (*Petauroides volans*) – Endangered		
5.2.6	Habitat descriptions should align with those provided in the SPRAT database and relevant DCCEEW documents.	5.6.3
5.2.7	Identify key denning and foraging resources, including the presence and density of tree hollows across the site.	5.6.3
5.2.8	Include a map of potential and future denning and foraging habitat across the Project area.	Figure 5-11 and Figure 5-12
5.2.9	In areas that may potentially be fragmented by the proposed action, provide average tree height to inform an understanding of Greater Glider gliding distance.	6.2.3
5.2.10	Demonstrate that surveys were adequate to detect the full extent of the species presence and abundance throughout the site.	4.7
Ornamental snake (*Denisonia maculata*) – Vulnerable		
5.2.11	Habitat descriptions should align with those provided in the SPRAT database and relevant DCCEEW documents.	5.6.5
5.2.12	Details and locations (including a map) of known food sources (i.e. frog species).	5.6.5
5.2.13	Demonstrate that surveys were adequate to detect the full extent of the species presence and abundance throughout the site.	4.7
Squatter Pigeon (southern) (*Geophaps scripta scripta*) – Vulnerable		
5.2.14	Habitat descriptions should align with those provided in the SPRAT database and relevant DCCEEW documents.	5.6.1
5.2.15	Include a map of all water bodies (including farm dams/troughs) within and surround the proposed Project area with an overlay of the different habitat features (e.g. breeding, foraging, dispersal).	Figure 5-7
5.2.16	Demonstrate that surveys were adequate to detect the full extent of the species presence and abundance throughout the site.	4.7
Ghost Bat (*Macroderma gigas*)		

PER Section	Summary of requirements	Section in this Report
5.2.17	Habitat descriptions should align with those provided in the SPRAT database and relevant DCCEEW documents.	5.6.14
5.2.18	Include a map of all rock overhangs and caves in the Project area and surrounding region.	5.6.14
5.2.19	Demonstrate that surveys were adequate to detect the full extent of the species presence and abundance throughout the site.	4.7
5.3	Water resource information	4.9
5.3.1	Provide a description of any third-party bores that may be impacted by the proposed action.	5.10.1
5.3.2	Provide a habitat assessment for known or likely terrestrial, aquatic and subterranean Groundwater Dependent Ecosystems (GDEs) on site.	5.10.4
5.3.3	Identify and describe known historical records of known or likely terrestrial, aquatic and subterranean GDEs in the broader region.	5.10.4
5.3.4	Identify and discuss the uncertainties in your predictions surrounding groundwater.	6.4.3.12, **Appendix P**
5.3.5	Provide the Geochemistry Assessment reports.	**Appendix R**
5.3.6	Investigate the possibility that the normal fault systems extend into the Project area.	6.4.3.13
5.3.7	Provide additional information about the geotechnical properties and final landform condition of the backfilled waste rock dump.	8.2, **Appendix G, Appendix J, Appendix AA**
5.3.8	Provide additional information about the design of the proposed diversions for the three headwater streams around the pits.	4.9, 6.4.1.5, 5.10.2
5.3.9	Provide acid mining drainage studies.	4.8, **Appendix R**
5.3.10	Provide additional information about proposed highwall mining areas to confirm depth to groundwater and groundwater elevations in the immediate vicinity of the highwall mining areas.	6.4.3.14
5.3.11	The PER should refer to water quality objectives approved in the State environmental authority that includes the extension where they are relevant to the assessment, and management and mitigation of impacts on EPBC protected matters.	4.9 and subsections therein
6	Impact Assessment	6
6.1	General impact information	6
6.2	Impacts to listed threatened species and ecological communities	6.1
6.2.1	An assessment of the likely impacts associated with the proposed action.	6.1
6.2.2	Include the total direct and indirect loss and/or disturbance of MNES individuals and habitat as a result of the proposed action.	6.1

PER Section	Summary of requirements	Section in this Report
6.2.3	Provide the total amount (in hectares) of each type of habitat in the disturbance footprint for each listed threatened species and ecological community and groundwater resource.	6.1
6.2.4	An assessment of the impacts of habitat loss and fragmentation in the proposed action area and adjacent areas, including consideration of species' movement patterns and habitat use.	6.1
6.2.5	An assessment of the likely duration of impacts to MNES as a result of the proposed action.	6.1
6.2.6	A discussion of whether the impacts are likely to be repeated, for example as part of ongoing maintenance.	6.1
6.2.7	A discussion of whether any impacts are likely to be unknown, unpredictable or irreversible.	6.1
6.2.8	Provide assessment of the impacts identified against the significant impact criteria and justification for the likelihood of occurrence.	6.2
6.2.9	An assessment of the likely and possible impacts resulting from highwall mining.	6.4.4
6.2.10	Where relevant, consider predicted future climatic conditions at the project site.	6.1
6.2.11	Justification, with supporting evidence, as to how the proposed action will not be inconsistent with the Apia Convention and CITES, and a recovery plan or threat abatement plan.	10.5
6.2.12	Justification, with supporting evidence, as to how the proposed action has taken into account any relevant approved conservation advice.	6.1 and 6.3
6.3	Impacts to water resources	6.4
General hydrology		
6.3.1	An assessment of the likely impacts to water resources associated with the proposed action.	6.4
6.3.2	A description of any potential third-party users of water in areas potentially affected by the proposed project.	6.4.1.8
6.3.3	In addition, include a description and assessment of likely and possible impacts to water resources resulting from highwall mining specifically.	6.4.1.13 and 6.4.4
6.3.4	Include a description and assessment of the impacts to water resources giving consideration to relevant departmental policies and guidelines.	6.4
6.3.5	Identify and address potential and likely cumulative impacts on surface water and groundwater from the proposed action and other nearby projects.	6.4.2, 6.4.3.18
6.3.6	Provide robust scientific information and supporting evidence.	6.4, **Appendix I**, **Appendix P**
Surface water		

PER Section	Summary of requirements	Section in this Report
6.3.7	A site-specific water balance for the proposed action area.	6.4.1.9
6.3.8	Discussion on any predicted reduction and change in water quality in catchment areas.	6.4.1.3
6.3.9	An assessment of potential impacts from stream diversions taking into account the length, location and design of likely diversions.	5.10.2
6.3.10	An assessment of potential flood impacts upstream of the mine on the floodplain of Hughes Creek.	6.4.1.4
6.3.11	Discuss the build-up of salts and contaminants in the environment or runoff to downstream receptors.	6.4.1.11, 6.4.1.12
Groundwater		
6.3.12	Demonstrate whether the proposed action is likely to have a significant impact on groundwater resources through drawdown, depressurisation and water quality.	6.4.3.5, 6.4.3.7
6.3.13	Discuss how post-mining ground water levels will seasonally fluctuate in and around the pit areas.	6.4.3.8
6.3.14	Discuss the likelihood of persistent pondage and a description of infiltration through the re-established soil profiles.	6.4.3.9
6.3.15	Suitable information to allow an independent reviewer to consider the appropriateness of the underlying assumptions and conceptual models on which numerical models are based.	6.4.3, 6.4.3.12 and subsections therein
6.3.16	A sensitivity analysis must be undertaken.	6.4.3.12 and **Appendix P**
6.3.17	Groundwater models must consider the Australian Groundwater Modelling Guidelines and the IESC explanatory notes.	6.4.3.1 and **Appendix P**
6.3.18	Investigations of surface water-groundwater interactions and any changes to infiltration patterns should be considered in groundwater modelling over the extended mine life, inclusive of altered groundwater flow pathways which may intersect nearby pits.	6.4.3.4
Groundwater dependent ecosystems (GDEs)		
6.3.19	An assessment of direct, indirect and consequential impacts to GDEs, including a discussion of any potential GDEs in the vicinity.	6.4.3.16
6.3.20	A desktop assessment used to identify potential GDEs for field assessment.	6.4.3.16 and 5.10.4
6.3.21	Field assessment data to confirm the outcomes of desktop assessments.	Section 5.10.4 and 4.7.4
6.3.22	The GDE assessment must provide the details and results of the above database searches and field studies.	4.7.4.1 and 4.7.4.2
6.3.23	Analysis and investigation of any GDEs should follow methods outlined in Doody et al (2019). Information Guidelines Explanatory Note: Assessing groundwater-dependent ecosystems.	4.7.4.1 and 4.7.4.2

PER Section	Summary of requirements	Section in this Report
6.3.24	An assessment of the potential impacts to stygofauna and other GDEs resulting from any potential decrease in electrical conductivity within the alluvium.	6.4.3.17, **Appendix P** and **Appendix V**
6.3.25	Sufficient evidence to support any conclusion that particular ecosystems are not groundwater dependent.	5.10.4
7	Proposed avoidance, minimisation, mitigation and management measures	7
7.1	Avoidance, mitigation and management measures	
7.1.1	A detailed summary of measures proposed to be undertaken by the proponent to avoid, minimise, mitigate and manage relevant impacts of the proposed action on MNES, for all stages of the proposed action.	7
7.1.2	All proposed measures for MNES must be drafted to meet the 'S.M.A.R.T' principle.	7.1
7.1.3	The proposed measures must be based on best available practices, appropriate standards, evidence of success for other similar actions and supported by published scientific evidence.	7.1 and subsections therein
7.1.4	Provide discussion on the measures employed to avoid, minimise and mitigate impacts to MNES from habitat loss and fragmentation.	6.1, 7.1.1
7.1.5	Provide discussion on the measures employed to avoid, minimise and mitigate impacts to MNES from short- and long-term erosion and sedimentation.	7.1.2
7.1.6	Provide management and mitigation measures related to impacts of groundwater drawdown, groundwater contamination and surface water contamination on water resources.	7.1.3 and 7.1.4
7.1.7	The PER must outline how the Reef 2050 Water Quality Improvement Plan has been taken into consideration.	7.4
7.1.8	Include details of specific and measurable environmental outcomes to be achieved for relevant MNES.	7.5
7.1.9	Include an assessment of the expected or predicted effectiveness of the proposed measures.	7.1 and subsections therein
7.1.10	Discuss how cumulative impacts are considered in the avoidance and mitigation measures.	6.2.8 (Terrestrial Ecology), 6.4.2(Surface water), 6.4.3.18 (Groundwater)
7.1.11	Discuss the likelihood of trees that are currently in smaller size classes transitioning into hollow-bearing trees throughout the lifetime of the proposed action, and describe measures taken to minimise impacts to these trees.	5.6.3.8
7.1.12	Provide bushfire mitigation and management measures.	7.1.5

PER Section	Summary of requirements	Section in this Report
7.1.13	Provide details of ongoing management that validate the effectiveness of the proposed measures and overall demonstrate that environmental outcomes will be achieved.	7 and subsections therein
7.1.14	Details of tangible, on-ground corrective actions that will be implemented in the event the monitoring programs indicate that the environmental outcomes have not or will not be achieved, and when these corrective actions would be triggered.	7.1 and 7.7
7.1.15	The proposed measures must identify which actions are relevant to which MNES within the impact area.	7 and subsections therein.
7.2	Management plans	7.6
7.2.1	A detailed outline of an Environmental Management Plan (EMP), or equivalent.	7.6.2 and **Appendix Y**
7.2.2	A Sediment and Erosion Management Plan, or equivalent.	7.6.3 and **Appendix W**
7.2.3	A Dewatering Groundwater Management Plan, or equivalent.	7.6.4
7.2.4	A Flood Management and Mitigation Plan, or equivalent.	7.6.5
7.2.5	A Receiving Environment Monitoring Plan (REMP) or equivalent.	7.6.6 and **Appendix X**
7.2.6	Trigger Action Response Plans (TARP) should be included in relevant management plans as required.	7.6
7.2.7	An ecohydrological conceptual model should be provided as outlined in the IESC guidelines.	7.1.6
7.2.8	A Rehabilitation Management Plan or equivalent.	7.6.7
7.2.9	An Offset Management Strategy (OMS) or an Offset Management Plan (OMP).	7.6.8, **Appendix Z**
8	Rehabilitation requirements	8
8.1	Provide details of any rehabilitation activities proposed to be undertaken as required by Commonwealth, State or Territory, and local government legislation.	8.1
8.2	Provide details of rehabilitation methods and how they meet best practice standards.	8 and subsections therein
8.3	A summary of the vegetation community/habitat that is being rehabilitated and the dominant species that will be included in the rehabilitation site.	8.4
8.4	Maps showing the areas that will be rehabilitated within the Project area and the size in hectares of these areas.	8.4 and Figure 8-2 and 8-3
8.5	Information on management of the rehabilitation site, including, but not limited to, weed and pest management.	7.6.1.8, 8.5

PER Section	Summary of requirements	Section in this Report
8.6	Rehabilitation acceptance criteria relevant to MNES and the procedures, including contingency measures, that will be undertaken to achieve them.	8.1, 8.6
8.7	Details of a monitoring program to determine the success of rehabilitation activities implemented by the proponent.	8.7
8.8	Include information on whether any post-construction rehabilitation sites will be subsequently cleared during the decommissioning stage.	8.8, not applicable
9	Offsets	9
9.1	An assessment of the likelihood of residual significant impacts occurring on relevant MNES, after avoidance, mitigation and management measures have been applied.	9.1
9.2	A summary of the proposed environmental offset and key commitments to achieve a conservation gain for each protected matter.	9 and 9.2
9.3	If an offset area has not been nominated, include a draft OMS as an appendix to the PER.	**Appendix Z**
9.4	Where offset area/s have been nominated, include a draft OMP as an appendix to the PER.	**Appendix Z**
9.5	The environmental offset/s proposed for the project must meet the core principles of the Offset Policy.	**Appendix Z**
10	Other requirements	10
10.1	Other approvals and conditions.	10.1
10.2	Consultation.	10.2
10.3	Environmental record of the person(s) proposing to take the action.	10.3
10.4	Economic and social matters.	10.4
10.5	Information sources provided in the PER.	10.6
11	Conclusion	11

1 Background Information

Queensland Coking Coal Pty Ltd (QCC) (a wholly owned subsidiary of 'Vitrinite Pty Ltd'), proposes to construct and operate the Vulcan South Coal Mine (the Project). The proponent is QCC, however is referred to as 'Vitrinite' throughout the PER. The Project is located 35 km south of Moranbah, Central Queensland adjacent to several established mining operations. The Project will extract premium coking coal (steel-making coal) and will consist of an open-cut mining area, a highwall mining trial area, rail loop loading facility, Coal Handling and Processing Plant (CHPP) and ancillary infrastructure.

The Project was referred under the *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act) to the Minister for the Environment on 1 February 2024. The Minister determined on 4 March 2024 that the Project is a controlled action and approval is required as the action has the potential to have a significant impact on the following Matters of National Environmental Significance (MNES) protected under Part 3 of the EPBC Act:

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

It was also determined that the proposed action was to be assessed by a Public Environment Report (PER).

This PER has been prepared to address the requirements of the final Vulcan South PER Guidelines, issued by the Department of Climate Change, Energy, the Environment and Water (DCCEEW) on 1 May 2024 (**Appendix A**).

Project Information	
Project title	Vulcan South Coal Mine
Proponent	Queensland Coking Coal Pty Ltd, owned by Vitrinite Pty Ltd (Vitrinite)
Address	Level 6, Suite 2, 12 Creek Street, Brisbane, Qld, 4000
Objective of the action	Open-cut and trial highwall mining for the purpose of extracting premium hard coking coal, with an incidental thermal secondary product.
Location of the action	Mining will take place on MLA 700073, approximately 35 km south of Moranbah in Queensland's Bowen Basin (−22.3678, 148.2352).
Background to the action's development	The Project is a greenfield development. An application for a Mining Lease was lodged on 10 May 2022. An application for an Environmental Authority (EA) was submitted to the Queensland Department of Environment, Science and Innovation on 6 June 2022, and was approved by the Department on the 22 January 2024. A Progressive Rehabilitation and Closure Plan and Schedule was submitted and approved as part of the State EA application process.
Relationship to other actions	The Project is located south of two Vitrinite actions which are currently approved and in operation, or under assessment. These are the Vulcan Coal Mine (EPBC 2022/8687) and the Vulcan Coal Mine – Matilda Pit and Ancillary Infrastructure (EPBC 2022/9361), respectively. The Project is located immediately west to mining projects operated by BHP Coal (Peak Downs and Saraji mines). Consultation has occurred between Vitrinite and BHP concerning water supply and management. Vulcan South (VS) and Vulcan Coal Mine (VCM) [EPBC number 2023/09708 and 2022/09361, respectively] are independent projects, approximately 10km apart. Therefore, we have not included reference to any previously submitted or approved Vulcan Coal Mine EPBC Referrals.

Project Information	
	VS is proposed to be developed following the conclusion of mining at VCM. Therefore, mining activities are proposed to be executed separately from a time and location perspective. The VCM is Vitrinite's first mining project and is scaled accordingly from a capital expenditure and operational cost management perspective. The VCM and VS have separate underlying landholders. Land access for each of the projects has required different negotiation pathways and timeframes. VS is not part of a staged development and is not part of a larger project. However, if there is an opportunity to commence the highwall trial during the VS construction period, ROM coal extracted from the trial may be handled through the VCM infrastructure. Dependant on timing, personnel, plant and equipment, ROM coal may be transferred from VCM to VS.
Current status of the action	The action has been approved by the Department of Environment, Science and Innovation through a finalised Environmental Authority (P-EA-100265081) (**Appendix E**).
Consequences of not proceeding with the action	The direct consequences of not proceeding with the action are the loss of sustained positive economic opportunities for the local area and region in the form of direct employment, procurement, community buy-in, royalty payments to the government and revenue to local businesses.
Identification of affected parties	The following are also key affected parties: • the Barada Barna People, as Native Title holders for the broader Project area (ILUA); • Underlying landholders (O'Sullivans).

1.1 Updates to technical information

The authorising of this PER in accordance with the guideline requirements (**Appendix A**) and information stage has necessitated updates and/or additional discussion on impacts to surface water, groundwater and ecological matters. The Terrestrial Ecological Assessment (**Appendix M**) has been updated to incorporate the additional information requested as part of the PER process. The Groundwater Impact Assessment (**Appendix P**) was also updated to include additional information highlighted by the Department and the IESC. Additional surface water analysis was undertaken by WRM in response to the Department and IESC has been included within **Appendix D.**

Where possible, the surface and groundwater technical assessments have been updated to reflect such information updates; however, in some instances the information has been provided in the PER body or within additional appendices. The cross-reference table below (**Table 1-1**) has been developed to provide reference to where additional surface and groundwater information is located within the PER document, if the information is not located within the associated technical assessment documents. The Terrestrial Ecology Assessment (**Appendix M**) has been updated in full to consider all additional information following the information requirements.

Table 1-1 Cross reference of additional surface and groundwater information

Additional information to technical assessment	Location of additional information
Groundwater	
Monitoring network information and the data-sharing agreement with neighbouring mines	**Section 7.2.2** of the PER.
Updated groundwater monitoring data used the verify the groundwater model	Refer to Groundwater Monitoring Data (**Appendix U**)
Updated groundwater monitoring locations and suitability for inclusion in the monitoring program	**Section 7.2.2** in the PER and **Figure 7-7**
Groundwater elevation hydrographs have been updated for the Project to consider updated groundwater monitoring data.	Refer to Hydrographs (**Appendix P**)
Groundwater levels in the highwall mining trial area	Refer to **Section 6.4.3.14**
Surface Water	
Detailed information on the potential for erosion and sedimentation within the diverted channels and from the altered floodplain dynamics.	Section 2.1 in the WRM response document (**Appendix D**)
The potential impacts to stream hydrology, and aquatic and riparian habitats due to the initial diversions and then the reinstatement of the original channels across a different substrate (waste rock) that is likely to have very different streambed characteristics (e.g. greater infiltration capacity).	Section 2.3 in the WRM response document (**Appendix D**)
Water management system performance under more extended and extreme storms, noting that this should now include allowance for the 1.3 °C of global warming that has occurred over the historical period used to derive design rainfall information (DCCEEW, 2023).	Section 4 in the WRM response document (**Appendix D**)
Sediment dam maintenance and the disposal of any sediment removed from the dams. Also, monitoring program of sediment quality in the dams to ensure that any material released or removed does not pose a contamination risk.	Refer to ESCP (**Appendix D**)
Sensitivity analysis on the inflow estimates computed for mine water balance dynamics using the Australian Water Balance Model (AWBM) rainfall-runoff model.	Section 5 in the WRM response document (**Appendix D**)
Potential cumulative impacts to surface water flows or cumulative impacts from the proposed project and other pits in the mining area. The potential changes to surface water flows arising from the combined effects of stream diversions, changes in flooding and decreased stream flows due to rainfall runoff captured by the water management systems.	Section 3 in the WRM response document (**Appendix D**)
A detailed description of rock lining and a description of the program for monitoring the environments downstream	Section 2.2 in the WRM response document (**Appendix D**)

from the diversions to assess the effectiveness of the mitigation.	
Additional parameters for water quality in uncontrolled releases from sediment dams.	Refer to Vulcan South REMP (**Appendix D**)
Predicted future climatic conditions, such as: • loss, fragmentation, or drying of potential climate refugia for MNES as a result of the proposed action – consider the potential impacts of removing or otherwise impacting climate refugia for the long-term survival of the MNES in the region • increased risk of fire as a result of the proposed action under drier conditions and periods of extreme heat.	**Section 6.4.1.7** outlines information in relation to Climate Change using the Representative Concentration Pathway 8.5.

The Response to the IESC is provided in **Appendix C**.

2 Description of the action

The Project is a small-scale coal mine that will extract approximately 13.5 Mt of run-of-mine (ROM) coal, consisting predominately of hard coking coal with an incidental thermal secondary product, at a rate of up to 1.95 million tonnes per annum (Mtpa). The project will operate for approximately nine years, including primary rehabilitation works, following a two-year construction period. Coal extraction will occur in three open-cut pits; Vulcan North, Vulcan Main and Vulcan South. The maximum pit depth will extend to 60m bgl. Truck-and-shovel mining operations will be employed to develop the pits. Coal will be processed by a modular CHPP. The proposed CHPP will include tailings dewatering technologies to maximise water recycling and to produce a dry tailings waste product for permanent storage within waste rock dumps (WRD's). No wet tailings wastes or tailings dams are proposed. Coal transportation will occur via a rail loop and load-out facility, located between the Vulcan North and Vulcan Main pits. Coal will be transported on the Goonyella Rail network to coal terminals at either Dalrymple Bay or Gladstone.

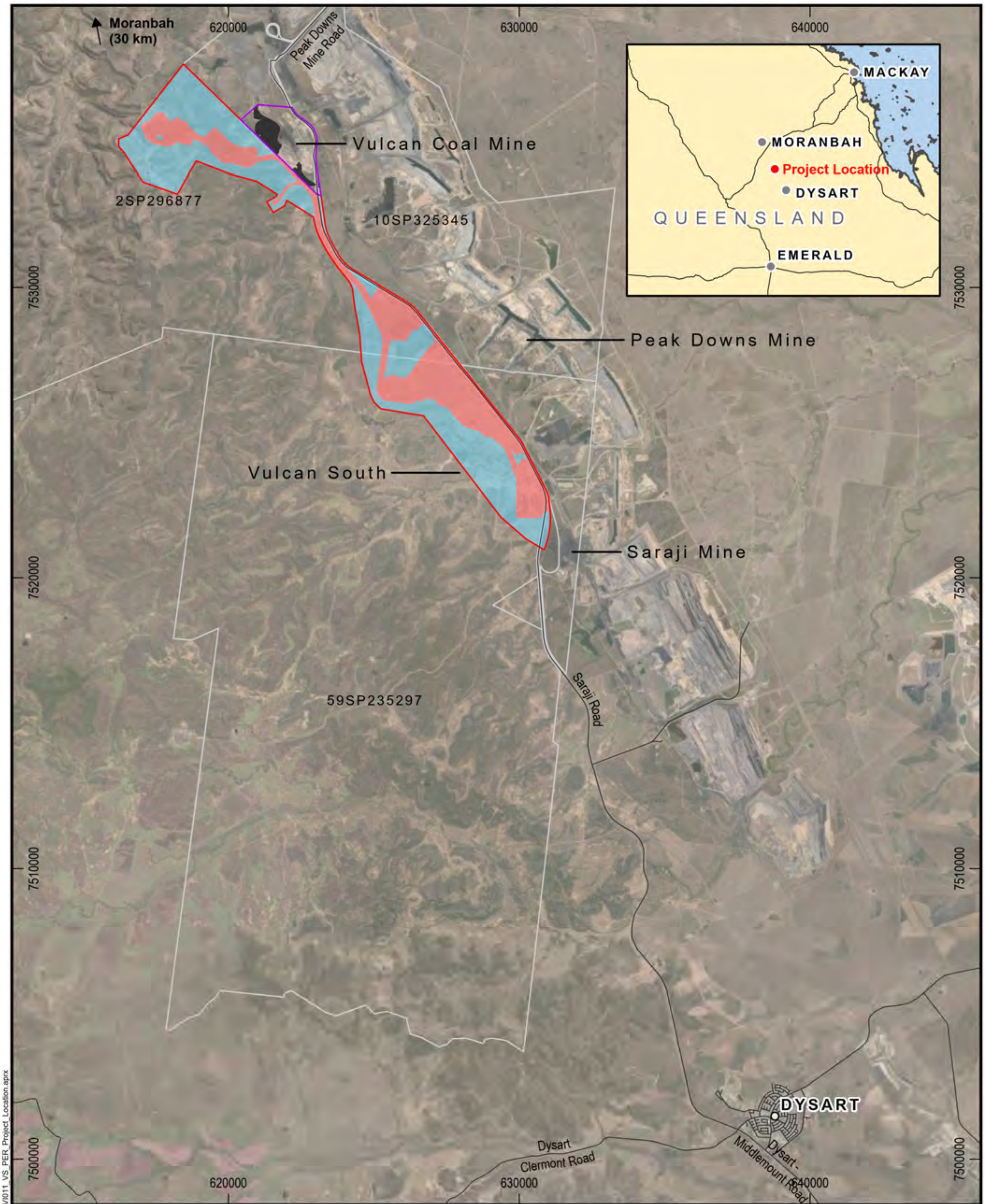
The Life of Mine (LOM) of the Project including construction, operation, decommissioning, remediation, and rehabilitation is approximately 22 years assuming a 2025 commencement and with all rehabilitation milestones being completed by the end of 2047.

No changes to the project description have occurred since the submission of the EPBC Act referral.

2.1 Location and Project area

The Project area (referring to the entire MLA, of which only a portion will be impacted by the proposed action) is located approximately 35 km south of Moranbah in Queensland's Bowen Basin (central point coordinates: −22.3678, 148.2352) (**Figure 2-1**). The Project lies to the immediate west of several established mining operations including BMA's Peak Downs and Saraji mines, and south of Vitrinite's Vulcan Coal Mine. The Project is located within mining lease application area (MLA) 700073. The Project area is 3,819 ha. An indicative layout plan is provided in **Figure 2-2**, and land use in the area is provided in **Figure 2-3**.

The proposed development footprint (or disturbance footprint) for the action is 1,476.4 ha, which includes the proposed infrastructure and areas potentially to be impacted directly or indirectly. It should be noted that areas that fall within the disturbance footprint that are not covered by specific infrastructure at this time, have conservatively been included in the disturbance footprint to facilitate operational flexibility, however, may not be disturbed if not required to support proposed operations. The surface area above the highwall mining trial panels has also conservatively been included in the disturbance footprint, however, is not expected to be disturbed.



Legend

- Town
- Road
- Cadastral Boundary

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- Avoidance Area

Vulcan Coal Mine (VCM) – Matilda Pit and Ancillary Infrastructure (2022/09361)

- ML 700060
- VCM Matilda Disturbance Footprint

Source: Population centres - Queensland, State of Queensland (Department of Resources) 2020; QLD Roads and Tracks, State of Queensland (Department of Resources) 2021; Cadastral data weekly - whole of State Queensland, State of Queensland (Department of Resources) 2022; Vulcan South and Vulcan Coal Mine datasets, Vitrinite & METServe 2022-2024; Imagery - Geosciences Australia, Esri, GEBCO, Garmin, NaturalVue, Earthstar Geographics.

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Project_Location.aprx

Vulcan South

Project Location

0 2 4 8

Kilometers

Scale: 1:190,000 (A4)

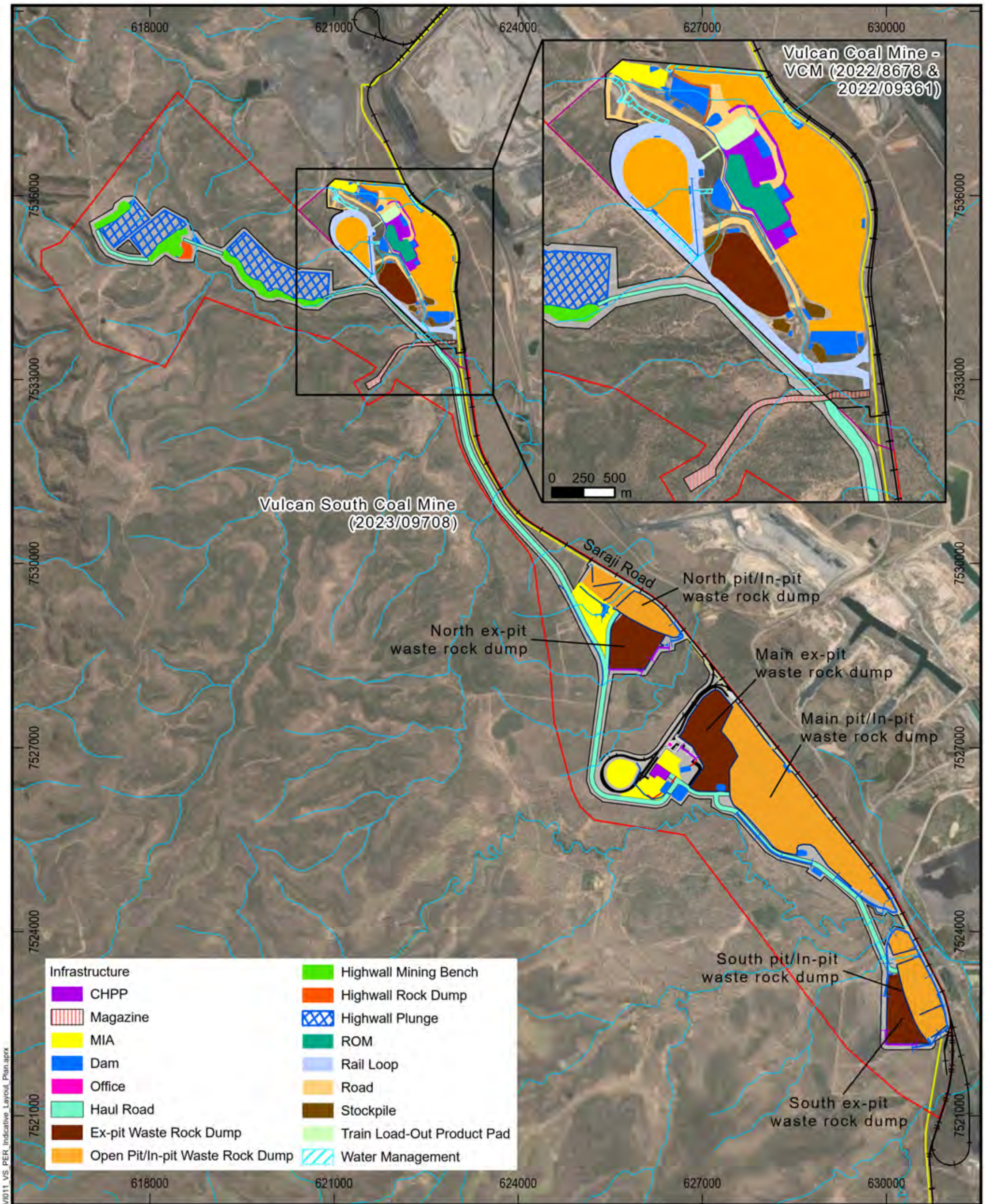
5/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 2-1

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd



Legend

- Railway
- Road
- Rail Loop and Mine Roads
- Mine Access Road
- Flood Levee
- Diversion Bund
- Diversion Drain
- Mine Water Drain
- Surface Water Drain
- Dam Wall
- Project Area (ML 700073)
- Disturbance Footprint
- ML 700060
- VCM Maximum Disturbance Footprint

Source: QLD roads and tracks - State of Queensland (Department of Resources) 2021; Rail network - QLD - State of Queensland (Department of Resources) 2022; Watercourse lines - QLD - State of Queensland (Department of Resources) 2023; Infrastructure - Vitrinite, WRM and METServe 2022-2024; Imagery - Earthstar Geographics, Maxar

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Indicative_Layout_Plan.aprx

Vulcan South

Indicative Site Layout

0 1 2 3

Kilometers

Scale: 1:90,000 (A4)

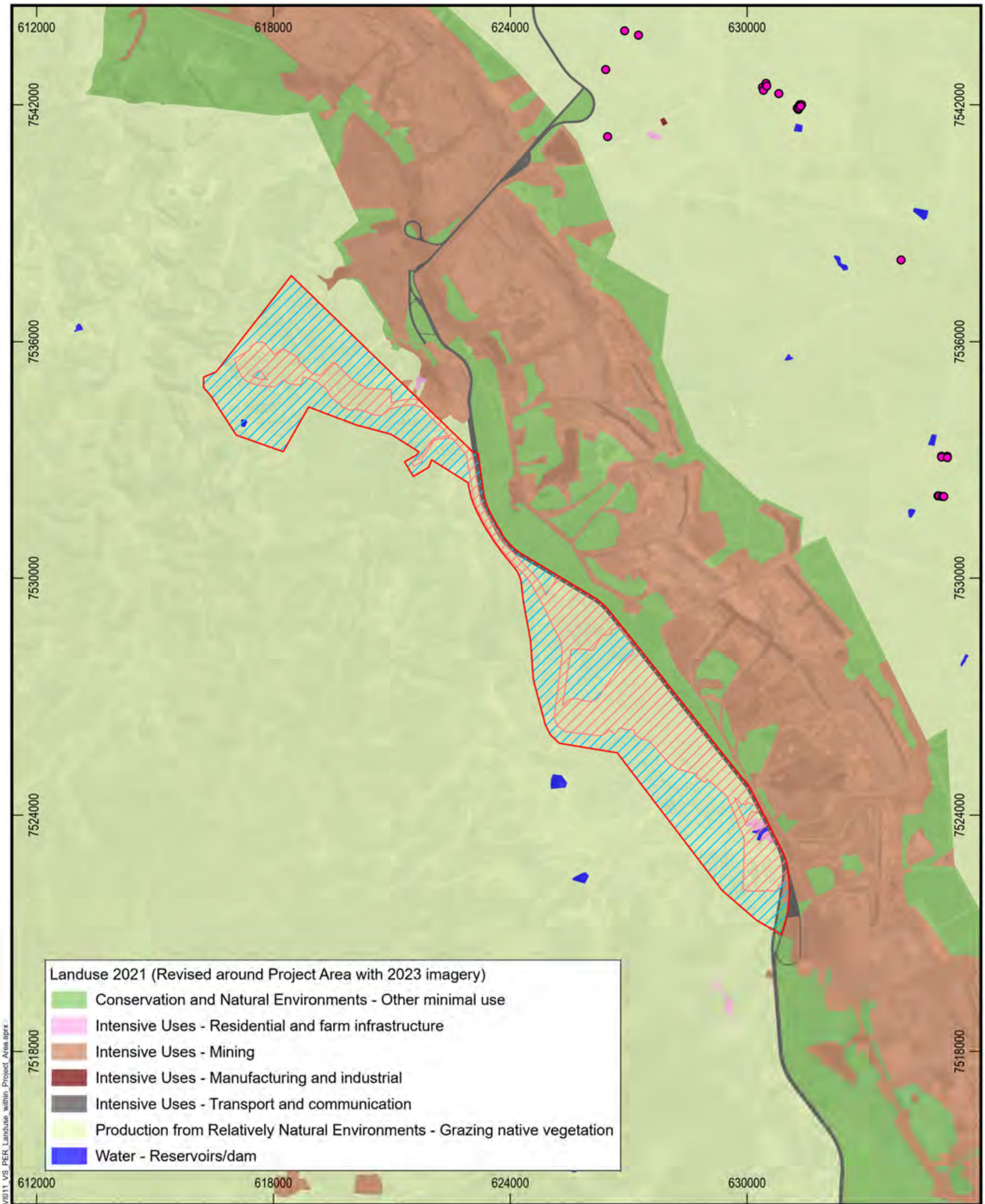
5/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 2-2

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd



Legend

- Coal Seam Gas Boreholes

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- Avoidance Area

Source: Land use mapping 2021 Great Barrier Reef NRM regions - State of Queensland (Department of Environment and Science) 2023; All bore hole and well locations QLD (Coal Seam Gas Boreholes) - State of Queensland (Department of Resources) 2023; Vulcan South and Vulcan Coal Mine datasets - Vitrinite & METServe 2022-2024; Imagery - Earthstar Geographics 28/03/2023

Vulcan South

Land Use within Project Area

0 1.25 2.5 5

Kilometers

Scale: 1:140,000 (A4)

8/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 2-3

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Landuse_within_Project_Area.aprx

2.2 Construction and Infrastructure

The proposed Project includes a two-year construction period (2024-2026). Construction of infrastructure associated with the mining operation, including the CHPP and the rail loop, is expected to be completed within two years. No wet tailings are proposed and therefore no tailings dams are required.

At each of the three pits, out-of-pit WRD's will be established prior to commencing in-pit dumping activities that will continue for the life of the operation. Ancillary infrastructure, including a ROM pad, offices, roads and surface water management infrastructure will be established to support the operation.

Realignment of the existing Saraji Road and services infrastructure to the eastern boundary of the MLA, adjacent to the existing rail easement, is also proposed in a number of locations. The realignment will occur within the MLA. Construction of the realigned Saraji Road Sections will be completed progressively as the pits advance towards the location of the existing road.

The highwall mining trial will involve the establishment of four highwall mining benches as is described further in **Section 2.3.5.**

Construction of the following infrastructure will also commence in 2024, which is described further below:

- explosive magazine
- administration buildings and warehouses
- fuel storage and workshops
- ROM pad
- CHPP, and
- Rail Loop and Train Load Out (TLO).

2.2.1 Explosive Magazine

Separation distances have been considered for the storage of explosives measured as Net Explosive Quantity (NEQ) at the Project.

Separation distances are the distances required to ensure that there will be no significant impact to humans or significant property damage as a result of stored ammonium nitrate exploding. This is to be applied for protected works and vulnerable facilities.

Appropriate separation distances for surrounding sensitive receptors and areas of public use, in accordance with AS2187.1 Explosive Storage, Transport and Use, along with Explosives Information Bulletin No. 53 being considered.

Table 2-1 below presents the compliance of the site based on a maximum storage of 6 t of NEQ.

Table 2-1 Minimum separation distances

Separation Distances (m)				
Net Explosive Quantity (NEQ) in tonnes	Protected Class A	Protected Class B	Vulnerable Facilities	Associated Works
6 t	305	453	906	98.4

The following definitions from AS 2187.1 1998 (Explosives- Storage, transport and use Part 1:Storage) and clarification as to their application have been included.

Associated works

Other magazines, process building and storages of energetic materials, e.g., ammonium nitrate or class 5 dangerous goods. ***There are no associated works on this site.***

Protected Works A. Public street, road or thoroughfare, railway, navigable waterway, dock, wharf pier or jetty, marketplace, public recreation and sports ground or other open place where the public is accustomed to assemble, open place of work in another occupancy, river-wall, seawall, reservoir, water main (above ground, radio or television transmitter, main electrical substation, private road which is the principal means of access to a church, chapel, college, school, hospital or factory. ***The Vulcan South rail loop is classified as Protected Works A facility and located approximately 1 km from the explosive storage facility.***

Protected Works B. Dwelling house, public building, church, chapel, college, school, hospital, theatre, cinema or other building or structure where the public is accustomed to assemble, shop, factory, warehouse, store, building in which any person is employed in any trade or business, depot for keeping of flammable or dangerous goods, major dam. ***The nearest occupied building is 2.45 km away and therefore there are no relevant Protective Works B facilities for this site.***

Vulnerable facility. A category of facility that includes, but is not restricted to, the following:

- Multistorey buildings, e.g., above 4 storeys.
- Large glass fronted building of high population.
- Health care facilities, childcare facilities, schools.
- Public buildings or structures of major historical value,
- Major traffic terminals e.g., railway stations, airports
- Major public utilities e.g., gas, water, electricity works.

There are no vulnerable facilities associated with this site.

In summary, the separation distances for key infrastructure areas and vulnerable facilities are within the approved minimum distance as described in *AS 2187.1 1998* (*Explosives- Storage, transport and use Part 1:Storage*)

2.2.2 Administration buildings and warehouses

Onsite offices and administrative buildings are to be located 70 metres north of the mine Infrastructure area (MIA) and adjacent to mine access roads for easy access.

2.2.3 Fuel storage and workshops

This will include mobile diesel fuel tanks, workshop containers and portable bathroom amenities. Earthmoving equipment will be required for the development of benches for the highwall miner to operate on as well as road construction and maintenance equipment to build and maintain the haul road to the CHPP/ ROM stockpile area.

2.2.4 ROM pad

ROM coal will be loaded from the discharge conveyor of the highwall miner onto a stacker belt for stockpiling on the active bench. Loaders will manage the stockpile and load B triple trucks for haulage to the CHPP. Waste rock from the benches will be temporarily stockpiled during highwall mining activities, prior to being back-filled into the bench areas during progressive rehabilitation. The ROM pad will be located within the MIA.

2.2.5 Rail Loop and TLO

Product coal will be railed from the Project rail loop onto the Goonyella Rail network. Export options include Dalrymple Bay to the north and RG Tanna, in Gladstone, to the south.

The train load out facility will link the product stockpiles with the proposed rail loop and will utilise a two-coal valve reclaim system to load at a rate of 3,500 tph. The train load out facility will be managed via an automated system, including overload protection and load veneering. The facility will be positioned over the rail line and will incorporate a suitable under rail spillage pit.

The rail Loop will be approximately 4.97 km long along its centreline.

2.2.6 Coal Handling and Processing Plant

The CHPP will be approximately 270m by 222m at its longest points.

2.2.7 Duration of Key Infrastructure

Key infrastructure will remain until operations at the southern pit cease and infrastructure will be maintained on an as needed basis. Considering that infrastructure will only be operational for approximately 7 years, it is unlikely that extensive maintenance works will be required. Ongoing establishment of internal road networks, surface water management infrastructure and other ancillary infrastructure will continue to be developed as the pits and in-pit dumps advance.

2.2.8 New and Existing Roads

The Project will include the construction and operation of the haul road, mine access road and internal roads, as well as the realignment of the Saraji Road which will remain in perpetuity following the completion of the project. Roads to be established for the Project are summarised below:

- Mine access road - A new mine access road (unsealed) will be established from Saraji Road in the centre of the MLA, between the rail loop and the northern extent of the Vulcan Main pit. This will lead to the site offices and administration and on to the Mine Infrastructure Area (MIA). This will be approximately 20m wide and 3km long (including the access road to the office).
- Main Haul Road – The main haul road (unsealed) will extend from the Highwall mining trial area in the north to the southern pit. The haul road will be approximately 80 m wide and total a length of 16.25 km.
- Highwall mining trial haul road will be between 30 and 60m wide depending on the Section of the highwall mining area and approximately 4km long.
- Saraji road realignment (sealed) - A realignment of the existing Saraji Road and services infrastructure to the eastern boundary of the proposed Mining Lease Application (MLA) area, adjacent to the existing rail easement, is also proposed in a number of locations. The re-alignment will occur within the MLA area. As a functioning council road that is intended to remain in place in perpetuity, Saraji Road must meet regional council requirements in its construction and maintenance. This is a condition specified in the agreement between Vitrinite and the IRC.
- The magazine access road corridor (unsealed) will be approximately 50-70m wide and approximately 1.2km long.

2.2.9 Culverts below haul road

There are 6 proposed culverts for the Project that are to be located beneath the haul road, these are summarised below in **Table 2-2.**

Table 2-2 Proposed culvert configurations, Operational and Post-closure conditions

Culvert ID	Type	Diameter/width (m)	No. of barrels	Upstream invert level (mAHD)	Downstream Invert level (mAHD)
CulvHR1.3	CSP	1.2	4	224.98	224.02
CulvHR1.4	CSP	1.2	4	226.19	225.9
CulvHR1.5	CSP	1.05	2	231.0	230.12
CulvHR2.3	CSP	1.2	6	204.93	204.75
CulvHR2.2	CSP	1.2	10	200.9	200.45
CulvHR2.1	**CSP**	**1.2**	**10**	**200.16**	**200.09**

CSP = Corrugated steel pipe

2.3 Operation

2.3.1 Open Cut Mining Activities

Vulcan South will operate for approximately seven years (mid-2026 -to mid-2033) and will target the Alex and multiple Dysart Lower coal seams. The Project will extract approximately 13.5 Mt of run-of-mine (ROM) coal, consisting predominately of hard coking coal (with an incidental thermal secondary product) at a rate of up to 1.95 Million tonnes per annum (Mtpa).

The three open cut pits will follow the seams as they dip eastwards. The footprints of the proposed open cut pits are provided in **Table 2-3**. Truck-and-shovel mining methods will be employed to extract waste rock and coal.

Table 2-3 Open cut pit characteristics

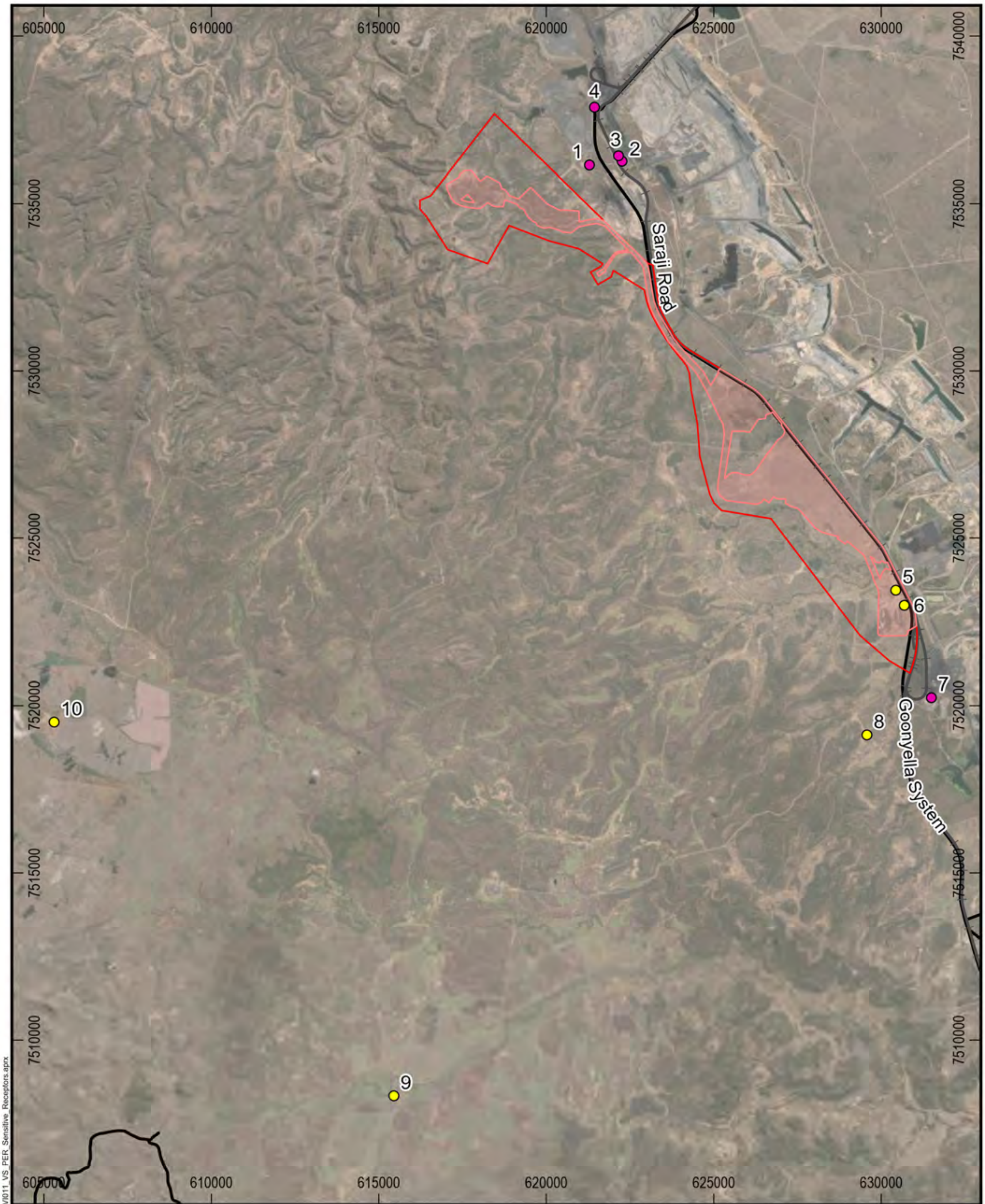
Open Cut Pit Name	Approximate Footprint (ha)	Approximate Maximum Depth (m)	Average Depth (m)	Mining Direction	Target Seams
Vulcan North	66	34	12.4	North to south	Alex and multiple Dysart Lower
Vulcan Main	334	60	32.0	North to south	Alex and multiple Dysart Lower
Vulcan South	77	38	23.5	North to south	Alex and multiple Dysart Lower

2.3.2 Blasting

Blasting is expected to be required to access resources below unweathered rock, with approximately 24 blasts per year are expected during the construction/operation (9 years). Blasts would be planned and scheduled to manage potential impacts on Saraji Road, nearby infrastructure and sensitive receptors. The Project's EA (**Appendix E**, Schedule D, Table D2 and **Table 2-4** below) outlines blasting noise and vibration limits for sensitive places. The location of sensitive receptors is displayed within **Figure 2-4** and summarised in **Table 2-5.** A Noise Impact assessment (**Appendix F**) was conducted to assess impacts from operations (including blasting) to sensitive receptors and commercial receptors. The assessment determined that the distance between receptors and blasting sites must be greater than 1.5 km for the sound levels to remain within the respective 120 dBZ limit. The assessment found that sensitive receptors 5 and 6 (see **Table 2-5**) would be most affected by blasting. All impacts to sensitive receptors (residential) will be mitigated through a proposed residential relocation and improvement agreement.

Table 2-4 Blasting noise and vibration limits in accordance with Vulcan South EA

Blasting noise and vibration limits	Sensitive place criteria	
	7 am to 6pm	**6pm to 7am**
Airblast overpressure	115dB (linear) Peak for 9 out of 10 consecutive blasts initiated and not greater than 120 dB (linear) peak at any time	No blasting is allowed during these times
Ground vibration peak particle velocity	5mm/second peak particle velocity for 9 out of 10 consecutive blasts and not greater than 10mm/second peak particle velocity at any time	No blasting is allowed during these times



Legend
- Road
- Rail Network

Vulcan South Coal Mine (2023/09708)
- Disturbance Footprint
- Project Area (ML 700073)

Sensitive Receptors
- Commercial
- Residential

Source: State of Queensland (Department of Resources) 2022, Vitrinite 2020-2024, METServe 2022-2024, Earthstar Geographics.

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Sensitive_Receptors.aprx

Vulcan South

Sensitive receptors within proximity of the Project area

0 2 4
Kilometers
Scale: 1:165,000 (A4)

13/08/2024

Datum: GDA2020
Projection: MGA55

FIGURE 2-4

VITRINITE BRIGHTER COAL
METSERVE Mining & Energy Technical Services Pty Ltd

Table 2-5 Sensitive receptors and commercial receptors for noise

Receptor number	Receptor	Receptor name	Description	Latitude and longitude	Distance (m) from nearest disturbance footprint area	Direction from Project
1.	Commercial	BMA Peak Downs	Commercial – Sustaining projects construction and support and geological services building	-22.276062 148.177274	1,365	North to East
2.	Commercial	BMA Peak Downs	Commercial – Field workshop and field office/crib area	-22.27497 148.18670	1,850	North to East
3.	Commercial	BMA Peak Downs	Commercial – Field office/crib area	-22.27351 148.18567	2,020	North to East
4.	Commercial	BMA Peak Downs	Commercial – main offices area and workshop area	-22.26044 148.17860	3,060	North to East
5.	Sensitive	Property Manager Residence	Residential – Property manager's residence	-22.390147 148.267067	Within MLA	Within MLA
6.	Sensitive	Workers' Residence	Residential – Workers' residence	-22.394204 148.269578	Within MLA	Within MLA
7.	Commercial	BMA Saraji	Commercial – Main office area and workshop	-22.418965 148.277679	1,960	South
8.	Sensitive	Saraji Station Residence	Residential	-22.42916 148.259057	2,970	South
9.	Sensitive	Luxor Residence	Residential	-22.527639 148.122611	>15,000	South-west
10.	Sensitive	Cheeseboro Residence	Residential	-22.427361 148.023250	>20,000	West

2.3.3 Waste rock removal and placement

In-pit dumping (with the encapsulation of potential acid forming material with non-acid forming waste rock) will fill the majority of the pits during operations. The remaining voids will be backfilled upon cessation of mining, resulting in the establishment of low WRD landforms over the former pit areas. Following backfill of the final voids, material remaining in the initial out-of-pit WRD's will be rehabilitated in situ.

Waste rock extracted during the early stages of each open pit will be placed in ex-pit dumps to the west of the open pits. Following this initial ex-pit placement and once sufficient pit space has developed, in-pit placement of waste rock will commence. This will continue for the life of each pit as it is developed. The in-pit dumps will have batters shaped up to a maximum slope of 15%. A central plateau will drain to the west to minimise the requirement for significant drainage infrastructure along the eastern toe of the dump (where space is limited, due to the presence of the existing road and rail).

An assessment of waste rock geochemistry has concluded that the waste rock does not pose a significant risk of generating saline or metalliferous drainage. Therefore, no selective handling and treatment measures are proposed. Furthermore, low-permeability capping over the dump surface is considered not to be required to create a geologically stable post-mining landform. Ongoing sampling and analysis of waste rock characteristics as it is removed will confirm the geochemical assessment and inform the disposal methodology.

The Geotechnical Assessment (**Appendix G**) discusses the final landform stability with regard to the in-pit and ex-pit emplacement strategies and the local characteristics of waste rock. This is discussed in more detail within **Section 8.2**.

2.3.4 Coal extraction

Once waste rock has been removed to expose the coal seam, coal will be extracted via truck and shovel. The coal will be hauled to the CHPP. Crushing and screening will be completed as part of the CHPP raw coal handling circuit.

Coal extraction in the north and main pit are expected to begin in the first year of operations, with the completion of extraction expected in year 3 for the north pit and year 7 for the main pit. Extraction at the southern pit is expected to begin in year 5 and be complete in year 7. Backfilling of each pit will occur progressively, whereby the pit will be completely backfilled once coal extraction is complete.

2.3.4.1 Coal handling and processing Plant (CHPP)

Coal will be processed by a modular coal CHPP. The proposed CHPP will include tailings dewatering technologies to maximise water recycling and to produce a dry tailings waste product for permanent storage within WRD’s. No wet tailings wastes or tailings dams are proposed.

The Project will include a modular CHPP to process ROM Coal into a number of marketable products (coking coal and thermal coal). In summary, the CHPP will include:

- a raw coal handling circuit to size ROM coal for further processing and remove incidental wastes
- a raw coal bypass conveyor to provide the option to direct appropriate quality raw coal to the product stockpile
- three CHPP circuits (coarse, secondary coarse and mid-sized) for coal beneficiation, producing a single product stream
- a tailings thickener to thicken ultrafine reject material; and
- tailings dewatering technology to dewater tailings to a solid cake for disposal in active WRD’s.

The CHPP will produce dual products at any one time with different products produced in campaigns via control of different ROM feed materials. The CHPP will operate 24 hours a day, seven days per week and is anticipated to function for approximately 6 years (it may take 2 years to construct following the beginning of coal extraction until the completion of active mining). If there is an opportunity to commence the highwall trial during the VS construction period, ROM coal extracted from the trial may be handled through the adjacent VCM infrastructure before the construction of the Vulcan South CHPP has been completed.

The following chemicals and hydrocarbons will be required for processes in the CHPP, and will be stored on site:

- 215kL of diesel;
- anionic flocculant (dry powder) 50m^3
- cationic flocculant (liquid) 50m^3; and
- acrylate polymer 10m^3.

2.3.5 Highwall Mining Trial

The Project includes a small-scale highwall mining trial program in the north of the MLA area. The trial will involve the establishment of four highwall mining benches across a number of hillsides to facilitate extraction of coal utilising a highwall miner (similar to CAT HW300). The highwall mining trial will target up to 750 kt of coal which will be transported by truck to the CHPP via a dedicated haul road within the MLA area. The trial is scheduled to be completed within the first year of mining operations.

The highwall mining trial will commence immediately given minimal infrastructure is required to support it and the trial is anticipated to be completed within a year (2024-2025).

2.3.6 Dust management

Dust will be managed in accordance with the Approved Queensland EA requirement (**Section 7.6.1.1**). Dust management measures will include:

- covering loads prior to transport;
- use of watering trucks on haul roads when EA dust limits are reached, and
- prioritising dust producing activities on still days following rainfall.

See **Table 7-1** for further details on specific project related dust management measures.

2.3.7 Traffic volume

The complete Project Transport Impact Assessment Report is provided in **Appendix H**. A summary is provided below.

GTA Consultants were engaged to complete a Transport Impact Assessment (TIA) of the Project. The TIA sets out the likely transport implications resulting from the construction, operation and decommissioning phases of the Project. The assessment considers the following:

- the existing traffic conditions proximate to the Project, including an assessment of the haul roads expected to service the Project;
- the traffic generating characteristics of the Project, inclusive of that generated by Vitrinite's Vulcan Coal Mine (VCM), where construction and operational activities coincide;
- the expected transport impact of the Project on the surrounding Local and State Controlled Road (SCR) network;
- proposed changes to road-related infrastructure required by the Project. This includes modifications to roads, access works and realignments of rail lines in the context of rail level crossings and services;
- expected traffic volume of heavy vehicle haul movements associated with the transport of materials, wastes and other goods for construction and operations phases of the Project;
- workforce journey-to-work traffic generated by Project activities, including anticipated traffic modes, volumes, composition, timing and routes; and
- identification of methods and strategies to reduce any identified traffic impacts.

A number of Project phases were assessed to determine the impact of various Project activities on the road network. Based on the analysis and discussions presented within the TIA, the following conclusions are made:

1. peak traffic demands for the Project are expected to occur in:
   - 2022 (project year 1): Construction opening year; and
   - 2024 (project year 3): Operations opening year.
2. All road segments on the Peak Downs Highway are expected to result in Project impacts of less than 5% of the baseline traffic volumes. On this basis, mitigating works are not required;
3. Saraji Road and Peak Downs Mine Road are expected to have Project traffic volumes which exceed 5% of the baseline traffic volumes. However, a capacity assessment has indicated that these roads are expected to operate well below their theoretical capacity and mitigating works are therefore not required;
4. A turn warrant assessment indicates that Left-Turn: Basic Left Turn (BAL) / Right-Turn: Basic Right Turn (BAR), turn treatments are required at the Project access location on Saraji Road to cater for Project generated traffic. It is noted this is lower than the turn warrant requirements of the VCM, which indicates that a BAL/ Right-Turn: Short Channelised Right Turn (CHR[s]) is required to accommodate forecast VCM traffic volumes;

5. Based on the calculated development Standard Axle Repetitions (SAR), pavement impacts of greater than 5% have been identified for a number of road links on the Peak Downs Highway. A monetary contribution will likely be required to ameliorate the impact. The results of this assessment indicate that the impact correlates to a monetary contribution for state-controlled roads of $45,090 as per GTIA methodology;
6. Contributions towards pavement impacts and rehabilitation of pavement on Council-controlled roads are subject to separate negotiations between the Proponent and Council. It is expected that a similar methodology to that adopted for the BSP and VCM may be adopted; and
7. Based on the Road Safety Risk Assessment all identified risks associated with the Project are expected to be within a medium level.

The workforce traffic generation is summarised in the **Table 2-6** and the Project heavy vehicle movements are summarised in **Table 2-7**.

The assumed haul routes for all heavy vehicle movements are Saraji Road, Peak Downs Mine Road and the Peak Downs Highway. It is assumed that traffic generation associated with operations haulage will occur steadily over a 24-hour workday. For all other heavy vehicle movements, it has been conservatively assumed that all movements will arrive and depart in the peak period and have been applied to both peak periods for assessment purposes.

Table 2-6 Workforce traffic generation

Project activity	Direction	AM Peak (veh/hr)		PM Peak (veh/hr)	
		In	Out	In	Out
Construction	Moranbah (North)	19	0	0	19
	Dysart (South)	19	0	0	19
Operations	Moranbah (North)	6	6	6	6
	Dysart (South)	6	6	6	6

Source: Veh/hr – vehicle movements per hour

Table 2-7 Daily (Peak) project Heavy Vehicle Movements (Two-way movements)

Project activity	Austroads vehicle class	Peak Daily Movements (veh/day)
		Mackay
Construction	Class 3	1
	Class 9	15
	Class 10	1
	Total	17
Operations	Class 3	1
	Class 9	0
	Class 10	3
	Total	4

2.3.8 Other activities

The following additional activities will be described below:

2.3.8.1 Changes to hydrological flow and groundwater

A hydraulic model was completed for the Project to determine the impacts of operations on peak velocities and water levels across the local catchments. The impact of the Project on the hydraulic characteristics of Boomerang Creek, Hughes Creek and their tributaries do not affect the existing conditions significantly. It is expected that the channel and floodplain will undergo little, if any, adjustment to the altered hydraulic conditions upstream or downstream of the Project as a result of the Project. There will be minor impacts that extend into the Norwich Park Branch Railway embankment and downstream of the Project boundary will require mitigation measures (**Section 6.4.1.2**) due to temporary operational increases in flow velocity and water levels during flooding scenarios. This is also described in **Section 6.4.1.4**. Overall, The Project surface water management system is designed to accommodate the proposed production schedule and to mitigate potential natural surface water and flooding impacts. With appropriate mitigation measures in place, the potential impact of the proposed mining operations on surface flows in the receiving waters downstream of the Project will be insignificant.

2.3.8.2 Material storage

Dry tailings and rejects will be stored using a specific emplacement strategy within the pit (see **Section 7.1.4.1**).

2.3.8.3 Construction camp and facilities

There are no construction camps or facilities associated with the project.

2.3.8.4 Workers' accommodation and facilities

There are no construction camps or facilities associated with the project.

2.3.8.5 Dust control management

All dust control mitigation measures are described in **Table 7-1**. These include covering loads prior to transport, the use of watering trucks on haul roads, and prioritising dust producing activities on still days following rainfall.

2.3.8.6 General waste management

A waste management plan will be completed in accordance with Approved Vulcan South EA. The content of this plan is summarised in **Section 7.6.1.4.**

2.4 Decommissioning

Most infrastructure within the Project area, including ancillary infrastructure (ROM pad, offices, fuel storage, haul roads and highwall benches), CHPP, Rail loop and TLO will be removed, de-contaminated, rehabilitated and decommissioned to comply with PMLU milestones.

All infrastructure related waste material, such as concrete, bitumen, tyres and fencing will be demolished/removed and disposed of offsite.

Services, such as water and electricity will also be disconnected and terminated prior to post-closure to comply with rehabilitation milestones required as part of the State approved PRCP Schedule (see **Section 8)**.

As part of the final landform, no final voids are proposed and all open cut pits will be backfilled with overburden material and drainage structures will be implemented on and around the final landform to ensure that the landform is free draining. When sediment dam catchments and MAW dams are completely rehabilitated, and water quality monitoring of the runoff has established that it is consistent with natural background conditions, the sediment dam and associated drainage infrastructure will be decommissioned.

In times when there is heavy rainfall, the plunges will accommodate the MAW runoff. When there is no runoff (or need for storage), then the plunges can be barricaded as the mining progresses along the bench.

In the highwall mining area, completed plunges will be either filled with MAW (as per **Appendix I**) and barricaded or just barricaded and rehabilitation will occur around this.

Diversions will be decommissioned and rehabilitated to comply with PMLU milestone requirements. Existing conditions natural topography will be reinstated within the Hughes Creek floodplain as well as Drainage line 6 and Drainage line 8 post-closure to replicate the existing drainage line channels to minimise the impacts associated with the Post-closure Conditions landform. Drainage line 1 is proposed to be diverted and subsequently reinstated as part of the Project. The Hughes Creek floodplain will be reinstated through the Vulcan Main and Vulcan South landforms (**Appendix I**).

2.5 Treatment of Contaminated Land

Treatment of contaminated land is a requirement of the State approved PRCP schedule and is conditioned under the milestone 'remediation of contaminated land'. The following is required as part of this milestone criteria:

- Detailed site investigation report, as required under the *Environmental Protection Act 1994* (EP Act), completed;
- All contamination is remediated or removed from site;
- Any contamination removed from site has been removed in accordance with relevant regulations; and
- A contaminated land investigation document has been prepared by an approved auditor, containing a site suitability statement that states that land is not contaminated and is suitable to achieve the rehabilitation.

As described above, all infrastructure related waste material, such as concrete, bitumen, tyres and fencing will be demolished/removed and disposed of offsite.

Other sources of waste generation include the following, which will be disposed at a licenced facility:

- used machinery parts and other scrap metal, such as wire cables;
- expired diesel and lubricants;
- waste oil and filters;
- hydrocarbon drums;
- sewage;
- gaseous emissions;
- general waste; and
- wooden pallets.

Coal mining specific waste material includes waste rock and coarse and fine reject material. Reject materials will be suitably emplaced within the pit, as per the emplacement strategy discussed in **Section 7.1.4.1**.

Contaminated land will be assessed and managed as part of mine site rehabilitation and closure, as documented in the Project PRCP (refer **Section 2.6**).

Spills will be managed through in accordance with best practice management (AS1940: The Storage and Handling of Flammable and Combustible Liquids), including the use of bunding and immediate clean-up of spills. This is discussed in more detail within **Section 4.9.6**.

2.6 Rehabilitation

The Vulcan South Progressive Rehabilitation and Closure Plan (PRCP, a requirement for the submission of an Environmental Authority application to the Queensland DESI) describes the rehabilitation activities for the Project (**Appendix J**). Progressive rehabilitation will commence within the first 12 months following the completion of the highwall mining trial which is expected to commence immediately. Progressive rehabilitation within the active mining pit will occur for all three pits.

The PRCP includes a rehabilitation Schedule (**Appendix K**) indicating the timing of rehabilitation activities across the Project's rehabilitation areas.

The Proponent and the BBAC have entered into an indigenous land use agreement (body corporate agreement) (ILUA) in respect of the Project, registered with the National Native Title Tribunal. The ILUA also contemplates the management of Aboriginal cultural heritage under the *Aboriginal Cultural Heritage Act 2003* (Qld). Engagement will continue in accordance with the ILUA.

3 Feasible alternatives

No favourable alternatives to the above description have been identified. Justification for this, in terms of timing and location, is discussed in the following sub-Sections.

3.1 Timing and rate

The action is a relatively small-scale coal mining project. The amount of coal resource available does not justify the use of larger mining machinery and processing facilities or a higher production rate, which would be required to complete the action in a shorter timeframe. Furthermore, a shorter timeframe could only be achieved if all pits were mined simultaneously. The sequential staging of mining (versus simultaneous mining of all pits) allows for progressive rehabilitation to occur. This reduces the total area disturbed at any one time and permits the east-west dispersal of wildlife through the Project area at all times.

3.2 Location and Activities

Vitrinite has considered a number of environmental and logistical constraints relevant to the positioning of infrastructure associated with the action. Firstly, the positioning of the Project area further East is constrained by the location of Saraji Road and adjacent mining project tenements (such as Saraji Mine located directly east). Locating infrastructure further west is constrained by several watercourses as well as the Harrow Range. For this reason, proposed works have been planned to avoid the most western portion of the MLA.

The proposed location of infrastructure for the action has been determined to minimise the potential impacts to existing surface water drainage channels and watercourses in the eastern Section of the MLA. For example, large corridors have been maintained between the north pit, main pit and south pit to minimise impacts to drainage features and watercourses (as defined under the *Water Act 2000*) that exist between these pits and to reduce impacts on surface water flows. Specifically, this separated placement will avoid a tributary of Plumtree Creek (between the north and main pit) and the Hughes Creek watercourse and tributary (located between the main and south pit) that contain high value habitat for the Koala and Greater Glider. These separations have also allowed the action (construction, operation, and rehabilitation) to occur in stages and therefore, the disturbance footprint at any one point-in-time is small and there will be available habitat for native species to utilise.

Excluding these intentional aforementioned corridors, infrastructure was generally designed to be located in a practical location to the coal seam as well as in close proximity to other related infrastructure (e.g. north in-pit WRD next to the ex-pit WRD). This achieves the following:

- reduced transportation disturbance footprint caused by roads;
- minimised carbon emissions of vehicles required to travel between these locations (such as haul trucks traveling on haul roads); and
- the connection of essential infrastructure.

Key alternatives discarded through the design phase included larger out-of-pit WRD and maintenance of a final void in the closure stage. The proposed closure strategy (complete backfill of the final void) has sought to facilitate improved environmental outcomes and sustainable post mining land use. This approach has allowed re-instatement of native fauna habitat and the pre-mining land use.

3.3 No Action

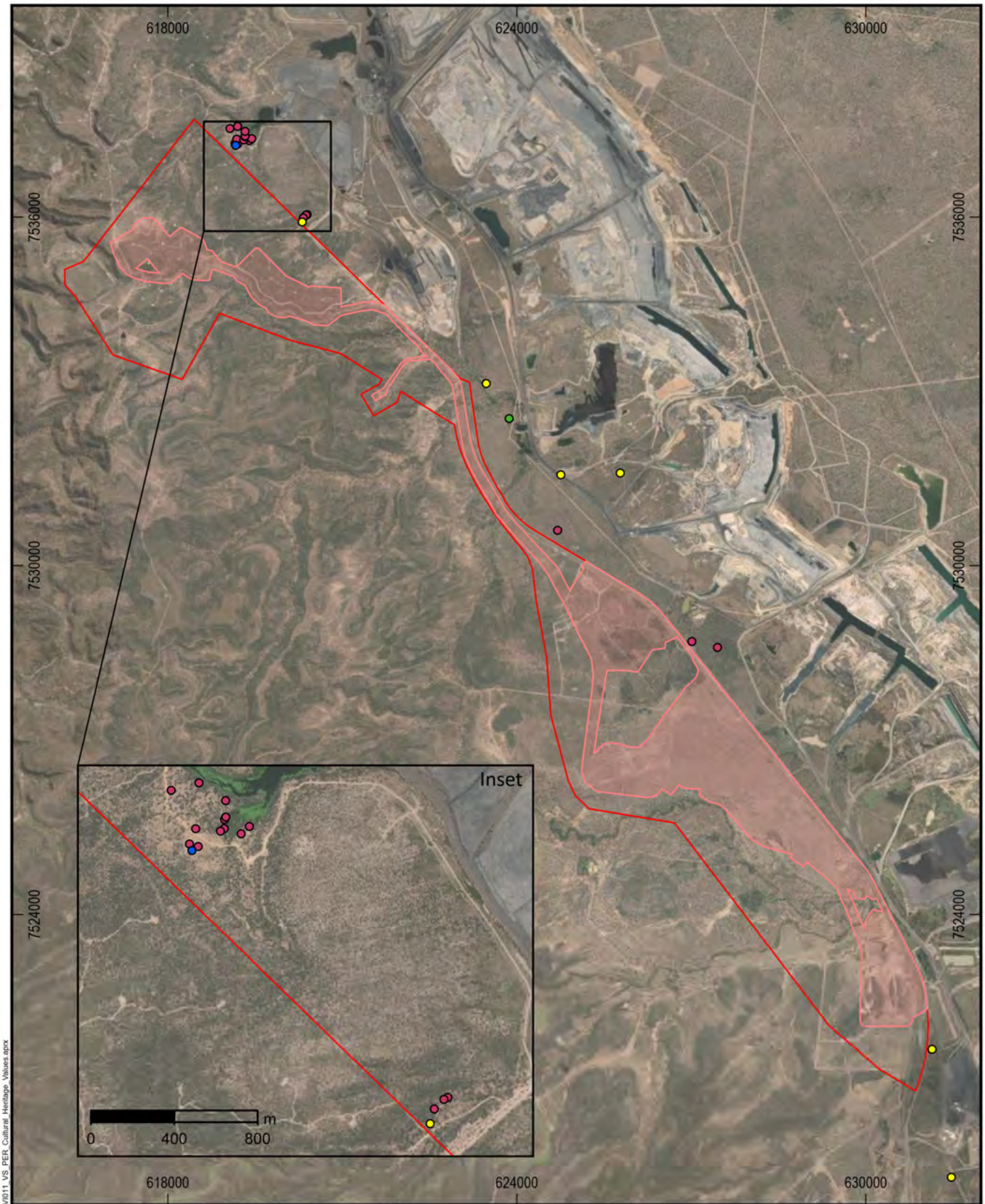
Vitrinite has also considered the alternative of the works not undertaking the action. The direct consequences of not proceeding with the action are the loss of sustained positive economic opportunities for the local area and region in the form of direct employment, procurement, community buy-in, royalty payments to the government and revenue to local businesses.

3.4 First Nations Consultation

The Barada Barna People (QUD380/08), represented by the Barada Barna Aboriginal Corporation RNTBC ICN 8343 (BBAC), are the native title holders for the broader Project area and the 'Aboriginal party' for the project under the Aboriginal Cultural Heritage Act 2003 (Qld).

The Proponent and the BBAC have entered into an indigenous land use agreement (body corporate agreement) (ILUA) in respect of the Project, registered with the National Native Title Tribunal. The ILUA also contemplates the management of Aboriginal cultural heritage under the *Aboriginal Cultural Heritage Act 2003* (Qld). Engagement is ongoing and will continue in accordance with the ILUA.

There are no areas of Indigenous cultural heritage importance within the Project area, as shown in **Figure 3-1**. Vitrinite acknowledge that if any artifacts are found during commencement the of the action, a representative of the Barada Barna peoples will be notified and the artefact removed by one of their representatives prior to clearing.



Legend

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint

Cultural Heritage Sites

- Artefact Scatter
- Earth Feature
- Scarred Tree
- Stone Feature

Source: Queensland Government Department of Seniors, Disability Services and Aboriginal and Torres Strait Islander Partnerships 2024, Vitrinite 2022-2024, METServe 2023-2024, Earthstar Geographics, Maxar, Esri, and the GIS User Community

Vulcan South

Indigenous Cultural Heritage Values near the Project Area

0 1 2 3

Kilometers

Scale: 1:95,000 (A4)

25/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 3-1

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Cultural_Heritage_Values.aprx

4 Description of the Environment

4.1 Tenure

4.1.1 Resource Tenure

The Project's mining lease application (MLA) covers an area of approximately 3800 ha and is situated over multiple underlying resource tenures:

- Exploration Permits Coal (EPC):
  - 1732;
  - 1233; and
  - 1234.
- Parcel Prospecting Permits (PPP):
  - Vulcan South Area 1 and Area 2- Lot 26 on CNS125;
  - Vulcan South Area 2 and Area 3- Saraji Road (Road Reserve);
  - Vulcan South Area 2- Lot 2 on SP296877; and
  - Vulcan South Area 3- Lot 2 on CNS109.

4.1.2 Land Holders

The proposed action, located on MLA 700073 comprises multiple lots including both lands lease, reserve and road licence tenure. A list of the properties, tenure, usage and owners/managers within the proposed ML boundary are provided in **Table 4-1**.

Table 4-1 Land tenure and real property descriptions

Lot/Plan	Tenure	Usage	Owner
2/SP296877	Lands Lease	Pastoral	O'Sullivan
59/SP235297	Lands Lease	Pastoral	O'Sullivan
72/SP137467	Reserve	Railway	Aurizon
Saraji Road	Road Licence	Road for public use	Isaac Regional Council
26/CNS125	Lands Lease	Norwich Park Branch Railway	Aurizon
2/CNS109	Lands Lease	Norwich Park Branch Railway	Aurizon
3/CNS109	Lands Lease	Saraji Mine Balloon Loop Railway	Aurizon

4.2 Land Use

The land within the Project is zoned as Rural under the Isaac Regional Council Planning Scheme. It is currently primarily used for low-intensity cattle grazing.

Forty-two percent of the proposed Project footprint had been previously cleared of its natural vegetation; the remaining 58% comprises native remnant vegetation with an understorey that has been highly modified by grazing. The dominant land use adjacent to the Project (to the north and east) is coal mining.

The land has an agriculture land class of C2 (land suitable for grazing on native pastures on lower fertility soils) or C3 (land suitable for light grazing on native pastures in accessible areas, and includes steep land), in accordance with the Guidelines for Agricultural Land Evaluation in Queensland (DSITI and DNRM, 2015).

The Project does not contain areas of regional interest (priority living areas, priority agricultural areas, strategic cropping land and strategic environmental areas) protected under the State *Regional Planning Interests Act 2014*.

The project location also contains Saraji Road and an existing rail corridor to the east.

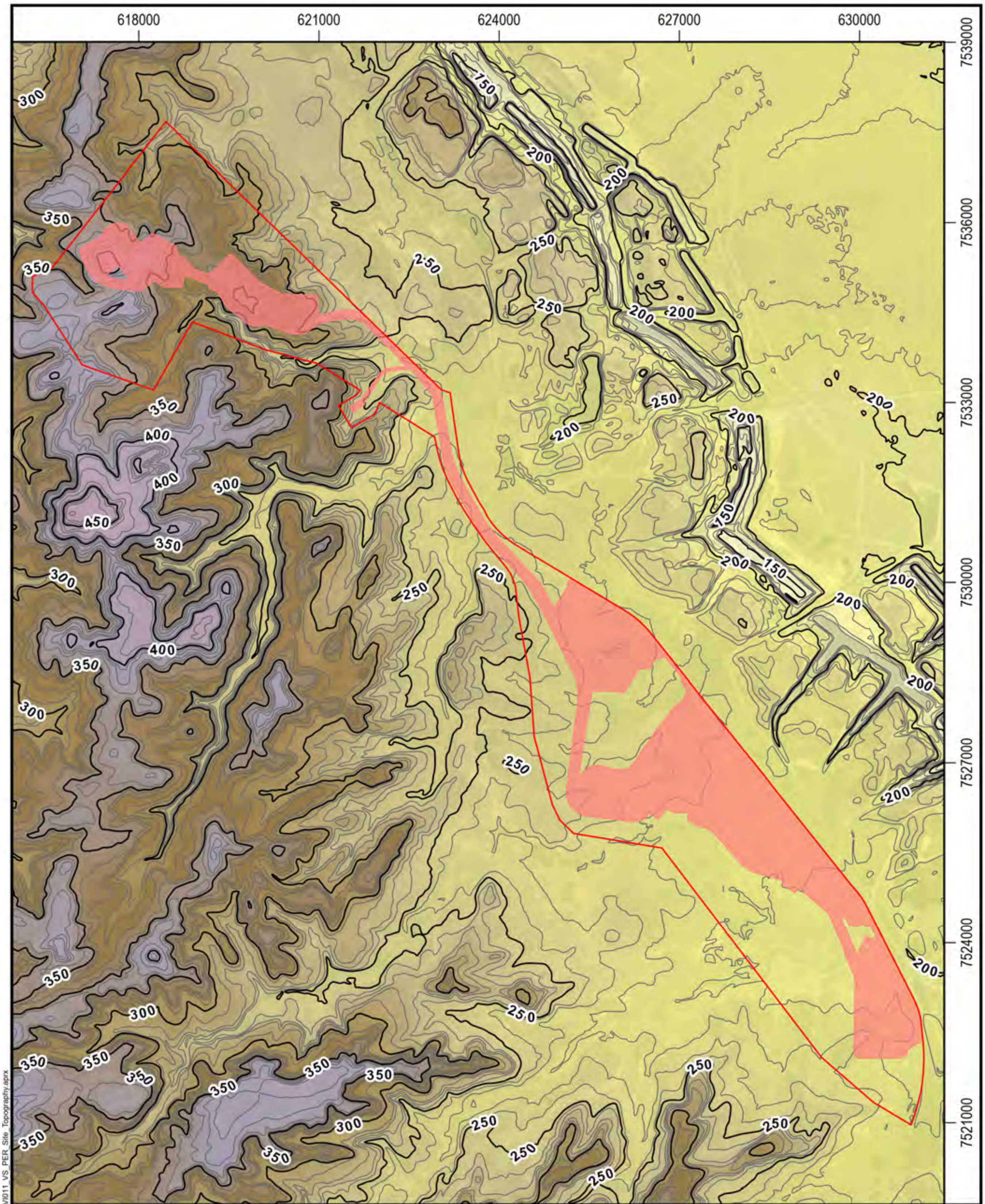
Based on the pre-mining land use and the results of the soil and land suitability assessment (**Appendix L**), it is anticipated that most rehabilitated landforms will be able to support a post-mining land use of cattle grazing.

The pre-mining land uses are:

- Low-intensity cattle grazing;
- Modified native ecosystems;
- Public road; and
- Rail.

4.3 Topography

The Project lies on plains and footslopes along the eastern edge of the Harrow Range. The Harrow Range (immediately west of Vulcan South) is generally 100-170 m higher than the surrounding plain. The plain itself slopes gently towards the east and varies in elevation from 210 metres Australian Height Datum (mAHD) in the south to 350 mAHD in the north (**Figure 4-1**).



Legend

Contours
- 10m
- 50m

Elevation (m)
- 481.988
- 87.4393

Vulcan South Coal Mine (2023/09708)
- Project Area (ML 700073)
- Disturbance Footprint

Source: Contours 10m - State of Queensland (Department of Resources) 2019, Elevation (derived from Contours 10m) - METServe 2022, Vulcan South datasets Vitrinite & METServe 2023-2024, Earthstar Geographics 26/05/2023

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Site_Topography.aprx

Vulcan South

Site Topography

0 1 2 3
Kilometers
Scale: 1:92,000 (A4)

8/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 4-1

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

4.4 Climate

The Project area (defined by the MLA boundary) is subtropical, with hot summers and mild winters. The nearest Bureau of Meteorology (BoM) weather stations are Mount Lebanon (29 km northwest) and Seloh Nolem (29 km east), both of which are currently closed. The nearest active weather station is Moranbah Airport (35 km north-northwest), which only commenced operations in 2012. Given the inconsistency of locally available data for discerning long-term average weather patterns, the Queensland Department of Environment, Science and Innovation's (DESI) SILO database was used for estimating average rainfall on site. The SILO database uses mathematical interpolation techniques to fill temporal and spatial data gaps from BoM's weather stations. Based on data generated for the SILO grid point -22.35, 148.20, the mean and median annual rainfall for the Project is 590.6 mm and 575.1 mm, respectively. However, this varies widely between years: standard deviation = 204.2, range = 275.5 to 1,152.7 mm. On average, 70% of the annual rainfall occurs between November and March (**Figure 4-2**).

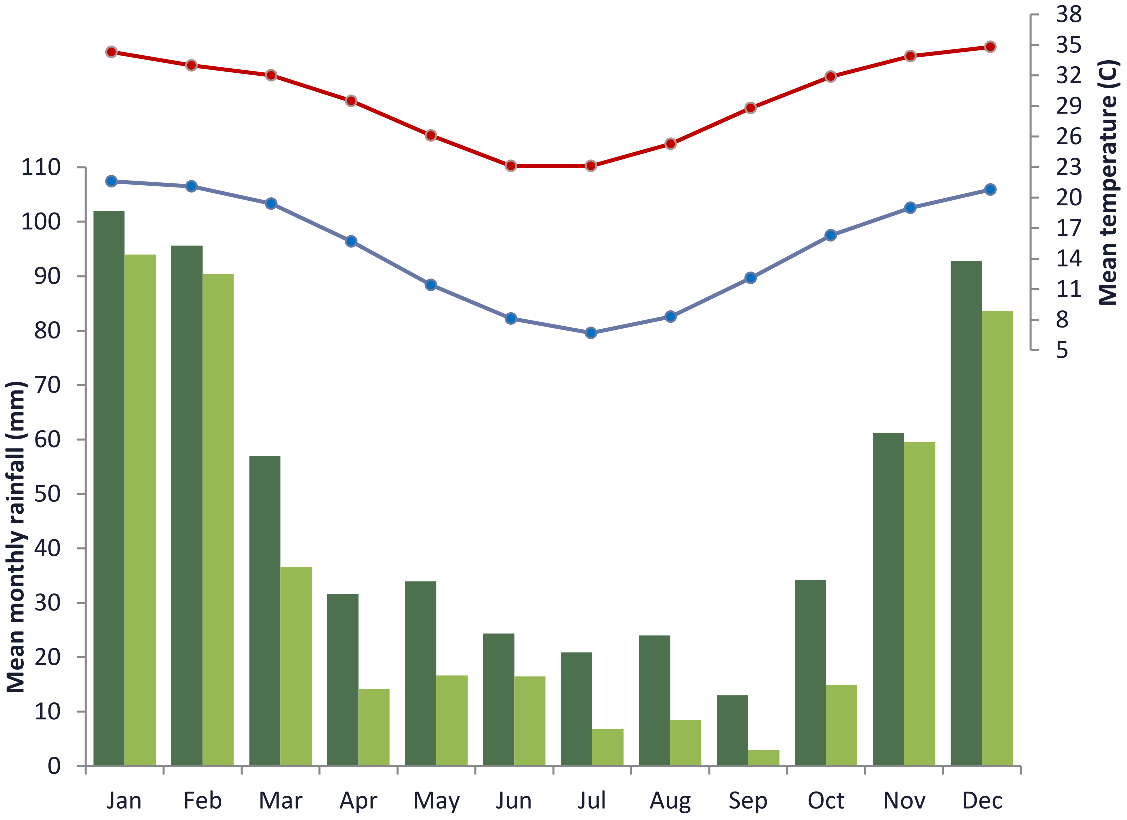


Figure 4-2 Average Weather Conditions at Vulcan South

Green bars refer to the mean (dark) and median (light) monthly rainfall over the past 50 years, as interpolated in the SILO database (Bureau of Meteorology 2019) for the SILO grid point -22.35, 148.20. Mean monthly maximum (red) and minimum (blue) temperatures over the past 50 years come from the Clermont Post Office meteorological station.

The mean potential evaporation rate for every month exceeds the mean rainfall for the respective month. However, the size of this deficit varies with season. The period between September and December is historically the driest (**Table 4-2**).

Table 4-2 Mean potential evaporation rates and mean water deficits in the project vicinity throughout the year

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean rainfall (mm)	102	95.65	56.94	31.64	33.96	24.38	20.86	23.99	13	34.26	61.17	92.78
Mean evaporation (mm)	220.2	178.9	182.9	145.3	115.5	91.85	102.2	132.7	173.3	216	225.6	237
Mean water deficit (mm)	118.3	83.25	126	113.6	81.56	67.47	81.33	108.8	160.3	181.7	164.5	144.2

(from the SILO grid point -22.35, 148.20).

4.5 Geology

The geology of the Project area is influenced by its position within the Bowen Basin, one of Queensland's largest depositional zones, formed through a period of rifting and subsidence lasting from the Early Permian to the Mid-Triassic. The area surrounding the Project is dominated by clastic sedimentary rocks of marine and lacustrine origin, including sandstones, mudstones, siltstones and coal (Geoscience Australia, 2019). Rock strengths range from extremely-low-strength weathered sandstone to high-strength fresh sandstone.

The solid geology of the region includes the:

- Moranbah Coal Measures – Permian, comprising coal and inter-seam material composed of sandstone, shale, siltstone with minor clay stone; and
- Back Creek Group – Early to Late Permian, comprising quartzose to lithic sandstone, conglomerate, siltstone, carbonaceous shale and coal. Occurs beneath the Moranbah Coal Measures, and outcrops to the west of the disturbance footprint.

The Permian and Triassic sediments are covered by a thin veneer of unconsolidated to semi-consolidated Cainozoic sediments (Tertiary to Quaternary alluvium and colluvium):

- Qr –(QLD) (Qr) – Quaternary clay, silt, sand, gravel and soil with colluvial and residual deposits; and
- TQa – QLD (TQa) – Late Tertiary to Quaternary poorly consolidated sand, silt, clay, minor gravel and high-level alluvial deposits.

Across the Project area, the uppermost stratum is generally a highly weathered regolith comprising a heterogeneous distribution of fine- to coarse-grained sand, clay, sandstone and claystone. These are either Tertiary sediments or a weathering profile that had developed during the Tertiary on Permian strata.

The base of weathering typically extends to depths of 15 to 45 mbgl (metres below ground level), where the unweathered Moranbah Coal Measures commence. Near the Project area the cumulative thickness of coal appears to be between 5 m and 15 m. The intention is to mine the lower seams of the Moranbah Coal Measures (the ALEX and Dysart Lower-Lower (DLL) coal seams).

Outcropping to the west of the Project is the basal Section of the Moranbah Coal Measures, a sequence of sandstones and siltstones, with imbedded coal. The ALEX coal seam lies near the top of this sequence, just below the base of weathering. It is of high quality and low ash content and is about 1 m thick. It overlies resistant, quartzose, medium- to coarse-grained sandstone, locally referred to as the Mesa Sandstone due to the characteristic mesa plateaus that have formed in the region. At its base, the Mesa Sandstone grades into the Mesa Siltstone.

The DLL coal seam lies immediately below the Mesa Siltstone. It lies near the base of the Moranbah Coal Measures. The DLL consists of a 2.5-m-thick seam with four plies, and contains high-ash and good-quality coal. An additional and a separate 1-m-thick coal seam beneath the main seam makes the entire sequence to be mined approximately 3.5 m thick.

Beneath the Moranbah Coal Measures are the Exmoor and Blenheim formations of the Back Creek Group. The top of the Exmoor formation is characterised by prominent, coarse-grained, siliceous boulder sandstone in outcrop, whilst the top of the Blenheim Formation is characterised by fossiliferous and worm-burrowed sandstone.

No igneous intrusions have been encountered within the Project to date in either drilling or field mapping exercises. However, neighbouring mining operations (the north and far west of EPC1234 and EPC1729) have localised basalt dykes and potential sills within their leases.

4.6 Soils

A Soil and Land Suitability Assessment of Vulcan South has been completed by AARC (**Appendix L**).

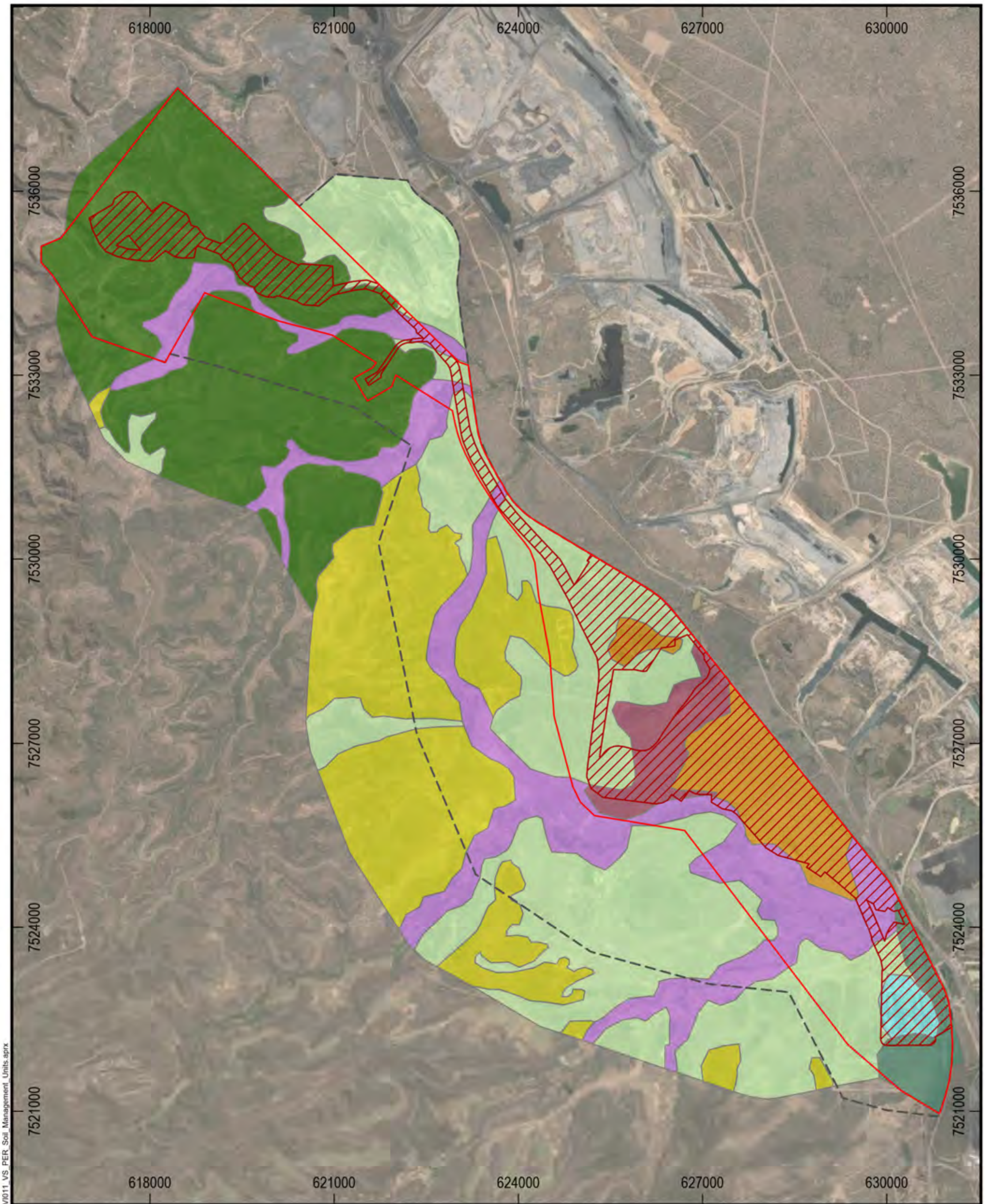
The Report on Lands of The Isaac-Comet Area (Story, et al., 1967), mapped at a scale of 1:500,000, indicates the Project area contains the following land system units:

- Carborough Land System: The Carborough Land System is characterised by mountains and hills with broken and dissected local relief ranging between 30 m to 400 m. Structural benches and cliffs are common landforms with severe weathering occurring in some areas. This mountainous land system has formed shallow, coarse-textured, rocky soils. A small area of the Carborough Land System is also characterised by lower slopes and hills and alluvial flats with a local relief between 10 m to 60 m. Texture-contrast soils have formed in these areas and possess a thick sandy topsoil. Geology in this land system is comprised of partly weathered, quartz sandstone.
- Connors Land System: The Connors Land System is characterised by alluvial plains composed of terraces and levees up to 3 km wide. Texture-contrast soils have developed in this area, which are characterised by a thick sandy topsoil and neutral to strongly alkaline subsoil.
- Cotherstone Land System: The Cotherstone Land System is characterised by hills and prominent strike ridges as well as gentler undulating terrain associated with low indefinite strike ridges and colluvial foot slopes. The more prominent strike ridges possess a local relief varying between 10 m to 30 m and have developed shallow course-textured to rocky soils. The gentler undulating terrain has a local relief of less than 15 m and is associated with texture-contrast soils with a sandy upper-horizon. The geology in this land system is weathered Permian sandstone and shale.
- Monteagle Land System: The Monteagle Land System is predominantly characterised by low-lying plains and colluvial foot slopes with local relief generally below 6 m. This land system is associated with texture-contrast soils composed of a thick sandy topsoil and neutral to strongly alkaline subsoils. Geology in this land system is comprised of undissected Tertiary sandstones and clays.

Mapping at a scale of 1:85,000, based on soil surveys undertaken on site, identified eight soil management units (SMUs) within the Project MLA area (**Figure 4-3**). These are described in detail in Section 1.2.7 of the PRCP (**Appendix J**), and are summarised here:

- Crocodile: This unit contains shallow, rocky soils associated with hill slopes and plateaus. Soils are classed as arenic rudosols. Soil textures grade from surface loams to loamy sands with depth. Soils often contain rock material with little to no pedologic development throughout the solum. The Crocodile SMU belongs to the Carborough land System and the Back Creek Geological Group.
- Fish: Occurring in flats within the southern portion of the ML, the Fish SMU is a grey kurosol. The Fish SMU belongs to the Cotherstone Land System and is part of the Back Creek Group. It is moderately permeable.
- Kei: The Kei SMU is a brown chromosol occurring mostly in flats on the south-eastern side of the Project area. It belongs to the Cotherstone Land System and Back Creek Group. Its texture grades from clayey to loamy sands at the surface, to medium clay with depth. Orange to yellow mottling is observed in its deeper horizons. The Kei SMU is moderately permeable.
- Komati: The Komati SMU is a brown vertosol belonging to the Monteagle Land System and is of Quaternary origin. It is a light to medium clay with calcareous segregations in deeper horizons. It is slowly permeable and is imperfectly to moderately well drained.

- Limpopo: This is a brown, texture-contrast soil unit. Soils are classed as brown sodosols. Soil textures grade from sands to clay sands in the surface soils to light clays in deeper horizons. The Limpopo SMU belongs to the Monteagle land System and the Back Creek Geological Group.
- Orange: The Orange SMU is comprised of dark, cracking clay, associated with the flat grassy plains in the middle of the Project area. It belongs to the Monteagle Land System and is of Quaternary origin. Soils predominantly range from light clays in surface soils to light medium clays in deeper horizons. The SMU is classified as a grey vertosol and is slowly permeable.
- Sabie: The Sabie SMU is a red sodosol comprised of dark, texture-contrast soils, consisting of sandy topsoil over a clay subsoil. It belongs to the Scarborough Land System and the Back Creek Group. Deep horizons contain red to orange mottles. Permeability is moderate.
- Zambezi: This unit contains grey, texture-contrast soils, with a sandy surface and clay subsoil. Lower horizons display diffuse orange to yellow mottles. Soils are classed as grey sodosols. The Zambezi SMU belongs to the Cotherstone Land System and the TQa geological formation (late-Tertiary to Quaternary poorly consolidated alluvium).



Legend

Survey Boundary

Vulcan South Coal Mine (2023/09708)

Project Area (ML 700073)

Disturbance Footprint

Soil Management Units

Crocodile

Fish

Kei

Komati

Limpopo

Orange

Sabie

Zambezi

Source: Soil Management Units - AARC Environmental Solutions 2019, Vulcan South datasets - Vitrinite & METServe 2022-2024, Earthstar Geographics 28/09/2022

Vulcan South

Soil Management Units of Vulcan South

0 1 2 3

Kilometers

Scale: 1:90,000 (A4)

8/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 4-3

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Soil_Management_Units.aprx

4.7 Terrestrial Ecology

51 species of plants and animals listed as threatened species under the EPBC Act were identified by database searches and the terrestrial ecology assessment as being potentially present in the region. Field surveys confirmed that four threatened fauna species (Koala, Greater Glider, Squatter Pigeon and White-throated Needletail) are present within the Project area and one TEC (Brigalow). No threatened species of plants were detected within the survey area or Project area. The likelihoods that the remaining species occur within the Project area were assessed by considering the proximity and recentness of records, as well as availability of potential habitat.

4.7.1 Terrestrial Ecology methodology

A Terrestrial Ecological Assessment was undertaken by METServe (**Appendix M**) to assess the presence of listed Threatened and Migratory species and Threatened Ecological Communities (TECs) in the Project area (also known elsewhere as the MLA - the portion of the ML that is to be directly affected by the Project, including the disturbance footprint) and adjacent habitats that may be affected by edge effects (collectively referred to as the “survey area”).

4.7.1.1 Literature Review

A desktop-based assessment was undertaken using publicly available databases to determine the ecological values potentially occurring in the vicinity of the Project. The following databases were consulted:

- DCCEEW’s Protected Matters Search Tool (PMST) on 16th April 2024 (records within a 20 km buffer from disturbance footprint shapefile) (**Appendix O**);
- Atlas of Living Australia, which includes eBird, WildNet, “research grade” iNaturalist and the Australasian Virtual Herbarium records, on 9th May 2024 (150 km buffer applied to the disturbance footprint); and,
- DESI’s regulated vegetation management mapping was consulted as part of the Terrestrial Ecological Assessment in 2022 however this was superseded by RE verification and subsequent BioCondition assessments.

For each MNES flagged during the literature review, but not recorded on site during field surveys, an assessment of the likelihoods of their presence within the survey area and Project area was undertaken based on the reliability and recentness of the record(s) and whether suitable habitat—as described by the Australian Government’s Species Profiles and Threats Database (SPRAT), species recovery plans, referral guidelines, and/or primary scientific literature—is present.

Table 5-3 in **Section 5.3** summarises the process of determining likelihood of occurrence within the impact and wider survey area. The following process was used to download and tidy the dataset prior to plotting it on GIS software for further spatial analysis.

1. A list of all MNES species highlighted in the PMST were downloaded from the Atlas of Living Australia spatial portal in CSV format, limited to records within 150 km and after the year 1980.
2. Data was tidied by:
   i. Removing all records with an uncertainty of over 5 km. No species were removed from the list at this step.
   ii. All records marked as “unconfirmed” were removed. No species were removed from the list.

Records which are pre-1980, which are unconfirmed, and which had an uncertainty of over 5 km are considered unreliable and are generally not discussed further. A list of sighting and presence records for Listed Threatened and Migratory Species is included as **Appendix N**. Sections 5.7, 5.8 and 5.9 treat wetland species, aerial overfly species and insectivorous woodland species collectively due to similarities in habitat preferences and include brief discussions and mapping of these occurrences.

4.7.2 Field Survey Methods

4.7.2.1 Flora (including terrestrial GDEs)

The principal flora survey was undertaken between 4 February and 15 February 2019 by Dr Chris Wiley (Principal Consultant – Ecology) and Jacob Rolley (Consultant – Ecology). The approach taken followed that prescribed by Neldner *et al*. (2019) in *Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland, Version 5.0*.

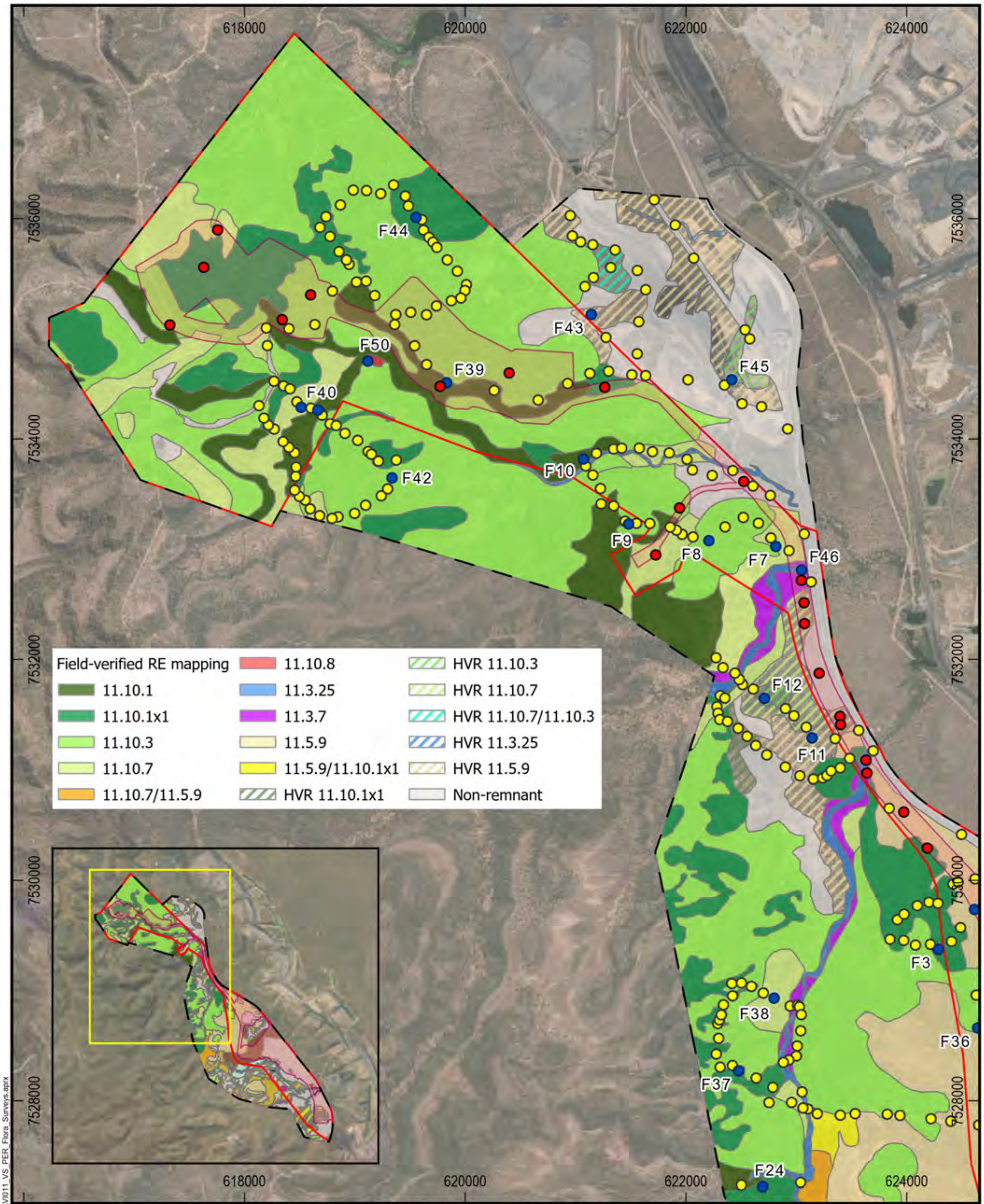
Survey timing coincided with maximum plant growth in the mid to late wet season and was optimal for detecting threatened species as well as describing overall diversity.

Additional surveys for supplementary vegetation mapping were undertaken on 1-2 October 2019 in the far south of the survey area, and between 27 March and 5 April 2020 in the far north-west of the survey area. The former took place in a small area of non-remnant vegetation added to the survey area subsequent to the February 2019 survey. Due to October being a sub-optimal month for flora surveys (dry conditions mean that most grasses and herbs are dormant), this survey aimed primarily to assess the spatial extent of vegetation units rather than comprehensively document the species present within these. The latter took place in a small area added to the north-western survey area subsequent to the October 2019 survey, and was optimal for detecting threatened species, vegetation mapping and recording diversity.

For all flora surveys, the survey area was traversed by car and (mostly) on foot, and routes were pre-selected to maximise coverage of the site and the number of mapped vegetation units visited. The aim of the field surveys was to ground-truth a sufficient sample of sites to enable interpolation of regional ecosystems across the survey area using detailed satellite imagery. In total, 485 sites were ground-truthed across the survey area (**Figure 4-4** and **Figure 4-5**). These comprised 433 quaternary sites and 52 secondary sites, as per Neldner *et al*. (2019). Secondary sites are detailed floristic and structural assessments of the vegetation communities present. These were only assessed during optimal conditions in February 2019 and March 2020. Quaternary sites are simple descriptions of the dominant species present and their corresponding regional ecosystem. A small subset (3.5%) of quaternary sites was assessed in October 2019, while the remainder were assessed under optimal conditions in February 2019 and March 2020. Field data were then used in conjunction with satellite imagery to produce a field-verified regional ecosystem map of the entire survey area. This field-verified map corrects numerous errors in certified mapping, as well as provides greater resolution due to its finer scale.

Neldner *et al*. (2019) recommends sampling a minimum of three secondary sites per regional ecosystem. An average of 3.25 secondary sites per regional ecosystem was sampled during field surveys. One quarter of the regional ecosystems present on site were represented by single, small patches less than 10 ha in extent, preventing them being sampled over three sites. The remaining regional ecosystems were sampled at an average of 4.3 secondary sites, surpassing guideline requirements.

In addition to plant lists generated at each secondary site, additional plant species were noted during timed meander searches while walking between sites. These searches had the primary goal of targeting species of conservation significance in accordance with the *Flora Survey Guidelines – Protected Plants version 2.01*. They also allowed for a comprehensive inventory of floral diversity across the survey area.



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Legend

Vulcan South Coal Mine (2023/09708)

Project Area (ML 700073)

Disturbance Footprint

Survey Boundary

Survey Points

Quaternary

Secondary

Biocondition

Source: State of Queensland (Department of Resources) 2023, METServe 2019-2024, Vitrinite 2024, Earthstar Geographics.

Vulcan South

Locations of Flora Surveys (North)

0 0.5 1 2

Kilometers

Scale: 1:50,000 (A4)

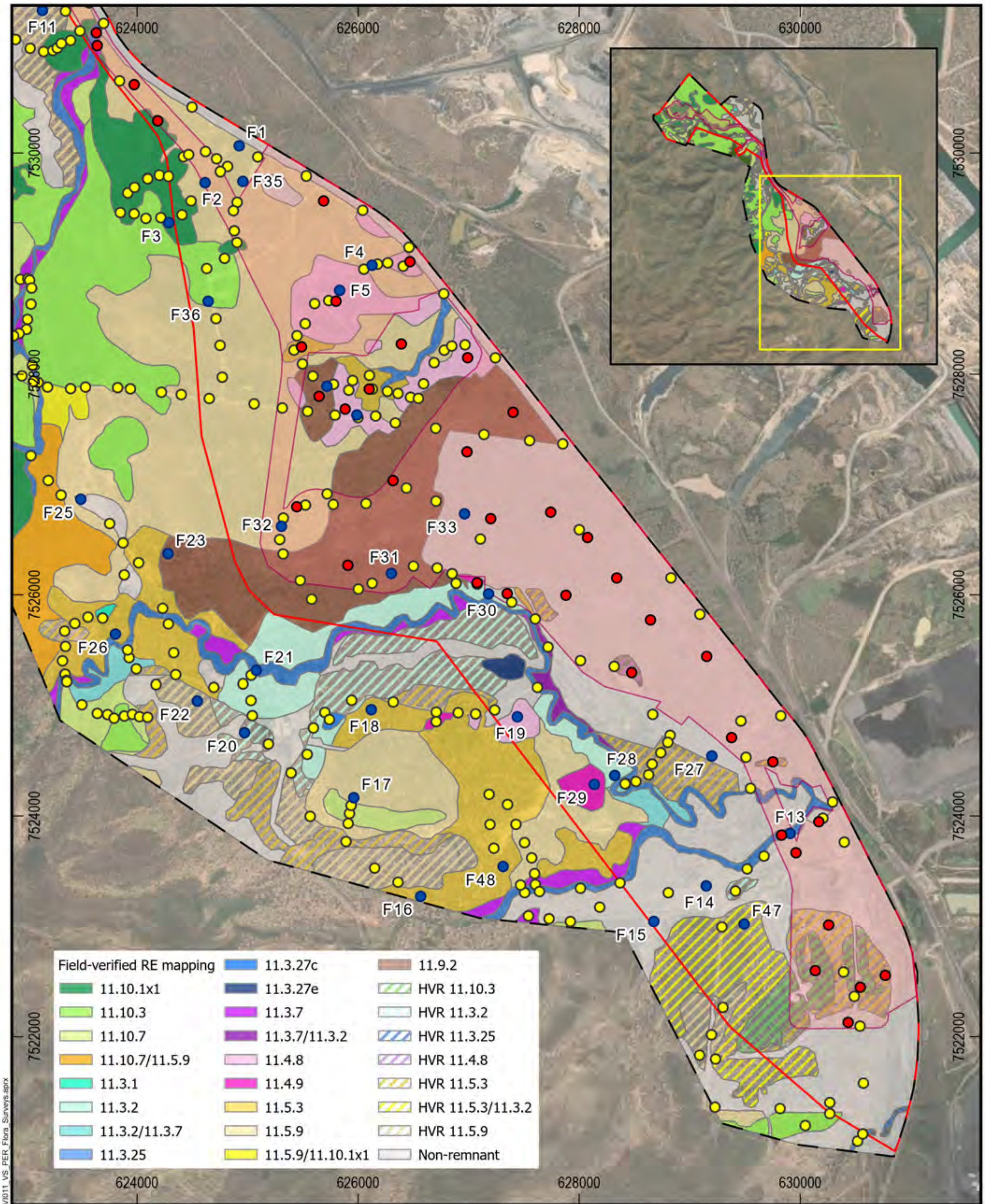
23/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 4-4

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd



Legend

Vulcan South Coal Mine (2023/09708)

Project Area (ML 700073)

Disturbance Footprint

Survey Boundary

Survey Points

Quaternary

Secondary

Biocondition

Source: State of Queensland (Department of Resources) 2023, METServe 2019-2024, Vitrinite 2024, Earthstar Geographics

Vulcan South

Locations of Flora Surveys (South)

0 0.5 1 2

Kilometers

Scale: 1:50,000 (A4)

23/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 4-5

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\Vi011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\Vi011_VS_PER_Flora_Surveys.aprx

4.7.2.2 Fauna

Seasonal Conditions

The following fauna surveys (**Figure 4-7** and **Figure 4-8**) were undertaken across the survey area in order to encompass seasonal variation in faunal movements and detectability:

1. 24 October 2018 to 2 November 2018;
2. 4 February 2019 to 15 February 2019 (bird surveys and spotlighting were undertaken during the flora survey);
3. 25 March 2019 to 29 March 2019 (abandoned prematurely due to heavy rain);
4. 8 April 2019 to 17 April 2019;
5. 1 May 2019 to 9 May 2019; and
6. 23 September to 4 October 2019.

All of the above surveys fell within the two seasons recommended by the *Terrestrial Vertebrate Fauna Survey Guidelines for Queensland version 3.0* (Eyre, et al., 2018) for the Brigalow Belt bioregion.

Heavy rain events (>100 mm within 24 h) occurred during the first and third surveys, leading to flash-flooding of creeks and the filling of temporary pools and gilgais. This provided optimal conditions for the detection of frogs and burrowing snakes. Light rain events (~15 mm) also occurred during the second and fourth surveys, stimulating moderate frog activity. A light shower (<5 mm) during the sixth survey was the first rain received by the site in many months, stimulating moderate frog activity.

The mean maximum temperature across all surveys was 33.4°C (range = 24.3°C–41.4°C). The mean minimum temperature across all surveyed was 16.8°C (range = 6.6°C–22.9°C). With the possible exception of three nights that fell below 10°C in May 2019, conditions were optimal for detecting ectothermic fauna.

General Approach

In accordance with the *Terrestrial Vertebrate Fauna Survey Guidelines for Queensland version 3.0* (Eyre, et al., 2018), the entire survey area was divided into assessment units (AU's) based on broad vegetation groups and age (remnant versus regrowth). These guidelines stipulate that each AU is to be sampled at a minimum of three trap sites. This sampling intensity was achieved for most of the broad vegetation groups present on site, and all broad vegetation groups contained within the Project area. Two of the broad vegetation groups present on site (7a and 34d) were not amenable to sampling via traps; 7a was too small, rocky and remote, while 34d was primarily open water. These were sampled via targeted searches (day and night), instead. A remote-sensory camera was also installed in broad vegetation group 7a. Where broad vegetation groups were represented on site by both remnant vegetation and high-value regrowth, sampling effort was focused on the former, but the latter was also sampled if it comprised more than 5% of the total area of the broad vegetation group. In total, 34 comprehensive trap sites were sampled. A list of sites and photographs of each are provided in **Appendix M.**

Table 4-3 Summary of sampling effort per broad vegetation group (BVG)

BVG	Constituent regional ecosystems	Short description	Area (hectares)		$N_{trap\ sites}$	
			Remnant	Regrowth	Remnant	Regrowth
10a	11.10.1	*Corymbia citriodora* woodland on hilly terrain.	244.5	0	3	0
12a	11.10.7, 11.10.1x1†	Ironbark (*Eucalyptus* spp.) and/or bloodwood (*Corymbia* spp.) woodland on scarps and sandstone tablelands.	836.7	59.6	3	2
16a/9e*	11.3.25/11.3.7	*E. camaldulensis* forest fringing drainage lines/*Corymbia* spp. woodland on alluvial terraces	147.7/86.1	5.3/0	3	0
17a	11.3.2, 11.5.3	*Eucalyptus populnea* woodland on sandplains or alluvium.	406.3	387.2	3	1
17b	11.9.2	*Eucalyptus orgadophila* woodland on fine-grained sedimentary rocks.	325.5	0	3	0
18b	11.5.9	*Eucalyptus crebra* woodland on flat to undulating plains.	877.7	271.4	3	2
24a	11.10.3	*Acacia shirleyi* or *A. rhodoxylon* open forest on residual surfaces.	1,589.0	68.8	3	1
25a	11.3.1, 11.4.8, 11.4.9	*Acacia harpophylla* woodland to open forest on clay soils	145.2	4.0	3	0
34d	11.3.27c, 11.3.27e	Freshwater swamps and billabongs on floodplains.	8.5	0	0	0
7a	11.10.8	Semi-evergreen vine thicket in sheltered habitats on medium to coarse-grained sedimentary rocks.	1.3	0	0	0
Non-remnant pasture		Cleared pasture, +/- scattered trees or young regrowth	1,517.6		4	

*Broad vegetation groups 16a and 9e occur as parallel, narrow bands along waterways. Due to the narrow width of these vegetation units relative to the area of the standard trapping array, trap sites placed on creek banks invariably spanned both broad vegetation groups. For this reason, they were treated as a single assessment unit (AU).

† The dominant unit in the western part of the survey area was mapped as a mixed mosaic containing 11.10.1, 11.10.3 and 11.10.8. While 11.10.3 is widespread in this unit, 11.10.8 is confined to a single, tiny patch (secondary site 50). Regional ecosystem 11.10.1 is represented by two distinctly different subtypes. The classic subtype (dominated by *Corymbia citriodora*, *Corymbia trachyphloia* and *Eucalyptus crebra*) is limited in extent, primarily occurring in sheltered gorges and south-facing slopes. The more widespread subtype was an open forest dominated by *Corymbia aureola* and *Eucalyptus melanophloia*, which usually grew on plateaux and other exposed sites with shallow, rocky soil. This vegetation unit did not match any of the described regional ecosystems in Queensland, but bore some similarity to 11.10.4a and 11.10.13b (both belong to the broad vegetation group 12a, unlike classical 11.10.1, which belongs to 10a). The Queensland Herbarium has opted to combine both subtypes under 11.10.1 in the updated regulated vegetation map. However, these subunits are mapped separately in this report, in light of their different habitat values to threatened fauna. The subtype dominated by *C. aureola* and *E. melanophloia* is assigned the code 11.10.1x1, as per Nelder et al. (2019).

Comprehensive Trap Sites

Each of the 34 comprehensive trap sites was sampled using methodology described in the *Terrestrial Vertebrate Fauna Survey Guidelines for Queensland version 3.0* (Eyre, et al., 2018). The following traps were installed and monitored twice daily over four days and nights per site:

1. 45 m of 40-cm-high aluminium fly-screen drift fence was installed flush with the ground in a T-arrangement (Figure 4-6);
2. four 20-L buckets were installed as pitfall traps beneath this drift fence;
3. three pairs of funnel traps were installed along the drift fence;
4. 20 Elliott traps (baited with an oat-and-peanut-butter mix) were placed at 10-m spacing parallel to the drift fence; and
5. one Reconyx HC550 Hyperfire White Flash remote-sensory camera (baited with an oat-and-peanut-butter mix) was installed approximately 50 m from the drift fence.

The entire trap array spanned approximately 120 m × 50 m. Note that the survey guidelines suggest the use of one cage trap per site, instead of the camera. This recommended approach was adopted during the October 2018 survey but abandoned in favour of cameras in all other survey rounds. Remote-sensory cameras are able to detect all species potentially caught by a cage trap but have several advantages. They are (i) easier to transport, (ii) able to 'catch' more than one individual/species per night, and (iii) able to detect a broader range of species that are too large (macropods, dingos, pigs) or small (birds, rodents) to be caught in a cage trap.

In addition to the four days of trapping, each trap site was also subjected to the following targeted surveys:

1. 40 person-minutes of spotlighting;
2. 40 person-minutes of diurnal active searches;
3. 80 minutes of bird surveys (10 minutes during each check of the traps); and
4. one night of recording with an AnaBat Express bat-call detector.

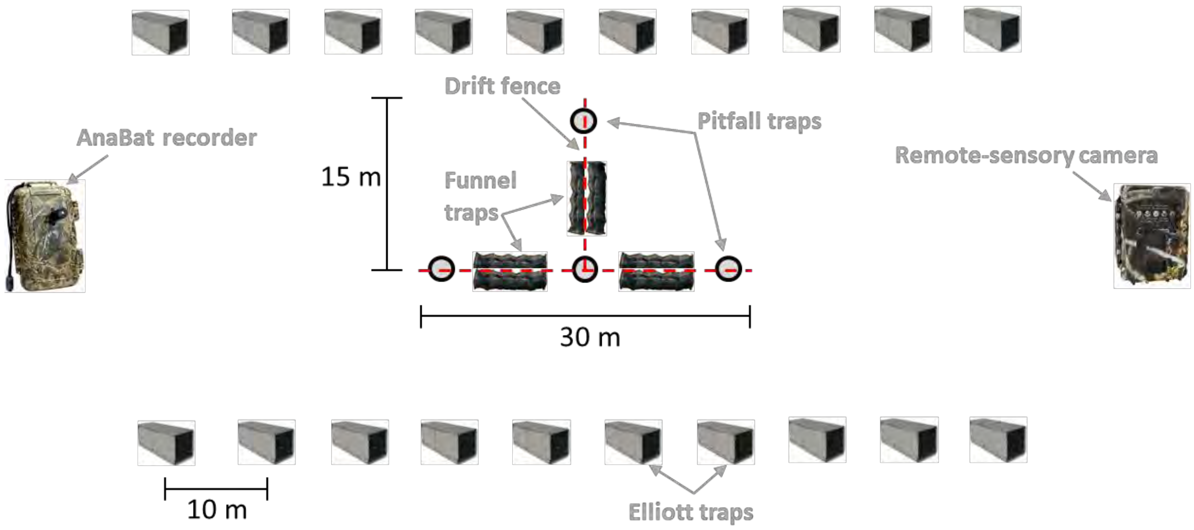


Figure 4-6 Schematic diagram of the trapping array at each comprehensive trap site

Supplementary Targeted Surveys

In addition to the sampling at comprehensive trap sites, further targeted searches were undertaken in a range of habitats that are difficult to sample using conventional trapping (e.g., rock outcrops, dams, wetlands, wood piles). Furthermore, targeted searches were undertaken to fill spatial gaps in AU's that were very extensive and/or spatially heterogenous.

The following surveys were undertaken at additional sites away from the comprehensive trap sites:

1. Diurnal active searches of at least 40 person-minutes' duration were undertaken at 28 sites. This involved turning over logs and rocks, raking through leaf litter, searching for signs of Koalas, and recording all birds seen or heard.
2. Spotlighting for at least 40 person-minutes was undertaken at 28 sites.
3. Bird surveys of at least 20 minutes' duration were undertaken at 24 sites, in addition to diurnal active search sites. All birds heard or seen during flora surveys (10 days of survey effort in February 2019) were also recorded.
4. AnaBat recordings were completed at 10 sites that represented likely flyways for bats: tracks through forest, creek lines and around dams. Recordings were made across a single night (12 hours) per site.
5. Remote-sensory cameras were installed at three sites (a total of 12 trap-nights) along creek lines, which are favoured movement pathways for fauna.

Total Survey Effort

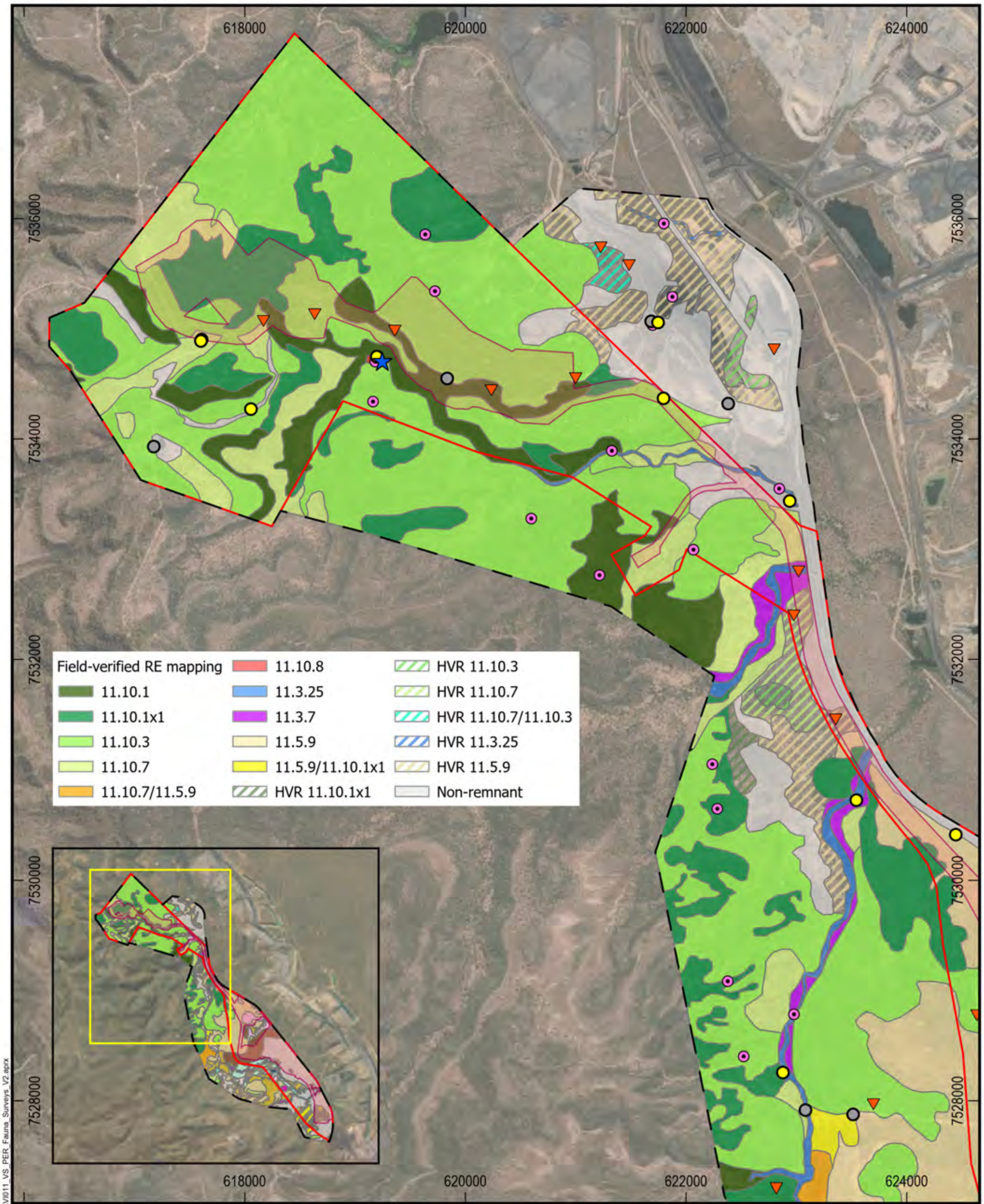
The total amount of survey effort expended for faunal surveys of the survey area is summarised in **Table 4-4** and the locations of surveys are shown on **Figure 4-7** and **Figure 4-8**.

Table 4-4 Fauna survey effort across the survey area between October 2018 and October 2019

Survey Method	Targeted Species	Potential EVNT Species*	Total Effort†	Unit
Pitfall trap	Frogs, small reptiles, small mammals	Ornamental Snake, Common Death Adder, Dunmall's Snake, Allan's Lerista	588	Trap-nights
Funnel trap	Lizards, snakes	Ornamental Snake, Common Death Adder, Yakka Skink, Dunmall's Snake, Allan's Lerista	882	Trap-nights
Elliott trap	Small mammals	n/a	2,860	Trap-nights
Cage trap	Medium-sized mammals	Northern Quoll	31	Trap-nights
Remote-sensory camera	Mammals, birds	Short-beaked Echidna, Northern Quoll, Squatter Pigeon	122	Trap-nights
AnaBat	Microchiropteran bats	Ghost Bat, Large Pied Bat	45	AnaBat-nights
Bird survey	Birds	Squatter Pigeon, Red Goshawk, Painted Honeyeater, Australian Painted-snipe, Black-throated Finch, migratory birds	288	Person-hours
Diurnal targeted search	Reptiles, larger mammals	Allan's Lerista, Yakka Skink, Dunmall's Snake, Common Death Adder, Short-beaked Echidna, Koala	45.3	Person-hours
Spotlighting	Frogs, reptiles, mammals, birds	Ornamental Snake, Common Death Adder, Short-beaked Echidna, Greater Glider, Koala	52.5	Person-hours

*Potential EVNT species are those listed as endangered, vulnerable, near threatened or special least concern within Queensland and/or nationally that have been historically recorded within the region.

†Note that not all sites were surveyed over four nights, as heavy rain necessitated the early closure of five sites. Four of these were re-surveyed on a later date, resulting in >4 survey nights for these sites.

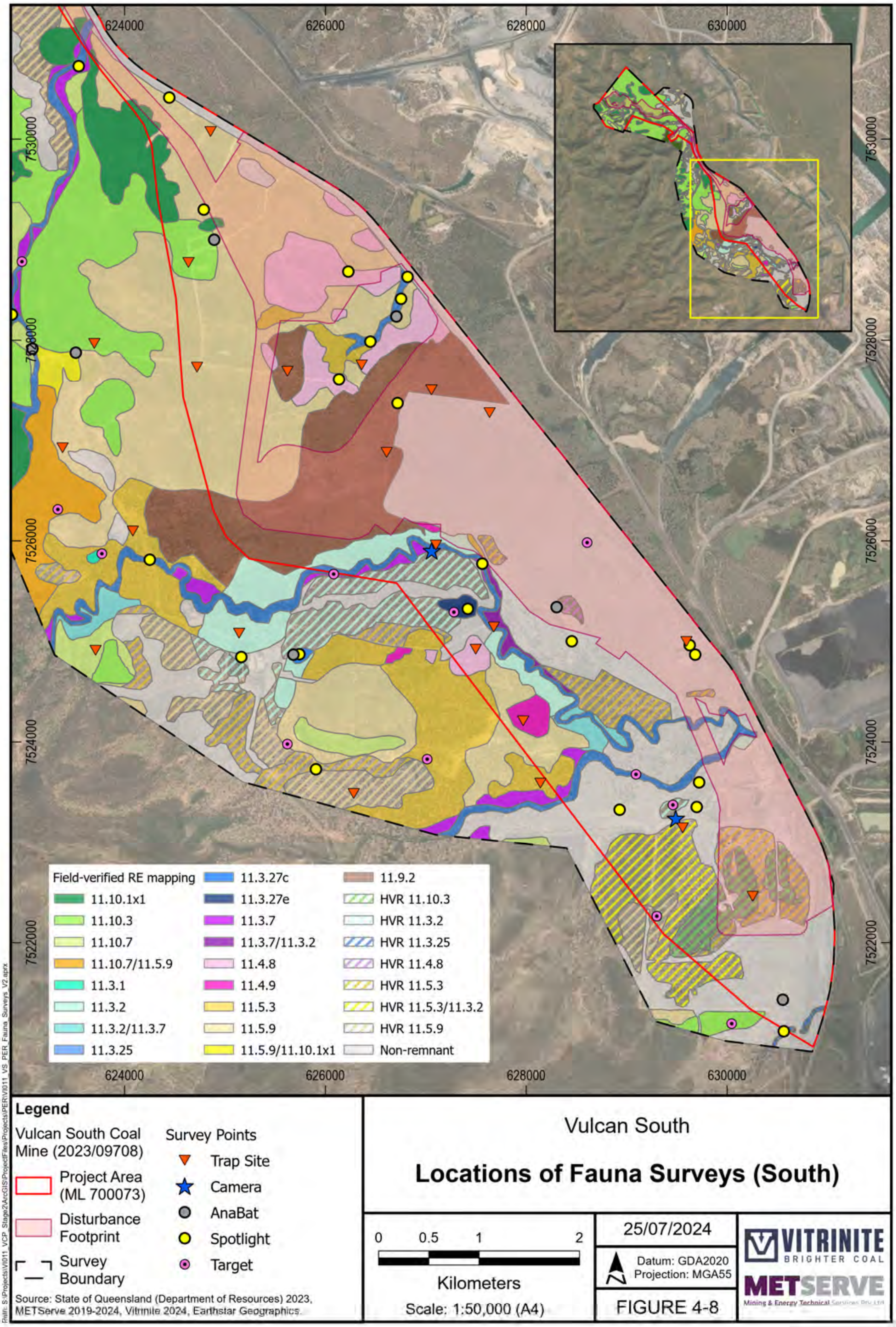


Vulcan South

Locations of Fauna Surveys (North)

25/07/2024

FIGURE 4-7


624000
626000
628000
630000
7530000
7528000
7526000
7524000
7522000
Field-verified RE mapping
11.10.1x1
11.10.3
11.10.7
11.10.7/11.5.9
11.3.1
11.3.2
11.3.2/11.3.7
11.3.25
11.3.27c
11.3.27e
11.3.7
11.3.7/11.3.2
11.4.8
11.4.9
11.5.3
11.5.9
11.5.9/11.10.1x1
11.9.2
HVR 11.10.3
HVR 11.3.2
HVR 11.3.25
HVR 11.4.8
HVR 11.5.3
HVR 11.5.3/11.3.2
HVR 11.5.9
Non-remnant
Legend
Vulcan South Coal Mine (2023/09708)
Project Area (ML 700073)
Disturbance Footprint
Survey Boundary
Survey Points
Trap Site
Camera
AnaBat
Spotlight
Target
Source: State of Queensland (Department of Resources) 2023, METServe 2019-2024, Vitrinite 2024, Earthstar Geographics
Vulcan South
Locations of Fauna Surveys (South)
0
0.5
1
2
Kilometers
Scale: 1:50,000 (A4)
25/07/2024
Datum: GDA2020
Projection: MGA55
FIGURE 4-8
VITRINITE
BRIGHTER COAL
METSERVE

4.7.3 BioCondition Study and Relevance of Survey Data

It is noted that the field data, collected between October 2018 and October 2019, are now over five years old. Despite their age, the 2018-2019 surveys are considered to be a reliable source of information. Habitat quality data were gathered from the footprint in June 2023 as part of a BioCondition assessment. Based on this assessment, there is little reason to expect any changes to the faunal habitat values of the site since the 2018-2019 surveys were undertaken. The footprint has not experienced any clearing, droughts, fires, floods or cyclones since the 2018-2019 surveys. The main alteration to the local landscape is the construction of the Vulcan Coal Mine immediately east of the footprint. Noise, light and dust associated with this disturbance may mean that habitats occupied in 2019 have since been vacated by some fauna. For this reason, data gathered in the 2018-2019 surveys represent a more conservative assessment of the habitat values of the site than if the surveys were to be undertaken today.

4.7.4 Groundwater-dependent Ecosystems survey methods

The information Guidelines Explanatory note was consulted for the assessment of presence and impact to GDEs (Doody, et al., 2019).

4.7.4.1 Terrestrial GDEs

The Queensland Government has undertaken mapping of groundwater-dependent ecosystems (GDEs) across most of the State (Department of Science, Information Technology and Innovation, 2015). The survey area has, however, not been mapped in the most recent version (version 1.5) of this GDE mapping.

Instead, the *National Atlas of Groundwater Dependent Ecosystems* (Bureau of Meteorology, 2019) was consulted to identify locations where there is a moderate to high potential for vegetation communities to be dependent on groundwater. This dataset was compared to the field-verified regional ecosystem mapping undertaken as per **Section 4.7.2**. Regional ecosystems present within areas mapped as potentially groundwater-dependent ecosystems were assessed for their likelihood of groundwater dependence by examining:

- Published literature on the ecology of the dominant tree species in each regional ecosystem;
- landscape position;
- water-holding capacity of the soil; and
- site-specific data on the depth to groundwater (where available).

For regional ecosystems considered likely to be groundwater-dependent, their mapped boundaries were taken from field-verified regional ecosystem mapping, rather than the coarser-scale *National Atlas of Groundwater Dependent Ecosystems.* This integration of GDE mapping with regional ecosystem mapping is a core principle of the Queensland GDE Mapping Project (Department of Science, Information Technology and Innovation, 2015).

There are three main categories of groundwater-dependent ecosystems (Department of Science, Information Technology and Innovation, 2015):

- vegetation that accesses sub-surface groundwater through its roots;
- wetlands that receive groundwater discharge (e.g., springs); and
- subterranean aquatic ecosystems, and marine systems that receive sub-marine discharge of groundwater.

Of these, categories 2 and 3 are aquatic ecosystems assessed elsewhere through the Groundwater Impact Assessment (**Appendix P**) as well the aquatic ecology survey (discussed in **Section 4.7.4.2**), which included a field assessment (**Appendix Q**). Category 1, however, refers to terrestrial ecosystems that are dependent on access to groundwater on a permanent or intermittent basis to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services.

For vegetation to access groundwater in the sub-surface, the roots must be able to reach the capillary zone above the water table and the water quality of groundwater must be adequate. In order to assess and map potential terrestrial groundwater-dependent ecosystems across the survey area, the following data sources were considered:

- National Atlas of Groundwater Dependent Ecosystems version 2.0 (Bureau of Meteorology, 2019);
- published literature on root depths and groundwater usage among local vegetation types;
- depth-to-groundwater mapping of part of the Project area (provided by *hydrogeologist.com.au*); and
- groundwater quality (**Appendix P**).

Groundwater model used to inform GDE mapping (level and aquifer)

Hydrogeologist.com.au (2024) (**Appendix P**) developed a calibrated, numerical groundwater model of all relevant aquifers within the vicinity of Vulcan South's proposed pits. This was based on a range of data sources, including an on-site groundwater monitoring network, groundwater assessments from nearby mines, and the *Queensland Groundwater and Surface Water Monitoring* database (DNRME, 2019b).

An aquifer is generally defined as a geological unit that can transmit and store significant quantities of groundwater. In the vicinity of the Project area, some geological units yield low volumes of groundwater and would not typically be classified as aquifers in most hydrogeological settings. However, as these could provide a small and/or temporary source of groundwater for vegetation, they are referred to as aquifers for the purposes of this assessment.

Groundwater may be stored, even if only temporarily, in two hydro-stratigraphic units present on site:

- Tertiary Sediments: This is a mix of Tertiary sediments (lenses of palaeochannel gravels and sands separated by dry, densely compacted sandy silts, sandy clays and clays) and weathered Permian regolith. These aquifers tend to be of limited lateral and vertical extent and consequently have low hydraulic conductivity. This layer was generally unsaturated in the survey area.
- Permian Coal Measures: The coal seam aquifers are generally confined above and below by the low-permeability inter- and overburden. The coal seam aquifers present on site are regarded as poor aquifers because of their limited thickness and the presence of low-permeability interburden. Across most of the survey area, these aquifers represent the shallowest source of groundwater for vegetation.

Although Quaternary alluvium can provide a temporary source of shallow, fresh groundwater for terrestrial vegetation, this is recharged exclusively via rain and surface flows, and is therefore unaffected by any drawdown that may result from Vulcan South. For most of the survey area, the Permian Coal Measures and, occasionally, the Tertiary sediments contain the uppermost groundwater.

4.7.4.2 Aquatic GDEs

The field survey for aquatic ecological values was carried out by frc environmental and is described in detail in **Appendix Q.**

The field survey was completed in the post-wet season, 10 – 12 April 2019, with notable rainfall recorded in the region in late March 2019, shortly prior to the survey. The rainfall recorded in early April 2019, prior to the field survey, was the highest rainfall recorded since the 2018 wet season. Thus, the field survey timing reflected typical wet season conditions. A dry season survey was not implemented because these waterways are highly ephemeral and at maximum hydrological condition and biological productivity during the wet season.

Aquatic Habitat

In-stream habitat attributes and condition were assessed using a method based on the Australian River Assessment System (AUSRIVAS) protocol described in the Queensland AUSRIVAS Sampling and Processing Manual. The following parameters were assessed:

- channel shape and pattern;
- bank slope, composition, stability, and vegetative cover;
- bed substrate composition and stability;
- in-stream habitat features, including submerged or emergent aquatic plants, large woody debris, undercut banks, boulders;
- water velocity, depth, and width; and

- riparian vegetation composition, extent and condition.

A Riverine Bioassessment Score was calculated for each site where macroinvertebrates were collected. This score is a numerical index of aquatic habitat complexity and suitability for supporting diverse macroinvertebrate communities that enables a direct comparison of habitat quality between sites. The method scores habitat complexity and suitability for macroinvertebrates for each of the following nine criteria:

- substrate or available cover;
- embeddedness;
- water velocity and depth;
- channel alteration;
- bed scouring and deposition;
- pool:riffle and run:bend ratio;
- bank stability;
- bank vegetative stability; and,
- streamside vegetation cover.

The sum of the scores for each criterion gives the overall habitat score ranging from excellent to poor (**Table 4-5**). This was used to allocate sites to one of four defined categories of habitat complexity and suitability for supporting diverse macroinvertebrate communities. Existing disturbances to riparian vegetation, bed and bank stability, flow and instream habitat were noted, including the presence of any existing barriers to fish passage.

Table 4-5 River habitat bioassessment scores used to derive overall habitat condition categories

Habitat Category	Category Score Range			
	Excellent	Good	Moderate	Poor
Bed substrate or available cover	16-20	11-15	6-10	0-5
Embeddedness	16-20	11-15	6-10	0-5
Water velocity and depth	16-20	11-15	6-10	0-5
Channel alteration	12-15	8-11	4-7	0-3
Bed scouring & deposition	12-15	8-11	4-7	0-3
Pool:riffle and run:bend ratio	12-15	8-11	4-7	0-3
Bank stability	9-10	6-8	3-5	0-2
Bank vegetative stability	9-10	6-8	3-5	0-2
Streamside vegetative cover	9-10	6-8	3-5	0-2
Total (Habitat Bioassessment Score for the Site)	**111-135**	**75-110**	**39-74**	**0-38**

Aquatic Plants

Aquatic plants were surveyed at each site using a timed meander survey (i.e., 15 – 20 minutes per site) across in-stream and riparian habitats, as recommended in the Department of Environment, Science and Innovation (DESI's) *Flora Survey Guidelines – Protected Plants*. Plants were identified to species level if they were flowering, otherwise they were identified to genus. It was noted if plants were growing in the water, in the dry instream or in riparian areas. The growth form of plants growing in water was recorded (see Table 4.3 of **Appendix Q**). There are no published biological objectives for aquatic plants to compare results against.

Macroinvertebrates

Macroinvertebrates were sampled from bed and edge habitat at each site that was holding water during the field survey using the AUSRIVAS sampling method as described in the AUSRIVAS manual (DNRM 2001a) and the Monitoring and Sampling Manual (DES 2018). Samples were collected by disturbing a 10 m long Section of bed or edge habitat with a standard triangular-framed dip net (250 µm mesh size), preserved using ethanol, and transported to frc environmental's biological laboratory.

Fish

Fish were surveyed using seine netting in accordance with recommendations in the Commonwealth Government's *Survey Guidelines for Australia's Threatened Fish*. Water was too shallow to set fyke nets as planned, noting that the seine nets were dragged through the full expanse of the isolated pools that were present at the sites holding water; thus, providing a thorough assessment of fish at those sites.

Turtles

No sites held sufficient water that enabled cathedral traps or fyke nets to be set as planned. However, if turtles were present in the isolated pools at the sites holding water, they would have been caught in the seine net hauls (described above for fish), which is a sampling method that reliably catches turtles in small shallow isolated pools. There are no published biological objectives for turtles.

4.7.5 Adherence to Relevant Survey Guidelines

Survey guidelines are in place for threatened and migratory species listed under the EPBC Act and in most cases these, being guidelines are not considered mandatory. State guidelines may be followed where relevant. In summary, the steps that generally apply to surveying for EPBC listed species are:

- identify taxa that may occur in the study area;
- determine optimal timing for surveys of 'target' taxa;
- determine optimal location of surveys;
- establish sampling design and survey effort;
- select appropriate personnel to conduct surveys; and
- document survey methods and results.

Table 4-6 summarises the recommended survey methods and efforts to determine likelihood of presence or absence of MNES, noting that these are to be used in conjunction with habitat assessment to determine final likelihood of species occurrence if target species are not observed.

It is noted that the surveys conducted for the Terrestrial Ecological Assessment detected the Greater Glider in areas considered suitable, and not in areas with lower soil moisture, less connectivity, and lower nutrients. However, due to the age of the surveys (originally conducted in 2018-2019), these surveys are older than what the DCCEEW considers appropriate. In this situation, the surveys are subordinate to habitat values as defined by the DCCEEW. The application of the Precautionary Principle determines that habitat values as determined by BioCondition and Habitat Assessment surveys will act as surrogates for species presence.

Table 4-6 Recommended Guidelines and Survey Effort

Target MNES Category	Relevant Guidelines/Documentation	Guideline methodology recommendations and minimum standards	Survey Effort	Survey Adequacy
Brigalow Belt Reptiles (Ornamental Snake)	Survey Guidelines for Australia's Threatened Reptiles Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles	**SPRAT Database:** Targeted surveys to confirm the presence/absence of the Ornamental Snake are done by actively searching suitable habitats, especially during warm evenings. Actively looking whilst driving along roads, especially following heavy rainfall events and/or on warm evenings, is recommended. Sufficient time is required to thoroughly search the area by day and to spotlight by night. The minimum survey effort required includes: • a minimum of three survey days and nights • at least one replicate survey if the species has not already been detected. **Survey Guidelines for Australia's Threatened Reptiles** Surveys should be conducted at night during warm, wet weather. Survey techniques should include searching around suitable gilgai habitat while frogs are active, diurnal searches under sheltering sites and driving roads at night after wet weather. Pitfall and funnel traps can also be used. Minimum standards are not outlined in this document, as it is considered here to be subordinate to the Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles (see below). **Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles** Diurnal searches of a minimum of 1.5 person-hours over three days per hectare. Spotlighting of a minimum of 1.5 person-hours over three days per hectare. Roads should be surveyed opportunistically on warm nights and following rainfall.	• 3 trap sites over 145.2 ha, each set for 4 nights • 882 trap nights (funnel traps) • 588 trap nights (pitfall) • 52.5 person hours spotlighting • Opportunistic night searches on roads following rainfall • 51 Habitat/BioCondition assessments were undertaken within 20 AU's across the disturbance footprint.	Fauna surveys for the original Terrestrial Ecological Assessment occurred in October and November 2018, and February, March, April, May, September and October in 2019. Surveys for reptiles that rely on warm and wet weather therefore occurred during optimal conditions. **SPRAT Database:** Spotlighting targeting the Ornamental Snake took place on warm, wet evenings following rain. Night-time targeted surveys for the Ornamental Snake were undertaken over 9 person-hours spread across ten separate nights. There are no roads through the project area apart from grassy tracks, on which it was difficult to spot reptiles at night. However, Saraji Road runs immediately east of the project area and this was driven at night on numerous occasions (20+ nights) in order to access sampling sites to the north. All fauna observed on the road (dead or alive) was recorded.

		The following trap site effort is considered minimum along a 30 m drift fence over 4 days where optimal microhabitats occur: a. 6 pitfall traps and b. 2 funnel traps should be installed c. At least two replicate fence lines per habitat type.		The 10 nights of survey exceeded the six nights recommended for completing the initial and replicate rounds of survey. **Survey Guidelines for Australia's Threatened Reptiles** Surveys for the Ornamental Snake included 100 pitfall trap-nights, 150 funnel trap-nights and 9 person-hours of spotlighting, which were conducted immediately after rain and targeted places where water pooled (gilgais and other ephemeral depressions). 5.3 person-hours of diurnal searches under shelter sites were conducted at eight sites in potential Ornamental Snake habitat. The pitfall trapping method used four rather than six buckets per site, which were 20 L rather than 10 L. The drift fence was three times longer than recommended. Drift fence length is expected to have a much larger effect on capture rates than number of buckets.

				Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles 5.3 person-hours of diurnal searches under shelter sites were conducted at 8 sites in potential Ornamental Snake habitat. Each site was checked on a different day. 9 person-hours of spotlighting, spread across 10 warm, wet nights following rain, targeted Ornamental Snake habitat (flooded gilgais and wetlands). There are no roads through the project area apart from grassy tracks, on which it was difficult to spot reptiles at night. However, Saraji Road runs immediately east of the project area and this was driven at night on numerous occasions (20+ nights) in order to access sampling sites to the north. All fauna observed on the road (dead or alive) was recorded. 100 pitfall trap-nights and 150 funnel trap-nights of trapping were undertaken in potential Ornamental Snake habitat under optimal weather conditions. The survey used six rather than two funnel traps per site. It also used four rather than the recommended

				six buckets per site, but the drift fence was 45 m instead of 30 m long. Drift fence length is expected to have a much larger effect on capture rates than number of buckets. Three replicate sites were installed in brigalow woodland on land zone 4, and two replicate sites were installed in seasonally flooded poplar box woodland on land zone 3. Potential Ornamental Snake habitat comprised 109 ha within the impact area. This was primarily made up of only two habitat types: brigalow woodland on clay plains and poplar box woodland on sandy flats with ephemeral pools. Both habitat types were evenly sampled. Species accumulation curves fitted to fauna data gathered across the Vulcan South area predicted that 100% of reptiles were detected during surveys. While there remains a possibility that some species were missed (especially species that aren't readily detected using the methods adopted), this statistical test suggests this number is very small. Furthermore, the methods used are known to successfully

				detect Ornamental Snakes elsewhere. **Survey Guidelines Met.**
Squatter Pigeon	Survey Guidelines for Australia's Threatened Birds Terrestrial Vertebrate Fauna Survey Guidelines for Queensland	**Survey Guidelines for Australia's Threatened Birds** Surveyed by area searches or transect surveys (minimum of 15 hours over three days), and by flushing surveys (10 hours over three days) for areas up to 50 ha.	• Timed Surveys (20 minutes) • Transect and flushing surveys • 51 Habitat/BioCondition assessments were undertaken within 20 AU's across the disturbance footprint. Incidental searches were conducted while traversing between survey locations.	Timed surveys of at least 20 minutes' duration were undertaken at 24 sites, including transect searches and flushing surveys, in addition to diurnal active search sites (refer **Appendix M**) in addition to 51 habitat/BioCondition assessments. All birds heard or seen during flora surveys (10 days of survey effort in February 2019) were also recorded. **Survey Guidelines Met.**
Koala	A Review of Koala Habitat Assessment Criteria and Methods Terrestrial Vertebrate Fauna Survey Guidelines for Queensland Conservation Advice for Phascolarctos cinereus (Koala) combined populations of Queensland, New South Wales and the Australian Capital Territory	**A Review of Koala Habitat Assessment Criteria and Methods** (Youngentob, et al., 2021) Strip transects during the day are one of the most commonly used survey methods for Koalas. Spotlighting detects Koalas more effectively than daytime searches. The highest detection rates are via thermal detection drones and scat surveys. Camera traps may also be used but are an inefficient way to detect Koalas specifically. Call playback can be effective for detecting males in the breeding season. **Terrestrial Vertebrate Fauna Survey Guidelines for Queensland** Spotlighting surveys are conducted within the 100 x 100 m generic survey site for 30-person minutes. Each spotlight survey involves an observer/s walking slowly and systematically through the 100 x 100 m generic survey site (e.g., spotlighting up and back the middle 100 m transect in sparsely vegetated sites, or	• Diurnal active searches of at least 40 person-minutes' duration was undertaken at 28 sites -including scat and scratch searches. • Spotlighting for at least 40 person-minutes was undertaken at 28 sites 51 Habitat/BioCondition assessments were undertaken within 20 AU's across the disturbance footprint. Habitat quality assessments included specially tailored habitat quality scores for all 'large trees' that could constitute habitat for nocturnal arboreal mammals. This includes listing the species and DBH	Diurnal searches including incidental scat and scratch searches and spotlighting at 84 sites for a total of 4070 person minutes (refer **Appendix M)** in addition to 51 habitat/BioCondition assessments. **Survey Guidelines Met.**

		spotlighting up one side of the 100 m x 100 m area and then spotlighting back the other side of the 100 m x 100 m area in more densely vegetated sites).	of all non-eucalyptus trees over 20 cm and all Eucalyptus/Corymbia trees over 30 cm with the BioCondition plot.	
Greater Glider	Survey guidelines for Australia's threatened mammals 2011 Guide to Greater Glider habitat in Queensland Terrestrial Vertebrate Fauna Survey Guidelines for Queensland	The **Survey Guidelines for Australia's Threatened Mammals** lists the following spotlight survey methodology for presence/absence for arboreal marsupials (in summary): • Hand-held spotlights, held near observer's line of vision and moved slowly at a consistent speed; • Binoculars, once an animal has been spotted, to confirm identity; • Speed of 10 m per minute; • Avoid very windy or rainy nights. Minimum standards are as follows: • Survey at least two 200 m transects per 5 ha site, or longer transects as necessary; • Maintain intervals of at least 100 m between transects; • Transect surveys repeated on two separate nights where possible; The Commonwealth guidelines also mention that Queensland methodology is also acceptable, placing a greater bias on habitat suitability. This is ascertained by presence of "Eucalypt" species with a DBH >30cm as a surrogate for presence of visible hollows. **Terrestrial Vertebrate Fauna Survey Guidelines for Queensland** Spotlighting surveys are conducted within the 100 x 100 m generic survey site for 30-person minutes. Each spotlight survey involves an observer/s walking slowly and systematically through the 100 x 100 m generic survey site (e.g., spotlighting up and back the middle 100 m transect in sparsely vegetated sites, or spotlighting up one side of the 100 m x 100 m area and	• Spotlighting for at least 40 person-minutes was undertaken at 28 sites • 51 Habitat/BioCondition assessments were undertaken within 20 AU's across the disturbance footprint. Habitat quality assessments included specially tailored habitat quality scores for all 'large trees' that could constitute habitat for nocturnal arboreal mammals. This includes listing the species and DBH of all non-eucalyptus trees over 20 cm and all Eucalyptus/Corymbia trees over 30 cm with the BioCondition plot. Gliding distance was measured as a % of trees within gliding distance to account for Greater Gliders.	Outcomes from the 51 BioCondition/habitat assessments identified suitable habitat and included data collection on visible hollows *and* tree DBH for *Corymbia, Eucalyptus* and *Angophora* species. Spotlighting was conducted at 84 sites for a total of 4070 person minutes. **Survey Guidelines Met.**

		then spotlighting back the other side of the 100 m x 100 m area in more densely vegetated sites).		
Wading birds	SPRAT database (Commonwealth of Australia 2010) Draft referral guidelines for 14 birds listed migratory under the EPBC Act Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species Survey Guidelines for Australia's Threatened Birds	**SPRAT database** In Australia, surveys should be conducted between October and February, which is the period between the species' arrival and departure in Australia. Surveys are best conducted during the day, as the snipe appears to disperse from roosting areas at dusk and then return before or at dawn. **Survey Guidelines for Australia's Threatened Birds** Populations of Latham's Snipe and the Australian Painted Snipe can be surveyed by performing area searches or line transects in suitable habitat (i.e. wetlands or other waterbodies and their surrounding vegetation). The surveys should be conducted on foot. To maximise the chances of detecting all birds present, a number of observers should arrange themselves into a line and then advance in unison, preferably whilst accompanied by bird dogs. Another potential technique is to drag a length of rope over an area of suitable habitat.	The Latham's Snipe was not listed as threatened during the survey period, therefore was not specifically searched for. Habitats were, however, assessed for suitability alongside other threatened wading birds such as the Australian Painted Snipe. Applicable surveys used: • Area surveys • General bird surveys • 51 Habitat/BioCondition assessments were undertaken within 20 AU's across the disturbance footprint.	Bird surveys of at least 20 minutes' duration were undertaken at 24 sites, in addition to diurnal active search sites. All birds heard or seen during flora surveys (10 days of survey effort in February 2019) were also recorded. Outcomes from the 51 BioCondition/habitat assessments identified suitable habitat. **Survey Guidelines Met**
Aerial insectivorous birds	Draft referral guidelines for 14 birds listed migratory under the EPBC Act	**Draft referral guidelines for 14 birds listed migratory under the EPBC Act** While there are no standard survey techniques for swifts, they should be counted by an experienced person from elevated viewpoints (if present) during the Austral summer. Prevailing weather conditions should be noted as this can greatly affect likelihood of occurrence (e.g. swifts often travel ahead of storm fronts).	• Area surveys • General bird surveys • 51 Habitat/BioCondition assessments	Bird surveys of at least 20 minutes' duration were undertaken at 24 sites, in addition to diurnal active search sites. All birds heard or seen during flora surveys (10 days of survey effort in February 2019, including in stormy weather) were also recorded. Outcomes from the 51 BioCondition/habitat assessments identified suitable habitat.

				Species accumulation curve described in **Section 4.7.6** (also refer **Appendix M**) below indicate that all birds species in the survey area were detected. **No specific survey requirement – however survey effort considered sufficient.**
Migratory woodland birds	Draft referral guidelines for 14 birds listed migratory under the EPBC Act	**Draft referral guidelines for 14 birds listed migratory under the EPBC Act** Area survey, preferably a two-hectare survey in 20 minutes, over sufficient survey plots to estimate a density, and hence the population size across the proposed development area. Surveys should be undertaken in an appropriate season - spring or summer in southern Australia.	• Area surveys • General bird surveys • 51 Habitat/BioCondition assessments	Bird surveys of at least 20 minutes' duration were undertaken at 24 sites, in addition to diurnal active search sites. All birds heard or seen during flora surveys (10 days of survey effort in February 2019) were also recorded. Outcomes from the 51 BioCondition/habitat assessments identified suitable habitat. Species accumulation curve described in **Section 4.7.6** (also refer **Appendix M**) below indicate that all bird species in the survey area were detected. **Survey effort considered sufficient.**
Brigalow TEC	Conservation Advice for the Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community (2013)	The Conservation Advice outlines key diagnostic characteristics and condition thresholds (in summary): • *Acacia haypophylla* must be one of the most abundant tree species in patch; • In Queensland, the patch must include at least one of the following Regional Ecosystems: REs 11.3.1,	The approach taken followed that prescribed by Neldner et al. (2019) in *Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland, Version 5.0*. Survey timing coincided with maximum	Regional Ecosystems were verified following Neldner (2019) methodology. The Queensland BioCondition process was used to determine the condition of Brigalow

	Brigalow (*Acacia harpophylla* dominant and co-dominant) information sheet (2001)	11.4.3, 11.4.7, 11.4.8, 11.4.9, 11.4.10, 11.5.16, 11.9.1, 11.9.5, 11.9.6, 11.11.14 and 11.12.21 for the Brigalow Belt region; • Patch size greater than 0.5 ha; • Exotic perennial plants comprise less than 50% of the total vegetation cover of the patch, as assessed over a minimum sample area of 0.5 ha; and, • Exclusion of REs 11.3.17, 11.9.10, 11.9.11, and 11.11.16 in the Brigalow Belt region. Further, surveys must be conducted in consideration of the time of year and history of disturbance.	plant growth in the mid to late wet season and was optimal for detecting threatened species as well as describing overall diversity. • 51 Habitat/BioCondition assessments were undertaken within 20 AU's across the disturbance footprint	patches, by including weed cover in the assessment. **Survey Guidelines met**
Bats	A Review of Ghost Bat Ecology, Threats and Survey Requirements 2021 Survey Guidelines for Australia's Threatened Bats 2010	The *Review of Ghost Bat Ecology, Threats and Survey Requirements* recommends the following methods (in summary): • Identify known caves and mines prior to survey; • Passive ultrasonic detection at cave entrances or within roost chambers (full-spectrum device recording at a sample rate of at least 128 kHz); • Active acoustic detection (playback) only when appropriate (i.e., at water holes or ponds in suspected foraging locations); • Omnidirectional and directional microphones, used as appropriate; • Trapping only when necessary for specific purposes; The following effort is recommended: • Surveys should be repeated twice, approximately 6 months apart; and, Once a potential location has been identified, echolocation detectors should be placed at the entrance for a minimum of 3 nights.	• Passive Acoustic monitoring with omnidirectional microphones • General spotlight searches • Note: No suitable caves were found to apply roost surveying methodologies to.	AnaBat recordings were completed at 10 sites that represented likely flyways for bats: tracks through forest, creek lines and around dams. Recordings were made overnight for one night at each site. Spotlight surveys were also conducted for 40 person minutes per site at 28 sites. No caves or overhangs were found to be suitable for Ghost Bat roosting or breeding. No Ghost Bats were detected by spotlight. Given that the opportunity for the existence of roosts was low due to none being found, the **survey effort was considered sufficient.**

<table>
<tr>
<td>Small to medium carnivorous marsupials</td>
<td>Survey guidelines for Australia’s threatened mammals 2011</td>
<td>Survey guidelines for Australia’s threatened mammals 2011
Cage trapping:
• 10 cage traps (or Elliott B traps, see species profiles for details) placed at each sampling site
• Traps placed on the ground approximately 50 metres apart in two parallel straight lines (transects) separated by 20–50 metres (a greater distance between traps is recommended in some species profiles)
• One sampling site per representative habitat, with a minimum of two sampling sites required per 5 hectares
• (replication across habitat types in areas greater than 5 hectares)
• Set traps for four consecutive nights.
Spotlighting:
• Survey at least two 200 metre transects per 5 hectare site (or longer transects for larger sites)
• Maintain an interval of at least 100 metres between the two transects in order to maximise the area surveyed, which is usually 1 kilometre.
In addition, the usage of camera traps is recommended in conjunction with other survey techniques such as spotlighting. The guidelines state:
• Cameras should be deployed for at least 14 nights, and
• Approximately 10 cameras should be deployed per hectare.</td>
<td>• Remote sensory camera
• Cage trapping
• Spotlight searches</td>
<td>The current survey included 122 camera-nights of sampling, in addition to 31 trap-nights of cage trapping and 28 spotlight surveys. These surveys failed to detect any Northern Quolls.
Survey Guidelines met</td>
</tr>
</table>

4.7.6 Sufficiency of surveys

For flora surveys, the approach taken followed that prescribed by Neldner et al. (2019) in *Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland, Version 5.0*. Survey timing coincided with maximum plant growth in the mid to late wet season and was optimal for detecting threatened species as well as describing overall diversity. The fauna surveys were completed in accordance with the *Terrestrial Vertebrate Fauna Survey Guidelines for Queensland version 3.0* (Eyre, et al., 2018), whereby the entire survey area was divided into AU's based on broad vegetation groups and age (remnant versus regrowth). Comprehensive trap sites in addition to targeted surveys were completed with adherence of survey methodology to approved EPBC Act guidelines. For these reasons, as discussed in detail in the Sections above, the survey effort was considered sufficient.

The nature of ecological surveys means that it is inevitable that some species that are present will remain undetected. To estimate the extent to which this occurred, species accumulation curves were fitted to the fauna and flora data using EstimateS 9.1.0. The total numbers of species that occur within the survey area were estimated using the Chao2 richness estimator. These analyses suggested that, of the species that could have been detected using the methodology employed, the surveys to date have detected:

- 88% of the floral diversity.
- 100% of reptiles.
- 97% of amphibians.
- 100% of birds.
- 92% of non-bat mammals; and
- 100% of bats.

This is described further in Section 4.1.4.1 of the Terrestrial Ecology Assessment (**Appendix M**).

4.8 Geochemistry

4.8.1 Assessment of Geochemical characteristics with potential to impact water quality

RGS completed a geochemical assessment of waste rock, coal reject and coal for the Vulcan South Project in accordance with relevant legislation, guidelines and policies (COA, 2016; DESI, 2024a; INAP, 2022; DME, 1999). It is included in this PER as **Appendix R**. It reviews the available geochemical and geological data and existing drill hole database associated with the Project, describes the material sampling methodology, assesses the potential for any acid and metalliferous drainage (AMD) or other salinity/erosion/dispersion issues related to the Project materials, and refines the environmental management measures related to waste rock/coal reject emplacement and rehabilitation and ROM coal stockpile management.

4.8.1.1 Acid-Base Account – Waste Rock

Based on the median pH and EC values, the waste rock (overburden/interburden) samples tested are generally regarded as having a 'Medium' to 'High' soil pH and 'Low' salinity characteristics, as indicated by the distribution of samples corresponding to each pH and salinity class.

The total sulfur content of the samples ranges from below the laboratory limit of reporting (LoR) to 0.30 %S and has a very low median value of 0.02 %S. Materials with a total sulfur content less than or equal to 0.1 %S are essentially barren of sulfur, generally represent background concentrations, and have negligible capacity to generate acidity. Based on the total sulfur content (and sulfide sulfur content, where available), the maximum potential acidity (MPA) that could be generated by the waste rock samples ranges from below the laboratory limit of reporting (LoR) to 4.7 kg H_2SO_4/t, and has a very low median value of 0.6 kg H_2SO_4/t. The acid neutralisation capacity (ANC) for the 138 samples ranges from 0.25 to 307 kg H_2SO_4/t and has a median value of 13.6 kg H_2SO_4/t, which is approximately 20 times the median MPA. The calculated Net Acid Producing Potential (NAPP) values range from -306.4 to 1.0 kg H_2SO_4/t, with a negative median value of -12.7 kg H_2SO_4/t.

Overall, the Acid Base Account results confirm that the overwhelming majority of the waste rock materials represented by the samples tested have low sulfur content, excess ANC, and are classified as non-acid forming (NAF). These materials have a high factor of safety and a very low risk of generating acidic drainage. One carbonaceous (weathered coal) sample has a slightly elevated sulfur content, however, as a bulk material, waste rock is likely to have excess ANC and be classified as NAF.

4.8.1.2 Acid-Base Account – Coal Reject

Based on the median pH and EC values, the coal reject samples tested are generally regarded as having a slightly 'High' soil pH and 'Low' salinity characteristics, as indicated by the distribution of samples corresponding to each pH and salinity class.

The calculated NAPP values range from -35.4 to +6.1 kg H_2SO_4/t, with a negative median value of -2.7 kg H_2SO_4/t. The NAPP data shows that while most of the coal reject samples have negative NAPP value or a value that is close to zero, two coarse reject samples have a slightly positive NAPP value.

Overall, the Acid Base Account results confirm that most of the coal reject materials represented by the samples tested have relatively low sulfide content, excess ANC, and are classified as NAF. As a bulk mixed material, it is expected that coal reject will have a relatively low risk of generating acidic drainage. Co-disposal of coarse and fine reject materials and subsequent disposal with waste rock materials is likely to be beneficial and eliminate any residual risk.

4.8.1.3 Acid-Base Account – Coal

Seepage may occur from mined coal temporarily stockpiled at the ROM area prior to processing at the CHPP. Based on the total sulfur content of a range of coal samples from the target seams it is likely that the coal materials will have similar geochemical characteristics to the coal reject materials. As is standard practice at coal mining operations in the Bowen Basin, any surface runoff and seepage from the ROM coal stockpile will be monitored for quality and managed in the mine water management system as part of the Water Management Plan.

4.8.1.4 Soil characteristics and sodicity

The effective cation exchange capacity (eCEC) results for six composite waste rock samples are presented in the geochemical assessment report. The results indicate that the eCEC of the six samples ranges from 4.8 to 18.6 meq/100g and is typically in the low to moderate range. The calcium:magnesium ratio is low and less than one in all samples tested. For waste rock materials with a low to moderate eCEC value and low calcium:magnesium ratio, some fertiliser and gypsum addition may be required to provide a reasonable growth medium for vegetation roots as part of revegetation and rehabilitation activities.

The results of the exchangeable sodium percentage (ESP) tests indicate that most waste rock materials represented by these samples are likely to be moderately to strongly sodic; and consequently, may be susceptible to dispersion and erosion and should be managed appropriately.

4.8.1.5 Water quality

The static and kinetic geochemical test results presented in the geochemical assessment report indicate that the surface runoff and seepage from NAF mining waste materials is likely to be pH neutral to slightly alkaline and have a low to moderate EC value indicating low to moderate salinity levels (and low to moderate concentrations of dissolved solids). Surface runoff and seepage from mining waste materials is likely to fall within the range for 95% species protection in freshwater aquatic ecosystems (pH 6 to 9) as set out in ANZECC & ARMCANZ (2000) now superseded by ANZG (2023).

The major ion concentrations in leachate from mining waste materials are relatively low and dominated by sodium, chloride, bicarbonate and sulfate. Lower concentrations of other major ions are also likely to be present in leachate from these materials. The sulfate concentration in leachate from all mining waste samples is well below the applied ANZECC & ARMCANZ and ANZG stock water quality guideline criterion (1,000 mg/L).

The water extract and kinetic leach column (KLC) test results for mining waste materials indicate that most trace metals/metalloids are sparingly soluble, and that the concentration of dissolved metals/metalloids in surface runoff and seepage is relatively low, predominantly below the laboratory LoR, and below the applied water quality guideline criteria. Minor exceptions may include aluminium, copper and selenium in pore water, which can occasionally be greater than the applied guideline concentrations (ANZECC & ARMCANZ, 2000; ANZG, 2023); in selected samples. The KLC test data over the test period indicates that the concentrations of most dissolved trace metal/metalloid in contact water are typically low and well within applied livestock drinking water guideline values.

4.8.1.6 Summary of impacts

In summary, waste rock at the Project had a universally low sulphide content and high acid-neutralising capacity. Waste rock did not display elevated metal concentrations during KLC tests. In addition, all carbonaceous interburden samples within the Project area were classified as non-acid forming and, as a mixed bulk material, carbonaceous interburden is considered to be non-acid forming.

Most of the coal reject materials represented by the samples tested have relatively low sulfide content, excess ANC, and are classified as non-acid forming. However, there was variability between samples, such that one sample (out of 11) was classified as "potentially acid forming", and a further three samples were classified as "uncertain". As a bulk mixed material, coal reject has a relatively low risk of generating acidic drainage. This risk can be further lessened by disposing reject materials within cells contained within WRD's that have a very high acid-neutralising capacity. As for waste rock, leachate from coal reject samples did not have elevated metal concentrations during KLC tests. All processing wastes, including reject material and dry tailings, will be stored within WRD's (primarily the in-pit dumps), removing the requirement for a tailings storage facility at the site. Priority will be given to disposing processing wastes within in-pit dumps at depth; however, scheduling constraints may necessitate storage of some material in out-of-pit waste rock dumps.

The in-pit disposal of mixed coarse and fine reject materials within waste rock cells is also a low-risk strategy as the much larger volume of waste rock typically has very low sulphur content and excess acid-neutralising capacity. This mining waste management strategy is currently used at a number of coal mines in the Bowen Basin (**Appendix R**).

Overall, surface runoff and seepage from the waste rock material is expected to be pH neutral to slightly alkaline and have a low level of salinity. Dissolved metal and metalloid concentrations in surface runoff and leachate from bulk mining waste materials are expected to be low and unlikely to pose a significant risk to the quality of surface and groundwater resources.

4.9 Water Resources

4.9.1 Hydrology

A surface water assessment (SWA) of the Project has been completed by WRM Water + Environment (WRM) (**Appendix I**).

The Project is located within the Isaac River sub-basin of the greater Fitzroy Basin. **Figure 4-9** shows the Upper Isaac River catchment to its confluence with Phillips Creek. The Isaac River commences approximately 100 km to the north of the Project site within the Denham Range. It drains in a south westerly direction through the Carborough and Kerlong Ranges before turning in a south easterly direction near the Goonyella Riverside Mine. It drains approximately 30 km to the east of the Project, and eventually flows to the Mackenzie River some 150 km to the southeast.

Three open water bodies are located in the Isaac upper catchment including Lake Elphinstone, Teviot Creek Dam and Burton Gorge Dam (**Figure 4-9**). Lake Elphinstone is a natural lake formed behind the Carborough Range whereas Teviot Creek Dam and Burton Gorge Dam are man-made structures that supply water to Burton and North Goonyella mines in the upper catchment.

Other than along the ranges, the majority of the Isaac River catchment has been cleared for agricultural use or for mining. There are several existing coal mines in the catchment, including Burton, North Goonyella, Goonyella Riverside, Broadmeadow, Broadlea North, Isaac Plains, Moranbah North, Millennium, Daunia, Poitrel, Grosvenor, Peak Downs, Saraji, Norwich Park and Lake Vermont mines.

Vulcan South is located in the headwaters of the Boomerang, Hughes, Barret and Harrow creek catchments (**Figure 4-10**):

- Headwater drainage features of Boomerang Creek, which is a watercourse and tributary of the Isaac River, drains the northern portion of the Project area. Within the Project MLA boundary, Boomerang Creek and its tributaries are identified as drainage lines. Boomerang Creek is identified as a watercourse approximately 1 km downstream (east) of the Project MLA where Drainage lines 1, 2, 3 and 4 join (Figure 2-2). Boomerang Creek and its tributaries drain from Project MLA boundary via a series of culverts under the Norwich Park Branch Railway.
- Hughes Creek is a watercourse and tributary of Boomerang Creek and drains the majority of the southern Project area. Hughes Creek is identified as a watercourse within the Project MLA boundary. Hughes Creek drains from the Project MLA boundary via a rail bridge under the Norwich Park Branch Railway.
- Barrett Creek, which is identified as a watercourse within the Project MLA and is and tributary of Hughes Creek, drains a small portion of the southern Project area. Barrett Creek drains from the Project MLA boundary via a culvert under the Norwich Park Branch Railway.
- Headwater drainage features of Harrow Creek, which is a tributary of Cherwell Creek and the Isaac River, drains a small portion of the northern Project MLA area. Harrow Creek is identified as a watercourse approximately 2.2 km downstream (northwest) of the Project MLA.

The confluence of Boomerang and Hughes Creek occurs approximately 10 km to the east of the Project. Boomerang Creek drains into the Isaac River a further 10 km to the east of the Project. The catchment area of the Isaac River to Boomerang Creek is approximately 5,226 square kilometres (km^2). The catchment area of Boomerang Creek is 788 km^2, of which 177 km^2 makes up the Hughes Creek catchment.

The catchments of Boomerang Creek, Hughes Creek and Barrett Creek commence to the west of the Project area and drain in an easterly direction towards Saraji Road and the Norwich Park Branch Railway. The Ripstone Creek catchment lies to the north of the Project area and drains into Boomerang Creek approximately 30 km southeast of the Project. The headwater tributaries of Boomerang and Hughes Creek are ephemeral streams which experience flow only after sustained or intense rainfall.

The predominant catchment land uses of Boomerang Creek include undeveloped areas with some stock grazing to the west of Saraji Road and stock grazing and coal mining to the east. Boomerang Creek, Hughes Creek and Barrett Creek flow into the existing BHP Billiton Mitsubishi Alliance (BMA) operations (Peak Downs and Saraji). The existing BMA operations have diverted the original alignment of Boomerang Creek and its tributaries, as well as Harrow Creek to the north. Additional diversions of Boomerang Creek and its floodplain are also planned for approved operations further to the east.

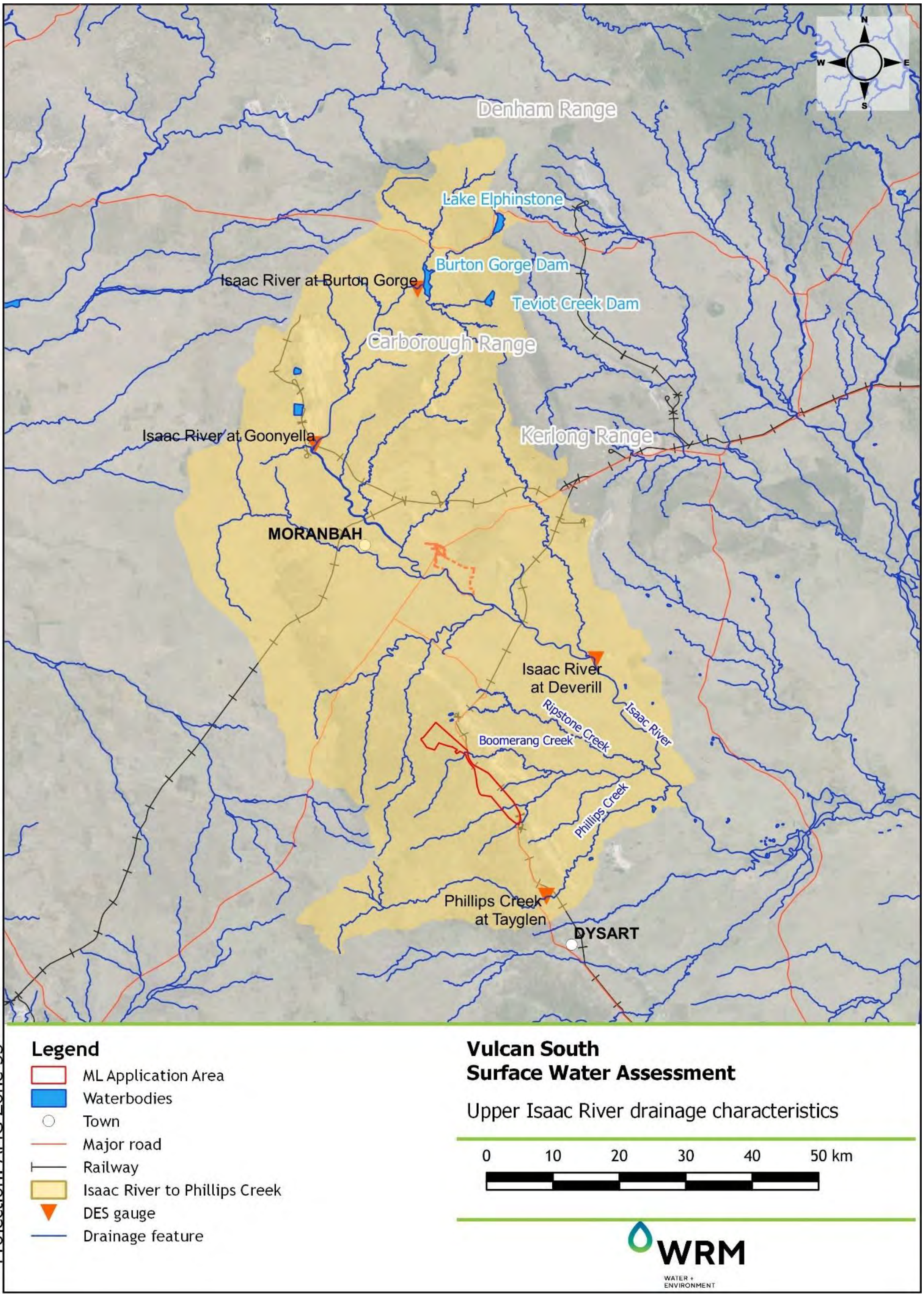


Figure 4-9 Upper Isaac River Drainage Characteristics (WRM 2023)

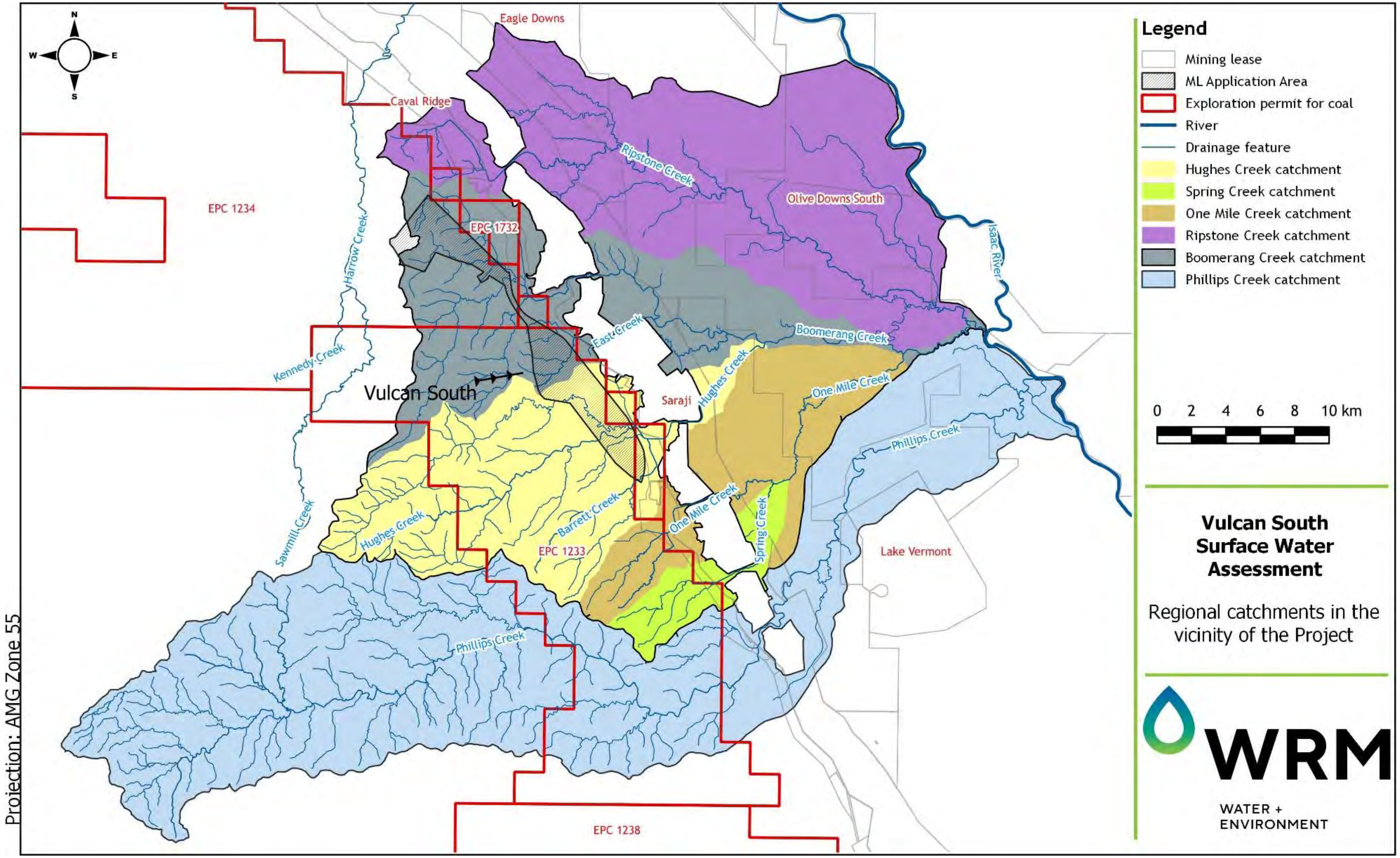


Figure 4-10 Regional Catchments in the vicinity of the Project

4.9.2 Surface Water Quality

Regional and local water quality has been investigated as part of the SWA (**Appendix I**). Full datasets are available for the Deverill Gauging Station on the Isaac River between 2011 and 2018 (**Table 4-7**). The water quality at the Deverill Gauging Station compares to Water Quality Objectives (WQO) in the following ways:

- the Electrical Conductivity (EC) values for high flows greater than 200 m^3/s are generally below the high flow WQO of 250 µs/cm;
- the EC of flows below 100 m^3/s vary significantly from 50 µS/cm to 1,870 µS/cm, and frequently exceed the low flow WQO of 720 µS/cm;
- the mean daily EC has exceeded the low flow WQO on a total of 23 days over this period, and all of these days experienced some flow (not stagnant flow); and
- stream flows are highly ephemeral with surface flows ceasing within a few days or weeks of a runoff event.

Further discussion of regional water quality can be found in **Appendix I.**

Table 4-7 Water quality of the Isaac River at Deverill

Parameter	Unit	Median value at Deverill	WQO default guideline value
Aluminium - Total	mg/L	-	< 5 (stock)
Aluminium - Dissolved	mg/L	0.05	< 0.055 (aquatic)
Boron - Total	mg/L	0.06	< 5 (stock)
Calcium - Dissolved	mg/L	16	-
Chloride - Total	mg/L	32	-
Copper - Dissolved	mg/L	0.03	< 0.0014 (aquatic)
EC	µS/cm	261	< 720 (baseflow) < 250 (high flow)
Filterable Reactive Phosphorus	µg/L	0.35	< 20 (aquatic)
Fluoride - Total	mg/L	0.14	< 2 (irrigation)
Iron - Dissolved	mg/L	0.06	-
Manganese - Dissolved	mg/L	0.01	< 1.9 (aquatic)
Nitrate - Total	mg/L	1.4	-
Nitrogen - Total	µg/L	0.76	< 500 (aquatic)
pH	-	7.6	6.5-8.5 (aquatic)
Phosphorus - Total	µg/L	0.35	< 50 (aquatic)
Potassium - Total	mg/L	4.55	-
Sodium - Total	mg/L	22	< 30 (drinking water)
Sulphate - Total	mg/L	10.9	< 25 (aquatic)
Total Alkalinity	mg/L	78	-
Total Dissolved Solids	mg/L	155	< 2,000 (stock)
Total Suspended Solids	mg/L	135	< 55 (aquatic)
Turbidity	NTU	247	< 50 (aquatic)
Zinc - Dissolved	mg/L	0.01	< 0.008 (aquatic)

Local water quality sampling has been undertaken as a component of the baseline surface water quality sampling in early 2020 (**Appendix I**). Analyses for a comprehensive range of physio-chemical parameters were completed at the monitoring sites.

The baseline monitoring locations in addition to the full suite of baseline monitoring undertaken for Vulcan South is presented in **Appendix I.** Monitoring results from the sites most relevant to Vulcan South have been reviewed as part of the SWA (**Appendix I**) and suggest that certain baseline water quality values surrounding Vulcan South do not meet the WQO for the region, these include:

- aluminium (filtered and total);
- zinc (filtered);
- iron (filtered and total);
- turbidity;
- total nitrogen;
- total phosphorous;
- chlorophyll; and
- hydrocarbons

The Queensland Water Quality Guidelines and the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP Water) guidelines establish Environmental Values (EVs) and Water Quality Objectives (WQOs) for natural waters in Queensland. Under the EPP (Water), the following EVs have been nominated for this area:

- Aquatic ecosystems;
- Irrigation;
- Farm supply/use;
- Stock Water;
- Aquaculture;
- Human consumption;
- Primary recreation;
- Secondary recreation;
- Visual recreation;
- Drinking water;
- Industrial use; and
- Cultural and spiritual values.

The WQO default trigger values for the above EVs are provided in the SWA (**Appendix I**).

4.9.3 Baseline Flooding

The baseline flooding conditions for the 10% annual exceedance probability (AEP) (**Figure 6-7**), 1% AEP (**Figure 6-8**) and 0.1% (**Figure 6-9**) AEP scenarios are as follows:

- East Creek:
    - for the 10% AEP event:

    - Floodwaters through the Vulcan South area are generally conveyed within the channel banks of natural drainage lines. Saraji Road is overtopped at some crossing locations. The Norwich Park Branch Railway culverts have sufficient flow capacity to convey the 10% AEP event.
    - Peak flood velocities along natural drainage channels in the vicinity of the Vulcan South area are up to 2.0 m/s in localised areas; and
    - Overbank flood depths adjacent to natural drainage lines are generally shallow (less than 0.5 m).
  - For the 1% AEP event:
    - floodwaters through the Vulcan South area are generally conveyed within the channel banks of natural drainage lines with limited overbank flooding. Saraji Road is overtopped at most crossing locations. The Norwich Park Branch Railway culverts have sufficient flow capacity to convey the 1% AEP event;
    - peak flood velocities in natural drainage channels exceed 2.0 m/s in localised areas. Overbank velocities are generally up to 1 m/s; and
    - flood widths and depths adjacent to natural drainage lines are greatest upstream of Saraji Road and Norwich Park Branch Railway where floodwaters are impounded behind the constructed embankments.
  - For the 0.1% AEP event:
    - floodwaters through the Vulcan South area are generally conveyed within the channel banks of natural drainage lines with confined overbank flooding;
    - flood velocities along natural drainage channels are typically elevated (greater than 2.5 m/s in localised areas). Overbank velocities are generally up to 1 m/s; and
    - peak flood widths and depths along the eastern side of the Vulcan South area increase as natural drainage lines drain towards Saraji Road and Norwich Park Branch Railway where floodwaters are impounded behind the constructed embankments. Flood depths impounded behind the railway embankment at the eastern boundary of Vulcan South are up to 5 m.
- Hughes Creek:
  - For the 10% AEP event:
    - floodwaters through the Project area are generally conveyed within the Hughes Creek channel. Minor breakouts occur along the Drainage line 8 and Barrett Creek channels upstream of Saraji Road. The Norwich Park Branch Railway culverts have sufficient flow capacity to convey 10% AEP events;
    - peak flood velocities along natural drainage channels in the vicinity of the Vulcan South area exceed 2.0 m/s in localised areas. Overbank velocities are generally up to 1 m/s; and
    - overbank flood depths adjacent to natural drainage lines are generally shallow (less than 0.5 m). Notwithstanding this, Hughes Creek flood depths are up to 3 m upstream of the railway.
  - For the 1% AEP event:
    - overbank flooding occurs at several locations within the Vulcan South area along Hughes Creek, with flood widths of up to 1.6 km just upstream of the railway;
    - overbank flood depths are up to 4.5 m adjacent to Hughes Creek upstream of the railway. The railway embankment is overtopped during this event; and
    - peak flood velocities along natural drainage channels are typically elevated (up to 3.2 m/s in localised areas). Overbank velocities are generally up to 1.5 m/s.
  - For the 0.1% AEP event:
    - significant overbank flooding occurs along Hughes Creek within the Vulcan South area along Hughes Creek and Barrett Creek, with flood widths of up to 2 km;
    - overbank flood depths are up to 5 m adjacent to Hughes Creek, with some localised areas that exceed 5 m; and

- peak flood velocities along natural drainage channels are typically elevated (up to 4 m/s in localised areas). Overbank velocities are generally up to 2.0 m/s.

4.9.4 Groundwater

In the vicinity of the Project, all geological formations yield low volumes of groundwater and hence would not typically be classified as aquifers in most hydrogeological settings. However, as individual lithological units within these formations have higher hydraulic conductivities than the intervening units, and groundwater in these formations was assessed for the determination of impact, they are referred to as aquifers for the purposes of this assessment. A detailed hydrogeological impact assessment has been completed by hydrogeologist.com.au for Vulcan South and is provided in **Appendix P**. This is summarised below.

The following geological formations within the Project area may contain groundwater:

1. Tertiary sediments and weathered regolith: Silts and clays, which comprise the bulk of the regolith overlying the coal measures, are densely compacted, hard and generally dry. Sand and gravel lenses embedded within the regolith are permeable but have low hydraulic conductivity and limited lateral and vertical extent. These have a potential to represent unconfined to confined aquifers, depending on location.
2. Permian coal measures: The ALEX and DLL coal seams are poor aquifers of low hydraulic conductivity. They are confined above and below by low-permeability regolith and sedimentary rocks. Nevertheless, these represent the largest and uppermost aquifers across most of the Project.
3. Back Creek Group: This formation of sandstones, siltstones and shale forms a largely impervious layer beneath the DLL coal seam aquifer. However, the Back Creek Group also contains narrow coal seams that can act as poor aquifers.

Aspects such as topography, geological and hydrogeology have been considered within the regional context of the Project and the limitations are understood when extrapolating regional data to local conditions. The conceptualisation within the hydrogeological impact assessment (**Appendix P**) is also based upon site specific data. This site-specific data includes geology data has been captured by the proponent (including 909 drill holes) to develop a detailed geology model of the site. This site-specific data also includes a dedicated groundwater drilling and investigation program and the installation of a dedicated project groundwater monitoring network. Site specific groundwater level, quality and permeability data has been captured as part of this drilling and investigation program.

The concept of faulting, paleochannels or igneous intrusions have been discussed (**Appendix P**) in the regional context and this discussion references other projects in the region. However, the site-specific geology model has not identified any faults, paleochannels or intrusions. Further, the dedicated groundwater drilling and investigation program did not identify faults, paleochannels or intrusions. As these geological features have not been identified in the Project area, they are not conceptualised as part of the local hydrogeology. There are no Tertiary sediments present in the Project area and there is an absence of Quaternary alluvium near the proposed open pits and more broadly within the Project area. Therefore, if there are no Quaternary sediments or Tertiary sediments present within the Project area, there cannot be any paleochannels present within the Project area.

In addition to the above, the groundwater level data collected to date from the Project groundwater monitoring network does not show any evidence of major faulting within the Project area. Compartmentalised groundwater blocks, high bore hole yields, broken ground and poor drilling conditions are indicative of faults. None of these conditions are observed with in the Project area.

4.9.5 Groundwater Quality

The pH of local groundwater is neutral to slightly acidic (**Appendix P**). Groundwater is brackish to highly saline (electrical conductivity of 2,700 to above 20,000 µS/cm) **(Appendix P**). This is driven mostly by high concentrations of sodium and chloride (with moderate bicarbonate in some samples). This groundwater is generally unsuitable for irrigation, but it may be used in limited quantities as water for livestock. Electrical conductivity above 7,463 µS/cm is associated with decline in animal health if consumed for prolonged periods (ANZG, 2023). All groundwater on site fails to meet guidelines for drinking water suitability for humans. Overall, groundwater on site has no or limited value for most uses, with the exception of limited stock watering and potential industrial purposes related to mining.

4.9.6 Containment of water resources

Hydrocarbon and chemical storage at the Project will be managed in accordance with best practice management (AS1940: The Storage and Handling of Flammable and Combustible Liquids), including the use of bunding and immediate clean-up of spills. Appropriate management of hydrocarbons and chemicals will prevent the contamination of both surface and groundwater resources.

Vehicles will be serviced regularly in appropriately bunded and lined workshops to ensure that oils and hydraulics fluid leaks are contained. The workshop will be fitted with appropriate contaminant 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, with contaminated soil removed from site and disposed of at an appropriate facility. Considering the appropriate controls that will be adopted, the Project has minimal risk of surface and groundwater contamination as a result of hydrocarbon and chemical contamination.

Following implementation of the mine water management system for the Project, no predicted mine water spills will occur to the receiving environment during the life of mine from the mine water dams or open cut pits.

4.10 Historical Surrounding Land Use

The predominant surrounding land uses include low intensity cattle grazing with coal mining to the east of Saraji Road. The Project lies to the immediate west of several established mining operations, including BHP's Peak Downs and Saraji mines, and south of Vitrinite's Vulcan Coal Mine. Further afield are grain (wheat) and chickpea farms.

The large coal mines were established in the early 1970s. Moranbah was created in 1971 by the Utah Development Company for miners and their families involved in mining of the Goonyella Mine and later Peak Downs Mine. It is now the largest community in the Isaac Region. Dysart was established in 1973 to cater to the surrounding coal mines and the many cattle and grain properties.

5 Matters of National Environmental Significance

Following the explanation of methodology undertaken for desktop research (literature review) and field surveys in **Section 4.7**, Section 5 does the following:

- Introduces Matters of National Environmental Significance (MNES) in **Section 5.1**
- Introduces the updates to listed species and TECs following a re-run of the PMST in **Section 5.2**,
- Provides the complete list of applicable MNES to the Project and a summary of the likelihood of occurrence process in table form in **Section 5.3**,
- Outlines methodology of assessing significance of impacts in **Section 5.4**,
- Outlines the adherence to relevant guidelines for surveying in **Section 4.7.5**
- Provides, for Threatened and Migratory MNES that are considered likely or confirmed present following the likelihood of occurrence process, descriptions of habitat and assessment of habitat suitability within the disturbance footprint and areas that may be affected by edge effects in **Sections 5.5** through to **5.9.**
- Discusses water Resources in Relation to a Large Coal Mining development in **Section 5.10**.

MNES that are considered "likely" to occur or "confirmed present" in this process are assessed for significance of impacts in **Section 6**, noting that those considered "possible" or "unlikely" to occur will not be considered further due to the likelihood of impacts occurring being too low.

For all species, a brief summary of historical occurrences is provided based on information from the Atlas of Living Australia database, which includes sightings from a range of sources. Where available and practical, the sources and dates for occurrences are noted.

5.1 Introduction to Matters of National Environmental Significance

MNES are defined in the *Significant Impact Guidelines 1.1* (Department of the Environment, 2013a) as the following:

- World heritage properties
- National heritage places
- Wetlands of international importance (often called 'Ramsar' wetlands after the international treaty under which such wetlands are listed)
- Nationally threatened species and ecological communities
- Migratory species
- Commonwealth marine areas
- The Great Barrier Reef Marine Park
- Nuclear actions (including uranium mining)
- A water resource, in relation to coal seam gas development and large coal mining development.

The first assessment consideration is to determine if a MNES is likely to occur. This can be summarised by the following workflow, each step being a further refinement to determine a final likelihood:

1. The Protected Matters Search Tool (PMST) was checked for MNES in the area, in this case with a 20 km search buffer around the Project's disturbance footprint.
2. The generated report was used to populate a list of MNES to investigate further.
3. At a desktop level, each of these MNES are assessed as follows:
    a. For local records submitted to the Atlas of Living Australia, eBird, WildNet, iNaturalist and more.

b. Using habitat descriptions from the Approved Conservation Advice as accessed through the Species Profile and Threats Database (SPRAT) and/or from the Queensland Regional Ecosystem Description Database (REDD), generally consulting government habitat mapping (such as Regional Ecosystem maps from QSpatial) and satellite imagery on a Geographical Information System (GIS). For many Threatened and Special Least Concern species under the Queensland framework, "Essential Habitat" mapping is often available to assist with mapping likelihood of MNES.

c. For any other publicly accessible information that will assist in narrowing down the likelihood of occurrence of a MNES in the disturbance footprint or adjacent to it, particularly in connected habitats.

4. If a MNES is determined to be "Possible", "Likely" or "Known" in the area, a site assessment or ecological survey may be warranted for further consideration. Commonwealth and State guidelines outline the level of effort required to conduct an appropriate survey for vegetation type and its general condition (Regional Ecosystem verification and BioCondition) and for various fauna groups (e.g., Guidelines for surveying Australia's Threatened Terrestrial mammals). Surveys may result in:

   a. Suitability of habitat being determined,

   b. Sightings of evidence of MNES (scratches, remains, burrows, etc)

   c. Direct sightings of MNES.

5. Likelihood of the MNES occurring is determined based on field survey results. MNES that are considered "Confirmed," "Likely" and in some cases "May occur" are assessed further and their known or potential habitat preferences mapped across the disturbance footprint and if downstream or edge effects are possible, the adjacent areas.

The need to re-run the PMST is outlined, and the likelihood of occurrence is presented in table format in **Section 5.3**.

5.2 Updates to MNES Listings

For the purposes of this PER, a new DCCEEW PMST search was conducted to check for listing updates since the production of the Terrestrial Ecology Assessment in 2022. The results of this updated search are attached in **Appendix O** and have been updated in a new 2024 revision of the Terrestrial Ecology Assessment **(Appendix M).**

Since the writing of the 2022 version of the Terrestrial Ecological Assessment (TEA) for Vulcan South, several MNES species have been uplisted which have required consideration within this PER. The potential relevance to the Project has been revised in this PER and in **Appendix M** for the following species (**Table 5-1**):

Table 5-1 New MNES for consideration

Species	Class	Common Name	Prior Listing under EPBC Act	New Listing under EPBC Act	Prior Project Assessment
Hemiaspis damelii	Reptile	Grey Snake	Not listed	Endangered (October 2022)	Has not been considered in prior assessments. This species was not present within the PMST mapping conducted for the Project's Terrestrial Ecological Assessment in July 2022.
Stagonopleura guttata	Bird	Diamond Firetail	Not listed	Vulnerable (March 2023)	Has not been considered in prior assessments. This species was not present within the PMST mapping conducted for the Project's Terrestrial Ecological Assessment in July 2022.
Polianthion minutiflorum	Plant	Not applicable	Vulnerable (July 2000)		Had not been considered in prior assessments. This species was not present within the PMST search conducted for the Project's Terrestrial Ecological Assessment in July 2022.
Calidris acuminata	Bird	Sharp-tailed Sandpiper	Migratory	Vulnerable (January 2024), Migratory	Reconsidered based on its threatened Vulnerable status.

Gallinago hardwickii	Bird	Latham's Snipe	Migratory	Vulnerable (January 2024), Migratory	Addressed within the Project's Terrestrial Ecological Assessment for its Migratory status and has required re-assessment based on its threatened Vulnerable status and updated information.

A likelihood of occurrence assessment has been conducted and summarised in **Table 5-3** for all species that have been listed in the latest desktop protected matter search, but not considered prior due to the reasons listed above in **Table 5-1**. None of the previously unlisted species are considered likely to occur in or directly adjacent to the Project.

Species determined to be "unlikely" or no more likely than "May occur" are not considered further in the significant impact assessment.

The Latham's Snipe was originally assessed by the Terrestrial Ecological Assessment as likely to be present within the survey area and the Project area. Based on their prior Migratory status, the Project was assessed as having no significant impacts on this species due to a lack of expected impacts on important habitat or lifecycle behaviour. Renewed assessment for likelihood of occurrence found the species to be a possible visitor rather than a likely visitor and therefore not subject to a further significant impact assessment.

The information described above has now been updated within the 2024 Terrestrial Ecology Assessment (**Appendix M**).

5.3 Likelihood of occurrence assessment for listed Threatened species, Migratory species and Ecological Communities

Summary of threatened species, TECs and migratory species

Fifty-one species have been identified either during the 2024 desktop review or the 2022 desktop review as potentially occurring within the Project area. Field surveys confirmed that four of these (Koala, Greater Glider, Squatter Pigeon and White-throated Needletail) are present within the Project area. No threatened species of plants were detected within the survey area. The likelihoods that the remaining species occur within the Project area were assessed by considering the proximity and recentness of records, as well as availability of potential habitat.

Migratory species listed in the following international agreements are protected under the EPBC Act as MNES:

- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention),
- China-Australia Migratory Bird Agreement (CAMBA),
- Japan-Australia Migratory Bird Agreement (JAMBA), and
- Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA).

For the purposes of this PER, species listed both as Migratory and Threatened are ignored as Migratory species and treated according to their Threatened status. One listed migratory species, the Rufous Fantail was detected during surveys. One additional species (Fork-tailed Swift) is a likely visitor, and an additional six species (Sharp-tailed Sandpiper, Oriental Cuckoo, Gull-billed Tern, Black-faced Monarch, Satin Flycatcher, Glossy Ibis) are possible visitors.

However, for no migratory species does the survey area contain "important habitat" that supports an "ecologically significant proportion of the population" by population usage probability or area in hectares, as defined by the *Matters of National Environmental Significance: Significant Impact Guidelines 1.1* (Department of the Environment, 2013a), *Referral Guidelines for 14 Birds Listed as Migratory Species under the EPBC Act* (Department of the Environment, 2015a) and *Industry Guidelines for Avoiding, Assessing and Mitigating Impacts on EPBC Act Listed Migratory Shorebird Species* (Department of the Environment and Energy, 2017a).

Summary of likelihood of occurrence

Prior to determining if the Project is likely to cause a significant impact to a MNES, the likelihood of presence must be determined, at minimum for all MNES determined as "likely to occur" or "may occur" within the "feature area" (the disturbance footprint) or "buffer area" (in this case an additional search radius of 50km) by the PMST. Species not listed within the PMST outputs have not been discussed or assessed within the likelihood of occurrence assessment table. This may include Matters of State Environmental Significance (MSES) which are beyond the scope of this document.

The definitions for likelihood that have informed the likelihood assessment are defined in **Table 5-2.**

Table 5-3 below provides a summary of the likelihood assessment for each TEC (**Section 5.5**), threatened (**Section 5.5.1.6**) and migratory (**Section 5.6.21)** species. For all species considered likely or known to utilise habitat as per the 'Updated likelihood conclusion following field surveys' final column, these species will be discussed in detail within **Section 6.**

<u>Note:</u> given that species were targeted in survey efforts for this Project, it will appear that greater densities of individuals of a given species occur within the Project area than surrounding areas, which suggests a greater level of importance than the reality. The likelihood that there is unreleased sighting data from other pending Projects is also high.

The likelihood of occurrence for each MNES is discussed in further detail in the subsections below.

Table 5-2: Definition of likelihood terms

Presence	Definition
Confirmed	• Species was sighted or photographed during field surveys; and/or, • Direct evidence of species was found during field surveys such as scats, feathers, burrows or other signs. • A TEC was confirmed as present, meeting the RE type and TEC condition threshold
Likely	• Habitat is suitable^; and, • Species known from local area with confirmed records
May occur	• Habitat is marginal*; and/or, • Habitat is outside normal flyways or migration paths. • Habitat is suitable^ but there are no recent (since 1980) records within 100 km, or this habitat is separated from known populations by geographic barriers to dispersal
Unlikely / Not Present	**Unlikely** • No suitable habitat on site; and/or, • No historic records within 100 km; and/or, • Species is considered locally extinct. **Not Present** • A TEC is found to be not present as determined by lack of component REs, or where component REs are present they do not meet condition thresholds.

^Suitable – The habitat contains the features required by a species at a quality that it is likely to occur in the habitat frequently or predictably, including areas visited regularly on migration routes.

*Marginal – The habitat lacks the required features and/or is of a reduced quality, is used by a species only irregularly or infrequently, or only a small proportion of individuals are found in the habitat. This also includes all areas outside normal migration routes.

Table 5-3 Summary Likelihood of occurrence assessment

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
1. ***Gallinago hardwickii* (Latham's Snipe)**	Bird	V, M/SL (Re-assessed in more detail as a newly listed Threatened species.)	**May** occur within area, in feature area.	Records are scattered in all directions, though none are within 60 km of the disturbance footprint. Predictably, most of these are associated with water bodies.	**Yes,** Satellite imagery shows potential wetlands and records indicate the species may infrequently fly through the area on migration.	**Possible** Local wetlands may possibly support this species during migration, though infrequently and in small numbers for very short time periods (likely to be days rather than weeks or months)	**Yes.** If the species was to occur in the disturbance footprint, this non-breeding visitor would only use these locations as stopovers for the purposes of foraging, and the airspace above for dispersal. Given that the sightings are more common on the coast and the area around the Project is subjected to surveys for a number of other projects, habitat may appear suitable but is unlikely to be used by the species as it is outside the normal flyway for this area.	**No** This species was not recorded within the survey area despite optimal survey timing. However, this species is cryptic, and the presence of undetected individuals is possible. Other surveys for other projects in the immediate area have not located this species.	**May occur** (Re-assessed. Was originally considered "likely")
2. ***Eucalyptus raveretiana* (Black Ironbox)**	Plant	V/LC	**May** occur within area, in feature area.	Yes, Most records are found over 60 km to the northeast and 100 km southeast in more humid ranges. A single record at around 100 km to the south exists, with another at Emerald within the town limits.	The only SPRAT listed RE that this species is known from that may occur in the disturbance footprint is 11.3.25a, which does not occur within the disturbance footprint. Other species this Eucalypt is known to be co-dominant with are known from the disturbance footprint, though these are all species that are wide ranging and tolerant of a wide variety of conditions.	**Possible** Listed co-dominant species exist in the disturbance footprint, based on mapping, though these are all wide-ranging species.	**No.** No suitable habitat for this species was found within the disturbance footprint or adjacent habitats.	**No.** Despite the thorough surveys in this project and other mining projects in the region, no evidence of this species was found.	**Unlikely**
3. ***Hemiaspis damelii* (Grey Snake)**	Reptile	E/E	**May** occur within area, in buffer area only.	Record from 1800 is 50km west (unable to be verified). Verified sighting approximately 120km south from Project (Springton) from 2004.	REs consistent with habitat known for the species are present. These are unlikely to be suitable as the closest record is over 100km away and is itself an outlier.	**Unlikely.** Due to the distance of the nearest record, which in itself is an outlier.	Not applicable	Not applicable	**Unlikely**
4. ***Polianthion minutiflorum***	Plant	V/V	**May**	The closest verified record is located approximately 132 km south from the	REDD database lists 12.9-10.7 as suitable habitat for this species.	**Possible.** Suitable habitat possibly exists,	**No**	**No.** Despite the presence of habitat deemed suitable	**Unlikely**

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
			occur within area, in feature area.	Project. A verified record approximately 149 km is located north from the Project.	This ecosystem is not known in the area of the Project as it is a coastal ecosystem. Sightings of low uncertainty were plotted onto Queensland Government mapping and were found to be on the following mapped REs: 11.7.2, 11.7.1, 11.9.5b, 11.7.2, 11.10.8, 11.10.1. The following REs are found within the Project area: 11.10.8, 11.10.1. Further, approved conservation advice indicated overlap with semi-evergreen thicket (RE 11.10.8), however this is not equivalent to the TEC Semi-evergreen vine thickets of the Brigalow Belt. In addition, RE 11.10.1x1 is considered suitable for this species. Prior ALA records are particularly associated with sandstone outcrops and substrate.	however records are disjunct. Therefore, it is possible based on a desktop review. The ALA records indicate colonies of this plant commonly contained of 200 hundred individuals or more. Field assessment did not identify the presence of colonies or individuals.		for this species, no individuals were found. The species' distribution is disjunct, and populations are widely separated by several hundred kilometres; Vulcan South is not located near these populations. Species accumulation curves (see Section 4.1.4.1 of **Appendix M**) fitted to the flora field data combined with estimations of species richness predict that 88% of floral diversity was detected by field surveys. Based on the relatively high modelled detection rate, it is unlikely that the species, or evidence of this species, was not detected during field survey. Further, the Principal Consultant on the survey was qualified by the Queensland Herbarium and was familiar with the species. It is therefore unlikely that the species, were it encountered during the survey, was unrecognised.	
5. *Stagonopleura guttata* (Diamond Firetail)	Bird	V/V	May occur within area, in feature area.	No The Project is located north from the majority of records. There are three uncertain records north from the Project. The closest record is located approximately 170 km south from the Project (Springsure).	Mapped likely to occur habitat within the SPRAT database is located south of Nanango (approximately 600 km south from the Project).	**Unlikely.** Due to the distance from mapped likely habitat within the conservation advice, it is unlikely. Further, the closest record is unverified and approximately 120 km from the Project.	Not applicable	Not applicable	**Unlikely**
6. Brigalow	TEC	Endangered /	**Likely** to occur, in feature area	N/A for a TEC	This TEC is represented by mapped component REs in the disturbance footprint	**Likely**	**Yes.** The component REs were confirmed as present	**Yes.** Component REs were assessed and met the condition thresholds for size and native cover to qualify as the TEC in remnant areas.	Confirmed

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
7. ***Poplar Box Grassy Woodland on Alluvial Plains***	TEC	Endangered /	**Likely** to occur, in feature area	N/A for a TEC	This TEC is represented by mapped component REs in the disturbance footprint	**Likely**	**Yes.** The component REs were confirmed as present	**No.** Despite the RE being suitable, the non-native vegetation cover meant that it did not meet the condition threshold to qualify as a TEC.	**Not present**
8. ***Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin***	TEC	Endangered /	**Likely** to occur, in feature area	N/A for a TEC	Not mapped within the disturbance footprint, but within the region	**Possible**	**No.** The component REs were not found in the disturbance footprint. No further consideration required.	**No.**	**Not present**
9. ***Weeping Myall Woodlands***	TEC	Endangered /	**Likely** to occur, in buffer area only	N/A for a TEC	Not mapped within the disturbance footprint, but within the region	**Possible**	**No.** The component REs were not found in the disturbance footprint. No further consideration required.	**No.**	**Not present**
10. ***Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions***	TEC	Endangered /	**Likely** to occur, in buffer area only	N/A for a TEC	Not mapped within the disturbance footprint, but within the region	**Possible**	**No.** A potential Section of this TEC was found during surveys; however it did not meet diagnostic thresholds for required soils.	**No.** Condition thresholds for the TEC as per the Approved Conservation Advice were not met.	**Not present**
11. ***Geophaps scripta scripta* (Squatter Pigeon)**	Bird	V/V	**Known** to occur within area, in feature area.	N/A, species is known from area	Yes	**Likely**	**Yes.** Suitable foraging and dispersal habitat is present in the survey area, including in the Project area.	**Yes.** Frequently sighted in suitable habitats	**Confirmed**
12. ***Hirundapus caudacutus* (White-throated Needletail)**	Bird	V/V	Not flagged by the latest PMST database search but appeared in prior searches during desktop assessments for the Terrestrial Ecological Assessment.	This species is likely to occur in airspaces over all habitats within their migration paths, records are therefore not important for this species due to its high level of mobility.	Yes. The species is likely over all habitats	**Likely**	**Yes.** Only foraging habitat was found. This species forages for insects overhead and is not likely to land or directly interact with any terrestrial habitats in the Project disturbance footprint.	**Yes.** The species was recorded on site.	**Confirmed**
13. ***Petauroides volans* (Greater Glider)**	Mammal	E/E	**Known** to occur within area, in feature area.	Yes	Yes	**Likely**	**Yes.** Breeding / shelter (denning), foraging and dispersal habitats are all confirmed by site surveys.	**Yes.** the species was sighted.	**Confirmed**
14. ***Phascolarctos cinereus* (Koala)**	Mammal	E/E	**Known**	N/A, species is known from area	Yes	**Likely**	**Yes.**	**Yes.**	**Confirmed**

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
			to occur in feature area, in feature area.				The survey area, including the Project area, features high to low value habitat.	Sighted within suitable habitats in the survey and disturbance footprint	
15. ***Denisonia maculata*** **(Ornamental Snake)**	Reptile	V/V	**Known** to occur within area, in feature area.	14 records exist within 10 km of the disturbance footprint, though all of these are to the east of the disturbance footprint and isolated from it by other mining projects.	Yes. However, the quality of these mapped REs on land zone 4 are questionable and field investigation is required.	**Likely**	**Yes.** Suitable habitat of low quality is present due to minor gilgai development. Further, where gilgais occurred, these tended to be less than 30 cm deep, and held water for less than one month after heavy rain. Consequently, frog diversity and density was very low in gilgais on site. Higher quality habitat is located east of Saraji Road.	**No.** Field surveys did not detect this species despite extensive survey effort and ideal conditions. However, the survey area is adjacent to known populations, and some potential habitat occurs on site. It is likely that small numbers of Ornamental Snakes utilise the survey area.	**May occur** Given the extremely low density of frog diversity (primary diet) and marginal quality of habitat and the species not being detected species
16. ***Aristida annua*** **(Annual Wiregrass)**	Grass	V/V	**Likely** to occur within area, in buffer area only.	A single record exists 35 km to the southwest of a preserved specimen collected in 1999 from the "Eastern slopes of Lord's Mountain".	Some possibly suitable habitat exists within the disturbance footprint.	**Unlikely**	**Yes.** Potential habitat exists within the survey area in the form of black clay soils derived from fine-grained sedimentary rock	**No.** This species was not found during surveys either in this or neighbouring projects.	**May occur**
17. ***Dasyurus hallucatus*** **(Northern Quoll)**	Mammal	E/LC	**Likely** to occur within area, in feature area.	The nearest recent (post-2000) records of the Northern Quoll are from the Clarke Range, 100 km northeast of the survey area. No Northern Quolls have ever been detected at neighbouring mines within the Bowen Basin.	The *EPBC Act Referral Guideline for the Endangered Northern Quoll* (Department of the Environment, 2016) defines critical habitat as "habitat within the modelled distribution of the northern quoll which provides shelter for breeding, and refuge from fire, predation and potential poisoning from Cane Toads". The survey area occurs within the modelled distribution of the Northern Quoll. Most of the otherwise suitable habitat in the disturbance footprint.	**Possible** Habitat is not especially likely to support the species considering the high probability of toads.	**Yes.** The survey area includes critical habitats on Land zones 3 and 10.	**No.** Northern Quolls were not detected during surveys including spotlighting and camera trapping; however the presence of suitable habitat indicates its presence remains a possibility.	**May occur**
18. ***Dichanthium queenslandicum*** **(King Blue-grass)**	Grass	E/V	**Known** to occur within area, in feature area.	9 records exist within 50 km since 2020. The closest is 11 km to the northwest of the disturbance footprint.	Heavy clay soils supporting grasses are represented within the area by remnant regional ecosystem	**Possible** Both habitats have been subjected to long periods of heavy grazing. This has led to	**Yes.** Potential habitat occurs on site; however, this is of poor quality. Nowhere within the survey area were clay soils	**No.**	**May occur**

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
					11.9.2 and cleared pastures that formerly supported regional ecosystem 11.4.9.	the almost complete replacement of native perennial grasses with the exotic *Bothriochloa pertusa*.	observed to support a native grassland community due to heavy grazing regimes and incursion of *Bothriochloa pertusa*.		
19. *Dichanthium setosum* (Hairy Bluegrass, bluegrass)	Grass	V/LC	**Likely** to occur within area, in buffer area only.	Based on herbarium records, there appears to be a 280 km gap between known populations at Springsure and Glenden. The survey area occurs within this gap; the nearest known record is 95 km to the north.	**Yes.** Potential clay soil habitat occurs on site, however the survey area lies just outside the Department of Climate Change, Energy, the Environment and Water's (2022d) modelled "may occur" range of the species.	**Possible** This species is associated with heavy basaltic black soils and red-brown loams with clay subsoil. It is tolerant of a moderate amount of disturbance, but excessive grazing and invasion of exotic grasses threatens the species (Department of Climate Change, Energy, the Environment and Water, 2022d). Despite potential habitat occurring on site, the lack of local records and the heavily degraded nature of the available habitat suggest that the survey area is not suitable for the Hairy Bluegrass.	**Yes.** Potential habitat occurs on site; however, this is of poor quality. All clay soils within the survey area which would support this species were dominated by the exotic pasture grass *Bothriochloa pertusa*. No native grass communities were observed on clay within the survey area.	**No.**	**May occur**
20. *Egernia rugosa* (Yakka skink)	Reptile	V/V	**May** occur within area, in feature area.	The nearest records (Queensland Museum specimens from 1976 and 2000) of this species are from the vicinity of Blackwater, 130 km to the south. Furthermore, no colonies have ever been recorded in the northern Bowen Basin, despite extensive ecological surveys undertaken across Dysart-Moranbah-Collinsville for various mining projects.	**Yes.** Suitable REs are mapped, though following field surveys may be found to be unsuitable.	**Possible** Given the lack of sightings, number of field surveys and distance to nearest records, the species would be considered unlikely, though its cryptic nature suggests it may go unnoticed, therefore remains a slim possibility.	**Yes.** All remnant and regrowth vegetation within the survey area qualifies as "suitable habitat" for the species, as all contain woody debris and/or rocks that provide structural support for burrows. The survey area does not contain habitat connected to known populations of the Yakka Skink.	**No.** No Yakka Skinks were recorded during surveys on site. However, given the large size of the survey area, it was not practical to inspect every possible burrow location within it.	**May occur**
21. *Erythrotriorchis radiatus* (Red Goshawk)	Bird	V/E	**May** occur within area, in feature area.	Three records exist within 150 km of the disturbance footprint.	**No** Large unfragmented habitat areas are no longer found in the	**Unlikely** Given the highly fragmented habitats in the region, and the	**Yes.** Potential habitat is present on site but is of low quality. Escarpments and nearby	This species was not recorded during surveys. Dispersing Red Goshawks	**May occur**

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
				The closest record is 80 km to the southwest, a 1938 record of an egg. The second record is 100 km to the north and is from Glenden, adjacent to remnant habitats. A third is from 120 km to the south and is a preserved egg kept with Museums Victoria, with no valid date.	region within or adjacent to the disturbance footprint.	numerous ecological surveys undertaken in the last 20 years, the species is unlikely from a desktop level.	waterways mostly lack surface water, and the surrounding landscape is already highly modified through mining and clearing for grazing.	may occasionally use the wider survey area.	
22. *Macroderma gigas* (Ghost Bat)	Mammal	V/E	**May** occur within area, in feature area.	A single Queensland government record exists 120 km north of the disturbance footprint from 2009 in Crediton State Forest.	No specific REs are attributed to the Ghost Bat as habitat, features such as caves are more important in considering likelihood of occurrence, and the species is known to be particular in choosing roost sites, more so when choosing breeding sites.	**Possible** There is some, though only a small likelihood of suitable caves existing on site and given the number of mines and ecological surveys in the area it would be expected that there would be records if the species did frequent the area. It is acknowledged that the Ghost Bat is difficult to detect by ultrasonic means, but the audible chirps would be likely to be detected on acoustic monitoring setups aimed at birds, especially after dark when bird calls are minimal.	**No.** There are no known roost sites in the survey area. However, the existence of unknown roost sites is possible, and the proliferation of mining across the Bowen Basin may have inadvertently created new roosting habitats (in disused mines).	**No.** This species was not recorded during surveys. It is possible that the disturbance footprint may be used intermittently by Ghost Bats. This use would solely be in a foraging capacity, as none of the sandstone ridges on site supported caves of a size and structure suitable as a roost site.	**May occur**
23. *Rostratula australis* (Australian Painted-snipe)	Bird	E/V	**May** occur within area, in feature area.	3 records exist within 150 km of the disturbance footprint. The closest, 28 km to the east was from 2017 and offers no information on spatial accuracy. A specimen was collected in Emerald, 120 km to the south in 1978. A 2015 record exists from St Lawrence on the coast, 120 km to the east.	Habitat is suboptimal with few suitable areas compared to closer to the coast.	**Possible**	**Yes.** Potential habitat was recorded at natural and artificial (dams) wetlands in the southern third of the survey area. In addition, a small dam in the northeast of the survey area possessed margins vegetated with suitable sedges and rushes, but the steep banks lacking areas of shallow mud limit the suitability of this habitat. One of the habitats within the survey area outside the	**No.** This species was not recorded in the survey area. Due to its secretive and highly mobile behaviour, it may still be considered a possible visitor to the survey area. Small numbers (singles or small groups) possibly utilise habitat within the Project area for short periods during transit through the region.	**May occur**

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
							Project area) contains a small island, which has potential as a nest site.		
24. ***Calidris ferruginea* (Curlew Sandpiper)**	Bird	CE/E	**May** occur within area, in feature area.	Two non-coastal records occur for this species between 80 and 90 km southeast and southwest, both since 2019, the southeastern record, however, is of dubious spatial accuracy. Records are clustered along the coast, as to be expected.	**No.** This species primarily inhabits coastal mudflats, but occasionally also uses the muddy margins of large freshwater wetlands.	**Unlikely** Given the coastal nature of the species and the lack of inland records in this highly surveyed region, the species is not likely to occur from a desktop level	Not applicable.	Not applicable.	**Unlikely**
25. ***Elseya albagula* (Southern Snapping Turtle)**	Reptile	CE/E	**May** occur within area, in feature area.	The closest records are located approximately 80 km east from the Project, both from the year 1988. Further records are located more than 100 km to the south.	**No** Permanent water in riverine systems is required, the waterways in the disturbance footprint are unsuitable.	**Unlikely**	**No** Suitable habitat was not found for this species	**No**	**Unlikely**
26. ***Furina dunmalli* (Dunmall's Snake)**	Reptile	V/V	**May** occur within area, in feature area.	2 records occur 70 km to the southwest, in the vicinity of Clermont. Both are preserved specimens.	Suitable habitat for the Dunmall's Snake is forests to woodlands within the range of species. Habitat fitting this very broad definition is mapped in the disturbance footprint.	**Possible**. The disturbance footprint is *not* within a zone marked as "likely to occur" by DCCEEW mapping, nor does it connect any such areas. For habitat to be considered "important" to this species, mapped "likely" areas must intersect with suitable habitat.	**Yes.** The survey area contains potential habitat fitting of the broad description given in the *Draft Referral Guidelines for Brigalow Belt Reptiles* (Department of Sustainability, Environment, Water, Population and Communities , 2011)	**No.** No Dunmall's Snakes were detected during surveys. The nearest record is from Clermont, 80 km southwest of the survey area. The species has never been recorded in the Dysart-Moranbah region, despite extensive ecological survey effort at other mine sites. Given the absence of local records despite targeted searches undertaken for Vulcan South and numerous neighbouring mining operations, it is considered unlikely that the species occurs locally.	**Unlikely**
27. ***Grantiella picta* (Painted Honeyeater)**	Bird	V/V	**May** occur within area, in feature area.	A single record 150 km south was recorded in 2017.	**Yes.** This species utilises open woodlands, especially dominated by *Acacia harpophylla* or other *Acacia* species. This species also relies	**Possible.** Sightings of this species show a tendency to avoid the region and given the lack of sightings available from a desktop assessment level and considering	**No.** This species depends on an abundance of mistletoe. Trees likely to be host to suitable mistletoes are present in the survey area, however mistletoe itself was	**No.** This species was not observed during field surveys.	**Unlikely**

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
					on the presence of mistletoes.	the number of ecological surveys conducted in the region over the last 20 years, this species should be regarded as "possible", as it is not highly likely.	scarce based on field surveys.		
***28. Lerista allanae* (Allan's Lerista)**	Reptile	E/E	**Likely** to occur within area, in feature area.	2 records exist 25-75 km to the west and southwest. Both are preserved specimens, one from 1938 and the other 1993.	The *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles* (Department of Sustainability, Environment, Water, Population and Communities , 2011) defines suitable habitat for the species as being regional ecosystems 11.8.5 and 11.8.11, both of which are lacking from the survey area. Nevertheless, regional ecosystem 11.9.2 (*E. orgadophila* open woodland on soil derived from fine-grained sedimentary rock) occurs on site, and closely resembles 11.8.5 in its floristics and soil attributes. Furthermore, models within the *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles* (Department of Sustainability, Environment, Water, Population and Communities , 2011) indicate that the species may occur within the survey area, despite the site being outside the modelled "known/likely to occur" zone.	**Possible** The species is difficult to rule out as marginal habitat may be found within the disturbance footprint.	**Yes.** Habitat similar to regional ecosystems known to support this species is present in the survey area.	**No.** No Allan's Leristas were found during surveys despite survey effort which exceeded the sample effort guidelines for Brigalow Belt reptiles. Taking into account the known distribution of the species and the search effort conducted to date, it is unlikely that Allan's Lerista occurs within the survey area.	**Unlikely**

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
29. *Neochmia ruficauda ruficauda* (Star Finch)	Bird	E/E	**Likely** to occur within area, in feature area.	The two nearest records (from the years 1996 and 2000) are located approximately 90 km east from the Project area.	**Yes.** The disturbance footprint is likely to contain habitat that would have been suitable for the Star Finch	**Unlikely.** Despite the presence of suitable habitat, the Star Finch is likely extinct in the Bowen Basin.	**Not applicable**	**Not applicable**	**Unlikely** The species is likely locally extinct
30. *Nyctophilus corbeni* (Corben's Long-eared Bat/south-eastern long eared bat))	Mammal	V/V	**May** occur within area, in feature area.	No records within 150 km. All records are to the south.	**No** Habitats are well outside this species' range	**Unlikely** Original desktop analysis incorrectly assessed this species as a cave-dwelling species. Reassessment determined that it remains unlikely, though this is based on known distribution.	**No** Habitat is well outside species' known range	Habitat may be broadly suitable; however, the disturbance footprint was determined to be well north of the known distribution of the species.	**Unlikely**
31. *Poephila cincta cincta* (Southern Black-throated Finch)	Bird	E/E	**May** occur within area, in feature area.	A 2022 record with a 30 km uncertainty is known from approximately 50 km south of the disturbance footprint. This record is backed by photographic evidence. It is acknowledged that this species has been the subject of recent public attention linked to other mining projects to the north. Given the publicity, efforts to locate other populations have been increased. The number of ecological surveys in the region would have been expected to locate individuals if they are persisting locally.	**Possible** The disturbance footprint may contain suitable foraging resources for this species.	**Unlikely** Despite the presence of suitable habitat, the Southern Black-Throated Finch is likely to be locally extinct	**Yes** Habitat may be marginally suitable in the area with water sources and a variety of grasses present, though it is degraded in quality to the point that this species may not persist.	**No** Surveys were conducted for this and other projects in the area and no individuals of this species were sighted.	**Unlikely**
32. *Pteropus poliocephalus* (Grey-headed Flying-fox)	Mammal	V/LC	**Likely** – in buffer only Foraging, feeding or related behaviour likely to occur within area, in buffer area only.	5 records are known from within 150 km. Of these, the only to the south was an entangled specimen from 145 km away. The remaining 4 records are all to the north in Eungella National Park and verified by the Queensland Parks and Wildlife Service.	**No** The disturbance footprint is unlikely to be of high enough quality to attract this species. Roosting camps are not known from the area, the only camp north of	**Unlikely**	**No.** Habitat is marginal at best; the species is unlikely in the area as anything more than a fly-by species and richer habitats closer to the coast are available.	**No.**	**Unlikely**

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
					Bundaberg is an outlier near Ingham.				
33. ***Rheodytes leukops* (Fitzroy River Turtle)**	Reptile	V/V	**May** occur within area, in feature area.	The closest records are located between 80km and 90km to the east of the Project, from the years 1980 and 1988 respectively. These records have been generalised for sensitivity concerns.	**No.** Permanent rivers are not found within the disturbance footprint or directly adjacent	**Unlikely**	**No.** Permanent rivers are not found within the disturbance footprint or directly adjacent	**No.**	**Unlikely**
34. ***Samadera bidwillii* (Quassia)**	Tree	V/V	**May** occur within area, in feature area.	One record is known from the coast, 130 km to the east.	**No**	**Unlikely**	**No.** No suitable habitat recorded.	**No** This distinctive species was not observed	**Unlikely**
35. ***Maccullochella peelii* (Murray Cod)**	Fish	V/-	Not flagged by the latest PMST database search but appeared in prior searches during desktop assessments for the Terrestrial Ecological Assessment.	No	The Project is outside the native range of this species, which is the Murray/Darling basin. Suitable waterways are not found within the disturbance footprint	**Unlikely**	**No**	**No**	**Unlikely**
36. ***Cycas ophiolitica* (Marlborough Blue Cycad)**	Cycad	E/E	Not flagged by the latest PMST database search but appeared in prior searches during desktop assessments for the Terrestrial Ecological Assessment.	Two records are found within 110-130 km southeast of the disturbance footprint. One from 2003 and one from 1990.	**No**	**Unlikely**	**No.** This is an obvious and distinctive species and given the number and thoroughness of flora and general ecological surveys in the region, its presence is highly unlikely in the disturbance footprint.	**No**	**Unlikely**
37. ***Cadellia pentastylis* (Ooline)**	Tree	V/V	Not flagged by the latest PMST database search but appeared in prior searches during desktop assessments for the Terrestrial Ecological Assessment.	The nearest record is located more than 100 km southeast from the Project, from the year 1991. More records are located further south.	**No** Habitat is unlikely to be present for this species.	**Unlikely** Habitat is not likely to be present for this species and closest records are sufficiently distant to rule this species out	**No** No habitat was surveyed in the disturbance footprint or greater survey area that would be considered suitable for this species	**No.** Despite BioCondition and other habitat surveys, this distinctive tree was not observed.	**Unlikely**
38. ***Tringa stagnatilis* (Marsh Sandpiper)**	Bird	M/SL	Not flagged by the latest PMST database search but appeared in	Two records, both from the year 2001, are located within about 12 km north	Muddy margins of shallow fresh or brackish water. These	**Unlikely**	**No**	**No**	**Unlikely**

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
			prior searches during desktop assessments for the Terrestrial Ecological Assessment.	of the Project area near the Peak Downs Mine.	are not likely present on site	Suitable habitat is not likely found within the disturbance footprint			
39. ***Gelochelidon nilotica* (Gull-billed Tern)**	Bird	M/SL	Not flagged by the latest PMST database search but appeared in prior searches during desktop assessments for the Terrestrial Ecological Assessment.	Yes, a record exists from a large wetland at Peak Downs Mine from 1999	Suitable wetlands are not likely in the disturbance footprint	**Possible**	Yes, although marginal	**No**	**May occur**
40. ***Rhipidura rufifrons* (Rufous Fantail)**	Bird	M/SL	**Likely** to occur within area, in feature area.	Yes, this species is expected to be found within the region	Yes, suitable habitat exists	**Likely**	**Yes**	**Yes**	**Confirmed**
41. ***Apus pacificus* (Fork-tailed Swift)**	Bird	M/SL	**Likely** to occur within area, in feature area.	Not important. This is a fast-flying species that almost certainly overflies the disturbance footprint as it utilises airspace over a wide range of habitats during migration.	N/A, habitat is likely to be airspace above entire region	**Likely**	Foraging and dispersal only in airspace above project	Yes, though only likely to overfly	**Likely**
42. ***Cuculus optatus* (Oriental Cuckoo)**	Bird	M/SL	**Likely** to occur within area, in feature area.	The only record within 100 km is approximately 6 km north from 2009.	Yes, suitable habitat for this species is similar to that of the rufous fantail, though more of a coastal species that may occasionally pass through the disturbance footprint	**Possible**	Habitat that may be suitable for the species was found, although it is not as close to the coast as this species prefers.	**No.**	**May occur**
43. ***Monarcha melanopsis* (Black-faced Monarch)**	Bird	M/SL	**Likely** to occur within area, in feature area.	Records are known from the area.	Typically associated with rainforest. Migrating individuals may utilise dense riparian vegetation	**Possible**	Possible in dense riparian vegetation in the limited portions of the disturbance footprint it may be found.	**No**	**May occur**
44. ***Myiagra cyanoleuca* (Satin Flycatcher)**	Bird	M/SL	**Likely** to occur within area, in feature area.	Records are known from the area.	Tall wet forests of the coast and nearby ranges. Vagrant individuals may occasionally occur inland,	**Possible**	Habitat is marginal, species may occasionally use the area, though better habitat is found closer to the coast.	**No**	**May occur**

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
					where they are most likely in denser forests (e.g., along waterways).				
45. ***Plegadis falcinellus* (Glossy Ibis)**	Bird	M/SL	**Likely** to occur within area, in feature area.	A 2001 record is known from 1 km from the disturbance footprint in an area that appears to be influenced by sheet flooding. Otherwise, records are known to be scattered throughout the region, over 70 km from the disturbance footprint.	Shallow, marshy edges of large freshwater wetlands	**Possible**	Marginal habitat was found	**No**	**May occur**
46. ***Calidris acuminata* (Sharp-tailed Sandpiper)**	Bird	M/SL	**Known** to occur in area, in feature area	Yes, a record exists from the BMA Peak Downs mine in a large wetland	Estuarine and freshwater wetlands with extensive shallow, muddy margins. These occur in the general area, but not in the disturbance footprint	**Possible**	Yes, although marginal	No	**May occur**
47. ***Actitis hypoleucos* (Common Sandpiper)**	Bird	M/SL	**May** occur in buffer area only	No, no records within 130 km	Estuarine and freshwater wetlands with extensive shallow, muddy margins. These occur in the general area, but not in the disturbance footprint	**Possible**	**No**	**No**	**Unlikely**
48. ***Calidris melanotos* (Pectoral Sandpiper)**	Bird	M/SL	**May** occur within area overfly marine area, in feature area	One record within 130 km from 2009, in the west of Shoalwater Bay	Estuarine and freshwater wetlands with extensive shallow, muddy margins	**Unlikely**	**No**	**No**	**Unlikely**
49. ***Motacilla flava* (Yellow Wagtail)**	Bird	M/SL	**May** occur within area, in feature area; may occur within area overfly marine area, in feature area	No records	**No**	**Unlikely**	**No**	**No**	**Unlikely**
50. ***Pandion haliaetus* (Osprey)**	Bird	M/SL	**Likely** to occur within area, in buffer area only	Most records occur along the coast. Near the Project, the closest is about 80 km to the east from the year 2000.	**No**	**Unlikely**	**No**	**No**	**Unlikely**

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
51. *Tringa nebularia* (Common Greenshank)	Bird	M/SL	**May** occur within area, in buffer area only	Two nearby records are from the Peak Downs Mine in 1999, and near the Moranbah Airport in 1978. The next closest sightings are located at least 60 km to the south of the Project.	No Primarily coastal, but occasionally also uses the muddy margins of large freshwater wetlands.	**Unlikely**	**No**	**No**	**Unlikely**

** EPBC Act = *Environment Protection and Biodiversity Act 1999* (Commonwealth). NC Act = *Nature Conservation Act 1992* (Queensland).

† Likelihood that species or species habitat occurs in the PMST database search. 'Feature area' = disturbance footprint.

E=Endangered, M=Migratory, SL=Special Least Concern, V=Vulnerable.

5.4 Methodology for assessing significance of impacts

This subsection explains the methodology for determining if an action will significantly impact MNES that are determined to be 'confirmed', 'likely', and, in some cases, 'may occur' within the disturbance footprint.

The Significant Impact Guidelines prescribe criteria to assess each MNES according to the type and conservation status of MNES, as listed above. Within the definitions listed in Section 5, criteria as they apply to the Threatened species and Threatened Ecological Communities (TECs) relevant to the Project, are broadly similar but unique for:

- Critically Endangered and Endangered TECs (but not Vulnerable TECs),
- Critically Endangered and Endangered species,
- Vulnerable species,
- Migratory species.

Impacts to any MNES may or may not be significant as determined by addressing the criteria. If any one or more of the criteria is assessed on its merits and returns a "yes" result, a significant impact is considered likely.

What is a significant impact?

"A 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts. You should consider all of these factors when determining whether an action is likely to have a significant impact on matters of national environmental significance" (Department of the Environment, 2013a).

A Significant Impact triggers the recommendation to refer a Project (known as an "action") to the Commonwealth Minister for the Environment. A referral may result in an action being:

- Controlled: Action is subject to the assessment and approval conditions under the EPBC Act.
- Not controlled 'particular manner': Approval is not required if the action is taken in accordance with the manner specified.
- Not controlled: Approval is not required if the action is taken in accordance with the referral.

The Project is considered a "controlled action". This subsection further describes the process behind determining significance of impacts relevant to this Project and the outcomes.

When is a significant impact likely?

To be 'likely', it is not necessary for a significant impact to have a greater than 50% chance of happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility. If there is scientific uncertainty about the impacts of your action and potential impacts are serious or irreversible, the precautionary principle is applicable. Accordingly, a lack of scientific certainty about the potential impacts of an action will not itself justify a decision that the action is not likely to have a significant impact on the environment (Department of the Environment, 2013a).

Criteria for determining whether or not an impact is significant are as follows for each type of MNES:

Critically Endangered and Endangered TECs

An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

- Reduce the extent of an ecological community,
- Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines,
- Adversely affect habitat critical to the survival of an ecological community,
- Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns,

- Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting,
- Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:
  - Assisting invasive species, that are harmful to the listed ecological community, to become established, or
  - Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community, or
  - Interfere with the recovery of an ecological community.

Critically Endangered and Endangered species

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- lead to a long-term decrease in the size of a population;
- reduce the area of occupancy of the species;
- fragment an existing population into two or more populations;
- adversely affect habitat critical to the survival of a species;
- disrupt the breeding cycle of a population;
- modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
- result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;
- introduce disease that may cause the species to decline; or
- interfere with the recovery of the species.

Vulnerable species

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- lead to a long-term decrease in the size of an important population of a species;
- reduce the area of occupancy of an important population;
- fragment an existing important population into two or more populations;
- adversely affect habitat critical to the survival of a species;
- disrupt the breeding cycle of an important population;
- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
- result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;
- introduce disease that may cause the species to decline, or
- interfere substantially with the recovery of the species.

Migratory species

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

- Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.
- Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or

- Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

It is important to note that there are specific meanings to “habitat critical to the survival” of a species or Ecological Community, “important habitat”, “important populations” and an “ecologically significant proportion”. These definitions are outlined below in **Table 5-4** (Department of the Environment, 2013a):

Table 5-4 Significant Impact glossary

Term	Definition
Habitat critical to the survival of a species or ecological community	‘Habitat critical to the survival of a species or ecological community’ refers to areas that are necessary: • For activities such as foraging, breeding, roosting, or dispersal, • For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators) • To maintain genetic diversity and long-term evolutionary development, or • For the reintroduction of populations or recovery of the species or ecological community. Such habitat may be, but is not limited to: • Habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; • And/or habitat listed on the register of critical habitat maintained by the minister under the EPBC act.
Important population of a species	An ‘important population’ is a population that is necessary for a species’ long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are: • Key source populations either for breeding or dispersal • Populations that are necessary for maintaining genetic diversity, and/or • Populations that are near the limit of the species range.
‘Important habitat’ for a migratory species	An area of ‘important habitat’ for a migratory species is: • Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, and/or • Habitat that is of critical importance to the species at particular life-cycle stages, and/or • Habitat utilised by a migratory species which is at the limit of the species range, and/or • Habitat within an area where the species is declining.
Ecologically significant proportion	Listed migratory species cover a broad range of species with different life cycles and population sizes. Therefore, what is an ‘ecologically significant proportion’ of the population varies with the species (each circumstance will need to be evaluated). Some factors that should be considered include the species’ population status, genetic distinctiveness and species-specific behavioural patterns (for example, site fidelity and dispersal rates).

If any of the relevant criteria are triggered for any MNES, a significant impact is considered likely to occur and a referral to the commonwealth minister for the Environment is recommended. Note that some MNES have prescribed lower limits on what constitutes a significant impact (e.g., Migratory species, the Ornamental Snake), however, many do not.

5.5 MNES TECs

The following five TECs were identified in the PMST Search:

- Brigalow (*Acacia harpophylla* dominant and co-dominant)
- Poplar Box Grassy Woodland on Alluvial Plains
- Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin
- Weeping Myall Woodlands
- Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions

The likelihood of occurrence assessment including field surveys (**Section 5.3**) discounted all TECs except for one, Brigalow, which was confirmed as occurring within the Impact area. All five TECs are described below.

All TECs were assessed by first confirming the RE by Quaternary or Secondary verification (Neldner, et al., 2019), then using the BioCondition Assessment methodology to confirm the quality of the RE, which subsequently is used to determine if the RE is a TEC, as defined within the various approved conservation advices accessed through the SPRAT database.

5.5.1 Brigalow (*Acacia harpophylla dominant and co-dominant*)

5.5.1.1 Listing Advice

- Commonwealth: Endangered
- Queensland: Treated as individual component Regional Ecosystems, which are generally Endangered under the *Vegetation Management Act 1999*.

5.5.1.2 Distribution

Brigalow occurs across semi-arid eastern Australia, and occurs in the Brigalow Belt North, Brigalow Belt South, Mulga Lands, Darling Riverine Plains and Southeast Queensland Interim Biogeographic Regionalisation for Australia (IBRA) bioregions in Queensland (Department of Climate Change, Energy, the Environment and Water, 2024b). A total of 71.2 ha of this TEC are contained within the disturbance footprint. This includes remnants and high-quality regrowth of the constituent regional ecosystems, 11.4.8 and 11.4.9.

5.5.1.3 Threatening Processes

Due to past extensive clearing activities, threats to the Brigalow TEC include activities which will further reduce its extent or condition. Key threats in Queensland include clearing (especially from clearing related to mining), invasive and exotic species, extreme fire conditions (especially where exotic grasses are present), and pest animals. Future climate change is considered an emerging threat, with changes to temperature, rainfall, and fire conditions compounding the impacts of existing threats (Department of the Environment, 2013b).

5.5.1.4 Vegetation Composition

The vegetation types that make up the Brigalow ecological community tend to occur on acidic and salty clay soils (Isbell, 1962) (Bui & Henderson, 2003); mostly on deep cracking clay soils with a microrelief pattern referred to as gilgai or melon holes, which intermittently fill with water. In Queensland, the soils are predominantly cracking clays where *Acacia harpophylla* is dominant, but texture contrast soils are common where *Eucalyptus* species are co-dominant. In Queensland, most of the listed Brigalow ecological community remnants occur on flat to gently undulating Cainozoic clay plains that are not associated with current alluvium, or on gently undulating landscapes on more or less horizontally bedded fine grained sedimentary rocks. About 10% of remnants are associated with river and creek flats. The remainder are associated with old loamy and sandy plains, basalt plains and hills, or hills and lowlands on metamorphic or granitic rocks (Accad, et al., 2001). The Brigalow ecological community occurs largely within the 500-750 mm annual rainfall belt with a predominance of summer rainfall, although winter rainfall peaks occur in the south of its distribution where the climate in western areas is more arid (Pulsford, 1984; Johnson, 1997).

To qualify as a TEC, the following must not apply, and are specific to Brigalow:

- Vegetation that has been comprehensively cleared (not just thinned) within the last 15 years;
- Vegetation in which exotic perennial plants have more than 50% cover, assessed in a minimum area of 0.5 ha (100 m by 50 m); and,
- Individual patches of Brigalow that are smaller than 0.5 ha.

The Brigalow within the disturbance footprint qualifies as a TEC based on the points above.

5.5.1.5 Habitat Assessment

Areas dominated by *Acacia harpophylla* were surveyed in the field using the Regional Ecosystem verification (RE verification) methodologies as outlined by (Neldner, et al., 2019) and its condition was checked using the BioCondition assessment methodology for Queensland Regional Ecosystems. Sufficient information is captured in the BioCondition assessment data collection to determine if Brigalow vegetation will qualify as a TEC based on weed cover. Following these workflows, satellite imagery was used to determine the size of Brigalow patches that had been surveyed to confirm their size, and therefore if they qualify as a TEC on size.

Weed dominance is measured along, and in addition to a BioCondition transect, averaging groundcover dominance from eight quadrats over 100 m, which is then averaged with non-native canopy, subcanopy and shrub composition. A final overall weed dominance percentage is determined. None of the sites had any non-native shrubs or trees recorded, therefore the shrubs and trees were regarded as being 100% native.

Note that the patch size includes areas of a patch that extend beyond the boundaries of the Project area.

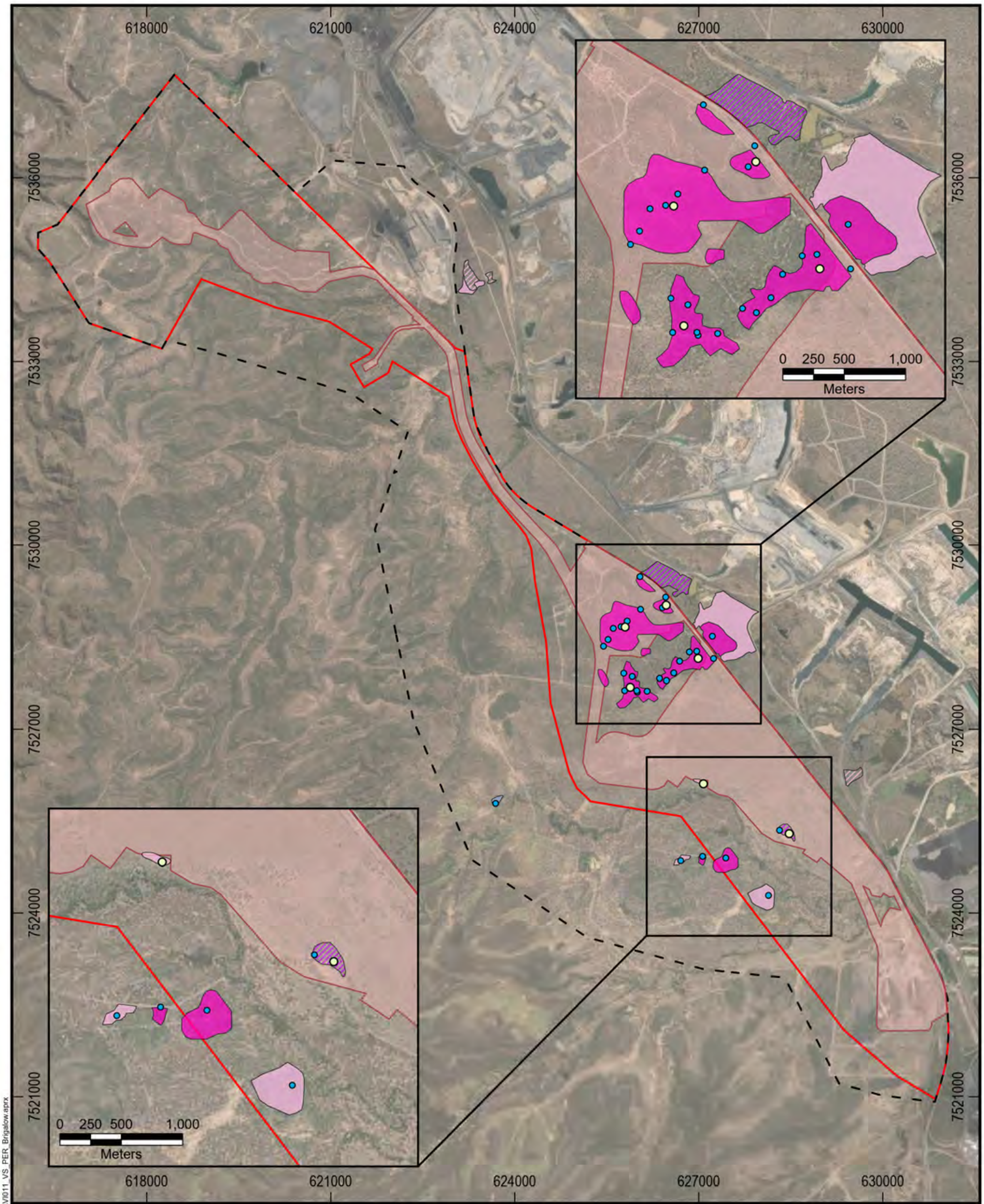
Of all the sample sites, the only area of regrowth that qualifies as the TEC is represented by I45, with an overall weed dominance of 11.87%.

71.2 ha of Brigalow is present within the disturbance footprint that qualifies as the Brigalow TEC. The following REs met size thresholds, but not all met condition thresholds for the TEC as outlined by red text in **Table 5-5**. Brigalow distribution is presented in **Figure 5-1**:

Table 5-5 Assessment of Brigalow vegetation composition against key diagnostic characteristics

Sample site	Assessment Unit (AU)	RE	Patch size in hectares	Groundcover total (%)	% of weeds in groundcover	Shrub cover (%)	Tree cover (%)	Overall weed dominance	Percentage of weed cover averaged across Assessment Unit
I23	AU04	11.4.8	4.41	3	0	75.6	33	0	5.2
I25	AU04	11.4.8	58.73	14	5.71	43.6	43.4	0.79	
I26	AU04	11.4.8	26.66	7.8	0	16.9	60.7	0	
I29	AU04	11.4.8	19.57	3.4	0	15.2	26.9	0	
I37	AU04	11.4.9	1.33	19.2	89.58	22.8	26.1	25.25	
I45	AU14	NR* 11.4.8	4.01	10.6	86.795	31	35.9	11.87	38.9
I46	AU14	NR 11.4.8	14.43	57.4	99.30	28.9	0	66.048	
I41	AU21	NR 11.4.8	29.98	84	95.71	3.3	0	92.093	72.4
I42	AU21	NR 11.4.8	47.53	43.4	95.85	35.3	0	52.858	

* NR = non-remnant, red indicates a high weed dominance



Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Brigalow.aprx

Legend

- Brigalow Flora Sites
- Brigalow Biocondition Sites

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- Survey Area

Brigalow Threatened Ecological Community (TEC)

- 11.3.1
- 11.4.8
- 11.4.9
- HVR 11.4.8
- HVR 11.4.9

Source: Vitrinite 2024, METServe 2020-2024, Earthstar Geographics

Vulcan South

Brigalow Threatened Ecological Community (TEC)

0 1 2 3

Kilometers

Scale: 1:90,000 (A4)

24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-1

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.5.1.6 Summary of likelihood

This TEC is known to occur within the Project area.

5.5.2 Poplar Box Grassy Woodland on Alluvial Plains

5.5.2.1 Listing Advice

- Commonwealth: Endangered
- Queensland (treated by individual component REs under the *Vegetation Management Act 1999* class):
  - 11.3.2: Of Concern
  - 11.3.17: Of Concern
  - 11.4.7: Endangered
  - 11.4.12: Endangered
  - 12.3.10: Endangered

5.5.2.2 Distribution

This TEC occurs generally across central to south-east Queensland (south of Charters Towers, west of Ipswich, and east of Longreach) and central New South Wales. It occurs within the Queensland Brigalow Belt North, Brigalow Belt South, and Darling Riverine Plains IBRA bioregions. In Queensland, this TEC occurs across regional ecosystems 11.3.2, 11.3.17, 11.4.7, 11.4.12, and 12.3.10 (Department of the Environment and Energy, 2019).

5.5.2.3 Threatening Processes

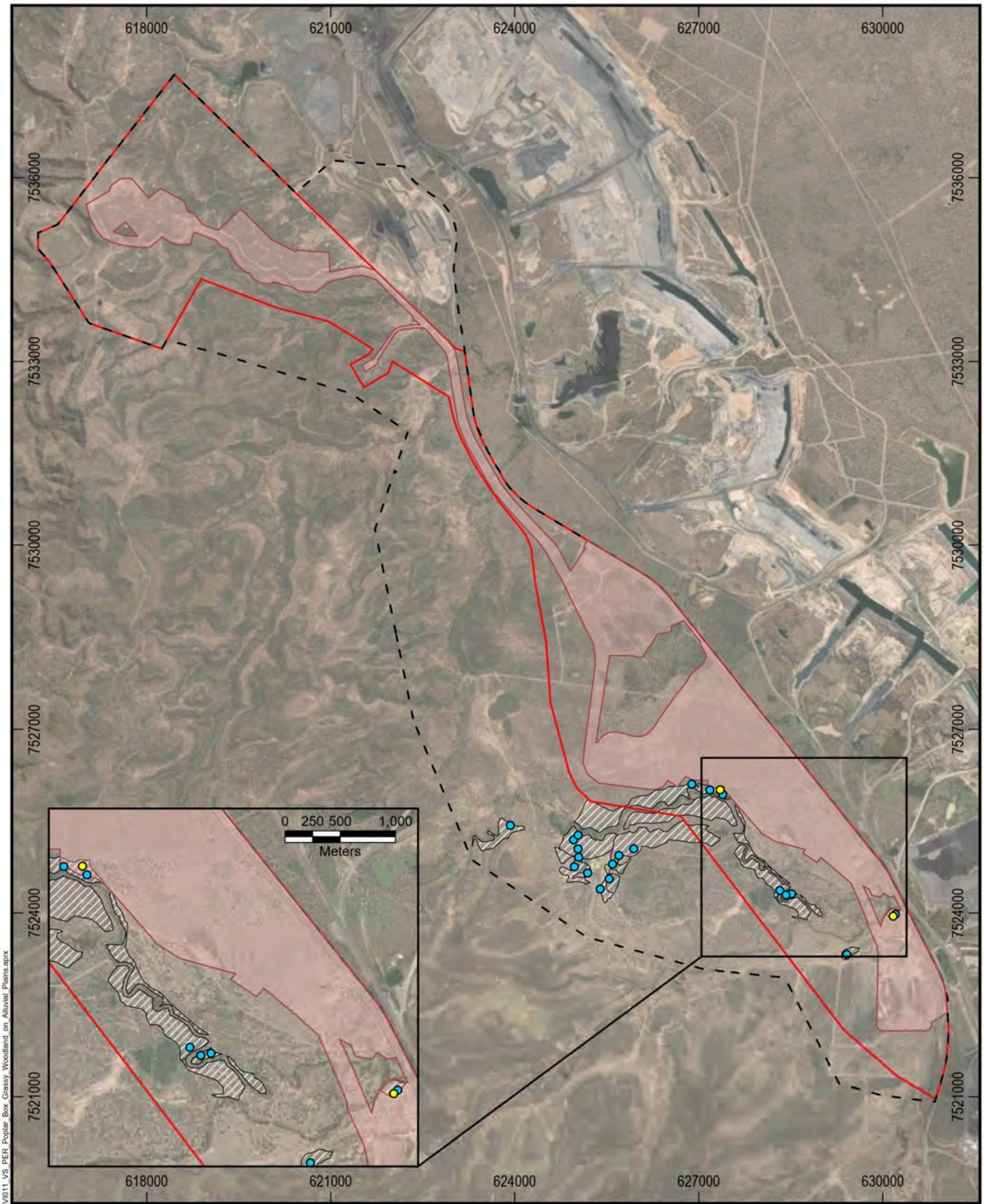
Numerous key threatening processes have been identified in the Commonwealth's Conservation Advice (Department of the Environment and Energy, 2019). In summary, this includes loss of climatic habitat caused by anthropogenic greenhouse gas emissions, land clearance, competition and land degradation by goats and rabbits, impact of novel biota on biodiversity, and invasive flora and fauna.

Key threats include:

- clearance and fragmentation;
- invasive weeds and fauna;
- inappropriate fire and grazing;
- dieback, from a range of causes;
- chemical impact and spraydrift;
- hydrological changes;
- salinisation and nutrient enrichment of the soil; and
- climate change.

5.5.2.4 Habitat Assessment

Despite the presence of suitable regional ecosystems (11.3.2), the presence of non-native vegetation cover results in this community not meeting the condition threshold to qualify as a TEC. In order to be considered an MNES, areas of the ecological community must meet diagnostic criteria and condition thresholds. One key diagnostic characteristic listed by the draft conservation advice is a "ground layer (<1 m) mostly dominated across a patch by native grasses, other herbs and occasionally chenopods". Dominance is defined as "accounting for more than 50% of the cover". None of the regional ecosystem 11.3.2 within the survey area met this criterion. Weeds (non-native species) comprised 91.8% and 92.9% of the ground layer at the two secondary sites sampled in remnant 11.3.2. These two sites were in the largest, best-quality examples of the community available. Given the dominance of weeds across alluvium within the survey area, none of the *E. populnea* woodlands occurring there qualify as a threatened ecological community under the EPBC Act, as shown in **Figure 5-2**.



Legend

- Flora Sites - Poplar Box Grassy Woodland on Alluvial Plains
- Biocondition Sites - Poplar Box Grassy Woodland on Alluvial Plains
- Poplar Box Grassy Woodland on Alluvial Plains (Regional Ecosystem 11.3.2) which **did not qualify as a TEC**

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- Survey Area

Source: Vitrinite 2024, METServe 2020-2024, Earthstar Geographics

Vulcan South

Poplar Box Grassy Woodland on Alluvial Plains - Threatened Ecological Community (TEC)

0 1 2 3

Kilometers

Scale: 1:90,000 (A4)

24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-2

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.5.2.5 Summary of likelihood

Areas matching the definitions of the Queensland Regional Ecosystem descriptions for RE 11.3.2 are present, but these are not of sufficient condition to qualify as a TEC under the EPBC Act. This TEC is not present.

5.5.3 Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin

5.5.3.1 Listing Advice

- Commonwealth: Endangered
- Queensland (treated by individual component REs under the *Vegetation Management Act 1999* class):
  - 11.3.21: Of Concern
  - 11.3.24: Endangered

5.5.3.2 Distribution

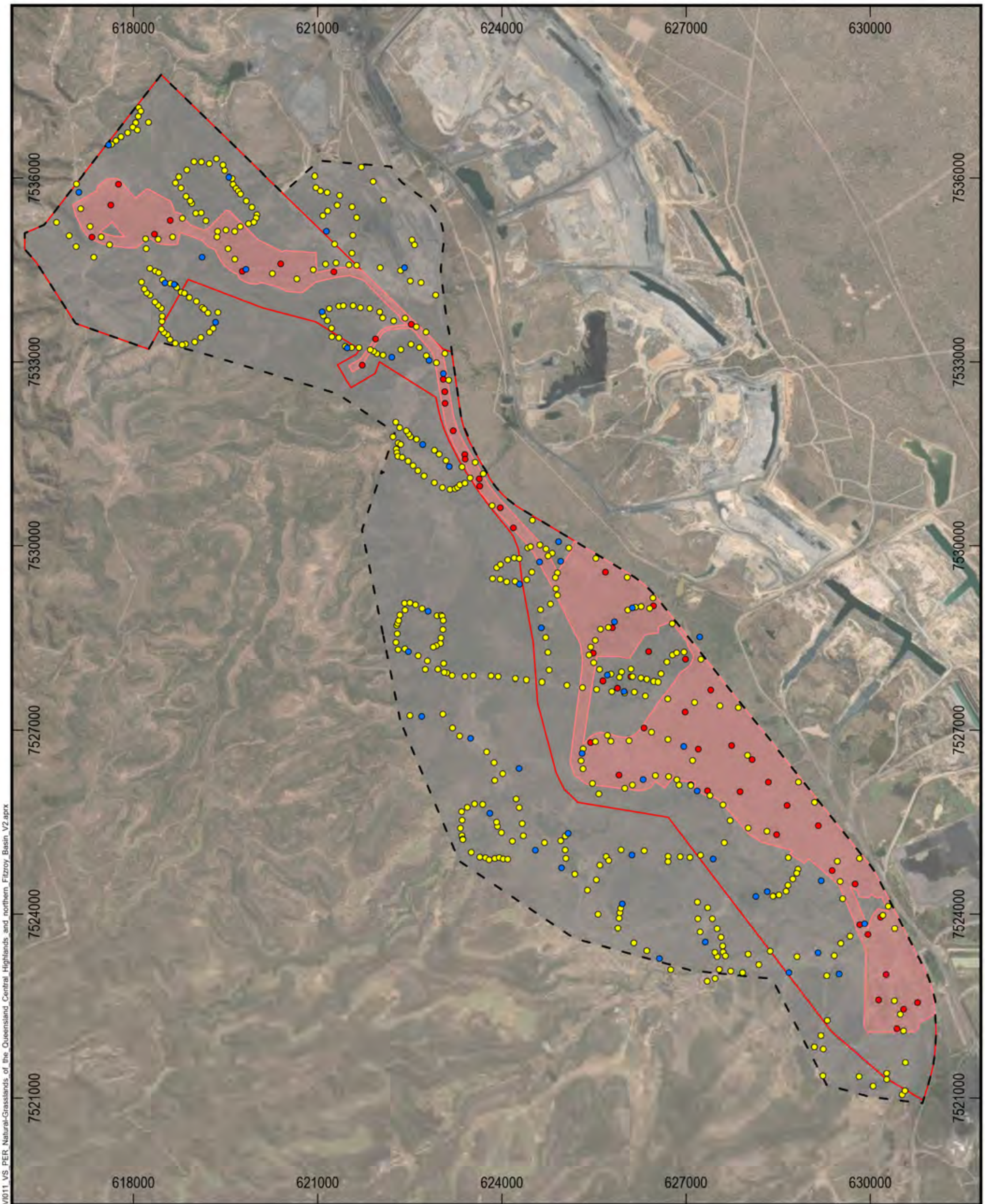
This TEC exists only in Queensland and extends from Collinsville in the north to Carnarvon National Park in the south. This community occurs within the Brigalow Belt North and Brigalow Belt South IBRA bioregions, and within the Fitzroy Basin, Burdekin, Southwest Qld, Border Rivers Maranoa-Balonne and Desert Channels Natural Resource Management regions (Department of the Environment, Water, Heritage and the Arts, 2008c).

5.5.3.3 Threatening Processes

Grazing, cropping and pasture improvement, weeds and pest animals, mining activities, and construction of roads and other infrastructure are key threats to this TEC. The main potential threats are lack of knowledge about grasslands and climate change (Department of the Environment, Water, Heritage and the Arts, 2008c).

5.5.3.4 Habitat Assessment

Suitable REs are mapped within the region, however the component REs are not found within the disturbance footprint or the broader survey area.



Legend

Survey Sites

- Quaternary
- Secondary
- BioCondition

Vulcan South Coal Mine (2023/09708)

- Survey Area
- Disturbance Footprint
- Project Area (ML 700073)

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin

- TEC Not Present

Source: Vulcan South datasets - Vitrinite 2024 & METServe 2020-2024. Earthstar Geographics 28/09/2023.

Vulcan South

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin

0 0.75 1.5 3

Kilometers

Scale: 1:90,000 (A4)

24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-3

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Natural-Grasslands_of_the_Queensland_Central_Highlands_and_northern_Fitzroy_Basin_V2.aprx

5.5.3.5 Summary of likelihood

No areas matching the definitions of the Queensland Regional Ecosystem descriptions for component REs 11.3.21 or 11.3.24 are present in the disturbance footprint, therefore this TEC is not present as shown in **Figure 5-3.**

5.5.4 Weeping Myall Woodlands

5.5.4.1 Listing Advice

- Commonwealth: Endangered
- Queensland:
  - 11.3.28: Of Concern
  - 11.9.3: Least Concern

5.5.4.2 Distribution

This TEC occurs on the inland alluvial plains west of the Great Dividing Range in NSW and Queensland. It occurs in the Riverina, NSW Southwestern Slopes, Darling Riverine Plains, Brigalow Belt South, Brigalow Belt North, Murray-Darling Depression, Nandewar and Cobar Peneplain IBRA Bioregions. The ecological community currently occurs in small pockets throughout this range (Department of the Environment, Water, Heritage and the Arts, 2008h).

5.5.4.3 Threatening Processes

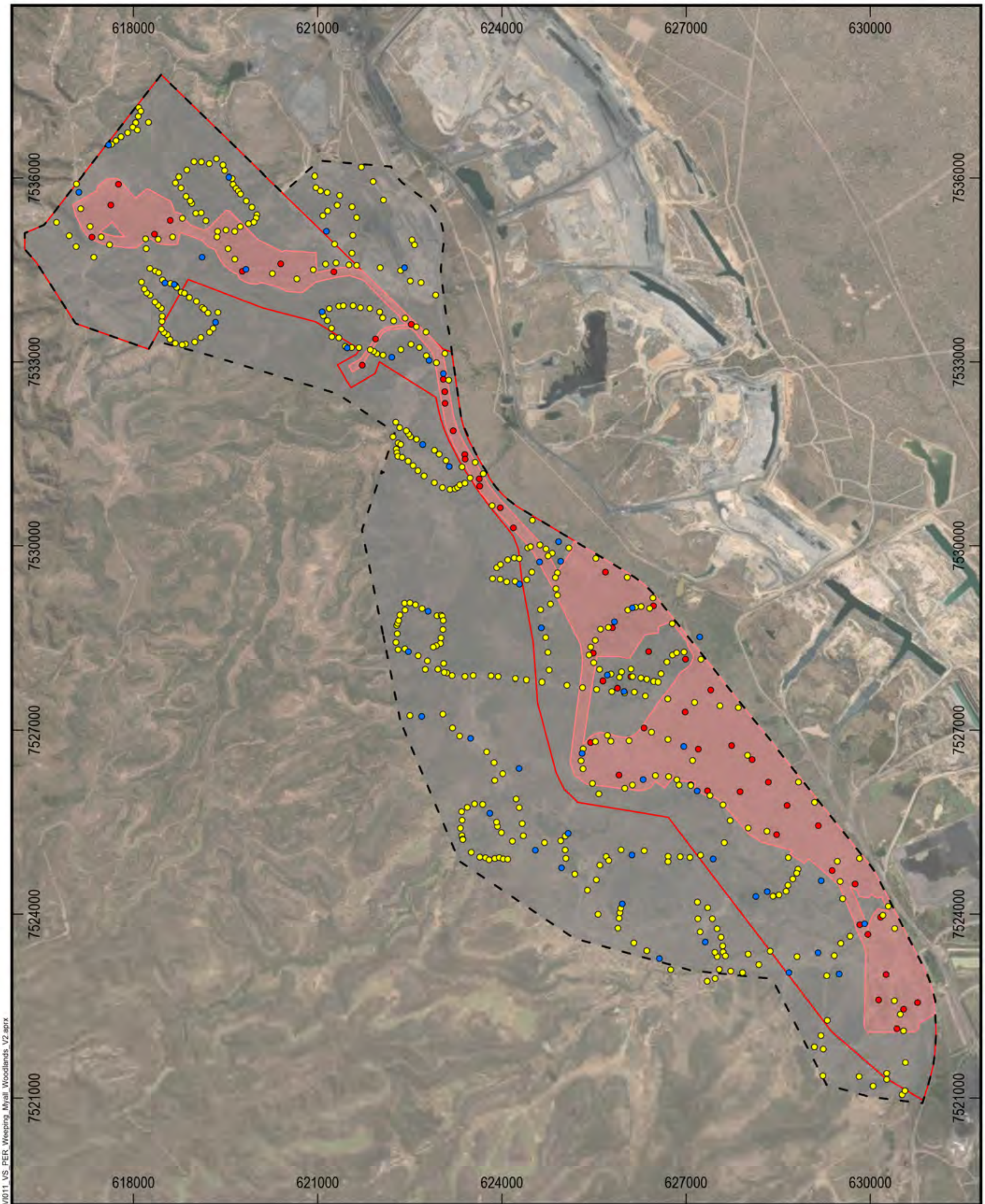
Key threats include clearing and ongoing degradation, especially from pasture clearance, over-grazing, weed invasion, and predation by the Bag-shelter Moth.

5.5.4.4 Habitat Assessment

Suitable REs are mapped within the region, however the component REs were not found within the disturbance footprint as shown in **Figure 5-4**.

5.5.4.1 Summary of likelihood

This TEC is not present as the required dominant species *Acacia pendula* was not present, and in the unlikely event that it was present as isolated trees, the species certainly would not have qualified as dominant.



Legend

Survey Sites
- Quaternary
- Secondary
- BioCondition

Vulcan South Coal Mine (2023/09708)
- Survey Area
- Disturbance Footprint
- Project Area (ML 700073)

Weeping Myall Woodlands
- TEC Not Present

Source: Vulcan South datasets - Vitrinite 2024 & METServe 2020-2024. Earthstar Geographics 28/09/2023.

Vulcan South

Weeping Myall Woodlands

0 0.75 1.5 3

Kilometers

Scale: 1:90,000 (A4)

24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-4

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.5.5 Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions

5.5.5.1 Listing Advice

- Commonwealth: Endangered
- Queensland:
  - 11.3.11: Endangered;
  - 11.4.1: Endangered;
  - 11.8.13: Endangered;
  - 11.11.18: Endangered;
  - 11.2.3: Of Concern; and
  - 11.9.4: Of Concern.

5.5.5.2 Distribution and description

Semi-evergreen vine thickets are an extreme form of dry seasonal subtropical rainforest occurring in the Brigalow Belt and Nandewar regions of Queensland and NSW. It is listed as Endangered under the EPBC Act. It occurs in areas with a subtropical, seasonally dry climate on soils of high to medium fertility. Mean annual rainfall ranges from 500–900 mm in the northern parts of the ecological community's distribution to 650–750 mm per annum from central areas of Queensland to northern New South Wales and falls predominantly in the summer. In Queensland, the ecological community is most common on undulating plains on fine grained sedimentary rocks (frequently shale) and on basalt hills and plains, though also occurring less frequently on coastal dunes, Quaternary alluvium, Tertiary clay plains, old loamy and sandy plains, or hills and lowlands on metamorphic rocks (Department of Climate Change, Energy, the Environment and Water, 2023a).

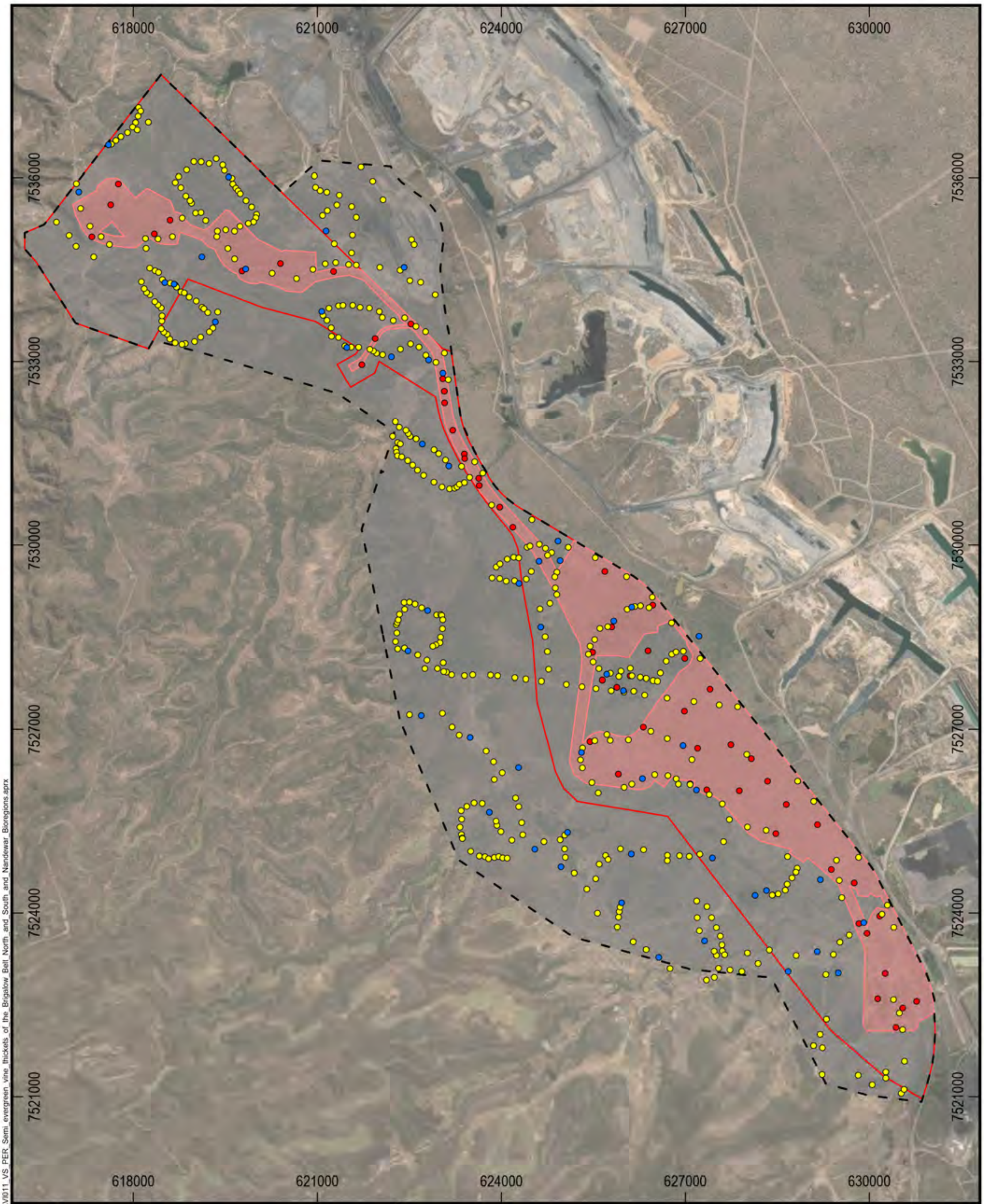
5.5.5.3 Threatening Processes

Seven key threats have been identified which have reduced or may reduce the extent of occurrence of this TEC:

- clearing (moderate threat);
- fire (moderate to high threat);
- weeds (moderate to high threat);
- grazing (moderate threat);
- other pests (low threat);
- coastal development (moderate threat); and
- climate change (potentially high threat).

5.5.5.4 Habitat Assessment

A small area (1.3 ha) of semi-evergreen vine thicket is located in a gorge in the upper reaches of North Creek. Floristically, this resembles the threatened ecological community listed under the EPBC Act as “Semi-evergreen Vine Thickets of the Brigalow Belt (North and South) and Nandewar Bioregions”. However, the particular regional ecosystem assigned to this vine thicket (11.10.8) is not included in the listed threatened ecological community, on the grounds that it occurs on coarse-grained sedimentary rock (Department of Climate Change, Energy, the Environment and Water, 2024v). Condition thresholds for the TEC as per the Approved Conservation Advice were not met. This TEC is not present, as shown in **Figure 5-5**.



Legend

Survey Sites

- Quaternary
- Secondary
- BioCondition

Vulcan South Coal Mine (2023/09708)

- Survey Area
- Disturbance Footprint
- Project Area (ML 700073)

Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions

- TEC Not Present

Source: Vulcan South datasets - Vitrinite 2024 & METServe 2020-2024. Earthstar Geographics 28/09/2023.

Vulcan South

Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions

0 0.75 1.5 3

Kilometers

Scale: 1:90,000 (A4)

24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-5

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Semi_evergreen_vine_thickets_of_the_Brigalow_Belt_North_and_South_and_Nandewar_Bioregions.aprx

5.5.5.5 Summary of likelihood

This TEC is not present as the soil type required for this to qualify as a TEC was not present.

5.6 MNES Threatened Species

51 species were identified either during the recent PMST search or the Terrestrial Ecology report as potentially occurring within the Project area. All confirmed present, likely, possible, and unlikely species are described further in this Section, with distribution, habitat, life history and habitat assessment provided to determine in more detail the species utilisation of habitat and the importance of such habitat. Following this, this Section concludes the final likelihood and whether the species will be impacted. All species determined to be impacted are described in detail within **Section 6**.

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

5.6.1.1 Listing Status

- Commonwealth: Vulnerable
- Queensland: Vulnerable

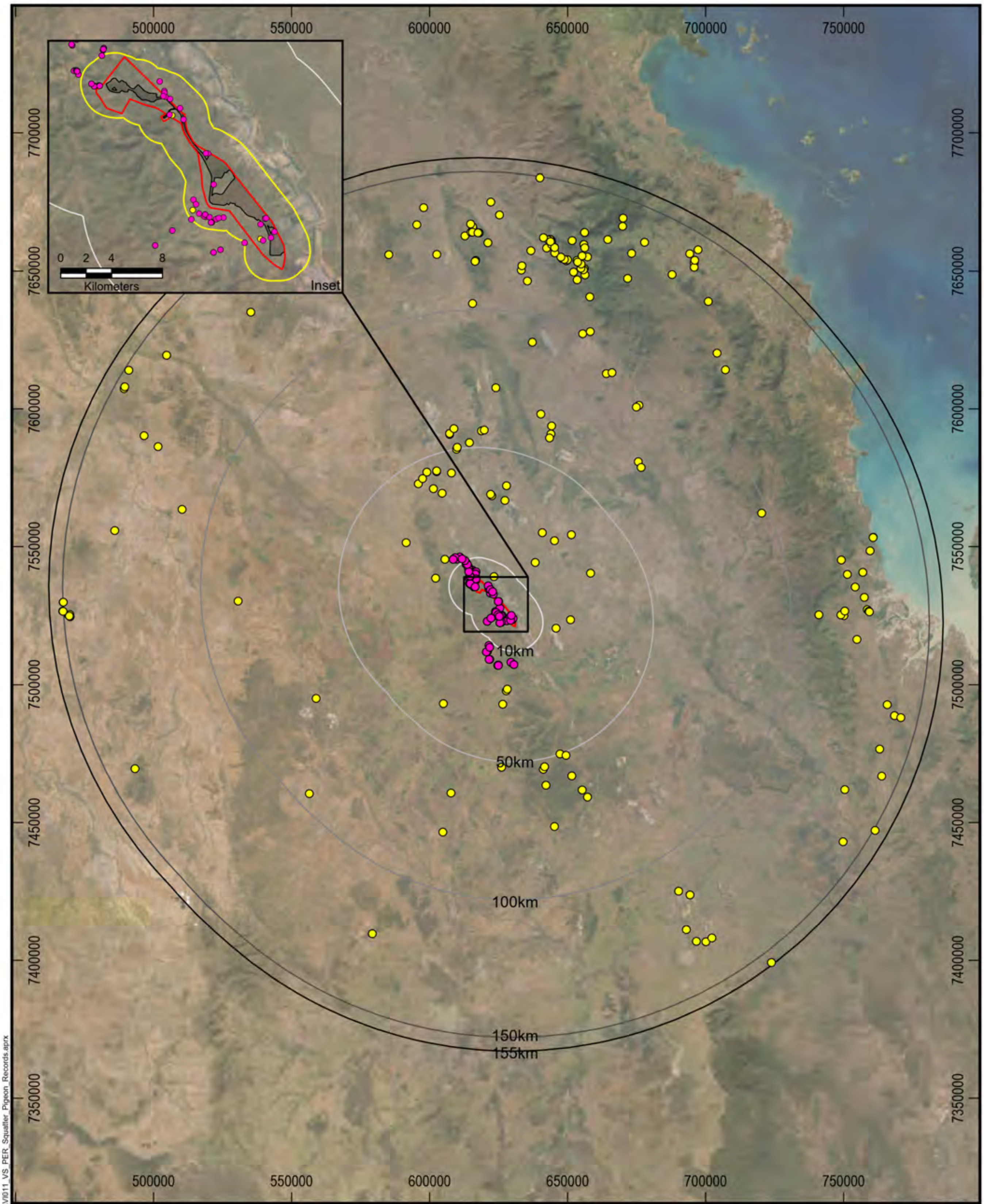
The southern subspecies of the Squatter Pigeon (*Geophaps scripta scripta*) is listed as vulnerable under the EPBC Act.

5.6.1.2 Distribution

Its known distribution extends south from the Burdekin-Lynd divide in the southern region of Cape York Peninsula to the Border Rivers region of northern NSW, and from the east coast to Hughenden, Longreach and Charleville, Queensland (Department of Climate Change, Energy, the Environment and Water, 2024h).

5.6.1.3 Historical Occurrence

Multiple records exist surrounding the Project area and this species was also sighted during field surveys, as shown in **Figure 5-6**. The closest records, up to 35 km from the Project, are as recent as 2020 (iNaturalist).



Legend

- Squatter Pigeon Sightings

ALA Records

- *Geophaps scripta* (Squatter Pigeon)

Vulcan South Coal Mine (2023/09708)

- 2 km Buffer
- Project Area (ML 700073)
- Disturbance Footprint

Impact Area Search Radius (km)

- 10
- 50
- 100
- 150
- 155

Source: Vitrinite 2024, METServe 2020-2024, Atlas of Living Australia 2024, Earthstar Geographics.

Vulcan South

Squatter Pigeon Records

0 20 40 80

Kilometers

Scale: 1:2,000,000 (A4)

24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-6

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.6.1.4 Habitat overview

As per the Conservation Advice (Threatened Species Scientific Committee, 2015b), the Squatter Pigeon is a ground-dwelling bird that feeds on seeds among sparse and low grass, in improved pastures, and beside railway lines and around settlements. The Squatter Pigeon inhabits the grassy understorey of open eucalypt woodland, and less often savannas. It is nearly always found near permanent water such as rivers, creeks and waterholes. Sandy areas dissected by gravel ridges, which have open and short grass cover, allowing easier movement, are preferred. It is less commonly found on heavier soils with dense grass. It often occurs in burnt areas and is sometimes found on tracks and roadsides. As per the Conservation Advice (Threatened Species Scientific Committee, 2015b), the Squatter Pigeon is a ground-dwelling bird that feeds on seeds among sparse and low grass, in improved pastures, and beside railway lines and around settlements. The Squatter Pigeon inhabits the grassy understorey of open eucalypt woodland, and less often savannas. It is nearly always found near permanent water such as rivers, creeks and waterholes. Sandy areas dissected by gravel ridges, which have open and short grass cover, allowing easier movement, are preferred. It is less commonly found on heavier soils with dense grass. It often occurs in burnt areas and is sometimes found on tracks and roadsides. The species nests on the ground, usually laying two eggs among or under vegetation (Threatened Species Scientific Committee, 2015b).

Provided land is not overgrazed, Squatter Pigeons coexist readily with cattle grazing; however, the species has largely disappeared from the southern part of its distribution (e.g., New South Wales and southern Queensland), where sheep grazing is widespread and rabbit densities are high (Threatened Species Scientific Committee, 2015b). Squatter Pigeons often favour thinned habitats where grazing cattle create open patches of ground for foraging. Some introduced pastures also provide a valuable food source for the species (Crome, 1976). A moderate amount of land modification probably benefits the species, reflected by long-term population increases (between 1934 and 1999) in grazing properties elsewhere in the Brigalow Belt (Woinarski & Catterall, 2004). This is also supported by data comparing undisturbed woodlands near Townsville with areas disturbed by grazing or military activities; the latter two land uses supported ten times more Squatter Pigeons (Woinarski & Ash, 2002).

Habitats in summary are defined as follows:

BREEDING HABITAT

Any remnant or regrowth open-forest to sparse, open-woodland or scrub dominated by *Eucalyptus, Corymbia, Acacia* or *Callitris* species, on sandy or gravelly soils (including but not limited to areas mapped as Queensland land zones 3, 5 or 7) and within 1 kilometre of a suitable, permanent or seasonal waterbody.

FORAGING HABITAT

Any remnant or regrowth open-forest to sparse, open-woodland or scrub dominated by *Eucalyptus, Corymbia, Acacia* or *Callitris* species, on sandy or gravelly soils (including but not limited to areas mapped as Queensland land zones 3, 5 or 7) and within 3 kilometres of a suitable, permanent or seasonal waterbody.

DISPERSAL HABITAT

Any forest or woodland occurring between patches of foraging or breeding habitat that facilitates movement between patches of foraging habitat, breeding habitat and/or waterbodies, and areas of cleared land less than 100 metres wide linking areas of suitable breeding and/or foraging habitat.

5.6.1.5 Life History

There is no specific information on this species regarding sexual maturity, life expectancy or natural mortality. Individuals in captivity are able to breed from one year of age, and generation length is estimated at five years. Breeding success relies on abundance of food resources. Breeding can occur throughout most of the year in good conditions, however peak breeding season likely coincides with the dry season (Department of Climate Change, Energy, the Environment and Water, 2024h; Threatened Species Scientific Committee, 2015b).

5.6.1.6 Threatening Processes

Key threats (Department of Climate Change, Energy, the Environment and Water, 2024h) include:

- Habitat clearing;
- Over-grazing and overstocking within habitat;

- Presence of invasive weeds and grasses;
- Predation by avian and terrestrial predators (including feral and exotic species);
- Bushfire; and,
- Drought.

5.6.1.7 Adequacy of bird surveys

Bird surveys found the species throughout suitable habitats in the survey area, including within the disturbance footprint. Driving internal tracks throughout the survey area was useful for incidental records in addition to planned bird surveys, conducted around trapping sites at 10 minutes per morning and 10 minutes per afternoon, repeated over the 5 days traps were active (refer to Section 3.2.2.3 of **Appendix M**). As the species was readily observed throughout the duration of the field surveys, the surveying methodology is considered successful and therefore adequate. Habitat calculations, therefore, are conservatively made with reference to current conservation advice and appropriate literature, as described below in 5.6.1.8.

5.6.1.8 Habitat Assessment in the Project area

Squatter Pigeon habitat is presented below in **Figure 5-7**. Habitat scoring methodologies are discussed in **Section 9.2.3**.

Except where this has been cleared, all vegetation within the survey area (with the exception of one small patch of vine-thicket) is dominated by *Eucalyptus*, *Corymbia* and/or *Acacia* species. Most is located on land zone 5 (sandy plain) and is favoured by Squatter Pigeons. Here, *Eucalyptus crebra*, *Eucalyptus populnea*, *Eucalyptus melanophloia* and *Corymbia clarksoniana* are the dominant canopy species. The understorey is usually dominated by the introduced pasture grasses *Bothriochloa pertusa*, *Cenchrus ciliaris* and *Melinis repens*. However, the native grasses *Aristida* spp., *Chrysopogon fallax*, *Eriochloa crebra* and *Alloteropsis cimicina* are occasionally dominant.

Narrow ribbons of land zone 3 (sandy alluvium) occur along creeks, where dense forests of *Eucalyptus camaldulensis* and *Melaleuca leucadendra* grow. Creek terraces support open forests of *Corymbia tessellaris*, *Eucalyptus populnea*, *Corymbia dallachiana* and *Corymbia clarksoniana*. In general, land zone 3 contains too thick a grass cover to be favourable for Squatter Pigeons; the mean ground vegetation cover is 58% and four out of five sites sampled exceeded 33% cover. However, most permanent water points (dams and natural wetlands) are located in this land zone, and these provide water resources for Squatter Pigeons. Furthermore, as the ground around these water points is often heavily grazed, patches of suitable foraging habitat exist in an otherwise unfavourable matrix. These “islands” of highly favourable habitat (water with adjacent foraging habitat) were the locations of many Squatter Pigeon sightings (**Table 5-6**).

Land zone 10 (sandstone rises and escarpments) occurs along the western fringe of the MLA area, and more extensively further west. Steep slopes, extensive rock outcropping, no surface water, and a lack of bare ground patches within this land zone make it largely unsuitable for Squatter Pigeons. Of 17 sites sampled, nine were unsuitable for Squatter Pigeons due to having >33% vegetation cover or <10% bare ground. The eight sites classed as suitable based on understorey composition were primarily in regional ecosystems 11.10.7 or 11.10.3 located on the foot slopes. Squatter Pigeon sightings largely mirrored these habitat assessments. Despite comprising 39% of the total survey area, only 3% of individuals sighted were in land zone 10 (all in regional ecosystem 11.10.7), and all were within 300 m of land zone 3 or 5.

The vast majority of sightings (69.7%) were in land zone 5, a finding that strongly accords with habitat preferences presented in the SPRAT profile.

No Squatter Pigeons were recorded on land zones 4 or 9. The heavy clay soils in land zone 9 support an excessively dense grass cover. In remnant 11.9.2, vegetation covers an average of 63% of the ground, and this increases to 85% in areas where 11.9.2 has been cleared. The clay soils in land zone 4 are similarly unsuitable for Squatter Pigeons. Sites surveyed within this land zone fell into one of two categories. In areas where the canopy was open, vegetation covered far greater than 33% of the ground. In areas where the canopy was dense, there was very little grass as a source of seed and/or bare ground on which to forage (one or both categories constituted less than 10% of the total ground cover).

In summary, data gathered on site strongly supports the habitat preferences described in the SPRAT profile, in that land zone 5 constitutes the primary foraging and breeding habitat for Squatter Pigeons within the survey area, land zone 3 is utilised in the vicinity of water, and land zone 10 is mostly not utilised, except for regional ecosystem 11.10.7 on the foot slopes. There is no local evidence that heavy clays on land zones 4 and 9 are utilised by Squatter Pigeons.

Table 5-6 Squatter Pigeon records per habitat type

land zone	Vegetation Age	Percentage of Survey Area	Percentage of Squatter Pigeon Records
3: Alluvium	Remnant Regrowth Cleared	5.5% 2.3% 4.2%	21.2%* 4.5%* 6.1%*
4: Clay plain	Remnant Regrowth Cleared	2.1% 0.1% 1.6%	0% 0% 0%
5: Sand plain	Remnant Regrowth Cleared	17.1% 7.5% 12.2%	15.2% 6.0% 48.5%
9: Clay derived from fine grained sedimentary rock	Remnant Regrowth Cleared	4.8% 0% 2.8%	0% 0% 0%
10: Sandstone ridges	Remnant Regrowth Cleared	37.5% 1.7% 0.8%	3% 0% 0%

Source: Appendix M

*Detection rates of Squatter Pigeons in alluvial areas may overestimate the true value of this habitat for the species, as the high grass density within this land zone means that individuals are more likely to forage on tracks, where they are more detectable.

Many cleared patches of vegetation within the survey area had regrown sufficiently, or a sufficient density of trees was retained during clearing, for some cleared areas to qualify as "sparse open-woodland or scrub" used by Squatter Pigeon for foraging and breeding. Accordingly, as can be seen from **Table 5-6**, many Squatter Pigeon records came from cleared vegetation.

There is no single, standard definition of "sparse" vegetation in Australia. The most widely used vegetation classification system (the Specht classification system) defines "sparse" vegetation classes as possessing 10-30% foliage projection cover or 20-50% canopy cover (the latter includes gaps between leaves within each canopy). However, in its National Forest and Sparse Woody Vegetation Data (Department of Climate Change, Energy, the Environment and Water, 2020), the Australian Government adopts a more conservative definition of sparse woody vegetation as having 5-19% canopy cover. Given that the definition of Squatter Pigeon habitat as "open-forest to sparse, open-woodland or scrub" was developed by the Australian Government for their SPRAT profile, the Australian Government's definition of "sparse" as >5% canopy cover was adopted for habitat mapping purposes.

Regardless of the status of vegetation under Queensland's VM Act (non-remnant, regrowth or remnant), any parts of land zones 3 or 5 that qualified as "sparse" vegetation according to National Forest and Sparse Woody Vegetation Data were considered Squatter Pigeon foraging habitat and/or breeding habitat. Likewise, any remnant or former regional ecosystem 11.10.7 was considered habitat if this qualified as "sparse" vegetation. Vegetation with less than 5% cover of woody vegetation, vegetation occurring on land zones 4 or 9, and any vegetation on land zone 10 that is not 11.10.7 were not considered appropriate foraging or breeding habitat.

Most habitats within the survey area that did not qualify as foraging or breeding habitat did qualify as dispersal habitat. Most of the survey area, including areas that do not qualify as "sparse woody vegetation" have trees that are 100 m or less apart. Satellite imagery was used to identify non-remnant patches where trees were further than 100 m apart. Any vegetation outside these bare patches that were not foraging habitat qualified as dispersal habitat.

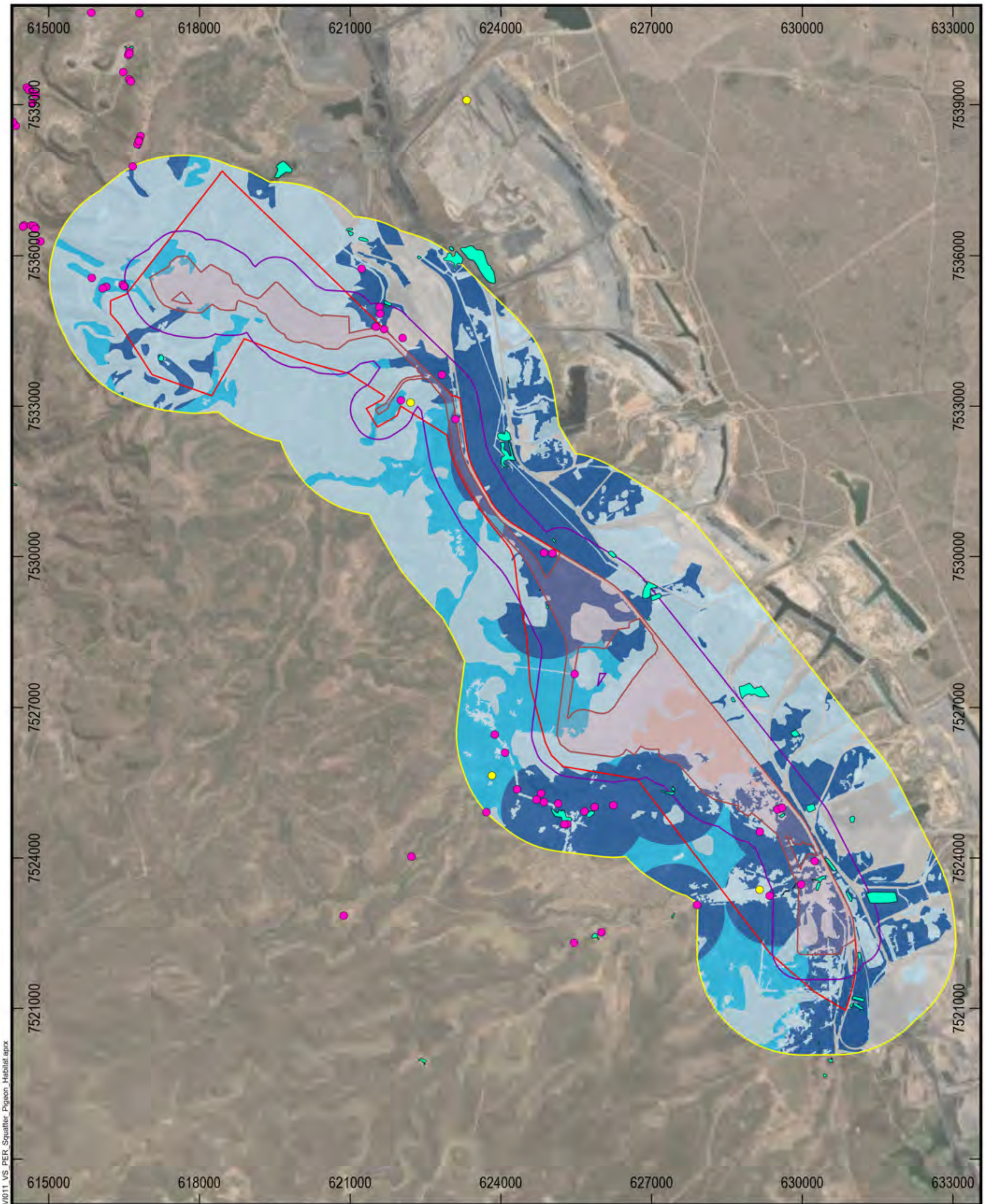
The disturbance footprint contains the following habitat categories (**Figure 5-7**):

- breeding and foraging: 372.5 ha;

- foraging: 78.9 ha; and
- dispersal: 767.6 ha.

Habitat within a 500m indirect impact buffer around the Project contains the following habitat categories (**Figure 5-7**):

- breeding and foraging: 858.8 ha;
- foraging: 338.7 ha; and
- dispersal: 1318.2 ha.



Legend

- Squatter Pigeon Sightings

Atlas of Living Australia Records

- Geophaps scripta (Squatter Pigeon)
- Waterbodies

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- 2 km Buffer
- 500m Indirect Impact Buffer

Squatter Pigeon Habitat

- Breeding and Foraging
- Foraging
- Dispersal
- Non-habitat

Source: Atlas of Living Australia 2024, Vitrinite 2024, METServe 2020-2024, Earthstar Geographics.

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Squatter_Pigeon_Habitat.aprx

Vulcan South

Squatter Pigeon Habitat

0 1 2 3

Kilometers

Scale: 1:110,000 (A4)

24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-7

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.6.1.9 Summary of likelihood

The Squatter Pigeon (Southern) was determined to be present and is assessed for significance of impacts in **Section 6.2.2**.

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

5.6.2.1 Listing status

- Commonwealth – Endangered
- Queensland – Endangered.

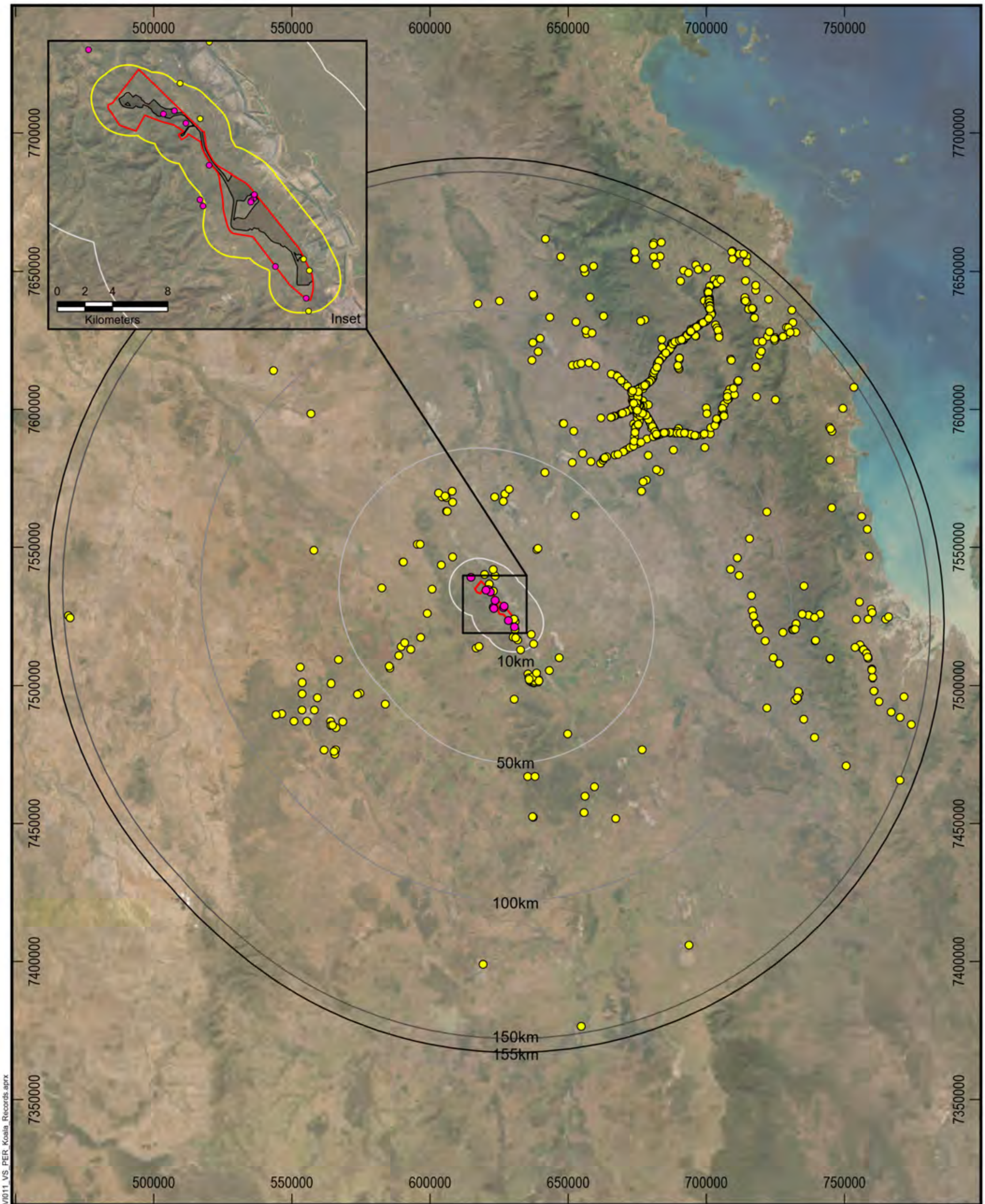
5.6.2.2 Distribution

Koalas (*Phascolarctos cinereus*) within Queensland, New South Wales and the Australian Capital Territory are listed as Endangered under the EPBC Act.

Koalas occur in patchy and often low-density populations, and across several regions including in the Brigalow Belt North and Brigalow Belt South (DAWE, 2022b). In the northwest of their range in Queensland (including the Project area), Koala distribution is limited by heat and water availability, with the highest densities of Koalas occurring along creek lines (Munks, et al., 1996; Sullivan, et al., 2003). Variability in leaf nutrition creates patchiness such that species-based assessments of habitat likely overestimate the availability of high-quality habitat (Threatened Species Scientific Committee, 2012). The Brigalow Belt bioregion contains the largest population of Koalas within Queensland (Department of Climate Change, Energy, the Environment and Water, 2022e), owing to its large size and subhumid climate (other large bioregions are in semi-arid climates with low Koala densities).

5.6.2.3 Historical Occurrence

There are numerous recent occurrences within 20 km of the Vulcan South Coal Mine. The Koala has been confirmed as present by field surveys. Field survey sightings are shown in **Figure 5-8.**



Legend

- Koala Sighting

ALA Records

- *Phascolarctos cinereus* (Koala)

Vulcan South Coal Mine (2023/09708)

- 2 km Buffer
- Project Area (ML 700073)
- Disturbance Footprint

Impact Area Search Radius (km)

- 10
- 50
- 100
- 150
- 155

Source: Vitrinite 2024, METServe 2020-2024, Atlas of Living Australia 2024, Earthstar Geographics.

Vulcan South

Koala Records

0 20 40 80

Kilometers

Scale: 1:2,000,000 (A4)

24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-8

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Koala_Records.aprx

5.6.2.4 Habitat

The main habitat requirement is availability of suitable food trees and, to a lesser extent, shelter trees, which tend to have shadier foliage, be taller and/or be located in sheltered locations in gullies (Crowther, et al., 2013). While Koalas have been observed sitting in or eating up to 120 species of eucalypt (Phillips, 1990), the diet of individual Koalas is usually limited to one or a few species (Moore & Foley, 2000). Preferences also vary between regions or seasons (Moore & Foley, 2000). Chemical anti-feedants, soil nutrients and leaf water content in semi-arid areas may limit or prevent Koalas feeding on foliage of individual trees, even when the species is considered preferred (Lawler, et al., 1998; Moore, et al., 2005).

5.6.2.5 Life History

Female Koalas reach sexual maturity between 2 and 3 years of age and may then produce one offspring per year. Females have a 12-month lactation period, and young Koalas are weaned after this period. Weaning coincides with periods of high food availability and favourable climatic conditions. Local factors, including population density, food quality and availability, soil type and climate, influence the timing of breeding. Koalas may not breed every year if conditions are unfavourable, and breeding can be unsuccessful due to poor body condition or disease (DAWE, 2022b).

5.6.2.6 Threatening Processes

Habitat clearance, climate change (bringing increased drought, bushfire, and heatwave frequency), a shrinking climate envelope, and disease represent threats to Koala populations in the Brigalow Belt. Road-based mortality is another local threat, and multiple fatalities occur along Saraji Road each year. Attacks by domestic dogs, a key threat in densely settled regions of Queensland, is a negligible threat locally, given the low density of houses. These threats can compound and exacerbate each other (DAWE, 2022b).

5.6.2.7 Habitat Assessment

Koala habitat is shown in **Figure 5-9**. Foraging habitat quality is shown in **Figure 9-1** in **Section 9.2**. Habitat connectivity is high across the region surrounding Vulcan South. Habitats containing secondary food trees connect ribbons of important habitat (containing primary food trees) occurring along major watercourses and provide opportunities for dispersal. Vulcan South, however, lies at a habitat edge, as it is bounded to the north and east by existing mining operations that represent an impediment to dispersal. The Koala population present within the survey area is connected to the broader region via extensive tracts of eucalypt forests that cover the Cherwell-Harrow Range, to the west and south.

The Australian Koala Foundation (2015) maintains a database of the food trees known to be used by Koalas in each local government area of Australia. **Table 5-7** below lists the most desired trees (primary), the trees less favoured (secondary) and *Eucalyptus crebra*, a species that is known to be utilised when it is growing in optimal conditions. Given that this tree species is eaten by Koalas at nearby sites (Ellis, et al., 2002; Melzer, et al., 2014), it is conservatively considered a food tree for the purposes of habitat mapping. This species is widespread across the survey area and surrounding region, being a dominant component of many of the regional ecosystems occurring on site. Given the low fertility of local sandy soils, it is unlikely that most local *E. crebra* is utilised to a significant extent by Koalas. Indeed, no Koalas were recorded anywhere on land zone 5 (sand plains), where soils are least fertile. However, small numbers were observed on land zone 10 (sandstone) where *E. crebra* was growing. In accordance with the DCCEEW (2022e) definition of Koala habitat (i.e., any forest or woodland containing species that are known Koala food trees), any vegetation containing *E. crebra* is included as potential habitat.

Table 5-7 Koala food trees in the Isaac region

Species	Primary or secondary	In disturbance footprint
Eucalyptus camaldulensis	Primary	Y
Eucalyptus tereticornis	Primary	Y
Eucalyptus brownii	Secondary	N
Eucalyptus coolabah	Secondary	N
Eucalyptus ochrophloia	Secondary	N
Eucalyptus orgadophila	Secondary	N
Eucalyptus populnea	Secondary	Y
Eucalyptus crebra	Occasional	Y

In addition, the document "A review of Koala habitat assessment criteria and methods" (The Australian National University, 2021) outlines the following locally important Koala trees in the Brigalow Belt. These include food trees (locally important Koala trees) and trees that are most likely used for shelter trees (Ancillary habitat trees). These are presented in **Table 5-8.**

Table 5-8 Locally important Koala trees in the Brigalow Belt

Species	Common name	In disturbance footprint?
Brigalow Belt locally important Koala trees		
Eucalyptus brownii	Brown's box, Red river box	N
Eucalyptus chloroclada	Baradine gum, Red gum, Dirty gum	N
Eucalyptus conica	Fuzzy box, Fuzzy gum	N
Eucalyptus coolabah	Coolibah, Coolabah	N
Eucalyptus drepanophylla	Queensland grey ironbark, Narrow-leaved ironbark	N
Eucalyptus dura	Ironbark	N
Eucalyptus fibrosa	Broad-leaved red ironbark, Blue-leaved ironbark, Dusky-leaved ironbark	N
Eucalyptus laevopinea	Silvertop stringybark	N
Eucalyptus largiflorens	Black box, Flooded box, River box	N
Eucalyptus longirostrata	Grey Gum	N
Eucalyptus major	Queensland grey gum, Grey gum	N
Eucalyptus microcarpa	Grey box, Narrow-leaved box, Inland box	N
Eucalyptus moluccana	Coastal grey box, Gum-topped box, Grey box	N
Eucalyptus ochrophloia	Yapunyah, Napunyah, Yellow jacket	N
Eucalyptus punctate	Grey gum, Grey iron gum, Long-capped grey gum	N
Eucalyptus saligna	Sydney blue gum, Blue gum	N
Eucalyptus sideroxylon	Red ironbark, Mugga ironbark, Three-fruited red ironbark	N
Eucalyptus camaldulensis	River Red Gum, Murray red gum, Yarrow	Y
Eucalyptus crebra	Narrow-leaved ironbark, Narrow-leaved red ironbark, Muggago	Y
Eucalyptus exserta	Queensland peppermint, yellow messmate, Bendo	Y
Eucalyptus melanophloia	Silver-leaved Ironbark	Y

Species	Common name	In disturbance footprint?
Eucalyptus orgadophila	Mountain Coolibah, Gum topped box	Y
Eucalyptus populnea	Poplar gum, Bimble box	Y
Eucalyptus tereticornis	Forest red gum, Flooded gum, Queensland blue gum	Y
Ancillary habitat trees		
Acacia harpophylla	Brigalow, Spearwood, Orkor	Y
Acacia salicina	Cooba, Motherumba, Broughton willow, Sally Wattle	Y
Acacia tephrina	Boree	N
Corymbia citriodora	Lemon-scented gum, Spotted gum	Y
Corymbia dallachiana	Dallachy's ghost gum	Y
Corymbia erythrophloia	Red bloodwood, Variable-barked bloodwood, Red-barked bloodwood, Gum-topped bloodwood	Y
Corymbia intermedia	Pink bloodwood, Red bloodwood	Y
Corymbia tessellaris	Moreton Bay ash, Carbeen	Y
Eucalyptus acmenoides	White Mahogany, Narrow-leaved white stringybark	Y
Eucalyptus baileyana	Bailey's Stringybark, Black stringybark	N
Eucalyptus cambageana	Dawson River blackbutt, Dawson’s gum, Coowarra box	Y
Eucalyptus decorticans	Gum-top Ironbark	N
Eucalyptus platyphylla	White Gum, Poplar gum	Y
Eucalyptus thozetiana	Thozet’s box, Mountain yapunyah	Y
Melaleuca bracteata	Black tea-tree, River tea-tree, Mock olive	Y

In consideration of both of the above sources, habitat for the Koala in the survey area includes the following remnant and non-remnant (NR) REs:

FORAGING/SHELTER/DISPERSAL:

- 11.10.1x1: (see **Table 4-3**): *Corymbia aureola* and *Eucalyptus melanophloia* open forest on scarps and sandstone tablelands. Primary food trees are absent. Secondary food trees include *Eucalyptus crebra* in low quantities.
- 11.10.3/NR 11.10.3: *Acacia shirleyi* open forest on coarse-grained sedimentary rocks. Primary food trees are absent. Secondary food trees include *Eucalyptus crebra* in low quantities.
- 11.10.7: *Eucalyptus crebra* woodland on coarse-grained sedimentary rocks. Primary food trees are absent. Secondary food trees include *Eucalyptus crebra.*
- 11.3.2: *Eucalyptus populnea* woodland on alluvial plains. Primary food trees are absent. Secondary food trees include *Eucalyptus populnea*.
- 11.3.25: *Eucalyptus camaldulensis* forest fringing drainage lines. Primary food trees include *Eucalyptus camaldulensis*. Secondary food trees include *Eucalyptus populnea* and/or *E. crebra*.
- 11.5.3/NR 11.5.3: *Eucalyptus populnea* woodland on Cainozoic sand plains and/or remnant surfaces. Primary food trees are absent. Secondary food trees include *Eucalyptus populnea.*
- 11.5.9/NR 11.5.9: *Eucalyptus crebra* and other *Eucalyptus* spp. and *Corymbia* spp. woodland on Cainozoic sand plains and/or remnant surfaces. Primary food trees are absent. Secondary food trees include *E. crebra* (some variants of this RE lack secondary food trees).

- 11.5.9a: *Eucalyptus melanophloia* woodland. Occurs on Cainozoic sandplains formed on plateaus and broad crests of hills and ranges.
- 11.9.2/NR 11.9.2: *Eucalyptus orgadophila* woodland on fine-grained sedimentary rocks. Primary food trees are absent. Secondary food trees include *Eucalyptus orgadophila*.
- 11.10.7: *Eucalyptus crebra* woodland on coarse-grained sedimentary rocks. Primary food trees are absent. Secondary food trees include *Eucalyptus crebra.*

SHELTER/DISPERSAL:

- 11.3.7/NR 11.3.7: *Corymbia* spp. woodland on alluvial terraces.
- 11.4.9*: Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains.
- 11.10.1: *Corymbia citriodora* woodland on coarse-grained sedimentary rocks.

  11.4.8/NR 11.4.8: Eucalyptus cambageana woodland to open forest with Acacia harpophylla on Cainozoic clay plains. No food trees are present.

DISPERSAL

Dispersal habitats are habitats that are between foraging habitats without dispersal barriers, i.e., habitats which are no more than 4 km apart but themselves contain little or no resources for the species. They are not functional for the Koala as standalone habitats. Despite the addition of these areas to calculations, they are inconsequential to the species for offsetting purposes. Dispersal habitat is generally considered to have little to no value as shelter from hot or dry conditions.

NON-HABITAT

Non-habitat areas are areas that contain little to no resources for the species. This includes areas that would be considered dispersal habitat, but with preferred corridors within them that contain forage and shelter trees. For example, an open treeless area with a defined line of trees intersecting it would be considered non-habitat, where the defined line of trees is considered foraging/shelter and therefore a preferred dispersal pathway. In the context of the Project, the open areas between foraging/shelter habitats and Saraji Road to the east are considered non-habitat due to the lack of dispersal destinations. As for dispersal habitat, non-habitat is generally considered to have little to no value as shelter from hot or dry conditions.

Figure 5-9 shows Koala habitat in the disturbance footprint (shaded pink area within the mining lease) and in the 500 m indirect impact buffer (pink line). Koala habitat in the disturbance footprint is delineated as follows:

- foraging/shelter/dispersal = 938.6 ha;
- shelter/dispersal = 45.5 ha; and
- dispersal = 182.2 ha.

Total direct: 1,166.9 ha.

Additional areas within 500 m indirect impact buffer include the following:

- foraging/shelter/dispersal = 1532.0 ha;
- shelter/dispersal = 188.4 ha; and
- dispersal = 390.5 ha.

Total indirect: 2,110.9 ha

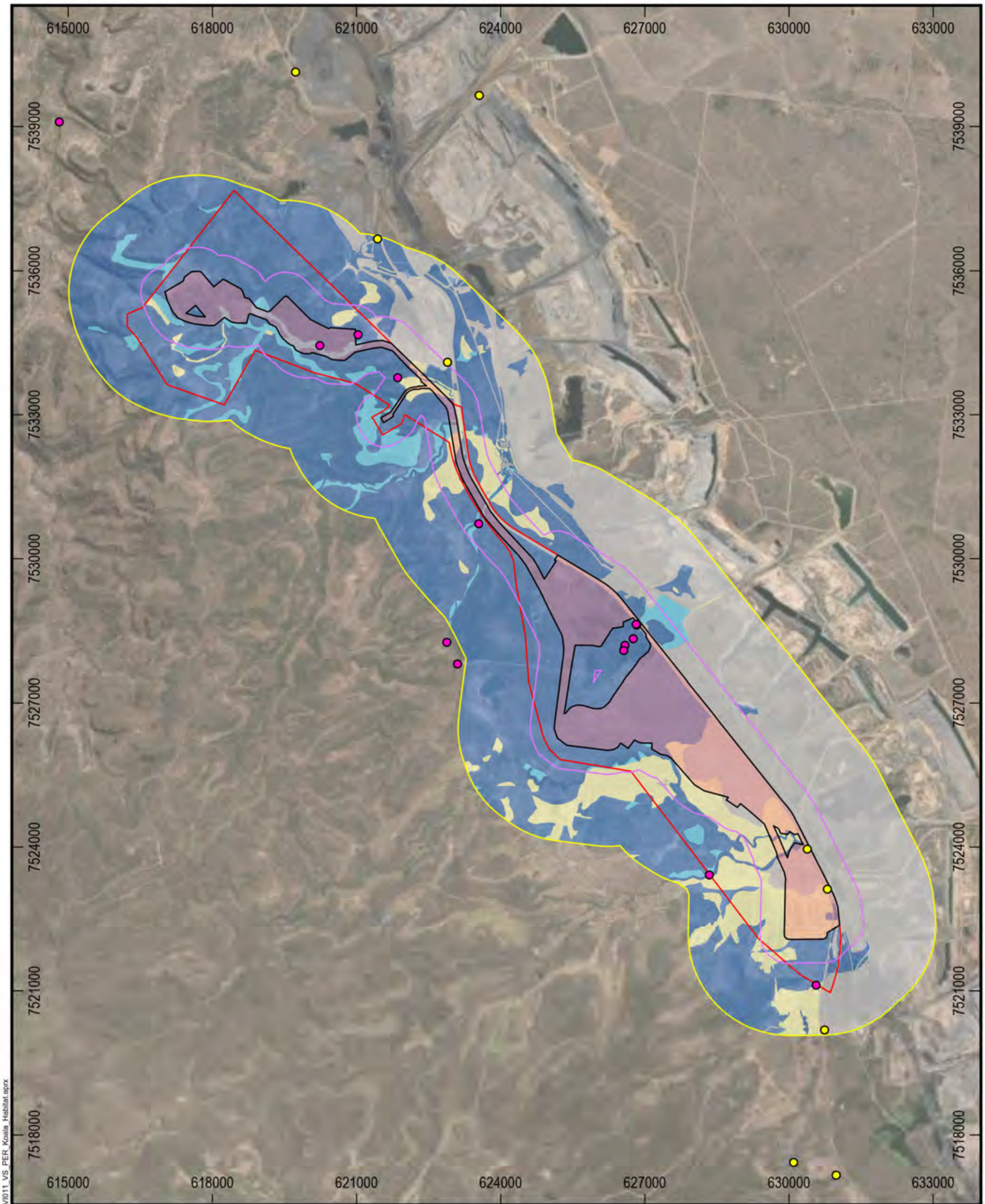
A 500 m buffer was used to represent impacts from noise, dust and vibration as these impacts reduce in intensity with distance and a distance further than 500 m would likely limit the impacts of these variables on wildlife to the point where the impact is negligible.

Koala habitat by type is presented in **Figure 5-9**. This represents the DCCEW definitions of Koala habitat into foraging, shelter and dispersal (these definitions are not prescribed in the Conservation Advice). This categorisation does not include any information regarding the quality of that Koala habitat, for example, poor quality non-remnant compared to high quality riparian vegetation cannot be differentiated within these definitions but will significantly affect how likely the habitats are to be utilised by the species. For this reason, a Koala habitat quality figure has been provided which shows the change in quality across the disturbance footprint and within a 2 km buffer around the disturbance footprint. This figure assists in showing where areas of the footprint have been removed to prevent the clearing of riparian or high-quality Koala habitat. Koala habitat by quality (habitat value) is discussed in **Section 9.2.3.**

5.6.2.8 Sightings

This species was recorded 14 times within the survey area, involving at least 12 individuals. It is highly likely that more individuals were present than were detected.

As far as this species is concerned, the detection of individuals demonstrates the species' presence and the purpose of the survey is considered to be achieved. Habitat type (foraging/shelter/dispersal) was conservatively estimated as outlined above, with habitat quality (density and size of Koala trees within each Assessment unit) subject to the findings of the BioCondition surveys and additional habitat assessments.



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Legend

- Koala Sighting

Atlas of Living Australia Records

- *Phascolarctos cinereus* (Koala)

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- 2 km Buffer
- 500m Indirect Impact Buffer

Koala Habitat Type

- Foraging/shelter/dispersal
- Shelter/dispersal
- Dispersal
- Non-habitat

Source: Atlas of Living Australia 2024, Vulcan South datasets - Vitrinite 2024 & METServe 2020-2024, Koala Habitat - METServe 2024. Earthstar Geographics 28/09/2023

Vulcan South

Koala Habitat Type

0 1 2 4

Kilometers

Scale: 1:115,000 (A4)

24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-9

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.6.2.9 Summary of likelihood

Important habitat for this species occurs across the Project area, confirmed through field surveys. For this season, impacts to this species are investigated in **Sections 6.1** and **6.2**.

5.6.3 Greater Glider (southern and central) (*Petauroides volans*)

5.6.3.1 Listing status

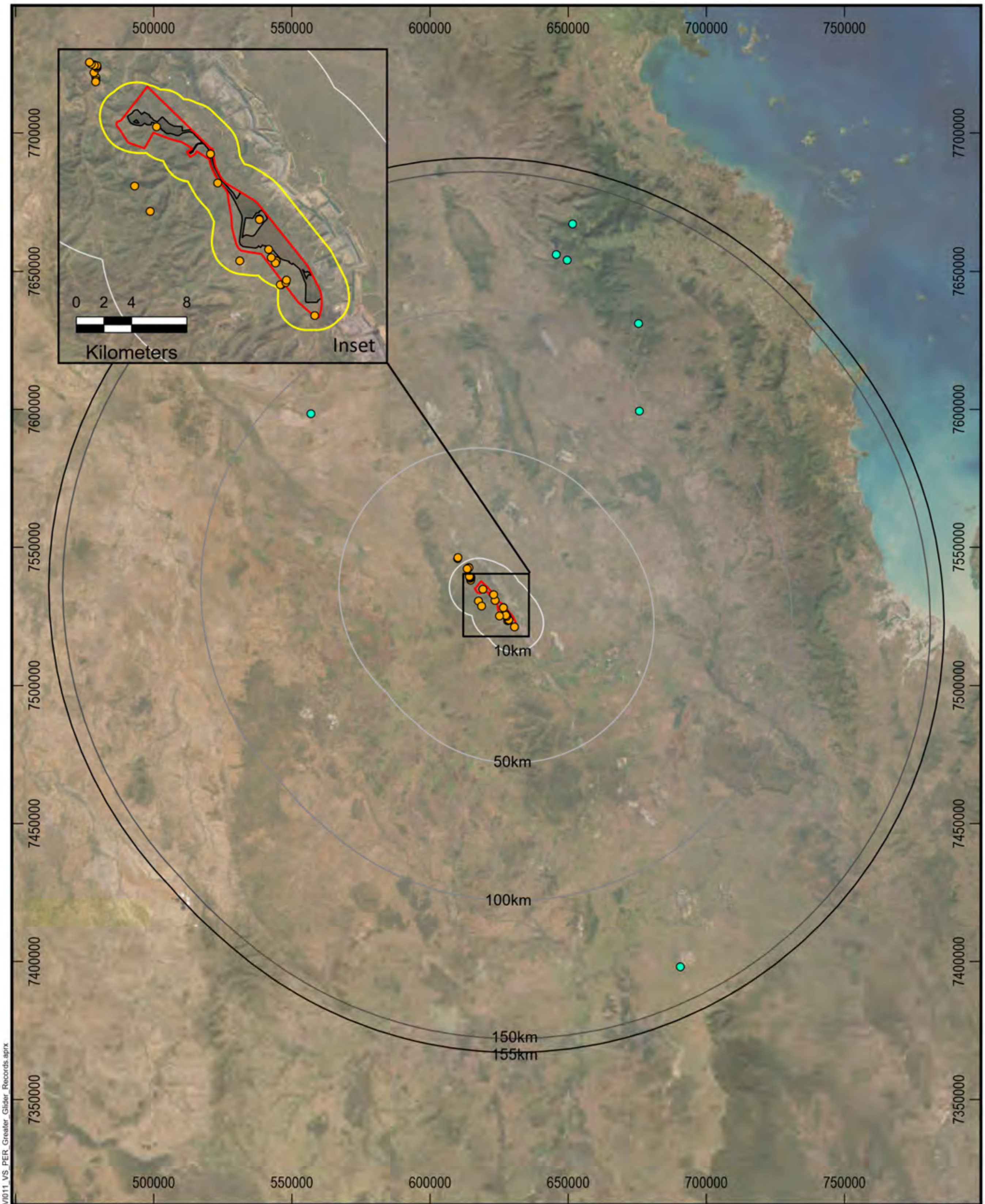
- Commonwealth: Endangered
- Queensland: Endangered

5.6.3.2 Distribution

The Greater Glider (*Petauroides volans*) occurs in eastern Australia, where it has a broad distribution from around Proserpine, and extending southwards to central Victoria (Department of Climate Change, Energy, the Environment and Water, 2022b). The population in the Wet Tropics was split into another species, the Northern Greater Glider (*P. minor*). Some authors include an additional split to include the Central Greater Glider as another species (*P. armillatus*) between Proserpine and Southeastern Queensland, though DCCEEW does not recognise this additional species at the time of writing.

5.6.3.3 Historical Occurrence

The closest records to the Project are mostly grouped between the Eungella and Homevale National Parks, however there are isolated occurrences closer to the Project. The closest of these isolated records include approximately 85 km to the north-east (2012, Queensland Museum) and 86 km north-west from the Project (1996, Queensland Museum). Field surveys confirmed the presence of this species. Historical records and survey sightings are shown in **Figure 5-10.**



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Legend

- *Petauroides volans* (Greater Glider) Sightings

ALA Records

- *Petauroides volans* (Greater Glider)

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint

Impact Area Search Radius (km)

- 2
- 10
- 50
- 100
- 150
- 155

Source: Vitrinite 2024, METServe 2020-2024, Atlas of Living Australia 2024, Earthstar Geographics.

Vulcan South

Greater Glider Records

0 20 40 80

Kilometers

Scale: 1:2,000,000 (A4)

24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-10

5.6.3.4 Habitat

Greater Gliders feed on the young leaves of *Eucalyptus* and *Corymbia* in a broad range of forests across eastern Australia. They have a preference for tall, montane, moist eucalypt forests with abundant hollows and a diversity of tree species present (Threatened Species Scientific Committee, 2016b; Department of Climate Change, Energy, the Environment and Water, 2022b), but also occur in drier lowland forests, provided tall, hollow trees are present.

Local populations are largely restricted to riparian environments, where large, hollow trees are most abundant, and subsoil moisture allows suitable food trees to grow fresh leaves over extended periods of the year.

Each individual requires many large, hollow-bearing trees within its home range of 1-4 ha (Comport, et al., 1996; Lindenmayer, et al., 2004). Southern Greater Gliders generally require trees larger than 50 cm (diameter of trunk at breast height) (Kehl & Borsboom, 1984), and even larger trees may be required in tropical environments, in order for hollows to be buffered against extreme daytime temperatures (Kearney, et al., 2010).

Non-remnant habitats (e.g., regrowth) are unlikely to be utilised by Greater Gliders, due to an absence of hollows for shelter. An exception is where many large, hollow trees were retained during clearing.

Habitat is broadly defined as follows, noting that denning habitat includes both breeding and shelter habitat:

DISPERSAL HABITAT

Areas with trees (that do not qualify as foraging or denning) which provide connectivity to isolated patches of denning habitat.

FORAGING HABITAT

Areas containing locally important dominant/co-dominant trees for foraging within 200 metres of denning habitat. The 200m foraging habitat was determined by calculating the average home range radius of for the Greater Glider, as derived from the *Guide to Greater Glider habitat in Queensland: Species Specific Guidance - greater glider habitats in Queensland* (Eyre, et al., 2022). The number was suggested by DCCEEW for the nearby Vulcan Coal Mine Project federal approval process in January 2024.

POTENTIAL/FUTURE DENNING HABITAT

Areas containing appropriate trees with a diameter at breast height greater than 30 cm, but less than the Regional Ecosystem threshold for large trees.

LIKELY/CURRENT DENNING HABITAT

Areas containing appropriate trees (*Eucalyptus, Corymbia, Angophora*) with a diameter at breast height greater than the Regional Ecosystem threshold for large trees generally >40cm.

Greater Gliders are known to use a range of trees for foraging and denning. The tree species present in the disturbance footprint as per the results of the BioCondition assessments that are also listed in the *Guide to Greater Glider Habitat in Queensland* (Eyre, et al., 2022) are outlined in **Table 5-9** below, with reference to their utility by the species.

Table 5-9 Trees from the "Eucalypt" group that may be utilised by Greater Gliders in the disturbance footprint

Tree species	Usage by Greater Gliders
Corymbia citriodora	Denning and foraging
Eucalyptus crebra	Denning and foraging
Eucalyptus molluccana	Denning and foraging
Eucalyptus tereticornis and Eucalyptus camaldulensis	Denning and foraging
Corymbia intermedia	Foraging
Corymbia tessellaris	Foraging
Eucalyptus melanophloia	Foraging
Corymbia aureola	No use recorded
Eucalyptus cambageana	No use recorded
Eucalyptus trachyphloia	No use recorded
Eucalyptus orgadophylla	No use recorded
Corymbia clarksoniana	Unspecified use
Corymbia dallachiana	Unspecified use
Corymbia erythrophloia	Unspecified use
Eucalyptus platyphylla	Unspecified use
Eucalyptus populnea	Unspecified use

5.6.3.5 Life History

Females give birth to a single joey from March to June and sexual maturity is reached in the second year (Department of Climate Change, Energy, the Environment and Water, 2022b). Longevity has been estimated at 15 years, and generation length is estimated to be six to eight years (Department of Climate Change, Energy, the Environment and Water, 2022b). The relatively low reproductive rate may render small populations in isolated remnants prone to extinction (Department of Climate Change, Energy, the Environment and Water, 2022b).

5.6.3.6 Threatening Processes

Threats include inappropriate prescribed burning, climate change (associated with increased temperatures and changes in rainfall), land clearing, and timber harvesting (Department of Climate Change, Energy, the Environment and Water, 2022b). Competition with or predation from native fauna, as well as predation from feral cats and foxes and entanglement with barbed wire fencing, are current threats which are expected to continue in the future (Department of Climate Change, Energy, the Environment and Water, 2022b).

5.6.3.7 Avoidance of impacts

The mine cannot be moved to avoid impacts to existing and future hollow trees, and all trees within the disturbance footprint that will be cleared to accommodate the required infrastructure and pits.

5.6.3.8 Habitat Assessment

With the exception of a single record in regional ecosystem 11.10.1, all survey sightings were in riparian environments (regional ecosystems 11.3.25, 11.3.7, 11.3.27e and regrowth 11.3.25 with many retained large trees), despite these habitats comprising only a small percentage of the survey area. This is clear evidence for the importance of riparian habitats for local populations of the Greater Glider.

The above habitat definitions in **Section 5.6.3.4** are based on highly conservative guidance provided by DCCEEW. The following points outline the notion that this is likely to vastly over-represent the extent of local habitat for the Greater Glider:

1. For an AU to be classed as "denning habitat", large trees (as defined by the BioCondition benchmarks) are to be present but no minimum density is required, as per DCCEEW's conservation advice. Some units that qualify as denning habitat possessed fewer than one large tree per hectare, on average, and lacked large trees at more than half the 0.5-ha plots surveyed. However, a study by Eyre *et al*. (2022) indicates that only 15-30% of "large" trees support hollows that may be suitable for Greater Gliders. Furthermore, all studies of Greater Gliders to date revealed they require more than one hollow tree per home range. The minimum density of hollows required for habitat to be inhabitable by Greater Gliders is unknown, but all available data suggest that at least four suitable hollows per hectare are required by the species (Eyre, 2006; Smith, et al., 1994; Comport, et al., 1996; Smith, et al., 2007). Given that only 15-30% of "large" trees support hollows, a density of at least 13 large trees per hectare is required to achieve the hollow densities typically required by Greater Gliders. Only two AU contained such high densities of eucalypts (regional ecosystems 11.3.25 and 11.3.2), suggesting that most of the area mapped as denning habitat is unlikely to be occupied by Greater Gliders.
2. Mapped foraging habitat is anywhere within 200 m of denning habitat that contains known species of food trees for Greater Gliders. However, the size of trees is not considered. Studies into the foraging behaviour of Greater Gliders have found that the species consistently find that trees with trunk diameters less than 30 cm are significantly avoided by the species when foraging, whereas foraging is generally concentrated on the largest trees (Smith, et al., 2007; McGregor, et al., 2023; Eyre, et al., 2022). As "denning habitat", by definition, contains larger trees than "foraging habitat", there is little reason to expect individuals to venture far from denning habitat to feed. Furthermore, it is unlikely that Greater Gliders would be expected to commute 200 m from their den to feed, even if food resources within the "foraging habitat" was superior to the that in the "denning habitat". The average distance from den trees to the edge of home ranges (data from (Starr, et al., 2021; Comport, et al., 1996; Kehl & Borsboom, 1984; Smith, et al., 2007) is only 45 m. Furthermore, radio-tracking data kindly provided by G. Smith from a study at Barakula State Forest revealed the average distance from a food tree to the nearest den was 42 m, and the 90th percentile was 82 m. All available data thus suggests that the foraging habitat mapped for Vulcan South is highly conservative.
3. Future denning habitat was mapped as anywhere containing eucalypts with a stem diameter at breast height of 30 cm or more. Based on an extensive dataset compiled by Ngugi et al. (2015) from across Queensland, the dominant local trees *Eucalyptus crebra*, *Eucalyptus melanophloia* and *Corymbia citriodora* exhibit mean diameter growth rates of 0.17 cm/y, 0.19 cm/y and 0.19 cm/y, respectively. Given these growth rates, it is expected that *E. crebra*, *E. melanophloia* and *C. citriodora* will take 65 years, 58 years and 82 years to reach the relevant "large tree" size threshold (for the regional ecosystems in which these species are dominant) from a starting size of 30 cm. Mapping "future" habitats that will take more than half a century to be realised clearly involves a high level of uncertainty, as it depends on future land management practices and natural disasters. Remnant areas that have not been cleared have already reached their capacity for large hollow-bearing trees, there is no capacity for additional hollows in these areas. Cleared/non-remnant areas have not been set aside for regrowth under the current agricultural land use, therefore further growth of trees and hollow formation is highly unlikely.

Within the disturbance footprint, the following habitat areas are mapped according to DCCEEW guidelines:

- 750 ha of likely/current denning habitat;
- 234.6 ha of future denning habitat;
- 19.3 ha of foraging habitat; and
- 52.9 ha of dispersal habitat.

Habitat according to these definitions is mapped in **Figure 5-11.** If the disturbance footprint was to be left undisturbed, habitat modelling based on BioCondition results and growth rates of trees within this Bioregion predict that additional habitat would be available to the species, particularly within areas of regrowth where vegetation is not yet mature. It has been calculated that undisturbed, the following habitat will be available within 20 years:

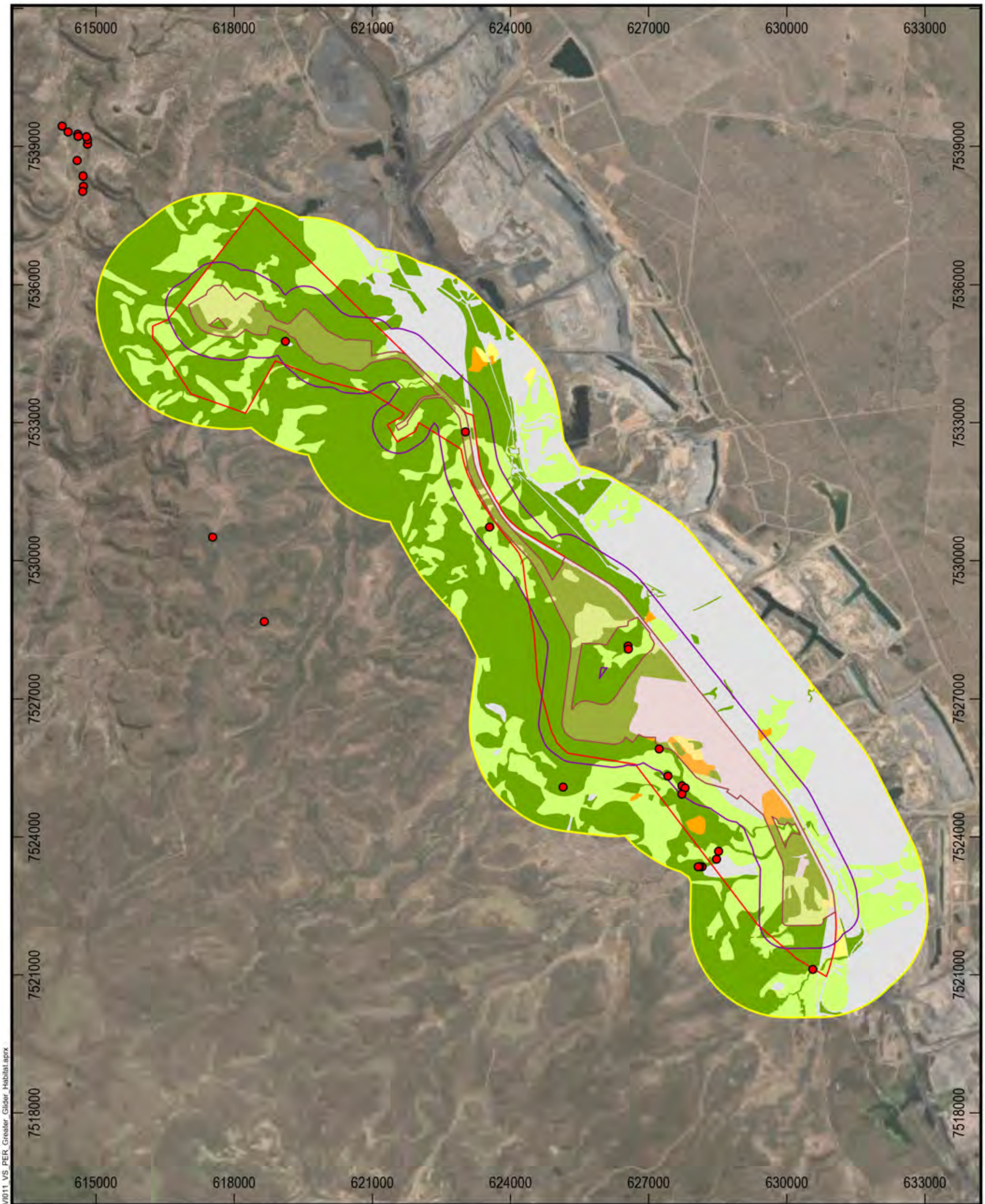
- 1021.03 ha of denning (including foraging and dispersal) habitat;
- 58.72 ha of foraging (including dispersal) habitat; and
- 8.97 ha of dispersal only habitat.

Future habitat is mapped in **Figure 5-12**. For the above reasons, the habitat definitions proposed by DCCEEW and applied in **Figure 5-11** and **Figure 5-12** are highly conservative. They also fail to illustrate variation in the quality of local habitats for Greater Gliders. To provide better guidance to Vitrinite about the locations of habitats of highest importance to Greater Gliders (so that these could be avoided to the maximum extent practicable during the design stage of Vulcan South), two alternate, independent data sources were used to map glider habitat.

Figure 5-11 illustrates the detection rates of Greater Gliders across each of the AU surveyed on site. Habitat quality scores, as assessed by combining scores for food resources, shelter resources, habitat connectivity and threat level, as measured across 55 habitat quality assessment sites within the disturbance footprint support this observation. As the two independent datasets revealed qualitatively similar patterns, it is with high confidence that these reflect the distribution of Greater Gliders across the Project area and neighbouring regions.

Predictive modelling as illustrated in **Figure 5-13** is based on field survey results gives estimates of Greater Glider density as individuals per kilometre per AU. This results in the following habitat value outcomes:

- High value with 2-4 individuals per kilometre – 7.69 ha;
- Moderate value with 1-2 individuals per kilometre – 53.72 ha; and
- Low value with 0-1 individuals per kilometre – 163.73 ha.



Legend

- Greater Glider Sightings

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- 500m Indirect Impact Buffer
- 2 km Buffer

Greater Glider Habitat (Current)

- Likely/Current Denning
- Potential/Future Denning
- Dispersal
- Foraging
- Non-habitat

Source: Vitrinite 2024, METServe 2020-2024, Earthstar Geographics.

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Greater_Glider_Habitat.aprx

Vulcan South

Greater Glider Habitat (Current)

0 1 2 4

Kilometers

Scale: 1:120,000 (A4)

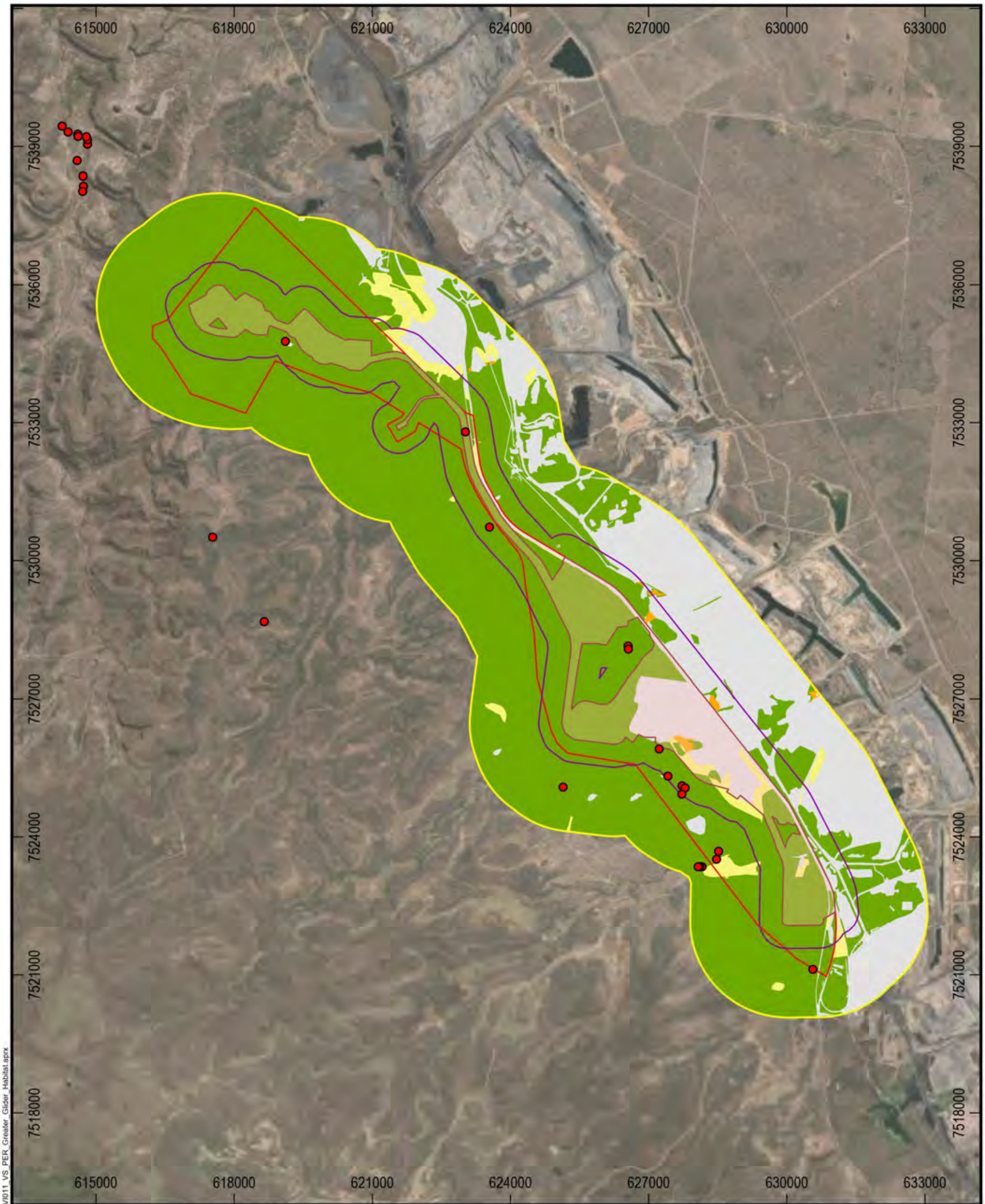
24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-11

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd



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Legend

- Greater Glider Sightings

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- 500m Indirect Impact Buffer
- 2 km Buffer

Greater Glider Habitat (Future)

- Future Denning
- Future Foraging
- Future Dispersal
- Non-habitat

Source: Vitrinite 2024, METServe 2020-2024, Earthstar Geographics.

Vulcan South

Greater Glider Habitat (Future)

0 1 2 4

Kilometers

Scale: 1:120,000 (A4)

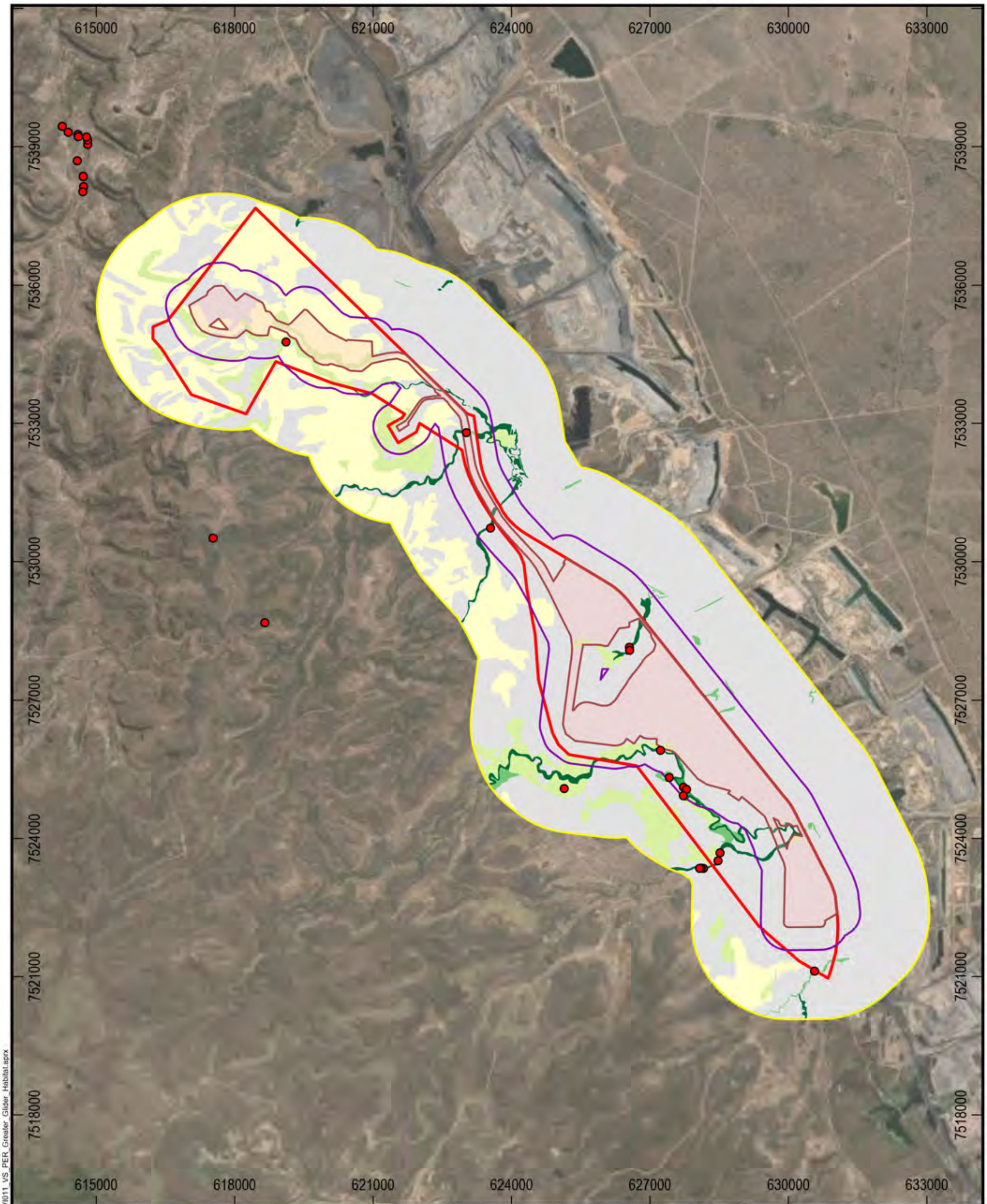
24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-12

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd



Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Greater_Glider_Habitat.aprx

Legend

- Greater Glider Sightings

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- 500m Indirect Impact Buffer
- 2 km Buffer

Greater Glider Relative Density (Individuals per km per Unit)

- 0
- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5

Source: Vitrinite 2024, METServe 2020-2024, Earthstar Geographics.

Vulcan South

Greater Glider Habitat Based on Relative Density of Individuals per km per Unit

0 1 2 4

Kilometers

Scale: 1:120,000 (A4)

24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-13

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.6.3.9 Adequacy of surveys

Spotlighting is the most appropriate method of detecting Greater Gliders, as their eyeshine is particularly easy to detect at a distance, and the species is highly unlikely to be caught in baited traps or to approach a baited camera. Vegetation density within the Project area was not prohibitive to detection of arboreal species. It should also be noted that areas of sparser, lower and more widely spaced trees are, due to their lower density and height may be surveyed more thoroughly than the taller, richer and more dense riparian habitats, in other words less effort is needed to cover more ground effectively in these sparse habitats.

Survey Guidelines for Australia's Threatened Mammals (Department of Sustainability, 2011) outlines the recommended minimum survey effort to be undertaken to confidently rule out the species in a given area. These are as follows, reproduced in **Table 5-10**:

Table 5-10 Survey guidelines assessed against efforts and methods for spotlighting for Greater Gliders

Guideline	Was the survey guideline met?
Use a handheld spotlight (50 or 75 watt) and adhere to the method described above	**Yes**
Survey at least two 200 metre transects per 5-hectare site (or longer transects for larger sites)	**No** Survey transect sites were nominated prior to the now current conservation advice and Endangered listing effective in July 2022. Habitat definitions were not aligned with current definitions and followed now superseded conservation advice, which was valid at the time (Threatened Species Scientific Committee, 2016b). Greater Glider spotlighting transects were not undertaken in the recommended survey density in areas considered at the time to be unlikely to be occupied by the species, but are now considered habitat
Maintain an interval of at least 100 metres between the two transects in order to maximise the area surveyed, which is usually 1 kilometre	**N/A** Surveys were conducted on narrow strips of linear habitat and in areas immediately surrounding them
The location of transects must be selected to sample appropriate habitats (see species profiles) occurring within the subject site. It is important to note, however, that transects will go through many habitats	**Yes** Surveys focused primarily on habitats the species was expected to occur in, with less effort in areas suspected to be of little or no value to the species (e.g. dry hillsides with more widely spaced, shorter trees and greater chance of species detection)
Move at a speed of 10 metres per minute, hence a 1000 metre transect will take 100 minutes (1 hour and 40 minutes) (this is a conservative estimate that is expected to vary according to the observer's experience and the vegetation density at the site). It is also beneficial to spend time standing still or searching trees with binoculars	**Yes** The pace was appropriate, as the species was readily detected in the most dense and tall habitats in riparian areas (RE 11.3.25) and where present in dense but lower RE 11.10.1.
Spotlight surveys along transects should be repeated on two separate nights where possible	**No** Spotlighting surveys were undertaken concurrently with flora surveying between the 4th and 15th of February 2019. A total of 40 person minutes of spotlighting was undertaken at each trapping site (refer to Table 3-1 in **Appendix M** for a total of 52.5 hours (refer to Table 3-2 in **Appendix M**). Efforts to detect

Guideline	Was the survey guideline met?
	Greater Gliders were lower in areas the species was not expected to occur in.
Avoid very windy or rainy nights as these conditions can reduce fauna activity and the observers' ability to detect fauna	**Yes** Surveys were conducted during appropriate weather
Investigators must be adequately experienced with the technique and be able to distinguish species using a combination of detection of eye shine and close-up examination using binoculars.	**Yes** All personnel that conducted surveys were adequately familiar with the species and methodology.

The surveys did detect the species in areas considered suitable within the TEA, and as suspected, not in areas with expected lower soil moisture on poor soils and little or no connectivity. However, DCCEEW regards appropriate tree species and size as the most important habitat features regardless of the other factors outlined, including confirmed presence or likely absence. Therefore, in the application of the *Precautionary Principle*, the habitat values as determined by BioCondition and Habitat Assessment, guided by approved conservation advices will act as surrogates for presence of the species.

5.6.3.10 Summary of likelihood

Important habitat for this species occurs across the Project area, confirmed through field surveys. For this season, impacts to this species are investigated in **Sections 6.1** and **6.2.**

5.6.4 White-throated Needletail (*Hirundapus caudacutus*)

5.6.4.1 Listing Advice

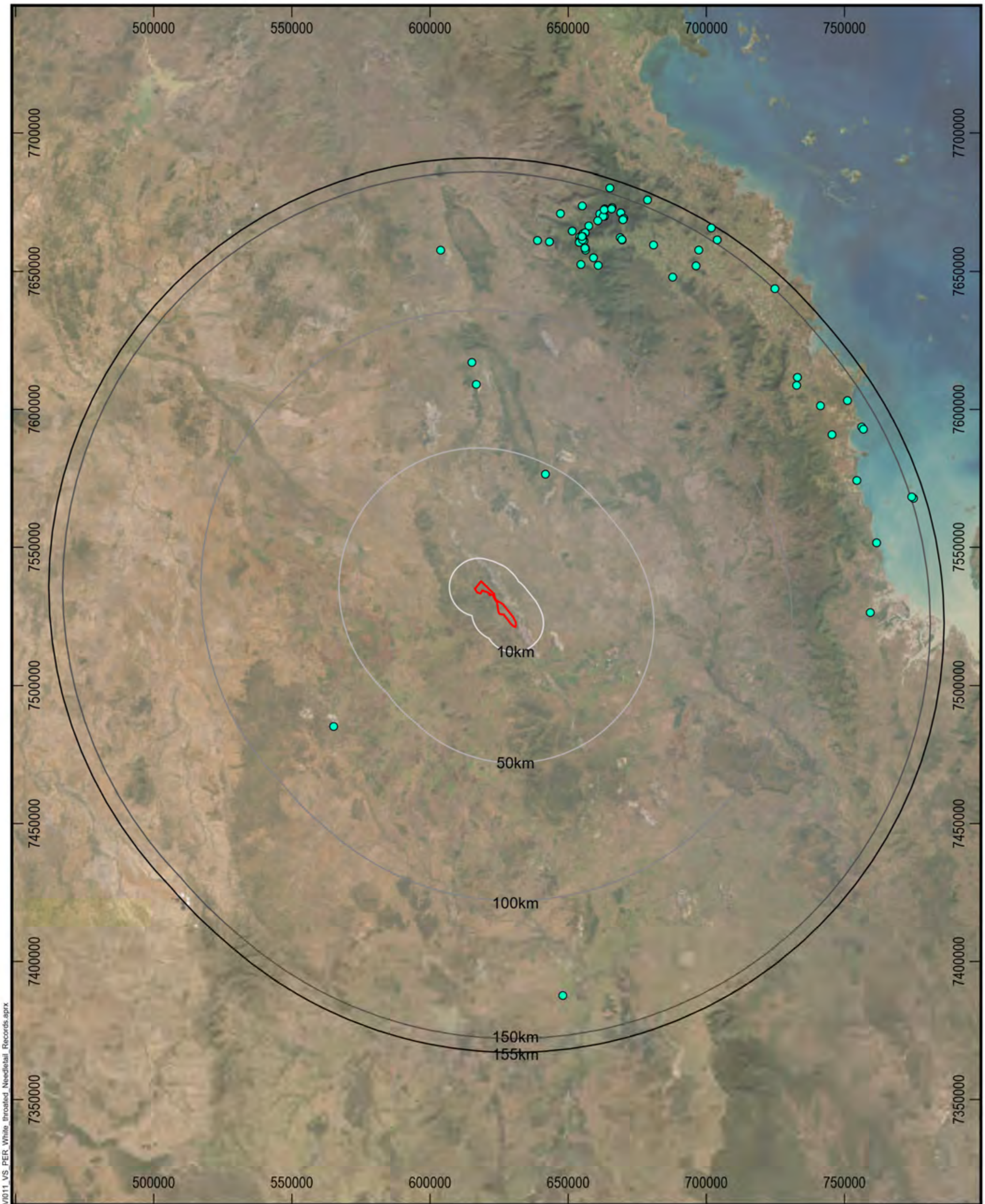
- Commonwealth: Vulnerable, Migratory
- Queensland: Vulnerable

5.6.4.2 Distribution

The White-throated Needletail is a species of swift that breeds in the northern hemisphere, known to nest in Mongolia, China, Siberia, Korea and Japan. It migrates south to Australia for the non-breeding season in the southern summer (Threatened Species Scientific Committee (2019).

5.6.4.3 Historical Occurrence

This species is likely to occur in airspaces over all habitats within their migration paths, records are therefore not important for this species due to its high level of mobility. There have been several sightings within 100 km of Vulcan South, the closest dated sightings being 45 km northeast at Coppabella (2012, BirdLife) and 71 km southwest near Clermont (1997, WildNet). These sightings are not likely indicative of distribution of the species, so it is assumed it is likely present over all of the Project's footprint from time to time. Occurrences are shown in **Figure 5-14.**



Legend

ALA Records

Hirundapus caudacutus (White-throated Needletail)

Vulcan South Coal Mine (2023/09708)

Project Area (ML 700073)

Impact Area Search Radius (km)

10

50

100

150

155

Source: Vitrinite 2024, METServe 2020-2024, Atlas of Living Australia 2024, Earthstar Geographics

Vulcan South

White-throated Needletail Records

0 20 40 80

Kilometers

Scale: 1:2,000,000 (A4)

24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-14

VITRINITE BRIGHTER COAL

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5.6.4.4 Habitat

Other than specific tall emergent trees which are used for roosting, the species is otherwise aerial in Australia, overflying but not directly interacting with a variety of terrestrial habitats. Habitat categories are defined as follows:

SHELTER HABITAT

Roosting habitat includes trees among dense foliage in the canopy or in hollows (Threatened Species Scientific Committee, 2019)

FORAGING/DISPERSAL HABITAT

In general, this species is recorded most often above wooded areas, including open forest and rainforest. This species may also fly below the canopy (Threatened Species Scientific Committee, 2019).

BREEDING HABTIAT

This species does not breed in the Southern Hemisphere (Threatened Species Scientific Committee, 2019).

5.6.4.5 Life History

The White-throated Needletail breeds in the northern hemisphere in May to June, making a nest in vertical hollows in tall conifers or vertical cliff faces. Nests are made from twigs and straw cemented into a cup shape by saliva or in a shallow scrape in the floor of a tree hollow. Estimated generation time is 8.5 years.

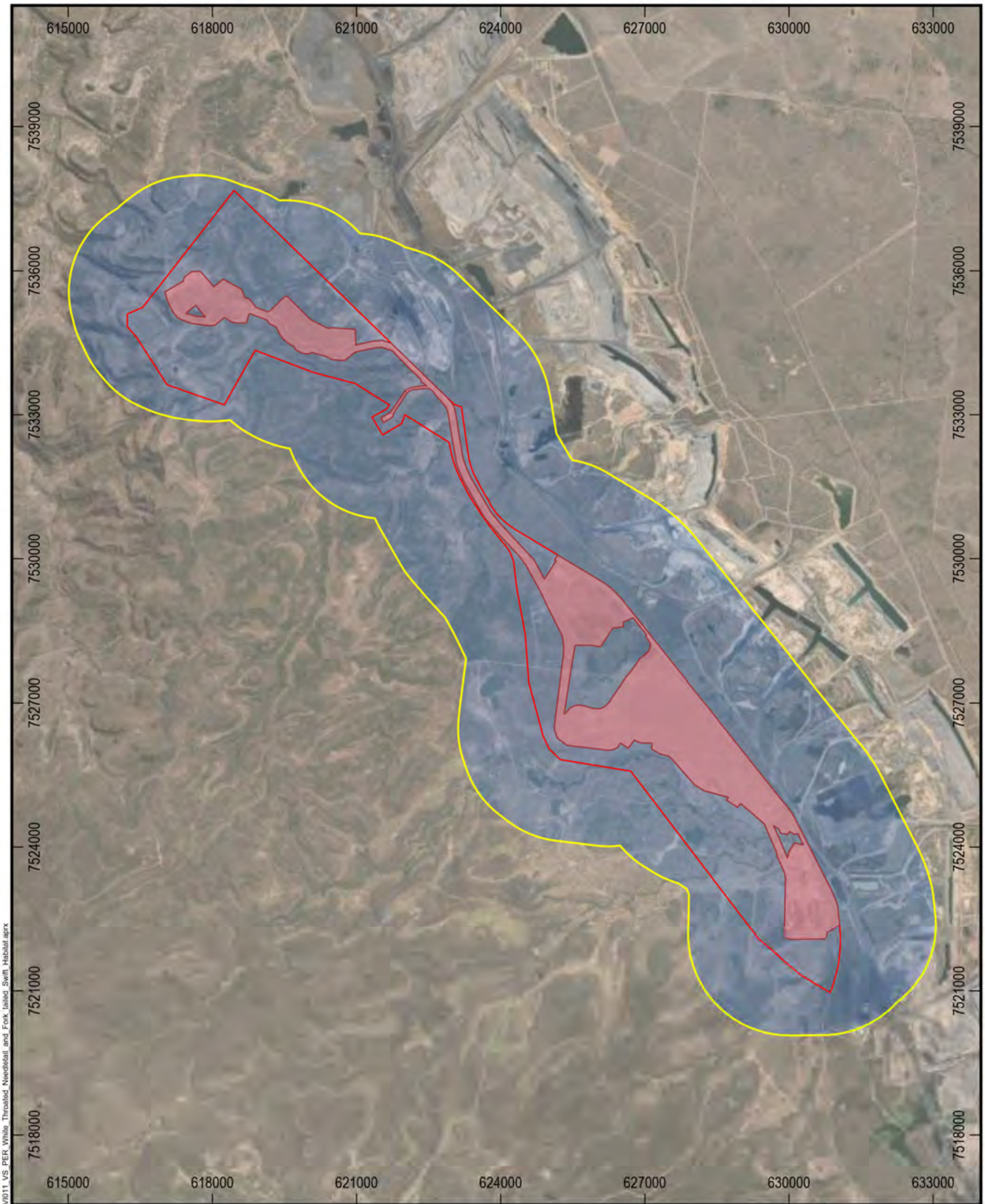
5.6.4.6 Threatening Processes

Within Australia the threats to this species are not as severe as within their breeding habitats or along migration routes outside Australia. Within Australia, the following threats are considered in the conservation advice for the species (Threatened Species Scientific Committee, 2019):

- Loss of roosting trees
- Loss of habitats that provide flying insects
- Wind turbines
- Poisoning by bioaccumulation of organochlorines.

5.6.4.7 Habitat Assessment

Habitat for this species is aerial above the Project area (**Figure 5-15**). This species does not interact with local terrestrial habitats and roosting trees are unlikely to be found here. The airspace above the entire Project area (1476.44 ha) is considered foraging and dispersal habitat for this species.



Legend

White-throated Needletail and Fork-tailed Swift Foraging and Dispersal Habitat in Airspace

Vulcan South Coal Mine (2023/09708)

Disturbance Footprint

Project Area (ML 700073)

2 km Buffer

Source: Vulcan South datasets - Vitrinite 2024 & METServe 2020-2024, White-throated Needletail habitat - METServe 2024, Earthstar Geographics 28/09/2023

Vulcan South

White-throated Needletail and Fork-tailed Swift Habitat (Airspace)

0 1 2 4

Kilometers

Scale: 1:115,000 (A4)

24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-15

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.6.4.8 Summary of likelihood

This species is known to occur overhead of the Project area but is not likely to land or directly interact with any terrestrial habitats in the Project disturbance footprint. Impacts are however discussed further in **Section 6** due to the species being known to occur.

5.6.5 Ornamental Snake (*Denisonia maculata*)

5.6.5.1 Listing Advice

- Commonwealth: Vulnerable
- Queensland: Vulnerable

5.6.5.2 Distribution

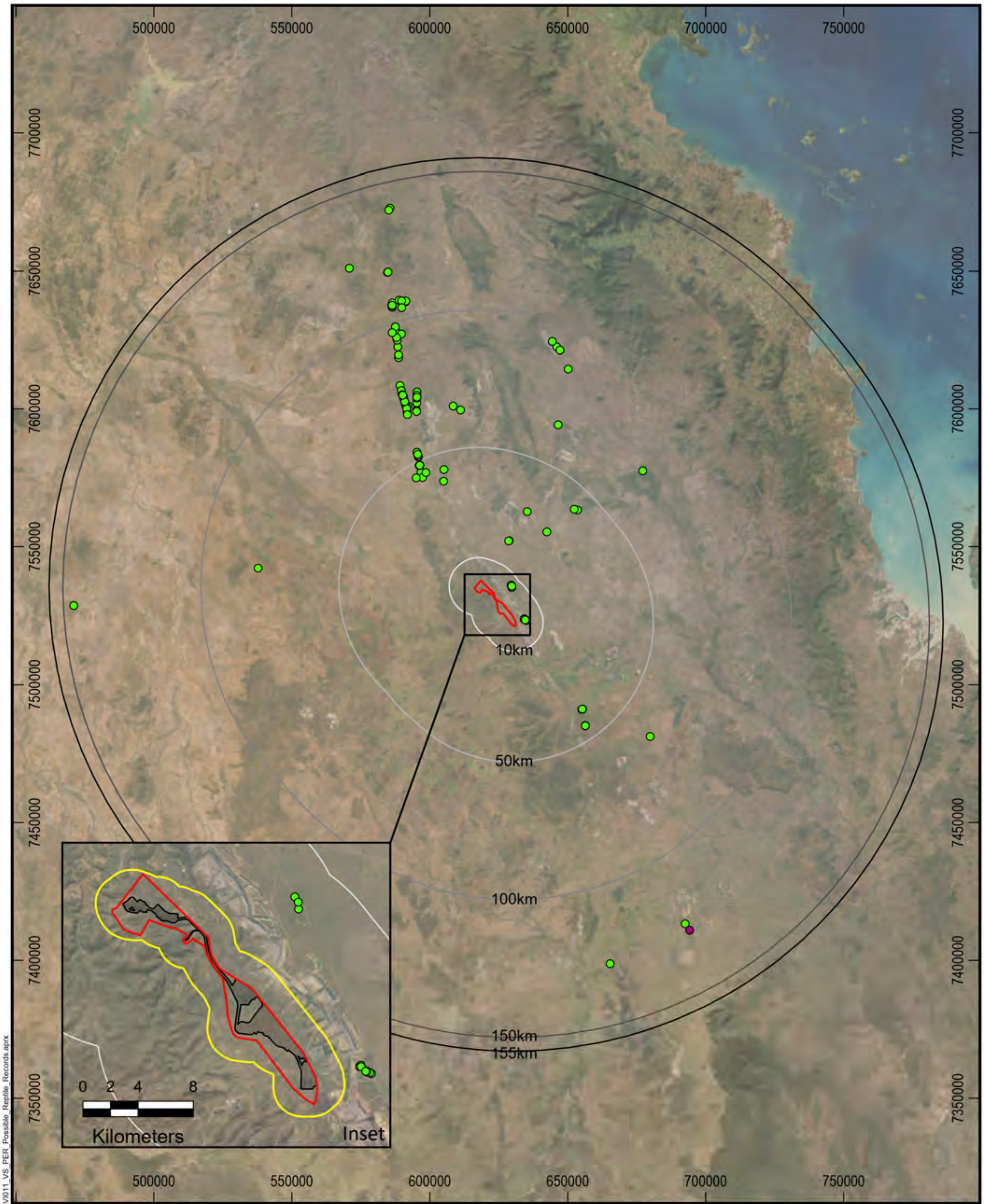
The Ornamental Snake is only known from the Brigalow Belt North and parts of the Brigalow Belt South biogeographical regions (Department of Climate Change, Energy, the Environment and Water, 2024d)

5.6.5.3 Historical Occurrence

Occurrences are shown in **Figure 5-16** (green points on map). 14 records exist within 10 km of the Project area, though all of these are to the east of the Project area and isolated from it by other mining projects. These include 3 records from 7 km to the east from the northern portion of the Vulcan South mining lease (2010, WildNet), and 11 more records approximately 4 km to the east of the southern portion of the Vulcan South mining lease from within the last 25 years (WildNet). There are several more records between 50 km and 150 km from the Project, most of which occur in the north.

Despite this proximity, significant dispersal barriers occur between known populations and the project area (see **Section 5.6.5.7**). Between known populations and the project area lies a 58-km-long chain of open-cut mine pits and WRD's. This represents a significant barrier to dispersal for a small snake incapable of climbing. Adjacent to these mines run Saraji Road and the Goonyella Rail line, which would represent hazards to any westward-dispersing Ornamental Snakes.

The extensive and rugged Harrow Range is located immediately west of the project area, and no eastward dispersal of Ornamental Snakes is likely from populations further west of this range to the project area.



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Legend

ALA Records
- *Denisonia maculata* (Ornamental Snake)
- *Egernia rugosa* (Yakka Skink)

Vulcan South Coal Mine (2023/09708)
- Project Area (ML 700073)
- Disturbance Footprint

Impact Area Search Radius (km)
- 2
- 10
- 50
- 100
- 150
- 155

Source: Vitrinite 2024, METServe 2020-2024, Atlas of Living Australia 2024, Earthstar Geographics.

Vulcan South

Ornamental Snake and Yakka Skink Records

0 20 40 80
Kilometers
Scale: 1:2,000,000 (A4)

24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-16

VITRINITE BRIGHTER COAL
METSERVE Mining & Energy Technical Services Pty Ltd

5.6.5.4 Habitat

Habitat for the Ornamental Snake includes floodplains, undulating clay pans, and along the margins of swamps, lakes and watercourses (Department of Climate Change, Energy, the Environment and Water, 2014). It also occurs on adjoining areas of elevated ground and has been recorded in woodlands and open woodlands of coolabah, poplar box, and brigalow, and in fringing vegetation along watercourses (Department of Climate Change, Energy, the Environment and Water, 2014). The Ornamental Snake feeds almost exclusively on frogs (Department of Climate Change, Energy, the Environment and Water, 2014).

The Ornamental Snake is endemic to Queensland, and is found mostly in the Brigalow Belt North and parts of the Brigalow Belt South bioregions. The core of the species' distribution is within the Fitzroy and Dawson River drainages (Department of Climate Change, Energy, the Environment and Water, 2024d). The Conservation Advice describes Ornamental Snake habitat is "floodplains, undulating clay pans and along the margins of swamps, lakes and watercourses" (Department of Climate Change, Energy, the Environment and Water, 2014). DCCEEW's (2023d) Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles defines suitable habitat as "open-forests to woodlands associated with gilgai formations and wetlands. These are commonly mapped as Queensland regional ecosystems 11.3.3, 11.4.3, 11.4.6, 11.4.8, 11.4.9, 11.5.16 or mapped as cleared but where the above ecosystems formerly occurred." Similarly, the Species Profile and Threats (SPRAT) database states that the preferred habitat is within or close to habitat favoured by frogs, especially gilgai mounds and depressions in Queensland Regional Ecosystem land zone 4 (clay plains), but also lake margins and wetlands.

Food, shelter and habitat connectivity needs of the species, along with threats, are discussed in the following subsections.

5.6.5.5 Food

The Ornamental Snake is a frog specialist (Department of Climate Change, Energy, the Environment and Water, 2024d). No published studies have explicitly examined which frog species are primarily eaten; however, the SPRAT database lists the following species as being present where Ornamental Snakes occur:

- Striped Burrowing Frog (*Cyclorana alboguttata*)
- Short-footed Frog (*Cyclorana brevipes*)
- Knife-footed Frog (*Cyclorana cultripes*)
- Wide-mouthed Frog (*Cyclorana novaehollandiae*)
- Water-holding Frog (*Cyclorana platycephala*)
- Rough Frog (*Cyclorana verrucosa*)
- Spotted Marsh Frog (*Limnodynastes tasmaniensis*)
- Green Tree-frog (*Litoria caerulea*)
- Eastern Sedge Frog (*Litoria fallax*)
- Floodplain Frog (*Litoria inermis*)
- Broad-palmed Rocket-frog (*Litoria latopalmata*)
- Roth's Tree-frog (*Litoria rothii*)
- Desert Tree-frog (*Litoria rubella*)
- Ornate Burrowing-frog (*Platyplectrum ornatum*).

Most of the above species are burrowers that only emerge to feed and breed in ephemeral waterbodies (e.g., gilgais) following rain. An abundance of burrowing frogs (*Cyclorana* species) is listed by the SPRAT database as a characteristic of sites favourable for Ornamental Snakes. Other characteristics listed as important predictors of Ornamental Snake habitat reflect its suitability as a breeding site for frog prey (Department of Climate Change, Energy, the Environment and Water, 2024d):

- presence of aquatic vegetation, especially in flooded gilgais where *Monochoria cyanea* grows
- diversity of gilgai size and depth

- soils with high clay content with high water retention capacity
- habitat patches greater than 10 ha in area and are within or connected to larger areas of remnant vegetation.

Not all gilgais are suitable as breeding sites for frogs. Soils with high salt content or gilgais of insufficient depth to facilitate the development of tadpoles are unfavourable as frog breeding sites. Tadpoles of all species known from Ornamental Snake habitat require water for the entirety of the tadpole stage. The length of time water in a gilgai is expected to persist after filling is a useful metric in determining the value of a gilgai to frogs. The length of this period of water retention is primarily driven by gilgai depth and climatic conditions.

Mean rainfall and evaporation rates are available for the Moranbah Airport (Bureau of Meteorology station 034035), 35 km north of the project area. As previous studies have found that most frog period occurs in the early wet season (Francis, 2013), weather from November to January is most relevant to frogs. In this period, the mean monthly water deficit (mean rainfall less mean evaporation) is -163.4 mm/month, which is equivalent to 37 mm of evaporation per week. This means that a gilgai that is 111 cm deep will completely dry within three weeks, on average.

Pools of water do not have to dry completely before becoming inhospitable to tadpoles. A study by Francis (Francis, 2013) found large-scale tadpole mortality, due to heat and increased predation, once pools dry to 68 mm deep in the northern Australian summer. Consequently, the minimum depth a pool must be to support a particular frog species can be estimated using the following formula: $T \times E + M$, where T is the number of weeks required to complete metamorphosis from egg-laying, E is the mean net weekly evaporation rate (37 mm) and M is the minimum depth of water required to sustain tadpoles (68 mm).

Frog species in **Table 5-11** are listed by DCCEEW (2024d) as being associated with the habitats known to support the Ornamental Snake. Most species require a depth of at least 253 mm to support breeding, while a depth of 660 mm is required to support a complete frog community.

Depth of breeding pools is not the only factor influencing frog populations. The total size and abundance of pools is also associated with higher frog abundances. Sarker *et al* (2022)found that the coverage of inundated areas in a given habitat has a direct effect on the density of frogs. This relationship is probably not linear, as a minimum area of dry land is probably required to provide shelter and foraging substrates for frogs.

Table 5-11 Minimum gilgai depths for local frog species

Species	Common name	Time required for metamorphosis	Source	Minimum gilgai depth
Cyclorana alboguttata	Striped Burrowing Frog	Two to eight weeks (6 weeks assumed as average)	FrogID (2020)	290 mm
Cyclorana breviceps	Short-footed Frog	At least one month (assumed to be 5 weeks on average)	FrogID (2020)	253 mm
Cyclorana novaehollandiae	Wide-mouthed Frog	Based on the similar *C australis*, this is assumed to be 9 weeks	Francis (2013)	401 mm
Cyclorana platycephala	Water-holding Frog	5 weeks on average	Francis (2013)	253 mm
Limnodynastes tasmaniensis	Spotted Marsh Frog	At least three and a half months (assumed to be 16 weeks)	FrogID (2020)	660 mm
Litoria caerulea	Green Tree Frog	At least one month (assumed to be 5 weeks)	FrogID (2020)	253 mm
Litoria inermis	Floodplain Frog	Around 6 weeks	Francis (2013)	290 mm
Litoria latopalmata	Broad-palmed Frog	Around two months (assumed to be 8 weeks)	FrogID (2020)	364 mm
Litoria rubella	Desert Tree Frog	5 weeks on average	Francis (2013)	253 mm
Platyplectrum ornatum	Ornate Burrowing Frog	Two weeks	Francis (2013)	142 mm

A final consideration when assessing the value of frog habitats (and Ornamental Snake foraging habitat consequentially) is the presence and abundance of potential predators within breeding pools. Macroinvertebrate predators (predatory diving beetles, beetle larvae, giant water bugs and dragonfly larvae) are the main tadpole predators in temporary pools (Francis 2013). Increasing numbers of macroinvertebrate predators throughout the wet season is a primary reason that most successful frog breeding occurs early in the season (Francis 2013). Fish are largely absent from the temporary pools favoured by breeding frogs (Francis 2013) and are the most likely factor limiting the use by breeding frogs of rivers, permanent waterbodies and pools connected to streams during periods of flood. Pools with fish or a high abundance of macroinvertebrate predators are associated with lower frog abundance and diversity.

This is described in more detail within **Appendix B**.

5.6.5.6 Shelter

The Ornamental Snake is viviparous (live bearing) and therefore does not require specific habitat features for breeding. The species does require shelter during extended dry periods, when it is inactive, as well as during the day in wet conditions (it is primarily nocturnal).

No studies have tracked Ornamental Snakes to determine the key features of dry-season or day-time shelter sites. It is currently thought that the species primarily shelters during the dry season in soil cracks. This is a feature of the heavy clay soils associated with gilgai development, so sites with gilgais typically also exhibit soil cracks, except in situations where a shallow, sandy topsoil layer is present. The SPRAT database states that deep-cracking characteristics important to Ornamental Snakes are a feature of soils with high fine clay particle fraction. Cracking clays with higher sand and more sodic cracking clays have lesser water-retention capacity and hence less propensity to form deep cracks (Department of Climate Change, Energy, the Environment and Water, 2024d).

During wet seasons, when cracks disappear, Ornamental Snakes rely on other shelter sites during daytime inactivity. The SPRAT database states that the species likely shelters under coarse woody debris and litter. Burrows made by other animals may also be used occasionally (Royal, et al., 2022).

No studies have examined whether a minimum density of daytime shelter sites is required for Ornamental Snakes. Benchmark values for the "coarse woody debris" component of BioCondition for regional ecosystems known to be occupied by the Ornamental Snake can be used as a guide to amount of shelter available in high-quality examples of habitat. The published values are presented in **Table 5-12**.

Table 5-12 Coarse woody debris benchmarks for regional ecosystems supporting Ornamental Snakes

Regional Ecosystem	Benchmark for Coarse Woody Debris*
11.3.3	285 m/ha
11.4.3	1,752 m/ha
11.4.6	667 m/ha
11.4.8	813 m/ha
11.4.9	980 m/ha
11.5.16	1,812 m/ha
Mean	1,051 m/ha

*From version 3.4 of the BioCondition Benchmark Database published by the Queensland Herbarium (2023). Coarse woody debris is defined as the total length in metres of woody debris that is >10 cm diameter and >0.5 m in length (and more than 80% in contact with the ground).

5.6.5.7 Habitat connectivity

The home range size or dispersal ability of Ornamental Snakes is not known. The SPRAT database states that the species is recorded in habitat patches that are typically greater than 10 hectares in area and are within, or connected, to larger areas of remnant vegetation (Department of Climate Change, Energy, the Environment and Water, 2024d). An Ornamental Snake has been recorded (presumably dispersing) during drought conditions in a paddock dominated by Buffel Grass (Cenchrus ciliaris), about one kilometre from a gilgaied patch of Brigalow regrowth (Department of Climate Change, Energy, the Environment and Water, 2024d).

The Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles (Department of Climate Change, Energy, the Environment and Water, 2023d) states that "habitat connectivity between gilgais and other suitable habitats is important" when deciding whether important habitat occurs on site. However, what constitutes "connected habitat" for a species that can inhabit a broad range of vegetation types, from exotic grassland to native forested habitats, is unclear. Connectivity probably reflects the distance between patches of favourable habitat (cracking clays with gilgais) rather than the nature of the intervening habitat, with the exception of obvious barriers to dispersal such as mine pits, urban environments, or rugged mountain ranges. Other small to medium-sized, nocturnal, Australian snakes tend to move relatively little (50-500 m) (Keogh, et al., 2007; Dubey, et al., 2008). These data from other snake species are consistent with the observation reported in the SPRAT database that habitat patches are to be at least 10 ha to support Ornamental Snakes; patches of this size can contain a home range of 315 m × 315 m. For the purposes of this review, habitat patches that are more than 1 km apart are considered poorly connected.

5.6.5.8 Important habitat

Approximately half the criteria for a significant impact on a vulnerable species, as defined by the Matters of National Environmental Significance Significant Impact Guidelines 1.1, are based on the effect of an action on "important populations". "Important populations" are defined by these guidelines as "a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- key source populations either for breeding or dispersal
- populations that are necessary for maintaining genetic diversity, and/or
- populations that are near the limit of the species range" (Department of the Environment 2015).

However, the Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles (DCCEEW 2023) considers "important habitat" to be a surrogate for "important populations" in the case of the Ornamental Snake. "Important habitat" is defined as "gilgai depressions and mounds…[noting] habitat connectivity between gilgais and other suitable habitats is important".

BREEDING/FORAGING/SHELTER AND DISPERSAL HABITAT

The *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles* (Department of Climate Change, Energy, the Environment and Water, 2023d) defines suitable habitat for Ornamental Snakes as "open forests to woodlands associated with gilgai formations and wetlands. These are commonly mapped as REs 11.3.3, 11.4.3, 11.4.6, 11.4.8, 11.4.9, 11.5.16 or mapped as cleared but where the above REs formerly occurred". Important habitat within these areas is defined by these guidelines as "gilgai depressions and mounds".

DISPERSAL-ONLY HABITAT

Dispersal habitat is not defined in the literature, however, is likely to be low lying areas connecting other suitable habitat types.

5.6.5.9 Life History

The Ornamental Snake is a live bearer, birthing 6.8 young in the average litter (Department of Climate Change, Energy, the Environment and Water, 2024d).

5.6.5.10 Threatening processes

No studies have examined the extent or causes of population declines in the Ornamental Snake. It is listed as a vulnerable species under the EPBC Act on the basis that it was listed as vulnerable under Schedule 1 of the former *Endangered Species Protection Act 1992* (Cwlth). It is assumed that populations have declined due to large-scale habitat clearance and modification (primarily for agriculture) throughout its distribution, but no population monitoring has taken place. Fauna surveys along a trench between Moranbah and Townsville (north of the project area) in 2004 found that Ornamental Snakes were the second-most abundant species within the trench among 20 species of snake recorded (Swan & Wilson, 2012). It was the fourth-most abundant species out of 56 species of reptiles recorded (Swan & Wilson, 2012). Given that the northern half of this trench was outside the known distribution of the species, this implies that the species continues to reach high densities in places where it is found.

The Conservation Advice identifies historical broadscale land clearing and habitat degradation as the principal threat to the Ornamental Snake. Habitat destruction due to feral pigs and poisoning from cane toads are additional threats listed.

DCCEEW (2024d) lists the following threats to the Ornamental Snake in its SPRAT database:

- Habitat loss through clearing (roads, ploughing, railways, mining-related activities, pipeline constructions)
- Habitat fragmentation
- Habitat degradation by overgrazing by stock, especially cattle, or grazing of gilgais during the wet season leads to soil compaction and compromising of soil structure
- Alteration of landscape hydrology in and around gilgai environments
- Alteration of water quality through chemical and sediment pollution of wet areas
- Contact with the Cane Toad
- Predation by feral species
- Invasive weeds.

Due to a lack of data, the importance of each of these threats is largely unknown.

5.6.5.11 Habitat Assessment

Habitat this species may occur in is shown in **Figure 5-17**.

Most of the Vulcan South Coal Mine area (the project area) comprises sandstone hills and adjacent sand plains, which do not constitute habitat for the Ornamental Snake. The southern half of the project area contains patches of clay plain (land zone 4) within a sandplain matrix. These patches support remnant and cleared examples of regional ecosystems 11.4.8 and 11.4.9, which constitute “suitable habitat” for the Ornamental Snake where gilgais are present. Gilgais are absent from most of these patches but are present in some (**Figure 5-17**).

All patches with gilgais were relatively small and separated from other patches by sand plain. Only two patches were larger than the 10-ha threshold suggested by the SPRAT database as potentially supporting Ornamental Snakes (**Table 5-13**). Both of these patches were further than 1 km from other habitat patches larger than 10 ha, which means they are effectively isolated.

Table 5-13 Patches of potential Ornamental Snake habitat within the project's impact area

Size of Patch	Habitat Type	Distance to Nearest Patch	Distance to Nearest Patch >10 ha
58.7 ha	Remnant 11.4.8	110 m	2,748 m
15.7 ha	Cleared land zone 4 with gilgais	59 m	1,276 m
8.8 ha	Regrowth *Eucalyptus populnea* on sandy alluvium where flood waters pool*	860 m	1,492 m
4.4 ha	Remnant 11.4.8	167 m	174 m
4.3 ha	Regrowth *Eucalyptus populnea* on sandy alluvium where flood waters pool*	860 m	1,524 m
4.0 ha	Regrowth 11.4.8	292 m	319 m
3.3 ha	Remnant 11.4.8	167 m	315 m
3.2 ha	Cleared land zone 4 with gilgais	59 m	59 m
2.8 ha	Remnant 11.4.8	392 m	392 m
2.3 ha	Cleared land zone 4 with gilgais	101 m	337 m
1.5 ha	Remnant 11.4.8	110 m	110 m

*These two sites do not contain gilgais or clay soils, so are not "important habitat" as defined by DCCEEW's (2023) *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles.* However, as ephemeral wetlands, they meet the definition of "suitable habitat" and are included in the above table on the basis that numerous frogs were recorded there.

Habitat quality surveys were undertaken across all assessment units within the impact area. These measured the dimensions of all gilgais recorded within 100 m × 50 m sampling plots, as well as abundance of coarse woody debris. Nine out of 55 sampling plots across the proposed impact site were located on land zone 4 (clay plains) and only four of these contained gilgais. In half of the four sites supporting gilgais, these depressions were too shallow to support the breeding of frogs (**Table 5-14**). At the remaining two sites, only one species of frog (the fast-maturing Ornate Burrowing-frog, *Platyplectrum ornatum*) is expected to regularly breed there successfully, based on gilgai depths, local evaporation rates and development times (refer to **Table 5-11** for a summary of the requirements for local frog species). These two sites corresponded to the largest two patches listed in **Table 5-13** (I25 was located in the 58.7 ha patch and I41 was located within the 15.7 ha patch).

The aquatic plant, *Monochoria cyanea*, which is an indicator of suitable Ornamental Snake habitat (Department of Climate Change, Energy, the Environment and Water, 2024d), was absent from gilgais.

The habitat quality data strongly accords with the results of fauna surveys within patches of potential Ornamental Snake habitat. Surveys of gilgai habitats immediately after heavy rain in the early wet season (optimal conditions for detecting frogs) recorded only a single frog species calling there: *P. ornatum*. No *Cyclorana* species (an indicator of optimal Ornamental Snake habitat, according to the SPRAT database) were recorded in gilgais, and the depth of the gilgais present is too shallow to support the breeding of these favoured prey species.

A rich diversity of frogs (including ten species that the SPRAT database lists as present where Ornamental Snakes occur) were recorded at sites away from clay soils and gilgais. These were primarily observed in low-lying depressions on sand plains where Poplar Box (*Eucalyptus populnea*) grew. Two such sites are found within the proposed impact site, and these are listed on **Table 5-13**. Despite containing food resources for the Ornamental Snake, these sites were smaller than the 10-ha threshold of patches typically occupied by Ornamental Snakes (DCCEEW 2024). Also, these were 1,313 m and 1,493 m respectively from the nearest patches of cracking clay soil that can provide dry season refuge, which is likely to be an excessive commuting distance for a small, slow-moving snake, based on studies of other species (see **Section 5.6.5.7**).

Shelter sites for Ornamental Snakes, in the form of coarse woody debris, were in below-average densities at all sites sampled that contained gilgais (**Table 5-13**). At two of the four gilgai sites, coarse woody debris was absent.

Table 5-14 Gilgai depths within the proposed impact site

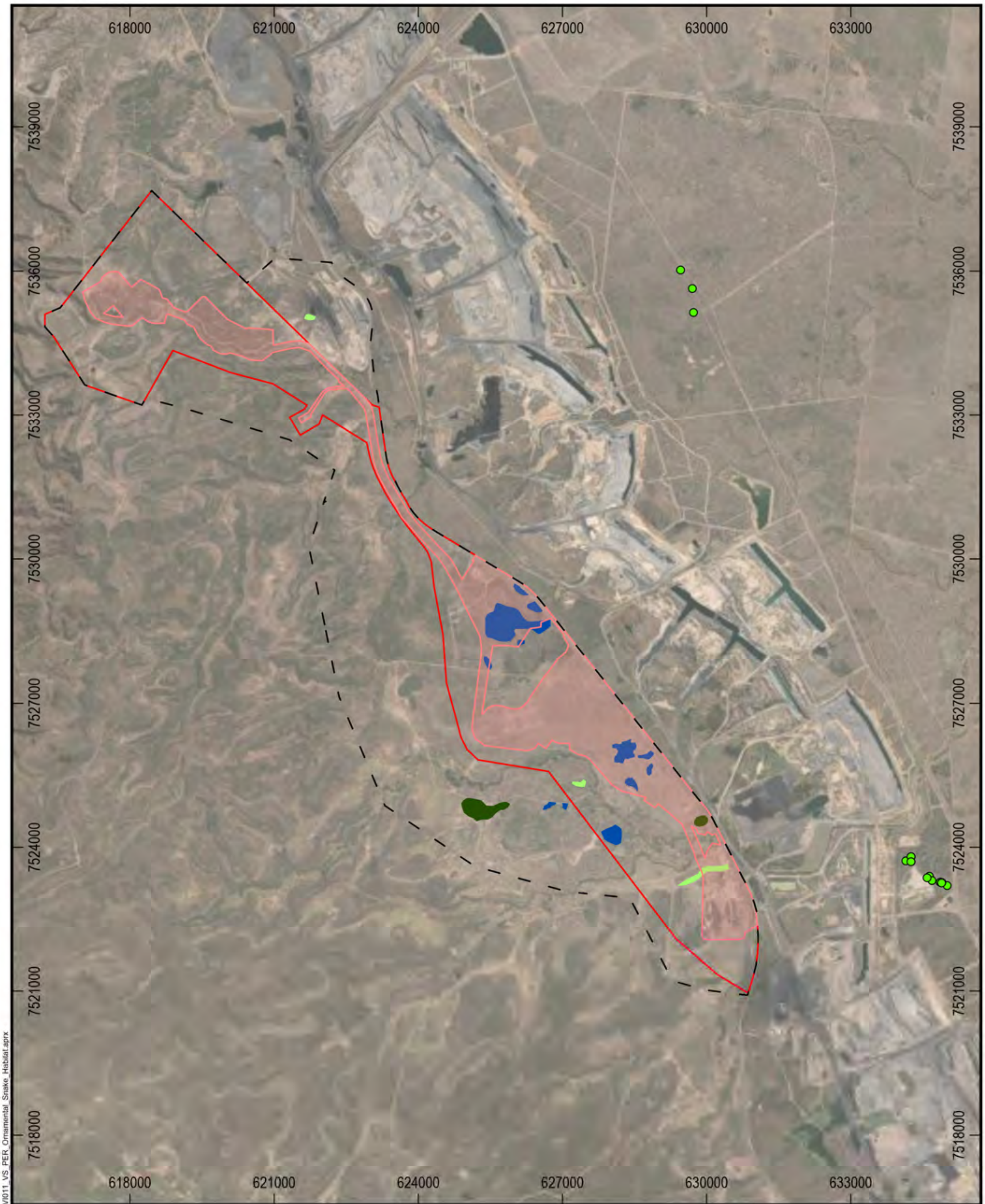
Sample site	Regional Ecosystem	$Number_{gilgais}$ /ha	Average depth (mm)	Maximum depth (mm)	% of site inundated*	Suitability for frogs	Coarse woody debris
I37	11.4.9	2	100	100	7.5	Gilgai depth is insufficient to support breeding by any frog species.	108 m/ha
I41	Cleared 11.4.8	24	125	200	5.0	*Platyplectrum ornatum* can breed in the deepest gilgai recorded, but most gilgais cannot support any frogs.	0 m/ha
I25	11.4.8	12	183	250	2.7	*Platypletrum ornatum* can breed in most gilgais recorded. The deepest gilgai is only marginally shallower than required by three additional frog species. These species may occasionally breed in this deepest gilgai, but high mortality rates are expected.	641 m/ha
I46	Cleared 11.4.8	4	75	100	0.2	Gilgai depth is insufficient to support breeding by any frog species.	0 m/ha
I23	11.4.8	0					228 m/ha
I26	11.4.8	0					854 m/ha
I29	11.4.8	0					756 m/ha
I42	Cleared 11.4.8	0					73 m/ha
I45	Cleared 11.4.8	0					288 m/ha

*Estimates of maximum inundation extent are highly conservative as they are calculated by multiplying the length by the width of each gilgai (reflecting a rectangle containing each gilgai). As most gilgais are round or irregularly shaped, these estimates could be up to twice as large as the true inundation coverage.

Overall threat levels for the Ornamental Snake at the proposed impact site are high. Approximately half of the potential habitat has been subjected to clearing for agriculture. All habitat patches are exposed to high grazing/trampling pressure from domestic cattle. Feral pigs were also recorded on site, but not in high densities. Cane Toads were the most abundant amphibian recorded across all habitats within the impact area. Finally, the impact site lies adjacent to Saraji Road, a sealed road that receives substantial night-time traffic. As a slow-moving reptile susceptible to collisions with vehicles, this traffic exerts substantial pressure on the viability of small, low-quality habitat patches occurring nearby.

In summary, the following habitat areas have been calculated within the disturbance footprint:

- Foraging only with high frog abundance: 4.3 ha;
- Foraging only with moderate frog abundance: 5.1 ha; and
- Shelter / Breeding habitat (not suitable foraging habitat): 88.9 ha.



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Legend

ALA Records

Denisonia maculata (Ornamental Snake)

Survey Area

Vulcan South Coal Mine (2023/09708)

Project Area (ML 700073)

Disturbance Footprint

Potential Ornamental Snake Habitat

Clay Soil with Gilgais

Frog Breeding Habitat in Sandy Soils

High frog abundance (>100 individuals and >5 species)

Moderate frog abundance (5-100 individuals or 2-5 species)

Source: Atlas of Living Australia 2024, Vulcan South datasets, Ornamental Snake and Frog Habitats - Vitrinite & METServe 2020-2024, Earthstar Geographics 28/09/2023.

Vulcan South

Potential Ornamental Snake Habitat

0 1 2 4

Kilometers

Scale: 1:115,000 (A4)

24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-17

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.6.5.12 Detectability of the species and adherence to survey guidelines

There is no published data on the detection probability of the species based on various survey techniques. Based on anecdotes reported in the SPRAT database, “the species is relatively easy to detect in suitable habitat, and under the right environmental conditions” (Department of Climate Change, Energy, the Environment and Water, 2024d). Optimal conditions are on warm, humid nights following heavy rainfall, when frogs are most active (Department of Climate Change, Energy, the Environment and Water, 2024d). High detectability accords with personal observations by METServe ecologists; at sites where the species is known to occur, spotlighting in optimal conditions produced detection rates of around one individual per hour of searching, with multiple individuals observed on each night of spotlighting. Detectability is thought to be low during cool, dry weather or if targeted surveys of shelter locations are conducted during the day (Department of Climate Change, Energy, the Environment and Water, 2024d).

Three Australian Government documents make recommendations about minimum survey effort when surveying for the Ornamental Snake. How the Vulcan South survey adhered to each of these is discussed in **Section 4.7.5.**

The total survey effort for the Ornamental Snake in potential habitats within the project area included 100 pitfall trap-nights, 150 funnel trap-nights and 9 person-hours of spotlighting. This is a subset of the total fauna surveys conducted across all habitat types within the project area. In addition, habitat quality surveys conducted in 2023 confirmed that the habitat values of the site had not fundamentally changed since the fauna surveys were undertaken, and further quantified what these habitat features were by measuring gilgai dimensions and abundance of shelter sites for the Ornamental Snake.

The surveys undertaken at Vulcan South utilised all methods recommended by all guidelines. Furthermore, surveys were undertaken under optimal environmental conditions, which detectability of the species is expected to be high. The survey effort expended was expected to be sufficient for detecting Ornamental Snakes if they were to occur on site.

5.6.5.13 Summary of likelihood

Potentially suitable habitat for the Ornamental Snake occurs in small, isolated patches of remnant and cleared brigalow woodland on clay plains. All but two of these patches were smaller than the 10 ha suggested by the SPRAT database as suitable for Ornamental Snakes. These two larger habitat patches contained gilgais, but based on evaporation rates and development times of local frog species, these gilgais were too shallow to support frog-breeding by all but a single species (Platyplectrum ornatum). Field surveys confirmed that P. ornatum was the only frog species breeding in these gilgais. Burrowing frogs in the genus Cyclorana, which the SPRAT database lists as indicators of Ornamental Snake habitat, were absent from gilgais. These habitat patches contained dry season refuges in the form of soil cracks, but wet season refuges (coarse woody debris) were absent from one patch and in below-average density in the other. Overall, patches of gilgai habitat on clay soil provided negligible foraging opportunities for Ornamental Snakes, contained below-average amounts of shelter, and were isolated from other patches by more than 1 km. No Ornamental Snakes were observed in these patches, despite the species being relatively detectable, and surveys were undertaken under optimal environmental conditions using methods recommended by guidelines.

Higher-quality (frog-rich) foraging habitat was available outside favoured clay soil where water pooled temporarily within sandy plains. Despite containing food resources for the Ornamental Snake, these sites were smaller than the 10-ha threshold of patches typically occupied by Ornamental Snakes. Also, these were 1,313 m and 1,493 m respectively from the nearest patches of cracking clay soil that can provide dry season refuge, which is likely to be an excessive commuting distance for a small, slow-moving snake, based on studies of other species. No Ornamental Snakes were recorded during surveys of this foraging habitat.

Habitats of poor quality that are unable to sustain Ornamental Snake populations may be occasionally utilised by dispersing individuals from nearby source populations. However, poor-quality habitat patches at Vulcan South are isolated from known populations by mountain ranges, mine pits and other physical barriers to dispersal. It is therefore unlikely to be utilised in any capacity by Ornamental Snakes.

5.6.6 Yakka Skink (*Egernia rugosa*)

5.6.6.1 Listing Advice

- Commonwealth: Vulnerable
- Queensland: Vulnerable

5.6.6.2 Distribution

Yakka Skinks are large, gregarious lizards that inhabit a broad range of woodland and forest communities across sub-coastal and semi-arid Queensland. The core habitat of this species is within the Mulga Lands and Brigalow Belt South Bioregions, and there are few records in the Brigalow Belt North Bioregion (where Vulcan South is located) (Department of Climate Change, Energy, the Environment and Water, 2024g).

5.6.6.3 Historical Occurrence

The nearest reliable record (2000, Queensland Museum) of this species is from the vicinity of Blackwater, 140 km to the south. This is shown in **Figure 5-16** (pink point) in **Section 5.6.5.3** above. No colonies have ever been recorded in the northern Bowen Basin, despite extensive ecological surveys undertaken across Dysart-Moranbah-Collinsville for various mining projects.

5.6.6.4 Habitat

Yakka Skinks live in colonies within cavities under and between partly buried rocks, logs or tree stumps, root cavities and abandoned animal burrows. They remain in close proximity to their burrows and are only active for brief periods at dawn and dusk. This, combined with their low density, makes them difficult to detect (Department of Climate Change, Energy, the Environment and Water, 2024g).

BREEDING/SHELTER/FORAGING HABITAT

The Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles (Department of Sustainability, Environment, Water, Population and Communities , 2011) defines suitable habitat for Yakka Skinks as “open-forests to low-woodlands and scrub in Queensland RE Land Zones (LZ) 3, 4, 5, 7, 8, 9, 10 and 12 (LZ 8 not considered core habitat; LZ 12 in Wet Tropics bioregion only). Colonies have been found in large hollow logs, cavities or burrows under large fallen trees, tree stumps, logs, stick-raked piles, large rocks and rock piles, dense ground-covering vegetation, and deeply eroded gullies, tunnels and sinkholes”. Habitat critical to the survival of the species is defined as “any contiguous patch of suitable habitat, particularly remnant vegetation, where a colony is known or identified, or any microhabitat where colonies are likely to be found”.

DISPERSAL HABITAT

Dispersal habitat is not defined, though it is logical to consider any vegetated areas of connectivity between patches of habitat that individuals are likely to be able traverse. The species is known to have high site fidelity and is known to be limited in their capacity to disperse from a colony site (Department of Climate Change, Energy, the Environment and Water, 2024g).

5.6.6.5 Life History

The Yakka Skink produces live young, with around six per litter (Department of Climate Change, Energy, the Environment and Water, 2024g).

5.6.6.6 Threatening Processes

Habitat degradation is the main threat to the species (Department of Climate Change, Energy, the Environment and Water, 2024g).

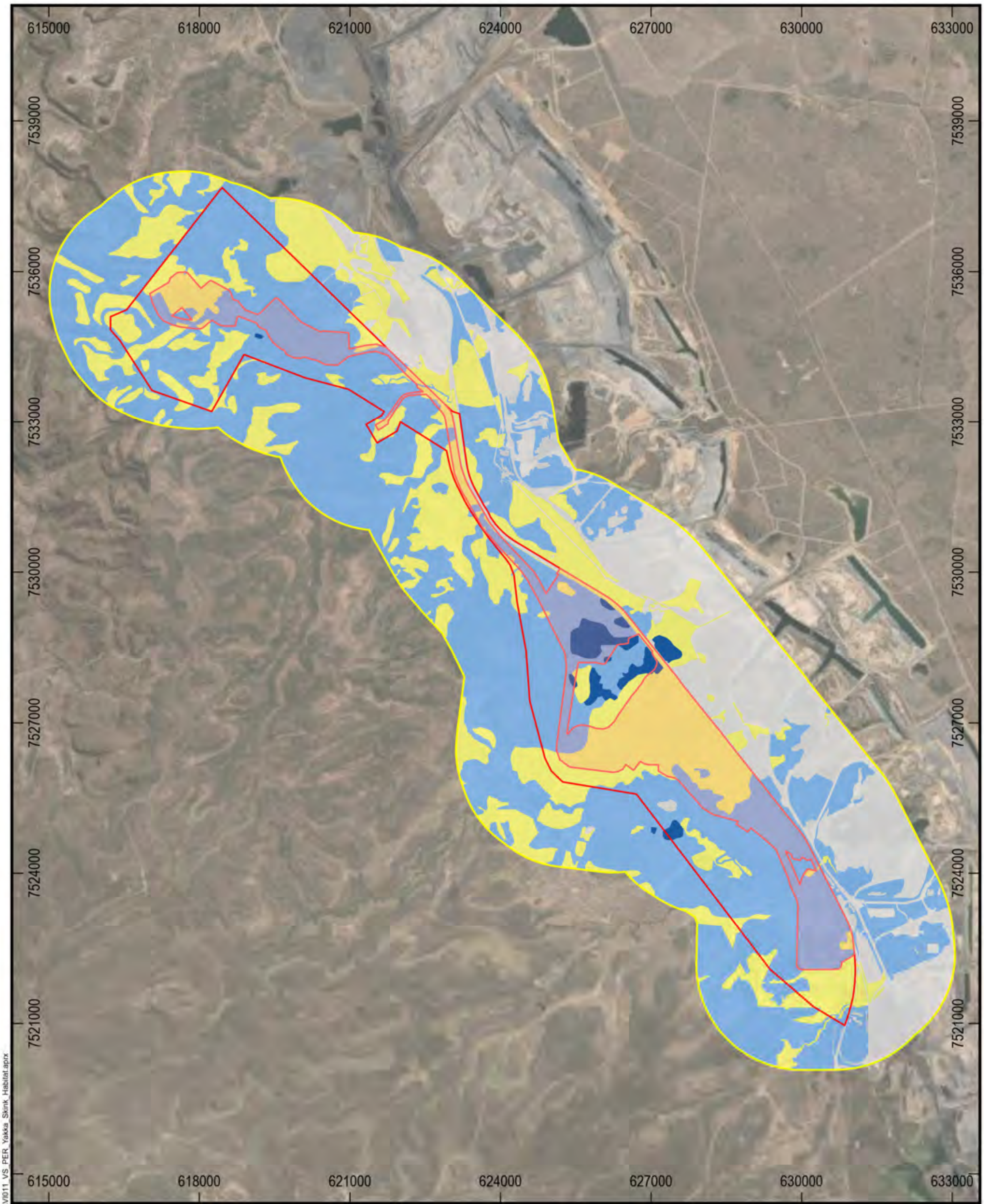
5.6.6.7 Habitat Assessment

No Yakka Skinks were recorded during surveys. Detectability is greatest during warm, humid conditions (Department of Climate Change, Energy, the Environment and Water, 2024g), and the surveys were therefore under optimal conditions. Nevertheless, given the large size of the survey area, it was not practical to inspect every possible burrow location within it. Yakka skinks are known to make communal latrine sites which are key indicators of occupancy, none of these were found. The survey area does not contain habitat connected to known populations of the Yakka Skink. The nearest records (Queensland Museum specimens from 1976 and 2000) of this species are from the vicinity of Blackwater, 130 km to the south. Furthermore, as no colonies have ever been recorded in the northern Bowen Basin, despite extensive ecological surveys undertaken across Dysart-Moranbah-Collinsville for various mining projects, colonies are not “likely to be found” in the vicinity of the Project area. Consequently, no “important habitat” is located within the survey area. Nevertheless, there are scattered records of Yakka Skinks as far north as Cape York, and there remains a slight possibility that the species occurs within the disturbance footprint. All remnant and regrowth vegetation within the disturbance footprint qualifies as “suitable habitat” for the species, as all contain woody debris and/or rocks that provide structural support for burrows.

The Project area lies outside the Yakka Skink’s modelled “known/likely to occur” distribution (Department of Sustainability, Environment, Water, Population and Communities , 2011). However, the modelled distribution of the Yakka Skink shows that the species “may occur” with the Project area. Habitat in the disturbance footprint is as follows:

- High density of coarse woody debris (>490 m/ha) = 66.94 ha;
- Medium density of coarse woody debris (245-490 m/ha) = 769.90 ha; and
- Low density of coarse woody debris (<245 m/ha) = 639.60 ha.

Habitat is shown in **Figure 5-18**.



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Legend

Vulcan South Coal Mine (2023/09708)

- Disturbance Footprint
- Project Area (ML 700073)
- 2 km Buffer

Potential Yakka Skink Habitat

- High density of coarse woody debris (>490 m/ha)
- Medium density of coarse woody debris (245-490 m/ha)
- Low density of coarse woody debris (<245 m/ha)
- Non-habitat

Source: Vulcan South datasets, Potential Yakka Skink Habitat - Vitrinite & METServe 2020-2024, Earthstar Geographics 28/09/2023

Vulcan South

Potential Yakka Skink Habitat

0 1 2 3

Kilometers

Scale: 1:110,000 (A4)

24/07/2024

N

Datum: GDA2020

Projection: MGA55

FIGURE 5-18

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.6.6.8 Summary of likelihood

This species is considered unlikely to occur due to the lack of sightings in the immediate area, including the efforts of numerous ecological surveys, and the lack of prior historical observations.

5.6.7 Northern Quoll (*Dasyurus hallucatus*)

5.6.7.1 Listing Status

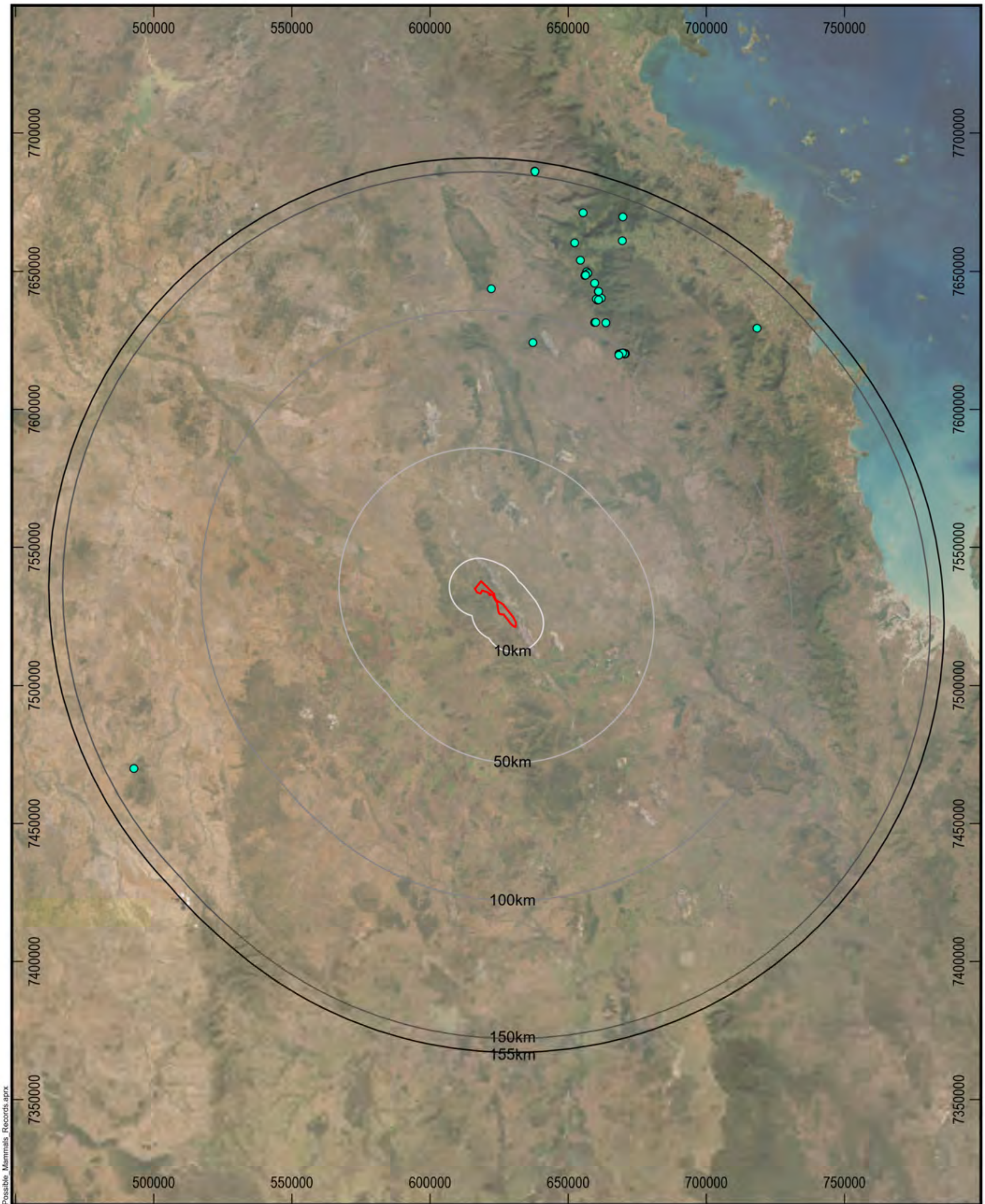
- Commonwealth: Endangered
- Queensland: Least Concern

5.6.7.2 Distribution

Historically, the Northern Quoll was common across northern Australia occurring almost continuously from the Pilbara, Western Australia to near Brisbane, Queensland. This range has shrunk to become 6 apparently disjunct populations within the former range (Threatened Species Scientific Committee, 2005c).

5.6.7.3 Historical Occurrence

Occurrences are shown in (**Figure 5-19**). The nearest recent (post-2000) records of the Northern Quoll are from the Clarke Range, 100 km northeast of the survey area. There is one 1998 (WildNet) record about 140 km west from the Project. No Northern Quolls have ever been detected at neighbouring mines within the Bowen Basin, despite numerous ecological surveys.



Legend

ALA Records

Dasyurus hallucatus (Northern Quoll)

Vulcan South Coal Mine (2023/09708)

Project Area (ML 700073)

Impact Area Search Radius (km)

- 10
- 50
- 100
- 150
- 155

Source: Vitrinite 2024, METServe 2020-2024, Atlas of Living Australia 2024, Earthstar Geographics.

Vulcan South

Northern Quoll Records

0 20 40 80

Kilometers

Scale: 1:2,000,000 (A4)

24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-19

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\Possible_Mammals_Records.aprx

5.6.7.4 Habitat

The Northern Quoll inhabits a broad range of habitats across eastern and northern Australia. The *EPBC Act Referral Guideline for the Endangered Northern Quoll Dasyurus hallucatus* (Department of the Environment, 2016) defines critical habitat as "habitat within the modelled distribution of the northern quoll which provides shelter for breeding, and refuge from fire, predation and potential poisoning from Cane Toads". These can include rocky habitats, treed creek lines and structurally diverse forest with large trees, termite mounds and hollow logs (Department of the Environment, 2016).

BREEDING/SHELTER HABITAT

Den sites close to (within 300 m of) permanent fresh water are preferred by the species (Pollock, 1999). Females create dens in hollow logs, termite mounds and especially rock crevices (Threatened Species Scientific Committee, 2005a). Specific habitats outside of large tracts of rocky areas for breeding purposes on a large scale are not easily defined and should be considered microhabitat features within foraging habitat rather than a separate habitat classification.

FORAGING HABITAT

Northern quolls forage in a wide range of habitats in the vicinity of breeding/shelter habitat for a wide range of food sources which include fruits, figs, invertebrates and small vertebrates. The habitats most likely to be inhabited by the species appear to be high relief rocky areas which provide shelter opportunities, particularly for denning females and an abundance of food (Threatened Species Scientific Committee, 2005a).

DISPERSAL HABITAT

Vegetated habitats in general are considered suitable for dispersal (Department of Climate Change, Energy, the Environment and Water, 2024l).

5.6.7.5 Life History

Northern Quolls breed once each year and bear on average seven young which are born after a gestation of up to 26 days. Females wean two to three young which become reproductively mature at 11 months. Northern Quolls have a short life span with most females only surviving one breeding season.

The majority of male Northern Quolls die after their first breeding season, which is atypical for a marsupial of this size. During a study in the lowland savannas of northern Australia, most males died within the two weeks following mating. Similar results were recorded from the Kimberely, Western Australia.

The intense physical effort of male Quolls appears to cause the physiological decline of males and subsequent die off at one year of age. This male die-off in combination with the fact females usually breed only once makes local populations highly vulnerable to extinction.

5.6.7.6 Threatening Processes

The two major threats to Northern Quolls (Feral Cats and Cane Toads: (Hill & Ward, 2010)) were common and widespread across the survey area. The introduction of Cane Toads to Northern Quoll habitat has been associated with population decline, with no evidence of recolonisation (Threatened Species Scientific Committee, 2005c).

5.6.7.7 Habitat Assessment

The survey area occurs within the modelled distribution of the Northern Quoll (Department of the Environment, 2016). Within the survey area, breeding/shelter and foraging habitats that may have historically supported the species were found on Land Zones 3 and 10 (2,901.8 ha within the survey area). Land Zone 10, particularly in the northwest of the survey area, contained boulder-strewn escarpments and gorges, which are potentially important as breeding/shelter and foraging habitats for Northern Quolls (Pollock, 1999; Woinarski, et al., 2008; Hill & Ward, 2010). Sites suitable for dens were scarce within the survey area.

Suitable habitat for the Northern Quoll is located in "rocky habitats, treed creek lines and structurally diverse forest with large trees, termite mounds and hollow logs" (Department of the Environment, 2016), which is locally restricted to the Harrow Range and major watercourses (see Section 4.3.2.7 in **Appendix M**). Areas matching these descriptions will be removed for Vulcan South. No Northern Quolls were recorded anywhere in the survey area. Possible habitat occurs above the highwall mining panels but are not expected to be affected by the project.

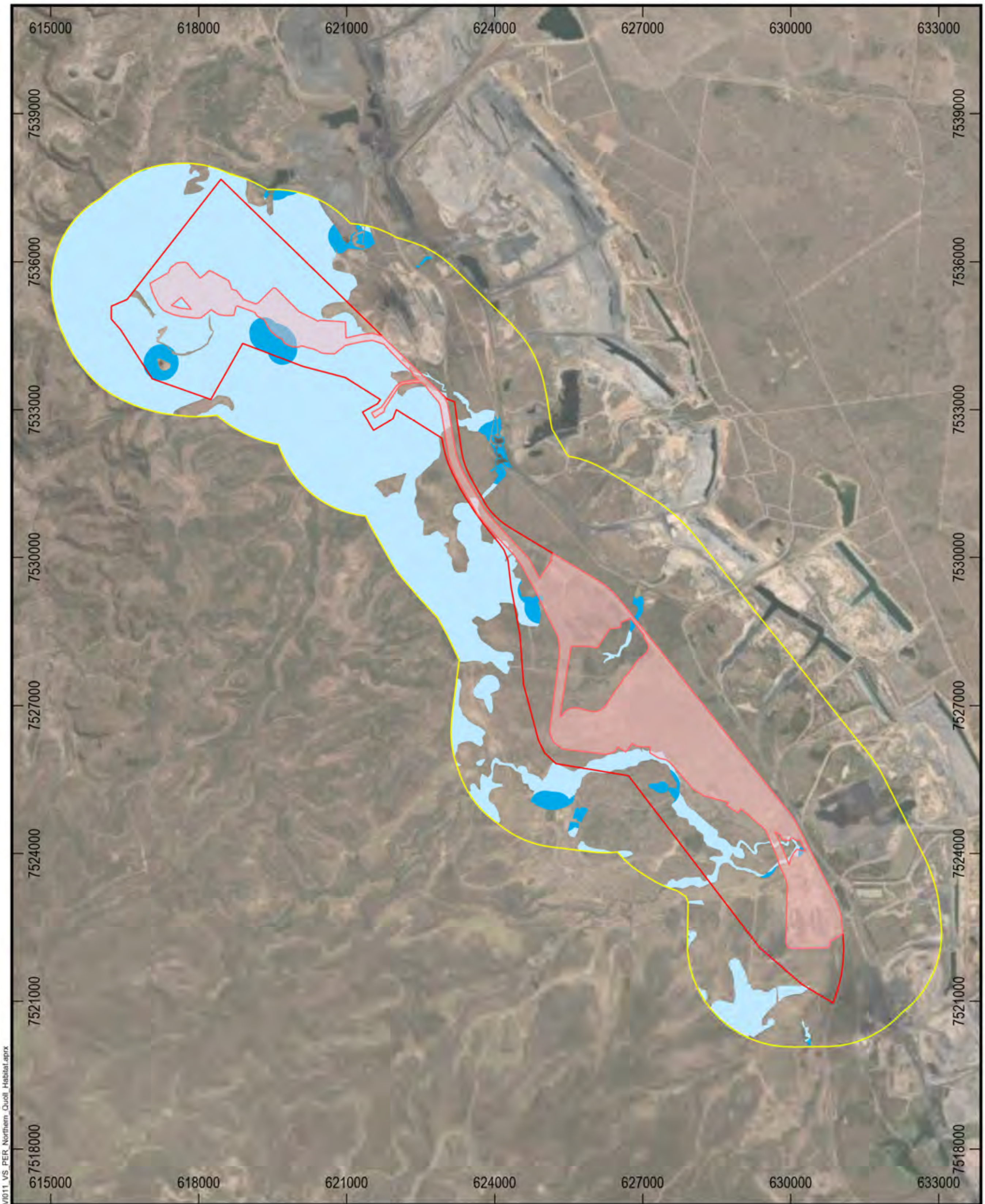
Overall, the impacts of Vulcan South on the Northern Quoll are difficult to predict as a result of uncertainty as to whether any of the potential habitat for Northern Quolls is occupied by the species. Extensive survey efforts, in optimal conditions, failed to detect one within the survey area. There are also no records of the species west of the Clarke Range or Redcliffe Plateau in the past 40 years. It is therefore most likely that the Northern Quoll is absent from the vicinity of Vulcan South, and the project will not affect the species.

However, in the unlikely event that the species does occur on site, Vulcan South may have a significant impact on the Northern Quoll as defined under the EPBC Act. The location of the highwall mining contains sandstone outcrops and gorges that if the species was present could potentially harbour breeding/shelter habitat for the species. However, most of the highwall mining area footprint is contained above the underground plunges, which are not expected to display any surface effects and will not require habitat clearing.

The short-term and minor impacts of lighting, noise and dust on the Northern Quoll near Vulcan South do not qualify as an additional significant impact if the species was to occur within 500 m of the disturbance footprint. Vulcan South is also unlikely to lead to an increase in populations of Feral Cats or Cane Toads, invasive species that would threaten Northern Quolls. Habitat in the disturbance footprint is as follows:

- Habitat within 300m of water = 19.70 ha;
- Land Zones 3 and 10 = 299.71 ha.

Habitat is shown in **Figure 5-20.**



Legend

Potential Northern Quoll Habitat

Habitat within 300m of water

Landzone 3 and 10

Vulcan South Coal Mine (2023/09708)

Project Area (ML 700073)

Disturbance Footprint

2 km Buffer

Source: Vitrinite 2024, METServe 2020-2024, Earthstar Geographics

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Northern_Quoll_Habitat.aprx

Vulcan South

Potential Northern Quoll Habitat

0 1 2 4

Kilometers

Scale: 1:112,000 (A4)

24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-20

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.6.7.8 Summary of likelihood

Extensive survey efforts, in optimal conditions, failed to detect any Northern Quolls within the survey area. There are also no records of the species west of the Clarke Range or Redcliffe Plateau in the past 40 years. For this reason, this species is technically considered possible at best within the Project area and therefore impacts to the species are not discussed further.

5.6.8 King Blue-grass (*Dichanthium queenslandicum*)

5.6.8.1 Listing Status

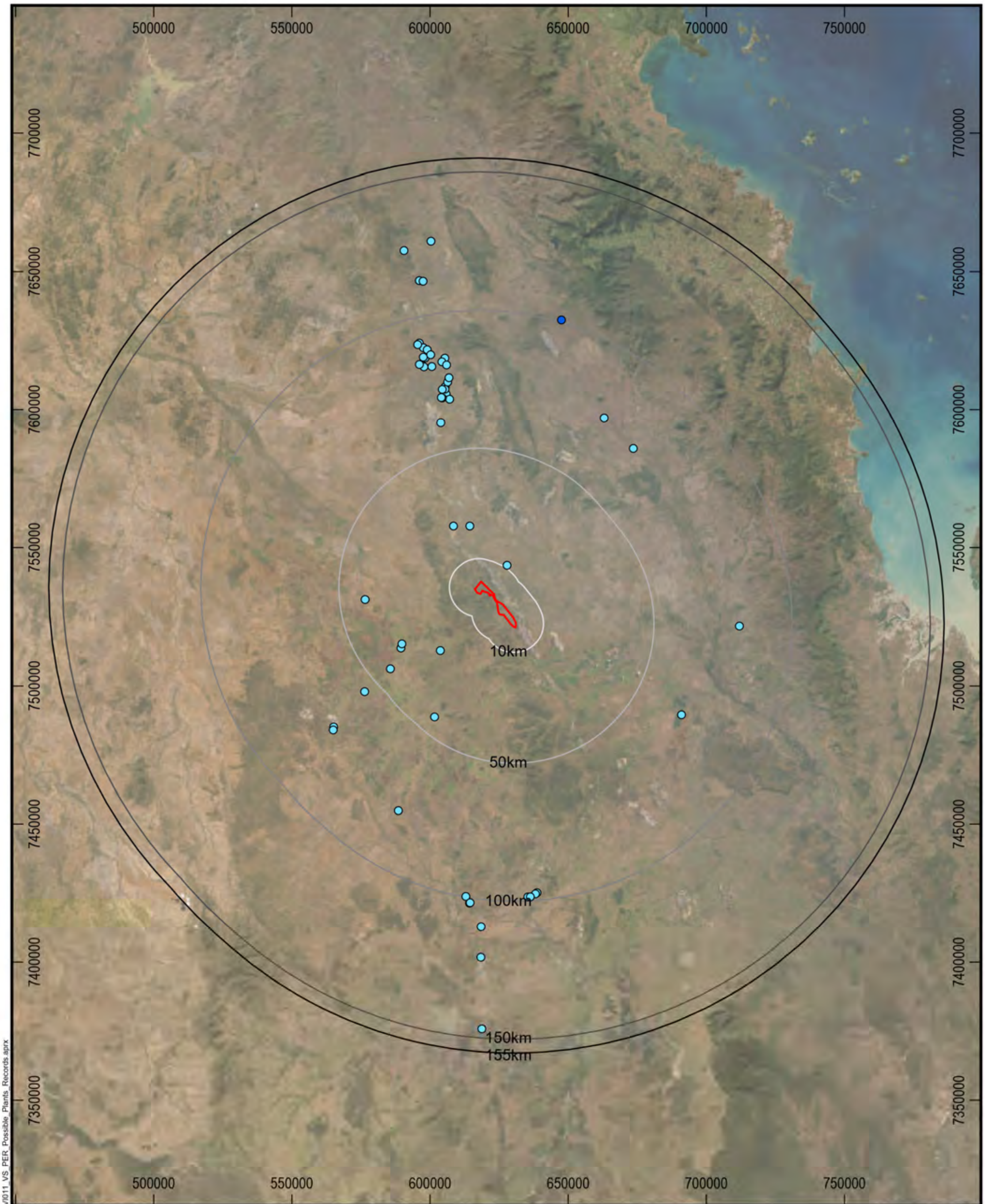
- Commonwealth: Endangered
- Queensland: Vulnerable

5.6.8.2 Distribution

King Blue-grass is endemic to central and southern Queensland where it occurs in three disjunct populations: 1) Hughenden district (one record); 2) from Nebo to Monto and west to Clermont and Rolleston; and 3) Dalby district, Darling Downs. Its extent of occurrence has reduced from 1100 km^2 to 245 km^2, and it is likely that its area of occupancy is also restricted. King Blue-grass occurs in several locations within Queensland, including in the Brigalow Belt. The distribution of King Blue-grass overlaps with several Threatened Ecological Communities, including Brigalow (*Acacia harpophylla* dominant and co-dominant) (Department of Sustainability, Environment, Water, Population and Communities, 2013).

5.6.8.3 Historical Occurrence

Occurrences are shown in **Figure 5-21** (light blue points). Nine records exist within 50 km since 2020. The closest is 11 km to the northeast of the Project area (2022, Queensland Herbarium). The next closest are 21 km north near Moranbah Airport (2011 and 2012, Queensland Herbarium), 25 km to the southwest (2011, Queensland Herbarium), and 37 km to the southwest (1995 and 2001, Queensland Herbarium). Several more records exist within 100 km of the Project, mostly within the north and the southwest.



Legend

ALA Records

Dichanthium queenslandicum (King Bluegrass)

Dichanthium setosum (Hairy Bluegrass)

Vulcan South Coal Mine (2023/09708)

Project Area (ML 700073)

Impact Area Search Radius (km)

10

50

100

150

155

Source: Vitrinite 2024, METServe 2020-2024, Atlas of Living Australia 2024, Earthstar Geographics.

Vulcan South

King Bluegrass and Hairy Bluegrass Records

0 20 40 80

Kilometers

Scale: 1:2,000,000 (A4)

24/07/2024

Datum: GDA2020

Projection: MGA55

FIGURE 5-21

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Possible_Plants_Records.aprx

5.6.8.4 Habitat

KNOWN HABITAT

King Blue-grass inhabits native grasslands and open woodlands on black cracking clay soil derived from basalt. The species also colonises pastures established following the clearance of *Acacia harpophylla* and other dense vegetation communities growing on heavy clay soil. King Blue-grass cannot tolerate continual heavy stocking regimes, and is outcompeted by exotic grass species and weeds, which tend to dominate heavily grazed pastures (Fensham, 1999). For this reason, most extant populations are confined to road reserves and other sites semi-protected from grazing livestock.

5.6.8.5 Threatening Processes

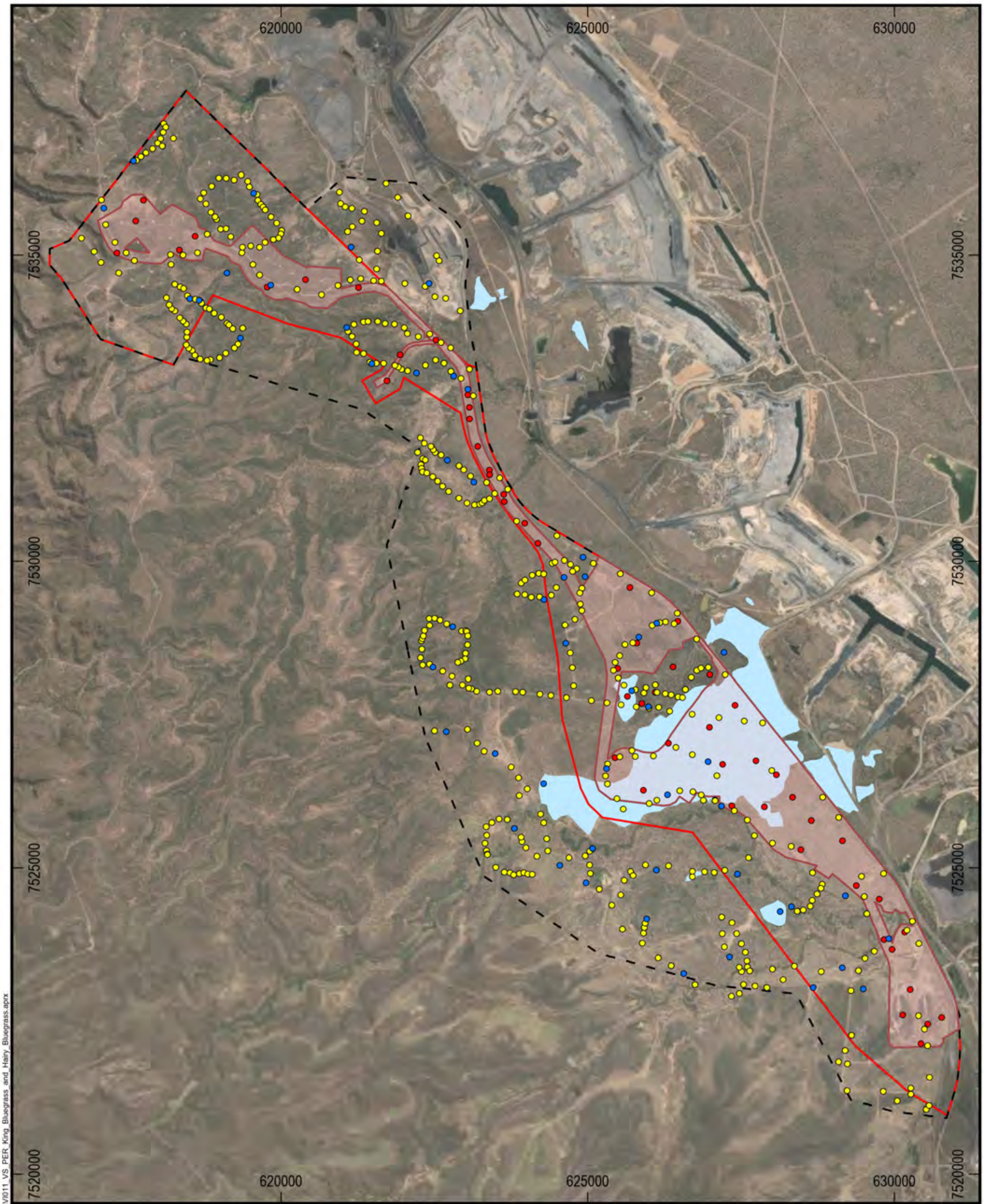
Key threats include habitat loss through land clearing and construction and infrastructure projects. Other threats include grazing and weed invasion (Department of Sustainability, Environment, Water, Population and Communities, 2013).

5.6.8.6 Habitat Assessment

Heavy clay soils supporting grasses are represented within the survey area by remnant regional ecosystem 11.9.2 and cleared pastures that formerly supported regional ecosystem 11.4.9. Both habitats have been subjected to long periods of heavy grazing. This has led to the almost complete replacement of native perennial grasses with the exotic *Bothriochloa pertusa.* Road verges protected from grazing livestock were dominated by other weed grasses, such as *Cenchrus ciliaris, Megathyrsus maximus, Chloris* spp. and *Hyparrhenia rufa*. Nowhere within the survey area were clay soils observed to support a native grassland community.

The nearest recorded King Blue-grass is in the vicinity of Moranbah Airport, 30 km north of the survey area. While the species may have occurred historically within the survey area, its continued existence is unlikely considering current grazing regimes. The survey area lies just outside the DCCEEW's (2022c) modelled "may occur" range of the species.

Potential habitat for King Bluegrass in the vicinity of Vulcan South is highly degraded by grazing and unlikely to support the species. Given the low likelihood that this species occurs onsite, the proposed habitat clearance will not be likely to cause an impact on the species. **Figure 5-22** shows the extent of suitable soils which are not suitable plant communities for this species (= 378.83 ha).



Legend

Survey Sites
- Quaternary
- Secondary
- BioCondition
- Suitable soils but not suitable plant communities for King Bluegrass and Hairy Bluegrass

Vulcan South Coal Mine (2023/09708)
- Project Area (ML 700073)
- Disturbance Footprint
- Survey Area

Source: Atlas of Living Australia 2024. Vitrinite 2024. METServe 2020-2024. Earthstar Geographics.

Vulcan South

Potential King Bluegrass and Hairy Bluegrass Habitat

0 1 2 3

Kilometers

Scale: 1:90,000 (A4)

24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-22

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_King_Bluegrass_and_Hairy_Bluegrass.aprx

5.6.8.7 Summary of Likelihood

Potential habitat for King Bluegrass in the vicinity of Vulcan South is highly degraded by grazing and unlikely to support the species.

5.6.9 Hairy Bluegrass (*Dichanthium setosum*)

5.6.9.1 Listing Advice

- Commonwealth: Vulnerable
- Queensland: Least Concern

5.6.9.2 Distribution

Hairy Bluegrass has a patchy distribution across subcoastal eastern Australia. Based on herbarium records, there appears to be a 280 km gap between known populations at Springsure and Glenden. Hairy Bluegrass is mapped as occurring from near Cooktown in Cape York Peninsula south to Sydney, found within 400 km of the coast.

5.6.9.3 Historical Occurrence

The closest record is 100 km north, near the Hail Creek Mine (2006, Queensland Herbarium). This is shown as the dark blue point in **Figure 5-21** (see **Section 5.6.8.3** above).

5.6.9.4 Habitat

KNOWN HABITAT

Hairy Bluegrass is associated with heavy basaltic black soils and red-brown loams with clay subsoil. It is tolerant of a moderate amount of disturbance, but excessive grazing and invasion of exotic grasses threatens the species (Department of Climate Change, Energy, the Environment and Water, 2022d).

5.6.9.5 Life History

A summer perennial, the species undergoes first growth in spring, flowers in summers and becomes dormant in late autumn (Yu, et al., 2000). A fire frequency of greater than five years has been recommended for the species (NSW Office of Environment and Heritage, 2013a).

5.6.9.6 Threatening Processes

Hairy bluegrass is threatened by the following as outlined in the SPRAT database (Department of Climate Change, Energy, the Environment and Water, 2022d).

- Heavy grazing by domestic stock;
- Clearing of habitat for pasture improvement and cropping;
- Frequent fires, especially regular burning for agricultural purposes;
- Invasion by introduced grasses such as coolatai grass (*Hyparrhenia hirta*), lippia (*Phyla canescens*) and African lovegrass (*Eragrostis curvula*); and
- Road widening.

5.6.9.7 Habitat Assessment

All clay soils within the survey area were dominated by the exotic pasture grass *Bothriochloa pertusa*. No native grass communities were observed on clay within the survey area. The survey area occurs within the distribution gap mentioned above, as the nearest known record is 95 km to the north. The survey area lies just outside the DCCEEW’s (2022d) modelled “may occur” range of the species.

Despite potential habitat occurring on site, the lack of local records and the heavily degraded nature of the available habitat suggest that the disturbance footprint is not occupied by, or important for the Hairy Bluegrass. **Figure 5-22** in **Section 5.6.8.6** shows the extent of suitable soils which are not suitable plant communities for this species (= 378.83 ha).

5.6.9.8 Summary of likelihood

This species is unlikely to occur within the disturbance footprint.

5.6.10 Common Greenshank (*Tringa nebularia*)

5.6.10.1 Listing Advice

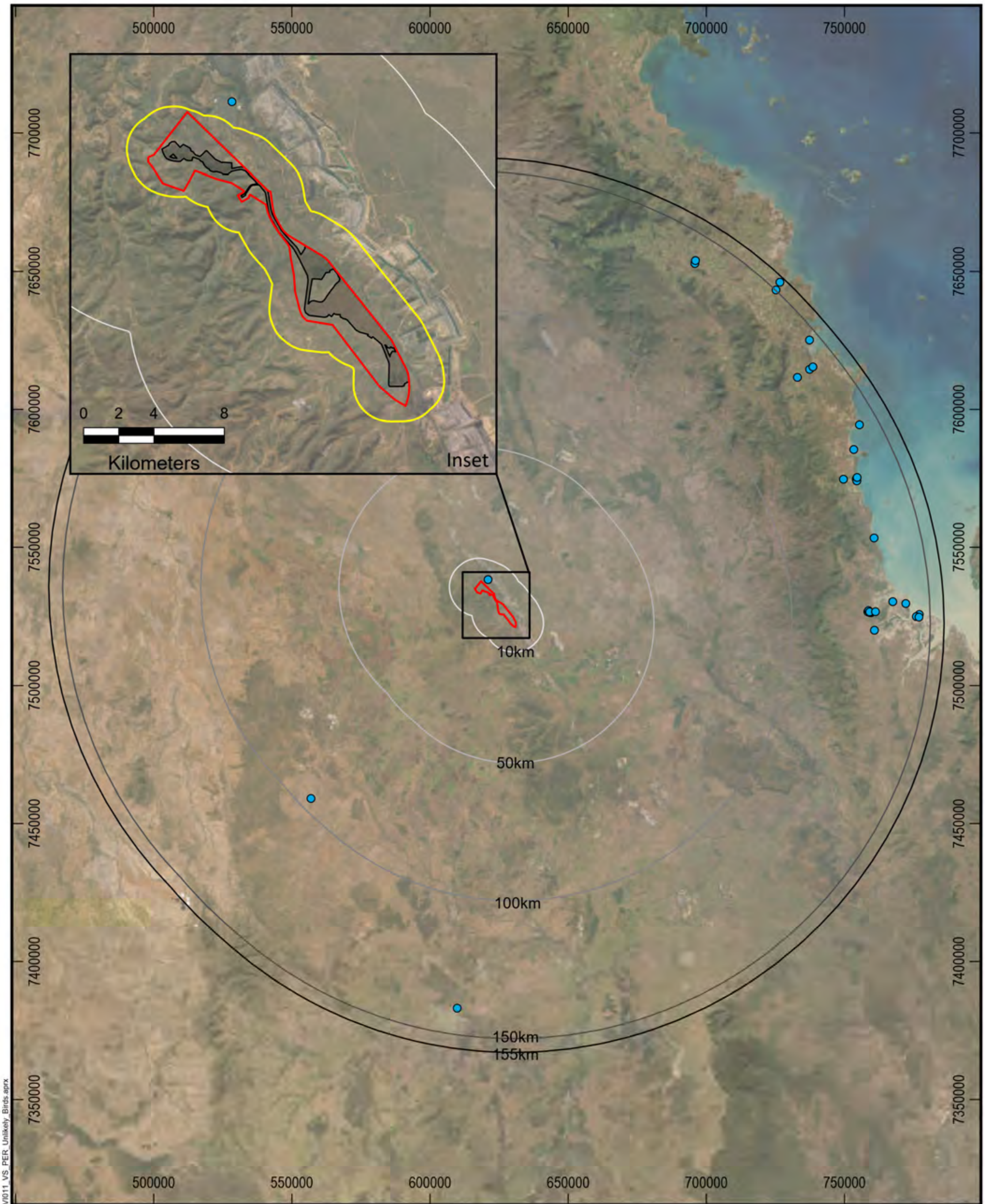
- Commonwealth: Endangered, Migratory, Marine
- Queensland: Special Least Concern

5.6.10.2 Distribution

This species can be found throughout coastal Australia and limited suitable locations inland.

5.6.10.3 Historical Occurrence

There is one post-1980 record from the Peak Downs Mine in 1999 (BirdLife Australia). The next closest reliable sightings are located at least 60 km to the south of the Project, and most are located near the coast. These records are shown in **Figure 5-23**.



Legend

ALA Records

Tringa nebularia (Common Greenshank)

Vulcan South Coal Mine (2023/09708)

Project Area (ML 700073)

Disturbance Footprint

Impact Area Search Radius (km)

2

10

50

100

150

155

Source: Vitrinite 2024, METServe 2020-2024, Atlas of Living Australia 2024, Earthstar Geographics.

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Unlikely_Birds.aprx

Vulcan South

Common Greenshank Records

0 20 40 80

Kilometers

Scale: 1:2,000,000 (A4)

24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-23

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.6.10.4 Habitat

FORAGING HABITAT

Foraging habitat includes wetland edges, in soft mudflats, channels, or within shallows around the edge of waterbodies. These locations are often situated near or among mangroves or other sparse, emergent or fringing vegetation such as sedges or saltmarsh (Department of Climate Change, Energy, the Environment and Water, 2024k). Roosting habitat includes estuary and mudflat environments, mangrove swamps and lagoons, and in billabongs, swamps, sewage farms, and flooded crops.

SHELTER HABITAT

Roosting habitat occurs in both on the coast and inland in estuaries and mudflats, mangrove swamps and lagoons, and in billabongs, swamps, sewage farms, and flooded crops (Department of Climate Change, Energy, the Environment and Water, 2024k).

BREEDING HABITAT

This species breeds in the northern hemisphere.

DISPERSAL HABITAT

As an aerial dispersing species, the Common Greenshank is not likely to land on any habitat it will not utilise for foraging or shelter.

5.6.10.5 Life History

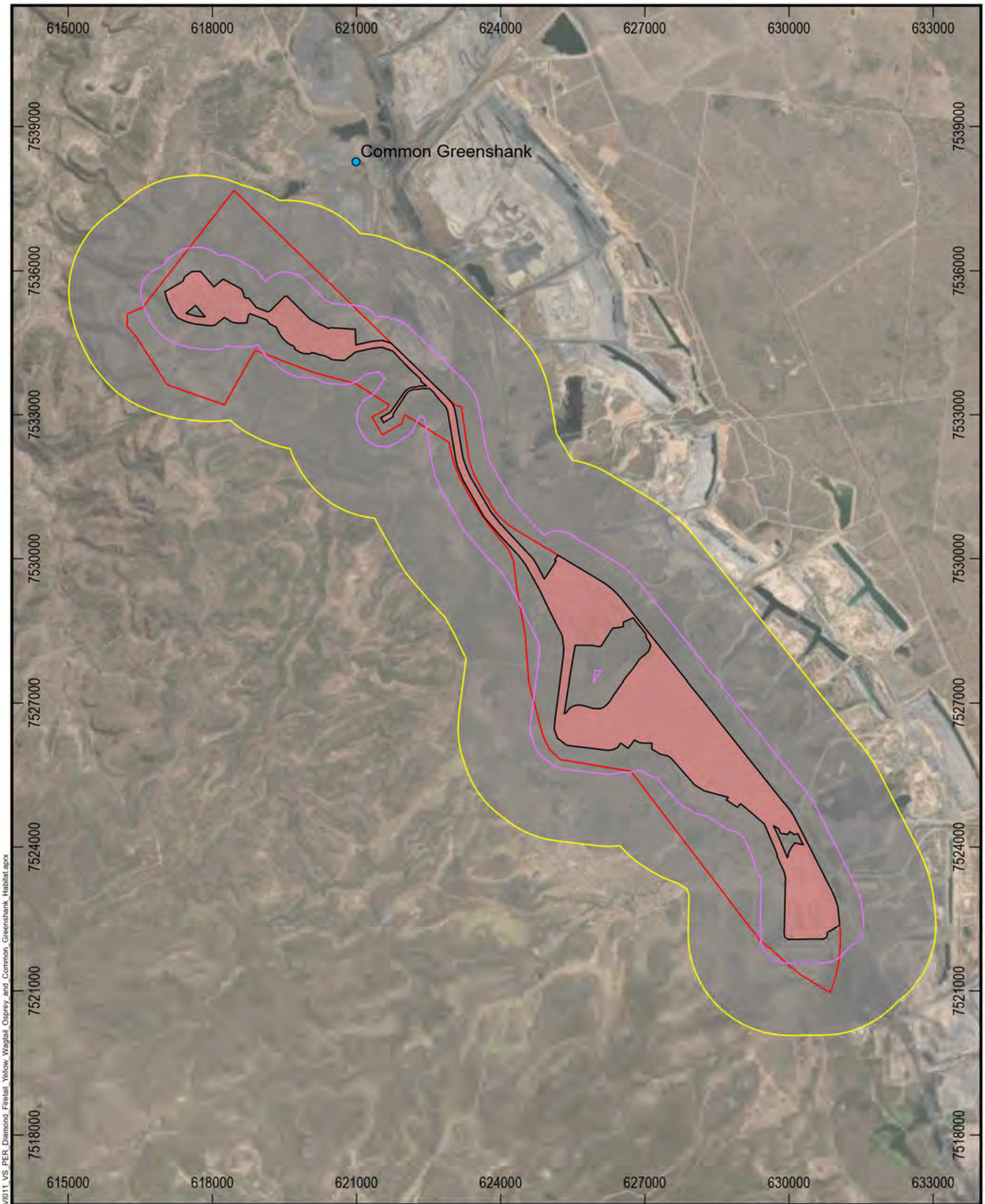
This species breeds outside Australia.

5.6.10.6 Threatening Processes

Key threats in Australia include habitat loss, degradation, and fragmentation, anthropogenic disturbance, impacts from climate change, invasive species, and pollution (Department of Climate Change, Energy, the Environment and Water, 2024k).

5.6.10.7 Habitat Assessment

There are 0 ha of habitat within the disturbance footprint and the broader Project area for this species, as shown in **Figure 5-24**. The Project area is within the DCCEEW modelled “Species or species habitat may occur”. It is unlikely that the species is present at all within the Project area as suitable habitat was not found during field surveys.



Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Diamond_Firetail_Yellow_Wagtail_Osprey_and_Common_Greenshank_Habitat.aprx

Legend

ALA Records

- *Tringa nebularia* (Common Greenshank)

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- 2 km Buffer
- 500m Indirect Impact Buffer
- Non-habitat

Source: Atlas of Living Australia 2024, Vulcan South datasets - Vitrinite 2024 & METServe 2020-2024, Earthstar Geographics 28/09/2023

Vulcan South

Diamond Firetail, Yellow Wagtail, Osprey and Common Greenshank Habitat

0 1 2 4

Kilometers

Scale: 1:115,000 (A4)

24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-24

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.6.10.8 Summary of likelihood

This species is unlikely to be present.

5.6.11 Annual Wiregrass (*Aristida annua*)

5.6.11.1 Listing Advice

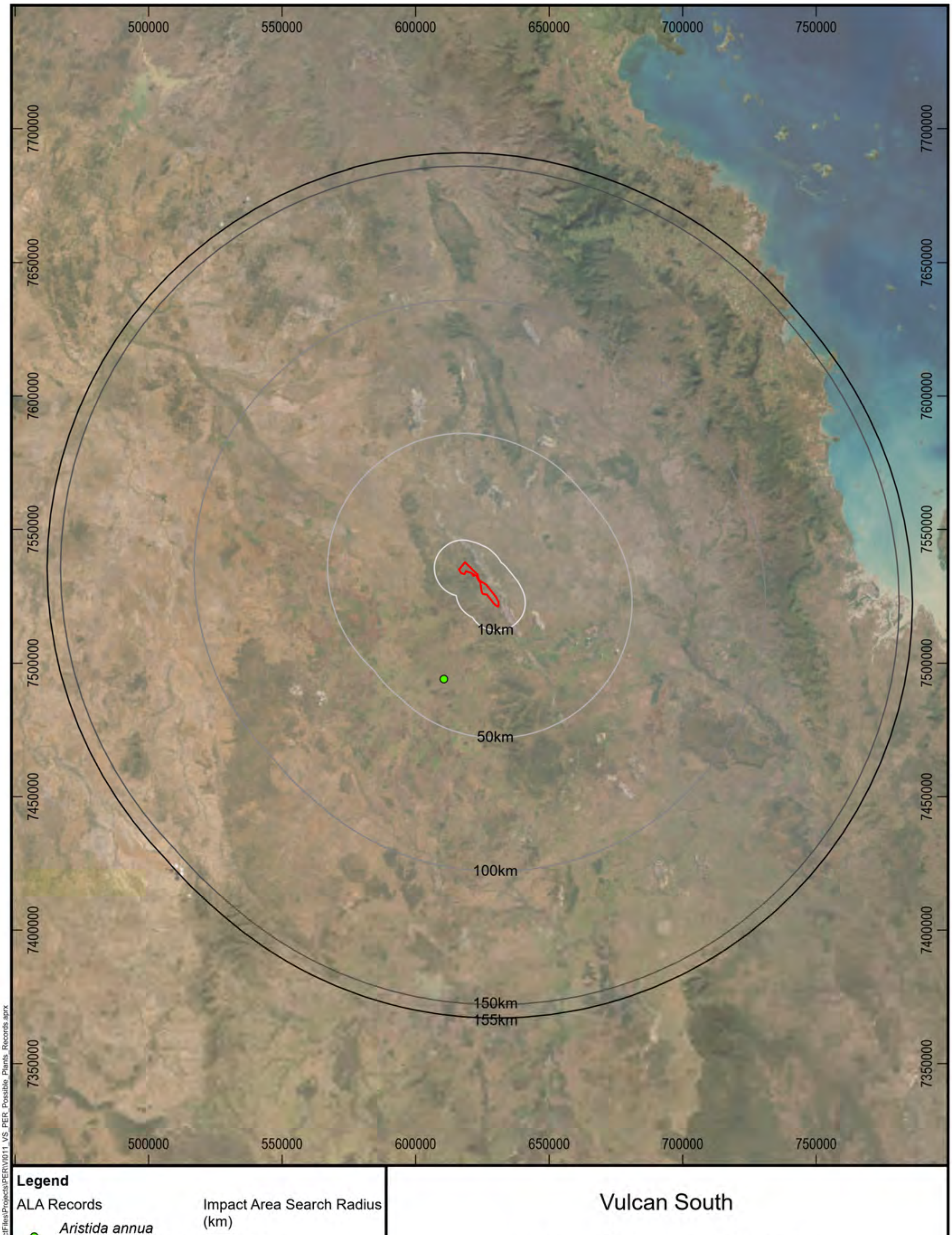
- Commonwealth: Vulnerable
- Queensland: Vulnerable

5.6.11.2 Distribution

Annual Wiregrass is thought to be restricted to central Queensland between Moranbah and Carnarvon National Park.

5.6.11.3 Historical Occurrence

There is only one recorded occurrence in the vicinity of the Project, 35 km to the south-west (1999, Queensland Herbarium) as shown in **Figure 5-25**.



Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Possible_Plants_Records.aprx

Legend

ALA Records

Aristida annua (Annual Wiregrass)

Vulcan South Coal Mine (2023/09708)

Project Area (ML 700073)

Impact Area Search Radius (km)

10

50

100

150

155

Source: Vitrinite 2024, METServe 2020-2024, Atlas of Living Australia 2024, Earthstar Geographics.

Vulcan South

Annual Wiregrass Records

0 20 40 80

Kilometers

Scale: 1:2,000,000 (A4)

24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-25

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.6.11.4 Habitat

KNOWN HABITAT

The Annual Wiregrass is thought to be restricted to the black clay soils of central Queensland (Simon, 1984), which is where almost all herbarium specimens have been collected. These soils are mostly derived from basalt and support native grasslands or open woodlands dominated by *Eucalyptus orgadophila*, *Eucalyptus crebra* or *Eucalyptus melanophloia*. One specimen (held at the Queensland Herbarium) was collected by D. Osten "on a ridge...[with] sandy red loam". However, according to regional ecosystem mapping, the collection location falls within land zone 8 (clay soil derived from basalt), and the habitat reported is probably erroneous. However, based on the highly degraded nature of the habitat present, the survey area is likely to be of negligible importance to the species.

5.6.11.5 Life History

The species flowers between March and June (Department of Climate Change, Energy, the Environment and Water, 2024r).

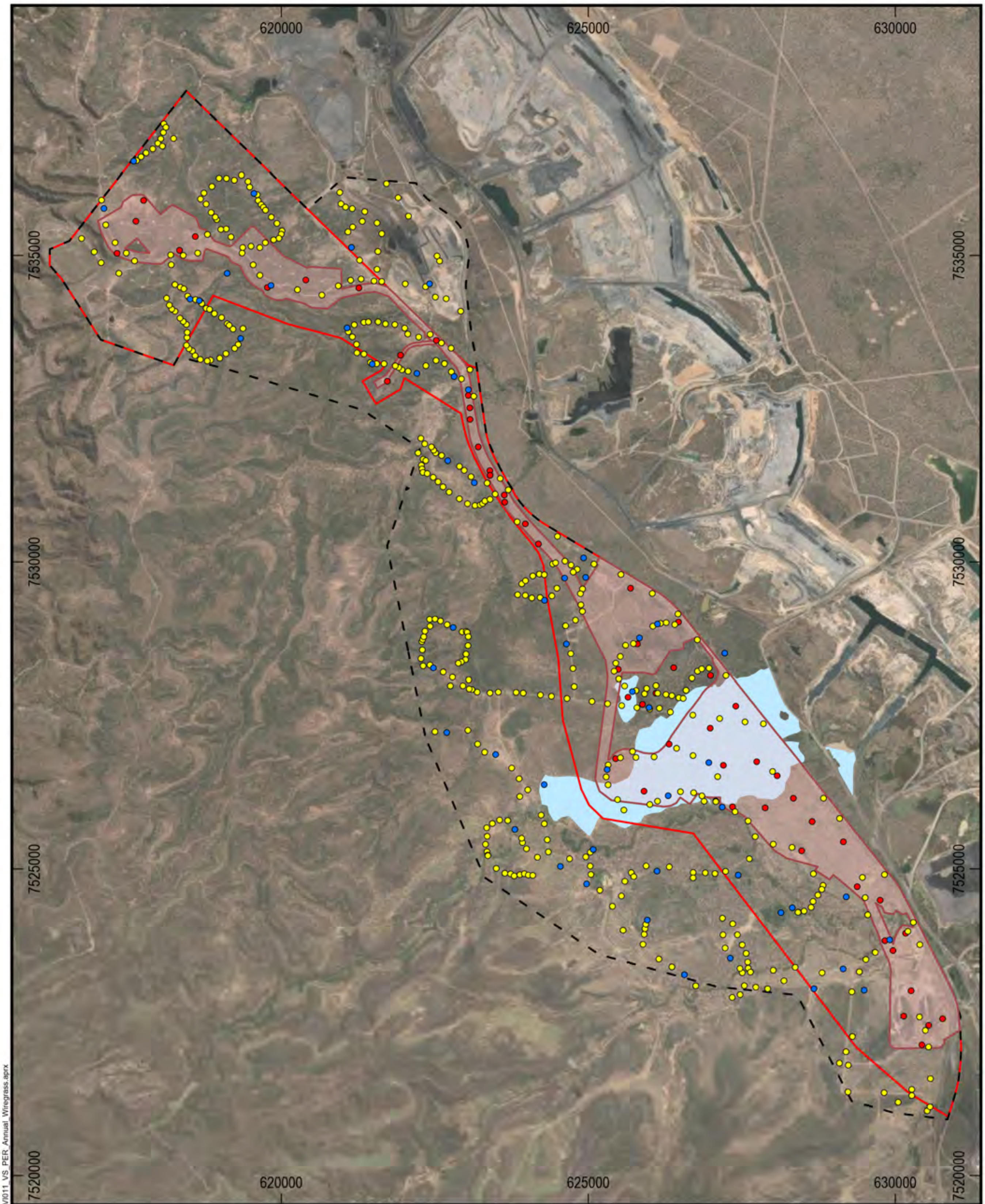
5.6.11.6 Threatening Processes

Key threats to the species include mining and agriculture (Department of Climate Change, Energy, the Environment and Water, 2024r) .

5.6.11.7 Habitat Assessment

The survey area lies outside the known distribution of Annual Wiregrass, and outside the modelled map of where the "species or species habitat may occur" (Department of Climate Change, Energy, the Environment and Water, 2024r). However, the nearest record is only 35 km southwest of the survey area. Given that potential habitat for this threatened grass exists within the survey area, its occurrence on site is considered possible.

No basalt-derived soil exists within the survey area, but black clay soils derived from fine-grained sedimentary rock occur on site and support similar vegetation communities (regional ecosystem 11.9.2). However, these areas were heavily degraded by grazing, with the exotic pasture grass *Bothriochloa pertusa* comprising more than 90% of the vegetation cover. No areas dominated by native grasses were observed on clay soil. No Annual Wiregrass was recorded during flora surveys. Elsewhere in central Queensland, the species has been collected in flower (when easiest to detect and identify) between February and June. The survey period coincided with the start of this period. Given the early start to the 2018-2019 growing season (e.g., heavy rain commenced in October 2018), and the abundance of flowering annual grasses of other species recorded in February 2019 and March 2020, it is expected that, if present, Annual Wiregrass would have been flowering and readily detectable at the time of survey. There are 364.18 ha of potential habitat within the disturbance footprint for this species, as shown in **Figure 5-26.**



Legend

Survey Sites

- Quaternary
- Secondary
- BioCondition
- Potential Annual Wiregrass Habitat

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- Survey Area

Source: Atlas of Living Australia 2024. Vitrinite 2024. METServe 2020-2024. Earthstar Geographics.

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Annual_Wiregrass.aprx

Vulcan South

Potential Annual Wiregrass Habitat

0 1 2 3

Kilometers

Scale: 1:90,000 (A4)

24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-26

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.6.11.8 Summary of likelihood

As the Annual Wiregrass was not found on-site and the habitat is suboptimal, impacts are considered unlikely and will not be discussed further in this document.

5.6.12 Red Goshawk (*Erythrotriorchis radiatus*)

5.6.12.1 Listing Advice

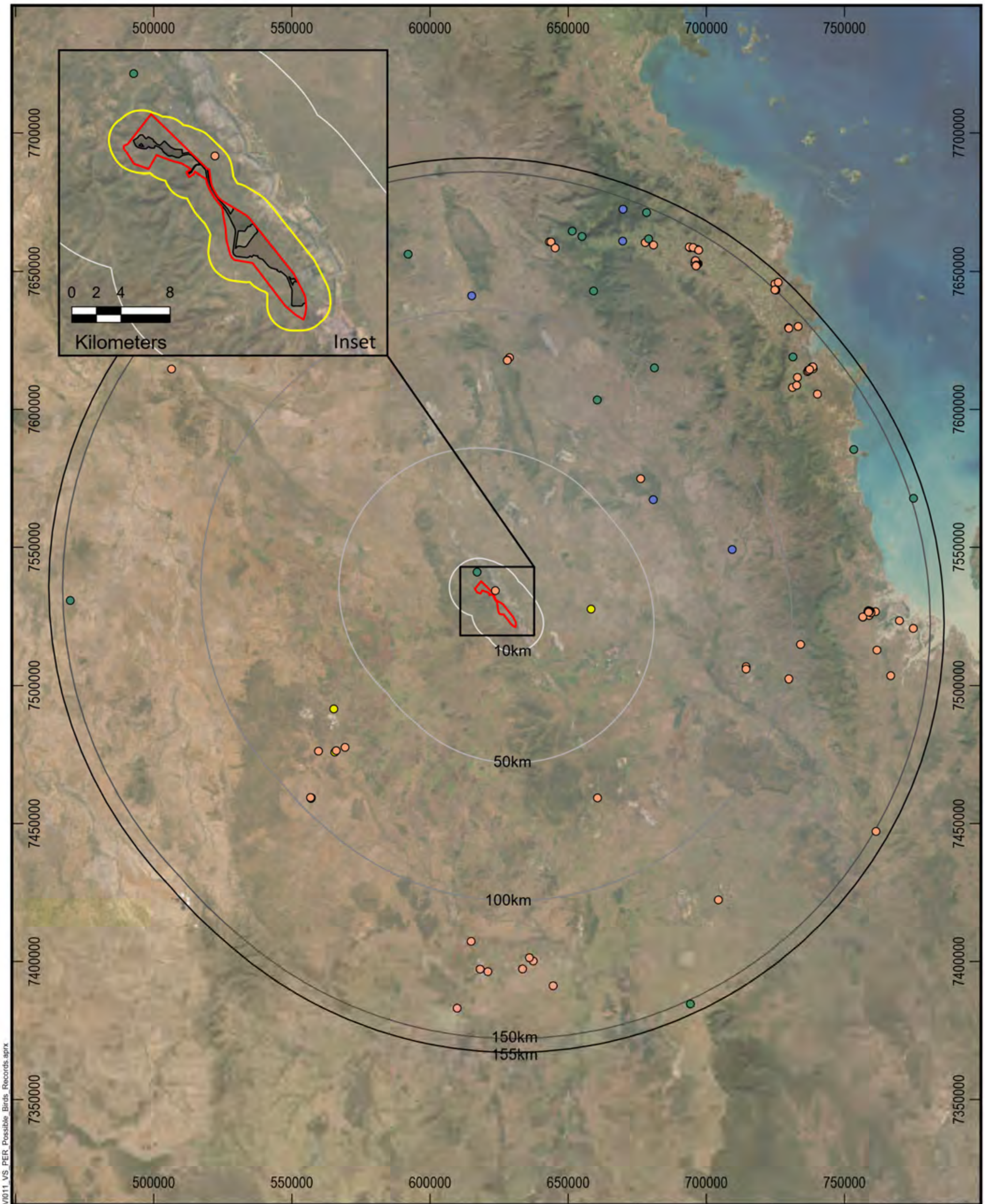
- Commonwealth: Endangered
- Queensland: Endangered

5.6.12.2 Distribution

The Red Goshawk formerly had a wide distribution across northern and eastern Australia. Within the last two decades, it has largely disappeared from the southern half of its former distribution. Since 2000, there have been very few (possibly no) confirmed records within New South Wales, where it is listed as critically endangered (NSW Scientific Committee, 2008). Likewise, over the past 20 years in Queensland there are very few records of the species south of Townsville. The Birdata database lists a single record (from Main Range, southeast Queensland, in 2000), while the eBird database contains a single record (from Maryborough, in 2005). Neither record is supported by photographic evidence.

5.6.12.3 Historical Occurrence

Several records exist within 150 km of the disturbance footprint, including a 1938 record of an egg about 80 km to the southwest (Museums Victoria); two records from 1992 and 2001 about 80 km north-east (WildNet); 80 km north near Hail Creek Mine (no date, WildNet); 100 km to the north near Glenden (2013, WildNet), adjacent to remnant habitats; 120 km to the south, a preserved egg kept with Museums Victoria with no valid date; and two records from 1989 and 1995 about 150 km north, near Eugenella National Park (WildNet). The dated post-1980 records are shown in **Figure 5-27** (see blue points).



Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Possible_Birds_Records.aprx

Legend

ALA Records
- *Cuculus optatus* (Oriental Cuckoo)
- *Erythrotriorchis radiatus* (Red Goshawk)
- *Plegadis falcinellus* (Glossy Ibis)
- *Rostratula australis* (Australian Painted Snipe)

Vulcan South Coal Mine (2023/09708)
- Project Area (ML 700073)
- Disturbance Footprint

Impact Area Search Radius (km)
- 2
- 10
- 50
- 100
- 150
- 155

Source: Vitrinite 2024, METServe 2020-2024, Atlas of Living Australia 2024, Earthstar Geographics.

Vulcan South

Australian Painted Snipe, Oriental Cuckoo, Red Goshawk and Glossy Ibis Records

0 20 40 80
Kilometers
Scale: 1:2,000,000 (A4)

24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-27

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.6.12.4 Habitat

The Red Goshawk occupies a variety of forested environments but favouring the ecotone between dense forest and open woodland, especially near rivers and wetlands. In partly cleared parts of eastern Queensland it is associated with gorge and escarpment country (Threatened Species Scientific Committee, 2015a).

FORAGING HABITAT

Includes coastal and subcoastal tall open forests and woodlands, tropical savannas traversed by wooded or forested creeks and rivers, freshwater wetlands and their margins, and edges of rainforest. (Threatened Species Scientific Committee, 2015a).

BREEDING HABITAT

As per the Threatened Species Scientific Committee (2015a) breeding habitat includes areas with large, tall trees (> 14 m) within proximity to a watercourse (within 2.5 km) that occur within foraging habitat. Particularly important breeding habitat includes riparian vegetation supporting tall stands of remnant paperbark trees (*Melaleuca spp*.) with horizontal limbs along watercourses and tall, dry woodlands in proximity to watercourses with Darwin stringybark (*Eucalyptus tetradonta*) dominated woodlands the primary breeding habitat across northern Australia.

Breeding habitats are often found in areas of topographic ruggedness such as plateaus or gorges where breeding can occur on elevated country in dry woodlands or on lower creek systems. Breeding success is impacted by forest clearing (> 25 % cleared forest within 4 km of nesting birds) and the removal of potential nest trees.

DISPERSAL HABITAT

Being a nomadic species dispersing by flight it is most likely that the species will overfly any habitats not used for foraging or breeding.

5.6.12.5 Life History

The breeding season for Red Goshawks is long with courtship starting as early as April and young not leaving their natal territories until as late as the end of December (Aumann & Baker-Gabb, 1991). Breeding occurs generally in the spring with eggs laid between May and October in the north (Aumann & Baker-Gabb, 1991), and between August and October in the southeast of its range (Debus & Czechura, 1988b). Adjacent pairs in the Northern Territory were observed with over a month of separation in fledge dates. Nonetheless, more Red Goshawk breeding records and breeding activity has been recorded from August through November than in other months (Aumann & Baker-Gabb, 1991) (Debus & Czechura, 1988b).

The Red Goshawk breeds solitarily, in forested or wooded areas, within one km of permanent water, and in a large (over 20 m tall) tree. They are probably monogamous (Aumann & Baker-Gabb, 1991). The length of bonding is not known, but replacement may occur if one of the pair is lost (Hill, 1911). Breeding pairs use the same nesting territories year after year, renovating the nest used in the previous year or nesting nearby (Aumann & Baker-Gabb, 1991). Conspecific interactions have been observed with Wedge-tailed Eagles and especially with Black-breasted Buzzards which prey on Goshawk nests (Aumann & Baker-Gabb, 1991) (Czechura, et al., 2010).

5.6.12.6 Threatening Processes

Habitat loss is the greatest threat to the Red Goshawk which includes fragmentation.

Additional potential threats include:

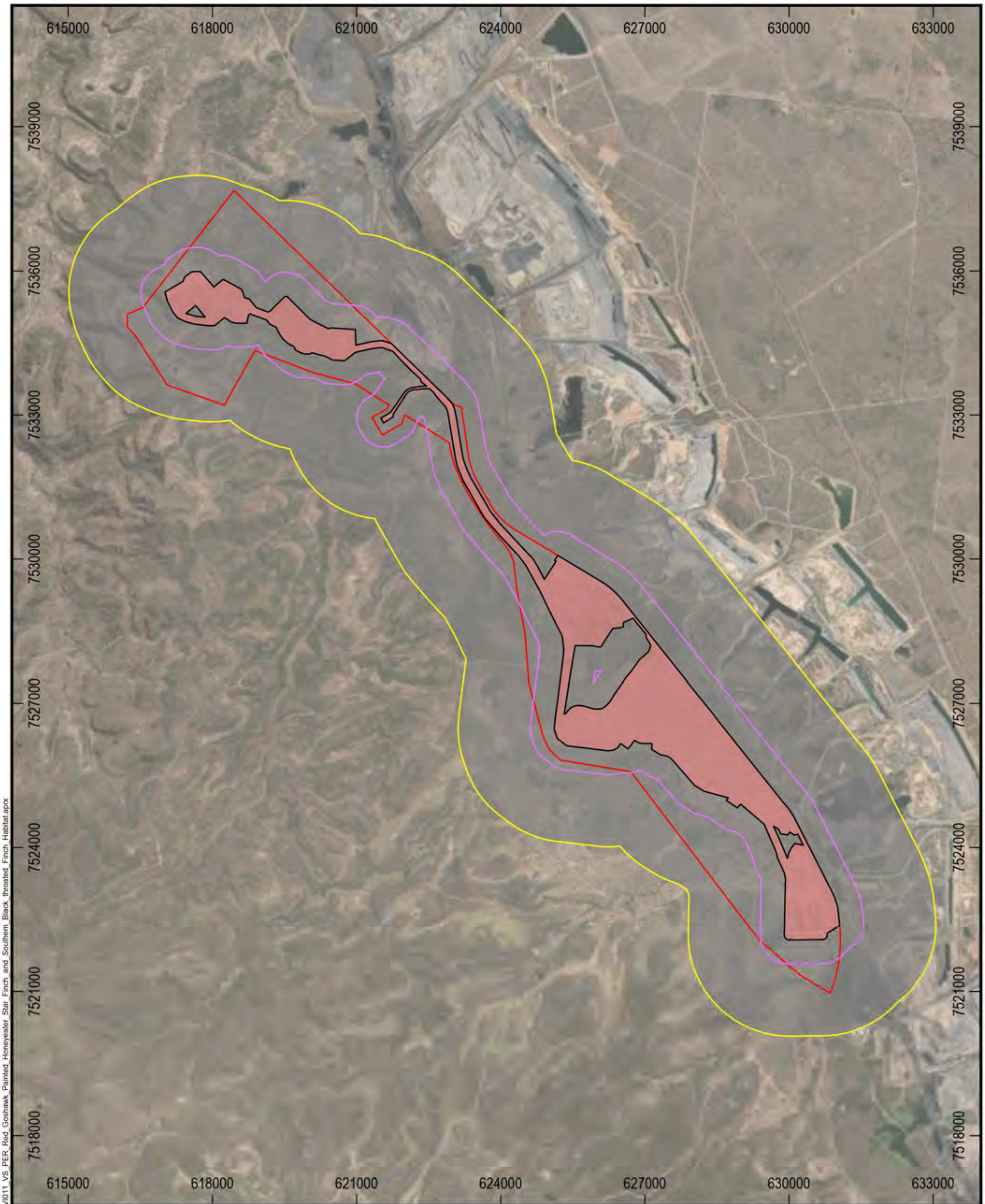
- It has been suggested that there may be a threshold above which habitat alterations within a breeding pairs home range will not be tolerated (Debus & Czechura, 1988b).
- Application of persistent pesticides such as DDT may have caused a historic reduction in population. The past impact of pesticides on breeding Red Goshawks remains speculative, but breeding failure due to eggshell thinning caused by organochlorines has been detected among other raptor species that occur within the range of the Red Goshawk (Olsen, et al., 1993). In 1989, Australia ceased widespread use of organochlorine pesticides, and most affected species have now recovered.
- Overgrazing, or other changes in land management could reduce prey availability, which may reduce productivity. It is suggested that Red Goshawks appear to be tolerant of moderate stocking levels, but that overgrazing can reduce the viability of riparian trees used for nesting, and could reduce prey availability (Aumann & Baker-Gabb, 1991). Increased Red

Goshawk sightings were preceded by a cessation of stock grazing and annual burning resulting in an increase in ground cover and ground dwelling birds (Hughes & Hughes, 1988).

- Fire, and changed burning regimes have the potential to impact breeding sites and reduce prey availability, thus reducing productivity.
- shooting of Red Goshawks, particularly by owners of poultry and pigeons;
- disease;
- catastrophic events, such as wildfire and tropical storms, which may exaggerate the impact of existing threats;
- possible genetic bottlenecks in the population;
- secondary poisoning; and
- persistent disturbance by birdwatchers at known nests (Department of Climate Change, Energy, the Environment and Water, 2024e).

5.6.12.7 Habitat Assessment

Some of the records (especially those older than ten years) are undoubtedly authentic, given that at least three nests were known in southeast Queensland between 2001 and 2003 (Czechura, et al., 2010). However, extensive targeted surveys at the same locations between 2013 and 2014 failed to find any Red Goshawks (Seaton, 2014). The survey area occurs within the historical distribution of the Red Goshawk. Potential habitat for the species occurs on site, although it is not of high quality; escarpments and nearby waterways mostly lack surface water, dense forest is lacking, and the surrounding landscape is highly modified through mining and clearing for grazing. The Red Goshawk rarely breeds in areas with fragmented native vegetation (Threatened Species Scientific Committee, 2015a), and never more than 1 km from water. While it is considered possible that dispersing Red Goshawks may occasionally use the survey area, the importance of the site to the species is considered to be low. There are 0 ha of habitat within or near the Project for this species, as shown in **Figure 5-28**.



Legend

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- 2 km Buffer
- 500m Indirect Impact Buffer
- Non-habitat

Source: Vulcan South datasets - Vitrinite 2024 & METServe 2020-2024. Earthstar Geographics 28/09/2023.

Vulcan South

Red Goshawk, Painted Honeyeater, Star Finch and Southern Black-throated Finch Habitat

0 1 2 4

Kilometers

Scale: 1:115,000 (A4)

24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-28

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Red_Goshawk_Painted_Honeyeater_Star_Finch_and_Southern_Black_throated_Finch_Habitat.aprx

5.6.12.8 Summary of likelihood

Given that the importance of this habitat to the species is extremely low and only dispersing individuals would occasionally occupy certain areas, the species is considered unlikely to use the Project area. For this reason, impacts have not been discussed further in **Section 6**.

5.6.13 Allan's Lerista (*Lerista allanae*)

5.6.13.1 Listing Advice

- Commonwealth: Endangered
- Queensland: Endangered

5.6.13.2 Distribution

Allan's Lerista is a skink that is confined to black soil downs (undulating plains formed primarily on basalt) in the vicinity of Clermont.

5.6.13.3 Historical Occurrence

Two records exist 25-75 km to the west and southwest. Both are preserved specimens, one from 1939 (Australian Museum) and the other from 1948 (South Australian Museum Adelaide). These are the only records within 150 km in the region and are dubious in their collection locations. There are no reliable records (post-1980) in or near the Project, as shown in **Figure 5-29**.

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Allans_Lerista_Records.aprx

Legend

No Records

Vulcan South Coal Mine (2023/09708)

Project Area (ML 700073)

Disturbance Area Search Radius (km)

155

Source: Vitrinite 2024, METServe 2020-2024, Atlas of Living Australia 2024, Earthstar Geographics.

Vulcan South

Allan's Lerista Records

0 20 40 80

Kilometers

Scale: 1:2,000,000 (A4)

24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-29

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.6.13.4 Habitat

Allan's Lerista is only known to occur in the root systems of grass tussocks on black soils within undulating plains formed on basalt, shale, sandstone and unconsolidated sediments of the Oxford land system in the central Brigalow Biogeographic Region. Broad habitat types likely to occur within this region include open grasslands, scattered gums, moderately heavy groves of tea trees and occasional Bottle trees on black and red soil (Department of the Environment, Water, Heritage and the Arts, 2008a; Department of Climate Change, Energy, the Environment and Water, 2024q).

BREEDING/FORAGING/SHELTER/DISPERSAL HABITAT

Given this is a small, fossorial species with probably low dispersal capabilities, it is likely that all occupied habitat is used for breeding, foraging, shelter and dispersal.

5.6.13.5 Life History

Unknown.

5.6.13.6 Threatening Processes

Key threats to Allan's Lerista are outlined in the approved Conservation Advice (Department of the Environment, Water, Heritage and the Arts, 2008a):

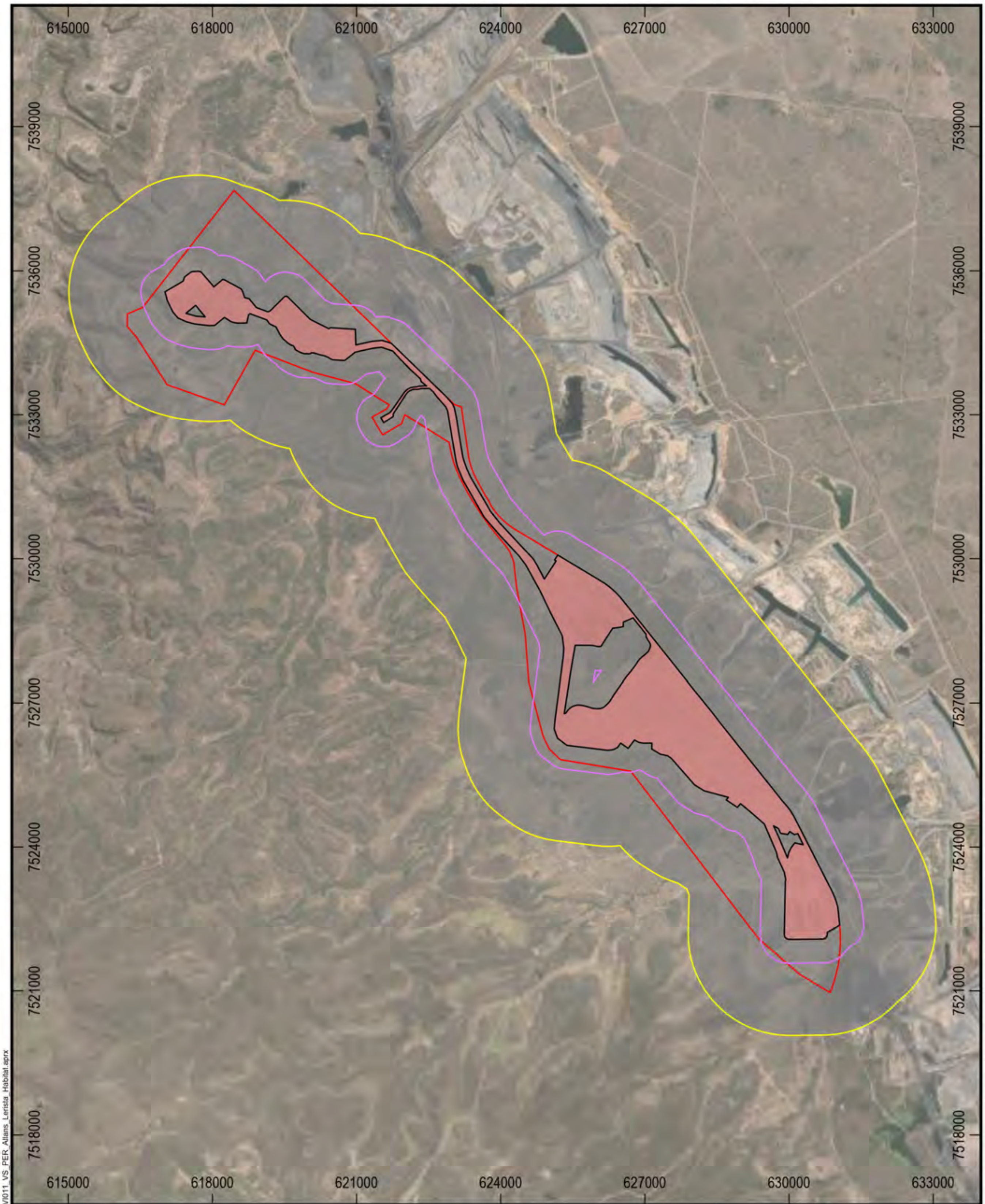
- habitat loss;
- stock overgrazing;
- pasture improvement; and
- intensive cropping.

5.6.13.7 Habitat Assessment

No Allan's Leristas were found during surveys. The nearest known population to the survey area is 30 km west. However, it is separated from the survey area by a 130-km long sandstone range, which likely constitutes an important barrier to dispersal. The species has never been recorded east of this range. The Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles (Department of Sustainability, Environment, Water, Population and Communities , 2011) defines suitable habitat for the species as being regional ecosystems 11.8.5 and 11.8.11, both of which are lacking from the survey area. Nevertheless, regional ecosystem 11.9.2 (*Eucalyptus orgadophila* open woodland on soil derived from fine-grained sedimentary rock) occurs on site, and closely resembles 11.8.5 in its floristics and soil attributes. Furthermore, models within the Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles indicate that the species may occur within the survey area, despite the site being outside the modelled "known/likely to occur" zone. A total of four trap sites were installed in the only patch of potential habitat located within the survey area (three in remnant 11.9.2 and one in cleared 11.9.2), which is twice the sample effort recommended by the Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles. There are 0 ha of habitat within or near the Project for this species, as shown in **Figure 5-30**.

5.6.13.8 Summary of likelihood

Considering the known distribution of the species and the search effort conducted to date, it is unlikely that Allan's Lerista occurs within the Project area.



Legend

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- 2 km Buffer
- 500m Indirect Impact Buffer
- Non-habitat

Source: Vulcan South datasets - Vitrinite 2024 & METServe 2020-2024. Earthstar Geographics 28/09/2023.

Vulcan South

Allan's Lerista Habitat

0 1 2 4

Kilometers

Scale: 1:115,000 (A4)

24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-30

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.6.14 Ghost Bat (*Macroderma gigas*) – Vulnerable

5.6.14.1 Listing Advice

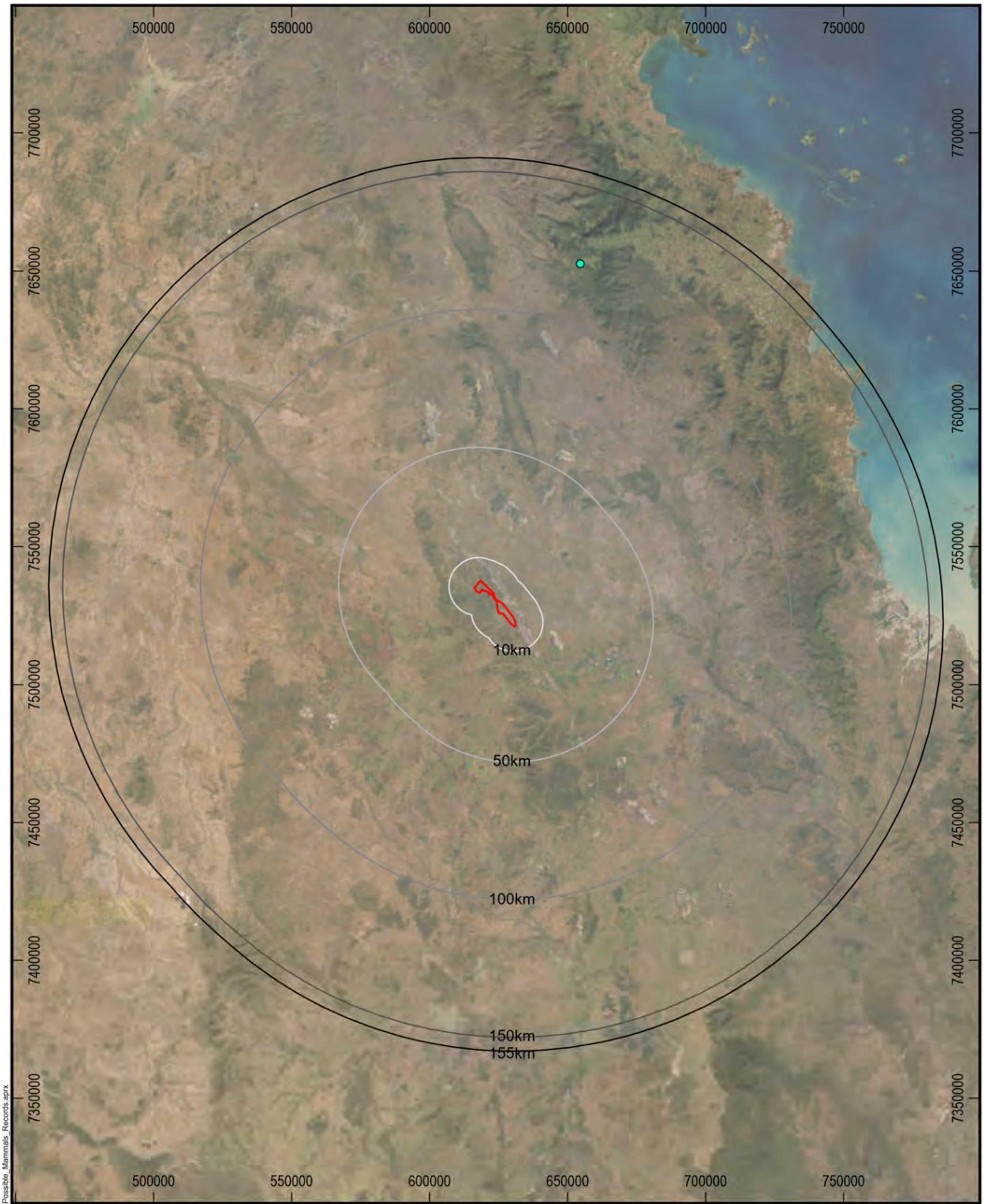
- Commonwealth: Vulnerable
- Queensland: Endangered

5.6.14.2 Distribution

Fossil data show that the ghost bat was once distributed widely over much of Australia except Victoria and Tasmania, including the arid zone, but contracted northwards during the Holocene period (Molnar, et al., 1984) (Churchill & Hekman, 1990). A study that combined information from ancient DNA obtained from remains in extinct southern populations, newly-generated and existing genetic data from extant northern populations, and ecological niche modelling based on past and present climatic conditions (Thomson, et al., 2012), suggested that the ghost bat expanded southwards during periods of higher humidity (interglacials) and contracted northwards in response to increasing aridity (e.g., preceding the last glacial maximum). The combined analyses support previous statements that the ghost bat is a geographically relictual species in southern, arid landscapes, present only because caves provide suitable roost microclimates.

5.6.14.3 Historical Occurrence

There is one record exist 120 km north of the Project area from 2004 in Crediton State Forest (WildNet), as shown in **Figure 5-31**.



Legend

ALA Records

Macroderma gigas (Ghost Bat)

Vulcan South Coal Mine (2023/09708)

Project Area (ML 700073)

Impact Area Search Radius (km)

10

50

100

150

155

Source: Vitrinite 2024, METServe 2020-2024, Atlas of Living Australia 2024, Earthstar Geographics.

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\Possible_Mammals_Records.aprx

Vulcan South

Ghost Bat Records

0 20 40 80

Kilometers

Scale: 1:2,000,000 (A4)

24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-31

5.6.14.4 Habitat

The Ghost Bat's distribution is primarily limited by suitable roost sites.

BREEDING HABITAT

Ghost Bats roost and breed in caves that comprise a small entrance hole and a large chamber, where conditions remain warm and humid year-round (Toop, 1985; Armstrong & Anstee, 2000). Armstrong and Anstee (2000) found that roost sites are often 30-50 m deep within the cave, where conditions are most stable. However, smaller caves may be used transiently. Ghost Bats move between a number of caves seasonally or as dictated by weather conditions and require a range of cave sites. Ghost Bats also colonise disused mines, especially those that are deep and complex, with an isothermal zone (an area of stable, suitable temperatures).

FORAGING HABITAT

Ghost Bats forage in a wide range of native vegetation types. Foraging areas average 61 ha in size and are generally within 1-10 km of roost sites (Tidemann, et al., 1985; Diete, et al., 2016).

SHELTER HABITAT

Suitable roost sites are scarce across eastern Queensland. There are only two known breeding colonies of Ghost Bats in central eastern Queensland: at Rockhampton and Cape Hillsborough. Genetic studies indicate that these populations are isolated from other populations and each other. This suggests a general lack of suitable breeding habitat elsewhere in central eastern Queensland (Worthington Wilmer, et al., 1999).

DISPERSAL HABITAT

Ghost Bats may disperse in winter 20-50 km from the maternity roosts (Toop, 1985), and the closest record of a dispersing individual (presumably from Cape Hillsborough) is at the Clarke Range (80 km northeast of the survey area). As this species disperses aerially, the only likely use for dispersal habitat is for overflying purposes; and therefore, impacts to dispersal habitat are unlikely to be significant to this species.

5.6.14.5 Life History

Female Ghost Bats gave birth to a single pup in late spring, but only 40 percent of females bred in their second year, increasing to 93 percent for females ≥ 2 years old. Annual adult survival ranged 0.57–0.77 for females and 0.43–0.66 for males and was lowest over winter–spring and greatest in autumn–winter. Juvenile survival for the first year ranged 0.35–0.46 for females and 0.29–0.42 for males. Adult survival varies among seasons and is negatively associated with rainfall but not associated with temperature apart from being less in late winter. Low survival may result from the inferior daytime roosts that bats must use if water seepage forces them to leave their normal roosts. Pregnant females congregate in the warmest caves and give birth over a month commencing in mid-October. As caves become warmer as summer progresses, some mothers shift the young to other caves. Juvenile bats commence flying at seven weeks with all young capable of flight by the end of January (Threatened Species Scientific Committee, 2016a).

5.6.14.6 Threatening Processes

Threats to the Ghost Bat, listed in severity from most to least severe include (Threatened Species Scientific Committee, 2016a):

- habitat loss due to mining;
- disturbance of breeding sites by human visitation;
- modification to foraging habitat;
- collision with barbed-wire fences;
- collapse or reworking of old mine adits;
- contamination of roost sites by mining residue;
- disease;
- poisoning by cane toads; and

- competition with foxes and feral cats.

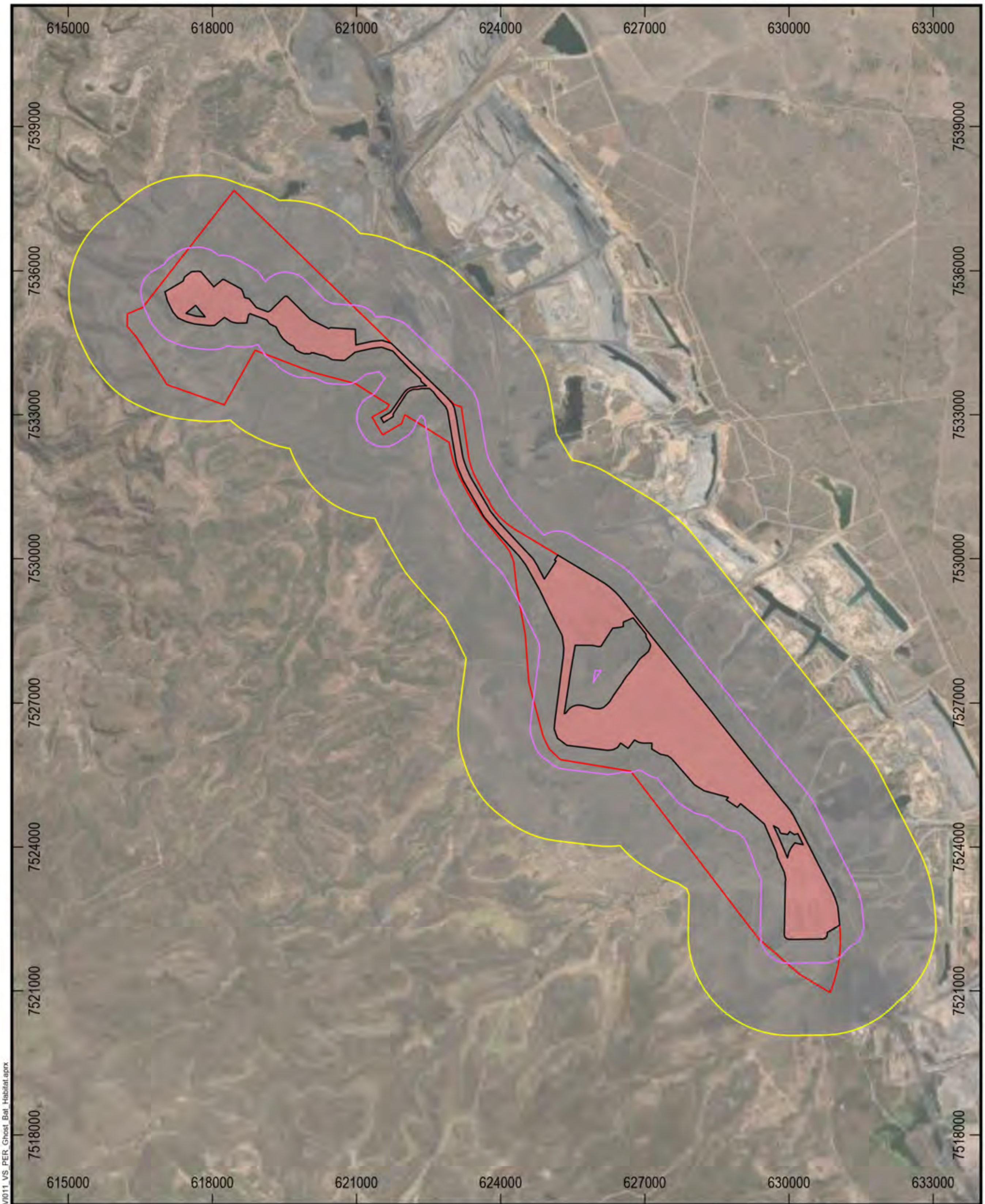
5.6.14.7 Habitat Assessment

Habitat for the Ghost Bat is shown in **Figure 5-32**. The survey area is well outside the known winter dispersal and foraging zones of the two central Queensland populations of Ghost Bats. However, given that the existence of unknown breeding sites is possible, and the proliferation of mining across the Bowen Basin may have inadvertently created new roosting habitats (in disused mines), it is considered of very low likelihood (less than 5%) that the survey area may be used intermittently by Ghost Bats. This use would solely be in a foraging capacity if suitable caves were to occur. It is highly unlikely that any foraging areas are utilised by this species given the lack of nearby habitats with the potential for roosting, as none of the sandstone ridges on site supported caves of a size and structure suitable as a roost site, nor were any areas within the broader survey area found to have suitable roosting caves or the potential for these.

No Ghost Bats were recorded during surveys.

There is 0 ha of habitat within the disturbance footprint or the broader Project area for this species given the lack of terrain suitable for the formation of roosts, the low likelihood of roosts being a determining factor.

Vulcan South will not disturb any roosts for Ghost Bats or remove foraging habitat within 1-10 km of known roost sites. It is unlikely that the project footprint contains habitat occupied, or likely to be occupied by the species and therefore no impacts, significant or otherwise are anticipated.



Legend

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- 2 km Buffer
- 500m Indirect Impact Buffer
- Non-habitat

Source: Vulcan South datasets - Vitrinite 2024 & METServe 2020-2024. Earthstar Geographics 28/09/2023.

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Ghost_Bat_Habitat.aprx

Vulcan South

Ghost Bat Habitat

0 1 2 4

Kilometers

Scale: 1:115,000 (A4)

25/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-32

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.6.14.8 Summary of Likelihood

There is no suitable habitat within the Project area, no individuals were recorded during surveys for this, or other local projects and the Project area is well outside of the species known range; therefore, it is considered unlikely for the Ghost Bat to occur.

5.6.15 Latham's Snipe (*Gallinago hardwickii*)

Following the submission of the EPBC referral, this species has been uplisted to Vulnerable under the EPBC Act. Upon review of the habitat for this species following the previous submission of the EPBC Referral, as per likelihood table (**Table 5-3**), this species is considered unlikely to occur and therefore not likely to be impacted.

5.6.15.1 Listing Advice

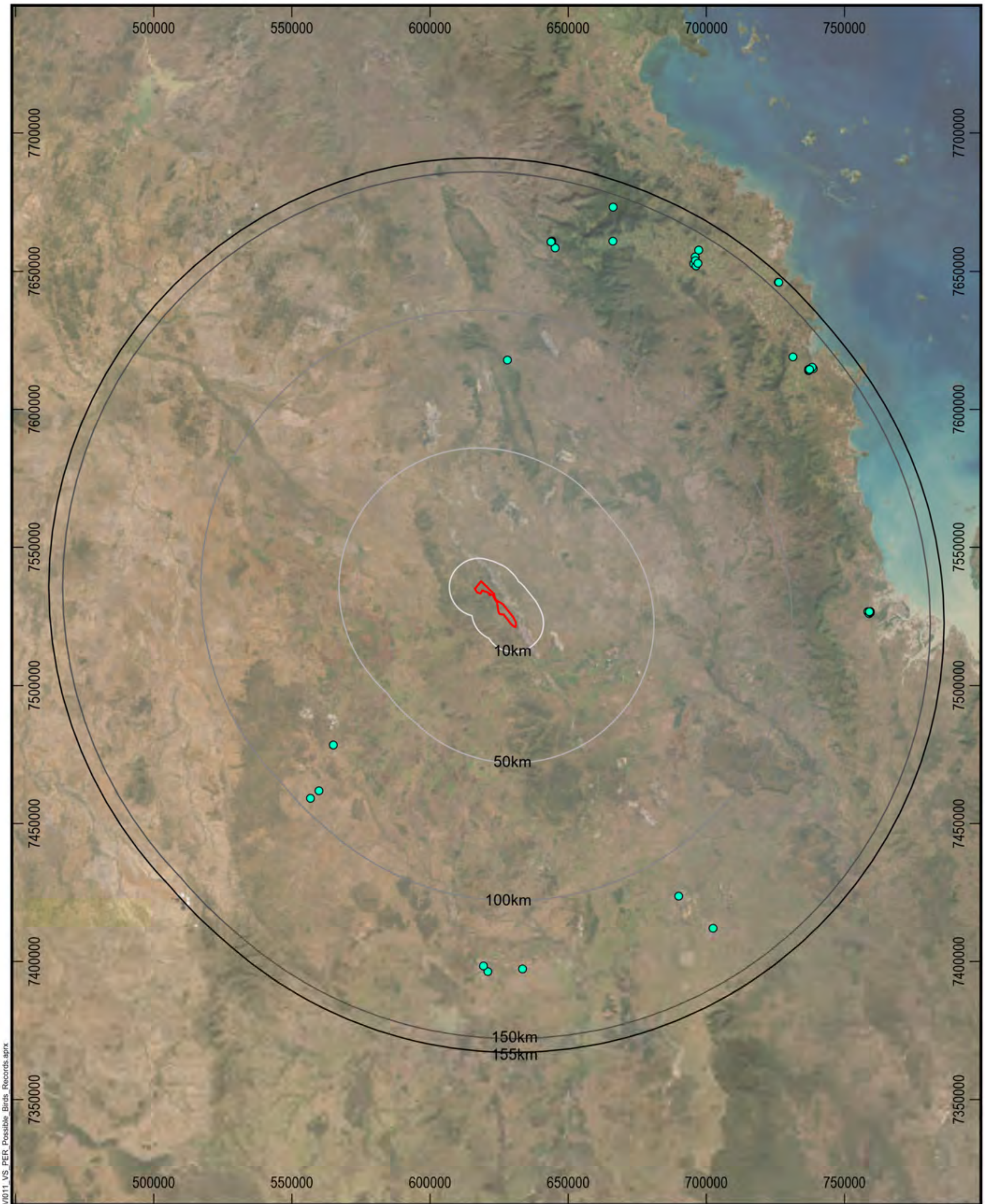
- Commonwealth: Vulnerable
- Queensland: Special Least Concern

5.6.15.2 Distribution

The Latham's Snipe is a migratory bird that visits south-eastern Australia and migrates through northern Australia. In Queensland, the range extends from south-eastern Queensland and (occasionally) from Rockhampton. The Latham's Snipe is also found throughout Tasmania and Victoria. The Latham's Snipe has been recorded in northwestern and southwestern Queensland (Department of Climate Change, Energy, the Environment and Water, 2024o).

5.6.15.3 Historical Occurrence

Records are scattered in all directions, although none are within 60 km of the disturbance footprint (**Figure 5-33**). Predictably, most of these are associated with water bodies. The closest dated records to the Project include 78 km south-west (2000 from BirdLife Australia, at Clermont), 81 km north (2018 from eBird Australia), 93 km south-west (1999, BirdLife Australia south of Clermont), and 97 km south-west (2000, BirdLife Australia, south of Clermont).



Legend

Gallinago hardwickii (Latham's Snipe)

Vulcan South Coal Mine (2023/09708)

Project Area (ML 700073)

Impact Area Search Radius (km)

10
50
100
150
155

Gallinago hardwickii (Latham's Snipe)

Source: Vitrinite 2024, METServe 2020-2024, Atlas of Living Australia 2024, Earthstar Geographics.

Vulcan South

Latham's Snipe Records

0 20 40 80
Kilometers
Scale: 1:2,000,000 (A4)

25/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-33

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.6.15.4 Habitat

Latham's Snipe is a shorebird with similar ecological requirements to the Australian Painted-snipe. Latham's Snipe inhabits the muddy edges of freshwater and brackish wetlands where there exists abundant low, dense vegetation for shelter. Important habitat for Latham's Snipe is defined in the Wildlife Conservation Plan for Migratory Shorebirds (Department of the Environment, 2015b) as "areas that have previously been identified as internationally important for the species, or areas that support at least 18 individuals of the species".

Habitat for the Latham's Snipe is as follows (Department of Climate Change, Energy, the Environment and Water, 2024o):

FORAGING HABITAT

Soft mudflats or shallow water typically at night, early morning, or evening.

SHELTER HABITAT

Small wetlands for shelter during the day, including urban water bodies, saltmarshes, as well as creek edges where there is adequate shallow flooded or inundated substrate. They also use crops and pasture. They mostly are found among dense cover comprising sedges, grasses, lignum, reeds, and rushes. The bird tends to disperse after dusk to forage over larger areas.

BREEDING HABITAT

This species does not breed in Australia.

DISPERSAL HABITAT

This species, being migratory is expected to follow seasonal migration routes and overfly most habitat types, stopping only to shelter and forage.

5.6.15.5 Life History

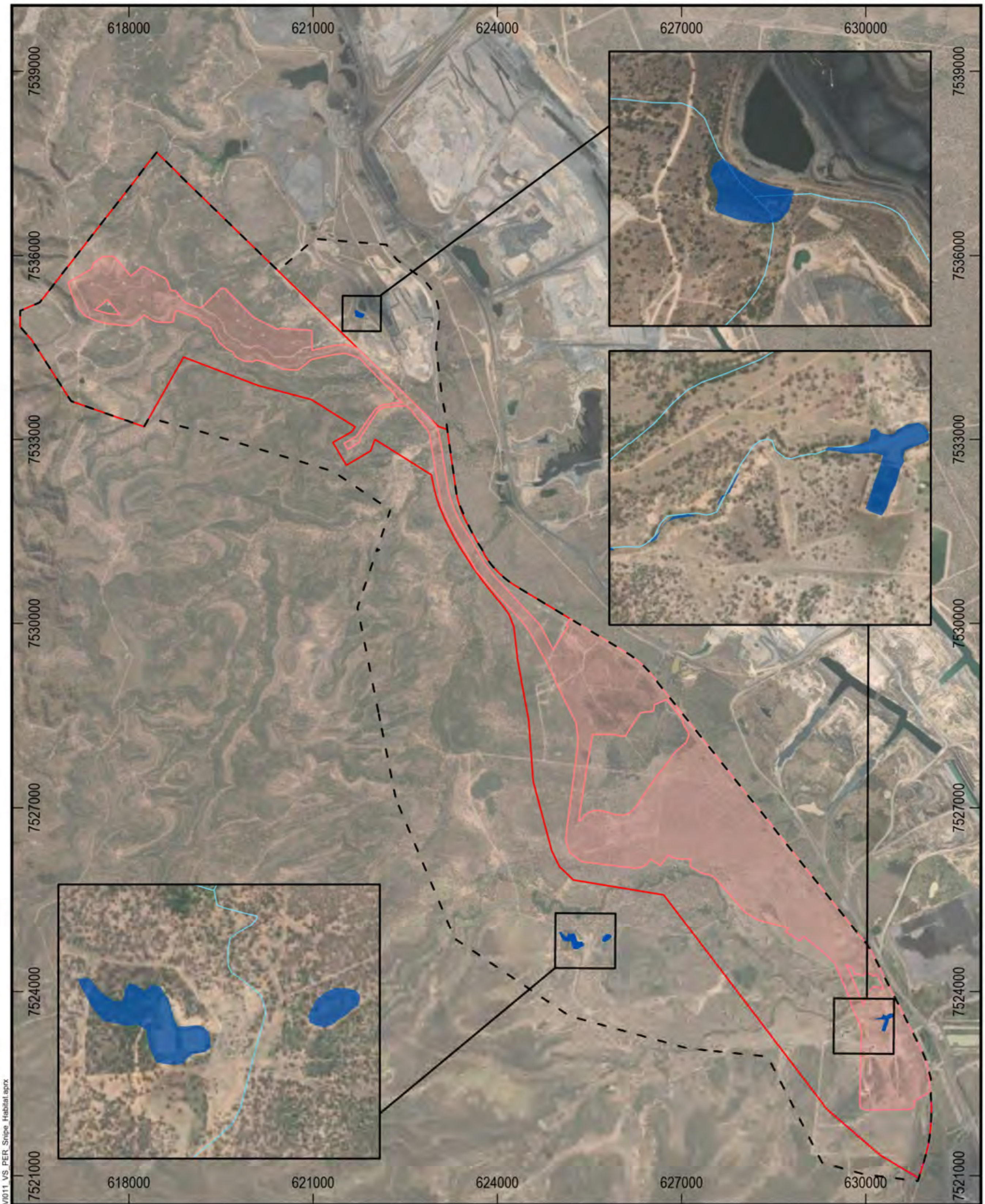
Egg laying occurs between May to early June, with an incubation (by the female) and nesting period of approximately 20 days. This species does not breed in Australia; breeding occurs in Japan and Russia (Department of Climate Change, Energy, the Environment and Water, 2024o).

5.6.15.6 Threatening Processes

Key threats in Australia include habitat loss/fragmentation/degradation, climate change, predation by invasive species, incursion of *Melaleuca viridiflora* (broad-leaved tea tree). Drought and severe fire events within the last 15 years have contributed to this species' decline. It is expected that climate change will pose an ongoing threat, as drought conditions intensify (Department of Climate Change, Energy, the Environment and Water, 2024o).

5.6.15.7 Habitat Assessment

Given the species is not especially likely to be found within the Project area, the habitat is considered marginal. During field assessment, the only potential habitats found were small farm dams. These are the same habitats that are considered suitable for the Australian Painted-snipe. There are 2.9 ha of potential habitat within the Project area for this species, as shown in **Figure 5-34**.



Legend

- Drainage Lines
- Potential Latham's Snipe and Australian Painted-snipe Habitat

Vulcan South Coal Mine (2023/09708)

- Survey Area
- Disturbance Footprint
- Project Area (ML 700073)

Source: Vitrinite 2022, METServe 2020-2022, Maxar, Earthstar Geographics

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Snipe_Habitat.aprx

Vulcan South

Potential Habitat for Latham's Snipe and Australian Painted-snipe

0 0.75 1.5 3

Kilometers

Scale: 1:90,000 (A4)

25/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-34

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.6.15.8 Summary of Likelihood

The species is considered as possible to occur and therefore further impacts have not been described in **Section 6**.

5.6.16 Australian Painted-Snipe (*Rostratula australis*)

The Australian Painted-snipe is a nomadic shorebird that is an endangered species under the EPBC Act. There is no recovery plan in place for the species. However, the Commonwealth Government has provided advice about the species' ecology and priority actions to mitigate key threats within the conservation advice (Threatened Species Scientific Committee, 2013).

5.6.16.1 Listing Advice

- Commonwealth: Endangered
- Queensland: Endangered

5.6.16.2 Distribution

The Australian Painted-snipe is distributed patchily from Perth in Western Australia to the Gulf of Carpentaria and down the east coast to southeastern Australia.

5.6.16.3 Historical Occurrence

The closest record, 28 km to the east from 2017 (Atlas of Living Australia), offers no information on spatial accuracy. There are two records from 1991 (WildNet) located near Clermont. A specimen was collected in Emerald, 120 km to the south in 1978 (Queensland Museum). A 2015 (eBird Australia) record exists from St Lawrence on the coast, 120 km to the east. There are other close records, but the dates and locations have been obscured. Records within 150 km of the Project are shown in **Figure 5-27** (yellow points) within **Section 5.6.12.3**

5.6.16.4 Habitat

The Australian Painted-snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans (Department of Climate Change, Energy, the Environment and Water, 2024n).

FORAGING HABITAT

Favoured wetlands have muddy shorelines and margins of rank grass, sedges, rushes, reeds, samphire, lignum (*Muehlenbeckia*), canegrass or sometimes tea-tree. The Australian Painted-snipe can use modified habitats, including farm dams; however, they do not necessarily breed in such habitats.

BREEDING HABITAT

Nest records are all, or nearly all, from or near small islands in freshwater wetlands, provided that these islands are a combination of very shallow water, exposed mud, dense low cover and sometimes some tall dense cover.

SHELTER HABITAT

This species is most likely to shelter adjacent to foraging and breeding habitats, therefore this habitat type is not considered a category of its own.

DISPERSAL HABITAT

Being a nomadic species dispersing by flight it is most likely that the species will overfly any habitats not used for foraging or breeding.

5.6.16.5 Life History

The Australian Painted Snipe may breed in response to wetland conditions rather than during a particular season. It has been recorded breeding in all months in Australia. In southern Australia most records have been from August to February. Eggs have been recorded from mid-August to March, with breeding in northern Queensland also recorded between May and October. Australian Painted Snipe are known to lay two to six eggs, and females may lay up to four clutches in a year. Incubation takes

15–21 days. Chicks are precocial and nidifugous, but they are brooded and dependent for the first few days. The incubation of the eggs, and all care of the young, is undertaken by the male (Department of Climate Change, Energy, the Environment and Water, 2024n).

5.6.16.6 Threatening Processes

The primary factor in the decline of the Australian Painted Snipe has probably been a loss and alteration of wetland habitat. Grazing, fires and weeds are also likely threats (Department of Climate Change, Energy, the Environment and Water, 2024n).

5.6.16.7 Habitat Assessment

This species was not recorded within the survey area. There are also very few records of the species from the region, and none of these are recent. Nevertheless, as this is a secretive, highly mobile species and potential habitat occurs in the vicinity of the project, it is considered a possible visitor to the survey area. Potential habitat for the Australian Painted-snipe was recorded at natural and artificial (dams) wetlands in the southern third of the survey area. In addition, a small dam in the northeast of the survey area possessed margins vegetated with suitable sedges and rushes, but the steep banks lacking areas of shallow mud limit the suitability of this habitat for Australian Painted-snipe. One of the habitats within the survey area contains a small island, which has potential as a nest site for Australian Painted-snipe. This wetland lies outside the Project area. The Australian Painted-snipe is highly mobile and is considered to occur in a single, contiguous breeding population (Department of Climate Change, Energy, the Environment and Water, 2024n). Small numbers (singles or small groups) possibly utilise habitat within the Project area for short periods during transit through the region. The total habitat the Australian Painted-snipe may occur in is 2.9 ha contained within the Project area, as shown in **Figure 5-34** in **Section 5.6.15.7**.

5.6.16.8 Summary of Likelihood

Small numbers (singles or small groups) possibly utilise habitat within the Project area for short periods during transit through the region. No further impact assessment has been completed on this species.

5.6.17 Sharp-tailed Sandpiper (*Calidris acuminata*)

5.6.17.1 Listing Advice

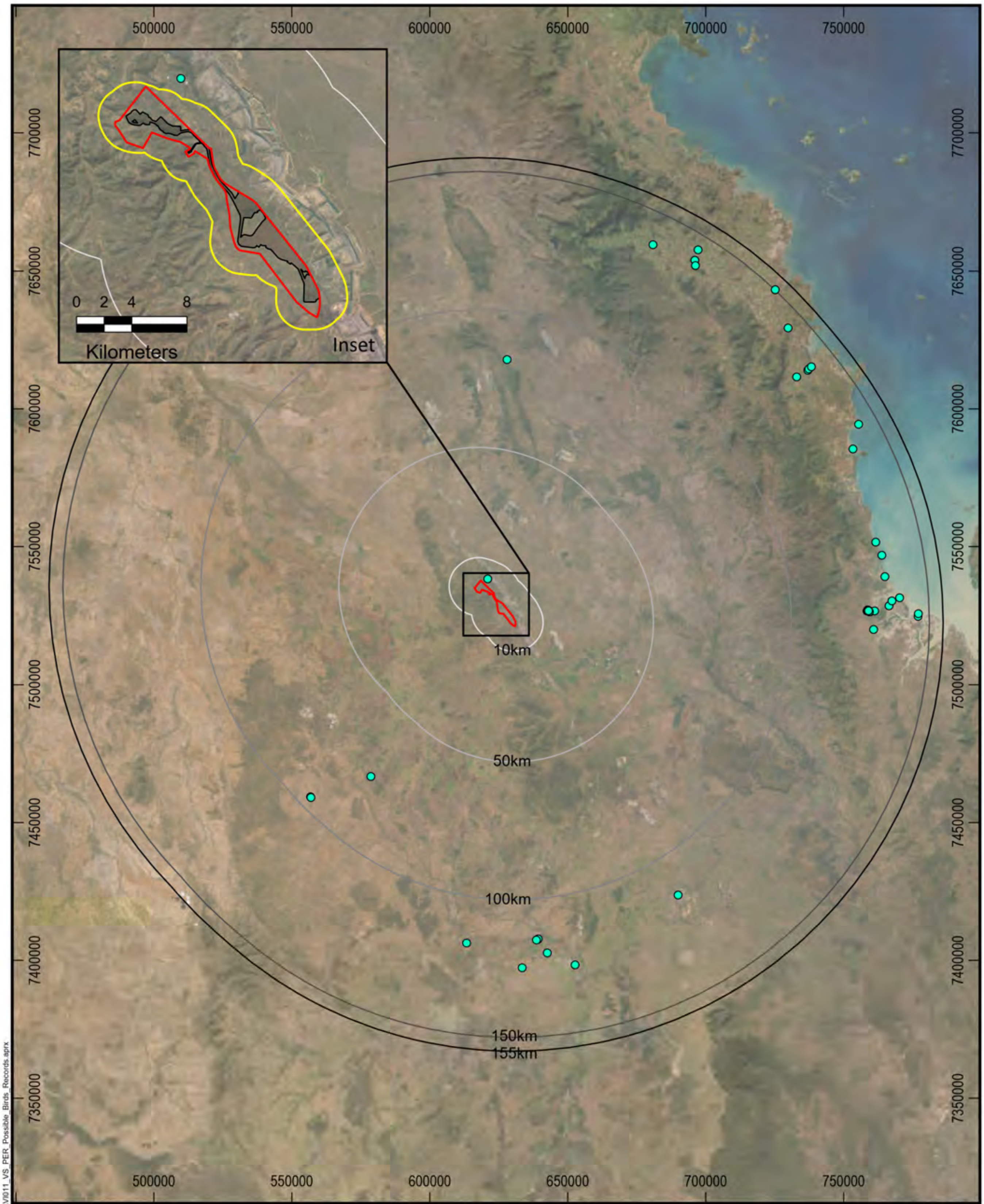
- Commonwealth: Vulnerable
- Queensland: Special Least Concern

5.6.17.2 Distribution

The Sharp-tailed Sandpiper is distributed from its non-breeding areas in wetlands both coastal and inland Australia, northwards through Asia and into Russia.

5.6.17.3 Historical Occurrence

A record exists from the Peak Downs mine in a large wetland (2001, BirdLife Australia). The next closest records are 81 km north (2018, eBird), 80 km south-west near Clermont (2011, BirdLife Australia), 100 km south-west near Clermont (2021, eBird), and 115 km south-east (2003, WildNet). Further records exist around Emerald to Blackwater, and clustered around St Lawrence and Rockhampton. These records are shown in **Figure 5-35.**



Legend

ALA Records

Calidris acuminata (Sharp-tailed Sandpiper)

Vulcan South Coal Mine (2023/09708)

Project Area (ML 700073)

Disturbance Footprint

Impact Area Search Radius (km)

2

10

50

100

150

155

Source: Vitrinite 2024, METServe 2020-2024, Atlas of Living Australia 2024, Earthstar Geographics.

Vulcan South

Sharp-tailed Sandpiper Records

0 20 40 80

Kilometers

Scale: 1:2,000,000 (A4)

25/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-35

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.6.17.4 Habitat

Sharp-tailed Sandpipers depend on open wetlands with shallow, muddy margins and often short, damp vegetation. Habitat can be divided into foraging, roosting, and breeding habitats (Department of Climate Change, Energy, the Environment and Water, 2024n).

FORAGING HABITAT

includes fresh and hypersaline environments, feeding along the edge of water on mudflats, coastal and inland wetlands, and sewage ponds. After rainfall events, the species may also feed on areas of agricultural pasture (Department of Climate Change, Energy, the Environment and Water, 2024n).

SHELTER HABITAT

Generally rocky and sandy beaches, freshwater habitats, and inland saltwater habitats (Department of Climate Change, Energy, the Environment and Water, 2024n).

BREEDING HABITAT

This species does not breed in Australia.

DISPERSAL HABITAT

This species, being migratory is expected to follow seasonal migration routes and overfly most habitat types, stopping only to shelter and forage.

5.6.17.5 Life History

The Sharp-tailed Sandpiper is migratory, breeding in northern Siberia and moving in flocks of less than a thousand, to non-breeding areas south of the Equator (Department of Climate Change, Energy, the Environment and Water, 2024n).

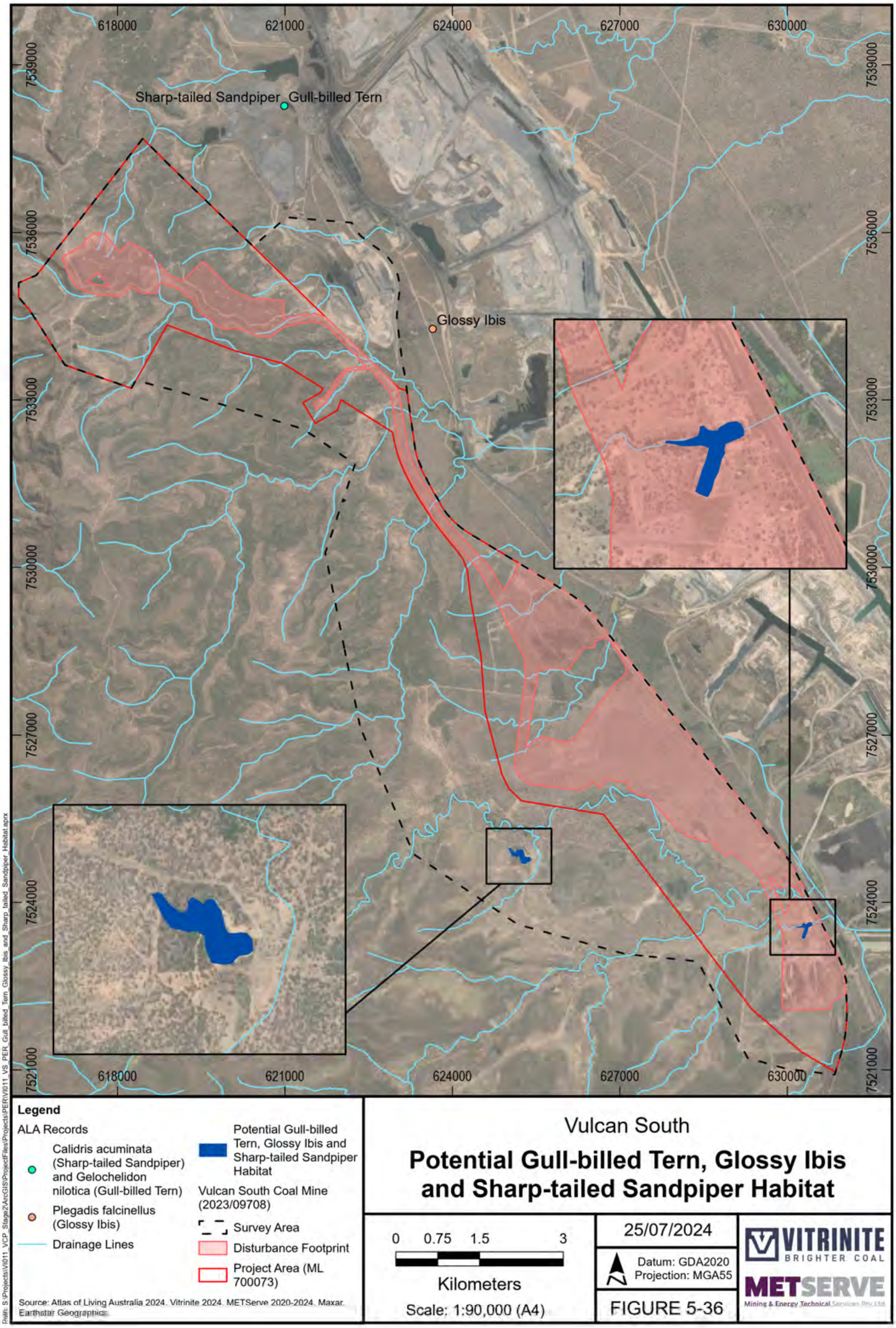
5.6.17.6 Threatening Processes

The Conservation Advice (2024n). lists the following threats to the Sharp-tailed sandpiper:

- habitat loss, degradation, and fragmentation;
- climate change (drought and sea level rise);
- invasive species;
- pollution; and
- exploitation (hunting and fishing bycatch, mostly occurring outside Australia).

5.6.17.7 Habitat Assessment

No Sharp-tailed Sandpipers were recorded within the survey area, but there is a nearby record from Peak Downs Mine in 2001. They are likely to be occasional summer visitors to suitable habitat within the survey area. The natural wetlands present on site are too small and/or are too heavily treed to provide favourable habitat for this species. However, two dams constitute marginal habitat that may be used briefly under optimal weather conditions (i.e., when retreating water levels expose muddy banks). Both dams are located in the southern half of the survey area, one of which is in the MLA area. None of the habitat present within the survey area is considered important for the Sharp-tailed Sandpiper. Potential habitat is shown in **Figure 5-36.** There are 2.82 ha of potential habitat in the disturbance footprint.


618000
621000
624000
627000
630000
7539000
7536000
7533000
7530000
7527000
7524000
7521000
Sharp-tailed Sandpiper, Gull-billed Tern
Glossy Ibis
Legend
ALA Records
Calidris acuminata (Sharp-tailed Sandpiper) and Gelochelidon nilotica (Gull-billed Tern)
Plegadis falcinellus (Glossy Ibis)
Drainage Lines
Potential Gull-billed Tern, Glossy Ibis and Sharp-tailed Sandpiper Habitat
Vulcan South Coal Mine (2023/09708)
Survey Area
Disturbance Footprint
Project Area (ML 700073)
Source: Atlas of Living Australia 2024. Vitrinite 2024. METServe 2020-2024. Maxar. Earthstar Geographics
Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Gull_billed_Tern_Glossy_Ibis_and_Sharp_tailed_Sandpiper_Habitat.aprx
Vulcan South
Potential Gull-billed Tern, Glossy Ibis and Sharp-tailed Sandpiper Habitat
0 0.75 1.5 3
Kilometers
Scale: 1:90,000 (A4)
25/07/2024
Datum: GDA2020
Projection: MGA55
FIGURE 5-36
VITRINITE
BRIGHTER COAL
METSERVE
Mining & Energy Technical Services Pty Ltd

5.6.17.8 Summary of likelihood

The likelihood of this species is considered possible. No further impact assessment has been completed on this species.

5.6.18 Diamond Firetail (*Stagonopleura guttata*)

5.6.18.1 Listing Advice

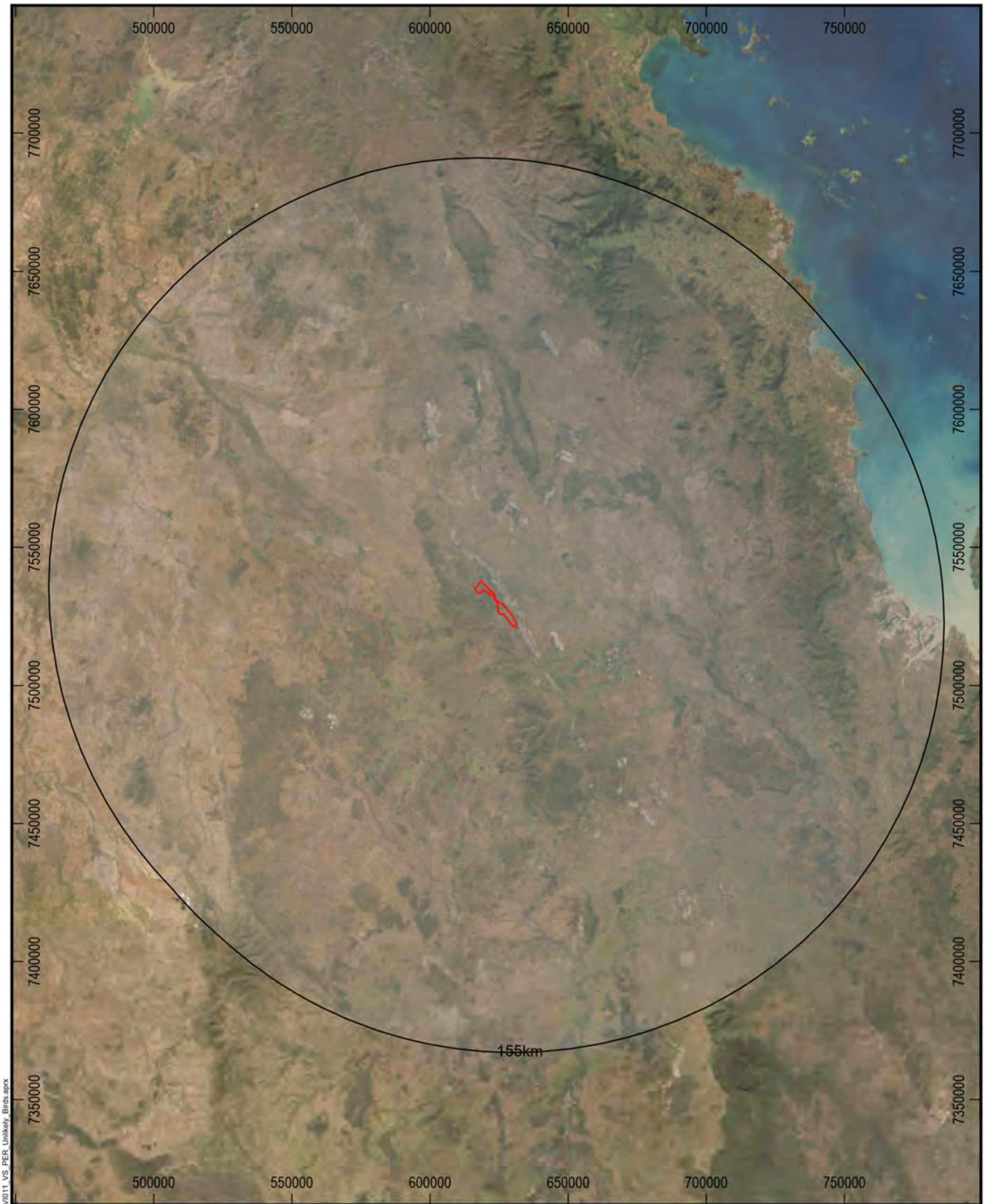
- Commonwealth: Vulnerable
- Queensland: Vulnerable

5.6.18.2 Distribution

Diamond firetails occur on the south-east mainland of Australia from south-east Queensland to Eyre Peninsula, South Australia, extending 300 km inland from the sea. Their range once extended to north Queensland inland from Cardwell, but they now occur only in the very south of the state (Department of Climate Change, Energy, the Environment and Water, 2023c).

5.6.18.3 Historical Occurrence

There are no records within 155 km of the Project (**Figure 5-37)**. The closest record is located approximately 180 km south from the Project at Springsure (2000, BirdLife Australia).



Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Unlikely_Birds.aprx

Legend

No Records

Vulcan South Coal Mine (2023/09708)

Project Area (ML 700073)

Disturbance Area Search Radius (km)

155

Source: Vitrinite 2024, METServe 2020-2024, Atlas of Living Australia 2024, Earthstar Geographics.

Vulcan South

Diamond Firetail and Yellow Wagtail Records

0 20 40 80

Kilometers

Scale: 1:2,000,000 (A4)

25/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-37

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.6.18.4 Habitat

Diamond firetails occur in *Eucalyptus, Acacia* or *Casuarina* woodlands, open forests and other lightly timbered habitats, including farmland and grassland with scattered trees.

BREEDING/FORAGING HABITAT

The species prefers areas with relatively low tree density, few large logs, and little litter cover but high grass cover. (Department of Climate Change, Energy, the Environment and Water, 2023c).

SHELTER HABITAT

Birds roost in dense shrubs or in smaller nests built especially for roosting (Department of Climate Change, Energy, the Environment and Water, 2023c).

DISPERSAL HABITAT

This species, like other finches is likely nomadic, moves according to seasonal resources. Most vegetated habitats have potential for the species to temporarily shelter in during dispersal.

5.6.18.5 Life History

Breeding occurs between August and January. Usually only one clutch is laid per season. A clutch size of 4–5 eggs is normal (Department of Climate Change, Energy, the Environment and Water, 2023c).

5.6.18.6 Threatening Processes

Historical and ongoing clearing of native vegetation is the main reason for the decline of the species. There is also widespread degradation of habitat that remains which has led to the replacement of native perennial grasses with exotic annual grasses. Habitat patches are also degraded by over-grazing stock, rabbits (*Oryctolagus cuniculus*), and overabundant kangaroos (*Macropus* spp.) that remove the shrub layer. Firetails are more likely to persist in remnants of native vegetation within a matrix of sheep grazing, however this is a land-use which has been in decline (Department of Climate Change, Energy, the Environment and Water, 2023c).

5.6.18.7 Habitat Assessment

Mapped likely to occur habitat within the SPRAT database is located south of Nanango (approximately 600 km south from the Project), as shown on **Figure 5-24** in **Section 5.6.10.7**.

5.6.18.8 Summary of likelihood

Due to the distance from mapped likely habitat within the conservation advice, the species is unlikely to be present. Further, the closest record is unverified and approximately 120 km from the Project.

5.6.19 Grey Snake (*Hemiaspis damelii*)

5.6.19.1 Listing Advice

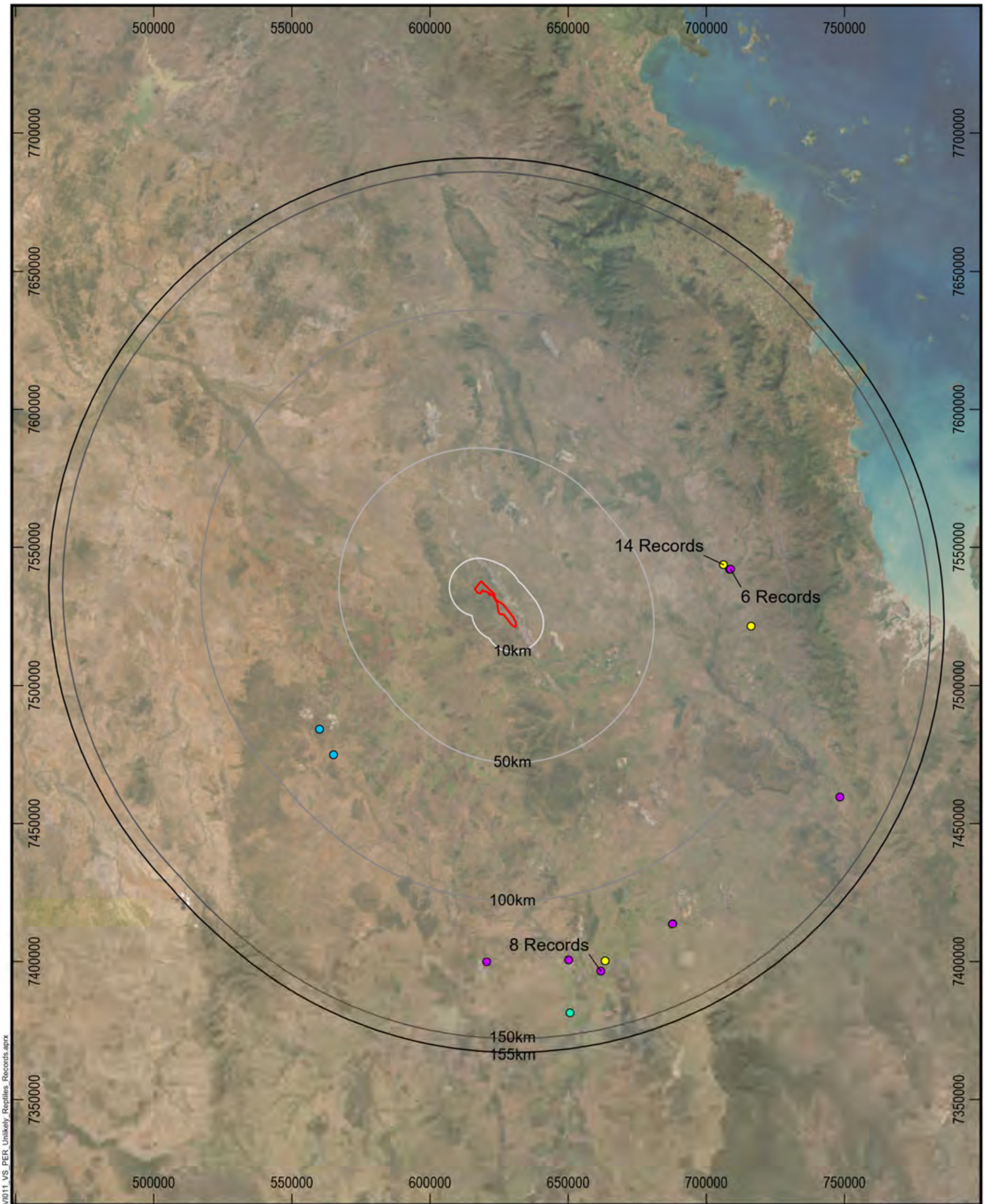
- Commonwealth: Endangered
- Queensland: Endangered

5.6.19.2 Distribution

In Queensland, the Grey Snake has a broader and more dispersed distribution, with most records along the Macintyre and Condamine Rivers and associated floodplains of the southern Brigalow Belt from Goondiwindi and Dalby west to Glenmorgan, on the Darling Downs and western Lockyer Valley, near Rockhampton on the central Queensland coast, and on the Darling Riverine Plains near Currawinya in south-western Queensland (Department of Climate Change, Energy, the Environment and Water, 2022a).

5.6.19.3 Historical Occurrence

There is one verified sighting approximately 140 km south from the Project (Springton) (2003, WildNet). The next closest records are clustered around Rockhampton, beyond 200 km to the south-east. Occurrences are shown in **Figure 5-38**.



Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Unlikely_Reptiles_Records.aprx

Legend

ALA Records
- *Hemiaspis damelii* (Grey Snake)
- *Furina dunmalli* (Dunmall's Snake)
- *Elseya albagula* (Southern Snapping Turtle)
- *Rheodytes leukops* (Fitzroy River Turtle)

Vulcan South Coal Mine (2023/09708)
- Project Area (ML 700073)

Impact Area Search Radius (km)
- 10
- 50
- 100
- 150
- 155

Source: Vitrinite 2024, METServe 2020-2024, Atlas of Living Australia 2024, Earthstar Geographics.

Vulcan South

Grey Snake, Southern Snapping Turtle, Fitzroy River Turtle and Dunmall's Snake Records

0 15 30 60
Kilometers
Scale: 1:2,000,000 (A4)

25/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-38

VITRINITE BRIGHTER COAL
METSERVE Mining & Energy Technical Services Pty Ltd

5.6.19.4 Habitat

The Grey Snake is known to be found in low lying areas associated with watercourses. Habitat is defined as follows:

BREEDING/FORAGING/SHELTER HABITAT

In Queensland, Grey Snake habitat is Brigalow *Acacia harpophylla* and Belah *Casuarina cristata* woodlands on heavy, dark brown to black cracking clay soils, particularly in association with water bodies, areas with small gullies and ditches, and floodplain environments where the species shelters beneath logs, rocks and soil cracks. Habitat in Queensland also includes Queensland bluegrass *Dichanthium sericeum* and/or Mitchell grass *Astrebla* spp. grassland on alluvial plains with cracking clay soils. Grey Snake occurrence on the western downs of Queensland has a strong positive association with red sodosol soils which have a strong texture contrast between the A horizon and sodic B horizon, and which are often quite dense and coarsely structured (blocky, prismatic or columnar peds) favouring the crack-inhabiting and foraging ecology of this species (Department of Climate Change, Energy, the Environment and Water, 2022a).

DISPERSAL HABITAT

It is logical to assume that this species may be dispersed by floodwaters, given the strong association the species has with floodplains. Dispersal abilities are likely limited otherwise, and dispersal habitat is probably low-lying areas adjacent to breeding/foraging/shelter habitat.

5.6.19.5 Life History

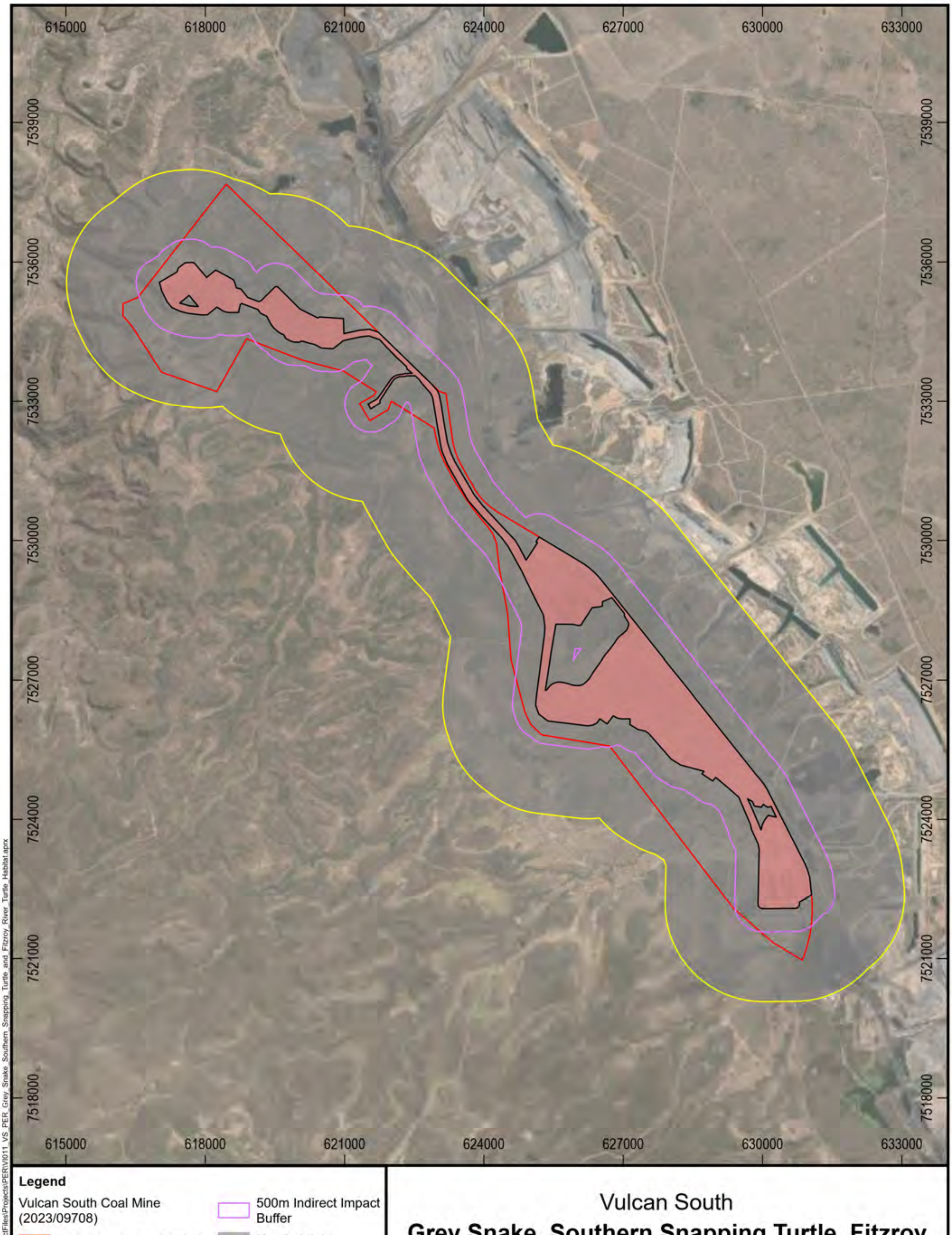
The Grey Snake bears live young and gives birth to 4-16 (average = 10) young between January and March. Males mature at around seven months of age and females mature at 12 months (Department of Climate Change, Energy, the Environment and Water, 2022a).

5.6.19.6 Threatening Processes

Key threats include land clearing and pasture improvement/cultivation, reductions in water flow due to changes in floodplain hydrology, invasive species, fire, and mining activities.

5.6.19.7 Habitat Assessment

REs consistent with habitat known for the species are present in the Project area, however it is outside its known distribution. There are 0 ha of habitat within the disturbance footprint and broader Project area for this species, as shown in **Figure 5-39**.



Legend

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- 2 km Buffer
- 500m Indirect Impact Buffer
- Non-habitat

Source: Vulcan South datasets - Vitrinite 2024 & METServe 2020-2024. Earthstar Geographics 28/09/2023.

Vulcan South

Grey Snake, Southern Snapping Turtle, Fitzroy River Turtle and Dunmall's Snake Habitat

0 1 2 4

Kilometers

Scale: 1:115,000 (A4)

25/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-39

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Grey_Snake_Southern_Snapping_Turtle_and_Fitzroy_River_Turtle_Habitat.aprx

5.6.19.8 Summary of likelihood

While suitable REs are present, the distance of the nearest records (which are outliers) indicate that this species is unlikely to be present.

5.6.20 Southern Snapping Turtle (*Elseya albagula*)

5.6.20.1 Listing Advice

- Commonwealth: Critically Endangered
- Queensland: Endangered

5.6.20.2 Distribution

This species is found only in Queensland in the Fitzroy, Mary and Burnett Rivers and associated smaller drainages in southeastern Queensland (Department of the Environment, 2014b).

5.6.20.3 Historical Occurrence

The closest records are located approximately 80 km east from the Project, from 1988 (WildNet, unconfirmed), 1998 (WildNet, unconfirmed), and 1980 (University of Canberra, verified). Further records are located more than 100 km to the south. Occurrences are shown in **Figure 5-38** (purple points on map) in **Section 5.6.19.3**.

5.6.20.4 Habitat

This species prefers clear, flowing, well-oxygenated waters within the river systems specified in 5.6.20.2 (Department of the Environment, 2014b).

BREEDING HABITAT

The conservative assumption is that any waterways occupied by this species will have suitable breeding sites adjacent to them above the high-water line.

FORAGING/SHELTER HABITAT

Clear, flowing, well oxygenated waters within catchments known to be occupied by the species will be utilised for foraging and shelter from most predators.

DISPERSAL HABITAT

Like other freshwater turtles, this species is likely to be somewhat mobile over land, though is likely only to move from one pool to another when the waterways are drying, not venturing further from water than absolutely necessary.

5.6.20.5 Life History

Turtle life histories are characterised by long life spans, slow growth to maturity and multiple breeding events, typically in a defined season. Age at first breeding is approximately 15-20 years. The present wild population is composed primarily of aging adults with little to no recruitment in most of is range (Department of the Environment, 2014b).

5.6.20.6 Threatening Processes

Threats include loss of eggs and hatchlings at nesting sites due to feral predators and trampling by cattle. Dam and weir construction leading to habitat fragmentation, migration obstruction, injury and death (from water releases and over-topping, and becoming trapped within infrastructure), low water flow, nest flooding, and loss of riparian vegetation are also important threats (Department of the Environment, 2014b).

5.6.20.7 Habitat Assessment

Permanent water in riverine systems is required, however such suitable habitat was not identified during field surveys; the waterways in the Project area are unsuitable as they are ephemeral. There are 0 ha of habitat within the disturbance footprint and broader Project area for this species, as shown in **Figure 5-39** in **Section 5.6.19.7**.

5.6.20.8 Summary of likelihood

Due to the lack of suitable habitat, this species is unlikely to be present.

5.6.21 Dunmall's Snake (*Furina dunmalli*)

5.6.21.1 Listing Advice

- Commonwealth: Vulnerable
- Queensland: Vulnerable

5.6.21.2 Distribution

In Queensland, its range extends from Yeppoon and the Expedition Range in the north, to Oakey, Glenmorgan and Inglewood in the south. Most locality records are from between 200 and 500 metres above sea level. This species occurs within the Brigalow Belt Bioregion and may also occur in the Burdekin, Fitzroy, Desert Channels, Burnett Mary, South East, and Condamine Natural Resource Management Regions (Department of the Environment, 2014a).

5.6.21.3 Historical Occurrence

There are two records from 1999 approximately 80 km south-west from the Project (north-west from Clermont and at Clermont, from WildNet and Queensland Museum respectively). Occurrences are shown in **Figure 5-38** (blue points on map) in **Section 5.6.19.3**.

5.6.21.4 Habitat

Dunmall's Snake is found in open forest, particularly brigalow *Acacia harpophylla* forest and woodland growing on floodplains of deep-cracking black clay and clay loam soils (Department of the Environment, 2014a).

5.6.21.5 Life History

Little is known about this species' life history. It is likely nocturnal and subsists on small skinks and geckos (Department of the Environment, 2014a).

5.6.21.6 Threatening Processes

The key threat is land clearing and habitat medication, through stock overgrazing, agricultural activities, pasture improvement, crop production, and urban development (Department of the Environment, 2014a).

5.6.21.7 Habitat Assessment

Suitable habitat for the Dunmall's Snake is forests to woodlands within its mapped range. Habitat fitting this very broad definition is mapped in the disturbance footprint. In the *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles*, important habitat for the species is defined as any forest or woodland "within the 'Known/Likely to occur' modelled distribution of the species…and any habitat corridors in between" (Department of Sustainability, Environment, Water, Population and Communities , 2011). Despite containing potential habitat for the species, the survey area lies outside the known/likely distribution of the Dunmall's Snake, as modelled in the *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles*. It is, therefore, not considered "important habitat" for the species. There are 0 ha of important habitat within the disturbance footprint or broader Project area for this species, as shown in **Figure 5-39** in **Section 5.6.19.7**.

5.6.21.8 Summary of likelihood

The Project area is not within a zone marked as "likely to occur" by DCCEEW mapping, nor does it connect any such areas. For habitat to be considered "important" to this species, mapped "likely" areas must intersect with suitable habitat.

No Dunmall's Snakes were detected during surveys. The nearest record is from Clermont, 80 km southwest of the survey area. The species has never been recorded in the Dysart-Moranbah region, despite extensive ecological survey effort at other mine sites. Given the absence of local records despite targeted searches undertaken for Vulcan South and numerous neighbouring mining operations, it is considered unlikely that the species occurs locally.

5.6.22 Fitzroy River Turtle (*Rheodytes leukops*)

5.6.22.1 Listing Advice

- Commonwealth: Vulnerable
- Queensland: Vulnerable

5.6.22.2 Distribution

This species is only found in the Fitzroy River and its tributaries (Department of the Environment, Water, Heritage and the Arts, 2008f).

5.6.22.3 Historical Occurrence

The closest records are located further than 80 km to the east of the Project, from the years 1980 (University of Canberra) and 1998 (Queensland Museum) respectively. These records have been generalised for sensitivity concerns. The next closest are further than 100 km to the south and southeast. All records within 200 km are confined the larger, permanent drainages of the Fitzroy catchment, the closest similar habitat being 64 km east of the Project area. Occurrences are shown in **Figure 5-38** (yellow points on map) in **Section 5.6.19.3**.

5.6.22.4 Habitat

Within its mapped distribution, the species appears to be confined to well-defined habitats which are characteristic of the main channels of the rivers in the catchment. Habitats are defined as follows:

SHELTER/FORAGING HABITAT

This species occurs in flowing rivers with large deep pools with rocky, gravelly or sandy substrates, connected by shallow riffles (Department of the Environment, Water, Heritage and the Arts, 2008f).

BREEDING HABITAT

Like other turtles, nesting is likely to occur in suitable substrates above the breeding season high water mark adjacent to suitable shelter and foraging habitats.

DISPERSAL HABITAT

Like other freshwater turtles, dispersal will almost entirely be along watercourses, with occasional dispersal overland, presumably to move from one drying pool to another when aquatic dispersal is not possible.

5.6.22.5 Life History

Nesting occurs between September and October, and the annual reproductive potential of females is 46–59 eggs laid in three to five clutches. This species can take between 15–20 years to reach sexual maturity (Department of Climate Change, Energy, the Environment and Water, 2024u).

5.6.22.6 Threatening Processes

include loss and disturbance of habitat from agriculture (particularly cotton and cattle farming), mining and salinity, damming of rivers, pollution and siltation of rivers and creeks habitats, and predation of eggs by feral animals (Department of the Environment, Water, Heritage and the Arts, 2008f).

5.6.22.7 Habitat Assessment

There are 0 ha of habitat within the disturbance footprint or the broader Project area for this species, as shown in **Figure 5-39** in **Section 5.6.19.7**. No suitable river systems are found within 60 km of the Project area, all watercourses within and adjacent are ephemeral and only experience surface flow following heavy rain.

5.6.22.8 Summary of likelihood

Due to the absence of suitable habitat and lack of nearby records, this species is unlikely to be present.

5.6.23 Painted Honeyeater (*Grantiella picta*)

5.6.23.1 Listing Advice

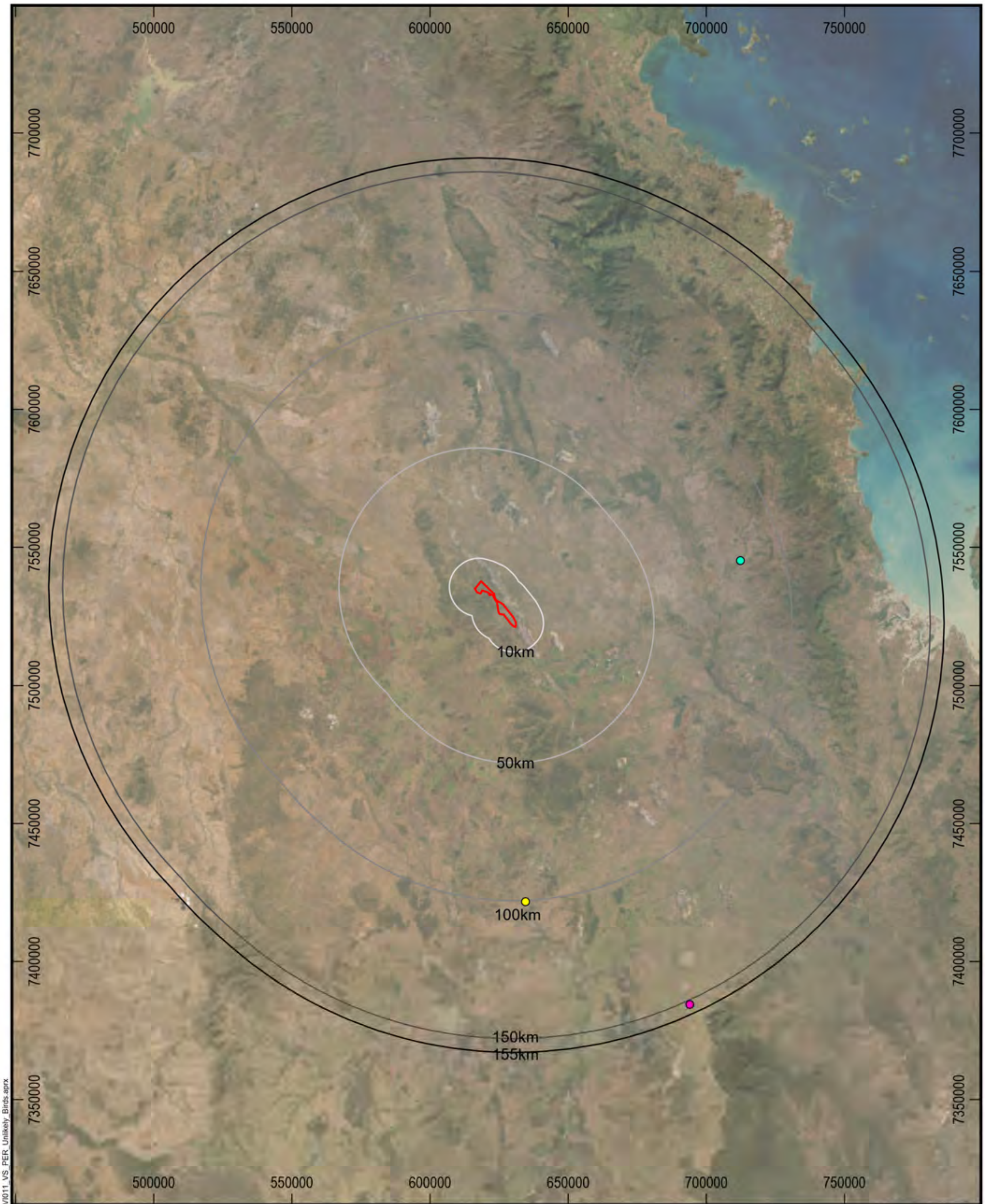
- Commonwealth: Vulnerable
- Queensland: Vulnerable

5.6.23.2 Distribution

The species is sparsely distributed from south-eastern Australia to north-western Queensland and eastern Northern Territory. The species exhibits seasonal north-south movements governed principally by the fruiting of mistletoe, with which its breeding season is closely matched. Many birds move after breeding to semi-arid regions such as north-eastern South Australia, central and western Queensland, and central Northern Territory. Considering its dispersive habits, the species is considered to have a single population (Department of the Environment, 2015c).

5.6.23.3 Historical Occurrence

There one record within 155 km south of the Project (2017, eBird). This is shown on **Figure 5-40** (pink point). The next closest records are approximately 300 km south from the Project.



Legend

ALA Records

- *Grantiella picta* (Painted Honeyeater)
- *Neochmia ruficauda* (Star Finch)

iNaturalist Records

- *Poephila cincta cincta* (Southern Black-throated Finch) - Uncertain within 20km

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)

Impact Area Search Radius (km)

- 10
- 50
- 100
- 150
- 155

Source: Vitrinite 2024, METServe 2020-2024, Atlas of Living Australia 2024, iNaturalist 2024, Earthstar Geographics.

Vulcan South

Painted Honeyeater, Star Finch and Southern Black-throated Finch Records

0 20 40 80

Kilometers

Scale: 1:2,000,000 (A4)

25/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-40

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Unlikely_Birds.aprx

5.6.23.4 Habitat

The species prefers woodlands which contain a higher number of mature trees, as these host more mistletoes (Department of the Environment, 2015c).

BREEDING HABITAT

The Painted Honeyeater makes nests in trees that contain mistletoes that they feed on, usually preferring to nest in mistletoe clumps (Department of the Environment, 2015c).

FORAGING /SHELTER HABITAT

This species inhabits mistletoes in eucalypt forests/woodlands, riparian woodlands of black box and river red gum, box-ironbark-yellow gum woodlands, *Acacia*-dominated woodlands, paperbarks, *Casuarina*, *Callitris*, and trees on farmland or gardens (Department of the Environment, 2015c).

DISPERSAL HABITAT

The Painted Honeyeater disperses widely outside the areas it is known to breed in. Being a species that disperses aerially, all dispersal habitat is likely to be overfly habitat that is not directly used for foraging.

5.6.23.5 Life History

Breeding occurs from October to March when mistletoe fruits are most available. Usually, 2-3 eggs are laid and both parents incubate the nest, brood and feed young (Department of the Environment, 2015c).

5.6.23.6 Threatening Processes

Key threats include habitat loss (from grazing and land clearing), competition with other species, predation by invasive species and other birds, and direct mortality from vehicle collision (Department of the Environment, 2015c).

5.6.23.7 Habitat Assessment

There are 0 ha of habitat within the disturbance footprint or broader Project area for this species, as shown in **Figure 5-28** in **Section 5.6.12.7**. This species depends on an abundance of mistletoe. Suitable regional ecosystems were present within the survey area, and trees likely to be host to suitable mistletoes are present in the survey area. However, mistletoe was scarce based on field surveys.

5.6.23.8 Summary of likelihood

This species was not observed during field surveys, and mapped sightings of this species show a tendency to avoid the region. Given this, and the lack of mistletoe observed during field surveys, this species is unlikely to be present in the area.

5.6.24 Star Finch (eastern) (*Neochmia ruficauda ruficauda*)

5.6.24.1 Listing Advice

- Commonwealth: Endangered
- Queensland: Endangered

5.6.24.2 Distribution

This subspecies occurs in central Queensland, however its distribution is poorly understood and it has disappeared from much of its former range. The most recent records occur in an area from near Wowan, north to Bowen, west to beyond Winton. It is possible that the subspecies could occur (or occurred) north of Bowen, based on historic records of Star Finches at Mount Surprise and in the Cloncurry/Mount Isa region, but these records cannot be definitively attributed to the eastern subspecies. The Star Finch (eastern) is suspected to occur in four discrete subpopulations. The Star Finch (eastern) occurs within the Desert Channels, Burdekin and Fitzroy (Queensland) Natural Resource Management Regions (Department of the Environment, Water, Heritage and the Arts, 2008d).

5.6.24.3 Historical Occurrence

The nearest record is 88 km east from the Project (1985, WildNet). There are no other reliable, dated records post-1980 within 200 km of the Project. This occurrence shown on **Figure 5-40** in **Section 5.6.23.3** (green point).

5.6.24.4 Habitat

BREEDING/FORAGING/SHELTER HABITAT

The Star Finch feeds primarily on seeds but will also eat insects and other invertebrates. This subspecies has been recorded from damp grasslands, sedgelands or grassy woodlands near permanent water or areas of regular inundation. Occasionally, individuals have been reported in disturbed habitat and suburban areas (Department of the Environment, Water, Heritage and the Arts, 2008d). Application of the *Precautionary Principle* would suggest all habitat utilised by this species for foraging would also be likely breeding habitat.

DISPERSAL HABITAT

Dispersal habits appear to be unknown for this species. Similar species tend to be nomadic, moving with food and water resources as dictated by seasons. As this is a species that disperses by flight, it is likely to be an overflying species and not interact much, if at all with habitats not used for foraging or breeding.

5.6.24.5 Life History

No information is available on the ages of sexual maturity, life expectancy or natural mortality in the Star Finch (eastern), however it is likely similar to that of the Star Finch at a species level. It may live for at least between 2 and 6 years. Its breeding biology is largely unknown but is again likely similar to the Star Finch at a species level. It may breed throughout the entire year. (Department of the Environment, Water, Heritage and the Arts, 2008d)

5.6.24.6 Threatening Processes

Key threats are habitat degradation through agricultural activity, predation from feral species, invasive weeds, and poisoning from contaminants (Department of the Environment, Water, Heritage and the Arts, 2008d).

5.6.24.7 Habitat Assessment

There are 0 ha of habitat within the disturbance footprint or broader Project area for this species, as shown in **Figure 5-28** in **Section 5.6.12.7**.

The disturbance footprint is likely to contain habitat that would have been suitable for the Star Finch (eastern), however this subspecies is likely extinct from the Bowen Basin. Habitat is well outside the subspecies' known range.

5.6.24.8 Summary of likelihood

Based on the lack of sightings, and the high probability of local extinction it is unlikely that this subspecies is present in the Project area.

5.6.25 Southern Black-throated Finch (*Poephila cincta cincta*)

5.6.25.1 Listing Advice

- Commonwealth: Endangered
- Queensland: Endangered

5.6.25.2 Distribution

The southern subspecies occurs in coastal northern Queensland and inland central Queensland.

5.6.25.3 Historical Occurrence

A 2022 record with a 30 km uncertainty is known from approximately 80 to 100 km south of the disturbance footprint on iNaturalist (**Figure 5-40** in **Section 5.6.23.3**, yellow point on map). This record is backed by photographic evidence of individuals drinking from a wet dirt road, but has 20 km spatial uncertainty applied, therefore the surrounding habitat details cannot be inferred.

The closest records otherwise within the last 20 years are from the Galilee Basin, over 300 km to the northwest.

5.6.25.4 Habitat

This subspecies occupies woodland savannah and riverine vegetation. Inland, it prefers grassy woodland dominated by eucalypts, paperbacks or acacias, where there is access to seeding grasses and water (Threatened Species Scientific Committee, 2005b).

BREEDING/SHELTER HABITAT

The Black-Throated Finch (Southern) requires three key resources for survival and breeding:

- Water sources within 400 m of potential breeding areas
- Grass seeds (*Urochloa mosambicensis, Enteropogon acicularis, Panicum decompositum, Panicum effusum, Dichanthium sericeum, Alloteropsis semialata, Eragrostis sororia* and *Themeda triandra*) within 1 km of nesting habitat
- Trees providing suitable nesting habitat

During the breeding season the species is rarely seen more than 1 km from water.

FORAGING HABITAT

The subspecies forages up to 3 km from water sources outside breeding season (Department of the Environment, Water, Heritage and the Arts, 2009). Areas that provide a high diversity of the grass species listed above, that are also in the vicinity of suitable nesting sites, given that the species is sedentary and appears to not be overly nomadic and certainly not migratory.

DISPERSAL HABITAT

The Black-Throated Finch (Southern) will disperse over uninhabitable areas, providing the distance to fly is less than 1 km, though this species is known to be sedentary overall (Department of the Environment, Water, Heritage and the Arts, 2009).

5.6.25.5 Life History

Life expectancy in the wild may be four to six years, and breeding can occur throughout the year (under optimal conditions) (Department of Climate Change, Energy, the Environment and Water, 2024t).

5.6.25.6 Threatening Processes

The key threat to this subspecies is the loss or degradation of habitat due to changes in land use management practices (Threatened Species Scientific Committee, 2005b).

5.6.25.7 Habitat Assessment

There are 0 ha of habitat within the Project area for this species, as shown in **Figure 5-28** in **Section 5.6.12.7**.

The disturbance footprint may contain suitable foraging resources for this species. Habitat may be marginally suitable in the area with water sources and a variety of grasses present, though it is degraded in quality to the point that this species may not persist. The lack of all of the components needed to ensure this subspecies could support a viable population strongly suggests that none of the broader Project area is considered habitat for this species.

5.6.25.8 Summary of likelihood

This species is unlikely to be present. It is acknowledged that this species has been the subject of recent public attention linked to other mining projects to the northwest. Given the publicity, efforts to locate other populations have been increased. The number of ecological surveys in the region would have been expected to locate individuals if they are persisting locally. Despite the presence of components of habitat, the Black-Throated Finch (Southern) is likely to be locally extinct.

5.6.26 Corben's Long-eared Bat/South-eastern Long Eared Bat (*Nyctophilus corbeni*)

5.6.26.1 Listing Advice

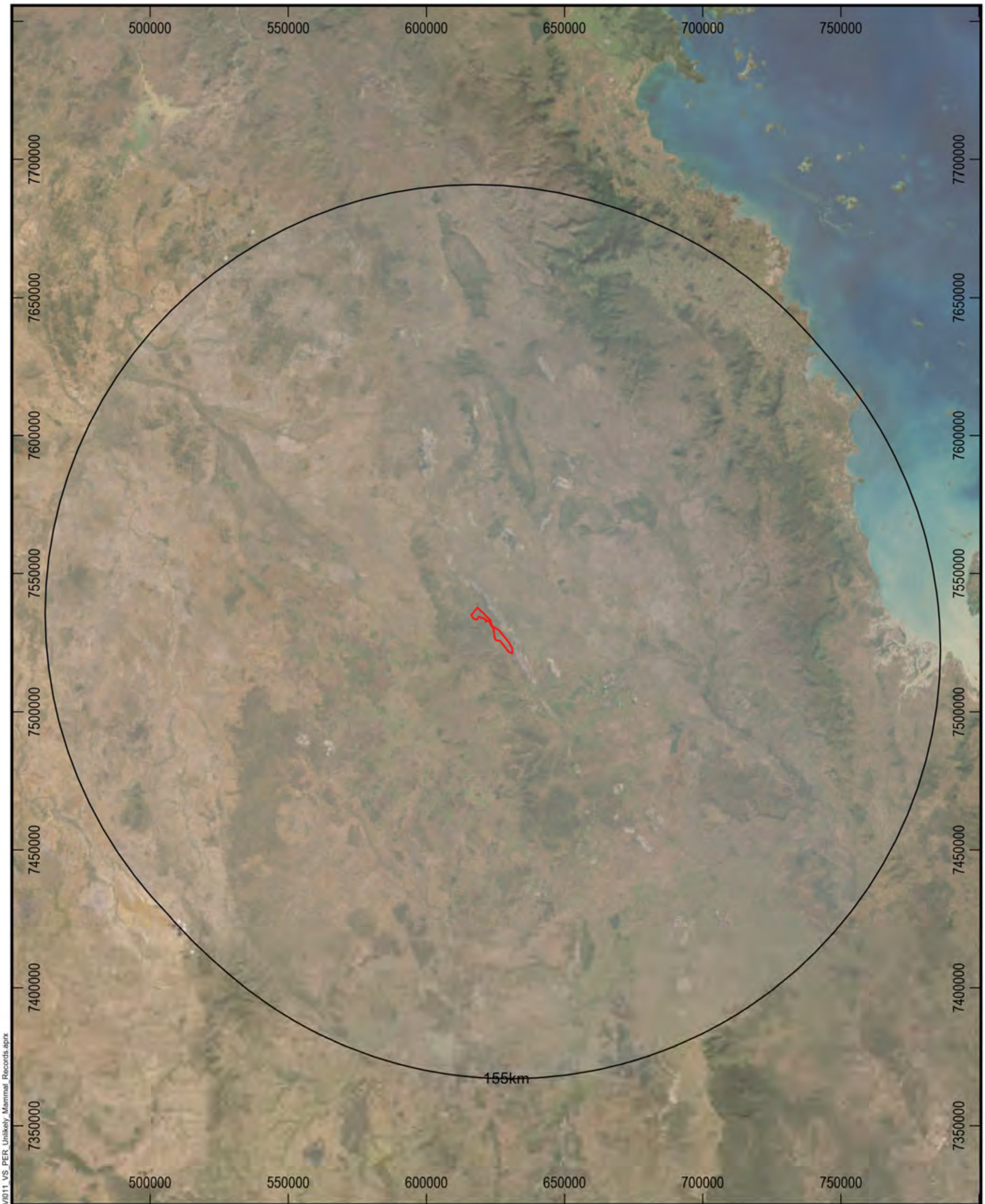
- Commonwealth: Vulnerable
- Queensland: Vulnerable

5.6.26.2 Distribution

This species is found in central Queensland (and in regions in New South Wales, Victoria, and South Australia). Approximately 30% of the total distribution of the species occurs in Queensland, although there are records from fewer than 30 localities, mainly from within the Brigalow Belt South bioregion (Threatened Species Scientific Committee, 2015c).

5.6.26.3 Historical Occurrence

There are no records within 155 km of the Project, as shown in **Figure 5-41.**



Legend

No Records

Vulcan South Coal Mine (2023/09708)

Project Area (ML 700073)

Disturbance Area Search Radius (km)

155

Source: Vitrinite 2024, METServe 2020-2024, Atlas of Living Australia 2024, Earthstar Geographics.

Vulcan South

Corben's Long-eared Bat Records

0 20 40 80

Kilometers

Scale: 1:2,000,000 (A4)

25/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-41

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.6.26.4 Habitat

FORAGING/BREEDING/SHELTER HABITAT

This species is found in a wide range of inland woodland vegetation types. These include box / ironbark / cypress pine woodlands, Buloke woodlands, Brigalow woodland, Belah woodland, smooth-barked apple woodland, river red gum forest, black box woodland, and various types of tree mallee (Threatened Species Scientific Committee, 2015c). Habitat types are likely to overlap with this species, foraging is likely to occur within or adjacent to breeding and shelter sites.

DISPERSAL HABITAT

Dispersal habits are not specified for this species, however it is an aerial dispersing species that is likely to overfly most or all terrestrial habitats during dispersal.

5.6.26.5 Life History

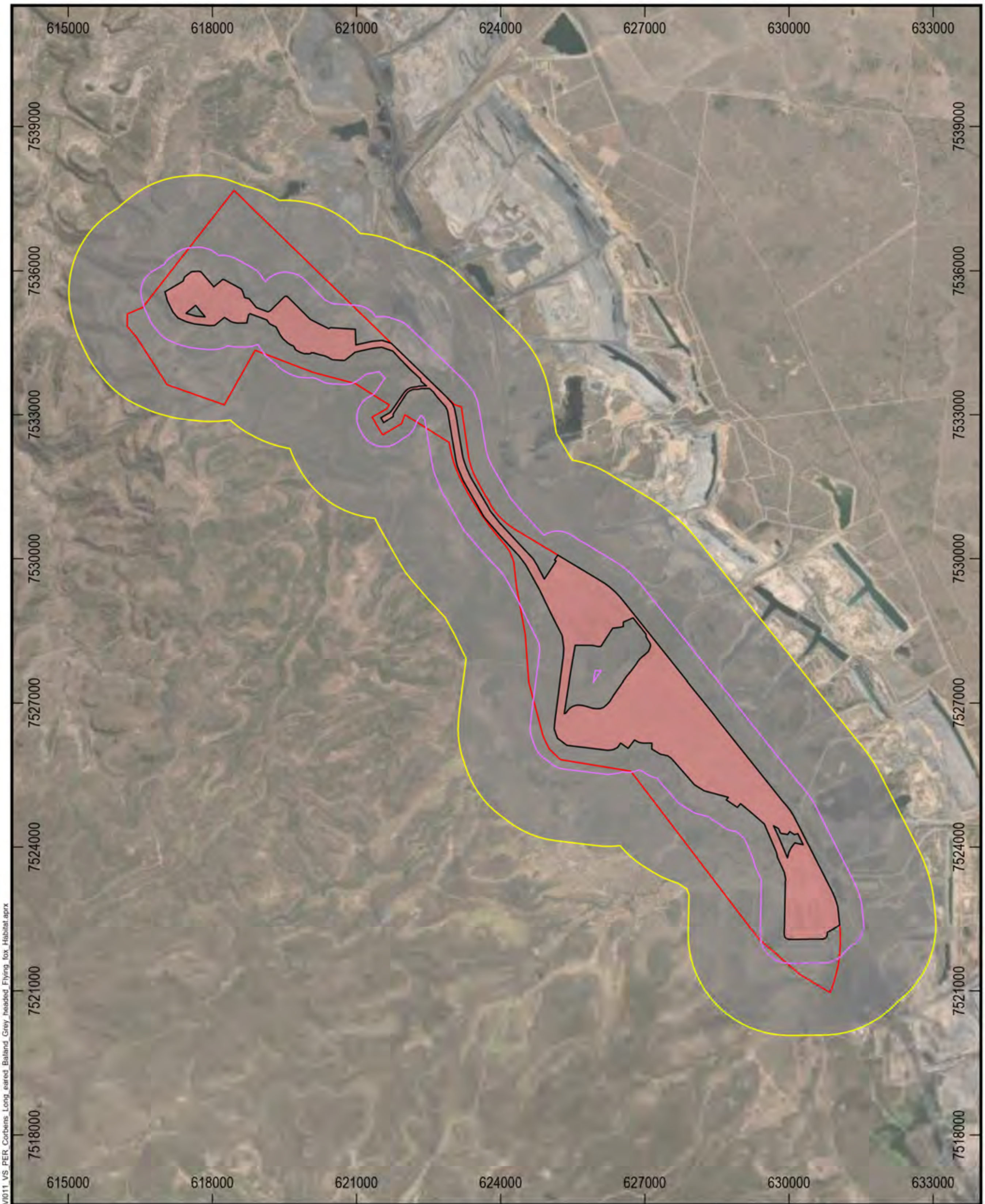
There is little available information on the species' reproductive biology. Breeding is likely to be seasonal, with pregnant and lactating females having been trapped in Queensland and New South Wales in November (Threatened Species Scientific Committee, 2015c).

5.6.26.6 Threatening Processes

It is likely that area of occupancy is declining due to habitat loss, particularly in New South Wales and Queensland, and to habitat degradation associated with altered fire regimes, timber extraction, mining and other factors (Threatened Species Scientific Committee, 2015c). Other threats likely include bushfire (through direct mortality and loss of habitat), loss of hollow availability, exposure to agrichemicals, grazing, and predation by feral animals (Threatened Species Scientific Committee, 2015c).

5.6.26.7 Habitat Assessment

Habitats are well outside this species' range. Habitat may be broadly suitable; however, the Project area is determined to be well north of the known distribution of the species. There are 0 ha of habitat within the disturbance footprint or broader Project area for this species, as shown in **Figure 5-42**.



Legend

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- 2 km Buffer
- 500m Indirect Impact Buffer
- Non-habitat

Source: Vulcan South datasets - Vitrinite 2024 & METServe 2020-2024. Earthstar Geographics 28/09/2023.

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Corbens_Long_eared_Baland_Grey_headed_Flying_fox_Habitat.aprx

Vulcan South

Corben's Long-eared Bat/South-eastern Long-eared Bat and Grey-headed Flying-fox Habitat

0 1 2 4

Kilometers

Scale: 1:115,000 (A4)

25/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-42

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.6.26.8 Summary of likelihood

This species is unlikely to be present, based on the absence of suitable habitat and lack of nearby sighting records. All records are 150 km or more to the south, and none to the north.

5.6.27 Grey-headed Flying-fox (*Pteropus poliocephalus*)

5.6.27.1 Listing Advice

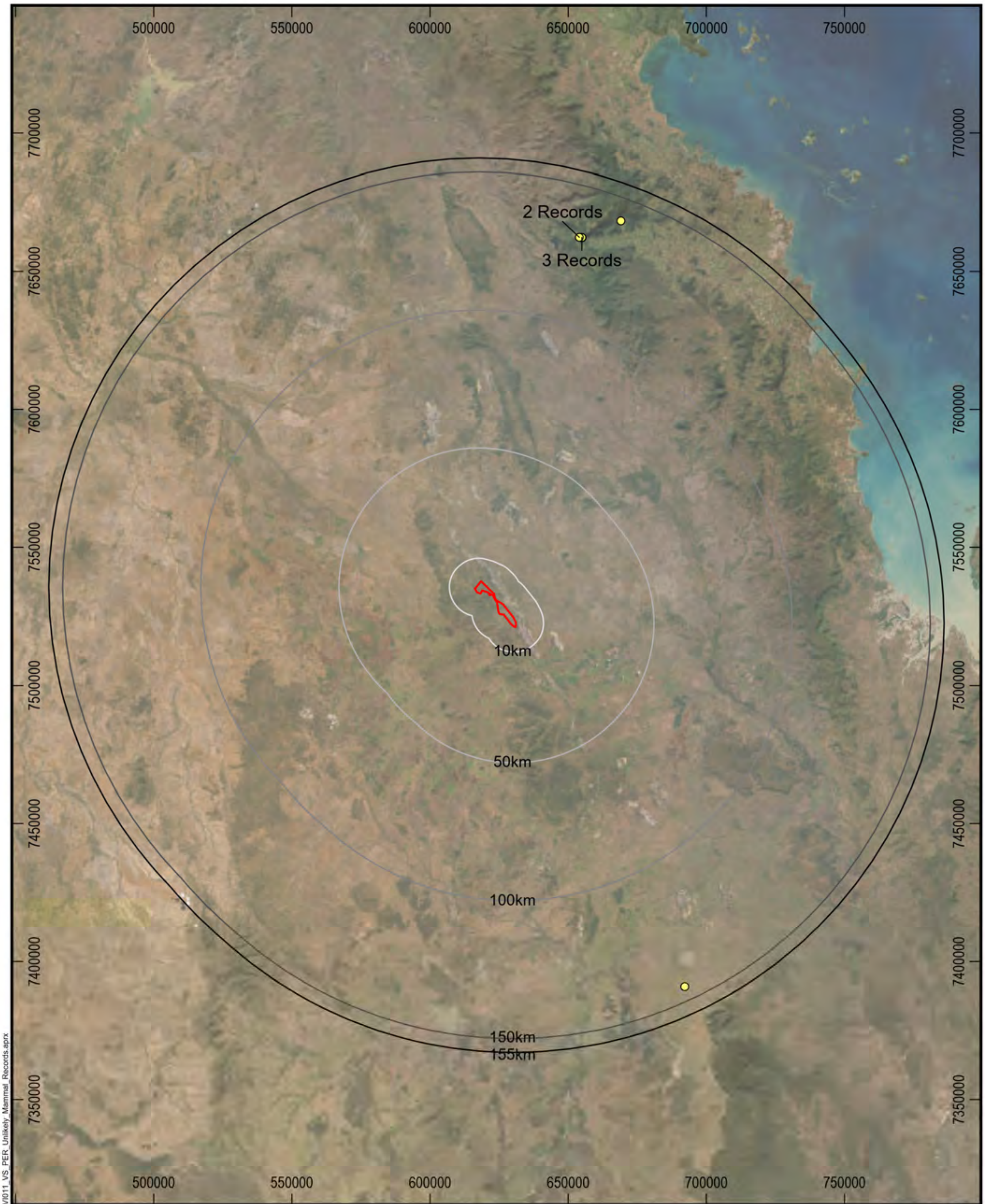
- Commonwealth: Vulnerable
- Queensland: Least Concern

5.6.27.2 Distribution

This distribution of the Grey-Headed Flying-Fox ranges from Bundaberg in Queensland to Melbourne in Victoria and may also occur in parts of South Australia (Threatened Species Scientific Committee, 2001). Occasional records at mixed-species camps occur in the Townsville, Mackay and Rockhampton regions (Department of Climate Change, Energy, the Environment and Water, 2024s).

5.6.27.3 Historical Occurrence

Seven records are known from within 150 km of the Project area. Of these, the only record to the south was an entangled specimen from 145 km away (2023, Entangled Wildlife Australia). The remaining records are all to the north in Eungella National Park (approximately 140 km from the Project area) and verified by the Queensland Parks and Wildlife Service. These records are shown in **Figure 5-43**.



Legend

ALA Records

Pteropus poliocephalus (Grey-headed Flying-fox)

Vulcan South Coal Mine (2023/09708)

Project Area (ML 700073)

Impact Area Search Radius (km)

10

50

100

150

155

Source: Vitrinite 2024, METServe 2020-2024, Atlas of Living Australia 2024, Earthstar Geographics.

Vulcan South

Grey-headed Flying-fox Records

0 15 30 60

Kilometers

Scale: 1:2,000,000 (A4)

25/07/2024

Datum: GDA2020

Projection: MGA55

FIGURE 5-43

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.6.27.4 Habitat

This species has historically occupied forests and woodlands in the coastal lowlands, tablelands and slopes of eastern Australia, from Bundaberg in Queensland to Geelong in Victoria, with some isolated camps and rare sightings outside this range (Department of Agriculture, Water and the Environment , 2021).

BREEDING/SHELTER HABITAT

Breeding and shelter sites are well known camps, which may be viewed on the National Flying-Fox Monitoring Viewer (Department of Climate Change, Energy, the Environment and Water, 2024s). These are generally in humid sites adjacent to water sources and may be shared with other flying-fox species.

FORAGING HABITAT

This species forages on blossoms of a range of species, especially from the genera *Eucalyptus, Syzigium, Banksia, Angophora* and *Corymbia*. Figs and a range of fruits are also consumed when available. Foraging habitat will ideally include as many of these foraging options as possible. Foraging habitat is within 40 km of roost sites (Department of Agriculture, Water and the Environment , 2021).

DISPERSAL HABITAT

The species disperses aerially over a range of habitats. Given the aerial dispersal method, it is unlikely to utilise any of the habitats it overflies, but, like other flying-fox species may occasionally roost in unexpected areas, particularly when displaced, sick or lost.

5.6.27.5 Life History

This species breeds once a year, and births mainly occur between October and December. It may live up to 20 years (Department of Agriculture, Water and the Environment , 2021).

5.6.27.6 Threatening Processes

The primary known threat to the survival of this species is loss and degradation of foraging and roosting habitat. Conflict with people, including disturbance in camps and mortality from actions to manage commercial fruit crops, is considered to be a moderate threat, but is increasing in urban areas. Climate change will also likely degrade habitat, but the full extent is unknown (Department of Agriculture, Water and the Environment , 2021).

5.6.27.7 Habitat Assessment

There are 0 ha of habitat within the disturbance footprint or broader Project area for this species, as shown in **Figure 5-42** in **Section 5.6.26.7**.

The disturbance footprint is unlikely to be of high enough quality to attract this species. Roosting camps are not known from the area, no camps were found in the National Flying-Fox monitoring viewed that were within 100 km. Habitat is marginal at best in the Project area; the species is unlikely in the area as anything more than an unlikely vagrant species as richer habitats closer to the coast are available.

5.6.27.8 Summary of likelihood

This species is unlikely to be present.

5.6.28 Murray Cod (*Maccullochella peelii*)

This species was not flagged by the 2024 search of the Protected Matters Search Tool database; however, it has appeared in prior searches conducted for the Terrestrial Ecological Assessment (2022). For completeness, this species has been included here.

5.6.28.1 Listing Advice

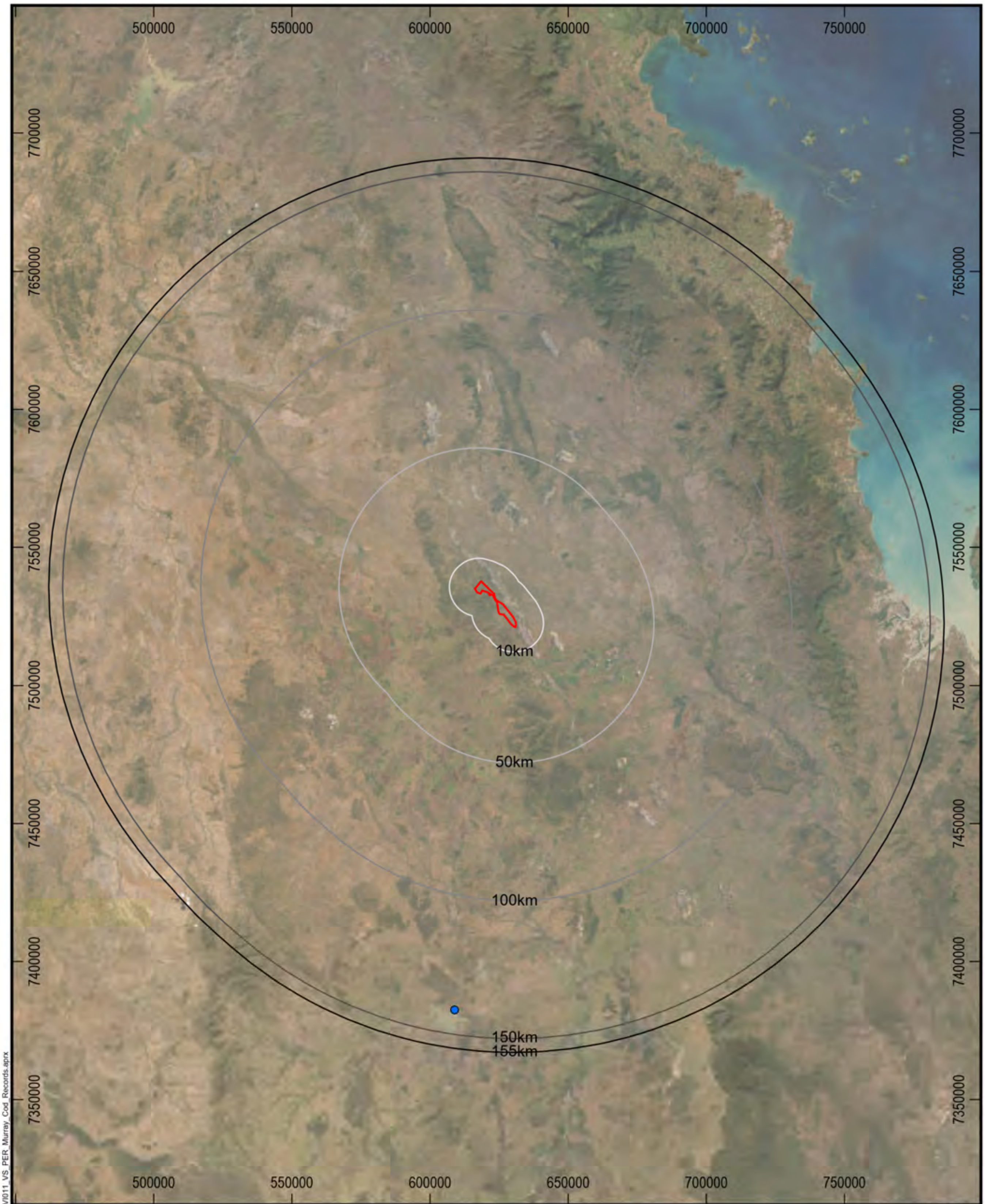
- Commonwealth: Vulnerable
- Queensland: Not applicable

5.6.28.2 Distribution

The Murray Cod occurs naturally in the waterways of the Murray-Darling Basin (Threatened Species Scientific Committee, 2003).

5.6.28.3 Historical Occurrence

The closest record is located approximately 145 km in the south (1990, WildNet). This is shown in **Figure 5-44.** The next closest records are further than 400 km south and west from the Project.



Legend

ALA Records

- *Maccullochella peelii* (Murray Cod)

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)

Impact Area Search Radius (km)

- 10
- 50
- 100
- 150
- 155

Source: Vitrinite 2024, METServe 2020-2024, Atlas of Living Australia 2024, Earthstar Geographics.

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Murray_Cod_Records.aprx

Vulcan South

Murray Cod Records

0 20 40 80

Kilometers

Scale: 1:2,000,000 (A4)

25/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-44

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.6.28.4 Habitat

BREEDING/FORAGING/SHELTER/DISPERSAL HABITAT

This species is known to live in a wide range of warm water habitats that range from clear, rocky streams to slow flowing turbid rivers and billabongs (Threatened Species Scientific Committee, 2003).

5.6.28.5 Life History

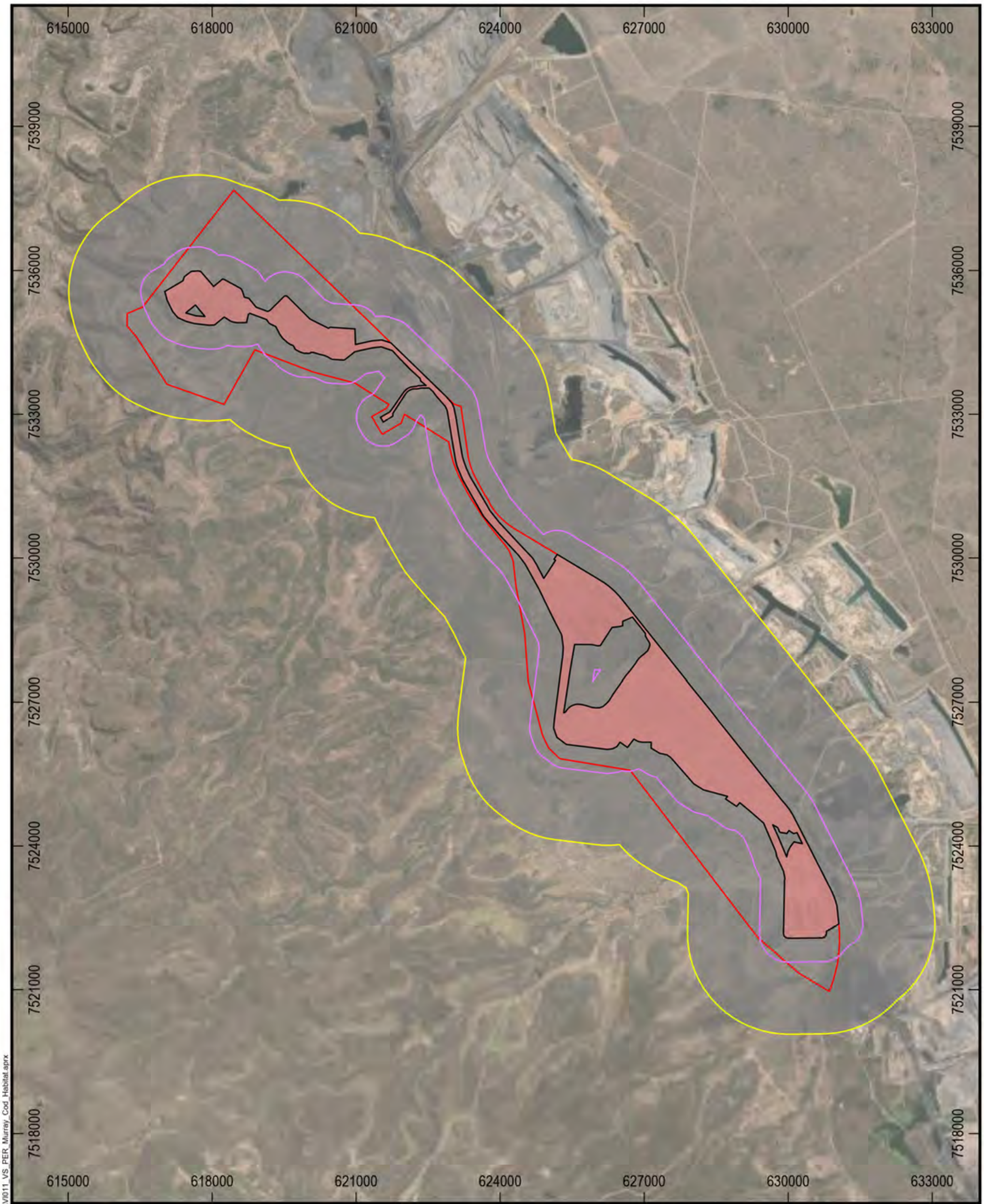
Murray Cod can live up to 47 years and reaches sexual maturity between 4 and 6 years (National Murray Cod Recovery Team, 2010).

5.6.28.6 Threatening Processes

Key threats include habitat loss, degradation, and fragmentation (Threatened Species Scientific Committee, 2003).

5.6.28.7 Habitat Assessment

There are 0 ha of habitat within the disturbance footprint or broader Project area for this species, as shown in **Figure 5-45**. The Project is outside the native range of this species, which is the Murray Darling basin. Suitable waterways are not found within the Project area.



Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Murray_Cod_Habitat.aprx

Legend

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- 2 km Buffer
- 500m Indirect Impact Buffer
- Non-habitat

Source: Vulcan South datasets - Vitrinite 2024 & METServe 2020-2024. Earthstar Geographics 28/09/2023.

Vulcan South

Murray Cod Habitat

0 1 2 4

Kilometers

Scale: 1:115,000 (A4)

25/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-45

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.6.28.8 Summary of likelihood

This species is not native to the catchment. Suitable habitat does not exist in the Project area. The Murray Cod will not be present unless introduced into artificial dams, which is unlikely.

5.6.29 Black Ironbox (*Eucalyptus raveretiana*)

5.6.29.1 Listing Advice

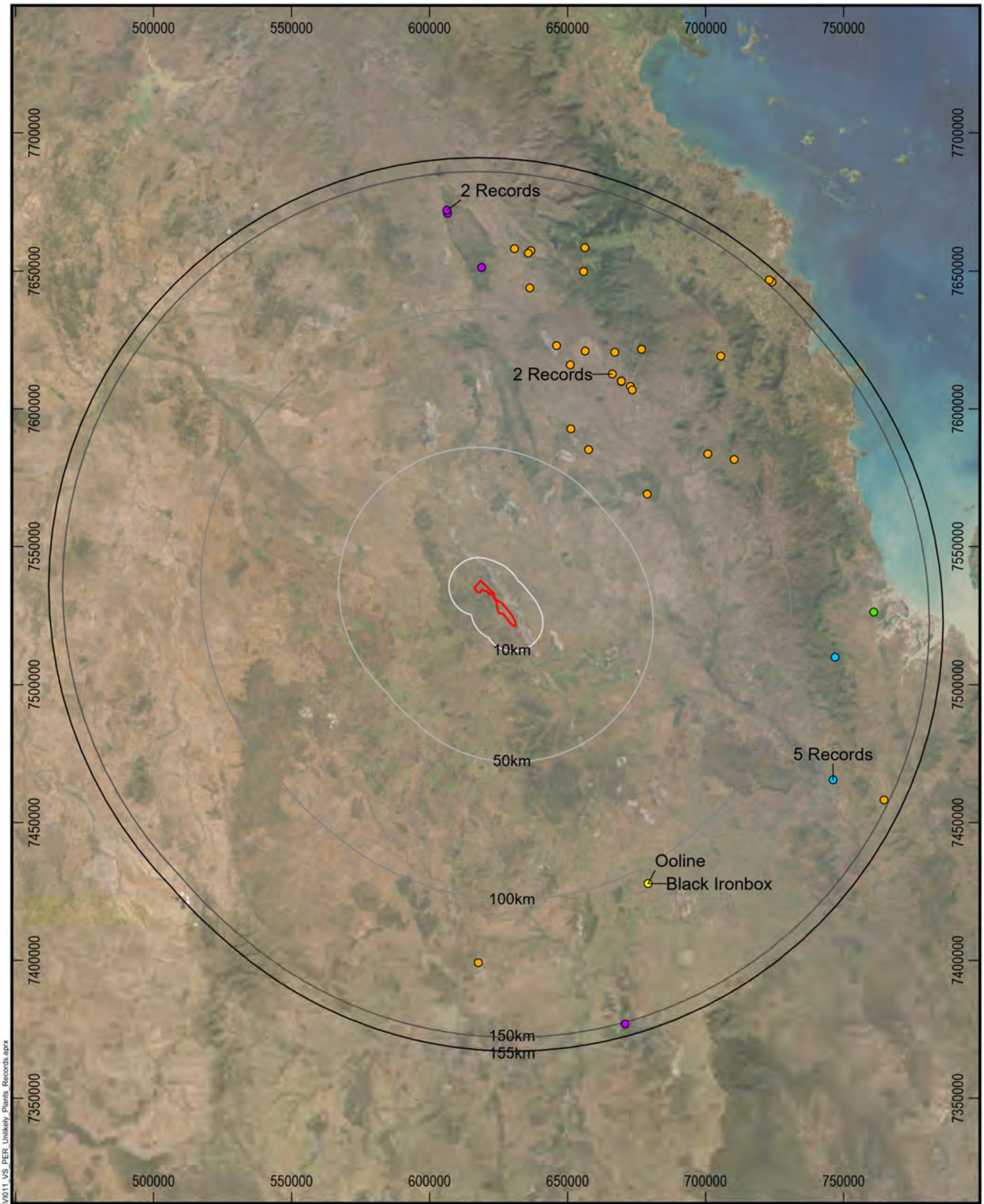
- Commonwealth: Vulnerable
- Queensland: Least Concern

5.6.29.2 Distribution

This species occurs between Rockhampton and Ayr in Queensland (Department of the Environment, Water, Heritage and the Arts, 2008b).

5.6.29.3 Historical Occurrence

Occurrences are shown in **Figure 5-46** (orange points on map). Most records are found over 60 km to the northeast (multiple years). A single record at around 100 km to the southeast exists (1991, WildNet), with another at Emerald (directly south from the Project) within the town limits (2004, Queensland Herbarium).



Legend

ALA Records

- *Cadellia pentastylis* (Ooline)
- *Cycas ophiolitica* (Marlborough Blue Cycad)
- *Eucalyptus raveretiana* (Black Ironbox)
- *Polianthion minutiflorum*
- *Samadera bidwillii* (Quassia)

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)

Impact Area Search Radius (km)

- 10
- 50
- 100
- 150
- 155

Source: Vitrinite 2024, METServe 2020-2024, Atlas of Living Australia 2024, Earthstar Geographics.

Vulcan South

Black Ironbox, *Polianthion minutiflorum*, Quassia, Marlborough Blue Cycad and Ooline Records

0 20 40 80

Kilometers

Scale: 1:2,000,000 (A4)

25/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-46

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.6.29.4 Habitat

KNOWN HABITAT

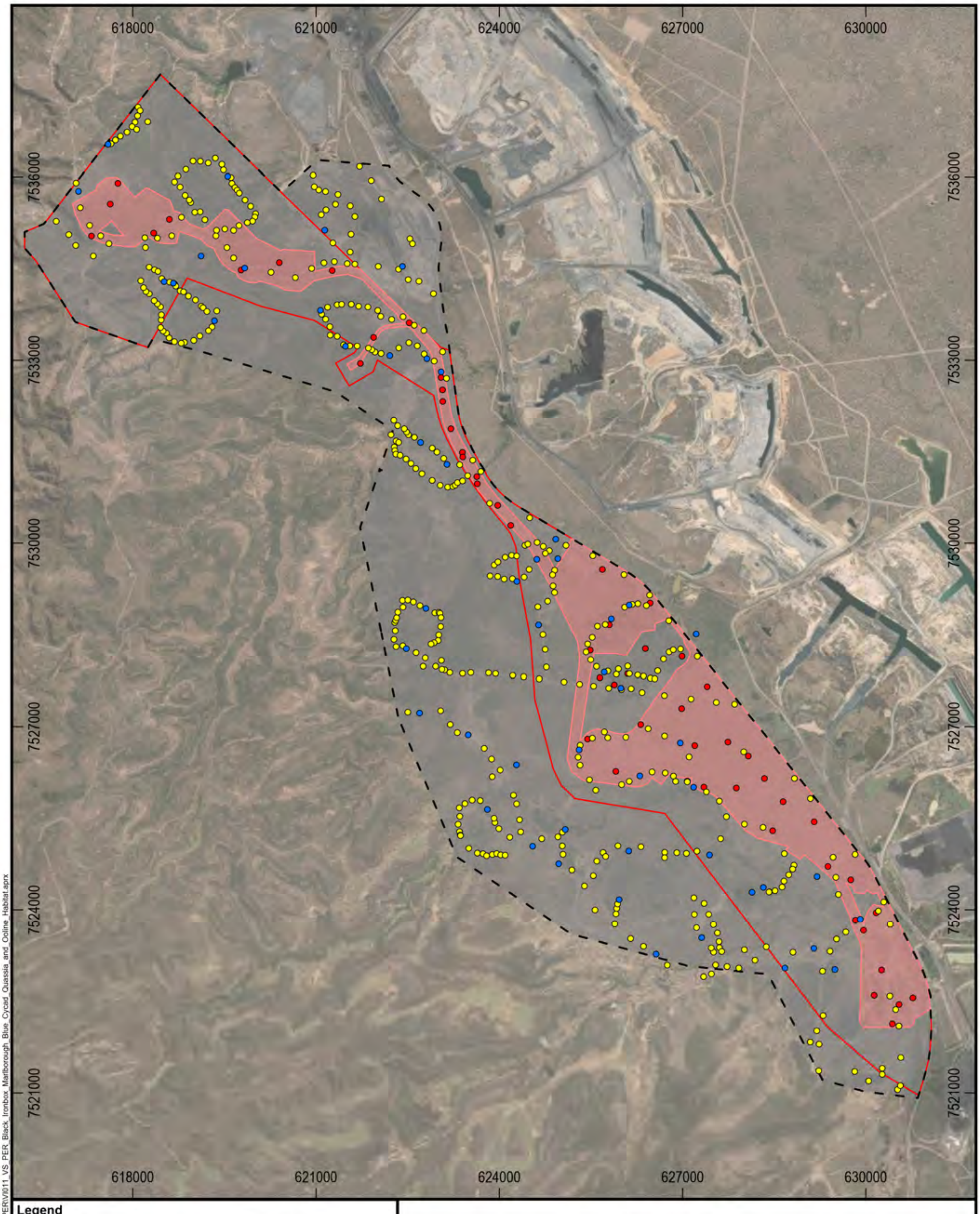
Black Ironbox occurs on the banks of rivers, creeks and other watercourses, on clayey or loamy soil (Department of the Environment, Water, Heritage and the Arts, 2008b).

5.6.29.5 Threatening Processes

The main identified threat to Black Ironbox is habitat disturbance and smothering by Rubber Vine (*Cryptostegia grandiflora*). Other potential threats include timber harvesting, fire, and inappropriate land management (Department of the Environment, Water, Heritage and the Arts, 2008b).

5.6.29.6 Habitat Assessment

There are 0 ha of habitat within the disturbance footprint or broader Project area for this species, as shown in **Figure 5-47**.



Legend

Survey Sites

- Quaternary
- Secondary
- BioCondition

Non-habitat

Vulcan South Coal Mine (2023/09708)

- Survey Area
- Disturbance Footprint
- Project Area (ML 700073)

Source: Vulcan South datasets - Vitrinite 2024 & METServe 2020-2024. Earthstar Geographics 28/09/2023.

Vulcan South

Black Ironbox, Marlborough Blue Cycad, Quassia and Ooline Habitat

0 0.75 1.5 3

Kilometers

Scale: 1:90,000 (A4)

25/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-47

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.6.29.7 Summary of likelihood

Given that the BioCondition assessment, RE verification and other flora surveys failed to locate any individuals of this species, it is considered unlikely to be present in the disturbance footprint or the broader Project area.

5.6.30 Polianthion minutiflorum

5.6.30.1 Listing Advice

- Commonwealth: Vulnerable
- Queensland: Vulnerable

5.6.30.2 Distribution

This species is known from five areas in east Queensland, from Redcliffe Vale, about 110 km west of Mackay, south to Kingaroy, covering a distance of approximately 800 km. It grows in forest and woodland on sandstone slopes and gullies with skeletal soil, or deeper soils adjacent to deeply weathered laterite (Department of the Environment, Water, Heritage and the Arts, 2008g).

5.6.30.3 Habitat

KNOWN HABITAT

The Queensland Government Regional Ecosystem Description Database (REDD) lists 12.9-10.7 as suitable habitat for this species. This primarily coastal ecosystem is not known in the Project area. Sightings of low uncertainty were plotted onto Queensland Government mapping and were found to be on the following mapped REs: 11.7.2, 11.7.1, 11.9.5b, 11.7.2, 11.10.8, 11.10.1.

5.6.30.4 Historical Occurrence

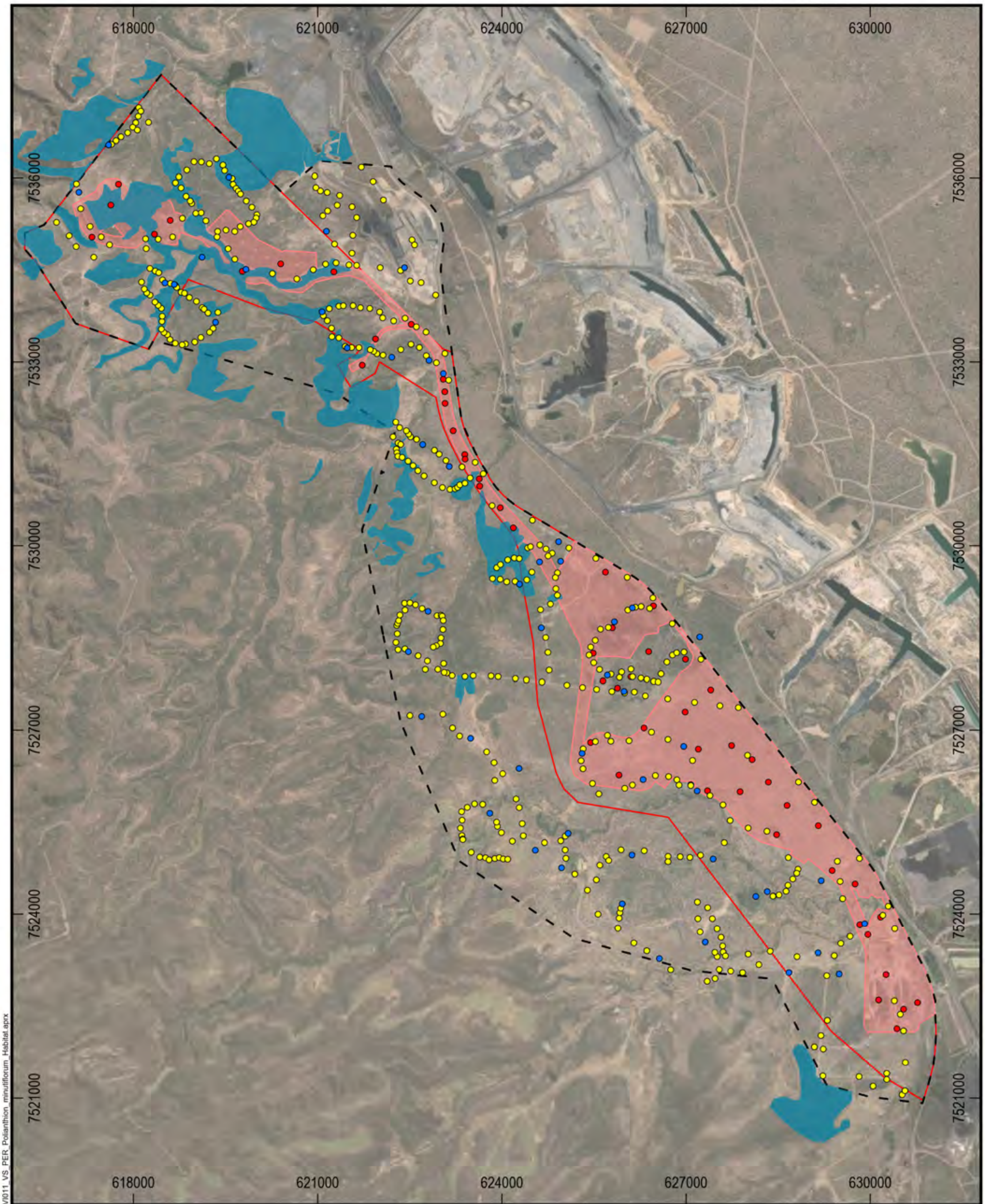
Occurrences are shown in **Figure 5-46** (purple point on map) in **Section 5.6.29.3**. There is one record 150 km south near Blackwater (2003, Queensland Herbarium), and several others more than 100 km north from the Project (2000, Queensland Herbarium; two from 2012, WildNet and Queensland Herbarium).

5.6.30.5 Threatening Processes

The main identified threats are vegetation clearing and altered fire regimes laterite (Department of the Environment, Water, Heritage and the Arts, 2008g).

5.6.30.6 Habitat Assessment

The following REs are found within the Project area: 11.10.8, 11.10.1. Further, approved conservation advice indicates the species is known from semi-evergreen thicket (RE 11.10.8), however this is not equivalent to the TEC Semi-evergreen vine thickets of the Brigalow Belt. In addition, RE 11.10.1x1 is considered suitable for this species. Prior ALA records are particularly associated with sandstone outcrops and substrate. There are 110.70 ha of potential habitat within the disturbance footprint for this species, as shown in **Figure 5-48**.



Legend

Survey Sites

- Quaternary
- Secondary
- BioCondition

Potential habitat for *Polianthion minutiflorum*

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- Survey Area

Source: Vulcan South datasets - Vitrinite 2024 & METServe 2020-2024. Earthstar Geographics 28/09/2023.

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Polianthion_minutiflorum_Habitat.aprx

Vulcan South

Potential habitat for *Polianthion minutiflorum*

0 0.75 1.5 3

Kilometers

Scale: 1:90,000 (A4)

25/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-48

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.6.30.7 Summary of likelihood

Suitable habitat possibly exists, however records are disjunct. Therefore, based solely on a desktop review this species may be present. The ALA records indicate colonies of this plant commonly contained of 200 individuals or more which makes detection in suitable habitats more likely. Field assessment, however, did not identify the presence of colonies or individuals, however. Despite the presence of habitat deemed suitable for this species, no individuals were found. The species' distribution is known to be disjunct, and populations are widely separated by several hundred kilometres; Vulcan South is not located near any of these populations.

Species accumulation curves (see Section 4.1.4.1 of **Appendix M**) fitted to the flora field data combined with estimations of species richness predict that 88% of floral diversity was detected by field surveys. Based on the relatively high modelled detection rate, it is unlikely that the species, or evidence of this species, was not detected during field survey. Further, the Principal Consultant on the survey was qualified by the Queensland Herbarium and was familiar with the species. It is therefore unlikely that the species, were it encountered during the survey, was unrecognised.

5.6.31 Quassia (*Samadera bidwillii*)

5.6.31.1 Listing Advice

- Commonwealth: Vulnerable
- Queensland: Vulnerable

5.6.31.2 Distribution

This species occurs between Scawfell Island (near Mackay) and Goomboorian (north of Gympie) (Department of the Environment, Water, Heritage and the Arts, 2008e).

5.6.31.3 Historical Occurrence

This species' occurrence is shown in **Figure 5-46** (green point on map) in **Section 5.6.29.3**. The nearest reliable record is about 130 km to the east at St Lawrence (1997, Northern Territory Herbarium). The next closest records are located further than 160 km south-east.

5.6.31.4 Habitat

KNOWN HABITAT

Quassia commonly occurs in lowland rainforest or on rainforest margins and can also occur in open forest and woodland. It is commonly found in areas adjacent to both temporary and permanent watercourses (Department of the Environment, Water, Heritage and the Arts, 2008e).

5.6.31.5 Threatening Processes

The main identified threats to Quassia are soil erosion and habitat clearing as a result of a range of activities including agriculture, forestry, urban development and recreational activities. Inappropriate fire regimes may also be a threat (Department of the Environment, Water, Heritage and the Arts, 2008e).

5.6.31.6 Habitat Assessment

There are 0 ha of habitat within the disturbance footprint or broader Project area for this species, as shown in **Figure 5-47** in **Section 5.6.29.6**. Quassia occurs in lowland rainforest approximately 120 km east of the Project area.

5.6.31.7 Summary of likelihood

This species is unlikely to be present due to the lack of suitable habitat and lack of nearby records. No individuals were sighted during flora surveys.

5.6.32 Marlborough Blue Cycad (*Cycas ophiolitica*)

This species was not flagged by the 2024 search of the Protected Matters Search Tool database; however, it has appeared in prior searches conducted for the Terrestrial Ecological Assessment (2022). For completeness, this species has been included here.

5.6.32.1 Listing Advice

- Commonwealth: Endangered
- Queensland: Endangered

5.6.32.2 Distribution

This species occurs from Marlborough in the north, to the Fitzroy River near Rockhampton in the south (Queensland Herbarium, Environmental Protection Agency, 2007).

5.6.32.3 Historical Occurrence

Occurrences are shown in **Figure 5-46** (blue points on map) in **Section 5.6.29.3**. Five records are found within 110-130 km southeast of the Project area (1990, National Herbarium of New South Wales) and there is one record 115 km east (1981, Northern Territory Herbarium). The next closest records are located more than of 170 km to the east, mostly east of Marlborough and Rockhampton.

5.6.32.4 Habitat

KNOWN HABITAT

General habitat is woodland or open woodland dominated by eucalypts, often on serpentinite substrates (Queensland Herbarium, Environmental Protection Agency, 2007).

5.6.32.5 Life History

Pollination ecology is unknown, but this species may be beetle pollinated. Seeds in *Cycas* species become ripe from March onwards (Queensland Herbarium, Environmental Protection Agency, 2007).

5.6.32.6 Threatening Processes

Key threats include land clearing, legal and illegal harvesting, commercial salvage, loss of genetic variation and insect pollinators, and various land management practices (Queensland Herbarium, Environmental Protection Agency, 2007).

5.6.32.7 Habitat Assessment

There are 0 ha of habitat within the disturbance footprint or broader Project area for this species, as shown in **Figure 5-47** in **Section 5.6.29.6.**

5.6.32.8 Summary of likelihood

This species is unlikely to be present, due to a lack of habitat and a lack of nearby records.

5.6.33 Ooline (*Cadellia pentastylis*)

This species was not flagged by the 2024 search of the Protected Matters Search Tool database; however, it has appeared in prior searches conducted for the Terrestrial Ecological Assessment (2022). For completeness, this species has been included here.

5.6.33.1 Listing Advice

- Commonwealth: Vulnerable
- Queensland: Vulnerable

5.6.33.2 Distribution

Ooline occurs on the western edge of the NSW north-west slopes, from Mt Black Jack near Gunnadah to west of Tenterfield, and extends into Queensland to Carnarvon Range and Callide Valley, south-west of Rockhampton (Department of the Environment, Water, Heritage and the Arts, 2008a).

5.6.33.3 Historical Occurrence

The nearest record is located more than 100 km southeast from the Project, from the year 1991 (WildNet) (**Figure 5-46**, yellow point on map) in **Section 5.6.29.3**). More records are located at least 180 km further south.

5.6.33.4 Habitat

Ooline grows in dry rainforest, semi-evergreen vine thickets and sclerophyll ecological communities, often locally dominant or as an emergent (Department of the Environment, Water, Heritage and the Arts, 2008a).

5.6.33.5 Life History

Flowering events occur in spring through to autumn in Queensland and fruits are borne in November to December (Department of Climate Change, Energy, the Environment and Water, 2024c).

5.6.33.6 Threatening Processes

The main identified threats to Ooline are localised extinction due to small and scattered populations, inbreeding which threatens genetic diversity in small populations, low seed viability which threatens breeding success, clearing for agriculture, grazing and soil compaction by domestic stock and feral species, frequent fires; tunnel and sheet erosion, damage to roadside populations during roadworks, and high insect attack (Department of the Environment, Water, Heritage and the Arts, 2008a).

5.6.33.7 Habitat Assessment

There are 0 ha of habitat within the disturbance footprint or broader Project area for this species, as shown in **Figure 5-47** in **Section 5.6.29.6**. No habitat was surveyed in the Project area or greater survey area that would be considered suitable for this species.

5.6.33.8 Summary of likelihood

Based on a lack of suitable habitat and a lack of nearby records, it is unlikely that this species is present.

5.7 MNES Migratory Wetland Species

Eight species are considered likely in some capacity to occur in the Project area following field surveys and desktop assessment as outlined in **Section 5.3**. Of these:

- 0 are confirmed as present; and
- 5 are considered as species that may occur.

All species that may occur are described further in this Section, with distribution, habitat, life history and habitat assessment provided. For all of these species, the habitat within the Project area is marginal, unlikely to be occupied but was determined to be a maximum of 2.6 ha. This habitat is restricted to small artificial dams within the Project area and immediate surrounds. The maximum habitat is considered the same in area for each of these species and is certainly over-estimated. The likelihood of occurrence is further assessed under each species' subSection.

None of the habitat was determined to be "important habitat" under the definitions provided for in Migratory species in the *Significant Impact Guidelines 1.1*, reproduced and assessed in **Table 5-15**:

Table 5-15 Important Habitat for Migratory species as defined by the Significant Impact Guidelines 1.1, assessed for Insectivorous Woodland Birds

An area of 'important habitat' for a migratory species is:	Assessment of habitat importance within and adjacent to the Project area
Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, and/or	**NO** The Project area does not support an ecologically significant proportion of the total population of any Migratory wetland bird species (threshold of 0.1%) at any time. This is due to the size of the Project area and the habitat being limited to small artificial dams.
habitat that is of critical importance to the species at particular life-cycle stages, and/or	**NO** No species is known or expected to nest in the Project area. The construction of the Project will not isolate or sever any migration routes.
habitat utilised by a migratory species which is at the limit of the species range, and/or	**NO** The Project, for all of these species is between (by latitude) seasonal foraging grounds and nesting areas. The Project area is not directly situated on normal migration routes.
habitat within an area where the species is declining.	**NO** The Project area is not in regions nominated by appropriate conservation advice, referral guidelines or SPRAT profiles of any of these species as areas of decline.
NO The Project area is not considered important habitat for any wetland birds listed as Migratory under the EPBC Act.	

5.7.1 Glossy Ibis (*Plegadis falcinellus*)

5.7.1.1 Listing Advice

- Commonwealth: Migratory, Marine
- Queensland: Special Least Concern

5.7.1.2 Distribution

Glossy Ibis are widely distributed within Australia. Outside Australia it is found in Europe, Asia, Africa and North America (Department of Climate Change, Energy, the Environment and Water, 2024p).

5.7.1.3 Historical Occurrence

A 2001 (BirdLife Australia) record is known from 1 km from the Project area in an area that appears to be influenced by sheet flooding. Otherwise, records are known to be scattered throughout the region, generally over 70 km from the Project area. Most records are concentrated towards the coast. See **Figure 5-27** (orange points within map) in **Section 5.6.12.3.**

5.7.1.4 Habitat

Habitats are described in the SPRAT database (Department of Climate Change, Energy, the Environment and Water, 2024p).

BREEDING HABITAT

The Glossy Ibis nests in mixed species colonies, with a low breeding site fidelity and will inhabit new habitat if it becomes available. The nest is a platform of twigs and vegetation usually positioned less than one metre above water (occasionally up to 7 m) in tall dense stands of emergent vegetation, low trees or bushes. The nest is often lined with aquatic vegetation.

Australian breeding habitat types include wooded and shrubby swamps in the semi-arid and arid regions of the Northern Territory and Queensland.

In Queensland, breeding appears to be mostly confined to the Channel Country of the following drainages:

- Bulloo;
- Diamantina;
- Georgina; and
- Cooper

FORAGING HABITAT

Glossy Ibis forage in the shallow, muddy edges of lakes, wet, marshy areas, and flooded pastures with short vegetation.

SHELTER HABITAT

The Glossy Ibis is most likely to roost in trees near foraging and breeding areas. Regular roosting sites are not likely to be regular in habitats the species only occasionally uses.

DISPERSAL HABITAT

The Glossy Ibis is migratory or nomadic and will overfly all habitats it does not utilise for shelter, foraging and breeding purposes.

5.7.1.5 Life History

Glossy Ibis breed from mid spring to the end of summer. Reproduction may extend to September to April if there are persistent food resources at breeding sites. In some areas, breeding is said to coincide with annual rains.

Three to six eggs are laid. Both adults care for young who fledge in approximately 25–28 days. Chicks will interact with chicks from nearby nests from approximately ten days of age. Once fledged, adults remain feeding young for several weeks (Department of Climate Change, Energy, the Environment and Water, 2024p).

5.7.1.6 Threatening Processes

Wetland destruction or degradation is the major threat to the Glossy Ibis. Activities including water diversion and drainage, irrigation, and hydroelectric power production damage suitable habitat for foraging and breeding. Such alterations of the Macquarie Marshes resulted in a failure of Glossy Ibis to nest there.

Clearing, grazing, burning, increased salinity, groundwater extraction and invasion by exotic plants and fish species are also threats to the species through habitat modification.

The bird is also threatened locally in some areas by hunting and pesticides (Department of Climate Change, Energy, the Environment and Water, 2024p).

5.7.1.7 Habitat Assessment

The natural wetlands present on site are too small and/or are too heavily treed to provide favourable habitat for the Glossy Ibis. However, two dams constitute marginal habitat that may be used briefly under optimal weather conditions (i.e., when water levels are optimal). Both dams are located in the southern half of the survey area, one of which is in the ML area. None of the habitat present within the survey area is considered important for the Glossy Ibis. No Glossy Ibis were recorded within the survey area, but the species has been recorded at the adjacent Peak Downs Mine. There are 2.82 ha of potential habitat in the disturbance footprint, as shown in **Figure 5-36** in **Section 5.6.17.7**.

5.7.1.8 Summary of likelihood

The species may occur within the disturbance footprint. Potential habitat is marginal at best.

5.7.2 Marsh Sandpiper (*Tringa stagnatilis*)

This species was not flagged by the 2024 search of the Protected Matters Search Tool database; however, it has appeared in prior searches conducted for the Terrestrial Ecological Assessment (2022). For completeness, this species has been included here.

5.7.2.1 Listing Advice

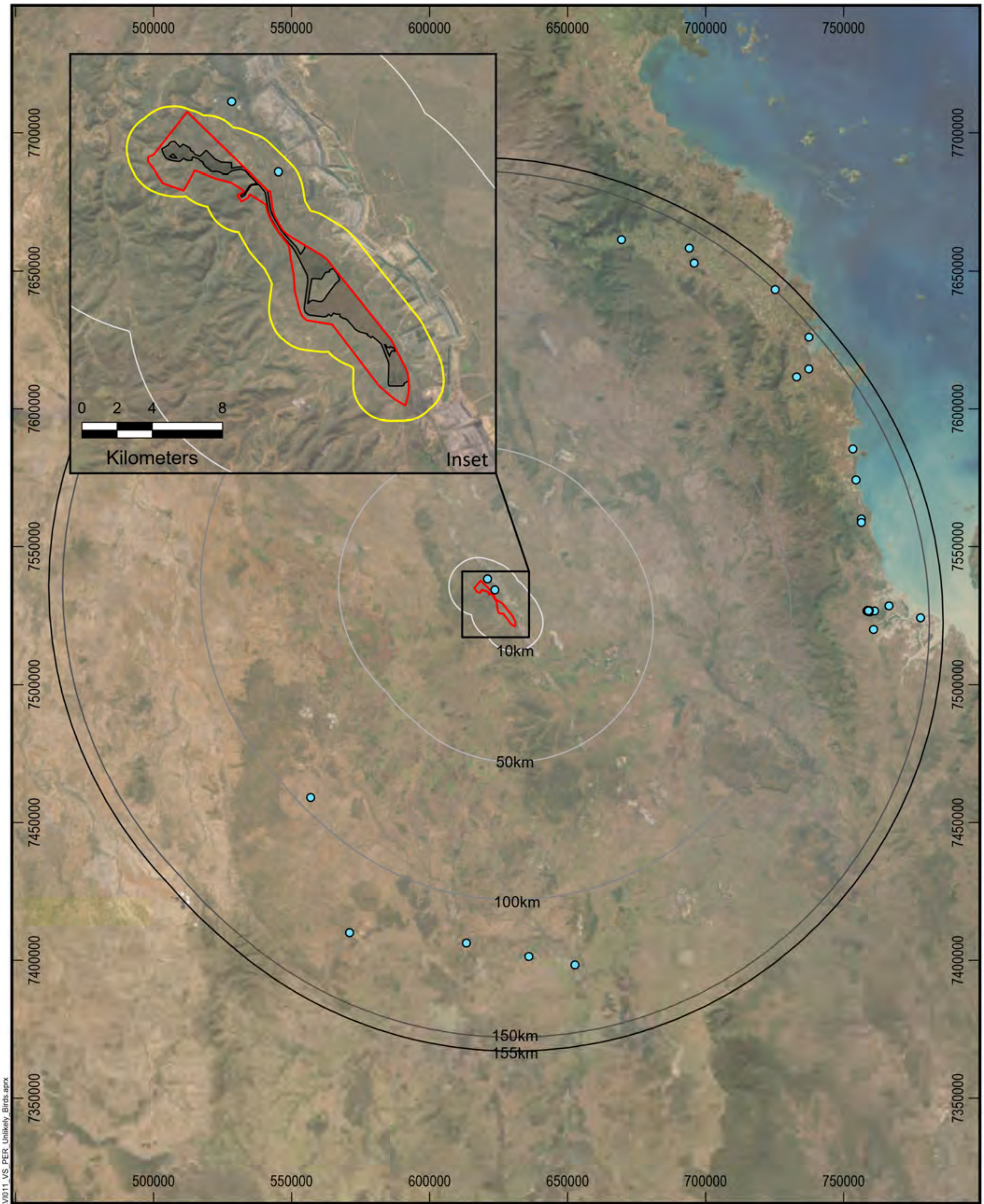
- Commonwealth: Migratory, Marine
- Queensland: Special Least Concern

5.7.2.2 Distribution

This species is found throughout coastal Australia and within inland wetlands.

5.7.2.3 Historical Occurrence

Occurrences are shown in **Figure 5-49**. Two records, from the years 1999 and 2001 (BirdLife Australia), are located within about 12 km north of the Project area near the Peak Downs Mine. Most records are concentrated along the Queensland coast and in the near (30 km) vicinity inland; these are all about 100 km away and further from the Project in the east and the south.



Legend

ALA Records

Tringa stagnatilis (Marsh Sandpiper)

Vulcan South Coal Mine (2023/09708)

Project Area (ML 700073)

Disturbance Footprint

Impact Area Search Radius (km)

2

10

50

100

150

155

Source: Vitrinite 2024, METServe 2020-2024, Atlas of Living Australia 2024, Earthstar Geographics.

Vulcan South

Marsh Sandpiper Records

0 20 40 80

Kilometers

Scale: 1:2,000,000 (A4)

24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-49

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Unlikely_Birds.aprx

5.7.2.4 Habitat

FORAGING/SHELTER HABITAT

This species utilises muddy margins of shallow fresh or brackish water (Department of the Environment, 2015b).

BREEDING HABITAT

This species does not breed in Australia (Department of the Environment, 2015b).

DISPERSAL HABITAT

This species disperses aerially, likely only to land in areas suitable for foraging and shelter.

5.7.2.5 Life History

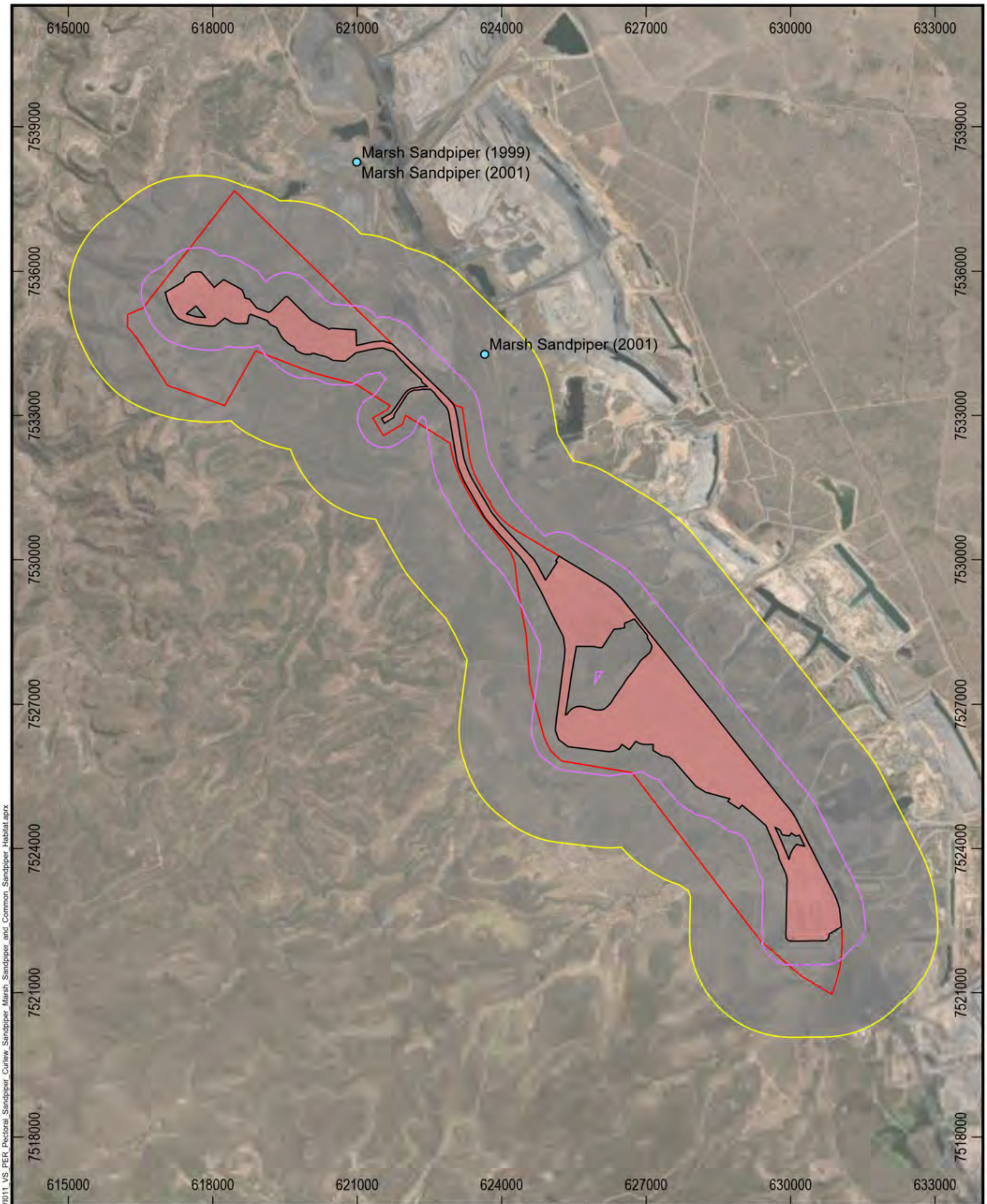
This species does not breed in Australia. This species migrates to Australia from abroad.

5.7.2.6 Threatening Processes

Threats include habitat loss and modification, anthropogenic disturbance, and climate change (Department of the Environment, 2015b).

5.7.2.7 Habitat Assessment

There are 0 ha of suitable habitat for this species in the disturbance footprint or broader Project area, as shown in **Figure 5-50.**



Legend

ALA Records

Tringa stagnatilis (Marsh Sandpiper)

Non-habitat

Vulcan South Coal Mine (2023/09708)

Project Area (ML 700073)

Disturbance Footprint

2 km Buffer

500m Indirect Impact Buffer

Source: Atlas of Living Australia 2024, Vulcan South datasets - Vitrinite 2024 & METServe 2020-2024, Earthstar Geographics 28/09/2023

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Pectoral_Sandpiper_Curlew_Sandpiper_Marsh_Sandpiper_and_Common_Sandpiper_Habitat.aprx

Vulcan South

Pectoral Sandpiper, Curlew Sandpiper, Marsh Sandpiper and Common Sandpiper Habitat

0 1 2 4

Kilometers

Scale: 1:115,000 (A4)

25/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-50

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.7.2.8 Summary of likelihood

Habitat for this species is marginal, and it is acknowledged that the species may occur under exceptional circumstances.

5.7.3 Common Sandpiper (*Actitis hypoleucos*)

5.7.3.1 Listing Advice

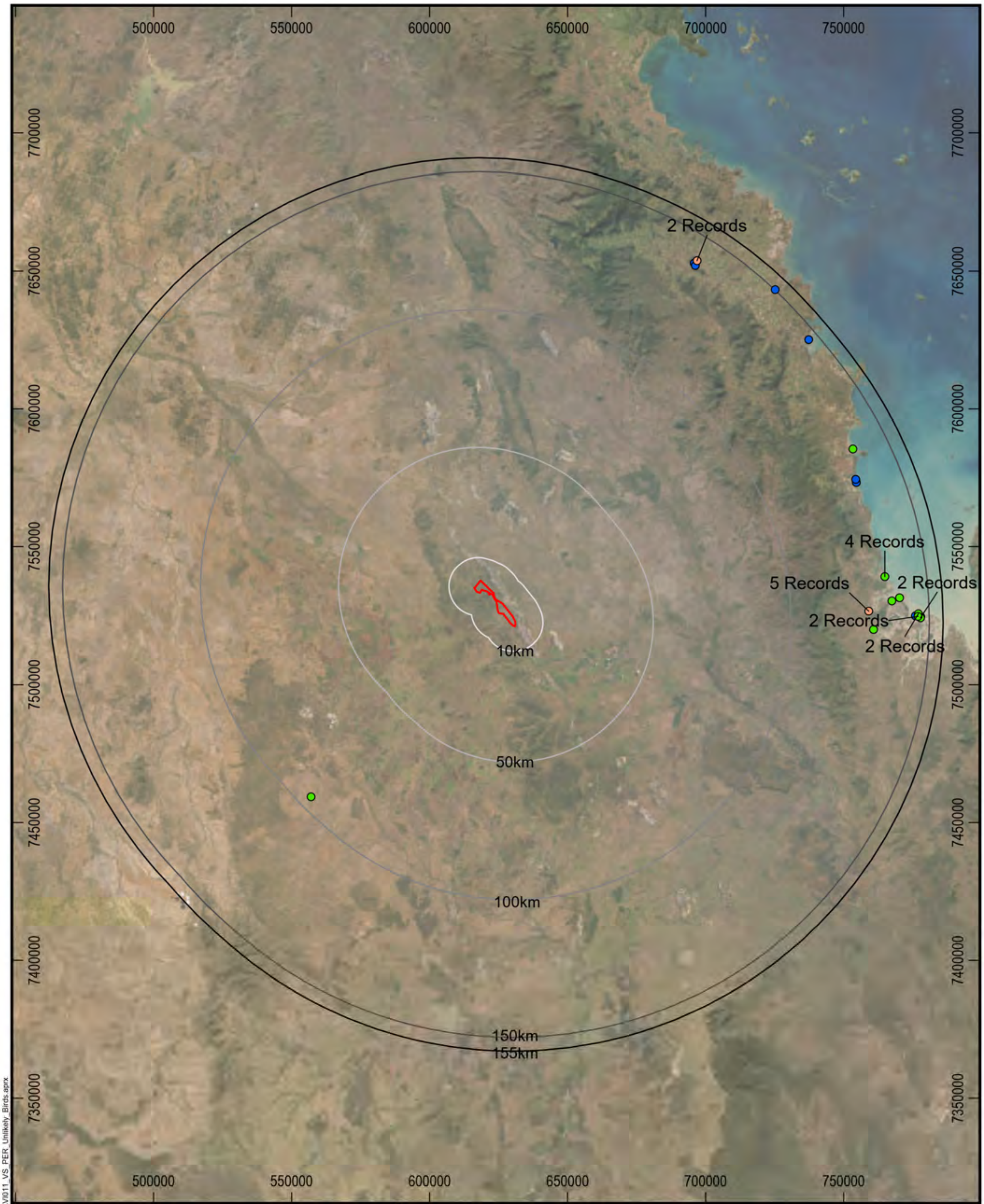
- Commonwealth: Migratory, Marine
- Queensland: Special Least Concern

5.7.3.2 Distribution

This species may be found throughout Australia.

5.7.3.3 Historical Occurrence

Records are approximately 140-150 km in the northeast (**Figure 5-51**, blue points on map). Records mainly follow the coastline.



Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Unlikely_Birds.aprx

Legend

ALA Records
- *Actitis hypoleucos* (Common Sandpiper)
- *Calidris ferruginea* (Curlew Sandpiper)
- *Calidris melanotos* (Pectoral Sandpiper)

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)

Impact Area Search Radius (km)
- 10
- 50
- 100
- 150
- 155

ALA Records
scientif_1
- *Actitis hypoleucos* (Common Sandpiper)
- *Calidris ferruginea* (Curlew Sandpiper)
- *Calidris melanotos* (Pectoral Sandpiper)

ALA Records
scientif_1
- *Actitis hypoleucos* (Common Sandpiper)
- *Calidris ferruginea* (Curlew Sandpiper)
- *Calidris melanotos* (Pectoral Sandpiper)

ALA Records
scientif_1
- *Actitis hypoleucos* (Common Sandpiper)
- *Calidris ferruginea* (Curlew Sandpiper)
- *Calidris melanotos* (Pectoral Sandpiper)

ALA Records
scientif_1
- *Actitis hypoleucos* (Common Sandpiper)
- *Calidris ferruginea* (Curlew Sandpiper)
- *Calidris melanotos* (Pectoral

Source: Vitrinite 2024, METServe 2020-2024, Atlas of Living Australia 2024, Earthstar Geographics.

Vulcan South

Common Sandpiper, Curlew Sandpiper and Pectoral Sandpiper Records

0 20 40 80

Kilometers

Scale: 1:2,000,000 (A4)

25/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-51

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.7.3.4 Habitat

Habitats are described in the SPRAT database (Department of Climate Change, Energy, the Environment and Water, 2024a).

BREEDING HABITAT

This species breeds in Russia.

FORAGING HABITAT

This species utilises estuarine and freshwater wetlands with extensive shallow, muddy margins. Sometimes foraging occurs in grassy areas.

SHELTER HABITAT

Roost sites are normally on rocks or in roots or branches of vegetation, especially mangroves. The species is known to perch on posts, jetties, moored boats and other structures, and to sometimes rest on mud or 'loaf' on rocks.

DISPERSAL HABITAT

This species disperses aerially and is therefore unlikely to land on habitats it does not utilise for foraging or shelter.

5.7.3.5 Life History

The Common Sandpiper breeds in Europe and Asia within the period of April to August. Four eggs are usually laid. The nest is usually close to water, though not always on flat ground or the slope of banks, concealed by vegetation or overhangs. Occasionally nests are on more open, bare ground or on artificial ledges. Incubation takes approximately 21–22 days, and chicks fledge in 26–28 days (Department of Climate Change, Energy, the Environment and Water, 2024a).

The Common Sandpiper migrates south from its northern hemisphere breeding grounds to Australia for the southern summer, spreading to wetlands across the Australian mainland, some islands and Tasmania (Department of Climate Change, Energy, the Environment and Water, 2024a).

5.7.3.6 Threatening Processes

Threats include habitat loss and modification, anthropogenic disturbance, and climate change (Department of the Environment, 2015b).

5.7.3.7 Habitat Assessment

There are 0 ha of habitat within the disturbance footprint or broader Project area for this species, as shown in **Figure 5-50** in **Section 5.7.2.7**. This species utilises estuarine and freshwater wetlands with extensive shallow, muddy margins. These occur in the general area, but not in the Project area.

5.7.3.8 Summary of likelihood

This species is unlikely to be present.

5.7.4 Curlew Sandpiper (*Calidris ferruginea*)

5.7.4.1 Listing Advice

- Commonwealth: Critically Endangered, Migratory, Marine
- Queensland: Endangered

5.7.4.2 Distribution

Curlew sandpipers are most common in the far south-east and north-west of Australia. They are found in many Australian coastal sites and may also be seen inland in suitable wetland habitats. In Queensland there are scattered records in the Gulf of Carpentaria. The species is widespread along the coast south of Cairns. Inland, the species is sparsely scattered, but there have been regular sightings around Mount Isa (Department of Climate Change, Energy, the Environment and Water, 2023b).

5.7.4.3 Historical Occurrence

One reliable non-coastal record occurs for this species, at 90 km southwest (2021, eBird) (**Figure 5-51** in **Section 5.7.3.3**, green points). Most records are clustered along the coast, as to be expected.

5.7.4.4 Habitat

BREEDING HABITAT

The Curlew Sandpiper does not breed in Australia. Breeding habitat occurs on the margins of marshes or pools, on the slopes of hummock tundra, or on dry patches in *Polygonum* tundra (Department of Climate Change, Energy, the Environment and Water, 2023b).

FORAGING HABITAT

Foraging habitat includes mudflats and nearby shallow water. Occasionally they forage on wet mats of algae or waterweed, or on banks of beachcast seagrass or seaweed. At high tide, the species tends to forage among low sparse emergent vegetation such as saltmarsh, and sometimes within flooded paddocks or inundated saltflats (Department of Climate Change, Energy, the Environment and Water, 2023b).

SHELTER HABITAT

Roosting habitat occurs around intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and also around non-tidal swamps, lakes, and lagoons near the coast. Roosting has been recorded on occasion near ponds in saltworks and sewage farms. Less often, individuals are recorded inland around ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand (Department of Climate Change, Energy, the Environment and Water, 2023b).

DISPERSAL HABITAT

The Curlew Sandpiper disperses aerially and is not likely to land on habitat it does not utilise for foraging or shelter.

5.7.4.5 Life History

This species breeds outside Australia, migrating from Siberia through Asia to Australia. Substantial numbers remain in northern Australia throughout the nonbreeding season (Department of Climate Change, Energy, the Environment and Water, 2023b).

5.7.4.6 Threatening Processes

Within Australia, the increased frequency and length of droughts is one of the primary threats to curlew sandpipers. Habitat loss and disturbance contribute to population declines in Australia. Sea level rise may be contributing to loss of foraging habitat at some sites, especially in southern Australia where tidal range is small (Department of Climate Change, Energy, the Environment and Water, 2023b).

5.7.4.7 Habitat Assessment

There are 0 ha of habitat within the disturbance footprint or broader Project area for this species, as shown in **Figure 5-50** in **Section 5.7.2.7**. This species primarily inhabits coastal mudflats, but occasionally also uses the muddy margins of large freshwater wetlands. No wetlands are large enough to be of any utility to this species.

5.7.4.8 Summary of likelihood

Given the coastal nature of the species and the lack of inland records in this highly surveyed region, the species is not likely to occur.

5.7.5 Pectoral Sandpiper (*Calidris melanotos*)

5.7.5.1 Listing Advice

- Commonwealth: Migratory, Marine
- Queensland: Special Least Concern

5.7.5.2 Distribution

This species may occur throughout Australia, with the coast being favourable.

5.7.5.3 Historical Occurrence

The closest records are located close to the coast at least 130 km from the Project (1987, WildNet; 2019, eBird). See **Figure 5-51** (orange points) in **Section 5.7.3.3**.

5.7.5.4 Habitat

BREEDING HABITAT

This species does not breed in Australia, breeding in northern Russia and North America. In Russia, its breeding distribution is from the Yamal Peninsula, east along the Arctic coast, through the Deltas of Lena and Kolmyra Rivers, to the Chukotskiy Peninsula. In North America, its breeding distribution extends from Goodnews Bay, north through Wales to Point Barrow, east and north Canada from the northern regions of Yukon and Mackenzie, north to Banks, Bathurst, Devon, north Baffin Island and south and west to Hudson Bay (Department of Climate Change, Energy, the Environment and Water, 2024f).

SHELTER HABITAT

It is likely that the Pectoral Sandpiper roosts in similar areas to other sandpipers such as the Common Sandpiper.

FORAGING HABITAT

In Australasia, the Pectoral Sandpiper prefers shallow fresh to saline wetlands. The species is found at coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands. The species is usually found in coastal or near coastal habitat but occasionally found further inland. It prefers wetlands that have open fringing mudflats and low, emergent or fringing vegetation, such as grass or samphire. The species has also been recorded in swamp overgrown with lignum (Department of Climate Change, Energy, the Environment and Water, 2024f).

DISPERSAL HABITAT

This species disperses aerially and is therefore unlikely to land on habitats it does not utilise for foraging or shelter.

5.7.5.5 Life History

This species transits between its northern hemisphere breeding grounds and northern hemisphere winter refuges in the southern hemisphere.

5.7.5.6 Threatening Processes

Threats include habitat loss and modification, anthropogenic disturbance, and climate change (Department of the Environment, 2015b).

5.7.5.7 Habitat Assessment

There are 0 ha of habitat within the disturbance footprint or broader Project area for this species, as shown in **Figure 5-50** in **Section 5.7.2.7**.

This species utilises estuarine and freshwater wetlands with extensive shallow, muddy margins. These occur in the general area, but not in the Project area.

5.7.5.8 Summary of likelihood

Due to the lack of habitat in the Project area and the lack of nearby records, it is considered that this species is not present.

5.7.6 Osprey (*Pandion haliaetus* or *P. cristatus*)

5.7.6.1 Listing Advice

- Commonwealth: Migratory, Marine

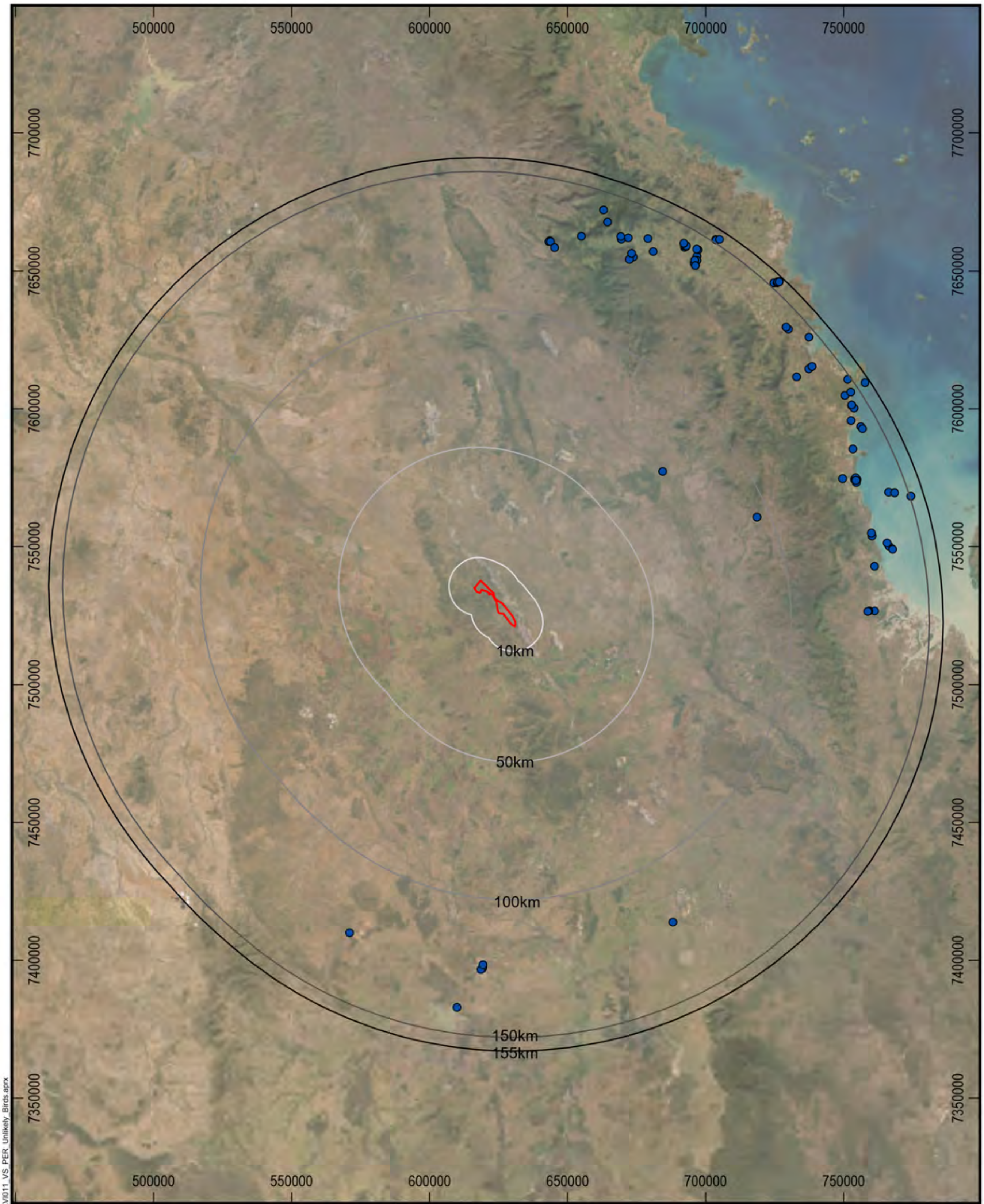
- Queensland: Special Least Concern

5.7.6.2 Distribution

This species occurs in littoral and coastal habitats and terrestrial wetlands of tropical and temperate Australia and offshore islands. They are mostly found in coastal areas but occasionally travel inland along major rivers, particularly in northern Australia (Australian Government, 2020).

5.7.6.3 Historical Occurrence

There are numerous records along the coastline. There are only isolated records closer to the Project, but none are closer than about 80 km. The closest is 80 km northeast (2000, BirdLife Australia), 125 km southeast (2018, eBird Australia), and four records at Emerald 120 km southwest (various dates). These records are shown in **Figure 5-52.**



Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Unlikely_Birds.aprx

Legend

ALA Records
Pandion haliaetus (Osprey)

Vulcan South Coal Mine (2023/09708)
Project Area (ML 700073)

Impact Area Search Radius (km)
10
50
100
150
155

ALA Records
scientif_1
Pandion haliaetus (Osprey)

ALA Records
scientif_1
Pandion haliaetus (Osprey)

ALA Records
scientif_1
Pandion haliaetus (Osprey)

ALA Records
scientif_1
Pandion haliaetus (Osprey)

ALA Records
scientif_1
Pandion haliaetus (Osprey)

Source: Vitrinite 2024, METServe 2020-2024, Atlas of Living Australia 2024, Earthstar Geographics.

Vulcan South

Osprey Records

0 20 40 80
Kilometers
Scale: 1:2,000,000 (A4)

25/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-52

VITRINITE BRIGHTER COAL
METSERVE Mining & Energy Technical Services Pty Ltd

5.7.6.4 Habitat

FORAGING/BREEDING/SHELTER HABITAT

This species frequents a variety of wetland habitats including inshore waters, reefs, bays, coastal cliffs, beaches, estuaries, mangrove swamps, broad rivers, reservoirs and large lakes and waterholes. Ospreys require extensive areas of open fresh, brackish or saline water for foraging. Breeding is in tall trees or structures near foraging areas. (Australian Government, 2020).

DISPERSAL HABITAT

Ospreys disperse aerially and are not likely to land or use any habitat during dispersal other than for the purposes of shelter or foraging.

5.7.6.5 Life History

This species breeds from April to February in Australia (Australian Government, 2020).

5.7.6.6 Threatening Processes

Key threats include habitat loss and modification, climate change, invasive species, prey depletion, and other anthropogenic processes related to disturbance and development (Australian Government, 2020).

5.7.6.7 Habitat Assessment

There are 0 ha of habitat within the disturbance footprint or broader Project area for this species, as shown in **Figure 5-24** in **Section 5.6.10.7**. The Project area is mapped as being within the Vagrant Range of the species (not the Core Range where suitable habitats are usually found) (Department of the Environment, 2015a).

5.7.6.8 Summary of likelihood

The Osprey is not a species that is considered to be present in the Project area.

5.7.7 Yellow Wagtail (*Motacilla flava*)

5.7.7.1 Listing Advice

- Commonwealth: Migratory, Marine
- Queensland: Special Least Concern

Note: The *Referral guideline for 14 birds listed as migratory species under the EPBC Act* (Department of the Environment, 2015a), the following advice is given:

"For the five non-breeding extremely uncommon migrants (Barn and Red-rumped Swallows, Grey and Yellow Wagtails, Oriental Reed-Warbler), the numbers of individuals at any one site are so small relative to their global populations that no small group of individuals is likely to be significant for either the species in Australia or the ecological attributes of a site. For these taxa lodgement of records to the Commonwealth is the only recommendation to proponents."

Following this advice, the species will be considered as one that may occur, some species information provided and not given further consideration.

5.7.7.2 Distribution

This species is generally rare but may occur throughout most of Australia.

5.7.7.3 Historical Occurrence

There are no records within 155 km of the Project (**Figure 5-37** in **Section 5.6.18.3)**. There is only one record located 200 km southeast of the Project and dated to 1905 (WildNet). The next nearest record is at Gladstone, about 350 km southeast from the Project (2016, WildNet).

5.7.7.4 Habitat

In Australia, habitat (non-breeding) is generally in well-watered open grasslands and the fringes of wetlands. Roosting habitat includes mangroves and other dense vegetation (Department of the Environment, 2015a).

5.7.7.5 Life History

This species breeds outside Australia.

5.7.7.6 Threatening Processes

The Yellow Wagtail is a common and widespread species throughout most of its range.

5.7.7.7 Habitat Assessment

Habitat is not considered for this species as the likelihood of significant impacts is extremely low. There is practically no habitat for this species in the Project area, as shown in as shown in **Figure 5-24** in **Section 5.6.10.7**.

5.7.7.8 Summary of likelihood

This species may occur in the Project area.

5.7.8 Gull-billed Tern (*Gelochelidon nilotica*)

This species was not flagged by the 2024 search of the Protected Matters Search Tool database; however it has appeared in prior searches conducted for the Terrestrial Ecological Assessment (2022). For completeness, this species has been included here.

5.7.8.1 Listing Advice

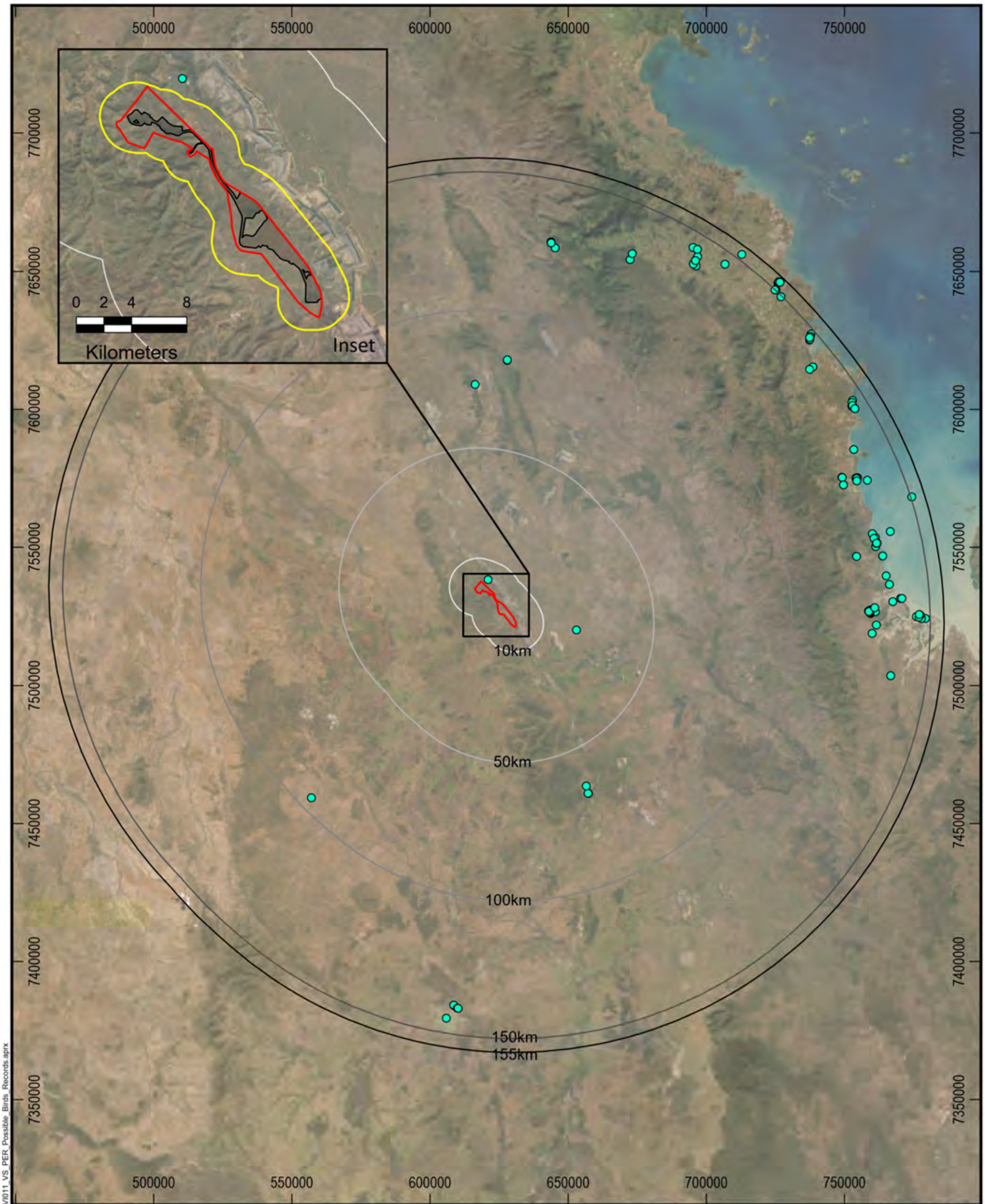
- Commonwealth: Migratory, Marine
- Queensland: Special Least Concern

5.7.8.2 Distribution

Gull-billed Terns are widely distributed in freshwater and marine habitats in Australia and worldwide.

5.7.8.3 Historical Occurrence

One record exists from a large wetland at Peak Downs Mine from 1999 (BirdLife Australia). The next closest is 20 km east from the Project (2016, Ocean Biodiversity Information System). Two additional records about 60 km south in Bundoora State Forest are from 2015 (eBird) and from 1985 (WildNet). These records are shown in **Figure 5-53.**



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Legend

Gelochelidon nilotica (Gull-billed Tern)

Vulcan South Coal Mine (2023/09708)

Project Area (ML 700073)

Disturbance Footprint

Impact Area Search Radius (km)

2

10

50

100

150

155

Gelochelidon nilotica (Gull-billed Tern)

Source: Vitrinite 2024, METServe 2020-2024, Atlas of Living Australia 2024, Earthstar Geographics.

Vulcan South

Gull-billed Tern Records

0 20 40 80

Kilometers

Scale: 1:2,000,000 (A4)

25/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-53

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.7.8.4 Habitat

FORAGING HABITAT

Gull-billed Terns forage over coastal estuaries and large inland lakes and wetlands for crabs and invertebrates, unlike most other terns it does not grab fish from the water (eBird, 2024).

BREEDING HABITAT

The Gull-Billed Tern breeds almost exclusively along the coast in saltmarshes, sandy beaches and sandy islands (Cornell Lab of Ornithology, 2024).

SHELTER HABITAT

Shelter habitat is not clearly defined, but this species is most likely to opportunistically roost on sandbars, shorelines or other low structures directly adjacent to water.

DISPERSAL HABITAT

This species disperses aerially and is only likely to land for the purposes of feeding or resting.

5.7.8.5 Life History

Being a wide-ranging species found almost worldwide, life history is likely to vary, however no recorded breeding habitat known for this species is found within the Project area or anywhere nearby.

5.7.8.6 Threatening Processes

This species is found almost worldwide, and no specific threats were identified.

5.7.8.7 Habitat Assessment

There are 2.82 ha of potential habitat in the disturbance footprint, as shown in **Figure 5-36** in **Section 5.6.17.7**. All water bodies within the survey area are too small to be favourable for the species, although the two largest dams in the southern part of the survey area may be used for brief periods by transient individuals. The species has been recorded (in 1999) at the adjacent Peak Downs Mine, which contains larger dams than are present within the survey area.

5.7.8.8 Summary of likelihood

This is considered a species that may occur as occasional overflying individuals.

5.7.9 Latham's Snipe (*Gallinago hardwickii*)

See **Section 5.6.15**.

5.7.10 Sharp-tailed Sandpiper (*Calidris acuminata*)

See **Section 5.6.17**.

5.8 MNES Migratory Aerial Overfly Species

One species of aerial overfly bird listed as Migratory under the EPBC Act was determined to be likely to occur within the Project area. This species is unlikely to land on-site for any reason, especially given the lack of suitable roosting trees. The presence of another aerial overly species, the White-throated Needletail, was confirmed during field surveys. This species is discussed in more detail within **Section 5.6** because it is also listed as Vulnerable.

None of the habitat was determined to be "important habitat" for the Fork-Tailed Swift or the White-throated Needletail under the definitions provided for Migratory species in the Significant Impact Guidelines 1.1, reproduced and addressed in **Table 5-16**:

Table 5-16 Important Habitat for Migratory species as defined by the Significant Impact Guidelines 1.1, assessed for aerial overfly species

An area of 'important habitat' for a migratory species is:	Assessment of habitat importance within and adjacent to the Project area
Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, and/or	**NO** The Project area does not support an ecologically significant proportion of the total population of the Fork-Tailed Swift (threshold of 0.1%) at any time. This is due to the size of the Project area and the lack of trees and other habitat features that could be used for roosting or shelter.
habitat that is of critical importance to the species at particular life-cycle stages, and/or	**NO** This species does not nest in Australia. The construction of the Project will not isolate or sever any migration routes.
habitat utilised by a migratory species which is at the limit of the species range, and/or	**NO** The Project is not near the limit of this species' range by any estimation.
habitat within an area where the species is declining.	**NO** Declines to this species are most likely to occur in their nesting habitats from tree clearing.
NO The Project area is not considered "important habitat" for migratory aerial overfly species	

5.8.1 Fork-tailed Swift (*Apus pacificus*)

5.8.1.1 Listing Advice

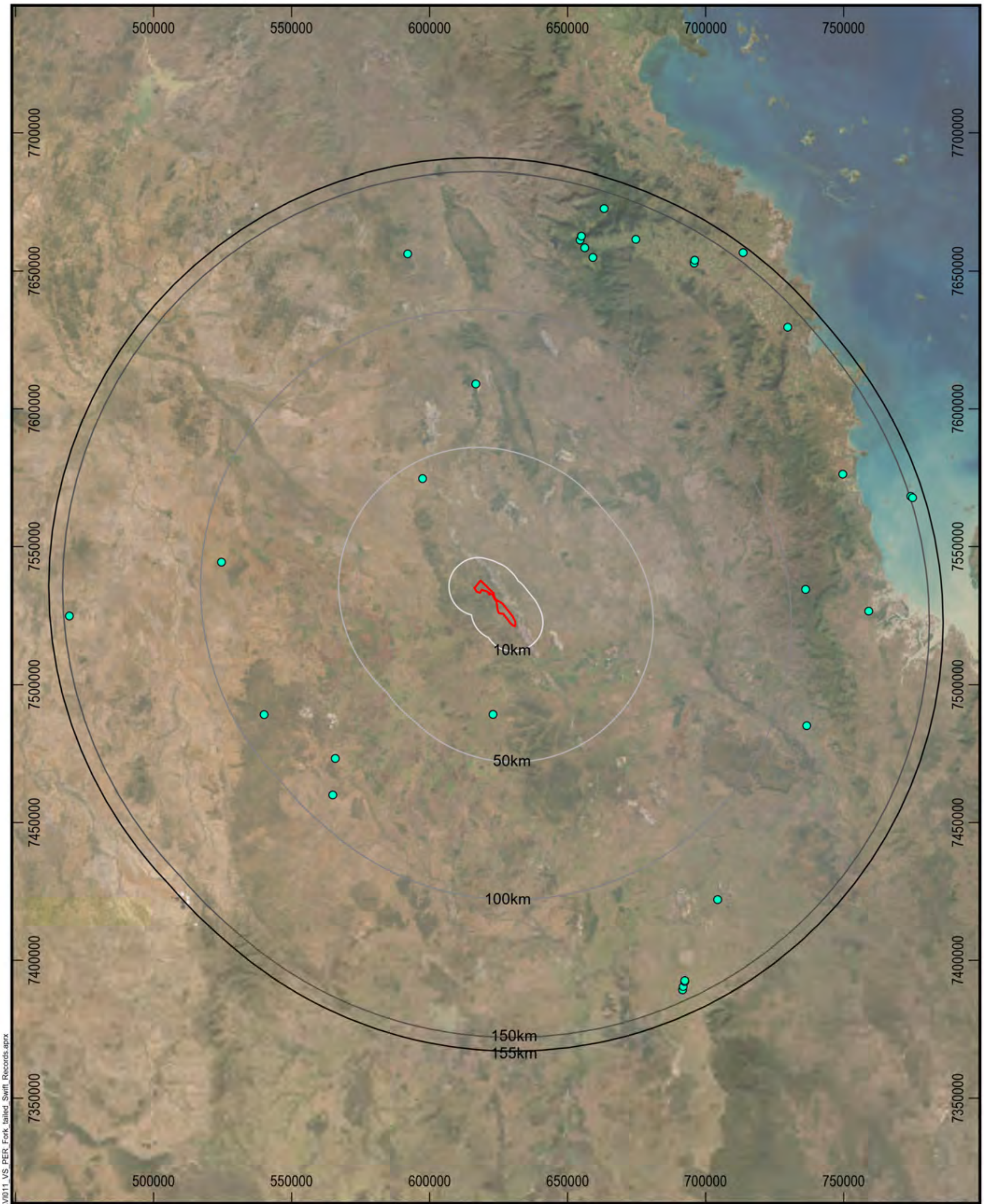
- Commonwealth: Migratory, Marine
- Queensland: Special Least Concern

5.8.1.2 Distribution

The fork-tailed swift is a non-breeding visitor to all states and territories in Australia, though in Queensland it is mostly found west of the Great Dividing Range. Outside Australia it is widely distributed throughout Asia and Russia.

5.8.1.3 Historical Occurrence

Numerous records exist along the coast and further inland, some within 100 km of the Project (**Figure 5-54**). The closest include records 30 km south (2023, eBird), 45 km north-west (2012, eBird), 70 km north (2022, eBird), and 80 km south-west in the Clermont/Blair Athol State Forest area (2000, BirdLife Australia; WildNet, 2014; eBird, 2019).



Legend

ALA Records

Apus pacificus (Fork-tailed Swift)

Vulcan South Coal Mine (2023/09708)

Project Area (ML 700073)

Impact Area Search Radius (km)

- 10
- 50
- 100
- 150
- 155

Source: Vitrinite 2024, METServe 2020-2024, Atlas of Living Australia 2024, Earthstar Geographics.

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Fork_tailed_Swift_Records.aprx

Vulcan South

Fork-tailed Swift Records

0 20 40 80

Kilometers

Scale: 1:2,000,000 (A4)

25/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-54

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.8.1.4 Habitat

Other than roosting recorded in tall trees and possibly cliff faces, the species is otherwise aerial in Australia, overflying but not directly interacting with a variety of terrestrial habitats.

BREEDING HABITAT

This species does not breed in Australia (Department of Climate Change, Energy, the Environment and Water, 2024j).

SHELTER HABITAT

This species is known to occasionally shelter in emergent trees overnight (Department of Climate Change, Energy, the Environment and Water, 2024j).

FORAGING/DISPERSAL HABITAT

This species forages for a variety of flying insects over a diversity of habitats. It takes prey on the wing and does not directly interact with terrestrial habitats for feeding purposes.

5.8.1.5 Life History

The white-throated needletail breeds in the northern hemisphere, known to nest in cliffs, rock caves, tree hollows and occasionally in houses.

5.8.1.6 Threatening Processes

No specific threats within Australia are known for this species (Department of Climate Change, Energy, the Environment and Water, 2024j).

5.8.1.7 Habitat assessment

Habitat for this species is aerial above the entire disturbance footprint (1476.4 ha), as shown in **Figure 5-15** in **Section 5.6.4.7.** This species does not interact with local terrestrial habitats and roosting trees are unlikely to be found here.

5.8.1.8 Summary of likelihood

While no Fork-tailed Swifts were recorded during ecological surveys, it is likely that passing flocks utilise the survey area briefly and intermittently during summer, but possibly not every year. This species is likely to overfly the entire disturbance footprint and not directly interact with terrestrial habitats, therefore despite likely presence, no impacts to the species are anticipated, therefore this species will not be discussed further.

5.8.2 White-throated Needletail (*Hirundapus caudacutus*)

See **Section 5.6.4**.

5.9 MNES Migratory Insectivorous Woodland Birds

Four species of insectivorous woodland bird species listed as Migratory under the EPBC Act were determined to have some probability of occurrence in the Project area as determined by the results of the PMST search. Of these, one was determined to be present during field surveys, and three are considered to be species that may occur, though in small numbers and not every year. It should be noted that three of these species (excluding the Oriental Cuckoo) are grouped as Migratory flycatchers in the *Draft Referral guidelines for 14 Migratory birds under the EPBC Act*, however given their similarities in diet and habitat are all grouped here as Migratory Insectivorous Woodland Birds. The subsections below outline the habitat preferences and probability of occurrence within the Project area. All of these species have similar habitat preferences, to the extent that mapping of habitats will be the same for all species, acknowledging that some will be over-estimated.

For all these species, the habitat within the Project area was determined to be 1503.3 ha.

None of the habitat was determined to be "important habitat" under the definitions provided for Migratory species in the Significant Impact Guidelines 1.1, reproduced and addressed in **Table 5-17**:

Table 5-17 Important Habitat for Migratory species as defined by the Significant Impact Guidelines 1.1, assessed for Insectivorous Woodland Birds

An area of 'important habitat' for a migratory species is:	Assessment of habitat importance within and adjacent to the Project area
Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, and/or	**NO** The Project area does not support an ecologically significant proportion of the total population of any of these species (threshold of 0.1%) at any time. This is due to the size of the Project area, the extent of habitats contained within and the distance from the normal migration routes of these species.
habitat that is of critical importance to the species at particular life-cycle stages, and/or	**NO** No species is known or expected to nest in the Project area. The construction of the Project will not isolate or sever any migration routes.
habitat utilised by a migratory species which is at the limit of the species range, and/or	**NO** The Project, for all of these species is between (by latitude) seasonal foraging grounds and nesting areas. The Project area is not directly situated on normal migration routes.
habitat within an area where the species is declining.	**NO** The Project area is not in regions nominated by appropriate conservation advice, referral guidelines or SPRAT profiles of any of these species as areas of decline.
NO The Project area is not considered important habitat for any woodland insectivorous birds listed as Migratory under the EPBC Act.	

Species profiles are provided in the following subSections, and as no important habitat has been identified and ecologically significant proportions of species' total populations are unlikely to be affected, no Significant Impacts are expected to occur for any Migratory Woodland Insectivorous Bird species.

5.9.1 Rufous Fantail (*Rhipidura rufifrons*)

5.9.1.1 Listing Advice

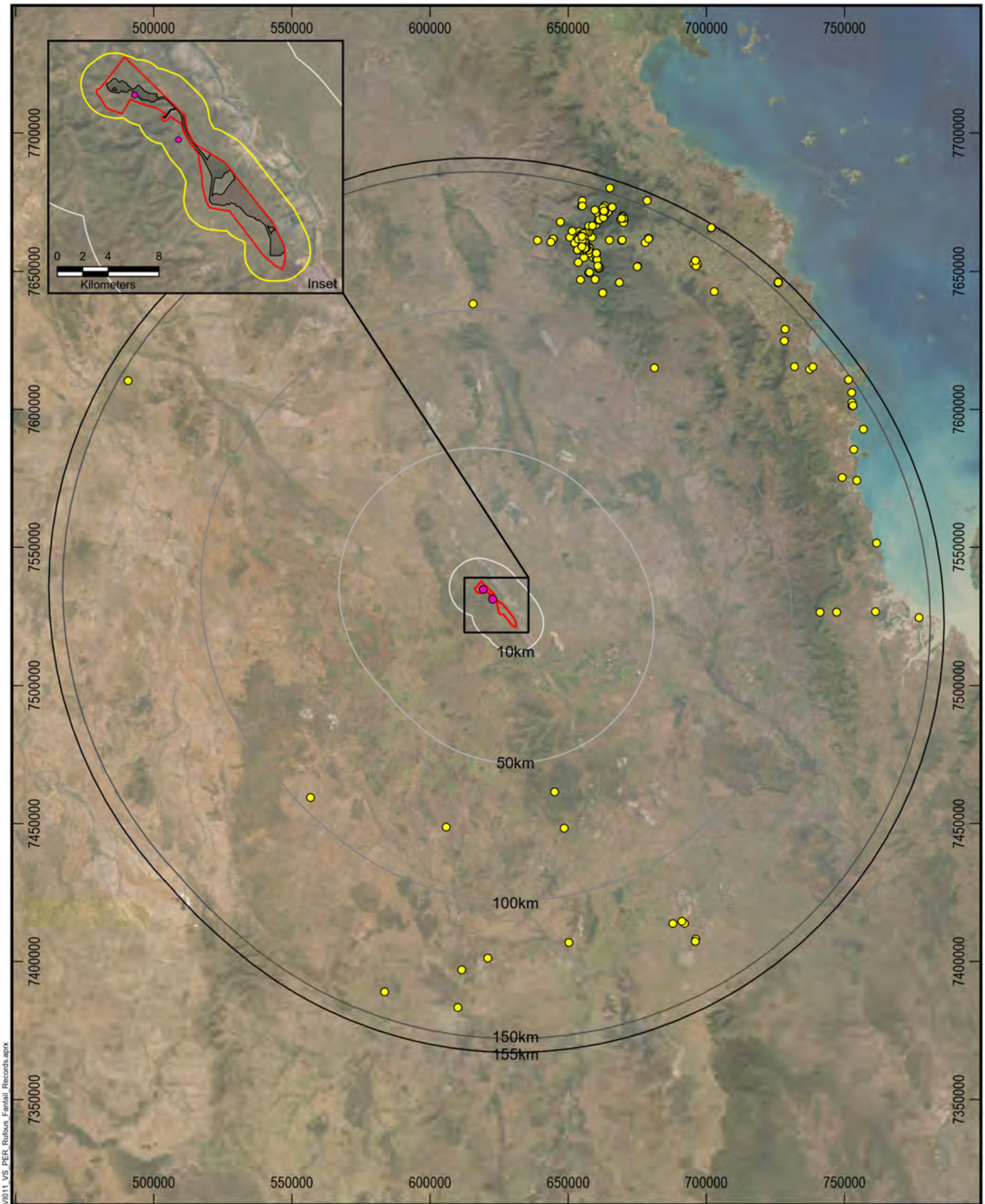
- Commonwealth: Migratory, Marine
- Queensland: Special Least Concern

5.9.1.2 Distribution

The Rufous Fantail is distributed from the Mariana Islands, south through Yap (Caroline Islands), to Sulawesi, the Moluccas and Lesser Sundas, east through southern Papua New Guinea, Louisiade Archipelago and Santa Cruz, to the Solomon Islands and Micronesia, and south to Australia. Within Australia the Rufous Fantail occurs in coastal and near coastal districts of the north and east (Department of Climate Change, Energy, the Environment and Water, 2024i).

5.9.1.3 Historical Occurrence

Numerous records exist east of the Project area, and some within 100 km of the Project, as shown in **Figure 5-55**. This species' presence was confirmed during field surveys.



Legend

- Rufous Fantail Sighting

ALA Records

- *Rhipidura (Howeavis) rufifrons* (Rufous Fantail)

Vulcan South Coal Mine (2023/09708)

- 2 km Buffer
- Project Area (ML 700073)
- Disturbance Footprint

Impact Area Search Radius (km)

- 10
- 50
- 100
- 150
- 155

Source: Vitrinite 2024, METServe 2020-2024, Atlas of Living Australia 2024, Earthstar Geographics.

Vulcan South

Rufous Fantail Records

0 20 40 80

Kilometers

Scale: 1:2,000,000 (A4)

25/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-55

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

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5.9.1.4 Habitat

BREEDING HABITAT

Breeding has never been recorded in dry habitats west of the coastal ranges in central Queensland (Barrett, et al., 2003) and is not likely within the survey area.

SHELTER/FORAGING HABITAT

The species occurs primarily along the east coast and nearby ranges, in rainforest and wet eucalypt forests with a dense, shrubby midstorey. During migration, they can inhabit drier woodlands further west, such as dry Eucalypt forests and Brigalow shrubland (Department of the Environment, 2015a).

DISPERSAL HABITAT

Rufous Fantails pass through the Project area during transit in spring and autumn in small numbers during migration.

5.9.1.5 Life history

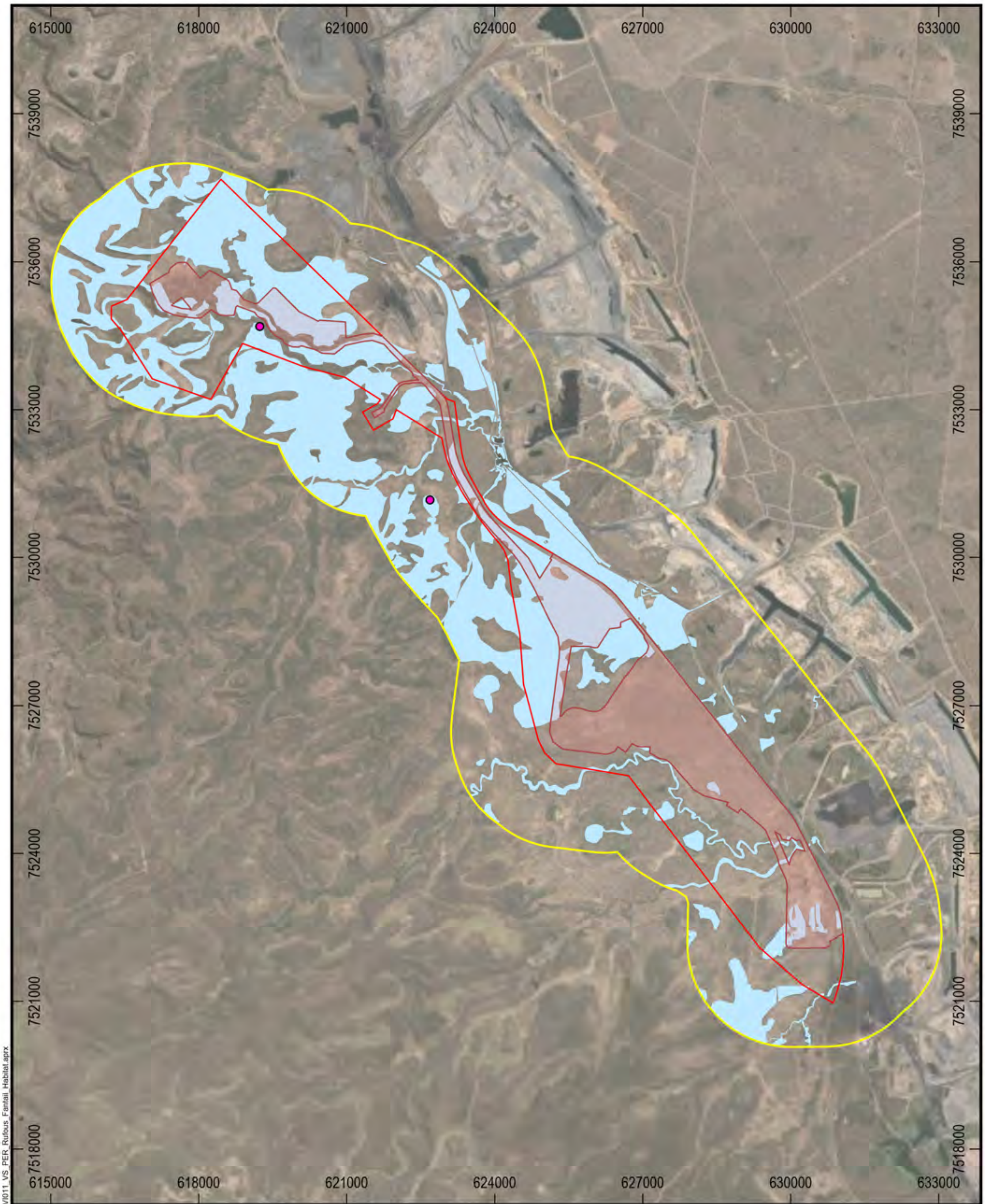
This species nests in spring to summer in a small cup shaped nest made from plant fibres and spider webs, placed in a tree between 30 cm and 6 m above the ground (Department of Climate Change, Energy, the Environment and Water, 2024i).

5.9.1.6 Threatening processes

Habitat loss is the major threat to this species, particularly fragmentation (Department of Climate Change, Energy, the Environment and Water, 2024i).

5.9.1.7 Habitat assessment

Two individuals were recorded on site in September-October 2019: one within vine-thicket and the other within dense *Acacia* regrowth. The subspecies of these individuals is not known, but given the suboptimal habitat usage, these were likely to be migrants. Therefore, they belonged either to *Rhipidura rufifrons rufifrons* (south-eastern Australian subspecies) or migratory sub-populations of *Rhipidura rufifrons intermedia* (Queensland subspecies). It is likely that small numbers (5 to 10) pass through the survey area during each northward or southward migration. According to population estimates provided by the *Referral guideline for 14 birds listed as migratory species under the EPBC Act* (Department of the Environment 2015a), this constitutes a tiny fraction (0.001% to 0.002%) of the total population size of the subspecies involved. Within the survey area, habitats possessing a dense midstorey of *Acacia, Melaleuca* or vine-thicket species are most likely to be used. In total 1,503.3 ha of habitat outside normal dispersal pathways suitable for shelter and foraging occurs within the disturbance footprint which, consequently, is of marginal significance for the Rufous Fantail, given that most of the population migrates through more coastal habitats further east (based on eBird and Atlas of Living Australia records). Consequently, the habitats within the Project area are not critical to the population and do not meet the definitions of “important habitat” for migratory species. Habitat for the Rufous Fantail is shown in **Figure 5-56**. There are 474.09 ha of habitat in the disturbance footprint.



Legend

Rufous Fantail Sighting

Rufous Fantail Habitat

Vulcan South Coal Mine (2023/09708)

2 km Buffer

Project Area (ML 700073)

Disturbance Footprint

Source: Vitrinite 2024, METServe 2020-2024, Earthstar Geographics.

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Rufous_Fantail_Habitat.aprx

Vulcan South

Rufous Fantail Habitat

0 1 2 4

Kilometers

Scale: 1:112,000 (A4)

25/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-56

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.9.1.8 Summary of likelihood

The survey area is acknowledged to be of use to, but of marginal significance for the Rufous Fantail. However, it is likely that small numbers pass through the Project area. This constitutes a tiny fraction (estimated at 0.001% to 0.002%) of the total population size of the subspecies involved. Due to this species' confirmed presence, it has been assessed for Significant Impacts further in **Section 6**.

5.9.2 Oriental Cuckoo (*Cuculus optatus*)

5.9.2.1 Listing Advice

- Commonwealth: Migratory
- Queensland: Special Least Concern

5.9.2.2 Distribution

Oriental Cuckoos are migratory birds protected under the China-Australia Migratory Bird Agreement, Japan-Australia Migratory Bird Agreement, Republic of Korea-Australia Migratory Bird Agreement and EPBC Act. In Queensland, they are also listed as Special Least Concern under the *Nature Conservation (Wildlife) Regulation 2006*. No Oriental Cuckoos were recorded within the survey area. The nearest published record is 78 km northeast of the survey area. Oriental Cuckoos visit Australia when not breeding in the Austral summer (November-April).

5.9.2.3 Historical Occurrence

The only record within 70 km is approximately 6 km north of the Project area from 2023. Numerous further records are located along the coast, and some are located scattered further inland south of the Project more than 100 km away. See **Figure 5-27** (green points within map) in **Section 5.6.12.3**.

5.9.2.4 Habitat

FORAGING/SHELTER HABITAT

When in Australia, Oriental Cuckoos typically inhabit monsoonal rainforest, vine thickets, wet sclerophyll forest and open woodlands. They typically favour riparian areas and other ecotones between dense forest and more open habitat.

BREEDING HABITAT

This species does not breed in Australia

DISPERSAL HABITAT

This species disperses aerially, and consequently is unlikely to land in habitat unsuitable for the purposes of foraging and shelter.

5.9.2.5 Life History

The Oriental Cuckoo does not breed in Australia, and it is difficult to detect due to its cryptic nature and silence when not breeding. This species migrates to Australia for the southern summer.

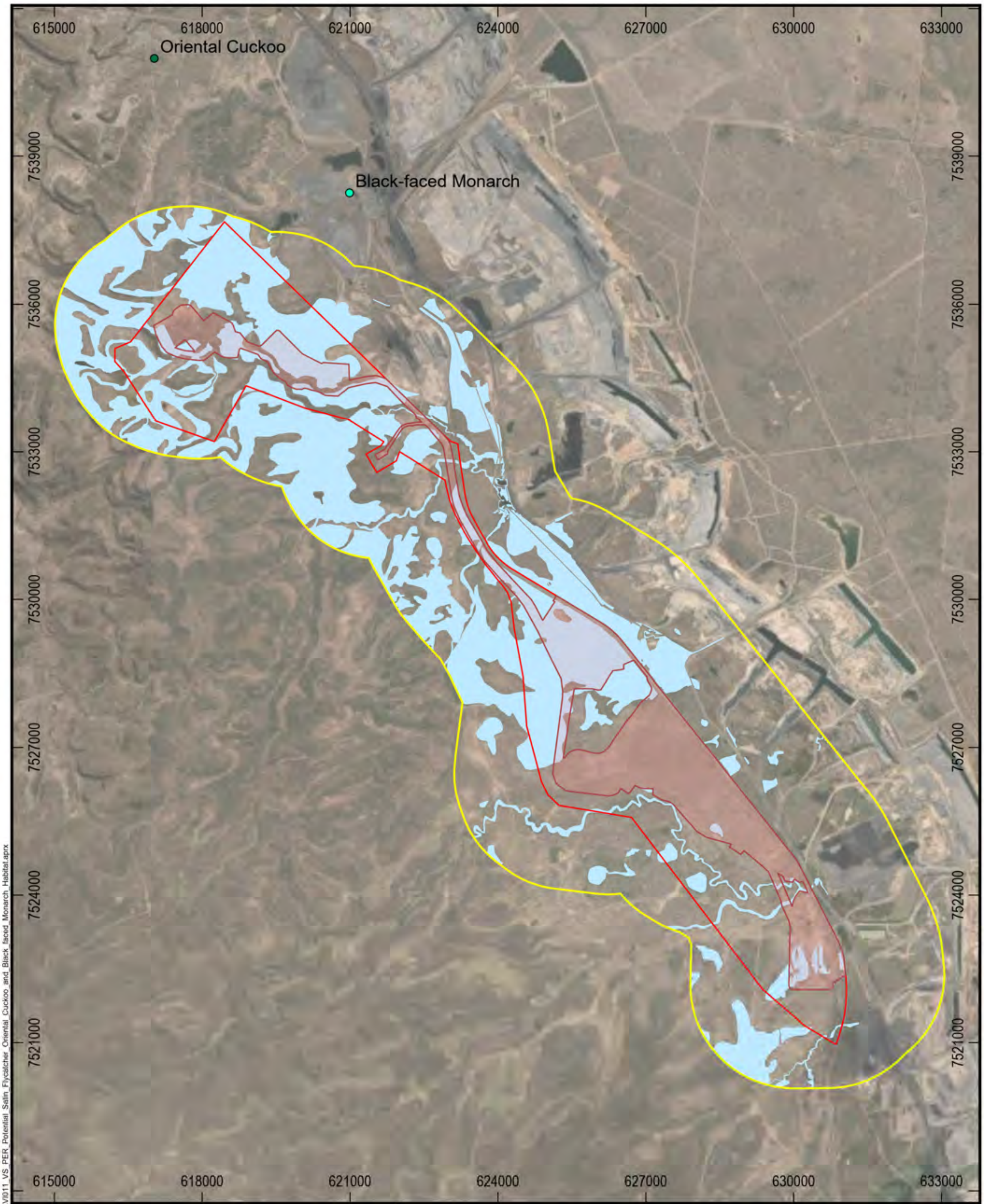
5.9.2.6 Threatening Processes

No threats are listed in referral guidelines or SPRAT. Presumably, the major threat within Australia would be loss of habitat used for resting and feeding during migration, though the definition of such habitat is broad for this species.

5.9.2.7 Habitat Assessment

Suitable habitat for this species is similar to that of the Rufous Fantail, though it is more of a coastal species that may occasionally pass through the Project area. For the Rufous Fantail (see **Section 5.9.1.7**), in total 1,503.3 ha of habitat outside normal dispersal pathways suitable for shelter and foraging occurs within the Project area which, consequently, is of marginal significance for the Oriental Cuckoo.

Most eastern Australian records are along the coast or sub-coastal ranges, with very few sightings further than 100 km from the coast. All inland records listed in eBird are in the vicinity of watercourses, corresponding with the species’ preference for denser forests. The survey area lies 135 km from the coast. Occasional individuals may stray to the survey area, where they are most likely to occur along forested watercourses. A nationally important, ecologically significant proportion of the species’ population is described by the former Department of the Environment (2015a) as 1,000 individuals. No more than one or two Oriental Cuckoos, if any are expected to utilise the survey area in any one 12-month period. Potential habitat for the Oriental Cuckoo is shown in **Figure 5-57**. There are 474.09 ha of potential habitat in the disturbance footprint.



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Legend

ALA Records

- *Cuculus optatus* (Oriental Cuckoo)
- *Monarcha melanopsis* (Black-faced Monarch)
- Potential Satin Flycatcher, Oriental Cuckoo and Black-faced Monarch Habitat

Vulcan South Coal Mine (2023/09708)

- 2 km Buffer
- Project Area (ML 700073)
- Disturbance Footprint

Source: Atlas of Living Australia 2024. Vitrinite 2024. METServe 2020-2024. Earthstar Geographics

Vulcan South

Potential Satin Flycatcher, Oriental Cuckoo and Black-faced Monarch Habitat

0 1 2 4

Kilometers

Scale: 1:112,000 (A4)

25/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-57

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.9.2.8 Summary of likelihood

This species may occur in the Project area.

5.9.3 Black-faced Monarch (*Monarcha melanopsis*)

Black-faced Monarchs breed in rainforest and wet sclerophyll forest, especially in mountainous areas, sheltered gullies and slopes with a dense understorey of ferns and/or shrubs. No Black-faced Monarchs were recorded within the survey area, although there is a published record (from 1999) at the adjacent Peak Downs Mine.

5.9.3.1 Listing Advice

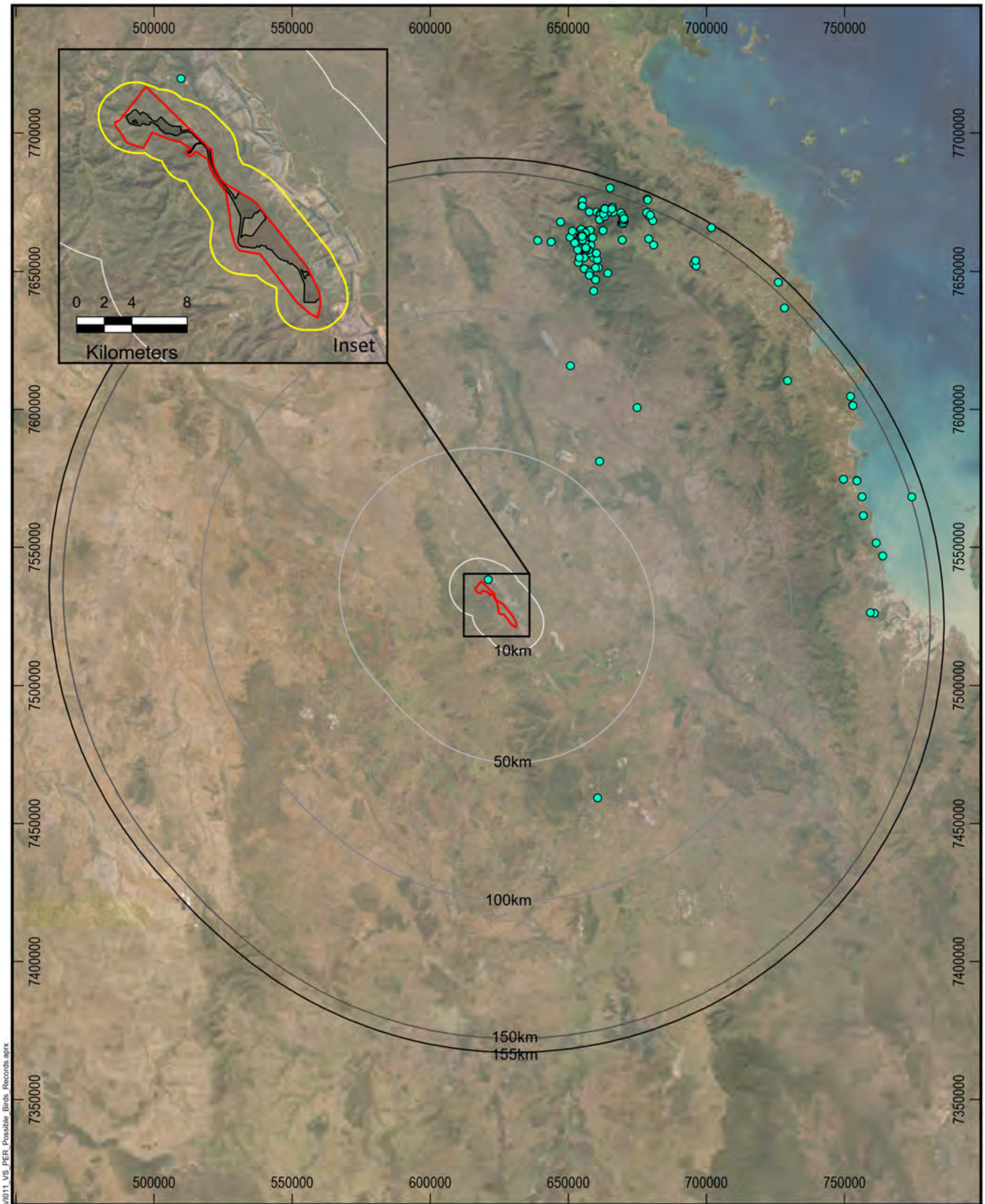
- Commonwealth: Migratory, Marine
- Queensland: Special Least Concern

5.9.3.2 Distribution

Within Australia the Black-faced Monarch is known from Victoria to Cape York.

5.9.3.3 Historical Occurrence

There is one record about 2 km northeast from the Project (1999, BirdLife Australia). Numerous additional records are located east and northeast from the Project. These records are shown in **Figure 5-58.**



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Legend

ALA Records

Monarcha melanopsis (Black-faced Monarch)

Vulcan South Coal Mine (2023/09708)

Project Area (ML 700073)

Disturbance Footprint

Impact Area Search Radius (km)

2

10

50

100

150

155

Source: Vitrinite 2024, METServe 2020-2024, Atlas of Living Australia 2024, Earthstar Geographics.

Vulcan South

Black-faced Monarch Records

0 20 40 80

Kilometers

Scale: 1:2,000,000 (A4)

25/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-58

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.9.3.4 Habitat

FORAGING/SHELTER/BREEDING HABITAT

The Black-faced Monarch mainly occurs in rainforest ecosystems, including semi-deciduous vine-thickets, complex notophyll vine-forest, tropical (mesophyll) rainforest, subtropical (notophyll) rainforest, mesophyll (broadleaf) thicket/shrubland, warm temperate rainforest, dry (monsoon) rainforest and cool temperate rainforest (Department of Climate Change, Energy, the Environment and Water, 2024m).

The species also occurs in selectively logged and 20—30 years old regrowth rainforest. It is also sometimes found in nearby open eucalypt forests (mainly wet sclerophyll forests), in gullies with a dense, shrubby understorey and dry sclerophyll forests and woodlands, often with a patchy understorey. The species occurs in 'marginal' habitats during winter or while migrating (Department of Climate Change, Energy, the Environment and Water, 2024m).

Other areas in which the Black-faced Monarch may be found include gullies in mountain areas or coastal foothills, softwood scrub dominated by Brigalow (*Acacia harpophylla*), coastal scrub dominated by Coast Banksia (*Banksia integrifolia*) and Southern Mahogany (*Eucalyptus botryiodes*) (Smith, 1984), occasionally among mangroves and sometimes in suburban parks and gardens.

In central Queensland, migrating individuals are rarely observed in drier woodlands further than 100 km from the coast (Department of the Environment, 2015a).

DISPERSAL HABITAT

This aerial dispersing species is likely to overfly any habitats not used for foraging, shelter or breeding during migration.

5.9.3.5 Life History

The Black-faced Monarch breeds from October to March, with eggs recorded mostly from November to mid-January. The clutch size is usually two or three. The incubation period is thought to be 13—15 days and the fledging period approximately 7 days or slightly more (Department of Climate Change, Energy, the Environment and Water, 2024m).

5.9.3.6 Threatening Processes

The only threat to this species listed in Department of Climate Change, Energy, the Environment and Water (2024m) is the threat of collisions with windows.

5.9.3.7 Habitat Assessment

Suitable habitat is possibly present in dense riparian vegetation in the limited portions of the Project area. As the survey area is west of their primary migration route, a significant proportion of the population will not utilise the Project area, therefore it does not contain important habitat for the Black-faced Monarch, even if the occasional individual may visit. There are 474.09 ha of potential habitat in the disturbance footprint, though this is almost certainly greatly overestimated. This is shown in **Figure 5-57** in Section **5.9.2.7**.

5.9.3.8 Summary of likelihood

This species may occur within the Project area.

5.9.4 Satin Flycatcher (*Myiagra cyanoleuca*)

5.9.4.1 Listing Advice

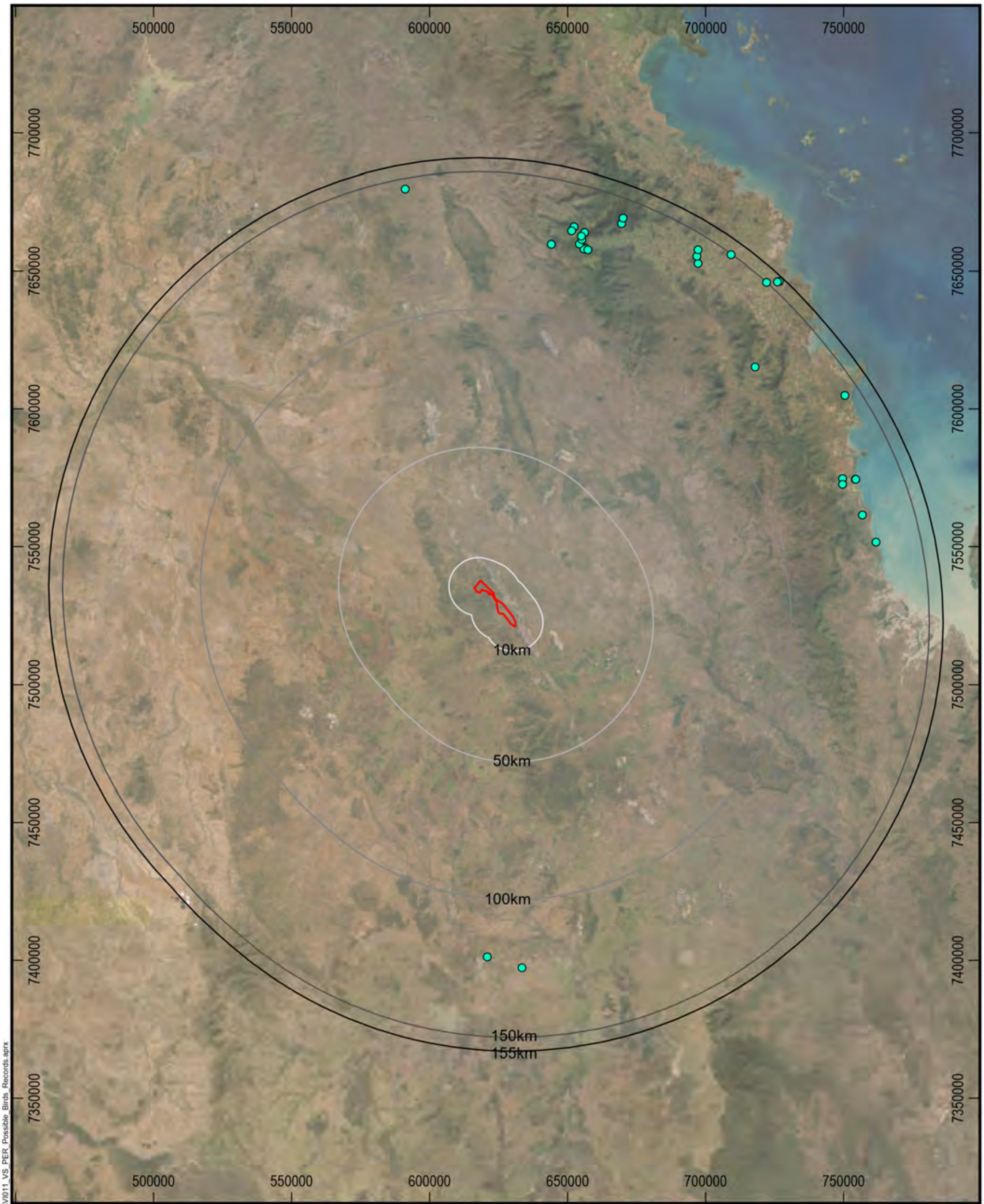
- Commonwealth: Migratory, Marine
- Queensland: Special Least Concern

5.9.4.2 Distribution

Satin Flycatchers breed in tall, wet sclerophyll forest at high altitudes in southeastern Australia and winter at rainforest edges in north Queensland and New Guinea (Department of the Environment, 2015a).

5.9.4.3 Historical Occurrence

The most recent dated records are two occurrences from 2004, about 125 km south, in the Emerald area (**Figure 5-59**). Numerous other records are located closer to the coast.



Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Possible_Birds_Records.aprx

Legend

ALA Records

Myiagra cyanoleuca (Satin Flycatcher)

Vulcan South Coal Mine (2023/09708)

Project Area (ML 700073)

Impact Area Search Radius (km)

10
50
100
150
155

Source: Vitrinite 2024, METServe 2020-2024, Atlas of Living Australia 2024, Earthstar Geographics.

Vulcan South

Satin Flycatcher Records

0 20 40 80

Kilometers

Scale: 1:2,000,000 (A4)

25/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-59

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.9.4.4 Habitat

BREEDING HABITAT

Satin Flycatchers inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands,

FORAGING/SHELTER HABITAT

On migration, the species occur in coastal forests, woodlands, mangroves and drier woodlands and open forests (Department of the Environment, 2015a).

DISPERSAL HABITAT

As a species that disperses aerially, it is likely that the Satin Flycatcher will overfly all terrestrial habitats that it will not use for the purposes of breeding, foraging or shelter.

5.9.4.5 Life History

The clutch size of the Satin Flycatcher is usually three, occasionally four. Incubation is by both sexes with stints often of a short duration with frequent change overs. Males have been recorded feeding the female on the nest. The incubation period is reportedly about 17 days. Causes of nest failure include the loss of eggs following heavy rain, nests blown from trees and nest abandonment (Department of the Environment, 2015a).

5.9.4.6 Threatening Processes

Populations of the Satin Flycatcher may have been reduced by clearing and logging of forests in south-eastern Australia, mainly the loss of old forests. Satin Flycatchers are generally absent from regrowth forests (Department of the Environment, 2015a).

5.9.4.7 Habitat Assessment

The survey area lies outside the known breeding and wintering range of the species. Most records of migrating individuals are along the coast and sub-coastal ranges, but occasional records occur in drier woodlands further west. No Satin Flycatchers were recorded within the survey area. The nearest published record is from 63 km southeast of the survey area. Most inland records listed in eBird occur in September-October or February-March, coinciding with southward and northward migration. While the survey area is west of their primary migration route, small numbers (fewer than five) may pass through annually in a transient capacity. The survey area does not support a nationally important, ecologically significant proportion (defined by the former Department of the Environment (2015a) as 1,700 individuals) of the population at any time. There are 474.09 ha of habitat within the disturbance footprint for this species, though this is almost certainly greatly overestimated. This is shown in **Figure 5-57** in **Section 5.9.2.7**.

5.9.4.8 Summary of likelihood

This species may occur in the Project area, and the area may be considered habitat if some individuals pass through, however this will not meet the definitions or thresholds of important habitat as defined in the *Significant Impact Guidelines 1.1*.

5.10 A Water Resource in Relation to a Large Coal Mining Development

5.10.1 Third Party Users

5.10.1.1 Water Licences

Water access licence holders in the vicinity of the Project which may be potentially affected are displayed in **Figure 5-60**. The active water access licences/licence to take water from waterways that drain through the Project area (Harrow Creek, East Creek, Boomerang Creek, and Hughes Creek) include:

- Moranbah Coal Measures WAL 608364/615421 (Purpose: Dewatering - Underground);
- Boomerang Creek WAL 617686 (Purpose: Site Water Management), Isaac Connors Water Management Area;
- Ripstone Creek WAL 614270 (Purpose: Site Water Management), Isaac Connors Water Management Area;
- Isaac River WAL 619183/619184 (Purpose: Any), Isaac Connors Water Management Area; and
- Harrow Creek WAL 43158L (Purpose: Industrial), Isaac Connors Water Management Area.

Four out of the five water licences are for nearby mining activities (Peak Downs operational coal mine), or other industrial activities. In consideration of the already heavily disturbed nature of the adjoining downstream catchment, it is unlikely that Project releases will have a measurable impact on receiving water quality or EVs. Third party downstream users are not expected to be impacted by the Project.

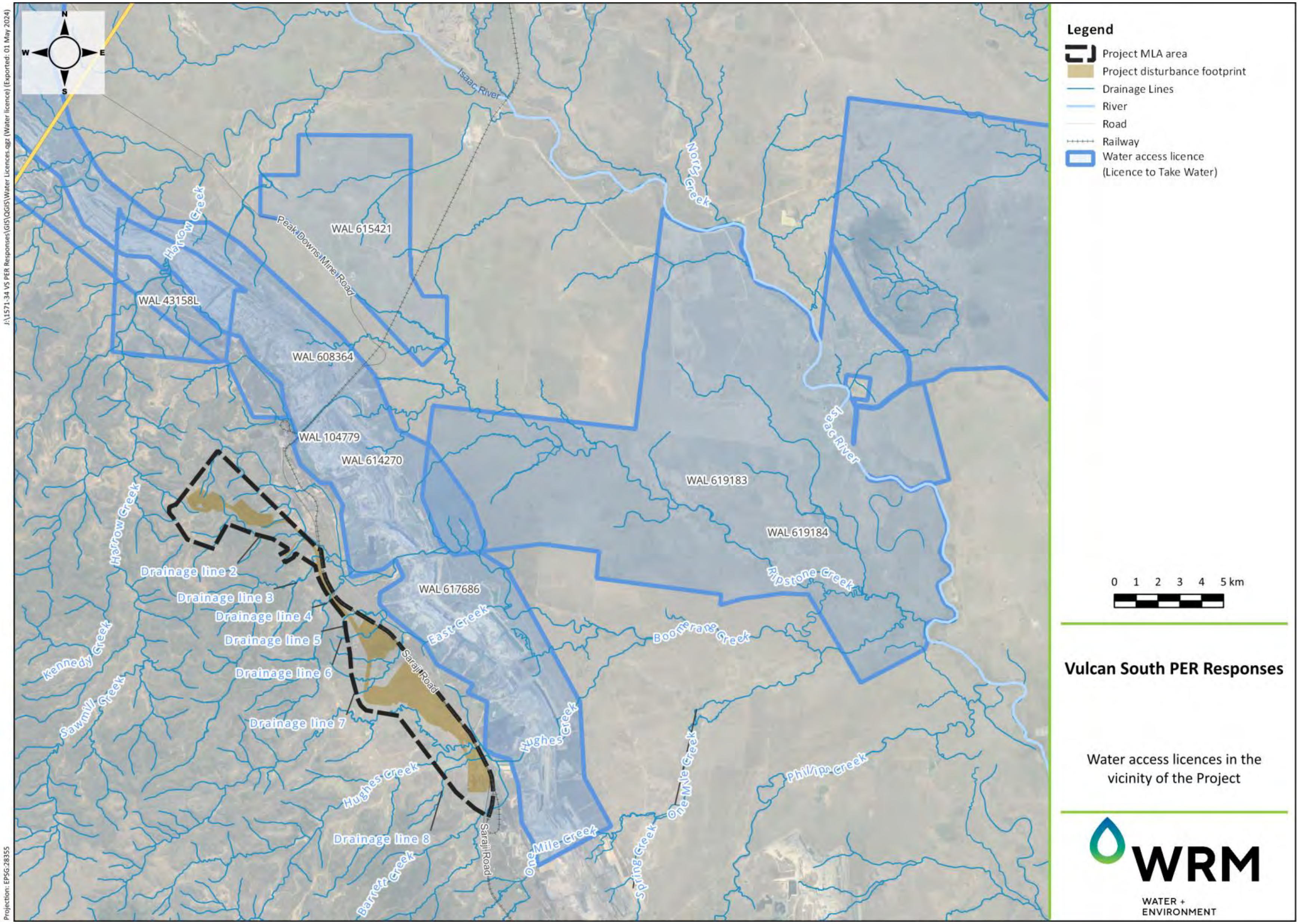


Figure 5-60 Active water access licences in the vicinity of the Project

5.10.1.2 Groundwater

The presence of third party bores was assessed by hydrogeologist.com.au (2024) (**Appendix P)**. Third party groundwater use were assessed through two mechanisms:

- consideration of the registered bores within 5 km of the numerical flow model domain on the Department of Regional Development, Manufacturing and Water's Groundwater bore database (DRDMW GWDB); and
- discussion with private landholders within 5 km of the proposed open pits.

The DRDMW GWDB stores registered water bore data from private water bores and Queensland Government groundwater investigation and monitoring bores. Data includes bore location, water levels, construction details, strata log and water quality. As such the DRDMW GWDB is the most reliable source of desktop information on groundwater use for the Project area.

Records within a 5 km distance of the numerical model domain extent were selected for subsequent analysis. Of the 83 DRDMW GWDB records within 5 km of the numerical flow model domain the following can be concluded:

- 65 (78%) are existing;
- 1 (13%) are abandoned and destroyed; and
- 7 (8%) are abandon ed but still useable.

There are 69 records classifying bore use or purpose within 5 km of the numerical flow model domain. These records suggest that the overwhelming use of bores is for mining:

- 51 (74%) are for monitoring (41 for mine, 5 for petroleum or gas and 5 for sub-artesian monitoring);
- 14 (20%) are for water supply (these may be for mine supply or private supply as water supply is used as a broad term); and
- 4 (6%) are for investigation (stratigraphic, exploration or water resources investigation).

It is the experience of hydrogeologist.com.au that the name of a bore may also reveal its purpose, i.e., bore names containing long numbers, company abbreviations or sequences such as "MB" or "INV" or "PIEZO" are for monitoring or investigation while private bores are named after the farm or the owner. Of the 62 records with names available, 52 (84%) appear to be for the purpose of mine investigation and monitoring.

Groundwater quality is an important consideration for groundwater use because high salinity will generally preclude or limit certain uses. For this reason, groundwater salinity data was also analysed. For the 5 km vicinity of the numerical flow model domain, most of the groundwater salinity information in DRDMW GWDB is provided as field electrical conductivity (EC). Using the classification of Mayer et al. (2005) that is provided in Table 5-8 of **Appendix P**, the 153 field EC records could be summarised as:

- none are fresh;
- one is marginal;
- 29 are brackish;
- 91 are saline; and
- 32 are highly saline.

The above statistics on field EC may somewhat be biased towards bores that are represented by several results (at different dates). The interpretation of hydrogeologist.com.au is that most bores in the vicinity of the Project area are for monitoring and investigation purposes (mostly for mining) and only a small fraction may be used for private groundwater use, probably for limited stock watering because of the high salinity of the groundwater.

The registered bores on the DRDMW GWDB are shown in **Figure 5-61**. It is clear that most registered bores are to the east and south-east and there are very few surrounding registered bores within close proximity of the Project. A private landholder bore (RN162506) is situated 300 m to the east of the Highwall Mining Area; however, the bore location has been ground-truthed and it has been confirmed that it does not exist; therefore, no impacts are anticipated. The next closest private landholder bore is RN8606 which is located 3,000 m to the west of the Highwall Mining Area. RN13040283, a Queensland government monitoring bore is located immediately to the east of the Vulcan main pit.

The cluster of bores shown immediately to the east of the Vulcan main pit and Vulcan south pit have been drilled by the BHP Mitsubishi Alliance (BMA) for the purposes of investigating and monitoring local water infrastructure.

Discussions have been held with the owners of the following property descriptions and Vitrinite to understand whether there are any groundwater bores on the property that may not be registered on the DRDMW GWDB:

- Lot 10 SP208611;
- Lot 2 SP296877;
- Lot 59 SP235297;
- Lot 7 CNS144;
- Lot 11 CNS394;
- Lot 14 CNS382; and
- Lot 9 SP235297.

The outcomes of the discussions indicate that there are no other groundwater supply bores in the Project area that are used by the local landholders.

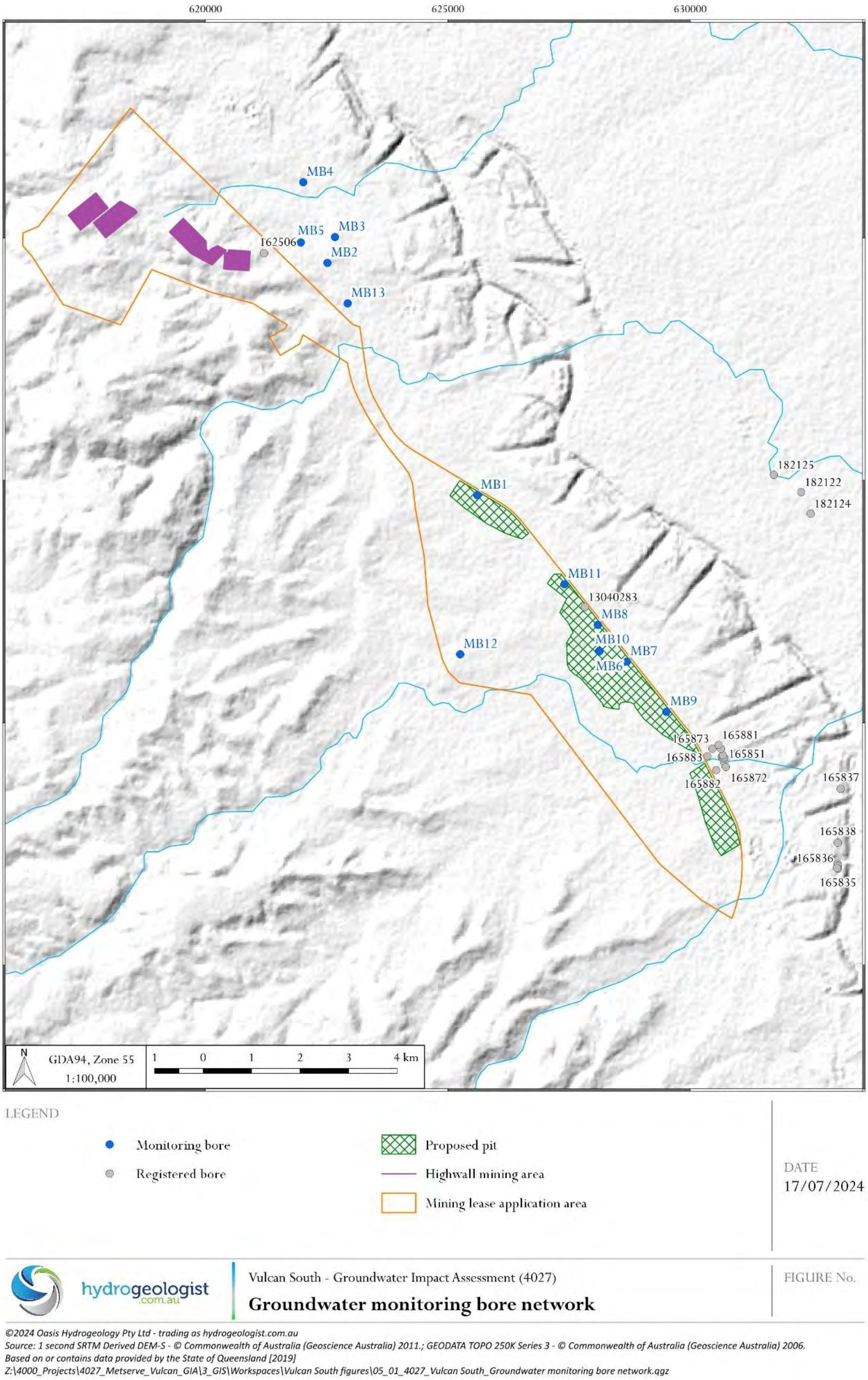


Figure 5-61 Third party groundwater bore locations close to Project disturbance footprint

5.10.1.3 Surface Water

The SWA describes the relevant surface water EVs for the Project. The Project is located within the 'Isaac western upland tributaries' area of the Isaac River sub-basin. Site specific trigger values were derived in accordance with the methodology outlined in ANZG (2018). Where different EVs have different water quality objectives, the Project has adopted the lowest concentration value for mine water and receiving waters trigger levels (**Appendix I**).

The Project does not propose to release mine affected water to the receiving waters; however, the water quality monitoring program will also include monitoring at all dams which contain mine affected water with the potential to discharge to the receiving waters to provide indication on mine affected water quality.

The Queensland Globe service (Queensland Government, 2024) was used to identify any wetlands in the vicinity of the Project. There were no matters of state environmental significance (MSES) wetlands, wetland values or wetland protection areas identified in or adjacent the Project area.

5.10.2 Hydraulic Assessment of Temporary Drainage

This Section represents additional assessment undertaken by WRM to meet the guideline and IESC requirements.

5.10.2.1 General Arrangement of the Proposed Diversions

The alignments of the temporary drainage diversions proposed during the mining stage of the Project are displayed in **Figure 5-62**. **Table 5-18** summarises the proposed drainage diversions for the Project. Two temporary diversions are proposed:

- Drainage line 6 diversion will divert Drainage line 6 along the proposed haul road upstream of the Vulcan North pit before discharging south into Drainage line 7 at the proposed haul road crossing.
- Drainage line 8 diversion will divert Drainage line 8 along the proposed haul road upstream of the Vulcan South pit before discharging north into Hughes Creek at the proposed haul road crossing.

Table 5-18 Proposed Drainage Diversion Summary

Detail	Unit	Drainage line 6 diversion	Drainage line 8 diversion
Length	m	1,396	298
Channel base width	m	10	10
Maximum channel top width	m	30	30
Channel batter slopes	m:m	0.33	0.33
Longitudinal slope	%	0.5	0.8
Catchment area	km^2	1.1	5.7

Drainage Line 6 Diversion

Figure 5-63 shows the cross Section of the Drainage line 6 diversion drain. The proposed diversion was designed to divert runoff from operational (mining stage) conditions catchments around the proposed Vulcan North pit to the proposed haul road crossing at Drainage line 7. The proposed Drainage line 6 diversion was designed for flood events up to the 0.1% AEP with the proposed haul road in place. The diversion drain and downstream Drainage line 7 will be suitably lined to manage channel erosion and prevent scour.

Drainage Line 8 Diversion

Figure 5-64 shows the cross Section of the Drainage line 8 diversion drain. The proposed diversion was designed to divert runoff from operational (mining stage) conditions catchments around the proposed Vulcan South pit to the proposed haul road crossing at Hughes Creek. The proposed Drainage line 8 diversion was designed for local 10% AEP flows as the Hughes Creek floodplain is inundated during larger events. The diversion drain and downstream Hughes Creek drainage line channel will be suitably lined to manage channel erosion and prevent scour.

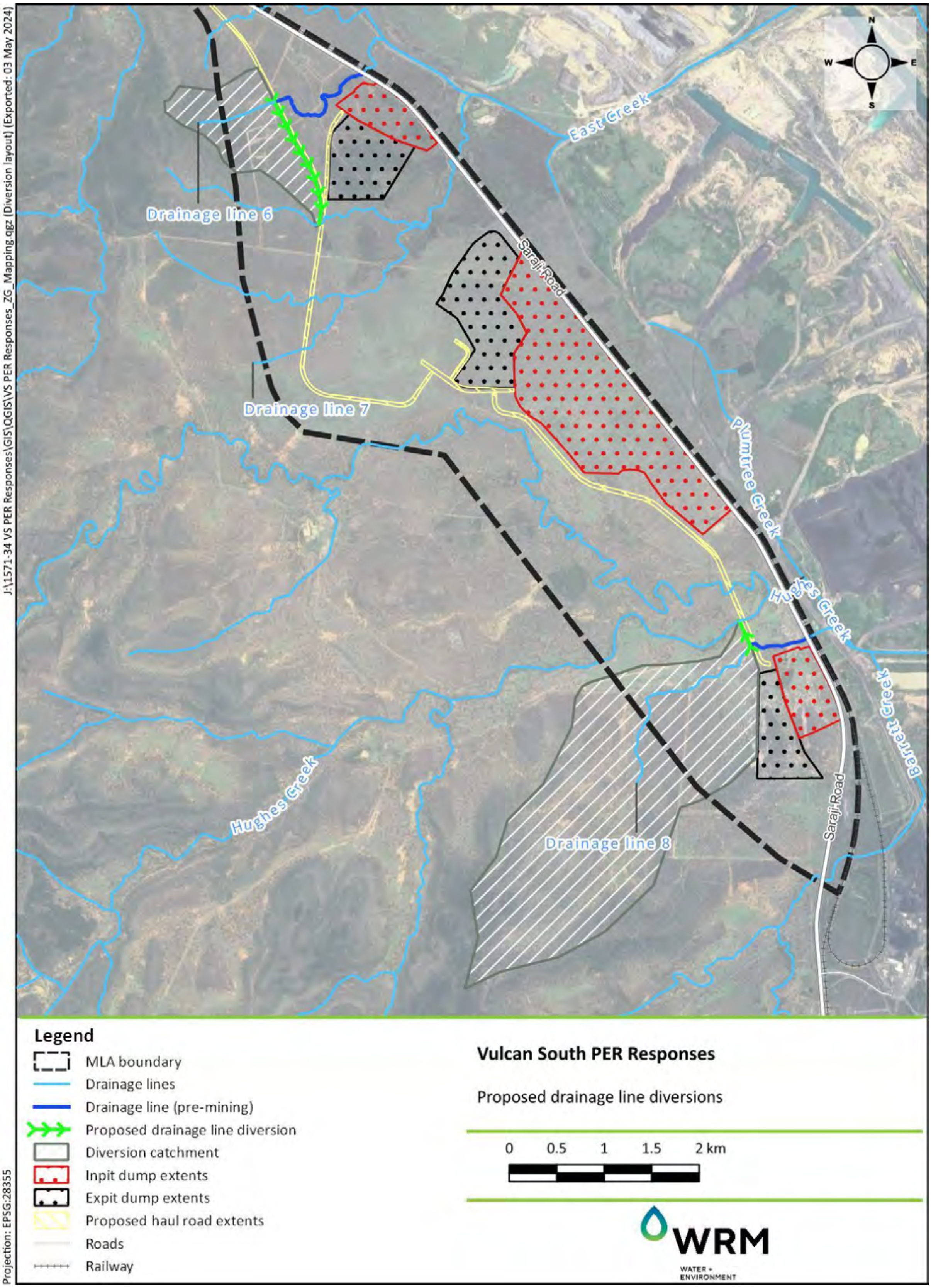


Figure 5-62 Proposed Drainage Line Diversions

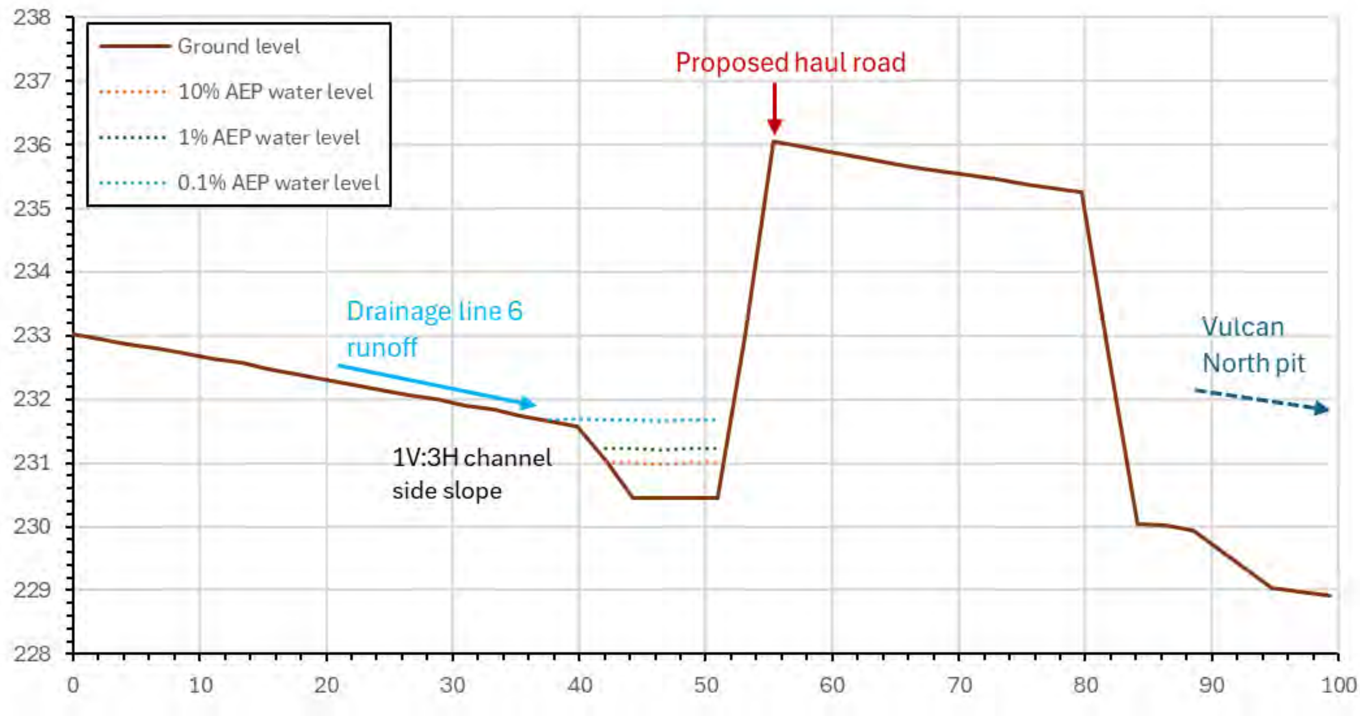


Figure 5-63 Typical Drainage Line 6 Diversion Cross Section

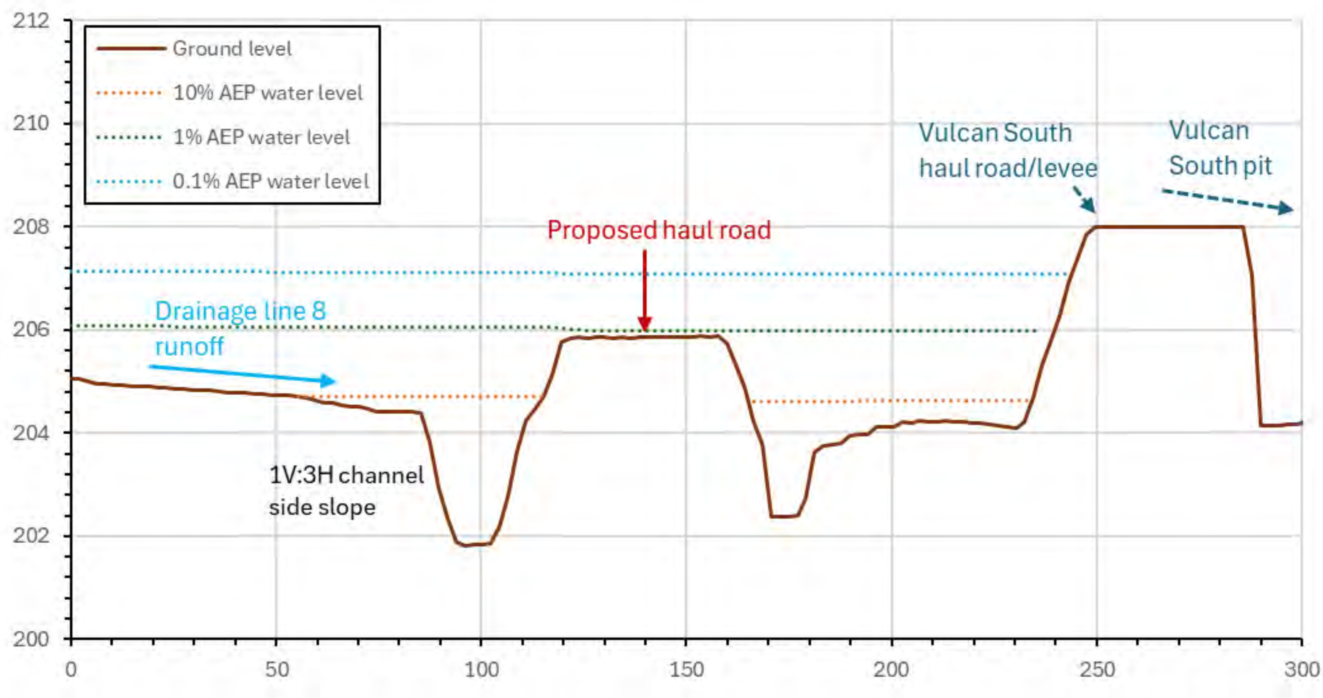


Figure 5-64 Typical Drainage Line 8 Diversion Cross Section

5.10.2.2 Diversion Design Principles

The Queensland Government Department of Natural Resources, Mines and Energy (DNRME's) *guideline: Works that interfere with water in a watercourse for a resource activity — watercourse diversions authorised under the Water Act 2000* (DNRME, 2019a) guideline was adopted. Although the Drainage line 6 and Drainage line 8 diversions are not watercourses, the DNRME (DNRME, 2019a)) design principles have been adopted for the design.

Under the DNRME (2019) guideline, the proposed watercourse diversion aims to achieve the following key objectives:

- be self-sustaining and include geomorphic and vegetation features of regional watercourses and the surrounding landscape;
- where possible, positively contribute to river health values for the system; and
- not impose liability on the Territory, the proponent or the community to maintain the watercourse diversion and its associated components.

The proposed diversions will need to satisfy the following outcomes:

OUTCOME 1 - The watercourse diversion incorporates natural features (including geomorphic and vegetation) present in the regional landscape and associated local watercourses.

OUTCOME 2 - The watercourse diversion maintains the existing hydrologic characteristics of surface water and groundwater systems.

OUTCOME 3 - The hydraulic characteristics of the watercourse diversion are comparable with other local watercourses and suitable for the region in which the diversion is located.

OUTCOME 4 - A sediment transport regime that allows the watercourse diversion to be self-sustaining and not result in material or serious environmental harm on upstream and downstream reaches.

OUTCOME 5 – The watercourse diversion and associated structures maintain stability and functionality and are appropriate for all substrate conditions they encounter.

5.10.2.3 Hydraulic design criteria

The DNRME (2019) guideline has been developed using the results of the Australian Coal Association Research Program (ACARP) stream diversion project (Fisher Stewart, 2002). The Fisher Stewart study investigated the hydraulic characteristics of a number of natural streams in the Bowen Basin. The performance and design faults of existing stream diversions within the Bowen Basin were also assessed as part of the Fisher Stewart study.

Table 5-19 shows the design criteria given in the DNRME (2019) guideline based on the ACARP study for the Bowen Basin streams. Stream power, stream velocity and shear stress are the main hydraulic characteristics of interest:

- Stream power is a function of discharge, hydraulic gradient and flow width. It represents the energy that is available to do work in and on the channel. High stream powers are indicative of elevated erosion potential.
- The velocity criteria have been selected to minimise the potential for damage to the channel through erosion associated with high flow velocities. Where calculated velocities exceed the adopted velocity criteria, additional bank protection (increased vegetation density or rock protection) will be required. Note there is no direct relationship between velocity and the force exerted on soil particles at the boundary and thus stream power and shear stress are used as more reliable indicators of erosion potential.
- The shear stress provides a measure of the tractive force acting on sediment particles at the boundary of the stream, and is used to determine the threshold of motion for bed material. It provides an indication of the potential for erosion of cohesive sediments or movement of non-cohesive sediments at the channel boundary.

Table 5-19 Design Criteria for the Bowen Basin (DNRME, 2019)

Scenario	Stream power (W/m^2)	Velocity (m/s)	Shear stress (N/m^2)
50% AEP event without vegetation	<35	<1.0	<40
50% AEP event with vegetation	<60	<1.5	<40
2 % AEP event with vegetation	<150	<2.5	<50

The DNRME (DNRME, 2019a) guideline design criteria are based on an incised channel with confinement of flows up to and including the 0.1% AEP design event. The DNRME (2019) guideline hydraulic parameters were derived in the Fisher Stewart (2002) study from depth averaged channel cross Sections using the HEC-RAS one dimensional hydraulic model. The Fisher Stewart study also derived the small event values for the 2 year average recurrence interval (ARI) event and not the 10% AEP event, which is slightly larger. The difference is expected to be minor. The guideline values given in **Table 5-19** for the 50% AEP event are intended to reflect hydraulic behaviour during events which are confined within the channel, and the values for the 2% AEP event are for events which exceed the capacity of the channel.

Notwithstanding, for this assessment the 10% AEP was in lieu of the 50% AEP event because the diversion will be confined channel with no overbank floodplains. The 1% AEP was also used in lieu of the 2% AEP.

5.10.2.4 Hydraulic Assessment of the Proposed Diversions

A hydraulic analysis was undertaken to assess the performance of the proposed diversions using the hydrologic (XP-RAFTS) and hydraulic (TUFLOW) models developed for the SWA (**Appendix F**). The hydraulic characteristics of the proposed diversions were compared to the DNRME (2019) guidelines as well as the existing drainage lines that will be diverted.

Figure 5-65 to **Figure 5-66** show the existing and diverted drainage lines reaches that have been assessed respectively. **Table 5-20** and **Table 5-21** presents the channel velocity (V), bed shear stress (BSS) and stream power (SP) along the existing and diverted drainage reaches for the 10% AEP and 1% AEP events. In summary, the proposed diversions should meet the DNRME (2019) hydraulic design objectives and key design outcomes for the diversions and receiving waters. The following is of note:

- Drainage line 6 diversion (**Figure 5-67**):
  - There are generally reductions in average and maximum V, BSS and SP values for both the reaches when compared with pre-mining conditions except for a small increase in average and maximum V when comparing Drainage line 6 diversion Reach 1 to the pre-mining Drainage line 6 Reach 2.
  - The average channel V, BSS and SPs and maximum channel V are below the DNRME (2019) guideline values for all reaches with vegetation. The maximum values are greatly reduced along the diversion length compared to pre-mining conditions, however at point locations along the reach, the maximum values exceed the guideline values similar to pre-mining conditions, which highlights the need to revegetate or rock line the channel to limit erosion risk. It is recommended that this reach is monitored and remediation works implemented where required. Where significant erosion is expected, reprofiling and rock lining may be required to stabilise the reach.
  - The diversion channel geomorphic indicators suggest that the channel will have similar to lower sediment transport characteristics when compared to the existing channel. This suggests that the diversion will convey sediment through the reach similar to the existing natural conditions with some potential minor deposition over time.
  - Considering the drainage diversion is temporary, and the existing Drainage line 6 and floodplain will be reinstated during post-closure conditions, it is expected that any potential increase in deposition within the Drainage line 7 catchment will be negligible.
- Drainage line 8 diversion (**Figure 5-68**):
  - There is an increase in average and maximum channel V, BSS and SP, however, the average values are below the DNRME (2019) guideline values for all reaches with vegetation.
  - The maximum values exceed guideline values at point locations similar to pre-mining conditions, which highlights the need to revegetate or rock line the channel to limit erosion risk. It is recommended that this reach is monitored and remediation works implemented where required. Where significant erosion is expected, reprofiling and rock lining may be required to stabilise the reach.
  - The diversion channel geomorphic indicators suggest that the diversion will have similar to lower sediment transport characteristics when compared to the existing channel. This suggests that the diversion will convey sediment through the reach similar to the existing natural conditions with some potential minor deposition over time.
  - Considering the drainage diversion is temporary, and the existing Drainage line 8 and floodplain will be reinstated during post-closure conditions, it is expected that any potential increase in deposition within the Hughes Creek catchment will be negligible.

Table 5-20 Geomorphic Characteristics- 10% AEP

Reach	Pre-mining		Diversion		Difference (%)	
	Mean	Max	Mean	Max	Mean	Max
Drainage line 6 diversion Reach 1	*Channel Velocity (m/s)*					
	0.9	1.4	0.8	1.3	-11.1	-7.1
	Bed Shear Stress (N/m²)					
	77.7	583.14	22.3	70/2	-71.3	-88.0
	Stream Power (W/m²)					
	74.1	696.7	19.8	91.2	-73.3	-86.9
Drainage line 6 diversion Reach 2	*Channel Velocity (m/s)*					
	0.6	1.0	-	-	33.3[a]	30.0[a]
	Bed Shear Stress (N/m²)					
	38.0	202.4	-	-	-41.3[a]	-65.3[a]
	Stream Power (W/m²)					
	24.0	165.3	-	-	-17.5[a]	-44.8[a]
Drainage line 8 diversion Reach 1	*Channel Velocity (m/s)*					
	0.4	0.9	1.1	1.6	175.0	77.8
	Bed Shear Stress (N/m²)					
	12.2	87.1	34.9	68.7	186.1	-21.1
	Stream Power (W/m²)					
	7.2	69.1	39.5	109.4	448.6	58.3

Note: a – compared to Drainage line 6 diversion Reach 1

Table 5-21 Geomorphic Characteristics – 1% AEP

Reach	Pre-mining		Diversion		Difference (%)	
	Mean	Max	Mean	Max	Mean	Max
Drainage line 6 diversion Reach 1	*Channel Velocity (m/s)*					
	1.1	1.8	0.9	1.5	-18.2	-16.7
	Bed Shear Stress (N/m²)					
	98.3	596.7	27.3	83.3	-72.2	-86.0
	Stream Power (W/m²)					
	114.1	714.5	28.0	121.2	-75.5	-83.0
Drainage line 6 diversion Reach 2	*Channel Velocity (m/s)*					
	0.7	1.1	-	-	28.6[a]	36.4[a]
	Bed Shear Stress (N/m²)					
	41.9	204.2	-	-	-34.8[a]	-59.2[a]
	Stream Power (W/m²)					
	29.2	166.8	-	-	-4.1[a]	-27.3[a]
Drainage line 8 diversion Reach 1	*Channel Velocity (m/s)*					
	0.5	1.5	1.2	1.7	140.0	13.3
	Bed Shear Stress (N/m²)					
	17.0	174.1	38.4	71.1	125.9	-59.2
	Stream Power (W/m²)					
	12.2	191.6	46.5	118.6	281.1	-38.1

Note: a – compared to Drainage line 6 diversion Reach 1

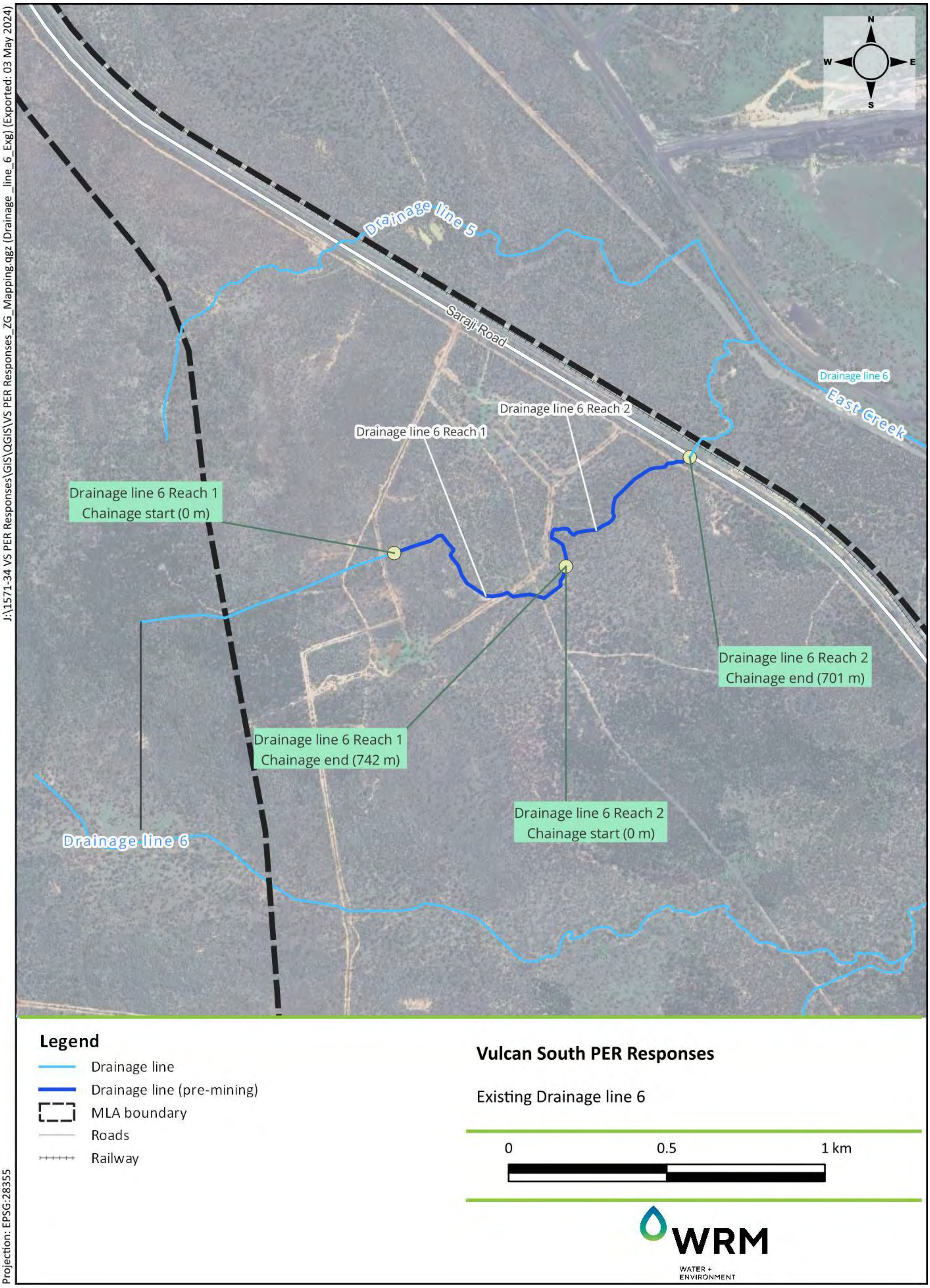


Figure 5-65 Existing Drainage line 6 Features

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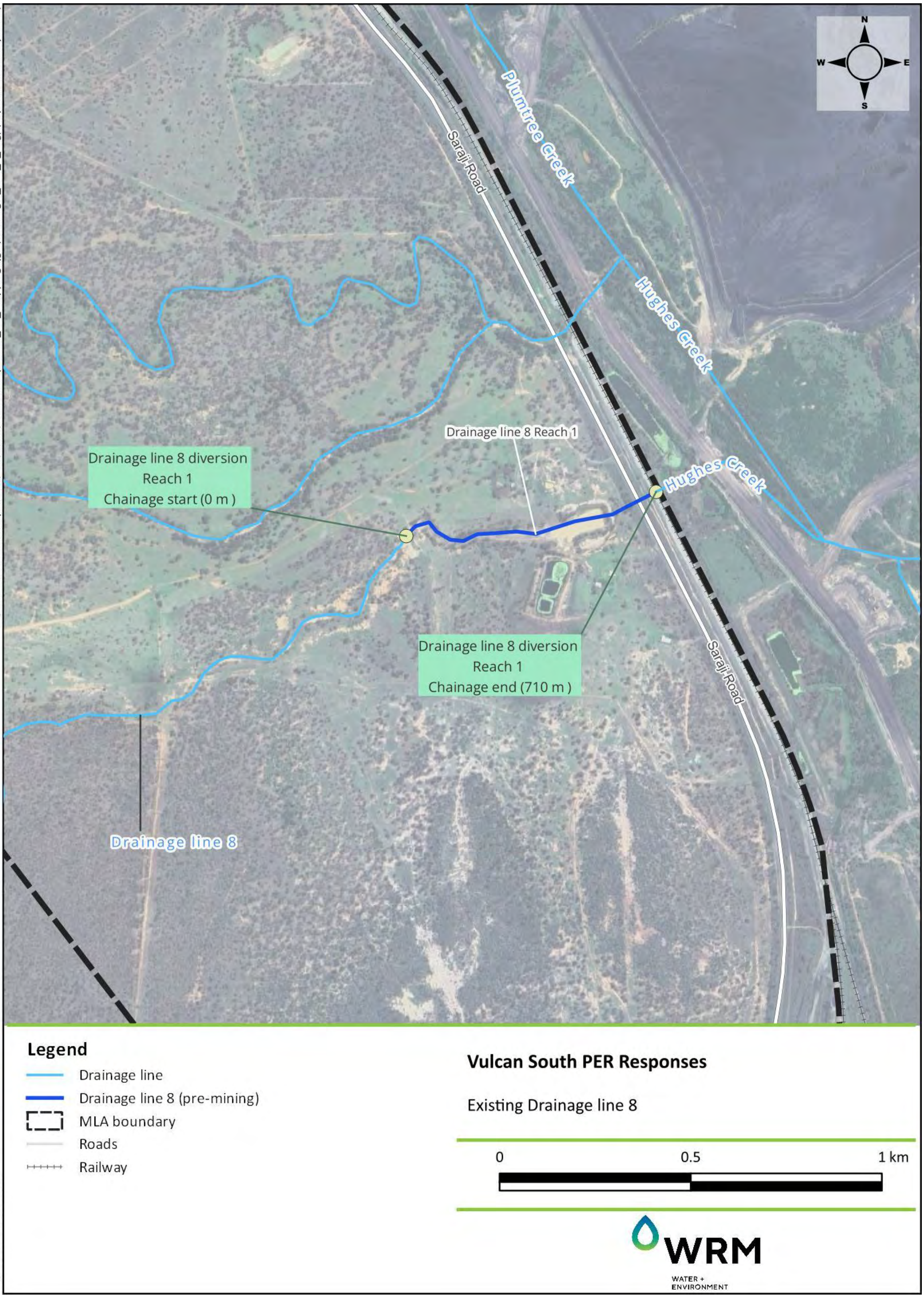

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Figure 5-66 Existing Drainage Line 8 Features

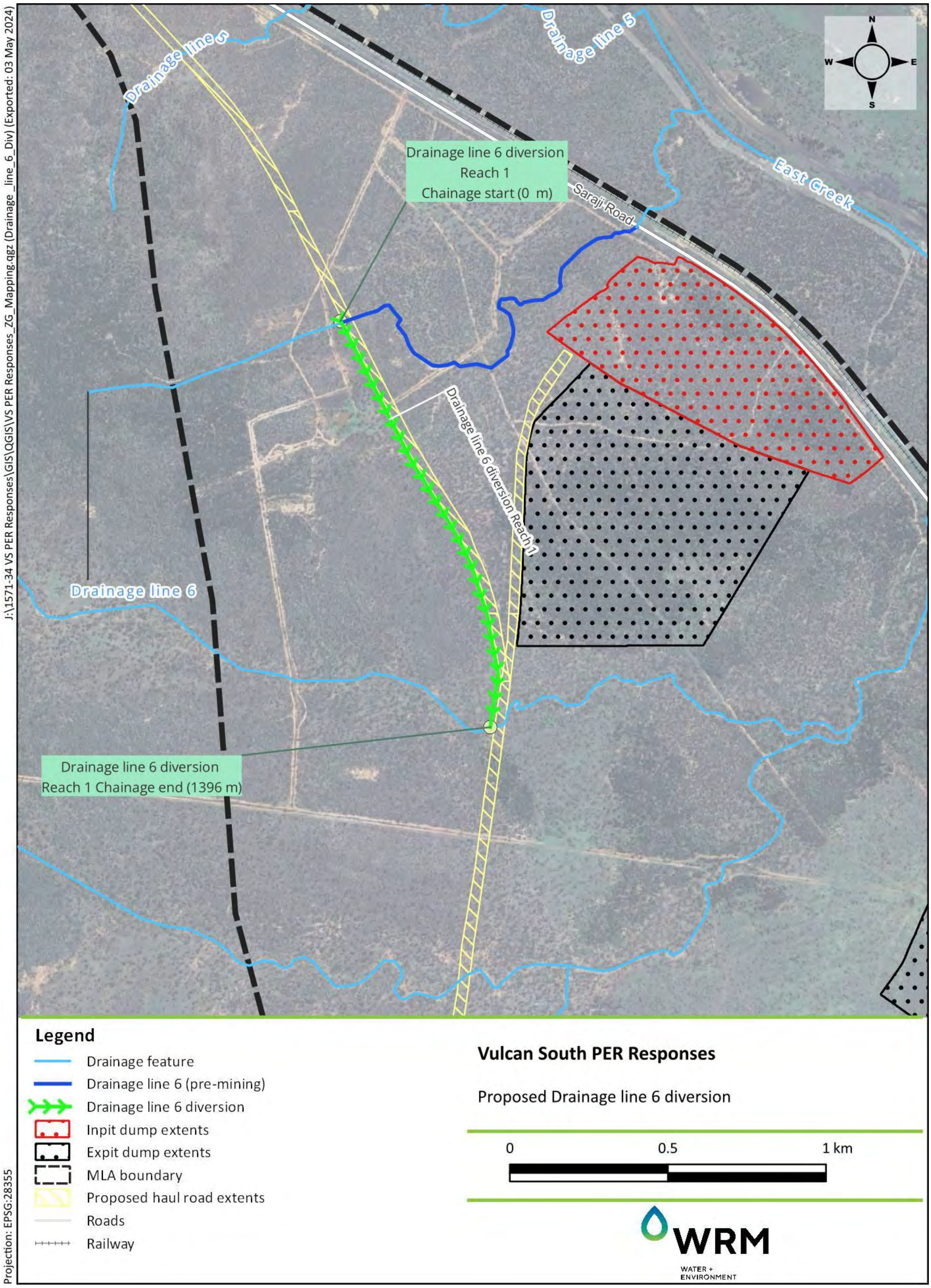


Figure 5-67 Proposed Drainage line 6 diversion – Operational conditions

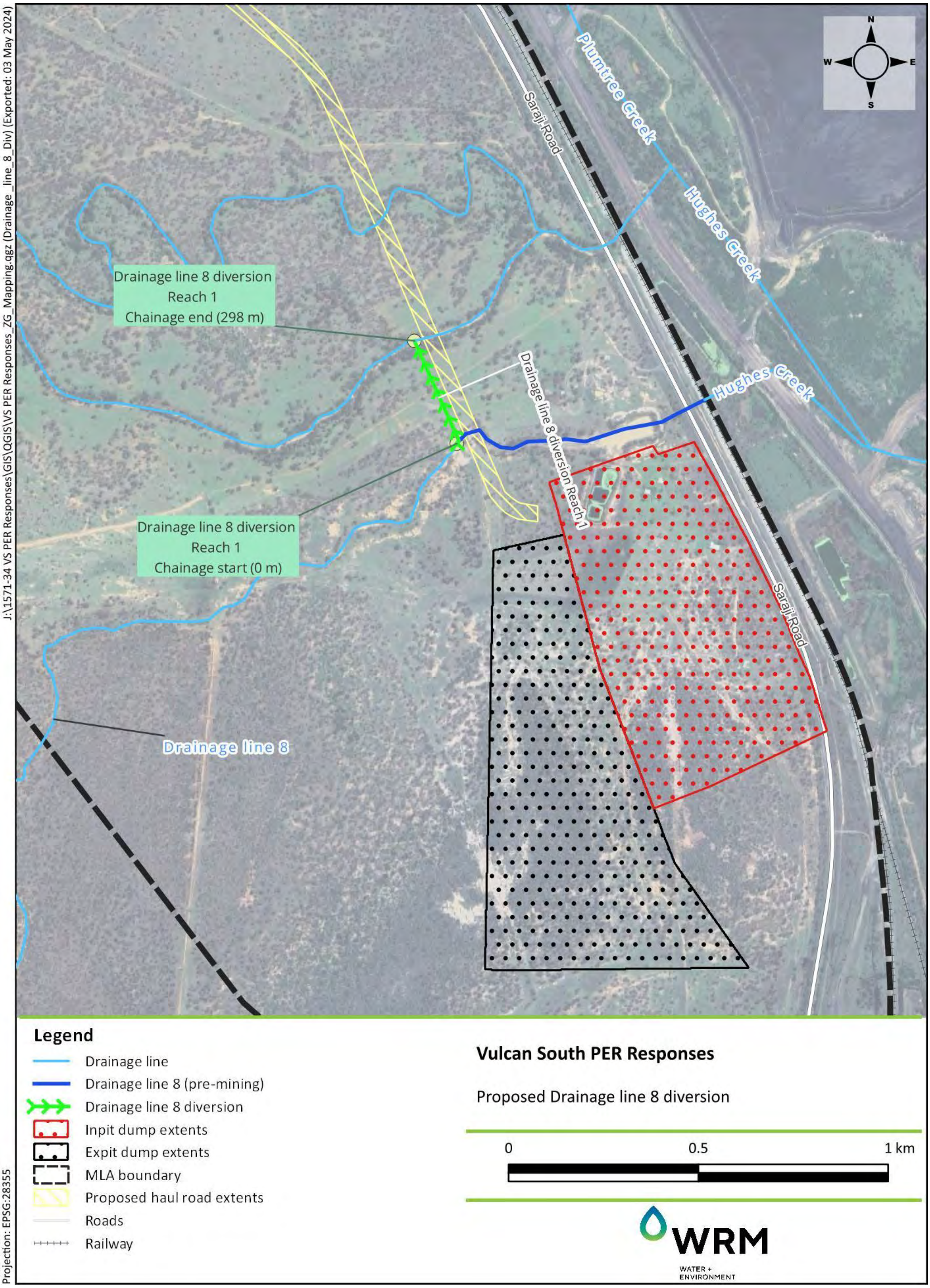


Figure 5-68 Proposed Drainage line 8 diversion – Operational conditions

5.10.3 Surface Water Quality Objectives

The processes to identify EVs and to determine Water Quality Guidelines (WQGs) and Water Quality Objectives (WQOs) in Queensland waters is based on the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ guidelines).

The WQOs approved by the State Government and outlined in EA100265081 are provide in **Table 5-22**. Surface water monitoring locations are outlined in **Table 5-23.**

Table 5-22 Surface Water Quality Objectives as per approved Vulcan South EA100265081 (Table F3)

Quality characteristic (units)	Sediment dam trigger value	Downstream monitoring point trigger value	Source	Frequency
pH	6.5-8.5	6.5-8.5	EPP WQO (aquatic ecosystems)	Monthly and daily during release (the first sample must be taken within 2 hours of commencement of release).
Electrical Conductivity (µS/cm)	864*	Baseflow: 720 Medium flow: 500 High flow: 250	EPP WQO	
Turbidity (NTU)	60*	50	EPP WQO	
Total Suspended Solids (mg/L)	102^	85	EPP WQO	
Sulphate as SO4 (mg/L)	37#	25	EPP WQO	
Ammonia (µg/L)	900	900	ANZG 2018	
Nitrate (µg/L)	1100	1100	For aquatic ecosystem protection, based on ambient Qld WQ Guidelines (2006) for Total Nitrate	
Filtered metals and metalloids				
Aluminum (µg/L)	192*	160	Locally derived	Monthly and Commencement of release and thereafter weekly during release.
Arsenic (µg/L)	16*	13	ANZG 2018	
Lead (µg/L)	4.1*	3.4	ANZG 2018	
Mercury (µg/L)	0.72*	0.6	EPP WQO (aquatic ecosystems)	
Molybdenum (µg/L)	40.8*	34	EPP WQO (aquatic ecosystems)	
Selenium (µg/L)	6*	5	ANZG 2018	

Notes:
All metals and metalloids must be measured as 'dissolved' (from analysis of a field filtered sample) and total (unfiltered). Limits for metals and metalloids apply to dissolved results.
*20% increase on trigger value
95th percentile site specific
^locally derived trigger values (80th percentile values of natural surface water monitoring).

Table 5-23 Surface Water Monitoring Locations

Station ID	Previous Station ID	Catchment Area	Latitude (GDA2020)	Longitude (GDA2020)	Description
Upstream sites					
DL2_US	N/A	Boomerang Creek	22.290841264°S	148.154357187°E	Drainage line 2 upstream of the highwall mining area
DL3_ US	N/A	Boomerang Creek	22.305612596°S	148.192716185°E	Drainage line 3 upstream of the haul road
DL4_US	N/A	Boomerang Creek	22.323035473°S	148.200252458°E	Drainage line 4 at the upstream mining lease boundary
DL6_US	N/A	East Creek	22.339508200°S	148.207957289°E	Drainage line 6 at the upstream mining lease boundary
DL7_US	N/A	East Creek	22.347211456°S	148.209392813°E	Drainage line 7 at the upstream mining lease boundary
HCN_US	N/A	Hughes Creek	22.370485469°S	148.226638033°E	Hughes Creek north tributary approximately 5.5 km upstream of Saraji Road
HC_US	VSW5	Hughes Creek	22.395927439°S	148.224656137°E	Hughes Creek approximately 2.8 km upstream of Saraji Road
DL8_US	N/A	Hughes Creek	22.395784122°S	148.251629364°E	Drainage line 8 approximately 2.2 km upstream of Saraji Road
BC1_US	VSW6	Hughes Creek	22.411388907°S	148.269449617°E	Barrett Creek upstream of Saraji
Downstream sites					
DD1_US	VSW1	Boomerang Creek	22.276596290°S	148.174514955°E	Diversion bund approximately
DD1_DS	VSW2	Boomerang Creek	22.301050508°S	148.195240117°E	Drainage line 2, downstream of the confluence of existing diversion drain
DL2_DS	VSW11	Boomerang Creek	22.298264498°S	148.189625245°E	Drainage line 2 upstream of confluence of existing diversion drain

5.10.4 Groundwater Dependent Ecosystems

5.10.4.1 Terrestrial

Based on literature reviews, depth-to-groundwater data, national GDE mapping, water quality data and terrestrial flora field surveys (see **Appendix M**), there are likely to be some terrestrial GDEs contained within the Project area. The locations of these likely GDEs closely match that mapped within the National Atlas of Groundwater Dependent Ecosystems. Additional partly groundwater-dependent ecosystems may be located in the central and southern parts of the Project area, based on depth-to-groundwater data. The location of these GDEs is presented in **Figure 5-69**.

There has been much recent worldwide research into groundwater-dependent ecosystems, combining tools such as stable isotope analysis, measurement of pre-dawn leaf water potential, and seasonal tracking of transpiration rates and "greenness" indices. One of the key findings of this research is that the use of groundwater by terrestrial vegetation depends greatly on the depth of this groundwater, and the influence of depth is largely consistent across continents and vegetation communities:

- In arid regions of China, groundwater up to 4–10 m below the surface is used by vegetation (Jin, et al., 2011; Lv, et al., 2012; Liu, et al., 2017).
- In California, groundwater up to a depth of 6–8 m is used by vegetation (McLendon, et al., 2008).
- Various studies in Australia have identified lower limits to the root extraction of groundwater of 7.5 m (Benyon, et al., 2006), 5–11 m (O'Grady, et al., 2006a), 8–10 m (Robinson, et al., 2006), and 9 m (Zolfaghar, et al., 2017).

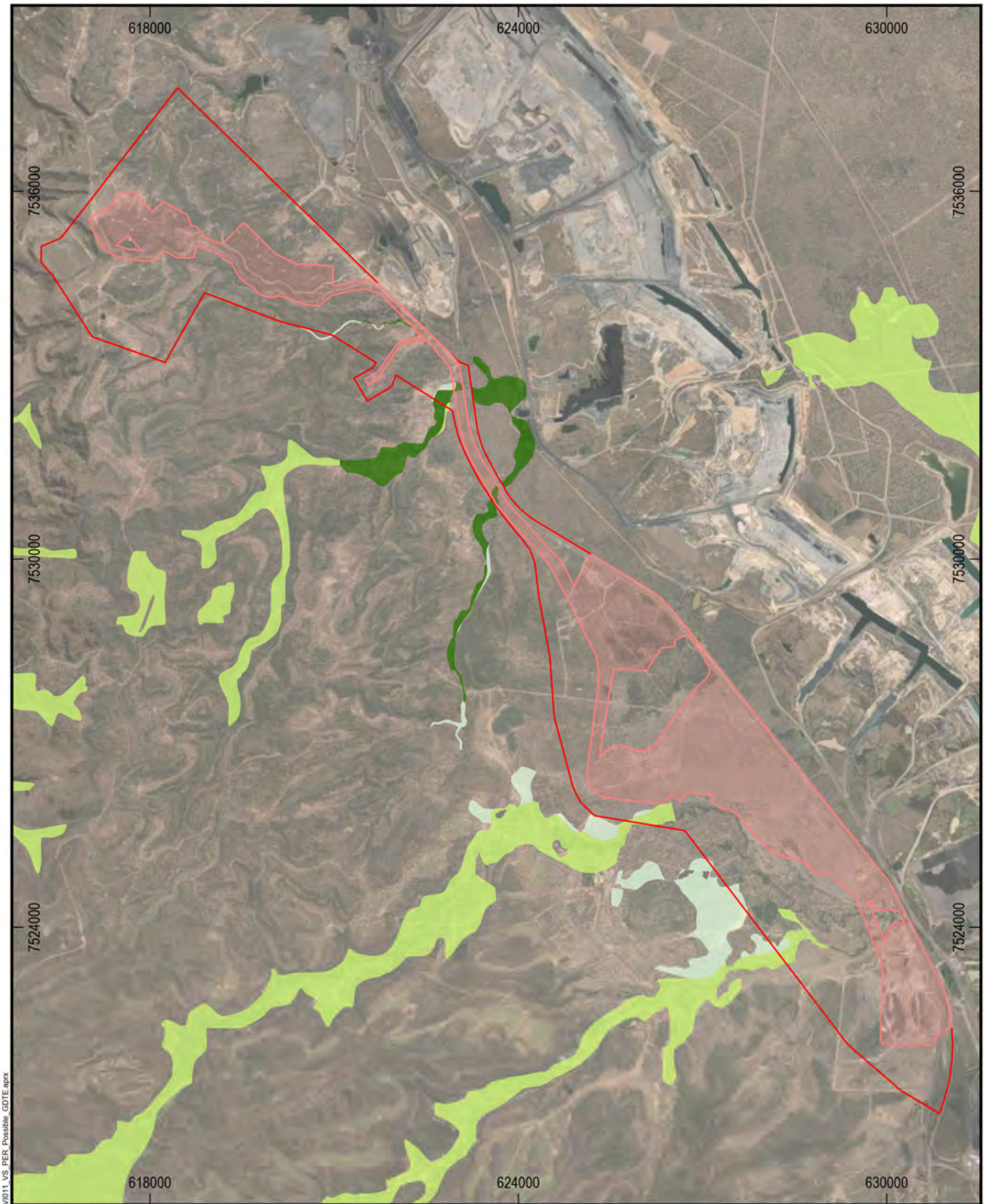
Despite these relatively consistent average patterns, not all tree species access groundwater equally. For example, based on spatial patterns in declining canopy conditions during drought, (Kath, et al., 2014) inferred that *Eucalyptus populnea* (a species native to the survey area) regularly accessed groundwater to a depth of 13 m and, to far lesser extent, up to 26 m. To explore this variation between species in their propensity to access groundwater, published data on local vegetation types were reviewed and summarised in **Table 5-24**. Note that this assessment is limited to regional ecosystems within the Project area, as the accuracy of depth-to-groundwater mapping far beyond this is limited by a lack of survey data.

Where data is lacking, it is practical to use the widely adopted rule-of-thumb (Eamus, et al., 2006a; Department of Natural Resources, Mines and Energy, 2019b) that vegetation is likely to use groundwater where it is up to a depth of 10 m, may possibly use groundwater at depths of 10-20 m, but is unlikely to access water deeper than 20 m.

Terrestrial GDEs are mapped within the disturbance footprint associated with the following species which may utilise saline groundwater, *Eucalyptus camaldulensis* and *Melaleuca leucadendra* (associated with RE11.3.25) – high potential and *Eucalyptus populnea* (11.3.2 and 11.5.3) – moderate potential.

Eucalyptus camaldulensis is often dependent on shallow aquifers and water courses (Bacon et al. 1993). Isotope studies indicate that *E. camaldulensis* accesses groundwater up to a depth of 9.4−11.2 m, but not deeper (Rumman et al. 2018). A similar finding—that *E. camaldulensis* commonly accesses groundwater to a depth of 12.5 m—was revealed by studies of tree condition (Kath et al. 2014). The latter study revealed that groundwater may also be accessed to a limited extent up to 20 m, but not deeper. *Melaleuca leucadendra* and other riparian Melaleuca spp. are reliant on river water and/or shallow groundwater, up to 9 m deep (O'Grady, et al., 2005; O'Grady, et al., 2006a; O'Grady, et al., 2006b).

Eucalyptus populnea accesses groundwater in some situations (Anderson & Hodgkinson, 1997) but not others (Fensham & Fairfax, 2007). On Brigalow Belt floodplains, *E. populnea* accesses groundwater up to 13 m deep and, to a lesser extent, up to 26 m, but not deeper (Kath, et al., 2014).



Legend

Groundwater Dependent Ecosystems

- High potential GDE
- Moderate potential GDE
- Low potential GDE

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint

Source: Bureau of Meteorology 2012. Hydrogeologist.com.au 2020. Vitrinite 2022-2024. METServe 2022-2024. Earthstar Geographics 28/09/2023

Vulcan South

Possible Groundwater Dependent Terrestrial Ecosystems

0 1.5 3

Kilometers

Scale: 1:90,000 (A4)

20/08/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-69

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Possible_GDTE.aprx

Table 5-24 Published groundwater usage by local tree species

Regional Ecosystem	Rooting depths of dominant species	Likelihood of groundwater-dependence
11.3.2	*Eucalyptus populnea* accesses groundwater in some situations (Anderson & Hodgkinson, 1997) but not others (Fensham & Fairfax, 2007). On Brigalow Belt floodplains, *E. populnea* accesses groundwater up to 13 m deep and, to a lesser extent, up to 26 m, but not deeper (Kath, et al., 2014).	**Moderate:** Possibly uses ground water where groundwater levels are within 13 m, and there may be minimal use of groundwater at sites where the water table is within 25 m of the surface.
11.3.7	*Corymbia tessellaris* accessed groundwater at the only site where it has been studied, where the water table was 4 m deep (O'Grady, et al., 2006a). As the species is largely confined to terraces along watercourses (where the water table is usually shallow), it is probably often groundwater dependent. *Corymbia clarksoniana* is highly dependent on groundwater between 6.5 and 10 m deep during the dry season (O'Grady, et al., 2006a; Cook & O'Grady, 2006).	**Moderate:** Possibly utilises groundwater where this is <20 m deep, and likely uses it within 10 m.
11.3.25	*Eucalyptus camaldulensis* is often dependent on shallow aquifers and water courses (Bacon, et al., 1993). Isotope studies indicate that *E. camaldulensis* accesses groundwater up to a depth of 9.4–11.2 m, but not deeper (Rumman, et al., 2018). A similar finding—that *E. camaldulensis* commonly accesses groundwater to a depth of 12.5 m—was revealed by studies of tree condition (Kath, et al., 2014). The latter study revealed that groundwater may also be accessed to a limited extent up to 20 m, but not deeper. *Melaleuca leucadendra* and other riparian *Melaleuca* spp. are reliant on river water and/or shallow groundwater, up to 9 m deep (O'Grady, et al., 2005; O'Grady, et al., 2006a; O'Grady, et al., 2006b).	**High:** Water tables are within reach of this vegetation, and the constituent species are regularly groundwater-dependent elsewhere.
11.3.27e	This is a vegetated wetland that, to be groundwater-dependent, requires the surface expression of groundwater.	**Nil:** The water table is too low for there to be any surface expression.
11.4.8	(Tunstall & Connor, 1981) found *Acacia harpophylla* roots to penetrate to at least a depth of 4 m, although high salt content of the soil caused plants to experience strong water deficiencies except immediately after rain. This dependence on rain implied a failure to utilise groundwater. Subsoils beneath *A. harpophylla* communities tend to be heavy, saline and/or sodic, impeding water availability (Tunstall & Connor, 1981). *A. harpophylla* tissue is even more resistant to desiccation than that of other shallow-rooted arid-zone *Acacia* spp. (Connor & Tunstall, 1968), implying a lack of reliance on groundwater.	**Low:** Unlikely to utilise groundwater.
11.4.9	Tunstall and Connor (1981) found *Acacia harpophylla* roots to penetrate to at least a depth of 4 m, although high salt content of the soil caused plants to experience strong water deficiencies except immediately after rain. This dependence on rain implies a failure to utilise groundwater. Subsoils beneath *A. harpophylla* communities tend to be heavy, saline and/or sodic, impeding water availability (Tunstall & Connor, 1981). *A. harpophylla* tissue is even more resistant to desiccation than that of other shallow-rooted arid-zone *Acacia* spp. (Connor & Tunstall, 1968), implying a lack of reliance on groundwater.	**Low:** Unlikely to utilise groundwater.

11.5.3	*Eucalyptus populnea* accesses groundwater in some situations (Anderson & Hodgkinson, 1997) but not others (Fensham & Fairfax, 2007). On Brigalow Belt floodplains, *E. populnea* accesses groundwater up to 13 m deep and, to a lesser extent, up to 26 m, but not deeper (Kath, et al., 2014).	**Low-Moderate:** Possibly uses ground water where groundwater level is within 13 m, and there may be minimal use of groundwater elsewhere.
11.5.9	Ironbark species (*Eucalyptus crebra* and *E. melanophloia*) are sensitive to die-back during drought and exhibit xylem flows and root depths consistent with a lack of access to groundwater (Rice, et al., 2004; Fensham & Fairfax, 2007). *Corymbia clarksoniana* is highly dependent on groundwater between 6.5 and 10 m deep during the dry season (Cook & O'Grady, 2006; O'Grady, et al., 2006a). Gow et al. (2016) found that *Eucalyptus crebra*, *E. decorticans* and *Corymbia* spp. woodlands on rocky hill slopes exhibited temperature radiation patterns consistent with the use of deep soil water. As the water table was generally between 10 m and 60 m, the authors hypothesised that most of the water used was intercepted while draining through the unsaturated zones of the soil profile, rather than originating from groundwater per se.	**Low-Moderate:** In places where the water table is within 10 m of the ground surface, sub-dominant components of this RE are likely to be groundwater-dependent.
11.9.2	No data has been published on the root structure or groundwater dependence of *Eucalyptus orgadophila*. *Corymbia erythrophloia*, a sub-dominant component of the ecosystem, showed xylem flow patterns consistent with access to some amount of sub-soil water (Rice, et al., 2004), although whether this reflects use of groundwater is not known.	**Low:** Unlikely to utilise groundwater, due to consistently large depths where this RE occurs.
11.10.1	When *Corymbia citriodora* grew above a shallow water table (i.e., 3.1 m deep), root and evapotranspiration patterns indicated that groundwater was an important water source (Falkiner, et al., 2006; Benyon, et al., 2006). No data are published on the use of deeper sources of groundwater by *C. citriodora*. Ironbarks (*Eucalyptus crebra* and *E. melanophloia*) are sensitive to die-back during drought and exhibit xylem flows and root depths consistent with a lack of access to groundwater (Rice, et al., 2004; Fensham & Fairfax, 2007).	**Low:** With the possible exception of the bases of certain gorges, groundwater is too deep within the sandstone ranges to be available to this RE.
11.10.1x1	No data have been published on the groundwater dependence of *Corymbia aureola, Corymbia trachyphloia* or *Eucalyptus exserta*. This vegetation type primarily occupies sandstone plateaux, where groundwater is far beyond the root zone of most trees.	**Low:** Unlikely to utilise groundwater, except when shallow.
11.10.3	There are no published data on the groundwater-dependence or rooting depths of *Acacia shirleyi* or *Acacia rhodoxylon*. However, other *Acacia* spp. that grow on similar rocky substrates (e.g., *A. aneura, A. aptaneura* and *A. kempeana*) do not access groundwater, but instead have reinforced xylem vessels that are able to cope with strong water deficiencies (Anderson & Hodgkinson, 1997; Nolan, et al., 2017).	**Low:** Dominant species are unlikely to utilise groundwater.
11.10.7	Ironbarks (*Eucalyptus crebra* and *E. melanophloia*) are sensitive to die-back during drought and exhibit xylem flows and root depths consistent with a lack of access to groundwater (Rice, et al., 2004; Fensham & Fairfax, 2007). Gow *et al*. (2016) found that *Eucalyptus crebra*, *E. decorticans* and *Corymbia* spp. woodlands on rocky hill slopes exhibited temperature radiation patterns consistent with the use of deep soil water. As the water table was generally between 10 m and 60 m, the authors hypothesised that most of the water used was intercepted while draining through the unsaturated zones of the soil profile, rather than originating from groundwater per se.	**Low:** Dominant species are unlikely to utilise groundwater and groundwater is likely to be too deep at the locations where this RE occurs (on terraces and slopes).

11.10.8	No data have been published on the root structure or groundwater dependence of local vine thicket trees and shrubs. Most species are semi-deciduous, avoiding drought stress by shedding their leaves and thereby minimising transpiration. Studies of vine thickets across a range of soil types in northern New South Wales found water stress to be ubiquitous during drought periods (Curran, et al., 2009), implying a lack of access to groundwater during dry periods.	**Low:** Dominant species are unlikely to utilise groundwater.

5.10.4.2 Aquatic

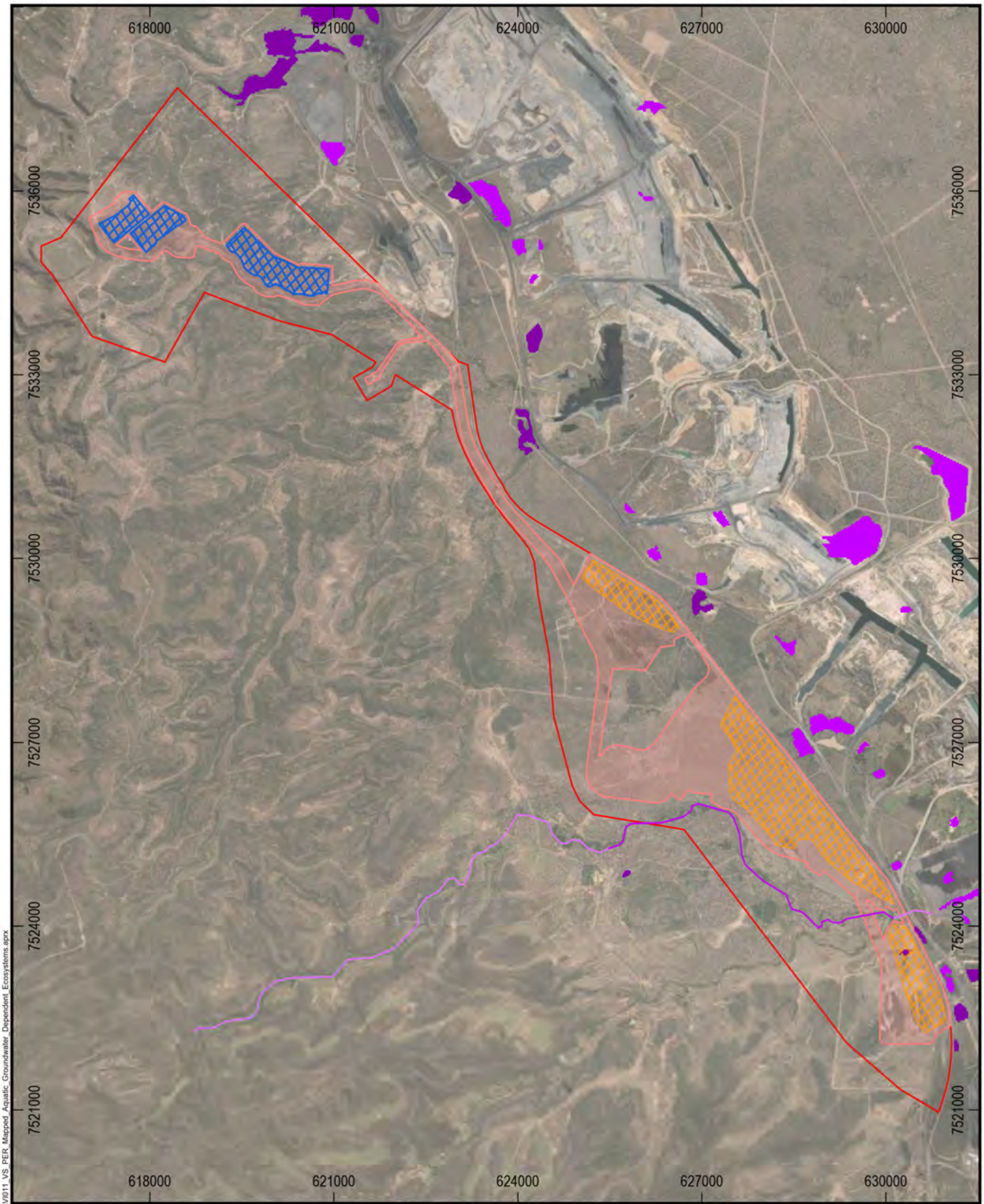
Figure 5-70 shows the maximum predicted drawdowns anytime during the modelling and the location of mapped aquatic GDEs. The modelled drawdown in layer 2 would be considered representative of impact to the groundwater table and the shallowest aquifer. While there are small pockets of high- and moderate potential aquatic GDEs shown within the maximum drawdown associated with the Vulcan Main pit, in it was the interpretation of hydrogeologist.com.au that it is highly unlikely for aquatic GDEs to be present within 1 km of the proposed pits. This is because aquatic GDEs with high or moderate potential for groundwater interaction are most likely to occur in areas where the seasonally high groundwater potentiometric heads are above or close to the corresponding surface water heads. This is necessary to maintain a hydraulic gradient from the groundwater to surface water, or at least have a hydraulically ‘connected’ system. Within or adjacent to the Project area, the surface water systems are above the groundwater table (see Section 5.6, **Appendix P**) and the surface water system is hydraulically disconnected from the groundwater system.

In addition, groundwater in the Project area is brackish to saline and therefore unsuitable for the maintenance of freshwater GDEs (see **Section 4.9.5** for further information on groundwater quality). It is the interpretation of hydrogeologist.com.au that it is highly unlikely for aquatic GDEs to be present within 1 km of the proposed pits.

The main stem of Hughes Creek within the specific Project area is mapped as a potential aquatic GDE based on a national-scale desktop mapping, with small areas of potential aquatic GDE also mapped to the east of the specific Project area (**Appendix Q**). Hydrogeological studies completed for the Project indicate that depth to the groundwater table is <5 m along Hughes Creek, moderate in the southern and northern ends of the Project area, and relatively deep (>10 to >20 m) for the central part of the Project area. However, satellite imagery, coupled with the aquatic habitat survey and flow data described above, confirms an absence of sustained surface water flows or other groundwater influences on surface water aquatic ecology in the Project area **Appendix Q**). Key criteria presented in Doody et al. (2019), that indicate the potential for surface expression GDEs were not met in the broader study area or specific Project area, because:

- The Isaac River did not flow all year (i.e., flows occur about 26% of the time on the Isaac River). Hughes Creek flows about 6% of the time, and waterways of the specific Project study area would flow less than Hughes Creek.
- The flow volume of specific waterways of the Project area does not increase in the absence of rainfall or tributary inflows (see **Appendix I**).
- There were no springs or seeps at any survey site, and review of aerial imagery indicates an absence of springs from the Project area.

Further information is contained within **Appendix Q**



Legend

Aquatic GDE

- High potential GDE
- Moderate potential GDE
- Low potential GDE

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- Open Pit/In-pit Waste Rock Dump
- Highwall Plunge

Source: Bureau of Meteorology 2012. Hydrogeologist.com.au 2020. Vitrinite 2022-2024, METServe 2022-2024, Earthstar Geographics 28/09/2023.

Vulcan South

Mapped Aquatic Groundwater Dependent Ecosystems

0 1.5 3

Kilometers

Scale: 1:90,000 (A4)

20/08/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-70

5.10.4.3 Subterranean GDE

Desktop assessment using the Groundwater Dependant Ecosystems Atlas (2018) (http://www.bom.gov.au/water/groundwater/gde/), which maps subterranean GDEs using a National and regional assessment (including available GIS data, field work analysis and satellite imagery) concluded that no subterranean GDEs were present within the vicinity of the Project area. No subterranean GDEs (cave and aquifer ecosystems) have been identified in the vicinity of the Project.

A map of composite groundwater elevation contours, within a buffer of 1 km out from the proposed mining pit edge, was developed by hydrogeologist.com.au (2024) (**Appendix P**). This was converted to a depth-to-groundwater map based on surface topography obtained from aerial LiDAR data. This map revealed that in some of the Project area water tables were within 20 m of the ground surface and were therefore potentially within reach of vegetation. In some areas, the groundwater was within 10 m of the ground surface, where it is likely to be utilised by vegetation. The chief location where this occurs is along Hughes Creek in the south of the Project area. Note the drilling undertaken in the highwall mining area indicates the groundwater is largely separated from the coal seam – see **Section 6.4.3.14.**

5.10.4.4 Stygofauna

A stygofauna assessment has been completed for the Project and is discussed in **Section 6.4.3.17**.

6 Impact Assessment

6.1 Listed Threatened Species and Ecological Communities

The Species Profile and Threats (SPRAT) database (https://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl) provides a description of threats to threatened and migratory matters, and to TECs, and where available will provide links to the preferred information found within approved Conservation Advices. Additionally, threats specific to the Vulcan South Project have also been outlined below, including threats posed by vegetation clearing, dust, noise and vibration, hydrological changes, and hydrogeological changes, surface water and groundwater contamination, lighting, waste, and the presence of highwall mining. The threats to each species, the anticipated impacts, mitigation measures aimed at reducing these risks, and the expected significant residual impacts are outlined below in the following subsections.

A 500 m buffer was used to represent impacts from noise/vibration, dust and light as these impacts reduce in intensity with distance and a distance further than 500 m would likely limit the impacts of these variables on wildlife to the point where the impact is negligible. An Australian study, Larney et all (1999), shows that dust deposition rates drop by 85% within the first 100 m from the source. It is unknown what noise level negatively effects Koala, Greater Gliders or Squatter Pigeons but a study by Baldwin (2007) found that laboratory rodents display clear stress responses to prolonged exposure to sudden noises of 90-100 dB. The noise limits prescribed in the EA require noise to be under 45 dB at any point in time and therefore the noise levels shown in the study are unlikely to occur, especially beyond 100 m from the disturbance footprint. 500 metres was therefore used conservatively to represent impacts from noise/vibration, dust and lighting which are not anticipated to result in health consequences to species at that distance.

Threats identified through the SPRAT database and Conservation Advices available therein for each species and TEC are summarised below, however these are discussed in greater detail and nuance in **Sections 6.1.1** to **6.1.7**.

- Koala: Loss of climatically suitable habitat, increased frequency and/or intensity of drought, heatwaves, and bushfire, declining nutritional value of foliage, habitat clearing and degradation, encounter mortality with vehicles and dogs, and Koala retrovirus and Chlamydia.
- Greater Glider: Inappropriate fire regimes, habitat clearing and fragmentation, timber harvesting, barbed wire fencing (entanglement), increased temperatures and changes to rainfall patterns, hyper-predation by owls, competition from the Sulphur-crested Cockatoo, and predation by feral cats and foxes.
- Squatter Pigeon: Inappropriate fire regimes, vegetation clearing and fragmentation, climate change, predation by feral cats and foxes, habitat overgrazing, weed introduction, thickening of understory vegetation, nest trampling, and illegal shooting.
- Brigalow TEC: Fire, clearing, climate change and drought, inappropriate grazing regimes, weed introduction, and invasive pest fauna.
- White-throated Needletail: Logging of breeding habitat, loss of habitat in the non-breeding range, direct mortality via wind turbines and overhead wires, and poisoning.
- Migratory insectivorous woodland bird species: Fragmentation and loss of core moist forest breeding habitat through land clearing and urbanisation, collision with windows (Black-faced Monarch only), Introduction of weeds, and black rats.
- Migratory wetland bird species: Habitat loss, habitat degradation, disturbance, direct mortality, and climate change.

6.1.1 Impacts to Brigalow TEC

Table 6-1 Impact Assessment for Brigalow TEC

Threat	Effect of Vulcan South	Direct			Indirect			Facilitated			Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
		Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation				
Threats Identified in the SPRAT Database														
Fire	The main effect of the Project on fire regimes is that it will reduce fire risk by enlarging the fire break (formed by the presence of the Project) between Saraji Road and large tracts of habitat in the Harrow Range to the west. As Saraji Road is a potential ignition source (via vehicle accidents, cigarette butts and broken glass), the likely consequence is a slight reduction in fire frequency within the Harrow Range. The effect is probably negligible, as most severe fires (fanned by hot, north-westerly winds) are likely to come from the other direction, so will not be affected by the Project. There is a slight chance that the Project could introduce new ignition sources (if smoking is permitted close to flammable vegetation adjoining the Harrow Range, or if potentially spark- or heat-producing machinery is located near coal or dry grass). Vitrinite maintains strict smoking policies on their mining lease, with smoking only permitted in defined smoking areas away from flammable materials. Coal stockpiles are maintained on the ROM, in the centre of operations, well away from vegetation. All workshops and other areas containing operating machinery (potential ignition sources) are kept clear of long grass and are surrounded by a firebreak. Any slight changes to fire regime that occur as a result of the Project will be temporary, as the post-mining land use will return vegetation similar in composition and structure to the pre-mining landform. There will be no permanent introductions of new ignition sources.	During construction there is some probability of fires being lit by activities such as hot works (welding, grinding) or vegetation ignition from trapped twigs and leaves in bulldozer exhaust within intact areas. These areas, if connected by flammable vegetation to nearby Brigalow may have the potential to allow fire to spread. The risk, however low is expected to last for less than a year, after which it is expected that sufficient clearing will have allowed for the creation of ample firebreaks.	Minimal impacts are anticipated. Firebreaks will be established during the life of operations, and protocols dictated by the Emergency Response Plan will minimise the risk of operations or personnel causing bushfire.	The greatest risk to Brigalow from fire occurs in the later stages of rehabilitation when the habitat re-establishing is destroyed. There is an elevated risk of rehabilitation areas becoming fuel for fires that may spread further, particularly in the first 2-5 years with the expected increase in ground and shrub layer cover, particularly if weeds become established which will change the fuel characteristics.	Not applicable.			Not applicable.			Unlikely to be a repeated risk.	Predictable and reversible.	See row 'fire' in **Table 7-1**	No significant impact is anticipated as a result of this project, risks are extremely low
Clearing	The clearing of vegetation to accommodate the Vulcan South Project will remove 71.2 ha of Brigalow habitat.	71.2 ha of Brigalow habitat will be cleared over a period of 3 years during the staged mining of the North Pit.	Not applicable.								Not repeated.	Known.	Provision of offsets of suitable Brigalow habitat.	**Certain,** offsets will likely mitigate this until rehabilitation can proceed in 10 years.
Climate change (increased temperatures and changes	Vulcan South on its own is unlikely to have any more than a negligible effect on worldwide climate and rainfall patterns. However, over the course of the projects rehabilitation, the following changes are expected	Not applicable.			If weather patterns are to become more hostile to the survival of habitats that would support the listed MNES, it is unlikely that the project would exacerbate impacts on its own. The habitats along riparian areas are unlikely to be affected, though the broader area where habitat is marginal is likely to be negatively affected by reduced			Facilitated impacts are not anticipated.			Unlikely to be a repeated risk.	Impacts are known and reversible.	Offsets are planned to mitigate these risks.	No significant impacts are considered likely as a result of this Project.

Threat	Effect of Vulcan South	Direct			Indirect			Facilitated			Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
		Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation				
to rainfall patterns).	in considering of the representative concentration pathway (RCP 8.5) scenario: • temperatures are expected to increase by between 1.14°C to 1.25°C; • annual rainfall changes are uncertain but could are expected to increase by up 1.3% (for the best case) or reduce by 18.7% (for the worst case); and • evapotranspiration is expected to increase by between 3.2% to 5.4%.				rainfall. The project will not form barriers to access to these areas that do not already exist.									
Increased intensity or frequency of drought	Vulcan South will have a negligible or unmeasurable effect at best on the drought cycles as this is a much wider issue.	Not applicable.			Impacts to the MNES will be indirect as drought will have unpredictable durations and intensities.			Facilitated impacts are not anticipated.			Possibly repeated.	Impacts are somewhat unpredictable.	Not applicable. Mitigations on the project scale are unlikely to be viable on the large-scale causes.	No significant impacts are considered likely as a result of this Project.
Invasive pest animals	Invasive pest animals, including pigs, foxes, cats, and the noisy miner, have major impacts on the Brigalow TEC. The impact of Vulcan South on this threat, however, will be minimal. Vulcan South will not add to the populations of invasive pest species. Food waste management is already suitably implemented in management plans, and pest animals are less likely to inhabit the Project area and surrounds during operations due to reduced food sources.	Not applicable.			Not applicable.			Not applicable.			Unlikely to be a repeated risk.	Predictable and reversible.	Existing food waste management protocols.	No significant impacts are considered likely as a result of this Project.
Invasive weeds	Land disturbance and the movement of soils, vehicles and people between areas can promote weed invasion. The risk that the project could encourage invasion by the seven restricted weeds recorded within the survey area. Controls must be in place to manage the risks posed by Rubber Vine, Harrisia Cactus, Prickly Pear, Velvet Pear and Parthenium to avoid being in violation of the *Biosecurity Act 2014*. While there are no legal obligations to manage non-declared weeds on site, the potential for these to spread and reduce habitat quality for threatened fauna must be considered when assessing the significance of impacts to individual matters. Non-native plants such as Buffel Grass, Indian Couch, Sabi Grass and Natal Grass are already abundant and widespread on site and have likely already reached the limits of their potential local distribution (limited by soil type and moisture availability). Impacts, if applicable would be short term and only occur for a maximum of 9 years.	Weeds may spread during construction and operations due to vehicle movement to and from the Project.		Incursion of invasive weeds may occur during rehabilitation during the establishment of other vegetation, causing delays in the achievement of rehabilitation milestones.	Not applicable.			Not applicable.			Unlikely to be a repeated risk.	Predictable and reversible.	Existing weed management plan, including wash-down procedures.	No significant impacts are considered likely as a result of this Project.
Inappropriate grazing regimes	Grazing, if too intense can trample native forbs, destroy groundcover, cause or exacerbate erosion and change vegetation characteristics by selectively grazing on particular plants.	No grazing will occur during the construction or operation / maintenance phases of the Project		During rehabilitation, low intensity grazing may occur within the Project area and there is some possibility that direct impacts such as unplanned negative effects to	No grazing will occur during the construction or operation / maintenance phases of the Project		Cattle grazing is unlikely to cause indirect effects to this TEC during rehabilitation.	No grazing will occur during the construction or operation / maintenance phases of the Project		Facilitated impacts to this TEC as a result of cattle grazing are unlikely.	Potential to be repeated or ongoing	Known and reversible	Low-intensity cattle grazing is outlined in the PRCP as potential or likely land use in portions of the Project area post mining. The PRCP provides further	Significant Impacts are unlikely if the mitigations in the PRCP are followed

Threat	Effect of Vulcan South	Direct			Indirect			Facilitated			Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
		Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation				
				vegetation or erosion may occur if it is permitted without due care.									guidance to avoid significant impacts	
Threats Specific to Vulcan South														
Impacts from Dust	Dust can impact nearby vegetation by blocking photosynthesis and increasing leaf temperature; both impacts can reduce drought tolerance (Farmer, 1993). Dust that is severe enough to inhibit plant growth is only likely where vegetation is close to (within 100 m of) the source (roads, operational areas). Koalas feed on new plant growth. It is possible dust could reduce food availability for these species. However, such effects would only occur close to highly disturbed areas, which these species will most likely avoid for other reasons (noise, light). Therefore, minimal effects from dust on these species are anticipated. Cattle farming, by the provision of water points, thinning of understorey vegetation and addition of plants that produce seeds eaten by the Squatter Pigeon is generally considered to be beneficial to the species overall and counteract any negative effects of dust.	Not applicable.			An additional 47.8 ha of Brigalow (*Acacia harpophylla* dominant and co-dominant) is located within 500 m of the project's footprint boundary and may experience temporary effects of dust beyond the project's footprint. This is anticipated to last for approximately 3 years, coinciding with the clearing and operation of the north pit, which is adjacent to this habitat.		Not applicable.	Dust is expected to be either a direct or indirect threat. Facilitated impacts are not likely.			Potential to be repeated, or ongoing.	Known and reversible.	Dust suppression methodologies will be sufficient to suitably reduce the risk of dust to as low as reasonably practicable.	No significant impacts are considered likely as a result of this Project.

6.1.2 Impacts to the Koala

Table 6-2 Impact assessment for the Koala

Threat	Effect of Vulcan South	Direct			Indirect			Facilitated			Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
		Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation				
Threats identified in the SPRAT Database														
Fire	The main effect of the Project on fire regimes is that it will reduce fire risk by enlarging the fire break (formed by the presence of the Project) between Saraji Road and large tracts of habitat in the Harrow Range to the west. As Saraji Road is a potential ignition source (via vehicle accidents, cigarette butts and broken glass), the likely consequence is a slight reduction in fire frequency within the Harrow Range. The effect is probably negligible, as most severe fires (fanned by hot, north-westerly winds) are likely to come from the other direction, so will not be affected by the Project. There is a slight chance that the Project could introduce new ignition sources (if smoking is permitted close to flammable vegetation adjoining the Harrow Range, or if potentially spark- or heat-producing machinery is located near coal or dry grass). Vitrinite maintains strict smoking policies on their mining lease, with smoking only permitted in defined smoking areas away from flammable materials. Coal stockpiles are maintained on the ROM, in the centre of operations, well away from vegetation. All workshops and other areas containing operating machinery (potential ignition sources) are kept clear of long grass and are surrounded by a firebreak. Any slight changes to fire regime that occur as a result of the Project will be temporary, as the post-mining land use will return vegetation similar in composition and structure to the pre-mining landform.	During all Project stages, mortality may occur if a fire burns hot enough to directly affect Koalas, though for the majority of the local habitat the fuel density is too low for this to be a significant risk.			There is some probability of fires being lit by activities such as hot works (welding, grinding) or vegetation ignition from bulldozer exhaust in greenfield areas. These areas, if connected to nearby habitat may have the potential to allow fire to spread. The risk is expected to last for 9 years of operations. Brownfield areas are less likely to contain enough material to start or sustain a fire that will spread to Koala habitat.	Areas within the Project footprint will not be vegetated, and as a result are less likely than prior to clearing to be a source of ignition, particularly considering the strict controls in place to prevent fires in coal mines. The potential area of impact could be considered the entire mining lease.	Rehabilitation will add some risk of fire, particularly during the early stages when ground cover and shrubs are at their most dense, and only during the dry season. This slightly elevated risk is expected to last 2-5 years. The potential area of impact could be considered the entire mining lease.	No facilitated fire risks are anticipated.	No facilitated fire risks are anticipated.	No facilitated fire risks are anticipated.	Unlikely to be a repeated risk.	Unpredictable.	See row 'fire' in **Table 7-1**	No significant impact is anticipated as a result of this Project.

Threat	Effect of Vulcan South	Direct			Indirect			Facilitated			Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
		Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation				
	There will be no permanent introductions of new ignition sources.													
Clearing and habitat degradation	The clearing of vegetation and other habitat features within the Project area is likely to cause almost complete site alienation for most listed species, including the Koala. During all Project stages, it should be assumed that all species' use of the Project area will be completely halted until at least the earliest stages of decommission and rehabilitation. The chances of permanent alienation for any species are low.	The following habitat for the Koala will be removed with a duration of approximately 19 years • Foraging/shelter/dispersal = 938.6 ha • Shelter/dispersal = 45.5 ha • Dispersal = 182.8 ha Direct mortality is unlikely during clearing, as this risk will be suitably mitigated with the use of fauna spotters. Risks associated with clearing are expected to span 24 months. Viable populations of Koalas are expected to be maintained in extensive neighbouring habitats, and extensive tracts of moderate quality habitat occur throughout the adjacent Harrow Range) throughout this disturbance period, providing a source of recruitment to rehabilitated areas in the future.		Not applicable during rehabilitation	Not applicable.	The following additional Koala habitat is located within 500m of the disturbance footprint and may experience some temporary disturbance from lighting, noise and dust: • Foraging/shelter/dispersal = 1532.0 ha • Shelter/dispersal = 188.4 ha • Dispersal = 390.5 ha Duration is expected to be 9 years or less. Given Koalas can disperse between forested areas, fragmentation for the purposes of dispersal will be minimal and is only anticipated during construction and operation where areas are inaccessible for a maximum of 9 years. During all Project stages, the habitat surrounding the Project's operational areas will potentially be affected to some degree by edge effects, such as dust, noise and light spill, though this is only for the operational life of the project and during this time is considered to be a minimal impact due to existing mitigation measures.	There is a potential risk that rehabilitation unsuccessfully rehabilitates habitat suitable for Koalas. This risk is considered low given that the PRCP explicitly prescribes mechanisms to reduce this risk. Refer to the PRCP. This risk would be considered long term (20-30 years	No facilitated effects that may result in clearing are anticipated outside the Project area. Influx of workers and families into the area may facilitate additional traffic on the road, but this is likely to be negligible at best, with most movement of vehicles likely to be limited to within the towns and outside peak Koala activity.			Unlikely to be a repeated risk.	Impacts are known and reversible	See clearing Section of **Table 7-1** Offsets, use of fauna spotter(s), rehabilitation.	Certain, until area is rehabilitated. All listed species are known to recolonise rehabilitated areas. The action will adversely affect habitat critical to the survival of the species (habitat used for feeding and resting), and the action thereby qualifies as a significant residual impact under the EPBC Act. As described in the direct impact Section, 19 years of disturbance is anticipated in consideration of recolonisation of mature trees). Viable populations of Koalas are expected to be maintained in extensive neighbouring habitats (98.9% of the high-quality habitat within the survey area is being retained, and extensive tracts of moderate quality

Threat	Effect of Vulcan South	Direct			Indirect			Facilitated			Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
		Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation				
														habitat occur throughout the adjacent Harrow Range) throughout this disturbance period, providing a source of recruitment to rehabilitated areas in the future.
Climate change (increased temperatures and changes to rainfall patterns).	Vulcan South on its own is unlikely to have any more than a negligible effect on worldwide climate and rainfall patterns. However, over the course of the Project's rehabilitation, the following changes are expected in considering of the RCP 8.5 scenario: • temperatures are expected to increase by between 1.14°C to 1.25°C; • annual rainfall changes are uncertain but could are expected to increase by up 1.3% (for the best case) or reduce by 18.7% (for the worst case); and • evapotranspiration is expected to increase by between 3.2% to 5.4%.	Not a direct impact			If weather patterns are to become more hostile to the survival of habitats that would support the listed MNES, it is unlikely that the project would exacerbate impacts on its own. Koalas will not be cut off from refugia, as ample opportunities exist for the population to move within the local area which will not be affected by the project. The project will not form barriers to access to these areas that do not already exist.			Climate change is an indirect impact and not treated as a facilitated impact in this assessment.			Unlikely to be a repeated risk.	Impacts are known and reversible.	Offsets are planned to mitigate these risks. Climate change mitigation measures is incorporated into the OAMP (**Appendix II**), such as considering climate refuges within the offset area for species.	No significant impacts are considered likely as a result of this Project.
Loss of climatically suitable habitat	Vulcan South will remove a total of 1,166.9 ha of habitat suitable for the Koala. This includes climatically suitable habitat. The rehabilitation stage will see the reinstatement of habitat.	See clearing section above.		There is a risk of rehabilitation failing, resulting in the habitat being unusable.	Not applicable.			Not applicable.			Not likely to be repeated.	Impacts are known and reversible.	Offsets.	Following the provision of offsets, the loss of climatically suitable habitat is expected to be suitably mitigated.
Increased intensity or frequency of drought	Vulcan South will have a negligible or unmeasurable effect at best on the drought cycles as this is a much wider issue.	Not applicable.			Impacts to the MNES will be indirect as drought will have unpredictable durations and intensities.			Unpredictable and likely negligible at best, and thus cannot be reasonably anticipated within the scope of this Project.			Possibly repeated.	Impacts are somewhat unpredictable.	N/A. Mitigations on the project scale are unlikely to be viable on the	No significant impacts are considered likely as a result of this Project.

Threat	Effect of Vulcan South	Direct			Indirect			Facilitated			Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
		Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation				
													large-scale causes.	
Increased intensity or frequency of heatwaves	Vulcan South will have a negligible or unmeasurable effect at best on the weather cycles as this is a much wider issue.	Not applicable.			Impacts to the species will be indirect as heatwaves will have unpredictable durations and intensities			Unpredictable and likely negligible at best, and thus cannot be reasonably anticipated within the scope of this Project.			Possibly Repeated.	Impacts are somewhat unpredictable.	N/A. Mitigations on the project scale are unlikely to be viable on the large-scale causes.	No significant impacts are considered likely as a result of this Project
Declining nutritional value of foliage	Nutritional value of foliage is largely a product of climate/weather patterns. Vulcan South will have a negligible effect on this matter.	Not likely to be affected by the Project.									Not likely to be repeated if this declines over time.	Impacts are somewhat unpredictable.	N/A. Mitigations on the project scale are unlikely to be viable on the large-scale causes.	No significant impacts are considered likely as a result of this Project.
Koala retrovirus (KoRV) and Chlamydia (*Chlamydia percorum*)	Vulcan South will not involve the moving of Koalas or infectious material that may affect Koalas. Therefore, the Project will be inconsequential to Koala diseases.	Not applicable. Vulcan South will not likely have an effect on Koala disease.									Unlikely to be repeated.	Not applicable.	Though not a mitigation to project related impacts, workers at the Project will be instructed to report any Koalas suspected of being sick to the nearest vet/wildlife carer.	No significant impacts are considered likely as a result of this Project.
Encounter mortality with vehicles and dogs	The Project amendment will not introduce any new major roads to the region. It will also not substantially increase the workforce (the number of commuters to/from the site each day). On the contrary, the shift from road to rail transport of coal will result in reduced heavy traffic on the existing road network. Rail transport results in fewer collisions with fauna than road transport simply because this allows fewer, larger shipments. The project will not affect local densities of dogs.	For all Project stages, road transport will be reduced overall, therefore reducing direct risks from the current level.			Not applicable			A general increase in traffic due to families moving into the area may increase the chances of encounters with vehicles, however this is unpredictable particularly with proposed changes to accommodation in the region. Impacts are unlikely to change more than negligibly.			Sporadic.	Impacts are known and reversible.	See **Table 7-1.**	No significant impacts are considered likely as a result of this Project.
Threats Specific to Vulcan South														

Threat	Effect of Vulcan South	Direct			Indirect			Facilitated			Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
		Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation				
Groundwater drawdown	The Koala has the potential to be impacted by groundwater drawdown indirectly through the negative impact groundwater drawdown can have on the ability for terrestrial GDE species (*Eucalyptus camaldulensis* and *Eucalyptus tereticornis*) to absorb nutrients through their roots and therefore, can result in the stunted growth of these important feeding and sheltering species. The Groundwater modelling has indicated that any effects of groundwater drawdown will be largely limited to only the area within the footprint.	Hydrogeologist.com.au (**Appendix P**) has developed a numerical groundwater flow model of the Project area and broader region to predict the effects of the Project on local groundwater levels. Groundwater flow into the main and Vulcan South Pits will be negligible, and these pits will be essentially dry. Groundwater flow into the Vulcan South Pit will be up to 2.7 m^3/day, which will cause localised drawdown in surrounding aquifers. The drawdown predicted from groundwater inflow into the pits at the Project is limited in geographic extent (up to 300 m from the pit crest), and most of the vegetation within this zone of drawdown will be removed to accommodate the rail loop and other infrastructure. Therefore, all GDEs present within the footprint will be cleared and therefore cannot be affected by drawdown. Drawdown will cease after the pit is backfilled and therefore will only last for 9 years of operations. The groundwater levels in the backfilled Vulcan South Pit are expected to fully recover within 15 to 20 years from the completion of mining. However, as described above, within the footprint this is irrelevant because the habitat will be cleared and once rehabilitation commences, any impacts of drawdown will have ceased and therefore not affect the growth of the new tree species.		Not applicable.	1.8 ha of potentially groundwater-dependent vegetation outside the project's clearing footprint is found within the zone of drawdown (see 'Area of impact (in hectares)' row in **Table 3-5**). All of this comprises regrowth 11.5.9 The effect of drawdown on vegetation within this 1.8 ha is expected to be minimal. The dominant species present (*Eucalyptus crebra* and *Eucalyptus melanophloia*) are unlikely to utilise groundwater and will not be affected by drawdown. The principal impact could be on the sub-dominant tree*, Corymbia clarksoniana*, which frequently utilises shallow groundwater. It is unclear whether a drawdown of 1–2 m (as forecast by modelling) will have any effect on tree health. However, even if all *C. clarksoniana* within this small patch of 11.5.9 were to die, this would have relatively little effect on local wildlife. This species is not usually a Koala food tree, rarely develops hollow limbs, and does not provide key habitat resources for other threatened fauna. Drawdown will cease after the pit is backfilled and therefore will only last for 9 years. The groundwater levels in the backfilled Vulcan South Pit are expected to fully recover within 15 to 20 years from the completion of mining.		Within the post closure setting, the pit will be backfilled and hence the take of groundwater will cease, promoting the recovery of groundwater levels to those observed prior to mining after 15-20 years. Therefore, there are no lasting effects of drawdown anticipated to GDEs within the footprint during the rehabilitation phase and therefore there are no impacts to growth of sheltering and feeding trees for the Koala.	Facilitated impacts are not anticipated.			Unlikely to be repeated.	Unknown as to whether drawdown of 1-2 m will affect tree health; however, it is considered unlikely.	See 'Groundwater Drawdown' in **Table 7-1**.	No significant residual impacts are anticipated.
Groundwater contamination	The Koala has the potential to be impacted by groundwater contamination indirectly through the negative impact it can have on the ability for Terrestrial GDE species (*E. camaldulensis* and *E. tereticornis*) to absorb nutrients through their roots and therefore, can result in the stunted growth of these important feeding and sheltering species.	Not applicable.			Impacts to groundwater quality is considered unlikely due to the minimal groundwater inflow into the pit, poor quality of groundwater as it currently stands and strict mine groundwater monitoring and management. Impacts to groundwater are considered very unlikely due to negligible groundwater inflow into pit. Regardless, this impact would only occur for 9 years maximum during operations, and it is unlikely groundwater would be impacted enough to affect growth of trees within the footprint. Regardless, all trees will be cleared within the footprint and therefore impacts of groundwater contamination are irrelevant. Impacts outside of the footprint is considered very unlikely and would be managed as per below.		Not applicable.	Not applicable. No facilitated impacts are anticipated, due to the minimal degree of direct and indirect impacts.			Unlikely to be repeated.	All impacts are known and reversible.	Mitigation measures outlined in **Section 6.4.3**.	No significant residual impacts are anticipated.
Surface water contamination	The Koala has the potential to be impacted by surface water contamination indirectly through the negative impact it can have on the ability for Terrestrial GDE species (*E. camaldulensis* and *E. tetracornis*) to absorb nutrients through their roots	The only potential direct impact of surface water contamination on this species is if Koalas were to drink any contaminated surface water, which they would only do under very dry conditions. This is considered negligible at best, especially with water sources found in more favourable areas nearby. The potential negative effect contamination may have on the growth of trees in the riparian areas within the footprint is considered the only indirect impact. However, these trees will be cleared during construction and operation and therefore any negative effects on tree growth are			Not applicable		Not appliable.	Not applicable. No facilitated impacts are anticipated, due to the minimal degree of direct and indirect impacts.			Repetition is possible.	Known and reversible.	All surface water related impacts will be adequately managed through the on-site water management system. See	No significant impacts are considered likely as a result of this Project.

Threat	Effect of Vulcan South	Direct			Indirect			Facilitated			Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
		Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation				
	and therefore, can result in the stunted growth of these important feeding and sheltering species.	irrelevant. This impact will cease after a maximum of 9 years, when operations cease. No surface water contamination effects will occur offsite. The highest risk of surface water contamination is during construction and operation, where the WRD's have not been fully rehabilitated yet and mining is active (duration 9 years). During this time, it is very unlikely Koalas would be present as all the trees will have been cleared and there will be no habitat for them. Therefore, they may return during the rehabilitation stage, at which the WRD's will be fully rehabilitated, and mining will have ceased and therefore the risk of surface water contamination will be very low. All surface water related impacts will be adequately managed through the on-site water management system. See Surface Water mitigation measures are provided in **Table 7-4** and geochemistry mitigation measures are provided in **Table 7-9** (these measures will prevent any contaminants seeping from overland flow). Relevant mitigation measures include the testing of potential overland flow contaminants to be included within the REMP, and in-depth paddock dumping and traffic compaction within the WRDs to prevent oxygen and water exposure of the potentially acid forming (PAF) reject material.											Surface Water mitigation measures are provided in **Table 7-4** and geochemistry mitigation measures are provided in **Table 7-9** (this will prevent any contaminants seeping from overland flow). Relevant mitigation measures include the testing of potential overland flow contaminants to be included within the REMP, and in-depth paddock dumping and traffic compaction within the WRDs to prevent oxygen and water exposure of the PAF reject material.	
Impacts from Dust	Dust can impact nearby vegetation by blocking photosynthesis and increasing leaf temperature; both impacts can reduce drought tolerance (Farmer, 1993). Dust that is severe enough to inhibit plant growth is only likely where vegetation is close to (within 100 m of) the source (roads, operational areas). Koalas feed on new plant growth. It is possible dust could reduce food availability for these species. However, such effects would only occur close to highly disturbed areas, which these species will most likely avoid for other	Not applicable.			An additional 2,110.9 ha of low-quality habitat are located within 500 m of the disturbance footprint and therefore may experience some disturbance from noise and dust. This disturbance is short-term, lasting only for the duration of the adjacent operations (1 to 9 years, depending on location).		Not applicable.	No facilitated impacts are anticipated.			Potential to be repeated.	Known and reversible.	Dust suppression methodologies will be sufficient to suitably reduce the risk of dust to as low as reasonably practicable.	No significant impacts are considered likely as a result of this Project.

Threat	Effect of Vulcan South	Direct			Indirect			Facilitated			Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
		Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation				
	reasons (noise, light). Therefore, minimal effects from dust on these species are anticipated. Cattle farming, by the provision of water points, thinning of understorey vegetation and addition of plants that produce seeds eaten by the Squatter Pigeon is generally considered to be beneficial to the species overall and counteract any negative effects of dust.													
Impacts from noise and vibration	Noise from traffic and industrial sources can have significant detrimental impacts on fauna (Shannon, et al., 2016; Cunnington & Fahrig, 2010; Barber, et al., 2010). The Project is located on a busy highway (Saraji Road), immediately west of a large mining operation. The increase in noise resulting from the amendment is therefore expected to be negligible relative to existing background noise. Nevertheless, there may be localised disturbance from noise where operational areas are close to (e.g., within 500 m of) habitats for threatened fauna (e.g., Greater Gliders, Koalas). Any effects of noise will be restricted to the operational life of the Project (9 years).	No effects within the footprint are considered relevant as the habitat will be cleared and it is very unlikely Koalas will be present. However, an additional 2,209.8 ha of habitat are located within 500 m of the disturbance footprint and therefore may experience some disturbance from lighting, noise and dust. This disturbance is short-term, lasting only for the duration of the adjacent operations (1 to 9 years, depending on location).		Not applicable.	Not applicable.			No facilitated impacts are anticipated.			During the life of the Project.	Known and reversible.	Noise will be in line with EA approved trigger limits, see **Appendix E**	No significant residual impacts are anticipated as a result of this Project.
Blasting	Noise and vibration specifically from blasting may disturb this species.	Noise and vibration due to blasting may disturb any Koalas in or near the disturbance footprint, resulting in behavioural changes which impact the normal routines of this species and abandon nearby habitat. The impact from Vulcan South is unlikely to be a significant addition in light of existing surrounding mining projects. The impact area for this is 2,110.9 ha (the disturbance footprint with a 500 m buffer surrounding it) and this disturbance is short-term, lasting only for the duration of the operations (9 years).		Not applicable.	It is possible but not highly likely that behavioural changes resulting from blasting disturbance may contribute to a slow reoccupation of habitat once rehabilitation has commenced. Any behavioural changes are not expected to be permanent.			Not applicable.			During the Project's operation.	Known and reversible.	Blasting will be in line with EA approved trigger limits, see **Appendix E**	No significant residual impacts are anticipated as a result of this Project.
Impacts from lighting	The Project operates 24 hours per day, which requires floodlighting around operational areas. Artificial lighting can impact fauna	Not applicable. No direct effects are anticipated as Koalas are unlikely to be present within the footprint during construction and operation (all the trees are cleared) where lighting will be the brightest.			Additional areas within 500m Indirect Impact Buffer: • Foraging/shelter/dispersal = 1532.0 ha • Shelter/dispersal = 188.4 ha		Not applicable.	No facilitated impacts are anticipated due to the lack of meaningful impact of this threat during all stages.			Likely to be ongoing throughout the operational	Known and reversible.	See artificial lighting mitigation measures in **Table 7-1**.	No significant residual impacts are anticipated as

Threat	Effect of Vulcan South	Direct			Indirect			Facilitated			Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
		Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation				
	through interfering with the navigation of nocturnal species (Howell, et al., 1954; Salmon, et al., 1995; Poot, et al., 2008; Longcore, et al., 2012) interrupting natural patterns of sleep and cell repair (Ben-Shlomo & Kyriacou, 2010), exposing nocturnal prey to elevated predation risks (Baker & Richardson, 2006; Rotics, et al., 2011; Davies, et al., 2012; Baker & Richardson, 2006) disturbing the timing of daily movements.				• Dispersal = 390.5ha Most of this will be outside of the effects of lighting. Impacts will only last for 9 years maximum.						life of the Project.			a result of this Project.
Waste	Food waste in particular has the likelihood of attracting cats, dogs, rats, foxes and pigs. Considering that the kitchen is offsite in an existing facility, and waste bins will be provided and emptied daily, the chances of elevated feral predators is unlikely to be more than negligible. Other waste not considered to have a high likelihood of contaminating is handled according to the waste management plan.	Not applicable.			Potential of food waste to attract and concentrate feral species. Once operational, the Project is unlikely to be habitat for MNES, and waste will be handled according to the waste management plan. Impacts will be negligible.		Not applicable.	No facilitated impacts are anticipated.			Potential to be repeated.	Known, reversible.	In accordance with Approved Vulcan South EA- A waste management plan will be completed.	Unlikely to be a significant impact resulting from this Project.
Highwall Mining	Highwall mining will not be likely to affect the habitat above. Dust and noise impacts are a possibility but unlikely to be more than negligible.	The Koala is not expected to be impacted by highwall mining. The area above highwall mining panel will not be cleared, and no subsidence is expected. The only area cleared will be the bench. Trees above the highwall mining trial area are not GDEs and therefore any impacts on groundwater (which will be negligible) are irrelevant.									No.	Known, predictable.	Impacts to habitat above the Highwall are unlikely to require further mitigations.	No significant impacts are expected as a result of this project

6.1.3 Impacts to the Greater Glider

Table 6-3 Impact assessment for the Greater Glider

Threat	Effect of Vulcan South	Direct			Indirect			Facilitated			Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
		Construction	Operation/ Maintenance	Decommissioning / Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning / Rehabilitation				
Threats Identified in the SPRAT Database														
Inappropriate fire regimes and intense bushfire (The Greater Glider is considered especially sensitive to fire. Trees used for denning, foraging and breeding by this species take over 100 years to regenerate to the point they will be of use if destroyed.)	The main effect of the Project on fire regimes is that it will reduce fire risk by enlarging the fire break (formed by the presence of the Project) between Saraji Road and large tracts of habitat in the Harrow Range to the west. As Saraji Road is a potential ignition source (via vehicle accidents, cigarette butts and broken glass), the likely consequence is a slight reduction in fire frequency within the Harrow Range. The effect is probably negligible, as most severe fires (fanned by hot, north-westerly winds) are likely to come from the other direction, so will not be affected by the Project. There is a slight chance that the Project could introduce new ignition sources (if smoking is permitted close to flammable vegetation adjoining the Harrow Range, or if potentially spark- or heat-producing machinery is located near coal or dry grass). Vitrinite maintains strict smoking policies on their mining lease, with smoking only permitted in defined smoking areas away from flammable materials. Coal stockpiles are maintained on the ROM, in the centre of operations, well away from vegetation. All workshops and other areas containing operating machinery (potential ignition sources) are kept clear of long grass and are	Mortality may be caused if a fire burns hot enough to affect Greater Gliders, though for the majority of the local habitat the fuel density is too low for this to be a significant risk.	Not applicable.	The greatest risk to Greater Gliders from fire occurs in the later stages of rehabilitation when Gliders have moved in as trees have become useful to the species. There is an elevated risk of rehabilitation areas becoming fuel for fires that may spread further, particularly in the first 2-5 years with the expected increase in ground and shrub layer cover.	Habitat may be affected to the degree that a loss of foraging opportunities may occur, though this impact is expected to last less than 6 months in affected areas as foliage will regrow within that time. Epicormic growth will occur in *Eucalyptus* in as little as 1 month, with foliage weight being restored in as little as 8 months. Greater Gliders have a preference for the new regrowth. (Burrows, G. E., 2013)		Indirect risks from fire are not anticipated.	No facilitated fire risks are anticipated.	No facilitated fire risks are anticipated.	No facilitated fire risks are anticipated.	Unlikely to be a repeated risk.	Unpredictable.	See row 'fire' in **Table 7-1**	No significant impact is anticipated as a result of this Project.

Threat	Effect of Vulcan South	Direct			Indirect			Facilitated			Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
		Construction	Operation/ Maintenance	Decommissioning / Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning / Rehabilitation				
	surrounded by a firebreak. Any slight changes to fire regime that occur as a result of the Project will be temporary, as the post-mining land use will return vegetation similar in composition and structure to the pre-mining landform. There will be no permanent introductions of new ignition sources. During construction there is some probability of fires being lit by activities such as hot works (welding, grinding) or vegetation ignition from trapped twigs and leaves in bulldozer exhaust within greenfield areas. These areas, if connected to nearby habitat may have the potential to allow fire to spread. The risk is expected to last for less than a year.													
Loss of trees that may produce hollows in the future	Trees that would otherwise contain hollows within 10 years (the approximate completion of mining and beginning of rehabilitation) will be cleared to accommodate the mine.	Areas of remnant vegetation are unlikely to increase in the number of old, hollow trees as a percentage of the total tree cover. This is due to these areas already being well established. Areas of low soil fertility and/or water availability are especially not expected to produce additional large trees. Regrowth areas have a much higher potential to produce large trees with suitable hollows, as habitat is not yet mature. These areas are likely to experience a setback of over 120 years (Refer to TEA) as tree growth will start from complete absence at the beginning of rehabilitation.			Loss of hollow trees can only be considered a direct effect on the Greater Glider that directly relies on them.						Not repeated	Known, predictable	Project footprint has been adjusted as much as practicable to avoid impacts to hollow trees, which are in areas mapped as "Denning" for the Greater Glider. The primary mitigation measure is the provision of offsets	Significant impact is certain, offsets are designed to mitigate this impact.
Habitat clearing and fragmentation	1,056.8 (total) ha of breeding/shelter/foraging/dispersal habitat will be removed. It should be assumed that all species' use of the Project area will be completely halted until at least the earliest	This will cause a loss spanning a 25-year timeframe for dispersal habitats, 35 years for foraging habitats, and the loss of tree hollows that	Not applicable.	Not applicable. No direct impacts are associated with this stage.	An additional 2209.8 ha of habitat for Greater Gliders is located within 500 m of the main operational areas and therefore may experience	The habitat surrounding the project's operational areas will potentially be affected to some degree by edge effects, such as dust, noise and	Considering that noise and dust impacts are anticipated to be no greater than the existing background levels of the site and that they will be short lived in	Effects during construction that may be regarded as facilitated may include reduced gene flow through the population.	Operation and maintenance are not expected to cause further effects.	The aim of rehabilitation is to re-connect dispersal pathways and neutralise or reverse this effect.	Unlikely to be a repeated risk.	Impacts related to loss of hollow bearing trees are almost irreversible due to rehabilitation timeframes of over 100 years,	Offsets, use of fauna spotters. See clearing Section of **Table 7-1.**	Certain, until area is rehabilitated. This species is known to recolonise rehabilitated areas. The project will adversely affect habitat critical to the survival of a species

Threat	Effect of Vulcan South	Direct			Indirect			Facilitated			Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
		Construction	Operation/ Maintenance	Decommissioning / Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning / Rehabilitation				
	stages of decommission and rehabilitation. The chances of permanent alienation for any species are low.	constitute breeding and shelter habitats to be considered near permanent (over 100 years; the time frames of these impacts are known with high confidence, as they are based on growth rate data from nearby areas). Direct mortality due to falling trees from clearing will be a risk for approximately 1 year, though this risk will be suitably mitigated through the use of fauna spotters. The clearing of vegetation and other habitat features within the Project area is likely to cause almost complete site alienation for all listed species, with the most likely exception being the Squatter Pigeon which may continue to utilise water resources within the disturbed area and forage along roads and in other suitable areas.			some disturbance when construction is occurring in these areas from noise and lighting for a maximum of 9 years. The impact is considered minimal. Negligible habitat fragmentation is expected to occur for dispersal habitat for approximately the operational life of the project as adjacent source and destination habitats within the Project footprint will be removed.	light spill, though this is only for the operational life of the project and during this time is considered to be a minimal impact due to existing mitigation measures.	duration, any long-term impacts on individuals or populations are not expected. Artificial lighting impacts are expected to be minimal and highly localised.					and therefore require offsets. Other impacts are reversible.		(i.e., by removing hollow trees). This impact will last until tree hollows have been replaced in rehabilitated areas post-mining. It is expected to take 120 years post-planting for trees to be large enough to form natural hollows. Re-colonisation of rehabilitated sites after 13 years has been recorded in central Queensland where nest boxes support glider populations in mining rehabilitation sites devoid of natural hollows. However, nest boxes require regular maintenance and replacement (Beyer & Goldingay, 2006), and it is doubtful whether such a commitment can be fulfilled over a 120-period, until natural hollows form. For this reason, it is conservatively predicted that the loss of hollow trees within Greater Glider habitat constitutes a near-permanent loss. However, where hollows are available nearby, Greater Gliders are expected to commence foraging within rehabilitated areas within 15 years.
Timber harvesting	Timber is currently harvested on site for local use (primarily to construct fence posts and stockyards). While this harvesting will cease due to the project, this won't confer any benefits to gliders, as the vegetation is being removed anyway to	Timber harvesting will cease due to the project; however, trees will be cleared to accommodate the action and therefore any impacts from timber harvesting are superseded.									Unlikely to be a repeated risk.	Impacts are known and reversible, except in areas containing hollow bearing trees .	Refer to 'Timber harvesting' in **Table 7-1**	Not applicable.

Threat	Effect of Vulcan South	Direct			Indirect			Facilitated			Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
		Construction	Operation/ Maintenance	Decommissioning / Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning / Rehabilitation				
	accommodate the proposed infrastructure.													
Barbed wire fencing (entanglement)	Vulcan South will see the removal of 1,056.8 (total) ha of habitat and associated barbed wire fences within this habitat. During rehabilitation, some fences are likely to be built to control cattle movement within the disturbance footprint.	Although barbed wire entanglement can occur at any time, it is extremely unlikely during construction, operation and maintenance as all of the habitats will be cleared and therefore there will be no Greater Gliders present to be entangled, or trees available for the species to glide from. Mortality is certain for entangled gliders if not rescued in a timely manner. Entanglement is most likely to occur once the trees have grown to a sufficient size for dispersal, or approximately 20 years following mine conception onwards, even then the most likely individuals to be entangled would be dispersing young males.			Not applicable.			Not applicable.			Likely to be repeated when fences transect Greater Glider habitat.	Impacts are known and reversible if Greater Glider is not mortally injured.	Replacement with electrified or smooth wire in habitat areas.	No significant impacts are considered likely following mitigation.
Climate change (increased temperatures and changes to rainfall patterns)	Vulcan South on its own is unlikely to have any more than a negligible effect on worldwide climate and rainfall patterns. However, over the course of the projects rehabilitation, the following changes are expected in considering of the RCP 8.5 scenario: • temperatures are expected to increase by between 1.14°C to 1.25°C; • annual rainfall changes are uncertain but could are expected to increase by up 1.3% (for the best case) or reduce by 18.7% (for the worst case); and • evapotranspiration is expected to increase by between 3.2% to 5.4%.	Not applicable.			If weather patterns are to become more hostile to the survival of habitats that would support the listed MNES, it is unlikely that the project would exacerbate impacts on its own. The Squatter Pigeons are unlikely to be sensitive to changes as they are known from a wide range of habitats and climates within their distribution. Koalas will not be cut off from refugia, as ample opportunities exist for the population to move within the local area which will not be affected by the project. Greater Gliders may be more affected due to their more limited dispersal ability and need for hollows. The habitats along riparian areas are unlikely to be affected, though the broader area where habitat is marginal is likely to be negatively affected by reduced rainfall. The project will not form barriers to access to these areas that do not already exist.			Not applicable.			Unlikely to be a repeated risk.	Impacts are known and reversible.	Offsets are planned to mitigate these risks. Climate change mitigation measures is incorporated into the OAMP **(Appendix II)**, including but not limited to consideration of climate refuges within the offset area for species.	No significant impacts are considered likely as a result of this Project.
Hyper predation by owls	Four species of owl are known to predate the Greater Glider: The powerful owl (*Ninox strenua*), masked owl (*Tyto novahollandiae*), rufous owl (*Ninox rufa*) and the sooty owl (*Tyto tenebricosa*). The Project is outside the known distribution of the	Not applicable.									Unlikely.	Not applicable.	Not applicable.	No significant impacts are considered likely as a result of this Project

Threat	Effect of Vulcan South	Direct			Indirect			Facilitated			Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
		Construction	Operation/ Maintenance	Decommissioning / Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning / Rehabilitation				
	powerful, sooty and rufous owl, while habitat is not considered suitable for the masked owl.													
Competition from *Cacatua galerita* (Sulphur-crested Cockatoos)	Vulcan South will not add to the populations of sulphur crested cockatoos as it will not be increasing foraging or nesting opportunities. Gliders displaced by this project are unlikely to have a high survival rate therefore competition with cockatoos is likely to be negligible at best.	Greater Gliders competing with sulphur crested cockatoos has been identified as a threat to the southern species (Department of Climate Change, Energy, the Environment and Water, 2022b). This appears to come from a paper by Smith (2018) which was based on studies in the lower Blue Mountains. Applicable studies or evidence that implicate cockatoos with glider declines in the Brigalow Belt of Queensland are lacking, and unlikely to constitute a measurable threat to the Greater Glider in the Bowen or Isaac basins.	Not applicable.	As for construction.	Not applicable.			Not applicable.			Unlikely to be a repeated risk.	Unknown.	N/A	No significant impacts are considered likely as a result of this Project.
Predation by feral cats and foxes (*Felis catus*) and European foxes (*Vulpes vulpes*)	Vulcan South will not add to the populations of feral cats and foxes. Food waste management is already suitably implemented in management plans.	Greater Gliders will not be affected by cats or foxes in the Vulcan South project, as the project will be removing suitable habitat, thus extirpating the species within the Project area until the later stages of rehabilitation. It is unlikely that cats and foxes will have greater opportunities to predate Greater	Not applicable.	As for construction.	Not applicable.			Not applicable.			Unlikely to be a repeated risk.	Impacts are known and reversible.	Not applicable.	No significant impacts are considered likely as a result of this Project.

Threat	Effect of Vulcan South	Direct			Indirect			Facilitated			Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
		Construction	Operation/ Maintenance	Decommissioning / Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning / Rehabilitation				
		Gliders in the rehabilitation stage as the species is expected to increase in numbers in the area overall as habitat reverts to being suitable.												
Loss of climatically suitable habitat	Vulcan South will remove a total of 1056.8 ha of habitat suitable for the Greater Glider. This includes climactically suitable habitat. The rehabilitation stage will see the reinstatement of habitat for these species.	Not applicable.		There is a risk of rehabilitation failing resulting in the habitat being unusable, in particular for this species due to the more specific needs of this species.	Not applicable.			Not applicable.			Not likely to be repeated.	Impacts are known and reversible.	Offsets.	Following the provision of offsets, the loss of climactically suitable habitat is expected to be suitably mitigated.
Increased intensity or frequency of drought	Vulcan South will have a negligible or unmeasurable effect at best on the drought cycles as this is a much wider issue.	Not applicable.			Impacts to the MNES will be indirect as drought will have unpredictable durations and intensities.			Not applicable.			Possibly repeated.	Impacts are somewhat unpredictable.	N/A. Mitigations on the project scale are unlikely to be viable on the large-scale causes.	No significant impacts are considered likely as a result of this Project
Increased intensity or frequency of heatwaves	Vulcan South will have a negligible or unmeasurable effect at best on the weather cycles as this is a much wider issue.	Not applicable.			Impacts to the species will be indirect as heatwaves will have unpredictable durations and intensities.			Not applicable.			Possibly repeated.	Impacts are somewhat unpredictable.	N/A. Mitigations on the project scale are unlikely to be viable on the large-scale causes.	No significant impacts are considered likely as a result of this Project.
Declining nutritional value of foliage	Nutritional value of foliage is largely a product of climate/weather patterns. Vulcan South will have a negligible effect on this matter.	Not applicable.									Not likely to be repeated if this declines over time.	Impacts are somewhat unpredictable.	Not applicable. Mitigations on the project scale are unlikely to be viable on the large-scale causes.	No significant impacts are considered likely as a result of this Project.
Threats Specific to Vulcan South														
Groundwater drawdown	The Greater Glider has the potential to be impacted by groundwater drawdown indirectly through the negative impact groundwater drawdown can have on the ability for terrestrial GDE species (*Eucalyptus camaldulensis* and	Hydrogeologist.com.au (**Appendix P**) has developed a numerical groundwater flow model of the Project area and broader region to predict the effects of the Project on local groundwater levels. Groundwater flow into the main and Vulcan South Pits will be negligible, and these pits will be essentially dry. Groundwater flow into the Vulcan South Pit will be up to 2.7 m^3/day, which will cause localised drawdown in surrounding aquifers. The drawdown predicted from groundwater inflow into the pits at the Project is limited in geographic extent (up to 300 m from the pit crest), and most of the vegetation within this zone of drawdown will be			The drawdown predicted from the groundwater flowing into the pits at Vulcan South is limited in geographic extent (up to 2,400 m to the east of the pits toward existing mining) and magnitude (up to 10 m) (**Section 6.4.3.5**) and will not affect any GDEs outside of the Projects disturbance footprint (**Figure 6-38**).		Within the post closure setting, the pit will be backfilled and hence the take of groundwater will cease, promoting the recovery of groundwater levels to those observed prior to mining after 15-20 years.	Not applicable, due to a lack of lasting effects.			Unlikely to be repeated.	Unknown as to whether drawdown of 1-2 m will affect tree health; however, it is considered unlikely.	See 'Groundwater Drawdown' in **Table 7-1**	No significant residual impacts are anticipated.

Threat	Effect of Vulcan South	Direct			Indirect			Facilitated			Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
		Construction	Operation/ Maintenance	Decommissioning / Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning / Rehabilitation				
	Eucalyptus tereticornis) to absorb nutrients through their roots and therefore, can result in the stunted growth of these important feeding and sheltering species. The Groundwater modelling has indicated that any effects of groundwater drawdown will be largely limited to only the area within the footprint.	removed to accommodate the rail loop and other infrastructure. Therefore, all GDEs present within the footprint will be cleared and therefore cannot be affected by drawdown. Drawdown will cease after the pit is backfilled and therefore will only last for 9 years. The groundwater levels in the backfilled Vulcan South Pit are expected to fully recover within 15 to 20 years from the completion of mining. However, as described above, within the footprint this is irrelevant because the habitat will be cleared and once rehabilitation commences, any impacts of drawdown will have ceased and therefore not affect the growth of the new tree species.					Therefore, there are no lasting effects of drawdown anticipated to GDEs within the footprint during the rehabilitation phase and therefore there are no impacts to growth of sheltering and feeding trees for the Greater Glider.							
Groundwater contamination	The Greater Glider has the potential to be impacted by groundwater contamination indirectly through the negative impact it can have on the ability for Terrestrial GDE species (*E. camaldulensis* and *E. tereticornis*) to absorb nutrients through their roots and therefore, can result in the stunted growth of these important feeding and sheltering species.	Not applicable.			Impacts to groundwater quality is considered unlikely due to the minimal groundwater inflow into the pit, poor quality of groundwater as it currently stands and strict mine groundwater monitoring and management. Impacts to Groundwater impacts are considered very unlikely due to negligible groundwater inflow into pit. Regardless, this impact would only occur for 9 years maximum during operations, and it is unlikely groundwater would be impacted enough to affect growth of trees within the footprint. Regardless, all trees will be cleared within the footprint and therefore impacts of groundwater contamination are irrelevant. Impacts outside of the footprint is considered very unlikely and would be managed as per below.		Not applicable.	Not applicable.			Unlikely to be repeated.	All impacts are known and reversible.	Mitigation measures outlined in **Section 6.4.3**.	No significant residual impacts are anticipated.
Surface water contamination	The Greater Glider has the potential to be impacted by surface water contamination indirectly through the negative impact it can have on the ability for Terrestrial GDE species (*E. camaldulensis* and *E. tetracornis*) to absorb nutrients through their roots and therefore, can result in the stunted growth of these important feeding and sheltering species.	Not applicable.			The only potential indirect impacts of surface water contamination on this species are the potential negative effect contamination may have on the growth of trees in the riparian areas within the footprint. However, during construction and operation these will be cleared and therefore any surface water contamination impacts are irrelevant. No surface water contamination effects will occur offsite, and impacts will only occur for 9 years maximum during construction and operation. All surface water related impacts will be adequately managed through the on-site water management system. See Surface Water mitigation measures provided in **Table 7-4** and geochemistry mitigation measures provided in **Table 7-9** (these measures will prevent any contaminants seeping from overland flow). As described above, the highest risk of surface water contamination is		Not applicable.	Not applicable due to a lack of long-term impacts.			Repetition is possible.	Known and reversible.	All surface water related impacts will be adequately managed through the on-site water management system. See Surface Water mitigation measures are provided in **Table 7-4** and geochemistry mitigation measures are provided in **Table 7-9** (this will prevent any	No significant impacts are considered likely as a result of this Project.

Threat	Effect of Vulcan South	Direct			Indirect			Facilitated			Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
		Construction	Operation/ Maintenance	Decommissioning / Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning / Rehabilitation				
					during construction and operation, where the WRD's have not been full rehabilitated yet and mining is active (duration 9 years). During this time, it is very unlikely Greater Gliders would be present as all the trees will have been cleared and there will be no habitat for them. Therefore, they may return during the rehabilitation stage, at which the WRD's will be fully rehabilitated, and mining will have ceased and therefore the risk of surface water contamination will be very low.								contaminants seeping from overland flow). Relevant mitigation measures include the testing of potential overland flow contaminants to be included within the REMP, and in-depth paddock dumping and traffic compaction within the WRDs to prevent oxygen and water exposure of the PAF reject material.	
Impacts from Dust	Dust can impact nearby vegetation by blocking photosynthesis and increasing leaf temperature; both impacts can reduce drought tolerance (Farmer, 1993). Dust that is severe enough to inhibit plant growth is only likely where vegetation is close to (within 100 m of) the source (roads, operational areas). Greater Gliders feed on new plant growth. It is possible dust could reduce food availability for these species. However, such effects would only occur close to highly disturbed areas, which these species will most likely avoid for other reasons (noise, light). Therefore, minimal effects from dust on these species are anticipated.	Not applicable.			2209.8 ha of Greater Glider habitat (Breeding/Shelter/Foraging/Dispersal) is within 500 m of the area most likely to cause disturbance. Impacts will only last for 9 years maximum. Any effects will cease immediately upon cessation of the adjacent operations.		Not applicable.	Not applicable.			Potential to be repeated.	Known and reversible.	Dust suppression methodologies will be sufficient to suitably reduce the risk of dust to as low as reasonably practicable.	No significant impacts are considered likely as a result of this Project.

Threat	Effect of Vulcan South	Direct			Indirect			Facilitated			Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
		Construction	Operation/ Maintenance	Decommissioning / Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning / Rehabilitation				
Impacts from noise and vibration	Noise from traffic and industrial sources can have significant detrimental impacts on fauna (Shannon, et al., 2016; Cunnington & Fahrig, 2010; Barber, et al., 2010). The Project is located on a busy highway (Saraji Road), immediately west of a large mining operation. The increase in noise resulting from the amendment is therefore expected to be negligible relative to existing background noise. Nevertheless, there may be localised disturbance from noise where operational areas are close to (e.g., within 500 m of) habitats for threatened fauna (e.g., Greater Gliders, Koalas). Any effects of noise will be restricted to the operational life of the Project.	No effects within the footprint are considered relevant as the habitat will be cleared and it is very unlikely Greater Gliders will be present. 2209.8 ha of Greater Glider habitat (Breeding/Shelter/Foraging/Dispersal) is within 500 m of the area most likely to cause disturbance. Impacts will only last for 9 years maximum.		Not applicable.	Not applicable.			Not applicable.			Likely to be ongoing throughout the operational life of the Project.	Known and reversible.	Noise will be in line with EA approved trigger limits, see **Appendix E**	No significant residual impacts are anticipated as a result of this Project.
Blasting	Noise and vibration specifically from blasting may disturb this species.	Not applicable.	No habitat will be present in the blast range at the time of blasting.	Not applicable.	Noise and vibration due to blasting may disturb any Greater Gliders in or near the disturbance footprint, resulting in behavioural changes which impact the normal routines of this species and abandon nearby habitat. The area of impact is the same as for noise and vibration. The impact from Vulcan South is unlikely to be a significant addition in light of existing surrounding mining projects. This disturbance is short-term, lasting only for the duration of the operations (9 years).		Not applicable	It is possible that behavioural changes resulting from blasting disturbance may contribute to a slow reoccupation of habitat once rehabilitation has commenced. Any behavioural changes are not expected to be permanent.			Not applicable.	During the Project's operation.	Known and reversible.	Blasting will be in line with EA approved trigger limits, see **Appendix E**
Impacts from lighting	The Project operates 24 hours per day, which requires flood-lighting around operational areas. Artificial lighting can impact fauna through interfering with the navigation of nocturnal species (Howell, et al., 1954; Salmon, et al., 1995; Poot, et al., 2008; Longcore, et al., 2012)	No direct effects are anticipated besides the disturbance it may cause; however, Greater Gliders are unlikely to remain present within the footprint during construction and operation where lighting will be the brightest.			2209.8 ha of Greater Glider habitat (Breeding/Shelter/Foraging/Dispersal) is within 500m of the area most likely to cause disturbance. Impacts will only last for 9 years maximum.		Not applicable.	No facilitated impacts are anticipated.			Likely to be ongoing throughout the operational life of the Project.	Known and reversible.	See artificial lighting mitigation measures in **Table 7-1**	No significant residual impacts are anticipated as a result of this Project.

Threat	Effect of Vulcan South	Direct			Indirect			Facilitated			Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
		Construction	Operation/ Maintenance	Decommissioning / Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning / Rehabilitation				
	interrupting natural patterns of sleep and cell repair (Ben-Shlomo & Kyriacou, 2010), exposing nocturnal prey to elevated predation risks (Baker & Richardson, 2006; Rotics, et al., 2011; Davies, et al., 2012) disturbing the timing of daily movements.													
Waste	Food waste in particular has the likelihood of attracting cats, dogs, rats, foxes and pigs. Considering that the kitchen is offsite in an existing facility, and waste bins will be provided and emptied daily, the chances of elevated feral predators is unlikely to be more than negligible. Other waste not considered to have a high likelihood of contaminating is handled according to the waste management plan.	Not applicable.			Potential of food waste to attract and concentrate feral species. Once operational, the Project is unlikely to be habitat for MNES, and waste will be handled according to the waste management plan. Impacts will be negligible.		Not applicable.	No facilitated impacts are anticipated.			Potential to be repeated.	Known, reversible.	In accordance with Approved Vulcan South EA- A waste management plan will be completed.	Unlikely to be a significant impact resulting from this Project.
Highwall Mining	Highwall mining will not be likely to affect the habitat above. Dust and noise are possibilities but unlikely to be more than negligible.	The Greater Glider is not expected to be impacted by highwall mining. The area above highwall mining panel will not be cleared, and no subsidence is expected. The only area cleared will be the bench. Trees above the highwall mining trial area are not GDEs and therefore any impacts on groundwater (which will be negligible) are irrelevant.									No.	Known, predictable.	Impacts to habitat above the Highwall are unlikely to require further mitigations.	No significant impacts are expected as a result of this project.

6.1.4 Impacts to the Squatter Pigeon

Table 6-4 Impact assessment for the Squatter Pigeon

Threat	Effect of Vulcan South	Direct			Indirect			Facilitated			Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
		Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning / Rehabilitation	Construction	Operation/ Maintenance	Decommissioning / Rehabilitation				
Threats Identified in the Conservation Advice														
Fire	The main effect of the Project on fire regimes is that it will reduce fire risk by enlarging the fire break (formed by the presence of the Project) between Saraji Road and large tracts of habitat in the	The Squatter Pigeon, other than nests and chicks, is not likely to be directly affected by fire as this species will fly away, therefore avoiding direct mortality. Nests may be affected;			Indirect effects to the Squatter Pigeon are likely to be related to habitat. Freshly burned areas may be used for foraging as seeds may be revealed by fire, but the plants that provide these seeds are likely to be destroyed or burnt to the ground. A fire is likely to burn undergrowth and groundcover that provide shelter to			No facilitated fire risks are anticipated.	No facilitated fire risks are anticipated.	No facilitated fire risks are anticipated.	Unlikely to be a repeated risk.	Unpredictable.	See row 'fire' in **Table 7-1**	No significant impact is anticipated as a

Threat	Effect of Vulcan South	Direct			Indirect			Facilitated			Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
		Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning / Rehabilitation	Construction	Operation/ Maintenance	Decommissioning / Rehabilitation				
	Harrow Range to the west. As Saraji Road is a potential ignition source (via vehicle accidents, cigarette butts and broken glass), the likely consequence is a slight reduction in fire frequency within the Harrow Range. The effect is probably negligible, as most severe fires (fanned by hot, north-westerly winds) are likely to come from the other direction, so will not be affected by the Project. There is a slight chance that the Project could introduce new ignition sources (if smoking is permitted close to flammable vegetation adjoining the Harrow Range, or if potentially spark- or heat-producing machinery is located near coal or dry grass). Vitrinite maintains strict smoking policies on their mining lease, with smoking only permitted in defined smoking areas away from flammable materials. Coal stockpiles are maintained on the ROM, in the centre of operations, well away from vegetation. All workshops and other areas containing operating machinery (potential ignition sources) are kept clear of long grass and are surrounded by a firebreak. Any slight changes to fire regime that occur as a result of the Project will be temporary, as the post-mining land use will return vegetation similar in composition and structure to the pre-mining landform. There will be no permanent introductions of new ignition sources.	however, this is only likely during nesting season which peaks in the dry season.			Squatter Pigeons, which is likely to create impacts lasting for around a year.									result of this Project.
					During construction there is some probability of fires being lit by activities such as hot works (welding, grinding) or vegetation ignition from bulldozer exhaust in greenfield areas. These areas, if connected to nearby habitat may have the potential to allow fire to spread. The risk is expected to last for less than a year.	Brownfield areas are less likely to contain enough material to start or sustain a fire that will spread to Squatter Pigeon habitat. During operation, areas within the Project footprint will not be vegetated, and as a result are less likely than prior to clearing to be a source of ignition, particularly considering the strict controls in place to prevent fires in coal mines.	Fire is most likely to affect the Squatter Pigeon in the early stages of rehabilitation when the higher density of groundcover and shrubs means a higher potential for ignition. This is expected to occur within the first 2-5 years of the rehabilitation stage.							
Habitat clearing and fragmentation	The clearing of vegetation to accommodate the Vulcan South Project will remove habitat for the Squatter Pigeon: • Breeding and Foraging: 372.5 ha • Foraging: 78.9 ha • Dispersal: 767.6 ha. Outside the Project area (within a 500m indirect buffer), there are the following: • Breeding and Foraging: 858.8 ha • Foraging: 338.7 ha; • Dispersal: 1318.2 ha. The clearing of vegetation and other habitat features within the Project area is likely to cause almost complete site alienation for all listed species, with the most likely exception being the Squatter Pigeon, which may continue to utilise water resources within the disturbed area and forage along roads and in other suitable areas. It is expected that Squatter Pigeon use of the Project area will be the least affected of the listed species, due to its ability to fly, foraging on exposed seeds in cleared areas and ready use of artificial water resources such as wash-down sediment ponds.	Habitat will be directly removed by vegetation clearing. It is likely that habitat for several hundred pairs will be retained in the local region, supporting a viable population that will serve as a source of recruitment for rehabilitated land post-mining.	Not applicable.		Not applicable.	The habitat surrounding the Project's operational areas will potentially be affected to some degree by edge effects, such as dust, noise and light spill, though this is only for the operational life of the project and during this time is considered to be a minimal impact due to existing mitigation measures.		No facilitated impacts are anticipated.			Unlikely to be a repeated risk.	Impacts are known and reversible	Offsets. See clearing Section of **Table 7-1**	Certain, until area is rehabilitated. All listed species are known to recolonise rehabilitated areas. This local population is expected to temporarily decline only temporarily. The impacts of habitat clearance will persist at least for the short- to medium-term, until vegetation is re-established on mined land. Being a ground-dwelling bird, they are not dependent on old trees, and

Threat	Effect of Vulcan South	Direct			Indirect			Facilitated			Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
		Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning / Rehabilitation	Construction	Operation/ Maintenance	Decommissioning / Rehabilitation				
														rehabilitated sites are expected to meet their requirements for a low, protective tree cover within 15 years. It is estimated that the duration of impacts will be approximately 25 years, although this estimate has low confidence, given the lack of data on the dietary requirements of the species.
Habitat fragmentation	Habitat fragmentation resulting from the Project will have a relatively limited impact on local wildlife, on account of the limited duration of isolation and the low quality of the isolated habitat.	The Project is located immediately south and west of existing mines (Peak Downs Mine and Vulcan Coal Mine), which already interrupts west-east movement of wildlife. There is a narrow, fragmented strip of vegetation, which is not likely to be of much value to MNES between the proposed disturbance footprint and Peak Downs Mine. Any fauna inhabiting this strip could potentially be prevented from dispersing westwards by the proposed open-cut pits.		Barriers preventing the Squatter Pigeon moving through habitats are temporary. Once mining is complete, the pits are to be refilled with waste rock material and rehabilitated.	It is possible that the flow-on effects from interrupting access to habitat will have longer-term implications for the behaviour of this species. There may be a period following operations and rehabilitation during which Squatter Pigeons do not access habitat corridors as they may have done before the Project was established.		Not applicable.	No facilitated impacts are anticipated, due to the relatively short timeframes for mine operations and the relatively poor and prior disturbed nature of the existing habitat.			Ongoing through the Project's construction, operational and rehabilitation stages.	Impacts are known and reversable.	Each of the mine pits is to be developed sequentially, so that Vulcan North pit will be rehabilitated prior to Vulcan South pit being developed. This will maintain dispersal corridors for east-west movement through the Project area throughout the duration of operations.	No significant impacts are considered likely as a result of this Project.
Climate change (increased temperatures and changes to rainfall patterns).	Vulcan South on its own is unlikely to have any more than a negligible effect on worldwide climate and rainfall patterns. However, over the course of the projects rehabilitation, the following changes are expected in considering of the RCP 8.5 scenario:	Not applicable.			If weather patterns are to become more hostile to the survival of habitats that would support the listed MNES, it is unlikely that the project would exacerbate impacts on its own. The habitats along riparian areas are unlikely to be affected, though the broader area where habitat is marginal is likely to be negatively affected by reduced rainfall.			Not applicable.			Unlikely to be a repeated risk.	Impacts are known and reversible.	Offsets are planned to mitigate these risks. Climate change mitigation measures is	No significant impacts are considered likely as a result of this Project.

Threat	Effect of Vulcan South	Direct			Indirect			Facilitated			Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
		Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning / Rehabilitation	Construction	Operation/ Maintenance	Decommissioning / Rehabilitation				
	• temperatures are expected to increase by between 1.14°C to 1.25°C; • annual rainfall changes are uncertain but could are expected to increase by up 1.3% (for the best case) or reduce by 18.7% (for the worst case); and • evapotranspiration is expected to increase by between 3.2% to 5.4%.				The project will not form barriers to access to these areas that do not already exist.								incorporated into the OAMP, including but not limited to consideration of climate refuges within the offset area for species.	
Predation by feral cats and foxes (*Felis catus*) and European foxes (*Vulpes vulpes*)	Vulcan South will not add to the populations of feral cats and foxes. Food waste management is already suitably implemented in management plans.	The Squatter Pigeon is likely to utilise areas of the Project footprint during all stages of the Project life cycle. Given the waste management procedures in place for mining camps and operational areas, an increase in cats and foxes is not likely.	Not applicable.	As for 'Construction'.	Not applicable.			Not applicable.			Unlikely to be a repeated risk.	Impacts are known and reversible.	Not applicable.	No significant impacts are considered likely as a result of this Project.
Overgrazing of habitat by livestock and feral herbivores such as rabbits	During rehabilitation there is some possibility of overgrazing by herbivores, however cattle will be managed and rabbit densities are already low within and around the Project area.	Not applicable.			Rabbits are unlikely to cause any disturbance to habitat until the rehabilitation stage where they may impact seedlings and groundcover. In the Project area, rabbits are found in low densities as evidenced by the lack of sightings, warrens and the healthy undergrowth and groundcover layers. Rabbits are unlikely to affect rehabilitation efforts.						Potential to be repeated	Impacts are known and reversible	N/A	No significant impacts are considered likely as a result of this Project.
Introduction of weeds	Land disturbance and the movement of soils, vehicles and people between areas can promote weed invasion. The risk that the project could encourage invasion by the seven restricted weeds recorded within the survey area. Controls must be in place to manage the risks posed by Rubber Vine, Harrisia Cactus, Prickly Pear, Velvet Pear and Parthenium to avoid being in violation of the *Biosecurity Act 2014*. While there are no legal obligations to manage non-declared weeds on site, the potential for these to spread and reduce habitat quality for threatened fauna must be considered when assessing the significance of impacts to individual matters. Non-native plants such as Buffel Grass, Indian Couch, Sabi Grass and Natal Grass are already abundant and widespread on site and have likely already reached the limits of their potential local distribution (limited by soil type and moisture availability). Impacts, if applicable	Weeds are suitably mitigated with the existing site weed management plans. There is some potential for temporary weed introduction, though this will be short term – an expected maximum of 9 years.			Not applicable.			Not applicable.			Potential to be repeated	Impacts are known and reversible	See weeds Section of **Table 7-1**	No significant impacts are considered likely as a result of this Project.

Threat	Effect of Vulcan South	Direct			Indirect			Facilitated			Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
		Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning / Rehabilitation	Construction	Operation/ Maintenance	Decommissioning / Rehabilitation				
	would be short term and only occur for a maximum of 9 years.													
Thickening of understorey vegetation	Thickening of understorey vegetation was identified as a threat in the Conservation Advice, which may occur during rehabilitation.	Not applicable.			Not applicable.		Excessive understorey vegetation does not limit the movement of Squatter Pigeons but will provide ambush opportunities for predators such as cats and reduce areas for foraging – including a reduction in plants species used for foraging. The impact is considered indirect/consequential. This impact would be temporary, it may take a few weeks for understorey to thicken to the point where it is not suitable, but as described, cattle grazing will keep levels low enough to support Squatter Pigeons. The area applicable is the entire Vulcan South footprint aside from Rehabilitation area (RA)6 (retained infrastructure). Therefore, the area applicable is 80.3 ha.	Not applicable.			Possibly repeated.	Impacts are unlikely, given the land management plan including use of cattle to thin vegetation. Impacts would be reversible.	No additional measures required.	Not applicable.
Trampling of nests by domestic stock	During rehabilitation, there is some, but a low possibility of stock trampling the nests of Squatter Pigeons. Squatter Pigeons are known to coexist readily with cattle. The low intensity grazing proposed during rehabilitation is consistent with current grazing which supports a reasonable sedentary population of Squatter Pigeons. It should be noted that cattle farming, by the provision of water points, thinning of understorey vegetation and addition of plants that produce seeds eaten by the Squatter Pigeon is generally considered to	Not applicable during these phases of the Project		The trampling of nests is considered a direct impact. The timing of this could be considered ongoing and the areas applicable are the entire Vulcan South footprint aside from Rehabilitation area (RA)6 (retained infrastructure) –	Not applicable during these phases of the Project			Not applicable.			Possible to be repeated.	Unpredictable	None required. The only mitigation measure that would prevent any accidental trampling of Squatter Pigeons by cattle	Not applicable.

Threat	Effect of Vulcan South	Direct			Indirect			Facilitated			Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
		Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning / Rehabilitation	Construction	Operation/ Maintenance	Decommissioning / Rehabilitation				
	be beneficial to the species overall and counteract any small chance of trampling.			therefore the area applicable is 80.3 ha. The areas set aside as habitat for threatened species during the rehabilitation stage is specified in the PRCP.									would be to exclude cattle; however, this would result in understorey growing uninhibited and therefore result in the habitat no longer being suitable for Squatter Pigeons.	
Illegal shooting	None. Firearms are not allowed within the mining lease. The only possibility of illegal shooting comes with illegal entry to the property. Given that illegal shooting is already unlikely overall, the likelihood of it occurring on the property given access limitations and firearm bans makes this highly unlikely.	Shooting of birds is considered a direct impact to the species. This could occur anywhere at any time. It is particularly unlikely within the Project area given the level of security and ban on firearms.		Shooting of birds is possible at this phase, but highly unlikely.	Shooting of birds would be considered a very direct threat. Indirect and facilitated impacts are not likely.						Sporadic, but unlikely overall.	Not applicable.	None required in addition to the existing rules on entry and firearm use.	Not applicable.
Threats Specific to Vulcan South														
Impacts from Dust	Dust can impact nearby vegetation by blocking photosynthesis and increasing leaf temperature; both impacts can reduce drought tolerance (Farmer, 1993). Dust that is severe enough to inhibit plant growth is only likely where vegetation is close to (within 100 m of) the source (roads, operational areas). Greater Gliders feed on new plant growth. It is possible dust could reduce food availability for these species. However, such effects would only occur close to highly disturbed areas, which these species will most likely avoid for other reasons (noise, light). Therefore, minimal effects from dust on these species are anticipated.	Squatter Pigeons are more likely to utilise the disturbance footprint during construction and operation. These species are not anticipated to be greatly affected by dust given they are known to exist in very disturbed areas, including cattle yards where dust is usually present in high quantities. Therefore, besides the nuisance dust may cause, its unlikely to create any negative direct effects beyond which the species naturally is exposed to. The timing is a maximum of 9 years during construction and operation.		Not applicable.	There is the potential that dust may affect the growth of plants that provide seeds this species forages on; however, these effects occur on a different temporal scale as the plants that shed seeds do so during the wet season where dust is less of an issue. Overall, impacts are considered negligible. No area has been quantified because the risk is considered negligible.		Not applicable.	Not applicable.			Potential to be repeated.	Known and reversible.	Dust suppression methodologies will be sufficient to suitably reduce the risk of dust to as low as reasonably practicable.	No significant impacts are considered likely as a result of this Project.
Impacts from noise and vibration	Noise from traffic and industrial sources can have significant detrimental impacts on fauna (Shannon, et al., 2016; Cunnington & Fahrig, 2010; Barber, et al., 2010). The Project is located on a busy highway (Saraji Road), immediately west of a large mining operation. The increase in noise resulting from the amendment is therefore expected to be negligible relative to existing background noise. Nevertheless, there may be localised disturbance from noise where operational areas are close to (e.g., within 500 m of) habitats for threatened fauna (e.g., Greater	Areas adjacent to haul roads utilised as foraging areas by Squatter Pigeons may be affected by noise within the disturbance footprint, noting this is unlikely given the species is commonly found foraging along noisy areas such as roads and cattle yards. 2515.66 ha of Squatter Pigeon habitat is within 500 m of the area most likely to cause disturbance, though only 100 m or less directly adjacent to the Project is likely to be affected, if at all.		Not applicable.	There is a potentially positive indirect effect, where the noise may scare off predators, given this species is ground dwelling and susceptible. Impacts will only last for 9 years maximum.		Not applicable.	Not applicable.			Likely to be ongoing throughout the operational life of the Project.	Known and reversible.	Mitigation measures provided in **Table 7-1**.	No significant residual impacts are anticipated as a result of this Project.

Threat	Effect of Vulcan South	Direct			Indirect			Facilitated			Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
		Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning / Rehabilitation	Construction	Operation/ Maintenance	Decommissioning / Rehabilitation				
	Gliders, Koalas). Any effects of noise will be restricted to the operational life of the Project.	Impacts will only last for 9 years maximum.												
Blasting	Noise and vibration specifically from blasting may disturb this species.	Noise and vibration due to blasting may disturb any Squatter Pigeons in or near the disturbance footprint, resulting in behavioural changes which impact the normal routines of this species and abandon nearby habitat. The impact from Vulcan South is unlikely to be a significant addition in light of existing surrounding mining projects. Impacts are likely to be short lived. The area of impact is the same as for noise and vibration. The impact from Vulcan South is unlikely to be a significant addition in light of existing surrounding mining projects. this disturbance is short-term, lasting only for the duration of the operations (9 years).		Not applicable.	Not applicable.		It is possible that behavioural changes resulting from blasting disturbance may contribute to a slow reoccupation of habitat once rehabilitation has commenced. Any behavioural changes are not expected to be permanent.	Not applicable.			During the Project's operation.	Known and reversible.	Blasting will be in line with EA approved trigger limits, see **Appendix E**	No significant impact is considered likely.
Impacts from lighting	The Project operates 24 hours per day, which requires flood-lighting around operational areas. Artificial lighting can impact fauna through interfering with the navigation of nocturnal species (Howell, et al., 1954; Salmon, et al., 1995; Poot, et al., 2008; Longcore, et al., 2012) interrupting natural patterns of sleep and cell repair (Ben-Shlomo & Kyriacou, 2010), exposing nocturnal prey to elevated predation risks (Baker & Richardson, 2006; Rotics, et al., 2011; Davies, et al., 2012) disturbing the timing of daily movements.	Haul roads may be affected by lighting within the disturbance footprint. Squatter Pigeons are unlikely to roost in these areas, and if they are to roost, impacts will only last 9 years maximum.		Not applicable.	2515.66 ha of Squatter Pigeon habitat is within 500 m of the area most likely to cause disturbance. Impacts will last 9 years maximum. Another potential indirect impact is the increased lighting may make individuals more susceptible to predation; however, the impact of noise would likely scare away predators, thus the net effect would be negligible. Impacts will only last for 9 years maximum.		Not applicable.	Not applicable.			Likely to be ongoing throughout the operational life of the Project.	Known and reversible.	See artificial lighting mitigation measures in **Table 7-1**	No significant residual impacts are anticipated as a result of this Project.
Waste	Food waste in particular has the likelihood of attracting cats, dogs, rats, foxes and pigs. Considering that the kitchen is offsite in an existing facility, and waste bins will be provided and emptied daily, the chances of elevated feral predators is unlikely to be more than negligible. Other waste not considered to have a high likelihood of contaminating is handled according to the waste management plan.	Not applicable.			Potential of food waste to attract and concentrate feral species. Once operational, the Project is unlikely to be habitat for MNES, and waste will be handled according to the waste management plan. Impacts will be negligible.		Not applicable.	Not applicable.			Potential to be repeated.	Known, reversible.	In accordance with Approved Vulcan South EA- A waste management plan will be completed.	Unlikely to be a significant impact resulting from this Project.
Highwall Mining	Highwall mining will not be likely to affect the habitat above. Dust and noise is a possibility but unlikely to be more than negligible.	The Greater Glider is not expected to be impacted by highwall mining. The area above highwall mining panel will not be cleared, and no subsidence is expected. The only area cleared will be the bench. Trees above the highwall mining trial area are not GDEs and therefore any impacts on groundwater (which will be negligible) are irrelevant.									No.	Known, predictable.	Impacts to habitat above the Highwall are unlikely to require further mitigations.	No significant impacts are expected as a result of this project.

6.1.5 Impacts to White-throated Needletail

There were no observations of White-throated Needletail within the Project area across the entirety of the field survey effort, which included dedicated/targeted bird surveys conducted in a range of habitats in suitable periods when White-throated Needletail is considered active. Due to records within the broader locality, it is considered that the species would occur within the Project area, however it would likely be as an aerial fly over only. Climate change is not listed as a threat for this species within the conservation advice (Threatened Species Scientific Committee, 2019). Effects of climate change on the White-throated Needletail are not expected to be exacerbated by the Project.

Within Australia the threats to this species are not as severe as within their breeding habitats or along migration routes outside Australia. Within Australia, the following threats are considered in the conservation advice for the species (Threatened Species Scientific Committee, 2019):

- Loss of roosting trees
- Loss of habitats that provide flying insects
- Wind turbines
- Poisoning by bioaccumulation of organochlorines.

An assessment of impacts of the Project to White-throated Needletail, including direct, indirect and facilitated threats, is detailed below in **Table 6-5**.

Table 6-5 Impact assessment for White-throated Needletail

Threat	Effect of Vulcan South	Direct			Indirect			Facilitated			Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
		Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning / Rehabilitation	Construction	Operation/ Maintenance	Decommissioning / Rehabilitation				
Threats Identified in the SPRAT Database														
Clearing / loss of habitats that provide flying insects	Clearing vegetation will have negligible effects on the habitat of the White-Throated Needletail, due to this species' aerial foraging and dispersal. The species is not likely to directly use the habitats within the Project area. Roosting opportunities are addressed below.	No direct effects are likely for the White-Throated Needletail as a result of habitat clearing.			Possible indirect effects to the White-Throated Needletail as a result of construction and operation would include a slight loss in flying insects over the Project area, though this is likely to be negligible at best.		Rehabilitation is likely to increase foraging opportunities with the return of flying insects to the area, however this is likely to be a negligible increase at best.	No facilitated effects to the White-Throated Needletail are likely as a result of this Project			Not repeatable	Predictable, reversible	Not applicable	Significant impact is unlikely
Introduction of weeds	Weeds may have some effect on the White-Throated Needletail through changes to flying insect availability, though this is expected to be negligible or unlikely.	Weeds are unlikely to affect the White-Throated Needletail as it is an aerial species within the Project area.									Unlikely to be repeated	Unknown	Weeds are handled as per the Weed Management Plan, which is a requirement under the Project's EA.	No Significant Impact is likely
Threats Specific to Vulcan South														
Impacts from Dust	Dust can impact nearby vegetation by blocking photosynthesis and increasing leaf temperature; both impacts can reduce drought tolerance (Farmer, 1993). Dust that is severe enough to inhibit plant growth is only likely where vegetation is close to (within 100 m of) the source (roads, operational areas).	Not applicable.			Not applicable.			Not applicable.			Not applicable to this species	Known and reversible.	Dust suppression methodologies will be sufficient to suitably reduce the risk of dust to as low as reasonably practicable.	No significant impacts are considered likely as a result of this Project.
Blasting	Noise and vibration specifically from blasting may disturb this species.	Noise and vibration due to blasting may disturb any White-throated Needletails in or near the disturbance footprint. However, this species only occupies the airspace above the Project area (if present at any one time). Any impacts are therefore likely to be extremely minor. Further, the impact from Vulcan South is unlikely to be a significant addition in light of existing surrounding mining projects. Blasting will occur for a maximum of 9 years, during the construction and operational phase.		Not applicable.	Not applicable.			No facilitated impacts are anticipated.			Not likely to be repeated following end of blasting schedule	Unpredictable, short term and reversible	Blasting will be in line with EA approved trigger limits, see **Appendix E**.	No significant impact expected
Loss of roosting trees	This species is known to roost at night in large trees or cliff edges	No suitable trees of a size that would facilitate roosting were found within or adjacent to the Project area.									Not applicable	Not applicable	None required	No significant Impact expected
Wind turbines	This species is known to collide with wind turbines	No wind turbines are expected to be built within the Project area in the foreseeable future.									Not applicable	Not applicable	None required	No significant Impact expected

Threat	Effect of Vulcan South	Direct	Indirect	Facilitated	Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
Poisoning by bioaccumulation of organochlorines.	Build-up of agricultural toxins in the food chain may be a threat to the White-Throated Needletail.	The Project is not likely to release organochlorides as these compounds (such as DDT) are no longer in use in Australia.			Not repeatable	Known	None required	No Significant Impact expected as a result of this Project

6.1.6 Impacts to Insectivorous woodland bird species

Impacts to the Insectivorous Woodland Birds are listed as follows, taken from SPRAT and, preferably, the conservation advice or referral guidelines. **Table 6-6** below assesses these threats and other Project-specific threats.

Rufous Fantail and Satin Flycatcher

- fragmentation and loss of core moist forest breeding habitat through land clearing and urbanisation;
- weeds such as the Rubber vine; and
- invasive species such as the Black rat.

Black-faced Monarch

- individuals occasionally collide with windows;
- invasive species such as the black rat; and
- weeds such as the Rubber vine.

Oriental Cuckoo

- none listed, but habitat loss is likely a key threat.

Table 6-6 Impact assessment for insectivorous woodland bird species

Threat	Effect of Vulcan South	Direct			Indirect			Facilitated			Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
		Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation	Construction	Operation/ Maintenance	Decommissioning / Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation				
Threats Identified in the SPRAT Database														
Fragmentation and loss of core moist forest breeding habitat through land clearing and urbanisation	Vulcan South will remove habitat that is confirmed as habitat for the Rufous Fantail and has been mapped as habitat the other species may occur in. 1503.3 ha in total is expected to be cleared.	During construction, the removed habitat will be an impact, though is unlikely to be a Significant Impact as habitat will not meet the definition of "important habitat" as outlined in Section 5.	No further threats to the listed species are expected after the construction phase.	Rehabilitation is expected to restore habitat values.	Indirect and facilitated effects are not considered likely due to habitat removal being a direct impact.						Unlikely to be repeated	Known and predictable	None required beyond rehabilitation	Significant Impact unlikely, as important habitat is not present (refer to Section 5)
Collision with windows	Only a listed threat for the Black-faced Monarch	There is a small, no more than negligible chance of collision with windows for this species if windows are present.			Collisions with windows are a very direct threat						Possibly repeated, unlikely on an individual level	Unpredictable	None required	Although an impact individually, unlikely to be a Significant Impact as defined by the Significant Impact Guidelines 1.1
Introduction of weeds	Weeds such as rubber vines can choke out and otherwise change the characteristics of riparian vegetation, therefore can seriously affect nesting habitats for some species.	Weeds may be introduced, however will be managed as per the General Biosecurity Obligations (GBO) within Queensland.	Weeds may be introduced or spread in soil movement operations if not managed correctly	Weeds may be introduced during rehabilitation and may cause problems for nesting birds if not managed.	Windblown weeds may be spread from the Project area to surrounding areas if weeds are not managed.			No facilitated impacts are expected.			Potential for repetition	Predictable, reversible	Weeds will be managed according to State General Biosecurity Obligations and rehabilitation targets as per the PRCP	Significant Impacts unlikely if management measures are followed.
Black rats	Black rats may raid nests and feed on the eggs or chicks of some species.	The Project is unlikely to directly introduce rats to the area as rats are already present.			Rats may potentially be increased if there is access to waste in the Project area. This is unlikely to affect nesting habitats of birds, as these nesting habitats will not exist at the same time as rat numbers would be expected to potentially climb.			Facilitated impacts unlikely.			Repetition is possible	Unpredictable	Waste management plans are adequate to manage this threat	No significant impact is likely.
Threats Specific to Vulcan South														
Impacts from Dust	Dust can impact nearby vegetation by blocking photosynthesis and increasing leaf temperature; both impacts can reduce drought tolerance (Farmer, 1993). Dust that is severe enough to inhibit plant growth is only likely where vegetation is close to (within 100 m of) the	Not applicable.			Not applicable.			Not applicable			Potential to be repeated.	Known and reversible.	Dust suppression methodologies will be sufficient to suitably reduce the risk of dust to as low as reasonably practicable.	No significant impacts are considered likely as a result of this Project.

Threat	Effect of Vulcan South	Direct	Indirect	Facilitated	Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
	source (roads, operational areas).							
Blasting	Blasting	Noise and vibration specifically from blasting may disturb this species for a maximum of 9 years. Noise and vibration due to blasting may disturb any birds in or near the disturbance footprint. However, this species only occupies the airspace above the Project area (if present at any one time). Any impacts are therefore likely to be extremely minor. Further, the impact from Vulcan South is unlikely to be a significant addition in light of existing surrounding mining projects.	Not applicable.	Noise and vibration due to blasting may disturb any birds in or near the disturbance footprint. However, this species only occupies the airspace above the Project area (if present at any one time). Any impacts are therefore likely to be extremely minor. Further, the impact from Vulcan South is unlikely to be a significant addition in light of existing surrounding mining projects.	Potential to be repeated.	Not applicable.	No facilitated impacts are anticipated.	Not likely to be repeated following end of blasting schedule

6.1.7 Impacts to Migratory wetland bird species

The Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species (Department of the Environment and Energy, 2017b) outlines threats to migratory shorebird species, despite being intended for sandpipers and plovers, these may apply to species with broadly similar feeding habits such as the Glossy ibis. The listed threats are as follows:

- habitat loss;
- habitat degradation;
- disturbance;
- direct mortality; and
- climate change

These threats are assessed below, in addition to project-specific threats in **Table 6-7**. Note that the Yellow Wagtail is considered a wetland species due to the species' affinity with wetlands and open areas, but significant impacts are considered unlikely for the reasons and government guidance as addressed in **Section 5.7.7**. Note that none of these species are considered to have any "important habitat" as addressed in **Section 5.7**. There is a total of 2.6 ha of habitat considered to be within the Project area, though this is unlikely to be used to the point that the species are considered as "May occur" species. All are considered to have less habitat in this calculation than exists in reality and species are all assessed highly conservatively.

Table 6-7 Impact assessment for migratory wetland bird species

Threat	Effect of Vulcan South	Direct			Indirect			Facilitated			Repeated	Unknown, Unpredictable, Irreversible	Mitigation Measures	Significant Residual Impact
		Construction	Operation/ Maintenance	Decommissioning / Rehabilitation	Construction	Operation/ Maintenance	Decommissioning / Rehabilitation	Construction	Operation/ Maintenance	Decommissioning/ Rehabilitation				
Threats Identified in the approved referral guidelines														
Habitat loss and Habitat degradation	Habitat loss and degradation will remove or decrease the utility of areas the species may use to forage or rest.	The Project will remove 2.6 ha of habitat for these species. Rehabilitation is expected to restore habitat values.			Habitat loss and degradation is considered a direct threat.						Not likely to be repeated	Predictable, reversible	Habitat rehabilitation following closure	An absence of "important habitat" translates to impacts not being significant
Disturbance	See "blasting" below													
Direct mortality	Killing of individual birds by shooting, collisions with equipment or other means is not likely to kill any birds on this Project, let alone enough to cause a significant impact. This is due to the already low likelihood of occurrence, and the almost immediate removal of the habitat that would attract these species to the area.										Unlikely	Unlikely	None required	Significant impacts unlikely
Climate change	Climate change is not likely to be exacerbated by this project in a way meaningful enough to cause a measurable impact.										Unlikely	Unlikely	None required	Significant impacts unlikely
Threats Specific to Vulcan South														
Impacts from Dust	Dust can impact nearby vegetation by blocking photosynthesis and increasing leaf temperature; both impacts can reduce drought tolerance (Farmer, 1993). Dust that is severe enough to inhibit plant growth is only likely where vegetation is close to (within 100 m of) the source (roads, operational areas). Dust can impact nearby vegetation by blocking photosynthesis and increasing leaf temperature; both impacts can reduce drought tolerance (Farmer, 1993). Dust that is severe enough to inhibit plant growth is only likely where vegetation is close to (within 100 m of) the source (roads, operational areas).	Not applicable.			Not applicable.			Not applicable			Potential to be repeated.	Known and reversible.	Dust suppression methodologies will be sufficient to suitably reduce the risk of dust to as low as reasonably practicable.	No significant impacts are considered likely as a result of this Project.
Blasting	Blasting, if adjacent to occupied habitat may disturb migratory wetland birds.	By the time blasting commences there will be no habitat present.		No blasting is to occur during rehabilitation	Blasting is not scheduled for the construction phase	By the time blasting commences there will be no habitat present.	No blasting is to occur during rehabilitation	Blasting is not scheduled for the construction phase	By the time blasting commences there will be no habitat present.	No blasting is to occur during rehabilitation	Not applicable.	Not applicable.	Not applicable.	No significant impacts anticipated

6.2 Significant Impact Assessment

A Significant Impact Assessment has been undertaken for MNES species and the Brigalow TEC which have been confirmed or assessed as likely to be present at the Project area.

MNES determined to be "may occur" or "unlikely" to occur matters have been omitted from further assessment because a likely significant impact is not considered possible based on likelihood of presence.

6.2.1 Brigalow (*Acacia harpophylla* dominant and co-dominant) – Endangered

Brigalow, as a TEC has been confirmed within the Project area and is assessed against the Commonwealth criteria specific to Critically Endangered and Endangered TECs, provided in **Table 6-8**.

Table 6-8 Assessment of Brigalow TEC against the MNES criteria for Critically Endangered and Endangered TECs

MNES criteria (Critically Endangered and Endangered ecological communities	Assessment against criteria
Reduce the extent of an ecological community	**YES** The ecological community will be reduced by **71.2** ha. No lower limit to significance thresholds is given for Brigalow, other than the requirement for a patch to be over 0.5 ha in area to qualify as the TEC.
Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines	**NO** The Brigalow in the Project area is already isolated and fragmented from other Brigalow patches, these patches within the Project footprint will be cleared entirely.
Adversely affect habitat critical to the survival of an ecological community	**YES** Habitat buffering the Brigalow TEC will also be removed.
Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns	**NO** No Brigalow will remain within or directly adjacent to the Project footprint.
Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting	**NO** The patches of Brigalow TEC within the Project area will be cleared, therefore other substantial changes are not applicable.
Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: – assisting invasive species, that are harmful to the listed ecological community, to become established, or – causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community	**NO** The patches of Brigalow TEC within the Project area will be cleared, therefore other substantial changes are not applicable.
Interfere with the recovery of an ecological community	**NO** The Brigalow in the Project footprint is not part of a specific recovery effort. Rehabilitation of the site following mine closure is planned.
YES The Project will cause a Significant Impact to the Brigalow TEC under the MNES Significant Impact criteria.	

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

The Koala, as an Endangered species is assessed against the Commonwealth criteria specific to Critically Endangered and Endangered species. Assessment is provided in **Table 6-9**.

Table 6-9 Assessment of the Koala against the MNES criteria for Critically Endangered and Endangered species

MNES criteria (Critically Endangered and Endangered species)	Assessment against the criteria
Lead to a long-term decrease in the size of a population	**NO** In the short-term there will be a decline of the local population within the Project footprint, however this is likely to be reversed with the rehabilitation of the site following closure. In the meantime, the species is already sparsely populated in the region and has sufficient habitat to occupy offsite.
Reduce the area of occupancy of the species	**NO** The Project is not on the edge of the species' distribution. Habitat loss is further assessed below.
Fragment an existing population into two or more populations	**NO** The Project will not provide additional barriers to movement for the species as it is abutting existing areas of removed habitat. Regardless, the effects of the Project as far as Koalas are concerned will be reversed during rehabilitation.
Adversely affect habitat critical to the survival of a species	**YES** Due to the removal of 1,166.9ha of habitat, the adverse effect to habitat critical to the survival of the species is triggered.
Disrupt the breeding cycle of a population	**NO** Koalas do not have specific breeding locations or requirements other than other Koalas of the opposite gender and safe habitats to retreat to. Breeding is therefore unlikely to be specifically affected on a population level.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**NO** Despite removal of habitat in the short term, habitat will be rehabilitated following mine closure.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	**NO** No habitat will remain within the Project footprint to be affected by weeds. It is unlikely that the Project itself will introduce novel weeds to the region, especially considering that the region is already heavily modified and intersected by main roads. The Project will not directly or indirectly increase the local populations of feral dogs
Introduce disease that may cause the species to decline	**NO** The Project will not involve the moving of animals or material likely to spread pathogens that may affect Koalas.
Interfere with the recovery of the species	**NO** The Project will not specifically interfere with the recovery plan for the Koala.
YES **The Project will cause a Significant Impact to the Koala under the MNES Significant Impact criteria.**	

6.2.3 Greater Glider (southern and central) (*Petauroides volans*) – Endangered

The Greater Glider, as an Endangered species is assessed against the Commonwealth criteria specific to Critically Endangered and Endangered species. Assessment is provided in **Table 6-11**.

Fragmentation

Vulcan South is located alongside Saraji Road, and beside large coal projects to the east. As the project is adjacent to existing disturbance, the extent of habitat fragmentation resulting from Vulcan South is limited. Nevertheless, the proposed haul road that connects the various pits will lead to the introduction of barriers to dispersal in four places along its length (**Figure 6-1**).

Greater Gliders preferred mode of locomotion is via gliding between trees, so any habitat gaps that are introduced that are wider than the gliding distance of a Greater Glider potentially impede movement. Glide angles of 31° to 40° have been published for the Greater Glider (Wakefield, 1970), (Taylor & Goldingay, 2009), which allow for a gliding distance that is 1.2 to 1.6 times the height of the trees. Based on habitat quality data, the heights of trees and likely gliding distances are presented in **Table 6-10** below.

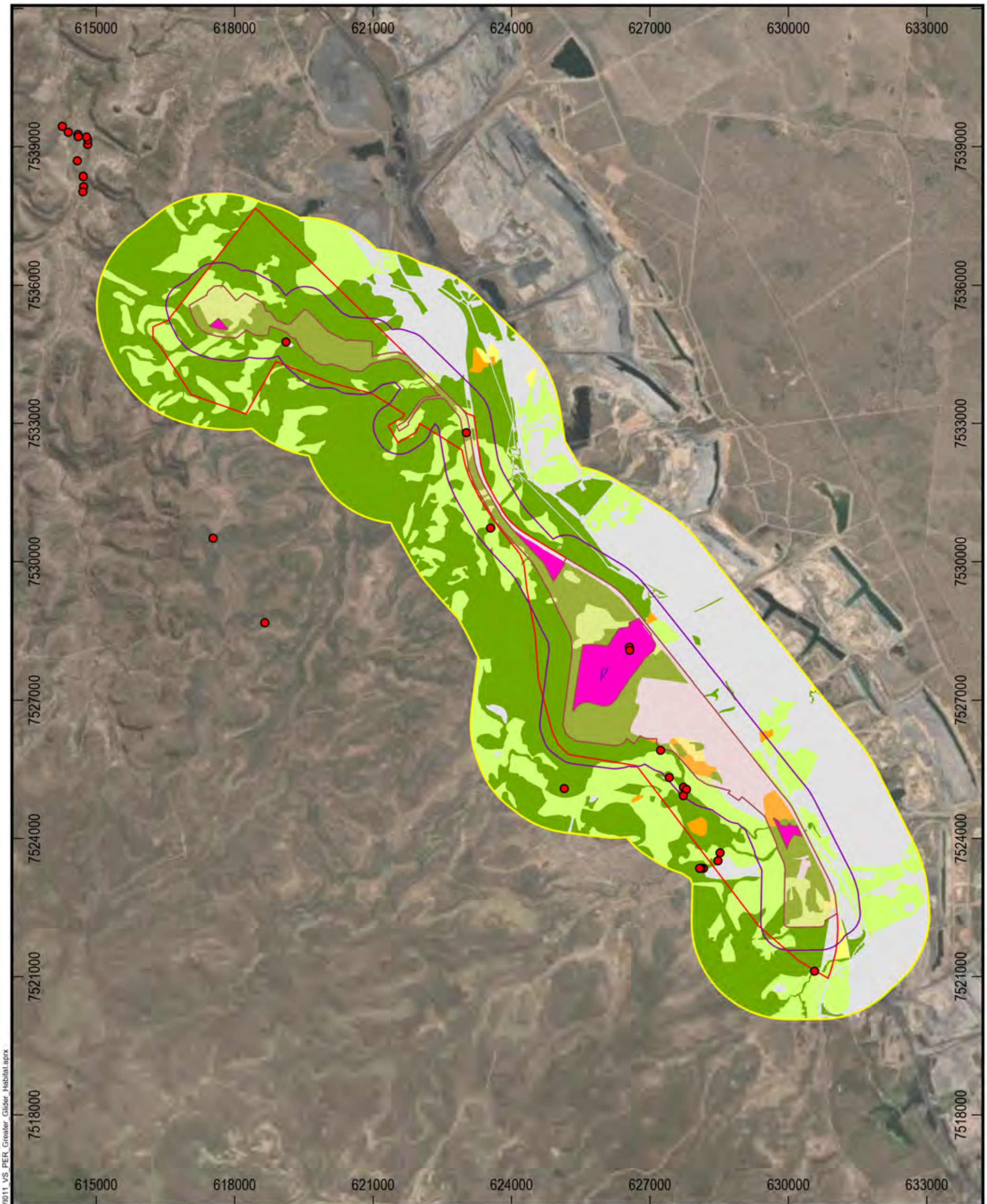
Table 6-10 Estimated gliding distances in the vicinity of the haul road

Barrier*	Average Tree height	Glide distance
A	12.5 m	15-20 m
B	11.1 m	13.3-17.8 m
C	13 m	15.6-20.8 m
D	18.8 m	22.6-30.1 m

*Listed from north to south

As the haul road is proposed to be 30 m wide, up to 17.7 m of walking will be required for Greater Gliders to cross this road. No fences or other obstacles to movement are proposed to be installed along the haul road, to facilitate movement across the ground. No studies have explicitly examined what amount of walking is acceptable to a dispersing Greater Glider. However, it can be conservatively assumed, based on the behaviour of other gliders, that this haul road will represent a partial barrier to the movement of Greater Gliders. Studies of other glider species found that only a small amount of dispersal across linear barriers (1% probability that an individual passes the partial barrier) is sufficient to maintain population viability on either side (Goldingay, et al., 2013).

Greater Gliders are known to disperse through regrowth vegetation (Eyre, et al., 2022), and isolated habitat patches will regain connectivity to neighbouring habitat within 15 years of closure. In total, these habitat patches will remain partially isolated for approximately 25 years.



Legend

- Greater Glider Sightings

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- 500m Indirect Impact Buffer
- 2 km Buffer

Greater Glider Habitat (Current)

- Likely/Current Denning
- Potential/Future Denning
- Dispersal
- Foraging
- Non-habitat
- Potential Habitat Fragmentation

Source: Vitrinite 2024, METServe 2020-2024, Earthstar Geographics

Vulcan South

Greater Glider Potential Habitat Fragmentation

0 1 2 4

Kilometers

Scale: 1:120,000 (A4)

24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 6-1

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Table 6-11 Assessment of the Greater Glider against the MNES criteria for Critically Endangered and Endangered species

MNES criteria (Critically Endangered and Endangered species)	Assessment against the criteria
Lead to a long-term decrease in the size of a population	**NO** Planned habitat removal will be temporary, and is expected to be rehabilitated following mining, though it is acknowledged that this will take many years to occur.
Reduce the area of occupancy of the species	**YES** The area of occupancy of the species will be somewhat reduced, however this is not at the edge of distribution.
Adversely affect habitat critical to the survival of a species	**YES** This project will remove 1056.8 ha of habitat.
Disrupt the breeding cycle of a population	**NO** The Project will not specifically disrupt the breeding cycle of the Greater Glider, as it will remove habitat which is addressed in the above criteria.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**YES** This project will destroy habitat during the construction and operational phases.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	**NO** Habitat will be removed and therefore unaffected by weeds and the weed management plan will address the issues of weeds as an edge effect and suitably mitigate them.
Introduce disease that may cause the species to decline	**NO** No disease has been mentioned in the conservation advice that would likely affect this species
Interfere with the recovery of the species	**NO** This Project will not likely interfere directly with the recovery of this species as no specific plan exists.
YES **The Project will cause a Significant Impact to the Greater Glider under the MNES Significant Impact criteria.**	

6.2.4 Squatter Pigeon (southern) (*Geophaps scripta scripta*) – Vulnerable

The disturbance footprint contains the following habitat for the Squatter Pigeon:

- breeding and Foraging: 372.5 ha;
- foraging: 78.9 ha; and
- dispersal: 767.6 ha.

Habitat within a 500m indirect impact buffer around the Project contains the following habitat:

- breeding and Foraging: 858.8 ha;
- foraging: 338.7 ha; and
- dispersal: 1318.2 ha.

The size of the average home range of a pair of Squatter Pigeons is not known, but the related Partridge Pigeon (*Geophaps smithii*) is thought to occupy a home range of approximately 8 ha (Fraser, et al., 2003). Assuming Squatter Pigeons are similar—a likely scenario, given their similar biology—the project could impact up to 54 breeding pairs of Squatter Pigeons.

This is very likely to be an over-estimate, and occupancy rates of 50% within potential habitat are more consistent with rates of detection in the field. This implies an expected loss of habitat for up to 27 pairs of Squatter Pigeons.

An additional 170 ha of breeding habitat was or is approved to be removed for the neighbouring Vulcan Coal Mine. Assuming habitat from the Vulcan Coal Mine is not rehabilitated prior to the commencement of Vulcan South, breeding habitat for 102 pairs will be retained in the local landscape throughout the project (assuming each pair occupies 8 ha and 50% of available territories are occupied). The estimated size of this retained local population is highly conservative, as it does not include contiguous habitat west and south of the survey area. It is more likely that habitat for several hundred pairs will be retained in the local region, supporting a viable population that will serve as a source of recruitment for rehabilitated land post-mining.

The impacts of habitat clearance will persist at least for the short- to medium-term, until vegetation is re-established on mined land. Being a ground-dwelling bird, they are not dependent on old trees, and rehabilitated sites are expected to meet their requirements for a low, protective tree cover within 15 years post-rehabilitation (Ngugi & Nelder, 2015). It is unknown whether the relatively simple understorey vegetation communities that typically establish on rehabilitated sites (Grigg, et al., 2000; Ngugi & Nelder, 2015) will meet the ecological needs of Squatter Pigeons. Their readiness to feed on introduced pasture species such as *Urochloa mosambicensis* and *Stylosanthes* spp. (Crome, 1976)(C. Wiley pers. obs. 2019) suggests that re-establishing appropriate food plants is likely to be achievable. Consequently, it is estimated that the duration of impacts will be approximately 24 years, although this estimate has low confidence, given the lack of data on the dietary requirements of the species. See table below.

Table 6-12 Assessment of the Squatter Pigeon against the MNES criteria for Vulnerable species

MNES criteria (Critically Endangered and Endangered species)	Assessment against the criteria
Lead to a long-term decrease in the size of a population	**NO** In the long term, it is likely that the Squatter Pigeon will readily return to the rehabilitating habitat post-mining more quickly than the other Threatened species.
Reduce the area of occupancy of the species	**NO** The Project is not located near the edge of the species' range and is unlikely to remove enough habitat to be considered a reduction in area of occupancy.
Fragment an existing population into two or more populations	**NO** The Project is not positioned in an area that will become two habitat blocks, and this species is capable of flight, so fragmentation of the population is unlikely.
Adversely affect habitat critical to the survival of a species	**YES** 1,219.1 ha of habitat in total (see details in **Section 5.6.1.8**) will be removed for the operational life of the Project.
Disrupt the breeding cycle of a population	**NO** The Project will remove habitat, which is a greater impact than disruption of breeding, though it is acknowledged that breeding will not occur where habitat does not exist.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**YES** Habitat quality and availability will be affected by removal. Declines will, however, be minor and likely affect the species for the operational stages of the mine prior to rehabilitation.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	**NO** Invasive species that are likely to negatively affect the Squatter Pigeon are already well established in the region and it is unlikely that the Project will introduce additional pest species.
Introduce disease that may cause the species to decline	**NO**

MNES criteria (Critically Endangered and Endangered species)	Assessment against the criteria
	Disease is not likely to be introduced as a result of the Project as birds and other infectious material is not likely to be transported into the Project area or surrounds.
Interfere with the recovery of the species	**NO** There are no adopted or made recovery plans for this species in effect at the time of assessment.
YES **The Project will cause a Significant Impact to the Squatter Pigeon under the MNES Significant Impact criteria.**	

6.2.5 White-throated Needletail and Fork-tailed Swift

These two species are known from the area, and the White-throated Needletail has been observed overflying the Project area. Despite being subjected to different significant impact criteria, no habitat these species use directly for shelter or breeding will be affected.

Both species are aerial insectivores that are unlikely to land in any trees or directly use any habitat within, or adjacent to the Project. As a result, no impacts, significant or otherwise are anticipated for these species.

Assessments are provided in **Table 6-13** and **Table 6-14**.

Table 6-13 Assessment of White-throated Needletail against the MNES criteria for Vulnerable species

MNES criteria (Vulnerable species)	Assessment against the criteria
Lead to a long-term decrease in the size of an important population of a species	**NO** The Project is not likely to directly affect any individuals or a significant proportion of their food supply to an extent that a decline is likely.
Reduce the area of occupancy of an important population	**NO** The species is not dependent on any terrestrial habitat features that may be impacted by the species.
Fragment an existing important population into two or more populations	**NO** The White-throated Needletail is not subject to fragmentation as it is an aerial species capable of overflying or circumventing any barriers this Project would otherwise introduce to the landscape.
Adversely affect habitat critical to the survival of a species	**NO** No terrestrial habitat present in the disturbance footprint is likely to be used by this species directly.
Disrupt the breeding cycle of an important population	**NO** An important population is not in the vicinity of the Project and this species does not breed in Australia; therefore, the Project will not disrupt any breeding cycles.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**NO** As this species is unlikely to utilise habitat in the Project’s vicinity, Project activities will not impact any habitat to the extent that this species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species’ habitat	**NO** Invasive species are not considered a specific threat, and the Project is not likely to introduce invasive species to the Project are which are not already present in the region.

MNES criteria (Vulnerable species)	Assessment against the criteria
Introduce disease that may cause the species to decline	**NO** Disease is not listed as a threat to the species.
Interfere substantially with the recovery of the species	**NO** There are no adopted or made recovery plans for this species in effect at the time of assessment.
NO This Project was assessed against the Significant Impact Criteria for the White-throated Needletail as a Vulnerable species, and it was determined that a Significant Impact is **not** likely to occur.	

Table 6-14 Assessment of White-throated Needletail and Fork-tailed Swift against the MNES criteria for Migratory species

MNES Criteria (Migratory Species)	Assessment against the criteria
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.	**NO** Important habitat is not in the vicinity of the Project; therefore, the Project will not impact important habitat.
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species.	**NO** Invasive species are not considered a specific threat, and the Project is not likely to introduce invasive species to the Project are which are not already present in the region.
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	**NO** An important population is not in the vicinity of the Project as these species are wide ranging and likely to only pass over occasionally. Furthermore, these species do not breed in Australia; therefore, the Project will not disrupt these species' lifecycles.
NO This Project was assessed against the Significant Impact Criteria for the White-throated Needletail and Fork-tailed Swift as Migratory species, and it was determined that a Significant Impact is not likely to occur.	

6.2.6 Ornamental Snake

The ornamental Snake was determined as unlikely to occur within the Project area as provided within **Section 5.6.5**. However, the department has requested additional information to be provided for this species and therefore an assessment of impact significance is provided below.

Significant impacts to matters of national environmental significance must be approved by the Australian Government and are typically conditional on environmental offsets. Two documents advise how the significance of impacts is to be assessed for the Ornamental Snake. These are discussed below.

6.2.6.1 Matters of National Environmental Significance Significant Impact Guidelines 1.1

According to this guideline, "*an action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:*

- *lead to a long-term decrease in the size of an important population of a species*
- *reduce the area of occupancy of an important population*
- *fragment an existing important population into two or more populations*
- *adversely affect habitat critical to the survival of a species*

- *disrupt the breeding cycle of an important population*
- *modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline*
- *result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat*
- *introduce disease that may cause the species to decline, or*
- *interfere substantially with the recovery of the species.*"

"Important populations" are defined by the guideline as "*a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:*

- *key source populations either for breeding or dispersal*
- *populations that are necessary for maintaining genetic diversity, and/or*
- *populations that are near the limit of the species' range.*"

Habitat at Vulcan South is not likely to contain an important population of Ornamental Snakes. The project is not near the limit of the species' range and does not support a source population. It does not qualify as habitat critical to the survival of the species, as it does not provide areas favourable for foraging, shelter or dispersal. The species is unlikely to decline as a result of the habitat removal, as this habitat is unoccupied and isolated from occupied habitats. The project will not move pathogens or potentially infected animals, so will not introduce disease. The project will not introduce feral predators. The Cane Toad, the principal invasive species thought to threatened the Ornamental Snake, is already widespread at the site. New weeds may become established during mining operations, but it is unlikely that these would be harmful to Ornamental Snakes, given that the species is unlikely to occur on site, and foraging and shelter resources are unlikely to be affected by weeds.

The proposed Vulcan South Coal Mine does not trigger any of the criteria for a significant impact on the Ornamental Snake based on definitions in the *Matters of National Environmental Significance Significant Impact Guidelines 1.1*.

6.2.6.2 Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles

Definitions of significant impacts provided this guideline are based on the nine criteria listed in the *Matters of National Environmental Significance Significant Impact Guidelines 1.1*, but with the following variations:

- Important habitat is defined as habitat (a) where the species has been identified during a survey, (b) near the limit of the species' known range, (c) in large, contiguous patches and viable landscape corridors (necessary for the purposes of breeding, dispersal or maintaining the genetic diversity of the species over successive generations), or (d) of a type where the species is identified during a survey, but which was previously thought not to support the species.
- Important habitat for the Ornamental Snake is further described as "*gilgai depressions and mounds*…[noting] *habitat connectivity between gilgais and other suitable habitats is important*".

Despite the presence of gilgais on site, these do not meet the definition of important habitat as they are not connected to other suitable habitats and are too shallow to support large frog populations and hence Ornamental Snakes. The species was not recorded on site, and the site is not located in large, connected patches of suitable habitat.

The *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles* also lists examples of actions that have a high or uncertain risk to the Ornamental Snake (**Table 6-15**). The proposed Vulcan South Coal Mine will not cause any of these impacts and is therefore a low risk of causing a significant impact to the Ornamental Snake.

Table 6-15 Examples of high-risk significant impacts listed by the Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles

Examples of high-risk significant impacts	Vulcan South Coal Mine
The loss, fragmentation or change in the ecological character or function of important habitat which is likely to adversely affect the recovery of one or more Brigalow Belt reptile species	Important habitat will not be affected by the project.
The fragmentation of important habitat or landscape corridors through the introduction of a barrier to dispersal	No barriers will be introduced within or between important habitats.
The introduction of invasive weeds, including the deliberate or accidental sowing of pasture grasses, within 30 m of important reptile habitat without appropriate and ongoing control measures	The project does not lie within 30 m of important habitat. Sites with gilgais already have a high weed cover (57.6% of groundcover vegetation is non-native). The project will not introduce pasture grasses not already occurring at the site.
Enabling the access of animal pests, including cats, pigs and cane toads, to important reptile habitat without appropriate and ongoing control measures	No important habitat is present in the disturbance footprint. The site already contains cats, pigs and cane toads. The project will not increase populations of these species.
Cattle grazing activities resulting in the degradation of microhabitat features within important habitat patches (for important gilgai habitats, this only applies when gilgais contain surface water)	The site is already grazed by cattle. The project will not introduce cattle to any important habitats.
Alteration of water quality or quantity affecting four or more hectares of important gilgai or riparian habitat	No important habitat is present in the disturbance footprint. Important habitats downstream will be unaffected as (a) these comprise gilgais that do not receive flood waters from creeks that receive water from the project area, and (b) water modelling suggests there will be negligible impacts of the project on water quality within receiving watercourses.
Clearing two or more hectares of important habitat has a high risk of significant impacts, while clearing of between one and two hectares has an uncertain risk.	No important habitat will be cleared.

6.2.7 Migratory Insectivorous Woodland Birds

The Rufous Fantail is known to use habitat within the disturbance footprint. The number of individuals likely to visit the site each year, however, is likely to be very low (less than 10), constituting approximately 0.001-0.002% of the total population. According to the *Draft referral guidelines for 14 listed migratory birds under the EPBC Act* (Department of the Environment, 2015a), the habitat to be cleared is not sufficient to meet the lower significant impact threshold for the southern subspecies which is treated the most conservatively of the subspecies at 113 individuals. See **Table 6-16.**

Table 6-16 Assessment of the Rufous Fantail against the MNES criteria for Migratory species

MNES Criteria (Migratory Species)	Assessment against the criteria
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.	**NO** Habitat to be cleared is not sufficient to meet the lower significant impact threshold.
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species.	**NO** Invasive species are not considered a specific threat, and the Project is not likely to introduce invasive species to the Project are which are not already present in the region.
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	**NO** An ecologically significant proportion of the population is not present in the vicinity of the Project; therefore, the Project is not likely to disrupt this species' lifecycle.
NO This Project was assessed against the Significant Impact Criteria for the Rufous Fantail as a Migratory species, and it was determined that a Significant Impact is not likely to occur.	

6.2.8 Summary of Significant Impact Assessment

Significant impacts as defined in the Significant Impact Guidelines 1.1 (See **Section 9.1**) will occur to the following MNES:

- Brigalow: Based on the criterion that the extent of the ecological community will be reduced by Vulcan South (71.2 ha), the residual impacts to the Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community qualify as significant.
- Squatter Pigeon: loss of 372.4 ha of breeding and foraging habitat, 78.948 ha of foraging (but not breeding) habitat and 767.6 ha of dispersal habitat to the extent that the population is likely to decline, albeit to a limited extent and only temporarily.
- Koala: adverse effect on habitat critical to the survival of the species (habitat used for feeding and resting) by 1,166.9 ha.
- Greater Glider: adverse effect on habitat critical to the survival of a species by 750 ha of likely/current denning habitat, 234.6 ha of potential/future denning habitat, 19.3 ha of foraging habitat and 52.9 ha of dispersal habitat, Vulcan South is likely to significantly impact the Greater Glider.

6.2.9 Cumulative Impact Assessment

A Terrestrial Ecological cumulative impact assessment was undertaken to quantify impacts to terrestrial ecological values, identified in the Vulcan South Terrestrial Ecological Assessment, to comparable projects in the broader region, to estimate the expected quantum of total impacts to these values in a regional context. Most of the projects included in the PER guideline were considered in the cumulative impact assessment subject to availability of data.

This assessment is provided in **Appendix S.** The assessment considered the impacts of projects within:

- The Brigalow Belt North bioregion as defined by the Queensland Government IBRA dataset, with particular attention to the:
  - Northern Bowen Basin sub-bioregion; and
  - The Isaac - Comet Downs sub-bioregion.

In addition, this assessment considered impacts of projects approved and/or commenced within the following time frames:

- no earlier than 01/01/2013; and
- no later than 01/01/2033.

Each project deemed relevant to the purposes of this assessment were searched for impact data within the following documents in order of preference:

- EIS Assessment Reports;
- Significant Impact Assessments (SIA); and
- Environmental Authorities (EA).

The Project will contribute to an impact on the following matters, where data are available:

- Brigalow TEC equivalent REs contained within Vulcan South clearing footprint:
- RE11.4.8:
  - 0.041% of the remnant extent in Isaac – Comet Downs,
  - 2.1% of the remnant extent in the Northern Bowen Basin; and
  - 0.016% of the remnant extent in the total Brigalow Belt North; and
- RE11.4.9:
  - 0.004% of the remnant extent in Isaac – Comet Downs;
  - 0.7% of the remnant extent in the Northern Bowen Basin; and
  - 0.039% of the remnant extent in the total Brigalow Belt North.

For the known habitat clearing for major projects within the Brigalow Belt North sub bioregion (including Isaac-Comet Downs and the Northern Bowen Basin) since January 2013, Vulcan South will include a conservative maximum of:

- 7.4% of the total Koala habitat cleared by similar projects;
- 6.8% of the total Squatter Pigeon (southern) habitat cleared by similar projects; and
- 8.3% of the total Greater Glider habitat cleared by similar projects.

These impacts in respect to Vulcan South and nearby projects are likely to be additive as the quantum of impacts is unlikely to be greater than the sum of the individual impacts as these are generally widely separated. It should also be noted that the actual percentage is likely much lower given the lack of publicly available information on total clearing for project, major or otherwise. Likewise, comparison is difficult or not possible with projects that, for example, were approved and/or commenced prior to species such as the Greater Glider being listed as threatened and with recent changes to habitat definitions that subsequently change the total habitat areas.

6.3 Summary of Impacts to Listed Threatened and Migratory Species and Communities

Listed species and communities will be impacted to varying degrees by the Project as described in preceding Sections. These are summarised below in **Table 6-17**.

Table 6-17 Summary of impact significance

Species or TEC	Habitat description	Likelihood of Occurrence	Direct and indirect impacts	Significance conclusion
Brigalow	Areas dominated by *Acacia harpophylla,* which, in the disturbance footprint is represented by Queensland Regional Ecosystems 11.3.1, 11.4.8 and 11.4.9.	Confirmed present	Direct: • 71.2 will be removed. Indirect: • 47.8 ha is within 500 m of the disturbance footprint and will likely temporarily experience dust	No lower limits are placed on significance of impacts if a patch of Brigalow meets the condition thresholds outlined in the conservation advice for this TEC. **Significant Impact likely**.
Squatter Pigeon	Open grassy woodland near water, with areas of bare ground, on land zones 3, 5 and 7.	Confirmed present	Direct: • 372.5 ha of breeding and foraging habitat will be removed, • 78.9 ha of foraging habitat will be removed, • 767.6 ha of dispersal only habitat will be removed. Indirect: • 858.8 ha of breeding and foraging habitat will be temporarily affected by edge effects (noise, dust) • 338.7 ha of foraging habitat will be temporarily affected by edge effects (noise, dust) • 1318.1 ha of dispersal habitat will be temporarily affected by edge effects (noise, dust)	Habitat for this species will be removed. No lower limit on significance of impacts is given in conservation advice or referral guidelines. **Significant Impact likely**.
Koala (combined populations of QLD, NSW and the ACT)	Vegetation communities containing food trees (Eucalypts and closely related species) especially near watercourses.	Confirmed present	Direct: • 1,166.9 ha of total habitat will be removed, Indirect: • 2,110.9 ha of habitat will be temporarily affected by edge effects such as dust or noise	Habitat for this species will be removed. No lower limit on significance of impacts is given in conservation advice or referral guidelines. **Significant Impact likely**.
Greater Glider	Tall, old-growth eucalypt forest with tree hollows.	Confirmed present	Direct: • 984.6 ha of current or future denning habitat • 19.3 ha of foraging • 52.9 ha of dispersal	Habitat for this species will be removed. No lower limit on significance of impacts is given in conservation

Species or TEC	Habitat description	Likelihood of Occurrence	Direct and indirect impacts	Significance conclusion
			Total: 1,056.8 ha of habitat will be removed. Indirect: • A total of 2,209 ha of habitat may be subject to noise and dust outside the disturbance footprint, temporarily.	advice or referral guidelines. **Significant Impact likely**.
White-Throated Needletail	Almost exclusively aerial, foraging on flying insects above all habitat types.	Confirmed present	No impacts anticipated due to being an aerial species that does not directly interact with habitats within or adjacent to the disturbance footprint.	**No significant impacts are anticipated**.
Rufous Fantail	Dense woody vegetation, including vine thickets, paperbark forests and rainforest.	Confirmed present	Direct: • 474.09 ha of foraging, shelter and dispersal habitat for this species	The habitat is not considered important under the definitions given in the draft referral guidelines. **No significant impacts are anticipated.**
Fork-Tailed Swift	Almost exclusively aerial, foraging on flying insects above all habitat types.	Likely	No impacts anticipated due to being an aerial species that does not directly interact with habitats within or adjacent to the disturbance footprint.	**No significant impacts are anticipated.**

6.4 Water Resources

6.4.1 Impacts to Surface water

6.4.1.1 IESC requirements

The Sections of the SWA (**Appendix I**) where the IESC information requirements have been addressed are outlined below in **Table 6-18**.

Table 6-18 IESC Information requirements - surface water cross reference table to SWA

Project information	
Description of the proposal	
Provide a regional overview of the proposed Project area including a description of: • **geological basin;** • **coal resource;** • **surface water catchments;** • **groundwater systems;** • **water-dependent assets; and** • **past, current and reasonably foreseeable coal mining and CSG developments.**	Section 1
Describe the proposal's location, purpose, scale, duration, disturbance area, and the means by which it is likely to have a significant impact on water resources and water-dependent assets.	Section 1
Describe the statutory context, including information on the proposal's status within the regulatory assessment process and any applicable water management policies.	Section 2
Describe how impacted water resources are currently being regulated under state or Commonwealth law, including whether there are any applicable standard conditions.	
Surface water – context and conceptualisation	
Describe the hydrological regime of all watercourses, standing waters and springs across the site including: • **geomorphology, including drainage patterns, sediment regime, and floodplain features;** • **spatial, temporal and seasonal trends in streamflow and/or standing water levels;** • **spatial, temporal and seasonal trends in water quality data (such as turbidity, acidity, salinity, relevant organic chemicals, metals, metalloids and radionuclides); and** • **current stressors on watercourses, including impacts from any currently approved projects.**	1. Section 4 2. Section 4.4 3. Section 4.5 4. Section 4, 10
Describe the existing flood regime, including flood volume, depth, duration, extent and velocity for a range of AEPs. Provide flood hydrographs and maps identifying peak flood extent, depth and velocity. This assessment should be informed by topographic data that has been acquired using lidar or other reliable survey methods with accuracy stated.	Section 8
Provide an assessment of the frequency, volume, seasonal variability and direction of interactions between water resources, including surface water/groundwater connectivity and connectivity with sea water.	
Surface water – analytical and numerical modelling	
Provide conceptual models at an appropriate scale, including water quality, stores, flows and use of water by ecosystems.	Section 5, 6, 7

Project information	
Use methods in accordance with the most recent publication of Australian Rainfall and Runoff (Ball et al. 2016).	Section 8.3
Develop and describe a program for review and update of the models as more data and information becomes available.	Section 7.5, 8.5
Describe and justify model assumptions and limitations and calibrate with appropriate surface water monitoring data.	Section 6, 8
Provide an assessment of the risks and uncertainty inherent in the data used in the modelling, particularly with respect to predicted scenarios.	Section 7.4
Provide a detailed description of any methods and evidence (e.g. expert opinion, analogue sites) employed in addition to modelling.	
Surface water – impacts to water resources and water-dependent assets	
Describe all potential impacts of the proposed project on surface waters. Include a clear description of the impact to the resource, the resultant impact to any assets dependent on the resource (including water-dependent ecosystems such as riparian zones and floodplains), and the consequence or significance of the impact. **Consider:** • **Impacts on streamflow under the full range of flow conditions.** • **Impacts associated with surface water diversions.** • **Impacts to water quality, including consideration of mixing zones.** • **The quality, quantity and ecotoxicological effects of operational discharges of water (including saline water), including potential emergency discharges, and the likely impacts on water resources and water-dependent assets.** • **Landscape modifications such as subsidence, voids, post rehabilitation landform collapses, onsite earthworks (including disturbance of acid-forming or sodic soils, roadway and pipeline networks) and how these could affect surface water flow, surface water quality, erosion, sedimentation and habitat fragmentation of water-dependent species and communities.**	1. Section 8.7, 8.8 2. Section 8.7 3. Section 7.3.9 4. Section 7.3.9 5. Section 5, 7.3.9, 8.5, 8.8
Discuss existing water quality guidelines, environmental flow objectives and requirements for the surface water catchment(s) within which the development proposal is based.	Section 2, 3
Identify processes to determine surface water guidelines and quantity thresholds which incorporate seasonal variation but provide early indication of potential impacts to assets.	Section 9
Propose mitigation actions for each identified significant impact.	Section 6, 8
Describe the adequacy of proposed measures to prevent or minimise impacts on water resources and water-dependent assets.	Section 6, 8

Project information	
Describe the cumulative impact of the proposal on surface water resources and water-dependent assets when all developments (past, present and/or reasonably foreseeable) are considered in combination.	Section 10
Provide an assessment of the risks of flooding (including channel form and stability, water level, depth, extent, velocity, shear stress and stream power), and impacts to ecosystems, project infrastructure and the final project landform.	
Surface water – data and monitoring	
Identify monitoring sites representative of the diversity of potentially affected water-dependent assets and the nature and scale of potential impacts, and match with suitable replicated control and reference sites (BACI design) to enable detection and monitoring of potential impacts.	Section 4.5, 9
Ensure water quality monitoring complies with relevant National Water Quality Management Strategy (NWQMS) guidelines (ANZECC/ARMCANZ 2000) and relevant legislated state protocols (e.g. QLD Government 2013).	Section 4.5, 9
Identify data sources, including streamflow data, proximity to rainfall stations, data record duration and a describe of data methods, including whether missing data has been patched.	Section 4.3, 4.4
Develop and describe a surface water monitoring programme that will collect sufficient data to detect and identify the cause of any changes from established baseline conditions and assess the effectiveness of mitigation and management measures. The program will: 1. **include baseline monitoring data for physico-chemical parameters, as well as contaminants (e.g. metals).** 2. **comparison of physico-chemical data to national/regional guidelines or to site- specific guidelines derived from reference condition monitoring if available.** 3. **identify baseline contaminant concentrations and compare these to national guidelines, allowing for local background correction if required.**	1. Section 4.5, Appendix A of the Surface Water Assessment 2. Section 4.5, Appendix A of the Surface Water Assessment 3. Section 4.5, Appendix A of the Surface Water Assessment
Describe the rationale for selected monitoring parameters, duration, frequency and methods, including the use of satellite or aerial imagery to identify and **monitor large-scale impacts.**	Section 9
Identify dedicated sites to monitor hydrology, water quality, and channel and floodplain geomorphology throughout the life of the proposed project and beyond.	
Water-dependent assets – context and conceptualisation	
Identify water-dependent assets, including: • **water-dependent fauna and flora and provide surveys of habitat, flora and fauna (including stygofauna) (see Doody et al. [in press]).** • **public health, recreation, amenity, Indigenous, tourism or agricultural values for each water resource.**	Refer to **Appendix V**, **Q** and **M** of the PER
Identify GDEs in accordance with the method outlined by Eamus et al. (2006). Information from the GDE Toolbox15 (Richardson et al. 2011) and GDE Atlas (CoA 2017a) may assist in identification of GDEs (see Doody et al. [in press]).	Refer to Groundwater Report (**Appendix P**)
Describe the conceptualisation and rationale for likely water-dependence, impact pathways, tolerance and resilience of water-dependent assets. Examples of ecological conceptual models can be found in Commonwealth of Australia (2015).	Refer to Groundwater Report in the PER (**Appendix P**)
Estimate the ecological water requirements of identified GDEs and other water dependent assets (see Doody et al. [in press]).	Refer to Groundwater Report in the PER (**Appendix P**)
Identify the hydrogeological units on which any identified GDEs are dependent (see Doody et al. [in press]).	Refer to Groundwater Report in the PER (**Appendix P**)

Project information	
Provide an outline of the water-dependent assets and associated environmental objectives and the modelling approach to assess impacts to the assets.	Section 3, 4
Describe the process employed to determine water quality and quantity triggers and impact thresholds for water-dependent assets (e.g. threshold at which a significant impact on an asset may occur).	
Water dependent assets – impacts, risk assessment and management of risk	
Provide an assessment of direct and indirect impacts on water-dependent assets, including ecological assets such as flora and fauna dependent on surface water and groundwater, springs and other GDEs (see Doody et al. [in press]).	Refer to Groundwater Report in the PER(**Appendix P**)
Describe the potential range of drawdown at each affected bore, and clearly articulate the scale of impacts to other water users.	Refer to Groundwater Report in the PER(**Appendix P**)
Indicate the vulnerability to contamination (e.g. from salt production and salinity) and the likely impacts of contamination on the identified water-dependent assets and ecological processes.	Section 7.3.9
Identify and consider landscape modifications (e.g. voids, on-site earthworks, and roadway and pipeline networks) and their potential effects on surface water flow, erosion and habitat fragmentation of water-dependent species and communities.	Section 5
Provide estimates of the volume, beneficial uses and impact of operational discharges of water (particularly saline water), including potential emergency discharges due to unusual events, on water-dependent assets and ecological processes.	Section 7.3.9, 7.3.10
Assess the overall level of risk to water-dependent assets through combining probability of occurrence with severity of impact.	Section 7, 8
Identify the proposed acceptable level of impact for each water-dependent asset based on leading-practice science and site-specific data, and ideally developed in conjunction with stakeholders.	Section 7, 8
Propose mitigation actions for each identified impact, including a description of the adequacy of the proposed measures and how these will be assessed.	Section 5, 8, 9

6.4.1.2 Flow Regimes

Operational flow regime

There were no stream flow data available for East Creek or Hughes Creek at the time of preparing the SWA. There are two streamflow gauges operated by the Department of Natural Resources, Mines and Energy (DNRME) in the vicinity of the Project including:

- Isaac River at Deverill (approximately 25 km northeast of the Project); and
- Phillips Creek at Tayglen (approximately 15 km southeast of the Project).

The stream gauge on the Isaac River at Deverill (Station ID: 130410A) is located approximately 20 km upstream of where Boomerang Creek meets the Isaac River.

Historical flow and river height monitoring data (1968 to 2018) for the Isaac River at Deverill, provides an indication of the flow regime (refer **Figure 6-2**). Surveyed cross Section data for this gauging station collected in September 2014 (DNRME, 2017) indicates that sediment covers the bottom one metre of the gauge range. The mean river height data shown in Figure 4.12, **Appendix I**, suggests that surface flow above the sand is more likely to occur only in the wetter months from November to April, reducing to shallow subsurface flows from about May to October in an average year.

The Phillips Creek at Tayglen Creek streamflow gauge (Station ID: 130409A) is located on Phillips Creek. Phillips Creek is an easterly draining tributary of the Isaac River, south of Hughes Creek. DNRME maintains data for the gauge between 1968 and 1988. The catchment area to the gauge location is 344 km^2.

A typical sequence of recorded flows from this station is shown in **Figure 6-3**. The creek is characterised by brief periods of flow interspersed by long periods of no flow. This ephemeral behaviour is typical for streams in this part of the Fitzroy Basin.

The median annual flow over the period of record was approximately 12,730 ML/a (52 mm of runoff), most of which occurred in the summer months (as shown in **Figure 6-4**).

Figure 6-5 compares flow frequency curves for a number of gauged catchments in the Isaac River catchment which are located in the vicinity of the Project. **Figure 6-5** shows that for Phillips Creek at Tayglen, flow only occurred approximately 22% of the time, which would be similar to other creeks in the vicinity of the Project.

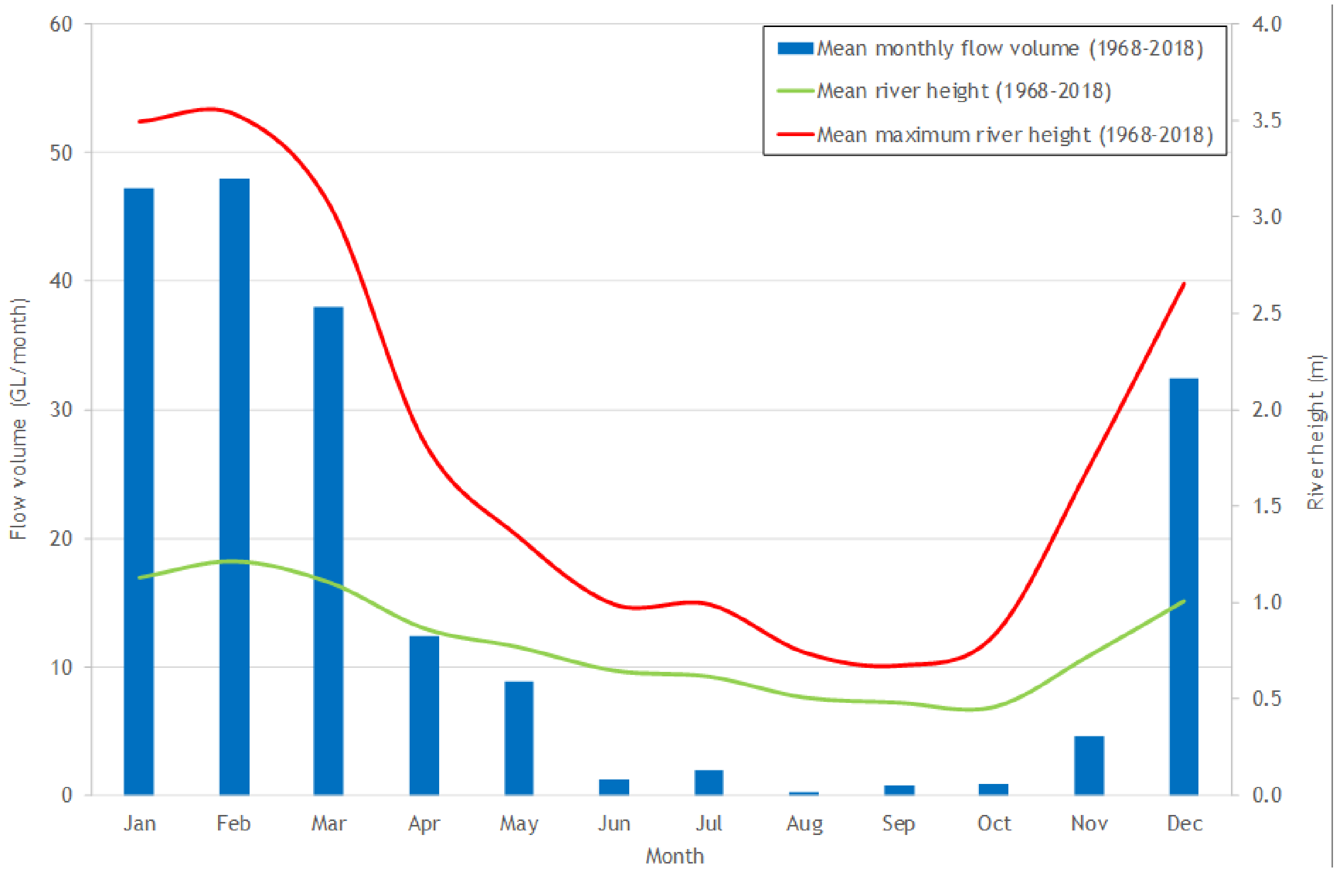


Figure 6-2 Flow volume and river height in the Isaac River at Deverill

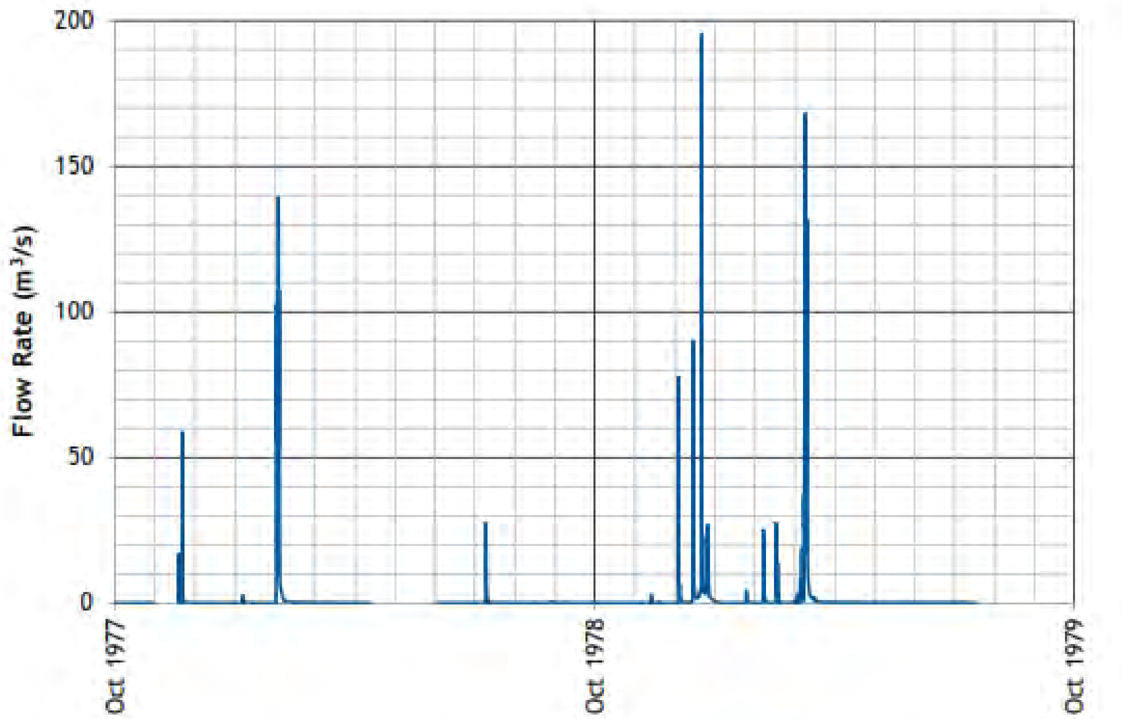


Figure 6-3 Sample flow sequence- Phillips Creek at Tayglen 1977-1979

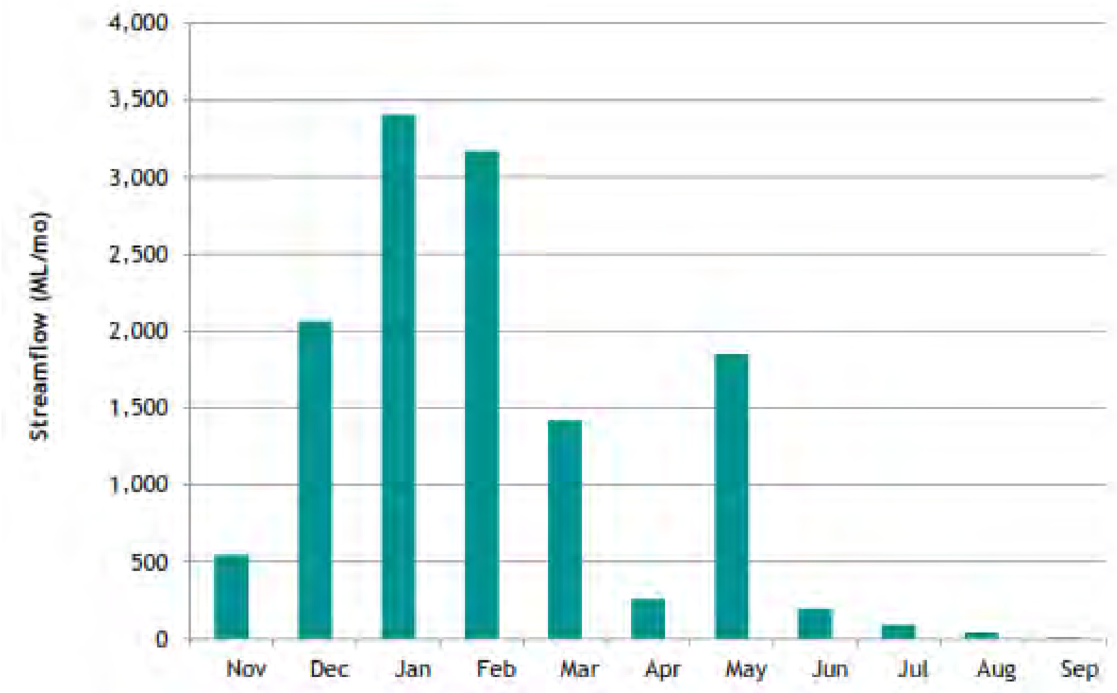


Figure 6-4 Measured mean monthly streamflow- Phillips Creek at Tayglen 1977-1979

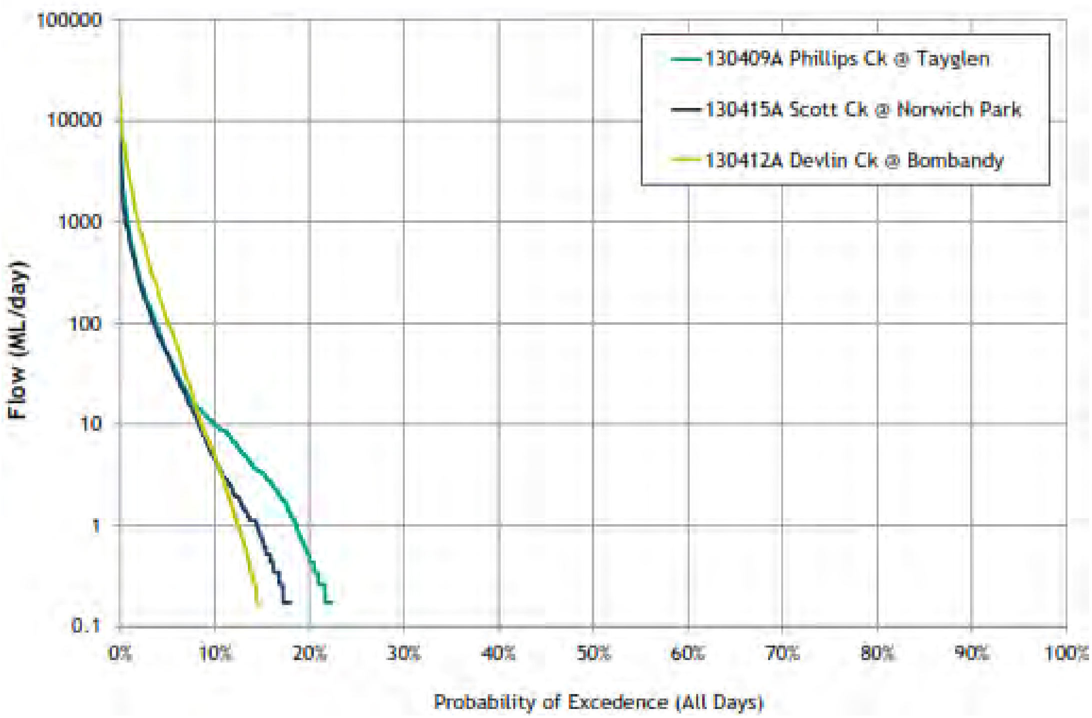


Figure 6-5 Recorded frequency curves at nearby DoR Gauges (no flow days included)

Figure 6-6 shows the proposed Life of Mine (Operational) Conditions configuration used in the TUFLOW model. The TUFLOW model results show that the proposed Operational Conditions configuration may cause potential flow constraints and flood impacts as a result of the life of mine infrastructure. These include:

- Changed flow conditions between the Norwich Park Branch Railway and proposed Saraji Road realignment and operational flood protection levees;
- Changed catchment areas due to the Operational Conditions configuration;
- Constriction of the overbank flooding areas at locations where the permanent out of-pit WRD emplacement are proposed;
- Constriction of the overbank flooding at proposed levee locations to protect pits from inundation; and
- Diversion of floodwaters around proposed pit locations into adjacent drainage lines.

Figure 6-7 to **Figure 6-12** shows the change in peak water levels and the change in peak velocities for Operational Conditions compared to Existing Conditions across the Project.

The Project surface water management system would be designed to accommodate the proposed production schedule and to mitigate potential natural surface water and flooding impacts. With appropriate mitigation measures in place, the potential impact of the proposed mining operations on surface flows and water quality in the receiving waters downstream of the Project will be insignificant.

Post-closure flow regime

There are very minimal modelled changes to hydrological flow in the final landform compared to existing conditions as described in **Appendix I** and shown in **Table 6-19.** In general, the Post-closure Conditions configuration will not impact on peak water levels or velocities along Drainage line 5, Drainage line 6, Drainage line 7 and East Creek for events up to and including the 0.1% AEP event. The results also show that there are negligible impacts along Drainage line 8 and Hughes Creek for the 10% and 1% AEP events and small impacts for the 0.1% AEP event (see flooding in **Section 6.4.1.4**).

Table 6-19 Changes in peak water level and velocities under post-closure conditions at reporting locations

	Modelled change in peak water level (m)			Modelled change in peak velocities (m/s(		
	10%	1%	0.1%	10%	1%	0.1%
RP1	0.00	0.00	0.01	0.00	0.00	0.01
RP2	0.00	0.00	0.00	0.00	0.00	0.00
RP3	0.00	0.00	0.00	0.00	0.00	0.00
RP4	0.00	0.00	0.00	0.00	0.00	0.00
RP5	0.00	0.00	0.00	0.00	0.00	0.00
RP6	0.01	0.02	0.02	0.00	0.00	-0.01
RP7	0.00	0.04	0.05	0.01	0.00	0.03
RP8	-0.01	0.04	0.04	0.00	0.01	0.01
RP9	0.01	0.03	0.05	0.00	0.00	-0.01
RP10	-0.01	0.02	0.04	-0.04	-0.04	0.00
RP11	0.00	0.03	0.04	0.01	0.01	0.01

Source: **Appendix I**– Surface water Impact assessment

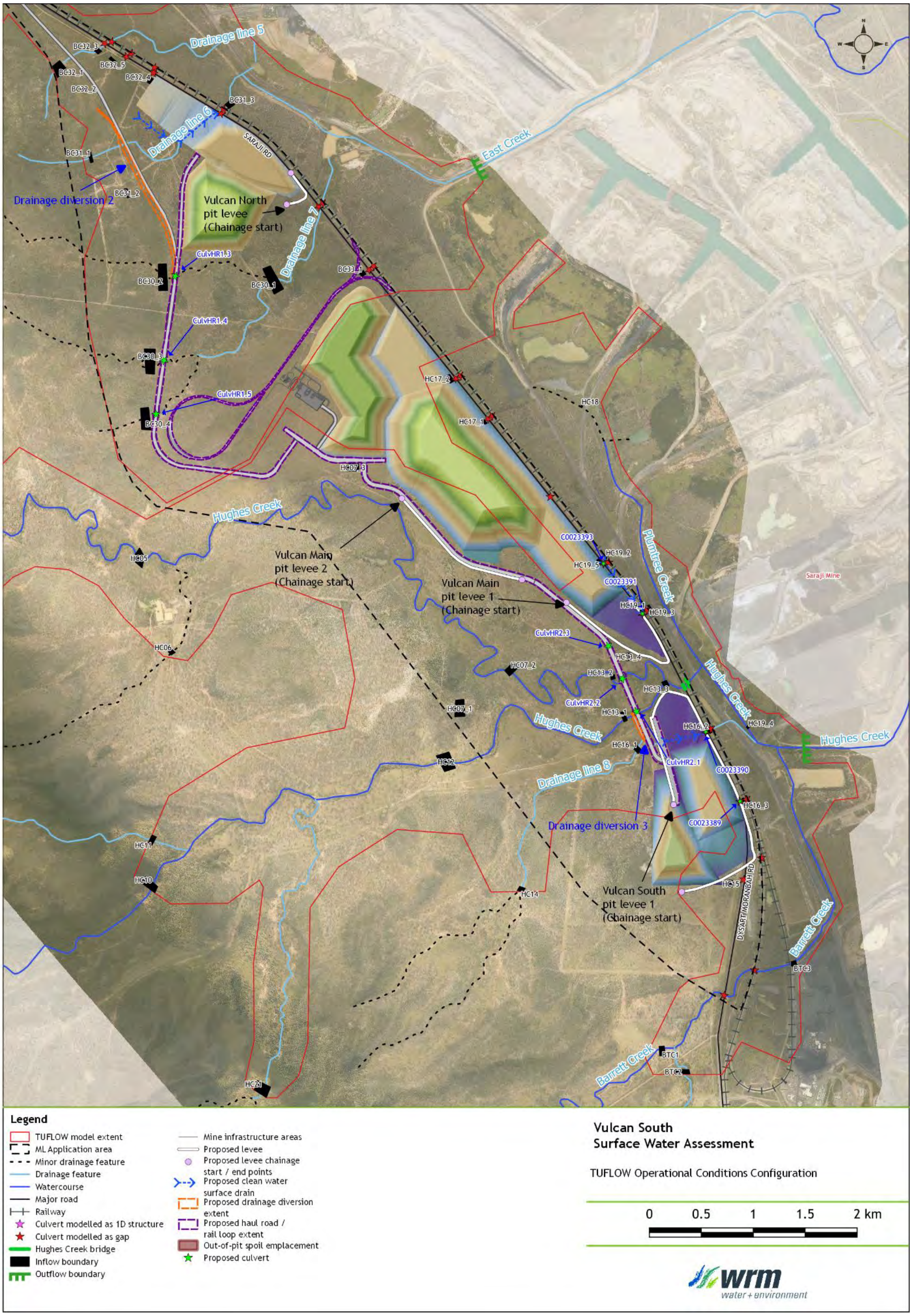


Figure 6-6 – Life of mine (Operational) Conditions hydraulic model configuration

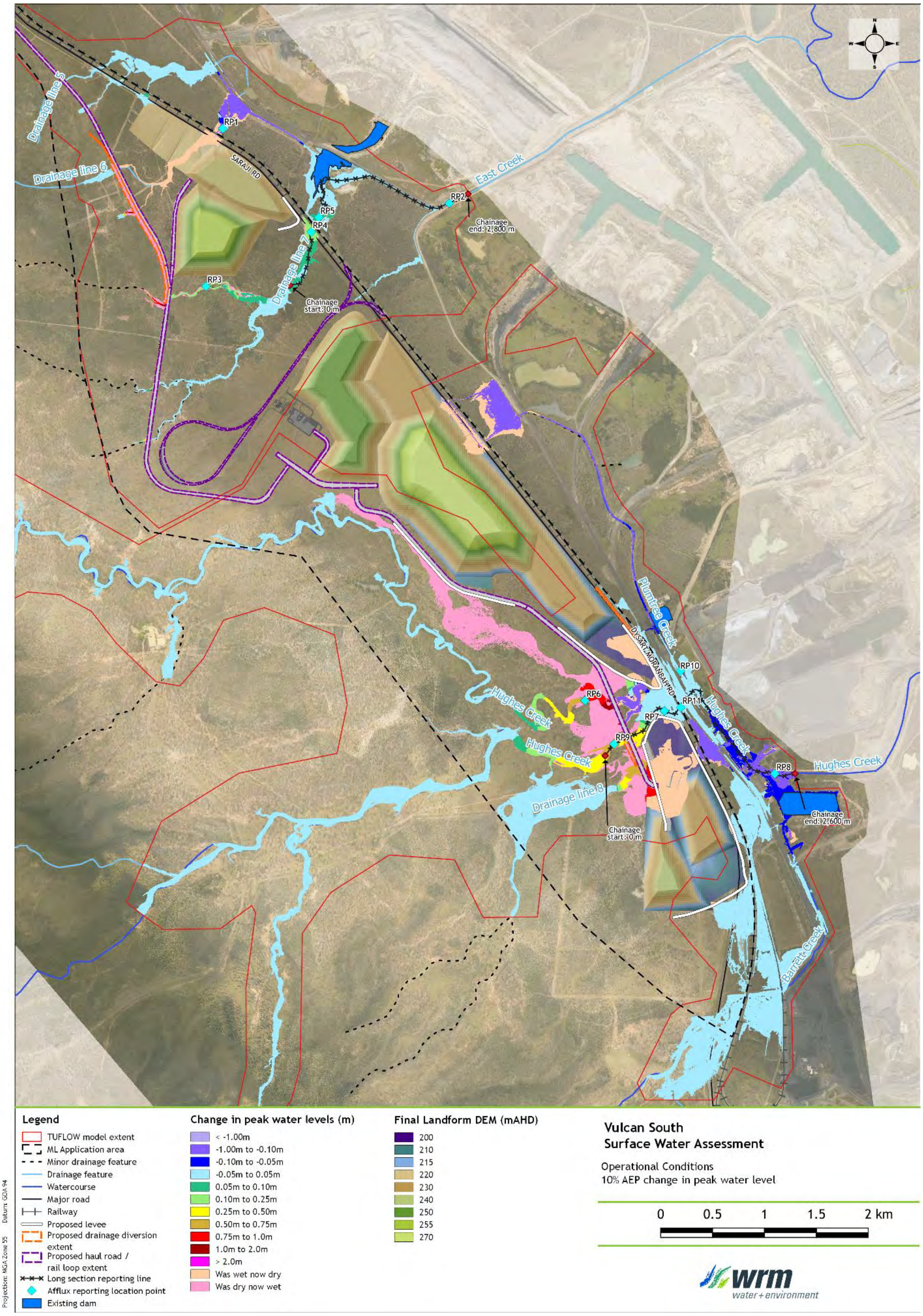


Figure 6-7 - 10% AEP change in peak water levels - Operational Conditions impacts

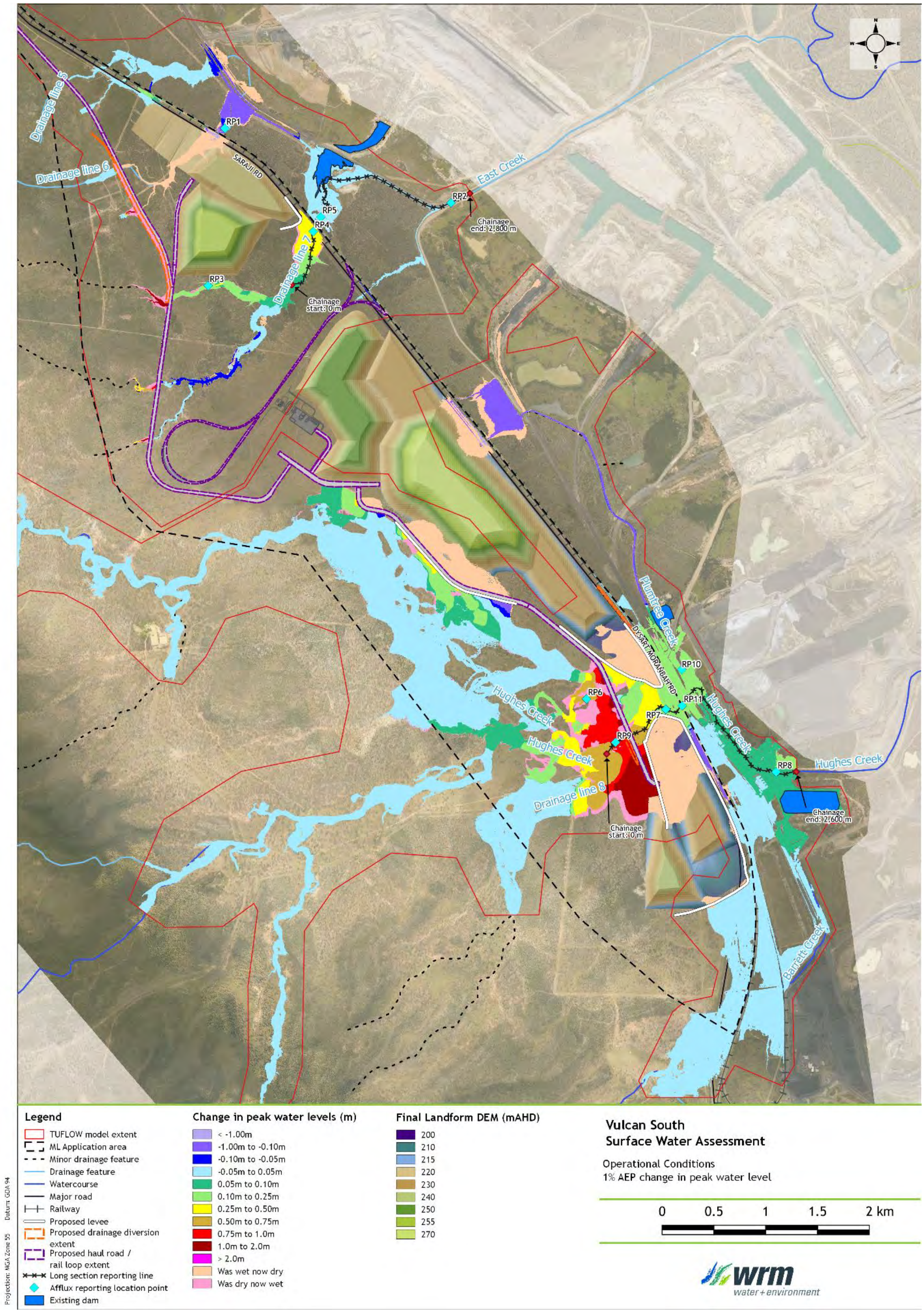


Figure 6-8 - 1% AEP change in peak water levels - Operational Conditions impacts

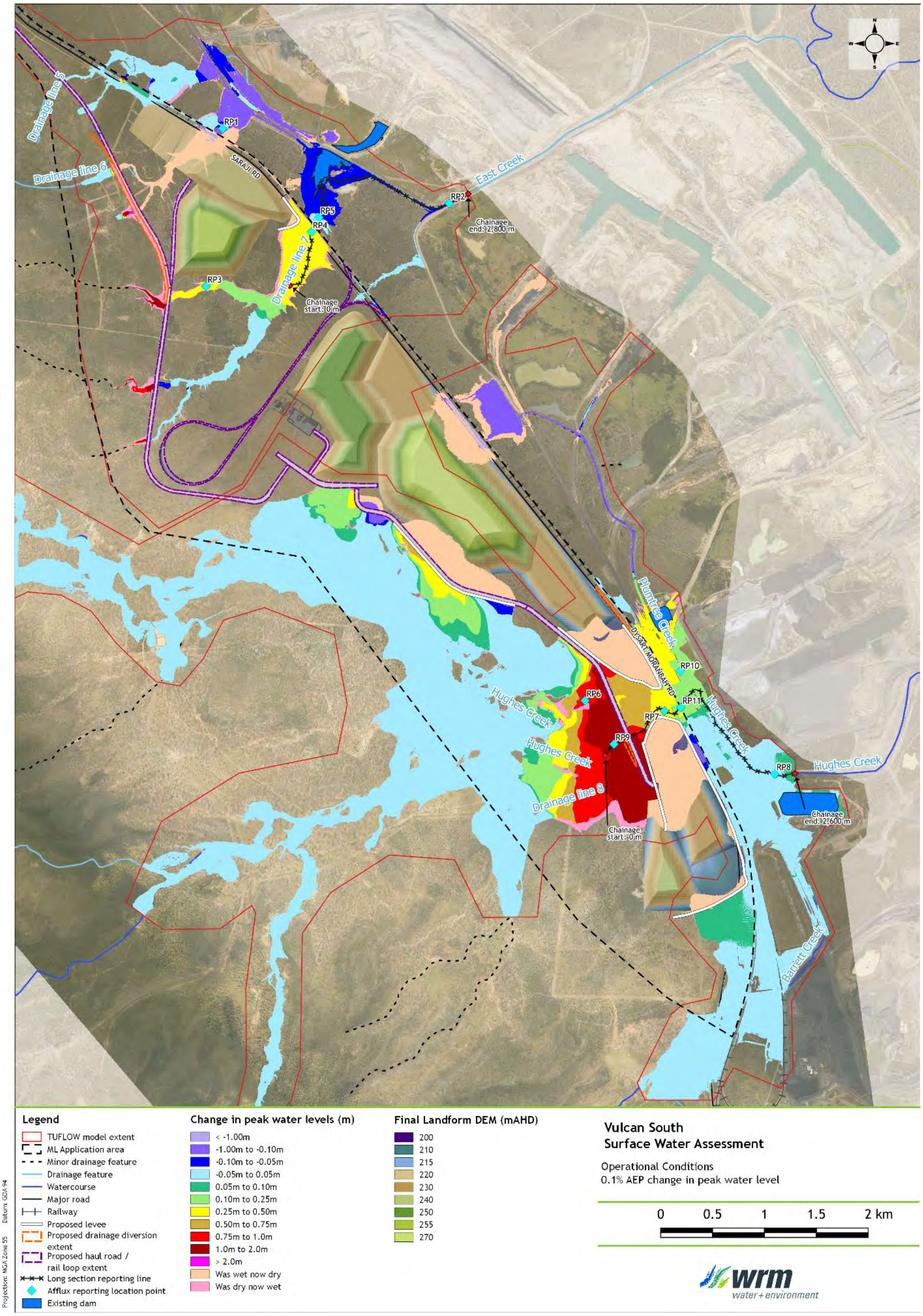


Figure 6-9 - 0.1% AEP change in peak water levels – Operational Conditions impacts

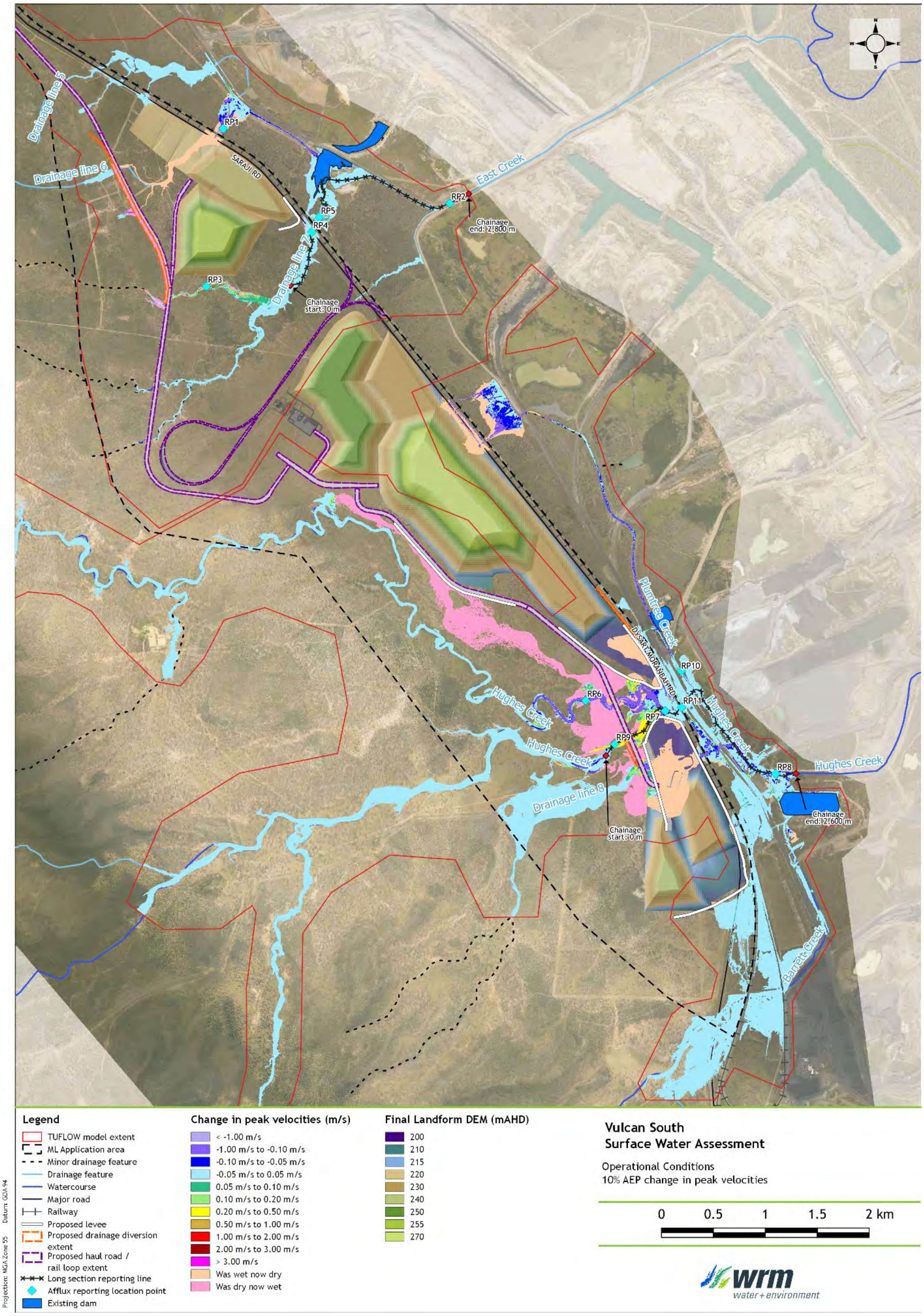


Figure 6-10 - 10% AEP change in peak velocities - Operational Conditions impacts

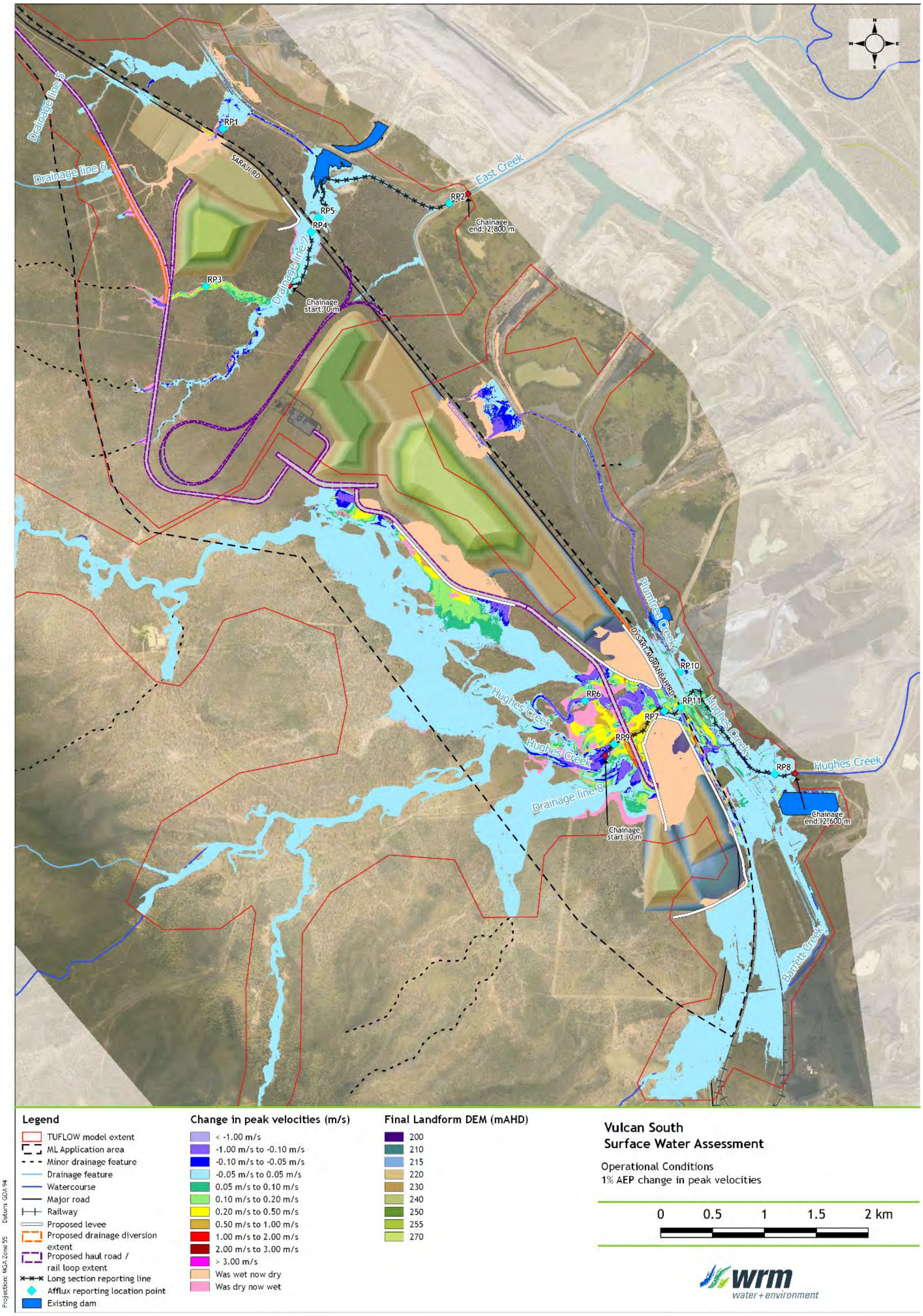


Figure 6-11 - 1% AEP change in peak velocities – Operational Conditions impacts

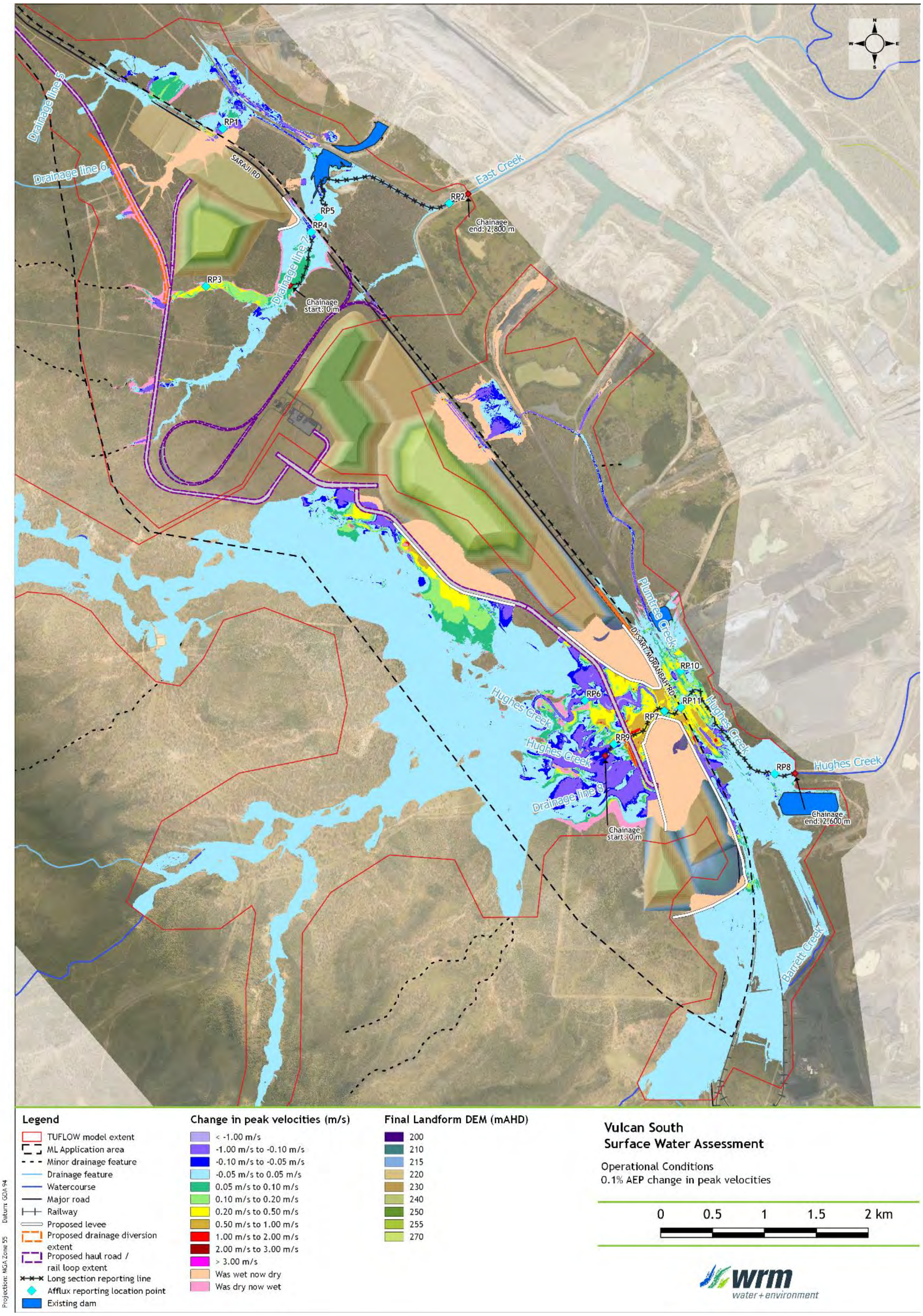


Figure 6-12 - 0.1% AEP change in peak velocities - Operational Conditions impacts

6.4.1.3 Surface Water Quality

The potential sources of receiving waters contamination from the water management system are releases from the sediment dams, releases from the mine affected dams, pumped releases from DD2 and overland flow from not properly rehabilitated WRD's. The mine affected dams are not predicted to spill under any of the modelled climate sequences. Releases from DD2 are expected to be of a water quality that is similar to the receiving waters as it primarily collects water from an undisturbed rural catchment.

Any potential discharges from sediment dams will be in accordance with Schedule F and Condition F4 of the Vulcan South EA. Sediment dam trigger values will be monitored against the 'Surface water quality objectives' outlined in Table F3 of the EA (see **Table 5-22**) and mine water dams will be managed and operated with a maximum 'operating volume' which defines the maximum volume the dams can operate up to before pumped inflows cease. The operating volumes of each dam are below their respective full storage volumes to maintain storage capacity below the spillway level of the dams which will reduce the risk of overflows to the receiving environment. If mine water dams are at their operating volumes, mine water can be pumped back to the pits in emergency.

Any potential releases from erosion and sediment control structures will be in accordance with Schedule F and Condition F4 of the Vulcan South EA. Sediment dam trigger values will be monitored against the 'Surface water quality objectives' outlined in Table F3 of the EA and **Table 5-22**. There are mitigation measures in place within Section 7.1.2 specifying the monitoring and mitigation of impacts from sediment dams (such as de-silting the sediment dams) and corrective actions should there be an exceedance of WQO's.

With regard to the risk of overland flow from WRD's, see below.

Water Quality Modelling

RGS Environmental (**Appendix R**) have undertaken an assessment of the overburden and potential coal reject materials at Vulcan South. RGS presented initial results from the Jupiter Pit area. A series of geochemical tests were completed on samples from the Jupiter pit to assess the risk of potential oxidation of sulphides, AMD, potential presence and potential leaching of soluble metals/metalloids and other salinity/erosion issues. RGS made the following findings regarding the geochemical characterisation of the potential waste rock:

- The vast majority tested had a high factor of safety and negligible risk of generating acid mine drainage;
- assay of the multi-element concentration present in selected representative samples indicates that there are no elements (metals/metalloids) enriched in the sample materials compared to median crustal abundance in unmineralised soils;
- the initial static and kinetic test results indicate that surface runoff and seepage from the sample materials are likely to be pH neutral with moderate excess alkalinity, and low levels of salinity;
- the initial geochemistry results are consistent with the larger data set of results obtained from geochemical characterisation of 139 samples from 21 drill holes across the broader Jupiter and Vulcan areas in the VCM and Vulcan South; and
- the results represent an 'assumed worst case' scenario as the samples are pulverised (to minus 75 micrometres) prior to testing. Therefore, samples have a very high surface area compared to materials in the field. This process provides a greater potential for dissolution and reaction and represents an assumed initial 'worst case' scenario for geochemical testing of these materials.

In consideration of the RGS findings from the preliminary geochemical characterisation, salinity is considered the key contaminant for assessment purposes. Assessment of other contaminants has not been undertaken as part of this surface water assessment. If subsequent monitoring data indicates that there are other contaminants of concern, the assessment can be updated to include additional water quality parameters.

The water balance model is configured to use salinity as an indicator of water quality using electrical conductivity (EC) values runoff for each land use type and other sources of water.

The proposed EC values are shown in **Table 6-20**. EC values have been sourced from previous water balance models for mines in similar areas of the Bowen Basin.

Table 6-20 Adopted Salinity Concentrations

Water source/land use	EC (µS/cm)	Comment
Natural/ undisturbed	300	Value adopted for Olive Downs SWA and Lake Vermont Northern Extension SWA
Disturbed	500	Runoff value typical for cleared/stripped areas
Mining pit	4,500	Value adopted for Lake Vermont Northern Extension SWA
In pit /out of pit waste rock dump	350	Value adopted for Olive Downs SWA
External water (pipelines from BMA Peak Downs)	10,000	Salinity of mine water unknown, conservatively high value adopted
Industrial area	900	Salinity of ROM coal unknown, conservatively high value adopted
Groundwater	9,520	Average groundwater salinity reading from historical groundwater monitoring undertaken at site (hydrogeologist.com.au, 2020)

Water Quality Summary

Preliminary baseline monitoring indicates that water in the surrounding environment is of poor quality. The water balance modelling indicates that no mine-affected spills are predicted from mine operations. Modelling (**Appendix I**) predicts that the EC for spills from the sediment dams will be below the water quality objective (720 µS/cm) for baseflows of the Project area. In consideration of the heavily disturbed nature of the surrounding catchment, it is unlikely that the Project will have a measurable impact on receiving water quality or EVs.

The landform evolution modelling determined that there would be negligible sedimentation effects on downstream waterways (**Appendix AA**).

Impacts on downstream water quality will be monitored throughout the duration of operations and rehabilitation, and specific milestone criteria have been developed to ensure no downstream impacts occur. In summary, the conceptual final landform is not considered likely to have a long-term significant impact on the receiving waters.

Further discussion on surface water quality impacts and their associated mitigation measures are provided within **Section 7.1.4.**

6.4.1.4 Flooding

The drainage features that cross the Project have been assessed to determine the potential impact of the Project on flood behaviour including the potential:

- to impact on flood levels;
- to increase the extent of flooding;
- to increase erosion and/or sedimentation of the impacted waterways;
- to impact on the morphology of the adjacent floodplains; and
- loss of flow from the catchment.

WRM (**Appendix I**) has modelled the extent of flood plains within the Project and surrounding areas based on the final landforms described in **Section 6.4.1.2** of **Appendix I** . Peak water levels and peak velocities for operational conditions (**Figure 6-7** to **Figure 6-12**) were compared to pre-mining conditions for the 10%, 1% and 0.1% AEP events.

Models show only minor changes to flood plain configuration and function under the final landform. Most impacts do not extend beyond the Project area. The models highlighted that erosion and scour protection will be required along the reinstated drainage lines and existing channels to mitigate the risk of rapid geomorphic change. These impacts are generally confined within the Vulcan South MLA. Existing conditions natural topography will be reinstated within the Hughes Creek floodplain, as well as Drainage line 6 and Drainage line 8 post-closure to replicate the existing drainage line channels to minimise the impacts associated with the post-closure conditions landform.

Overall, the impact of the Project on the hydraulic characteristics of Boomerang Creek, Hughes Creek and their tributaries do not affect the existing conditions significantly.

The flood impact assessment undertaken shows that there are no impacts upstream of the Project MLA area. Upstream risks have been mitigated by effectively managing potential downstream impacts. Any potential discharges from sediment dams will be in accordance with Schedule F and Condition F4 of the Vulcan South EA. Sediment dam trigger values will be monitored against the 'Surface water quality objectives' outlined in Table F3 of the EA (see **Table 5-22**) and mine water dams will be managed and operated with a maximum 'operating volume' which defines the maximum volume the dams can operate up to before pumped inflows cease. The operating volumes of each dam are below their respective full storage volumes to maintain storage capacity below the spillway level of the dams which will reduce the risk of overflows to the receiving environment. If mine water dams are at their operating volumes, mine water can be pumped back to the pits in emergency.

It is expected that the channel and floodplain will undergo little, if any, adjustment to the altered hydraulic conditions upstream or downstream of Vulcan South as a result of the Project.

The full details of flood modelling are found in **Appendix I**, along with full mapping of flood extents under existing, operational and post-closure conditions presented in **Appendix I.**

6.4.1.5 River-Floodplain Connectivity

The frequency and duration of river-floodplain connection and inundation events are important for floodplain ecosystems. Inundation events move nutrients and sediments, allow flora and fauna linkages between habitats, provide water for floodplain vegetation and refuges like billabongs and lagoons.

There will be changes to the extent of floodplain inundation as a result of the development of the Project. The primary change is the introduction of diverted water drains, bunds and diversion levees, which will result the loss of channel and floodplain in one area and its replacement in another. The diversions are necessary to divert runoff from undisturbed catchments around areas disturbed by mining.

Three diverted water drains are proposed as part of the Project:

- Drainage diversion 2 will be constructed in Stage 1 and will divert a catchment of approximately 105 ha away from the Vulcan North pit and dam DD2. This drainage diversion will collect an undisturbed catchment to the west of the Vulcan North pit and associated haul road. This drainage diversion will divert a portion of Drainage line 6 and discharge under a haul road to Drainage line 7 (which is a tributary of East Creek).
- Drainage diversion 3 will be constructed in Stage 3 and will divert a portion of Drainage line 8 around the Vulcan South pit. This drainage diversion will collect an undisturbed catchment of approximately 570 ha and discharge to Hughes Creek.
- A minor drainage diversion diverts water southward around the Vulcan Main levee 1, to discharge into Hughes Creek.

A number of diverted water bunds are proposed in the vicinity of the three open cut pits. These bunds will collect runoff from minor catchments (i.e. smaller than 15 ha) where a drain is not deemed necessary and divert these catchments around mining operations. All diversions will be reinstated post mining to their natural topography to replicate the existing drainage line channels to minimise the impacts associated with post closure for river-floodplain connectivity.

Four flood levees are also proposed for the Project, including:

- Vulcan North levee on the southern edge of the Vulcan North pit to be constructed in Stage 1;
- Vulcan Main levee 2 on the western edge of the Vulcan Main pit to be constructed in Stage 2 and Vulcan Main levee 1 on the southern edge of the Vulcan Main pit to be constructed in Stage 3; and
- Vulcan South levee around the full extent of the Vulcan South pit to be constructed in Stage 3.

The flood levees will be regulated structures under the EP Act and will therefore be required to have a crest above the 0.1% AEP event.

The SWA (**Appendix I**) outlines flood conditions used to estimate design flood levels, velocities and extents in Boomerang Creek, Hughes Creek and their tributaries across the Project area for the 10% (1 in 10) AEP, 1% (1 in 100) AEP and 0.1% (1 in 1000) AEP design flood events for the Existing Conditions, Life of Mine (Operational) Conditions and the proposed Final Landform Conditions.

The Existing Conditions TUFLOW models developed for Boomerang Creek and Hughes Creek were updated to include mine water infrastructure required during operations. The model updates representing the Operational Conditions configuration is shown in Figure 6-6and include:

- proposed life-of-mine landforms and open cut pits;
- modified inflow boundary locations to represent Operational Conditions catchment areas;
- proposed culverts along the proposed haul roads, levees, and diversions;
- proposed levees and diversions; and
- proposed haul roads.

The results of the comparison between Operational Conditions peak flood levels and Existing Conditions peak flood levels show that flood impacts as a result of the proposed mine water infrastructure are generally within the Project MLA area. The impacts that extend into the Norwich Park Branch Railway corridor and downstream of the Project boundary may require mitigation measures. These could include erosion protection in locations of increased flood velocities, staged flood protection levee construction (acknowledging this may impact on mine plan scheduling), limit the timeframe that the proposed infrastructure is in place, and additional road/rail culverts, etc. Where impacts cannot be fully mitigated, consent may be required from impacted neighbouring landowners/stakeholders (e.g., Aurizon, council, BMA).

The results of the comparison between Post-closure Conditions peak flood levels and Existing Conditions peak flood levels show that generally there are only minor impacts under the final landform configuration. These impacts are generally confined within the Project MLA area. Existing conditions natural topography will be reinstated within the Hughes Creek floodplain as well as Drainage line 6 and Drainage line 8 (**Figure 6-6**) post-closure to replicate the existing drainage line channels to minimise the impacts associated with the Post-closure Conditions landform.

Local Drainage Network

The local drainage network was assessed as part of the SWA (**Appendix I**) and shows the local drainage features within the northern, central and southern Project areas respectively, including the channel bed widths, channel top widths, channel depths and overbank floodplain widths. Drainage features in the north of the Project area (in the vicinity of the highwall mining test area) primarily drain to Boomerang Creek. Drainage features in the centre of the Project area (near the Vulcan North pit) primarily drain to Boomerang Creek. Drainage features in the central and southern areas of the Project area (near the Vulcan Main and Vulcan South pits) primarily drain to Hughes Creek and Barrett Creek. All drainage lines within the Project area eventually drain to the Isaac River.

The main drainage features which intersect the mining areas are (**Figure 6-13** to **Figure 6-15**):

- Drainage line 1 (a tributary of Boomerang Creek);
- Drainage line 2 (a tributary of Boomerang Creek);
- Drainage line 6 (a tributary of Boomerang Creek);
- Drainage line 7 (a tributary of Boomerang Creek);
- Hughes Creek; and
- Drainage line 8 (a tributary of Hughes Creek).

Drainage Line 1 and 2

Drainage lines 1 and 2 are tributaries of Boomerang Creek which drain the northern extent of the Project area (**Figure 6-13**). Drainage lines 1 and 2 drain a significant portion of the VCM and have previously been described in detail (WRM, 2022).

Drainage line 1 drains the northeastern extent of the Project area, in particular the northern extent of the Highwall mining area. Drainage Line 1 crosses the Saraji Road and the Norwich Park branch railway to the northeast of the Project area before discharging into the Peak Downs Mine Lease (ML) downstream of the railway. Drainage Line 1 flows into an existing on-line water storage within the Peak Downs operations before eventually discharging into Drainage Line 2 to the east of the Project boundary. Drainage Line 1 has been diverted and significantly modified within the Peak Downs ML.

The typical dimensions of the Drainage Line 1 channel are (WRM, 2022):

- channel bed widths of 2 m to 5 m;
- channel top widths of 10 m to 25 m;
- channel depths 0.5 to 1 m; and
- overbank floodplain widths of 20 m to 50 m.

Drainage line 1 is proposed to be diverted and subsequently reinstated as part of the VCM (WRM, 2022). No further works are proposed for Drainage line 1 as part of this Project.

A minor drainage feature which is a tributary of Drainage line 2 drains the southern extent of the Highwall mining area before discharging into Drainage line 2 at the eastern Project extent (**Figure 6-13**). Drainage line 2 has a catchment area of approximately 30 km^2. Drainage Line 2 crosses the Saraji Road and the Norwich Park branch railway to the east of the Project area before discharging into the Peak Downs ML downstream of the railway.

The typical dimensions of the Drainage Line 2 channel are (WRM, 2022):

- channel bed widths of 3 m to 5 m;
- channel top widths of 10 m to 30 m;
- channel depths 1 to 2 m; and
- overbank floodplain widths of 50 m to 150 m.

Drainage Line 2 will not be modified as part of the Project.

Drainage Line 6

Drainage line 6 drains the majority of the Vulcan North mining area. The drainage line passes through a culvert under Saraji Road and the Norwich Park branch railway within the Project area. Drainage line 6 discharges into an existing drainage diversion within the Saraji Mine known as East Creek which in turn, passes through the Saraji Mine operation before draining into Boomerang Creek approximately 5 km to the east of the Project.

The typical dimensions of the Drainage Line 6 channel through the Project area are (**Figure 6-16**):

- channel bed widths of 1 m to 5 m;
- channel top widths of 5 m to 20 m;
- channel depths 0.5 to 1 m; and
- overbank floodplain widths of 15 m to 80 m.

Drainage line 6 will be diverted as part of the Project to avoid the Vulcan North mining area. The 1.8 km long drainage diversion will divert Drainage line 6 into Drainage line 7 during operations. Drainage Line 6 will be reinstated post-mining by constructing a drainage corridor through backfilled WRD. DD2 will collect runoff from the remaining Drainage line 6 catchment.

Drainage Line 7

Drainage line 7 lies between the proposed Vulcan North and Vulcan Main mining areas, and north of the TLO and CHPP area. Drainage line 7 will receive releases from sediment dams around the Vulcan North out of pit emplacement area and the diverted water catchment from Drainage line 6 during operations.

Drainage line 7 collects a natural catchment to the west of the Project area and discharges through existing box culverts under Saraji Road and the Norwich Park Branch railway. The Drainage line 7 flows into a dam 400 m east of the Project area, which forms part of the drainage diversion known herein as East Creek within the Saraji Mine.

The typical dimensions of the Drainage Line 7 channel through the Project area are (**Figure 6-16**):

- channel bed widths of 3 m to 5 m;
- channel top widths of 10 m to 15 m;
- channel depths 1.0 to 2.0 m; and
- overbank floodplain widths of 50 m to 100 m.

Hughes Creek

Hughes Creek is a watercourse which collects a significant natural catchment to the west of the Project area. The creek flows west-east between the Vulcan Main and Vulcan South areas, passing under two bridges crossings of Saraji Road and the Norwich Park branch railway. A number of drainage features discharge into Hughes Creek to the east of the Project area, including Barrett Creek and Drainage line 8. Hughes Creek passes through the Saraji Mine operation before discharging to Boomerang Creek, approximately 10 km to the east of the Project area. Hughes Creek has been diverted and significantly modified within the Saraji ML.

A tributary of Hughes Creek flows on the southern edge of the Vulcan Main mining area and will receive releases from sediment dams around the southern side of the Vulcan Main in pit and out of pit emplacement areas and the northern side of the Vulcan South in pit emplacement areas. Hughes Creek will also receive the diverted water catchment from Drainage line 8 during operations.

The typical dimensions of the Hughes Creek channel within the Project area are (**Figure 6-16**):

- channel bed widths of 3 m to 10 m;
- channel top widths of 30 m to 50 m;
- channel depths 2 to 5 m; and
- overbank floodplain widths of 50 m to 150 m.

Drainage Line 8

Drainage line 8 is a tributary of Hughes Creek which flows through the proposed Vulcan South mining area. Drainage line 8 currently passes through box culverts under Saraji Road and the Norwich Park branch Railway before discharging into Hughes Creek to the east of the Project area. Drainage line 8 is proposed to be diverted during operations around the Vulcan South mining area into Hughes Creek to the north. Drainage Line 8 will be reinstated postmining by constructing a drainage corridor through backfilled WRD.

The typical dimensions of the Drainage Line 8 channel through/upstream of the Project area are (**Figure 6-16**):

- channel bed widths of 1 m to 3 m;
- channel top widths of 10 m to 20 m;
- channel depths 0.5 to 1.0 m; and
- overbank floodplain widths of 50 m to 150 m.

Drainage line 8 is not well defined in its lower reaches (i.e., closer to the proposed Vulcan South mining area) and an existing farm is located on the Section of Drainage Line 8 that is to be diverted.

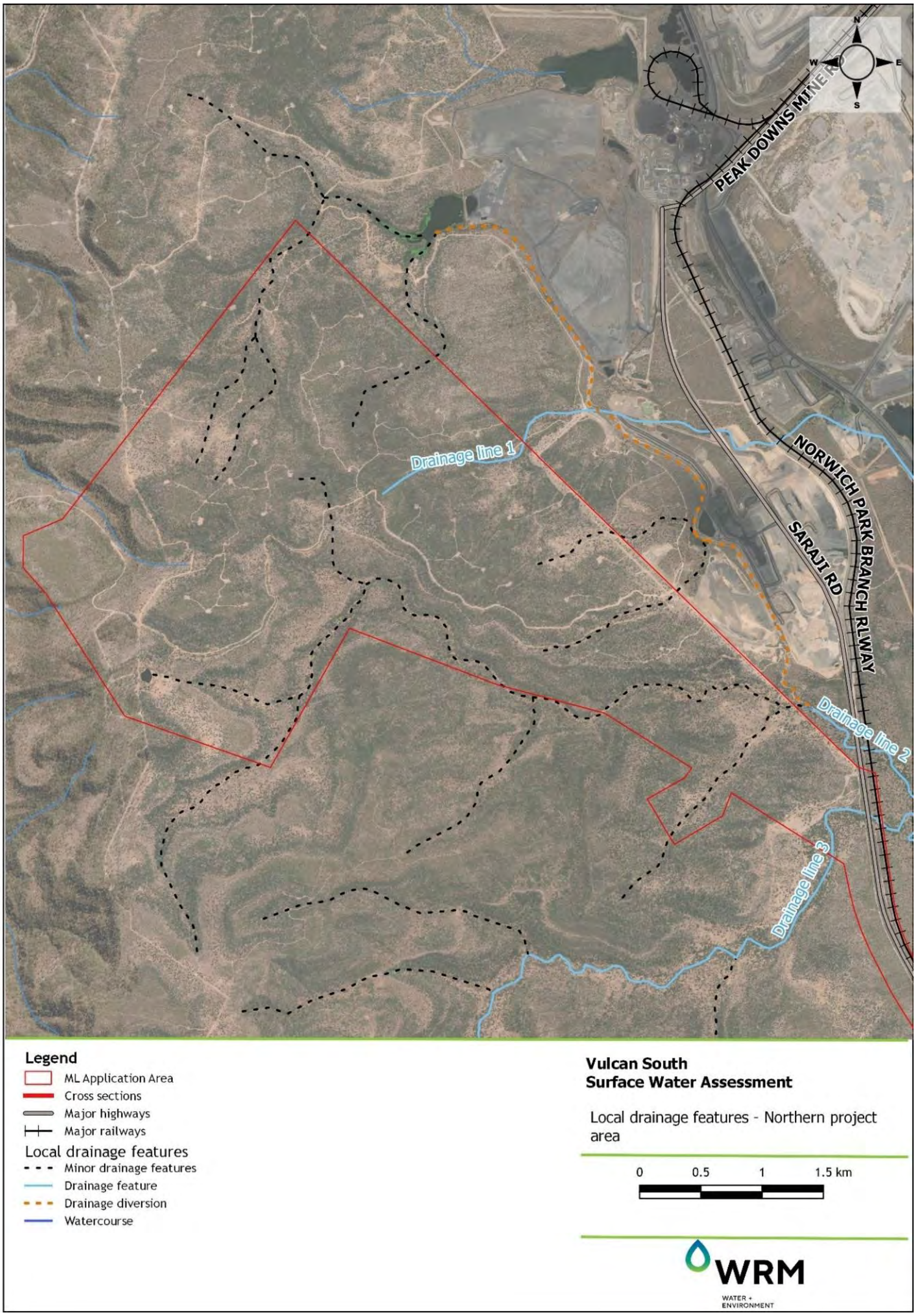


Figure 6-13 Local Drainage Features- Northern Project area

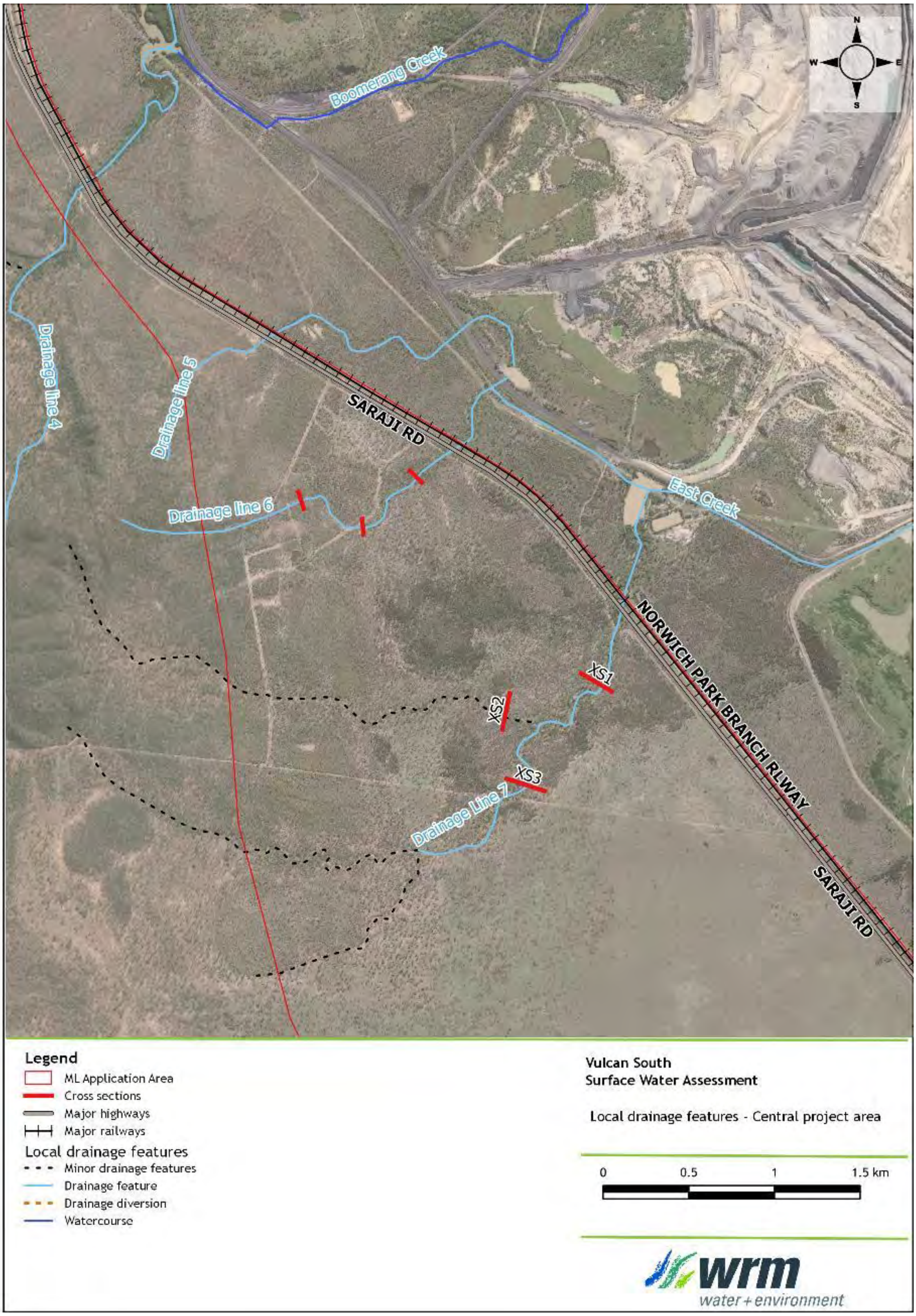


Figure 6-14 Local Drainage Features- Central Project area

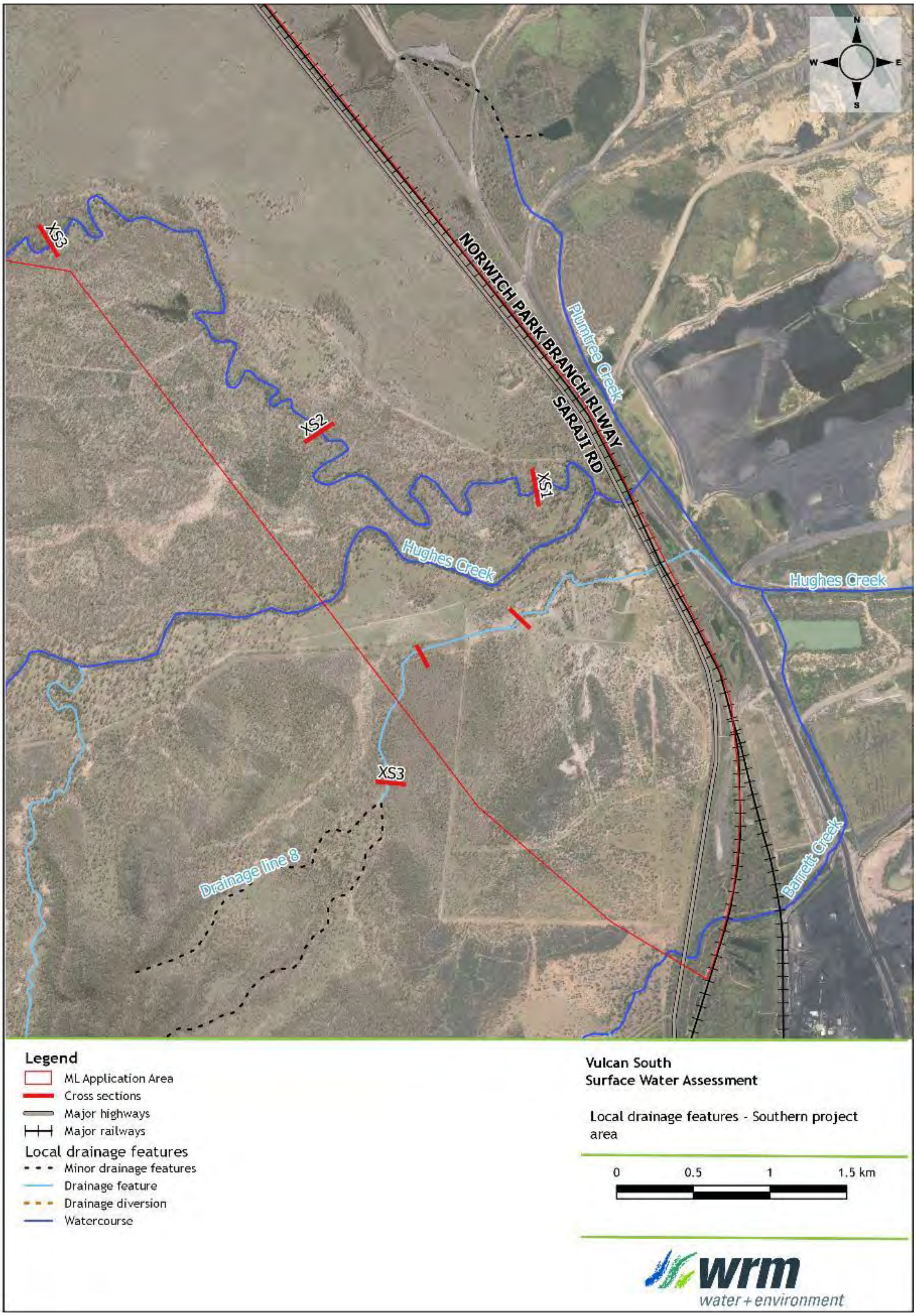


Figure 6-15 Local Drainage Features- Southern Project area

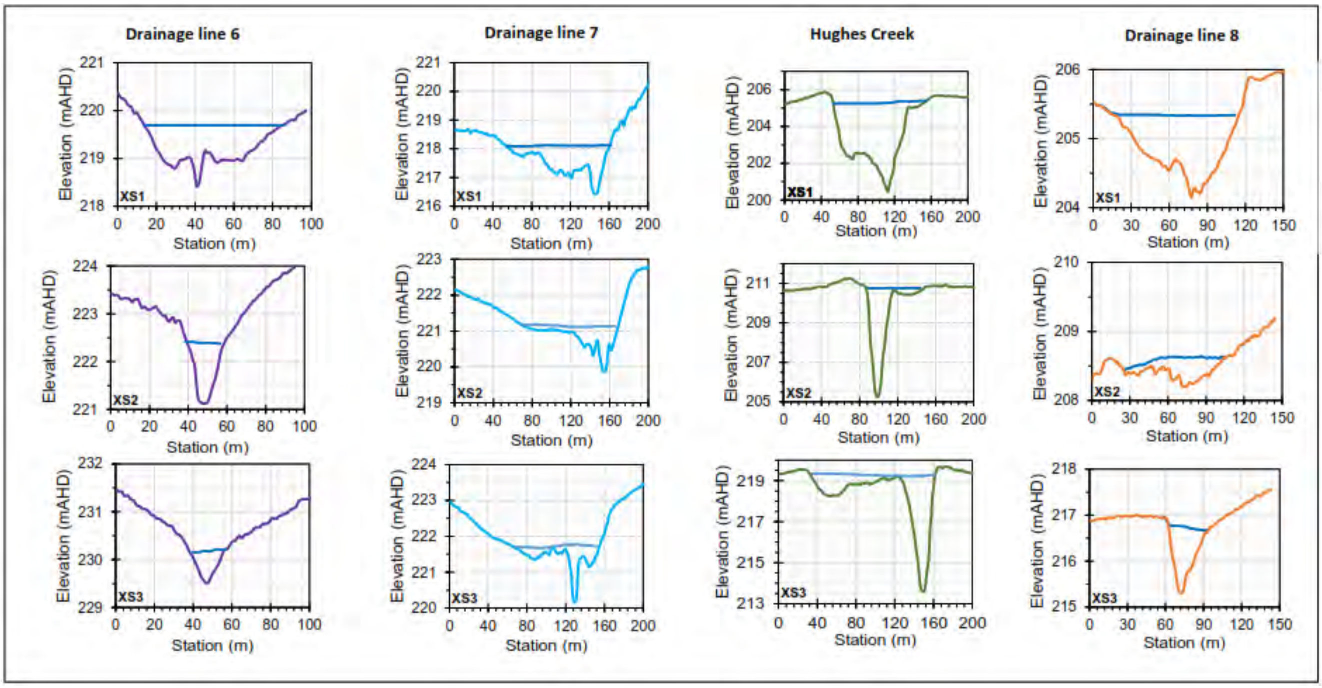


Figure 6-16 Drainage Line Cross Sections with 1% AEP Flood Levels

6.4.1.6 Changes to drainage line diversion hydrology and habitat for threatened fauna

As described in **Section 5.10.2.4**, a hydraulic assessment on the potential for erosion of the drainage diversions was undertaken by WRM in response to the guideline requirements and the IESC. The diversions were assessed using the using the hydraulic design criteria based on the Australian Coal Industry's Research Program (ACARP) study for the Bowen Basin streams, which assess stream power, stream velocity and shear stress as the main hydraulic characteristics of interest. The assessment shows that for the 10% and 1% AEP design flood events, the operational diversion channels will have similar sediment transport characteristics as the existing channels.

The Project proposes to install cross drainage structures to convey the 20% AEP design discharge. Hence, it is unlikely that there will be significant impacts to the sediment transport to the downstream environment compared to existing conditions for smaller events. During large and infrequent events, the Project has potential to increase flood levels and velocities, however, the critical duration of these storm events are less than 6 hours as assessed in the Surface Water Assessment (SWA) (**Appendix I**) and are unlikely given the expected duration of operations (7 years of operation).

The Progressive Rehabilitation and Closure Plan (PRCP) (**Appendix J**) outlines the rehabilitation of the drainage lines in post-closure conditions. It is proposed to monitor the landforms and reinstated drainage lines for erosion until the appropriate vegetative cover is established and rehabilitation milestones are achieved. There will be negligible post-closure impacts to stream hydrology or flood inundation as the catchments and drainage lines will be reinstated to pre-mining conditions. Restoration of the drainage lines post-closure will have negligible flood impacts compared to pre-mining conditions because the drainage lines being diverted are only temporary, and flows within the in the vicinity of the project are highly ephemeral.

Section 6.4.1.2 of the PER discusses potential changes to stream hydrology from the post closure rehabilitation of drainage lines and watercourses.

Reinstatement of native ecosystems

As described in **Section 8.3.1.3** of the PER, all REs within the Project area that are classified as 'native ecosystem' will be reinstated to their initial classification. All REs across the Project area to be reinstated and their corresponding rehabilitation areas are summarised in **Section 8.**

Erosion monitoring

During detailed design of the temporary diversions, a detailed description of the ESC mitigation measures will be provided. The temporary diversions are proposed to be rock lined, which is a viable ESC measure in accordance with IECA (2008), however, this is one of many alternative ESC measures. The most appropriate ESC measures will be selected and implemented during detailed design.

Notwithstanding, the appropriate rock protection will be used in the diversion design, and will outline:

- availability of rock types to be used for the diversion;
- rock hardness; and
- availability and design of rock sizing.

It is proposed that monitoring of the diversion drains will be undertaken post-flood event to inspect any sediment transport, erosion or scour issues, and remediation of the ESC measures will be undertaken if required.

Erosion monitoring is required as part of the rehabilitation milestone criteria in riparian areas for two milestone criteria -RM4 (surface preparation) and RM9 (achievement of native vegetation land use areas. Therefore, an erosion monitoring methodology will be undertaken at two stages during the rehabilitation of all drainage lines and watercourse diversions. An Appropriately Qualified Person (AQP) will be employed to certify that the final landform is geotechnically stable. Erosion monitoring methodology is further detailed in **Section 8.3.1.3**. Erosion and sedimentation mitigation measures are summarised in **Section 7.1.2.**

6.4.1.7 Climate Change using the Representative Concentration Pathway 8.5

Potential changes in climate have been obtained using the projection builder tool provided in the Climate Change Australia website (CSIRO, 2020). Climate variable inputs for the 'best case', 'maximum consensus' case 'and 'worst case' RCP8.5 climate change scenarios and the comparison between the RCP4.5 and RCP8.5 pathways are provided in **Table 6-21**. Comparing RCP8.5 to the best case scenario, by 2030:

- temperatures are expected to increase by between 1.14°C to 1.25°C;
- annual rainfall changes are uncertain but could are expected to increase by up 1.3% (for the best case) or reduce by 18.7% (for the worst case); and
- evapotranspiration is expected to increase by between 3.2% to 5.4%.

Table 6-21 Projections of change to climate RCP 8.5

Scenario	Projection RCP 4.5				Projection RCP 8.5			
	Climate model	Mean surface temperature	rainfall	evapotranspiration	Climate model	Mean surface temperature	Rainfall	Evapotranspiration
Best case	MIROC5	1.02°C	-3.1%	3.2%	CESM1-CAM5	1.25°C	1.3%	5.4%
Worst case	GFDL-ESM2M	1.07°C	-10.4%	3.9%	GFDL-ESM2M	1.24°C	-18.7%	3.7%
Maximum consensus	MIROC5	1.02°C	-3.1%	3.2%	MIROC5	1.14°C	-6.3%	3.2%
Best case	MIROC5	1.02°C	-3.1%	3.2%	CESM1 CAM5	1.25°C	1.3%	5.4%

Figure 6-17 to **Figure 6-19** show the forecast annual modelled demand for water from external sources for the 'best', 'worst' and 'maximum consensus' case climate scenarios, respectively. In summary, there is an increase in external water demand requirements under all climate projection scenarios, when compared with the base case results.

Table 6-22 compares the external water requirements for the basecase model results compared to the RCP 8.5 climate change results. The following is of note with respect to the model results:

- 'Best' case climate scenario (**Figure 6-17**):

- For the 1%ile model results (very dry climatic conditions), max annual external water demands (Stage 1) are up to 14 ML/a higher than the base case results; and
- For the 50%ile model results, there is negligible difference in max annual external water requirement compared to the base case results.

- 'Worst' case climate scenario (**Figure 6-18**):
  - For the 1%ile model results (very dry climatic conditions), max annual external water demands (Stage 1) are up to 25 ML/a higher than the base case results; and
  - For the 50%ile model results, max annual external water requirements are up to 101 ML/a higher than the base case.
- 'Maximum consensus' case climate scenario (**Figure 6-19**):
  - For the 1%ile model results (very dry climatic conditions), max annual external water demands (Stage 1) are up to 19 ML/a higher than the base case results; and
  - For the 50%ile model results, max annual external water requirements are up to 40 ML/a higher than the base case.

Table 6-22 Climate change assessment (RCP 8.5) results, change in external water demand compared to the basecase scenario

Scenario	Wet climate conditions (1%ile) max annual external water demand (ML/a)	Increase in external demand compared to basecase for wet climate conditions (1%ile) (ML/a)	Median climate conditions (50%ile) max annual external water demand (ML/a)	Increase in external demand compared to basecase for median climate conditions (50%ile) (ML/a)
Base case	1,520	-	1,260	-
Best case	1,534	14	1,260	-
Worst case	1,545	25	1,361	101
Maximum consensus	1,539	19	1,300	40

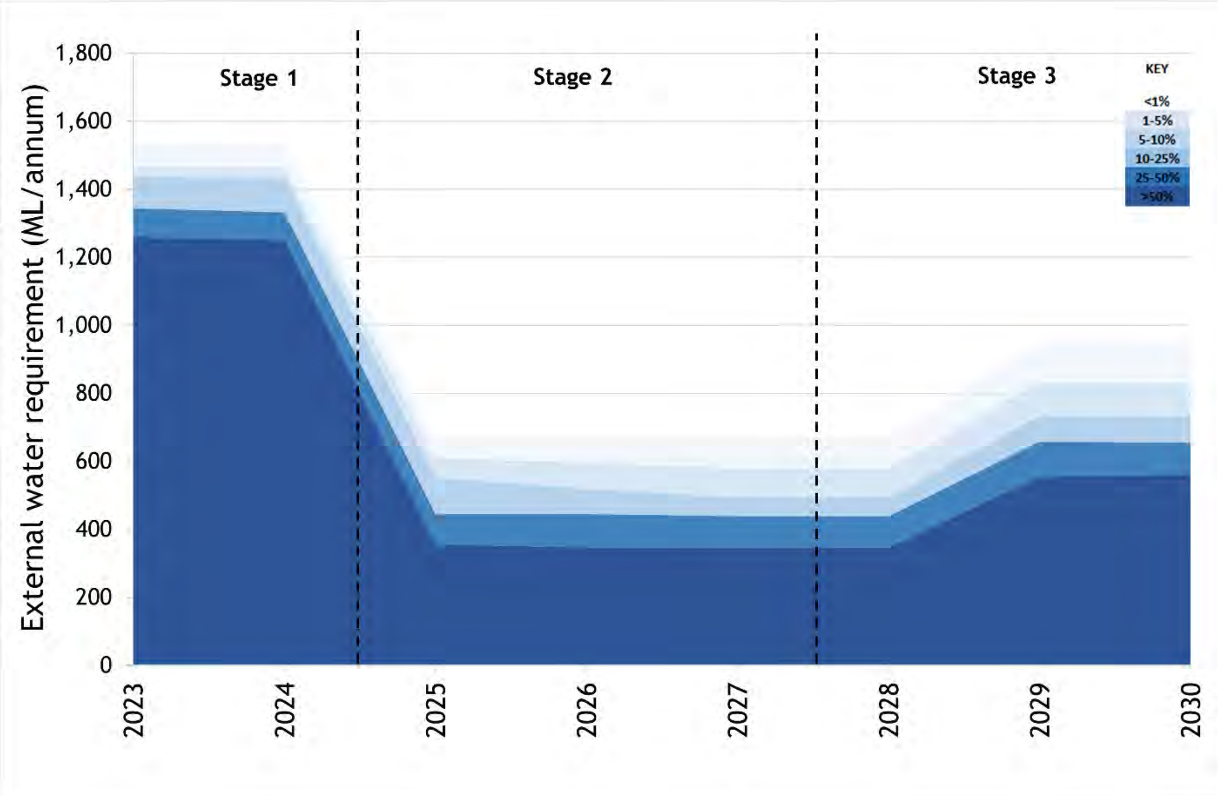


Figure 6-17 Best Case external water requirement scenario (RCP 8.5)

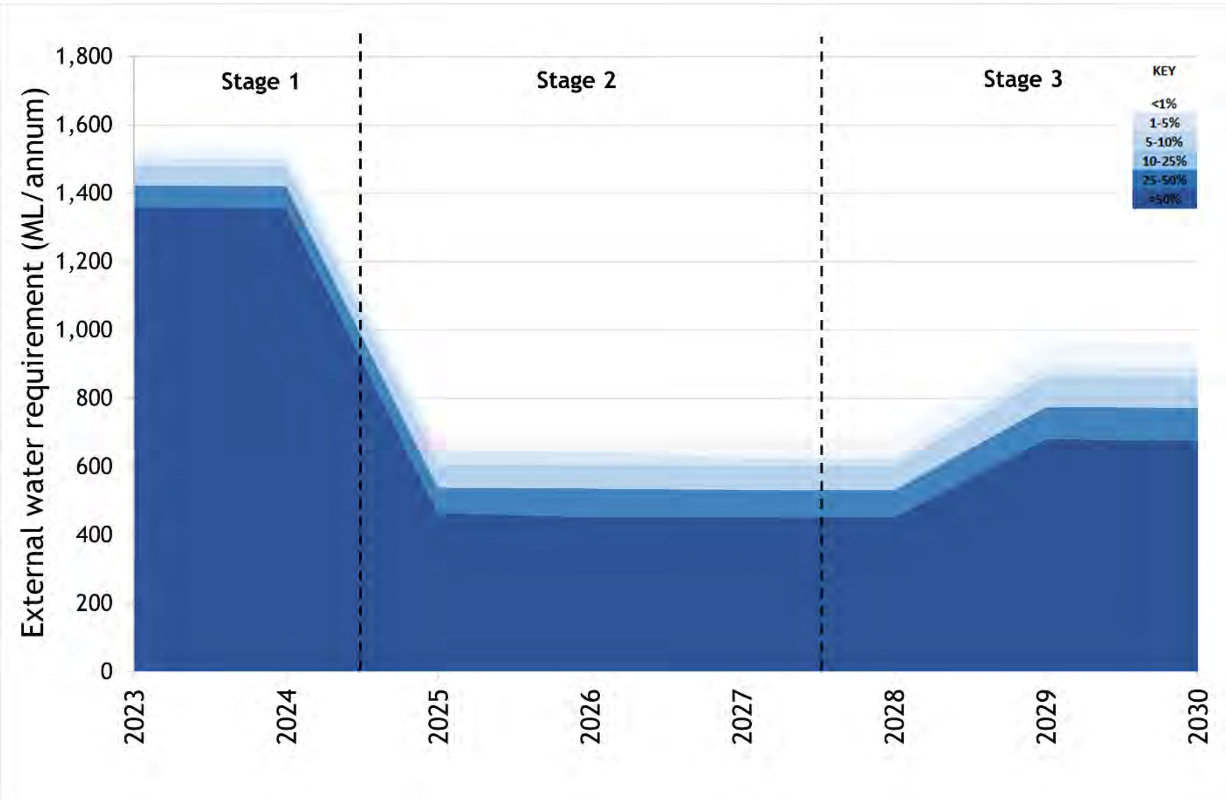


Figure 6-18 Worse case external water requirement scenario (RCP 8.5)

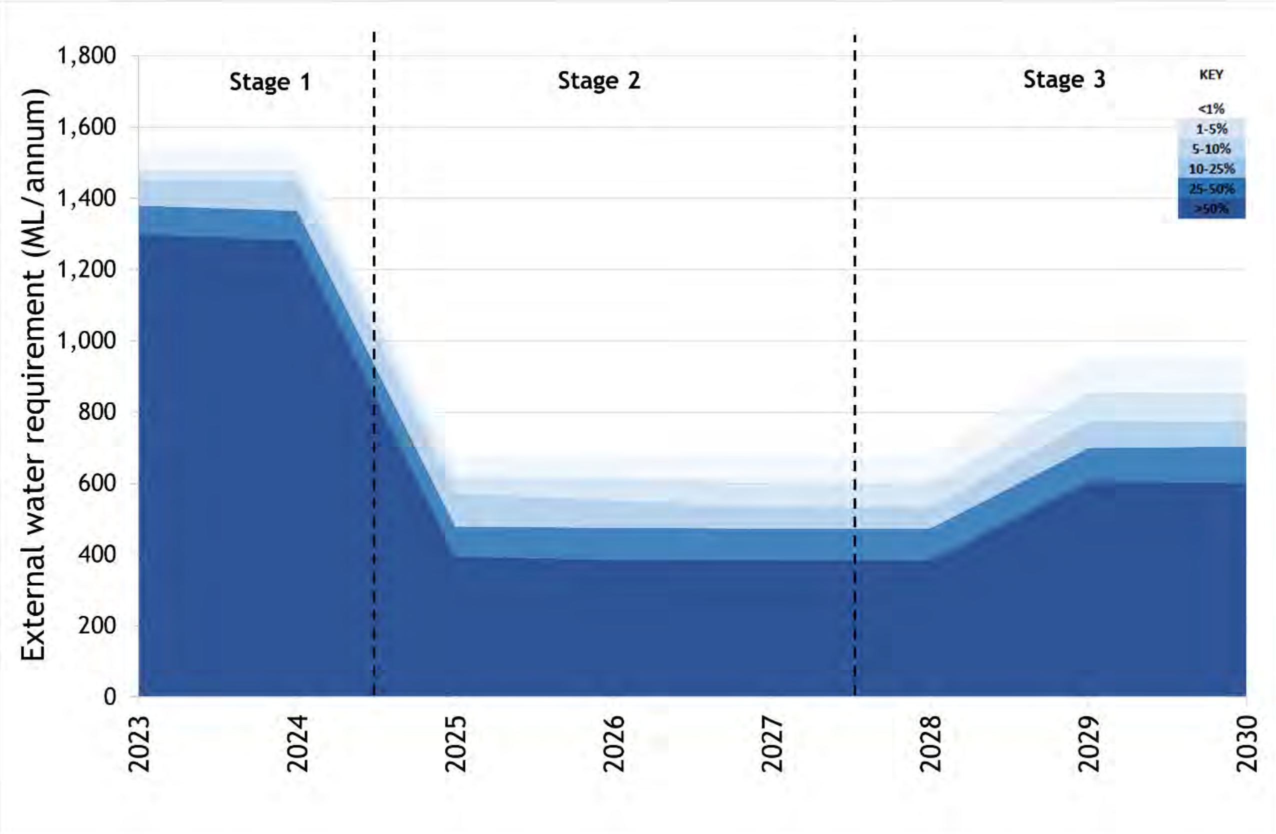


Figure 6-19 Maximum consensus external water requirement scenario (RCP 8.5)

6.4.1.8 Third Party Users

There are five active water access licences/licence to take water from waterways that drain through the Project area (Harrow Creek, East Creek, Boomerang Creek, and Hughes Creek). The surface water modelling indicates the Project will have insignificant impacts on surface flows and water quality to the receiving environment following implementation of mitigation measures, therefore the impacts on third party users is expected to be negligible. Mitigation measures will be implemented if third party users emerge.

6.4.1.9 Surface Water Balance Model

A computer-based operational simulation model (OPSIM) was used to assess the dynamics of the mine water balance under conditions of varying rainfall and catchment conditions throughout the development of the Project. The OPSIM model dynamically simulates the operation of the water management system and keeps complete account of all site water volumes and representative water quality on a daily time step.

The Project OPSIM model was used to assess the performance of the water management system, using the following key performance indicators:

- overall water balance – the average inflows and outflows of the water management system based on all model realisations;
- mine water inventory – the risk of accumulation (or reduction) of the overall mine water inventory;
- in-pit storage – the risk of accumulation of water in the mining pits, and the associated water volumes;
- external water demand – the volumes of imported external water (via the external pipeline) required to supplement site mine water supplies;
- uncontrolled spillway discharges – the risk and associated volumes of uncontrolled discharge from the mine affected water storages and sediment dams to the receiving waters;
- overall salt balance – the average salt loads in and out of the water management system based on all model realisations;
- potential receiving water impacts - predicted water quality in the receiving waters during predicted ‘worst case’ release scenarios; and
- sensitivity analysis - varying the assumed haul road dust suppression over the mine life and the potential impacts of climate change.

Site water demands

Water for haul road dust suppression is primarily sourced from the mine dams. Haul road dust suppression demands are estimated using supplied haul road design plans and historical climate data as follows:

- Daily pan evaporation and rainfall rates are sourced from the SILO database.
- For a dry day (zero rainfall), the haul road watering rate is equal to the daily evaporation rate.
- For a rainy day when rainfall is less than the daily evaporation rate, the watering rate is reduced and is only required to make up the remaining depth to the daily evaporation rate.
- For a rainy day when rainfall exceeds the daily evaporation rate, no haul road watering is required.

Assuming a haul road width of 30 m, an in-pit haul road length of 3 km for Vulcan North/South pits and 5 km for Vulcan Main pit, the estimated demand rates averaged over each month are summarised in **Table 6-23**.

Table 6-23 Forecast Haul Road Dust Suppression Usage

Month	Haul road demand (kL/day)		
	Stage 1	Stage 2	Stage 3
January	4073	1412	2310
February	3583	1242	2033
March	3752	1300	2128
April	3234	1121	1835
May	2463	854	1397
June	2006	695	1138
July	2216	768	1257
August	2867	994	1626
September	3934	1364	2232
October	4569	1584	2592
November	4652	1613	2639
December	4486	1555	2545
Annual	3486	1208	1977

The CHPP will also require water for washing and processing the coal during each stage of the Project. Based off the production schedule and key CHPP parameters, the model then predicted the water demand for processing the coal. The average CHPP water makeup requirement over each stage is provided in **Table 6-24**.

Table 6-24 Estimated CHPP Makeup Requirements

Stage	CHPP makeup requirement (ML/day)
1	0.56
2	0.53
3	0.51

Additional water demands included in the model include:

- train load out demand of 0.2 ML/d (200 kL/d) was assumed; and
- potable water demand was assumed at 50 ML/annum (137 kL/d).

Site water supply

A key objective of the mine site water management system is to reuse surface water runoff captured within the mine affected water system. Recycling mine water will reduce the volume of water from external sources that is required to satisfy site demands. However, the volume of water captured onsite is highly variable and dependent upon climatic conditions. Hence, there is a requirement to source water from reliable external sources.

For the purposes of the assessment, it has been assumed that Vitrinite will source external mine water from neighbouring operations to provide water as required via a pipeline for the life of the Project. The pipeline will transfer mine affected water to be stored in MWD8 when mine affected water inventories are low.

Water Management Infrastructure

The conceptual Project water management system layout as well as catchment areas and land uses for the three mine stages. **Figure 7-3** shows the schematised plan of the proposed water management system configuration.

To limit the risk of uncontrolled discharges from the mine water storages, Operating Volumes (OVs) have been set for these water storages (see Table 5.3 of **Appendix I**) as follows:

- MWD8 and MWD9 have a maximum operating volume (MOV) of 131.6 ML and 25.0 ML respectively. When the water inventory in these dams exceeds its MOV, all transfers to these dams (i.e., pit dewatering and mine water transfers) cease.
- MWD6 and MWD7 have OVs. When the water inventory in these dams exceeds their respective OVs, these storages commence dewatering to MWD9.

Water Balance Results

The use of a large number of climate sequences reflecting the full range of historical climatic conditions provides an indication of the system performance under very wet, very dry and average climatic conditions. It is important to note that the results of the water balance modelling are dependent on the accuracy of input assumptions. There is inherent uncertainty with respect to some key site characteristics (e.g. catchment yield/runoff, groundwater inflows etc.).

The Project will be a net importer of water due to the predicted water demands exceeding rainfall runoff and groundwater inflows into the mine site water management system.

The water balance model results show that:

- there are no predicted mine water spills to the receiving environment during the life of mine from the mine water dams or open cut pits;
- under 'average' climatic conditions, the proposed water management system is in deficit, meaning external water will be required to meet site demands such as dust suppression, CHPP makeup demands, and TLO demands. During 50%ile climate conditions, the predicted external water required is up to 1,260 ML/yr and up to 1,520 ML/yr during 1%ile (very dry) climate conditions; and
- the site water management system has been designed such that the risk of offsite release of mine affected water is very low (with no mine affected dam uncontrolled releases predicted under any modelled climatic conditions).

More detailed information on the surface water balance model can be found in **Appendix I.**

6.4.1.10 Sensitivity analysis on water balance model

Although the AWBM parameters adopted in the SWA (WRM, 2023a) are typical for coal mines in the part of the Bowen Basin where the Project is located, a sensitivity assessment of the AWBM parameters was undertaken to assess the likelihood of overflows from the proposed sediment dams. **Table 6-25** shows the adjusted In pit WRD/Out of pit WRD landuse AWBM parameter adopted in the SWA (WRM, 2023a) compared to the sensitivity assessment. Consistent with the IECA guidelines (2008), sediment dams do not provide 100% containment for captured runoff. Hence overflows will occur from sediment dams when rainfall exceeds the design standard. The results show that under 10%ile (wet conditions), releases to Hughes Creek are increased by up to 325 ML/year (Stage 3) and releases to East Creek are increased by up to 82 ML/year (Stage 2). However, there is negligible increase in water quality in the receiving waters compared to the SWA (WRM, 2023a).

Table 6-25 Sensitivity assessment In pit WRD/Out of pit WRD AWBM parameter

Parameter	SWA adopted AWBM	Sensitivity AWBM
A1	0.07	0.07
A2	0.10	0.10
A3	0.83	0.83
C1	5	5
C2	10	10
C3	200	150
C_{avg}	167.4	125.8
BFI	0.5	0.5
k_{base}	0.9	0.9
k_{surf}	0.1	0.1
C_v*	12%	14%

*Long-term volumetric runoff coefficient

Figure 6-20 shows the forecast annual sediment dam releases to Hughes Creek. **Figure 6-21** shows the forecast annual sediment dam releases to East Creek. The model results indicate that:

- The predicted sediment dam releases to Hughes Creek progressively increases over the mine life. This is due to sediment dams which release to Hughes Creek progressively being constructed over the mine life as the dump areas associated with the Vulcan Main and Vulcan South pits increases.
- The predicted sediment dam releases to East Creek increase in Stage 2 compared to Stage 1 before decreasing again in Stage 3. This is due to no new sediment dams draining to this creek being constructed at the commencement of Stage 3. The surface water catchment areas do not change between Stages 2 and 3, however mine demands for the sediment dam water increase in Stage 3.
- Under wet (10%ile) conditions, the annual volume of sediment dam releases to Hughes Creek is approximately:
  - up to 344 ML/yr during Stage 1;
  - up to 529 ML/yr during Stage 2; and
  - up to 899 ML/yr during Stage 3.
- Under wet (10%ile) conditions, the annual volume of sediment dam releases to East Creek is approximately:
  - up to 177 ML/yr during Stage 1;
  - up to 239 ML/yr during Stage 2; and
  - up to 236 ML/yr during Stage 3.
- Under 50%ile conditions, the annual volume of sediment dam releases to Hughes Creek is approximately:
  - up to 40 ML/yr during Stage 1;
  - up to 22 ML/yr during Stage 2; and
  - up to 48 ML/yr during Stage 3.
- Under 50%ile conditions, the annual volume of sediment dam releases to East Creek is approximately:
  - 0 ML/yr during Stage 1; and
  - up to 10 ML/yr during Stage 2 and Stage 3.

- Overall, the results indicate that under average or drier conditions low spill volumes are expected to the receiving waters, while wet conditions result in more significant spill volumes.

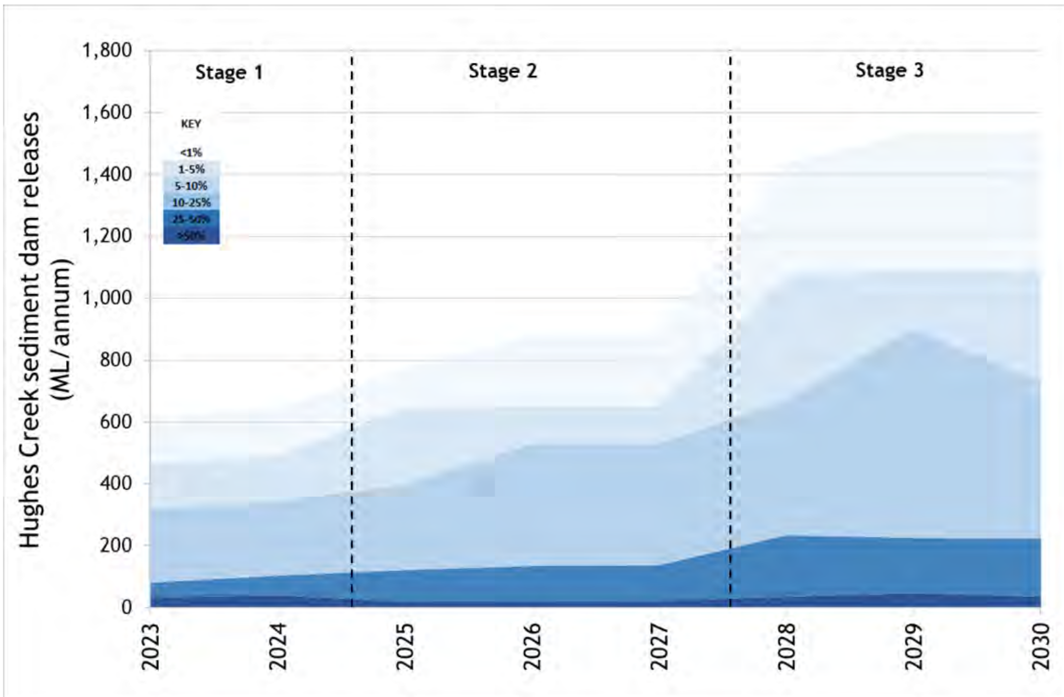


Figure 6-20 Forecast annual sediment dam releases to Hughes Creek

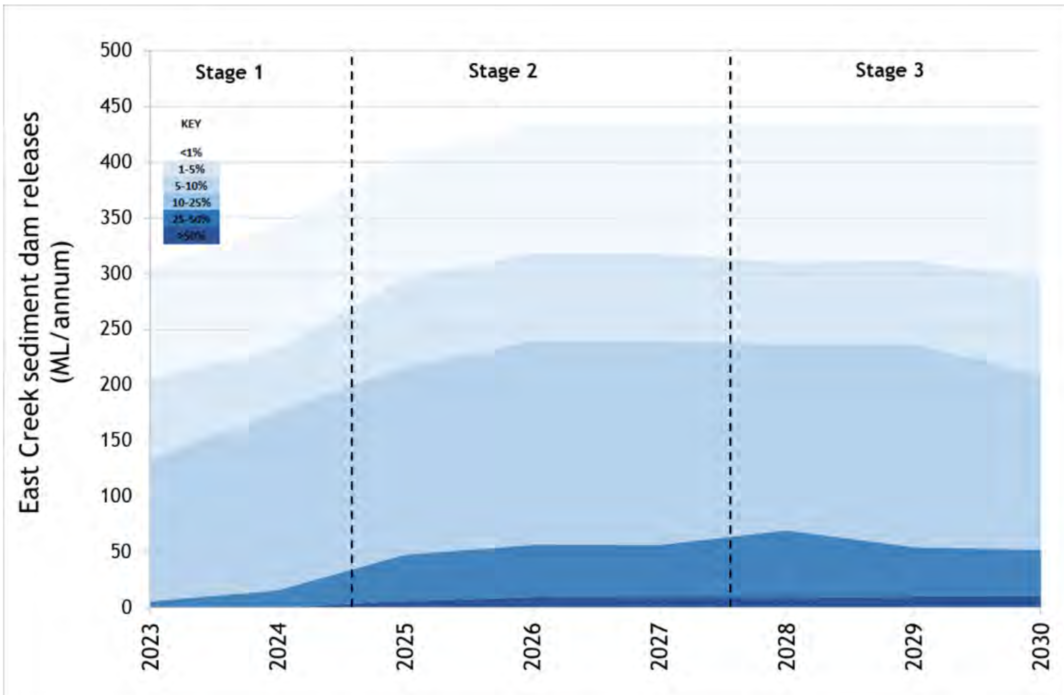


Figure 6-21 Forecast annual sediment dam releases to East Creek

Figure 6-22 shows the predicted annual maximum EC in Hughes Creek over the mine life. **Figure 6-23** shows the predicted annual maximum EC in East Creek over the mine life. The 1%ile, 5%ile, 10%ile, 25%ile and 50%ile (median climatic conditions) traces are shown. The results predict that:

- For Hughes Creek:

    - Under 1%ile conditions the maximum EC is approximately 430 µS/cm in Stage 1, 405 µS/cm in Stage 2 and 410 µS/cm in Stage 3; and
    - Under 50%ile conditions the maximum EC is approximately 320 µS/cm in Stage 1 and 350 µS/cm in Stage 2 and Stage 3.
- For East Creek:
    - Under 1%ile conditions the maximum EC is approximately 500 µS/cm in Stage 1, Stage 2 and Stage 3; and
    - Under 50%ile conditions the maximum EC is approximately 490 µS/cm in Stage 1, Stage 2 and Stage 3.

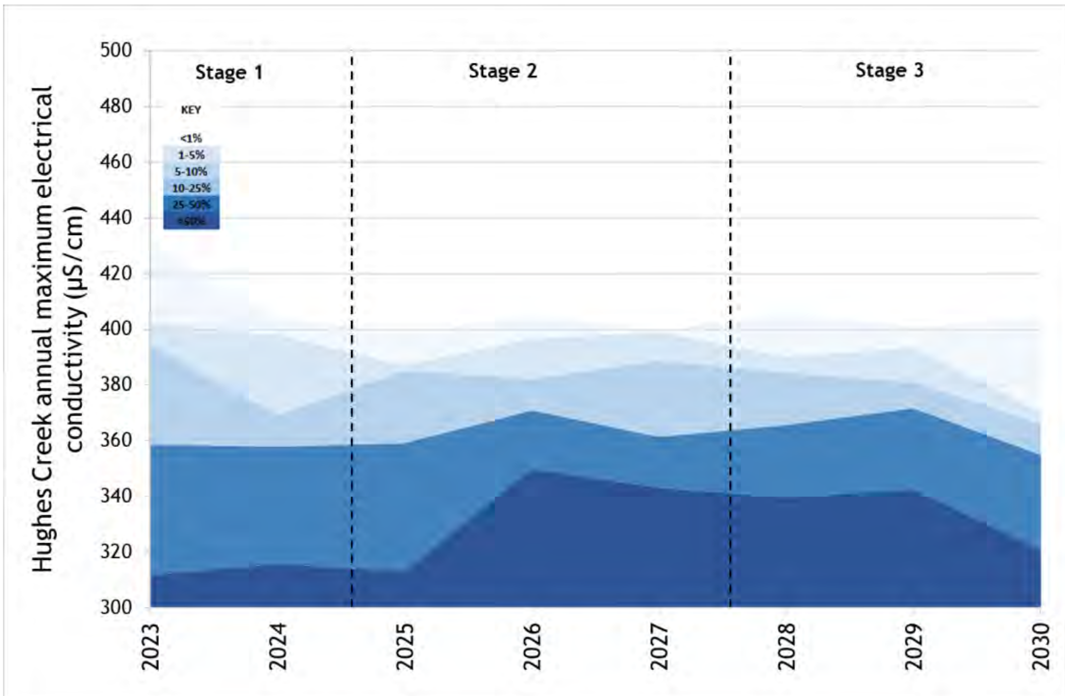


Figure 6-22 Predicted Hughes Creek annual maximum EC variation downstream of the Project

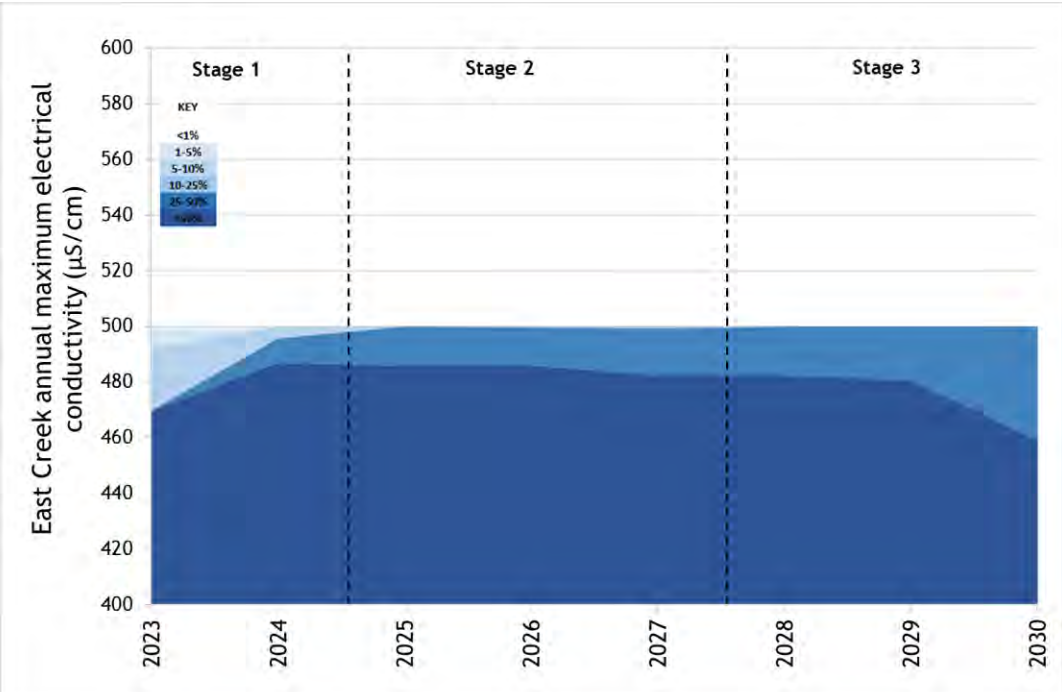


Figure 6-23 Predicted East Creek annual maximum EC variation downstream of the Project

6.4.1.11 Risks of MAW spills under RCP 8.5

As described above, the Surface Water assessment determined that there are no modelled MAW releases to the receiving environment under any scenario.

A sensitivity assessment of the mine water management system was undertaken using the RCP 8.5 climate change scenario which represents a 1.25°C global warming and increase in rainfall compared to the basecase scenario presented in the Surface Water Assessment (SWA) , 2023a). The dewatering rates of the proposed mine affected water (MAW) dams were also reduced by 50% to assess the risk of uncontrolled releases during operations.

Under the reduced dewatering scenario, the risk of uncontrolled releases is minimal and occurs only during the wettest climatic conditions assessed. However, there is sufficient MAW capacity overall (and within the pits if necessary) to dewater the MAW dams prior to uncontrolled releases to the environment.

MWD8 inventory

Figure 6-24 shows the forecast inventory for MWD8 which is the key out-of-pit mine affected water storage, controlling the dewatering of the pit. The results show the 1%ile (wettest climatic conditions), 5%ile, 10%ile, 25%ile and 50%ile traces. The model results show the following:

- The MWD8 inventory is maintained below the full storage volume (FSV) for all climatic conditions assessed and therefore is not predicted to spill under any modelled climate sequence.
- The MWD8 inventory is maintained below its MOV for 5%ile and drier conditions in Stage 1 and 25%ile & drier conditions in Stages 2 & 3. This means pit and mine dam dewatering is restricted under 1%ile in Stage 1 and 10%ile and wetter conditions in Stages 2 and 3.
- Under the 50%ile trace, the MWD8 inventory is maintained below 12 ML for the entire mine life.
- Under very wet (1%ile) conditions, MWD8 has an inventory of up to 156 ML during Stage 2.
- Under wet (10%ile conditions), MWD8 has a maximum inventory of approximately:
  - up to 62 ML during Stage 1; and
  - up to 132 ML during Stage 2 and 3.

MWD9 inventory

Figure 6-25 shows the forecast inventory for MWD9. The results show the 1%ile (wettest climatic conditions), 5%ile, 10%ile, 25%ile and 50%ile traces. The model results show the following:

- Under the 1%ile (wettest climatic conditions), the MWD9 inventory reaches the FSV under the reduced dewatering scenario. However, in the event that the proposed dewatering is constrained, there is sufficient storage within the MAW system for MWD9 to dewater to prevent uncontrolled releases.
- Under wet (10%ile conditions), MWD9 has a maximum inventory of approximately up to 18 ML during both Stage 1 & 2.

MWD6 and MWD7 inventories

Figure 6-26 shows the annual maximum forecast combined inventory for MWD6 and MWD7. The results show the 1%ile (wettest climatic conditions), 5%ile, 10%ile, 25%ile and 50%ile traces. The model results show the following:

- Under the 1%ile (wettest climatic conditions), the MWD6 and MWD7 inventory reaches the FSV under the reduced dewatering scenario and indicate that the mine dams spill into MWD8 very infrequently (i.e. less than 1% of the time).
- Under the 50%ile trace, the mine water inventory is maintained well below the MOV for all years.
- The maximum water inventory only rises above the MOV under conditions wetter than the 5%ile during all stages.

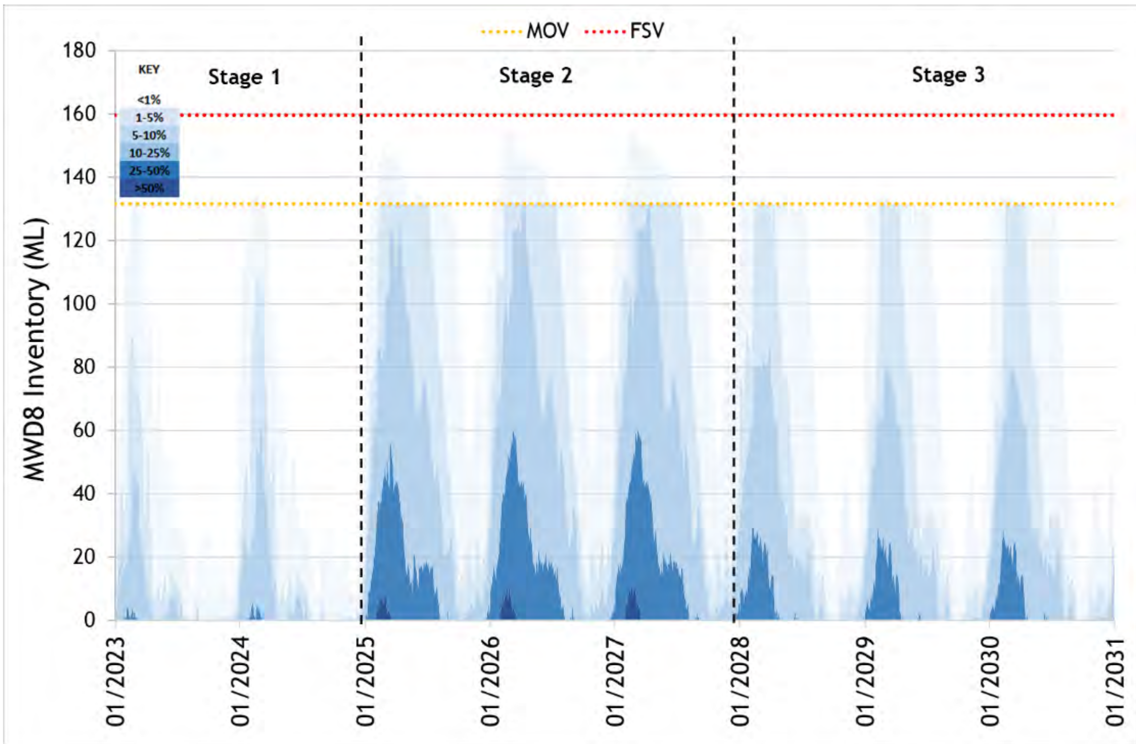


Figure 6-24 Forecast MWD8 inventory

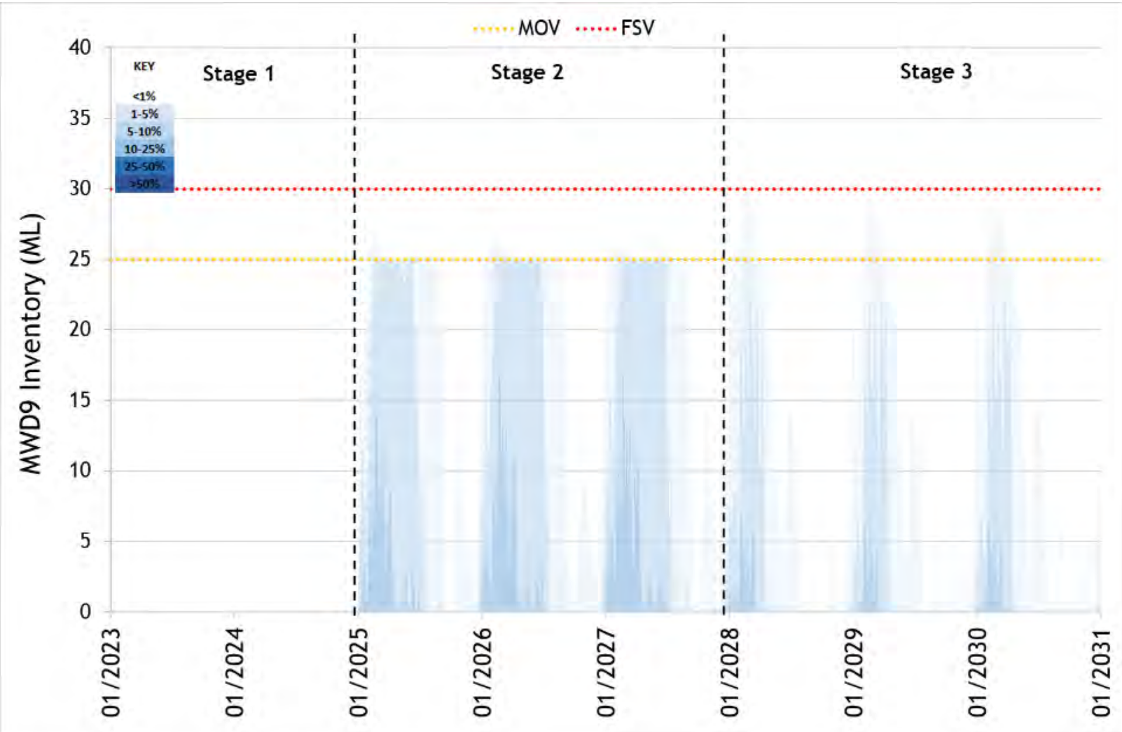


Figure 6-25 Forecast MWD9 inventory

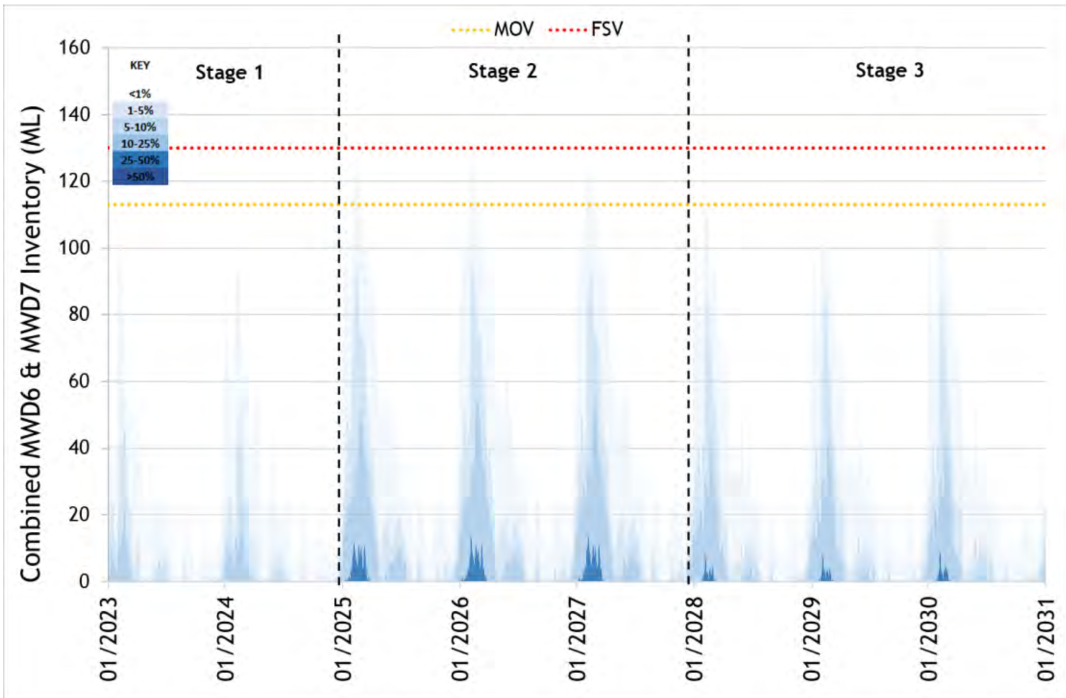


Figure 6-26 Forecast MWD6 and MWD7 inventory

6.4.1.12 Overall Salt Balance

The average annual salt balance for the Project for each stage is presented in **Table 6-25**.

Salt inputs to the Project include salts in the groundwater inflow, catchment runoff, salt stored in ROM coal and external water. Salt inputs from direct rainfall was assumed to be zero.

Salt outputs from the Project include site demands and offsite (spillway) discharges from the water management system.

The results indicate the following:

- The largest contributor to the Project salt load is due to external water assuming it is sourced from BMA. This is due to the high assumed salinity of the BMA water (**Appendix I**).
- The largest outflow in the salt balance from the Project is haul road dust suppression demands.
- The change in stored salt load is generally low in comparison to the total inputs and outputs, which suggests that salt will not accumulate within the site water management system.

Note that the salt balance is reported in annual tonnes of total dissolved solids (TDS) based on an EC to TDS conversion factor of 0.7.

Table 6-26 Average annual salt balance (based on TDS)

Description	Stage 1	Stage 2	Stage 3
Inflows (t/year)			
Rainfall runoff			
Mine affected water	214	156	139
Surface water	83	92	143
Diverted water	20	31	20
Groundwater inflow	4	77	36
ROM coal moisture	640	602	581
External pipeline	8,552	2,326	3,681
Trucked potable water	0	0	0
Total Input	**9,515**	**3,285**	**4,601**
Outflows (t/year)			
Evaporation	0	0	0
Dam overflows			
Mine affected water	0	0	0
Surface water	36	43	64
Diverted water	20	31	20
CHPP			
Product moisture	576	380	390
Coarse rejects moisture	455	427	412
Fine rejects moisture	736	486	498
Haul road dust suppression	7,266	1,651	2,929
TLO demand	419	264	289
Potable water demand	0	0	0
Total Output	**9,508**	**3,283**	**4,602**
Change in salt (t/year)			
Change in stored volume	7	2	-1

In consideration of the RGS (2022) findings from the preliminary geochemical characterisation, salinity is considered the key contaminant for assessment purposes. Assessment of other contaminants has not been undertaken as part of the SWA. If subsequent monitoring data indicates that there are other contaminants of concern, the assessment can be updated to include additional water quality parameters.

6.4.1.13 Highwall Mining Strategy

Figure 6-27 shows the proposed mine affected water management strategy for the Project. The active mining area (MAW catchment) is proposed to progressively shift as highwall mining panels are completed and rehabilitated to surface runoff water catchments. The key components of the mine water management strategy throughout the highwall mining stage of the Project include:

- Clean water drains/contour banks and rock chutes/drop structures above the plunges will divert natural catchment runoff to the proposed surface water drains/sediment control structures and prevent contamination where active plunges are located.
- Bunds along the bench will be built as required. These will direct MAW into the adjacent plunges. Bunds will also divert haul road runoff to the surface water drainage systems.
- direct mine water runoff (via gravity) either directly into a plunge or via a sump that dewaters to the plunge;
- As the highwall miner progresses, a mobile coal stockpile will keep pace within 100 m of the highwall miner before being trucked to the CHPP for processing. Disused coal stockpiles that are greater than 100 m from the highwall miner will be rehabilitated.
- Where plunges are no longer active, rehabilitation will commence to cover the voids at the surface. After covering the voids, surface runoff water would not be classified as MAW, and can be treated through the proposed sediment control structures.

The MAW catchment consists of an approximate area of 3.2 ha based on 318 m in length of highwall mining panels (4 active longwall mining panels + 2 panels with rehabilitation commenced) and a 100 m wide bench (including haul road and batter). This is based on:

- Each longwall mining panel is approximately 53.0 m in length and consists of 10 x 3.5 m wide x 1.5 m high plunges. Each panel will include 9 x 1.5 m wide pillars that will be left between each plunge with a 4.5 m wide pillar every 10 plunges.
- MAW catchment extends from edge of highwall bench to the clean water contour bank on batter slope above highwall batter/plunges (nominally 100 m width).
- One (1) panel (10 plunges) would store approximately 9.9 ML. This is based on the void capacity of each completed plunge of approximately 990 m^3 assuming plunge dimensions of 1 m high, 3.5 m wide and 300 m deep at 3% gradient.
- Each panel will take approximately 1 to 2 weeks to complete.
- MAW catchment runoff for a 10% AEP 72 hour storm event containment (extreme storm storage [ESS]) = 6.1 ML (rainfall depth = 189 mm, catchment area of 3.2 ha, assumed all rainfall is converted to runoff). This is equivalent to two thirds of the storage capacity of a panel.
- Runoff from MAW catchments would be directed to the designated water storage panel using bunds, drains and pumps (where required). Where possible, there will be an interim panel separating the active panel and the water storage panel to limit the amount of seepage through the coal seam into the seam being actively mined. As mining progresses, the water storage panel plunge openings will be buried, with any water stored in the plunge to remain within the voids. The adjacent panel would then be designated the water storage panel.
- Runoff from areas external to the active mining area including haul roads and batters are considered surface runoff water and not MAW provided the two waters do not mix. Surface runoff water would be managed with erosion and sediment control (ESC) structures and can be released after passing through an ESC structure. Surface runoff water does not require water containment.
- Mobile coal stockpiles will be located within the MAW catchment within 100 m of the highwall miner. The mobile coal stockpile will keep pace with the highwall miner. Coal will be loaded into trucks and hauled to the VS operations. Abandoned coal stockpile areas that are more than 100 m away from the highwall miner will be cleared of any residual coal material (including fines and rejects). Once the area is cleared of residual coal material and the plunges, runoff will be classified as surface runoff water and can be directed to ESC controls.

The proposed storage capacity is considered adequate to contain MAW generated from the highwall mining activities and the risk of releasing MAW runoff is low. Once plunges are no longer active, rehabilitation will commence to cover the voids at the surface. After covering the voids, surface runoff water would not be classified as MAW, and can be treated through the proposed sediment control structures.

Any potential releases from erosion and sediment control structures will be in accordance with Schedule F and Condition F4 of the Vulcan South EA. Sediment dam trigger values will be monitored against the 'Surface water quality objectives' outlined in Table F3 of the EA and **Table 5-22**.

The cumulative impact assessment undertaken includes the likely and possible impacts of the highwall mining as part of the Project. **Table 6-26** from the SWA is replicated below with the highwall mining area added as a component of the cumulative impact assessment. The highwall mining component of the Project will have negligible contribution to the cumulative impacts for the Isaac River to Phillips Creek catchment.

Table 6-27 Catchment Area of Existing Projects Considered in the Cumulative Impact Assessment (WRM, 2023)

Catchment	Total catchment area (km^2)	Estimated mine affected catchment (km^2)
Vulcan South (the Project)	15.3	4.8
-Highwall mining area component	*2.7*	*0.03*
Other mines	551	182
Combined	566	187
Isaac River (to the Phillips Creek confluence)	7,731	-

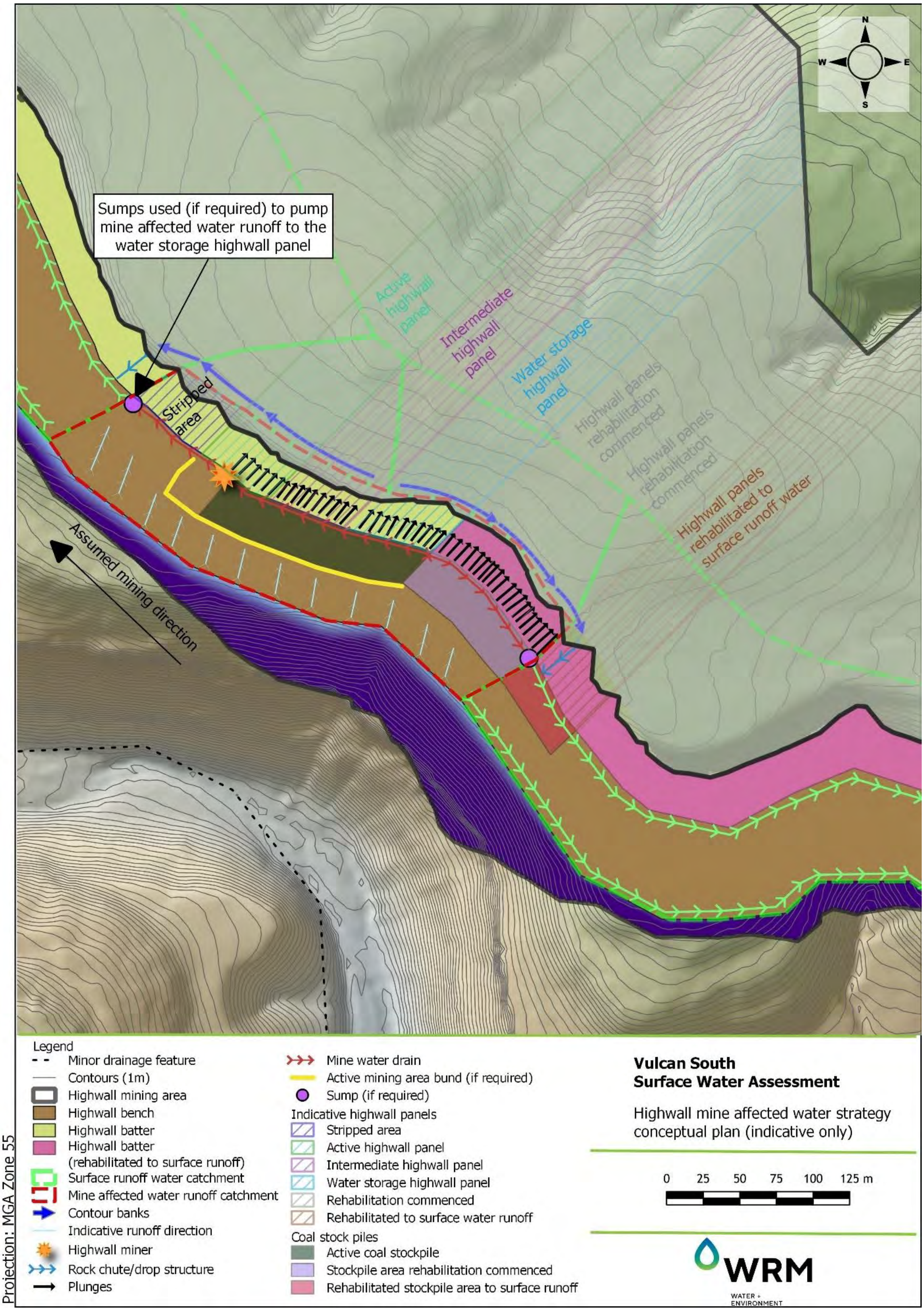


Figure 6-27 Highwall Mine Affected Water Strategy Conceptual Plan

6.4.1.14 Duration and extent

Duration

The duration of surface water impacts will occur until drainage diversions are remediated and drainage lines reinstated to the natural topography, backfilling of the pit and removing all other water management infrastructure post closure. It is expected all water management infrastructure that requires removal or remediation at the Project, will be completed by 2034.

Extent

The area of surface water impact is expected to be minimal and localised.

Overall, the impact of the Project on the hydraulic characteristics of Boomerang Creek, Hughes Creek and their tributaries do not affect the existing conditions significantly. It is expected that the channel and floodplain will undergo little, if any, adjustment to the hydraulic conditions upstream or downstream of the Project as a result of the Project.

Mine affected water from the proposed Project will be managed through a mine water management system which is designed to operate in accordance with proposed EA conditions that are based on Model Mining Conditions, and incorporated into the release criteria used in modelling the mine water management system in this report.

In consideration of the already heavily disturbed nature of the surrounding catchment, it is unlikely that Project releases will have a measurable impact on receiving water quality or EVs.

In summary, the conceptual final landform is not considered likely to have a long-term significant impact on the receiving waters.

6.4.1.15 Whether any impacts are likely to be unknown, unpredictable or irreversible

All surface water impacts are known and have been confidently predicted through the SWA (**Appendix I**). The flood modelling was developed for the Project to design the proposed flood protection infrastructure required to protect key mining infrastructure and to assess the potential flood impacts caused by the proposed infrastructure on downstream property. The water balance model was used to assess varying rainfall and climatic conditions using a daily timestep to simulate all major components of the water management system and the water management system will be implemented to mitigate the potential effects of the Projects operations on natural surface water quantity and quality.

6.4.2 Cumulative Surface Water Impacts

A summary of cumulative water impacts, including surface water impacts, is provided in **Appendix T**.

The SWA (**Appendix I**) discussed cumulative impacts at local and regional levels. This considered the impacts of existing and proposed mining operations near the Project and broader impacts to the Bowen Basin region.

The objective of the assessment was to identify the potential for impacts from the Project to have compounding interactions with similar impacts from other projects, including activities proposed, under development or already in operation within a suitable region of influence of the Project.

There were two levels at which cumulative impacts have been assessed:

- Localised cumulative impacts – These are the impacts that may result from multiple existing or proposed mining operations in the immediate vicinity of the Project. Localised cumulative impacts include the effect from concurrent operations that are close enough to potentially cause additive effect on the receiving waters. For the purposes of the assessment, all existing and proposed projects located within the Isaac River catchment have been included.
- Regional cumulative impacts – These include the Project's contribution to impacts that are caused by mining operations throughout the Bowen Basin region or at a catchment level. Each coal mining operation in itself may not represent a substantial impact at a regional level; however, the cumulative effect on the receiving waters may warrant consideration.

Projects which are currently operating within the Isaac River catchment upstream of the Deverill gauging station and have been included in the cumulative impacts assessment for the project are listed in **Table 6-27.**

Table 6-28 Existing projects considered in the cumulative impact assessment

Project-Proponent	Description	Operational Status	Relationship to the Project Mining Lease	
			Timing	Location
Vulcan Coal Mine	Open cut coal mine	Operational	Operational phase of Matilda Amendment will overlap with Vulcan South	
Burton Mine (Peabody Energy Australia)	Open cut coal mine	Ceased production indefinitely	May have overlapping operational phases with the construction and operations of the project, although unlikely given the current operational status.	Located 75 km to the north of the Project area. Located within the Isaac River catchment (upstream).
Eaglefield Mine (Peabody Energy Australia)	Open cut coal mine	Operating	May have overlapping operational phases with the construction and operations of the project.	Located 75 km to the northwest of the Project area. Located within the Isaac River catchment (upstream).
North Goonyella Mine (Peabody Energy Australia)	Open cut coal mine	Operating	May have overlapping operational phases with the construction and operations of the project.	Located 75 km to the northwest of the Project area. Located within the Isaac River catchment (upstream).
Goonyella Riverside Mine (BMA)	Open cut coal mine	Operating	May have overlapping operational phases with the construction and operations of the project.	Located 60 km to the northwest of the Project area. Located within the Isaac River catchment (upstream).
Moranbah North Mine (Anglo American)	Underground coal mine	Operating	May have overlapping operational phases with the construction and operations of the project.	Located 50 km to the northwest of the Project area. Located within the Isaac River catchment (upstream).
Grosvenor Mine (Anglo American)	Underground coal mine	Operating	May have overlapping operational phases with the construction and operations of the project.	Located 40 km to the north of the Project area. Located within the Isaac River catchment (upstream).
Broadlea Mine (Fitzroy Australia Resources)	Open cut coal mine	Care and maintenance	May have overlapping operational phases with the construction and operations of the project.	Located 40 km to the north of the Project area. Located within the headwaters of Smoky Creek, within the Isaac River catchment.
Carborough Downs Mine (Fitzroy Australia Resources)	Underground coal mine	Operating	May have overlapping operational phases with the construction and operations of the project.	Located 35 km to the northeast of the Project area. Located within the headwaters of Billy's Gully, within the Isaac River catchment.
Isaac Plains Mine (Stanmore Coal)	Open cut coal mine	Operating	May have overlapping operational phases with the construction and operations of the project.	Located 35 km to the north of the Project area. Located within the headwaters of Billy's Gully, within the Isaac River catchment.

Project-Proponent	Description	Operational Status	Relationship to the Project Mining Lease	
			Timing	Location
Millennium Mine (Peabody Energy Australia)	Open cut coal mine	Operating	May have overlapping operational phases with the construction and operations of the project.	Located 30 km to the northeast of the Project area. Located within the headwaters of Southern Gully, within the Isaac River catchment.
Daunia Mine (BMA)	Open cut coal mine	Operating	May have overlapping operational phases with the construction and operations of the project.	Located 25 km to the northeast of the Project area. Located within the Isaac River catchment (upstream).
Poitrel Mine (BMA)	Open cut coal mine	Operating	May have overlapping operational phases with the construction and operations of the project.	Located 20 km to the northeast of the Project area. Located within the Isaac River catchment (upstream).
Caval Ridge Mine (BMA)	Open cut coal mine	Operating	May have overlapping operational phases with the construction and operations of the project.	Located 10 km to the north of the Project area. Located within the Isaac River catchment (upstream).
Peak Downs Mine (BMA)	Open cut coal mine	Operating	May have overlapping operational phases with the construction and operations of the project.	Located directly adjacent (i.e., less than 1 km to the north and east of the Project area. Located within the Isaac River catchment.
Moorvale Mine (Peabody Energy Australia)	Open cut coal mine	Operating	May have overlapping operational phases with the construction and operations of the project.	Located 35 km to the northeast of the Project area. Located within the headwaters of North Creek, within the Isaac River catchment.
Saraji Mine (BMA)	Open cut coal mine	Operating	May have overlapping operational phases with the construction and operations of the project.	Located 10 km to the southeast of the Project area. Located within the Isaac River catchment.
Norwich Park Mine (BMA)	Open cut coal mine	Ceased production indefinitely	May have overlapping operational phases with the construction and operations of the project, although unlikely given the current operational status.	Located 45 km to the southeast of the Project area. Located within the Isaac River catchment (downstream).
Lake Vermont Mine (Jellinbah Group)	Open cut coal mine	Operating	May have overlapping operational phases with the construction and operations of the project.	Located 30 km to the southeast of the Project area. Located within the Isaac River catchment (downstream).

Relevant projects that have been considered include:

- Projects within the predicted sphere of influence of the Project, as listed on the Department of State Development, Manufacturing, Infrastructure and Planning (DSDMIP) website that are undergoing assessment under the *State Development and Public Works Organisation Act 1971* (SDPWO Act) for which an Initial Advice Statement (IAS) or an EIS are available.
- Projects within the predicted sphere of influence of the Project, which are listed on the website of DESI that are undergoing assessment under the *Environmental Protection Act 1994* (EP Act) for which an IAS or an EIS are available.

- Projects within the predicted sphere of influence of the Project, which are listed on the website of the Department of Infrastructure, Local Government and Planning (DILGP) that are undergoing assessment under the *Regional Planning Interests Act 2014* (RPI Act) for which an Assessment Application is available.

Projects currently undergoing assessment or having recently completed assessment under these processes and included in the cumulative impact assessment for the Project are listed in **Table 6-28.**

Table 6-29 Proposed projects considered in the cumulative impact assessment

Project-Proponent	Description	Operational Status	Relationship to the Project Mining Lease	
			Timing	Location
Moranbah South Project (Anglo American)	Underground coal mine	Approved project	May have overlapping operational phases with the construction and operations of the project.	Located 30 km to the northwest of the Project area. Located within the Isaac River catchment (upstream).
Moorvale South Project (Peabody Energy Australia)	Open cut coal mine	Approved project	May have overlapping operational phases with the construction and operations of the project.	Located 25 km to the northeast of the Project area. Located within the Isaac River catchment (upstream).
Eagle Downs Mine (Bowen Central Coal Joint Venture)	Underground coal mine	Construction on hold – site on care and maintenance	May have overlapping operational phases with the construction and operations of the project.	Located 10 km to the north of the Project area. Located within the Isaac River catchment upstream).
Winchester South Project (Whitehaven Coal)	Open cut coal mine	EIS active	May have overlapping operational phases with the construction and operations of the project.	Located 15 km to the northwest of the Project area. Located within the Isaac River catchment (upstream).
Olive Downs Coking Coal Project (Pembroke Olive Downs Pty Ltd)	Open cut coal mine	Approved with conditions	May have overlapping operational phases with the construction and operations of the project.	Located 10 km to the west of the Project area. Located within the Isaac River catchment (downstream).
Saraji East Mine (BMA)	Open cut coal mine	EIS active	May have overlapping operational phases with the construction and operations of the project.	Located 15 km to the southwest of the Project area. Located within the Isaac River catchment (downstream).
Dysart East Coal Mine (Bengal Coal)	Underground coal mine	ML granted	May have overlapping operational phases with the construction and operations of the project.	Located 35 km to the southwest of the Project area. Located within the Isaac River catchment (downstream).
Red Hill (BMA)	Underground coal mine	Approved with conditions	May have overlapping operational phases with the construction and operations of the project.	Located 60 km to the northeast of the Project area. Located within the Isaac River catchment (upstream).
Isaac Downs Project (Stanmore IP South Pty Ltd)	Open cut coal mine	EIS active	May have overlapping operational phases with the construction and operations of the project.	Located 30 km to the north of the Project area. Located within the Isaac River catchment (upstream).

6.4.2.1 Water Quality

The Project will have negligible cumulative impacts on surface water quality and associated EVs, given policy frameworks introduced by the Queensland Government (see **Section 3.3.1** of **Appendix T**), and the disturbed nature of the catchment. The Project's water releases will be managed within an existing overarching strategic framework for management of cumulative impacts of mining activities, thus the proposed management approach for mine water from the project is expected to have negligible cumulative impact on surface water quality and associated EVs.

The Project will reduce the catchment area draining to receiving waters due to capture of runoff from disturbed catchment areas within the water management system. The Project catchment area represents approximately 0.2% of the total catchment area of the Isaac River to its confluence with Phillip Creek. Of this, approximately 40% will be managed through the Project ESC and released back to receiving waters. The combined total catchment area of the existing mines (including the Project) represents around 7.3% of the total catchment area of the Isaac River to the Phillips Creek confluence. The site water management system has been designed such that the risk of offsite release of mine affected water is very low (with no mine affected dam uncontrolled releases predicted under any modelled climatic conditions).

6.4.2.2 Loss of Catchment and Stream Flows in the Isaac River

The Project will result in a loss of catchment to the Isaac River during operations which will be reinstated post-mining. There are approximately 19 existing coal mines in the vicinity of the Project that also capture runoff from the Isaac River catchment (**Figure 6-28**).

The potential cumulative impact to surface water flows (runoff volume) lost from the catchment considering water captured by water management systems will generally be in proportion to the loss of catchment area and is indicated by the following and shown in **Table 6-29**:

- The combined total catchment area of the existing mines (including the Project and VCM pits) represents around 7.4% of the total catchment area of the Isaac River to the Phillips Creek confluence. The Project area contributes approximately 0.2% of the Isaac River to Phillips Creek.
- The estimated mine affected catchment areas from existing mining projects represents less than 2.5% of the total Isaac River catchment area to the Phillips Creek confluence. The Project mine affected catchments contributes approximately 0.06% of the Isaac River to Phillips Creek.

The combined total catchment area of the existing mining projects suggests that the loss of Isaac River catchment during operations would reduce surface water flows when rainfall and runoff is collected within their respective water management systems. However, when considering the current approved release rules and their potential discharges and stream diversions generally only diverting catchments (not taking water) around the existing mining projects during operations, the overall loss of catchment area and associated decrease in stream flows is relatively small.

The Project does not contribute significantly to the cumulative impact on surface water flows as the Project itself proposes to only temporarily capture of mine water during operations. Post-closure, mining pits will be backfilled and the pre-mining catchment areas within the Project will be reinstated. During operations, approximately 50% of the Project disturbance area will be captured and the remainder will be released to the downstream environment following sediment removal by an ESC control. The neighbouring VCM applies similar principles in managing catchment runoff and diverting catchments around the operational areas and therefore when considering the entirety of the approved and planned operations at the VCM, the cumulative impact of the Project in post closure within the Isaac River catchment to Phillips Creek confluence is negligible.

Table 6-30 Catchment area of existing projects considered in the cumulative impact assessment

Catchment	Total Catchment Area (km^2)	Estimated mine affected catchment area (km^2)
Vulcan South (the Project)	15.3	4.8
Vulcan Coal Mine	2.64	1.1
Other mines	551	182
Combined	566	187
Isaac River (to the Phillips Creeks confluence)	7,731	-

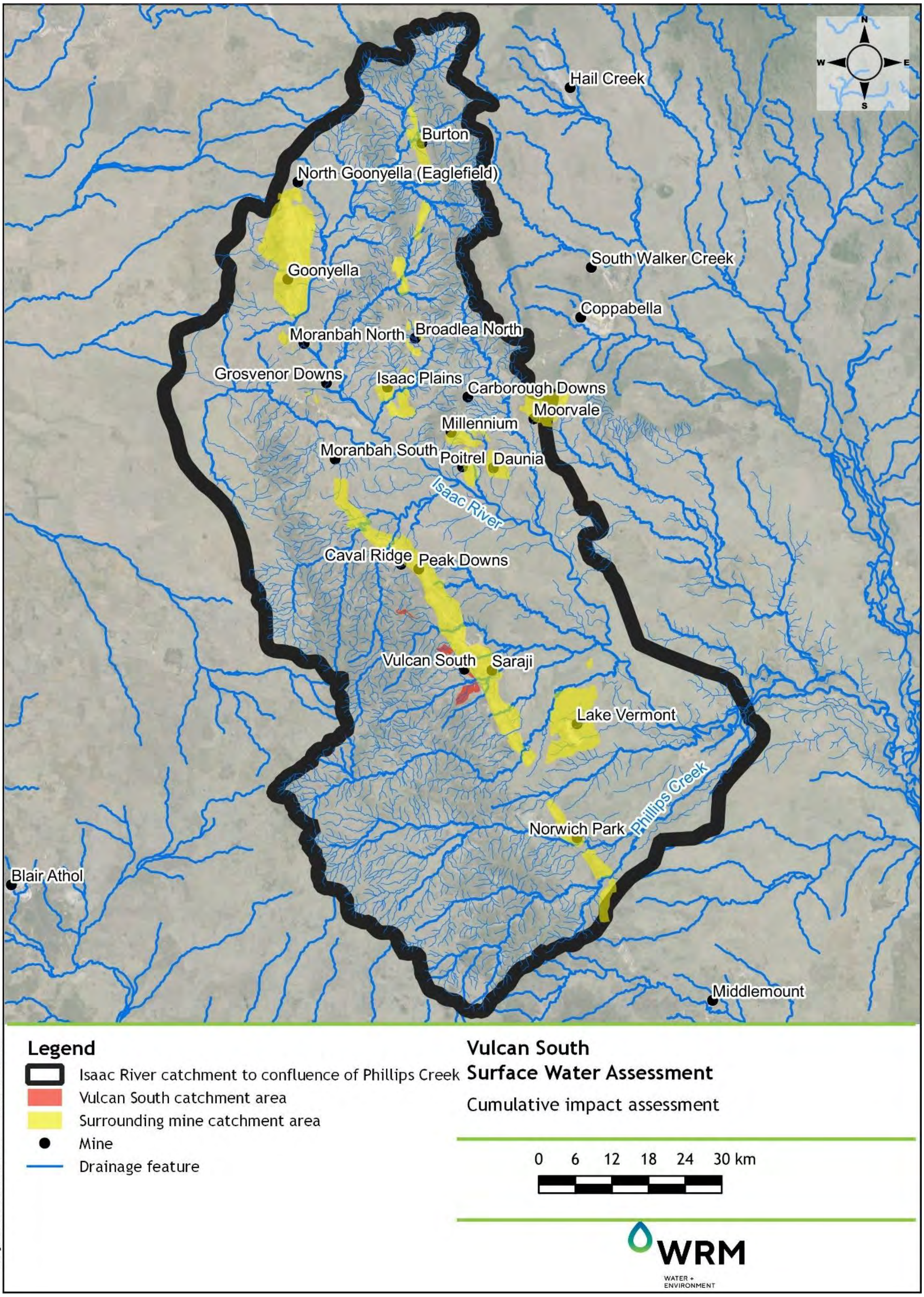


Figure 6-28 Cumulative surface water impact assessment - location of surrounding mines

6.4.3 Impacts to Groundwater

This Section provides a detailed assessment of potential impacts from the Project on the limited groundwater resources within the Project area.

A summary of cumulative water impacts, including groundwater impacts, is provided in **Appendix T**.

The extent of impacts to groundwater in terms of area in ha is described in **Section 6.4.3.5.**

6.4.3.1 IESC requirements

Whilst the Project is not considered to be a large coal mining development, the IESC information requirements checklist is presented in **Table 2-1** (Groundwater Impact Assessment, **Appendix P**), with details on where aspects have been addressed and documented within the report. This table is reproduced below:

Table 6-31 IESC Information requirements - groundwater cross reference table to GIA

Project information	Groundwater Impact assessment (Appendix P) Section
Description of the proposal	
Provide a regional overview of the proposed Project area including a description of the: • **geological basin;** • **coal resource;** • **surface water catchments;** • **groundwater systems;** • **water-dependent assets; and** • **past, present and reasonably foreseeable coal mining and CSG developments.**	Section 3, 4, 5, 5.7.2
Describe the statutory context, including information on the proposal's status within the regulatory assessment process and any applicable water management policies or regulations.	Section 2
Describe the proposal's location, purpose, scale, duration, disturbance area, and the means by which it is likely to have a significant impact on water resources and water-dependent assets.	Section 1, 5.9, 6.2, 7
Describe how impacted water resources are currently being regulated under state or Commonwealth law, including whether there are any applicable standard conditions.	Section 2
Risk Assessment	
Identify and assess all potential environmental risks to water resources and water-related assets, and their possible impacts. In selecting a risk assessment approach consideration should be given to the complexity of the project, and the probability and potential consequences of risks.	Section 6
Assess risks following the implementation of any proposed mitigation and management options to determine if these will reduce risks to an acceptable level based on the identified environmental objectives.	Section 7
Incorporate causal mechanisms and pathways identified in the risk assessment in conceptual and numerical modelling. Use the results of these models to update the risk assessment.	Section 6
The risk assessment should include an assessment of: • **all potential cumulative impacts which could affect water resources and water-related assets; and** • **mitigation and management options which the proponent could implement to reduce these impacts.**	Section 6
Groundwater – Context and Conceptualisation	
Describe and map geology at an appropriate level of horizontal and vertical resolution including: • **definition of the geological sequence(s) in the area, with names and descriptions of the formations and accompanying surface geology, cross-Sections and any relevant field data; and,**	Section 4

• geological maps appropriately annotated with symbols that denote fault type, throw and the parts of sequences the faults intersect or displace.	
Define and describe or characterise significant geological structures (e.g. faults, folds, intrusives) and associated fracturing in the area and their influence on groundwater – particularly groundwater flow, discharge or recharge. • Site-specific studies (e.g. geophysical, coring / wireline logging etc.) should give consideration to characterising and detailing the local stress regime and fault structure (e.g. damage zone size, open/closed along fault plane, presence of clay/shale smear, fault jogs or splays). • Discussion on how this fits into the fault's potential influence on regional-scale groundwater conditions should also be included.	Section 4, 5, 5.9.1
Provide site-specific values for hydraulic parameters (e.g. vertical and horizontal hydraulic conductivity and specific yield or specific storage characteristics including the data from which these parameters were derived) for each relevant hydrogeological unit. In situ observations of these parameters should be sufficient to characterise the heterogeneity of these properties for modelling.	Section 5, 5.4
Provide time series level and water quality data representative of seasonal and climatic cycles	Section 5.3, 5.8
Provide data to demonstrate the varying depths to the hydrogeological units and associated standing water levels or potentiometric heads, including direction of groundwater flow, contour maps, and hydrographs. All boreholes used to provide this data should have been surveyed.	Section 5.5.5
Provide hydrochemical (e.g. acidity/alkalinity, electrical conductivity, metals, and major ions) and environmental tracer (e.g. stable isotopes of water, tritium, helium, strontium isotopes, etc.) characterisation to identify sources of water, recharge rates, transit times in aquifers, connectivity between geological units and groundwater discharge locations.	Section 5.8
Describe the likely recharge, discharge and flow pathways for all hydrogeological units likely to be impacted by the proposed development.	Section 5.5.4
Assess the frequency (and time lags if any), location, volume and direction of interactions between water resources, including surface water/groundwater connectivity, inter-aquifer connectivity and connectivity with sea water.	Section 5.5, 5.6
Groundwater – Analytical and Numerical Modelling	
Provide a detailed description of all analytical and/or numerical models used, and any methods and evidence (e.g. expert opinion, analogue sites) employed in addition to modelling.	Section 6.1, Appendix C of the GIA
Undertake groundwater modelling in accordance with the Australian Groundwater Modelling Guidelines (Barnett et al. 2012), including independent peer review.	Section 6.1, Appendix C of the GIA
Calibrate models with adequate monitoring data, ideally with calibration targets related to model prediction (e.g. use baseflow calibration targets where predicting changes to baseflow).	Section 6.1, Appendix C of the GIA
Describe each hydrogeological unit as incorporated in the groundwater model, including the thickness, storage and hydraulic characteristics, and linkages between units, if any.	Appendix C of the GIA
Describe the existing recharge/discharge pathways of the units and the changes that are predicted to occur upon commencement, throughout, and after completion of the proposed project.	Section 5.5.4, 6, Appendix C of the GIA
Describe the various stages of the proposed project (construction, operation and rehabilitation) and their incorporation into the groundwater model. Provide predictions of water level and/or pressure declines and recovery in each hydrogeological unit for the life of the project and beyond, including surface contour maps for all hydrogeological units.	Section 1, Appendix C of the GIA
Identify the volumes of water predicted to be taken annually with an indication of the proportion supplied from each hydrogeological unit.	Section 6.2.1, Appendix C of the GIA
Undertake model verification with past and/or existing site monitoring data.	Appendix C of the GIA
Provide an explanation of the model conceptualisation of the hydrogeological system or systems, including multiple conceptual models if appropriate. Key assumptions and model limitations and any consequences should also be described.	Section 5.9

Consider a variety of boundary conditions across the model domain, including constant head or general head boundaries, river cells and drains, to enable a comparison of groundwater model outputs to seasonal field observations.	Appendix C of the GIA
Undertake sensitivity analysis and uncertainty analysis of boundary conditions and hydraulic and storage parameters, and justify the conditions applied in the final groundwater model (see Middlemis and Peeters [in press]).	Section 6.2.4, Appendix C of the GIA
Provide an assessment of the quality of, and risks and uncertainty inherent in, the data used to establish baseline conditions and in modelling, particularly with respect to predicted potential impact scenarios. **Undertake an uncertainty analysis of model construction, data, conceptualisation and predictions (see Middlemis and Peeters [in press]).**	Appendix C of the GIA
Provide a program for review and update of models as more data and information become available, including reporting requirements. Provide a program for review and update of models as more data and information become available, including reporting requirements.	Appendix C of the GIA
Provide information on the magnitude and time for maximum drawdown and post-development drawdown equilibrium to be reached. Provide information on the magnitude and time for maximum drawdown and post-development drawdown equilibrium to be reached.	Section 6.2.3
Groundwater – Impacts to Water Resources and Water-dependent Assets	
Provide an assessment of the potential impacts of the proposal, including how impacts are predicted to change over time and any residual long-term impacts. Consider and describe: • **any hydrogeological units that will be directly or indirectly dewatered or depressurised, including the extent of impact on hydrological interactions between water resources, surface water/groundwater connectivity, interaquifer connectivity and connectivity with sea water;** • **the effects of dewatering and depressurisation (including lateral effects) on water resources, water-dependent assets, groundwater, flow direction and surface topography, including resultant impacts on the groundwater balance;** • **the potential impacts on hydraulic and storage properties of hydrogeological units, including changes in storage, potential for physical transmission of water within and between units, and estimates of likelihood of leakage of contaminants through hydrogeological units;** • **the possible fracturing of and other damage to confining layers; and** • **for each relevant hydrogeological unit, the proportional increase in groundwater use and impacts as a consequence of the proposed project, including an assessment of any consequential increase in demand for groundwater from towns or other industries resulting from associated population or economic growth due to the proposal.**	Section 6
Describe the water resources and water-dependent assets that will be directly impacted by mining or CSG operations, including hydrogeological units that will be exposed/partially removed by open cut mining and/or underground mining.	Section 5, 5.7.2, 6
For each potentially impacted water resource, provide a clear description of the impact to the resource, the resultant impact to any water-dependent assets dependent on the resource, and the consequence or significance of the impact. For each potentially impacted water resource, provide a clear description of the impact to the resource, the resultant impact to any water-dependent assets dependent on the resource, and the consequence or significance of the impact.	Section 6
water planning rules) for the groundwater basin(s) within which the development proposal is based. D**escribe existing water quality guidelines, environmental flow objectives and other requirements (e.g. water planning rules) for the groundwater basin(s) within which the development proposal is based.**	Section 2, 5.8.3, 5.8.4
Provide an assessment of the cumulative impact of the proposal on groundwater when all developments (past, present and/or reasonably foreseeable) are considered in combination. Provide an assessment of the cumulative impact of the proposal on groundwater when all developments (past, present and/or reasonably foreseeable) are considered in combination.	Section 6
Describe proposed mitigation and management actions for each significant impact identified, including any proposed mitigation or offset measures for long-term impacts post mining.	Section 7

Provide a description and assessment of the adequacy of proposed measures to prevent/minimise impacts on water resources and water-dependent assets. Provide a description and assessment of the adequacy of proposed measures to prevent/minimise impacts on water resources and water-dependent assets.	Section 7
Groundwater – Data and Monitoring	
Provide sufficient data on physical aquifer parameters and hydrogeochemistry to establish pre-development conditions, including fluctuations in groundwater levels at time intervals relevant to aquifer processes. Provide sufficient data on physical aquifer parameters and hydrogeochemistry to establish pre-development conditions, including fluctuations in groundwater levels at time intervals relevant to aquifer processes.	Section 5
Develop and describe a robust groundwater monitoring program using dedicated groundwater monitoring wells – including nested arrays where there may be connectivity between hydrogeological units – and targeting specific aquifers, providing nested arrays where there may be connectivity between hydrogeological units – and targeting specific aquifers, providing an understanding of the groundwater regime, recharge and discharge processes and identifying changes over time.	Section 5
Develop and describe proposed targeted field programs to address key areas of uncertainty, such as the hydraulic connectivity between geological formations, the sources of groundwater sustaining GDEs, the hydraulic properties of significant faults, fracture networks and aquitards in the impacted system, etc., where appropriate.	Section 7
Provide long-term groundwater monitoring data, including a comprehensive assessment of all relevant chemical parameters to inform changes in groundwater quality and detect potential contamination events.	Section 5.8
Ensure water quality monitoring complies with relevant National Water Quality Management Strategy (NWQMS) guidelines (ANZECC/ARMCANZ 2000) and relevant legislated state protocols (e.g. Ensure water quality monitoring complies with relevant National Water Quality Management Strategy (NWQMS) guidelines (ANZECC/ARMCANZ 2000) and relevant legislated state protocols (e.g. QLD Government 2013).	Section 5.8
Cumulative Impacts – Context and Conceptualisation	
Provide cumulative impact analysis with sufficient geographic and temporal boundaries to include all potentially significant water-related impacts. Provide cumulative impact analysis with sufficient geographic and temporal boundaries to include all potentially significant water-related impacts.	Section 6, Appendix C
Consider all past, present and reasonably foreseeable actions, including development proposals, programs and policies that are likely to impact on the water resources of concern in the cumulative impact analysis. Where a proposed project is located within the area of a bioregional assessment consider the results of the bioregional assessment. Consider all past, present and reasonably foreseeable actions, including development proposals, programs and policies that are likely to impact on the water resources of concern in the cumulative impact analysis. Where a proposed project is located within the area of a bioregional assessment consider the results of the bioregional assessment.	Section 6, Appendix C
Cumulative Impacts – Impact	
Provide an assessment of the condition of affected water resources which includes: • **identification of all water resources likely to be cumulatively impacted by the proposed development;** • **a description of the current condition and quality of water resources and information on condition trends;** • **identification of ecological characteristics, processes, conditions, trends and values of water resources;** • **adequate water and salt balances; and,** • **identification of potential thresholds for each water resource and its likely response to change and capacity to withstand adverse impacts (e.g. altered water quality, drawdown).** • **identification of potential thresholds for each water resource and its likely response to change and capacity to withstand adverse impacts (e.g. altered water quality, drawdown).**	Section 6, Appendix C
Assess the cumulative impacts to water resources considering:	Section 6, Appendix C

• **the full extent of potential impacts from the proposed project, (including whether there are alternative options infrastructure and mine configurations which could reduce impacts), and encompassing all linkages, including both direct and indirect links, operating upstream, downstream, vertically and laterally;** • **all stages of the development, including exploration, operations and post closure/decommissioning;** • **appropriately robust, repeatable and transparent methods;** • **the likely spatial magnitude and timeframe over which impacts will occur, and significance of cumulative impact; and** • **opportunities to work with other water users to avoid, minimise or mitigate potential cumulative impacts.**	
Cumulative Impacts – Mitigation, Monitoring and Management	
Identify modifications or alternatives to avoid, minimise or mitigate potential cumulative impacts. Evidence of the likely success of these measures (e.g. case studies) should be provided.	Section 7
Identify cumulative impact environmental objectives.	Section 7
Identify measures to detect and monitor cumulative impacts, pre and post development, and assess the success of mitigation strategies. Identify measures to detect and monitor cumulative impacts, pre and post development, and assess the success of mitigation strategies.	Section 7
Describe appropriate reporting mechanisms.	Section 7
Propose adaptive management measures and management responses.	Section 7

6.4.3.2 Third Party Users

As described in **Section 5.10.1**, there are no third party bores within 3km of the Project area. Therefore, there are no identified third party landholder bores, either upgradient or down gradient that could be potentially effected and identified bores are outside the predicted zone of drawdown / impact. Therefore, there are no impacts are predicted for third party groundwater users.

6.4.3.3 Impacts to Stakeholders

As **Figure 6-29** and **Figure 6-30**, indicate, the predicted extent of maximum drawdown in the Tertiary / weathered zone (layer 2) and the DLL coal seam (layer 10) are limited. There are no third-party groundwater users within the predicted extent of drawdown and hence impacts on existing users are considered very unlikely. The nearest third-party bores (to any of the Vulcan South pits) comprise a network of monitoring bores drilled at Saraji Mine by BMA. These are approximately 400 m from the 1 m predicted drawdown contour line.

The uncertainty analysis shows that the maximum probable drawdown extent includes this BMA monitoring bore network. Whilst predicted drawdown at these monitoring bores is possible, the bores are not relied upon for water supply and they have been designed to monitor for mine related impact to the groundwater regime. On this basis impacts to third party groundwater users are unlikely and the proposed monitoring program (**Section 7**) will ensure that third-party bores are not put at undue risk by the Project.

6.4.3.4 Surface-groundwater Interaction.

A desktop assessment of potential interaction between surface water and groundwater has been conducted (**Appendix P**) on the basis of the Project's surface water and groundwater regimes and comparison with similar investigations conducted at similar projects.

The ephemeral nature of the surface water systems means that the creeks are dry for the majority of time. The groundwater table beneath the creeks occurs within either the Tertiary sediments or Permian coal measures at depth (greater than 10 m below ground level) and forms part of the regional groundwater table.

There is a significant thickness (generally greater than 10 m) of unsaturated material beneath the creek and above the groundwater table. The site monitoring bores have demonstrated over the period of record (since 2019) that the depth to the groundwater table is typically in excess of 25 m below ground in the vicinity of the proposed open pits.

It is assessed that there is currently no surface water/groundwater interaction in the Project area. There is not predicted to be a significant increase in groundwater levels in the region (or over the life of the project, or during post closure) to change this conclusion. It is assessed that post mining there will be no surface water/groundwater interaction in the Project area.

No further investigations are necessary to confirm that surface water / groundwater interaction does not exist within the Project area.

6.4.3.5 Groundwater Drawdown and Depressurisation

Hydrogeologist.com.au (2024) (**Appendix P)** has developed a numerical groundwater flow model of the survey area and broader region to predict the effects of Vulcan South on local groundwater levels. For the purposes of this assessment, drawdown and depressurisation are effectively treated as the same effect. Depressurisation is generally referred to for deeper confined aquifers.

The predicted drawdown in the Tertiary / weathered zone (layer 2) and the DLL coal seam (layer 10) are shown in **Figure 6-29** and **Figure 6-30**, respectively. The figures show the maximum predicted drawdown throughout the model simulation. The drawdowns represent the Project only drawdown and do not include the impacts of the VCM, Saraji Mine or Peak Downs Mine.

The maximum predicted drawdown in the Tertiary / weathered zone (layer 2) is approximately 10 m in the vicinity of the Vulcan Main pit. Negligible drawdown is predicted in layer 2 in the vicinity of the Vulcan North pit and Vulcan South pit. The drawdown extent occurs some 2,200 m (from the pit crest to the 1 m drawdown contour) and the predicted drawdown preferentially propagates towards the east and the existing Saraji Mine.

The proposed pits are to be backfilled following mining and therefore no residual drawdown is expected to occur post closure. There may be some minor change to the local groundwater elevations and flow directions post closure however these are expected to be negligible and will not impact materially on the groundwater regime.

The maximum drawdown in the DLL coal seam (layer 10) is predicted to be larger than, but of a similar magnitude to, that predicted for layer 2. The maximum magnitude of drawdown is approximately 10 m in the vicinity of the proposed Vulcan Main pit with negligible drawdown predicted in the vicinity of the Vulcan North pit and Vulcan South pit. The drawdown extent in layer 10 occurs some 2,400 m (from the pit crest to the 1 m drawdown contour) and the predicted drawdown preferentially propagates towards the east and existing Saraji Mine.

As per the layer 2 drawdown, the proposed pits are to be backfilled following mining and therefore no residual drawdown is expected to occur post closure in layer 10.

Predicted drawdown due to the proposed VS is limited to generally less than 2 km from the proposed pit. This limited drawdown propagation is mainly due to the limited extent of saturation in the Project area, the low hydraulic conductivities and low storage coefficients. The predicted drawdown extends towards the east, toward Saraji Mine. The predicted maximum drawdowns in **Figure 6-29** and **Figure 6-30** are for any stage throughout the simulation for the weathered zone/regolith (layer 2) and the DLL coal seam (layer 10), respectively, and the actual drawdowns at any other times during the simulations will be less than those presented.

The drawdown predicted from the groundwater at Vulcan South is limited in geographic extent (up to 2,400 m to the east of the pits toward existing mining) and magnitude (up to 10 m). As the pits will be back-filled, no residual drawdown is expected following the cessation of the project. No remnant vegetation outside the project's clearing footprint is found within the zone of drawdown. Furthermore, any non-remnant vegetation within this zone is highly disturbed by existing mining operations associated with the Peak Downs Mine.

The *absolute amount of drawdown due to proposed mining* is referred to in the GIA as project drawdown. **Figure 6-29** and **Figure 6-30** show the project drawdown in layers 2 and 10 which represent the maximum extent over the life of the project.

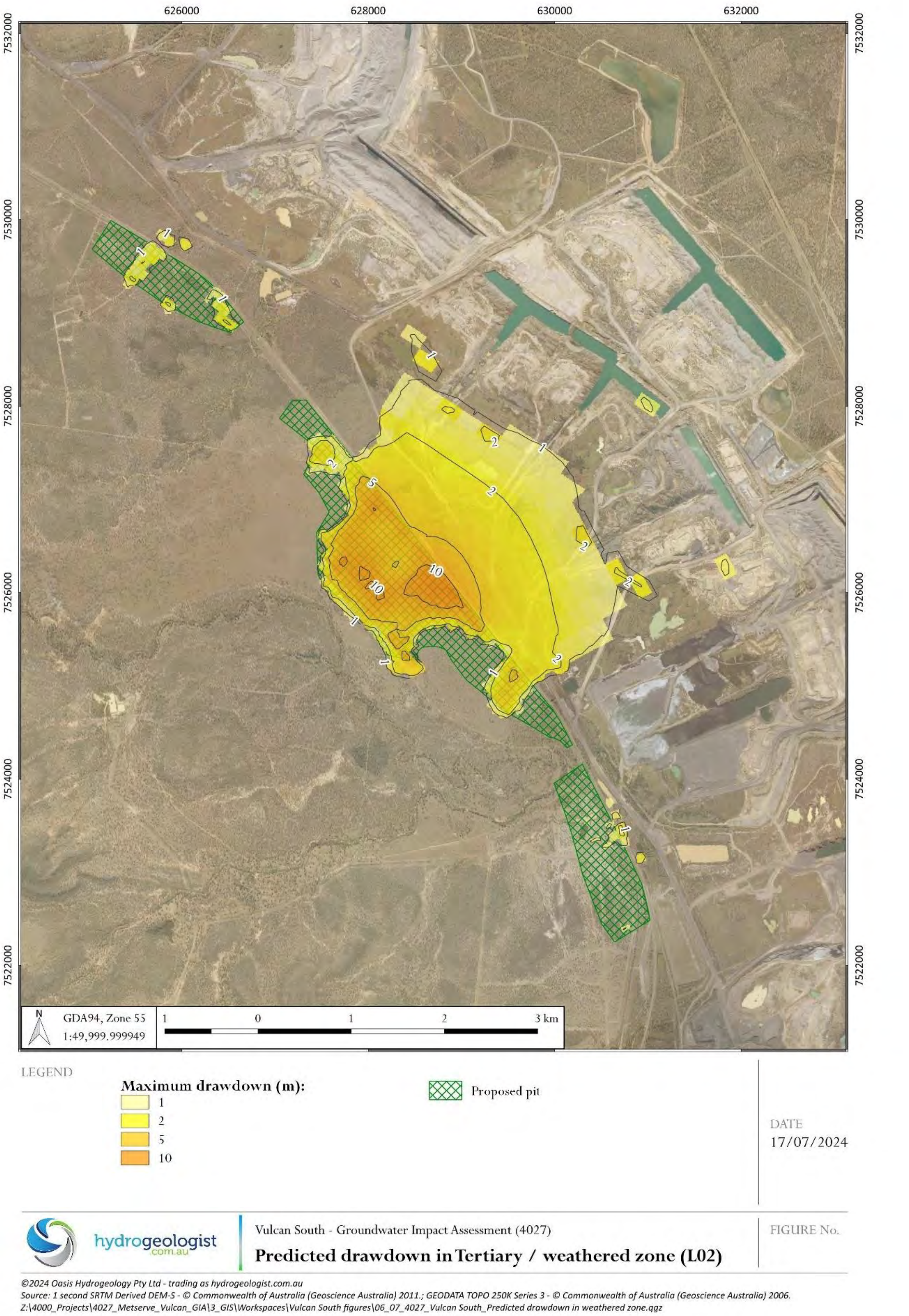


Figure 6-29 Project predicted Drawdown in Tertiary layer

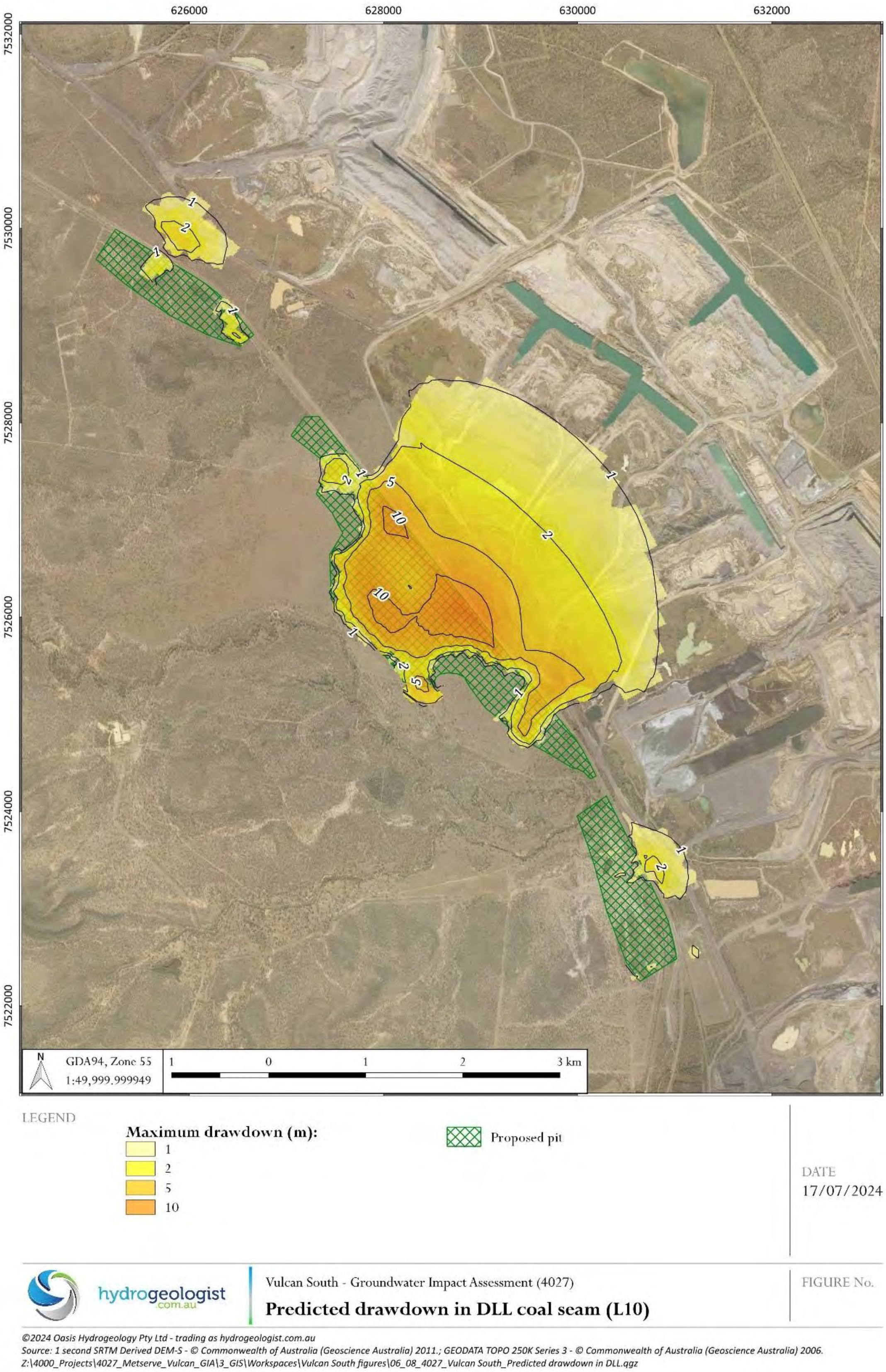


Figure 6-30 Project predicted drawdown in DLL coal seam

6.4.3.6 Groundwater inflow into pits

Groundwater inflow estimates to the open cut pits were provided by Hydrogeologist.com.au (2024) and have been provided as daily rates for six-monthly periods over the mine life. The low magnitude of the predicted groundwater inflows means that the inflows will likely have a negligible impact on the Project water balance. Notwithstanding, groundwater inflows for each stage have been averaged and were input into the model as per **Table 6-32.** The full table is provided in **Table 6-33.**

Table 6-32 Modelled Groundwater Inflows

	Groundwater inflow (kL/day)		
	Vulcan North	Vulcan Main	Vulcan South
Stage 1	1.05	0.7	0
Stage 2	0	31.79	0
Stage 3	0	13.97	0.91

Groundwater flow into the Vulcan South and Vulcan North pits will be negligible, and these pits will be essentially dry. Groundwater flow into the Vulcan Main pit will be up to 43 m^3/day, which will cause localised drawdown in surrounding aquifers. **Table 6-32** summarises the predicted inflows rates and volumes for the proposed VS Vulcan pits. The rate of inflow to the Vulcan pits is consistent with **Figure 6-31** and shows that the maximum inflow is less than 43 m^3/d occurring in Year 5 of mining. The maximum annual volume of predicted inflow to the VCM pit is less than 15 ML/yr.

Overall, the predicted groundwater seepage to the proposed pits is low and will very likely be lost through evaporation on the pit face or as entrained moisture within the mined coal. Hence seepage to the pit is very unlikely to be observed during the Project.

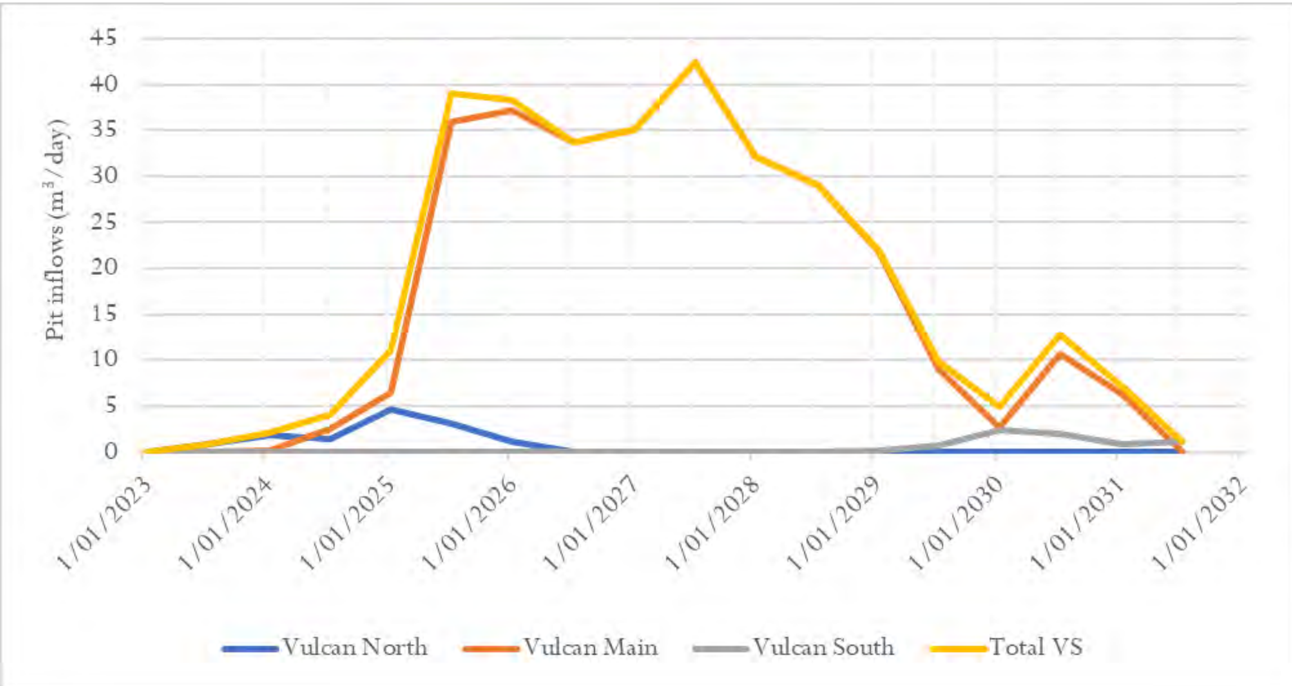


Figure 6-31 Predicted mine inflow rates for the Project (Figure 6.5 of the GIA)

Table 6-33 Predicted inflow volumes for the Project (North, main and South pit) (Table 6.2 of the GIA)

SP	Days	Sp End	DRN Inflow (m^3 / day)			Volume (ML)
			Vulcan North	Vulcan Main	Vulcan South	
59	184	01/01/2023	0.00	0.00	0.00	0.16
60	181	01/07/2023	0.88	0.00	0.00	
61	184	01/01/2024	1.86	0.21	0.00	1.12
62	182	01/07/2024	1.45	2.60	0.00	
63	184	01/01/2025	4.71	6.41	0.00	9.11
64	181	01/07/2025	3.09	35.93	0.00	
65	184	01/01/2026	1.15	37.14	0.00	13.15
66	181	01/07/2026	0.00	33.72	0.00	
67	184	01/01/2027	0.00	35.09	0.00	14.14
68	181	01/07/2027	0.00	42.42	0.00	
69	184	01/01/2028	0.00	32.20	0.00	11.20
70	182	01/07/2028	0.00	29.00	0.00	
71	184	01/01/2029	0.00	21.90	0.15	5.83
72	181	01/07/2029	0.00	9.05	0.77	
73	184	01/01/2030	0.00	2.62	2.34	3.23
74	181	01/07/2030	0.00	10.72	2.05	
75	184	01/01/2031	0.00	6.28	0.89	1.52
76	181	01/07/2031	0.00	0.00	1.10	

6.4.3.7 Groundwater Quality

The groundwater quality is unlikely to be significantly altered by Vulcan South and, in any case, all local potentially groundwater-dependent ecosystems occur upgradient (in terms of the groundwater flow, which mimics the surface water drainage pattern from west to east) of potential effects.

It is assumed that the pit voids at Saraji Mine and Peak Downs Mine will likely remain into perpetuity and will behave as regional evaporative sinks on the groundwater system hence minimising and capturing any eastward migration of potential contaminants from the Project.

Please refer to **Section 4.9.5**.

6.4.3.8 Post-mining Groundwater Levels

Drawdown will cease upon the cessation of mining (**Section 6.4.3.5**) and groundwater is expected to recharge during post closure (**Appendix P**). The recharge rate to groundwater will be significantly and almost entirely influenced by the adjacent mining projects to the East (BHP mines – Saraji and Peak Downs) which are the cause of drawdown within the footprint prior to the Projects commencement of mining and will continue to impact the nature of groundwater in the Project area. Vitrinite do not have access to groundwater level data within the BHP footprint, BHP pit lake data nor do they have foresight as to planned BHP mining projects beyond that which is publicly available. For this reason, the exact date of which recharge will return to pre mining levels is unknown; however, as specified in **Appendix P, Section 6.6**, Groundwater is predicted to recover towards the pre-mining groundwater level subject to mining plans that include the adjacent Saraji and Peak Downs Mines.

The observed monitoring data does not show any evidence of seasonal responses in the groundwater system. This static or slightly declining trend in the monitoring bores is calibrated within the numerical model. The static and declining trends are evidence of a groundwater system that is currently in equilibrium or declining in response to regional mining effects.

As seasonal responses do not form part of the current groundwater regime it is highly unlikely that they will form part of the future or closure scenario. Post mining groundwater predictions have not assessed seasonal responses and should be focused on a longer-term response.

6.4.3.9 Groundwater Pondage and Infiltration

Post mining landscapes are designed to shed water and minimise ponding on the surface. Post mining landscapes will be shaped to follow a pre-mine topography. The ability of water to pond on the landscape will be low. The backfilled pit voids will be heavily compacted by machinery and heavy equipment. This trafficking will serve to compact the overburden and reduce the vertical permeability or ability of the profile to accept infiltration. Thus, permeability will serve to minimise infiltration. Evapotranspiration rates are generally higher than rainfall throughout the year therefore it's unlikely that any long term or persistent ponding will occur. Further to this, the depth to groundwater is deep enough so that any soil infiltration processes within the post mining landscape are negligible.

6.4.3.10 Recharge rates, aquifer pressure or pressure relationships between aquifers, inter-aquifer connectivity, groundwater table and potentiometric surface levels

Recharge rates

While the literature generally agrees on the recharge and discharge mechanisms, the rates of recharge and discharge vary significantly. AECOM (2016) used a preliminary recharge rate of 1.43 mm/yr for the Quaternary alluvium and 0.89 mm/yr for the rest of the model domain (**Table 6-33**). URS (2012) and Arrow (2016) used a minimum of 1 mm/yr for Triassic/Permian strata and “more for alluvium” (Arrow Energy, 2016).

HydroSimulations (2018) used model calibrated recharge rates of 2.8 mm/yr to 5.1 mm/yr for the Quaternary alluvium, 0.15 mm/yr for Tertiary sediments and 0.06 mm/yr for outcropping Permian coal measures. These recharge rates are summarised in Table 5-7 together with indicative long-term average recharge/rainfall percentages.

HydroSimulations (2018) also refer to recharge rates used in Arrow Energy’s Bowen Gas Project and other nearby projects (not sighted during the preparation of this report). According to HydroSimulations (2018), recharge at Lake Vermont was simulated as the equivalent of 2% mean annual rainfall and at Isaac Plains it was simulated as 0.5% (mean annual rainfall) to alluvium and 0.25% (mean annual rainfall) elsewhere. For the Arrow Energy Bowen Gas Project, recharge to the Quaternary alluvium was simulated as 1 mm/yr to 3 mm/yr (low recharge scenario) or 9 mm/yr to 27 mm/yr (high recharge scenario). Recharge was simulated as 0.3 mm/yr or 3 mm/yr for Tertiary sediments, 0 mm/yr for the Rewan Group and 0.33 mm/yr to 3 mm/yr for outcropping Permian coal measures.

For discharge, URS (2012) and Arrow (2016) modelled the difference between potential and actual evapotranspiration with an extinction depth of 10 m in their respective numerical models. HydroSimulations (2018) applied maximum potential evaporation rates using actual evapotranspiration values with an average value (600 mm/yr) used as the transient calibration evapotranspiration rate. Extinction depths were set to 2 m below ground across the model domain.

Table 6-34 Estimates on recharge rates

Reference	Quaternary alluvium	Tertiary sediments	Permian coal measures
AECOM (2016)	1.43 (0.2%)	0.89 (0.1%)	0.89 (0.1%)
URS (2012)	>1 (>0.1%)	1 (0.1%)	1 (0.1%)
HydroSimulations (2018)	2.8-5.1 (0.4% - 0.7%)	0.15 (0.02%)	0.06 (0.009%)

Aquifer pressure or pressure relationships between aquifers

Aquifer pressure is measured through groundwater level measurements where the higher the groundwater level the higher the pressure. The groundwater level data shows that the pressure/levels are low in proximity to the coal resulting in a minimal potential for drawdown to occur and therefore the significance of aquifer pressure on drawdown is considered low. Aquifer pressure is demonstrated by the groundwater level measurements presented in **Table 6-34** and hydrographs shown in **Appendix P.** A visual of pressure changes across the landscape are shown in **Figure 6-33.** Ultimately the effects of BHP's operations will significantly drawdown the baseline for the project and the drawdown impact of the project itself is limited.

Predicted change to aquifer pressure as a result of the project is shown in **Appendix C** of the GIA, **Section 5.2**. Much of the weathered profile (shallow aquifers) are dry and therefore have a negligible potential to interact with the Permian aquifers. This is because a gradient of pressure differential is required to force an interaction between the two layers, which does not occur when the weathered profile is dry. The Model determined that changes to aquifer pressure over time due to the project, are limited in extend and magnitude and more largely a result of BHP's activities. This is discussed further in **Section 6.4.3.5.**

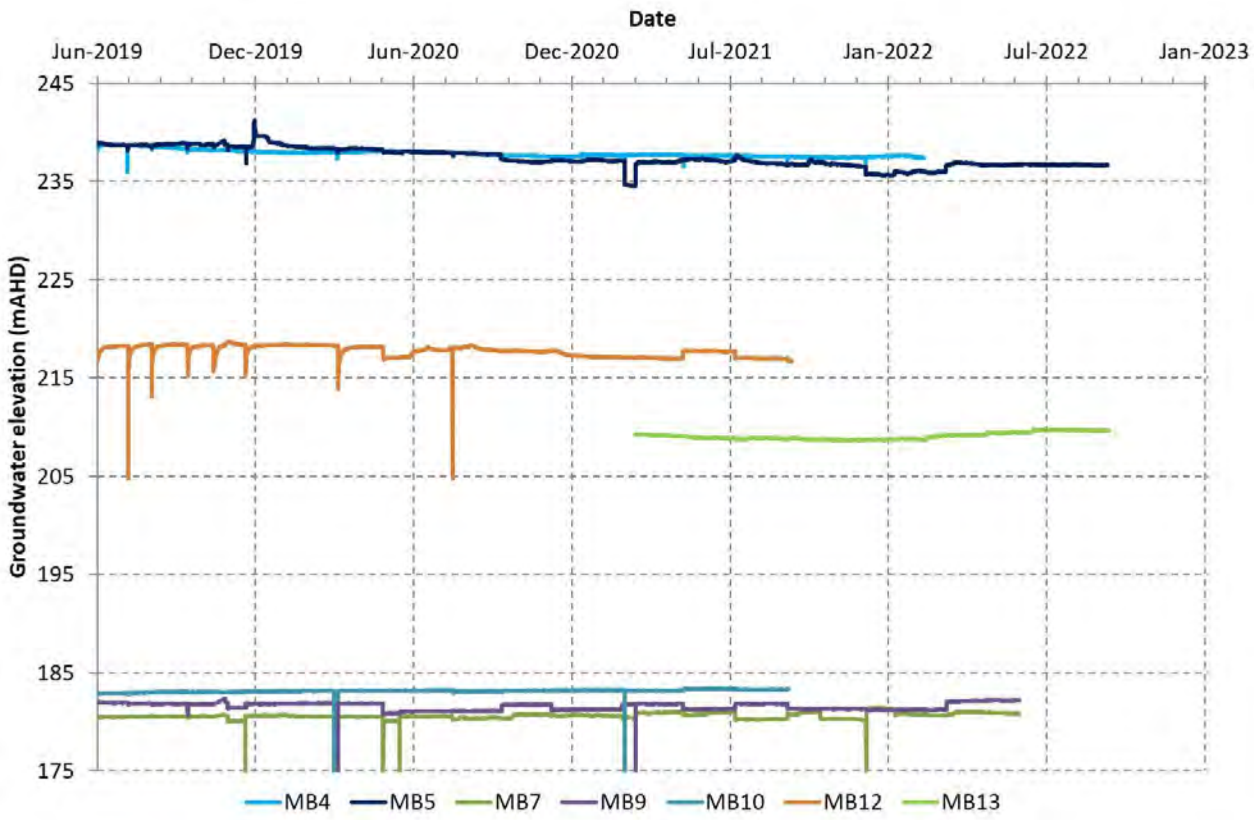


Figure 6-32 Groundwater hydrographs for Vulcan South monitoring bores

Table 6-35 Summary of groundwater level measurements

Site ID	Casing Elevations (mAHD)	SWL														
		Jun 2019	Jul 2019	Aug 2019	Sep 2019	Oct 2019	Dec 2019	Mar 2020	Jun 2020	Aug 2020	Oct 2020	Dec 2020	Mar 2021	May 2021	Jul 2021	Sep 2021
MB1	222.91	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
MB2	254.69	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
MB3	257.68	239.38	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
MB4	243.28	237.47	237.58	237.45	237.18	237.75	238.13	237.53	237.53	236.76	236.54	236.37	236.58	236.61	236.53	236.41
MB5	252.70	238.17	238.01	237.99	238.23	238.69	238.55	238.10	227.77	235.95	236.62	236.53	236.37	236.72	236.41	236.04
MB6	214.61	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
MB7	215.99	181.19	179.71	179.77	179.79	180.31	180.12	180.40	189.79	179.92	179.87	179.91	179.99	179.91	179.96	180.03
MB8	212.24	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
MB9	208.98	181.57	181.34	181.36	181.39	181.81	181.48	182.12	181.88	181.24	180.98	181.29	181.35	181.33	181.32	181.43
MB10	214.60	182.09	181.15	182.20	182.29	183.04	183.00	183.04	188.10	182.49	182.50	182.55	182.60	182.56	182.61	182.65
MB11	225.66	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
MB12	241.43	2115.36	216.22	216.41	216.66	218.00	218.39	216.94	215.71	216.55	216.56	216.53	215.85	215.60	215.61	214.85
MB13	223.13	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	209.12	208.53	208.49	208.63

Easting and northing coordinates are in GDA94, Zone 55 from differential GPS. SWL = standing water level. mAHD = metres above Australian Height Datum from differential GPS. mbTOC = Metres below top of casing (PVC). See **Appendix U** for more groundwater level data.

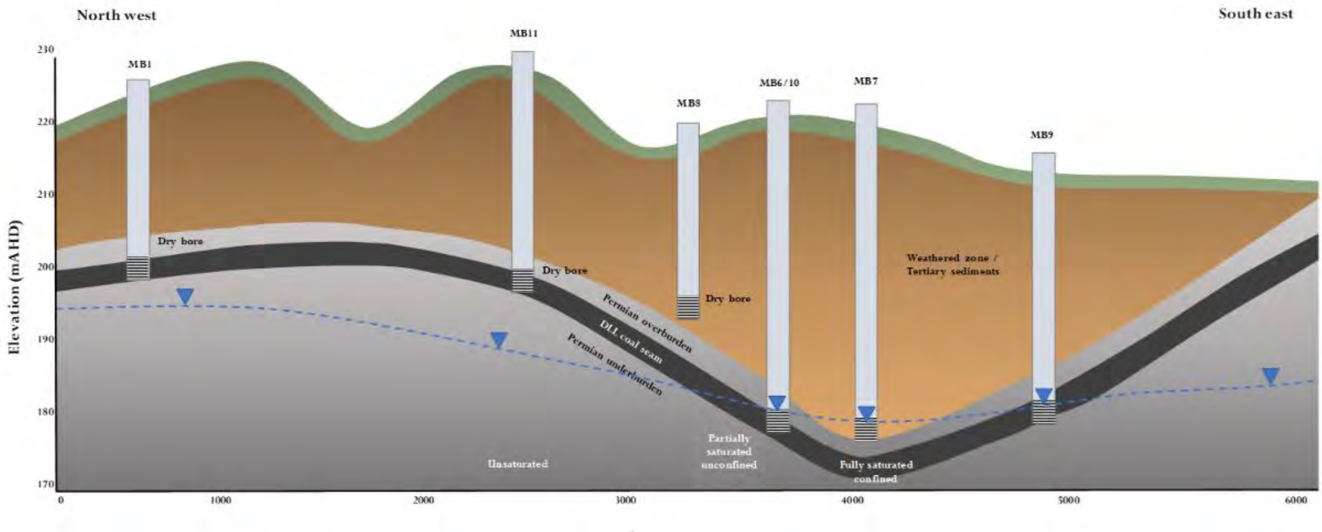


Figure 6-33 Groundwater level pressure within coal seam

Inter-aquifer connectivity

The project only intersects aquifers within the Permian geological layers within the vicinity of the pits, given groundwater is only located within this geological layer. Negligible shallow aquifers will be impacted, therefore vertical interaction of groundwater is negligible.

Groundwater table and potentiometric surface levels

Groundwater drawdown predictions for layer 2 (weathered geological layer) are representative of the groundwater table or unconfined aquifers. These predictions are discussed in **Figure 6-43**.

Groundwater drawdown predictions for layer 10 *(DLL or xola seam layer) are indicative of confined aquifer/ potentiometric surface, which is shown in **Figure 6-30**.

The drawdown is limited in magnitude and extend for both these two layers, as is described in detail within 0.

6.4.3.11 Climate change model using the Representative Concentration Pathway 8.5 emissions scenario

Climate change will impact evaporation effects and rainfall effects, which effect the groundwater system as changes to recharge. Evaporation rates are unlikely to effect the groundwater system (besides groundwater that has inflowed to the surface) and this is already applied to the subsurface part of the model (to account for transpiration). Recharge is influenced by the quantity and intensity rainfall and therefore the model includes an upper and lower bound on the baseline estimates to account for this. This is discussed in **Section 6.4.3.10**. Post closure, the influence of the BHP pits on the groundwater regime will far outweigh any influence climate change may have on the Vulcan South project.

6.4.3.12 Groundwater Modelling and Sensitivity Analysis

Calibration constrained, null space Monte Carlo stochastic method uncertainty analysis has been completed for the groundwater impact assessment (Appendix C of **Appendix P**). This uncertainty analysis has been completed in consideration of the Independent Expert Scientific Committee (IESC) guidelines and confirms minimal inflows reporting to the pit, and limited drawdown extent and magnitude. Sensitivity analysis is a type of Uncertainty analysis and falls under the category of “Deterministic scenario analysis with subjective probability assessment” as is presented in *Information Guidelines Explanatory Note – Uncertainty analysis – Guidance for groundwater modelling within a risk management framework* (2018). This type of uncertainty analysis was not chosen given the scale, depth and duration of mining, as this type of analysis is considered simple and generally used for projects which have a smaller impact. For this reason, a more rigorous, Calibration constrained, null space Monte Carlo stochastic method uncertainty analysis was conducted. This is also described within the IESC guideline.

The objective of the groundwater modelling assessment was to identify the impacts of the Project on groundwater in a robust manner that meets the expectations of multiple stakeholders. To achieve this objective, the numerical model has been developed to support the impact assessment and the environmental approvals process. The numerical model needs to quantify the response of groundwater levels and flows to the proposed future stresses on the groundwater system, that is groundwater extraction due to coal mining activities. The quantification of impacts will be provided in the form of:

- Drawdown - providing spatial and temporal information about the extent and magnitude of impacts on the groundwater resource and third-party users (e.g. landholders or groundwater dependant ecosystems [GDE]).
- Groundwater balance of individual hydro-stratigraphic units. This will provide an insight into changes in flow within the groundwater system and will allow for the quantification of pit inflows (or seepage). Understanding the predicted changes in flow rates between individual hydro-stratigraphic units may also provide an indication of changes in groundwater quality.

Given the existence of historical coal mining in the close vicinity to the project (that is BMA Saraji Mine), the analysis of groundwater impacts will be shown in a cumulative sense, as well as groundwater impacts solely due to the project.

Groundwater modelling calibration

Model calibration is a process of adjusting model parameters (hydraulic properties and boundary conditions such as recharge rates or cross-boundary flow rates) so that the model replicates the behaviour of the physical groundwater system. The quality of this replication can be assessed by comparing model outputs (modelled heads and flows) with calibration targets - observed behaviour of the actual groundwater flow system (observed heads and flows).

The numerical model includes a steady-state and a transient calibration (1972 to 2019). The transient calibration captures historical development at Saraji Mine and Peak Downs Mine which was based upon an interpolated mine progression assessed from Landsat imagery. In accordance with the Australian groundwater modelling guidelines (Barnett, et al., 2012), the objective of a model calibration is to replicate the groundwater levels measured in the site monitoring network and other bores. A set of 55 selected observation points (and a total of 176 observations) were used in the calibration process, some with single values and some with time-series observations. The observation points included historical observation data from mining investigations (AECOM, 2016), publicly available sources (Department of Natural Resources, Mines and Energy, 2019a), and on-site data collected from open drill-holes and data collected from the new monitoring bores (hydrogeologist.com.au, 2019).

An overall (all observations and all time steps) transient calibration was achieved with an RMS (root mean square error) of 3.6 m and an SRMS (scaled root mean square error) of 4% (**Table 6-36**). The SRMS value of 4% (3.6 m / 90.5 m=0.04 or 4%) indicates a good fit between measured and modelled data. Notwithstanding that, other criteria (such as good correlation between measured and modelled hydrographs and contour maps) also apply, an SRMS that is less than 10% may be acceptable (Barnett, et al., 2012) while an SRMS < 5% represents generally good calibration in the experience of hydrogeologist.com.au.

Table 6-36 Model calibration - calibration statistics

Calibration measure		Value	Unit
Number of observation	n	176	-
Range of measured heads	-	90.51	m
Sum of squared residuals	SSQ, Φ	2292.3	m^2
Mean sum of residuals	MSR	2.7	m
Scaled mean sum of residuals	SMSR	2.9	%
Root mean squared error	RMS	3.6	m
Scaled root mean squared error	SRMS	4.0	%

Source: **Appendix P**

Confidence level classification

The degree of confidence with which model predictions can be used are described using a ‘confidence classification’ scale which is presented as part of the Australian Groundwater Modelling Guidelines (Barnett, et al., 2012). The classification scale conveys understanding about the model complexity, level of calibration and potential for the predictions to be incorrect. The model can fall into three classes:

- Class 1 – the simplest model, often not calibrated, used as starting points for more complex models, used for prediction of low-value aquifers, least amount of confidence in the modelling results.
- Class 2 – more complex models, prediction capability could vary depending on the location within the model domain, calibration and prediction runs can vary in terms of magnitude of model stresses and time discretisation, used for prediction in medium- or high-value aquifers.
- Class 3 – detailed and complex models, high trust in validity of modelling predictions, used to simulate detailed, small scale processes, used for predictions in high-value aquifers, the highest amount of confidence in the results of the modelling.

Barnett et al. (2012) state that every model should be evaluated using multiple criteria, that is:

- Available data, accuracy of the data, spatial and temporal distribution of the data. Is the dataset sufficiently representing the described system (in place and in time)? Is the dataset giving us sufficient insight into the system behaviour?
- Quality of calibration process undertaken during model development. What type of data was used to calibrate the model? To what level does the model replicate past behaviour given the properties of the model and model inputs (boundary conditions)? Is the higher level of calibration localized in specific area or is it evenly distributed throughout the whole model domain?
- Consistency between the calibration and predictive analysis. Are the calibration run and prediction run consistent with respect to length of the model run, temporal discretisation, model stresses?

Table 6-37 below summarises the classification indicators suggested by groundwater modelling guidelines (Barnett, et al., 2012) for the available data. A self-assessment has been completed by hydrogeologist.com.au and the resultant classification for each indicator is presented.

Table 6-36 below summarises the classification indicators presented by (Barnett et al., 2012) for the calibration. A self-assessment has been completed by hydrogeologist.com.au and the resultant classification for each indicator is presented.

Table 6-37 below summarises the classification indicators presented by (Barnett et al., 2012) for the consistency between model calibration and model predictions. A self-assessment has been completed by hydrogeologist.com.au and the resultant classification for each indicator is presented.

Based upon the results summarised and presented, the model has been self-assessed by hydrogeologist.com.au and has been classified as a Class 2 model under the Australian Groundwater Modelling Guidelines (Barnett et al., 2012).

Table 6-37 Model classification - available data indicators

Classification indicator	Classification
Climate data	*Class 2*
Long term rainfall and evaporation data is available in the form of long-term synthetic/interpolated dataset only. (Class 2)	
Landuse information	*Class 3*
Ecological field survey/mapping undertaken to complement generalised state-wide datasets. (Class 3)	
Surface drainage (streams) and SW/GW interaction	*Class 2*
Streamflow data and baseflow estimates available at a few points. (Class 2)	
Groundwater flow system – hydraulic properties	*Class 3*
Key aquifer parameters were defined by in-situ (or laboratory) aquifer tests. The tests spatially cover either the whole model domain or at least the area of interest and adjacent aquifer (hydro-stratigraphic) units (Class 3)	
Groundwater flow system – structure, aquifer geometry	*Class 3*
Good quality and adequate spatial coverage of digital elevation model to define ground surface elevation. (Class 3) Spatial distribution of bore logs and associated stratigraphic interpretations clearly define aquifer geometry. (Class 3)	
Observations of water levels	*Class 2*
Groundwater head observations and bore logs are available but may not provide adequate coverage throughout the model domain. Transient observation data are available for only few bores with temporal extent not covering the whole calibration period.	
Groundwater and surface water use (recharge and discharge)	*Class 1*
No available records of metered groundwater extraction or injection. Little useful data on river flows and/or stage elevations.	

Source: Groundwater Impact Assessment Modelling Appendix (Appendix C of **Appendix P**)

Table 6-38 Model classification - calibration indicators

Classification indicator	Classification
Calibration statistics	*Class 3*
• Calibration statistics are acceptable. (Class 3) • Mass balance closure error is less than 0.5% of total. (Class 3)	
Long term trends replication, temporal discretization	*Class 2 – Class 3*
• Long-term trends are adequately replicated where these are important. (Class 3) • Seasonal fluctuations are adequately replicated where these are important. (Class 3) • Validation either not undertaken or is not demonstrated for the full model domain. (Class 2) • Transient calibration to historic data but not extending to the present day. (Class 2)	
Types of calibration targets, spatial distribution of calibration targets	*Class 2 – Class 3*
• Transient calibration is current, i.e. uses recent data. (Class 3) • Observations of the key modelling outcomes (water levels in Project observation bores) is used in calibration. (Class 3) • Calibration only to water level dataset, predicting both water levels (water levels change) and flows (pit inflows). (Class 2)	

Source: Groundwater Impact Assessment modelling Appendix (Appendix C of **Appendix P**)

Table 6-39 Model classification - consistency between calibration and prediction

Classification indicator	Classification
Classification indicator	Classification indicator
Model run length and temporal discretization	*Class 2 – Class 3*
• Length of predictive model is not excessive compared to length of calibration period. (Class 3) • Model predictive time frame is less than 3 times the duration of transient calibration. (*Class 3*) • Temporal discretization used in the prediction is different that used in transient calibration (Class 2)	
Boundary conditions and stresses	*Class 3*
• Level and type of stresses included in the predictive model are within the range of those used in the transient calibration (Class 3)	
Steady state vs transient	*Class 3*
• Both calibration and prediction are based on transient model. Steady state model is used to establish initial conditions for the transient predictive model. (Class 3)	

Source: (Groundwater Impact Assessment Modelling Appendix (Appendix C of **Appendix P**)

Groundwater Model Verification

Model verification has recently (June 2024) been conducted on the numerical model. The verification has included more recent site-specific groundwater monitoring data and publicly available regional data from the BHP groundwater monitoring network.

Additional groundwater monitoring data has included an additional 36 months of groundwater level data from the site specific monitoring bores. The site-specific groundwater level dataset now considers a duration of three years from 2019 through to the end of 2022. This dataset is significant and exceeds the expectations of a two-year dataset as per the draft IESC guidelines. The verification has also included an additional 65 bores within the public domain. These additional bores are typically limited to only a single groundwater level measurement.

Calibration statistics from the model verification yield an SRMS of 7.6% compared to 4% in the original calibration (**Appendix P**).

The verification has shown that the model provides a suitable predictor of groundwater conditions within the Vulcan pits. The verification has had mixed success with the BHP monitoring bores to the east of the Vulcan pits. The BHP monitoring bores are within previously mined areas and adjacent to tailings dams and the numerical model has broad assumptions around topography, geology and mining conditions throughout the Saraji Mine and the Peak Downs Mine. The publicly available data from the BHP monitoring bores is highly likely to be influenced by BHP mining activities. The representation of BHP mining activities are uncertain in the numerical model.

Despite the numerical model not matching some of the regional observations, it provides and maintains a good match to the observations at the site-specific project groundwater monitoring network.

The current site-specific groundwater monitoring network is being supplemented with additional monitoring data from bores installed for the project in April 2024. These bores will confirm the current conceptual understanding and groundwater conditions.

A data sharing agreement is currently being negotiated between Vitrinite and BHP and this will provide additional groundwater data and confirmation of mining activities (historic, current and future approved) for future model updates. This will be active 12 months from receiving the final federal approval.

The calibration hydrographs of the observed versus modelled levels are provided in **Appendix P**.

Uncertainty Analysis

In the context of model-based decision support or risk assessment or management, uncertainty can be defined as any deviation from the unachievable ideal of completely deterministic knowledge of the relevant system (Walker, et al., 2003).

Understanding where the unknowns are hidden and what their impact on modelling prediction is (or might be) is a strength of the model and a necessary tool supporting the decision-making effort (Johnson, 2010).

In more current (and Australian) context (Peeters, et al., 2018) pilot a combination of approaches to discuss impact of limitations of knowledge on modelling predictions in the context of decreasing risks associated with the environmental impact assessments. Authors further refined their recommendations in the form of guidelines (Middlemis & Peeters, 2018) where they recommend both qualitative and quantitative approach to uncertainty analysis (Appendix C of **Appendix P**).

The numerical model has been calibrated using site specific and regional groundwater level data and recently verified. The conceptual understanding of site conditions indicates minimal impact on the basis of dry conditions throughout much of the Project area which has been contributed to be approved mining operations at BHP. The base case predictions confirm this conceptualisation of impact and show a minimal extent and magnitude of incremental drawdown associated with the project. A risk assessment determined minimal impact to the groundwater environment from the Project. The calibration uncertainty analysis was not undertaken at the time of the initial model calibration process. Once the model was considered sufficiently calibrated, project impacts were assessed, and the predictive uncertainty analysis was completed in accordance with the guidelines at the time of development.

The approach to the predictive uncertainty analysis followed the traditional decision support modelling approach below:

- Define sampling distributions for all model parameters that could possibly impact the model predictions – the limits for the sampling distributions were adjusted based on calibrated value and possible variability of individual parameters.
- Generate model input dataset (model 'realisation') honouring the sampling distributions.
- Run the model for each 'realization' and extract predictions (heads, flows). Check for calibration statistics (SSQ and SRMS) to assess level of 'miscalibration'. Remove predictions from runs that would be considered not sufficiently calibrated.
- Calculate impacts (in our case pit inflows and drawdown) for each of the accepted 'realizations'.
- Calculate minimum, maximum and selected percentile values for both pit inflow rates and drawdowns.
- Use the percentile values to describe the probability of exceedance of modelled outcome in accordance with ISEC Uncertainty guidelines (Middlemis & Peeters, 2018).

As discussed, it is conceptualised (and supported by numerical modelling) that the Project area groundwater conditions are heavily influenced by the approved BHP operations, showing considerable contribution to cumulative impact in the region. The calibration process focused effort on achieving a good calibration in the Project area, whilst still achieving an acceptable calibration in the remainder of the model domain. In the professional opinion of Hydrogeologist, the representation of the approved BHP operations has the ability to significantly influence the current model calibration. The representation of mining (geological layering, drain elevations, progression, temporary filling of pit lakes) is hardwired into the model and cannot practically be included in such quantitative uncertainty analysis of model parameterisation. Hence the parameter ranges in the uncertainty analysis were pre-defined and purposely constrained (normal distribution) around the calibrated values in order to assess the uncertainty of impacts from the Project only.

The parameter ranges used in the uncertainty analysis are considered appropriate and are commensurate with the level of environmental risk of the project, that is minimal impact to groundwater on the basis of dry conditions throughout much of the Project area.

It is understood that as uncertainty analysis methodologies develop and improve overtime, further uncertainty analysis is required to fully address with the current uncertainty guidelines (2023).

An update to the uncertainty analysis (using contemporary methods) can be carried out once a data sharing agreement between Vitrinite and BHP is established in 12 months from receiving the final federal approval (after acquiring additional observation data and better understanding of geological setting and mining activities in BHP managed areas), thus reducing the qualitative uncertainty around the representation of approved BHP mining activities.

Qualitative uncertainties

Qualitative uncertainties are defined by lack of knowledge with respect to either structure or processes within the groundwater flow system. They can be usually reduced by collecting more data or collecting data from areas that were not previously sampled or monitored.

The 'conceptual/knowledge' issues recognised during the evaluation of the impacts of the Project on the groundwater system are:

- precision of topographic elevation data, precision of observation elevation data;
- precision of structural elevation data – elevation/thickness of individual hydrostratigraphic units;
- existence and function of structural geological features (faults) – impact on cross-boundary flow definition;
- spatial heterogeneity of hydrostratigraphic units;
- timing of system stresses – dewatering (pumping, mining) or recharge (water storage in pits); and
- lack of relevant surface water flow information.

Quantitative uncertainties

The method quantifying the probability of impacts exceeding certain value follows these steps:

- Define sampling distributions for all model parameters.
- Generate model input dataset (model 'realisation') honouring the sampling distributions.
- Run the model for each 'realization' and extract predictions (heads, flows). Check for calibration statistics (SSQ and SRMS) to assess level of 'miscalibration'. Remove predictions from runs that would be considered not sufficiently calibrated.
- Calculate impacts (in our case pit inflows and drawdown) for each of the accepted 'realizations'.
- Calculate minimum, maximum and selected percentile values for both pit inflow rates and drawdowns.
- Use the percentile values to describe the probability of exceedance of modelled outcome (**Table 6-38**) in accordance with ISEC Uncertainty guidelines (Middlemis & Peeters, 2018).

The uncertainty of exceedance of particular pit inflow rate is presented in **Figure 31** of **Appendix P**. The original model prediction (see **Figure 6-34**) lies within the expected 'as likely as not' exceedance probability range. This indicates that the model prediction is not 'over-calibrated' and unrealistic. The highest possible inflow rate was quantified to be 115 m^3/day.

The spatial extent of maximum drawdown (**Figure 6-35**) is represented by 1 m contour. The zones of probability of exceedance of drawdown values are again based on the ISEC Uncertainty guidelines – the green zone presents 90% probability of larger extent than presented, yellow zone means the drawdown will be larger as likely as not, the red zone shows area where the probability of exceedance of 1 m drawdown is very low – with likelihood of less than 10%. The calibrated prediction of 1 m drawdown extent (the 'basecase') is shown as black dashed line.

Table 6-40 Combined numeric, narrative and visual description of likelihood

Percentile	Colour	Description (in terms of likelihood of exceedance)	Alternative description or framing
<10%		It is **very likely** that the outcome is **larger** than this value	It is **very unlikely** that the outcome is **smaller** than this value
10–33%		It is **likely** that the outcome is **larger** than this value	It is **unlikely** that the outcome is **smaller** than this value
33–67%		It is as **likely as not** that the outcome is **larger** than this value	It is as **likely as not** that the outcome is **smaller** than this value
67–90%		It is **unlikely** that the outcome is larger than this value	It is **likely** that the outcome is **smaller** than this value
>90%		It is **very unlikely** that the outcome is **larger** than this value	It is **very likely** that the outcome is **smaller** than this value

Groundwater Impact Assessment Modelling Appendix (Appendix C of **Appendix P**)

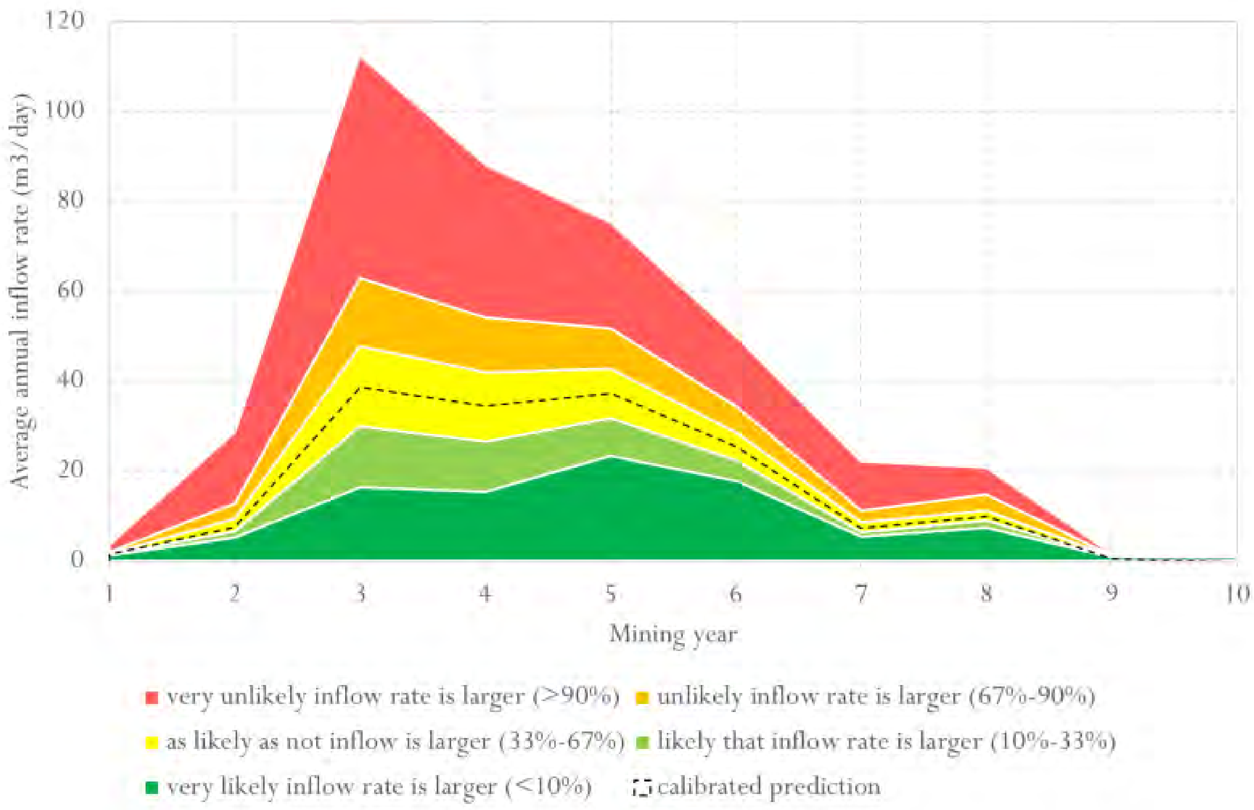
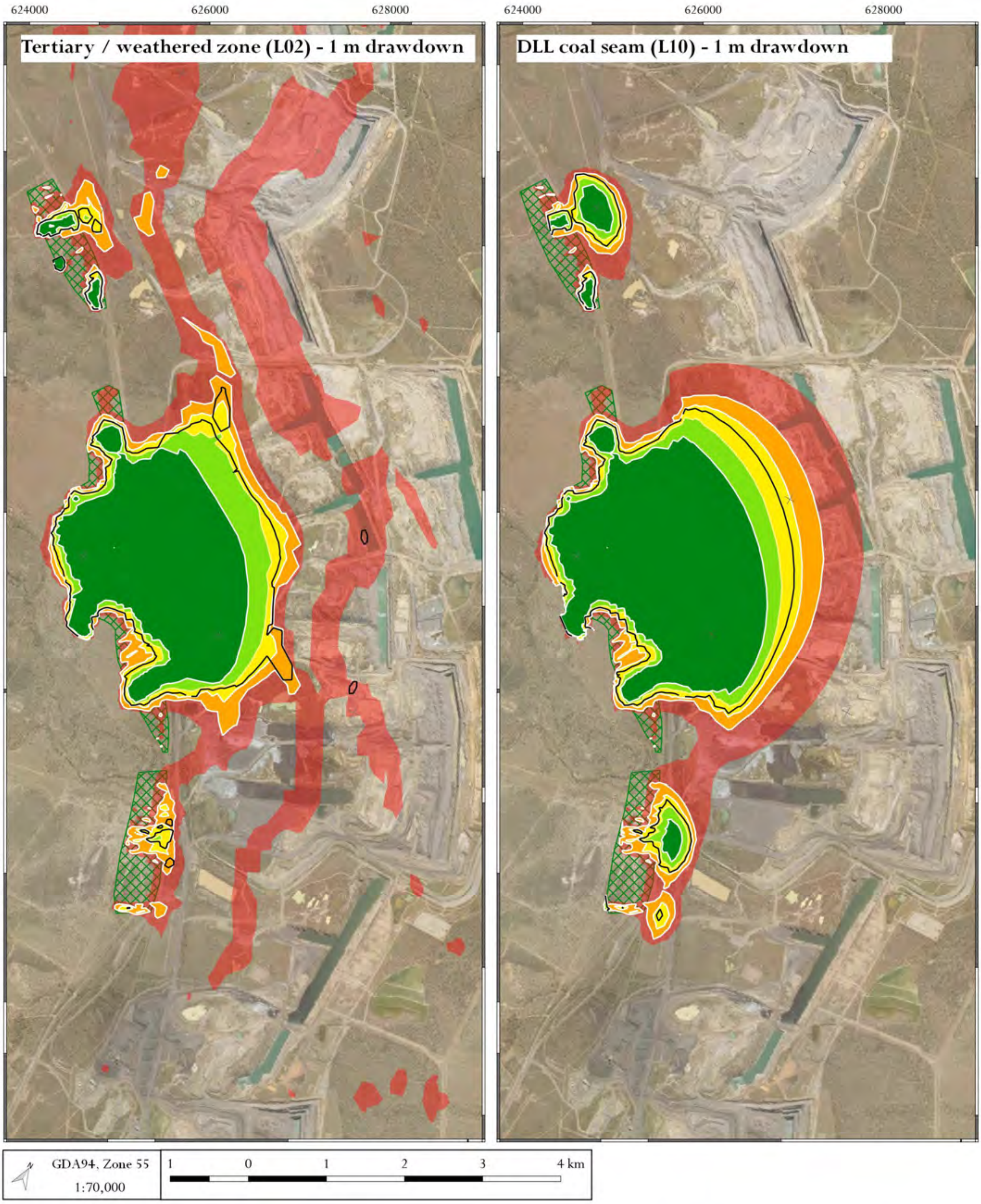


Figure 6-34 Uncertainty runs - Project pit inflow rates



LEGEND

Proposed pit

<10% - it is very likely that the outcome is larger than this value

10% - 33% - it is likely that the outcome is larger than this value

33% - 67% - it is as likely as not that the outcome is larger than this value

67% - 90% - it is unlikely that the outcome is larger than this value

>90% - it is very unlikely that the outcome is larger than this value

Maximum drawdown - basecase

DATE 22/02/2022

hydrogeologist.com.au

Vulcan South - Groundwater Impact Assessment (4027)

Uncertainty analysis - maximum drawdown

FIGURE No. 6-35

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.

Z:\4000_Projects\4027_Metserve_Vulcan_GIA\3_GIS\Workspaces\Vulcan South figures\06_10_4027_Vulcan South_Uncertainty drawdown in L02 and L10.qgz

Groundwater Modelling post Closure

Post closure modelling has not been completed for the Project. The rationale for not completing post closure modelling is provided below:

- Following cessation of mining, the project open pits will be backfilled with overburden emplacement.
- The backfilling of the project open pits will cease any evaporative groundwater losses resulting from the project and the local groundwater levels will likely recover to pre-mine conditions.
- The BHP Saraji Mine and Peak Downs Mine will include the presence of final pit voids as part of their final landform.
- The number of, location of, and depth of the BHP final pit voids are currently unknown.
- It is likely that pit lakes will form in these BHP final pit voids, however the elevations of these pit lakes is unknown.
- The BHP final pit voids will result in evaporative sinks into perpetuity, thus resulting in regional drawdown effects that extend to the west and to the east.
- The post closure drawdown effects of the BHP final pit voids are highly likely to extend into the Project area and influence local groundwater conditions.
- Regional groundwater flow is from west to east and any potential leachate that may be introduced via the project open pits will be captured in the evaporative sinks of the BHP final voids.

The post closure scenario is heavily dependent upon the closure conditions and final landforms at Saraji Mine and Peak Downs Mine (which are unknown). It is not reasonable to expect that numerical modelling is carried out when there is such uncertainty in the current approved mining operations.

The groundwater model for the Project will be reviewed and potentially updated within two years of approval. The model is to be updated to incorporate available BHP data and the updated dataset from the project groundwater monitoring network. The model is to be updated to include post-mining simulation (pending availability of data).

6.4.3.13 Fault systems

CSIRO (2002) presents the distribution of faults, dykes and sills within the Project area and this is reproduced as **Figure 6-36** (**Appendix P**). In **Figure 6-36** red lines represent thrust faults with > 3m throw, blue lines indicate normal fault with 1 m to 3 m throw, and turquoise lines show normal faults with > 3 m throw; purple rectangles signify inferred basement structures. The approximate location of the Project area is indicated on the figure to show the location relative to the Jellinbah Thrust Fault Zone and the structures mapped at Saraji Mine and Peak Downs Mine. The proposed open pits are unlikely to be significantly influenced by local structures mapped at the adjacent Saraji Mine. The recent drilling and updates to the geology model within the Vulcan south disturbance footprint have not identified or intersected any faults that could influence groundwater flow. Further, In the extensive excavations that have occurred to date at the adjacent Vulcan Coal Mine, no normal faults have been identified or exposed in the pit to an extent whereby these structures impact the continuity of the mined coal seam. For this reason, fault systems are not anticipated to effect groundwater flow.

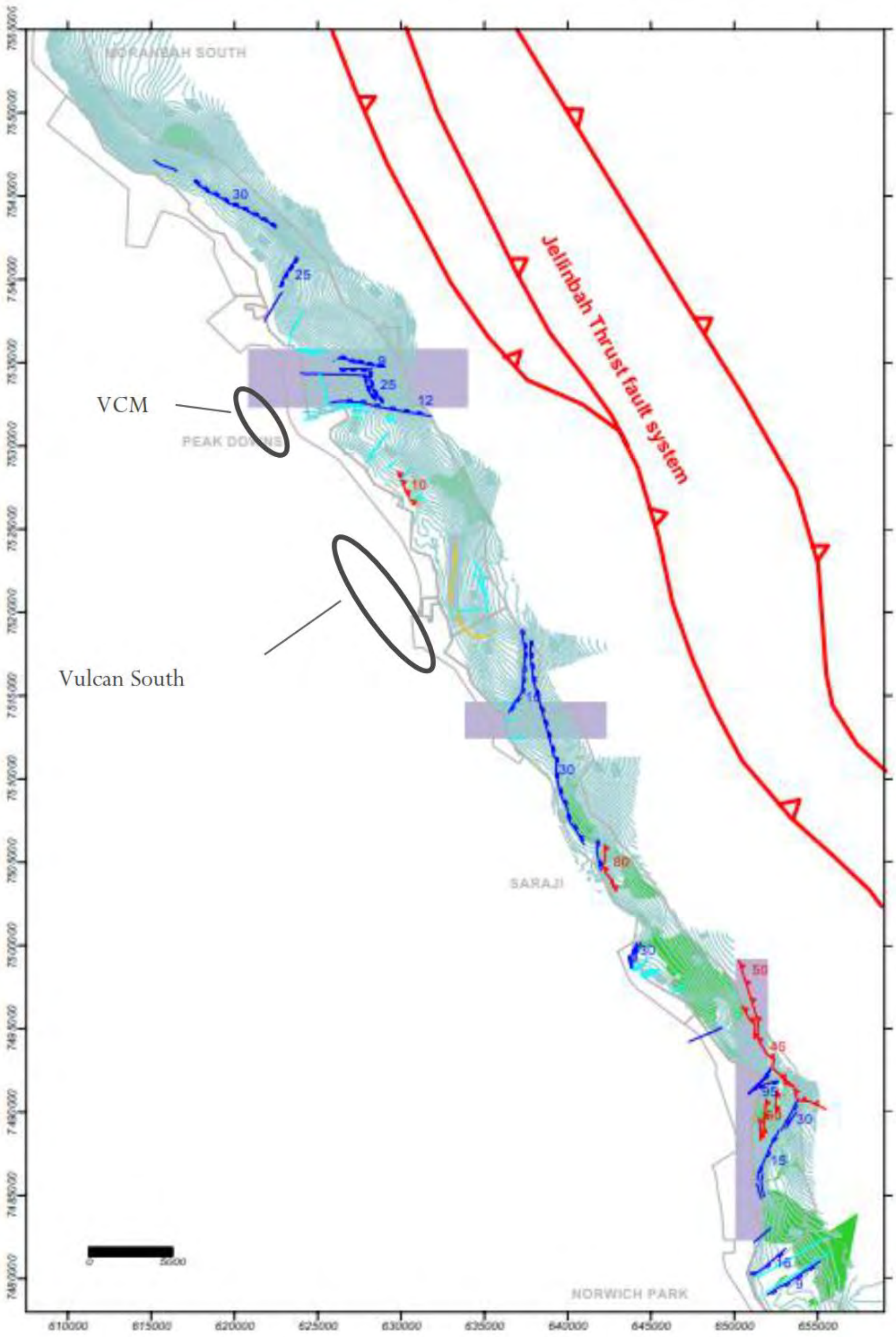


Figure 6-36 Fault systems in Dysart seam

6.4.3.14 Highwall mining area relative to groundwater

An assessment of available groundwater level data at the time of preparing the Hydrogeological Impact Assessment concluded that there was typically greater than 10 m distance between the floor of the MAT coal seam in the Highwall Mining area and the underlying groundwater table. A more recent assessment of comprehensive groundwater level data in the highwall mining area has confirmed that the groundwater table is generally below the floor of the MAT coal seam. Numerous exploration drill holes have been used to measure the groundwater table within and adjacent to the Highwall Mining area confirming that the MAT coal seam is generally dry and unsaturated. Generally, the distance between the floor of the MAT coal seam and the groundwater table is greater than 2 m in the highwall mining area; however, this can be up to 20 m in some areas. There is a single exploration bore hole (VSW301) within the highwall mining area (**Table 6-41**) that has measured a groundwater level that is 0.7 m above the MAT seam floor. At this drill hole location, the MAT seam is 1.1 m thick and hence the coal seam is only partially saturated.

Whilst there are differences between the original and recent assessment of the groundwater table elevation and its distance from the floor of the target coal seam in the highwall mining area, these differences are not considered significant. The highwall mining process is not like conventional open cut mining whereby the entire mined sequence is depressurised, nor is it like conventional underground mining which requires full depressurisation of the target coal seam during mining. Highwall mining involves the use of a highwall miner which extracts coal from plunges in the coal. Any entrained moisture within the coal will be removed as part of the mining process; however, as the process does not actively dewater from the coal face, there is unlikely to be full depressurisation or dewatering of the coal seam or the plunges. Therefore, the groundwater effects of highwall mining will be highly localised and constrained to the partially saturated extent of the target coal seam. Once the plunge is mined, groundwater inflow will fill the remnant void and groundwater levels will return to pre-mine conditions. The highwall mining will have no foreseeable effects on the receiving groundwater environment.

Site specific groundwater monitoring bores within the Highwall mining area are proposed and are scheduled to be installed within three months.

Table 6-41 Highwall Mining Area Groundwater Levels

Drill hole ID	Easting	Northing	Difference between highwall MAT seam floor elevation and groundwater level (m)
VSW298	617678.03	7535222.72	1.68
VSW299	617401.77	7535541.44	0
VSW301	617916.58	7535545.19	-0.7
VSW302	618204.58	7535279.55	5.21
VSW303	618409.05	7535595.22	4.9
VSW209	619730.97	7535224.41	20.55

6.4.3.15 Alluvial groundwater system

The public geology mapping infers the presence of widespread alluvial sediments over the Project area. However, site specific geology data has been captured by the proponent (including 909 drill holes) to develop a detailed geology model for the site. The site geology model includes a horizon which indicates the base of unconsolidated Tertiary material. As discussed in the Hydrogeological Impact Assessment (**Appendix P**), hydrogeologist.com.au has assessed that the lithology intersected above the fresh Permian coal measures in the Project area does not constitute Tertiary aged sediments, rather a weathering profile that has developed during the Tertiary on the Permian strata.

The dedicated groundwater drilling and investigation program completed for the project does not support the presence of alluvial sediments within the Project area. None of the groundwater monitoring bores intersected alluvial sediments, and several of the monitoring bores that are drilled into specific hydrostratigraphic horizons in the Project area have been dry since installation. These dry monitoring bores confirm that much of the shallow strata (regardless of lithology and hydro-stratigraphic units) is dry.

A site-specific creek and alluvium investigation has recently been undertaken in the drainage features within the Project area. Numerous examples of Permian strata outcrop have been identified within the major tributaries of the Project area, including tributaries of Hughes Creek. Sub-surface investigations into the creek bed sediments have revealed that these sediments are often clayey. Sandy zones occur within the creek bed sediments; however, they are highly localised, limited spatially to the narrow creek bed and limited in depth. This can be expected given the highly incised terrain that occurs upgradient of the Project area. The creek bed sediments do not constitute widespread, extensive and continuous alluvial sediment deposition. On the basis of the above geological data, it can be confirmed that there is no Quaternary alluvium within the Project area. **Figure 6-37** provides a photograph showing the visual inspection of the area.

This represents an update to **Appendix P**, which had previously discussed the presence of quaternary alluvium across the Project area.

Vitrinite will drill a groundwater monitoring bore immediately adjacent to Hughes Creek. The objectives of this monitoring bore will be to confirm the absence of alluvial sediments beneath Hughes Creek and to confirm the groundwater level, depth to groundwater table and groundwater quality in this area. The bore is to be drilled to a depth of 10 m to 15 m and is expected to be constructed with the weathered profile of the Permian coal measures

Figure 6-37 Alluvial inspection across Project area. This image shows silty creek bed sediments with presence of weathered profile in the background creek bank and creek bed.

6.4.3.16 Groundwater Dependent Ecosystems (aquatic, terrestrial and subterranean)

Terrestrial

Terrestrial GDEs mapped within the disturbance footprint associated with the following species which may utilise saline groundwater, *Eucalyptus camaldulensis* and *Melalueca leucadendra* (associated with RE11.3.25) – high potential and *Eucalyptus Populnea* (11.3.2 and 11.5.3) – moderate potential. Small areas of these will be cleared during the project, which are covered as loss of habitat for Koalas and Greater Gliders, and are to be rehabilitated as required by the PRCP Schedule (**Appendix K**).

Hydrogeologist.com.au (2024) has developed a numerical groundwater flow model of the survey area and broader region to predict the effects of Vulcan South on local groundwater levels. Groundwater flow into the Vulcan South and Vulcan North pits will be negligible, and these pits will be essentially dry (**Section 6.4.3.6**). Groundwater flow into the Vulcan Main pit will be up to 43 m^3/day, which will cause localised drawdown in surrounding aquifers. The drawdown predicted from the groundwater flowing into the pits at Vulcan South is limited in geographic extent (up to 2,400 m to the east of the pits toward existing mining) and magnitude (up to 10 m) (**Section 6.4.3.5**) and will not effect any GDEs outside of the Projects disturbance footprint (**Figure 6-38**). As the pits will be backfilled, no residual drawdown is expected following the cessation of the project. Therefore, by the time new GDE species (*Eucalyptus camaldulensis*, *Melalueca leucadendra* and *Eucalyptus Populnea*) have established following rehabilitation, to the size where they will reach the groundwater table, the groundwater will have fully recharged and therefore, there will be no impacts on the effectiveness of rehabilitation for GDEs (demonstrated visually in **Figure 7-4**). No remnant vegetation outside the project's clearing footprint is found within the zone of drawdown. Furthermore, any non-remnant vegetation within this zone is highly disturbed by existing mining operations associated with the Peak Downs Mine (**Figure 6-38**).

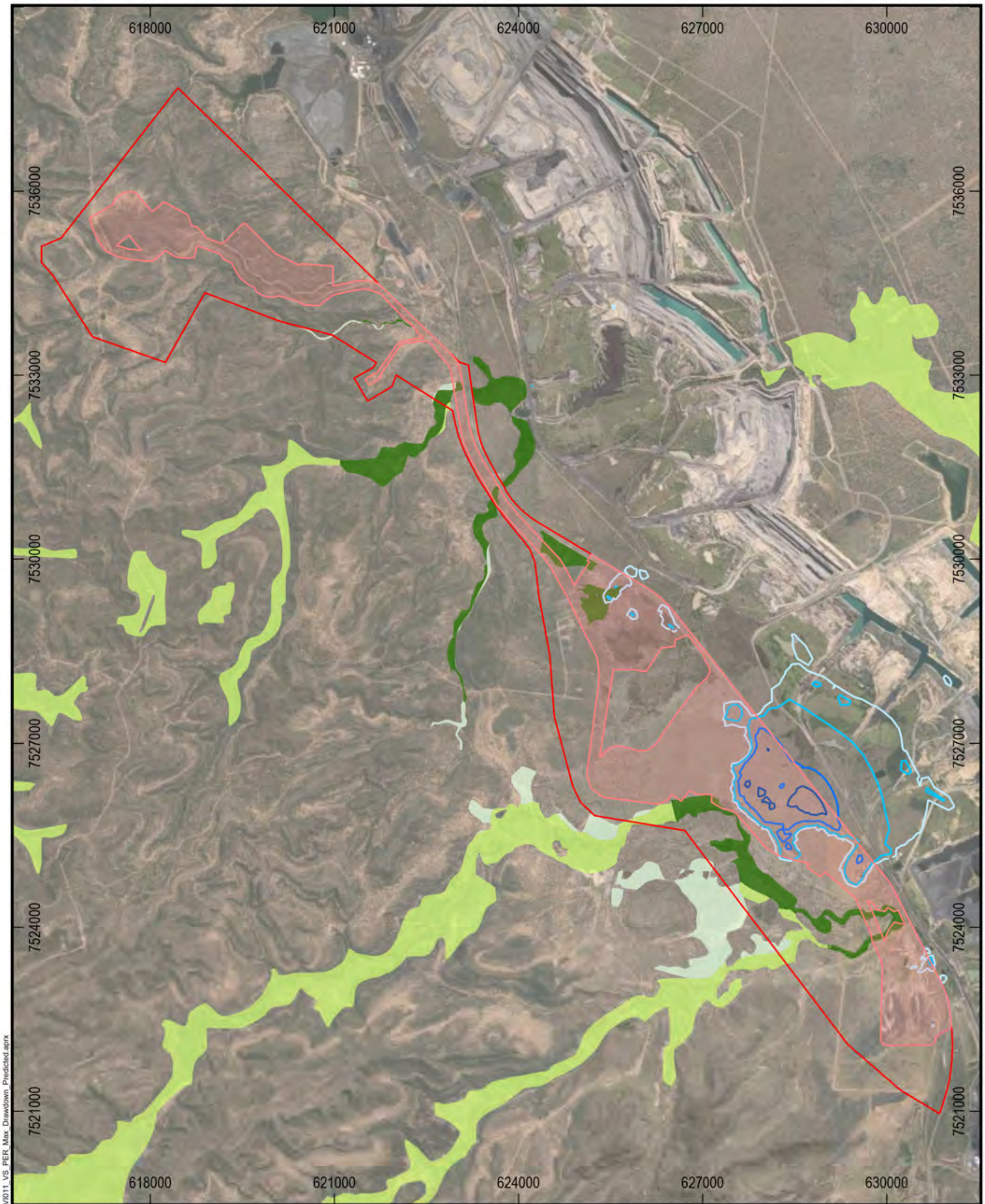
The groundwater quality is unlikely to be significantly altered by Vulcan South and, in any case, all local potentially groundwater-dependent ecosystems occur upgradient (in terms of the groundwater flow, which mimics the surface water drainage pattern from west to east) of potential effects. In summary, no impacts to GDEs are predicted to result from Vulcan South beyond that which will occur due to vegetation clearing within the disturbance footprint (therefore there are no indirect or consequential impacts). Direct impacts refer to clearing of GDEs within the disturbance footprint.

Aquatic

No impacts are anticipated as discussed in **Section 5.**

Subterranean

No further assessment of impacts has been conducted on subterranean GDEs given they were not identified using desktop assessment See **Section 5**.



Legend

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint

Groundwater Dependent Ecosystems

- High potential GDE
- Moderate potential GDE
- Low potential GDE

Predicted Drawdown (m)

- 1m
- 2m
- 5m
- 10m

Source: Bureau of Meteorology 2012, Hydrogeologist.com.au 2020, Vitrinite 2023-2024, METServe 2023-2024, Esri, Maxar, Earthstar Geographics 28/09/2023.

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Max_Drawdown_Predicted.aprx

Vulcan South

Maximum Drawdown of Groundwater Predicted

0 1 2 3

Kilometers

Scale: 1:90,000 (A4)

25/07/2024

Datum: GDA2020
Projection: MGA55

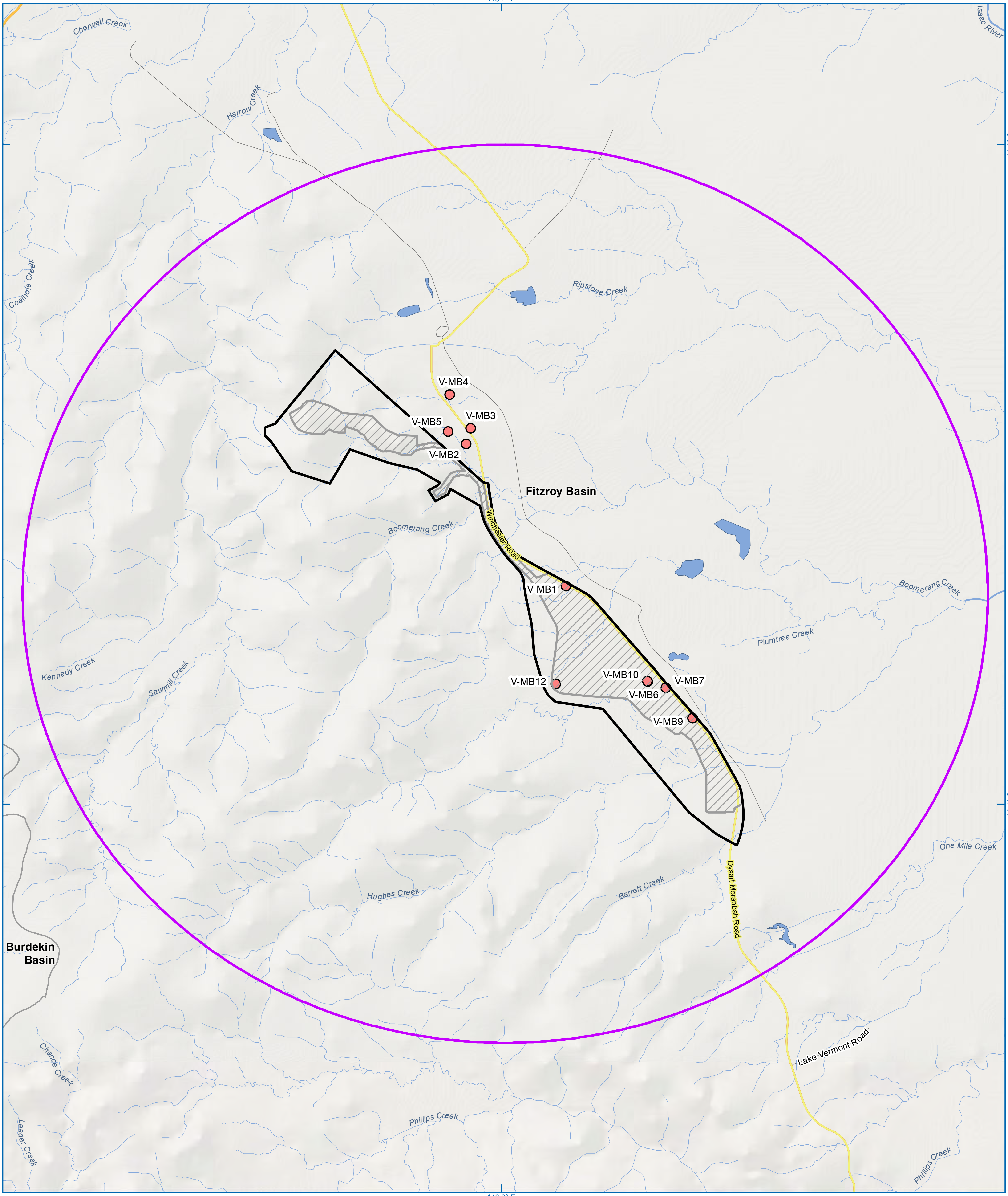
FIGURE 6-38

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

6.4.3.17 Stygofauna

An assessment of the potential impacts to stygofauna values within and surrounding the Project has been conducted by frc environmental (**Appendix V**). The assessment focused on the Project area (i.e., the mining lease) and a broader study area (i.e., comprising the mining lease and surrounding areas as shown in **Figure 6-39.**



Vulcan South Project: Stygofauna Pilot Study

Figure 6-39

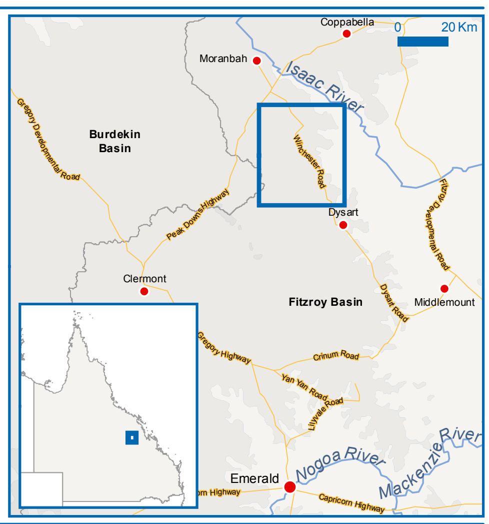
Bores sampled for stygofauna

LEGEND

- Broader Study Area
- Bores
- Mining Lease Application Boundary
- Conservative Disturbance Footprint

Road Network

- Highway
- Main Road
- Local Road
- Lake/Reservoir
- Watercourse



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SOURCES

DATE	DRAWN BY	VERSION	PROJECTION
2022-02-28	AB	02	Coordinate System: GCS GDA 1994 Datum: GDA 1994 Units: Degree

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The suitability of a groundwater ecosystem to provide habitat for stygofauna is dependent on several environmental factors, including:

- geology;
- groundwater hydrology; and
- groundwater quality.

While exceptions exist in Queensland, stygofauna are generally thought to prefer shallow aquifers with high secondary porosity in groundwater recharge areas, with groundwater of high quality (specifically neutral pH and low electrical conductivity) intersecting the root zone of terrestrial vegetation (**Appendix V**, page 7). While the mean electrical conductivity of water from which stygofauna have been sampled is less than 4,000 µS/cm, they have been recorded from a broad range of electrical conductivities (11.5 – 54,800 µS/cm) (**Appendix V**, page 9).

Six bores were surveyed for stygofauna on 04 December 2019 (**Figure 6-39** and **Table 6-42**; see **Appendix V Stygofauna Pilot Study –** Map 4.1 and Table 4.1), with all other bores in the broader area dry at the time of survey. In March 2020 ten bores were sampled for stygofauna across the broader study area (**Appendix V)**. The full water column in each bore was sampled using six hauls of a weighted phreatobiological net (like a plankton net). Three of the hauls were with a very fine net (mesh size 50 µm), and three hauls were with a fine net (mesh size 150 µm). Samples were preserved in 100% ethanol and transported to frc environmental's laboratory where stygofaunal specimens were identified to Order or Family using available taxonomic keys. Each specimen was then identified to morpho-species as taxonomic keys are not available for species-level identification of stygofauna. All laboratory analyses were completed by trained and experienced aquatic ecologists.

Table 6-42 Bore name, location, and depth with survey dates

Bore	Easting	Northing	Survey dates	Geological unit	Drilled Depth (m)
V-MB4	622016	7536148	Dec-19; Mar-20	DLL coal seam	21.5
V-MB5	621965	7534904	Dec-19; Mar-20	MAT coal seam	40.9
V-MB7	628692	7526260	Dec-19; Mar-20	Weathered Permian	43.0
V-MB9	629511	7525225	Dec-19; Mar-20	DLL coal seam	34.4
V-MB10	628125	7526470	Dec-19; Mar-20	DLL coal seam	40.3
V-MB12	625252	7526409	Dec-19; Mar-20	Permian underburden	38.2
V-MB1	625608	7529692	Mar-20	DLL coal seam	24.9
V-MB2	622515	7534485	Mar-20	DLL coal seam	12.0
V-MB3	622665	7535021	Mar-20	DLL coal seam	33.8
V-MB6	628121	7526477	Mar-20	Weathered Permian	24.6

Source:

The environmental values of stygofauna of the broader study area were determined using the following criteria:

- High value: threatened species listed under State or National legislation.
- Moderate value: non-listed stygobites and/or suitable habitat for stygofauna present. Note that suitable habitat means geological, hydrological and water quality characteristics of groundwater ecosystems that are generally known to support high diversity of stygofauna; see Sections 2.4 and 3 in **Appendix V** for further information.
- Low value: only non-listed stygoxenes and/or potentially suitable habitat for stygofauna present. Note that potentially suitable habitat means geological, hydrological and/or water quality characteristics of groundwater ecosystems that are

outside the general habitat characteristics known to support diverse stygofauna communities, but within the range from which stygofauna have been recorded.

The assessment concluded that the stygofauna community of the mining lease area of Vulcan South had low environmental value. This conclusion was based on the following:

- an absence of any listed stygofauna taxon;
- an absence of any stygobitic (i.e., obligate groundwater dependent) taxon;
- the occurrence of only a single, widely distributed *stygoxene* (i.e., not groundwater dependent) taxon;
- the depth to water table in the mining lease area, which is deeper than the typical depth from which stygofauna have been reported in Queensland (i.e. <15 m); and,
- The concentration of total dissolved solids and electrical conductivity of groundwater in the broader study area, which is commonly higher than the range reported for groundwater from which stygofauna are typically found.

The mean electrical conductivity of water from which stygofauna have been sampled, generally, is less than 4,000 µS/cm; however, the range of electrical conductivity concentrations of groundwater that stygofauna have been sampled from is very large (11.5 – 54,800 µS/cm) (**Appendix V**). Electrical conductivity recorded from bores in the broader study area ranged from 2,280– 21,600 µS/cm (Table 4.2 of **Appendix V**) and was therefore consistent with the preferred range of electrical conductivity for stygofauna at only two bores (i.e., bores V-MB4 and V-MB5). Therefore, the electrical conductivity of groundwater of the Project area is generally unsuitable for stygofauna.

The following sources of potential Project impact on stygofauna were identified:

- vegetation clearing;
- contamination of groundwater;
- physical disturbance of groundwater ecosystems by:
    - removal of topsoil and overburden from development areas;
    - open cut coal mining;
    - drawdown of water tables;
    - compaction of shallow aquifers below haul roads, and
    - cumulative impacts of the Project interacting with other nearby existing and proposed mines.

However, a risk-based assessment determined that the mitigated risk of impact was low for each of these potential sources of impact.

6.4.3.18 Cumulative impacts

Groundwater inflow

Cumulative impacts have been assessed by representing historical and proposed mining for the VCM, Saraji Mine and Peak Downs Mine, the latter have been active since the 1970s. The impacts of these approved mines have been predicted in isolation of the Project and in a cumulative sense through the development of the ‘mine’ vs ‘no mine’ model scenarios. For the purposes of this assessment, the cumulative impact on groundwater is represented in **Figure 6-40**. The graph shows the long-term model predicted inflows to the Saraji Mine and Peak Downs Mine with recent and proposed average annual inflow rates in the order of 3,000 m 3/day to 5,000 m^3/day. The proposed mining inflow rates correlate with AECOM (AECOM, 2016). The minimal inflow rates predicted for the Project (maximum inflow rate of 43 m^3/d) represent less than a 1% increase in groundwater seepage within the model domain. For this reason the projects inflow rates cannot even be seen within the figure given how negligible they are. Hence the scale of the project impacts on the groundwater resource are negligible when compared to the cumulative effect.

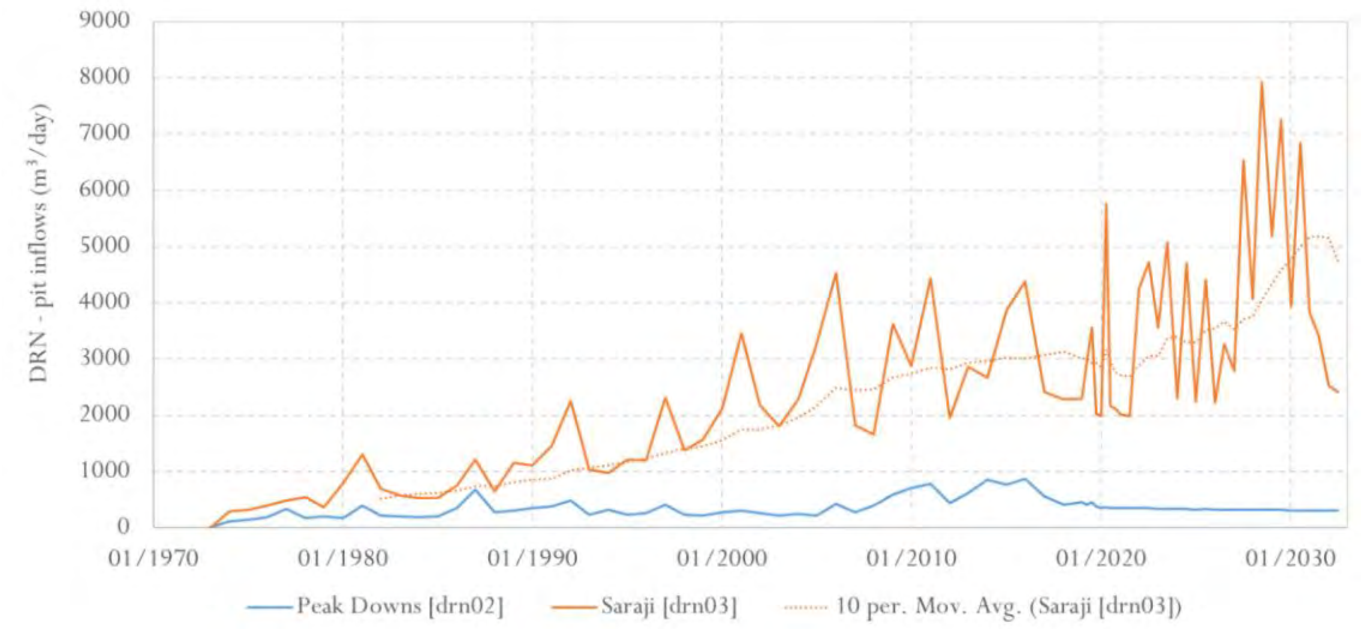


Figure 6-40 Predicted inflow rates - Saraji Mine and Peak Downs Mine

Drawdown

An assessment of cumulative impacts was completed by preparing a further greenfield scenario whereby no mining has been simulated. The difference between the greenfield scenario and the mine scenario represents the cumulative impacts. Three scenarios were developed in the cumulative impact assessment of groundwater drawdown:

- Greenfield (i.e. no mine)
- BHP only mines (mines to the east)
- BHP and the Project.

A figure showing the cumulative drawdown on the groundwater table has been prepared below (**Figure 6-41** and **Figure 6-42).**

Figure 6-41 represents the projects and the neighbouring BHP mines cumulative drawdown extent within the models 2nd layer (reglolith) which is a relatively shallow aquifer layer. The extent of project only drawdown is shown as a purple line. Figure A also shows the extent of cumulative drawdown that is predicted to occur from both the project and also approved mining operations in the region (i.e. BHP). The extent of cumulative drawdown in the regolith demonstrates that there is typically 20 m of cumulative drawdown in the main Vulcan South pit. The maximum predicted project drawdown is 10 m for the regolith, therefore locally the project contributes to approximately 50% of the cumulative drawdown (**Figure 6-43**). This contribution reduces to 0% at the extent of project only drawdown (**Figure 6-43**).

Figure 6-42 represents the extent of project only drawdown in layer 10 of the model which represents the DLL coal (target) seam. The extent of drawdown in this layer is generally greater than that of **Figure 6-41** due to the removal of the target coal seam, opening up space to act as a groundwater sink. The extent of project only drawdown is shown as a purple line. Figure B also shows the extent of cumulative drawdown that is predicted to occur from both the project and also approved mining operations in the region (i.e. BHP). The extent of cumulative drawdown in the DLL seam demonstrates that there is typically 20 m of cumulative drawdown in the main Vulcan South pit. The maximum predicted project drawdown is 10 m for the DLL seam, therefore locally the project contributes to approximately 50% of the cumulative drawdown within the pit itself. This contribution reduces to 0% at the extent of project only drawdown (**Figure 6-44**). Therefore, cumulative contributions to drawdown are limited to within the pit itself and negligible outside the footprint as the drawdown encroaches BHP drawdown which is significantly greater. As is shown using the orange and yellow shades within **Figure 6-41** and **Figure 6-42** (darker orange/grey indicates a high degree of drawdown and yellow indicates less), there is existing drawdown evident within the project footprint caused by the adjacent mining activity to the west (BHP mines – Saraji and Peak Downs) that is in significant greater magnitude to what the project will contribute to.

The cumulative drawdown contours also demonstrate a similar rationale. The cumulative drawdown from approved mining operations is significant and is extensive. The contribution of the project to this cumulative drawdown is limited to the predicted extent of project drawdown.

The groundwater levels in the vicinity of the North and South pit are low relative to the pit floors and therefore the pits do not result in much project drawdown.

The total predicted cumulative drawdown values are shown in the recent **Figure 6-41** and **Figure 6-42** for layers 2 and 10 which represent the maximum cumulative drawdown extent over the life of the project.

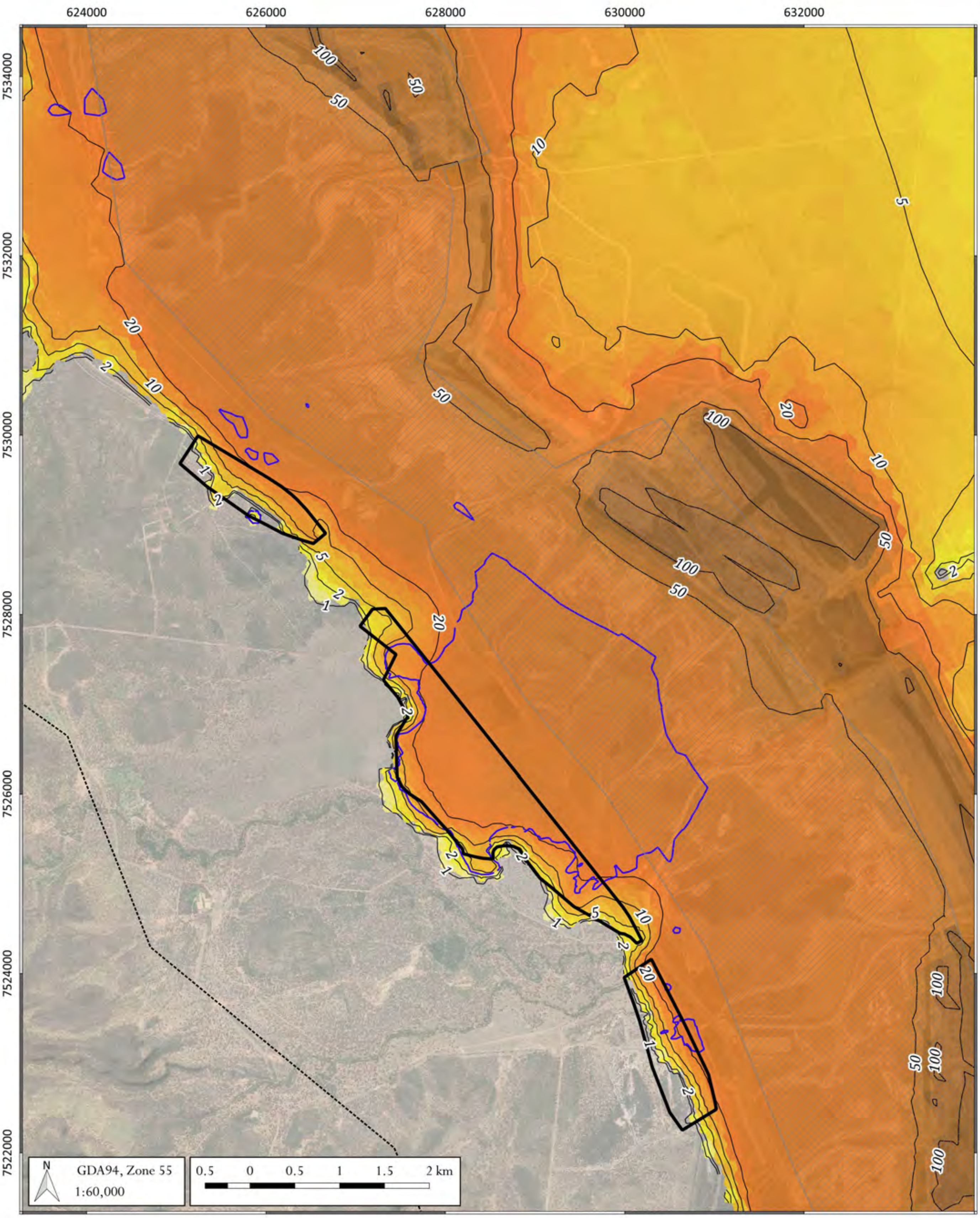
This predicted contributions to cumulative drawdown have been derived through development of three model scenarios.

- Greenfield scenario - representing nil mining;
- No mine scenario - representing approved mining operations; and
- Mine scenario - representing the project and approved mining operations.

The absolute amount of drawdown due to proposed mining has been calculated by subtracting the difference between scenario 2 and 3.

The total predicted cumulative drawdown has been calculated by subtracting the difference between scenario 1 and 3.

A post closure simulation was not carried out as part of the Hydrogeological Impact Assessment. The post closure groundwater conditions will be heavily influenced by the approved BHP operations, including the number of, location of, and depth of the final pit voids. Further, the final pit lake elevations are not known. These factors will have significant influence on the groundwater flow conditions including the long-term groundwater levels in the Project area and extent of post closure maximum drawdown. A reliable prediction of post closure conditions is not possible until information is provided by BHP.



LEGEND

Cumulative drawdown contour (m)

Extent of 1 m drawdown (Project)

Proposed pit

Established mining operation

Model domain

DATE
02/05/2024

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Vulcan Complex Project (4027D)

Project and cumulative drawdown - Layer 2 (Regolith)

FIGURE No.
6-41

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.

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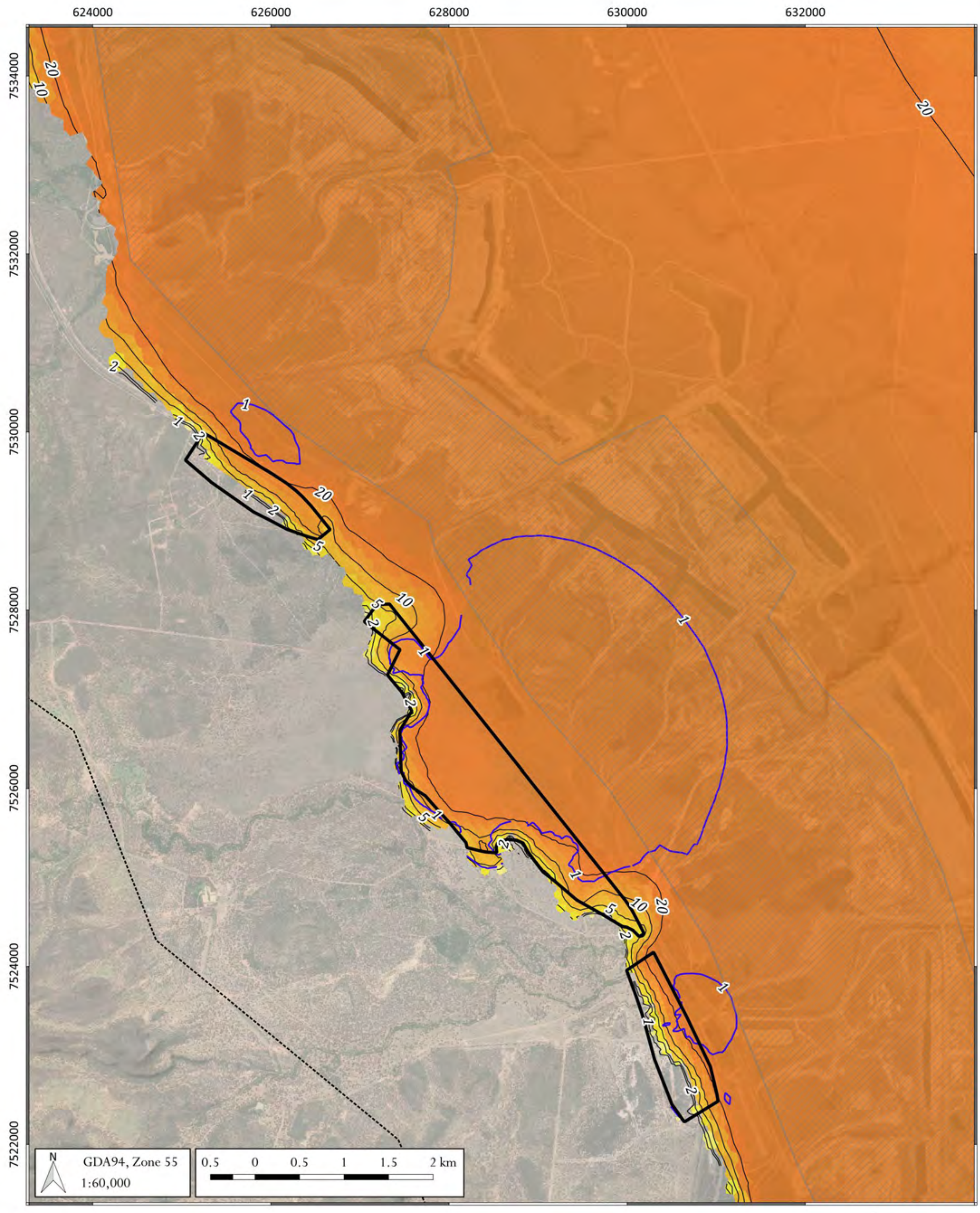

LEGEND

- Cumulative drawdown contour (m)
- Extent of 1 m drawdown (Project)
- Proposed pit
- Established mining operation
- Model domain

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02/05/2024

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Vulcan Complex Project (4027D)

Project and cumulative drawdown - Layer 10 (DLL Seam)

FIGURE No.
6-42

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.

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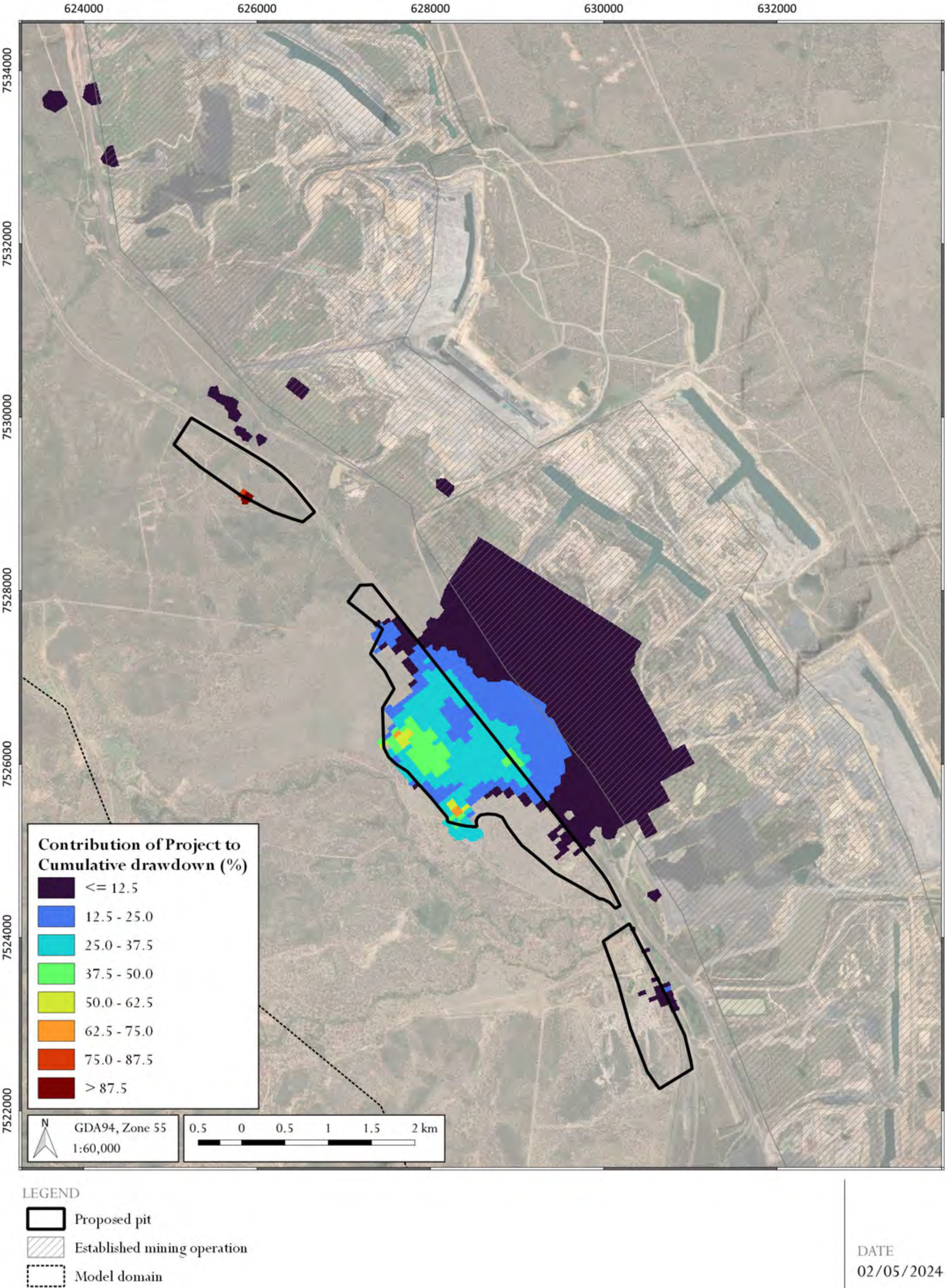

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Vulcan Complex Project (4027D)

Contribution to cumulative drawdown - Layer 2 (Regolith)

FIGURE No.
6-43

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.
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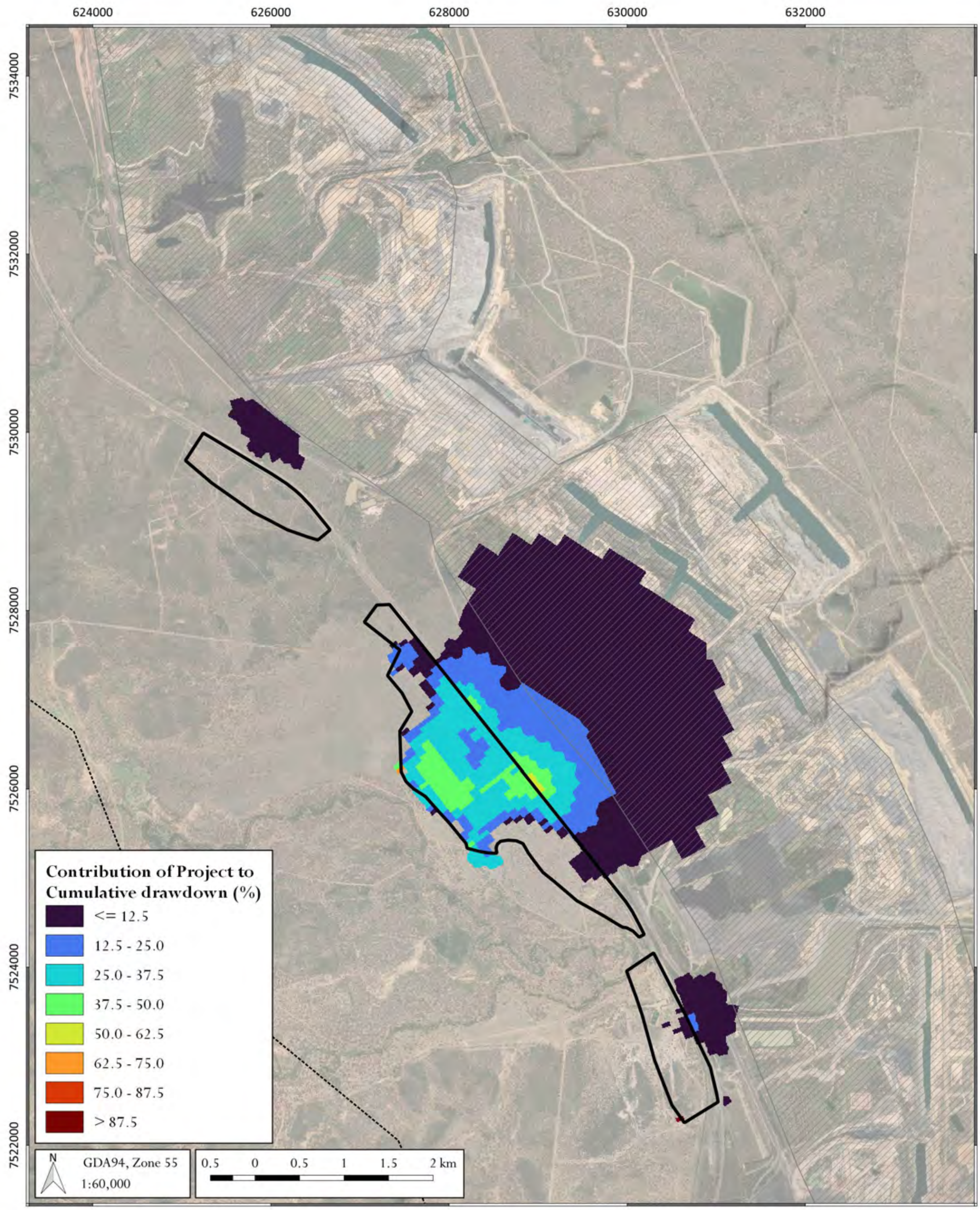

LEGEND

Proposed pit

Established mining operation

Model domain

DATE

02/05/2024

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Vulcan Complex Project (4027D)

Contribution to cumulative drawdown - Layer 10 (DLL Seam)

FIGURE No.

6-44

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.

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Water Quality

Inflow rates are minimal (1%) and drawdown is localised in extent.

The impacts from the project on groundwater is considered negligible and it was determined through the GIA that the risk of groundwaters within the backfilled pit impacting on surrounding groundwater quality is very low. For this reason, the contribution to cumulative impacts on water quality of the surrounding environment is considered to be negligible, particularly considering its currently brackish to highly saline nature and its lacking suitability for most uses.

6.4.3.19 Duration and extent

The duration of Groundwater impacts, of which the primary impact is inflow and drawdown associated with mining, will occur for 3 years within the North and South Pit, and 8 years for the central pit. Following backfilling of the pit, drawdown will cease and recharge will commence. Groundwater levels will then recharge to their original levels post-closure.

All groundwater impacts are known and irreversible, aside from the uncertainty associated with BHP's proposed and future mining activities beyond that which is publicly available. This includes Groundwater Drawdown, pit lake, groundwater level data, future site designs and mining activities. This will significantly influence the nature of groundwater within the vicinity of the Project area, more than which the Project itself is responsible for.

6.4.4 Highwall Mining

6.4.4.1 Subsidence

The target areas for the trial present competent roof and floor materials and target seams that are relatively flat dipping and non-undulating. The coal seams are of a thickness that is appropriate for highwall mining (0.9 to 1.5 m) and the coal itself is of reasonable strength whilst still being easily cut with a highwall continuous miner.

The depth of cover ranges between 12 and 50 m. This is considered optimal as the underground stress regime will be low to moderate, contributing to stable immediate roof conditions and reduced pillar loads. Reduced pillar loads allow for higher extraction ratios without impacting pillar stability, increasing coal recovery. Varying pillar parameters will be tested during the trial however the objective of the operation is maintain stability and avoid subsidence of the overlying roof material.

The highwall mining trial program has been designed based on the following criteria:

- minimum Depth of cover of 12 m;
- minimum seam thickness of 0.9 m; and
- maximum plunge length 300 m.

Panel designs have been completed using empirical design software, ARMPS. This software considers site specific conditions including cover depth, coal strength, entry width and vertical stress conditions. The software then compares those parameters to a developed database to provide recommended ranges for panel design layouts based on stability factors that have been proven successful. As an average, the resultant panel design parameters used for the highwall trial are as follows:

- plunge width – 3.5 m;
- web width – 1.2 m;
- barrier pillar width – 5 m;
- number of entries per barrier – 10; and
- plunge height - 1.1 m.

The above design parameters are considered conservative and exceed the ARMPS recommended stability factors for the overall panel layout, web width and barrier pillar width. This conservatism is considered warranted as a starting point; however, layout optimisation is expected to occur once the trial has commenced. The above layout results in an extraction ratio of approximately 70 %, with up to 2,500t per plunge and up to 25,000t per panel.

The most important impact of subsidence on vegetation is through changes to surface water runoff patterns and infiltration (Vishwakarma et al. 2020). Cracking increases water infiltration and hydrologic associations between aquifers (Vishwakarma et al. 2020). However, the vegetation growing above the proposed highwall panels is on the crest of an already well-drained sandstone ridge. Furthermore, no groundwater occurs within the coal seams or in overlying strata, such that highwall activities will not affect the broader groundwater regime.

The minimum depth of the cover above the coal seam is 12 m, which is deeper than almost all tree roots (**see Section 4.1.3.1**) such that highwall activities will not materially affect vegetation root systems.

Overall, highwall mining is not expected to affect the overlying surface drainage, groundwater system or health of vegetation growing above the panels. The inclusion of these panels within the disturbance footprint is highly conservative.

6.4.5 Risks to Receiving Environment

During mining, the proposed pits and the Saraji Mine pits will act as sinks for surrounding groundwater. Any local contamination of the groundwater regime will report to the mine pit and will be contained during operations. The ex-pit and in-pit waste rock emplacement areas will be progressively rehabilitated during mine development and therefore no final voids or evaporative sinks will remain in the Project area. Groundwater is predicted to recover towards the pre-mining groundwater levels, subject to mining plans that include the adjacent Saraji and Peak Downs Mines. It is assumed that the pit voids at Saraji Mine and Peak Downs Mine will likely remain into perpetuity and will behave as regional evaporative sinks on the groundwater system hence minimising any eastward migration of potential contaminants.

The evaluation of groundwater EV in the Project area indicated that groundwater is of no, or limited value for most uses because of the high salinity. Local groundwater was found to be brackish to highly saline and even an unprecedented 50% increase in salinity would not impact on the beneficial uses identified (livestock beef cattle watering (limited); and industrial purposes, limited to dust suppression in mining). This is because the salinity of local groundwater is well in excess of the WQOs for aquatic ecosystems and drinking water suitability. Therefore, the risk of groundwaters within the backfilled pit impacting on surrounding groundwater quality is highly unlikely.

All new mine infrastructure areas including workshops, fuel and chemical storage areas will include spill containment measures, for example bunding and / or spill kits. These structural and administrative controls will assist in preventing groundwater contamination. Impacts on groundwater quality, associated with local contamination from mine activities are considered highly unlikely.

6.4.6 Significance of Potential Impacts

A 'significant impact' is defined in the Guidelines as an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends on the sensitivity, value, and quality of the water resource which is impacted, and on the intensity, duration, magnitude and geographic extent of the impacts. To be 'likely', it is not necessary for there to be a greater than 50% chance of a significant impact; it is sufficient if there is a real or not remote chance or possibility of a significant impact on a water resource. The significance of surface and groundwater is outlined below.

6.4.6.1 Surface water

Sensitivity of resource

Surface water in the Project area is generally poor quality, within a highly disturbed catchment and a downstream environment that has been highly altered from mining activities. The sensitivity of the resource is considered insignificant.

Value of resource

Third party users utilise surface water for nearby mining activities (Peak Downs operational coal mine) and other industrial activities. In consideration of the already heavily disturbed nature of the adjoining downstream catchment, it is unlikely that Project releases will have a measurable impact on receiving water quality or environmental values. Third party downstream users are not expected to be impacted by the Project. The value of resource is considered insignificant.

Quality of surface water resource

Preliminary baseline monitoring indicates that water quality in the surrounding environment is of poor quality. The surrounding catchment areas are considered heavily disturbed by agriculture and operational mining activities. The quality of the resource is not assessed to be significant. The quality of resource is considered insignificant.

Intensity of the impacts

The project is located in an area already impacted by surrounding mining operations and agricultural activities. Much of the proposed mining area has altered flow regimes and changes to the stream geomorphology due to the downstream area being located within the operational Peak Downs coal mine. The intensity of the impacts is considered insignificant.

Duration of the impacts

The Project is to occur over a nine year mine life with some pits being mined over a three to four year duration. The nearby BHP mines have been in operation since the 1970s and the duration of mining impacts from the project are insignificant when compared to approved mining. The duration of the impacts is considered insignificant.

Magnitude and extent of the impacts

The magnitude and extent of surface water impacts are presented in the SWA (**Appendix I**). Overall, the impact of the Project on the hydraulic characteristics of Boomerang Creek, Hughes Creek and their tributaries do not affect the existing conditions significantly. It is expected that the channel and floodplain will undergo little, if any, adjustment to the hydraulic conditions upstream or downstream of the Project as result of the Project. The extent of flooding during the final landform configuration are generally confined within the Project MLA area. The magnitude and extent of the impacts is considered insignificant.

Summary

In summary, the impacts to receiving surface waters is considered insignificant.

6.4.6.2 Groundwater

Sensitivity of resource

The effected groundwater resource is generally of poor quality, within a low permeability environment with a relatively deep groundwater level beneath drainage features and potential GDEs. The groundwater levels do not appear to be influenced by seasonal effects and therefore they are not sensitive to recharge. The sensitivity of the resource is not assessed to be significant.

Value of resource

The groundwater resource directly impacted by the project and surrounding projects is not regulated, the impacted strata is not considered to be a high yielding or high quality groundwater resource. There is little value of the groundwater resource that is impacted by the project. The value of the resource is not assessed to be significant.

Quality of resource

Groundwater quality in the region is brackish to highly saline. The salinity of the resource governs third party use of the groundwater. The quality of the resource is not assessed to be significant.

Intensity of the impacts

The project is located in an area already impacted by surrounding mining operations. Much of the proposed mining area is already unsaturated (dewatered) by approved mining operations and will not be impacted by the project. The intensity of the impacts are not assessed to be significant.

Duration of the impacts

The project is to occur over a nine year mine life with some pits being mined over a three to four year duration. The nearby BHP mines have been in operation since the 1970s and the duration of mining impacts from the project are insignificant when compared to approved mining. The duration of the impacts are not assessed to be significant.

Magnitude and extent of the impacts

The magnitude and extent of project drawdown is presented in the GIA. The magnitude of drawdown is limited to approximately 10 m within the immediate vicinity of the open pits. The extent of drawdown is limited to within 2 km of the open pit crests and extends towards the approved area of disturbance at the adjacent BHP mines. The take of groundwater as a result of the project is negligible when compared to the take of groundwater from approved mining operations. The magnitude and extent of the impacts are not assessed to be significant.

Summary

In summary the impacts to groundwater resources are not assessed as significant.

7 Proposed Avoidance, Minimisation, Mitigation and Management Measures

This Section outlines the avoidance strategies, minimisation, mitigation and management measures developed for the potential impacts for 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 Project for threatened species are detailed in **Table 7-1**.

7.1 Proposed mitigation measures

This Section summarises the proposed avoidance, minimisation, mitigation and management measures proposed as part of the Project to reduce impacts to the greatest extent practicable. Where possible, the mitigation measures implemented by Vitrinite are continuously improved upon through review and update of management plans and other implementation documentation.

Throughout the initial conceptual planning and pre-feasibility assessment stages of the Project, environmental values were thoroughly considered with regulated vegetation, threatened species and watercourses/larger drainage lines avoided where possible. In consultation with the State Government (DESI), the disturbance footprint of the Project has been refined significantly to avoid environmental values by retaining connectivity with surrounding habitat areas and upholding continuity of surface water features. The original disturbance footprint proposed was reduced by approximately 250 ha following these discussions with DESI to further protect environmental values. Additionally, there will be no final voids at the completion of the project with the final landform being consistent with the surrounding landscape and having vegetation similar to that of the previous environment.

All mitigation measures have been designed so that they meet the S.M.A.R.T principles:

- S – Specific (what and how)
- M – Measurable (baseline information, number/value, auditable)
- A – Achievable (timeframe, money, personnel)
- R – Relevant (conservation advice, recovery plans, threat abatement plans)
- T – Time-bound (specific timeframe to complete).

7.1.1 Threatened species mitigation measures

The Project will include unavoidable impacts to MNES, and mitigations are proposed in **Table 7-1** to reduce these impacts to as low as reasonably practicable. Mitigation measures for threatened species are described within the following management plans:

- Environmental Management Plan (EMP)
- Progressive Rehabilitation and Closure Plan (PRCP) – describes rehabilitation outcomes and monitoring for threatened species habitat.
- Air Quality Management Plan

The relevant documentation and government guidelines listed below were consulted to assist in the development of the mitigation measures proposed in **Table 7-1:**

- National Light Pollution Guidelines for Wildlife (DCCEEW);
- Environmental Management Plan Guidelines (DCCEEW);
- Vehicle and Machinery Clean down Procedures (Biosecurity QLD, DAF);

- Best Practice Erosion and Sediment Control (BPESC) document (International Erosion Control Association);
- Conservation Advice and National Recovery Plans for listed threatened species – (DCCEEW/DAWE);
- EPBC Act Significant Impact Guidelines 1.1;
- Noise and Vibration EIS Information Guideline - Department of Environment, Science and Innovation;
- Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration - Australian and New Zealand Environment Council;
- State Code 16 - Native vegetation clearing; and
- Guidelines for Groundwater Quality Protection in Australia - Australian Government 2013.

Table 7-1 Mitigations for threats to MNES

Impact	Mitigation measure ('specific' and 'achievable')	Timing ('Time-bound')	Responsibility	Completion criteria ('measurable')	Supporting documentation ('relevant')	Effectiveness of individual mitigation measure (negligible, low, moderate, high)	Effectiveness of mitigation measures on overall risk (negligible, low, moderate, high)	**Corrective actions if completion criteria are not met**
Habitat loss (including fragmentation and loss of habitat features) on threatened species, terrestrial GDEs and Brigalow TEC	Vitrinite employees and contractors will be made aware of environmental obligations and compliance requirements through the most up to date and relevant site induction program.	Prior to commencement of work for all personnel.	Site Senior Executive (SSE)	The induction program will be completed for all onsite personnel and contractors.	**Environmental Management Plan** **Risk Treatment Action Plan** **Receiving Environment Monitoring Plan** **State Code 16**	**Low** The induction program is expected to raise awareness on issues facing threatened species and habitats. Measuring actual effectiveness is not possible, however it provides a baseline level of expectations for all employees and is the best first line of defence against incidents or accidents as a result of misunderstanding.	Negligible-low – therefore a significant impact remains which will be offset through the use of environmental offsets.	Vitrinite employees are to repeat the inductions and will be removed from site in the event of repeated breach.
	The edges of the project's footprint will be marked out to prevent unnecessary accidental clearing of neighbouring habitats.	During the construction and operation stage. Workers will be alerted to the footprint boundaries during induction. Edges marked at least 24 hours before clearing commences.	SSE	Clear, signage, fencing, spray paint or other will be displayed on the edge of the project disturbance footprint to outline clearly where the boundary is. Personnel and contractors have been made aware in the induction as to where the boundary is.	**Environmental Management Plan** **Risk Treatment Action Plan** **Receiving Environment Monitoring Plan**	**Low** This eliminates any subjectivity on the boundary outline and ensures that regardless of who is clearing, they are within the approved footprint. This is expected to have a moderate effect on reducing the chance of clearing outside of the boundary and therefore unnecessarily impacted upon habitat.		An investigation will be undertaken and the disturbed area will be rehabilitated. Further corrective actions will be developed to improve existing processes, such as reviewing communication protocols prior to shifts.

Impact	Mitigation measure (‘specific’ and ‘achievable’))	Timing (‘Time-bound’)	Responsibility	Completion criteria (‘measurable’)	Supporting documentation (‘relevant’)	Effectiveness of individual mitigation measure (negligible, low, moderate, high)	Effectiveness of mitigation measures on overall risk (negligible, low, moderate, high)	**Corrective actions if completion criteria are not met**
	Overburden will be placed within either the in-pit WRD’s or the ex-pit WRD’s, with placement in the in-pit WRD prioritised as per the approved site layout. As part of the design placement of waste in-pit has been maximised to limit the need for additional project footprint associated with ex-pit WRD’s.	Construction and operation	SSE	Overburden will not be stored externally where there is clear space within the pit for storage.	**Environmental Management Plan**	**Low** This reduces unnecessary disturbance where not absolutely required. The impact of this individually is expected to be small.		An investigation will be undertaken and the disturbed area will be rehabilitated. Further corrective actions will be developed to improve existing processes, such as reviewing communication protocols prior to shifts.
Loss of habitat features	Habitat features such as hollow-bearing trees and large woody debris will be identified by fauna spotter-catchers or site environmental advisor during pre-clearance surveys and recorded. If suitable, habitat features will be relocated/salvaged to use in rehabilitation areas.	Construction and operation	Site Environmental Advisor	Habitat/Micro habitat features will be retained/relocated where possible and suitable to do so.	**Environmental Management Plan** **Progressive Rehabilitation and Closure Plan**	**Low** Reduces the total amount of habitat loss, however relocated habitat features may not be suitable for fauna immediately	Moderate	If suitable habitat features are not salvaged during clearing, identify and harvest suitable habitat features following clearing. Further corrective actions will be developed to improve existing processes.

Impact	Mitigation measure ('specific' and 'achievable'))	Timing ('Time-bound')	Responsibility	Completion criteria ('measurable')	Supporting documentation ('relevant')	Effectiveness of individual mitigation measure (negligible, low, moderate, high)	Effectiveness of mitigation measures on overall risk (negligible, low, moderate, high)	**Corrective actions if completion criteria are not met**
Excessive habitat fragmentation	Infrastructure locations have been selected to minimise fragmentation of habitat and the removal of connectivity (climate change refugia). Connectivity to be restored following rehabilitation.	Construction, operation, Rehabilitation	Site Environmental Advisor	Complete fragmentation of habitat avoided Potentially suitable climate change refugia (or connection to) retained or reinstated	**Environmental Management Plan** **Progressive Rehabilitation and Closure Plan**	**Low – Moderate** Reduces the total amount of habitat loss, any level of connectivity retained will aid in fauna dispersal, particularly in times of environmental stress (drought, heat waves)	Moderate	• If habitat fragmented and/or connectivity removed beyond the assessed and approved footprint, the subject area will be rehabilitated to reinstate connectivity.
Avoidable destruction of breeding places	Desktop and pre-clearance surveys completed by fauna-spotter catchers and/or site environmental advisors will be conducted prior to the clearing of vegetation, with the intention of: • Identifying areas of breeding and/or denning/nesting habitat for threatened species • Identifying breeding and active seasons of threatened species	Construction, operation	Site Environmental Advisor	Approved Species Management Programs, including (if warranted) High Risk Species Management Programs are to be approved by the State Government prior to disturbing any breeding places for any protected wildlife. Ideally these will be completed prior to commencement of clearing to avoid delays.	**Environmental Management Plan** **Relevant Survey Guidelines and Conservation Advice** **Information sheet—Species Management Program requirements for tampering with a protected animal breeding place**	**Low – Moderate** Reduces impact to breeding fauna and identifies areas that may contain suitable habitat features to relocate/salvage	Moderate	• All clearing activities will be stopped in the habitat where the performance criteria are not met. • Additional assessment by a qualified ecologist will be undertaken to assess potential impacts on threatened species and to recommend measures to mitigate impacts caused.

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Habitat values are not returned following rehabilitation.	Post-mine rehabilitation will aim to restore habitat values for the Squatter Pigeon, Koala and Greater Glider. Given this is a requirement of the approved EA and PRCP Schedule, it is a legislative requirement for Vitrinite to ensure completion criteria for threatened species habitat rehabilitation are met. See **Table 8-1.** Mitigations listed in the rows below provide examples from this criteria which is ultimately described in the PRCP.	Operation, Rehabilitation and maintenance stage	SSE	Rehabilitation milestone criteria for the establishment of target vegetation type has been met, as per the PRCP. Rehabilitation milestone criteria for the achievement of post mining land use stability has been met, as per the progressive Rehabilitation and closure plan	**Progressive Rehabilitation and Closure Plan**	**Very High** The effective management of progressive rehabilitation through following the PRCP schedule and guideline is considered arguably the most important mitigation measure in ensuring the final landform is safe, stable and non-polluting and achieves the post-mining land-use requirements (as defined in the PRCP).	**High**	If PRCP milestone criteria not met, rectification and/or additional works will be conducted until criteria met. This is required by the schedule.
	Seed mixes have been based on other mine sites across north-eastern Australia.	Rehabilitation	SSE	Only the seeds specified in the Final PRCP Schedule are to be used -see **Appendix K**	**Progressive Rehabilitation and Closure Plan**	**Moderate** Establishment of Greater Glider food plants on the site post-mining is considered likely, based on successes at other mines in central Queensland. The return of hollows to the site has greater uncertainty due to the long timescales required for mature regrowth. Offsets are proposed to mitigate habitat		If seeds not specified in PRCP are used. As soon as error is realised, no further seeding will be conducted until the correct seed mix is used. If necessary, rectification works will be carried out. Where necessary further corrective actions will be developed to improve existing processes

Impact	Mitigation measure ('specific' and 'achievable'))	Timing ('Time-bound')	Responsibility	Completion criteria ('measurable')	Supporting documentation ('relevant')	Effectiveness of individual mitigation measure (negligible, low, moderate, high)	Effectiveness of mitigation measures on overall risk (negligible, low, moderate, high)	**Corrective actions if completion criteria are not met**
						clearing. How offsets will increase denning habitat and improve foraging habitat is described in the Offset strategy (**Appendix Z)**		
	Seed application rates will be modified pending the outcome of the initial rounds of rehabilitation.	Every two years	SSE	Seed application rates are to be modified pending the outcome of the initial rounds of rehabilitation.	**Progressive Rehabilitation and Closure Plan**	**Moderate** This will allow the methodology for seed application to be adaptive to initial outcomes and improve the chance of rehabilitation success. This is expected to be moderately effective but contributes to a cumulative positive effect.		• Review rehabilitation outcomes and monitoring results every two years. • Modify/adjust seed applications rates as needed.
	Regular monitoring aims for the early detection of sites with inadequate seedling establishment.	Immediately following the wet season	SSE	Monitoring for inadequate seed detection is conducted immediately following the wet season, after planting.	**Progressive Rehabilitation and Closure Plan**	**Moderate** This will allow for the early detection of inadequate seeding establishment		• Review rehabilitation outcomes and seed germination following wet season after planting. • Modify/adjust seed applications rates as needed. • Consider supplementary seeding or planting
	Sites with insufficient density of trees and shrubs developing over the first	Every two years when required	SSE	Sites with densities of shrubs less than what was there prior to	**Progressive Rehabilitation and Closure Plan**	**Low** This is expected to be marginally effective but		• Review rehabilitation outcomes and

Impact	Mitigation measure (‘specific’ and ‘achievable’))	Timing (‘Time-bound’)	Responsibility	Completion criteria (‘measurable’)	Supporting documentation (‘relevant’)	Effectiveness of individual mitigation measure (negligible, low, moderate, high)	Effectiveness of mitigation measures on overall risk (negligible, low, moderate, high)	**Corrective actions if completion criteria are not met**
	two years will undergo supplementary planting of tubestock.			clearing must undergo supplementary planting of tubestock.		contributes to a cumulative positive effect.		monitoring results every two years. • Conduct supplementary planting of tubestock as needed.
	Eucalyptus camaldulensis is to constitute 33% of the total basal area of woody vegetation in riparian areas (RE 11.3.25)	Assessed during rehabilitation monitoring every two years	SSE	*Eucalyptus camaldulensis is to constitute 33% of the total basal area of woody vegetation in riparian areas (RE 11.3.25)*	**Progressive Rehabilitation and Closure Plan**	**High** These species are essential food trees for Koalas and Greater Gliders and therefore, ensuring there are of an adequate quality and density is important when determining the rehabilitation of habitat for these species. This mitigation measure is expected to have a significant effect on rehabilitation success for these two species.		• Review rehabilitation outcomes and monitoring results every two years. • Adjust seed mixes as required • Conduct supplementary planting of tubestock as needed.

	Topsoil removed from each site in preparation for mining will be stored and managed in accordance with a PRCP, to protect a favourable growing medium for vegetation post-mining.	Construction and operation	SSE	Different soil management units will be stored separately at all times. Topsoil will not to be stored for more than a 12-month period before being replaced. Topsoil stockpiles will be less than 2 m high and will be contoured and positioned in a manner that encourages water drainage and discourages erosion. Grass and herbaceous plants germinating from the soil seed bank will be maintained as a protective cover for stockpiles. If there is a risk of a grass cover not establishing voluntarily, stockpiles will need to be ripped and seeded with a quick establishment pasture. Topsoil will be stockpiled for the minimum time practicable. Stockpiles will be monitored annually for weeds and control measures implemented to prevent weed	**Progressive Rehabilitation and Closure Plan**	**High** This is considered imperative to the success of rehabilitation, where topsoil is extremely important in ensuring growth of seedlings.		• Soil management will be carried out in accordance with the PRCP, with any deviation rectified as soon as possible. • Topsoil storage methodology and procedures will be reviewed and amendments made if the methodology is not successful • Staff will be retrained if the procedure is not followed • Where necessary further corrective actions will be developed to improve existing processes

				colonisation on the stockpiles. Where soil must be stockpiled for extended periods (>2 years), soil testing will be considered before use for rehabilitation purposes. Topsoil stockpiles will be located in areas fenced to exclude livestock.				

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Weed invasion	All vehicles that enter undisturbed parts of the site must be washed and certified weed free prior to arrival at the project site, to restrict the introduction of new weeds. Weed management activities must control weeds in high traffic areas.	Prior to driving on the Mining lease	SSE	Vehicles will been certified to have undergone a weed and seed check	**Risk Treatment Action Plan** **Environmental Management Plan** **Biosecurity QLD (DAF) - Vehicle and machinery cleandown procedures** **General Biosecurity Obligation** **Weed Management Plan**	**Moderate** Ensure that all vehicles that enter the site have undergone a weed and seed wash down will have a significant effect on the prevention of weed infestations and outbreaks. Given the known negative effect weeds have on the establishment of native species, this mitigation measure is expected.	**High**	• Record and file vehicle hygiene certifications. • Review weed hygiene certifications, any vehicles found to be lacking certification will immediately be required to undertake washdown and certification process.
	Operational areas and the visitor carpark will be inspected one month after heavy rainfall (defined as >20 mm in 24-h period) to identify new infestations of restricted weeds. These must be treated within 2 weeks of detection, with follow-up treatment until populations are eradicated.	One month after heavy rainfall in high-risk areas (vicinity of wash-down facilities, edges of light vehicle car park, topsoil stockpiles and edges of haul roads and ROM pad) and annually milestone monitoring. Populations of new infestations must be eradicated within 1 year.	SSE	Rehabilitated areas have less than 0.2% cover of *Parthenium hysterophorus* AND less than 0.1% cover of *Harrisia martinii*. Any other weeds listed under the *Biosecurity Act 2014* (Qld) will be present in densities of <1 individual per hectare. Mandatory reporting for Category 2 weeds within 24 hours of detection to the Queensland Department of	**Risk Treatment Action Plan** **Environmental Management Plan** **Weed Management Plan** **Biosecurity QLD (DAF) - Vehicle and machinery cleandown procedures** **General Biosecurity Obligation** **Environmental Management Plan**	**Moderate** This is expected to have a moderately positive effect given there is often an exponential effect of weed infestations and they progressively become more difficult to manage.		• Conduct rectification (weed control) works as soon as possible to eradicate new infestation and to prevent any further spread. • Immediately report category 2 weeds to DAF (Biosecurity Queensland 13 25 23) upon recognition of failure to initially report.

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				Agriculture and Fisheries.				
	Only native species, or species with low weed risk, will be included within seed mixes applied to rehabilitated sites.	Prior to spreading seeds	SSE	Seed mixes have been checked prior to use and it is confirmed (by a suitably qualified person) that minimal weed seeds are present, except where exotic species, such as Buffel grass are naturally contained within the mix (as they occur throughout the region).	**Progressive Rehabilitation and Closure Plan**	**Low** This is expected to be marginally effective but contributes to a cumulative positive effect.		• Review seed germination following wet season after planting. • Modify/adjust seed mix as needed. • Conduct rectification works as necessary.
	Stockpiles must be monitored annually for weeds and control measures implemented to prevent weed colonisation on the stockpiles.	annually	SSE	Stockpiles are monitored for weeds every 12 months	**Progressive Rehabilitation and Closure Plan** **Environmental Management Plan** **Weed Management Plan**	**Moderate- High** This will prevent weed colonisation on stockpiles and then spread to rehabilitation areas		• Monitor stockpiles every 12 months. • Conduct rectification (weed control) works as necessary.
	In-depth weed milestone monitoring completed every two years, including the development of a survey report.	Every two years	SSE	The weed monitoring survey report is complete every two years and: maps weed species to show showing the boundaries of the weed density zones (or rehabilitation areas/domains, for rehabilitated sites);	**Progressive Rehabilitation and Closure Plan** **Environmental Management Plan** **Weed Management Plan**	**Moderate-High** This will map and monitor weeds over time to ensure outbreaks are accurately and effectively managed. Effectiveness is considered to be moderate.	**Moderate**	• Complete weed monitoring survey report as soon as possible following awareness of delay of completion. • Development of weed management programs and works. • Where necessary further corrective

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				presents results from each sampling transect, along with an overall weed density score for each weed species; and, compares how the weed density scores have changed over time to assess whether the success criteria are being achieved.				actions will be developed to improve existing processes
Direct mortality during the clearing process	Clearing will occur in stages, to allow fauna the opportunity to exit the area.	Construction	SSE	Clearing will be completed in the same general direction throughout any single continuous clearing campaign to ensure connectivity is retained. Clearing will be done methodically and progressively in line with the sites stage plans.	**Environmental Management Plan** **Risk Treatment Action Plan**	**Low** This is expected to be negligibly effective but contributes to a cumulative positive effect.	**Moderate**	• Pre-clearance surveys will be undertaken. • If mortality occurs, instances will be recorded and reported to necessary agencies/departments . (i.e DESI). • Work methods will be reviewed to further reduce the risk of mortality before recommencing clearing works
	Injured fauna must be taken to the nearest wildlife carer or veterinarian.	All stages and immediately after observed	SSE	If injured fauna are observed, they will be called in immediately and taken to the Moranbah Veterinary Clinic or the vet is to	**Environmental Management Plan** **Risk Treatment Action Plan**	**Low** The effectiveness is considered low but contributes to a cumulative positive effect.		• Pre-clearance surveys will be undertaken. • Work methods will be reviewed to further reduce the risk of injury before

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				be contacted for further instructions.				recommencing clearing works. • Where necessary further corrective actions will be developed to improve existing processes
	Any injury and/or mortality will be communicated to DESI within 24 hours.	Within 24 hours	SSE	Any injury and/or mortality will be communicated to DESI within 24 hours.	**Environmental Management Plan** **Risk Treatment Action Plan**	**Low** Effectiveness is considered low but contributes to a cumulative positive effect.		• Pre-clearance surveys will be undertaken. • Work methods will be reviewed to further reduce the risk of injury/mortality before recommencing clearing works. • Immediately report DESI upon recognition of failure to initially report. • Where necessary further corrective actions will be developed to improve existing processes
	Vitrinite employees and contractors will be made aware of environmental obligations and compliance requirements through the site induction program.	Prior to completion of site induction	SSE	Employees have completed training in the site induction program.	**Environmental Management Plan** **Risk Treatment Action Plan**	**Moderate** The induction program is expected to raise awareness. Measures of actual effectiveness is not possible; however, this mitigation measure provides a baseline level of expectations for all		• Vitrinite employees and contractors cannot work/enter site without completing site inductions. • If Vitrinite employees and contractors are not site inducted – they will be required

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						employees and is the best first line of defence against incidents or accidents as a result of misunderstanding.		to stop work and attend an induction as soon as possible.
	When clearing is undertaken, there must be a suitably qualified and experienced fauna spotter catcher who completes a preclearance survey of the area and marks any suitable habitat. A fauna spotter catcher will also be present during clearing, one for each machine involved for observation and to assist with injured wildlife.	During Construction, suspected hollow trees are to be shaken with a bulldozer or excavator and left standing for 24 to 48 hours to allow fauna to self-relocate before felling. Breeding places are not to be removed or tampered with prior to the approval of a relevant SMP/HRSMP	Site Environmental Advisor	A suitably qualified and experienced fauna spotter catcher will complete a preclearance prior to clearing and be present during clearing. Breeding and denning places are to be left standing for 24 to 48 hours to allow fauna to self-relocate before felling.	**Environmental Management Plan** **Risk Treatment Action Plan** **Survey guidelines and relevant Conservation Advice**	**High** Preventing mortality through a fauna spotter catcher is anticipated to have the greatest effect on reducing direct mortality.		• Clearing will be stopped and work methods reviewed. • Individuals who have not correctly implemented recommendations of the preclearance survey report will be retrained through the induction process.
	No fauna is to be handled by anyone other than a suitably qualified and experienced fauna spotter catcher. Records will be kept and reported to DESI in the timeframe agreed to in the Rehabilitation Permit.	All stages	SSE	No fauna is to be handled by anyone other than a suitably qualified and experienced fauna spotter catcher	**Environmental Management Plan** **Risk Treatment Action Plan**	**Low** It is unlikely that incorrect handling would lead to death very often but ensuring proper handling would reduce unnecessary risk. Regardless this is a legal		• Immediately report DESI upon recognition of failure to report within the agreed timeframe. • Work methods will be reviewed to further reduce the risk of injury/mortality.

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						requirement and must be followed.		• Where necessary further corrective actions will be developed to improve existing processes
Risk of vehicle collisions with threatened wildlife	Buses must transport ~80% of workers daily from accommodation to site, to reduce the total number of vehicles using the roads.	All stages	SSE	80% of workers are being transported to site via buses - criteria met.	**Environmental Management Plan**	**Low** This is expected to be low in effectiveness but contributes to a cumulative positive effect.	**Low** The incidence of Vitrinite’s vehicles injuring wildlife through vehicle collision is low, therefore mitigation measures are not required to decrease the risk significantly.	• Work methods will be reviewed to meet completion criteria. i.e additional buses. • Where necessary further corrective actions will be developed to improve existing processes
	Where Practicable, trains used to transport coal must be of the largest size suitable for the relevant tracks, to reduce the total number of trips required.	Operation	SSE	Trains to (where practicable) meet the maximum standard for road travel	**Environmental Management Plan**	**Low** This is expected to be low in effectiveness but contributes to a cumulative positive effect.		• Where necessary further corrective actions will be developed to improve existing processes
	On-site speed limits will be restricted to 60 km/h on all roads through or adjacent to habitat critical to the survival of the Koala during dawn and dusk and at night.	All stages	SSE	Speed limits will be clearly outlined in the induction, which will be completed prior to site access. Speed signs will be visible on access roads and through critical habitat areas. Speed limits apply and will be enforced.	**Environmental Management Plan** **Risk Treatment Action Plan**	**Moderate** This is expected to have moderate effectiveness in reducing mortality on roads given that cars are driving slower and will have more time to react and therefore be more likely to safely prevent mortality.		• Speed limits apply and will be enforced. • Where necessary further corrective actions will be developed to improve existing processes

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Impacts of artificial lighting on threatened fauna	Artificial lighting used in operational areas will be angled away from habitats supporting sensitive species (e.g., riparian areas supporting Koalas and Greater Gliders) (Sanders, et al., 2020). This must be covered in the site induction for relevant workers.	All stages	SSE	Lighting will be checked frequently (quarterly), with a check for 'lighting pointed away from sensitive habitat areas. This topic is covered in the site induction.	**National Light Pollution Guidelines for Wildlife** **Environmental Management Plan** **Risk Treatment Action Plan**	**Low** As described above, mitigation measure topics to be covered on the onsite induction it provides a baseline level of expectations for all employees and is the best first line of defence against incidents or accidents as a result of misunderstanding.	**Moderate**	• Lighting is redesigned or reinstalled if found to not meet performance criteria. • Vitrinite employees and contractors cannot work/enter site without completing site inductions. • If Vitrinite employees and contractors are not site inducted – they will be required to stop work and attend an induction as soon as possible. • Quarterly monitoring to identify any instances of lighting not pointed away from sensitive habitat areas. Rectification works as necessary
	Floodlights with "low glare" louvres/attachments will be used to limit lateral transmission of light. Note that newer LED-type flood lights may have glare-reduction technology built-in (Newport, et al., 2014).	All stages	SSE	All floodlights near sensitive areas will be approved low glare or use glare reduction technology.	**National Light Pollution Guidelines for Wildlife** **Environmental Management Plan**	**Low** This is expected to have low effectiveness but contributes to a cumulative positive effect.		• Check lighting is suitable prior to installation. • If necessary, replace unsuitable lighting. • Where necessary further corrective actions will be developed to improve existing processes

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	Any streetlights used will be of the "aeroscreen" type (flat glass lenses), to reduce sideways glare (Newport, et al., 2014).	All stages	SSE	Where streetlights are used, they will be of the 'aeroscreen' type.	**National Light Pollution Guidelines for Wildlife** **Environmental Management Plan**	**Low** This is expected to be negligibly effective but contributes to a cumulative positive effect.		• Check lighting is suitable prior to installation. • If necessary, replace unsuitable lighting. • Where necessary further corrective actions will be developed to improve existing processes
	Light fittings will be positioned as close to horizontally as possible (Newport, et al., 2014).	On installation and with regular maintenance checks	SSE	Light fittings will be checked for positioning when they are maintained throughout the year and upon installation.	**National Light Pollution Guidelines for Wildlife** **Environmental Management Plan**	**Low** This is expected to be negligibly effective but contributes to a cumulative positive effect.		• Rectification works as necessary. • Where necessary further corrective actions will be developed to improve existing processes
	Except in the case of safety concerns, lighting will be installed and used in accordance with the National Light Pollution Guidelines for Wildlife, including the best practice lighting design principles: 1) Start with natural darkness and only add light for specific purposes. 2) Use adaptive light controls to manage light timing, intensity and colour. 3) Light only the object or area intended – keep lights	All stages	SSE	Light fittings will be checked for timing, intensity and positioning when they are maintained throughout the year and upon installation	**National Light Pollution Guidelines for Wildlife** **Environmental Management Plan**	**Low - Moderate** Measures of actual effectiveness is not possible; however, this mitigation measure provides a baseline level of artificial lighting mitigation and is the first line of defence against impacts as a result of installed artificial lighting.	**Moderate**	• Check lighting is suitable prior to installation. • If necessary, replace unsuitable lighting. • Rectification works as necessary. • Where necessary further corrective actions will be developed to improve existing processes

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	close to the ground, directed, and shielded to avoid light spill. 4) Use the lowest intensity lighting appropriate for the task. 5) Use non-reflective, dark-coloured surfaces. 6) Use lights with reduced or filtered blue, violet and ultraviolet wavelengths.							
Noise	Blasting conducted in line with EA limits and site controls.	Construction and operation	SSE	Noise levels are below EA trigger levels.	**Environmental Management Plan** **Risk Treatment Action Plan** **Project EA conditions** **Noise and Vibration EIS Information Guideline** **Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration**	**Moderate** This is expected to have a moderate effect on reducing unnecessary excessive noise.	**Moderate**	• EA Conditions – Schedule D • Consider adjusting blast regime. • Noise abatement measures must be immediately implemented to minimise any adverse impacts to the sensitive place and to limit any further exceedances
Dust	Covering loads prior to transport.	Construction and operation	SSE	All loads are covered during transport.	**Environmental Management Plan** **Risk Treatment Action Plan**	**Low** This is expected to be low in effectiveness but contributes to a	**Moderate**	• EA Conditions – Schedule B • Dust abatement measures must be immediately implemented in

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					Air Quality Management Plan	cumulative positive effect.		accordance with the Air Emissions Management Plan required under condition B8
	Use of watering trucks on haul roads when EA dust limits are reached.	Construction and operation	SSE	When dust deposition gauges indicate EA limits are close to the limit, watering trucks are to be used in the area where the limit is associated.	**Environmental Management Plan** **Risk Treatment Action Plan** **Air Quality Management Plan**	**Moderate** This is expected to have a moderate effect		• EA Conditions – Schedule B • Dust abatement measures must be immediately implemented in accordance with the Air Emissions Management Plan required under condition B8
	Prioritising dust producing activities on still days following rainfall.	Construction and operation	SSE	Activities including earthworks and haulage are to be completed on still days following rainfall, where feasible.	**Environmental Management Plan** **Risk Treatment Action Plan** **Air Quality Management Plan**	**Moderate** This is expected to have a moderate effect.		• EA Conditions – Schedule B • Dust abatement measures must be immediately implemented in accordance with the • Air Emissions Management Plan required under condition B8
	Blasting conducted in line with EA limits and site controls	Construction and operation	SSE	Blasting activities are to be completed, where possible, on days with weather conducive to minimise dust generation.	**Environmental Management Plan** **Risk Treatment Action Plan** **Air Quality Management Plan**	**Moderate** This is expected to have a moderate effect.	**Moderate**	• EA Conditions – Schedule B and Schedule D • Dust abatement measures must be immediately

Impact	Mitigation measure (‘specific’ and ‘achievable’))	Timing (‘Time-bound’)	Responsibility	Completion criteria (‘measurable’)	Supporting documentation (‘relevant’)	Effectiveness of individual mitigation measure (negligible, low, moderate, high)	Effectiveness of mitigation measures on overall risk (negligible, low, moderate, high)	**Corrective actions if completion criteria are not met**
					Project EA conditions			implemented in accordance with the Air Emissions Management Plan required under condition B8 • Immediately implement airblast overpressure abatement measures so that airblast overpressure from the activity does not result in further environmental nuisance
Fire during construction/operation	Standard mining fire safety and smoking protocols and procedures apply; therefore, no additional fire mitigation measures are required during construction/operation.	Construction and operation	SSE	Standard mining fire safety and smoking protocols and procedures apply. This includes an Emergency Response Plan which describes processes in place to control fires that originate on site. Therefore, no additional fire mitigation measures are required.	**Emergency Response Plan** **Risk Treatment Action Plan**	**High** The proposed mitigation measures are standard practices at Queensland coal mines, where fire is an important risk to the safe operation of the mine and transport of the product. The effectiveness of these measures is considered, with high confidence, to be high, based on the fact that the fires that occur at coal mines are usually isolated in nature and very rarely	**High**	Emergency Response Plan and other procedures as necessary will be reviewed.
Fire during the rehabilitation stage	A fire break will be maintained along the western boundary of the mine during rehabilitation, to minimise the risk of fires	During rehabilitation	SSE	A fire break is maintained along the western boundary of the mine during rehabilitation, to	**Risk Treatment Action Plan** **Emergency Response Plan**			Rectification works as necessary following fire. i.e infill planting.

Impact	Mitigation measure ('specific' and 'achievable'))	Timing ('Time-bound')	Responsibility	Completion criteria ('measurable')	Supporting documentation ('relevant')	Effectiveness of individual mitigation measure (negligible, low, moderate, high)	Effectiveness of mitigation measures on overall risk (negligible, low, moderate, high)	**Corrective actions if completion criteria are not met**
	originating within bushland areas of the Harrow Range.			minimise the risk of fires originating within bushland areas of the Harrow Range.	**Environmental Management Plan**	spread beyond their source (Hansen, 2018).		
Timber harvesting	N/A	N/A	N/A	N/A		N/A	N/A	
Barbed wire fencing (entanglement)	Fences will be altered in dispersal corridors to prevent entanglement. At minimum, fences will have the top barbed wire replaced with smooth wire.	Rehabilitation	SSE	Amended fencing in habitat corridors.	**Environmental Management Plan** **Progressive Rehabilitation and Closure Plan**	**Moderate**	**Moderate**	• Fences will be scheduled to be altered as part of the rehabilitation maintenance program when identified to be needed.
Climate change (increased temperatures and changes to rainfall patterns)	N/A	N/A	N/A	N/A		N/A	N/A	
Hyper predation by owls	N/A	N/A	N/A	N/A		N/A	N/A	
Competition from *Cacatua galerita* (Sulphur-crested Cockatoos)	N/A	N/A	N/A	N/A		N/A	N/A	
Predation by feral cats and foxes **(*Felis catus*) and European foxes (*Vulpes vulpes*)**	N/A	N/A	N/A	N/A	**Environmental Management Plan** **Progressive Rehabilitation and Closure Plan**	N/A	N/A	N/A
Loss of climatically suitable habitat	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Impact	Mitigation measure ('specific' and 'achievable'))	Timing ('Time-bound')	Responsibility	Completion criteria ('measurable')	Supporting documentation ('relevant')	Effectiveness of individual mitigation measure (negligible, low, moderate, high)	Effectiveness of mitigation measures on overall risk (negligible, low, moderate, high)	**Corrective actions if completion criteria are not met**
Increased intensity/frequency of drought	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Declining nutritional value of foliage	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Koala retrovirus (KoRV) and Chlamydia (*Chlamydia percorum*)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Predation by wild dogs	N/A	N/A	N/A	N/A	**Environmental Management Plan** **Progressive Rehabilitation and Closure Plan**	N/A	N/A	N/A
Overgrazing of habitat by livestock and feral herbivores such as rabbits	N/A	N/A	N/A	N/A	**Progressive Rehabilitation and Closure Plan**	N/A	N/A	Review PRCP and either exclude livestock or increase feral animal control methods.
Thickening of understorey vegetation	N/A – refer to justification in the impacts table.	N/A	N/A	N/A	**Progressive Rehabilitation and Closure Plan**	N/A	**Negligible**	Thin vegetation with reference to the specific methodologies within the PRCP/RMP
Trampling of nests by domestic stock	N/A – refer to justification in the impacts table.	N/A	N/A	N/A	**Progressive Rehabilitation and Closure Plan**	N/A	**Negligible**	Cattle to be excluded from areas with ground-nesting birds
Illegal shooting	None required, only possible through illegal entry to property.	N/A	N/A	N/A		N/A	N/A	

Impact	Mitigation measure ('specific' and 'achievable'))	Timing ('Time-bound')	Responsibility	Completion criteria ('measurable')	Supporting documentation ('relevant')	Effectiveness of individual mitigation measure (negligible, low, moderate, high)	Effectiveness of mitigation measures on overall risk (negligible, low, moderate, high)	**Corrective actions if completion criteria are not met**
Groundwater contamination and drawdown (also provided in Table 7-3)	As per **Table 7-3**	As per **Table 7-3**	SSE	As per **Table 7-3**	**Groundwater monitoring program**	As per **Table 7-3**	**High**	As per **Table 7-3**
Surface water contamination.	Surface water mitigation measures are specified in **Table 7-4**.	As per **Table 7-4**.	SSE	As per **Table 7-4**.	**surface water monitoring program** **Water Management Plan**	As per **Table 7-4**.	High	As per **Table 7-4**

i. Where the Impact assessment in Section 6 determined that there were no impacts, the term N/A has been listed within this table to represent that mitigation measures are not relevant.

7.1.2 Erosion and Sedimentation

Sediment water containment (runoff from WRD and incomplete rehabilitated areas) will be managed in accordance with the site Erosion and Sediment Control Plan (ESCP). The ESCP (**Appendix W**) will adopt the three cornerstones of ESC:

- Drainage control – prevention or reduction of soil erosion caused by concentrated flows and appropriate management and separation of the movement of diverted and surface water through the area of concern.
- Erosion control – prevention or minimisation of soil erosion (from dispersive, nondispersive or competent material) caused by rain drop impact and exacerbated overland flow on disturbed surfaces.
- Sediment control – trapping or retention of sediment either moving along the land surface, contained within runoff (i.e. from up-slope erosion) or from windborne particles.

The Project will require a combination of the three control measures to effectively manage sediment and erosion at the site. The ESC plan for the Project will reference the document prepared by the International Erosion Control Association (IECA) entitled Best Practice Erosion and Sediment Control Guidelines (International Erosion Control Association, 2008)

ESC will be evaluated and implemented for the following phases of work:

- Planning and design (non-operational);
- Operation and construction; and
- Rehabilitation and mine closure.

A list erosion and sedimentation management measures have been developed to be consistent with S.M.A.R.T principles and are outlined in **Table 7-2**.

Table 7-2 Erosion and Sedimentation Mitigation measures

Topic	Mitigation measure	Timing	Responsibility	Completion criteria	Effectiveness of individual mitigation measure	Corrective action	Relevant resource
Scheduling of activity (e.g. avoiding construction during wet periods)	Clearing will be staged to minimise potential loss of sediment.	Construction	SSE	Clearing will be completed in the same general direction throughout any single continuous clearing campaign to ensure connectivity is retained. Clearing will be done methodically and progressively in line with the sites stage plans.	Low-moderate	Additional ESC will be installed upon recommendation of an AQP.	Vulcan South Progressive Rehabilitation and Closure Plan International Erosion Control Association (IECA) Best Practice Erosion and Sediment Control Manual (2008).
	Saturated topsoil will not be handled when wet and is to be left for 72 hours to dry to at least a damp condition prior to placement. Manual handling of wet soils is logistically difficult, damages the soil's structure and leads to compaction.	Construction Saturated soil is to be left for 72 hours before handling	SSE	Topsoil is only to be stripped and placed using either damp or dry soil, not saturated.	Low-moderate	Topsoil stripping and stockpiling will be rectified when feasible after rain event.	International Erosion Control Association (IECA) Best Practice Erosion and Sediment Control Manual (2008).
Implementation of best-practice erosion and sediment control measures	The sizing of sediment basins and development of erosion and sediment control measures will be undertaken in accordance with the Best Practice Erosion and Sediment Control Guidelines (IECA, 2008).	All stages	SSE	Sizing as determined through the ESCP has been reviewed by an AQP and a statement is included within the ESCP Pre-wet season preparedness inspection has determined that all water infrastructure is in accordance with IECA guideline.	High	• If monitoring of a sediment dam identified an exceedance of the WQOs, all water in that structure will be transferred to a mine water dam. • After three consecutive exceedances of WQOs, an investigation into the cause and potential for environmental harm will be carried out by an AQP. • A written report will be provided to DESI.	Vulcan South Erosion and Sediment Control Plan International Erosion Control Association (IECA) Best Practice Erosion and Sediment Control Manual (2008). Vulcan South Environmental Authority

	Any runoff captured within the sediment basins will be released to the downstream environment in accordance with the site ESCP or pumped back into the mine water system.	All stages	SSE	Primary control of sediment will be via sediment basins, designed and constructed in accordance with the Best Practice Erosion and Sediment Control guidelines (IECA, 2008). Coarse and medium sediments will sink through the water column of the basin whilst cleaner water will flow through the outlet of the sediment basin.	High	• If monitoring of a sediment dam identified an exceedance of the WQOs, all water in that structure will be transferred to a mine water dam. • After three consecutive exceedances of WQOs, an investigation into the cause and potential for environmental harm will be carried out by an AQP. • A written report will be provided to DESI.	Vulcan South Erosion and Sediment Control Plan International Erosion Control Association (IECA) Best Practice Erosion and Sediment Control Manual (2008).
Minimising the extent and duration of soil disturbance	The mining schedule will minimise the duration for which open soils are exposed to the erosive elements (wind, rain and flowing water). This will occur through the placement of sterile, fast-growing grasses and hydromulch for bank stabilisation. Reducing the period where soils are exposed to erosive elements during the construction phase lessens opportunity for displaced sediment to enter into the surrounding environment.	All stages Protectant placed within 3 months of clearing	SSE	Sterile, fast-growing grasses and hydromulch are to be placed onto non-operational disturbed areas (open soils) within 3 months	Moderate-high	Rectification works will be conducted as necessary.	Vulcan South Progressive Rehabilitation and Closure Plan International Erosion Control Association (IECA) Best Practice Erosion and Sediment Control Manual (2008).
Employment of erosion mitigation infrastructure during operation	Employment of erosion and sediment control measures during operation	During operations and rehabilitation stages	SSE	Temporary runoff collection, conveyance and disposal systems to minimise erosion prior to commencement.	High	Additional ESC will be installed upon recommendation of an AQP.	Vulcan South Erosion and Sediment Control Plan International Erosion Control Association (IECA) Best Practice Erosion and Sediment Control Manual (2008).
	Contour banks on slopes will be constructed at a spacing of 80 m for slopes of 1V:6H. Larger contour drains are generally more stable and	During rehabilitation	SSE	Contour banks are constructed at a spacing of 80 m for slopes of 1V:6H	High	Remedial earthworks will be conducted immediately after	Vulcan South Progressive

	longer lasting. Berms should be constructed of compacted material (IECA Erosion and Sediment Control Guidelines). Contour banks will convey water to engineered rock-lined spine drains on steep slopes. A competent basalt or alternative rock source will be used.					a deviation from the design plan is identified.	Rehabilitation and Closure Plan Vulcan South Erosion and Sediment Control Plan International Erosion Control Association (IECA) Best Practice Erosion and Sediment Control Manual (2008).
	Sediment dams must be de-silted (removal of sediment accumulating within the sediment storage zone) as part of the sediment dam maintenance to restore the volume of the sediment dams to the original design volume.	Sediment damns are de-silted where required, following the outcomes of the twice-yearly wet season inspection	SSE	Sediment dams are de-silted when the settled sediment has exceeded 90% of the nominated storage volume as prescribed within the ESCP or; If Total Suspended Solids reach > 50 mg/L in the basin (IECA 2008)	Moderate-high	Desilting will commence as soon as it is discovered that performance criteria has been exceeded.	Vulcan South Erosion and Sediment Control Plan International Erosion Control Association (IECA) Best Practice Erosion and Sediment Control Manual (2008).
Requirements during soil work	All personnel involved in clearing are to have read the ESCP	Prior to clearing/soil work	SSE	All clearing personnel have signed off that they have read and understood the ESCP prior to clearing	Moderate	The worker will be made to stop work and read the ESC	Vitrinite EMS
	All personnel involved in clearing or soil work are to have completed a risk assessment including the environmental conditions at the time and are to stop work if there is a high risk of erosion	Prior to clearing/soil work	SSE	All personnel are to complete an erosion risk assessment prior to commencement of soil works	Moderate	If discovered there is non-compliance, the worker will be made to stop work and only resume once a risk assessment has been completed.	Vulcan South Erosion and Sediment Control Plan
Erosion monitoring	Monitoring will be undertaken by a suitably qualified person in accordance with the industry best practice methods	In accordance with IECA (2008) all ESC measures will be inspected as follows:	SSE	Daily site inspections taking place during periods of runoff inducing rainfall will check: All drainage, erosion and sediment control measures;	High	All corrective actions recommended by AQP following monitoring will be implemented as per the	Vulcan South Erosion and Sediment Control Plan

		At least daily when rain is occurring; Within 24 hours prior to expected rainfall; and Within 2 hours of a rainfall event of sufficient intensity and duration to cause on-site runoff.		Occurrences of excessive sediment deposition (whether on-site or off-site); and All site discharge points. Site inspections immediately prior to anticipated runoff inducing events will check: All drainage, erosion and sediment control measures; and All temporary (i.e. overnight) flow diversion and drainage works. Site inspections immediately following runoff producing rainfall must check: Treatment and dewatering requirements of sediment basins; Sediment deposition within sediment basins and requirements for its removal; All drainage, erosion and sediment control measures; Occurrences of excessive sediment deposition (whether on-site or off-site); Occurrences of construction materials, litter or sediment placed, deposited, washed or blown from the site, including deposition by vehicular movements; and Occurrences of excessive erosion, sedimentation, or mud generation around the		PRCP schedule requirement under the EP Act 1994.	International Erosion Control Association (IECA) Best Practice Erosion and Sediment Control Manual *(2008).*

				site office, car park and/or material storage area.			
	Erosion monitoring across the Project area is to be completed every two years	Every two years (including rehabilitation)	SSE	Groundcover is to remain above 80% on all slopes with a gradient higher than 10%, and 50% on slopes with a gradient lower than 10% Erosion monitoring has been completed and the average erosion rate is <5 t/ha/year No active rill or gully erosion deeper than 30cm present An AQP must be employed to certify that the final landform is geotechnically stable	Moderate-high	All corrective actions recommended by AQP following monitoring will be implemented as per the PRCP schedule requirement under the *EP Act 1994*.	Vulcan South Erosion and Sediment Control Plan Vulcan South Progressive Rehabilitation and Closure Plan Schedule Vulcan South Progressive Rehabilitation and Closure Plan
	All water management infrastructure is to be inspected prior to and following the wet season to ensure there are no risks to capacity and no damage, respectively	Twice yearly	SSE	Water management infrastructure is inspected twice yearly by a suitably qualified person	Moderate	All corrective actions recommended by AQP following monitoring will be implemented under the *EP Act 1994*.	Vulcan South Erosion and Sediment Control Plan International Erosion Control Association (IECA) Best Practice Erosion and Sediment Control Manual (2008). General environmental duty prescribed under the *Environmental Protection Act 1994*.

7.1.3 Groundwater Drawdown and Contamination

As described in **Section 6.4.3** Impacts to groundwater were assessed to be negligible; however, the monitoring and management measures outlined in **Table 7-3** will be implemented. Groundwater mitigation measures will be described further in the Groundwater Monitoring Program and the Groundwater Management Plan, which are required to be complete prior to the commencement of the action as prescribed under the Approved EA.

Table 7-3 Groundwater mitigation measures

Mitigation measure	Timing	Responsibility	Completion criteria	Relevant Guidelines	Effectiveness of individual mitigation measure	Corrective action
Groundwater is to be managed as per the Groundwater Management and Monitoring Report to ensure Groundwater quality is in line with EA trigger levels.	Monthly or quarterly testing depending on the GW bore.	SSE	Groundwater contamination level remains below EA. specified trigger levels for each parameter.	Groundwater Management and Monitoring Report Guidelines for Groundwater Quality Protection in Australia - Australian Government 2013 Environmental Authority	**High** The assurance that groundwater levels remain below the approved EA trigger levels is expected to have a large positive effect on the risk of groundwater contamination.	• After three consecutive exceedances of groundwater quality limits, DESI will be notified and an investigation into the cause and potential for environmental harm will be carried out by an AQP. • A written report will be provided to DESI. • Appropriate mitigation measures to address the groundwater contamination and prevent recurrence of the contamination will be implemented. • If SWL triggers are exceeded, DESI will be notified and an investigation into the cause will be completed by an AQP. Immediate action will be taken to ensure compliance with SWL trigger thresholds.
In accordance with the EA, if monitoring results from groundwater monitoring bores exceed trigger levels on three consecutive sampling occasions Vitrinite must notify DESI and an investigation must occur to determine if the exceedance is a result of:	• DESI is notified within 24 hours from receiving the monitoring bore data • A investigation report is provided to DESI within 14 days	SSE	• DESI is notified within 24 hours from receiving the monitoring bore data • A investigation report is provided to DESI within 14 days • If the results indicate the exceedance is caused by	Environmental Authority	High The assurance that groundwater quality levels remain below the approved EA trigger levels is expected to have a large positive effect on the risk	The completion criteria can be regarded as the corrective action

Mitigation measure	Timing	Responsibility	Completion criteria	Relevant Guidelines	Effectiveness of individual mitigation measure	Corrective action
• The Project • Natural variation • Neighbouring land use.	• If the results indicate the exceedance is caused by the Project, a further investigation must be completed within 28 days from the provision of the report.		the Project, a further investigation must be completed within 28 days from the provision of the report. • Once the cause is identified through the further investigation, issue- specific corrective actions will be developed and implemented.		of groundwater contamination.	
In accordance with the EA If the Level Trigger Thresholds of groundwater measured at monitoring bores specified in the EA exceeds any of the corresponding SWL trigger thresholds Vitrinite must: • notify DESI within 24 hours of becoming aware of the exceedance; and • complete an investigation into the cause of the exceedance within ten (10) business days of becoming aware of the exceedance; and • if the investigation carried out determines that the Project are a potential cause or contributor to the exceedance, Vitrinite must notify DESI within twenty-four (24) hours and take immediate action to ensure and notify DESI of when	24 hours, 10 business days and 24 hours, respectively.	SSE	• DESI is notified within 24 hours of becoming aware of the exceedance; and • An investigation is completed into the cause of the exceedance within ten (10) business days of becoming aware of the exceedance; and • if the investigation carried out determines that the Project are a potential cause or contributor to the exceedance, Vitrinite must notify DESI within twenty-four (24) hours and take immediate action to ensure and notify DESI of when action has been completed	Environmental Authority	Moderate The assurance that groundwater levels remain below the approved EA trigger levels is expected to have a large positive effect on the risk to groundwater values .	The completion criteria can be regarded as the corrective action

Mitigation measure	Timing	Responsibility	Completion criteria	Relevant Guidelines	Effectiveness of individual mitigation measure	Corrective action
action has been completed.						
The groundwater monitoring network is to be regularly reviewed to ensure it remains representative of groundwater conditions and fit for purpose.	Every two years.	SSE	The groundwater monitoring network must be reviewed every two years to determine whether additional monitoring bores are required.	Groundwater Management and Monitoring Report Guidelines for Groundwater Quality Protection in Australia - Australian Government 2013 Environmental Authority	Moderate This is expected to be moderately effective as contemporary groundwater information becomes available, the network can be updated accordingly.	The review will be carried out as soon as possible after discovery of omission.
Establish and continue a groundwater data sharing arrangement between Vitrinite and BHP. Routine groundwater level and quality monitoring from Saraji Mine and Peak Downs Mine will be completed to provide Vitrinite with a greater understanding of the hydrogeological system responses during mining.	12 months from receiving the final federal approval	SSE	Vitrinite has continuous access to BHP's groundwater monitoring network data.	Groundwater Management and Monitoring Report Guidelines for Groundwater Quality Protection in Australia - Australian Government 2013 Environmental Authority	Moderate This allows for a clearer understanding of the sources of contaminants. This is expected to be moderately effective in mitigating risk.	If access to data is lost, re-engagement and negotiation with neighbouring mines will be initiated.
The initial update of the groundwater model and Groundwater Impact Assessment will occur 12 months from receiving the final federal approval and will include the additional groundwater monitoring data from the neighbouring BHP mine	12 months from receiving the final federal approval (associated with the commencement of operations)	SSE	A model verification is complete with findings as to whether the existing model is fit for purpose with regard to contemporary groundwater conditions and if this concludes that it is not, a recalibration must be done.	Environmental Authority Groundwater Monitoring and Management Program – requirement of EA	High This allows for a potentially more accurate and contemporary model to be used and therefore, impacts and mitigation measures to be more clearly understood in the early stages of mining	In the instance the review suggests a model update is required, the development of required mitigation and management is considered the corrective action, as dictated by any issues raised by the model outputs.
Every three years, the numerical groundwater model will be reviewed by a third party, where it will be recalibrated and redeveloped if determined it is required.	Initially the model will be updated 12 months from receiving the final federal approval (at the same time that the data sharing agreement takes place)	SSE	A model verification is complete with findings as to whether the existing model is fit for purpose with regard to contemporary groundwater conditions and if	Groundwater Management and Monitoring Report Guidelines for Groundwater Quality Protection in Australia - Australian Government 2013 Environmental Authority	Moderate This allows for a potentially more accurate and contemporary model to be used and therefore, impacts and mitigation	EA Conditions – Schedule E The review will be carried out as soon as possible after discovery of omission.

Mitigation measure	Timing	Responsibility	Completion criteria	Relevant Guidelines	Effectiveness of individual mitigation measure	Corrective action
	and every 3 years thereafter.		this concludes that it is not, a recalibration must be done.		measures to be understood.	
Vitrinite will test for aluminium, arsenic, cadmium, copper, manganese, nickel and zinc (identified in the geochemistry assessment to potentially leach from WRDs) within their groundwater monitoring program.	Monthly or quarterly testing depending on the GW bore.	SSE	Groundwater quality testing results received for aluminium, arsenic, cadmium, copper, manganese, nickel and zinc every month for MB15 and MB16, and every quarter for MB05, 13, 14 and 17.	Groundwater Management and Monitoring Report Guidelines for Groundwater Quality Protection in Australia - Australian Government 2013 Environmental Authority	Moderate This will effectively assess the impacts of any potential leaching of reject material in WRDs into groundwater.	Testing will be carried out as soon as possible following recognition of the omission.

7.1.4 Surface Water mitigation measures

Mitigation measures for surface water with specific relation to ecological matters is described in **Table 7-4**.

The performance of the mine water management system in managing impacts to water has been investigated using a detailed site water balance model (**Appendix I**). The model simulated water inflows and outflows through the various stages of mine development, based on 122 realisations with different climatic sequences. The potential impacts of the Project on surface water resources will be effectively mitigated through the implementation of a mine site water management system to control the flow and storage of water of different qualities across the site. These mitigation measures for surface water are described below in **Table 7-4**.

A surface water monitoring program will be implemented to monitor potential environmental impacts and ensure that the site water management system is meeting its objectives. Surface water mitigation measures will also be outlined within the REMP (**Appendix X**).

Table 7-4 Surface water Mitigation Measures

Stage (construction, operation and post closure)	Impact	Mitigation measure	Timing	Responsibility	Completion criteria	Design considerations	Relevant resources	Effectiveness of mitigation measures	Corrective action
Construction	Construction of drainage diversions around pits resulting in changes to surface water conditions	The proposed mine water management system is adequately sized to dewater the catchment runoff collected in active mining pits. Mine water is also used on-site to meet site demands and to reduce inventory of mine water dams. Please note that under no modelling scenarios were any of the mine water dams anticipated to overflow.	Installation/ construction of diversions will be completed in conjunction with the construction of the proposed roads and pits.	SSE	• Drainage diversions will be inspected following rain events to identify and remediate any sedimentation built up within the diversions and/or erosion damage.	Drainage diversion sizing and flood protection requirements will be confirmed during detailed design.	• ESCP • International Erosion Control Association (IECA) Best Practice Erosion and Sediment Control Manual (2008). • Surface Water management Plan	High*	Sediment buildup and erosion damage will be remediated.
Construction and Operation	Haul and access roads will potentially result in sediment laden runoff discharging to the downstream environment.	Runoff must be directed to ESC controls before discharge to the downstream environment in accordance with the site ESCP or pumped back into the mine water system.	ESC controls will be implemented prior to roads construction and maintained during operations	SSE	• ESC controls will be checked at the beginning of the wet season and following significant rainfall events to remove accumulated sediment and repair damage. • WQO's met following testing of downstream surface water monitoring sites after rainfall events per the EA.	ESC controls will be suitably selected, designed and installed in accordance with the ESCP and IECA (2008)	• ESCP • International Erosion Control Association (IECA) Best Practice Erosion and Sediment Control Manual (2008). • REMP • Surface Water	High*	• After three consecutive exceedances of WQOs, an investigation into the cause and potential for environmental harm will be carried out by an AQP. • A written report will be provided to DESI.

Stage (construction, operation and post closure)	Impact	Mitigation measure	Timing	Responsibility	Completion criteria	Design considerations	Relevant resources	Effectiveness of mitigation measures	Corrective action
							Manageme nt Plan		
Construction and Operation	Potential increase in flood levels and erosion/scouring of drainage line channels due to proposed haul roads, access roads and railway.	Proposed culverts/floodw ays will convey flows through road and railway crossings.	Installation/const ruction of culverts/floodwa ys will be completed in conjunction with the construction of the proposed roads and railway.	SSE	Crossings and culverts will be inspected following rain events to identify and remediate any sedimentation built up within the culverts and/or erosion damage.	Culvert and floodway sizing and scour protection requirements will be confirmed during detailed design.	• ESCP • Internationa l Erosion Control Association (IECA) Best Practice Erosion and Sediment Control Manual (2008). • EP Act 1994 – general environmen tal duty	High*	• After three consecutive exceedances of WQOs, an investigation into the cause and potential for environmental harm will be carried out by an AQP. • A written report will be provided to DESI.
Construction and Operation	Existing natural catchments within the Project are modified. The proposed disturbance areas have different land use types (e.g. waste rock dump, pit, disturbed/industrial, etc.) which generate catchment runoff of varying water quality.	Proposed water management system (clean, surface and mine affected water systems) will separate water from different sources based on anticipated water quality.	• Mine water dams and drains will be constructed prior to mining activity or when it is anticipated high volumes of mine affected water quality will be generated. • Surface water drains and sediment dams will be constructed once "natural" areas are disturbed.	SSE	Water management drains will be inspected following rainfall events to identify and remediate any sedimentation preventing the drains from flowing into downstream sediment dams/mine water dams and/or erosion damage.	Water management infrastructure sizing and scour protection is confirmed during detailed design.	• ESCP • Internationa l Erosion Control Association (IECA) Best Practice Erosion and Sediment Control Manual (2008). • Surface Water Manageme nt Plan	High*	• After three consecutive exceedances of WQOs, an investigation into the cause and potential for environmental harm will be carried out by an AQP. • A written report will be provided to DESI.

Stage (construction, operation and post closure)	Impact	Mitigation measure	Timing	Responsibility	Completion criteria	Design considerations	Relevant resources	Effectiveness of mitigation measures	Corrective action
							• EP Act 1994 – general environmental duty		
Operation	Proposed mining pits subject to flood risk will alter existing catchment runoff and downstream flow regime.	Proposed clean water diversion infrastructure (i.e. clean water diversion levees, bunds, drains and dams) will mitigate flood risk into active mining areas/pits and diverts the majority of clean water catchment runoff around the Project to existing drainage lines.	Clean water infrastructure will be constructed prior to areas becoming disturbed to reduce mixing of clean water runoff with water of lower quality. This will also reduce the potential volumes to be managed through the surface/mine water management systems.	SSE	Annual inspection of levees and diversion drains will be undertaken to ensure structural integrity.	• Design and construction of levees will be in accordance with the Manual for assessing consequence categories and hydraulic performance of structures. • Drain/bund sizing is confirmed during detailed design.	• ESCP • International Erosion Control Association (IECA) Best Practice Erosion and Sediment Control Manual (2008). • Environmental authority	High*	• Recommendations from the Registered Professional Engineer of Queensland (RPEQ) will be implemented. • If a mine dam discharges mine affected water, an investigation by an AQP, and notification to DESI as per the EA will be undertaken. • Access to mine affected water stored in a dam by wildlife and livestock will be prevented until testing demonstrates the quality meets the WQOs.
Operation	Mining pits will accumulate mine affected water and mining operations	Catchments reporting to pits have been reduced via the proposed diversion	Mine water dams will be constructed prior to when mine affected water runoff	SSE	• Reporting of storage volumes at the beginning of the wet season as well as on a	• Design and construction of dams will be in accordance with the *Manual for assessing consequence*	• ESCP • International Erosion Control Association	High*	• Recommendations from the Registered Professional Engineer of

Stage (construction, operation and post closure)	Impact	Mitigation measure	Timing	Responsibility	Completion criteria	Design considerations	Relevant resources	Effectiveness of mitigation measures	Corrective action
	will be delayed if the pits are inundated.	infrastructure. The proposed mine water management system is adequately sized to dewater the catchment runoff collected in active mining pits. Mine water is also used on-site to meet site demands and to reduce inventory of mine water dams. Please note that under no modelling scenarios was any of the mine water dams anticipated to overflow.	will be generated due to mining activity. The active pits will be dewatered to the mine water management system whenever there is available storage. Mine water will be used on-site wherever possible.		monthly basis and following significant rainfall events. • Contingency mine water storages will be constructed prior to the wet season if there is inadequate storage volume within the existing mine water management system to dewater the active pits. Dewatering of the active pit into inactive pits should be undertaken in emergency.	*categories and hydraulic performance of structures*. A consequence category assessment for each dam will be undertaken to confirm operating volumes and required storage capacity. • An assessment of mine water inflows to the mine water system will be undertaken to determine maximum operating volumes."	(IECA) Best Practice Erosion and Sediment Control Manual (2008). • Environmental authority • Surface Water Management Plan		Queensland (RPEQ) will be implemented. • If a mine dam discharges mine affected water, an investigation by an AQP, and notification to DESI as per the EA will be undertaken. • Access to mine affected water stored in a dam by wildlife and livestock will be prevented until testing demonstrates the quality meets the WQOs.
Operation	Mine water will potentially overflow from mine water storages to the receiving environment during extreme rainfall events or due to dam failure.	• Mine water dams will be managed and operated with a maximum 'operating volume' which defines the maximum volume the dams can operate up to before pumped inflows cease.	• Mine water dam sizing, pump sizing and operating volumes will be designed prior to the construction of the dams. • Max operating volumes will be active throughout the operational period.	SSE	• Reporting of storage volumes at the beginning of the wet season as well as on a monthly basis and following significant rainfall events. • All regulated structures will be inspected a suitably qualified person yearly, with an	• Design and construction of dams will be in accordance with the "Manual for assessing consequence categories and hydraulic performance of structures". A consequence category assessment for each dam must be undertaken to confirm operating volumes	• ESCP • International Erosion Control Association (IECA) Best Practice Erosion and Sediment Control Manual (2008). • Surface Water	High*	• Recommendations from the Registered Professional Engineer of Queensland (RPEQ) will be implemented. • If a mine dam discharges mine affected water, an investigation by an AQP, and notification to

Stage (construction, operation and post closure)	Impact	Mitigation measure	Timing	Responsibility	Completion criteria	Design considerations	Relevant resources	Effectiveness of mitigation measures	Corrective action
		The operating volumes of each dam are below their respective full storage volumes to maintain storage capacity below the spillway level of the dams which will reduce the risk of overflows to the receiving environment. However, mine dams were not modelled to overflow under even the most extreme climate scenario. • If mine water dams are at their operating volumes, mine water can be pumped back to the pits in emergency.	• Installation of pumps will be completed during construction of the mine water dams."		annual inspection report	and required storage capacity. • All regulated structures must be designed by, and constructed under the supervision of, a suitably qualified and experienced person in accordance with the requirements of the latest version of the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933). • An assessment of mine water inflows to the mine water system will be undertaken to determine maximum operating volumes."	Manageme nt Plan • Environmen tal authority –stipulates conditions of regulated structures		DESI as per the EA will be undertaken. • Access to mine affected water stored in a dam by wildlife and livestock will be prevented until testing demonstrates the quality meets the WQOs.
Operation	Water will be required on-site to meet site demands.	It is proposed to use available water in on-site storages prior to using external water	Use water available on-site wherever possible. Use external water when water in storages on-site is	SSE	Monthly reporting of storage volumes and water usage (e.g., dust suppression, CHPP makeup) within the mine water system will be undertaken regularly	Permits/licensing to take external water.	• Water managemen t plan	High*	• Recommendati ons from the Registered Professional Engineer of Queensland

Stage (construction, operation and post closure)	Impact	Mitigation measure	Timing	Responsibility	Completion criteria	Design considerations	Relevant resources	Effectiveness of mitigation measures	Corrective action
		supply to meet site demands.	insufficient to meet demands.		to anticipate/forecast available volumes and demands.				(RPEQ) will be implemented. • If a mine dam discharges mine affected water, an investigation by an AQP, and notification to DESI as per the EA will be undertaken. • Access to mine affected water stored in a dam by wildlife and livestock will be prevented until testing demonstrates the quality meets the WQOs.
Post-closure	Sedimentation of drainage lines during flood events due to construction of the final landform within the floodplain.	Proposed drainage corridors will divert floodwaters up to the 0.1% AEP event (inclusive) to mitigate the potential erosion risk of the final landform during flooding.	Final landform drainage corridors will be constructed prior to or in conjunction with the final landform waste rock dumps.	SSE	Annual inspection of drainage corridor until vegetation is established within the drainage corridor and a "natural" flow regime is formed.	Sizing of water management infrastructure is confirmed during detailed design.	• Environmental Authority • International Erosion Control Association (IECA) Best Practice Erosion and Sediment Control Manual (2008).	High*	• Investigation and report will not be finalised until landform stability is demonstrated. • An AQP will recommend mediation works to ensure stability of final landform.

Stage (construction, operation and post closure)	Impact	Mitigation measure	Timing	Responsibility	Completion criteria	Design considerations	Relevant resources	Effectiveness of mitigation measures	Corrective action
Post-closure	Erosion risk of the final landform prior to rehabilitation/vegetation establishment potentially leading to reduced water quality/sedimentation.	Proposed water management system (i.e. surface water drains, sediment dams, drop structures, contours banks, etc.) manage runoff from final landforms to prevent erosion risk. These will be rehabilitated once vegetation is established and the final landform has reduced erosion risk.	Final landform surface water management will be constructed as part of the final landform waste rock dumps.	SSE	• Surface water management system will be inspected following rainfall events to identify any sedimentation/erosion on and around the final landform until vegetation is established. • A suitably qualified person will sign off that the final landform is geotechnically stable	Sizing of water management infrastructure is confirmed during detailed design.	• Environmental Authority • International Erosion Control Association (IECA) Best Practice Erosion and Sediment Control Manual (2008). • PRCP schedule • PRCP plan	High*	• Investigation and report will not be finalised until landform stability is demonstrated. • An AQP will recommend mediation works to ensure stability of final landform.

*The Project surface water management system would be designed to accommodate the proposed production schedule and to mitigate potential natural surface water and flooding impacts. With appropriate mitigation measures in place, the potential impact of the proposed mining operations on surface flows and water quality in the receiving waters downstream of the Project will be insignificant. Therefore the potential impacts of the Project on surface water resources will be mitigated through the implementation of a mine site water management system to control the flow and storage of water of different qualities across the site. A surface water monitoring program will be implemented to monitor potential environmental impacts and ensure that the site water management system is meeting its objectives.

7.1.4.1 Waste Rock Geochemistry Management Measures

Whilst the results of this assessment indicate that the occurrence of any PAF materials is unlikely, if any carbonaceous waste rock is identified as posing a potential risk (possibly PAF) through sampling and total sulfur analysis, this will be selectively handled and buried within NAF waste rock as shown in **Figure 7-1**. Short term planning and truck management planning will be updated upon identification of any carbonaceous waste rock that is possibly PAF to ensure that this material is hauled directly to the correct emplacement areas used for storing coal rejects and without storage in temporary stockpiles.

Any carbonaceous waste rock material identified as possibly PAF (and all coal reject materials) will be preferentially stored in the in-pit waste rock dumps when sufficient capacity is available and below predicted post-mining groundwater level, where practical, to reduce the potential oxidation of materials in the longer term post-closure (**Figure 7-1**).

The extents of any PAF carbonaceous waste rock (and all coal reject materials) transferred to emplacement areas will be tracked with regular surveys. Spatial data files in an appropriate format will be created to record the extents/dimensions of the storage areas. All possibly PAF carbonaceous waste rock and all coal reject materials will be paddock dumped, traffic compacted and covered by NAF overburden to limit the infiltration of air and water into covered materials.

Table 7-5 Geochemistry mitigation measures

Project Phase	Waste Rock	Coal Rejects	Coal
Construction	Stored at out-of-pit WRD	None produced	None produced
Operations	Stored at out-of-pit WRD and/or backfilled in-pit.	Preferentially co-disposed /backfilled/traffic compacted in-pit and covered with 5 m of NAF waste rock material. Contact water monitored for quality and managed in the mine water management system as part of Water Management Plan.	Temporarily stockpiled at ROM. Contact water monitored for quality and managed in the mine water management system as part of Water Management Plan
Rehabilitation	Final landforms rehabilitated/ revegetated	Final landforms rehabilitated/ revegetated	ROM removed and footprint rehabilitated/revegetated
Decommissioning	Final landform performance monitoring moving towards lease relinquishment	Final landform performance monitoring moving towards lease relinquishment	None

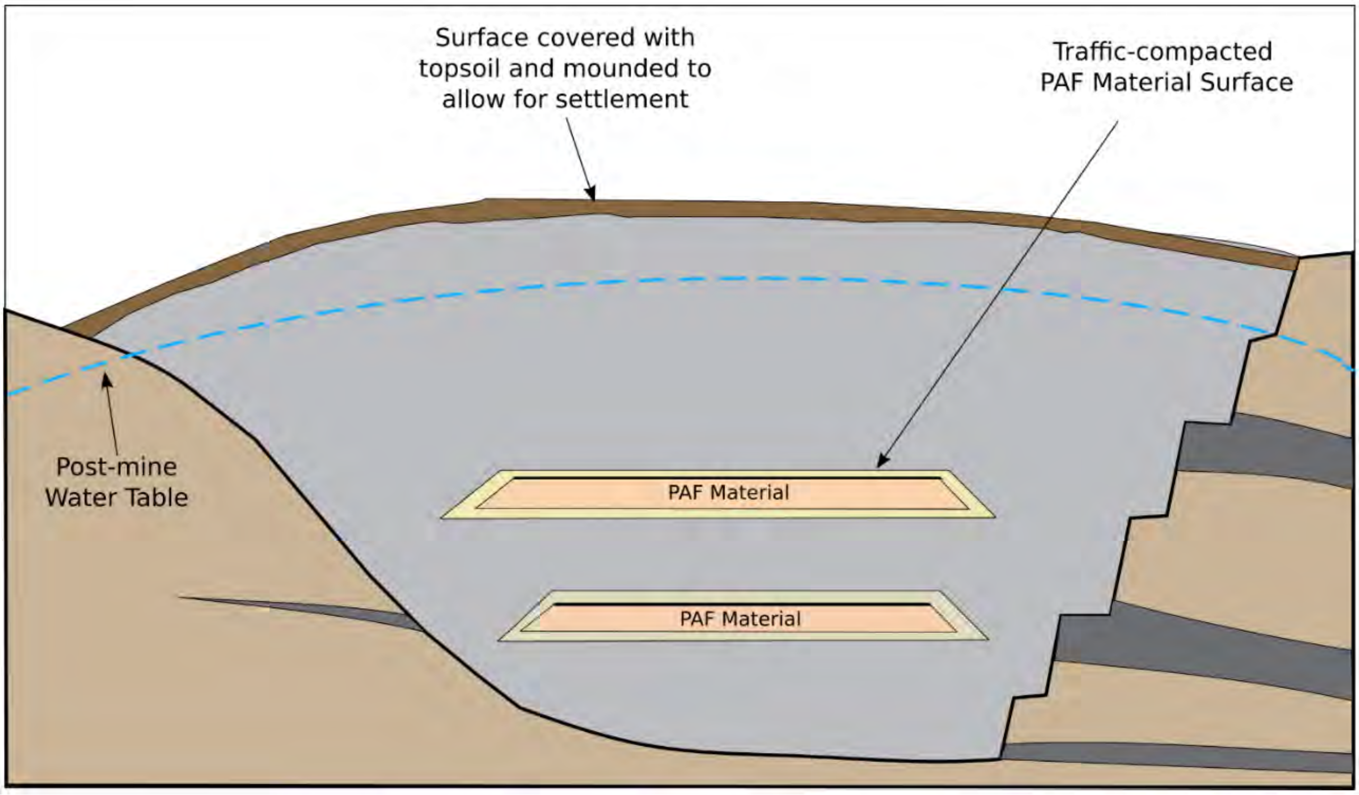


Figure 7-1 PAF emplacement strategy

7.1.5 Bushfire Management

The bushfire season for the Project area generally occurs between winter and spring (July to October) and can extend through to February. However, bushfires in Queensland can occur at any time during the year depending on the fuel loads within bushlands, long term climate conditions, and short-term weather events. Climate change can also have an influence on bushfires by extending the fire seasons through extremes of environment (higher temperatures, drought conditions etc).

A list bushfire management measures have been developed to be consistent with S.M.A.R.T principles and are outlined in **Table 7-6**.

Table 7-6 Bushfire Management Measures

Topic	Mitigation Measure	Effectiveness of Individual Mitigation Measure	Where	Timing	Responsible	Corrective action	Relevant Resource
Identify high risk areas for fire	Identify risk areas on site, and mechanisms through which bushfire may be triggered. Risk areas include: • Areas with coal stockpiles • Areas where flammable materials are located or stored • Areas where vegetation with a fuel load are located • Areas with high asset value equipment and infrastructure • Areas with vehicle access Potential trigger mechanisms include: • Lightning strike • Heat • landholder dry vegetation reduction burn • Deliberate lighting of fire.	**High** Identification of risk areas allows for effective and targeted management to be implemented.	Coal stockpiles, CHPP, MIA, explosives magazine, Highwall trial area which has vegetation, steep slopes and high value machinery assets that are highly immobile.	Ongoing throughout construction, operations and rehabilitation phases of the Project.	Site Senior Executive	Emergency Response Plan and other procedures as necessary will be reviewed. Rectification works as necessary following fire. i.e infill planting.	Emergency Response Plan Environmental Management Plan
Prevent uncontrolled fire events	The purpose of fire management will be to avoid and reduce the risks of an uncontrolled fire event occurring. In particular to avoid a hot bushfire occurring in the Project area as this has potential to result in death of MNES species, loss of habitats and Brigalow TEC. Fire management will include: • Establishing and maintaining access tracks and fire breaks; • Implement measures to minimise mining activities starting a fire and having an emergency response plan to control any unplanned fires;	**High** MNES species will have a higher level of protection with the implementation of fire management measures.	Access tracks and fire breaks will be established within approved disturbance areas. Areas outside of approved disturbance areas existing access tracks and fence boundaries will be maintained. These tracks will also act as firebreaks.	Access tracks and fire breaks to be installed during vegetation clearing phase. Access tracks and fire breaks to be maintained during all phases and allow access for fire units into zones downwind of uncontrolled fires.	Environmental Advisor Site Senior Executive	Location of fire break will be reviewed in the event that a fire enters the mine site from outside.	Emergency Response Plan

	• Fire-fighting equipment will be installed, inspected and serviced in accordance with risk assessments and relevant legislation and standards; • Manage fuel loads (this may be through grazing in some areas, cool mosaic burns and slashing where exotic grassland only); and • Manage activities that could start a fire such as mulch stockpiles, machinery, hot tyre bays etc.						
Buildings to meet Bushfire design regulations	Where applicable, buildings will be constructed in adherence to local bushfire building requirements.	**High** Adherence to the applicable standards will ensure structures on site are appropriate to the local environment.	MIA, site offices, train loadout, Highwall trial area	During construction phase of the Project	Site Senior Executive	Noncompliance will be reported and require immediate action to ensure standards are met	*Australian Standard for the Construction of Buildings in Bushfire Prone Areas - AS3959-2009* Isaac Regional Planning Scheme
Storage of flammable materials	Flammable materials will be stored onsite and handled in accordance with the applicable safety standards.	**High** Storage in accordance with safety standards will reduce or eliminate fire occurring due to inappropriate storage and handling.	MIA, CHPP, explosives magazine, Fuel storage areas	Ongoing throughout construction, operations and rehabilitation phases of the Project.	Environmental Advisor Site Senior Executive Field Operations Manager SHT Manager	Noncompliance will be reported and require immediate action to ensure standards are met	Australian Standard *AS1940: The storage and handling of flammable and combustible liquids*. Environmental Management Plan Safety data sheet for each flammable substance.

Vitrinite will actively engage with relevant stakeholders and the local community to promote and support effective bushfire management through shared responsibility. To achieve this, Vitrinite will establish a close working relationship with the following stakeholders:

- landholders of underlying and adjoining properties to the Project;
- other surrounding land managers;
- Barada Barna indigenous group; and
- Government agencies and departments.

Vitrinite will actively engage with stakeholders to manage the following issues effectively:

- fire break establishment and management plans;
- hazard reduction plans; and
- emergency contact lists.

Discussion on bushfire management will be included within the site Emergency Response Plan.

7.1.6 Ecohydrological Conceptual Model

An Ecohydrological Conceptual Model (ECM) and impact pathways diagram (IPD) have been developed to evaluate the potential impacts of Vulcan South on potentially impacting environmental receptors. These were developed in accordance with the IESC's explanatory note on using impact pathway diagrams's (IESC, 2024).

The IPD (**Figure 7-2**) demonstrates the mine water management system with regard to surface water and groundwater impacts from a source (components of the Project) and the effect on ecological parameters (primarily minor effects on GDEs or riparian vegetation). The components and connectivity of the mine water management system is demonstrated in more detail within **Figure 7-3**, whilst **Figure 7-2** primarily focusses on components relevant to potential ecological receptors. **Figure 7-4** and **Figure 7-5** demonstrates the rehabilitation of the groundwater environment (changes in drawdown, inflow and recharge) and surface water environment, respectively, over time and the achievement of final rehabilitation outcomes.

As shown in **Figure 7-4**, there is negligible inflow of groundwater into the open pits during operation (even so, the maximum inflow is within the deeper central pit), which has been shown (**Appendix P**) to all be lost to evaporation and therefore seepage into the pit is very unlikely. Drawdown will be centralised to within the pit and be minimal in magnitude and extend. Drawdown will not extend beyond the open pits. Drawdown will cease immediately upon the backfilling of the pit and groundwater levels will have completely recharged by post closure and have no impact on rehabilitation of vegetation.

Figure 7-5 demonstrates the change of the risks to ecological values during the rehabilitation of a reinstated drainage diversion. The highest risks to erosion and sedimentation will be the recently reinstated drainage line before it has been rehabilitated. ESC controls will be implemented, and fast-growing grasses will be planted to allow for near immediate stability of the soil. An AQP will assess any risks of erosion which will be remediated immediately. Previously occurring regional ecosystem vegetation will be included in the seed mixes and rehabilitated to reinstate values for threatened species and return the habitat to its previous state. An AQP will assess the final PMLU, as is described within rehabilitation milestone criteria in **Table 8-1.**

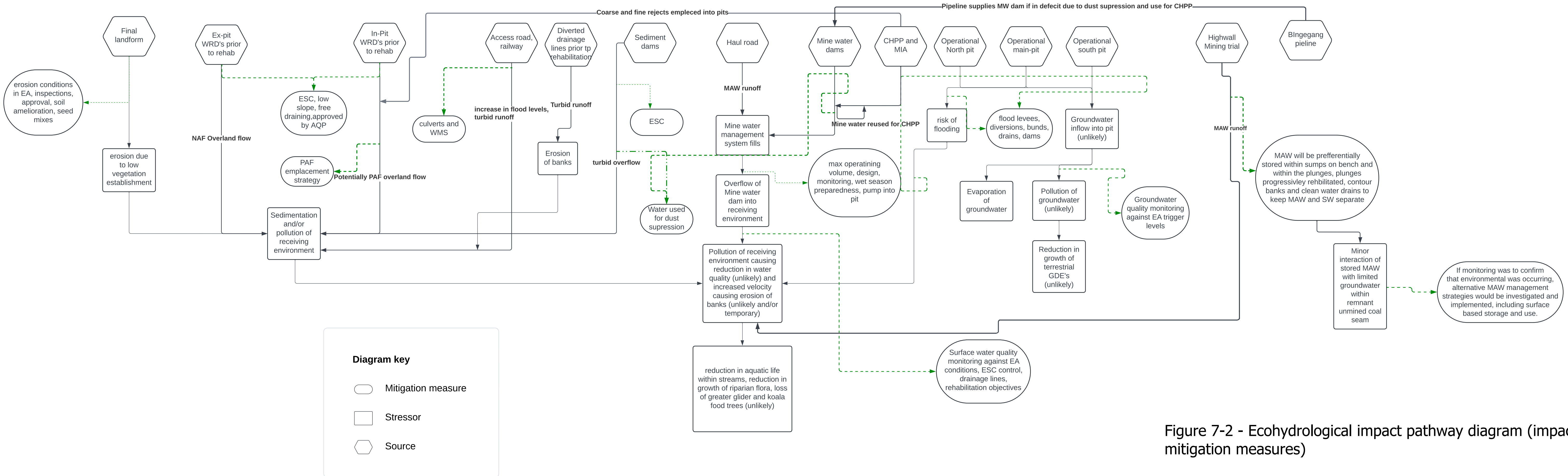
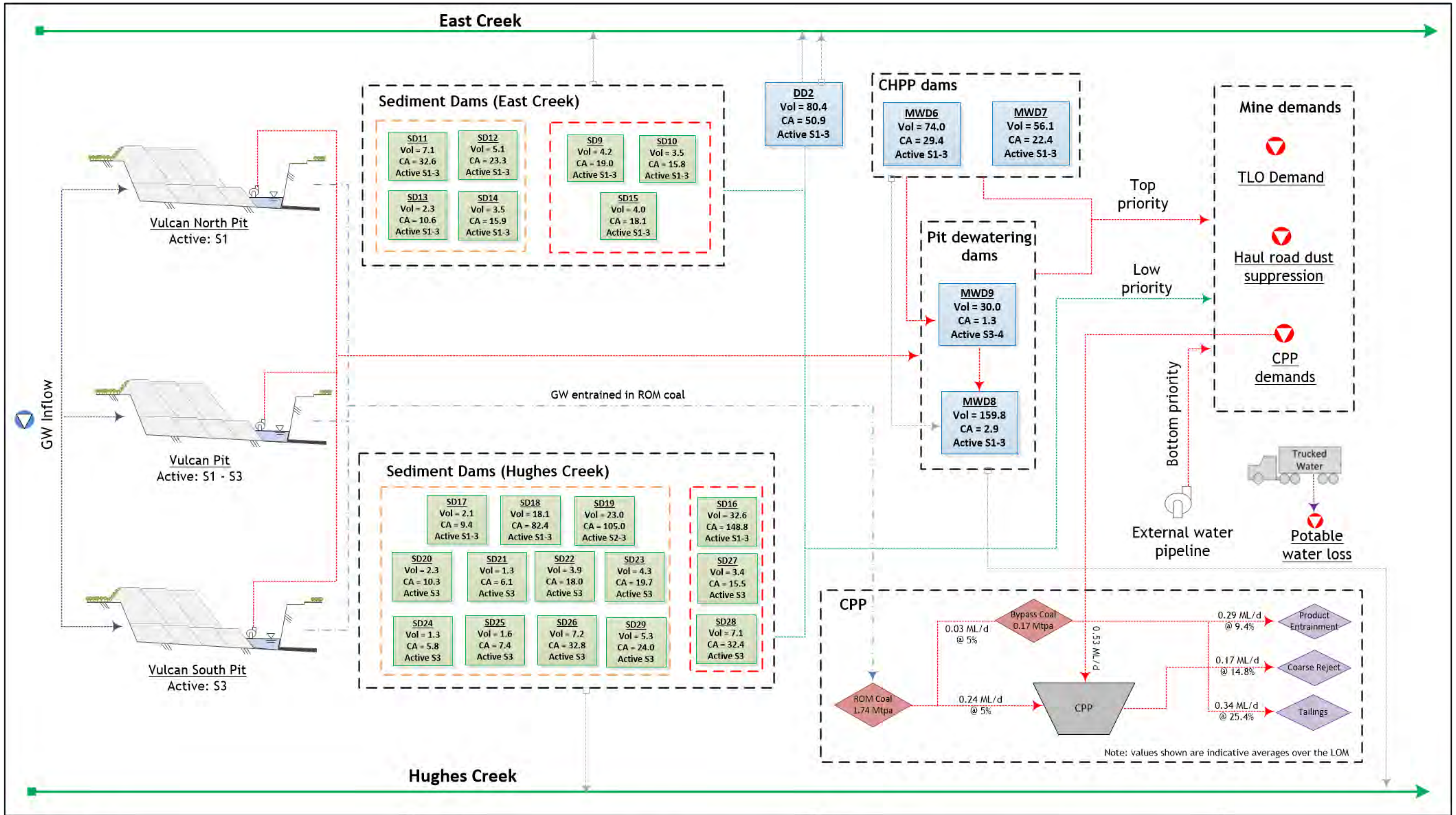


Figure 7-2 - Ecohydrological impact pathway diagram (impacts and mitigation measures)



Vulcan South

Figure	Proposed integrated water management system schematic
Job	1571-20
Date	18/03/2022

Legend

- Surface water
- Mine affected water
- Raw water
- Groundwater
- External/diverted water
- Pumped flow
- Coal moisture
- Spillway/overflow
- Receiving waterway
- In pit runoff
- Out of pit runoff

Notes

Spill Flow Directions:
Good engineering practice is to include a stabilised spillway as a contingency for dam safety. This arrow does not indicate that these discharges (spills/overflows) are a part of the water management system or that spills will occur. The arrow is to show the direction of water flow (by gravity) should the dam water level exceed the dam spillway level.

Volumes (Vol.) recorded in ML, catchment areas (CA) in hectares, coal amounts in dry tonnage.

wrm water + environment

Figure 7-3 - Water management system schematic for the Project

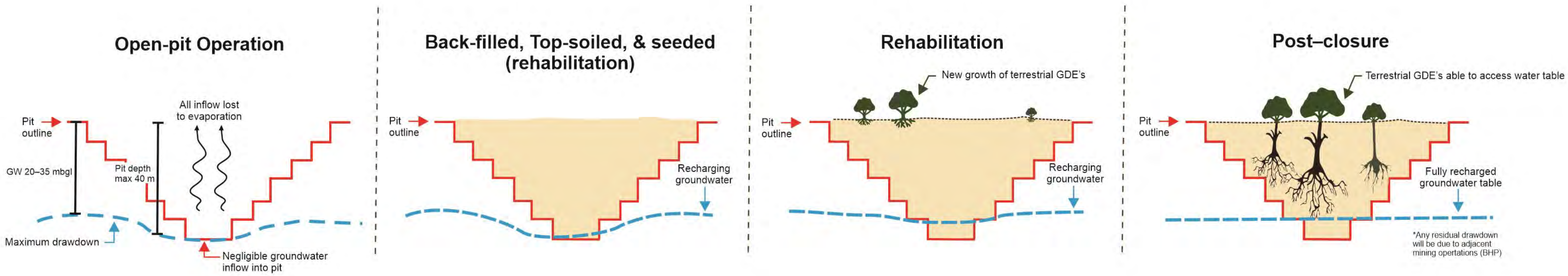


Figure 7-4 Ecohydrological conceptual diagram - Groundwater interaction with GDEs over time

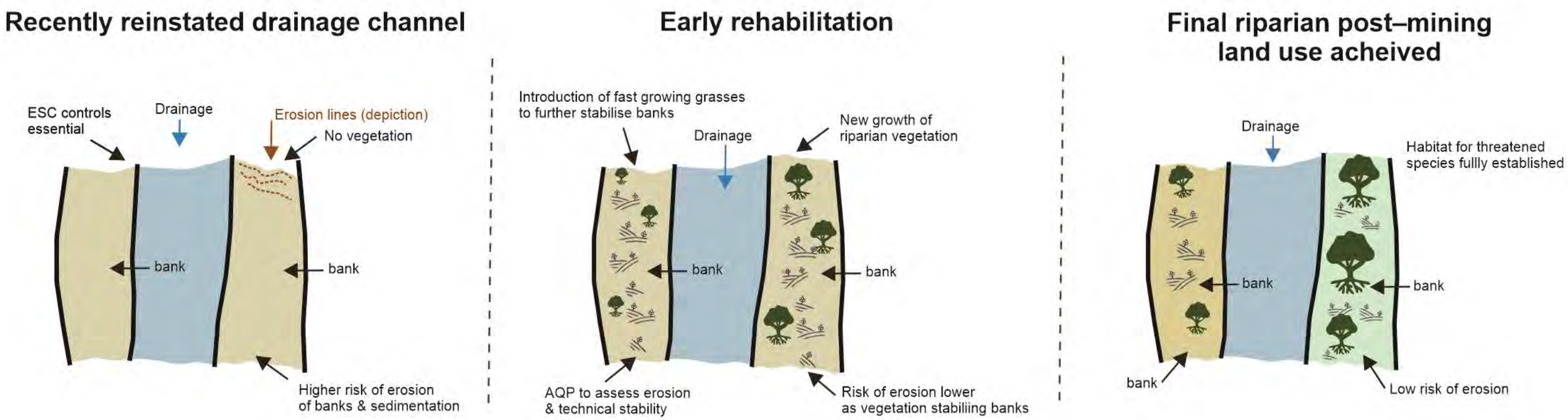


Figure 7-5 Ecohydrological conceptual diagram - Rehabilitated surface water drainage diversions over time

7.2 Ongoing Management and Monitoring

The approved State Environmental Authority stipulates that surface water, groundwater, erosion, weed, air and noise are to be managed. Monitoring programs are in compliance with the regulating authority and, as such, support an adaptive and effective management approach which is evidence-based. Monitoring programs are designed to detect when impact triggers are reached, and to quantify impacts on environmental values and protected matters.

7.2.1 Surface water

7.2.1.1 Surface Water Management Strategy

A mine site water management system will be implemented throughout the operational and rehabilitation phases of the Project to mitigate the potential impacts on surface water resources. A surface water monitoring program will be implemented to monitor potential environmental impacts and ensure that the site water management system is meeting its objectives.

The proposed Project surface water management strategy consists of a number of surface water management measures that will be implemented during construction and operational periods.

For surface water management purposes, the surface water that is generated and/or managed at the Project is divided into the following types based on water quality:

- **Mine affected water**: Mine affected water means the following water types:
  - pit water, tailings dam water, processing plant water;
  - rainfall runoff which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated, excluding rainfall runoff discharging through release points associated with erosion and sediment control structures that have been installed in accordance with the standards and requirements of an Erosion and Sediment Control Plan to manage such runoff, provided that this water has not been mixed with pit water, tailings dam water, processing plant water or workshop water;
  - groundwater which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated;
  - groundwater from the mine dewatering activities; and
  - a mix of mine affected water and other water
- **Surface water**: Surface water runoff from areas that are disturbed by mining operations (including out-of-pit waste rock emplacements). This runoff does not come into contact with coal or other carbonaceous material and may contain high sediment loads but does not contain elevated levels of other water quality parameters (e.g. electrical conductivity, pH, metals, metalloids, non-metals). This runoff must be managed to ensure adequate sediment removal prior to release to receiving waters.
- **Diverted water**: Surface runoff from areas unaffected by mining operations. Diverted catchment water includes runoff from undisturbed areas and fully rehabilitated areas.
- **Raw water**: Untreated water that has not been contaminated by mining activities.
- **Potable water**: Treated water suitable for human consumption.
- **External water**: Water supplied from a source that is external to the Project area to make up water shortfalls for onsite water demands when site water sources cannot meet demand.

The water management system for the Project aims to protect the identified downstream Environmental Values and comprises the following key objectives:

- separate diverted water from mine affected water to ensure that up-catchment water and mine affected water do not mix wherever practicable;

- capture of mine affected runoff (e.g., mine industrial area, haul road/ROM pad runoff), storage and priority reuse as mine water supply;
- divert up-catchment water runoff from upstream catchments around the active mining area;
- limit external catchment runoff draining into pits;
- manage sediment from disturbed catchment areas (e.g., out-of-pit waste rock emplacements, cleared/pre-strip areas) by using erosion and sediment control (ESC) measures prior to release offsite;
- reuse onsite water (e.g., mine affected water) where possible to support mine operational water demands (and therefore limit mine affected water inventories under normal operating conditions); and
- manage any mine affected water releases to the receiving waters to meet environmental release conditions (not currently proposed).

The above objectives will be achieved by implementing the following water-related infrastructure:

- diverted water drains, bunds and drainage diversions to divert runoff from undisturbed catchments around areas disturbed by mining;
- flood protection levees along the southern side of the Vulcan North pit extent, along the western and southeastern sides of the Vulcan Main pit, and around the Vulcan South pit;
- sediment dams and drains to collect and treat runoff from waste rock emplacement areas; and
- mine-affected water drains and dams to store water pumped out of the open cut mining areas and to collect runoff from the infrastructure areas.

The above water management objectives, when implemented through appropriate management plans, will mitigate the effects of the Project operations on natural surface water quantity and quality and flooding downstream of the mine site during operations.

7.2.1.2 Surface Water Monitoring

Monitoring of surface water quality both within and external to the mine site will form a key component of the surface water management system. Monitoring of upstream, onsite and downstream water quality will assist in demonstrating that the site water management system is effective in meeting its objective of minimal impact on receiving water quality and will allow for early detection of any impacts and appropriate corrective action.

The surface water monitoring protocols will:

- provide valuable information on the performance of the water management system;
- ensure compliance with the Project EA; and
- facilitate adaptive management of water resources on the site.

The monitoring program will operate throughout all phases of the Project, including through decommissioning. The approved surface water monitoring locations as per the approved EA100265081 are provided in **Table 7-7** and **Figure 7-6** below. Sediment dam monitoring locations are listed in **Table 7-8** below with a description of which receiving waters the sediment dam monitoring locations are collecting water quality data for. The approved downstream trigger limits and frequency of monitoring are shown in **Table 7-9**. As stated in **Table 7-2,** sediment dams must be de-silted (removal of sediment accumulating within the sediment storage zone) as part of the sediment dam maintenance to restore the volume of the sediment dams to the original design volume.

Surface water quality monitoring includes onsite water storages (including sediment dams), receiving water and release water monitoring on both a rainfall event and monthly basis. The event-based sampling enables quantification of any pollutant loads from the site and their corresponding impact on the receiving water quality.

For a detailed description of the methodology to be adopted and the location of sampling sites, refer to the Receiving Environment Water Monitoring Program, which is to be completed prior to the commencement of the Project (see **Section 5** of that document).

Table 7-7 provisional Surface water monitoring locations as per EA100265081 - Table F2

Station ID	Previous station ID	Catchment area	Easting*	Northing*	Description
Upstream sites					
DL2_US	N/A	Boomerang Creek	618,915	7,534,526	Drainage line 2 upstream of the highwall mining area
DL3_US	N/A	Boomerang Creek	622,854	7,532,860	Drainage line 3 upstream of the haul road
DL4_US	N/A	Boomerang Creek	623,615	7,530,925	Drainage line 4 at the upstream mining lease boundary
DL6_US (Post-closure only)	N/A	East Creek	624,394	7,529,095	Drainage line 6 at the upstream mining lease boundary
DL7_US	N/A	East Creek	624,535	7,528,242	Drainage line 7 at the upstream mining lease boundary
HCN_US	N/A	Hughes Creek	626,291	7,525,650	Hughes Creek north tributary approximately 5.5 km upstream of Saraji Road
HC_US	VSW5	Hughes Creek	626,063	7,522,835	Hughes Creek approximately 2.8 km upstream of Saraji Road
DL8_US	N/A	Hughes Creek	628,840	7,522,828	Drainage line 8 approximately 2.2 km upstream of Saraji Road
BC1_US	VSW6	Hughes Creek	630,660	7,521,085	Barrett Creek upstream of Saraji
Downstream sites					
DD1_US	VSW1	Boomerang Creek	621,004	7,536,087	Diversion bund approximately
DD1_DS	VSW2	Boomerang Creek	623,118	7,533,363	Drainage line 2, downstream of the confluence of existing diversion drain
DL2_DS	VSW11	Boomerang Creek	622,542	7,533,676	Drainage line 2 upstream of confluence of existing diversion drain
DL3_DS	VSW3	Hughes Creek	623,054	7,532,781	Minor drainage line, upstream of confluence of Drainage Line 2
DL4_DS	VESW4	Hughes Creek	623,622	7,531,089	Drainage line 4 upstream of the confluence of Boomerang Creek
DL6_DS	VSW9	East Creek	625,831	7,529,607	Drainage line 6, at the downstream mining lease boundary
DL7_DS1	VSW7	East Creek	626,768	7,528,678	Drainage line 7, at the downstream mining lease boundary
HC_DS1	VSW4	Hughes Creek	630,358	7,524,022	Hughes Creek at the downstream mining lease boundary
DL8_DS	VSW10	Hughes Creek	630,542	7,523,649	Drainage line 8 at the downstream mining lease boundary
Mine Water Dams					
MWD6	N/A	MWD Monitoring point	626,384	7,526,339	MWD6 spillway
MWD7	N/A	MWD Monitoring Point	626,720	7,526,641	MWD7 spillway

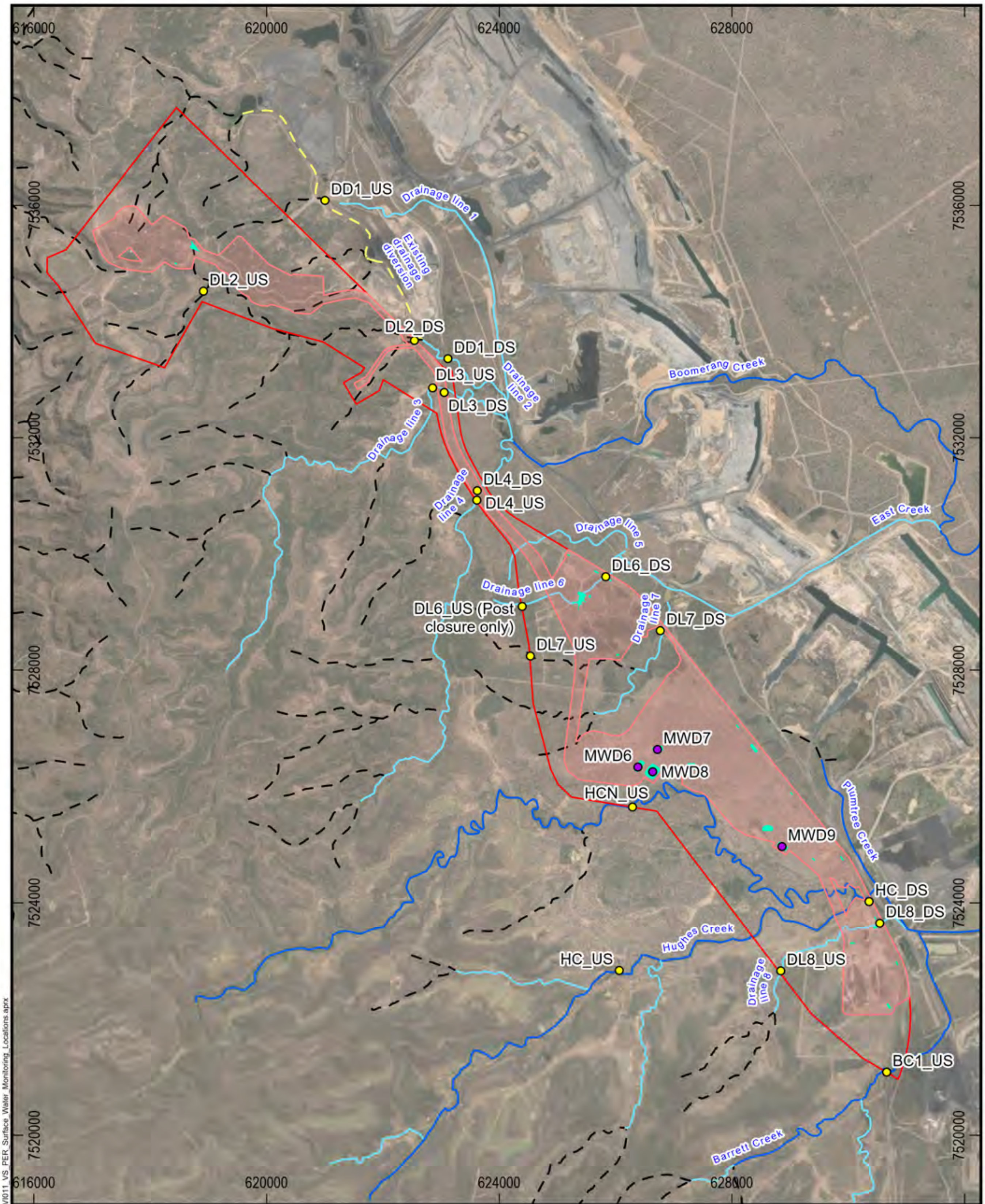
MWD8	N/A	MWD Monitoring Point	626,638	7,526,257	MWD8 spillway
MWD9	N/A	MWD Monitoring Point	628,861	7,524,969	MWD9 spillway

Table 7-8 Sediment dam monitoring locations (Table F1 of the EA)

Sediment dam	Location latitude (GDA2020)	Location longitude (GDA2020)	Sediment dam water source location	Downstream monitoring point	Receiving waters description
SD9	-22.3432	148.2276	Vulcan North Out of Pit Dump	DL7_DS	Drainage Line 7
SD10	-22.3469	148.224	Vulcan North Out of Pit Dump	DL7_DS	Drainage Line 7
SD11	-22.3379	148.2193	Vulcan North In Pit Dump	DL6_DS	Drainage Line 6
SD12	-22.3418	148.2297	Vulcan North In Pit Dump	DL7_DS	Drainage Line 7
SD13	-22.3353	148.2226	Vulcan North In Pit Dump	DL6_DS	Drainage Line 6
SD14	-22.3341	148.2203	Vulcan North In Pit Dump	DL6_DS	Drainage Line 6
SD15	-22.3315	148.2157	Vulcan North Out of Pit Dump	DL5_DS	Drainage Line 5
SD16	-22.3643	148.2365	Vulcan Main Out of Pit Dump	HC_DS	Hughes Creek
SD17	-22.3578	148.2441	Vulcan Main In Pit Dump	HC_DS	Hughes Creek
SD18	-22.3612	148.2469	Vulcan Main In Pit Dump	HC_DS	Hughes Creek
SD19	-22.3737	148.2488	Vulcan Main In Pit Dump	HC_DS	Hughes Creek
SD20	-22.3682	148.2532	Vulcan Main In Pit Dump	HC_DS	Hughes Creek
SD21	-22.3738	148.2582	Vulcan Main In Pit Dump	HC_DS	Hughes Creek
SD22	-22.3782	148.2617	Vulcan Main In Pit Dump	HC_DS	Hughes Creek
SD23	-22.3784	148.257	Vulcan Main In Pit Dump	HC_DS	Hughes Creek
SD24	-22.3852	148.2658	Vulcan South In Pit Dump	HC_DS	Hughes Creek
SD25	-22.3875	148.2673	Vulcan South In Pit Dump	HC_DS	Hughes Creek
SD26	-22.3888	148.2676	Vulcan South In Pit Dump	HC_DS	Hughes Creek
SD27	-22.3914	148.2636	Vulcan South out of Pit Dump	HC_DS	Hughes Creek
SD28	-22.4011	148.2697	Vulcan South out of Pit Dump	DL8_DS	Barrett Creek
SD29	-22.3944	148.271	Vulcan South In Pit Dump	HC_DS	Hughes Creek

SD30	-22.3818	148.2641	Vulcan South In Pit Dump	HC_DS	Hughes Creek

Source: Environmental Authority



Legend

Vulcan South Coal Mine (2023/09708)

Project Area (ML 700073)

Disturbance Footprint

Dams

Proposed Surface Water Monitoring Locations

Receiving water monitoring site

Mine water dam monitoring location

Local Drainage Features

Minor Drainage Features

Drainage Features

Drainage Diversion

Watercourse

Source: WRM 2023, State of Queensland (Department of Resources) 2021-2024, Vitrinite 2023-2024, METServe 2023-2024, Earthstar Geographics 28/09/2023

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Surface_Water_Monitoring_Locations.aprx

Vulcan South

Surface Water Monitoring Locations as per Approved EA

0 1 2 3

Kilometers

Scale: 1:95,000 (A4)

22/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 7-6

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Table 7-9 Surface Water Quality Objective as per approved Vulcan South EA100265081

Quality Characteristic (units)	Sediment dam trigger value	Downstream monitoring point trigger value	Source	Frequency
pH	6.5-8.5	6.5-8.5	EPP WQO (aquatic ecosystems)	Monthly and Daily during release (the first sample must be taken within 2 hours of commencement of release
Electrical conductivity (µS/cm)	864*	Baseflow: 720 Medium flow: 500 High flow: 250	EPP WQO	
Turbidity (NTU)	60*	50	EPP WQO	
Total Suspended Solids (mg/L)	102^	85	EPP WQO	
Sulphate as SO4 (mg/L)	37[#]	25	EPP WQO	
Ammonia (µg/L)	900	900	ANZG 2018	
Nitrate (µg/L)	1100	1100	For aquatic ecosystem protection, based on ambient Qld WQ Guidelines (2006) for Total Nitrate	
Filtered metals and metalloids				
Aluminium (µg/L)	192*	160	Locally derived	Monthly and Commencement of release and thereafter weekly during release
Arsenic (µg/L)	16*	13	ANZG 2018	
Lead (µg/L)	4.1*	3.4	ANZG 2018	
Mercury (µg/L)	0.72	0.6	EPP WQO (aquatic ecosystems)	
Molybdenum (µg/L)	40.8*	34	EPP WQO (aquatic ecosystems)	
Selenium (µg/L)	**6***	**5**	**ANZG2018**	

All metals and metalloids must be measured as 'dissolved' (from analysis of a field filtered sample) and total (unfiltered). Limits for metals and metalloids apply to dissolved results.

*20% increase on trigger value

[#] 95th percentile site specific

^locally derived trigger values (80th percentile values of natural surface water monitoring)

7.2.2 Groundwater

7.2.2.1 Groundwater Monitoring

The Project will have a groundwater monitoring program operating throughout all phases of the Project, including through rehabilitation and closure. The approved groundwater monitoring locations as per the approved EA100265081 are provided in **Table 7-11** and **Figure 7-7** below. The approved downstream trigger limits and frequency of monitoring are shown in **Table 7-10.**

The groundwater monitoring network was established based on available information relating to the general understanding of groundwater flow conditions (west to east), the coal resource and general geology of the region and the available mining and exploration tenure. The rationale for locating the monitoring bores was to have an upstream and downstream bore plus an understanding of groundwater conditions within the Project area and to the north and south. The groundwater within the Permian coal measures is often brackish to saline which restricts the environmental value of the groundwater which is typically limited livestock watering and industrial use.

The site-specific groundwater monitoring network was designed to target the Permian coal measures and the Tertiary sediments as there is no mapped Quaternary alluvium within or in close proximity to the Project area. A number of the site-specific project groundwater monitoring bores (within and immediately adjacent to the proposed mining area) that target the Permian coal measures and the Tertiary sediments are consistently dry. Dry bores may be seen as a limitation, however this is also valuable information as these bores have been able to consistently demonstrate that a large percentage of the shallow strata targeted by project open pit mining activities are in fact unsaturated and do not contain groundwater. The project monitoring bore network (including the consistently dry bores) confirm the conceptual understanding that much of the strata within the project mining area is dry and that there will be minimal drawdown resulting from the project. The dry monitoring bores indicate that the groundwater levels in the Project area have been historically impacted by the BHP Saraji Mine and Peak Downs Mine, therefore the project is highly unlikely to result in significant impact on the groundwater regime. This is confirmed by the numerical model predictions which demonstrate limited extent and magnitude of drawdown resulting from the Project.

The target coal seams of the Moranbah Coal Measures generally strike in a north north-west to south southeast orientation and dip to the east. This local orientation of geology spatially constrains the groundwater monitoring network to the west of proposed Vulcan pits. As a result, monitoring bore MB12 has been constructed within the Back Creek Group. The Back Creek Group underlies the Moranbah Coal Measures.

The general groundwater flow conditions are from west to east and a suitable upstream monitoring site in the target coal seam(s) was not able to be practically established. However, it is assessed that MB12 will be able to provide an appropriate site for the monitoring of drawdown that may propagate through the Back Creek Group extending to the west of the Vulcan pits. There is no mining development upstream of the Vulcan pits. The Project area is adjacent to existing mining leases which are operated by BMA. The establishment of Project specific groundwater monitoring bores on the BMA mining leases to the east is not practical or achievable therefore mining tenure has spatially constrained the groundwater monitoring network to the east of proposed Vulcan pits. Monitoring bores MB01, and MB06 through to MB11 were all located and designed on existing cleared drill pads (to minimise land and vegetation clearances). The monitoring bores were spatially distributed so far as was reasonably practical to do so to provide an adequate spatial spread of the data. At the time of monitoring bore installation, the mine plan was not available for consideration.

The VCM groundwater monitoring bores were located in association with ML700060 to the north and to the immediate east of the Project area. The layout of the groundwater monitoring network is constrained by the following two factors:

- Geological extent of the coal seams. The target coal seams of the Moranbah Coal Measures generally strike in a north north-west to south south-east orientation and dip to the east. This local orientation of geology spatially constrains the groundwater monitoring network to the west of proposed Vulcan pits. That is, a monitoring bore that is drilled to the west of the proposed Vulcan pits will intersect Permian strata that is stratigraphically below the target coal seam. The Permian strata below the target coal seam is not predicted to impacted by the project, hence providing little benefit to the groundwater monitoring network; and
- Extent of tenure. The site is immediately adjacent to the BHP MLs of Saraji Mine and Peak Downs Mine. The establishment of site-specific project groundwater monitoring bores on the BHP MLs to the east is not practical or achievable. This tenure spatially constrains the project groundwater monitoring network to the east of proposed Vulcan pits.

Since the submission of the GIA in 2022, a data sharing agreement between Vitrinite and BHP is being established. Until the data agreement is finalised, conditions of this agreement are still unknown, and so is the availability of data under this agreement. The data sharing agreement is currently being established between Vitrinite and BHP. The data sharing agreement will be finalised within 12 months from receiving the final federal approval.

Since submission of the GIA, monitoring of groundwater levels and quality has continued to further establish a baseline dataset to confirm the understanding of pre-project groundwater conditions. Further, additional monitoring bores have been installed for the project (April 2024) to supplement the groundwater monitoring network and confirm the current conceptual understanding.

The groundwater monitoring network is considered to be fit for purpose for this assessment. Future changes to the network or the monitoring plan will be needed which are planned for and outlined in a proposed adaptive management strategy.

Table 7-10 Groundwater Quality Objectives as per approved Vulcan South EA100265081 (Table E2)

Parameter	Unit	Bores	Limit	Comment
pH (field)	pH unit	All bores	5.5-8.0	ANZG (2018)
*** Electrical Conductivity (Field)**	(µS/cm)	MB01R^	16,000*	EPP WQO
		MB07	5,791	Site-specific 95th percentile
		MB09	12,007	Site-specific 95th percentile
		MB10	4,102	Site-specific 95th percentile
		MB12	22,872	Site-specific 95th percentile
		MB12R^	16,000*	EPP WQO
		MB14	16,000*	EPP WQO
		MB15	16,000*	EPP WQO
		MB16	16,000*	EPP WQO
		MB17	16,000*	EPP WQO
		MB18	16,000*	EPP WQO
***Sulphate**	Mg/L	MB01R^	398*	EPP WQO
		MB07	707	Site-specific 95th percentile
		MB09	769	Site-specific 95th percentile
		MB10	418	Site-specific 95th percentile
		MB12	874	Site-specific 95th percentile
		MB12R^	398*	EPP WQO
		MB14	398*	EPP WQO
		MB15	398*	EPP WQO
		MB16	398*	EPP WQO
		MB17	398*	EPP WQO
		MB18	398*	EPP WQO
Dissolved Metals and metalloids				
Aluminium	mg/L	All bores	0.055	ANZG (2018)
Arsenic	mg/L	All bores	0.013	ANZG (2018)
Barium	mg/L	All bores	0.10	Site-specific 95th percentile (grouped)
Boron	mg/L	All bores	0.66	Site-specific 95th percentile (grouped)

Cobalt	mg/L	All bores	0.004	Site-specific 95th percentile (grouped)
Copper	mg/L	All bores	0.0014	ANZG (2018)
Iron	mg/L	MB01R^	0.246*	EPP WQO
		MB07	0.46	Site-specific 95th percentile
		MB09	0.38	Site-specific 95th percentile
		MB10	0.2	Site-specific 95th percentile
		MB12	4.94#	Site-specific 95th percentile
		MB12R^	0.246*	EPP WQO
		MB14	0.246*	EPP WQO
Lead	mg/L	All bores	0.0034	ANZG (2018)
Mercury	mg/L	All bores	0.0006	ANZG (2018)
Molybdenum	mg/L	All bores	0.034	ANZG (2018)
Selenium	mg/L	All bores	0.005	ANZG (2018)
Strontium	mg/L	MB01R^	TBD	Site-specific 95th percentile
		MB07	2.2	Site-specific 95th percentile
		MB09	5.7	Site-specific 95th percentile
		MB10	1.2	Site-specific 95th percentile
		MB12	8.4	Site-specific 95th percentile
		MB12R^	TBD*	Site-specific 95th percentile
		MB14	TBD*	Site-specific 95th percentile
		MB15	TBD*	Site-specific 95th percentile
		MB16	TBD*	Site-specific 95th percentile
		MB17	TBD*	Site-specific 95th percentile
		MB18	TBD*	Site-specific 95th percentile
Uranium	mg/L	MB01R^	0.0005*	ANZG 2018
		MB07	0.003	Site-specific 95th percentile
		MB09	0.005	Site-specific 95th percentile
		MB10	0.0005*	ANZG 2018
		MB12	0.0005*	ANZG 2018
		MB12R^	0.0005*	ANZG 2018
		MB14	0.0005*	ANZG 2018
		MB15	0.0005*	ANZG 2018
		MB16	0.0005*	ANZG 2018
		MB17	0.0005*	ANZG 2018
		MB18	0.0005*	ANZG 2018
TRH (C6-C10)	µg/L	All bores	<20	LOR
TRH (C10-40)	µg/L	All bores	<50	LOR

Major Ions			
Major ions (mg/L) (calcium, chloride, potassium, magnesium, sodium, bicarbonate, carbonate)	mg/L	All bores	For interpretation purposes only
Hardness	**Mg/L**	**All bores**	**For interpretation purposes only**

All metals and metalloids must be measured as 'dissolved' (from analysis of a field filtered sample) and total (unfiltered). Limits are based on 'dissolved' measurements.

* Site-specific limits are to be provided in accordance with condition E11.

^ indicates replacement bores to be installed to replace dry bores and bores that require relocation due to mining activities.

Requires additional investigated to ensure it is indicative of background conditions.

EPP WQO: Groundwater quality parameters derived from EPP (water) policy 2009 Isaac River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Isaac River Sub-basin (including Connors River), Zone 34-deep (80th percentile).

Table 7-11 provisional groundwater monitoring locations

Groundwater bore	Latitude	Longitude
MB01	22.333428732° S	22.333428732° S
MB01R	148.220070636° E	148.220070636° E
MB06	22.333428732° S	22.333428732° S
MB07	148.220070636° E	148.220070636° E
MB08	22.360790237° S	22.360790237° S
MB09	148.247150363° E	148.247150363° E
MB10	22.364540522° S	22.364540522° S
MB11	148.250437058° E	148.250437058° E
MB12	22.357739524° S	22.357739524° S
MB12R	148.244501266° E	148.244501266° E
MB14	22.373728533° S	22.373728533° S
MB15	148.258356674° E	148.258356674° E
MB16	22.360862044° S	22.360862044° S
MB17	148.247209269° E	148.247209269° E
MB18	22.350287991° S	22.350287991° S

Legend

- Groundwater Monitoring Bores

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint

Vulcan South

Groundwater Monitoring Locations as per Approved EA

0 1 2 3

Kilometers

Scale: 1:95,000 (A4)

22/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 7-7

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Source: Geoscience Australia 2020, hydrogeologist.com.au 2023, Vitrinite 2022-2024, METServe 2023-2024, Earthstar Geographics, Maxar, Esri, and the GIS User Community.

7.3 Cumulative Impacts

The cumulative impacts of the project are considered in **Section 6.2.8** (Terrestrial Ecology),**6.4.1.14** (Surface water) and **6.4.3.18** (Groundwater).

7.4 Reef 2050 Water Quality Improvement Plan

The *Reef 2050 Water Quality Improvement Plan* 'seeks to improve the quality of water flowing from the catchments adjacent to the Reef'. The Plan is aimed at 'reducing sediment and nutrient pollution loads' from industry within catchments connected to the Reef. The Plan includes long-term progress towards 2050 water quality targets in reference to the reduction of dissolved inorganic nitrogen (DIN) and sediment discharge.

Erosion and Sediment Control measures using the Best Practice Erosion and Sediment Control document (IECA, 2008) will address:

- the fullest separation possible of diverted, surface and mine-affected water runoff;
- the diversion of upstream runoff from disturbed areas;
- the stabilisation of soils in disturbed areas; and
- the installation and maintenance of control measures such as sediment and erosion control devices (e.g., silt fences, swales, settling basins, energy dissipaters and vegetated buffers).

A detailed Erosion and Sediment Control Plan will be prepared for the Project prior to commencement of the action, (however surface water and diverted water releases from the Project do not trigger the need for an assessment under Section 41AA of *Environmental Protection Regulations 2019*).

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018) provides guideline values for DIN based on findings within Updating nitrate toxicity effects on freshwater aquatic species.

As per the SWA (**Appendix I**), DIN levels were assessed using the baseline surface water quality samples to support the aim of reducing end-of-basin fine-sediment and DIN loads. DIN concentrations are below the threshold guideline nitrate concentration value for 95% protection. As such, in the event of an uncontrolled release from sediment dams, DIN concentrations on site are likely to have negligible impact and result in 'no net decline' in water quality.

7.5 Environmental Outcomes for MNES

Section 9.2.4 provides information on outcomes for MNES as they relate to the proposed offsets strategy. **Section 6** provides detailed assessment information on the anticipated impacts and associated outcomes for MNES. Specific and measurable environmental outcomes to be achieved for relevant MNES have been outlined.

7.6 Management Plans

Summary of other plans required (state and federal approval conditions) and will be implemented upon commencement of the action.

The Environmental Management Plan, Air Emissions, Mineral Waste Management Plan, Weed Management Plan will contain a TARP. The REMP (Section 5.5 of **Appendix X**) contains a procedure which includes information normally covered by a TARP – as prescribed under the *Receiving environment monitoring program guideline For use with environmentally relevant activities under the Environmental Protection Act 1994*.

7.6.1 Management Plans required under the EA

The final approved Vulcan South EA requires the following management plans to be implemented for all stages of the authorised activity and submitted to the administering authority on, or before the commencement of authorised activities. The management plans listed below will be made available for public review on the Vitrinite website (https://vitrinite.com.au/community/sustainability/environment/) prior to the commencement of the action.

7.6.1.1 Air Emissions Management Plan (B8) is summarised below and is required to be reviewed by an AQP every three years:

The Air Emissions Management Plan required by condition B8 must incorporate a program for continuous improvement for the management of dust and particulate matter resulting from the authorised activities with respect to, but not limited to:

- the collection of air quality and meteorological data at locations and using the monitoring methods described in Table B1 – Ambient air quality limits; and
- a system to identify adverse meteorological conditions likely to produce elevated levels of dust deposition, PM10 at a sensitive place due to the authorised activities; and
- a dust and particulate matter control strategy which:
  - activates a timely implementation of management control action;
  - acts in response to the system required by condition B9(b);
  - acts in response to any air quality monitoring that indicates a potential for an exceedance of the air quality limits of Table B1 – Ambient air quality limits.

7.6.1.2 Greenhouse Gas Abatement Plan (B13)

The Greenhouse Gas Abatement Plan is provided within **Appendix HH**. The EA stipulates conditions which the plan was authored to comply with. These conditions are described below.

A greenhouse gas (GHG) abatement plan must be developed and implemented prior to the commencement of authorised activities. The GHG abatement plan must include:

- an inventory of projected unmitigated annual Scope 1 and Scope 2 emissions for each GHG over the life of the project; and
- the intended objectives, measures and performance standards to avoid and mitigate GHG emissions consistent with the latest version of the Queensland Climate Action Plan and relevant targets; and
- a process for regularly reviewing, assessing, and implementing new technologies to identify opportunities to further reduce GHG emissions and energy use and progressively improve energy efficiency; and
- a program for annual monitoring, auditing and reporting on GHG emissions from all relevant activities and the success of measures to avoid and mitigate GHG emissions and achieve reduction targets; and
- a biennial review and update of the effectiveness of the plan.

A schedule of targets for GHG reduction required under condition B13(d) will be provided to the administering authority prior to the commencement of authorised activities and be made available for each year of authorised activities on request. The results of the program conducted under condition B13(d) will be made publicly available.

This will be supplementary to the existing Projected Greenhouse Gas Emissions Assessment which includes projected Scope 1, 2 and 3 emissions associated with the action. This is provided within **Appendix GG**.

Over the Life of Mine (LOM), the action is estimated to contribute to a total of 960 kilo tonnes of carbon dioxide equivalent (856 ktCO2e of scope 1 (3.42% of total GHG emissions) and104 ktCO2e for scope 2 (0.42% of total GHG emissions)). These are the emissions under operational control of the action. The action It is also expected to contribute to 24, 059 ktCO2e of Scope 3 (96.16%). The total Scope 1, 2 and 3 contribution is a total of 25,019ktCO2e. A breakdown of these projected emissions are provided in. The actions GHG emissions are a relatively small proportion of both the Australian and

Queensland's total GHG emissions, accounting for 0.02% of Australia's total GHG emissions and 0.08% of Queensland's GHG emissions. The action is expected to be significantly smaller in emissions and production than other mines in the area. Mitigation and abatement measures include optimisation activities to be performed include the following:

- use of method 2 open cut fugitive GHG emissions
- CHPP operating settings and the use of additives to optimise yield and efficiency. This will result in a high-quality export product with a lower thermal coal byproduct.
- Improvements related to shift changeovers and work through crib times will improve the utilisation of excavators- which is expected to result in secondary GHG benefits.
- The implementation of variable speed drives, improving energy efficiency.
- road optimisation techniques to reduce the rolling resistance of roads, decrease water usage, decrease damage to equipment and therefore reduce the frequency of equipment replacement and repair.

7.6.1.3 Mineral Waste Management Plan (C11)

The Mineral Waste Management Plan required by condition C11 must include at least:

- a program for the effective characterisation of mineral waste to predict, under the proposed placement and disposal strategy, the quality of runoff and seepage generated concerning salinity, acidity, alkalinity and dissolved metals, metalloids, and non-metallic inorganic substances;
- a program of progressive sampling and characterisation to identify dispersive and nondispersive waste rock, the salinity and metal/metalloid concentrations of waste rock and the salinity, sulphate, acid and alkali producing potential;
- a materials balance and disposal plan demonstrating how potentially acid forming and acid-forming waste rock and coal rejects will be selectively placed and/or encapsulated to minimise the potential generation of acid mine drainage;
- a disposal plan demonstrating how highly sodic and dispersive waste rock is identified and selectively placed and/or encapsulated to ensure that it will not report to final landform surfaces and will not be used for construction activities;
- where relevant, a sampling program to verify encapsulation and/or placement of potentially acid-forming and acid-forming waste;
- details regarding the management of seepage and leachates; and
- monitoring of rehabilitation, research and/or trials to verify the requirements and methods for decommissioning and final rehabilitation of waste rock, including the prevention and management of acid mine drainage, saline drainage, erosion minimisation and establishment of vegetation cover.

This plan will be reviewed an updated at regular intervals not exceeding two years.

7.6.1.4 Non-mineral waste management Plan (C7)

The program required under condition C7 must include:

- a description of each waste stream generated by the authorised activity; and
- a description of the authorised activity that may generate waste; and
- waste management control strategies including:
  - recording of the types and amounts of wastes generated by the authorised activity;
  - segregation of the wastes;
  - storage of the wastes;
  - transport of the wastes;
  - disposal of waste including leachate management; and
  - monitoring and reporting matters concerning the waste; and

- the hazard characteristics of the wastes generated including disposal procedures for regulated wastes; and
- a program for reusing, recycling or disposing of all wastes; and
- how the waste will be dealt with in accordance with the waste and resource management hierarchy, including a description of the types and amounts of waste that will be dealt with under each of the waste management practices in the waste management hierarchy (i.e. avoidance, reuse, recycling, energy recovery, disposal); and
- how the waste will be stored, handled and transferred in a proper and effective manner;
- procedures for identifying and implementing opportunities to minimise the amount of waste generated, promote efficiency in the use of resources and improve the waste management practices employed; and
- procedures for dealing with accidents, spills, and other incidents that may impact on waste management; and
- details of any accredited management system employed, or planned to be employed, to deal with the waste; and
- how often the performance of the waste management practices will be assessed; and
- indicators or other criteria on which the performance of the waste management practices will be assessed; and
- staff training and induction to the waste management program; and
- a system for regular review.

The program will be reviewed at no greater than every 5 five years.

7.6.1.5 Tailings and Coarse Rejects Disposal Plan (C13)

The Tailings and Coarse Rejects Disposal Plan required under condition C13 must at a minimum include:

- effective characterisation of the CHPP tailings and coarse rejects to predict, under the proposed placement and disposal strategy, the quality of runoff and seepage generated concerning potentially environmentally significant effects including salinity, acidity, alkalinity and dissolved metals, metalloids and non-metallic inorganic substances;
- a program of progressive sampling and analysis to characterise the CHPP tailings and rejects and identify dispersive and non-dispersive materials and the salinity, acid and alkali producing potential, metal and acid concentrations of tailings and rejects;
- a material balance and disposal plan demonstrating how potentially acid forming tailings and coarse rejects will be selectivity placed and/or encapsulated to minimise potential generation of acid mine drainage, where relevant;
- re-testing of tailings and coarse rejects geochemistry and water quality limits of parameters;
- where relevant, a sampling program to verify encapsulation and/or placement of potentially acid forming waste rock;
- data for run-off water quality;
- how often the suitability of the plan will be assessed and triggers for plan revisions; and
- the indicators or other criteria on which the suitability of the plan will be assessed.

7.6.1.6 Water Management Plan (F3)

The Water Management Plan must provide for effective water management of actual and potential environmental impacts resulting from the authorised activity; and include:

- a study of the source of contaminants; and
- a water balance model for the site; and
- a water management system for the site; and
- measures to prevent, manage and reduce mine drainage; and
- contingency procedures for incidents and emergencies; and
- a program for monitoring and review of the effectiveness of the Water Management Plan.

The Water Management Plan must be reviewed by 1 August for each calendar year. The review must be documented and:

- include a statement that the Water Management Plan has been reviewed by an AQP; and
- assess the plan against the requirements under condition F25; and
- include recommended actions to ensure actual and potential environmental impacts are effectively managed; and
- provide details and timelines of the actions to be taken; and
- identify any amendments to be made to the Water Management Plan.

A copy of the Water Management Plan must be kept up to date following each annual review and must be provided to the administering authority on request.

7.6.1.7 Erosion and Sediment Control Plan (F29)

The Erosion and Sediment Control Plan must demonstrate how erosion and sediment control measures detailed in the plan adequately minimise the release of sediment to receiving waters and must include at least the following:

- an assessment of the size and characteristics of all catchment areas; and
- an assessment of relevant properties of soils and waste materials; and
- identification of receiving waters environmental values, water quality objectives and management intent; and
- specification of minimum design criteria for erosion and sediment control structures to achieve the management intent of receiving waters; and
- locations and descriptions of all erosion and sediment control measures; and
- an audit schedule to ensure erosion and sediment control measures are maintained.

This plan will be reviewed each calendar year and will:

- include a statement that the Erosion and Sediment Control Plan has been reviewed by an AQP; and
- assess the plan against the requirements of condition F30; and
- include recommended actions to ensure actual and potential environmental impacts are effectively managed; and
- provide details and timelines of the actions to be taken; and
- identify any amendments made to the Erosion and Sediment Control Plan.

An erosion and Sediment Control Plan is provided within **Appendix W**.

7.6.1.8 Weed Management Plan (G9)

A weed management plan must be developed prior to the commencement of authorised activities and implemented for MLA700073 for the duration of authorised activities and must outline:

- areas of control priority and the methods used to determine such areas; and
- strategies to promote dense pasture cover (to decrease weeds establishment) through reduced disturbance; and
- monitoring methodologies that document the spread of weeds and any new outbreaks; and
- methods for the control of weeds that include best practice management; and
- stringent wash-down and inspection procedures for both machinery involved in clearing/construction activities and those operating outside of designated roads during mine operation; and
- truck wash procedure to reduce weed infestations; and
- protocol for an annual weed inspection; and
- promotion of the awareness of weed management issues at the site.

7.6.2 Environmental Management Plan

An Environmental Management Plan has been prepared and submitted with this PER (**Appendix Y**). The Commonwealth's Environmental Management Plan Guidelines have been followed in the preparation of the plan. It focuses on the significant impacts on the relevant MNES but is also consistent with commitments made in other management plans. The content of the Environmental Management Plan and the purpose of the information are described in **Table 7-12** below.

Table 7-12 Content of Environmental Management Plan

Content	Purpose
Cover page	Required by Environmental Management Plan Guideline
Declaration of accuracy	Required by Environmental Management Plan Guideline
Table of Contents	Page references for all Sections, tables, figures and appendices
Introduction	Introduction to the project and objectives of the plan. The scope of the environmental outcomes and context are defined.
Project description	A more detailed description of the project with figures showing location and site layout. Activities related to construction, operation/rehabilitation and decommissioning phases are provided. Brief description of the existing environment is included.
Statutory requirements and licenses	Description of Queensland and Commonwealth legislation, and other relevant legislation.
Environmental Management Framework	Description of environmental management roles and responsibilities, training, auditing and review, and emergency contacts and procedures.
Potential environmental impacts and risks	Definition of consequence scales, likelihood ratings and risk assessment matrix. Risk assessment tables for each phase, itemising impacting activities, potential impacts and consequences, preliminary risk assessment, mitigation/management measures to minimise risk, and residual risk.
Environmental management measures	For each environmental aspect of construction, operation or decommissioning that needs management to minimise impacts, an environmental management schedule has been prepared containing the following: • Environmental outcome • Timing • Responsibility • Reference documents • Implementation, including actions and performance criteria.
Abbreviations	Abbreviations of terminology used in the document.

7.6.3 Sediment and Erosion Management Plan

An Erosion and sediment Control plan (ESCP) is a requirement of the approved Project EA under Condition F29 and is described in detail within **Section 7.6.1.7.** The ESCP is provided within **Appendix W.**

7.6.4 Dewatering Groundwater Management Plan

As is described in the GIA (**Appendix P**) and further in **Section 6.4.1.14** and **7.1.3** of this report, pooling of groundwater within the pits is not anticipated and hence no pit dewatering will be required. Inflow of groundwater within the North, Central and Southern pits is expected to be at a maximum of 4.71, 42.42 and 2.05 m^3/day. This quantity is considered very low and will very likely be lost through evaporation on the pit face or as entrained moisture within the mined coal and is highly unlikely to pool. Hence inflow to the pit is very unlikely to be observed during the Project and therefore, pit groundwater dewatering is not anticipated. For reference, inflow rates at Saraji and Peak Downs are in the order of 3,000 m^3/day to 5,000 m^3/day. Inflow is discussed further in **Section 6.4.3.6** of this document.

7.6.5 Flood Management and Mitigation Plan

A hydraulic (TUFLOW) model was developed for the Project to design the proposed flood protection infrastructure required to protect key mining infrastructure and to assess the potential flood impacts caused by the proposed infrastructure on downstream property. The TUFLOW model results show that:

- Flood level impacts as a result of the Project are generally within the Project MLA area. Any impacts that extend into the Norwich Park Branch Railway corridor and downstream of the Project boundary may require mitigation measures. Where impacts cannot be fully mitigated, consent may be required from impacted neighbouring landowners/stakeholders (e.g., Aurizon, council, BMA).
- There are only minor impacts under the final landform configuration. These impacts are generally confined within the Project MLA area. Existing conditions natural topography will be reinstated within the Hughes Creek floodplain as well as Drainage line 6 and Drainage line 8 Post-closure to replicate the existing drainage line channels to minimise the impacts associated with the Post-closure Conditions landform.

The Project surface water management system has been designed to accommodate the proposed production schedule and to mitigate potential natural surface water and flooding impacts. With appropriate mitigation measures in place, the potential impact of the proposed mining operations on surface flows and water quality in the receiving waters downstream of the Project will be insignificant (**Appendix I**). For this reason, a flood management and mitigation plan is not considered to be required, given that the existing surface water assessment discusses flood impacts and mitigation measures in detail.

7.6.6 Receiving Environment Monitoring Plan (REMP)

The REMP is provided in **Appendix X.**

This is a requirement of the approved Final EA, under Condition F16-21. The requirements of this plan are summarised below:

The REMP must at a minimum:

- address and comply with the latest version of the administering authority's guideline 'Receiving environment monitoring program guideline' (ESR/2016/2399); and
- identify, describe and monitor any adverse impacts to surface water environmental values, quality, and flows; and
- assess the long-term condition or state of surface waters and aquatic ecosystem health; and
- include monitoring from background reference sites (e.g., upstream sites) and downstream sites from the release (as a minimum, the locations specified in Table F2 – Surface water monitoring locations;
- identify and describe all environmental values of the receiving environment; and
- include monitoring and assessment of dissolved oxygen saturation, temperature and all water quality parameters listed in Table F3 – Surface water quality objectives against the surface water quality objectives in Table F3 – Surface water quality objectives.
- include an assessment of the potential impacts of the activity and propose appropriate mitigation measures; and
- assess the status of and any change to aquatic ecosystem health including aquatic flora and fauna within and immediately surrounding the Project area; and
- assess the status of and any change to riparian vegetation health within and immediately surrounding the Project area; and
- apply procedures and/or guidelines from ANZG 2018 and other relevant standards and guideline documents; and
- describe sampling and analysis methods and quality assurance and control; and
- incorporate stream flow and hydrological information in the interpretations of water quality and biological data.

The REMP Annual Report required by condition F20 must:

- be prepared by an AQP; and

- outline the findings of the REMP, including but not limited to:
  - **i.** an assessment of long-term upstream water quality; and
  - **ii.** an assessment of the long-term condition or state of surface waters, including sediment and aquatic ecosystem health; and
  - **iii.** recommendations for further investigation or actions; and
  - **iv.** recommendations for changes or improvements to the monitoring program; and
  - **v.** potential changes to management of the authorised activity to minimise impacts; and
  - **vi.** all monitoring results; and
  - **vii.** a description of all conclusions formed.

7.6.7 Rehabilitation Management Plan

A rehabilitation management plan is a component of the Progressive Rehabilitation and Closure Plan (PRCP) prescribed under the Queensland *Environmental protection Act 1994*, which is discussed in detail within **Section 7.7** of this document and is provided as **Appendix J.**

7.6.8 Offset Management Strategy

This Offset Strategy (**Appendix Z**) is provided in and summarised in further detail below in **Section 9.2.**

7.7 On-ground corrective actions

Vitrinite operates under a risk management process. The risk management process and its outcomes will be documented and reported following each review. This will assist the following processes:

- Communication of risk management activities and outcomes across the organisation;
- Providing information for decision making; and
- Facilitating interaction with stakeholders, including those with responsibility and accountability for risk management activities.

Internal reporting will predominantly take the form of incident and RMS review reporting. Vitrinite will conduct internal audits against mitigation measures they have committed to in this preliminary documentation on a regular basis.

- A risk treatment Action Plan will be completed after the identification of a mitigation measure that has not been carried out (see template below in **Figure 7-8**). Following this, communication protocols will be reviewed to ensure this does not happen again. Additionally, these mitigation measures will be stated in the onsite environmental management plan, which the worker who was unable to complete the mitigation measure, will be required to review.

Examples of corrective actions for surface water and groundwater are provided in the sections below (**Section 7.7.1** and **Section 7.7.2)**. Corrective actions are included within each relevant mitigation table in **Section 7.1.** On ground corrective actions are a requirement of the Queensland state governments rehabilitation milestone criteria, as per the PRCP Schedule (**Appendix K**). All milestone criteria are provided in **Table 8-1** and rehabilitation contingency measures are described in **Section 8.6**.

METSERVE
Mining & Energy Technical Services Pty Ltd

Environmental Risk Management System
Vulcan Coal Mine

Action Plan

Risk Assessment			
Date Raised		**Department**	
Risk Assessment Owner		**Document Controller**	

Priority	**Recommended Action**	**Action Owner**	**Due Date**

Risk Management Action Plan: Priorities determined from Risk Matrix. Extreme (18-25) Priority 1, High (13-17) Priority 2, Medium (7-12) Priority 3, Low (1-6) Priority 4.

Approval for action plan (SSE / Process Owner).	**Authorisation:**	Date: / /
Sign off for completion of Risk Assessment (SSE / Process Owner).	**Authorisation:**	Date: / /

Method of Recording and Monitoring: Once the action plan is authorised by the SSE / Process Owner, all authorised actions are to be placed into the site corrective and preventative actions register.

Final sign-off of the Risk Assessment: The Initiator of the risk assessment will be responsible for ensuring the SSE / Process Owner signs-off on the completed risk assessment after all actions have been completed. Evidence of the completed actions will be required.

Figure 7-8 Environmental Risk Management System Template

7.7.1 Surface Water

As per the approved EA, if a water quality characteristic measured at a downstream site exceeds any water quality objective specified in the EA, Vitrinite must compare this result to the applicable upstream site and:

- If the quality measured at a downstream site is equal to or less than the quality measured at the applicable upstream site, no further action is required; or
- If the quality measured at a downstream site is greater than the quality measured at the applicable upstream site, complete an investigation into the cause of the deterioration in water quality and the potential for environmental harm and submit a written report to DESI within twenty (20) business days outlining:
  - details of the investigation carried out including any assumptions and limitations of the investigation; and
  - findings of the investigation including an explanation of the cause identified; and
  - recommendations of the investigation; and
  - actions taken to comply with the conditions of the environmental authority and to prevent environmental harm.

If an exceedance in accordance with condition F13(b) occurs, the holder of the environmental authority must notify DESI within twenty-four (24) hours of receiving the monitoring result.

All surface water monitoring data must also be submitted to DESI.

Once the cause is identified through the further investigation, issue- specific corrective actions will be developed and implemented and processes strengthened to prevent future exceedances.

These are discussed in more detail within **Table 7-4.**

7.7.2 Groundwater

The following corrective actions apply to Groundwater:

- In accordance with the EA, if monitoring results from groundwater monitoring bores exceed trigger levels on three consecutive sampling occasions Vitrinite must complete the following:
  - DESI will be notified within 24 hours from receiving the monitoring bore data;
  - An investigation report is provided to DESI within 14 days; and
  - If the results indicate the exceedance is caused by the Project, a further investigation must be completed within 28 days from the provision of the report.

Once the cause is identified through the further investigation, issue- specific corrective actions will be developed and implemented and processes strengthened to prevent future exceedances. These are discussed in more detail within **Table 7-3**.

8 Rehabilitation Activities and Methods

The development, approval and implementation of a Progressive Rehabilitation and Closure Plan (PRCP) is a requirement of the *Environmental Protection Act 1994* prior to the commencement of an action. This has been provided in **Appendix J**, without the inclusion of appendices as these are duplicated within this PER.

The content requirements for the PRCP include, but are not limited to:

- general information about the site and operation;
- information about community consultation;
- analysis and justification of Post Mine Land Uses (PMLUs) and Non-Use Management Areas (NUMAs);
- justification of timeframes for land being available for rehabilitation (Section 126D of the EP Act) and available for improvement (Schedule 6 Part 1 of the Environmental Protection Regulation 2019 (EP Regulation)) ; and
- details of the rehabilitation methodologies and techniques that will be used to develop rehabilitation milestones and management milestones and supporting documentation.

The content of the PRCP considers and includes topics required within Guideline requirement Section 8 – 'Rehabilitation Requirements'. These are discussed below in **Section 8.1** to **8.8.**

The Final Approved PRCP Schedule has also been provided separately as **Appendix K.** The PRCP schedule is approved by the administering authority as prescribed under the EP Act 1994 and includes maps of final rehabilitation and closure outcomes for the site and tables of time-based milestones for achieving each PMLU and/or NUMA. The PRCP schedule consists of the following:

- rehabilitation and management milestones;
- milestone criteria;
- identification of PMLUs or NUMAs;
- when land becomes available for rehabilitation and available for improvement;
- rehabilitation areas and improvement areas; and
- milestone completion dates.

8.1 Proposed Rehabilitation Activities

Proposed rehabilitation activities can be summarised based on the approved rehabilitation milestone criteria (**Table 8-1**) for each stage of rehabilitation. The rehabilitation milestone criteria pertain to different rehabilitation areas, which are classified into post-mining land uses (PMLU). The locations of these are shown in **Figure 8-1**. Further information can be found in the appended PRCP (**Appendix J**) and is summarised below.

The projects approved PMLUs are described below and shown within **Figure 8-1**:

- Low-intensity cattle grazing;
- Native ecosystems non-riparian;
- Native ecosystems riparian;
- Saraji Road; and
- Rail corridor.

The approved rehabilitation areas are listed below and shown visually in **Figure 8-2** and **Figure 8-3**:

- RA1: North and South Ex-Pit Waste Rock Dump;
- RA2: Main Ex-pit Waste Rock Dump;

- RA3: Reinstated Watercourses;
- RA4: North and South In-pit Dumps;
- RA5: Main In-pit Waste Rock Dump;
- RA6: Previously wooded infrastructure areas (infrastructure, haul roads, offices, stockpiles, train load-out, rail loop CHPP, MIA and magazine);
- RA7: Previously cleared infrastructure areas (haul roads);
- RA8: Water management infrastructure in previously wooded areas;
- RA9: Water management infrastructure in previously cleared areas;
- RA10: Highwall Mining Area (bench, dams, ex-pit WRD).

Table 8-1 Rehabilitation milestones

Code	Milestone	Milestone criteria	Rehabilitation areas (RA)
RM1	Infrastructure decommissioning and removal.	With the exception of any infrastructure to remain as part of the post-mining land use (PMLU) or where infrastructure is agreed to be retained by the landholder as evidenced by a signed landholder agreement, the following are complete: RM1.1 All services disconnected, terminated and removed; RM1.2 All hardstand, concrete areas and road materials (bitumen, gravel) removed; RM1.3 All pipelines (above- and below- ground) drained and removed; RM1.4 All fencing that is not part of the post mining land use (PMLU) removed; RM1.5 All buildings demolished and removed; RM1.6 All machinery and equipment removed; RM1.7 All surface water drainage infrastructure that is not required in the PMLU is removed; RM1.8 All rubbish removed; RM1.9 All waste is to be transported, disposed of, and handled in accordance with relevant waste legislature; and RM1.10 All drifts, shafts, tunnels, boreholes, and other openings to be sealed, and are geotechnically stable and certified by an AQP (AQP).	RA6, RA7, RA8, RA9 and RA10
RM2	Remediation of contaminated land.	RM2.1 Detailed site investigation report, as required under the Environmental Protection Act 1994 (EPA 1994), completed; RM2.2 All contamination is remediated or removed from site; RM2.3 Any contamination removed from site has been removed in accordance with relevant regulations; and RM2.4 A contaminated land investigation document has been prepared by an approved auditor, containing a site suitability statement that states that land is not contaminated and is suitable to achieve the PMLU.	RA4, RA5, RA6, RA7, RA8, RA9 and RA10
RM3	Landform development and reshaping/reprofiling.	RM3.1 All earthworks except topsoil handling and placement are complete; RM3.2 Subsoil of a suitable quality, as signed-off by an AQP, has been applied, spread and compacted over RA2 (in-pit dumps) to the specified depth (minimum of 0.3 m) and design specifications;	RA1, RA2, RA3, RA4, RA5, RA6, RA7, RA8, RA9 and RA10

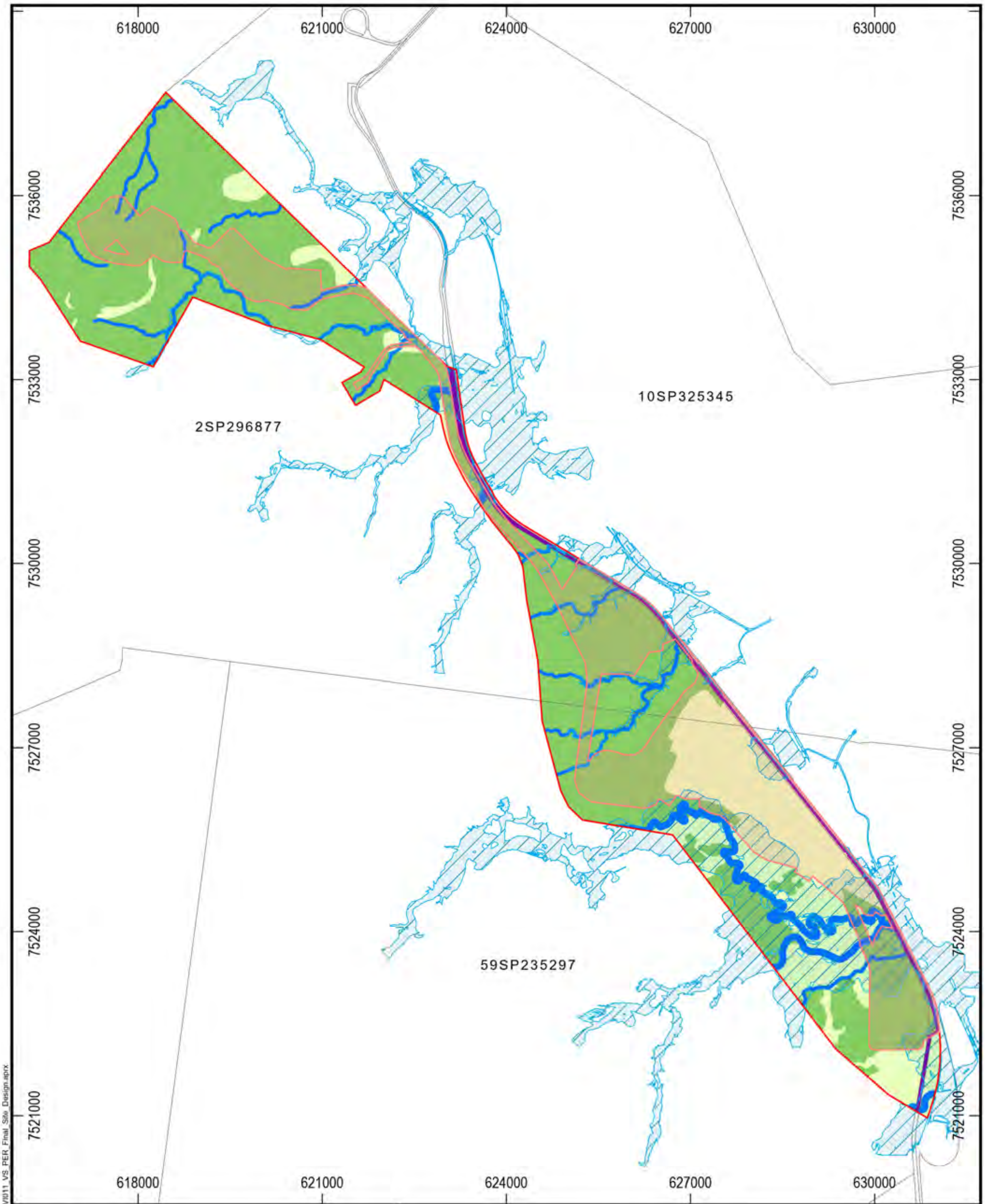
		RM3.3 All erosion and sediment control systems have been installed as per the construction design and are functioning properly as verified by an AQP; RM3.4 The final landform surveyed is to be constructed as per the approved design plan; RM3.5 Batters do not exceed a maximum slope of 15% and are stable as demonstrated by erosion modelling; RM3.6 All areas of substantial surface cracking (vertosol soil types) or subsidence are remediated and no associated effects of erosion or changed surface water flow paths are evident; RM3.7 Areas of surface ponding are remediated by re-profiling and ripping to be free draining; RM3.8 All rehabilitation and associated works are to have 'as-constructed' plans prepared; RM3.9 All pits are backfilled and are certified as geotechnically stable by an AQP; RM3.10 Post-closure drainage channels are reinstated with similar geometry and vegetation characteristics to pre-mining drainage channels. This includes: a) Pre-mining channel longitudinal slope and geometry to be reinstated; and b) Channel and floodplain to function as a natural drainage line including similar geomorphic and vegetation characteristics to pre-mining conditions; RM3.11 Permanent drainage channels to be designed in accordance with the Guideline: Works that interfere with water in a watercourse for a resource activity— watercourse diversions authorised under the Water Act 2000; and RM3.12 All drainage channels and associated works are to have 'as-constructed' plans prepared.	
RM4	Surface preparation.	RM4.1 Any erosion classified as 'moderate' or 'severe' as defined in Attachment 1 - Erosion classification framework, that occurs after the achievement of RM3, has been remediated prior to topsoil application; RM4.2 All substantial surface cracks or subsidence evident after the achievement of RM3, have been remediated prior to topsoil application; RM4.3 Areas of ponding that persist after the achievement of RM3 have been remediated and are free draining prior to topsoil application; RM4.4 Soil health and suitability is assessed and documented by an AQP to confirm topsoil is suitable for the PMLU and target vegetation establishment; RM4.5 Prior to topsoil application, an assessment of the need for soil amelioration has been undertaken and soil ameliorants such as fertiliser, gypsum and/or organic matter have been applied at rates determined by an AQP; RM4.6 A minimum of 0.25 m of topsoil suitable for the PMLU has been placed over all areas (except for RA10). RM4.7 Topsoil (equivalent to a depth of 0.15 m) has been mixed with crushed rock to achieve a final depth of 0.25m and applied to RA10 as per final design specifications; RM4.8 Organic mulch is applied at a rate of at least 5t/ha of hay or organic material on all slopes;	RA1, RA2, RA3, RA4, RA5, RA6, RA7, RA8, RA9 and RA10

		RM4.9 Topsoil to meet the following suitability targets: a) pH in the range of 5.5 - 8.5 (average); b) Electrical Conductivity (EC) ≤1.5 dS/m (1,500 µS/cm); and c) Exchangeable sodium percentage (ESP) <6%.	
RM5	Revegetation.	RM5.1 Seeding is completed at an average rate of: a) Grazing PMLU - 0.25 kg/ha for trees and shrubs, 13-15 kg/ha for grasses and 13-15 kg/ha for sterile cover crops; b) Native ecosystem PMLU - 2-3 kg/ha for trees and shrubs, 9-11 kg/ha for grasses and 8-10 kg/ha for sterile cover crops; and c) Native ecosystem – riparian PMLU – 2-3 kg/ha for trees and shrubs, 13-15 kg/ha for grasses and 13-15 kg/ha for sterile cover crops; RM5.2 With the exception of a non-permanent cover crop species, the seed mix to satisfy RM5.1 contains only those species listed in Attachment 2 – Seed Mix Species List for the relevant PMLU and reflect the regional ecosystem distribution spatially shown in Figure 4 - Spatial extent of regional ecosystems to be established post-mining; RM5.3 Vegetation groundcover >40%; RM5.4 Any species not establishing after seeding (as identified 12 months after seeding) have been planted as tubestock in RA2, RA3 and RA4 at a density suitable to establish the tree cover and shrub cover of the relevant PMLU; and RM5.5 Supplementary seeding and tubestock planting completed within one year of sites failing to achieve vegetation establishment on initial attempt.	RA1, RA2, RA3, RA4, RA5, RA6, RA7, RA8, RA9, RA10
RM6	Land is suitable for the commencement of grazing.	RM6.1 Perennial pasture cover >50%; RM6.2 Rehabilitated areas are to have less than 0.2% cover of Parthenium hysterophorus AND rehabilitated areas are to have less than 0.1% cover of Harrisia martinii AND any invasive plants listed under the Biosecurity Act 2014 are not to exceed densities of 1 individual per hectare, as confirmed by an AQP from annual monitoring; RM6.3 All corrective actions recommended by an AQP in response to erosion or deficiencies in vegetation cover criteria have been implemented; RM6.4 Rehabilitated areas are to have a land suitability class for cattle grazing of 3 or lower; RM6.5 No active rill or gully erosion deeper than 30 cm present as stated in Attachment 1 – Erosion classification framework; RM6.6 Trees of the target species, as identified in Attachment 2 – Seed Mix Species List are, on average, at least 4 m tall; RM6.7 Stock water sources have been installed and meet the approved water criteria for stock use (EC <7800 µS/cm); RM6.8 Stock fencing installation is complete; and RM6.9 Rehabilitation is non-polluting of surface water and achieves surface water runoff water quality criteria of: a) pH: 6.5-8.5; b) TSS <110 mg/L; and c) EC: <310 µS/cm.	RA2, RA5, RA7 and RA9
RM7	Establishment of target vegetation in non-riparian areas	RM7.1 Rehabilitated areas are to have less than 0.2% cover of Parthenium hysterophorus AND rehabilitated areas are to have less than 0.1% cover of Harrisia martinii AND any invasive plants listed	RA1, RA4, RA6, RA8 and RA10

		under the Biosecurity Act 2014 are not to exceed densities of 1 individual per hectare, as confirmed by an AQP from annual monitoring; RM7.2 Vegetation groundcover >50%; RM7.3 A BioCondition assessment is undertaken by an AQP using the methodology outlined in the latest version of the Queensland Herbarium's 'BioCondition Assessment Manual'; RM7.4 A rehabilitation performance assessment completed under RM7.3 achieves a score of at least 40/80 of the reference site based on the benchmark criteria in **Table 8-5** for the relevant native ecosystem PMLU; RM7.5 Rehabilitation is non-polluting of surface water and achieves water quality criteria of: a) pH: 6.5-8.5; b) TSS 110 mg/L; and c) EC: <310 µS/cm; RM7.6 Soil testing indicates the following parameters are met: a) Rootzone EC <1.5 dS/m (1,500 µS/cm); b) Soil pH <8.5 and >5.5 (average) as measured at any part of the root zone; c) Exchangeable Sodium Percentage (ESP%) <6% (at 0-10cm depth).	
RM8	Establishment of target vegetation in riparian areas	RM8.1 Rehabilitated areas are to have less than 0.2% cover of Parthenium hysterophorus AND rehabilitated areas are to have less than 0.1% cover of Harrisia martinii AND any invasive plants listed under the *Biosecurity Act 2014* are to be <1 individual per hectare, as confirmed by an AQP from annual monitoring; RM8.2 Vegetation groundcover > 50%; RM8.3 Eucalyptus camaldulensis is to constitute 33% of the total basal area of woody vegetation; RM8.4 A BioCondition assessment is undertaken by an AQP using the methodology outlined in the latest version of the Queensland's Herbarium 'BioCondition Assessment Manual'; RM8.5 A rehabilitation performance assessment completed under RM8.4 must achieve a score of 40/80 of the reference site based on the benchmark criteria in **Table 8-5** for the native ecosystem - riparian PMLU (RE11.3.25); RM8.6 Rehabilitation is non-polluting of surface water and achieves water quality criteria of: a) pH: 6.5-8.5; b) TSS 110 mg/L; and c) EC: <310 µS/cm; RM8.7 Soil testing indicates the following parameters are met: a) Rootzone EC <1.5 dS/m (1,500 µS/cm); b) Soil pH <8.5 and >5.5 (average) as measured at any part of the root zone; c) Exchangeable Sodium Percentage (ESP%) <6% (at 0-10cm depth).	RA3
RM9	Achievement of native ecosystem land use with a stable condition.	RM9.1 All corrective actions recommended by an AQP in response to erosion or deficient vegetation cover have been implemented; RM9.2 No evidence of erosion classified as 'moderate' or 'severe' as defined by Attachment 1 – Erosion classification framework;	RA1, RA3, RA4, RA6, RA8 and RA10

		RM9.3 An AQP has certified that the final landform is geotechnically stable; RM9.4 Native ecosystems are to be substantially established spatially as per **Figure 8-1**; RM9.5 A BioCondition assessment has been undertaken by an AQP using the methodology outlined in the latest version of the Queensland Herbarium's 'BioCondition Assessment Manual'; RM9.6 A rehabilitation performance assessment completed under RM9.5 achieves a score of 60/80 based on the benchmark criteria in **Table 8-5** for the relevant PMLU; RM9.7 Groundcover is to remain above 80% on all slopes with a gradient higher than 10%, and 50% on slopes with a gradient lower than 10%; RM9.8 Erosion monitoring has been completed and the average erosion rate is <5 t/ha/year; RM9.9 No active rill or gully erosion deeper than 30cm present; RM9.10 Rehabilitated areas have less than 0.2% cover of *Parthenium hysterophorus* AND rehabilitated areas less than 0.1% cover of *Harrisia martinii* AND any invasive plants listed under the Biosecurity Act 2014 are not to exceed 1 individual per hectare, as confirmed by an AQP from annual monitoring; RM9.11 At least 60% of established target species show natural recruitment; RM9.12 Free draining landform and no cracks greater than 0.15 m deep; RM9.13 The extent and frequency of surface cracking and ponding of the mined land is within 10% of that measured in adjacent unmined land; RM9.14 Surface water quality results monitored monthly during flow at, but not limited to, downstream locations specified in Attachment 4 - Surface Water Monitoring Locations, must not exceed the parameters and limits defined in **Table 7-9** for a minimum of 5 consecutive years; RM9.15 Soil testing indicates the following parameters are met: a) Rootzone EC <1.5 dS/m (1,500 µS/cm); b) Soil pH <8.5 and >5.5 (average) as measured at any part of the root zone; c) Exchangeable Sodium Percentage (ESP%) <6% (at 0-10cm depth).	
RM10	Achievement of cattle grazing ;land use with a stable condition	RM10.1 All corrective actions recommended by an AQP in response to erosion or deficient vegetation cover have been implemented; RM10.2 No evidence of erosion classified as 'moderate' or 'severe' as defined by Attachment 1 – Erosion classification framework; RM10.3 An AQP has certified that the final landform is geotechnically stable; RM10.4 The land suitability class of rehabilitated land is to be 3 or lower for cattle grazing; RM10.5 >6 species of perennial pasture species present and perennial grass cover >30%; RM10.6 Groundcover is to remain above 80% on all slopes with a gradient higher than 10%, and 70% on slopes with a gradient lower than 10%; RM10.7 Erosion monitoring has been completed and the average erosion rate is <5 t/ha/year;	RA2, RA5, RA7 and RA9

		RM10.8 No active rill or gully erosion deeper than 30 cm present; RM10.9 Rehabilitated areas have less than 0.2% cover of Parthenium hysterophorus AND rehabilitated areas are to have less than 0.1% cover of Harrisia martinii AND any invasive plants listed under the *Biosecurity Act 2014* do not exceed 1 individual per hectare, as confirmed by an AQP from annual monitoring; RM10.10 Surface water quality results monitored monthly during flow at, but not limited to, downstream locations specified in Attachment 4 - Surface Water Monitoring Locations, must not exceed the parameters and limits defined in Attachment 5 - Surface Water Quality Limits for a minimum of 5 consecutive years; RM10.11 Soil testing indicates the following parameters are met: a) Rootzone EC <1.5 dS/m (1,500 µS/cm); b) Soil pH <8.5 and >5.5 (average) as measured at any part of the root zone; c) Exchangeable Sodium Percentage (ESP%) <6% (at 0-10cm depth).	



Legend

- Cadastral Boundary
- Flood Plain Extent

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint

Post Mining Land Use (PMLU)

- Grazing
- Native Ecosystems Non-Riparian
- Native Ecosystems Riparian
- Saraji Road
- Rail

Source: State of Queensland (Department of Resources) 2022, Vitrinite 2020-2022, METServe 2020-2024.

Vulcan South

Final Site Design

0 1 2 3

Kilometers

Scale: 1:90,000 (A4)

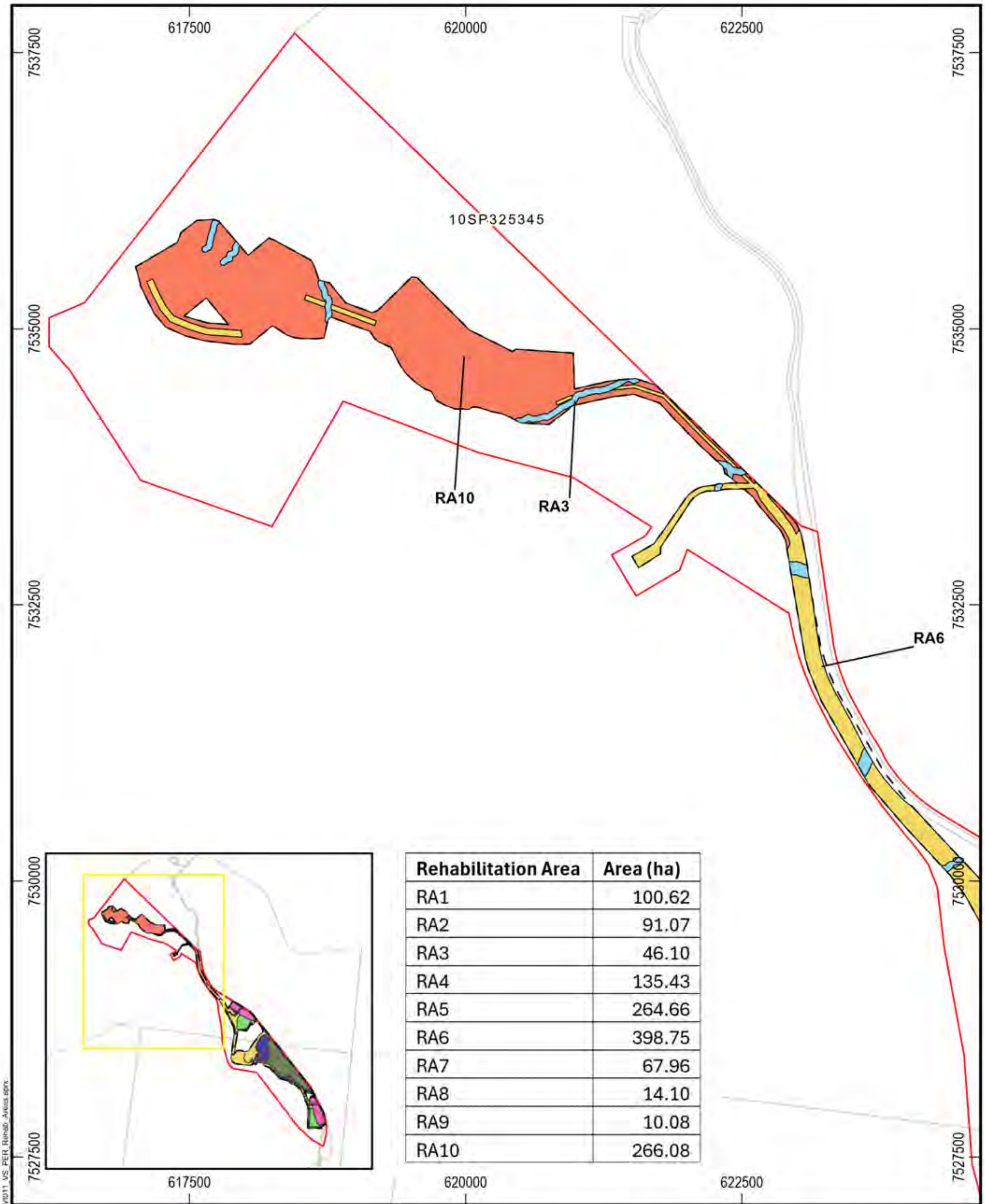
22/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 8-1

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd



Rehabilitation Area	Area (ha)
RA1	100.62
RA2	91.07
RA3	46.10
RA4	135.43
RA5	264.66
RA6	398.75
RA7	67.96
RA8	14.10
RA9	10.08
RA10	266.08

Legend

Cadastral Boundary

Vulcan South Coal Mine (2023/09708)

Project Area (ML 700073)

Disturbance Footprint

Rehabilitation Areas

RA1
RA2
RA3
RA4
RA5
RA6
RA7
RA8
RA9
RA10

Source: State of Queensland (Department of Resources) 2022, Vitrinite 2020-2023, METServe 2020-2024.

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Rehab_Areas.aprx

Vulcan South

Rehabilitation Areas Northern Section

0 0.5 1 2

Kilometers

Scale: 1:50,000 (A4)

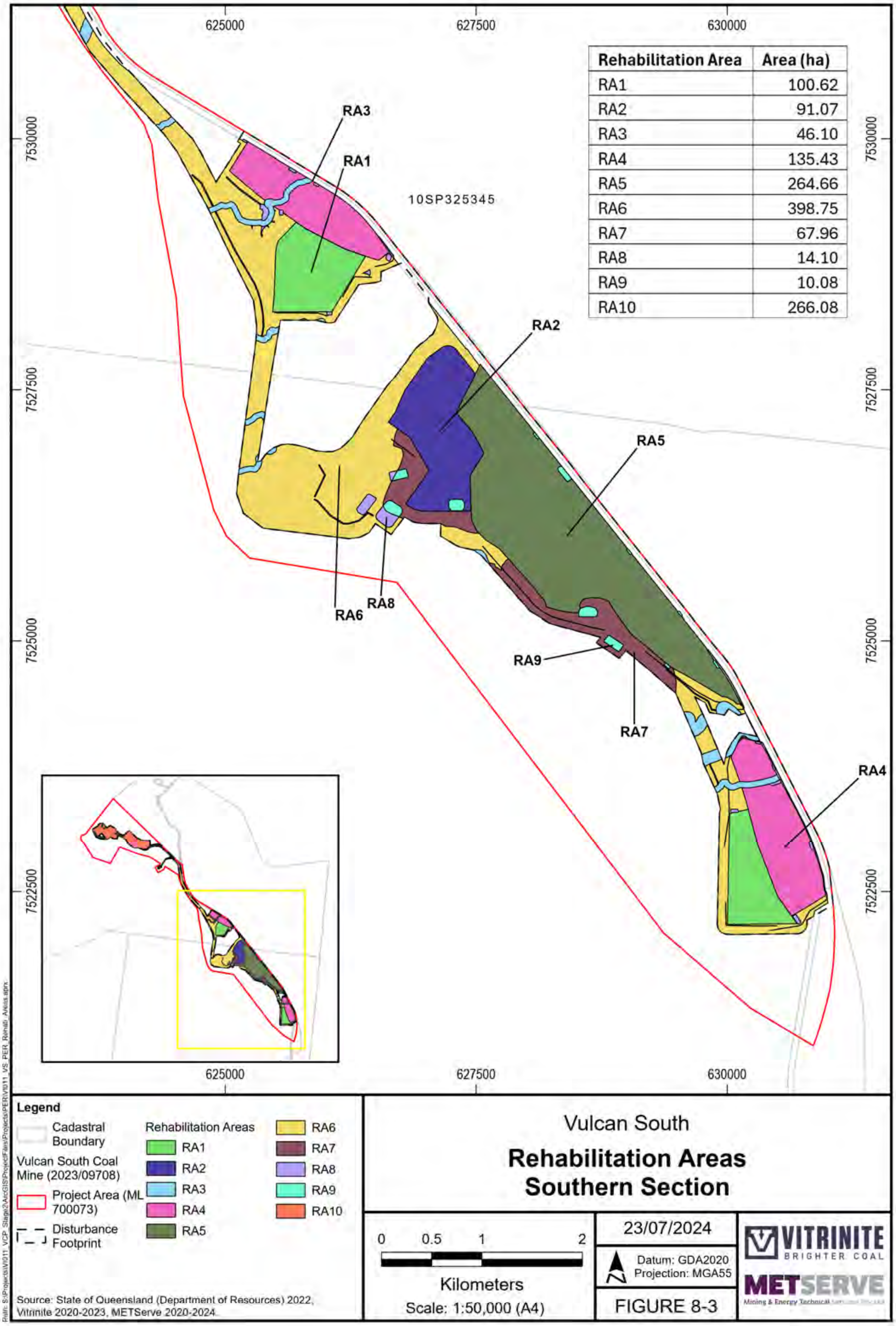
23/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 8-2

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services



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RA3	46.10
RA4	135.43
RA5	264.66
RA6	398.75
RA7	67.96
RA8	14.10
RA9	10.08
RA10	266.08

Source: State of Queensland (Department of Resources) 2022, Vitrinite 2020-2023, METServe 2020-2024.

Vulcan South

Rehabilitation Areas Southern Section

23/07/2024

FIGURE 8-3

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services

8.2 Landform evolution modelling and geotechnical stability of WRDs

8.2.1 Landform Evolution Modelling report

Landform evolution modelling (LEM) was undertaken for the six proposed Waste Rock Dumps (WRDs) to determine long term stability and erosion potential over time (**Appendix AA**). These included the Vulcan North in-pit and ex-pit WRDs, Vulcan Main in-pit and ex-pit WRDs, and the Vulcan South in-pit and ex-pit WRDs. The LEM assessed the ability for the proposed WRD cover designs and embankment slopes to demonstrate that landform rehabilitation criteria are achievable and should result in long-term stability.

Erosion behaviour was simulated using SIBERIA software for the six proposed WRD landforms over a 10-year and 100-year timeframe. Slope angle, length of slope, dispersive characteristics of soil units, sediment transport information, and percentage of ground cover are important factors affecting erosion and are inputs to the model. The LEM analysed five proposed landform cover management scenarios (see table below) to determine which is the most suitable for the longevity of a stable landform. Erosion modelling predicted rilling, gully erosion and sedimentation for each of the potential cover design scenarios, which were compared to rehabilitation objectives.

An erosion risk rating was determined for each of the cover designs based on these rehabilitation objectives. The LEM predicted that once the proposed WRD landforms have fully established a cover of rock mulch with grass cover, rehabilitation objectives as outlined in the PRC Plan **(Appendix J**) and Approved PRCP Schedule (**Appendix K**) would be achieved (see table below and **Appendix AA**).

Erosion objectives achieved with this cover design in place include:

- land is stable, with only minor active rills no deeper than 0.25 m;
- erosion only affecting uppermost topsoil layer;
- negligible sedimentation effects on downstream waterways; and
- vegetative cover is effective, but may have reduced ability to recover following disturbance from mining in some areas.

The results of the LEM cover design scenarios were incorporated into the final PMLU and milestone criteria that is now located within the Approved PRCP Schedule.

More detailed information about the LEM is contained in the Landform Evolution Modelling Study (**Appendix AA**). **Table 8-2** outlines the LEM's erosion risk assessment results.

Table 8-2 LEM erosion risk assessment results

Scenario	10 year model simulation	100-year model simulation
1 – bare Earth	High	High
2 – 30% rock mulch (pre-vegetation)	High	High
3 – 30% rock mulch with 30% grass cover	Moderate	High
4 – 30% rock mulch with 50% grass cover	Low	High
5 – 30% rock mulch with 70% grass cover	very low	Moderate

Source: Appendix AA

8.2.2 Geotechnical assessment of WRD stability

A geotechnical assessment was completed to determine the geotechnical stability of the final landforms, the in-pit and ex-pit WRD's (**Appendix G**). Two-dimensional (2D) limit equilibrium analyses were performed to determine the overall slope stability in terms of a Factor of Safety (FoS) as part of mine closure requirements.

It was concluded from the 2D limit equilibrium analyses that:

- In-pit and external WRD's were assessed to be geotechnically stable, based on the assumptions and final landform designs provided by METServe; and
- The proposed final landform design exceeds the minimum FoS of 1.5 (see **Table 8-3** below) for long-term stability, based on the assumptions, and is therefore acceptable from a geotechnical perspective.

Table 8-3 Final landform slope geotechnical stability analysis results

Final Landform	Failure Surface	Search Method	FoS
Vulcan North – Ex-Pit Dump	Circular	Auto-Refine	3.48
Vulcan North – In-Pit Dump			3.01
Vulcan Main – In-Pit Dump			2.56
Vulcan Main – Ex-Pit Dump			3.99
Vulcan South – In-Pit Dump			3.14
Vulcan South – Ex-Pit Dump			4.03

8.3 Rehabilitation Methods

8.3.1 Relevant MNES

The following threatened species under the EPBC Act have been recorded within the Project area, and were determined as likely being impacted by the Project. The remaining species highlighted through database searches were discounted following assessment with consideration to their habitat requirements, regional and local distribution and the likely importance and use of the habitat by the species. Therefore, the list below represents the EPBC Act species in which their needs have been considered in the rehabilitation planning:

- Koala (*Phascolarctos cinereus*) (endangered under the EPBC Act and NC Act);
- Squatter Pigeon (*Geophaps scripta scripta*) (vulnerable under the EPBC Act and NC Act);
- Greater Glider (*Petauroides armilatus*) (endangered under the EPBC Act and NC Act); and
- Brigalow (*Acacia harpohylla*) threatened ecological community (Endangered under the EPBC Act and NC Act)

The following milestone monitoring methodologies are summarised below related to applicable MNES:

- Milestone 7: Establishment of target vegetation in non-riparian areas
- Milestone 8: Establishment of Target vegetation in riparian areas
- Milestone 9: Achievement of native ecosystem and use with stable condition

8.3.1.1 Rehabilitation milestone 7: Establishment of target vegetation in non-riparian areas

Rehabilitation areas requiring the assessment of target vegetation in non-riparian areas include RA4, RA6, RA8 and RA10.

Field Surveys

Field surveys are to monitor the following attributes of rehabilitation areas:

- relative dominance of Koala food trees;
- height of Koala food trees;
- basal area of *Casuarina cristata*;
- species richness of Greater Glider food trees;
- percentage cover of declared weeds;
- species composition of the pasture;
- density of woody vegetation within rehabilitated areas is to be sufficient for Squatter Pigeons; and
- availability of food for the Glossy Black-Cockatoo
- BioCondition score in accordance with BioCondition Assessment manual.
- Rehabilitation is to be non-polluting as derived from surface water quality criteria and soil testing

These attributes are to be measured within a 10 m × 50 m belt transect installed within rehabilitation areas.

Tree height is measured with a range-finder or clinometer. The five tallest Koala trees present within the belt transect are to be measured.

Basal area of woody vegetation is to be measured using a Bitterlich gauge. Each species of tree/shrub is to be measured separately. Each site is to be assessed using two 360° sweeps of the gauge (one at each end of the transect, 50 m apart), and the basal area of each woody species is the average from the two sweeps. The proportion of the total basal area of all woody vegetation that comprises Koala food trees (*Eucalyptus camaldulensis, Eucalyptus crebra, Eucalyptus exserta, Eucalyptus melanophloia, Eucalyptus orgadophila, Eucalyptus populnea, Eucalyptus tereticornis*) is used to assess the milestone criterion pertaining to Koalas. The total basal area of *Casuarina cristata* is used to assess the milestone criterion pertaining to Glossy

Black-Cockatoos. The presence of different *Eucalyptus* and *Corymbia* species is used to the milestone criterion pertaining to the Greater Glider.

The entire belt transect is to be searched, and all species of forbs and grasses contained within it are to be recorded. Percentage ground cover of each species is to be estimated to the nearest 0.1%, with 0.1% cover being equivalent to 0.5 m^2 total cover within the transect. From this data, milestone completion criteria pertaining the grass species richness and weed cover can be assessed. Specifically, rehabilitated areas have less than 0.2% cover of *Parthenium hysterophorus* and rehabilitated areas are to have less than 0.1% cover of *Harrisia martinii* AND any invasive plants do not exceed 1 individual per hectare, as confirmed by an AQP from annual monitoring.

Field surveys are to be undertaken in the late wet season (February-May), to coincide with maximum growth of grasses and forbs. Permanent monitoring sites are to be installed within all rehabilitation areas, and each end of each transect is to be marked with a star picket. An average of one monitoring site is to be installed per 10 ha of rehabilitated land. Reference sites are to be installed in nearby undisturbed land used for grazing. Reference sites are to be of a similar soil type and slope to rehabilitated sites and must have a vegetation density appropriate for Squatter Pigeons.

Reference sites will be selected to (a) meet the requirements for soil, slope and vegetation density, (b) be evenly spaced, with at least 500 m between them, and (c) be preferentially located within the MLA area, and therefore not subject to any external access permissions. To avoid biases in the placement of these reference sites, their coordinates will be selected based on GIS information rather than through site visits. The baseline condition of reference sites must represent a random sample of analogous, nearby, unmined vegetation communities. Reference sites are to be surveyed concurrently with every second rehabilitation area monitoring round. Reference sites must be monitored in the year rehabilitation success is expected. Vegetation development is to be assessed every two years until milestone criteria have been achieved.

After vegetation establishment (after 6 to 12 months since sowing) soils will be re-tested to determine if any follow-up application of ameliorants is required.

Non-polluting criteria

Field surveys are to also monitor the following attributes of rehabilitation areas:

- soil testing for rootzone EC, Soil pH and Exchangeable Sodium Percentage (ESP).
- Surface water testing for pH, TSS and EC

These attributes are to be measured within a 10 m X 50 m belt transect installed within rehabilitation areas.

Eucalyptus camaldulensis is to constitute 33% of the total basal area of woody vegetation as measured using a Bitterlich (described above). Rehabilitation areas must achieve a BioCondition score of at least 40/80, based on benchmarks relevant to the analogous regional ecosystem 11.3.25 using site-based attributes only. The methodology for BioCondition assessments is described above in **Section 8.3.1.1**.

Soil testing will be conducted on the following parameters:

- Rootzone EC <1.5 dS/m (1,500 µS/cm);
- Soil pH <8.5 and >6 as measured at any part of the root zone; and
- Exchangeable Sodium Percentage (ESP%) <6% (at 0-10cm depth).

Surface water quality testing will achieve the following criteria:

- pH: 6.5-8.5;
- TSS 110 mg/L; and
- EC: <310 µS/cm.

BioCondition Assessment

All REs across the Project area must achieve a BioCondition score of at least 40/80, based on benchmarks relevant to an analogous regional ecosystem and site based attributes only. A milestone criteria target BioCondition score of 40/80, is proposed because studies conducted in similar environments concluded this to be a suitable score. A mean score of 42/80 was achieved by 10-20 year old rehabilitated sites at Meandu, southeast Queensland, the only site for which publicly available data is available (Ngugi & Nelder, 2015), suggesting that 40/80 is a reasonable and achievable target for the Project. The monitoring of BioCondition is to be undertaken by an AQP in accordance with the latest version of the BioCondition Assessment Manual.

All REs within the Project area that are classified as 'native ecosystem' will be reinstated to their initial classification. All REs across the Project area to be reinstated and their corresponding rehabilitation areas are summarised below in **Table 8-4** below.

Table 8-4 Summary of dominant REs across Project area

Regional Ecosystems	Description	Relevant RAs
11.4.8	*Eucalyptus cambageana woodland to open forest with Acacia harpophylla or A. argyrodendron on Cainozoic clay plains*	*RA1, RA4, RA6, RA8*
11.5.3	*Eucalyptus populnea +/- E. melanophloia +/- Corymbia clarksoniana woodland on Cainozoic sand plains and/or remnant surfaces*	*RA1, RA4, RA6, RA8*
11.10.1	*Corymbia citriodora woodland on coarse-grained sedimentary rocks*	*RA6,RA8*
11.3.25	*Eucalyptus tereticornis or E. camaldulensis woodland fringing drainage lines*	*RA3, RA8*
11.10.3	*Acacia Shirleyi* open forest	*RA1, RA4, RA6, RA8*
11.5.9	*Eucalyptus crebra* and *melanophloia* woodland	*RA6, RA8*
11.9.2	*Eucalyptus melanophloia +/- E. orgadophila* woodland to open woodland	*RA6, RA8*

The methodology to be adopted when undertaking habitat quality assessments with regard to environmental offsets in Queensland is prescribed by the Guide to Determining Terrestrial Habitat Quality version 1.3 (DES, 2020a) (see **Appendix M**). BioCondition will be assessed following the methodology prescribed by the BioCondition Assessment Manual version 2.2 (Eyre, et al., 2015). This methodology uses quadrat sampling to generate measurements of native plant richness, recruitment, shrub and tree cover, native perennial grass cover, litter cover, amount of coarse woody debris, nonnative plant cover, tree height and number of large trees. These measurements are then compared to benchmarks published by the Queensland Herbarium compiled from various reference sites. The most recent revision (version 3.2) of these the benchmarks will be used. Each RE will also be assessed against different reference site benchmarks, to account for variability in "quality" between RE's, as per **Table 8-5**..

The scoring system prescribed by the BioCondition Assessment Manual version 2.2 (Eyre, et al., 2015)results in a score out of 80, while the Guide to determining terrestrial habitat quality version 1.3 (DES, 2020a) requires that this score is out of 100. To achieve this conversion, the original score will be multiplied by 1.25.

Table 8-5 BioCondition benchmark criteria

Relevant PMLU	Native Vegetation																	
BioCondition Assessable Attributes	11.4.8			11.5.3			11.9.2			11.10.1			11.10.3			11.5.9		
	40/80	60/80	80/80	40/80	60/80	80/80	40/80	60/80	80/80	40/80	60/80	80/80	40/80	60/80	80/80	40/80	60/80	80/80
Recruitment (tree species)	1	2	3	3	4	6	1	1	2	2	3	4	1	2	3	1	2	3
Non-native plant cover (%)	max. 10	max. 5	0	max. 10	max. 5	0	max. 10	max. 5	0	max. 10	max. 5	0	max. 10	max. 5	0	max. 10	max. 5	0
Tree (native) species richness*	1	2	3	3	4	6	1	1	2	2	3	4	1	2	3	1	2	3
Shrub (native) species richness*	5	7	10	3	4	6	5	7	10	2	3	4	2	3	4	3	4	6
Grass (native) species richness*	4	7	9	3	4	6	3	5	7	4	7	9	3	5	7	4	7	9
Forb/other (native) species richness	3	5	7	5	7	10	6	9	12	8	13	17	4	7	9	5	8	11
Tree canopy cover (%)	8	13	17	8	12	16	7	11	15	12	18	24	7	11	15	12	19	25
Native perennial grass cover (%)	10	15	20	9	14	19	9	13	18	8	12	16	11	17	23	13	19	26
Litter and other vegetation cover (%)	18	26	37	10	15	20	15	22	30	25	37	50	16	24	32	15	22	30

*Species richness must be based on species that occur in the RE technical description

8.3.1.2 Rehabilitation milestone 8: Establishment of Target vegetation in riparian areas

All information described above in **Section 8.3.1.1** applies for RM8 and this milestone criteria will be managed in the same way.

Field surveys are to also monitor the following attributes of rehabilitation areas:

- percentage basal area of *Eucalyptus camaldulensis;*
- BioCondition score relevant to the analogous regional ecosystem 11.3.25.

8.3.1.3 Rehabilitation Milestone 9: Achievement of native ecosystems land use with stable condition

The achievement of a stable landscape that can support ecosystem land use is to be monitored through field survey programs, described below.

Presence of species

Field surveys (measured within a 10 m × 50 m belt transect installed within rehabilitation areas) are to assess the following rehabilitation criteria have occurred to determine milestone success:

- at least 50% of established species show natural recruitment and therefore soil amelioration techniques and seed mixes are appropriate for rehabilitation goals;
- *Eucalyptus crebra*, *Eucalyptus orgadolphila* and/or *Eucalyptus populnea* are to constitute 21% of the total basal area of woody vegetation on soil management units Limpopo, Fish, Kei and Komati;
- rehabilitated areas are to contain *Eucalyptus camaldulensis* and at least one other species of Corymbia or Eucalyptus;
- rehabilitated areas where the ground is level and soil management unit "Orange" has been used as topsoil are to have a minimum stem basal area of 0.5m^2/ha of *Casuarina cristata*; and
- sites fulfil all other milestone criteria after having experienced at least one “drought” year (defined as having a total rainfall over a 12-month period that falls within the lowest decile recorded at the nearest weather station, Moranbah Airport). This is to ensure the longevity of rehabilitation and its sustainability into the future across diverse climactic and environmental conditions.

Landscape Function Analysis

Monitoring of the stability of rehabilitated land is to be based on the “stability index” of Landscape Function Analysis (LFA) (Tongway & Hindley, 2004). Methodology to be adopted is described in detail by Tongway and Hindley (2004). Permanent monitoring sites used for vegetation monitoring are also to be monitored for soil stability.

Monitoring is to take place in the late wet season (February-May), to coincide with maximum plant growth. Reference sites are to be monitored at the time of planting and then every two years for ten years after planting. This time series of six intervals will generate a sigmoidal curve for the stability index. A stable PMLU will be achieved when the landscape function analysis scores for soil stability have started to plateau, and the plateau values predicted from sigmoidal curve fitted to the data are equivalent to or exceed values at analogue sites (Tongway & Hindley, 2004). If the curve does not plateau or exceed the target value within ten years, additional rounds of monitoring will take place every five years until the target is achieved.

Slope gradients, soil types and vegetation densities have all been considered when site locations were chosen. The Locations of proposed reference sites are listed in **Table 8-6.**

Table 8-6 Proposed reference sites for LFA monitoring

Site	Slope	Start Easting	Start Northing	End Easting	End Northing
R1	Flat[1]	620964.65097	7535047.20624	620992.47603	7535085.49969
R2	Flat	620844.94853	7534066.38659	620894.26898	7534058.12426
R3	Flat	629184.84267	7522788.01160	629230.03485	7522797.59895
R4	Flat	627353.36337	7525088.33690	627389.73435	7525118.17137
R5	Flat	624851.64841	7527710.07831	624902.85635	7527702.30345
R6	Sloping[2]	619917.42716	7535876.11707	619930.41274	7535827.41415
R7	Sloping	620078.22373	7535360.09998	620111.95529	7535367.34973
R8	Sloping	620303.14802	7534902.02272	620313.05410	7534948.37178
R9	Sloping	623912.93586	7524955.12550	623958.71296	7524958.20992
R10	Sloping	626001.58270	7523995.80409	625981.64716	7523952.12251

Reference sites are to be surveyed concurrently with every second round of rehabilitation area monitoring. Reference sites must be monitored in the year rehabilitation success is expected. Vegetation development is to be assessed every two years until milestone criteria have been achieved.

BioCondition Assessment

All REs across the Project area must achieve a BioCondition score of at least 60/80 for achievement of native ecosystem land use with a stable condition, based on benchmarks relevant to an analogous regional ecosystem and site based attributes only. The monitoring of BioCondition is to be undertaken by an AQP as per the latest version of the BioCondition Assessment Manual.

All REs within the Project area that are classified as 'native ecosystem' will be reinstated to their initial classification. A few examples of the dominant RE's across the Project area to be reinstated are summarised in **Table 8-4.**

The methodology to be adopted when undertaking habitat quality assessments with regard to environmental offsets in Queensland is prescribed by the Guide to Determining Terrestrial Habitat Quality version 1.3 (DES, 2020a). BioCondition will be assessed following the methodology prescribed by the BioCondition Assessment Manual version 2.2 (Eyre, et al., 2015). This methodology uses quadrat sampling to generate measurements of native plant richness, recruitment, shrub and tree cover, native perennial grass cover, litter cover, amount of coarse woody debris, nonnative plant cover, tree height and number of large trees. These measurements are then compared to benchmarks published by the Queensland Herbarium compiled from various reference sites. The most recent revision (version 3.2) of these the benchmarks will be used. Each RE will also be assessed against different reference site benchmarks, to account for variability in "quality" between REs.

The scoring system prescribed by the BioCondition Assessment Manual version 2.2 (Department of Science, Information Technology, Innovation and the Arts 2015) results in a score out of 80, while the Guide to determining terrestrial habitat quality version 1.3 (DES, 2020a) requires that this score is out of 100. To achieve this conversion, the original score will be multiplied by 1.25.

Ground Cover

Landscape Function Analysis, discussed above, involves an assessment of percentage ground cover as classes.

A more accurate measurement is required to specifically assess the rehabilitation completion criteria that "Groundcover is to remain above 80% on all slopes with a gradient higher than 10%, and 50% on slopes with a gradient lower then 10%". While this criteria relates specifically to rehabilitation areas to which cattle have been introduced (at advanced stages of rehabilitation development), it is prudent to commence this monitoring prior to the introduction of cattle. This data can then be used to calculate the effect of grazing on percentage cover, and thereby predict the groundcover expected at ungrazed sites following cattle introduction. This in turn will be useful for adjusting stocking rates, if required.

[1] Flat- reference sites located on slope gradients less than 6%.
[2] Sloping- reference sites located on slope gradients between 10-20%.

Ground cover is to be calculated by running a 50 m measuring tape along the length of each vegetation monitoring transect. Observations of the type of cover (limited to the cover present below 1 m above ground level) are made at point intercepts along the centre line of the 50 m transect at 0.5 m intervals. Cover types include (a) vegetation (including all live vegetation and standing senescent vegetation that is still attached to the main plant and is not in intimate contact with the soil); (b) leaf litter and woody debris; (c) rock or (d) bare ground. The cover type that is intercepted directly below each point is recorded. The intercept point is to be assessed by viewing the ground through a small observation hole (in a piece of stiff card or plastic) or tube. Preferably, this should contain a cross hair, although this is not obligatory. A total of 100 observations are made per transect, and the sum of each cover type equates to its percentage cover.

Percentage cover is to be assessed at rehabilitation sites only (reference site data is not required). Monitoring is to be undertaken concurrently with assessments of landscape function and vegetation surveys in the late wet season.

Erosion Monitoring

Additional erosion monitoring across the landform will also be undertaken for the early detection of erosion, to allow for early intervention. In-field erosion monitoring will be undertaken at permanent monitoring transects, (50 m in length) established across the landform in conjunction with the LFA monitoring sites, to provide a basis for temporal assessments.

Visual observations will be taken whilst traversing transects on foot and recording the number and average depth of any erosion features, rill lines or gullies. Visual assessments should identify any evidence of excessive sediment movement, including the formation of rills, removal of soil around the base of plants and accumulation of loose sediment at the base of slopes. In-field erosion monitoring will be accompanied by assessment of the water quality of run-off water released from the catchment of given rehabilitation areas.

An AQP will be employed to certify that the final landform is geotechnically stable. Erosion monitoring methodology is further detailed in Section 9.6 of the Vulcan South Soils and Land Suitability Assessment (**Appendix L**).

Water Quality

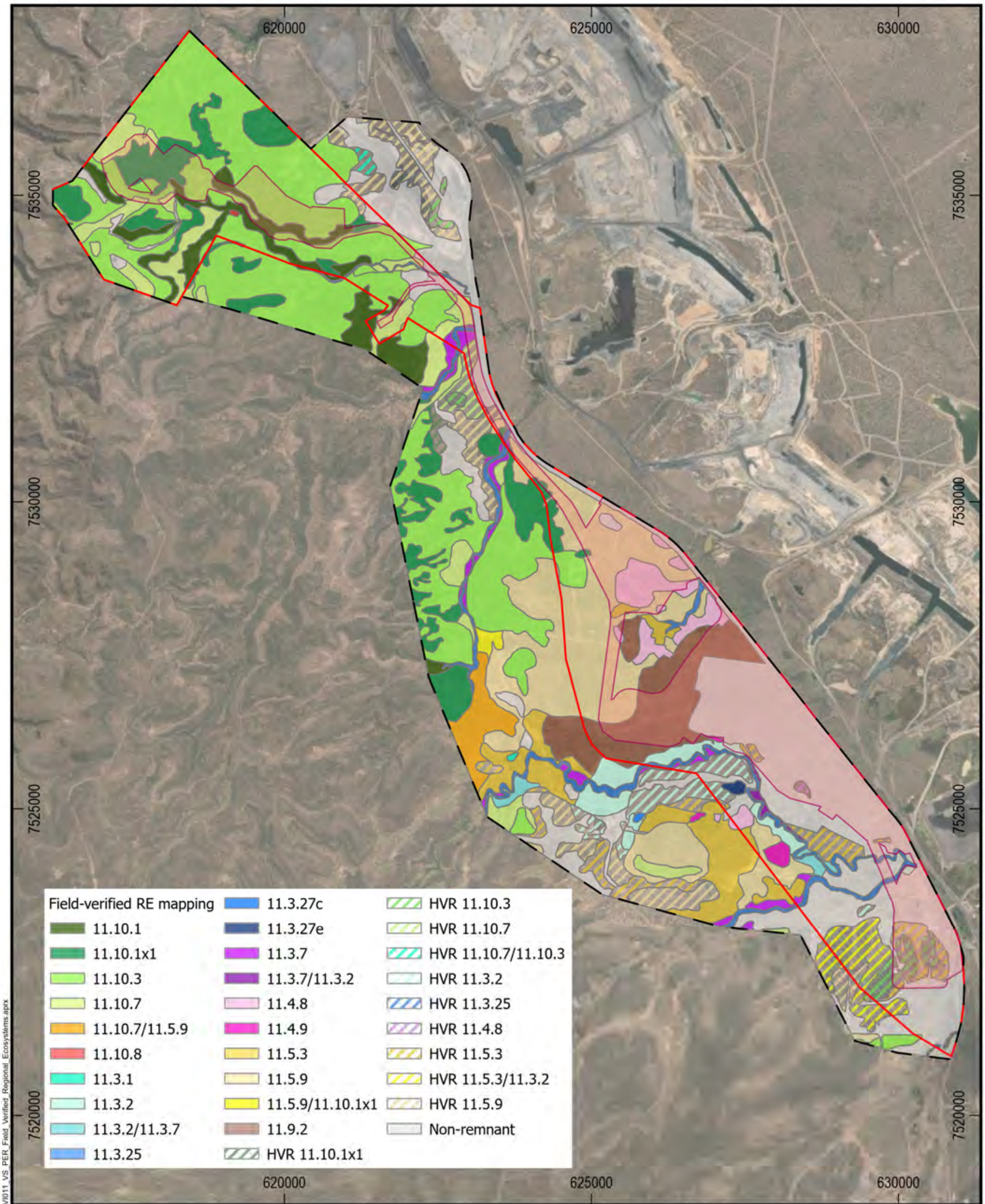
The Project will have a groundwater and surface water monitoring program operating throughout all phases of the Project, including through rehabilitation and closure. The proposed surface water monitoring locations as per the approved EA100265081 are provided in **Figure 7-6**, and the approved trigger limits and frequency of monitoring are shown in **Table 7-6.** The Final EA is provided in **Appendix E**. For a detailed description of the methodology to be adopted and the location of sampling sites, refer to the Receiving Environment Water Monitoring Program (**Appendix X**).

8.3.2 Sedimentation and Erosion

Erosion monitoring is described in **Section 8.3.1.33**– achievement of Native ecosystems PMLU.

8.4 Vegetation Community and Habitat to be Rehabilitated

The REs to be reinstated are listed in **Table 8-4** with their corresponding rehabilitation areas. Rehabilitation areas across the Project area are shown in **Figure 8-2** and **Figure 8-3.** Of those RE's to be reinstated, they are to be native ecosystems are to be substantially established spatially as **Figure 8-4**.



Legend

Vulcan South Coal Mine (2023/09708)

Project Area (ML 700073)

Disturbance Footprint

Survey Boundary

Source: State of Queensland (Department of Resources) 2023, METServe 2019-2024, Vitrinite 2024, Earthstar Geographics

Vulcan South

Field-verified Regional Ecosystems

0 0.75 1.5 3

Kilometers

Scale: 1:90,000 (A4)

25/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 8-4

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

8.5 Rehabilitation Management

This is described above in relation to threatened species PMLU and rehabilitation area management (**Section 8.3.1)**.

Methodology for milestone monitoring is described in Section 9.1 of the PRCP (**Appendix J**) and summarised above in **Section 8.3**.

Rehabilitation milestones RM6, RM7, RM8, RM9 and RM10 are expected to be assessed concurrently and, as they constitute the primary rehabilitation completion criteria for the Project, they will be monitored over an extended period of at least 10 years.

The results of each-yearly monitoring event will be presented in a report that assesses progress of these five milestones. Each report will contain details about how the methodology used is consistent with this PRC Plan. Each report will also discuss how the results obtained indicate progression towards the fulfilment of milestone criteria.

This monitoring report is to be completed by 1 October in the calendar year in which surveys are undertaken, to allow adequate time to report on the findings by the state-wide reporting deadline of 10 December.

8.6 MNES Rehabilitation Acceptance Criteria and contingency measures

Rehabilitation Milestone Criteria are provided within **Section 8.1.**

Vitrinite has a legal obligation to meet the milestones detailed in **Table 8-1** under the QLD State Government *Environment Protection Act 1994 (EP Act)* as part of the approved Progressive Rehabilitation and Closure Plan schedule. Under section 206A of the EP Act, the following applies:

- It is a condition of a PRCP schedule that, in carrying out a relevant activity under the schedule, the holder must comply with a requirement stated in the environmental authority relevant to the carrying out of the activity.
- It is condition of the PRCP schedule that the holder must comply with the following matters stated in the schedule – (a) each rehabilitation milestone and management milestone; and (b) when each rehabilitation milestone and management milestone is to be achieved.

This is monitored by the completion of an annual progress report that is submitted to the state Department for review and consideration. An independent audit must also be completed every three years to ensure compliance with the rehabilitation milestone criteria within the PRCP schedule. Vitrinite must comply with any conditions of the audit notice. Specific contingency measures for MNES rehabilitation acceptance criteria are included within the 'Habitat values are not returned following rehabilitation" row of **Table 7-1**. Examples of these are provided below:

Habitat establishment

- Seeds are not establishing as planned:
  - seed or fertiliser application rates and mixes will be modified as required
- Sites with insufficient density of trees and shrubs developing over the first two years:
  - will undergo supplementary seeding or planting of tubestock.

Weed invasion

- All vehicles that enter undisturbed parts of the site must be washed and certified weed free prior to arrival at the project site:
  - Review weed hygiene certifications, any vehicles found to be lacking certification will immediately be required to undertake washdown and certification process.
  - Weed infestations will be controlled in accordance with the weed management plan

Erosion

- Any erosion classified as 'moderate' or 'severe' as defined in the PRCP Schedule has been remediated prior to topsoil application on rehabilitated areas:

- Corrective actions recommended by AQP have been implemented – such as the application of fast growing grasses with additional fertilizer and the application of rock cover to protect the surface.
  - If these corrective actions are not implemented, this is considered a non-compliance with the PRCP Schedule under the EP Act

8.7 Monitoring Program

The monitoring program is described above in relation to threatened species PMLU and rehabilitation area management (**Section 8.3.1)**.

8.8 Post-Construction Sites

All clearing and disturbance associated with the construction and operational phase will be rehabilitated progressively over the course of the project mine life, as prescribed by the PRCP schedule (**Appendix K**). There is no clearing proposed for the project following decommissioning or any clearing of areas that have previously been rehabilitated. All rehabilitation will remain in perpetuity.

9 Environmental Offsets

The Terrestrial Ecological Assessment (**Appendix M**) examined the environmental values in and near the Project area. The significance of impacts of Vulcan South on MNES was assessed against the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (Department of the Environment, 2013a) within the EPBC Act referral documentation. This assessment determined that the following listed threatened species and ecological communities are likely to experience significant residual impacts as a result of Vulcan South:

- Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community;
- Squatter Pigeon (southern subspecies), *Geophaps scripta scripta* (Vulnerable);
- Koala (combined populations of Queensland, NSW and the ACT), *Phascolarctos cinereus* (Endangered); and
- Greater Glider, *Petauroides volans* (Endangered).

Vitrinite has prepared a draft Offset Area Management Plan (OAMP) for approval (**Appendix II**).

9.1 Residual Significant Impacts on MNES

9.1.1 Brigalow TEC

Field-verified vegetation mapping reveals that a total of 71.2 ha of the threatened ecological community listed as "Brigalow (*Acacia harpophylla* dominant and co-dominant)" is to be cleared to accommodate the proposed mine and infrastructure (**Figure 5-1**). Of these, 67.2 ha constitute remnant vegetation and the remainder is regrowth that meets the criteria of being older than 15 years, in accordance with the definition of the community within the approved conservation advice (Department of the Environment, 2013b).

Note that this amount is less than what is indicated by the regulated vegetation map, which includes additional remnant regional ecosystems 11.4.8 and 11.4.9 (constituents of the Brigalow threatened ecological community) over the already-cleared Saraji Road and Norwich Park Branch Railway, along with a patch of regrowth 11.4.9 (which field surveys indicate does not exist) in the vicinity of the Vulcan Main pit.

An additional 47.8 ha of Brigalow (*Acacia harpophylla* dominant and co-dominant) is located within 500 m of the project's footprint boundary and may experience temporary effects of dust beyond the project's footprint. However, this is not considered significant.

According to the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (Department of the Environment, 2013a), an action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

- reduce the extent of an ecological community
- fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines
- adversely affect habitat critical to the survival of an ecological community
- modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns
- cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting
- cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:
  - assisting invasive species, that are harmful to the listed ecological community, to become established, or
  - causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community that kill or inhibit the growth of species in the ecological community, or

- interfere with the recovery of an ecological community.

Based on the criterion that the extent of the ecological community will be reduced by Vulcan South, the residual impacts to the Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community qualify as significant.

9.1.2 Squatter Pigeon

A total of 372.5 ha of breeding and foraging habitat, 78.9 foraging habitat and 767.6 ha of dispersal habitat are contained within the disturbance footprint.

The loss of habitat will result in significant residual impacts to this species. Furthermore, two sources of water (dams) used by Squatter Pigeons will be removed for Vulcan South. The removal of these water sources has the potential to reduce the local extent of breeding habitat beyond the boundaries of the disturbance footprint, as breeding habitat is defined by distance to water. However, the addition of new water sources (sediment dams, mine water dams, etc) have the potential to offset some or all of these impacts. In order to assess the net effect of water source removal and addition, Squatter Pigeon breeding habitat was recalculated for the survey area outside the disturbance footprint, based on planned water infrastructure. This analysis revealed that the installation of new water sources will more than make up for the removal of former water sources, and the net gain of breeding habitat outside the clearing footprint will be 85.6 ha (i.e., 85.6 ha of foraging habitat is within 1 km of the new water sources, making this appropriate for breeding).

The size of the average home range of a pair of Squatter Pigeons is not known, but the related Partridge Pigeon (*Geophaps smithii*) is thought to occupy a home range of approximately 8 ha (Fraser, et al., 2003). Assuming Squatter Pigeons are similar—a likely scenario, given their similar biology—the project could impact up to 54 breeding pairs of Squatter Pigeons. This is very likely to be an over-estimate, and occupancy rates of 50% within potential habitat are more consistent with rates of detection in the field. This implies an expected loss of habitat for up to 27 pairs of Squatter Pigeons.

An additional 170 ha of breeding habitat was or is approved to be removed for the neighbouring Vulcan Coal Mine. Assuming habitat from the Vulcan Coal Mine is not rehabilitated prior to the commencement of Vulcan South, breeding habitat for 102 pairs will be retained in the local landscape throughout the project (assuming each pair occupies 8 ha and 50% of available territories are occupied). The estimated size of this retained local population is highly conservative, as it does not include contiguous habitat west and south of the survey area. It is more likely that habitat for several hundred pairs will be retained in the local region, supporting a viable population that will serve as a source of recruitment for rehabilitated land post-mining.

The impacts of habitat clearance will persist at least for the short- to medium-term, until vegetation is re-established on mined land. Being a ground-dwelling bird, they are not dependent on old trees, and rehabilitated sites are expected to meet their requirements for a low, protective tree cover within 15 years post-rehabilitation (Ngugi & Nelder, 2015). It is unknown whether the relatively simple understorey vegetation communities that typically establish on rehabilitated sites (Grigg, et al., 2000; Ngugi & Nelder, 2015) will meet the ecological needs of Squatter Pigeons. Their readiness to feed on introduced pasture species such as *Urochloa mosambicensis* and *Stylosanthes* spp. (Crome, 1976); C. Wiley pers. obs. 2019) suggests that re-establishing appropriate food plants is likely to be achievable. Consequently, it is estimated that the duration of impacts will be approximately 24 years, although this estimate has low confidence, given the lack of data on the dietary requirements of the species.

The significance of impacts to MNES is defined by the *Matters of National Environmental Significance Significant Impact Guidelines 1.1*. An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- lead to a long-term decrease in the size of an important population of a species;
- reduce the area of occupancy of an important population;
- fragment an existing important population into two or more populations;
- adversely affect habitat critical to the survival of a species;
- disrupt the breeding cycle of an important population;
- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;

- result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;
- introduce disease that may cause the species to decline; or
- interfere substantially with the recovery of the species.

As Vulcan South lies north of the Carnarvon Ranges, the local population of Squatter Pigeons does not qualify as an "important population" according to the (Department of Climate Change, Energy, the Environment and Water, 2024h), and hence criteria 1, 2, 3 and 5 are not relevant. The scale of habitat loss, relative to the large extent of habitat remaining in the local landscape, means that the project is not likely to jeopardise the viability of local populations (criterion 9 is not triggered).

Nevertheless, this local population is expected to temporarily decline by approximately 54 individuals, which may trigger a significant impact under the sixth criterion listed above. Also, because habitat used for foraging, breeding, roosting and dispersal (qualifies as "habitat critical to the survival of a species" under the *Matters of National Environmental Significance Significant Impact Guidelines 1.1*) is proposed to be removed, criterion 4 is also triggered by the project.

Vulcan South may also lead to localised increases in some weeds, which qualify as invasive species potentially threatening ground-feeding Squatter Pigeons. Weed introduction could potentially occur during the construction, operation and rehabilitation phases of the project. However, these impacts are not likely to extend far beyond Vulcan South's disturbance footprint and are not considered significant. As this impact assessment assumes all habitat within this footprint is to be removed, no additional impacts of weeds are anticipated.

Overall, Vulcan South is likely to have a significant residual impact on the Squatter Pigeon under the EPBC Act due to the expectation that it causes the loss of 372.5 ha of breeding and foraging habitat, 78.9 ha of foraging (but not breeding) habitat and 767.6 ha of dispersal habitat to the extent that the population is likely to decline, albeit to a limited extent and only temporarily.

9.1.3 Koala

A total of 1,166.9 ha of Koala habitat (foraging, shelter and dispersal) are contained within Vulcan South's proposed maximum disturbance footprint. Of this,938.6 ha is foraging, shelter and dispersal habitat, 45.5 ha is shelter and dispersal habitat and 182.8 ha is dispersal habitat. Little of this (12.7ha) is high-quality habitat (the habitat type in which most records occurred). Of the remainder, 494.4 ha of the disturbance footprint is moderate-quality habitat and 343.7 ha of the disturbance footprint is low-quality habitat (**Figure 5-9**). The remainder is dispersal habitat.

The impact of clearing will last until mature food trees have re-established in rehabilitated areas post-mining. Re-colonisation of rehabilitated sites after six years has been observed in wetter climates in south-east Queensland (Cristescu, et al., 2013), but a more conservative estimate of 15 years is adopted here due to the drier climate and slower growth rates expected. As the final blocks of disturbed land can only commence rehabilitation at the cessation of mining activities (nine years after the commencement of the project), the duration of disturbance is estimated to be 24 years. Viable populations of Koalas are expected to be maintained in extensive neighbouring habitats (95.1% of the high-quality habitat within the survey area is being retained, and extensive tracts of moderate-quality habitat occur throughout the adjacent Harrow Range) throughout this disturbance period, providing a source of recruitment to rehabilitated areas in the future. Average Koala densities in the Brigalow Belt are thought to be 0.005 Koalas/ha (Threatened Species Scientific Committee, 2012). Given that the Cherwell-Harrow Range spans over 170,000 ha, the remaining Koala population is expected to exceed 850 individuals.

The location of the proposed disturbance adjacent to existent mining operations, and the progressive staging of Vulcan South (at no time will all three pits be operational) means that no new barriers to dispersal are anticipated to arise as a result of Vulcan South.

An additional 2,110.9 ha of foraging/shelter/dispersal habitat are located within 500 m of the disturbance footprint and therefore may experience some disturbance from lighting, noise and dust. This disturbance is short-term, lasting only for the duration of the adjacent operations (1 to 9 years, depending on location) and is not considered significant.

Freight of construction materials and daily commute of workers will increase traffic rates on existing roads by up to 2.8% over baseline levels. This will lead to a negligible increase in risk of vehicles strikes. Due to the short duration and minor magnitude of these impacts, significant long-term impacts on local Koala populations are unlikely.

An action is likely to have a significant impact on an endangered species if there is a real chance or possibility that it will:

- lead to a long-term decrease in the size of a population;
- reduce the area of occupancy of the species;
- fragment an existing population into two or more populations;
- adversely affect habitat critical to the survival of a species;
- disrupt the breeding cycle of a population;
- modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
- result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;
- introduce disease that may cause the species to decline; or
- interfere with the recovery of the species.

The *National Recovery Plan for the Koala* (DAWE, 2022a) defines "area of occupancy" as the area within the extent of occurrence that is occupied by the species using 2 km × 2 km grid cells. Vulcan South will result in one grid cell that is currently occupied by Koalas becoming unoccupied, triggering criterion 2. Furthermore, Vulcan South will adversely affect habitat critical to the survival of the species (habitat used for feeding and resting), and thereby triggers criterion 4. The action therefore qualifies as a significant residual impact under the EPBC Act.

9.1.4 Greater Glider

A total of 1,056.8 ha of Greater Glider habitat is contained within the maximum disturbance footprint (**Figure 5-11**).

This impact will last until tree hollows have been replaced in rehabilitated areas post-mining. It is expected to take 120 years post-planting for trees to be large enough to form natural hollows (Gibbons & Lindenmayer, 2002; Smith & Agnew, 2002). Re-colonisation of rehabilitated sites after 13 years has been recorded in central Queensland where nest boxes support glider populations in mining rehabilitation sites devoid of natural hollows (Cristescu, 2011). However, nest boxes require regular maintenance and replacement (Beyer & Goldingay, 2006), and it is doubtful whether such a commitment can be fulfilled over a 120 year-period, until natural hollows form. For this reason, it is conservatively predicted that the loss of hollow trees within Greater Glider habitat constitutes a near-permanent loss. However, where hollows are available nearby, Greater Gliders are expected to commence foraging within rehabilitated areas within 15 years. As the majority of the disturbance is for haul roads, it is expected that most of this will be usable by Greater Gliders within 15 years after rehabilitation, as hollow trees will be retained nearby.

Viable populations of Greater Gliders are expected to be maintained in extensive neighbouring habitats (91.7 % of Greater Glider habitat is retained in the broader landscape) throughout the disturbance period, providing a source of recruitment to rehabilitated areas in the future. No data on population density is available for Greater Gliders within the Brigalow Belt, but the related Greater Glider occurs at average densities of 0.6 to 4 individuals per hectare (Henry, 1984; Kehl & Borsboom, 1984; Nelson, et al., 2018) while the Northern Greater Glider occurs at a density of 3.3 to 3.8 individuals per hectare at the single site (Taravale) in which they have been studied (Comport, et al., 1996). With a conservative assumption that densities within the survey area are on the lower end of published data (i.e., 0.6 per hectare), the 561.8 ha of habitat that will remain uncleared within the survey area supports at least 337 individuals. Furthermore, this population is likely to be connected to others throughout the Harrow Range to the west.

The location of this disturbance immediately west of existing mining operations means that no new barriers to dispersal are anticipated to arise as a result of the project. West of the project footprint, continuous tracts of riparian habitat remain connected to forests in sheltered gorges of the Harrow Range.

An additional 2,209.8 of habitat for Greater Gliders is located within 500 m of the main operational areas (highwall mining and hauling, mine pit, waste rock dumps and offices) and therefore may experience some disturbance from lighting, noise and dust. This disturbance is short-term, lasting only for the duration of the adjacent operations (1 to 9 years, depending on location) and is not considered significant.

The significance of impacts to MNES is defined by the *Matters of National Environmental Significance Significant Impact Guidelines 1.1*. An action is likely to have a significant impact on an endangered species if there is a real chance or possibility that it will:

- lead to a long-term decrease in the size of a population;
- reduce the area of occupancy of the species;
- fragment an existing population into two or more populations;
- adversely affect habitat critical to the survival of a species;
- disrupt the breeding cycle of a population;
- modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
- result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;
- introduce disease that may cause the species to decline; or
- interfere with the recovery of the species.

On the grounds that the project will reduce the area of occupancy by 1,056.8 ha and adversely affect habitat critical to the survival of a species (i.e., by removing hollow trees), Vulcan South is likely to significantly impact the Greater Glider.

Vulcan South may also lead to localised increases in some weeds, although no local weeds pose a threat to the health and long-term viability of large eucalypts used by Greater Gliders.

9.2 Offsets Strategy

An Environmental Offsets Strategy (EOS) has been prepared for the Vulcan South Project and is attached in **Appendix Z**. Vitrinite has developed the EOS to articulate and commit to a process that will be undertaken to identify and assess suitable offset sites.

To achieve the required environmental offsets, Vitrinite intends to procure, protect and restore areas of land that support the matters that will be impacted by Vulcan South. Suitable land to achieve these goals has been identified, and Vitrinite has confirmed that a prospective property is suitable to meet the requirements for each applicable MNES. All required species have been identified on the prospective property. The landholder is agreeable to host the offset on the property and commercial negotiations are progressing. Vitrinite has prepared a draft OAMP for approval (**Appendix II**).

While the primary consideration in determining suitable offsets is delivering a conservation gain for the impacted protected matter, the delivery of offsets that establish positive social or economic co-benefits is encouraged by the *EPBC Act Environmental Offsets Policy.* Three examples provided within the policy include an offset:

- contributing to an area recognised as important to increasing landscape connectivity, above and beyond what is required by the impacted protected matter;
- that employs local Indigenous rangers to undertake management actions; and
- delivered by paying rural landholders to protect and manage land for conservation purposes.

The approach to be taken for Vulcan South is one based on one or more of the above social benefits listed above.

9.2.1 Habitat quality

A robust assessment of habitat quality within the impact and proposed offset areas is necessary for confirming the appropriateness of offsets for three reasons:

- The Offsets Assessment Guide requires evidence-based quality scores for the impact and offset areas, in order for the Commonwealth Government to assess the offset proposal.

- Improvement in habitat quality over time is one of two means by which conservation gains can be achieved via offsets (the other is via increased levels of habitat protection), and the assessment of baseline habitat quality and improvements over time are important for monitoring the success of offsets.
- In accordance with Section 7.1 of the EPBC Act Environmental Offsets Policy, an offset area must possess, as a minimum, the quality of the habitat at the disturbance footprint, or be managed and resourced over a defined period of time so that its habitat quality is improved to meet the quality of habitat originally impacted.

As stated within the EPBC Act *Environmental Offsets Policy*, "in most cases [a suitable location for an offset site] will be as close to the disturbance footprint as possible. However, if it can be shown that a greater conservation benefit for the impacted protected matter can be achieved by providing an offset further away, then this will be considered."

Not only must suitable offset areas be located near the disturbance footprint, but the tenure of this land is important, as this affects the risk that habitat will be lost in the future without the additional protection afforded by offsets. Offsets are only suitable for areas of land that are not fully protected from clearing by other laws or legal instruments.

Even though remnant vegetation is protected in Queensland as category B regulated vegetation under the *Vegetation Management Act 1999* (VM Act), a small amount of clearing occurs annually through exempt works and illegal activities. The rate of clearing differs between tenure types (**Table 9-1**). Of the dominant land tenures in Queensland, background clearing rates of remnant vegetation are highest on freehold land, followed by leasehold. These tenures therefore stand to benefit most from the additional protection afforded by offsets. These patterns are reversed for regrowth vegetation; category C and X vegetation under the VM Act has a two to three times higher risk of clearing on leasehold than freehold land (**Table 9-2**).

Offset areas containing large amounts of non-remnant vegetation (category C, R and X vegetation under the VM Act) stand to benefit most from protection, as such vegetation is less fully protected (category C and R) or not protected (category X) under the VM Act, and experience high rates of re-clearing to maintain open landscapes for agriculture. Category C vegetation has, on average, twice the risk of clearing as remnant vegetation (category B), while category X vegetation has, on average, four times the risk (**Table 9-2**).

Table 9-1 Clearing rates of remnant vegetation per tenure type in the Brigalow Belt Bioregion since the introduction of the Vegetation Management Act 1999

Tenure	Percent of remnant vegetation that was cleared between 1999 and 2019*					
	Land Zone					Total
	3: Alluvial	4: Clay Plain	5: Sand Plain	9: Siltstone	10: Sandstone	
Freehold	9.40%	18.26%	17.71%	9.52%	6.75%	11.56%
Leasehold	7.02%	14.86%	16.11%	9.05%	4.48%	8.01%
State Forest	0.38%	0.16%	0.18%	0.82%	0.36%	0.30%
National Park	0.00%	0.04%	0.26%	0.18%	0.03%	0.05%

*Values represent the average of the Brigalow Belt Bioregion since the enactment of the Vegetation Management Act 1999, as reported by Accad et al. (2022).

Table 9-2 Clearing rates of all vegetation types within the Brigalow Belt Bioregion between 2015 and 2018

Land zone	Class under the VM Act*	Percent of vegetation class that was cleared between 2015 and 2018†	
		Freehold	Leasehold
3: Alluvial	Category B: Remnant vegetation	1.40%	1.38%
	Category C: High-value regrowth	0.53%	1.61%
	Category X: No protection	1.46%	3.00%
5: Sand Plain	Category B: Remnant vegetation	1.45%	1.16%
	Category C: High-value regrowth	0.62%	2.69%
	Category X: No protection	4.79%	5.08%
10: Sandstone	Category B: Remnant vegetation	1.27%	0.65%
	Category C: High-value regrowth	1.57%	6.08%
	Category X: No protection	4.34%	7.92%

*Category R regulated vegetation (regrowth along watercourses) was not recognised under the VM Act during the period of data collection, so is not included.

†Data was calculated by overlaying the Statewide Landcover and Trees Study (SLATS) clearing data for the periods 2015-2016 and 2016-2017 with version 10 of regional ecosystem mapping, and SLATS data for 2017-2018 with version 11 of regional ecosystem mapping. This ensured that the clearing data corresponded with the vegetation present at the start of each period. This analysis will be repeated for other land zones and to include the latest year of SLATS data, to inform the baseline risk of loss at prospective offset sites.

A suitable offset area for Vulcan South is one that:

- is located within Isaac Regional Council area, the Northern Bowen Basin subregion or Isaac-Comet Downs subregion. If no suitable offset area can be located within these areas, an alternate location will be chosen that lies within the northern half of the Brigalow Belt Bioregion;
- has freehold or leasehold tenure; and
- contains some areas with category C and X vegetation under the VM Act.

9.2.2 Methodology for assessing habitat quality

The methodology to be adopted when undertaking habitat quality assessments with regard to environmental offsets in Queensland is prescribed by the *Guide to Determining Terrestrial Habitat Quality version 1.3* (DES, 2020a). The Australian Government recommended that this guideline was used to inform habitat quality inputs in the *Offsets Assessment Guide* for the neighbouring Vulcan Coal Mine, and the same approach will be used for Vulcan South.

This guideline proposes two methodologies for assessing habitat quality:

- BioCondition assessments conducted in accordance with the *BioCondition Assessment Manual version 2.2* (Eyre, et al., 2015); and
- specially tailored, species-specific habitat quality scores developed by considering the foraging, breeding, sheltering and dispersal requirements of each species, along with local threat levels.

The former provides a general assessment of the overall state of the vegetation community. BioCondition assesses both site-specific habitat quality attributes, as well as landscape-scale attributes such as connectivity, size of habitat patch and regional context. The site-specific component of BioCondition is broadly analogous to the "site condition" score suggested within *How to Use the Offset Assessment Guide.* The landscape-scale component is broadly analogous to "site context" score. Meanwhile, the species-specific habitat quality scores indirectly reflects the potential stocking rate of the listed species that the habitat is able to support, by specifically targeting habitat features that are likely to be limiting local populations.

The Offsets Assessment Guide requires evidence-based habitat quality scores for the impact and offset areas. Habitat quality is to consider site condition, site context and species stocking rates, but no federal guidelines or manuals exist that prescribe how habitat quality is to be assessed. The *Guide to Determining Terrestrial Habitat Quality version 1.3* (DES, 2020a) was used to assess the habitat quality of the Vulcan south footprint. This guide recommends undertaking a comprehensive literature review of the species to identify the factors that constitute, and have the ability to affect, the following components of habitat quality:

- 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; and
- exposure to threats.

9.2.3 Habitat quality Scoring for the disturbance footprint

A project-specific set of indicators and a scoring system has been devised in order to assess habitat quality for the Koala, Greater Glider and Squatter Pigeon, as shown in **Table 9-3**. Koala and Greater Glider habitat value scoring is represented in **Figure 9-1** and **Figure 9-2.**

Further to this, the results of these assessments is provided in **Table 9-4** and **Appendix Z**. Note that the resulting habitat quality scores are largely independent from the habitat type. The calculations to derive the habitat quality scores for the disturbance footprint are provided in **Appendix BB**.

The species-specific habitat quality scores indirectly reflect the potential stocking rate of the listed species that the habitat is able to support, by specifically targeting habitat features that are likely to be limiting local populations. This is because when the habitat is higher quality the amount of individuals the environment can support (the carrying capacity) increases.

Sample site locations rather than AUs were used to derive the habitat quality scores as these provide a point in space rather than a broad area. This enabled a finer level of resolution to be achieved for the habitat quality scores as shown below in **Table 9-4.**

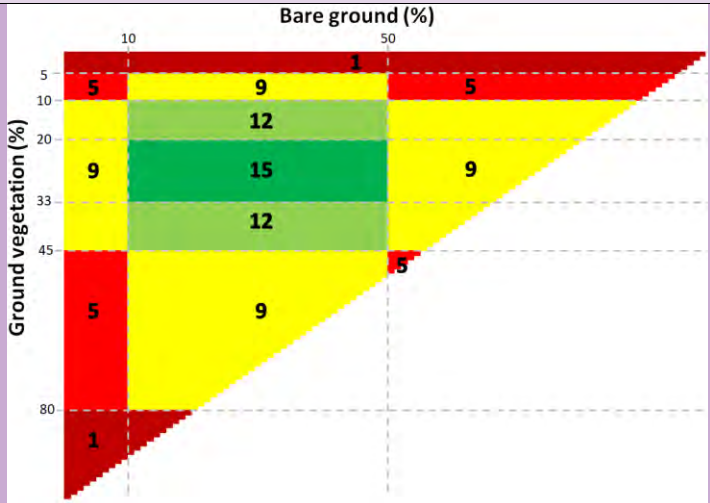
Table 9-3 Species-specific habitat quality scoring system proposed for the disturbance footprint

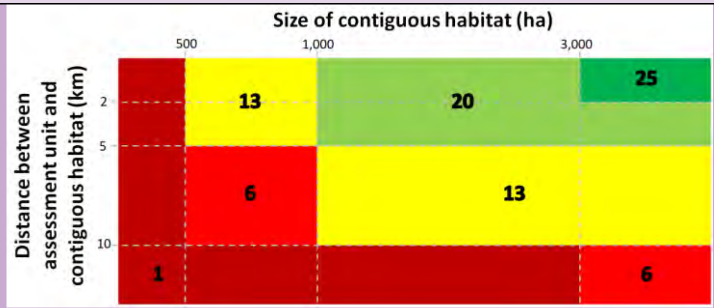
Koala	**1 Threats to species**	Score	0	3	6	8
		Risk of road-based mortality	High: Assessment unit borders a public road with 100 kph speed limit.	Moderate: Assessment unit is within 1 km of a public road with 100 kph speed limit, OR borders a public road with 60-100 kph speed limit.	Low: Assessment unit lies 1-2 km from public roads, AND any private tracks through or near the unit are used infrequently at night (less than once per week) and at low speeds (less than 50 kph).	Nil: Assessment unit lies >2 km from a public road, AND any private tracks through or near the unit are used infrequently at night (less than once per week) and at low speeds (less than 50 kph).
		Score	0	5	8	
		Risk of dog attack	High: Assessment unit is within 18 km of a town, dump or other source of supplementary food for dogs, and no control programs are in place.	Moderate: Assessment unit is within 18 km of a town, dump or other source of supplementary food for dogs, but active control measures (baiting, trapping or shooting) occur within the assessment unit and effectively reduce dog densities (as shown by monitoring).	Low: Assessment unit is further than 18 km from a town, dump or other source of supplementary food for dogs.	
		Score	0	5	9	
		Importance as a drought refuge	**Low:** The assessment unit is further than 2 km from a watercourse or source of surface water, OR is 1-2 km from a watercourse, but no vegetation occurs along the watercourse.	**Medium:** The assessment unit is 1-2 km from a watercourse or source of surface water and is connected to vegetation along the watercourse.	**High:** The assessment unit is within 1 km of a watercourse or source of surface water.	
	2 Quantity and quality of food	Score	Scores are assigned based on combination of basal area and proportion of common food trees, as shown in the below table			
		Density and quality of locally important koala trees trees	(see table below)			

		Percentage of total food tree basal area that comprises common food trees (*E. camaldulensis* or *E. tereticornis*)				
		0	**<10**	**10-40**	**40-70**	**70-100**
Combined basal area of all food	**0**	0	0	0	0	0
	<2	1	2	3	4	5

2-5	2	3	5	7	8
5-8	3	5	7	10	12
8-10	4	7	10	13	16
>10	5	8	12	16	20

		Score	1	2	3	4	5
		Number of large food trees (>BioCondition "large tree" threshold for stem diameter)	**None:** No large food trees	**Poor:** 1 or 2 large food trees per 0.5 ha	**Moderate:** 3 to 6 large food trees per 0.5 ha	**High:** 7 to 10 large food trees per 0.5 ha	**Very high:** >10 large food trees
	3 Quality and availability of shelter	Score	1	2	4	7	10
		Canopy cover of trees taller than 4 m.	**None:** No trees taller than 4 m.	**Poor:** <10% cover.	**Moderate:** 10-30% cover.	**High:** 30-60% cover.	**Very high:** >60% cover.
		Score	0	2	4	7	10
		Number of large non-food trees	0	1	2-4	5-10	>10
		Score	0	5			
		Presence of dense shade trees	Trees taller than 6 m and with a crown that has >75% cover are absent	Trees taller than 6 m and with a crown that has >75% cover are present			
	4 Species mobility capacity	Score	1	5	10	17	25
		Extent of contiguous habitat.	**Very poor:** Assessment unit is further than 5 km from contiguous habitat larger than 200 ha.	**Poor:** Assessment unit is 2-5 km from contiguous habitat larger than 200 ha	**Moderate:** Assessment unit is connected to, or within 2 km of, a contiguous landscape that is 200-500 ha.	**Good:** Assessment unit is within 2 km of a contiguous landscape that is 500-1,000 ha.	**Very good:** Assessment unit is connected to or within 2 km of a contiguous landscape that is >1,000 ha.
Squatter Pigeon	**1 Threats to species**	Score	1	6	11	16	
		Invasion by Buffel Grass	**High:** Buffel Grass has a ground cover >40%	**Moderate:** Buffel Grass has a ground cover of 10-40%.	**Low:** Buffel Grass has a ground cover of 0.1-9.9%.	**None:** Buffel Grass is absent.	
		Score	0	3	7	9	

		Predation by feral predators	**Very High:** Assessment unit is within 5 km of a town, dump or other source of supplementary food for dogs and cats, and no control programs are in place.	**High:** Assessment unit is within 18 km of a town, dump or other source of supplementary food for dogs, and no control programs are in place.	**Moderate:** Assessment unit is within 18 km of a town, dump or other source of supplementary food for dogs and cats, but active control measures (baiting, trapping or shooting) occur within the assessment unit and effectively reduce cat and dog densities (as shown by monitoring).	**Low:** Assessment unit is further than 18 km from a town, dump or other source of supplementary food for dogs and cats.	
	2 Quality and availability of food and foraging habitat	Score	**0**	**1**	*Unlike for other habitat attributes and species, the score for distance to water is multiplied by the sum of the other foraging scores to generate an overall foraging habitat score for Squatter Pigeons.		
		Distance to water*	**High:** Assessment unit is >3 km from water.	**Low:** Assessment unit is within 3 km of water.			
		Score	Scores (1-15) are assigned based on the percentage of ground covered by low vegetation (<1 m) and bare ground, as shown in the below table				
		Ground cover					
		Score	**1**	**3**	**5**	**8**	**10**
		Understorey richness	**Very low:** <5 species of grasses and forbs.	**Low:** 5-14 species of grasses and forbs.	**Moderate:** 15-24 species of grasses and forbs.	**High:** 25-29 species of grasses and forbs.	**Very high:** >30 species of grasses and forbs.
		Score	**0**	**1**			

	3 Quality and availability of habitat for shelter and breeding	Distance to water*	**High:** Assessment unit is >1 km from permanent water	**Low:** Assessment unit is within 1 km of permanent water.	*Unlike for most other habitat attributes and species, the score for distance to water is multiplied by the other breeding habitat score below to generate an overall breeding habitat score for Squatter Pigeons.		
		Score	**1**	**4**	**11**	**18**	**25**
		Normalised Difference Vegetation Index (NDVI)	**Very poor:** the assessment unit does not contain any 1-ha cells with a mean NDVI > 0.125.	**Poor:** <30% of the assessment unit has NDVI > 0.125.	**Moderate:** 30-60% of the assessment unit has NDVI > 0.125.	**Good:** 60-80% of the assessment unit has NDVI > 0.125.	**Very good**: >80% of the assessment unit has NDVI > 0.125.
	4 Species mobility capacity	Score	Scores are assigned based on the below table				
		Extent of, and distance to, large patches of contiguous habitat					

Central Greater Glider	**1 Threats to species**	Score	Scores are assigned based on the below table				
		Threat of intense canopy fires					

		Position in landscape		
		Valley	**Midslope**	**Crest**
Elevated Fine Fuel Hazard	**Low**	10	9	8
	Moderate	7	5	4
	High to extreme	5	2	1

		Score	**0**	**3**	**5**	**7**	**10**

		Importance as a climate change refuge	**None:** Assessment unit is further than 1 km from a drought refuge OR occurs within 1 km of a drought refuge but there is a vegetation gap > 0.5 km between the unit and the drought refuge.	**Low:** Assessment unit is <1 km from a permanent watercourse or an area mapped as a 'moderate' or 'high' potential groundwater-dependent ecosystem in the National GDE Atlas AND is connected to these drought refuges by woody vegetation.	**Moderate:** Assessment unit is within 100 m of a farm dam or other water impoundment OR overlaps with a 'low' potential groundwater-dependent ecosystem in the National GDE Atlas.	**High:** Assessment unit is adjacent to a permanent watercourse or overlaps with a 'moderate' or 'high' potential groundwater-dependent ecosystem in the National GDE Atlas.	**Very high:** Assessment unit is above 450 m in altitude.
		Score	**0**	**5**			
		Threat of barbed wire fences	**High:** Assessment unit is crossed by one or more fences with barbed top wire.	**Low:** Assessment unit is not crossed by any fences with a barbed top wire			
	2 Quality and availability of food	Score	Scores are assigned based on combination of tree diameter and basal area and proportion of food trees, as shown in the below table				
		Density and quality of food trees (*Eucalyptus* and *Corymbia* species)	(see table below)				
		Score	**1**	**2**	**3**	**4**	**5**
		Number of large food trees (>30 cm DBH)	**None:** No large food trees	**Poor:** 1 or 2 large food trees per 0.5 ha	**Moderate:** 3 to 6 large food trees per 0.5 ha	**High:** 7 to 10 large food trees per 0.5 ha	**Very high:** >10 large food trees
		Score	**0**	**4**	**6**	**10**	**15**

Total basal area of food trees (m^2/ha)	Species richness of *Eucalyptus* and *Corymbia* in 0.5 ha: 1	2	3	4	5+
0	0	0	0	0	0
<2	**1**	**2**	**3**	**4**	**5**
2-5	**2**	**3**	**5**	**7**	**8**
5-8	**3**	**5**	**7**	**10**	**12**
8-10	**4**	**7**	**10**	**13**	**16**
>10	**5**	**8**	**12**	**16**	**20**

	3 Quality and availability of shelter	Number of large shelter trees (>RE threshold for DBH) per 0.5 ha transect.	**None:** No eucalypt trees >RE threshold for DBH	**Poor:** 1 to 2 eucalypt trees >RE threshold for DBH.	**Moderate:** 3 to 5 eucalypt trees >RE threshold for DBH.	**High:** 6 to 9 eucalypt trees >RE threshold for DBH.	**Very high:** > 10 eucalypt trees >RE threshold for DBH.
		Score	**0**	**1**	**3**	**6**	**10**
		Availability of hollows of a suitable size (over 8 cm entrance diameter) per hectare (double the number recorded per half hectare BioCondition transect).	**None:** No hollows observed, trees unlikely to be able to support hollows (<30 cm DBH)	**Low:** 2 suitable hollows	**Moderate:** 4 or 6 suitable hollows	**High:** 8 or 10 suitable hollows	**Very high:** More than 10 suitable hollows
	4 Species mobility capacity	Score	Scores are assigned based on a combination of size of the habitat patch and connectivity to other patches, as shown in the below table.				
		Size and connectivity of habitat patch	(see table below)				

		Connectivity to nearest patch					
		Patches <1 km apart and connected by woody vegetation*	**Patches 1-8 km apart and connected by woody vegetation***	**Patches >8 km apart and connected by woody vegetation***	**Patches <0.5 km apart and separated by open areas***	**Patches 0.5-3 km apart and separated by open areas***	**Patches >3 km apart and separated by open areas***
Size of habitat patch†	**>300 ha**	25	23	21	20	18	15
	100-300 ha	24	20	17	15	12	10
	50-100 ha	23	17	10	8	6	4
	<50 ha	22	14	8	6	3	1

*Distinction between open areas versus wooded vegetation is defined by the gliding distance of Greater Gliders (i.e., average spaces between trees should not exceed the height of trees in wooded vegetation).

†Habitat patch size classes are based on ability of the patch to support a viable population of 100 Greater Gliders, assuming a mean home range size of 3 ha.

Table 9-4 Species specific habitat scores

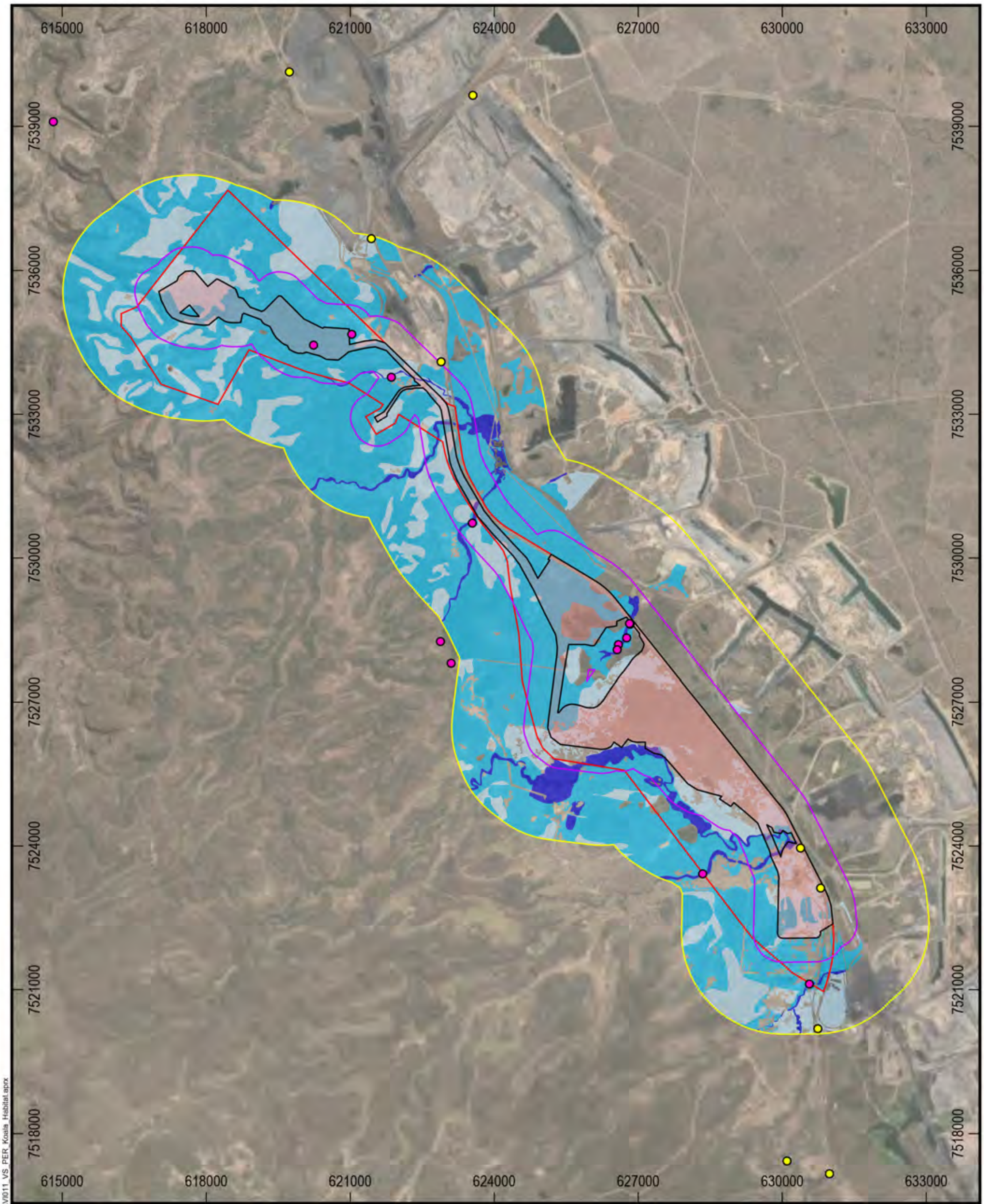
Sample Site code	RE	Area (ha)	Koala habitat type	Koala habitat score	Greater Glider habitat type	Greater Glider habitat score	Squatter Pigeon habitat type	Squatter Pigeon habitat score
I01	11.10.1x1	6.86	Foraging / shelter / dispersal	49	Potential/future denning	58	Dispersal	81
I02	11.10.7	41.44	Foraging / shelter / dispersal	52	Potential/future denning	52	Foraging	61
I03	11.10.1x1	99.83	Dispersal	48	Potential/future denning	47	Dispersal	49
I04	11.10.3	57.46	Foraging / shelter / dispersal	52	Likely Denning	53	Dispersal	67
I05	11.10.1	9.03	Shelter / dispersal	51	Likely Denning	60	Dispersal	64
I06	11.10.3	48.4	Foraging / shelter / dispersal	55	Likely Denning	58	Dispersal	65
I07	11.10.1	105.57	Shelter / dispersal	67	Likely Denning	50	Dispersal	64
I08	11.10.3	519.00	Dispersal	60	Potential/future denning	46	Dispersal	60
I09	11.10.7	30.85	Shelter / dispersal	55	Potential/future denning	56	Foraging	46
I10	11.10.3	1448.68	Shelter / dispersal	60	Potential/future denning	51	Dispersal	68
I11	NR 11.3.7	11.30	Shelter / dispersal	61	Likely Denning	54	Breeding and Foraging	62
I12	11.3.7	8.60	Shelter / dispersal	55	Likely Denning	57	Breeding and Foraging	74
I13	NR 11.10.7	39.10	Dispersal	46	Dispersal	41	Breeding and Foraging	80
I14	NR 11.10.7	39.10	Dispersal	54	Potential/future denning	43	Breeding and Foraging	78
I15	NR 11.5.9	14.66	Foraging / shelter / dispersal	66	Likely Denning	48	Breeding and Foraging	79
I16	11.5.9	46.12	Dispersal	64	Potential/future denning	42	Breeding and Foraging	75

Sample Site code	RE	Area (ha)	Koala habitat type	Koala habitat score	Greater Glider habitat type	Greater Glider habitat score	Squatter Pigeon habitat type	Squatter Pigeon habitat score
I17	11.5.9a	1.54	**Dispersal**	**64**	**Likely Denning**	**58**	**Breeding and Foraging**	**86**
I18	11.3.25	16.5	**Foraging / shelter / dispersal**	**75**	**Likely Denning**	**67**	**Breeding and Foraging**	**83**
I19	11.3.7	6.86	**Shelter / dispersal**	**58**	**Likely Denning**	**63**	**Breeding and Foraging**	**73**
I20	11.5.9	639.41	**Dispersal**	**51**	**Potential/future denning**	**41**	**Foraging**	**72**
I21	11.10.1x1	71.97	**Dispersal**	**52**	**Potential/future denning**	**44**	**Dispersal**	**76**
I22	11.5.9	639.41	**Foraging / shelter / dispersal**	**58**	**Potential/future denning**	**48**	**Breeding and Foraging**	**88**
I23	11.4.8	4.41	**Shelter / dispersal**	**64**	**Likely Denning**	**49**	**Dispersal**	**85**
I24	11.5.9	30.49	**Foraging / shelter / dispersal**	**66**	**Potential/future denning**	**45**	**Breeding and Foraging**	**82**
I25	11.4.8	58.73	**Shelter / dispersal**	**59**	**Potential/future denning**	**48**	**Dispersal**	**61**
I26	11.4.8	26.66	**Dispersal**	**57**	**Potential/future denning**	**44**	**Dispersal**	**83**
I27	11.9.2	306.32	**Foraging / shelter / dispersal**	**46**	**Potential/future denning**	**53**	**Dispersal**	**69**
I28	11.5.3	13.39	**Foraging / shelter / dispersal**	**62**	**Potential/future denning**	**45**	**Foraging**	**67**
I29	11.4.8	19.57	**Dispersal**	**58**	**Denning**	**51**	**Dispersal**	**70**
I30	11.9.2	19.15	**Foraging / shelter / dispersal**	**50**	**Potential/future denning**	**57**	**Dispersal**	**61**
I31	11.5.3	5.92	**Foraging / shelter / dispersal**	**65**	**Potential/future denning**	**53**	**Breeding and Foraging**	**65**
I32	NR 11.9.2	185.10	**Foraging / shelter / dispersal**	**42**	**Nil**	**17**	**Dispersal**	**52**
I33	11.9.2	306.32	**Foraging / shelter / dispersal**	**47**	**Potential/future denning**	**55**	**Dispersal**	**51**

Sample Site code	RE	Area (ha)	Koala habitat type	Koala habitat score	Greater Glider habitat type	Greater Glider habitat score	Squatter Pigeon habitat type	Squatter Pigeon habitat score
I34	11.9.2	306.32	**Foraging / shelter / dispersal**	**61**	**Likely Denning**	**63**	**Dispersal**	**49**
I35	11.5.9	639.41	**Foraging / shelter / dispersal**	**54**	**Likely Denning**	**49**	**Foraging**	**64**
I36	NR 11.9.2	185.10	**Shelter / dispersal**	**46**	**Nil**	**18**	**Non-habitat**	**45**
I37	11.4.9	1.33	**Shelter / dispersal**	**62**	**Dispersal**	**48**	**Dispersal**	**77**
I38	11.3.2	52.5	**Foraging / shelter / dispersal**	**62**	**Likely Denning**	**61**	**Breeding and Foraging**	**78**
I39	NR 11.9.2	185.10	**Foraging / shelter / dispersal**	**46**	**Nil**	**17**	**Non-habitat**	**68**
I40	NR 11.9.2	185.10	**Dispersal**	**46**	**Nil**	**17**	**Non-habitat**	**62**
I41	NR 11.4.8	29.98	**Shelter / dispersal**	**46**	**Nil**	**17**	**Non-habitat**	**63**
I42	NR 11.4.8	47.53	**Shelter / dispersal**	**42**	**Nil**	**17**	**Non-habitat**	**46**
I43	NR 11.5.3	192.26	**Foraging / shelter / dispersal**	**57**	**Nil**	**21**	**Dispersal**	**77**
I44	NR 11.5.3	192.26	**Foraging / shelter / dispersal**	**48**	**Nil**	**18**	**Dispersal**	**58**
I45	NR 11.4.8	4.01	**Foraging / shelter / dispersal**	**71**	**Likely Denning**	**46**	**Dispersal**	**70**
I46	NR 11.4.8	14.43	**Dispersal**	**51**	**Foraging**	**42**	**Dispersal**	**61**
I47	11.3.2	1.89	**Foraging / shelter / dispersal**	**71**	**Likely Denning**	**82**	**Breeding and Foraging**	**70**
I48	11.3.25	87.52	**Foraging / shelter / dispersal**	**83**	**Likely Denning**	**77**	**Breeding and Foraging**	**68**
I49	NR 11.5.3	78.09	**Foraging / shelter / dispersal**	**58**	**Likely Denning**	**55**	**Dispersal**	**61**
I50	NR 11.5.3	31.95	**Foraging / shelter / dispersal**	**54**	**Potential/future denning**	**40**	**Breeding and Foraging**	**70**

Sample Site code	RE	Area (ha)	Koala habitat type	Koala habitat score	Greater Glider habitat type	Greater Glider habitat score	Squatter Pigeon habitat type	Squatter Pigeon habitat score
I51	NR 11.10.3	40.84	**Foraging / shelter / dispersal**	**59**	**Likely Denning**	**43**	**Dispersal**	**76**
I52	NR 11.5.3	12.36	**Foraging / shelter / dispersal**	**52**	**Potential/future denning**	**40**	**Breeding and Foraging**	**70**
I53	NR 11.10.3	12.69	**Foraging / shelter / dispersal**	**57**	**Foraging**	**36**	**Dispersal**	**70**
I54	NR 11.5.9	0.71	**Foraging / shelter / dispersal**	**49**	**Foraging**	**39**	**Breeding and Foraging**	**73**
I55	NR 11.5.3	192.26	**Foraging / shelter / dispersal**	**51**	**Dispersal**	**43**	**Breeding and Foraging**	**72**

Table note: "Patch size" refers to the size of the individual mapped polygon the sample point is located within, therefore the total area will not equal the total area to be disturbed.



Legend

- Koala Sighting

Atlas of Living Australia Records

- *Phascolarctos cinereus* (Koala)

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- 500m Indirect Impact Buffer
- 2 km Buffer

Koala Habitat Value (Average Overall Scores)

- High Quality (Score ≥ 65)
- Moderate (Score 55 - 65)
- Low (Score 45 - 55)

Source: Atlas of Living Australia 2024, Vulcan South datasets - Vitrinite 2024 & METServe 2020-2024, Koala Habitat - METServe 2024. Earthstar Geographics 28/09/2023

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PER\VI011_VS_PER_Koala_Habitat.aprx

Vulcan South

Koala Habitat Value

0 1 2 4

Kilometers

Scale: 1:115,000 (A4)

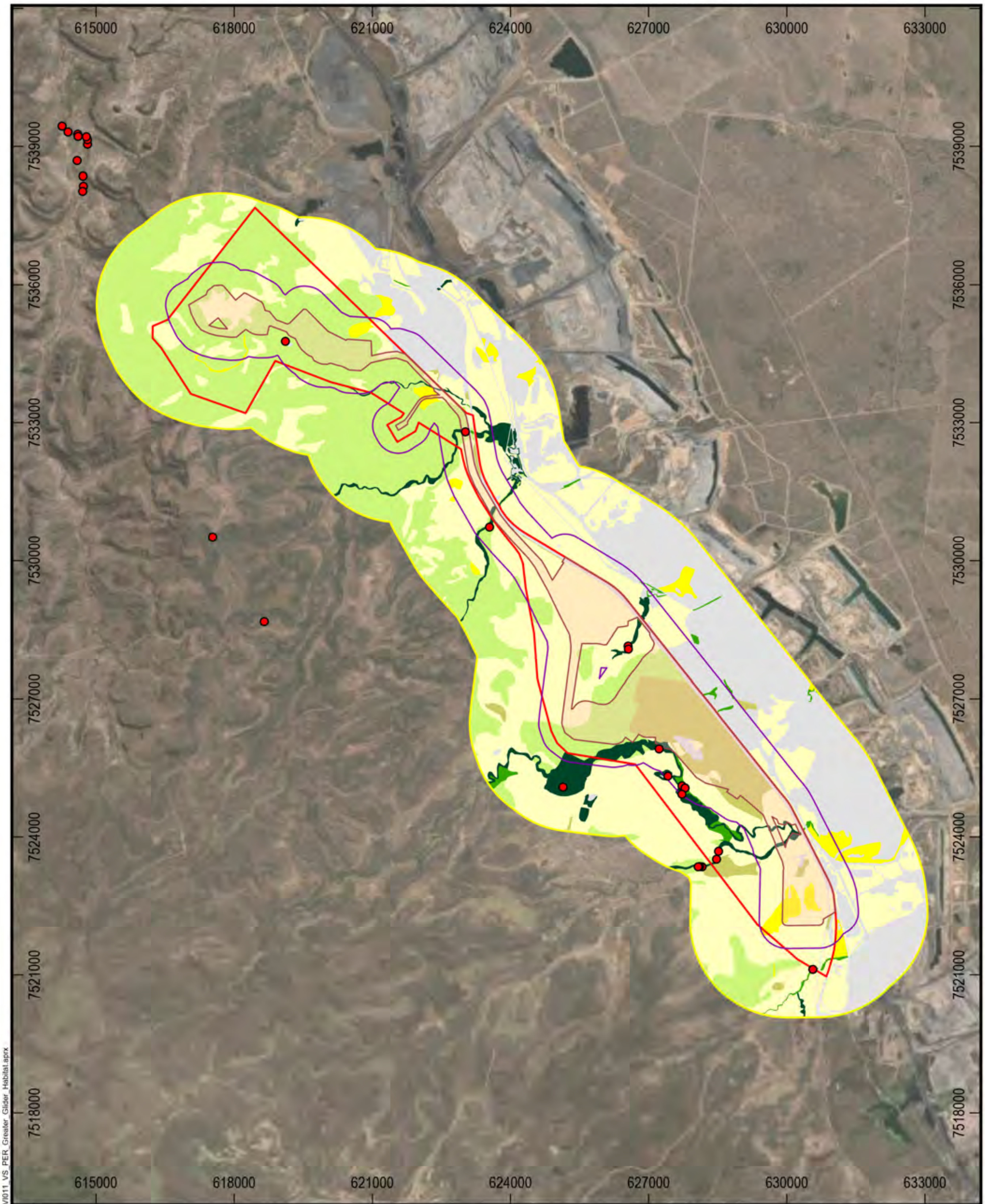
24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 9-1

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd



Legend

- Greater Glider Sightings

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- 500m Indirect Impact Buffer
- 2 km Buffer

Average Overall Greater Glider Habitat Value Score

- 0
- <30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- >70

Source: Vitrinite 2024, METServe 2020-2024, Earthstar Geographics.

Vulcan South

Average Overall Greater Glider Habitat Value Score

0 1 2 4
Kilometers
Scale: 1:120,000 (A4)

24/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 9-2

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

9.2.4 Legal Entitlement to Offset Sites

The risk of not being able to secure an offset for the Vulcan South Project is considered to be low. The landholder of the prospective property is agreeable to host the offset and commercial negotiations are progressing. Furthermore, given the subject species have broad habitat requirements and are widely distributed within the region, suitable habitat is common and identification of alternative offset sites, should they be required, is anticipated to be easily achievable. Vitrinite also employs the services of an offsets broker who assists with identification of suitable offsets sites.

To counter the Project's significant residual impacts to the Koala, Greater Glider, Squatter Pigeon and Brigalow TEC, Vitrinite proposes to deliver 7415 ha of suitable offset, located on Lot 3 of Plan SP314273 (Tay-Glen) via 100% direct offset. The proposed offset site is located approximately 3 km west of Dysart, Queensland and approximately 6 km southwest of the impact site. Vitrinite proposes to ensure the habitat quality gains (1/10 gain over 20 years) are achieved by reducing the threats of clearing, management of feral predators and weeds, reduction of fire risk and removal of barbed wire and by improving the habitat condition via active management measures such as, providing water points, active grazing management and potentially installation of artificial hollows. For all matters, the starting habitat quality in the candidate offset site exceeded, or with active management will exceed the quality of the habitat disturbed at the impact site, a requirement of the EPBC Act Environmental Offsets Policy. Overall, this offset site will satisfy the requirements of the EPBC Act Environmental Offsets Policy (as determined using the Offsets Assessment Guide).

An OAMP (Appendix II) has been prepared to demonstrate how the Tay-Glen offset area addresses the EPBC Act Environmental Offsets Policy. The plan utilises the findings of the ecological assessments from both the impact site and offset area to outline how the offset obligations and requirements, under the OAMP, will be addressed. The OAMP also details the management of offsets and how monitoring and reporting are to take place. Once approved by the Australian Government, the offset area is to be managed in accordance with the OAMP.

9.2.5 Conservation gains for MNES

As the proposed management of an offset site is contingent on the starting quality and attributes that are most sensitive to improvement, specific management measures cannot be prescribed until a final site has been chosen. Nevertheless, a range of management options are presented in the tables below, as examples of the types of actions that will be considered for improving habitat attributes that are deficient at the offset site at the time of acquisition.

The principal means through which offsets will achieve environmental gains for the Koala and Squatter Pigeon will be through the protection of regrowth vegetation that otherwise has a high risk of repeated clearing. This vegetation may already qualify as habitat for these two species at the procurement of the offset(s) or be expected to develop into suitable habitat in the near future. If required, supplementary water points will be installed in the offset area to maximise the amount of foraging and breeding habitat for the Squatter Pigeon and offer drinking sites for Koalas during droughts. As young regrowth is unable to support Greater Gliders unless mature, hollow trees were left standing during clearing, suitable offset sites must also contain ample remnant vegetation to provide a source of den sites. Nevertheless, protection of regrowth will have the benefit of increasing connectivity between habitat patches for Greater Gliders. Regrowth adjacent to existing den sites also increases food availability for gliders.

It is expected that offsets for the Koala, Greater Glider and Squatter Pigeon are not mutually exclusive of cattle grazing, provided the stocking rates are sustainable. All three species coexist readily with cattle, and some amount of grazing is probably beneficial (Woinarski & Ash, 2002) Grazing promotes bare ground required by the Squatter Pigeon for foraging and reduces the density of grass swards that may otherwise hinder the movement of Koalas between trees. By reducing grass density, grazing also facilitates movement between trees by arboreal marsupials (Neilly & Schwarzkopf, 2017) and decreases the risk posed by uncontrolled fires, which is a major threat of both the Koala and Greater Glider (Department of Climate Change, Energy, the Environment and Water, 2022e; Department of Climate Change, Energy, the Environment and Water, 2022b).

9.2.5.1 Koala

The environmental gains from offsets for the Koala are summarised in **Table 9-5**.

The principal means through which offsets will achieve environmental gains for the Koala through the protection of regrowth vegetation that otherwise has a high risk of repeated clearing. This vegetation may already qualify as habitat for these two species at the procurement of the offset(s) or be expected to develop into suitable habitat in the near future.

Some matters, especially the Koala, could benefit from enhanced control measures for feral predators within the offset area.

Table 9-5 Environmental gains from offsets for the Koala

Potential Scenario	Habitat Attribute	Management Measure	Expected Improvements/conservation gain
K1	A low level of pre-existing vegetation protection places this at a high risk of future loss through clearing for agriculture.	Habitat within the offset area will be protected and will retain this protection at least for the duration of impacts arising from Vulcan South.	The benefits of additional habitat protection depend on the pre-existing risk of loss, which is to be determined based on recent historical clearing patterns associated with the tenure, land zone and level of protection under the VM Act within the offset site. This data is available from (Accad, et al., 2001) and the Statewide Landcover and Trees Study datasets published by the Queensland Government. Protecting regrowth and allowing it to develop will improve the habitat quality for Koalas by increasing the basal area of food trees, increasing the canopy cover of trees taller than 4 m, and allowing dense shade trees to form.
K2	Low cover of trees taller than 4 m (large enough to be used by Koalas)	The passive regeneration of woody vegetation will be allowed	Seedlings and suckers of canopy trees that are <1 m tall are expected to reach ≥4 m within five years in central Queensland. Regrowth as young as four to seven years is regularly used by Koalas (Kavanagh & Stanton, 2012; Rhind, et al., 2014). The success of passive regeneration depends on the clearing methods originally used at the offset site, with pulled vegetation recovering faster than that killed with herbicide (Back, et al., 2009a). Recruitment is also stronger when clumps of standing trees have been retained in the cleared landscape (Back, et al., 2009a). In most grazed areas of central Queensland, a moderate to high amount of natural recruitment is expected, and the amount can be anticipated at the start of offsets (by observing the presence of seedlings or suckers).

K3	Lack of access to surface water during drought	No areas are to fail to fall within 1 km of water. This will be remediated through the installation of tanks and troughs at 1.4 km intervals, which will be regularly refilled, and troughs will be checked and maintained at regular intervals.	Sites that lack nearby surface water are unlikely to be suitable as offsets for the Koala and Squatter Pigeon, as they will not meet the definition of suitable habitat for the latter. Koalas readily and frequently drink from artificial water placed on the ground (Mella, et al., 2019) and are expected to make use of water provided for Squatter Pigeons, provided the design of the troughs allows access by Koalas. Use of supplementary water by Koalas is highest during hot, dry weather (Mella, et al., 2019) indicating that it can be important for sustaining Koala populations during drought.
K4	Lack of connectivity between surface water and Koala habitats located 1-2 km away.	Allowing the passive regeneration of woody vegetation surrounding water sources.	Regrowth as young as four to seven years is regularly used by Koalas (Kavanagh & Stanton, 2012; Rhind, et al., 2014), and there is therefore a high likelihood that connectivity would be restored within 10 years.
K5	Absence of trees and natural recruitment	Direct seeding and/or tubestock planting of food and shelter tree species	Expansive treeless areas will not constitute suitable offset sites on their own, as these are unlikely to achieve habitat scores comparable to the Project area in a reasonable timeframe (e.g., 20 years). Nevertheless, if small, treeless areas form a minor subset of the total offset site, high habitat scores within the remaining forested subset of the offset site could deliver average habitat scores across the offset site that meet targets set by the Project area. Generally, such small treeless areas experience natural recruitment via seed blown from nearby forest. In the event that this does not occur, active planting of Koala food trees is a highly successful means of introducing these to the site (Kavanagh & Stanton, 2012; Rhind, et al., 2014). Planted trees as young as four to seven years old are used by Koalas (Kavanagh & Stanton, 2012; Rhind, et al., 2014).
K6	Deficiency of large trees and dense regrowth of small trees (many of which are non-food trees), inhibiting their development into “large trees”.	Thinning of midstorey non-food and non-shelter tree species, so that these constitute less than half of the total woody vegetation basal area.	The rate at which trees develop into “large trees” depends on their initial size and extent of competition with other trees. In forested areas, *Eucalyptus crebra*

			and *Eucalyptus melanophloia* generally increase in trunk diameter by 0.16 to 0.22 cm per year in the 600-800 mm annual rainfall regions of Queensland (Ngugi *et al.* 2015). This implies that only those trees with a diameter within 3.5 cm of the "large tree" threshold (as per BioCondition) are likely to develop into large trees within a 20-year timeframe. Growth rates can be accelerated by thinning dense regrowth (Back, et al., 2009b). Over a 20-year period at Dingo, Queensland, *E. populnea* trees in unthinned plots increased in circumference by 20%, while those in thinned plots increased by 50% (Back, et al., 2009b). The extent of thinning used in this study was much higher (80% of trees removed) than would be considered appropriate within an offset site, and the relative benefits of thinning an offset site would be accordingly lower.
K7	Elevated risk of dog attack within 18 km of supplementary food sources (towns, dumps, mine camps)	Exclusion fencing around supplementary food sources will be installed.	Preventing access by wild-roaming dogs and dingoes to nearby supplementary food sources would limit their local population densities (and associated risk to Koalas) to background levels. Such measures are only feasible in specific circumstances (e.g., fencing off waste storage areas at a nearby mine camp, or fencing off a public landfill), but would not be employed for isolating whole towns.
		Implementation of a wild dog control program, involving baiting, trapping and shooting.	Dog control programs in south-eastern Queensland, where dogs constitute a major cause of death, successfully reduced mortality rates of adult Koalas by 85-92% (Beyer, et al., 2017). Any improvements in Koala survivorship are expected to be short-lived, however, due to ongoing recolonisation of the site by new dogs. Consequently, such a control program would need to continue throughout the life of the offsets (at a minimum, for the duration of the impact at Vulcan South).

9.2.5.2 Squatter Pigeon

The environmental gains from offsets for the Squatter Pigeon are summarised in **Table 9-6**.

As for the Koala, the principal means through which offsets will achieve environmental gains for the Squatter Pigeon is through the protection of regrowth vegetation that otherwise has a high risk of repeated clearing. This vegetation may already qualify as habitat for these two species at the procurement of the offset(s) or be expected to develop into suitable habitat in the near future.

As for the Koala, the Squatter Pigeon could benefit from enhanced control measures for feral predators within the offset area.

Table 9-6 Environmental gains from offsets for the Squatter Pigeon

Potential Scenario	Habitat Attribute	Management Measure	Expected Improvements/conservation gain
S1	A low level of pre-existing vegetation protection places this at a high risk of future loss through clearing for agriculture.	Habitat within the offset area will be protected and will retain this protection for the duration of impacts arising from Vulcan South.	The benefits of additional habitat protection depend on the pre-existing risk of loss, which is to be determined based on recent historical clearing patterns associated with the tenure, land zone and pre-existing level of protection under the VM Act within the offset site. This data is available from (Accad, et al., 2022) and the Statewide Landcover and Trees Study datasets published by the Queensland Government.
S2	Low woody vegetation cover providing inadequate protection (based on NDVI)	Allowing the passive regeneration of woody vegetation.	Protecting regrowth and allowing it to develop will improve the habitat quality for Squatter Pigeons via increasing the NDVI (protective woody vegetation cover) at sites where this is initially deficient.
S3	High density of grass swards limiting the extent of bare ground required for foraging.	Allowing the passive regeneration of woody vegetation.	Density of grass in E. populnea and E. crebra woodlands in Queensland has a strong negative association with the basal area of trees and shrubs (Scanlon & Burrows, 1990). As regrowth is allowed to grow, overly dense groundcover vegetation is expected to naturally thin to provide more favourable foraging habitat for Squatter Pigeons.
		Cattle grazing intensities will be modifed to reduce overall grass biomass and provide open areas for foraging.	Grazing management generally has a more pronounced effect on ground-storey composition of plant communities than tree density (Jones, et al., 2009; Good, et al., 2012). These effects are also more immediate, compared to those achieved through passive regeneration of trees. Grazing can be an effective conservation tool for managing excessive pasture densities in Queensland, although secondary invasion by the exotic grass Indian Couch (Bothriochloa pertusa) may undermine the biodiversity benefits gained by grazing in conservation areas (Lebbink, et al., 2021).

S4	Insufficient amount of ground -storey vegetation due to shading and litter fall beneath overly dense woody vegetation.	Thinning of the midstorey and/or trees (of species not used by Koalas or Greater Gliders for food or shelter).	Woody regrowth is commonly much denser than undisturbed forest, leading to a suppression of ground-storey vegetation and diversity (Jones, et al., 2014). Thinning has been demonstrated to restore the ground-storey vegetation to a state similar to remnant forest (Jones, et al., 2014). Reducing the cover of overly dense woody vegetation leads to the (mostly) rapid expansion of grass cover, and greater representation within the understorey community of large-seeded, perennial grasses such as Themeda triandra and Heteropogon contortus (Scanlon & Burrows, 1990). Effectiveness of thinning varies with vegetation community, with the understorey being less responsive to the removal of Eucalyptus melanophloia than Eucalyptus populnea (Hall, et al., 2016). Thinning only successfully restores ground-storey vegetation communities at sites with few weeds; otherwise, thinning can promote the proliferation of weeds (Jones, et al., 2014).
		Controlled burning will be designed to reduce biomass within the midstorey.	Regular fires encourage the growth of grasses, forbs and sub-shrubs, at the expense of sapling trees (Williams, et al., 2003). However, unlike targeted thinning, burning is expected to have some collateral damage on Koala and glider food and shelter tree species. Furthermore, areas with too little ground-storey vegetation may have insufficient fuel to initiate or support a sufficient burn (MacLeod, et al., 2014). Prescribed burns are therefore likely to be more valuable for maintaining a favourable understorey composition, once established, than for converting areas of dense regrowth to an open, patchy forest favourable for Squatter Pigeons.
S5	Insufficient amount of ground-storey vegetation due to overgrazing	Grazing intensity will be reviewed and reduced	Grazing management generally has a more pronounced effect on ground-storey composition of plant communities than tree density (Jones, et al., 2014; Good, et al., 2012) On average, heavily degraded pastures (>60% bare ground, erosion visible and/or few palatable perennial grasses) need to be “rested” for approximately four years to recover their condition (Hunt, et al., 2014).
S6	Low species richness of grasses and forbs in the ground-storey	Cattle grazing intensity will be modified to improve species diversity.	Generally, the composition of ground-storey vegetation is slow to respond to changes in grazing intensity, compared to

			the density of this vegetation (Grice & Barchia, 1995). However, de-stocking heavily grazed sites in northern Queensland resulted in a 19% to 37% increase in native species richness (measured within 10 m2 per site) within ten years (Kemp & Kutt, 2020). In some locations, namely those dominated by palatable, perennial grasses such as Themeda triandra and Heteropogon contortus, intermediate levels of grazing results in an increase in diversity, as grazing releases other plant species from competition (Calvert, 2001). These studies indicate that modest improvements to understorey diversity may be achieved over medium timeframes by optimising grazing intensities.
S7	Lack of nearby water	No areas are to fail to fall within 1 km of water. This will be remediated through the installation of tanks and troughs at 1.4 km intervals, which will be regularly refilled, and troughs will be checked and maintained at regular intervals.	Squatter Pigeons readily use artificial water sources. The provision of artificial water points rapidly increased the numbers and diversity of birds inhabiting semi-arid woodlands in Victoria (Starks, 2015). The installation of permanent water points within habitat that otherwise provides favourable foraging and breeding habitat for Squatter Pigeons would have large, immediate benefits.
S8	Elevated risk of predation by cats and dogs within 18 km of supplementary food sources (towns, dumps, mine camps)	Exclusion fencing around supplementary food sources will be installed.	Preventing access by wild-roaming dogs and cats to nearby supplementary food sources would limit their local population densities (and associated risk to Squatter Pigeons) to background levels. Such measures are only feasible in specific circumstances (e.g., fencing off waste storage areas at a nearby mine camp, or fencing off a public landfill), but would not be suitable for isolating whole towns.
		Implementation of a wild dog and cat control program, involving baiting, trapping and shooting.	There is no available data on the effects of predator-control programs on the Squatter Pigeon, but this ground-nesting species is expected to benefit from measures implemented for the Koala. Due to ongoing colonisation of the site by new individual cats and dogs, any control program would need to continue throughout the life of the offsets (at a minimum, for the duration of the impact at Vulcan South).

9.2.5.3 Greater Glider

The environmental gains from offsets for the Greater Glider are summarised **Table 9-7**.

As young regrowth is unable to support Greater Gliders unless mature, hollow trees were left standing during clearing, suitable offset sites must also contain ample remnant vegetation to provide a source of den sites. Nevertheless, protection of regrowth will have the benefit of increasing connectivity between habitat patches for Greater Gliders. Regrowth adjacent to existing den sites also increases food availability for gliders.

Table 9-7 Environmental gains from offsets for the Greater Glider

Potential Scenario	Habitat Attribute	Management Measure	Expected Improvements/conservation gain
G1	A low level of pre-existing vegetation protection places this at a high risk of future loss through clearing for agriculture.	Habitat within the offset area will be protected and will retain this protection for at least for the duration of impacts arising from Vulcan South.	The benefits of additional habitat protection depend on the pre-existing risk of loss, which is to be determined based on recent historical clearing patterns associated with the tenure, land zone and pre-existing level of protection under the VM Act within the offset site. This data is available from (Accad, et al., 2022) and the Statewide Landcover and Trees Study datasets published by the Queensland Government.
G2	High elevated fine fuel hazard, leading to a high risk of canopy fires.	Implementation of a controlled fire regime, reducing midstorey fuel load.	Semi-frequent, low intensity burns of open eucalypt forests are a well-recognised tool for reducing their fuel load and the intensity of wildfires they experience (Fernandes, 2015). As the midstorey shrubs and saplings removed by prescribed burns are not utilised by Greater Gliders for shelter or food (Eyre, 2002), risk of fire can be reduced without compromising habitat quality.
		Thinning of midstorey non-food trees, and either lying felled debris flat or piling it in forest gaps, so it does not act as a ladder for fire to reach the canopy.	Mechanical fuel load reduction is a relatively new approach in Australia (Ximenes, et al., 2017). Only a small number of trials have been undertaken to date. Eucalypt forests burnt after experimental thinning experienced lower-severity fires than un-thinned forest, due to the reduction in elevated fuel (Volkova & Weston, 2019) However, thinned debris left on the ground can fuel intense fires during severe fire weather (Weston, et al., 2022) suggesting that the value of thinning versus prescribed burning as a means of fuel reduction should be ascertained on a case-by-case basis.
		Installation of fire breaks around or within the offset area.	Firebreaks (e.g., cleared tracks) are a useful tool for stopping the spread of low-intensity grass fires, but are ineffective at stopping larger fires

			(Price et al. 2007). They are primarily useful for containing low-intensity prescribed burns.
		Reducing risk of ignition, by limiting public access to the offset area and implementing rules for land managers pertaining to the lighting of fires or use of machinery that could generate sparks during risky weather conditions.	In Australia, most bushfires are initiated by humans, whether intentionally, accidentally or through negligence (Ganteaume & Syphard, 2017). Natural causes (of which lightening is the most frequent) ignite less than one-quarter of Australian bushfires (Ganteaume & Syphard, 2017). By reducing the risk of local ignition through human actions, the overall chance of fire is substantially reduced.
G3	Deficiency of large trees and dense regrowth of small trees, inhibiting their development into “large trees” and shelter for Greater Glider.	Thinning of midstorey non-food tree species, so that these constitute less than half of the total woody vegetation basal area.	The rate at which trees develop into “large trees” depends on their initial size and extent of competition with other trees. In forested areas, Eucalyptus crebra and Eucalyptus melanophloia generally increase in trunk diameter by 0.16 to 0.22 cm per year in the 600-800 mm annual rainfall regions of Queensland (Ngugi & Nelder, 2015) This implies that only those trees with a diameter within 3.5 cm of the “large tree” threshold (as per BioCondition) are likely to develop into large trees within a 20-year timeframe. Growth rates can be accelerated by thinning dense regrowth (Back, et al., 2009b). Over a 20-year period at Dingo, Queensland, E. populnea trees in un-thinned plots increased in circumference by 20%, while those in thinned plots increased by 50% (Back, et al., 2009b). The extent of thinning used in this study was much higher (80% of trees removed) than would be considered appropriate within an offset site, and the relative benefits of thinning an offset site would be accordingly lower.
G4	Lack of connectivity between drought refuges (groundwater-dependent ecosystems and riverine forests) and Greater Glider habitat located less than 1 km away.	Allowing the passive regeneration of woody vegetation surrounding drought refuges.	While regrowth will not provide hollows for Greater Gliders in the timeframe of offset management, it will allow Greater Gliders the opportunity to more effectively move through the landscape without having to go to the ground. This will not only improve the “mobility” component of habitat

			quality, but also an offset area's value as a refuge against drought.
G5	Protection of hollow-bearing trees providing shelter habitat for the Greater Glider from forestry.	No food or shelter trees for Greater Gliders will be removed when constructing tracks or undertaking thinning within the offset site.	Queensland landholders are legally allowed to remove otherwise protected vegetation on their land if this is to be used as construction timber to maintain existing buildings and structures (e.g., sheds, stockyards and fences) on the land. This constitutes a type of exempt clearing work under the VM Act. Selective harvesting of eucalypts for construction is a common practice on grazing properties throughout central Queensland. By explicitly protecting trees of value to the Greater Glider from harvest, the offset will maintain existing sources of food and dens.
G7	Risks to dispersal due to barbed wire	Removal of top-wire on fences intersecting Greater Glider habitat if barbed and replaced with smooth wire.	Although a minor threat, the removal of barbed wire in dispersal areas will have a positive effect on Greater Gliders and incidentally for other species of glider and bats.

9.2.5.4 Brigalow TEC

Environmental gains from offsets for the Brigalow TEC are summarised in **Table 9-8**.

Most patches of Brigalow within the offset area are relatively young, despite most of these qualifying as "remnant" vegetation. Most also possess high weed cover within their ground vegetation. There is therefore potential for the BioCondition of these patches to be improved through management.

Table 9-8 Environmental gains from offsets for the Brigalow TEC

Potential Scenario	Habitat Attribute	Management Measure	Expected Improvements/conservation gain
B1	A low level of pre-existing vegetation protection places this at a high risk of future loss through clearing for agriculture.	Habitat within the offset area will be protected and will retain this protection for at least for the duration of impacts arising from Vulcan South.	The benefits of additional habitat protection depend on the pre-existing risk of loss, which is to be determined based on recent historical clearing patterns associated with the tenure, land zone and pre-existing level of protection under the VM Act within the offset site. This data is available from Accad et al. (2022) and the Statewide Landcover and Trees Study datasets published by the Queensland Government.
B2	High density of exotic grasses, such as Buffel Grass, elevates the risk of fire damaging or killing mature Brigalow trees.	Periodic intense grazing to reduce grass fuel loads	Brigalow is fire-sensitive, but intact Brigalow communities rarely burn due to a lack of fine grass fuels within the ground layer. Fire within Brigalow invaded by Buffel Grass results in widespread tree death and exacerbation of weed infestations (Butler & Fairfax, 2003). The risks associated with grazing (extinction of

			grazing sensitive species, spread of weed seeds and trampling) may be lower than those posed by fire (Butler & Fairfax, 2003).
		Removal of Buffel Grass using herbicides	Removal of large Buffel Grass infestations is likely to be costly, and result in substantial collateral damage to native understorey plants. However, the targeted removal of small, newly establishing infestations may be prudent. Furthermore, removal of Buffel Grass within an outer ring can act as a firebreak for the interior of the Brigalow patch. Herbicide treatments are known to be effective and more efficient than manual removal (Dixon, et al., 2002).
		Enhancement of crown cover around the edges of the Brigalow patch, by ripping strips around the edges of Brigalow remnants to encourage sucker growth dense enough to shade out grass.	This approach was proposed by Butler and Fairfax (2003), but has not been subject to widespread testing. Dense clusters of Brigalow are known to impair grass growth underneath (Scanlon, 1991), so this measure may prove effective.
		Installation of fire breaks around or within the offset area.	Firebreaks (e.g., cleared tracks) are a useful tool for stopping the spread of low-intensity grass fires, but are ineffective at stopping larger fires (Price, et al., 2007). They are primarily useful for preventing low-intensity prescribed burns ignited in neighbouring eucalypt woodlands from entering patches of Brigalow.
		Reducing risk of ignition, by limiting public access to the offset area and implementing rules for land managers pertaining to the lighting of fires or use of machinery that could generate sparks during risky weather conditions.	In Australia, most bushfires are initiated by humans, whether intentionally, accidentally or through negligence (Ganteaume & Syphard, 2017). Natural causes (of which lightening is the most frequent) ignite less than one-quarter of Australian bushfires (Ganteaume & Syphard, 2017). By reducing the risk of local ignition through human actions, the overall chance of fire is substantially reduced.
B3	High density of Buffel Grass reduces species richness of ground vegetation.	Removal of Buffel Grass using herbicides	Managing Buffel Grass infestations through heavy grazing is the cheapest option for reducing cover of this invasive weed, but can have substantial negative effects, such as elevated soil erosion and water runoff (Thornton & Elledge, 2021). Removal via herbicide treatment retains dead clumps as soil protection. Herbicide treatments are known to be effective and more efficient than manual removal (Dixon, et al., 2002). Buffel Grass removal resulted in substantial improvements to the richness and quantity of native forbs and annual grasses near Alice Springs (Wright, et al., 2020). Due to feasibility,

			removal of Buffel Grass using herbicides is only feasible over small scales (Lebbink, et al., 2021).
		Periodic intense grazing to reduce Buffel Grass cover	Pulse grazing implemented at the end of the summer growing season results in an increase in native grasses and herbs in pastures containing Buffel Grass (Lebbink, et al., 2021).This approach is only appropriate where Indian Couch (Bothriochloa pertusa) is absent; otherwise, the gaps will be filled by this other invasive species (Lebbink, et al., 2021).
B4	High stem density of small trees, inhibiting the growth rates of trees and slowing development into mature Brigalow woodland.	Selective thinning to achieve a target stem density that maximises structural development of the ecological community.	Experimental thinning trials and simulation models revealed that thinning Brigalow to 6,000 stems ha−1 (the density of mature Brigalow forest is usually 1,250–2,070 stems ha-1: (Ngugi & Nelder, 2015) is optimal for expediting development of a regrowth ecosystem towards the structure of mature reference forest over a 20-year period (Dwyer, et al., 2010). Plots with high initial stem densities accumulate less aboveground biomass over the subsequent 45 years, compared to those that have lower stem densities (Ngugi & Nelder, 2015). Thinning is not recommended in areas containing Buffel Grass, as this flammable species will invade the gaps created by thinning and the increased fire risk surpasses the potential gains from improved growth rates of unthinned trees (Dwyer & Mason, 2017).
B5	Excessive dominance of rainforest species	None advised	While the identity of the Brigalow (Acacia harpophylla dominant and co-dominant) ecological community could be maintained through the selective removal of rainforest species, this is not justified. The types of rainforest communities into which Brigalow is most likely to transition belong to another endangered community (Semi-evergreen vine thickets of the Brigalow Belt and Nandewar Bioregions), and are therefore protected. Careful selection of offset sites that are sufficiently dominated by Acacia harpophylla is important to avoid this issue.
B6	Absence of grazing-sensitive plant species	Excluding cattle or reducing grazing pressure	Exclusion of grazing from Acacia shrubland in New South Wales improved the species richness of ground vegetation by 19% over 18 years (Daryanto & Eldridge, 2010). Decreased grazing pressure will only improve ground vegetation diversity in the absence of

			Buffel Grass, which otherwise spreads and excludes native species (Clarke, et al., 2005). The presence of Indian Couch also reduces the ability of native perennial grasses to colonise and spread, although over extended periods of low grazing pressure (>10 years) native species do increase in dominance in pastures dominated by Indian Couch (Bartley, et al., 2014).
B7	Deficiency of coarse woody debris	Thinning excessively dense Brigalow regrowth and leaving dead stems as debris for fauna habitat.	Improvements will be immediate at sites with dense regrowth and little existing woody debris. This approach is only suitable at sites with stem densities exceeding 6,000 stems ha-1 (Dwyer, et al., 2010) or else thinning existing vegetation will jeopardise other ecosystem structural traits (e.g., canopy cover, basal area, etc).

10 Other Requirements

10.1 Other Approvals and Conditions

10.1.1 Local

The project is located within the Isaac Regional Council and will comply with the applicable local laws and subordinate local laws as made under the *Local Government Act 2009*. This includes Subordinate Local Law 1.15 (Carrying out works on a road or interfering with a road or its operation) 2011 and Local Law No. 3 (Community and Environmental Management) 2011. Approval from Isaac Regional Council to commence construction of an intersection for Vulcan South Mine access road from Saraji Road is required.

10.1.2 State

The following applications have been made under Queensland State legislation:

- A mining lease application (MLA700073) has been submitted under Queensland's *Mineral Resources Act 1989* (MR Act).
- An Environmental Authority (EA) application and a Progressive Rehabilitation and Closure Plan (PRCP) have been submitted and approved by the Queensland Government under the *Environmental Protection Act 1994* (EP Act) (provided in **Appendix E**).

Mining cannot proceed under state legislation until all Queensland State Government approvals have been granted (approved ML, EA and PRCP).

10.1.2.1 Mineral Resources Act 1989

The MR Act provides for the grant, conditioning and management of exploration and mining tenements. The Department of Resources is the administering authority. Note that activities authorised under the MR Act are not subject to the provisions of the Queensland *Planning Act 2016* under Part 3, Section 4A. The exceptions are building work under the *Building Act 1975* and development on heritage land under the *Queensland Heritage Act 1992*. Vitrinite must have a conduct and compensation agreement (CCA) with the relevant landholders.

10.1.2.2 Environmental Protection Act 1994

The EP Act regulates prescribed environmentally relevant activities (ERAs) and resource activities (which includes a mining activity) through the issuing of EAs and the enforcement of the conditions of granted authorities. Schedule 3 of the *Environmental Protection Regulation 2019* identifies the ERAs for particular resource activities while Schedule 2 identifies the ancillary ERAs that are applicable to this Project. The following ERAs are authorised under the EA for Vulcan South Coal Project (P-EA-100265081):

- Schedule 3, 13: Mining black coal
- Ancillary 31: Mineral processing 2: processing, in a year, the following quantities of mineral products, other than coke – (b) more than 100,000t
- Ancillary 33: Crushing, grinding, milling or screening more than 5,000t of material in a year.

The EA contains conditions and compliance activities that Vitrinite must comply with under schedules related to authorised activities and disturbance, complaints, reporting, monitoring, ambient air quality, waste management, noise and blasting nuisance, groundwater levels and quality, surface water quality, contamination of land, residual impacts on MSES, environmental offsets requirements, and regulated structures.

A notifiable activity is an activity that has the potential to cause land contamination. The notifiable activities, as described in Schedule 3 of the EP Act, expected to be carried out on MLA700073 are listed below. In accordance with Section 371 of the EP Act, the administering authority may record the land under MLA700073 in the environmental management register as being suspected contaminated land.

- 7 – Chemical storage (other than petroleum products or oil under item 29) (chemical storage areas and workshops)
- 24 – Mine wastes (waste rock emplacements)
- 29 – Petroleum product or oil storage (refuelling facility and workshops)

Vitrinite has been granted a PRCP schedule with conditions under the EP Act. Vitrinite must comply with each progressive rehabilitation milestone and milestone criteria nominated in the schedule, in addition to the monitoring and maintenance program.

Section 297 of the EP Act states that it is a condition of an EA for a resource activity that the holder must not carry out, or allow the carrying out of, a resource activity under the authority unless an estimated rehabilitation cost (ERC) decision is in effect for the resource activity. The EA holder must pay a contribution to the scheme fund or give a surety for the authority under the *Mineral and Energy Resources (Financial Provisioning) Act 2018*. Vitrinite is yet to calculate the ERC and apply for an ERC decision.

10.1.2.3 Environmental Offsets Act 2014

An environmental offset is required in accordance with the *Environmental Offsets Act 2014* and the Queensland Environmental Offsets Policy for each prescribed environmental matter that has a significant residual impact as a result of the project. The deemed conditions provided in Section 16 of the Environmental Offsets Act apply to the EA also.

10.1.2.4 Aboriginal Cultural Heritage Act 2003

The main purpose of this Act is to provide for the effective recognition, protection and conservation of Aboriginal and Torres Strait Islander cultural heritage. Section 23(1), places 'duty of care' obligations on all persons to take all reasonable and practicable measures to ensure that their activities do not harm Aboriginal cultural heritage. The Indigenous Land Use Agreement that Vitrinite have with the determined Native Title holders, the Barada Barna People, meets the requirements of the Aboriginal Cultural Heritage Act.

10.1.2.5 Water Act 2000

The Water Act 2000 provides a framework for the planning, allocation and use of non-tidal water including underground water. In summary, the Act provides:

- sustainable management of Queensland's water resources
- sustainable and secure water supply for the south-east Queensland region and other designated regions
- management of impacts on underground water caused by the exercise of underground water rights by the resource sector
- effective operation of water authorities.

The project is within the Fitzroy River Basin and as such, the *Water Plan (Fitzroy Basin) 2011* applies. This plan is subordinate legislation to the Water Act. The *Water Regulation 2016* is also subordinate legislation providing the details and protocols for water planning, water licences, water allocations, and watercourses declarations.

Given the small quantity of groundwater inflow into the open cut pits, criteria is met for the 'exercising of underground water rights' and therefore Vitrinite will complete an Underground Water Impact Report (UWIR) prior to 'exercising underground water rights' or excavating the open cut pit. The requirements for reporting are contained within the Act and UWIR Guideline. Vitrinite will continue to monitor and assess the impact of the exercise of underground water rights on water bores, aquifers and springs.

10.1.3 Commonwealth

Applicable Commonwealth legislation, other than the EPBC Act, are the *Native Title Act 1993* (NT Act) and the *National Greenhouse and Energy Reporting Act 2007* (NGER Act).

The NT Act provides for the recognition of native title rights and interests in land and provides procedures for holders of native title rights related to consultation and participation in decisions about future acts. Vitrinite has an Indigenous Land Use

Agreement with the determined Native Title holders, the Barada Barna People which provides for the consents required for the project development.

The NGER Act is a framework for reporting information regarding a corporation's greenhouse gas emissions and energy use. In the event that Vitrinite meet the thresholds for reporting, they must register under the framework and report on their emissions, energy production and energy consumption each year. The facility threshold is 25,000 tonnes or more of carbon dioxide equivalence (scope 1 and scope 2 emissions), or production of 100 terajoules(TJ) or more of energy, or consumption of 100 TJ or more of energy. Corporate group thresholds are double the facility thresholds.

10.2 Consultation

A Stakeholder Engagement Plan (SEP) that complies with Section 126C(1)(c)(iv) of the *Environmental Protection Act 1994* (Qld) was prepared to guide stakeholder engagement activities associated with Project planning, the environmental approvals process and the development of the PRCP (**Appendix J**).

The SEP also discusses ongoing stakeholder engagement during progressive rehabilitation and closure. The SEP includes a consultation register, which outlines the consultation that has taken place for the Project.

Given that the proposed post-mining land uses seek to re-establish, for the most part, the current site land uses, the key landholders for rehabilitation consultation are listed in **Table 10-1**.

Table 10-1 Land tenure and real property descriptions

Lot/Plan	Tenure	Usage	Owner
2/SP296877	Lands Lease	Pastoral	O'Sullivan
59/SP235297	Lands Lease	Pastoral	O'Sullivan
72/SP137467	Reserve	Railway	Aurizon
Saraji Road	Road Licence	Road for public use	Isaac Regional Council
26/CNS125	Lands Lease	Norwich Park Branch Railway	Aurizon
2/CNS109	Lands Lease	Norwich Park Branch Railway	Aurizon
3/CNS109	Lands Lease	Saraji Mine Balloon Loop Railway	Aurizon

An extensive public consultation process was conducted for a number of years as part of the State approval process for the environmental authority and the mining lease (MLA700073). This has continued throughout the federal assessment process. Specifically, engagement:

- including combined notification for both the MLA and associated EA to relevant stakeholders, newspaper advertisements;
- with underlying and surrounding landholders;
- with surrounding infrastructure holders, Aurizon, Powerlink, Ergon;
- with the relevant native title party, Barada Barna Aboriginal Corporation (BBAC) as part of ongoing relations pursuant to the relevant Indigenous Land Use Agreement;
- with overlapping tenure holders, Eureka Pty Ltd;
- with neighbouring mining operations, BMA Pty Ltd for the CQCA JV participants;
- with Issac Regional Council, including signing a Housing Contribution Agreement, which includes social spending commitments;
- with environmental advocacy stakeholder groups (including Environmental Advocacy in Central Queensland and Mackay Conservation Group);
- with surrounding local community groups including Moranbah and District Support Service;
- With key relevant government departments has been ongoing, including:

- Queensland Department of Environment, Science and Innovation (DESI);
- Queensland Department of Resources (DoR);
- Queensland Department of Transport and Main Roads (DTMR); and
- Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW).

As a result of this consultation, agreements were entered into with relevant stakeholders, significant additional technical work was undertaken on areas of interest to the stakeholder groups, amendments were made to the environmental authority, including disturbance areas on account of feedback and engagement with those groups. Significant reductions to the project footprint and in turn, the potential impacts on MNES have been achieved. The key affected parties are the Barada Bana people and the O'Sullivan Family. Agreements with both parties have been negotiated.

The Vulcan South project is addressed by the existing ILUA with the Barada Barna Aboriginal Corporation (BBAC). Vitrinite and the BBAC have developed a close working relationship over the past few years as consultation and agreements have progressed. Vitrinite has been an active supporter of the BBAC and the BBAC has been a supporter of the project. The BBAC has joined Vitrinite in its consultation with other interested parties and has advocated for the Project and the positive opportunities it brings for the Barada Bana people.

Vitrinite has worked alongside the O'Sullivan family who are the underlying landholders for the project to secure agreeable access to the property to facilitate the project. These negotiations have identified and managed aspects of the property that are important to the landholders whilst allowing Vitrinite to develop the proposed project in an efficient and viable manner.

10.3 Vitrinite's Environmental Record

Vitrinite, propose to undertake the action within the MLA 700073. QCC (subsidiary of 'Vitrinite') will be the statutory owner and proponent of the Project. It is registered as a suitable operator in Queensland. Vitrinite's Environmental, Governance and Social statement is included in **Appendix DD**. This is summarised below:

Vitrinite is committed to effectively managing its impact on Environment, Social and Governance (ESG) matters. This ESG statement provides for sustainable environmental management, socially responsible operations and ethical business management, driven by the board of directors.

Environment

- *Vitrinite aim to tread lightly and leave all lands as or better than we found them.*
- *We promote resource stewardship and sustainable land management through establishment of post mining land uses.*
- *We optimise equipment selection and its use to reduce Greenhouse Gas Emissions.*
- *We regularly report on environmental outcomes and maintain accountability of sites until relinquishment.*

Social

- *Vitrinite have a recruitment strategy with a preference for local employees.*
- *Vitrinite use local business where they are technically capable and commercially competitive.*
- *Vitrinite have implemented Indigenous employment targets.*
- *Vitrinite have implemented procedures to facilitate Equal Opportunities in recruitment.*
- *Vitrinite encourage Indigenous business opportunities and recruitment where practicable.*
- *Vitrinite actively promote healthy lifestyle choices through education and training.*
- *Vitrinite actively promote occupational health and safety through education and training, in order to minimise the incidence of workplace accidents.*
- *Involve families of workers through Family Fun Day.*
- *Sponsorship of Community Events.*

Governance

- *Vitrinite are committed to human rights in line with the Guiding Principles on Business and Human Rights (United Nations). This also extends to elimination of modern slavery.*
- *Our suppliers are key partners in our commitment to operate in a way that is responsible, transparent and respects the rights of all.*
- *We have a zero-tolerance approach to bribery and corruption and are committed to conducting business with integrity.*
- *At Vitrinite, risk is managed in accordance with AS ISO 31000:2018 Risk Management—Guidelines.*

Implementation of values

We operate on a policy of being a good neighbour and corporate citizen, holding ourselves to the highest standard.

We strive to minimise our environmental footprint and offset unavoidable ecological impacts at Vitrinite's operations. We manage the impact of our projects by:

- *Reducing vegetation clearing by prioritising pre-cleared sites and access tracks;*
- *Avoiding ecological impacts where possible; and*
- *Progressively rehabilitating sites as soon as practicable.*

Vitrinite endeavour to be active members of the communities within which we work, support local business and strive to maximise project benefits and opportunities. Our board of directors acknowledge the need to respect human rights, acknowledge the transition to a lower carbon future and foster a corporate culture that considers all stakeholders.

Vitrinite actively fosters positive working relationships with traditional owner groups associated with the land upon which it operates, through the commitment to involve Traditional Owners — who are the guardians, keepers, and knowledge holders of Aboriginal cultural heritage — during our activities.

As residents of Queensland, we recognise the importance of the role we play in social, community, economic and environmental issues among our friends, family, neighbours and colleagues.

Vitrinite will never compromise any of these responsibilities and hold our role in the community paramount.

Vitrinite has recently been subject to compliance action under the EPBC Act related to the contravention of conditions attached to the EPBC Act approval for the adjacent Vulcan Complex Project approval (EPBC 2020/8676). Vitrinite is currently working through this directed variation of the approval conditions with the DCCEEW compliance team.

Importantly, this disturbance:

- remains within the total area (ha) of disturbance authorised; and
- has not impacted MNES beyond that authorised in the 2020/8676 approval conditions.

An environmental protection order (EPO) pursuant to the *Environmental Protection Act 1994* (Qld) was issued (22 March 2024) to Queensland Coking Coal Pty Ltd and QLD Coal Aust No.1 Pty Ltd (Vitrinite) by the administering authority. The EPO was issued with respect to the activities at Vulcan Coal Mine which is to the north of the proposed Vulcan South Project. It was issued on the grounds that a number of conditions of the environmental authority were contravened as a result of sediment releases from a sediment dam after a number of surface water exceedance investigations were reported to the administering authority. Vitrinite has met the required actions to date including:

- Identification and installation of the relevant measures identified by the AQP (AQP) to ensure any release from a sediment dam is sampled in accordance with the EA
- An assessment of the current mine water management system onsite and the current erosion and sediment control measures onsite to determine their effectiveness
- An updated Water Management Plan and an updated Erosion and Sediment Control Plan

The Vulcan South Water Management Plan and Erosion and Sediment Control Plan, inclusive of the relevant mitigation measures proposed in this PER, have been developed by an AQP who is cognisant of these matters and their resolution.

10.4 Economic and Social Impacts

The following information is derived from the Vulcan South Social Impact Assessment, included in this document as **Appendix EE.**

10.4.1 Public Consultation – Stakeholder Engagement

All stakeholders for the Project have been consulted throughout the Vulcan South State Approvals process, as described in the Stakeholder Engagement Table below. Stakeholders will continue to be engaged during the Federal assessment process and beyond during project construction, operations and closure phases.

The level of stakeholder engagement is:

- based on the goals / objectives of the engagement program and effectiveness of the technique in reaching the target audience; and
- varies considerably depending on the level of interest and impact the stakeholder has.
- The methods of stakeholder engagement that have been considered include:
  - Face to face meetings;
  - Scheduled and routine conferences (monthly, quarterly, annual, etc.);
  - Telephone meetings;
  - Workshops; and / or
  - Newsletters and email correspondence.

Regardless of the stakeholder group or method of engagement, all engagement will apply the following principles:

- Transparent – Open and honest in engagement activities, setting expectations;
- Realistic – Set clear objectives and understanding of what is to be achieved out of the engagement;
- Inclusive – Identify stakeholders and provide meaningful opportunities for them to engage;
- Respectful – Listen and acknowledge the needs of stakeholders, different opinions and
- perspectives; and
- Responsive – Consider and respond to issues and concerns, providing feedback to stakeholders.

The Vitrinite stakeholder register is attached to the Stakeholder Engagement Plan which is provided as **Appendix CC**.

10.4.2 Projected Economic Costs and Benefits and Employment Opportunities

Vitrinite are rolling out a training and development scheme. They have identified the need for up to 8 trade assistants, with a view to advancing those employees through apprenticeships. Vitrinite currently have three apprentices on site, with a target of five, and are actively recruiting to fill the positions.

In relation to Indigenous employment opportunities, Vitrinite have indigenous employment targets of 5% under the ILUA agreement. The company is currently exceeding those employment targets and prides itself on its collaborative relationship with the Barada Barna Aboriginal Corporation. Where candidates are nominated to the company, Vitrinite prioritises recruitment of those candidates and facilitating support of cultural events and social support requests from members of the group.

Table 10-2 below summarises the social, environmental and economic costs and benefits of the Project across the construction, operational and rehabilitation and decommissioning phases. The costs and benefits relevant to the MNES associated with the Project are discussed in far greater detail in the preceding impact assessment, mitigation and offsets Sections of this PER document. Further information is described in the Social Impact Assessment (**Appendix EE**).

Table 10-2 Cost benefit analysis

Project Phase	Benefits	Costs
Construction	Social • Construction workforce employment • Corporate sponsorship of local groups and services by Vitrinite • Indigenous employment and land access Environmental • Offset area establishment and commencement of associated conservation management Economic • Significant capital expenditure on infrastructure (regional and state economies) • Offset area funding (landholder and manager) • Landholder compensation funding (landholder) • local economic inputs from construction workforce and supply chain • Construction workforce wages and salaries – local increase in household income • Corporate and other taxes	Social • Minor short-term pressure on social services – housing, health, childcare, education and emergency services associated with increased local population - minor Environmental • Initial vegetation and habitat removal • Potential noise and dust emissions • Construction greenhouse gas emissions • Increased traffic associated with construction fleet Economic • Significant capital expenditure on infrastructure (proponent) • Offset area funding (proponent) • Landholder compensation funding (proponent)
Operation	Social • Investment in housing rather than mine camps • Indigenous employment and land access • Corporate sponsorship of local groups and services by Vitrinite • Construction workforce employment • Population increases in Dysart providing greater support for establishment and maintenance of local services and business	Social • Pressure on social services – housing, health, childcare, education and emergency services associated with increased local population - minor Environmental • Progressive vegetation and habitat removal • Potential noise and dust emissions • Operational greenhouse gas emissions

	Environmental • Management and enhancement of offset area – improving habitat quality and availability for threatened species and communities • Progressive rehabilitation – re-establishing habitat for threatened species and communities Economic • Ongoing capital expenditure on infrastructure and equipment (regional and state economies) • Ongoing operational expenditure on mining activities (local, regional and state economies) • Ongoing offset area funding (landholder and manager) • Ongoing landholder compensation funding (landholder) • Royalties paid to the state government • Corporate and other taxes • Local economic inputs from operational workforce and supply chain • Operational workforce wages and salaries • Improved utilisation of available rail and port capacity	• Minor reduction in surface water drainage catchment area • Minor drawdown of groundwater table Economic • Ongoing capital expenditure on infrastructure and equipment (proponent) • Ongoing operational expenditure on mining activities (proponent) • Ongoing offset area funding (proponent) • Ongoing landholder compensation funding (proponent)
Rehabilitation and Decommissioning	Social • Rehabilitation workforce employment • Corporate sponsorship of local groups and services by Vitrinite • Indigenous employment and land access Environmental • Ongoing management and enhancement of offset area – substantially improving habitat quality and availability for threatened species and communities • Final rehabilitation – re-establishing habitat for threatened species and communities	Social • Reduced pressure on social services – housing, health, childcare, education and emergency services associated with increased local population - minor • Potential impacts on services and business associated with a reduction in local population Environmental • Potential noise and dust emissions until rehabilitation works complete • Rehabilitation greenhouse gas emissions Economic

	• Final rehabilitation – re-establishing pre-mining land use – native vegetation with low intensity grazing • Re-establishment of surface drainage and catchment areas • Re-establishment of groundwater table Economic • Minor ongoing capital expenditure (regional and state economies) • Ongoing operational expenditure on rehabilitation activities (local, regional and state economies) • Ongoing offset area funding (landholder and manager) • Ongoing landholder compensation funding (landholder) • Corporate taxes • Local economic inputs from rehabilitation workforce and supply chain • Rehabilitation workforce wages and salaries	• Minor ongoing capital expenditure (proponent) • Ongoing operational expenditure on rehabilitation activities (proponent) • Ongoing offset area funding (proponent) • Ongoing landholder compensation funding (proponent)

10.5 Consistency with Australia's international obligations

Vitrinite has considered all recent recovery and threat abatement plans into the likelihood assessments and mitigation measures for species considered likely to occur on site. The following international conventions have also been considered.

10.5.1 Biodiversity Convention

It is understood that Australia's commitments under the Biodiversity Convention involve reducing the impact on biodiversity, using resources in an ecologically sustainable way, maximising the number of species secure and respecting traditional knowledge on ecological stewardship. These are discussed below.

The action has been designed to reduce, as much as possible, its impact on the environment. The action is a relatively small-scale coal mining project. The amount of coal resource available does not justify the use of larger mining machinery and processing facilities or a higher production rate, which would be required to complete the action in a shorter timeframe. Furthermore, a shorter timeframe could only be achieved if all pits were mined simultaneously. The sequential staging of mining (versus simultaneous mining of all pits) allows for progressive rehabilitation to occur. This reduces the total area disturbed at any one time and permits east-west dispersal of wildlife through the Project area at all times.

Vitrinite has considered a number of environmental and logistical constraints relevant to the positioning of infrastructure associated with the action. Firstly, the positioning of the Project area further east is constrained by the location of Saraji Road and adjacent mining project tenements (such as Saraji Mine located directly east). Locating infrastructure further west is constrained by several watercourses as well as the Harrow Range. For this reason, proposed works have been planned to avoid the most western portion of the MLA.

The proposed location of infrastructure for the action has been determined to minimise the potential impacts to existing surface water drainage channels and watercourses in the eastern Section of the MLA. For example, a large corridors have been maintained between the north pit, main pit and south pit to minimise impacts to drainage features and watercourses (as defined under the Water Act 2000) that exist between these pits and to reduce impacts on surface water flows. Specifically, this separated placement will avoid a tributary of Plumtree Creek (between the north and main pit) and the Hughes Creek watercourse and tributary (located between the main and south pit) that contain high value habitat for the Koala and Greater Glider. These separations have also allowed the action (construction, operation and rehabilitation) to occur in stages and therefore, the disturbance footprint at any one-point-in-time is small and there will be available habitat for native species to utilise.

Excluding these intentional aforementioned corridors, infrastructure was generally designed to be located in a practical location to the coal seam as well as in close proximity to other related infrastructure (e.g. north in-pit waste rock dump next to the ex-pit waste rock dump). This achieves the following:

- reduced transportation disturbance footprint caused by roads
- minimised carbon emissions of vehicles required to travel between these locations (such as haul trucks traveling on haul roads); and
- the connection of essential infrastructure.

Key alternatives discarded through the design phase included larger out-of-pit waste rock dumps and maintenance of a final void in the closure stage. The proposed closure strategy (complete backfill of the final void) has sought to facilitate improved environmental outcomes and sustainable post mining land use. This approach has allowed re-instatement of native fauna habitat and the pre-mining land use.

Vitrinite has also considered the alternative of the works not going ahead at all. The direct consequences of not proceeding with the action are the loss of sustained positive economic opportunities for the local area and region in the form of direct employment, procurement, community buy-in, royalty payments to the government and revenue to local businesses.

Vitrinite will implement mitigation measures for terrestrial ecology (as outlined in **Section 7.1.1**) and for surface water impacts (outlined in **Section 6.4.1**). Where mitigation measures do not significantly reduce the impact, as is the case where significant impacts remain for the Koala, Squatter Pigeon, and Greater Glider, Environmental offsets will be placed as is described in the Environmental Offsets Strategy previously provided. The principal means through which offsets will achieve environmental gains for the Brigalow TEC, Koala and Squatter Pigeon is expected to be through the protection of regrowth vegetation that otherwise has a high risk of repeated clearing.

This vegetation may already qualify as habitat for these MNES at the procurement of the offset(s) or be expected to develop into suitable habitat in the near future. If required, supplementary water points will be installed in the offset area to maximise the amount of foraging and breeding habitat for the Squatter Pigeon and offer drinking sites for Koalas during droughts. As young regrowth is unable to support Greater Gliders unless mature, suitable offset sites must also contain ample remnant vegetation to provide a source of den sites. Nevertheless, protection of regrowth will have the benefit of increasing connectivity between habitat patches for Greater Gliders. Regrowth immediately adjacent to existing den sites also increases food availability for Greater Gliders.

Vitrinite and the Barada Barna People (the native title holders for the broader region) maintain a positive and mutually beneficial relationship, where respect, sharing of ecological knowledge and stewardship of nature form the primary pillars of the agreement. The Barada Barna People (QUD380/08), represented by the Barada Barna Aboriginal Corporation RNTBC ICN 8343 (BBAC), are the 'Aboriginal party' for the Project under the Aboriginal Cultural Heritage Act 2003 (Qld).

The proponents and the BBAC have entered into an indigenous land use agreement (body corporate agreement) (ILUA) for the Project (NNTT number QI2020/006). The ILUA also contemplates the management of Aboriginal cultural heritage under the Aboriginal Cultural Heritage Act 2003 (Qld).

10.5.2 Convention on Conservation of nature in the South Pacific (Apia Convention)

It is understood that the main objective of the APIA Convention is to commit parties to take action for the conservation, utilisation and development of the natural resources of the South Pacific region through careful planning and management for the benefit of present and future generations.

It is noted that the APIA Convention also relates to protection of indigenous flora and fauna in protected areas and national parks. There are no protected areas or national parks located within or in close proximity to the project disturbance footprint. The closest protected area is a small, isolated portion of the Coolibah Nature Refuge, as well as the Peak Range National Park which are located approximately 30km Southeast and Southwest, respectively. No impacts on these areas are anticipated given their distance.

10.5.3 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

The Project does not involve international trade in wildlife and does not threaten wild populations of plants and animals and therefore, the CITES convention is not relevant.

10.6 Information sources provided within the PER

The PER Guidelines require, in section 10.4, the PER to state the following for information used in the PER:

- the source of the information;
- how recent the information is;
- how the reliability of the information was tested;
- what uncertainties (if any) are in the information.

This chapter responds to this requirement.

The PER was informed by technical studies carried out to understand the existing conditions of the study area and assess the potential impacts of the action. Information sources are referenced throughout the PER and the corresponding Technical Appendices. A list of all references for the PER are outlined in the reference list. The list includes references to sources of information and to reference materials.

The reliability and associated uncertainties of the information in each appendix is documented in **Table 10-3** below.

Table 10-3 PER Information Sources

Appendix and Author	Date	Reliability	Uncertainties
Appendix A- PER Guidelines	2024	High – prepared by Commonwealth Government	None
Appendix B- Ornamental Snake habitat memo	2024	High – prepared by a qualified senior and Principal ecologist with nearly 30 years combined experience and using relevant resources to back up claims.	None
Appendix C- Response to the IESC	2024	High- prepared by METServe.	None known
Appendix D- Additional Surface Water Information	2024	High- WRM Water and Environment Pty Ltd (WRM) prepared responses to the information requests. WRM are surface water specialists with high-level expertise in water resource engineering and environmental water management.	None known
Appendix E- Environmental authority	2024	High – prepared by Queensland State Government	None
Appendix F- Noise Impact Assessment	TBC	High- prepared by Trinity Consultants Pty Ltd (Trinity). Trinity is a leading environmental consultant which specialises in air quality, noise and acoustics and water quality.	None known
Appendix G- Geotechnical Assessment	2022	Moderate- prepared by Blackrock Mining Solutions Pty Ltd (Blackrock). Blackrock makes assumptions on inclusion of rejects, uses previous geotechnical characteristics	Predictions using assumptions
Appendix H- Transport Impact Assessment	2022	High – prepared by GTA Consultants (Qld) Pty Ltd (GTA) with an AQP in accordance with the requirements of the Department of Transport and Main Roads (TMR) Guide to Traffic Impact Assessment (GTIA)	None known
Appendix I- Surface water Impact Assessment	2023	High – prepared by WRM with rainfall and evaporation data and baseline monitoring results used to verify modelling, sensitivity analysis performed	None known
Appendix J- Progressive Rehabilitation and Closure Plan	2024	High – prepared by METServe based on other highly reliable studies and investigations	None known
Appendix K- PRCP Schedule	2024	High – prepared by METServe and approved by Queensland State Government	None known
Appendix L- Soil and Land Suitability Assessment	2022 updated 2023	High – prepared by AARC Environmental Solutions Pty Ltd (AARC). AARC are a specialist in providing environmental services in the resource industry. AARC's	None known

Appendix and Author	Date	Reliability	Uncertainties
		survey design, field investigations and analysis were in accordance with relevant standards and guidelines	
Appendix M- Terrestrial Ecology Report	2022 updated 2023	High – prepared by METServe with AQPnel undertaking the field surveys in accordance with guidelines	None known
Appendix N- Sightings and Presence Records for Listed Threatened ad Migratory species	2024	Medium-prepared by METServe with record outliers being removed by AQP	Uncertain listings have been removed from the records
Appendix O- Protected Matters Search Tool	2024	High – prepared by METServe and uses up-to-date government database	None known
Appendix P- Groundwater Impact Assessment	2022	High – prepared by Hydrogeoloigist.com.au Pty Ltd and has a calibrated model, uses site-specific data, uncertainty analysis performed on model	None known
Appendix Q- Aquatic Ecology Assessment	2022	Moderate - prepared by FRC Environmental Pty Ltd (FRC) who have the expertise and experience to deliver insight across the full range of aquatic environments, from freshwater (including Groundwater) and estuarine to marine ecosystems. This has been written by an AQP in accordance with widely used sampling and analysis methodology	Field survey was completed 5 years ago (2019); however, reflected typical wet season conditions.
Appendix R- Geochemistry Assessment	2022	High – prepared by RGS Environmental Pty Ltd (RGS) who are specialise in environmental geochemistry and hydrogeochemical services	None known
Appendix S- Terrestrial ecology cumulative Impact Assessment	2023	Moderate – prepared by METServe and relies on third party publicly available data	Age of information available, changes in species listings over time
Appendix T- Water resources cumulative impact assessment	2023	Moderate – relies on third party publicly available data and predictions	Inherent uncertainty related to accuracy of input assumptions to models, age of references
Appendix U- Groundwater Data	2024	Moderate- compiled by Vitrinite	Gaps in data where monitoring was unavailable
Appendix V- stygofauna pilot study	2022	High – prepared by FRC who have based their assessment on desktop and sampling of groundwater bores	Age of some references
Appendix W- Erosion and Sediment Control Plan	2024	High – prepared by WRM with an AQP and has been prepared to meet the requirements of the Model Mine Conditions (DES, 2017) and Conditions F29 and F30 of the Environmental Authority P-EA-100265081 (the EA) for VS.	None known

Appendix and Author	Date	Reliability	Uncertainties
Appendix X- Receiving Environment Monitoring Program	2024	High – prepared by WRM with an AQP in accordance with the requirements of the *Approved EA and Receiving Environment Monitoring Program Guideline – For use with Environmentally Relevant Activities under the Environmental Protection Act 1994-* Version3.01 (DESI, 2024b)	None known
Appendix Y- Environmental Management Plan	2024	High – prepared by METServe by AQP in accordance with relevant guidelines	None known
Appendix Z- Offsets Strategy	2024	High – prepared by METServe by AQP in accordance with relevant guidelines	None known
Appendix AA- Landform Evolution Model	2023	High – prepared by WRM with an AQP developing a model and using conservative assumptions	None known
Appendix BB- Habitat quality data for Vulcan South Disturbance Footprint	2024	High- prepared by METServe with an AQP developing the habitat quality data in accordance with relevant guidelines	None known
Appendix CC- Stakeholder Engagement Plan	2024	High – prepared by METServe and follows widely accepted format and content	None known
Appendix DD- Environment and Social Governance Statement	2022	High- prepared by Vitrinite and outlines environmental, social and governance information which is up to date.	None known
Appendix EE- Social Impact Assessment	2022	Moderate– prepared by METServe with qualitative and quantitative Census data used, informed by stakeholder consultation	Updated census data since the social impact assessment has been completed
Appendix FF- Persons authorising this report	2024	-	-
Appendix GG- Greenhouse Gas emissions Assessment	2023	Moderate –prepared by Energy Link with internal records, third party data and industry databases used	Forecast as project not developed rather than measured
Appendix HH Greenhouse Gas Abatement plan	2023	Moderate –prepared by Energy Link with internal records, third party data and industry databases used	None
Appendix II Offset Area Management Plan	2024	High prepared by third party AQP and METServe AQP in accordance with relevant guidelines and using field verified data	None

11 Conclusion

This PER has described the existing environmental values within the Vulcan South Project area, including Matters of National Environmental Significance (MNES) associated with listed threatened species and communities and water resources. An impact assessment has been conducted, including a Significant Impact Assessment for relevant species under the *Significant Impact Guidelines 1.1*, and measures to avoid, minimise, mitigate, and manage these impacts have been identified and discussed. Rehabilitation activities and proposed offsets for impacted environmental values are also described.

An EA and final PRCP schedule have been approved under the EP Act. The EA addresses the management of the MNES addressed by this PER and the PRCP addresses rehabilitation of Project disturbance back to MNES habitat, in addition to proposed offsets.

A summary of terrestrial ecology, surface water and groundwater assessment findings are presented below. This PER determined that significant residual impacts remain for the Koala, Greater Glider, Squatter Pigeon and Brigalow TEC, of which the habitat will be offset for, as described in the Offset Strategy.

11.1 Terrestrial Ecology

The Terrestrial Ecological assessment, which utilised desktop assessment and field surveys, determined through a likelihood of occurrence assessment, that seven listed species were considered likely to occur within the Project; however, only three threatened species and one TEC were considered to have significant residual impacts following mitigation measures.

Due to habitat clearing within the maximum disturbance footprint, significant impacts were considered likely for the following species and communities:

- Koala
  - Direct impacts: 1,166.9 ha of foraging, shelter and dispersal habitat (938.6 for all three habitat types, 45.5 ha for shelter and dispersal and 182.8 ha for dispersal only)
- Greater Glider (based on current habitat as per the guideline)
  - Direct impacts: 1,056.8 ha (750 ha of likely/current denning, 234.6 of potential/future denning, 19.3 ha of foraging and 52.9 ha of dispersal).
- Squatter Pigeon
  - Direct Impacts: 1,219.1 ha (372.5 ha breeding and foraging – of which 78.9 ha is foraging only, 767.6 ha of dispersal habitat)
- Brigalow TEC
  - Direct Impacts: 71.2 ha

For all MNES listed above, indirect impacts were also assessed however were determined to be minor and temporary. On-site mitigation measures, such as dust suppression, will manage such impacts and they were determined to be insignificant.

Some impacts, such as necessary clearing for the mine, could not be practicably avoided and are therefore mitigated via proposed offsets.

Key mitigation measures for threatened species included a reduction of the project footprint to the smallest practicable area, the establishment of Environmental Offsets and rehabilitation objectives and criteria that reinstate habitat within the footprint, as part of the approved progressive rehabilitation and closure plan.

11.2 Surface Water

The surface water environment is characterised by the following points:

- The project lies in the very upper catchment of the surface water system.
- Drainage features are highly ephemeral and only flow for very short periods following sustained rainfall

- Drainage features have little aquatic ecological value due to highly ephemeral nature
- Existing drainage features have been disturbed through long term agricultural practice
- The receiving waters for the Project flow directly to the Saraji Mine water management system and are subsequently managed by BMA and part of its water circuit.
- No modelled release of mine affected water, even under extreme climactic scenarios

Mitigation measures

- Surface water management system assessed to effectively mitigation against all surface water impacts
- State EA has conditioned requirement for:
    - Water Management Plan
    - Erosion and Sediment Control Plan
    - Receiving Environment Monitoring Program
    - Full mine and receiving environment monitoring program with trigger limits and reporting requirements
    - Flooding protection has been built into Project infrastructure design following assessment. Included in Water Management Plan scope.

There is no significant residual impact to surface water values.

11.3 Groundwater

The groundwater environment is characterised by the following points:

- Groundwater presence is limited, is poor quality and presents limited connectedness to the broader groundwater system.
- Due to the above, there are no landholder stock/ domestic supply bores in close proximity to the project (within 10km).
- Presence of GDEs is limited, clearing of these within the footprint is addressed through clearing of habitat for threatened species and will be offset through environmental offsets and progressive rehabilitation of MNES habitat.
- All groundwater pit inflow is lost to evaporation and hence no pit dewatering is modelled to be required.
- Drawdown is temporary, limited in extent and magnitude and largely a result of pre-existing adjacent mining activities at BHP's Saraji Mine.

Mitigation measures

The EA has conditioned requirements for:

- The preparation of a Groundwater Management and Monitoring Plan.
- A full groundwater monitoring program with trigger limits and reporting requirements.
- Prevention of environmental harm to Groundwater Dependent Ecosystems outside of the disturbance footprint

There is no significant residual impact to groundwater values.

11.4 ESD Principles

This Project's planning and management meets the principles of Ecologically Sustainable Development (ESD) as outlined below in **Table 11-1**:

Table 11-1 Compliance with Principles of ecologically sustainable development (s3A of EPBC Act)

Principles of ecologically sustainable development (s3A of EPBC Act)	Project Compliance
(a) Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations.	Vitrinite will maintain the health and safety of all personnel associated with the Project and will conduct operations in line with all applicable legislation relating to environmental and workplace compliance. Comprehensive engagement with landholders, the community and Traditional Owners has been undertaken to drive decision making processes, and the Project is economically feasible and broadly supported by stakeholders. Vitrinite have well developed Environmental, Health and Safety management systems in place which require staff, contractors, and subcontractors, comply with: • Environmental legislation; • The Environmental Authority and associated approvals/licenses; • Management plans, procedures, work method statements and safe work method statements; and • Reporting requirements for environmental incident or non-compliance. The Project will contribute to economic growth and employment within the local region. The implementation of environmental offsets will enhance environmental protection for values contained within the offset area, while diversifying income for landholders on a short term and long-term basis. It is acknowledged that the Project will result in impacts to the surrounding environment. The Project will comply with required environmental legislation and the conditions of the Project's EA to address these impacts. Operations will also align with management plans that aim to ensure environmental sustainability and responsibility. Impacts to MNES over short- and long-term scales have been assessed. The Project's proposed offsets programme will aim to restore or enhance local environmental values in the long term. Project planning has taken social impacts into account, as addressed in the Project's Social Impact Assessment and Stakeholder Engagement Plan. The Project will continue to respond to social considerations as planning evolves.
(b) If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.	The precautionary principal has been adopted throughout the risk assessment process and considered in all phases of Project development. This includes the design, construction, operation, decommissioning and rehabilitation phases. Project activities are designed to comply with relevant legislation including the EPBC Act, and with relevant management plans and risk assessments. The ecological values of the site are well understood through intensive survey effort. Studies have been undertaken into the surface water, groundwater and geochemistry of the site, in order to identify potential sources of serious or irreparable

	environmental damage. Vitrinite has taken a conservative approach to environmental management to ensure impacts are accurately assessed. Where possible, impacts to significant species and ecological communities have been avoided though the placement of mine infrastructure in locations of lowest ecological importance, and by minimising the total project footprint. Significant residual impacts that will occur to threatened species will be offset to ensure no net loss of habitat for these species.
(c) The principle of inter-generational equity – that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.	Vitrinite have undertaken impact assessments and incorporating management plans into the Project's activities and will continue to evolve the Project's strategy where appropriate. Where the Project will have an impact on the surrounding environment, Vitrinite have adopted offsets programmes and will engage in progressive rehabilitation in affected areas. These measures are made with the collective goal of maintaining or enhancing the environment for the benefit of future generations.
(d) The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making	Project planning has been designed to avoid or minimise impacts to environmental values where reasonably practicable. This includes following a best-practice environmental management approach in line with industry standards.
(e) Improved valuation, pricing and incentive mechanisms should be promoted.	The Project has adhered, and will continue to adhere, to all policies and guidelines published by the Commonwealth and Queensland Governments. All costs associated with environmental sustainability, including offsets programmes and rehabilitation, will be covered by the Proponent. Additionally, mitigation measures will be in place to avoid the production of unnecessary waste and will re-use and recycle waste materials where waste production is unavoidable.

This Project's planning and management meets the objectives and principles of the *Environment Protection and Biodiversity Conservation Act 1999* as outlined below in **Table 11-2**:

Table 11-2 Compliance with Objects of the Act (s3 of EPBC Act)

Objects of the Act (s3 of EPBC Act)	Project Compliance
(a) To provide for the protection of the environment, especially those aspects of the environment that are matters of national environmental significance.	In planning the Project, Vitrinite has operated under the principle of avoiding and minimising impacts on areas of highest ecological, social and cultural value. While some aspects of the Project are not relocatable (coal resource), supporting infrastructure has been located to avoid MNES where possible and the disturbance footprint minimised as much as possible.
(b) To promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources.	By avoiding and minimising impacts to prescribed environmental matters, the Project will contribute to the protection of the environment and the conservation of biodiversity. The successful rehabilitation of the Project site and provision of offsets are aimed at maintaining or enhancing the environment for the benefit of future generations, thus promoting ecological sustainability.
(c) To promote the conservation of biodiversity **(ca) To provide for the protection and conservation of heritage**	
(d) To promote a co-operative approach to the protection and management of the environment involving governments, the community, landholders and indigenous peoples.	Vitrinite has engaged with a wide range of stakeholders and interested persons during the course of planning and designing the Project components. Details are provided in the Stakeholder Engagement Plan and the current Stakeholder Register. Vitrinite

	will continue to look for cooperative approaches, such as a Community Advisory Group, that will enhance the protection of environmental values and the minimisation of impacts from the Project.
(e) To assist in the co-operative implementation of Australia's international environmental responsibilities.	By complying with the provisions of the EPBC Act and ensuring that impacts to MNES are avoided or minimised, Vitrinite are contributing to the implementation of Australia's international environmental obligations.
(f) To recognise the role of indigenous people in the conservation and ecologically sustainable use of Australia's biodiversity.	The Barada Barna People (determined Native Title holders) are key stakeholders for this Project. Vitrinite recognises the importance of Barada Barna knowledge of the Project area and their past, present and ongoing connection to the land. Vitrinite has signed an Indigenous Land Use Agreement with the Barada Barna People.
(g) To promote the use of indigenous peoples' knowledge of biodiversity with the involvement of, and in co-operation with, the owners of the knowledge.	

The proposed Vulcan South Project should proceed as proposed and assessed in this PER. The environmental values of the site have been identified through thorough investigation. The impacts have been determined through detailed modelling and assessment and appropriate mitigation measures have been proposed. The impacts of the project have been reduced through design, including reduction of the footprint, avoidance of sensitive areas where possible, backfilling of final voids and avoidance of tailings dams and wet tailings. Rehabilitation plans include re-establishment of habitat for threatened species.

Unavoidable impacts have been quantified and will be conservatively offset through local land-based offsets. The project will have significant economic and social benefits for the local area, region and state and these benefits should be realised.

12 References

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13 Appendices

A PER Guidelines

B Ornamental Snake habitat memo

C Response to the IESC

D Additional Surface water assessment to respond to PER requirements

E Environmental Authority

F Noise Impact assessment

G Geotechnical Assessment

H Transport Impact assessment

I Surface water Impact Assessment

J Progressive Rehabilitation and Closure Plan (PRCP)

K PRCP Schedule

L Soil and Land Suitability Assessment

MTerrestrial Ecology Assessment

N Sightings and Presence records for listed threatened and migratory species

O Protected Matters Search Tool

P Groundwater impact assessment (GIA)

Q Aquatic Ecology Assessment

R Geochemistry assessment

S Terrestrial Ecology Cumulative impact assessment

T Surface Water Cumulative Impact assessment

U Groundwater level data

V Stygofauna Pilot study

W Erosion and Sediment control plan

X Receiving Environment Monitoring Program

Y Environmental Management Plan

Z Offsets Strategy

AA Landform Evolution Model

BB Habitat quality data for the disturbance footprint

CC Stakeholder Engagement plan

DD Environment and Social Governance Statement

EE Social impact Assessment

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All relevant Stakeholders have been engaged from the conception of this project and are described in the stakeholder engagement section of this report	

GG Greenhouse gas emissions assessment

HH Greenhouse Gas Abatement Plan

II Offset Area Management Plan