Progressive Rehabilitation and Closure Plan - Eagle Downs Mine (ML70389 and PL485)



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1. INTRODUCTION

This transitional Progressive Rehabilitation and Closure Plan (**PRC Plan**) has been prepared for the Eagle Downs Coal Mine (**EDCM or the mine**) in accordance with the requirements of the *Mineral and Energy Resources (Financial Provisioning) Act 2018* (**MERFP Act**) (**Table 1**). This PRC Plan has been developed to meet the requirements of the *Environmental Protection Act 1994* (EP Act) and the Progressive Rehabilitation and Closure Plan Guideline (**PRC Plan Guideline**) (DES, 2024).

Table 1 Project details

Environmental Authority Holder:	Boomerang QLD Coal Pty Ltd and Echo QLD Coal Pty Ltd
Environmental Authority Number:	EPML00586713 (27 February 2023)
PRCP schedule:	PRCP_EPML00586713_V1 (draft number) (10 February 2025)
Land Description	ML70389 and PL485

Environmentally relevant activities (**ERAs**) at EDCM are mining black coal, petroleum or GHG storage activity, chemical storage, electricity generation, fuel burning, mineral processing, resource recovery, sewage and water treatment. They are undertaken under the conditions of the site's Environment Authority (**EA**) EPML00586713 (Appendix A). This EA is the land outcome document (LOD) for this transitional PRC Plan.

This PRC Plan comprises two parts:

- **Section A:** Rehabilitation Planning - providing information about the site, the rehabilitation plans, and evidence and justification to support the development of the proposed PRC Plan Schedule.
- **Section B:** PRC Plan Schedule - including maps of rehabilitation and closure outcomes for the site, and tables of time-based rehabilitation milestones.

This PRC Plan also includes Appendices, providing key information and technical studies used to support development of this plan.

EDCM was commercially acquired from the previous proponents (South32 Eagle Downs Pty Ltd and Aquila Coal Pty Ltd) by Boomerang Qld Coal Pty Ltd and Echo QLD Coal Pty Ltd, both wholly owned subsidiaries of Stanmore Resources Limited (Stanmore or the Proponent), in August 2024. While the tenure and associated approvals transition is ongoing at the time of the take effect date, Stanmore, acting on behalf of the current proponents, has negotiated the first issue of the PRCP schedule (Appendix B) from September to December 2024.

2. TRANSITIONAL PROVISIONS

EDCM is located approximately 20 km south-east of the township of Moranbah in Central Queensland. It is a proposed a multi-seam, underground longwall mine with a peak production of up to 7 million tonnes per annum (Mtpa) of Run-of-Mine (ROM) metallurgical coal for the export market. EDCM was originally approved by the Department of Environment and Resource Management (DERM) in 2010, however ongoing mining has not been conducted to date. Infrastructure associated with early works that includes administration buildings, access roads, a test pit, power facilities, water dams, a workshop and drift conveyors have been constructed. The mine is in 'care and maintenance' whilst assessments are being undertaken to evaluate a revised mine design.

A PRC Plan transition notice was sent to the previous proponents on 16 December 2020 stating the first transitional PRC Plan must be submitted to the administering authority by 2 October 2023, which was achieved.

Under section 750 of the EP Act, Land Outcome Documents (LOD) relevant to the project are:

- a) An environmental authority for a resource activity on the land. Environmental Authority EPML00586713 that took effect on 3 December 2021. The EA (Table E1 (Final land use and rehabilitation approval schedule) stipulated the post mining land uses (PLMUs) that are the same as the current EA.

- e) An EIS assessment report. The assessment report discussed the commitments for rehabilitating the DREA, establishment of appropriate native shrubs, legumes, and grass species. The assessment report discussed developing a Rehabilitation Management Plan (RMP) in accordance with proposed conditions in the Environmental Management Plan. The final post mine land uses in the RMP are consistent with the EA conditions.

Therefore, the Proponent PLMUs presented in the LOD are pre-approved for transition to the PRCP schedule, and the PRC Plan has been prepared using those PLMUs, being intermittent cattle watering holes, grazing, and native ecosystems.

3. REHABILITATION PLANNING PART

In accordance with section 126C(1)(b) and (c)(ii) of the EP Act, the rehabilitation planning part of the PRC Plan must include a description of:

Legislative Requirements	Compliance
Legislative Requirements.	Section 3.1.2
Each resource tenure, including the area of each tenure.	Section 3.1.2
The relevant activities to which the application relates.	Section 3.1.2
The likely duration of the relevant activities.	Section 3.1.2
How and where the relevant activities are to be carried out, including maps.	Section 3.1.2

3.1 Project Planning

3.1.1 Baseline Information

3.1.1.1 Site Topography

The Project is situated between the Harrow Range to the west and the Isaac River to the east, with gently undulating terrain and an overall gradient to the east, towards the Isaac River. According to AGE (2022a) local relief ranges from approximately 235 metres above Australian Height Datum (mAHD) in the west to 200 mAHD in the east.

Isaac River is approximately 4 km north-east of the project area (at the closest point to the ML) and flows in a south-eastern direction. Several (smaller) ephemeral drainage channels traverse the ML and similarly flow in an east or south-easterly direction towards the Isaac River (**Figure 1**). The JB Gully drainage channel is located in the north-west of the ML and drains into Cherwell Creek (approximately 1.5 km north of the northern boundary of the ML). It flows in an easterly direction before discharging into the Isaac River.

Ripstone Creek is located in the south of the Project ML. It flows in a south-east direction until it discharges into Isaac River (further downstream of the ML). Ripstone Creek is also the receiving waters for an approved Environmental Authority (EA) release point for the Peak Downs Coal Mine, to the west of EDCM. Other gullies drain east and dissipate before reaching the Isaac River.

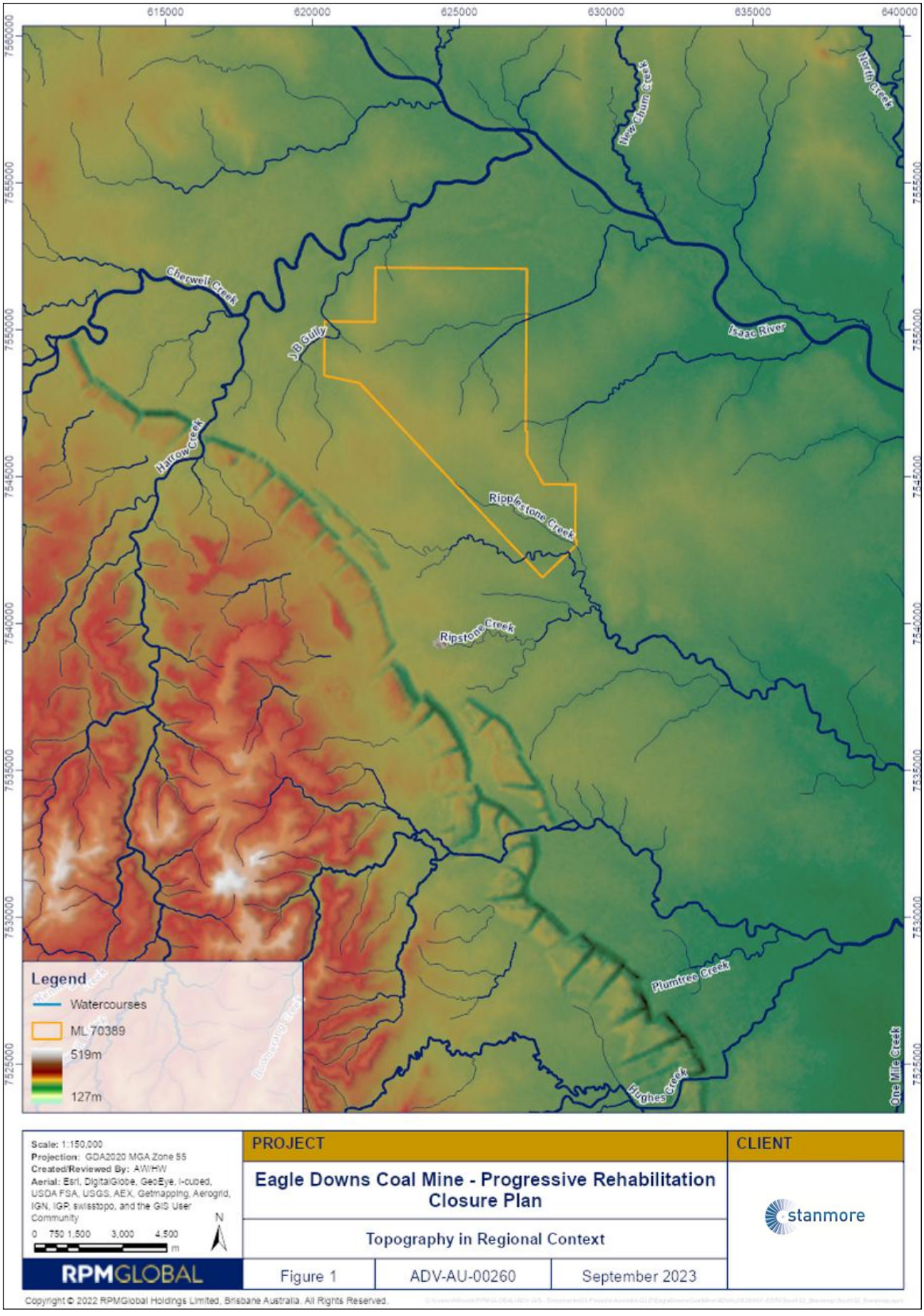


Figure 1 Project Location

3.1.1.2 Climate

The climate of the Project location can be classified as semi-arid with warm, dry winters and hot, humid summers. The mean daily summer maximum temperature in the region ranges between 33.2°C and 34.2°C while the mean winter maximum temperature ranges from 23°C and 25.2°C. The predominant wind direction in the Project area is south to south easterly and less than 10 km per hour.

AGE (2022a) reviewed Department of Environmental Science (DES) SILO gridded data between January 1889 to December 2019, to determine long-term rainfall trends (quality checked against three nearby BoM stations: Carfax, Iffley and Moranbah Airport). AGE (2022a) established that:

- The average annual site rainfall is 577 millimetres (mm).
- The two highest annual rainfalls were recorded for the years 1890 and 2010, with annual rainfalls of 1250 mm and 1122 mm, respectively.
- The minimum annual rainfall occurred in 1902 with 222.2 mm.

The monthly averages for the three stations and SILO grid point were summarised by AGE (2022a) and are presented in **Table 2**.

Table 2 Summary of Rainfall Averages (AGE, 2022a)

(mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean Annual
Silo Rainfall	108	96	65	30	27	30	21	19	16	31	50	84	577
Carfax	110.9	95.3	62.5	31.8	35.6	28.0	22.3	22.5	18.5	35.7	55.3	95.2	616
Iffley	112.5	87.3	62.0	40.3	15.8	40.6	18.9	39.1	13.8	33.9	55.8	90.0	561
Moranbah Airport	86.2	103.6	97.7	26.2	27.4	17.3	29.5	8.3	7.4	24.7	42.5	56.5	529

AGE (2022a) calculated the Cumulative Rainfall Departure (CRD) using monthly rainfall records obtained from the SILO gridded data, to provide a comparison of actual rainfall and long-term averages. The AGE (2022a) report indicates that the Millennium Drought occurs until 2007, when rainfall began to increase until 2013 and that average to above average rainfall patterns occurred between 2013 and 2016. It indicates that a severe drought period followed until about the late 2020's from when above average rainfall occurred to the present. **Figure 2** illustrates the variability in rainfall patterns where the maximum recorded monthly rainfall was close to 300 mm (AGE, 2022a).

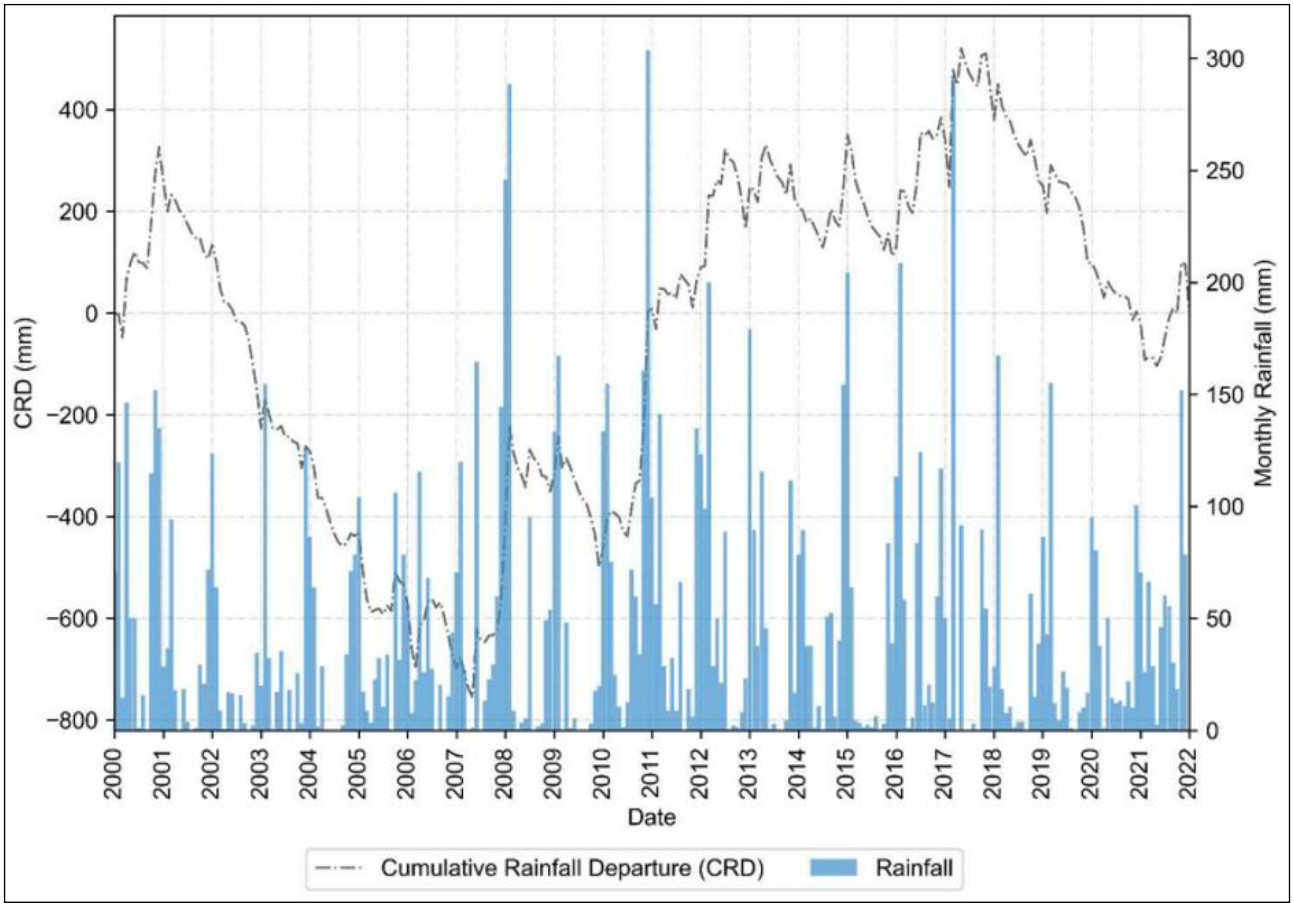


Figure 2 Cumulative Rainfall Departure (2000 – 2021)

The weather stations used to determine long-term rainfall trends was also used to establish actual[1] and potential[2] evapotranspiration (ET). According to AGE (2022a), the potential ET in the project area is approximately 1600 mm/year (**Table 3**) whilst the actual ET in the project area is approximately 600 mm/year (**Table 4**).

Table 3 Average Monthly Potential Evapotranspiration (PET) (AGE, 2022a)

PET (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean Annual
Carfax	187	155	170	124	96	80	81	100	126	172	189	188	1668
Iffley	181	151	167	122	96	80	81	99	125	172	188	184	1646
Moranbah	175	147	163	120	95	80	81	98	124	171	186	179	1619

[1] The definition for actual ET is: "... the ET that actually takes place, under the condition of existing water supply, from an area so large that the effects of any upwind boundary transitions are negligible and local variations are integrated to an areal average". For example, this represents the predicted ET that is occurring over a large area of land under the existing (mean) rainfall conditions (AGE, 2022).

[2] The definition of potential ET is: "… the ET that would take place, under the condition of unlimited water supply, from an area so large that the effects of any upwind boundary transitions are negligible and local variations are integrated to an areal average". For example, this represents the ET which would occur over a very large wetland or large irrigated area, with a never-ending water inflow. Further to this, where the water table approaches the ground surface, ET can also approach the potential ET value (AGE, 2022).

Table 4 Average Monthly Actual Evapotranspiration (AET) (AGE, 2022a)

AET (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean Annual
Carfax	72	64	70	45	33	29	29	29	34	55	67	67	594
Iffley	70	65	71	46	35	31	30	29	33	54	67	66	597
Moranbah	63	62	65	43	33	29	27	25	28	47	62	60	544

Given the climatic data for the Project area indicates high evaporation rates relative to rainfall, groundwater recharge is unlikely to be high, with the exception of prolonged periods of rainfall when there is a potential for deep drainage to underlying groundwater systems.

In coming decades Australia will experience ongoing changes to its climate (BOM, 2020). It is expected that there will be continued increases in air temperature, more heat extremes, and fewer cold extremes. A consequential increase in dangerous fire weather days is expected. Fewer tropical cyclones are expected but a greater proportion projected to be of high intensity, with large variations from year to year. Rainfall intensity is expected to increase. Changes in climate will need to be considered for all aspects of mine closure, including landform stability and erosion potential, plant selection and growth and flooding. Flood impact modelling for more extreme events has been undertaken (Section 3.5.1.2) for the Project, and the proposed landform erosion has been assessed over an extended timeframe (Section 3.5.1.5).

3.1.1.3 Geological Setting

The Project area is located in the northern part of the Permo-Triassic Bowen Basin containing principally fluvial and some marine sediments. According to AGE (2022a), the Bowen Basin is divided into several tectonic units comprising north, north-westerly to south, south-easterly trending platforms separated by sedimentary troughs. **Table 5** provides a summary of the stratigraphy of the ML and surrounds.

Table 5 Summary of the Site Stratigraphy

Period	Stratigraphic Unit	Description	Distribution	Max Thickness (m)
Cainozoic	Isaac River Quaternary alluvium (Qa)	Flood plain alluvium comprising clay, silt, sand, and gravel.	Surficial cover localised along Isaac River. Occurring within the Eagle Downs ML as indicated in **Figure 3**.	~50
	Regolith – alluvium colluvium and other sediments in floodplains, alluvial fans, and high terraces (Qa,Qr,Qr\b and TQa)	Colluvial and residual deposits comprising poorly sorted clay, silt, sand, gravel and black soils, silts and muds derived from weathered basalts.	Associated Cherwell Creek and Ripstone Creek.	0 to 15
Triassic	Mimosa Group: Rewan Group (Rr) (Rewan Formation and Sagittarius Sandstone)	Rewan Formation: green lithic sandstone, pebbly lithic sandstone, green to reddish brown mudstone and minor volcanolithic pebble	Outcrops or subcrops within the Study Area, and central and northern zones of the Project.	~200

Period	Stratigraphic Unit	Description	Distribution	Max Thickness (m)
		conglomerate (at base). Sagittarius Sandstone: lithic sandstone interbedded with mudstones and siltstones with scattered carbonaceous plant material.		
Permian (late)	Blackwater Group: Rangal Coal Measures (Pwj)	Coal seams, carbonaceous shale and mudstone, tuff, siltstone, and mudstone.	Within Project Area; Isolated outcrops in the eastern zones of the Project.	~200
	Blackwater Group: Fort Cooper Coal Measures (Pwt) (Fair Hill Formation)	Coal, brown and green sandstone, conglomerate, carbonaceous shale, and tuff.	Within Project Area; Isolated outcrops and subcrops most of the Project.	~350
Permian (early to middle)	Blackwater Group: Moranbah Coal Measures (Pwb)	Quartzose to sublabile locally argillaceous sandstone, siltstone, mudstone, carbonaceous mudstone, and coal.	Within/underlies the Project; Outcrops or subcrops in the west of the Study Area.	~400
	Back Creek Group (Pb)	Quartzose to lithic sandstone, siltstone, carbonaceous shale, minor coal and sandy coquinite.	Within/underlies Project; Outcrops in the west of the Study Area.	~400

Geological investigations indicate that the economic coal seams in the area belong to the wholly terrestrial Moranbah Coal Measures (MCM), which the Fort Cooper Coal Measures overlie. The coal measures are of Late Permian age. Alluvial (TQa) sediments are distributed extensively across the region. The Fort Cooper Coal Measures are unconformably overlain by a thin veneer (1 to 12 m, averaging 2.5 m) of unconsolidated to semi-consolidated Tertiary sediments and localised unconsolidated Quaternary sediments (Qr and Qr\b) (AGE, 2022a).

The stratigraphic profile across the Project area is described by (AGE, 2022a) as comprising of two distinct units namely a Permian sandstone/siltstone/mudstone/coal sequence (the Coal Measures) which are overlain by a thin Tertiary clay, sandy clay, clayey sand sequence. The Permian rocks form a regular layered sedimentary sequence that subcrops to the west of the Eagle Downs area and dips at three to eight degrees to the east, while the Tertiary materials are more complex and irregular.

Figure 3 and **Figure 4** provide a surface geological and solid geology map for the project area respectively, whilst **Figure 5** shows a typical stratigraphic column for the EDCM Project area.

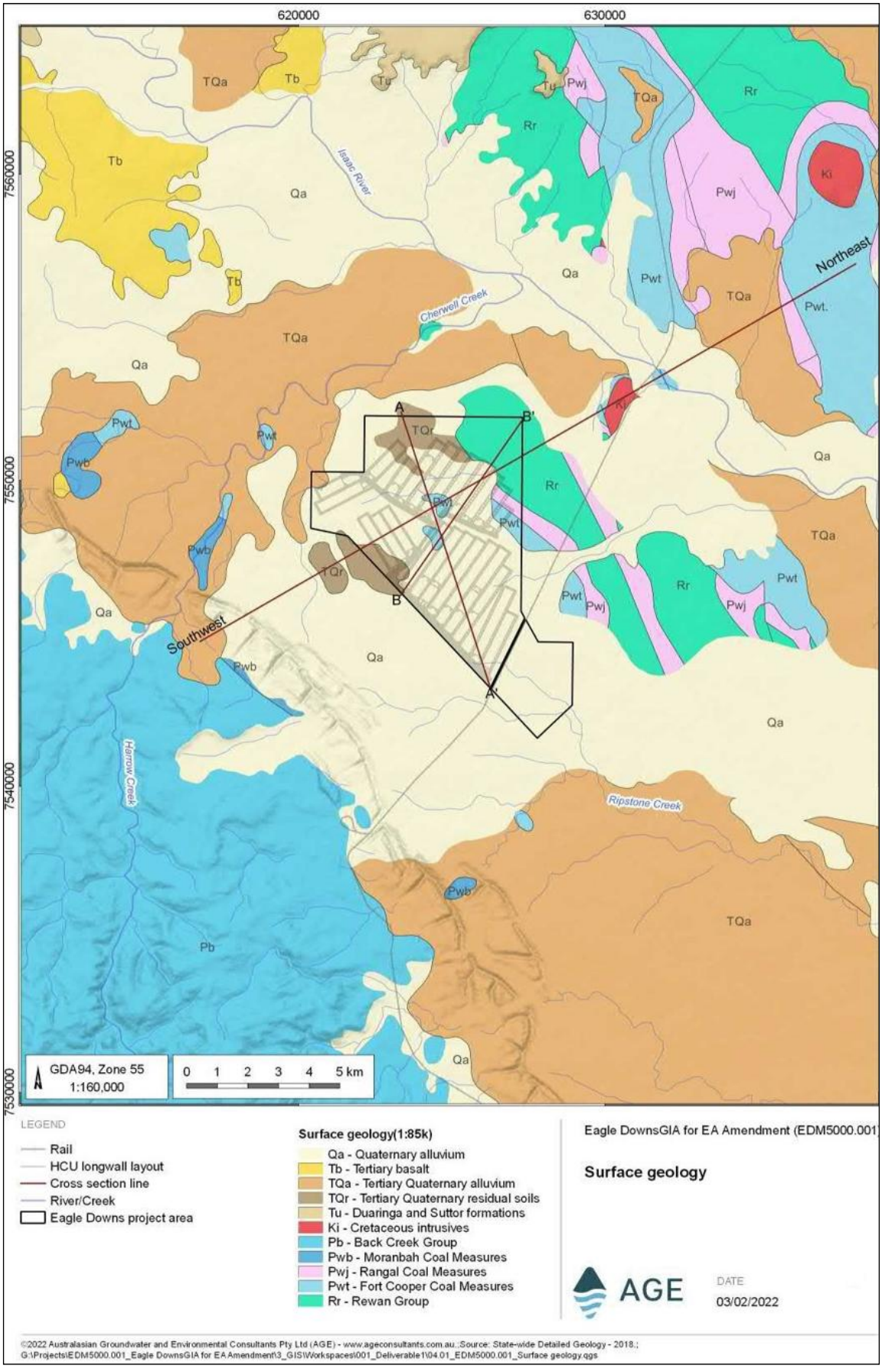


Figure 3 Surface Geology

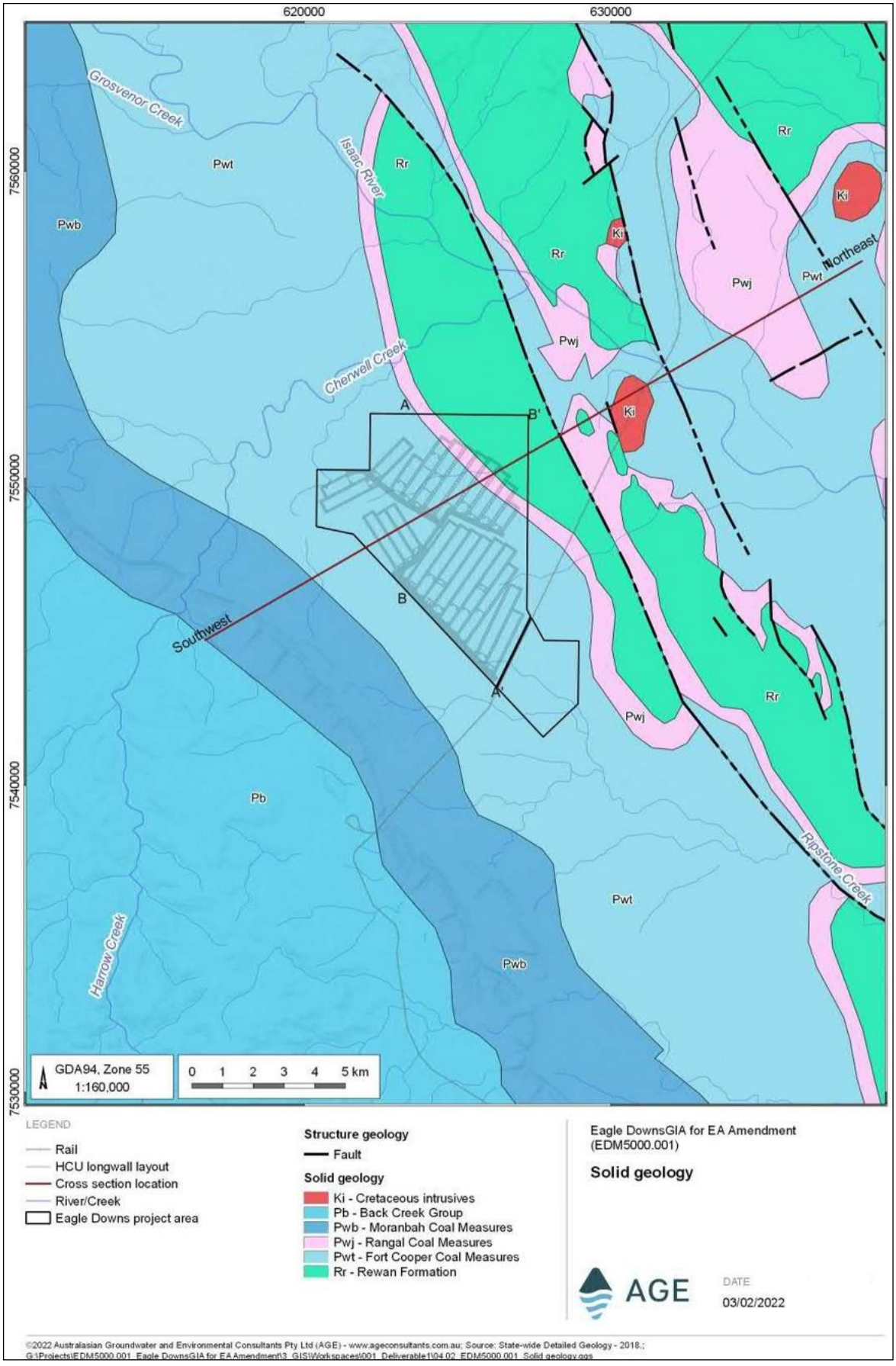


Figure 4 Solid Geology

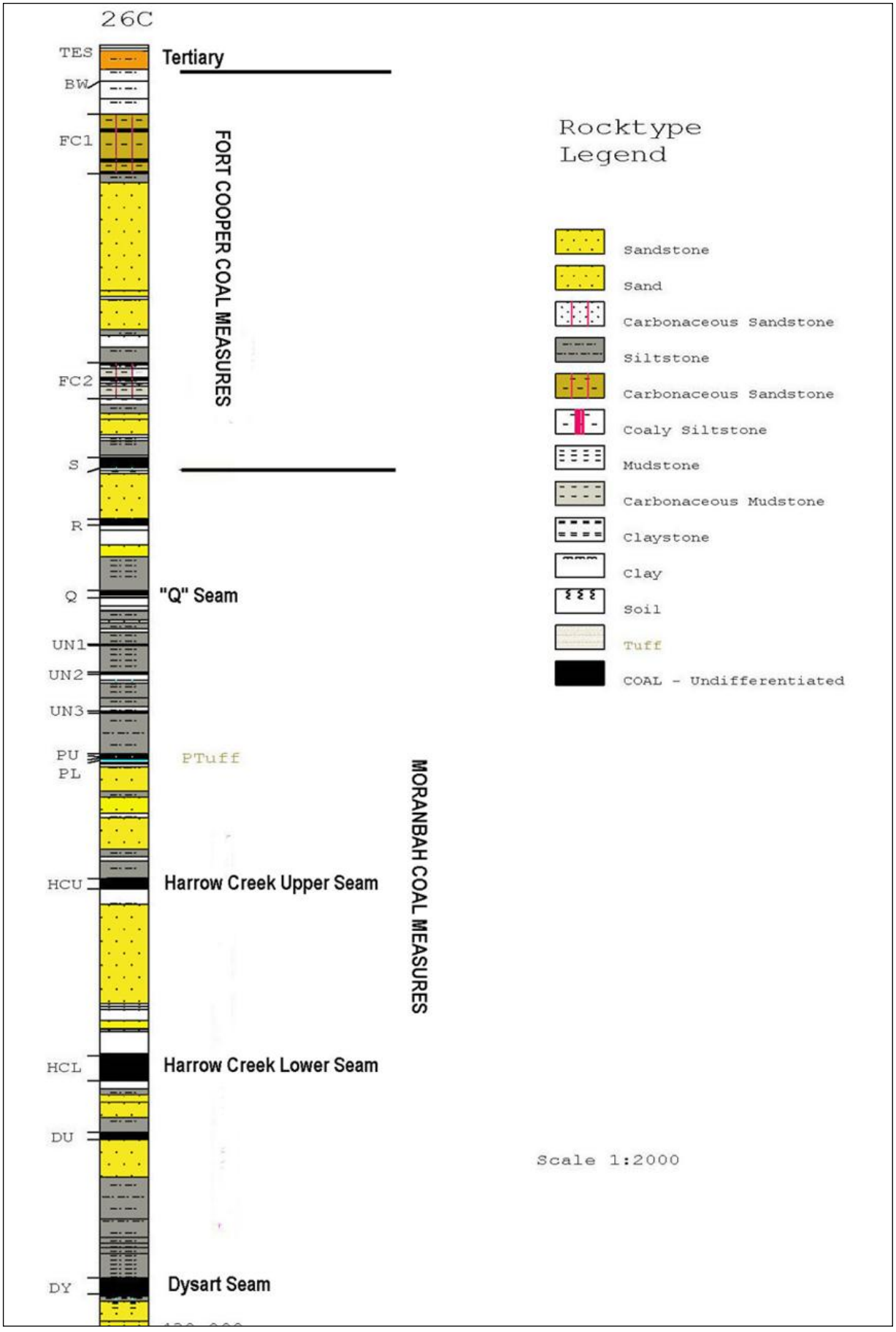


Figure 5 Typical Stratigraphic Column (Hole 26C)

The MCM consists of sandstone, siltstone, claystone and mudstone, coal, coal parting materials and sub-coal (under-burden) strata. AGE (2022a) indicate that six coal bearing horizons exist, however, significant reserves are restricted to the Q Seam, Harrow Creek Upper (HCU) and Lower Seams (HCL) and the Dysart Seam (DY) that form the principal economic coal resource of the Eagle Downs project.

A single 12 m to 15 m thick seam consisting of HCU and HCL combine in the south of the project area. Although the longwall is able to be mined at maximum height within this area, only the HCU is able to be practically mined. **Figure 3** indicates two cross section locations over the project area, whilst **Figure 5** and **Figure 6** provide the diagrammatic sections of those locations where two separate seams (HCU and HCL) are identifiable.

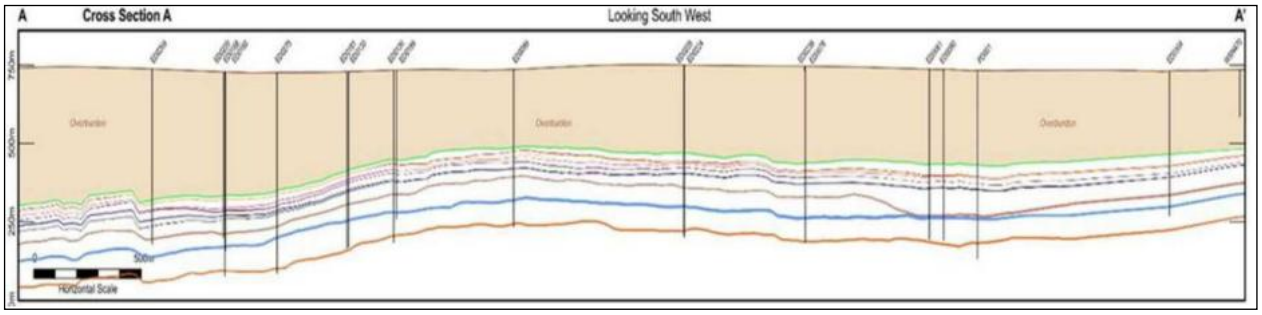


Figure 6 Cross Sections A-A (South32, 2020)

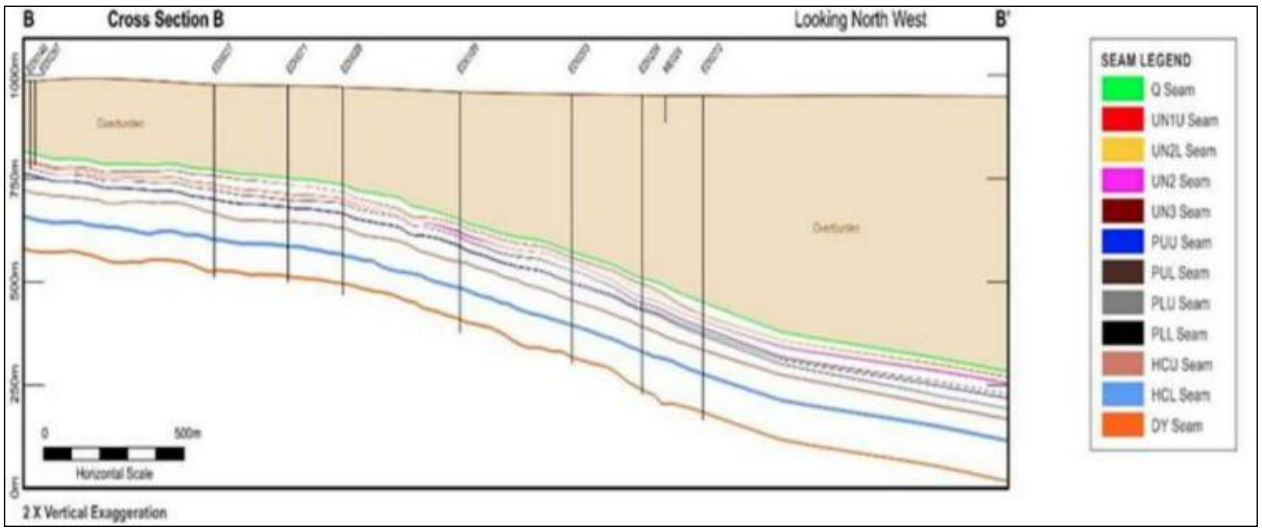


Figure 7 Cross Sections B-B (South32, 2020)

The main target seam at the Eagle Downs site is the HCU seam, which lies approximately 110 m below the Q seam. The HCU seam is 4 m in thickness on average, and ranges in depth from 250 m in the south-west to more than 600 m in the north-east. AGE (2022a) states that the immediate roof of the HCU seam is a predominantly siltstone-based material interspersed with varying proportions of sandstone and mudstone, the latter typically presenting as sub-horizontal bedding. A review of the boreholes, previous reports and geophysical logs indicates small areas where the combined sandstone thickness in the immediate 50 m of overburden is up to 22 m, however these appear to be laminated and not massive.

AGE (2022a) identified that the shallowest coal in the HCL seam is approximately 300 m below the surface, reaching 600 m towards the north-east. The seam thickness was found to range from 6.3 m to over 10.0 m (averaging 8 m in the central and northern regions of the project area and thinning to 6 m, where it coalesces with the HCU seam.(AGE, 2022a)

Interburden between the HCU and the HCL seams was found to rapidly thicken away from the coalescence zone in the south, whilst towards the north, it thickens to approximately 50 m and even 75 m thick in some places. Two major sandstone channels were found to be contained within the interburden that vary in thickness across the lease, exceeding 55 m in thickness towards the centre of the lease.

AGE (2022a) reports that the DY seam structure and stress regime can be translated down from the HCU and HCL seams, with obvious offsets for the dip of any structure. The interburden between the seams varies between 50 m thick to the east and 100 m thick to the north-west. Furthermore, the depth of the DY seam is greater than the HCL seam, the average interburden thickness between the HCL and DY seams is around 60 m to 70 m, without any of the thick and strong sandstone channels found between the HCU and HCL seams.

In terms of structural geology, a large-scale thrust system, the Isaac Thrust, is situated east of the Isaac River. While not measured, some localised stress changes may impact the mine due to this structured zone. The north-west south-east trending thrust faults are estimated to have up to 100 m throw with Permian sediments displaced upwards by these faults to the east. These faults are interpreted to extend up to the base of weathering beneath the Isaac River. The locations of these faults are shown on **Figure 4**.

Well defined drilling (at 500 m spacings) has enabled geological structures to be identified within the project area. In addition, 2D and 3D seismic surveys undertaken provide complementary information on a mixture of normal faults, thrust faults and seam rolls, with varying confidence levels across the project area. This is shown in **Figure 8**.

As is illustrated, there are two main fault orientations in the project area, those being north-east to south-west and north-west to south-east, AGE (2022a) identify that the principal structural features (faults with a throw greater than 10 m) are:

- Two normal faults in the centre of the project area, oriented north-west to south-east, with throws of up to 17 m.
- A north-east to south-west oriented normal fault, almost parallel to the railway line with a maximum throw of 17 m.

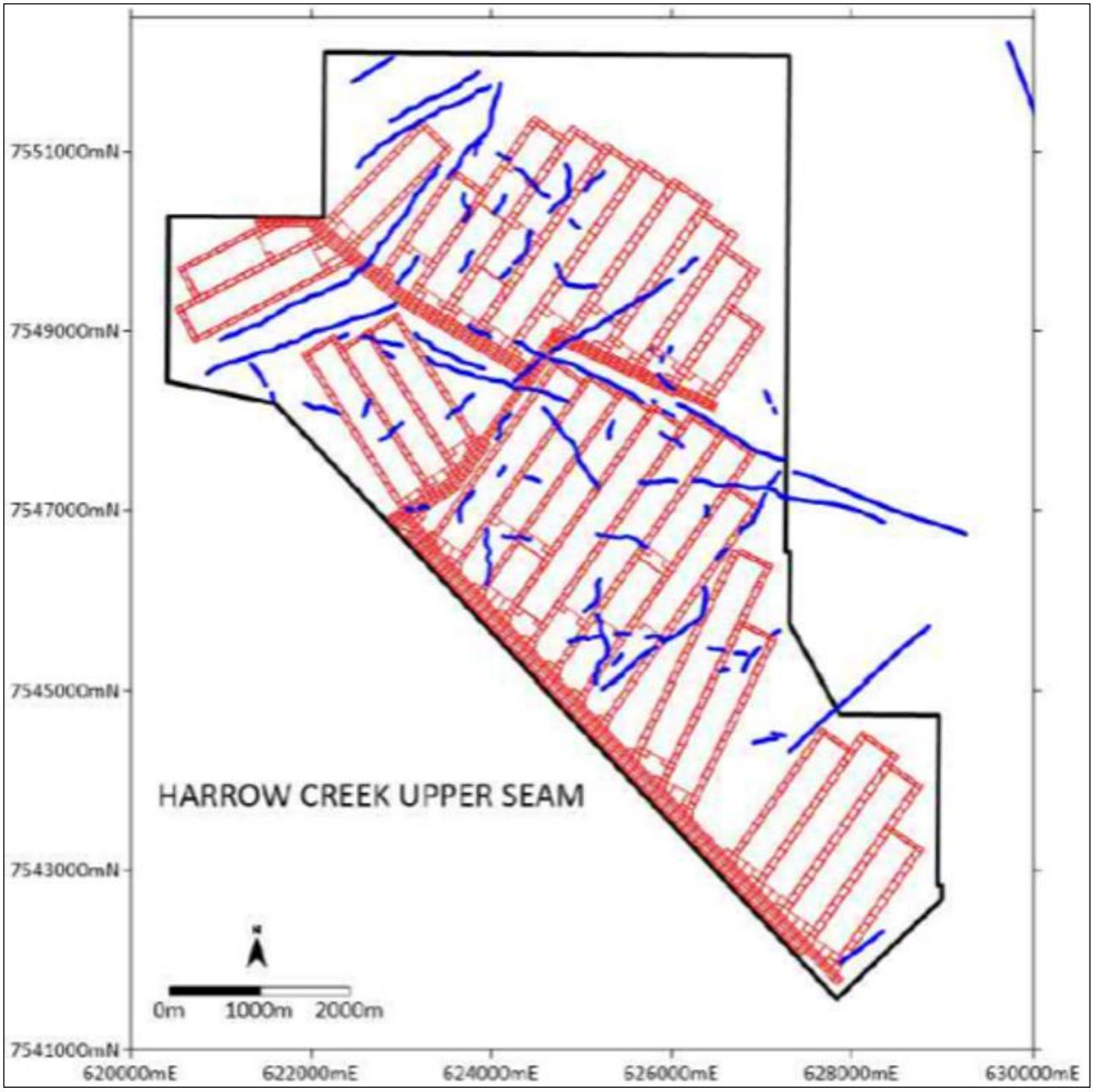


Figure 8 Fault Interpretation Projected on the HCU Seam (South32, 2020)

3.1.1.4 Site Hydrology and Fluvial Networks

The Isaac River catchment has seen significant changes in land use over the past 50 years. Widespread land clearing and coal mine development have occurred throughout the catchment. The extent to which these activities have affected water quality is difficult to ascertain. Coal mines have historically discharged mine-affected water immediately following significant rainfall events, but few records are available of the timing and quality of these releases. Typically, under normal conditions, water is conserved on-site to provide water for site use.

Within a regional context, the Project area is located within the Isaac River sub-catchment of the Fitzroy Basin. On a local scale, the project ML is positioned across four local catchments and several waterways surround and traverse (drain) the project ML as is shown in **Figure 9**.

Cherwell Creek (stream order five) is situated north of the project area. JB Gully (stream order two) traverses the north-west of the ML flowing north into Cherwell Creek. The majority of the project drains to the north-east into Isaac River (stream order six), which is at its closest point is located 3.5 km from the ML boundary.

The southern section of the project area drains into Ripplestone Creek (stream order two) before entering Ripstone Creek (stream order four) that joins Isaac River approximately 30 km further downstream.

All watercourses listed above, exhibit the characteristics of a watercourse as defined under the *Water Act 2000* (Queensland) (Water Act). The remaining waterways that drain through the Project area are identified as “drainage features” and therefore are not considered watercourses under the Water Act (WRM, 2008).

Primarily, these watercourses are ephemeral, only flowing after largely unpredictable rainfall and runoff; and they are generally dry for most of the year (AGE, 2022a) **(Figure 9**). The Isaac River is a seasonally flowing watercourse, typically with surface flows in the wetter months from November to April, reducing to shallow subsurface flows from about May to October. Stream flows are highly variable, with most channels drying out during winter to early spring when rainfall and runoff is historically low, although with some pools are expected to hold water for extended periods. The PRCP schedule includes monitoring points downstream of mining activities for Features 1 and 2 as shown in **Figure 9** and detailed in Appendix G to ensure the receiving environment is not impacted from rehabilitation post closure. Sampling will need to occur within 48 hours of flows across the landscape.

Therefore, physical attributes, water quality, and the composition of aquatic flora and fauna communities are also expected to be highly variable over time (WRM, 2008).

The Peak Downs mine is located west of the Project area. Mine water discharged from this mine enters Ripstone Creek upstream of the confluence of Ripplestone Creek. The Isaac River joins the Mackenzie River approximately 190 km downstream of the site, just upstream of Tartrus Weir. The Mackenzie River joins the Fitzroy River and flows to the Coral Sea (GJR, 2008).

Regional Water Quality

Publicly available regional water quality data for the Isaac River at the Burton Gorge, Goonyella and Deverill gauging stations and at Red Hill Mining Lease (Lower and Upper Isaac River locations) have been analysed and a comparison of the water quality statistics at these sites are displayed in Appendix G. The Red Hill, Isaac River (Burton Gorge) and Isaac River (Goonyella) stations are located downstream of the Goonyella, North Goonyella, Broadlea and Burton mines and therefore measured water quality may be affected by mine releases. The Red Hill, Isaac River (Burton Gorge) and Isaac River (Goonyella) stations are about 70 km, 85 km, and 50 km upstream of the Project, respectively. However, these stations provide an indication of water quality, including metal toxicants, in the Isaac River upstream of the Project.

The review of the regional water quality data indicates that there are some water quality indicators that are consistently above the relevant regional guideline values, specifically aluminium (dissolved), copper (total and dissolved), filterable reactive phosphorus, zinc (dissolved), iron (total and dissolved), TSS and turbidity. This indicates that the current Water Quality Objectives (WQOs) may not necessarily reflect the typical background water quality within the Upper Isaac River.

Local Water Quality

According to AGE (2022a), the primary land uses downstream of the project site that are relevant to the environmental values (EV) of the water include:

- Aquatic ecosystems.
- Agricultural supply (farm, stock, and irrigation).
- Human consumption – suitability for drinking water with minimal treatment.
- Recreation and spiritual values.
- Industrial.

The EVs for this region are the same as for the main channel region, except for the addition of the aquaculture EV. The WQO relevant to the identified EVs were analysed as a part of the Surface Water impact Assessment (Appendix G). Where different EVs have different WQOs, the most conservative value has been adopted to inform the trigger limits adopted for post-closure monitoring. This approach remains in line with the receiving waters contaminant trigger levels within the latest version of the EA.

The Receiving Environment Monitoring Program (REMP) was developed in accordance with the relevant conditions of the EA and has been conducted annual from 2016 to present. The aims of the REMP involve

developing a dataset to understand the overall health of the aquatic receiving environment, identifying and describing the extent of any adverse impacts to local environmental values and monitoring any changes in the receiving water. The receiving environment is considered the waters of Ripplestone Creek (Easter Tributary) and connected waterways within 20 km downstream of the release points at the site. The mine is unlikely to discharge MAW as it has been designed as a nil discharge system, however, the REMP has been developed to gather data as a point of comparison for any future assessments of mine-related disturbance on the receiving environment and in the event that discharges do occur.

Annual data from targeted wet and dry season monitoring of representative sites in Ripstone Creek up to 20 km downstream of release points, with occasional additional sampling events will be available to inform the post closure monitoring program. The data includes information on stream sediment quality, macroinvertebrate assemblage, flow when available, and water quality.

The project area, according to Hansen Bailey (2008) is above the one-hundred-year flood level, with the exception of a small area in the north-east of the site. With the exception of an area in the north-eastern corner and a small area in the north-western corner of the project ML, the majority of the site is above the estimated level of the Probable Maximum Flood (PMF) from the Isaac River (as shown in **Figure 56** in Section 3.5.1.2) (AGE, 2022a).

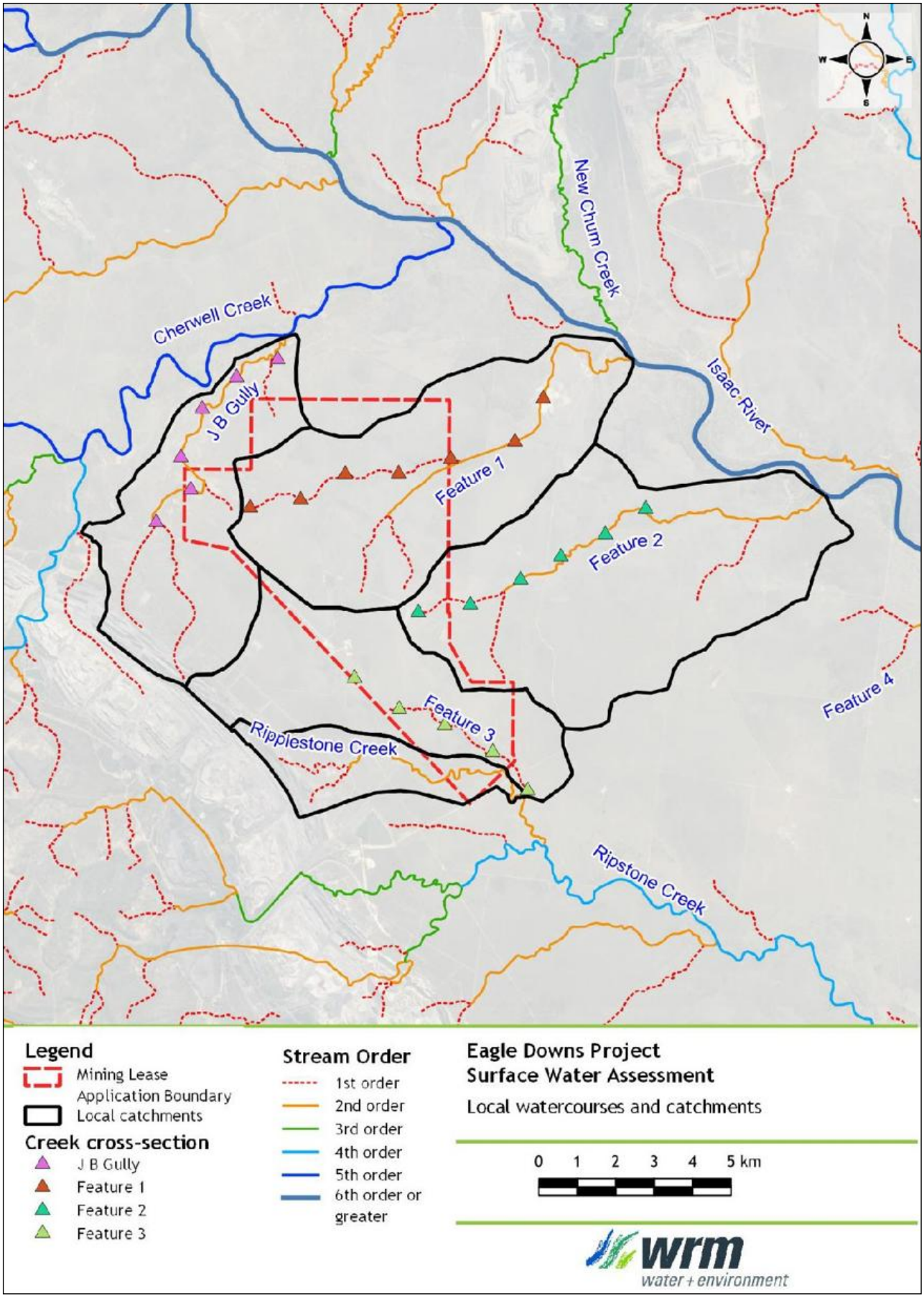


Figure 9 Local Watercourses and Catchments

3.1.1.5 Groundwater levels and properties

The Project area is located in the Isaac Connors Groundwater (GW) Management Area of Queensland's Fitzroy Basin.

There are two aquifer systems in the Project area:

- A shallow aquifer associated with the upper weathered/fractured rock.
- Aquifers associated with the Permian formations.

The weathered zone of the Fort Cooper Coal Measures exists across the Project area and averages about 22 m in thickness. It is connected to the Permian coal seam aquifers, where the coal seams are shallow and weathered; and by deeper open fractures that intersect the coal seams at depth. The weathered zone occurs across the whole of the area generally from surface level. To the east of the ML, it underlies the alluvium of the Isaac River. The water table is generally in a weathered fractured rock zone. Available information on farm bores suggest that the base of the shallow aquifer does not extend beyond 80 m (AGE, 2008a).

The Permian coal seam aquifers are deep and confined beneath the Project area, but subcrop to the west. Groundwater storage and movement occurs in the coal seam cleats and fissures and in open fractures that intersect the seams. Other sediments in the coal overburden and inter-burden sequence are of significantly lower permeability and form aquitards (AGE, 2022a).

There are no deep Quaternary or Tertiary palaeo-channels present in the project ML. Although there are no alluvial aquifers within the ML boundary, they do occur outside the ML and are associated with sand and gravel deposits along Cherwell Creek and the Isaac River.

Exploration drilling results were obtained from the Integrated Isaac Plains Project. Based on results, the alluvium of the Isaac River provided yields of up to 1 L/s suggesting that the river alluvium is likely to function as a poor to medium yielding unconfined aquifer. The drilling results indicated the sporadic nature of groundwater occurrence in the alluvium. Rising and falling head permeability tests undertaken on six monitoring bores in the area indicated the following permeability value:

- Isaac River alluvium: 2.3 to 3.6 m/day.
- Coal seams: 0.0005 to 0.024 m/day.
- Permian siltstone/sandstone: 0.0001 m/day.

Creeks within the EDCM Project area and surrounds are ephemeral, and there are a few stock water bores in the alluvium indicating unsaturated or thinly saturated conditions. Recharge of the alluvium is by rainfall and seepage from the river during periods of flow. During drier periods, the alluvium discharges as baseflow to the river (AGE, 2022a).

The only environmental value identified for groundwater in the area is for agricultural use: stock watering; and the impact on farm bores (AGE, 2022a).

An extensive network of monitoring bores has been installed across the project area, to monitor groundwater levels in standing water level (SWL) meters below ground level (mbgl), as listed in **Table 6** and **Table 7** and

shown in

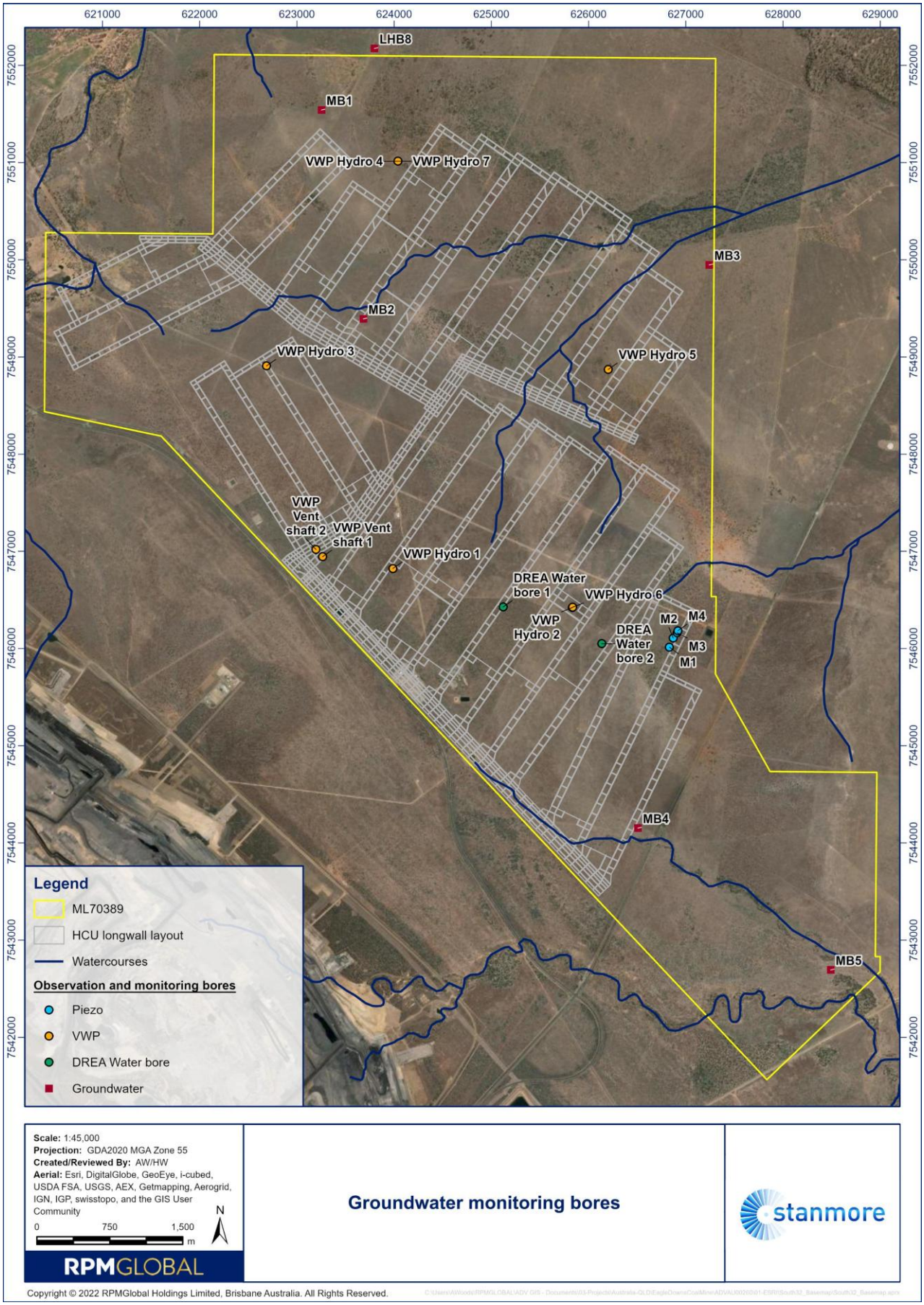


Figure 10.

Table 6 EA Monitoring Bores (in Shallow Weathered Fractured Rock) (AGE, 2022a)

Bore Name	East	North	Collar mAHD	Bore Depth (m)	GW Level (mbgl)			Average GW Elevation (mAHD)
					Ave	Min	Max	
MB1	623253.9	7551541	221.4	51.4	32.4	29.9	35.7	189.0
MB2	623683.3	7549390	210.1	51	16.3	15.8	17.7	193.8
MB3	627239.6	7549945	203.6	51.4	33.1	31.6	34.7	170.5
MB4	626507.2	7544150	214.9	52	18.8	18.4	19.4	196.1
MB5	628490.5	7542693	209.3	52	14.5	14.2	15.1	194.8
LHB13	627200	7546952	217.9	Unknown	13.1	11.5	16.6	204.8

Table 7 Water Levels in Exploration Bores (Coal Seam Aquifers) (AGE, 2022a)

Bore	East	North	Collar (mAHD)	Hole Depth (m)	Depth Steel Casing (m)	Date	SWL (mbgl)	SWL (mAHD)
E795006R	622097.76	7550179.79	227.14	420.21	Unknown	7/08/07	22.39	204.75
E795009R	624105.74	7546179.17	236.41	420.22	Unknown	7/09/07	33.16	203.25
E795012R	625112.91	7546175.09	229.18	432.46	Unknown	22/08/07	22.25	206.93
E795013R	625111.06	7545181.75	223.23	420.46	Unknown	22/08/07	16.57	206.66
E795015C	623360.80	7458176.88	223.30	471.45	144.37	7/08/07	12.97	210.33
E795016C	626123.55	7547179.61	223.53	570.23	259.83	21/07/07	13.75	209.78
E795017C	625091.00	7550180.73	203.68	640.41	195.70	7/08/07	Flowing	Unknown
E795021C	625488.22	7546073.03	227.68	501.36	251.61	22/08/07	19.39	208.29
E795022	624069.41	7548885.92	213.38	527.65	209.50	7/08/07	3.54	209.84
E795023	622646.02	7547476.15	243.39	419	119.00	26/08/07	34.39	209.00
E795024	621238.56	7548885.49	230.29	454	129.00	7/08/07	22.67	207.62
E795025	621268.86	7548910.86	230.35	466	136.00	7/08/07	22.62	207.73
E795026	623323.26	7546785.42	239.87	430	130.00	7/10/07	33.17	206.70
E795027	624038.006	7547496.32	266.51	316.87	171.00	28/08/07	17.66	208.85
E795028	624688.26	7548160.08	220.88	502	208.00	7/08/07	12.08	208.80
E795029	622627.92	7550293.79	221.34	657.9	346.00	7/08/07	13.93	207.41
E795030	626911.94	7546054.17	225.20	Unknown	346.00	7/09/07	14.98	210.22
E795031	624069.99	7546065.27	235.46	371.53	152.00	7/09/07	29.27	206.19
E795032	624074.99	7546075.79	235.61	285	180.00	7/09/07	29.47	206.14
E795033	625488.00	7544654.59	219.77	342	230.00	7/09/07	12.47	207.30
E795034	624660.50	7546589.76	232.72	502	218.00	21/08/07	25.17	207.55
E795035	624120.33	7545968.64	233.68	462.15	289.90	7/09/07	27.72	205.96
E795036	622686.01	7547381.73	242.34	413	130.00	7/08/07	35.85	206.49
E795038	622594.80	7550302.80	221.81	581	318.00	7/08/07	14.83	206.98
E7905039	625838.87	7544291.38	Unknown	504.8	209.00	14/11/07	10.41	Unknown
E795040	626899.53	7546766.25	Unknown	282.34	282.34	14/11/07	6.21	Unknown

Bore	East	North	Collar (mAHD)	Hole Depth (m)	Depth Steel Casing (m)	Date	SWL (mbgl)	SWL (mAHD)
E795041	623010.44	7550655.34	Unknown	630.27	324.29	14/11/07	11.18	Unknown
E795042	623010.44	7547119.80	Unknown	137.86	137.86	14/11/07	34.5	Unknown
E795043	624424.66	7545705.59	Unknown	454.05	174.30	14/11/07	22.43	Unknown

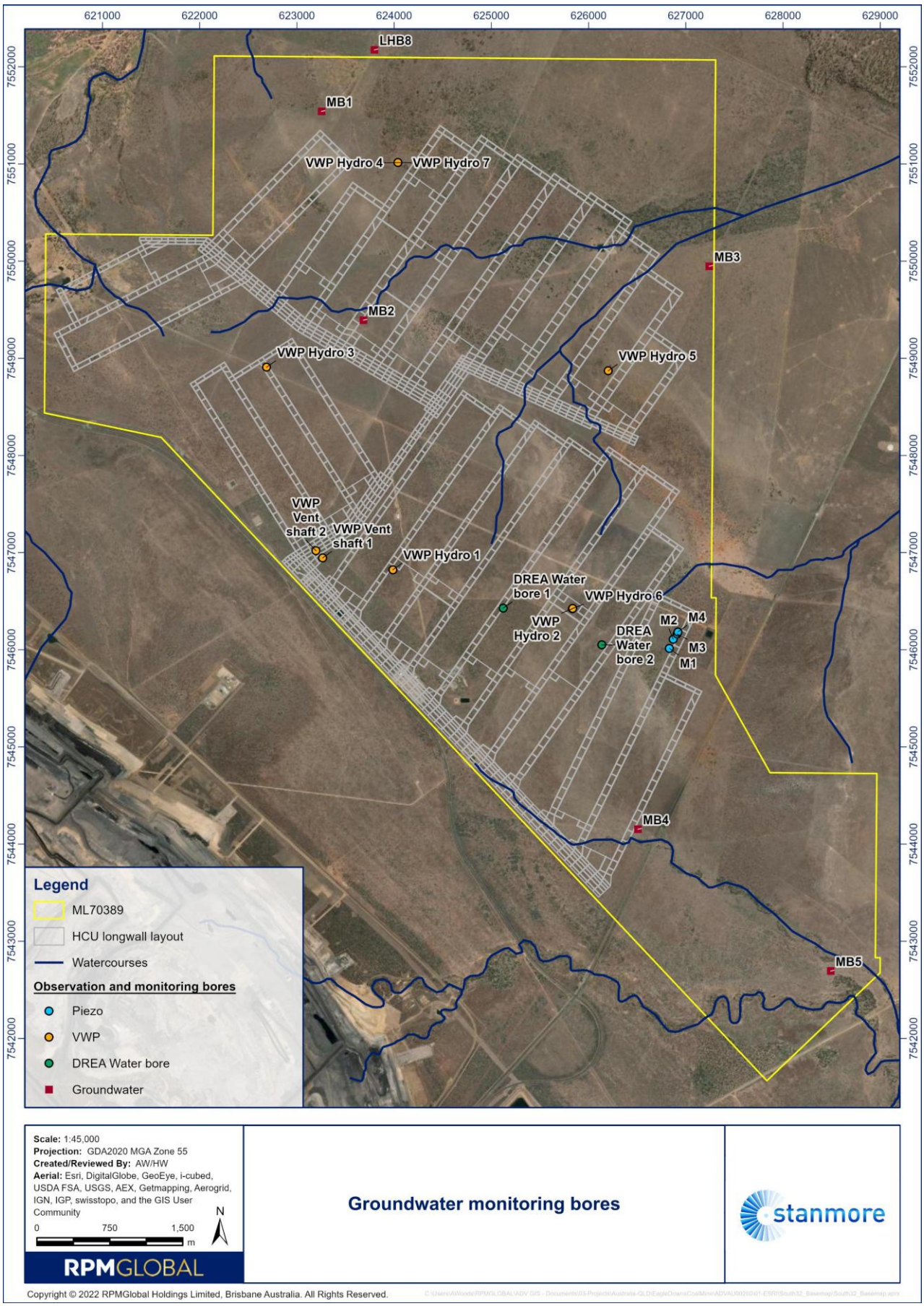


Figure 10 Groundwater Monitoring Bores

3.1.1.6 Soil Types, Properties and Productivity

A soils and land suitability assessment of the Project area was conducted in 2008 by GJR Holdings (2008) as a part of the EIS baseline studies. The soil types were confirmed within the Project area through a desktop assessment and sampling program. Preliminary terrain mapping was interpreted from aerial photos, existing topographical, geological, and regional soils information, and background data sources The preliminary mapping was supported by a sampling program conducted in 2007 at 11 site locations supplemented with exploration data from drilling sites. were described and mapped, which complemented earlier soil mapping.

The majority of the soils across the Project area tend to be texture-contrast (duplex) soils with clay subsoils or relatively uniform clay soils. The subsoils are known to be sodic in areas, which can be prone to erosion when exposed. Other limitations include salinity and acidity at depth. The various soil types located within the Project area are outlined in Table 8 and characteristics and management considerations depicted in **Figure 11**.

From the terrain units identified within the Project area, GJR (2008) conducted a land suitability assessment for dryland cropping and grazing enterprises, from which the agricultural land capability was assessed. The major proportion (85%) of the pre-mining Project area was classed as pastureland, with the remaining proportion split between limited crop land (7.3%) and non-agricultural land (7.7%). None of the pre-mining land was suitable to be classed as crop land.

None of the terrain units or soil type variants identified offered any more than a very marginal potential for dryland cropping, due to erratic rainfall patterns and restricted plant available water capacity (GJR, 2008). Thus, the overall cropping class assigned to the Project area's pre-mining land was "Class 5: unsuitable land due to extreme limitations for the intended land use".

Table 8 Soil Types (GJR, 2008)

Soil Type	Description	Australian Soil Classification (ASC)	Geological Regimes	Management Considerations
5.1	Sandy loam to clay loamy surface duplex soils with reddish to orange - brown to acidic clay subsoils.	Chromosol or Kurosol	TQr Pwt	Subsoils may be moderately dispersive and erosion-prone if exposed.
5.2	Thick sandy surface acidic yellow-brown duplex soils.	Chromosol or Kurosol	Qr0	Subsoils may have low permeability and are often dispersive and erosion-prone where exposed.
2-5.2	As for type 5.2, with some uniform coarse-textured sandy alluvial soils.	Rudosols (Type 2) Chromosol or Kurosol (Type 5)	TQa	Subsoil often imperfect to poorly drained and can be dispersive.
6	Thin fine sandy to silt loamy surface with yellow-brown alkaline sodic medium to heavy clay subsoils.	Chromosols, Sodosols, or Calcarosols	Qrb	Poorly drained, subject to surface water ponding. Subsoils can be prone to dispersion if exposed (high ESP).
6-8	As for Type 6, in association with dark grey or dark brown cracking clay soils.	Chromosols, Sodosols, or Calcarosols (Type 6) Vertosols (Type 8)	TQr Qr Pwj	Low permeability, increased salinity with depth, high levels of sodium and magnesium in the subsoils – prone to erosion by dispersion if exposed.
6-8g	Mosaic of fine sandy to loamy surface alkaline duplex soils and dark grey to fark brown cracking clay soils with intensive melon-hole gilgai development.	Chromosols, Sodosols, or Calcarosols (Type 6) Vertosols (Type 8)	Qr Rr	Subsoils likely to be dispersive and prone to erosion if exposed, subsoils can be strongly acid and sodic with depth. Gilgai can result in ponding of water.
7-8	Association of medium to deep uniform or gradational clays with hard coarse-structured subsoils and dark grey to dark brown.	Dermosols or Hydrosols (Type 7) Vertosols (Type 8)	Qrb	Subsoils with low permeability, strongly alkaline and sodic with depth.
7-8g	As for soil association 7-8, with locally intensive linear gilgai formation.	Dermosols or Hydrosols (Type 7) Vertosols (Type 8)	Qrb	Subsoils with low permeability, strongly alkaline and sodic with depth.
8	Medium to deep dark grey to brownish black cracking clay soils.	Vertosols	Qrb Pwt	Low permeability and potential waterlogging. Can be strongly acidic, saline and sodic with depth

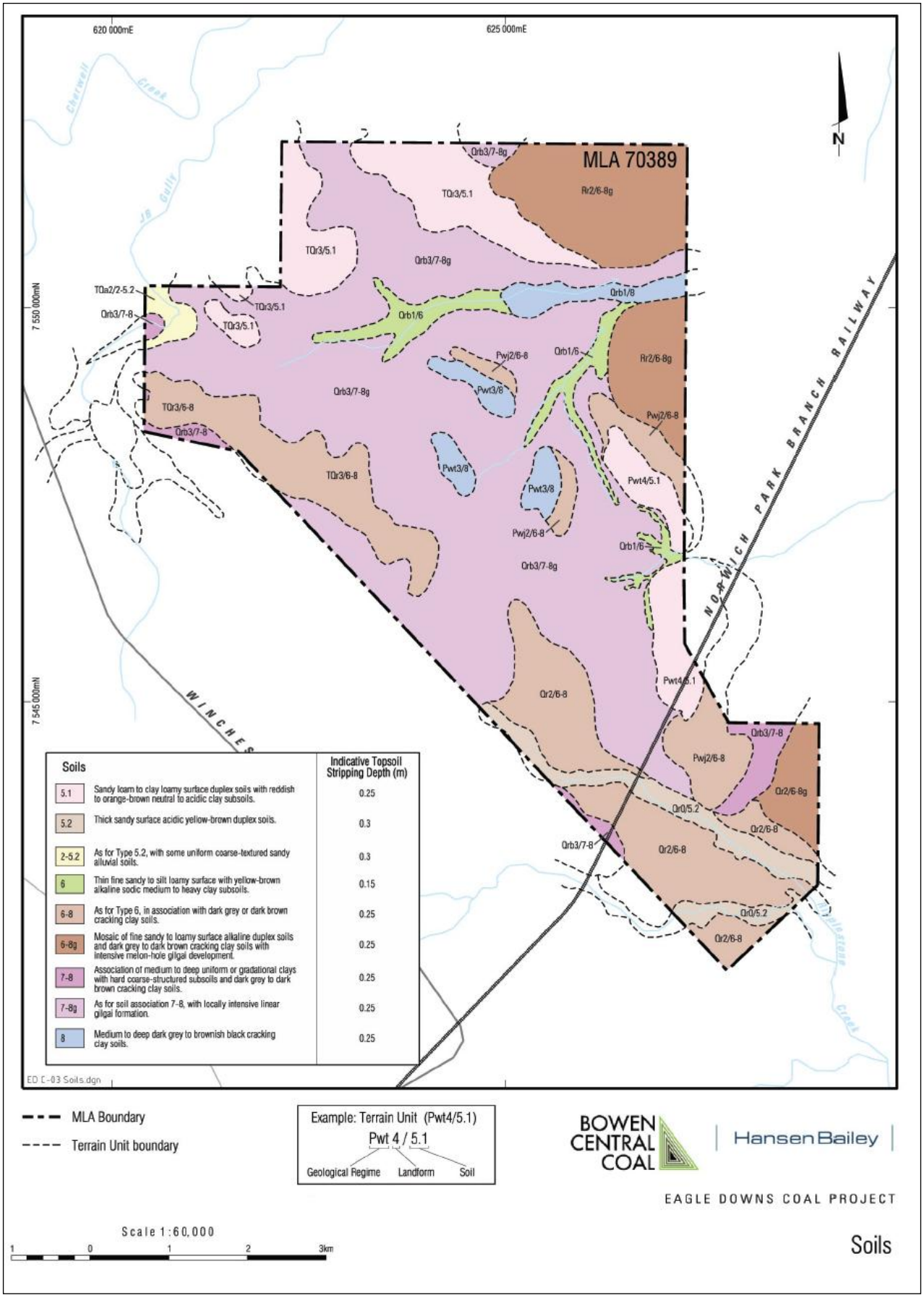


Figure 11 Soil Types

In 2022 a topsoil quality assessment was completed for the Project to meet modern sampling requirements and to fill in data gaps from the initial baseline survey conducted in 2009 (RGS, 2022b). The sampling program characterised soil materials based on their geochemical, nutrient and physical properties through the following methods:

- Soil Sampling and Analysis Plan (SSAP) developed by RGS acting as an appropriately qualified person (AQP) to inform the location, method and analysis program.
- Obtained 17 samples from topsoil stockpiles from existing disturbance areas where the original soil profile is less understood.
- Obtained 15 baseline soil samples from undisturbed areas to get a better representation of the natural soil profile (A horizon, B horizon, etc).
- Obtain a sufficient number of samples to accurately characterise the nature, distribution, and variability of critical parameters in each material type.

Sampling the in-situ soil profile of the currently undisturbed proposed locations for the dry reject emplacement area (DREA) and underground portal. The 2022 topsoil assessment (RGS, 2022b) is available as Appendix M. The key study findings are summarised as follows.

- The static geochemical test results demonstrate that the soil samples have negligible potential to generate acid and generally have excess buffering capacity. Soil samples are classified as NAF (Barren).
- Geochemically, inherent acid-producing minerals are low, but there is some minor variation in buffering capacity based on calcite content.
- Multi-element testing indicated that all of metals and metalloids tested in the soil samples have Geochemical Abundance Index (GAI) values less than 3 and therefore no elements were identified to be a concern for revegetation.
- The exchangeable (DTPA) metals test indicated that all micronutrients are above critical levels for cropping guidelines with exception of Zn. As mining solid are not expected to meet agricultural guidelines, the levels of Zn are sufficient for the growth of native vegetation.
- Soil samples do not contain any significantly enriched concentrations of total metal/metalloid concentrations compared to applied guideline values and/or un-mineralised soils.
- The concentration of dissolved trace metals/metalloids released into initial contact water is low and typically below the laboratory LoR. A minor exception is F, which can have a dissolved concentration in a few soil samples slightly above the applied Livestock Drinking Water guideline value (ANZG, 2018), but is likely to be naturally occurring.
- The soil quality assessment verifies that the soils have moderate cation exchange capacity, are nonsodic, and contain sufficient exchangeable cations and nutrients for plant growth.
- The soils classify as Class 2A soils based on salinity and sodicity. These soils have good structure and stability, are not expected to be susceptible to dispersion or erosion, will support vegetation, and are suitable for general landform rehabilitation activities.
- Physically, the soils are rich in clay with lesser proportions of silt and sand, and therefore have good moisture and stability characteristics suitable for most earthworks.
- The Emerson Class was classified as 4c and 5 which shows some slaking but no dispersion, and described as aggregated materials that are generally stable.
- Organic matter and total organic carbon in topsoil and in-situ samples verified that there were no significant difference in these ratios between topsoil stockpile samples and in-situ soil.
- All soil samples are classified as Vertosols and contain shrink/swell clays (montmorillonite) that may show some cracking when dry. Vertosols have high soil fertility, a large water holding capacity, and a good ability to supply plant nutrients. Vertosols are prized for their agricultural value and make excellent rehabilitation soils (QLD Govt, 2013).
- The range of the carbon: nitrogen ratio for the soil samples was from 13:1 to 21:1 (median 20:1), which presents a good balance for soil microbes and are ideal for “grasses in a vegetative state”. The C:N ratio for topsoil stockpile ranged from 15:1 to 18:1 (median 17:1), which was less variable than in-situ samples.

- The median of extractable potassium (K) for both topsoil and in-situ samples was above its upper critical limit, and it is unlikely that K fertilizer will be required for these soils. In addition the bicarbonate extractable phosphorous (P) levels were slightly higher in topsoil stockpiles than in the in-situ samples.Topsoil stockpiles show a slight increase in potential nutrients and buffering capacity over in-situ soil samples from the underground portal and DREA areas.
- Soil water characterisation curve confirms that these soils are likely to have good water retention but will drain reasonably well after a rain event. The water retention curves verify the favourable characteristics of the soil, and the establishment of vegetation over time will continue to improve the water holding capacity of the soil.
- All soil samples assessed are expected to be suitable for use as rehabilitation materials.
- The DREA area may contain up to 4 different soil types:
  - Predominantly cracking clays;
  - Occasional loamy solid with heavy clay subsoils;
  - Some deep uniform clay subsoils; and
  - Occasional black cracking clay.

The DREA samples were relatively fine, almost classified as clay loam, and contained a higher proportion of silt and less sand compared to other soil samples. Further information on the RGS (2022b) sampling program as it relates to use in rehabilitation activities is included in Section 3.5.1.3.

3.1.1.7 Land Stability

The Project area is gently sloping, and a shallow creek runs across the southern part. The majority of the Project area has been extensively cleared for cattle grazing.

Many of the soil types within the Project area (**Figure 11**) included soil horizons that exhibit a slight to high potential for dispersion and, consequently, are likely to be subject to sheet, rill, and gully erosion. GJR (2008) conducted an evaluation of the erosion potential of the terrain units in the Project area. There was high variability in erosion potential across the terrain units, however, a medium erosion potential was the most common across the Project area's terrain units (GJR, 2008).

- High erosion potential = Qr0/5.2;
- Medium-High erosion potential = TQa2/2-5.2;
- Medium erosion potential = Qrb1/6, Qrb3/7-g, TQr3/5.1, TQr3/6-8, Pwt3/8, and Pwt4/5.1;
- Low-Medium erosion potential = Qr2/6-8, Qrb3/7-8, Rr2/6-8g, and Pwj2/6-8; and
- Low erosion potential = Qr2/6-8g and Qrb1/8.

The following definitions were used to assess erosion potential by GJR (2008):

- Low – the combination of surface slope, run-on/run-off and soil erodibility is such that no appreciable erosion damage is anticipated.
- Moderate – significant short-term erosion is likely to occur due to the combination of slope, soil erodibility factors, and extent of run-on/run-off. Erosion control can be achieved using structural works, topsoiling, and revegetation techniques, and other site-specific intensive soil conservation works. Some slightly dispersive soil layers may be present in the profile.
- High – high to very-high erosion losses are likely due to steepness of slopes, soil erodibility factors, and surface run-off conditions. Intensive soil conservation works will be required to minimise the effects of erosion. Moderately high to highly dispersive soil layers may be present.

Natural site characteristics (such as groundwater conditions) and operational processes, such as subsidence, may influence geotechnical stability at closure.

3.1.1.8 Vegetation communities and ecological data (including existing regional ecosystems)

The Project area has been partially cleared of remnant vegetation, although extensive areas of natural grasslands and grassy open woodland are present throughout the centre of the Project area. Approximately half of the Project area supports remnant vegetation and high-value regrowth vegetation. The balance of the

Project area supports non-remnant vegetation, including cleared grazing paddocks, cultivation areas, farm infrastructure and roads. The historic clearing for agricultural land uses and mining activities has resulted in fragmented remnant vegetation, particularly in the south-eastern and northern areas (EcoSM, 2022a).

Table 9 describes the vegetation types, conservation significance, and extent of remnant and non-remnant vegetation identified in the Project area prior to disturbance activities. The conservation status for each regional ecosystem (RE) is described under the *Vegetation Management Act 1999* (Queensland) (VM Act) and the *Commonwealth Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). The total area of each RE within the ML is described, based upon the ecology study prepared by EcoSM (2023).

Certified, field validated remnant vegetation mapped within the Project area includes 12 RE types, including four Endangered and three Of Concern REs under the VM Act. A total of 268 flora species were recorded within the Project area during the field surveys. This included 225 (84%) native species and 43 (16%) exotic species representing 64 families and 175 genera.

In addition to remnant vegetation, the Queensland Government mapped one small polygon of high-value regrowth vegetation containing least concern RE 11.9.2. This polygon was mapped across a portion of the Goonyella rail corridor where it connects with Ripstone Creek (eastern tributary) in the southern portion of the Project area (EcoSM, 2022a).

Six threatened flora species listed under the Nature Conservation Act 1992 (Queensland) (NC Act) were returned from database searches as occurring or potentially occurring in the search area. None of these species were identified in the Project area during the field surveys. However, one species, King Bluegrass (*Dichanthium queenslandicum*), was considered to have a moderate likelihood to occur. No near threatened flora species listed under the NC Act were identified or considered likely to occur in the Project area.

Three state restricted invasive plants (under the *Biosecurity Act 2014* (Queensland)) were recorded during the field flora survey. One of these, Parthenium (*Parthenium hysterophorus*), is also listed as a Weed of National Significance (WoNS). The remaining 40 exotic species are non-restricted and were recorded throughout the Project area (EcoSM, 2022a).

The following Threatened Ecological Communities (TEC) listed under the EPBC Act as matters of national environmental significance (MNES) were identified in the Project area:

- Brigalow (*Acacia harpophylla* dominate and subdominant communities);
- Northern Fitzroy Basin ecological community (Bluegrass); and
- Semi-evergreen vine thicket.

Table 9 Mapped Regional Ecosystems

Regional Ecosystem Description	Conservation Status		Total Area within ML (ha)
	VM Act	EPBC Act	
11.3.1 – *Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains.	Endangered	Not Listed	27.8
11.3.3 – *Eucalyptus coolabah* woodland on alluvial plains.	Of concern	Not Listed	82.8
11.3.7 – *Corymbia* spp. open woodland on alluvial plains.	Least concern	Not Listed	1.6
11.3.21 – *Dichanthium sericeum* and/or *Astrebla* spp. grassland on alluvial plains. Cracking clay soils.	Of concern	Endangered	42.4
11.3.25 – *Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines.	Least concern	Not Listed	28.2
11.4.8 – *Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains.	Endangered	Endangered	7.2
11.4.9 – *Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains.	Endangered	Endangered	5.3
11.5.3 – *Eucalyptus populnea* +/- *E. melanophloia* +/- *Corymbia clarksoniana* woodland on Cainozoic sand plains and/or remnant surfaces.	Least concern	Not Listed	10.8
11.9.2 – *Eucalyptus melanophloia* +/- *E. orgadophila* woodland to open woodland on fine-rained sedimentary rocks.	Least concern	Not Listed	718.2
11.9.3 – *Dichanthium* spp., *Astrebla* spp. grassland on fine-grained sedimentary rocks.	Least Concern	Endangered	1,263.0
11.9.5 - Acacia harpophylla and/or Casuarina cristata open forest to woodland on fine-grained sedimentary rocks.	Endangered	Endangered	54
11.9.3/11.9.2 (50/50) – Grassland dominated by *Dichanthium sericeum* and/or *Astrebla* spp. On fine-grained sedimentary rocks and *Eucalyptus melanophloia* (silver leafed Ironbark) grassy woodland to open woodland on fine-grained sedimentary rocks with or without *E. orgadophila.*	Not of Concern	Endangered/ Not Listed	19.4
11.5.3/11.4.9 (70/30) - *Eucalyptus populnea* +/- *E. melanophloia* +/- *Corymbia clarksoniana* woodland on Cainozoic sand plains and/or remnant surfaces and *Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains.	Endangered	Not Listed / Endangered	0.2
11.3.2/11.3.7(90/10) – *Eucalyptus populnea* woodland on alluvial plains and *Corymbia* spp. (Bloodwoods) woodland on alluvial plains on sandy soils.	Of Concern	Not Listed	8.2
Non-remnant	N/A	N/A	2,286.5
Total ML Area			**4,555.6**

3.1.1.9 Fauna Presence and Populations

The ecological reports (EcoSM, 2022, 2023) concluded that habitats in the Project area have been heavily disturbed and many of the patches of eucalypt woodland have been fragmented through agricultural and infrastructure clearing, and canopy dieback. Nonetheless, the remnant and regrowth vegetation communities present provide habitat for a range of native fauna species, including species of conservation significance. The following major habitat types occur within the Project area:

- Open eucalypt woodlands (REs 11.3.2, 11.3.7, 11.5.3, 11.5.9, 11.9.2);
- Riparian vegetation (REs 11.3.3 and 11.3.25);
- Brigalow woodland;
- Natural grasslands (REs 11.3.21 and 11.9.3); and
- Cleared, exotic pasture.

A total of 122 native terrestrial fauna species were recorded during the fauna survey, comprising 4 amphibians, 78 birds, 21 reptiles and 19 mammals. In addition, 7 introduced fauna species were recorded. Three threatened fauna species listed under the NC Act were recorded within the Project area during the fauna survey, and four additional listed threatened species were considered to have a moderate or higher likelihood to occur (EcoSM, 2022).

Table 10 describes the fauna species, conservation significance, and likelihood of occurrence within the Project area prior to disturbance activities. The conservation status for each species is described under the NC Act and the EPBC Act. The total area of each fauna habitat within the ML is described, based upon the ecology study prepared by EcoSM (2022) and EcoSM (2023).

The status, likelihood of occurrence, and habitat area within the Project are included in **Table 10**.

Table 10 Threatened Fauna Species and Habitat Likely to be Impacted

Fauna Species	Status		Likelihood of Occurrence	Estimated Habitat in the Project Area (ha)
	NC Act	EPBC Act		
Squatter Pigeon (southern) (*Geophaps scripta scripta)*	Vulnerable	Vulnerable	Present	1,144.7[2]
Ornamental Snake (*Denisonia maculata*)	Vulnerable	Vulnerable	Present	276.1
Australian Painted Snipe (*Rostratula australis*)	Vulnerable	Endangered	High	40.0
Greater Glider (*Petauroides volans*)	Endangered	Endangered	High	972.1
Koala (*Phascolarctos cinereus*)	Endangered	Endangered	High	1,060.2
White-throated Needletail (*Hirundapus caudacutus*)	Vulnerable	Vulnerable	Moderate	963.6
Short-beaked Echidna (*Tachyglossus aculeatus*)	Special least concern	Not listed	Present	1,011.2

3.1.1.10 Pre-Mining Land Use

The pre-mining land use of the project area is low intensity cattle grazing on pastures. Much of the area has been historically cleared, for the purpose of establishing improved pastures. There are some areas of remnant vegetation remaining.

No existing homesteads are located within the project area, with the closest private residence (Winchester Downs Homestead) approximately 1 km from the northern boundary of the mining lease.

Figure 12 illustrates a land use map for the EDCM Project area and surrounds.

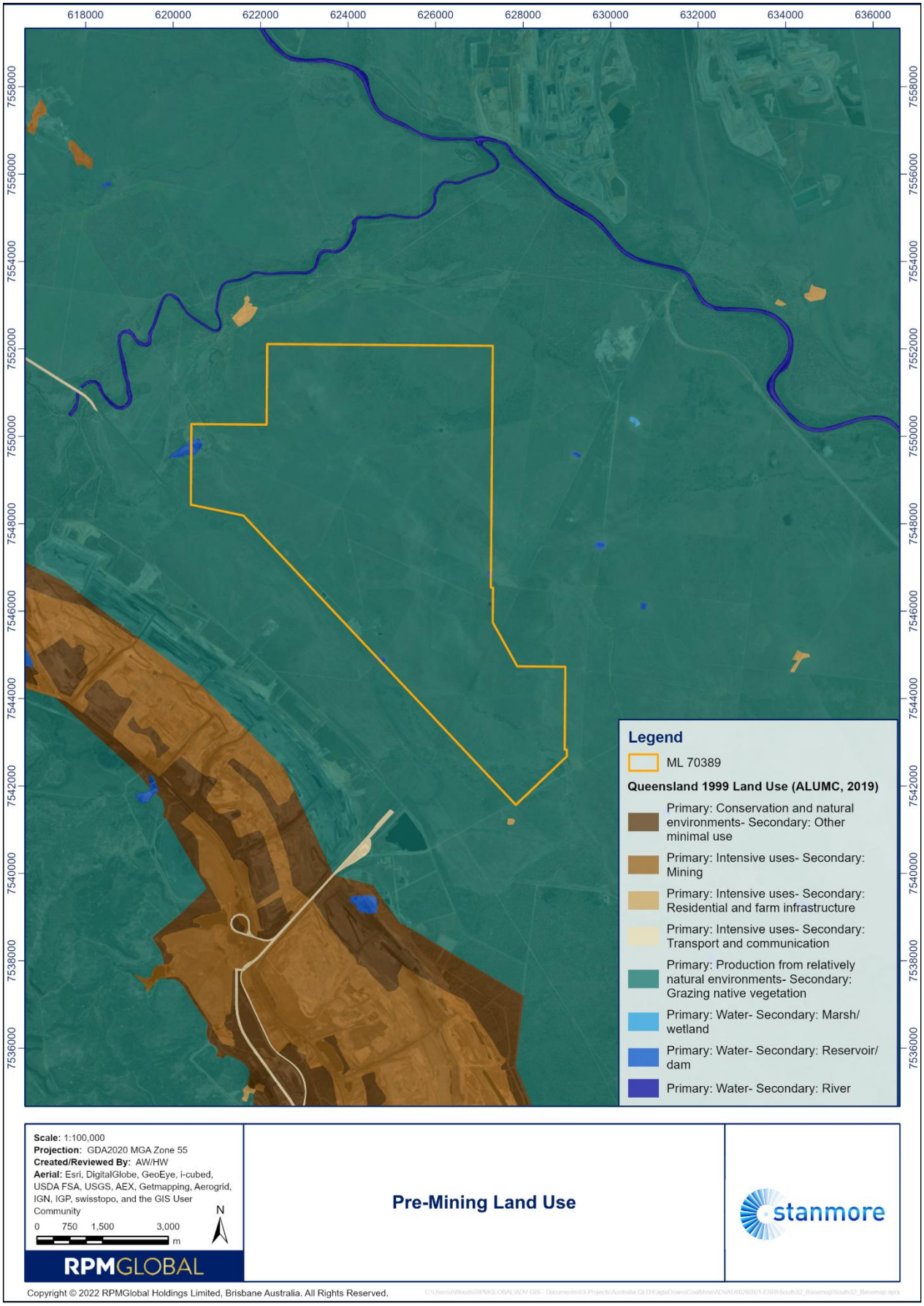


Figure 12 Pre-Mining Land Use

3.1.1.11 Identification of Underlying Landholders

The underlying landholders are detailed in **Table 11** and illustrated in **Figure 13**.

Table 11 Underlying Landholders

Lot	Plan	Tenure	Ownership
A	CNS399	Easement	N/A
G	CNS400	Easement	N/A
F	CNS400	Easement	N/A
A	CNS45	Easement	Beryl Anne Neilsen
1	CNS78	Lands Lease	Department of Transport and Main Roads
2	CNS79	Freehold	Department of Transport and Main Roads
5	CNS90	Freehold	Beryl Anne Neilsen
7	SP244492	Freehold	Queensland Electricity Transmission Corporation Limited A.C.N 078 849 233
K	SP249130	Easement	N/A
8	SP277384	Freehold	Beryl Anne Neilsen
1	SP277384	Freehold	Queensland Electricity Transmission Corporation Limited A.C.N 078 849 233
PK	SP277384	Easement	N/A
AA	SP277384	Easement	N/A

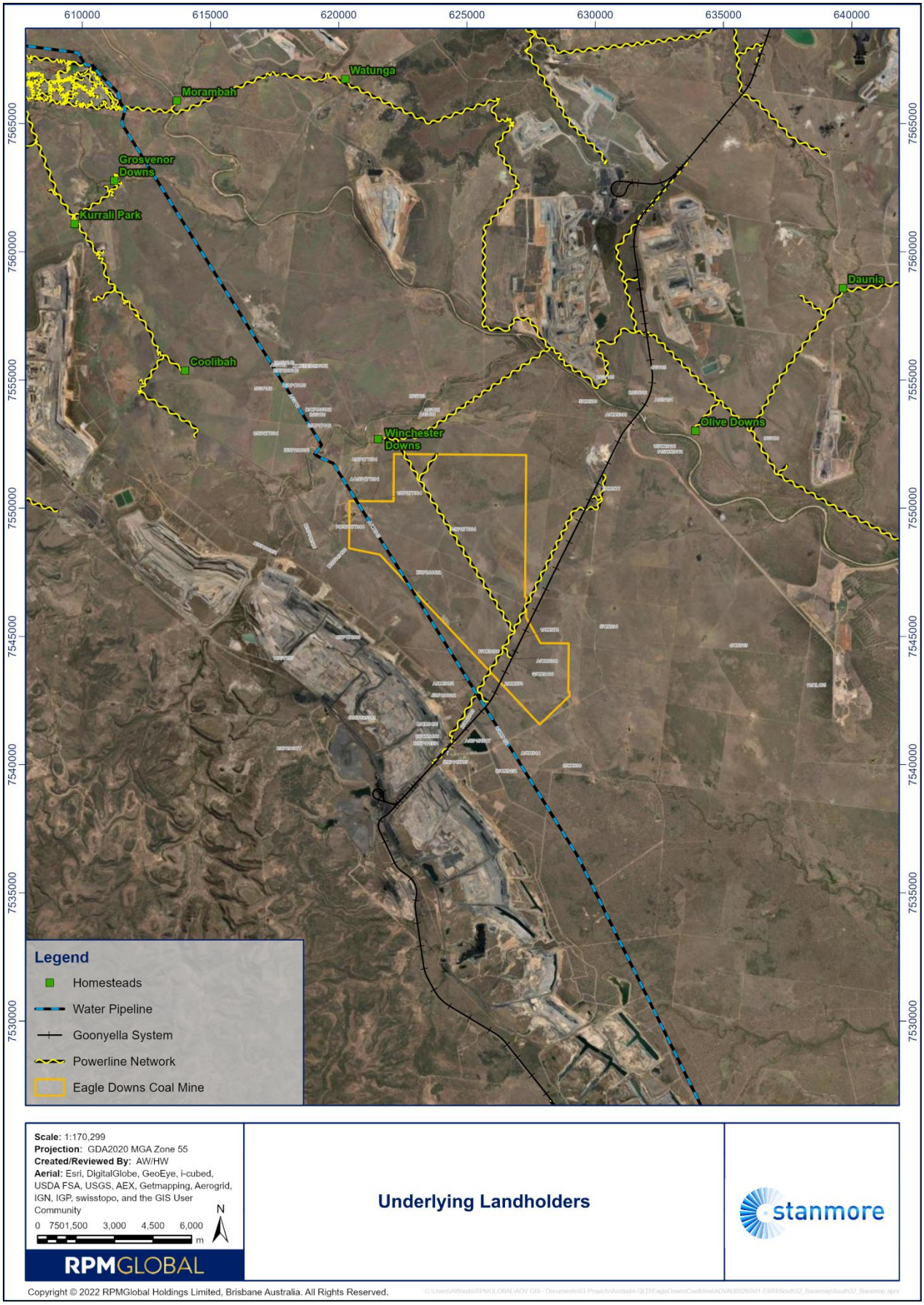


Figure 13 Underlying Landholders

3.1.1.12 Native Title

There is no land subject to Native Title in the project area. Most of the Isaac Local Government Area (LGA), including the project area, is within the traditional country of the Barada Barna people.

3.1.2 Project Description

Mining Tenements

Eagle Downs Metallurgical Coal Mine (EDCM), located approximately 20 km south-east of the township of Moranbah in Central Queensland (**Figure 14**), is a multi-seam, underground longwall mine with a peak production of up to 11 million tonnes per annum (Mtpa) of Run-of-Mine (ROM) coal, which equates to approximately 7 Mtpa of product coking and thermal coal for the export market.

The approved Project is authorised by Environmental Authority (EA) EPML00586713 (DES, 2023), which was last amended and approved on 27 February 2023. The EA covers two tenures, being Mining Lease (ML) 70389 and Petroleum Lease (PL) 485. ML70389 was granted on 19 August 2011. It is located southeast of Moranbah within the Isaac Regional Council area and is approximately 4559 hectares.

Primary Mine Features and Infrastructure

The primary mine infrastructure for the project includes:

- Underground longwall mining of three coal seams;
- Gas drainage system and associated infrastructure;
- Mine access roads, carparks, and laydown areas;
- ROM coal stockpiles;
- Coal handling and preparation plant (CHPP);
- Rail loop and train loading facilities;
- 40 MW gas-fired power station;
- Administration and workshop facilities;
- Water storage and sediment dams;
- Reverse Osmosis Water Treatment Plant (ROWTP);
- Dry rejects emplacement area (DREA); and
- Topsoil and capping stockpiles.

The site layout is illustrated in **Figure 15**.

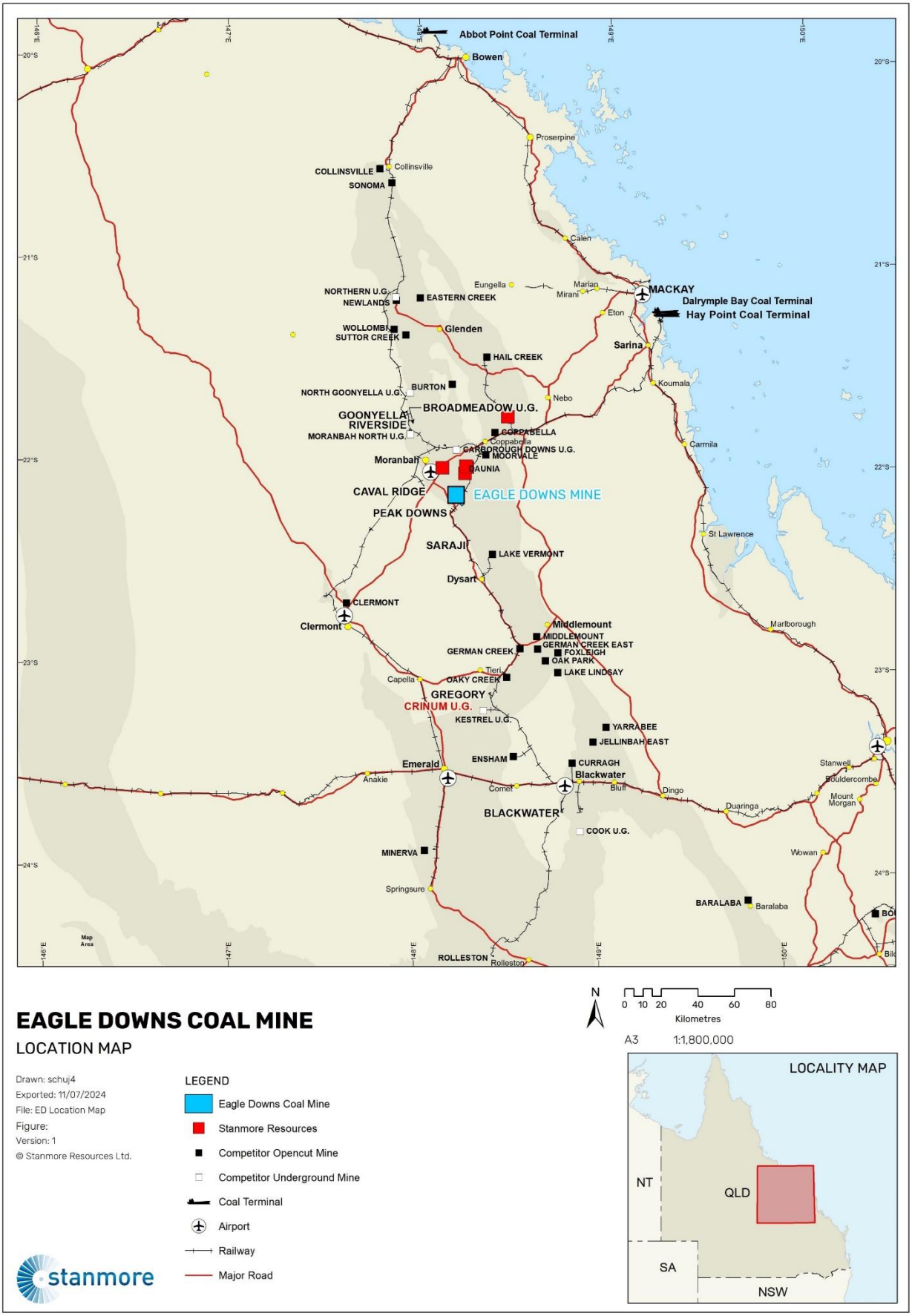


Figure 14 Location of Eagle Downs Metallurgical Coal Mine

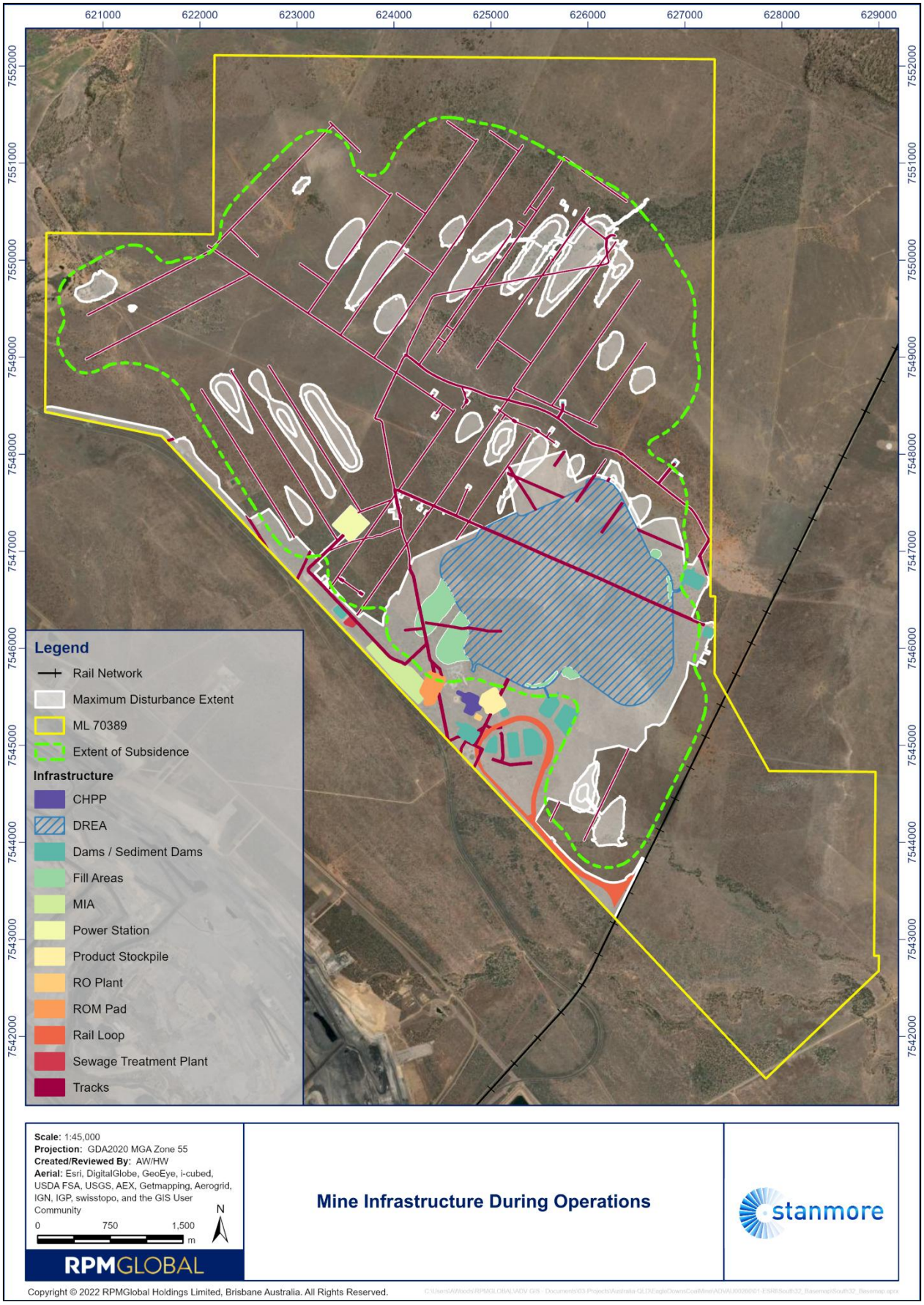


Figure 15 Mine Infrastructure During Operations

Type of Mining Operation

Underground mining operations will commence in the HCU seam, before moving on to the HCL seam and then the DY seam (**Figure 16**). The resources will be extracted using the underground longwall mining method. Top coal caving longwall mining is planned in the HCL and DY seams. Due to the thickness of the HCU seam, single pass longwall extraction only is planned for this seam.

An overland conveyor will transport coal from the conveyor drift portal to an on-site CHPP, where it would be crushed to an on-site DREA.

Each longwall involves using a complex system of mining equipment that incorporates hydraulic roof supports, coal cutting and coal transport equipment. The coal shearer cuts the coal from the coal face on each pass and delivers the coal to a face conveyor that runs the full length of the longwall.

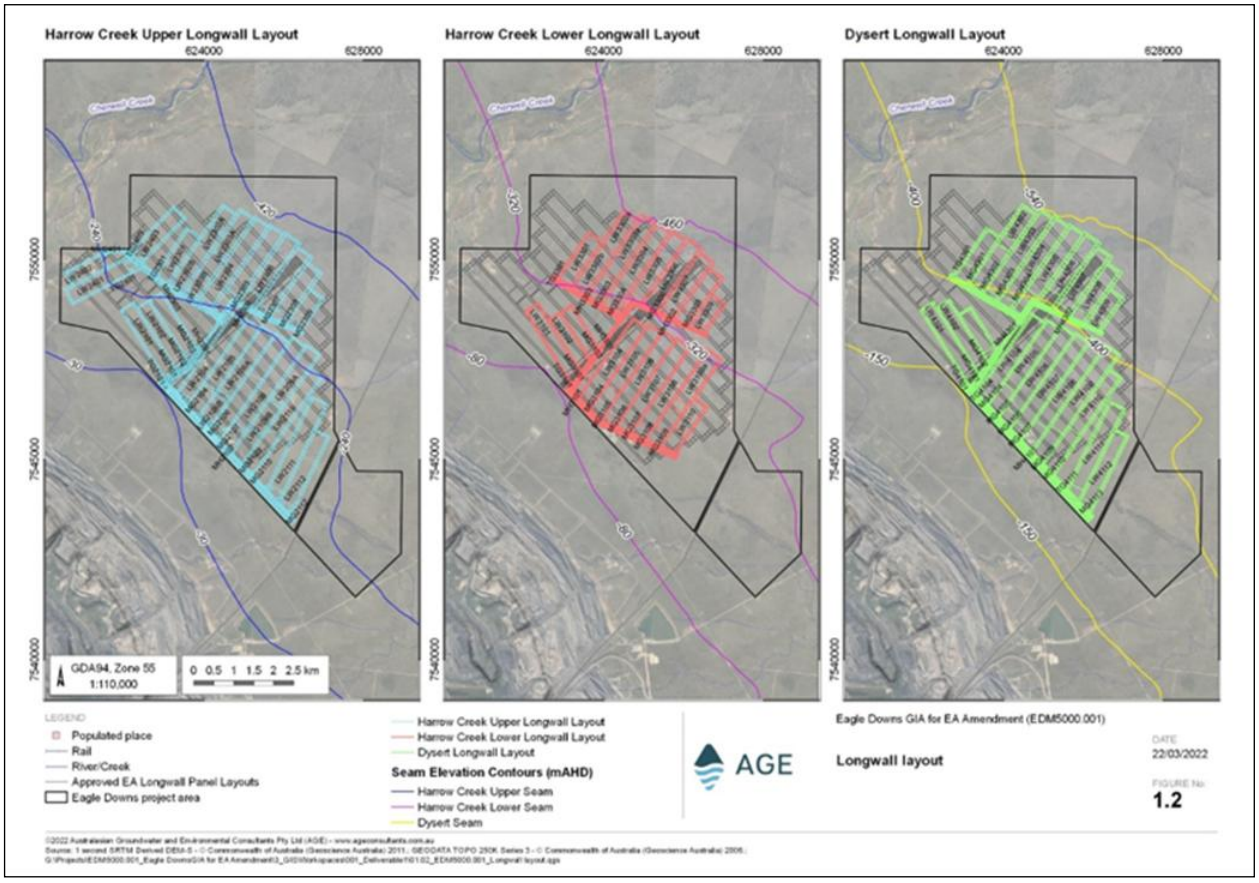


Figure 16 Underground Mine Layout of Longwall Panels

Proposed Duration of Operation

Following a Concept Study that identified the Moranbah Coal Measures are present throughout the mining lease area, a feasibility study was completed in 2011. Drift construction commenced in late 2013. However, the contractor went into liquidation in late 2014, with construction at approximately 44% complete. Given the depressed market conditions, the project was subsequently placed into care and maintenance.

A Feasibility Study was completed in 2020 with the first stage undertaken in 2019, which was the basis of selecting a single go-forward design. It identified areas of risk and value that needed to be resolved for the project to produce an economic return and gain financial approval. The second stage addressed these areas and further identified optimisation opportunities with the surface infrastructure and underground mine design.

Care and maintenance are continuing for the Project while the recently proponents are reviewing the mine plan and developing an investment strategy for the project. Mining has not commenced.

The following list provides a history of relevant environmental approvals for the project:

- 2009 – Environmental Impact Statement (EIS) was finalised and an EA was granted.

- 2011 – Mining Lease (ML) 70389 approved.
- 2011 – Environment Protection and Biodiversity Conservation Act 1999 (EPBC) Controlled Action (Reference: EPBC 2008/3945) was approved.
- 2014 – Petroleum Lease (PL) 485 was approved.
- 2014 – EA amendment to include 40 Mega Watt (MW) gas-fired power station.
- 2023 - EA amendment to revise impacts resulting from revised mine plan as proposed in this plan.
- 2025 – first PRCP schedule issued (February 2025).

The proposed mine life is in excess of 50 years. The active Life of Mine (LOM) is approximately 47 years and approved to extract 11 million tonnes of ROM per annum at full production. **Figure 17** provides a simplified representation of the life of mine plan over the proposed period, with timeframes identified for the development of each longwall panel in each coal seam. Decommissioning and closure actions will progressively be undertaken where practicable, with final closure activities scheduled to commence approximately 47 years after mining commences.

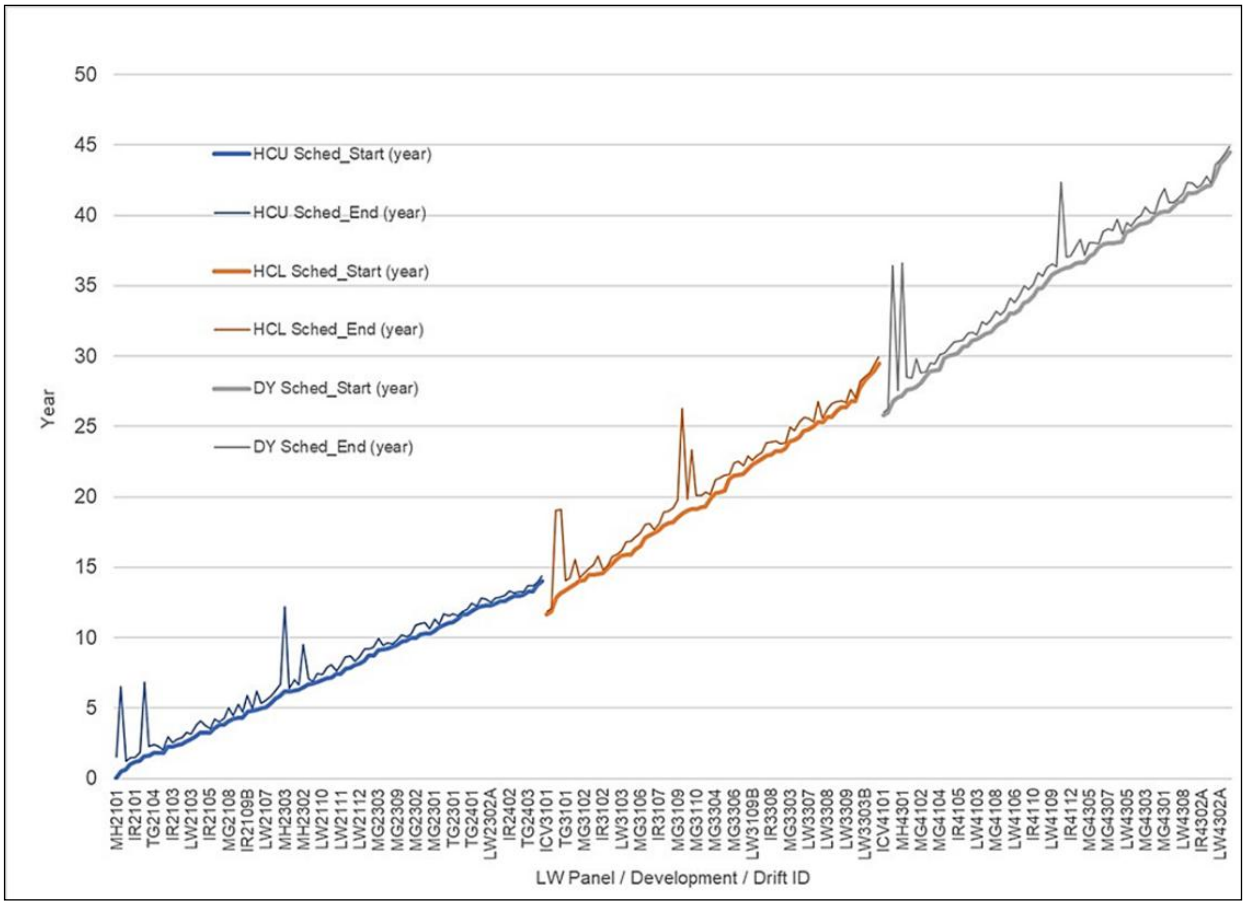


Figure 17 Life of Mine

Visual Impact

The visual impacts of the EDCM project are discussed in the EDCM EIS (Hansen Bailey, 2010). As EDCM is an underground mine operation, the main visual element of the project will be the DREA and associated capping material and topsoil stockpiles, located in the south of the project area (maximum height of the DREA is up to 40 m in height). The general location and height have not changed since the EIS was prepared.

According the EDCM EIS (Hansen Bailey, 2010), Winchester Road is 2.5 km from the surface facilities and ROM coal stockpile and 3 km from the DREA and the CHPP. Intervening vegetation and topography will provide intermittent screening of the mine facilities during a journey along Winchester Road, and views to the facilities will be limited in duration and will be lateral to the direction of travel as is shown in **Figure 18** and **Figure 19**.

The DREA is located approximately 7 km from the homestead. Some areas of the top of the DREA may be visible from the homestead, however the visual effect will be very low as the views are long range and there is some screening from intervening topography and vegetation. It is therefore anticipated that the DREA will have a low visual impact on the homestead during the operational phase. Once the DREA is rehabilitated the visual effect will reduce and there will be no significant visual impact (Hansen Bailey, 2010)(**Figure 20**).



Figure 18 View Looking Towards the DREA from the Homestead Access Road (Hansen Bailey, 2010)



Figure 19 View of the Site from Winchester Road (Hansen Bailey, 2010)

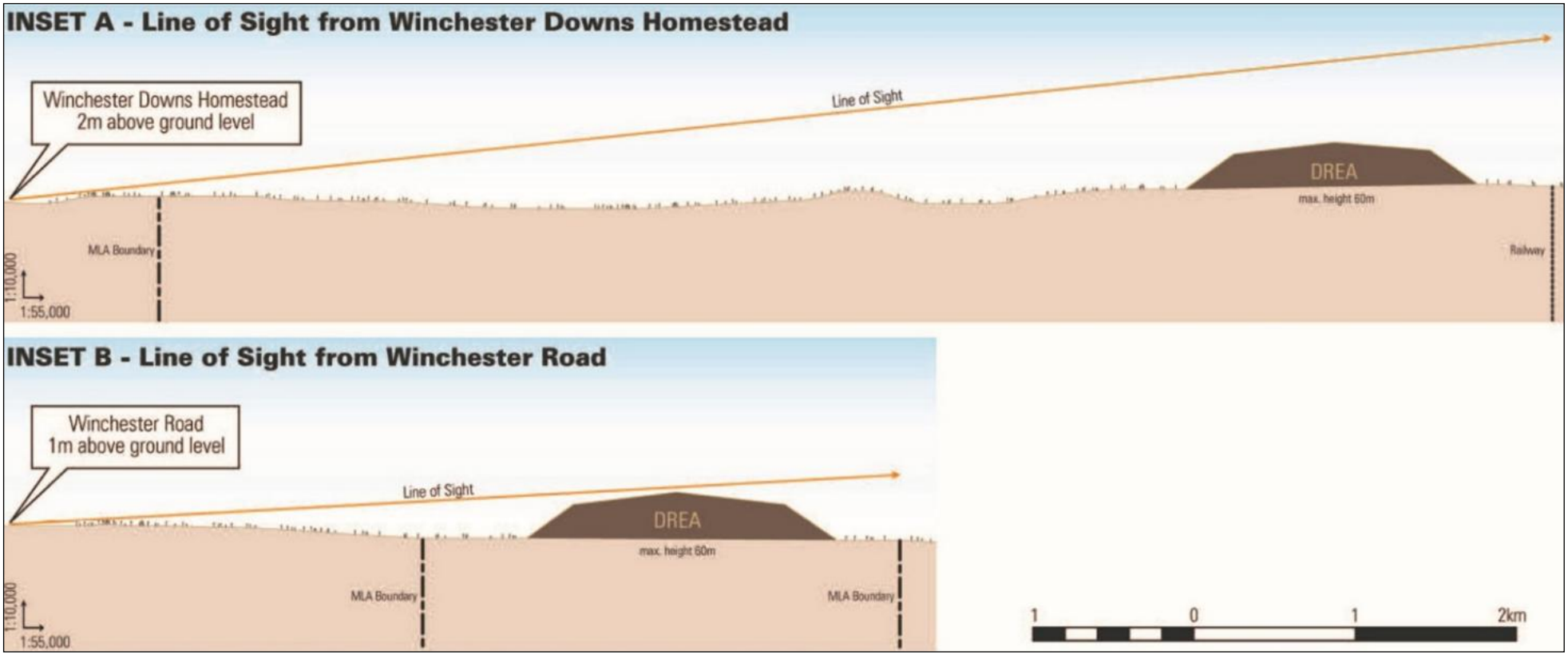


Figure 20 Visual Impact (Hansen Bailey, 2010)

3.1.3 Design for Closure

In accordance with the PRC Plan Guidelines (DES, 2023b), transitional PRC Plans are not required to demonstrate how aspects of the mine have been designed for closure for any approved disturbance. Disturbance in the Project area (**Figure 21**) currently includes:

- Two portals and associated drifts;
- Two above-ground conveyors with concrete pads;
- Five dams;
- Three Mine affected water (MAW) dams;
- One lined raw water dam; and
- One sediment dam.
- Electrical cables;
- Above-ground gas pipeline and air ducting pipelines;
- Seven gas drainage bores;
- Bitumen and gravel/access tracks and roads;
- 2.5 ha of drift stockpiles;
- 60,400 m^2 of topsoil;
- Miscellaneous infrastructure, including Mine Industrial Area (MIA); and
- Five (5) exploration bores.

The infrastructure is for operations and have not been progressively rehabilitated.

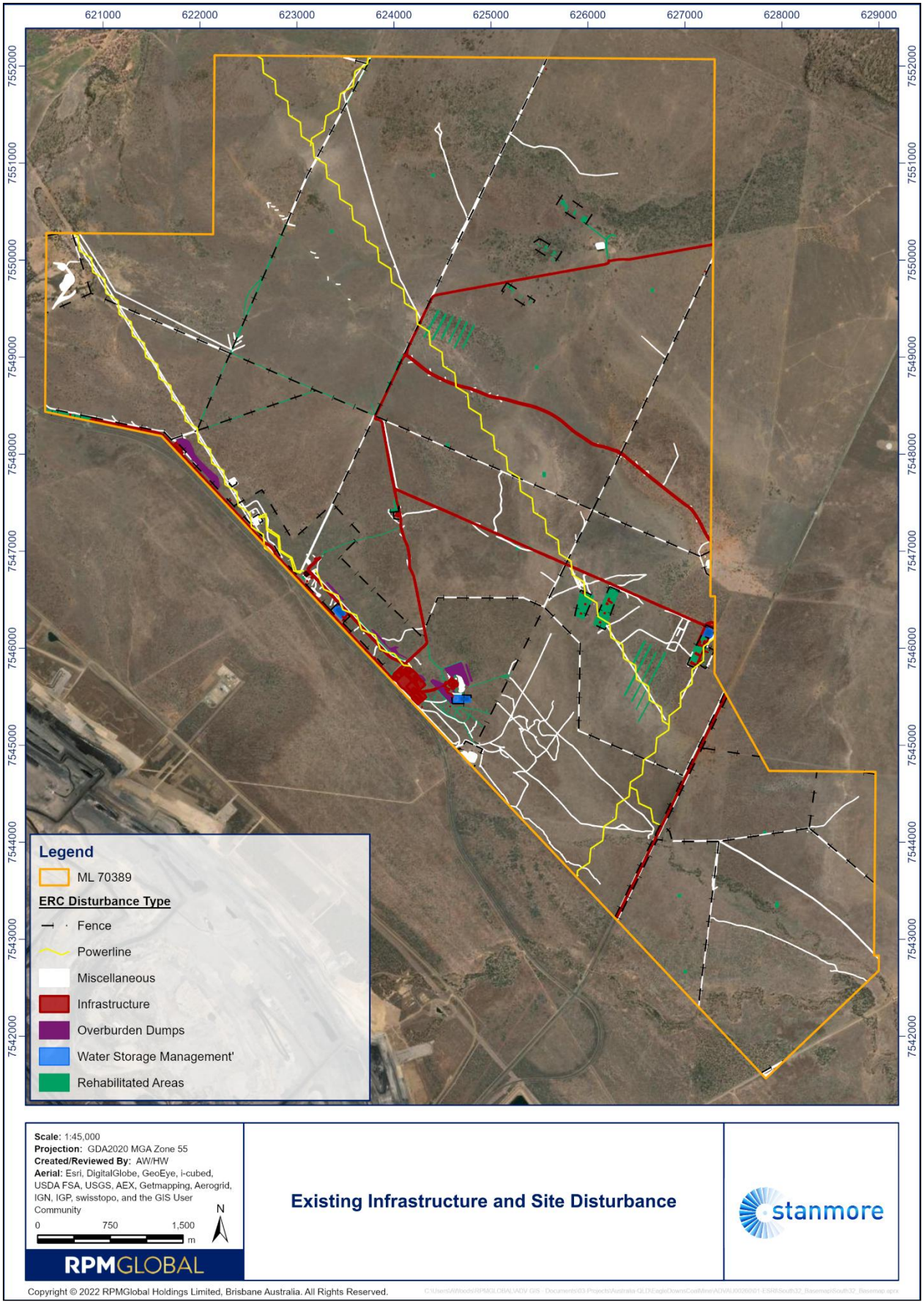


Figure 21 Existing Infrastructure and Disturbance

3.1.4 Rehabilitation and Improvement Planning

Relevant Activities on the Mine Site

Relevant activities for a PRC Plan are defined in the EP Act as the relevant activities to be carried out on land, the subject of the plan. These are provided for in EA EPML00586713 (DES, 2023a) and listed below in **Table 12**.

Table 12 Relevant Activities

Environmentally Relevant Activities	Location (s)
Schedule 3 13: Mining black coal	ML70389
Schedule 3 08: A petroleum or greenhouse gas (GHG) storage activity, other than items 1 to 7, that includes an activity from Schedule 2 with an aggregate environmental score (AES)	PL485
Ancillary 08 - Chemical Storage 1: Storing a total of 50 t or more of chemicals of dangerous goods class 1 or class 2, division 2.3 under subsection (1)(a)	ML70389, PL485
Ancillary 14 - Electricity Generation 1: Generating electricity by using gas at a rated capacity of 10MW electrical or more	ML70389, PL485
Ancillary 15 - Fuel burning Using fuel burning equipment that is capable of burning at least 500 kg of fuel in an hour	ML70389, PL485
Ancillary 31 - Mineral processing 2: Processing, in a year, the following quantities of mineral products, other than coke (b) more than 100,000 t	ML70389, PL485
Ancillary 62 - Resource recovery and transfer facility operation 1: Operating a facility for receiving and sorting, dismantling, baling or temporarily storing- (d) category 1 regulated waste	ML70389, PL485
Ancillary 62 - Resource recovery and transfer facility operation 1: Operating a facility for receiving and sorting, dismantling, baling or temporarily storing- (c) category 2 regulated waste	ML70389, PL485
Ancillary 63 - Sewage Treatment 1: Operating sewage treatment works, other than no-release works, with a total daily peak design capacity of (b-i) more than 100 but not more than 1500 equivalent persons (EP) if treated effluent is discharged from the works to an infiltration trench or through an irrigation schemed	ML70389, PL485
Ancillary 64 - Water treatment 2: Desalinating, in a day, the following quantity of water, allowing the release of waste to waters other than seawater (a) more than 0.5 ML but not more than 5 ML	ML70389, PL485

As outlined in Section 3.1.3, the project has limited project infrastructure established. A recently revised mine plan was approved for the project. Underground mining has not yet commenced, and the construction phase of the mine has not yet been completed, therefore progressive rehabilitation has not been undertaken for the mine activities.

Duration, Size and Availability of Rehabilitation of Relevant Activities

The PRCP schedule has assumed a 47 year mine with mine commencement in 2027. The areas impacted by subsidence will be addressed at the cessation of mining with the subsidence area (RA3) being the first commencing rehabilitation in the year 2042.

The majority of the land will, however, be available to be rehabilitated after 2074.

An expectation of the administering authority is that all disturbed land, which is available for rehabilitation or improvement, should be progressively rehabilitated throughout the operation of the mine. As such, EDCM

have identified the predicted duration, size and availability of relevant activities, which is presented in **Table 13**.

Table 13 Rehabilitation Milestone dates in Relation to Life of Mine Planning

Relevant Activity Disturbance Area (Domain)	Predicted Duration (Years)	Commencement of first milestone (Year)	Size (ha)	Progressive Rehabilitation Availability
Residual Ponding Areas (wet)	1	2045	76.4	Available for rehabilitation once underground mine operations and subsidence has ceased. (An area in the northwest corner will be available after subsidence associated with only the HCU seam has occurred – mining underground only in the HCU seam).
Subsided Areas (dry)	3	2045	180.5	Available for rehabilitation once underground mine operations and subsidence has ceased. (An area in the northwest corner will be available after subsidence associated with only the HCU seam has occurred – mining underground only in the HCU seam).
Fill Areas (Subsided Areas - mitigated)	34	2042	24.4	Available for rehabilitation once subsidence has ceased and backfilling of subsided fill areas has been completed.
Topsoil and Capping Material Stockpiles	6	2065	34	Available for rehabilitation once they are no longer required for stockpiling.
Power Station	9	2065	6.9	No, this area will be rehabilitated once the power station is decommissioned.
Sediment and Supply Dams	7	2075	25.3	To be determined whether the landholder will request to retain some dams. Available for rehabilitation it is deemed the dams are no longer required.
Infrastructure	9	2065	464.8	Available for rehabilitation at the completion of operations.
Surface to Seam Workings (boreholes, gas drainage,	10	2065	<5	Available for rehabilitation at the completion of underground mining operations and gas drainage.

Relevant Activity Disturbance Area (Domain)	Predicted Duration (Years)	Commencement of first milestone (Year)	Size (ha)	Progressive Rehabilitation Availability
ventilation shafts)				
DREA	44	2065	32.2	Available for rehabilitation once operations have ceased.
Total			**1202.55**	

As shown in **Figure 16** and **Figure 17**, the top coal caving longwall mining will be employed along each over lapping coal seam which is largely within the same throughout the entire extent of disturbance. Due to the weight and activities of machinery used in rehabilitation activities for filling, ripping and seeding, the repair of subsidence areas safely will only be achievable when there is no active mining occurring below.

Residual Ponding Areas (Wet), rehabilitation will start once mining activities ceased due to following:

- Minimizing of environmental impact, as rehabilitation of wet residual pond areas involves significant land disturbance along with risks of contaminating the surrounding area.
- Drying out and stabilizing, as wet material usually contains water or slurry materials that need time to naturally dry out, stabilise and then rehabilitation can begin.

There will be a small area in the northwest corner of the mining lease expected to be available for rehabilitation prior to completing all the mining. Underground mining will only occur in the HCU seam in that location. After subsidence is completed, rehabilitation can commence.

Subsided Areas (Dry):

The majority of subsidence will potentially involve:

- Stabilisation work including cross ripping and installing of contour drains to remediate any steepened areas prone to erosion;
- Rehabilitation of surface cracks by ripping/ploughing or excavating and backfilling, and reseeding· Repair of surface buckling by grading and re-spreading excess material and reseeding
- Remedial drainage earthworks to redirect drainage paths; and
- Cut and/or fill earthworks to re-establish free drainage in depression/ponding areas.

Therefore, subsided area cannot be rehabilitated prior to cessation of mining due to the potential uncontrolled erosion occurrence. In addition, parts of the DREA life-of-mine footprint is above the underground mine workings and will be impacted by subsidence that cannot get rehabilitated before cessation of mine. All disturbed areas that have been progressively rehabilitated as shown in the PRCP schedule will be reseeded with introduced and native seeds depending on the selected PMLU.

Similarly, to the Residual Ponding Areas (Wet), the small area in the northwest corner of the mining lease is expected to be available for rehabilitation prior to completing all the mining activities. Underground mining will only occur in the HCU seam. After subsidence is completed, rehabilitation can commence.

Fill Areas (Subsided Areas – Mitigated):

The mitigated subsided area involves minimising the impacts of land subsidence caused by mining activities. After extracting finishes, the voids will be filled to reduce subsidence. Rehabilitation activities in fill areas can be challenging and potentially hazardous during active mining operations. Heavy machinery, ongoing excavations, and underground activities pose safety risks to workers and may hinder rehabilitation efforts. Therefore, rehabilitation of these areas has to start once mining activities have ceased.

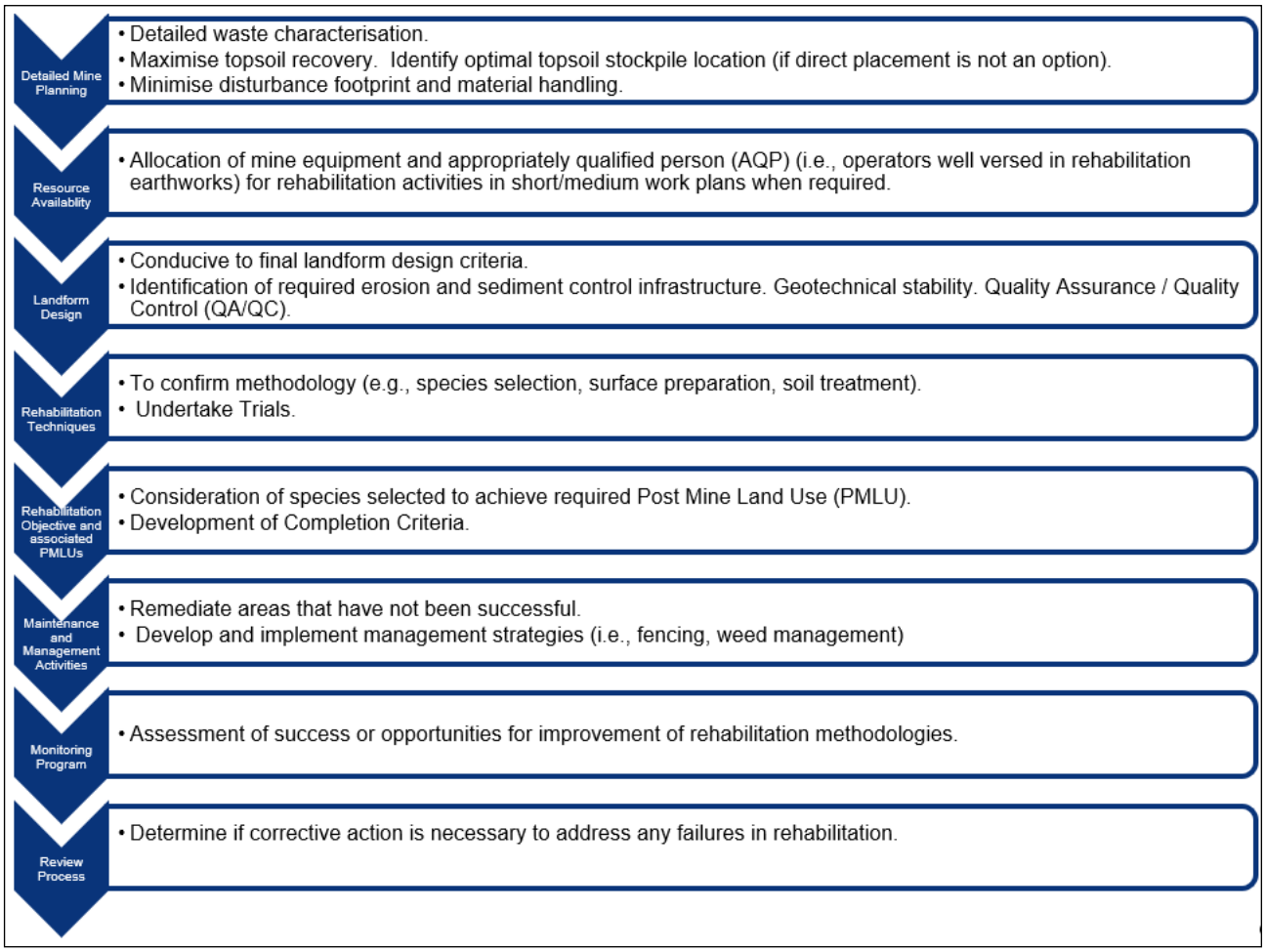
Infrastructure:

Surface infrastructure used for coal washing and transport will remain until the last stockpiles are processed following the cessation of mining activities. Roads and tracks will be the last infrastructure to be removed from the site prior to surrender. In the event that the infrastructure is removed, prior to cessation of mining activities, those areas will be returned to a stable self- sustaining ecosystem consistent with the surrounding environment.

Rehabilitation Strategy

The EDCM progressive rehabilitation plan aims to restore the Project area successfully to enable the land to support the selected post mining land uses. To achieve these goals, the rehabilitation strategy has been developed to integrate the key considerations, as outlined in **Table 14**.

Table 14 Rehabilitation Strategy



Improvement Areas

At this stage of project development, no improvement areas have been identified for the EDCM project.

3.1.5 Spatial Information

The following spatial information is being provided as part of the PRC Plan application:

- The location and maximum extent of disturbance footprint for the mine life;
- The PMLU and non-use management areas (NUMAs) for the area within the resource tenures;
- Any sensitive receptors; and
- All spatial information outlining the rehabilitation areas that correspond to the PRC Plan schedule.

3.2 Post-Mining Land Uses (PMLU)

In accordance with section 126C(1)(d) of the EP Act, the rehabilitation planning part of the PRC Plan must state the extent to which each post-mining land use for land identified in the PRC Plan schedule for the plan is consistent with:

Legislative Requirements	Compliance
The outcome of consultation with the community in developing the plan.	Section 3.2.1
Any strategies or plans for the land of a local government, the State or the Commonwealth.	Section 3.2.2

A PMLU is defined under section 112 of the EP Act as the purpose for which the land will be used after all relevant activities for the PRC Plan carried out on the land have ended. PMLUs must consider the surrounding landscape, community views and the objectives of any local and regional planning strategies.

The EP Regulation requires that each PMLU:

- Is viable, having regard to the use of land in the surrounding region; and
- Satisfies at least one of the following:
  - The use is consistent with how the land was used before a mining activity was carried out on the land;
  - The use is consistent with a development approval relating to the land;
  - The use is consistent with a use of the land, other than a use that is mining, permitted under a State or Commonwealth Act, including, for example, a planning instrument under the Planning Act; and
  - The use will deliver, or is aimed at delivering, a beneficial environmental outcome.

3.2.1 Outcome of Community Consultation in Developing the Plan

As is required by the PRC Plan Guidelines, community consultation is a key component of the PRC Plan and is intended to ensure that anyone impacted by proposed rehabilitation and closure activities at the site has an opportunity to provide input to the planning process. Early and continuous engagement will allow EDCM to establish and maintain relationships within the community and better understand and manage community expectations and the potential environmental, economic, and social risks associated with mine closure.

Consultation with community members commenced during the EIS approval stage of the Project and will continue to be undertaken over the life of mine. Consultation conducted for the project, relating to land rehabilitation and closure activities is described in the following sections.

EIS Consultation

In 2008, EDCM submitted an EIS to DERM. DERM provided their assessment of the EIS in 2010 and listed key concerns for rehabilitation and closure activities at EDCM. These concerns, and EDCM's consideration and addressing of them, are described in the following section. Responses to these topics were addressed during the EIS assessment process. Responses have been updated where they have further been considered in the latest mine design.

Rehabilitation:

Concern: DERM does not favour the DREA remaining un-rehabilitated for long periods of time until all subsidence on site ceases.

- As a result, EDCM staged the development of the DREA. This enables progressive rehabilitation to be undertaken on the DREA over the life of its development. Three stages have been designed. Stage 1 of the DREA, at the southern end of the landform, allows for rehabilitation trials to be conducted during the active mine life, which will be utilised to confirm methods are appropriate and adaptively modify methods, where required.

Matters of National Environmental Significance:

Concern: Offsets will be required for the loss of Brigalow and Bluegrass (includes Ornamental Snake habitat); and

- As a result, EDCM secured environmental offsets under the EPBC Act (approval 2008/3945).

Geochemical Characterisation of Waste Rock Material (i.e., Characterisation of Tailings):

Concern: Uncertainty around consistency of DREA material (fine reject waste may be flowable), potential for water percolating through the DREA over a long period of time into mining operations below that could be connected to the shallow groundwater and surface water areas on and off the site as well as the effect of subsidence cracking on hydraulic connectivity to the shallow groundwater.

- As a result, EDCM has committed to (as required by EA EPML00586713):
  - Tailings / coal rejects requirements - specifically pertaining to sampling regime and the characterisation of tailings;
  - Developing a Mining Waste Management Plan (to ensure all mining waste is progressively characterised);
  - Developing a monitoring program to monitor for infiltration of water in the DREA and mitigation measures should the DREA system increase the level of the phreatic surface relative to surrounding areas and thereby create a differential hydraulic pressure or 'head' of water between under the DREA and surrounding areas; and
  - Undertaking periodic monitoring of runoff water from, and groundwater down gradient of, the DREA by measuring electrical conductivity and pH in order validate the predicted benign geochemical nature of the total rejects.
  - EDCM have undertaken additional studies to characterise waste material (RGS, 2022) and the findings are discussed in Section 3.5.1.4.

Subsidence Impacts on Surface Water:

Concern: Potential for Isaac River flood water to enter the residual ponding areas, runoff from residual ponded catchments, potential subsidence impacts on surface drainage post mining and progressive establishment of free drainage in the subsidence areas.

- As a result, EDCM has conducted extensive flood modelling and subsidence modelling (WRM, 2022) to understand the impacts from subsidence and to identify what mitigation and management measures are required to control possible impacts. EDCM have committed to preparing and implementing a Subsidence Management plan, which includes monitoring subsidence effects on a quarterly basis and installing drainage, and erosion and sediment control works to minimise the residual water ponding.
- For the final landform conditions with the mitigation measures in place, using the 1% Annual Exceedance Probability (AEP), there are some areas predicted to experience a decrease in flooding - the majority of the area will be less than -0.1 m. There are some areas that are predicted to increase flooding up to 0.1 m.
- Overall, the impacts on the local waterways of JB Gully and Ripplestone Creek are not significant. The impact on Feature 1 is more significant. However, Feature 1 is not a watercourse and has no defined bed and banks where flow would drain. Feature 3 drains to the Isaac River. The overall reduction in flows to the Isaac River would be negligible given it has a catchment area of about 4,100 km^2 from Feature 1 (refer **Figure 9).**

Soils and Land Capability:

Concern: The intensity of the preliminary soil site investigation was considered to be inadequate.

- EDCM has since undertaken additional soil studies focusing on topsoil which will be used to inform rehabilitation and a key impact on soil management in the project area(to identify the available topsoil stripping depths and topsoil/subsoil management requirements) supported by a higher sampling intensity (RGS, 2022). In addition, EDCM will conduct rehabilitation trials at the southern end of the DREA during the active mining life.

Although the EIS was submitted 15 years prior to this PRCP submission and community expectations have evolved, the above key concerns will be considered in the context of new PRCP requirements.

PRC Plan Consultation

In August 2023, EDCM sent an update to Barada Barna and the underlying bregarding the project status and rehabilitation and closure activities at EDCM. The information sheet conveyed the following key points:

- Current Status of the Project – Care and Maintenance, with recommencement planned in 2025 in line with PRC Plan Schedule;
- Approved PMLUs as per EA EPML00586713, predominately grazing, no change since EIS. The maximum height of any landform is 40 m (modified as the design has been improved); and
- Explanation of the PRC Plan Approvals process.

University of Queensland Report

A project by the Sustainable Minerals Institute of the University of Queensland (Moranbah post-mining land use collaborative project) was undertaken in 2020 with the aim to establish a better understanding of PMLU options, long-term community priorities, opportunities for collaboration, and planning constraints and opportunities for (post closure) mine assets within the Moranbah region. The report recommended several PMLU options, including:

- Re-establishment of native ecosystems;
- Renewable energy projects;
- Grazing;
- Agricultural options using irrigation of mine water;
- Hydroponics or protected horticulture; and
- Livestock production.

EDCM has considered the feedback and stakeholder feedback to develop the PRC Plan; specifically the PMLUs selected for the Project area align to those presented in the EIS; and they are consistent with existing land uses undertaken before the mining commenced.

The main feature of the Project area, after closure, will be the formation of the DREA landform, which was also presented in the EIS. As demonstrated in Section 3.1.2 (Project Description), the design of landform precludes it from being visible from the identified viewing locations and sensitive receptors (homestead).

3.2.2 Strategies or Plans for the Land

State or Commonwealth legislation relevant to the land use of the surrounding area, and how it applies and was considered in the PRC Plan, is provided in Appendix E.

An interrogation of Queensland's land use mapping indicates that the land on which the EDCM ML is positioned, and the majority of surrounding land, is classified as "grazing native vegetation". Other land uses in the vicinity of the project area are "Mines", "other minimal use areas", pockets of "Infrastructure" (in the form of farm buildings), pockets of "water storages" (in the form of intensive use farm dams) and various waterways.

The project lies wholly within the Isaac Regional Council government area and is therefore subject to the provisions of the following government plans.

- Isaac Regional Council (IRC)
  - Isaac Regional Planning Scheme (IRC, 2021)
- Natural Resource Management (NRM) Regions Queensland
  - Central Queensland Sustainability Strategy 2030 (FBA, 2021)
- Queensland Government
  - Mackay, Isaac, Whitsundays Regional Plan (DLGP, 2012)

IRC Planning Scheme 2021

The IRC planning scheme has been prepared in accordance with the *Planning Act 2016* (Queensland) as a framework for managing development in a way that advances the purpose of the Act. The IRC planning scheme applies to the area of Isaac Regional Council including all premises, roads, internal waterways, and local government tidal areas and interrelates with the surrounding local government areas. The following provisions from the scheme are extracted from *Part 3 Strategic Framework*. It demonstrates that the PMLUs proposed for the EDCM are strongly aligned with the future direction of the planning scheme. The relevant parts of section 3.5 of the IRC planning scheme are outlined in **Table 15**.

Table 15 Isaac Regional Council Planning Scheme 2021 Relevant Sections to PRC Plan

Section	Description	How the PRC Plan is Compatible
Productive Rural Lands	(1) Rural land use is the dominant land use (by area) within Isaac Region, and rural production is a major source of economic activity and employment. Reconfiguration (where not associated with a mining or petroleum activity) in rural areas avoids the fragmentation of rural land into allotment sizes which do not support the long term economic viability of farming enterprises. (2) Reconfiguration (where not associated with a mining or petroleum activity) on rural land classified as Class A and Class C to allotments of a minimum area of 50 hectares and 1000 hectares respectively will occur only where it has been demonstrated that the reconfiguration: (a) can support an ongoing and viable rural enterprise on the land; and (b) will not impact on adjoining farming activities through the inclusion of sufficient buffers within the proposed allotments; and (c) will not adversely impact upon Important Agricultural Areas; and (d) will not adversely impact on infrastructure and services. (3) Reconfiguration where directly associated with a mining or petroleum activity is limited to aligning lot boundaries with mining or petroleum tenements or establishing necessary infrastructure corridors or buffers.	The predominant land use proposed is grazing, which will be part of an existing grazing enterprise. The Intermittent cattle watering holes will be compatible with supporting grazing productivity. Some native ecosystem areas are proposed, which is consistent with existing land management practices. Reconfiguration of a lot is not proposed.
Extractive, mineral, gas, and petroleum resources	(2) Urban areas are contained within Restricted Areas (as identified on the Queensland government online mapping portal) declared under the *Mineral Resources Act 1989* (Queensland). Future mineral, gas and petroleum extraction and exploration activities do not occur within these areas. (4) Extractive resource operations only occur where compatible with the intentions of the relevant zone and overlays applying to the site, and where impacts on visual amenity, the natural environment, including Matters of State Environmental Significance, or the safety and amenity of the surrounding area can be mitigated to an acceptable standard.	No urban areas are proposed. Extractive resource development and operation have been assessed for environmental impacts and are authorized by EA EPML00586713. The PRC Plan has been developed to progressively rehabilitate the ML to restore the natural environment.

Section	Description	How the PRC Plan is Compatible
	(5) Extractive resource operations whether within a key resource area (KRA) or not are managed to avoid or mitigate to an acceptable standard, impacts including impacts on visual amenity, the natural environment and water quality and offsite impacts on adjoining uses caused by noise, dust, light, blasting or vibration. (6) Resource extraction areas are progressively rehabilitated following extraction to restore the natural environment and to mitigate environmental impacts including impacts associated with dust.	
Biodiversity, water quality and the natural environment	(1) Development avoids or mitigates impacts on Matters of National and State Environmental Significance and maintains a connected network of habitat areas. Where development results in a significant residual impact on these areas, the impacts are offset. (2) Development ensures impacts on local biodiversity values are minimised. (3) Development avoids the introduction or spread of pest plant and animals in the region. (4) Development minimises disturbances to natural topography and avoids changes to natural waterways, their bed and banks and riparian vegetation. (5) Development avoids the disturbance to areas of potential acid sulfate soil or treats disturbed soils to a standard required to neutralise impacts. (7) The environmental values of the region's waterways are protected or enhanced, and development does not adversely impact on the quality of receiving waters, including waterways, wetlands and Great Barrier Reef waters.	Impacts to matters of National and State Environmental Significance have been identified. Impacts to prescribed matters are authorized by EA EPML00586713 and EPBC approval (2008/3945). An Offset Management Plan will be developed as required by EA EPML00586713 and EPBC approval (2008/3945) conditions.

Central Queensland Sustainability Strategy 2030 (CQSS2030)

The CQSS2030 draws on the scientific knowledge, as well as global, Australian and Queensland targets, and marries them with what the Central Queensland community wants for their future. CQSS2030 recommends 33 strategies to reach regionally relevant targets relating to air, soil, land-based, freshwater, groundwater, coastal and marine as well as drivers (e.g., climate change). The CQSS2030 strategies relevant to the EDCM project are (note: coastal related strategies have been omitted) defined in **Table 16**.

Table 16 Central Queensland Sustainability Strategy 2030 Relevant Strategies for the PRC Plan

Item #	Progressive Rehabilitation Closure Plan Strategies	How the PRC Plan is Compatible
1	Promote and support management practices that maintain air quality within appropriate guidelines.	PRC Plan requirements for groundcover to be achieved during progressive and final rehabilitation stages will minimise dust emissions. Air quality monitoring to detect exceedances of air quality limits (section 3.7.3) to identify where management practices are required to maintain air quality within appropriate guidelines.
2	Monitor and communicate trends in carbon emissions.	External to the PRC Plan process, NGER and NPI reporting in line with Clean Energy Regulator requirements once operations commence to trend emissions.
3	Promote and support mitigation actions including carbon sequestration and emissions reduction.	PRC Plan management actions associated with sealing underground workings as part of closure actions will reduce fugitive emissions post-closure.
4	Improve our understanding of linkages between freshwater and coastal/marine and groundwater systems.	The results of groundwater and surface water monitoring to be undertaken as part of this PRC Plan (section 3.7.3) will increase the understanding of linkages between freshwater and groundwater systems. Coastal/marine linkages not relevant due to the Project's inland location.
5	Identify and protect priority species/ecosystems and critical refugia to maintain viable populations and key ecosystem services.	Impacts to matters of National and State Environmental Significance have been identified. Impacts to prescribed matters are authorised by EA EPML00586713 and EPBC approval (2008/3945) and will be monitored and managed during the implementation of this PRC Plan.
6	Promote and support management practices that protect/maintain/restore critical refugia, riparian ecosystems and wetlands.	Impacts to matters of National and State Environmental Significance have been identified. Impacts to

Item #	Progressive Rehabilitation Closure Plan Strategies	How the PRC Plan is Compatible
		prescribed matters are authorised by EA EPML00586713 and EPBC approval (2008/3945) and will be monitored and managed during the implementation of this PRC Plan.
7	Promote and support integrated water resource planning (ground and surface water).	The Groundwater Monitoring Program (GMP), Water Management Plan (WMP) and Receiving Environment Management Plan (REMP) (section 3.7.3) have been developed to manage potential environmental impacts resulting from water management associated with the mining activity as per EA. EPML0058671
8	Reduce the impact of barriers to aquatic connectivity within and between freshwater and coastal waterways.	Not relevant due to the Project's inland location
9	Build knowledge and awareness about sustainable long-term use of groundwater resources.	Results of GMP will assist in building knowledge and awareness about sustainable long-term use of groundwater resources.
10	Promote and support management practices that reduce demands on water resources, manages salinity risk and avoid contamination of water sources.	WMP required by EA condition C36. PRCP requires water balance model review during operations and in preparation for closure.
11	Build knowledge and awareness about groundwater dependent ecosystems (GDEs).	An assessment of GDE Atlas was undertaken and mapped. EDCM are aware of GDEs in relation to ML. Groundwater monitoring and management actions implemented under this PRCP will assist in ensuring groundwater dependent ecosystems are not compromised.
12	Develop, promote, and support management practices that protect, maintain and restore critical groundwater dependent ecosystems.	
13	Understand and prepare for changes in sea temperatures, ocean acidity and coastal currents.	Not relevant due to the Project's inland location
14	Protect and prioritise the coastal zone as a critical buffer	Not relevant due to the Project's inland location
15	Understand and prepare for changes in sea level and tidal/storm surges	Not relevant due to the Project's inland location
16	Understand and address individual threats to maintain ecological services and values.	Impacts to matters of National and State Environmental Significance have been identified. Impacts to prescribed matters are authorized by EA EPML00586713 and EPBC approval (2008/3945).

Item #	Progressive Rehabilitation Closure Plan Strategies	How the PRC Plan is Compatible
		An Offset Management Plan will be developed as required by EA EPML00586713 and EPBC approval (2008/3945) conditions.
17	Build knowledge, awareness and skills that minimise negative impacts on natural assets.	Impacts to matters of National and State Environmental Significance have been identified. Impacts to prescribed matters are authorized by EA EPML00586713 and EPBC approval (2008/3945). An Offset Management Plan will be developed as required by EA EPML00586713 and EPBC approval (2008/3945) conditions.
18	Identify and protect priority sites and species of cultural significance (local, regional, state and federal level).	Impacts to matters of National and State Environmental Significance have been identified. Impacts to prescribed matters are authorized by EA EPML00586713 and EPBC approval (2008/3945). An Offset Management Plan will be developed as required by EA EPML00586713 and EPBC approval (2008/3945) conditions.
19	Promote and support business/lifestyle choices and practices that minimise negative impacts on our natural assets.	The predominant land use proposed is grazing, which will be part of an existing grazing enterprise. The Intermittent cattle watering holes will be compatible with supporting grazing productivity. Some native ecosystem areas are proposed, which is consistent with existing land management practices.
20	Understand and prepare for changes in temperature, rainfall patterns and extreme weather events (climate change).	PRC Plan Risk Assessment considers the need for climate change awareness and consideration of predicted climate change scenarios throughout LOM.
21	Build knowledge and awareness about soil health management techniques.	EDCM Topsoil Management Plan (TMP) developed covers topsoil storage and amelioration requirements and will be implemented under this PRC Plan. Soil management and monitoring requirements when implemented under this PRC Plan will assist to build knowledge and awareness about soil health management techniques.

Item #	Progressive Rehabilitation Closure Plan Strategies	How the PRC Plan is Compatible
22	Promote and support management practices that identify and preserve high quality soils.	TMP requirements to be implemented under this PRC Plan will assist in promoting and supporting management practices that identify and preserve high quality soils.
23	Promote and support management practices that best maintain and build soils.	TMP requirements to be implemented under this PRC Plan will assist in promoting and supporting management practices that best maintain and build soils.
24	Build knowledge and awareness about the extent of degraded lands and rehabilitation techniques.	The PRC Plan has been developed to progressively rehabilitate the ML to restore the natural environment, as such it will assist in building knowledge and awareness about the extent of degraded lands and rehabilitation techniques.
25	Promote and support management practices that restore degraded sites.	The PRC Plan has been developed to progressively rehabilitate the ML to restore the natural environment, as such it will assist in promoting and supporting management practices that restore degraded sites.
26	Build knowledge and awareness about end-of-dry season groundcover/biomass standards by land type.	The PRC Plan includes requirements for biodiversity monitoring (section 3.7.3), as such it will assist in building knowledge and awareness, about end-of-dry season groundcover/biomass standards by land type
27	Promote and support management practices that effectively maintain groundcover/biomass.	The PRC Plan includes management practices aimed at effectively establishing and maintaining groundcover/biomass in areas to be rehabilitated.
28	Understand critical elements of habitats and promote and support management practices that conserve these.	Impacts to matters of National and State Environmental Significance have been identified. Impacts to prescribed matters are authorized by EA EPML00586713 and EPBC approval (2008/3945). An Offset Management Plan will be developed as required by EA EPML00586713 and EPBC approval (2008/3945) conditions.
29	Understand and address drivers of decline in ecosystem extent and condition.	Impacts to matters of National and State Environmental Significance have been identified. Impacts to

Item #	Progressive Rehabilitation Closure Plan Strategies	How the PRC Plan is Compatible
		prescribed matters are authorised by EA EPML00586713 and EPBC approval (2008/3945).
30	Promote and support vegetation management practices that conserve biodiversity values and ecosystem function.	The PRC Plan contains objectives for PMLUs that conserve biodiversity values and ecosystem function.
31	Promote and support management practices that minimise the impacts of weed and pest species.	The PRC Plan requires the implementation of weed and pest monitoring (section 3.7.3) that will promote and support management practices that minimise the impacts of weed and pest species
32	Promote and support management practices that improve vegetation connectivity at the local and regional scale.	Some native ecosystem areas are proposed, which is consistent with existing land management practices.

Community Strategic Plan – Isaac's 20 Year Vision

Isaac Regional Council's Community Strategic Plan (IRC, 2012) identifies the needs of future generations of their community, by providing clear goals for four themes to focus on to 2035, being communities, economy, infrastructure, and environment.

The PRC Plan is aligned to the plan that recognises ongoing global and metallurgical coal demand and the coal industry in the region whilst supporting strong and diverse communities that live, work and raise families in the shire. The Shire aims to continue to be a thriving, resilient and diverse regional economy; have effective and sustainable infrastructure for the community and economic sectors; and have an appropriate and sustainable balance to ensure natural resources are managed and protected.

Mackay, Isaac, Whitsundays Regional Plan 2012

The Mackay, Isaac and Whitsunday Regional Plan (the Regional Plan) (DLGP, 2012) establishes a vision and direction for the region to 2031. It provides direction about where the region is heading and provides a framework to respond to challenges and opportunities that may arise. The Regional Plan states the Project is in an important agricultural land zone. Protecting priority agricultural land uses while supporting co-existence and future opportunities for the resource sector is a key point of the Regional Plan. The Regional Plan states:

"Managing the cumulative social and economic impacts from major mining and industrial projects is critical for the future of the subregion. To enhance the liveability and attractiveness of living in resource communities, significant and timely investment in social and community infrastructure will be required."

3.2.3 Consideration of PMLU options

The EA EPML00586713 provides the final land use and approval schedule for EDCM and therefore a methodology for determining PMLUs is not required (refer **Table 17**). However, in accordance with the requirements of section 126C(1)(j) of the EP Act, EDCM have considered the following regarding PMLUs assigned for the EDCM project. These are outlined in **Table 17**. The Post Mining Land Uses are illustrated in **Figure 22**.

Table 17 Consideration of PMLU Options

PMLU Options	Consideration	EDCM Response
As pre-defined in Table F1 of EA EPML00586713: 1. Grazing. 2. Native ecosystem. 3. Intermittent cattle watering holes.	Any regulatory constraints on, or objectives for, the proposed land use (e.g., Indigenous Land Use Agreements (ILUA), site management plan (contaminated land, local and regional land use plans, endangered species, or registered heritage place).	There are no identified sites of cultural significance identified during cultural heritage assessment – no ILUA. There are no identified contaminated sites or registered heritage places on EDCM ML. The EA authorises disturbance to specified MNES and MSES that are threatened species.
	Physical constraints (e.g., slopes, voids, geology).	Topography of the ML is gently undulating terrain (Section 3.1.1.1). The Geology is typical of the Bowen Basin (Section 3.1.1.3). The DREA will be approximately 40 m height at closure. There will be no voids at closure.
	Chemical characteristics (e.g., residual contamination from tailings or other waste disposal).	The DREA is designed to encapsulate reject material and prevent exposure to surrounding environment (refer to Section 3.5.1.5). Management strategies include waste characterisation of reject material and monitoring for potential seepage.
	Available rehabilitation methods, including best practice (e.g., backfill, profile, capping).	Rehabilitation methods adopted are industry best practice, including capping and reprofiling of the DREA. Final slopes, conducive to revegetation success and minimal erosion and sedimentation, are proposed. Fill areas will be backfilled after subsidence to ensure no ponding and stability of the DREA landform.
	Relative costs of each rehabilitation option.	The rehabilitation method was established and approved in the rehabilitation management plan and costed in the mine closure plan (South32, 2020). No other options have been considered recently. The costs of each rehabilitation item are outlined in the Estimated Rehabilitation Costs (ERC) calculator and estimated to be $204.4 M.

PMLU Options	Consideration	EDCM Response
	Potential economic benefits of each option (e.g., create wildlife corridors, revegetation).	Not relevant. The PMLUs have been accepted. The Australian Bureau of Statistics indicate that Agriculture and Mining are key industries in the Fitzroy NRM region.
	Compatibility with surrounding land uses (e.g., agriculture, ecosystem).	Queensland's land use mapping indicates that the EDCM ML is classified as "grazing native vegetation". Other land uses in the vicinity of the project area are "Mines", "other minimal use areas", pockets of "Infrastructure" (in the form of farm buildings), pockets of "water storages" (in the form of intensive use farm dams) and various waterways. The PLMUs are consistent with the land use mapping.
	The land use before the mining activity commenced.	The pre-mining land use was grazing.
	Options for retaining/transitioning infrastructure and utilities such as road and rail transport accessibility as well as power, communications, and water management systems.	The landholder will be consulted with as to whether some essential management infrastructure (i.e., roads, dams, monitoring bores, fencing) is required at closure. Similarly, if other significant infrastructure (i.e., rail, power station, power lines) are to be retained at closure as part of a regional planning strategy – then the appropriate approvals and formal agreements will be obtained.

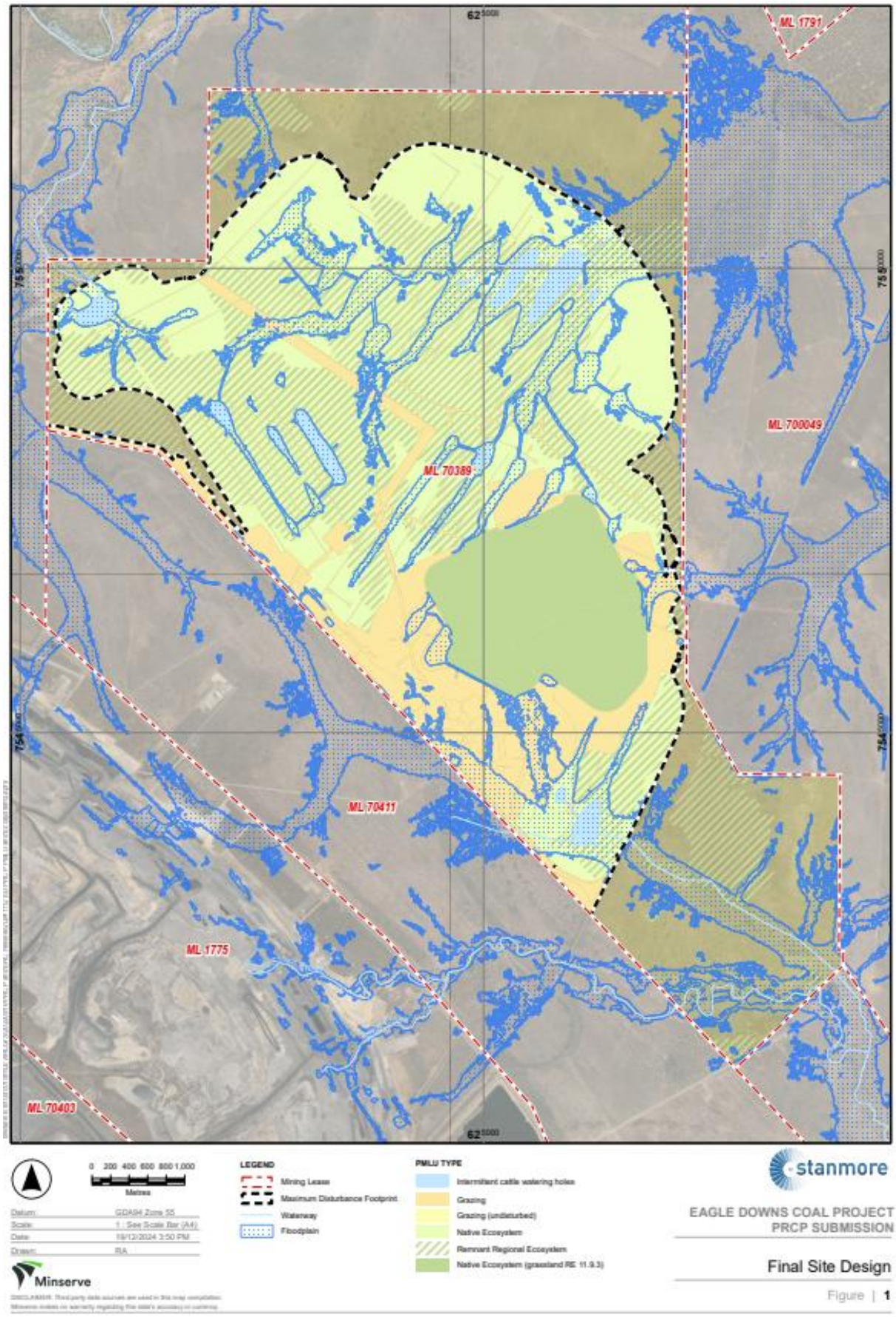


Figure 22 Post Mining Land Uses (PLMU)

3.2.4 Details of Nominated PMLUs

In accordance with advice provided in the Department of Environment and Heritage Protection (DEHP), the Department of Natural Resources and Mines (DNRM) and Queensland Treasury's *Mined Land Rehabilitation Policy*, where there are clear requirements for rehabilitation outcomes in the approved Environmental Authority, public consultation is not required. Although EA EPML00586713 authorises the PLMUs, EDCM value public consultation in the PRCP process.

Description of the use of the land

At closure, the EDCM ML will contain (as illustrated in **Figure 22**):

- A rehabilitated DREA landform with a height of approximately 40 m AHD that will be vegetated with a native grassland ecosystem;
- Disturbed land required for mining infrastructure will become land to be used for grazing;
- Land that has subsided and holds water will take the form of intermittent cattle watering holes; subsided land where water does not pond will be used for grazing, with some native ecosystem retained; and
- Undisturbed land to remain as grazing land with existing remnant vegetation not directly impacted within the approved extent of subsidence.

The PRCP schedule has assigned the PMLUs transitioned from the EA to relevant rehabilitation areas (also referred to as "domain" or "RA"). RAs are land in the PMLU to which a rehabilitation milestone for the post-mining use relates.

As shown in **Figure 22**, **Figure 23** and justified in **Table 17** which are aligned with the obligations in Table E1 of EPML00586713, the PMLUs for the project area will remain as **Table 18**.

Table 18 Rehabilitation Areas

Rehabilitation Areas		PMLU	Area (ha)
RA1	Residual Ponding Areas	Intermittent cattle watering holes	76.4
RA2	Subsided Areas (dry)	Native Ecosystem (Remnant vegetation)	2094
RA3	Subsidence		
RA4	Infrastructure	Grazing	595.9
RA5	Sediment and Supply Dams	Grazing	
RA6	DREA	Native ecosystem (grassland)	385

As required by the PRC Plan Guidelines, a description of the use of land must be provided. This is provided in **Table 19**, as conditioned and approved within the Project Environmental Authority (EA EPML00586713).

Table 19 Final Land Use and Rehabilitation Approval Schedule (EA EPML00586713 Table E1)

	Disturbance Type						
Details	**Residual Ponding Areas**	**Fill Areas**	**Extent of Subsidence**	**DREA (Including Topsoil and Capping Material Stockpiles)**	**Power Station**	**Sediment / Supply Dams**	**Infrastructure (Including ROM Stockpiles, ROWTP and Roads / Tracks)**
Maximum disturbance area (ha)	76.4	25.1	2771.7	621.4 (The maximum DREA footprint is 385 ha)	8.4	25.3	300.4
Map reference	As per Figure 3 in EA	As per Figure 3 in EA	As per Figure 3 in EA	As per Figure 3 in EA	As per Figure 3 in EA	As per Figure 3 in EA	As per Figure 3 in EA
Pre-mine land use	Grazing	Grazing	Grazing	Grazing	Grazing	Grazing	Grazing
Post-mine land use	Intermittent cattle watering holes	Grazing	Grazing and native ecosystem	Native Ecosystem for DREA and grazing for topsoil and capping material stockpiles	Grazing	Grazing or to remain as water storage upon agreement with landholder	Grazing or roads/tracks may remain as farm access upon agreement with the landholder
Post-mine land capability classification	Class D Agricultural Land	Class C Agricultural Land	Class C Agricultural Land	Class C and Class D Agricultural Land	Class C Agricultural Land	Class D Agricultural Land	Class C and Class D Agricultural Land
Projective cover range (%)	N/A	70%	70%	70%	70%	N/A	70%

Vegetation Types

As required by the PRC Plan Guidelines, specific vegetation types or land suitability classification (post mine land) must be described. The pre-approved PLMUs relevant to selecting vegetation types are:

- Native ecosystem; and
- Grazing.

Given how surface impacts are realised during multi seam mining and to remain in line with the transitionally approved PMLUs as described in the **Table 19**, the expectations associated with native ecosystem have been mapped in three different ways (**Figure 22**) that include:

- Subsided areas that do not collect water where native ecosystem is presumed to be largely preserved (RA2)
- The area within the approved extent of subsidence that is not predicted to be directly impacted (RA3); and

- The DREA which has been committed to native ecosystem associated with native grassland RE 11.9.3 in the EA that has transition to the PRCP schedule (RA6).

The expectation for the 180 ha of native ecosystem associated with dry subsidence area (RA 2) is there will be no change to the existing native ecosystem at the cessation of mining. This will need to be established through the baseline study required by the general conditions of the PRCP schedule ahead of mining.

The 1914 ha associated with remanent native ecosystem refers to the areas within the 'extent of subsidence' now known as RA3 (Subsidence). The expectation for this area as described in the PRCP general conditions and associated RM criteria is there is no change to land not directly impacted by surface disturbance or subsidence. A baseline study of the land prior to mining the panels must be conducted to gather the criteria to assess against post mining to determine there has been no change to remnant vegetation, drainage and other environmental values caused by mining. Baseline conditions for existing environmental values are also described in detail in Appendix F, Appendix G, and Appendix J. Areas of no direct impact from subsidence are based on the modelling results presented in Appendix L.

The DREA (RA6) will be rehabilitated to a native ecosystem (grassland) PMLU with grassland species associated with the pre-mining undisturbed landscape.

The DREA is proposed to be revegetated with species consistent with RE 11.9.3 *Dichanthium* spp., *Astrebla* spp. grassland on fine-grained sedimentary rocks to support the native ecosystem. The proposed vegetation types proposed for each PMLU area are described in **Table 20**.

The disturbed areas required for tracks and infrastructure will be revegetated to introduced or native pasture (non-remnant vegetation). The intermittent cattle watering holes may support pasture species when not inundated with water, however the land surrounding them is still classed as native ecosystem.

The land capability classes are provided in **Table 20**, as conditioned and approved within the Project EA EPML00586713.

Table 20 Vegetation Types for the PMLUs

Regional Ecosystem Description	Conservation Status		Infrastructure/ Disturbance Type	Approved Post Mining Land Use	Native Ecosystem PLMU Sub Category
	VM Act	EPBC Act			
11.9.3 – *Dichanthium* spp., *Astrebla* spp. grassland on fine-grained sedimentary rocks	Least Concern	Endangered	DREA, Mitigated Subsidence areas	Native Ecosystem	Grassland
Non-remnant (native and introduced pasture)	n/a	n/a	Infrastructure areas- including tracks, stockpiles, power station, intermittent cattle watering holes.	Grazing	n/a
Non-remnant (native and introduced pasture)	n/a	n/a	Residual ponding (subsidence) areas	Intermittent cattle watering holes	n/a

Grazing

The acceptance criteria for cattle grazing outlined in the EA have been superseded by the PRCP schedule (Appendix B) which mandates the rehabilitation of grazing areas to Class 3. Grazing PMLU areas are required to meet Class 3 as defined in the Rehabilitated Mined Land Suitability for Beef Cattle Grazing in the Bowen Basin guideline (Short, 2023). This framework identifies eleven land use limitations that influence the suitability of rehabilitated land for cattle grazing. To achieve a Class 3 classification, the criteria described in **Table 21** must be satisfied.

Table 21 Criteria to achieve a beef cattle grazing PMLU Class 3

Indicator	Class 3
Soil water storage (mm)	<60-40
Available-P (mg/kg) in 0-0.1 m depth increment	<14-8
pH in 0-0.1 m depth increment	<6.0-5.6 >7.9-8.4
Surface condition	Surface crust
Ece (dS/m) in ERD (0-0.6 m depth increment)	>4-10
Gravel, 20 – 60 mm (%) Cobble, 60 – 200 mm (%) Stone, 200 – 600 mm (%) Boulders, >600 mm (%)	>50-70 >20-50 >10-20 2-10
Slope grade (%)	>10-15
Vertical interval (m)	0.2-0.4
Slope (%), ESP <6 (%) in 0-0.1 m soil depth increment Slope (%), ESP 6-14 (%) in 0-0.1 m soil depth increment Slope (%), ESP >14 (%) in 0-0.1 m soil depth increment	>8-12 >6-10 >2-4
ESP (%) at 0.5 m depth	>14-23
Strongly acid conditions (pH <4.5) within (x) m depth	<2-0.9

Source: Table 15 of the Rehabilitated mined land suitability for beef cattle grazing in the Bowen Basin - Technical Paper

Permanent or Essential Management Infrastructure

Some essential management infrastructure (such as roads, dams, monitoring bores, fencing) may be considered as part of the PMLU, where it is considered consistent with the land use. This may occur if the landholder makes a formal request and has agreed through a signed landholder statement declaring that they will accept responsibility for the infrastructure.

Other more significant permanent infrastructure (such as rail, power station, power lines) has been accounted for in EDCM's rehabilitation and closure activities. However, if such infrastructure is identified post PRC Plan approval, as part of a regional planning strategy and is to be retained on the ML at closure, appropriate consultation with community members and the attainment of relevant approvals (i.e. landholder acceptance, approvals under the EP Act, *Mineral Resources Act 1989* (Queensland) etc.) must be undertaken and obtained.

All infrastructure to be retained onsite will be assessed by an appropriately qualified person (AQP) to be safe, stable, and not cause environmental harm.

Completion Criteria to Measure Whether PMLUs have been Successfully Achieved

The rehabilitation goal for each RA is to achieve a landform that is safe, non-polluting, stable, and self-sustaining. The PRCP schedule establishes rehabilitation objectives for each domain and developed indicators and completion criteria to ensure rehabilitation goals and objectives are met through rehabilitation milestones (RM) (**Table 22**).

These criteria will be reviewed over time and aligned with the PRC Plan milestones (Appendix B) to ensure the performance of the rehabilitation can be effectively assessed. Evidence from time series rehabilitation monitoring data will be used to demonstrate the trajectory of rehabilitation success or identify potential rehabilitation failures as soon as practicable.

If any monitoring results show a disparity with the target criteria trajectory, then rehabilitation performance issues will be addressed by adaptive management intervention, and improvements to the rehabilitation execution methodology will be implemented.

Table 22 Rehabilitation Completion Criteria for Each Domain

Mine Domain	Rehabilitation Goal	Rehabilitation Objective	Indicator	Completion Criteria
Dry Rejects Emplacement Area (DREA) – RA6	Safe	Safe for humans and native fauna now and in the foreseeable future. Reject materials characterized to assess potential generation of mobile contaminants or processes. DREA landform is geotechnically stable.	Structurally sound with no major slumping. The safety of the rehabilitated areas is not compromised by the presence of any hazardous material. Geochemical assessment of materials to be emplaced during operations. Geotechnical Stability Assessment complete. Risk Assessment for the DREA and ROM areas complete.	All services disconnected, terminated and removed offsite. All buildings, and associated infrastructure (including concrete slabs and footings) demolished or removed offsite. All roads (bitumen, blue metal, aggregate) removed. All fencing not included in the PMLU removed offsite. Machinery and equipment removed offsite. All waste removed offsite. All pipelines drained and removed. All surface drainage infrastructure removed. Contaminated sediments and liners removed or incorporated into the final landform of the Dry Rejects Emplacement Area (DREA). An AQP confirms that performance objectives for the DREA clay liner have been achieved during construction, maintained during operations and are suitable for closure. Geotechnical stability of landform verified by an appropriately qualified person. An AQP certifies that the constructed landform achieves design criteria for geotechnical stability with a Factor of Safety (FOS) ≥ 1.5. Final surfaces (batters and top surface) reprofiled to achieve final landform design and final capping layers as per *Final Landform Design Report 119224.02R01 Rev B April 2023.* Batter slopes reshaped following cessation of subsidence in accordance with the AQP design. Batter slopes reshaped to ≤15%.Prior to surrender, long term adequacy of safety measures is assessed by an appropriately qualified person (AQP). Closure and decommissioning plan have been reviewed and detailed design completed and certified by a third-party AQP. Fencing to exclude livestock installed.

Mine Domain	Rehabilitation Goal	Rehabilitation Objective	Indicator	Completion Criteria
	Stable Landform	Rehabilitated areas are structurally safe. Minimise erosion and slope slippage. Landform incorporates batter slopes that are sufficiently shallow to be revegetated, enhancing erosion protection.	Structurally sound with no major slumping. Geotechnical Stability Assessment complete. Monitoring demonstrates the site to be stable with no active rill/gullies or erosion. encourage the ponding of water or create surface flow significantly different to surrounding undisturbed areas.	All major earthworks completed. Batter slopes reshaped following cessation of subsidence in accordance with the AQP design. Batter slopes reshaped to ≤15%. Free-draining top surface graded to 2%. Geotechnical stability of landform verified by an appropriately qualified person. Confirmation by an AQP that the cover system has been installed as per the design and displays erosional stability, is geotechnically stable and supports the PMLU. Any erosion or effects of subsidence remediated as per the closure conditions of the latest version of the Subsidence Management Plan and to ensure maintenance of the baseline condition (latest assessed).
	Non-Polluting	No environmental harm to land and receiving waters. Avoid stormwater infiltrating into DREA landform. DREA containment systems prevent release of contaminants to the receiving environment.	Monitoring is being completed. The safety of the rehabilitated areas is not compromised by the presence of any hazardous material. All non-permanent regulated structures decommissioned appropriately. Runoff and seepage do not cause environmental harm and receiving water quality indicators do not exceed specified criteria limits. Results from Contaminated Land Assessment for DREA and ROM areas indicate contamination has been remediated.	Installation of a cover system in accordance with the AQP design. Confirmation from AQP that the installed cover is effective in mitigating the potential for migration of contaminants from the DREA to the receiving environment. . At least 200mm of topsoil placed over disturbed areas. Rainfall infiltration ≤5% on top-surface and batters. Surface water runoff is non-polluting to receiving waters and complies with **Table 62.** Groundwater quality results must not exceed the limits in **Table 63**, for 3 consecutive results. Prior to placement of soil material for rehabilitation, growth media[3] health and suitability must be assessed and certified by an AQP as suitable for PMLU and target vegetation and to determine the need for ameliorants and fertilisers prior to sowing seed.

[3] Growth media is defined as all soil and soil-like material that will support the final vegetation cover. This includes the topsoil and subsoil where these materials are applied independently. Where the topsoil is incorporated into the underlying subsoil/spoil, topsoil refers to the depth of incorporation and the remaining depth is regarded as subsoil. The total depth of growth media is nominally considered to be the effective plant root zone.

Mine Domain	Rehabilitation Goal	Rehabilitation Objective	Indicator	Completion Criteria
				Where growth media health and suitability assessment identify that growth media criteria below are not met, a recommendation is made for ameliorants and fertilisers prior to sowing seed, growth media (to meet the following: (a) ECe ≤4 dS/m; (b) Soil pH ≥5 and ≤9; and (c) Exchangeable Sodium Percentage (ESP%) ≤6%. Ameliorants such as fertiliser, gypsum and/or organic matter applied at rates determined by an AQP. Average soil loss rates of ≤5t/ha/y on outer slope batters, with a maximum erosion rate of 10/t/ha/y. No rills or gully erosion present ≥0.3m deep. The surface and groundwater monitoring network, as per PRCP schedule is installed and monitoring underway (one year of sampling undertaken). Complete seeding of DREA surfaces using a rehabilitation seed mix comprising only the species permitted by PRC schedule, Appendix 2 – Native grassland (RE 11.9.3). Seed with native grassland species applicable to RE 11.9.3 at 12kg/ha.
	Sustainable Land Use	Achieve a Post Mining Land use of a Native Ecosystem	Revegetated with native species to control erosion and provide a suitable environment for native fauna. Native vegetation species established have sufficient diversity and density to support native ecosystem function. Self-sustaining, resilient native species. Declared weed populations in rehabilitated areas do not compromise the intended post-mine land use of a native ecosystem area.	A minimum depth of 200 mm topsoil applied (over 1 m of subsoil) to cover surface for a plant growth medium. The area is fenced to prevent cattle/ livestock entering the area. Vegetative groundcover of 70% for native ecosystem PMLU. Native vegetation communities must achieve ≥18/30 of values from reference benchmark criteria of mapped pre-clear regional ecosystem for RE 11.9.3 as per **Table 53**, when measured by an AQP using the BioCondition Assessment Methodology. Updated landform evolution modelling confirms erosional stability of subsided DREA landform has not been compromised relative to original LEM predictions.

Mine Domain	Rehabilitation Goal	Rehabilitation Objective	Indicator	Completion Criteria
				Average soil loss rates of ≤5t/ha/y on outer slope batters, with a maximum erosion rate of 10/t/ha/y. No rills or gully erosion present ≥0.3m deep.
Infrastructure, Roads and Tracks, ROM Stockpiles, ROWTP, Fill areas, Power Station, gas drainage boreholes, surface to seam boreholes, and Topsoil and Capping Material Stockpiles – RA4	Safe	Protects humans, cattle, and fauna now and in the foreseeable future.	All infrastructure constructed for the environmental authority holder during the licensed activities is removed from the site prior to surrender, except where agreed in writing by the post mining land owner / holder. Structural and geotechnical site stability. Services disconnected.	Safety hazards in rehabilitated areas are not significantly different to surrounding undisturbed areas. Demolition or removal of all infrastructure (not to be retained) is removed. • All services disconnected, terminated and removed offsite. • All buildings, and associated infrastructure (including concrete slabs and footings) demolished or removed offsite. • All roads (bitumen, blue metal, aggregate) removed. • All fencing not included in the PMLU removed offsite. • Machinery and equipment removed offsite. • All waste removed offsite. • All pipelines drained and removed. All surface drainage infrastructure removed.Only infrastructure certified structurally stable by AQP is retained. Formal asset handover for engineered or non-engineered assets. Sign off of asset transfer by post-mining landholder (for retained structures). Drill holes are rehabilitated such that intended post-mine land use of grazing will not be impacted. Prior to surrender, long-term adequacy of safety measures assessed by a AQP. Geotechnical stability of domain verified by an appropriately qualified person. Borehole decommissioning completed in accordance with the Code of Practice for the Construction and Abandonment of

Mine Domain	Rehabilitation Goal	Rehabilitation Objective	Indicator	Completion Criteria
				Petroleum wells and associated bores in Queensland (the Code) (Department of Resources, 2019) latest edition. An appropriately qualified person (AQP) has certified the borehole has been remediated in accordance with the Code. For all surface to seam boreholes (including but not limited to, exploration bores, water monitoring bores, dewatering bores and bores with diameter up to 300mm): (a) Boreholes grouted and/or plugged. (b) Boreholes capped 0.5 m below surface. (c) Decommission of exploration bores completed in accordance with 'Eligibility Criteria and Standard Conditions for Exploration and Mineral Development Projects'.
	Stable Landform	Minimise erosion and low probability of slope slippage. Landform slopes sufficiently shallow to be revegetated, enhancing erosion protection. Rehabilitated areas are structurally safe for grazing.	Geotechnical stability of domain Monitoring demonstrates the site to be erosively stable with no active rill/gullies. Final landform slopes are at an angle suitable for the post-mine land use of grazing.	Remediation of any erosion or subsidence by, but not limited to, addition of rock and/or log cover to assist erosion resistance of eventual vegetative groundcover. At least 200mm of topsoil placed over disturbed areas[4]. Rehabilitated areas stabilised and reshaped to a slope of less than 5%. All major earthworks completed, slopes and general reshaping and pushing/trimming completed to achieve final landform. An AQP certifies that the constructed landform achieves design criteria for geotechnical stability with a Factor of Safety (FOS) ≥ 1.5. Any erosion or effects of subsidence remediated as per the closure conditions of the latest version of the Subsidence Management Plan and to ensure maintenance of the baseline condition (latest assessed) as determined in section 3.5.1.5.

[4] Disturbed area is defined as any area where activities authorised under Environmental Authority EPML00586713 has resulted in ground disturbance. Disturbance may include removal of vegetation, groundcover or soil material from an area.

Mine Domain	Rehabilitation Goal	Rehabilitation Objective	Indicator	Completion Criteria
				Prior to placement of soil material for rehabilitation, growth media[5] health and suitability must be assessed and certified by an AQP as suitable for PMLU and target vegetation and to determine the need for ameliorants and fertilisers prior to sowing seed. Where growth media health and suitability assessment identifies that growth media criteria below are not met, a recommendation is made for ameliorants and fertilisers prior to sowing seed, growth media (to meet the following: (a) ECe ≤4 dS/m (b) Soil pH ≥5 and ≤9 (c) Exchangeable Sodium Percentage (ESP%) ≤6%. Ameliorants such as fertiliser, gypsum and/or organic matter applied at rates determined by an AQP. The surface and groundwater monitoring network, including, but not limited, to those locations identified in Appendix 6 and Appendix 7 of the PRC Schedule (Appendix B), is installed and monitoring underway (one year of sampling undertaken).
	Non-Polluting	No environmental harm to land and receiving waters.	Site monitoring results confirm no impact to land and receiving waters. Runoff or seepage discharge water, from rehabilitated areas to the receiving environment, has acceptable characteristics (i.e., does not adversely impact surface or groundwater quality). Results from the Contaminated Land Assessment indicate identified contamination has been remediated.	Contaminated Land Investigation Document completed in accordance with the *Environmental Protection Act 1994*, including a site investigation report, and, where required, a Validation Report and/or a draft Site Management Plan. Contaminated and hazardous material either remediated in-situ or removed/transported to an approved landfill for disposal and waste tracking information recorded and submitted. A declaration from an Suitably Qualified Person that no contamination unsuitable for the post-mining land use remains. No deterioration of water quality originating from the mining area.

[5] Growth media is defined as all soil and soil-like material that will support the final vegetation cover. This includes the topsoil and subsoil where these materials are applied independently. Where the topsoil is incorporated into the underlying subsoil/spoil, topsoil refers to the depth of incorporation and the remaining depth is regarded as subsoil. The total depth of growth media is nominally considered to be the effective plant root zone

Mine Domain	Rehabilitation Goal	Rehabilitation Objective	Indicator	Completion Criteria
			The safety of the grazing areas is not compromised by the presence of any hazardous material.	Surface water runoff is non-polluting to receiving waters and complies with **Table 62.** Groundwater quality results must not exceed the limits in **Table 63**, for 3 consecutive results. Areas free of hazardous materials or are rendered safe. Nitrogen fixing legume species included in seed mix. Complete seeding of all topsoil surfaces using a rehabilitation seed mix comprising only the species permitted by **Table 45**. Native or introduced pasture grass seed species used to control erosion applied at 12 kg/ha. Groundcover 60% perennial pasture biomass for grazing PMLU. Less than 5% of declared weeds (as defined in the *Biosecurity Act 2014*). Weed presence is a maximum of 10% of total vegetative groundcover confirmed by an AQP in annual monitoring. No evidence of erosion classified as 'moderate' or 'severe' as defined in **Table 67**. A third party AQP certifies that any erosion present will not compromise the achievement of a PMLU to a stable condition.
	Sustainable Land Use	Achieve a post mining land use - Grazing.	Revegetated with native or introduced pasture species to control erosion. Nutrient cycling in grazing pasture. Self-sustaining, resilient pasture can support cattle grazing. Declared weed populations in rehabilitated areas do not compromise the intended post-mine land use of grazing.	Vegetation ground cover >70%. 3P (perennial, persistent and palatable) pasture species listed in **Table 45**, including legumes and grasses, remain present and showing evidence of natural recruitment in rehabilitation monitoring data. Weed presence is a maximum of 10% of total vegetative groundcover confirmed by an AQP in annual monitoring. Weed management recommendations to be provided in annual reports and completed. Less than 5% of total vegetative groundcover is declared weeds (as defined in the *Biosecurity Act 2014*). Certification of rehabilitation to Grazing Class 3 by an AQP.

Mine Domain	Rehabilitation Goal	Rehabilitation Objective	Indicator	Completion Criteria
				No evidence of erosion classified as 'moderate' or 'severe' as defined by **Table 67**. A third party AQP certifies that any erosion present will not compromise the achievement of a PMLU to a stable condition. The slope of rehabilitated infrastructure areas is less than 5%. Surface water runoff is non-polluting to receiving waters and complies with PRC Schedule, **Table 62 .** Surface water quality results monitored within 48 hours of flow, but not limited to, downstream locations specified in **Table 64**, must not exceed the limits in PRC schedule, **Table 62**– Surface water quality limits, for a minimum of 5 consecutive years. If the surface water quality exceeds criteria above, the applicable upstream site must be compared to the downstream site result. For a minimum of five consecutive years groundwater quality must be monitored quarterly at, but not limited to, bores specified in PRC schedule, **Table 65**, for all quality characteristics listed in **Table 63**. Groundwater quality results must not exceed the limits in PRC Schedule, **Table 63**, for 3 consecutive results. Exploration activities outside approved disturbance area shown in PRC Schedule, Figure 1: Final Site Design are rehabilitated in accordance with the latest version of the Eligibility Criteria and Standard Conditions for Exploration and Mineral Development Projects (ESR/2016/1985). All remaining infrastructure removed.
Subsided Areas with Residual Ponding – RA1	Safe	Subsidence ceased. Protects humans and fauna now and in the foreseeable future	Subsidence depressions or cracks are filled and re-profiled. Subsidence has ceased within 12 months of the completion of mining.	All services disconnected, terminated and removed offsite. All buildings, and associated infrastructure (including concrete slabs and footings) demolished or removed offsite. All roads (bitumen, blue metal, aggregate) removed.

Mine Domain	Rehabilitation Goal	Rehabilitation Objective	Indicator	Completion Criteria
			Safety hazards are not significantly different to surrounding undisturbed areas. Rehabilitated areas are structurally, geotechnically, and hydraulicly safe. Minimal erosion.	All fencing not included in the PMLU removed offsite. Machinery and equipment removed offsite. All waste removed offsite. All pipelines drained and removed. All surface drainage infrastructure removed. Gas drainage boreholes decommissioning completed in accordance with the Code of Practice for the Construction and Abandonment of Petroleum wells and associated bores in Queensland (the Code) (Department of Resources, 2019) latest edition. An appropriately qualified person (AQP) has certified the borehole has been remediated in accordance with the Code. For all surface to seam boreholes (including but not limited to, exploration bores, water monitoring bores, dewatering bores and bores with diameter up to 300mm): (d) Boreholes grouted and/or plugged. (e) Boreholes capped 0.5 m below surface. Decommission of exploration bores completed in accordance with 'Eligibility Criteria and Standard Conditions for Exploration and Mineral Development Projects'.
	Stable Landform	Subsidence ceased. Protects humans, cattle, and fauna now and in the foreseeable future	Subsidence depressions or cracks are filled and re-profiled. Subsidence has ceased within 12 months of the completion of mining. Rehabilitated areas are structurally, geotechnically, and hydraulicly safe. Erosion is stable in the area. Final landform slopes are at an angle suitable for holding water and appropriate cattle access.	Rehabilitated areas stabilised and reshaped to a slope of less than 5%. All major earthworks completed, slopes and general reshaping and pushing/trimming completed to achieve final landform. An AQP certifies that the constructed landform achieves design criteria for geotechnical stability with a Factor of Safety (FOS) ≥ 1.5. The cessation of subsidence confirmed by AQP. Subsidence cracks do not exceed ≥25 mm in subsided areas. Depression/ ponding areas are free draining and require no further drainage works. Assessment of permanent ponds is completed by an AQP and identified sediment and water management actions are completed.

Mine Domain	Rehabilitation Goal	Rehabilitation Objective	Indicator	Completion Criteria
				Ponds are safe for native animals and stock access and have vegetated banks. Water storages to be assessed and approved as safe and stable by an AQP. No bed and bank erosion within drainage structures or watercourses as a result of subsidence or subsidence management. No cracking or destabilisation present in beds or bands of drainage structures or watercourses as a result of subsidence or subsidence management. Excavated drainage channels do not expose highly erodible material. Subsidence areas intersecting flood-prone zones must be designed to withstand flood events without compromising the stability of drainage structures or causing erosion. No evidence of erosion classified as 'moderate' or 'severe' as defined by **Table 67**. A third party AQP certifies that any erosion present will not compromise the achievement of a PMLU to a stable condition. No evidence of erosion classified as 'moderate' or 'severe' as defined by **Table 67**.
	Non-Polluting	Areas do not cause any serious environmental harm to land.	Monitoring results confirm non polluting land do not cause environmental harm. The safety of the area is not compromised by the presence of any hazardous material. Runoff or seepage discharge water, from areas to the receiving environment, has acceptable characteristics (i.e., does not adversely impact surface or groundwater quality).	No evidence of erosion classified as 'moderate' or 'severe' as defined by **Table 67**.All watering holes to be assessed and approved as safe and stable by an AQP. Watering holes contain water of a suitable quality for native wildlife and/or livestock ingestion.
	Sustainable Land Use	Domain supports intermittent cattle watering holes	Water available to cattle as an intermittent water supply.	Watering holes contain water of a suitable quality for native wildlife and/or livestock ingestion.

Mine Domain	Rehabilitation Goal	Rehabilitation Objective	Indicator	Completion Criteria
			Cattle able to source water safely and intermittently throughout the year when grazing.	A third party AQP certifies that any erosion present will not compromise the achievement of a PMLU to a stable condition.
Subsided Areas (mitigated by draining) – RA2	Safe	Subsidence ceased. Protects humans and fauna now and in the foreseeable future	Subsidence depressions or cracks are filled and re-profiled. Subsidence has ceased within 12 months of the completion of mining. Safety hazards are not significantly different to surrounding undisturbed areas. Rehabilitated areas are structurally, geotechnically and hydraulically safe. Minimal erosion.	All services disconnected, terminated and removed offsite. All buildings, and associated infrastructure (including concrete slabs and footings) demolished or removed offsite. All roads (bitumen, blue metal, aggregate) removed. All fencing not included in the PMLU removed offsite. Machinery and equipment removed offsite. All waste removed offsite. All pipelines drained and removed. All surface drainage infrastructure removed. Gas drainage boreholes decommissioning completed in accordance with the Code of Practice for the Construction and Abandonment of Petroleum wells and associated bores in Queensland (the Code) (Department of Resources, 2019) latest edition. An appropriately qualified person (AQP) has certified the borehole has been remediated in accordance with the Code. For all surface to seam boreholes (including but not limited to, exploration bores, water monitoring bores, dewatering bores and bores with diameter up to 300mm): (d) Boreholes grouted and/or plugged. (e) Boreholes capped 0.5 m below surface. (f) Decommission of exploration bores completed in accordance with 'Eligibility Criteria and Standard Conditions for Exploration and Mineral Development Projects'.
	Stable Landform	Subsidence ceased. Protects humans, cattle, and fauna now and in the foreseeable future	The safety of the rehabilitated areas is not compromised by the presence of any hazardous material. Subsidence depressions or cracks are filled and re-profiled.	The cessation of subsidence confirmed by AQP. Subsidence cracks do not exceed ≥25 mm in subsided areas. Depression/ ponding areas are free draining and require no further drainage works.

Mine Domain	Rehabilitation Goal	Rehabilitation Objective	Indicator	Completion Criteria
			Subsidence has ceased within 12 months of the completion of mining. Rehabilitated areas are structurally, geotechnically, and hydraulically safe. Erosion is stable on rehabilitated areas.	Complete seeding of topsoil surfaces for disturbed areas using a seed mix that aligns with the species composition identified in the baseline condition assessment as described by **Table 46**. Vegetative groundcover of 70% for native ecosystem PMLU. Less than 5% of declared weeds (as defined in the *Biosecurity Act 2014*). Weed presence is a maximum of 10% of total vegetative groundcover confirmed by an AQP in annual monitoring. No bed and bank erosion within drainage structures or watercourses as a result of subsidence or subsidence management No cracking or destabilisation present in beds or bands of drainage structures or watercourses as a result of subsidence or subsidence management. Excavated drainage channels do not expose highly erodible material. Subsidence areas intersecting flood-prone zones must be designed to withstand flood events without compromising the stability of drainage structures or causing erosion.
	Non-Polluting	Areas do not cause any serious environmental harm to land.	Monitoring results confirm non polluting land do not cause environmental harm.	No evidence of erosion classified as 'moderate' or 'severe' as defined by **Table 67**. Areas free of hazardous materials or are rendered safe
	Sustainable Land Use	Achieve a Post Mining Land Use of Native Ecosystem	Revegetated with native species to control erosion and provide a suitable environment for native fauna. Self-sustaining, resilient species.	Areas achieve ≥50% established and persistent vegetative groundcover. Species used in revegetation (listed in **Table 46**) remain present and showing evidence of natural recruitment in rehabilitation monitoring data. Weed presence is a maximum of 10% of total vegetative groundcover confirmed by an AQP in annual monitoring. Weed management recommendations to be provided in annual reports.

Mine Domain	Rehabilitation Goal	Rehabilitation Objective	Indicator	Completion Criteria
				Less than 5% of total vegetative groundcover is declared weeds (as defined in the Biosecurity Act 2014). No evidence of erosion classified as 'moderate' or 'severe' as defined by **Table 67**. A third party AQP certifies that any erosion present will not compromise the achievement of a PMLU to a stable condition. Surface water runoff is non-polluting to receiving waters and complies with **Table 62.** Surface water quality results monitored within 48 hours of flow at, but not limited to, downstream locations specified in **Table 64**, must not exceed the limits in **Table 62**, for a minimum of 5 consecutive years. If the surface water quality exceeds criteria in **Table 62**, the applicable upstream site must be compared to the downstream site result. For a minimum of five consecutive years groundwater quality must be monitored quarterly at, but not limited to, bores specified in **Table 65**, for all quality characteristics listed in **Table 63**. Groundwater quality results must not exceed the limits in **Table 63**, for 3 consecutive results. Exploration activities outside approved disturbance area show in **Figure 25** are rehabilitated in accordance with the latest version of the Eligibility Criteria and Standard Conditions for Exploration and Mineral Development Projects (ESR/2016/1985). No change to baseline vegetation species composition and structure to the latest baseline condition that has been assessed under condition described in section 3.5.1.5.
Sediment/ Supply dams RA5	Safe	Protects humans, cattle, and fauna now and in the foreseeable future.	All water infrastructure constructed for the environmental authority holder during the licensed activities is removed from the site prior surrender, except	All services disconnected, terminated and removed offsite. All buildings, and associated infrastructure (including concrete slabs and footings) demolished or removed offsite. All roads (bitumen, blue metal, aggregate) removed.

Mine Domain	Rehabilitation Goal	Rehabilitation Objective	Indicator	Completion Criteria
			where agreed in writing by the post mining land owner / holder. Structural and geotechnical site stability.	All fencing not included in the PMLU removed offsite. Machinery and equipment removed offsite. All waste removed offsite. All pipelines drained and removed. All surface drainage infrastructure removed. Dams dewatered and desilted. Liners from dams removed. Rehabilitated areas stabilised and reshaped to a slope of less than 5%. All major earthworks completed, slopes and general reshaping and pushing/trimming completed to achieve final landform. An AQP certifies that the constructed landform achieves design criteria for geotechnical stability with a Factor of Safety (FOS) ≥ 1.5.
	Stable landform	Minimise erosion and low probability of slope slippage. Landform slopes sufficiently shallow to be revegetated, enhancing erosion protection.	Geotechnical stability of domain Monitoring demonstrates the site to be stable with no active rill/gullies or erosion.	Rehabilitated areas stabilised and reshaped to a slope of less than 5%. No evidence of erosion classified as ‘moderate’ or ‘severe’ as defined by **Table 67**. An AQP certifies that the constructed landform achieves design criteria for geotechnical stability with a Factor of Safety (FOS) ≥ 1.5. Any erosion or effects of subsidence remediated as per the closure conditions of the latest version of the Subsidence Management Plan and to ensure maintenance of the baseline condition (latest assessed) as determined in section 3.5.1.5. Remediate any erosion or subsidence by, but not limited to, addition of rock and/or log cover to assist erosion resistance of eventual vegetative groundcover. Prior to placement of soil material for rehabilitation, growth media health and suitability must be assessed and certified by an AQP as suitable for PMLU and target vegetation and to

Mine Domain	Rehabilitation Goal	Rehabilitation Objective	Indicator	Completion Criteria
				determine the need for ameliorants and fertilisers prior to sowing seed. Ameliorants such as fertiliser, gypsum and/or organic matter applied at rates determined by an AQP. The surface and groundwater monitoring network, including, but not limited, to those locations identified in **Table 64** and **Table 65**, is installed and monitoring underway (one year of sampling undertaken). At least 200mm of topsoil placed over disturbed areas.
	Non-polluting	No environmental harm to land and receiving waters.	Site monitoring results confirm no impact on the land and receiving waters. Results from the Contaminated Land Assessment indicate any identified contamination has been remediated.	Contaminated Land Investigation Document completed in accordance with the *Environmental Protection Act 1994*, including a site investigation report, and, where required, a Validation Report and/or a draft Site Management Plan. Contaminated and hazardous material either remediated in-situ or removed/transported to an approved landfill for disposal and waste tracking information recorded and submitted. Brine disposed at a licenced waste facility. A declaration from a Suitably Qualified Person that no contamination unsuitable for the post-mining land use remains. Surface water runoff is non-polluting to receiving waters and complies with **Table 62**. Groundwater quality results must not exceed the limits in **Table 63**, for 3 consecutive results.
	Sustainable Land Use	Achieve a post mining land use - Grazing	Revegetated with native or introduced pasture species to control erosion. Self-sustaining, resilient pasture can support cattle grazing. Declared weed populations in rehabilitated areas do not compromise the intended post-mine land use of grazing.	Nitrogen fixing Legume species included in seed mix. Complete seeding of all topsoil surfaces using a rehabilitation seed mix comprising only the species permitted as per **Table 45**. Native or introduced pasture grass seed species used to control erosion applied at 12 kg/ha.

Mine Domain	Rehabilitation Goal	Rehabilitation Objective	Indicator	Completion Criteria
				Less than 5% of declared weeds (as defined in the Biosecurity Act 2014). Weed presence is a maximum of 10% of total vegetative groundcover confirmed by an AQP in annual monitoring. Areas free of hazardous materials or are rendered safe. Surface water runoff is non-polluting to receiving waters and complies with **Table 62.** A third party AQP certifies that any erosion present will not compromise the achievement of a PMLU to a stable condition Where growth media health and suitability assessment identify that growth media criteria below are not met, a recommendation is made for ameliorants and fertilisers prior to sowing seed, growth media (to meet the following: (a) ECe ≤4 dS/m (b) Soil pH ≥5 and ≤9 (c) Exchangeable Sodium Percentage (ESP%) ≤6%.
Subsidence – RA3	Safe	Subsidence ceased Protects humans and fauna now and in the foreseeable future	Subsidence depressions or cracks are filled and re-profiled. Subsidence has ceased within 12 months of the completion of mining. Safety hazards are not significantly different to surrounding undisturbed areas. Rehabilitated areas are structurally, geotechnically and hydraulically safe. Minimal erosion.	All services disconnected, terminated and removed offsite. All buildings, and associated infrastructure (including concrete slabs and footings) demolished or removed offsite. All roads (bitumen, blue metal, aggregate) removed. All fencing not included in the PMLU removed offsite. Machinery and equipment removed offsite. All waste removed offsite. All pipelines drained and removed. All surface drainage infrastructure removed. No evidence of erosion classified as ‘moderate’ or ‘severe’ as defined by **Table 67**.
	Stable Landform	Subsidence ceased.	The safety of the rehabilitated areas is not compromised by the presence of any hazardous material.	No evidence of erosion classified as ‘moderate’ or ‘severe’ as defined by **Table 67**.

Mine Domain	Rehabilitation Goal	Rehabilitation Objective	Indicator	Completion Criteria
		Protects humans, cattle, and fauna now and in the foreseeable future	Subsidence depressions or cracks are filled and re-profiled. Subsidence has ceased within 12 months of the completion of mining. Rehabilitated areas are structurally, geotechnically, and hydraulically safe. Erosion is stable on rehabilitated areas.	Remediate any erosion or subsidence by, but not limited to, addition of rock and/or log cover to assist erosion resistance of eventual vegetative groundcover. Prior to placement of soil material for rehabilitation, growth media health and suitability must be assessed and certified by an AQP as suitable for PMLU and target vegetation and to determine the need for ameliorants and fertilisers prior to sowing seed. The cessation of subsidence confirmed by AQP. Subsidence cracks do not exceed ≥25 mm in subsided areas. Depression/ ponding areas are free draining and require no further drainage works. Complete seeding of topsoil surfaces for disturbed areas using a seed mix that aligns with the species composition identified in the baseline condition assessment as described by **Table 46**. Vegetative groundcover of 70% for native ecosystem PMLU. Less than 5% of declared weeds (as defined in the *Biosecurity Act 2014*). Weed presence is a maximum of 10% of total vegetative groundcover confirmed by an AQP in annual monitoring. No bed and bank erosion within drainage structures or watercourses as a result of subsidence or subsidence management No cracking or destabilisation present in beds or bands of drainage structures or watercourses as a result of subsidence or subsidence management. Excavated drainage channels do not expose highly erodible material. Subsidence areas intersecting flood-prone zones must be designed to withstand flood events without compromising the stability of drainage structures or causing erosion.

Mine Domain	Rehabilitation Goal	Rehabilitation Objective	Indicator	Completion Criteria
	Non-polluting	Areas do not cause any serious environmental harm to land.	Monitoring results confirm non-polluting land do not cause environmental harm.	No evidence of erosion classified as 'moderate' or 'severe' as defined by **Table 67**. Areas free of hazardous materials or are rendered safe. Surface water runoff is non-polluting to receiving waters and complies with **Table 62**. Surface water quality results monitored within 48 hours of flow at, but not limited to, downstream locations specified in **Table 64**, must not exceed the limits in **Table 62**, for a minimum of 5 consecutive years. If the surface water quality exceeds criteria in **Table 64** and **Table 62**, the applicable upstream site must be compared to the downstream site result. For a minimum of five consecutive years groundwater quality must be monitored quarterly at, but not limited to, bores specified in **Table 65**, for all quality characteristics listed in **Table 63**. Groundwater quality results must not exceed the limits in **Table 63**, for 3 consecutive results.
	Sustainable Land Use	Achieve a Post Mining Land Use of Native Ecosystem	Revegetated with native species to control erosion and provide a suitable environment for native fauna. Self-sustaining, resilient species.	Areas achieve ≥50% established and persistent vegetative groundcover. Species used in revegetation (listed in **Table 46**) remain present and showing evidence of natural recruitment in rehabilitation monitoring data. Weed presence is a maximum of 10% of total vegetative groundcover confirmed by an AQP in annual monitoring. Weed management recommendations to be provided in annual reports. Less than 5% of total vegetative groundcover is declared weeds (as defined in the Biosecurity Act 2014). No evidence of erosion classified as 'moderate' or 'severe' as defined by **Table 67**. A third party AQP certifies that any erosion present will not compromise the achievement of a PMLU to a stable condition.

Mine Domain	Rehabilitation Goal	Rehabilitation Objective	Indicator	Completion Criteria
				No change to baseline vegetation species composition and structure to the latest baseline condition that has been assessed under condition described in section 3.5.1.5.

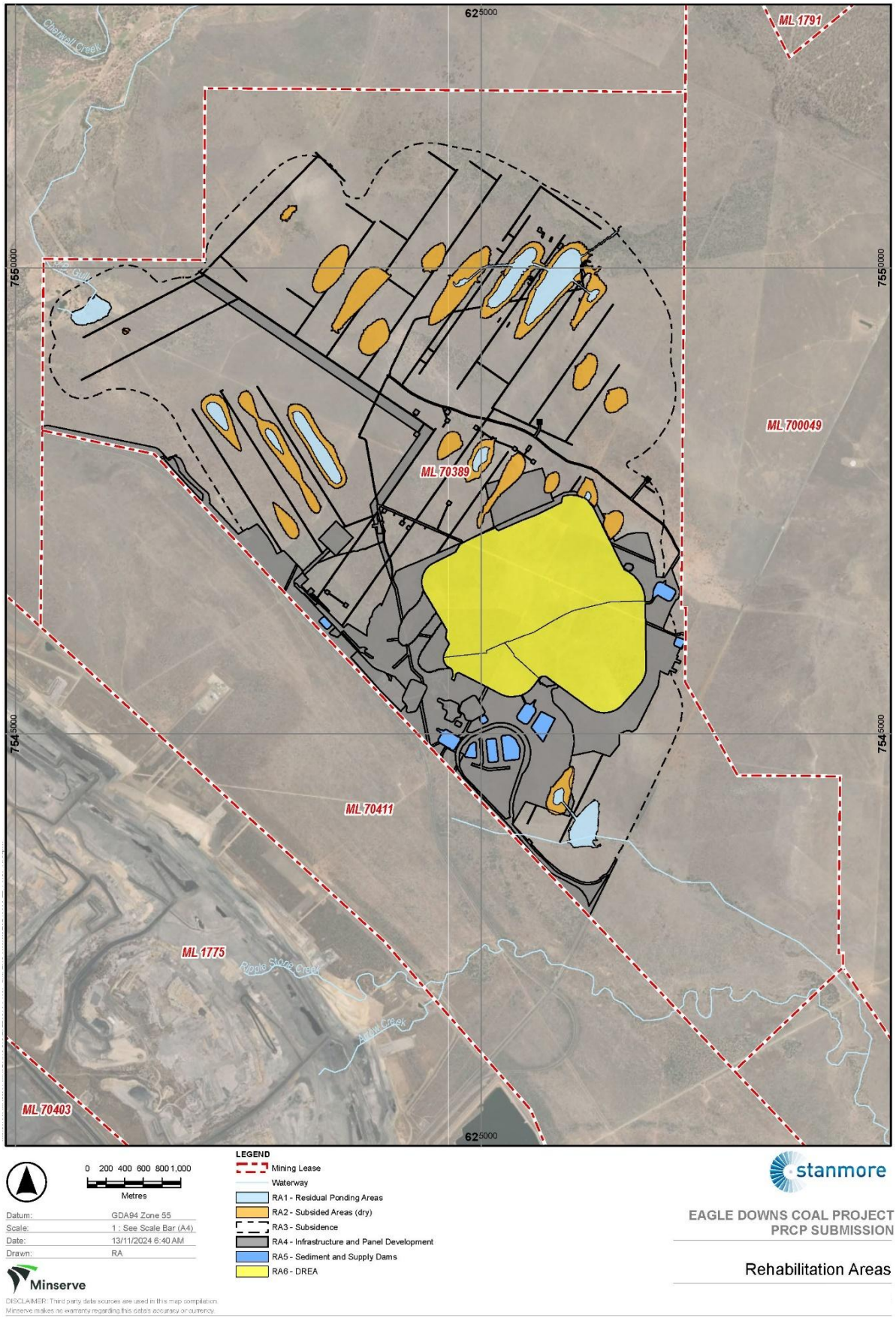


Figure 23 Rehabilitation Areas

3.3 Community Consultation

In accordance with section 126C(1)(c)(iii) and (iv) of the EP Act, the rehabilitation planning part of the PRC Plan must include:

Legislative Requirements	Compliance
Details of the consultation undertaken by the applicant in developing the proposed PRC Plan.	Section 3.3.1
Details of how the applicant will undertake ongoing consultation in relation to the rehabilitation to be carried out under the plan.	Section 3.3.2

3.3.1 Community Consultation Plan

Objectives for Community Consultation

The objective of community consultation for the EDCM PRC Plan, is to ensure that anyone impacted by proposed rehabilitation and closure activities at the project is identified, informed, and given opportunities to raise issues. EDCM's objective is to address and respond to community issues and keep members informed on progressive rehabilitation and the status of mine closure activities.

To ensure these objectives are met, a Community Stakeholder Engagement Plan (CSEP), which is the Project's Community Consultation Plan (CCP), has been developed by EDCM, and revised, to address the requirements of EP Act, and the *PRC Plan Guideline* (ESR/2019/4964) (DES, 2023b).

Identification of Stakeholders

Several considerations were given in the EDCM CSEP in order to map and identify relevant stakeholders. For the purposes of the PRCP, members of the community considered to be stakeholders are those who are deemed to have a "genuine interest" in the project. According to the DES Information sheet Community consultation for *Progressive Rehabilitation and Closure Plan* (ESR/2019/5101, 2019) a "genuine interest" must be demonstrable and legitimate. It may include but is not limited to direct impact interest (underlying or adjacent land holders); cultural interest (for example Indigenous communities, Traditional Owners including Native Title Holders); heritage interest; environmental interest; recreational interest; land use interest; or health interest).

A list of all possible community members was proactively identified through background research on the local and regional area and by networking with different parties and organisations (as described in the EDCM EIS (Hansen Bailey, 2010) and MCP (South32, 2020)). Over 60 community members with varying interest levels were identified in this process, and of these, a number were identified as having a genuine interest in rehabilitation and closure activities at EDCM.

Stakeholders identified for the EDCM project include;

- The underlying landholder;
- The neighbouring landowners;
- Traditional Owners (Barada Barna);
- Local, State and Federal government;
- Industry bodies;
- Community groups; and
- Other interested parties.

This list is not exhaustive and will be regularly reviewed and updated when required.

The locality of genuine interest community members is illustrated in **Figure 24**.

Note, the location of the following groups are not able to be shown in **Figure 24**:

- Environmental Groups.

- Community Groups.
- Local, State, Commonwealth Governments.
- How will the Community be engaged?

As described in the EDCM CSEP, as the project progresses the community and relevant stakeholders, who may be directly influenced by the rehabilitation process or final land outcomes, will be engaged on the:

- Plan of the mine;
- Post-mining land use (PMLU);
- Non-use management area (NUMA);
- Areas of disturbance;
- Rehabilitation and management methods; and
- Progressive rehabilitation and closure timeframes.

The community will be engaged via various methods including face to face meetings, emails, phone calls, Community Information Sheets, and website updates.

In August 2023, Traditional Owners and the Landholder received a comprehensive written update concerning the PRCP for EDCM, reflecting the direct impact and genuine interest of these stakeholders hold in the project. Stakeholders were asked to provide feedback and despite the absence of feedback, the Project remains committed to ensuring that stakeholders are continuously informed with relevant updates and applications whenever possible.

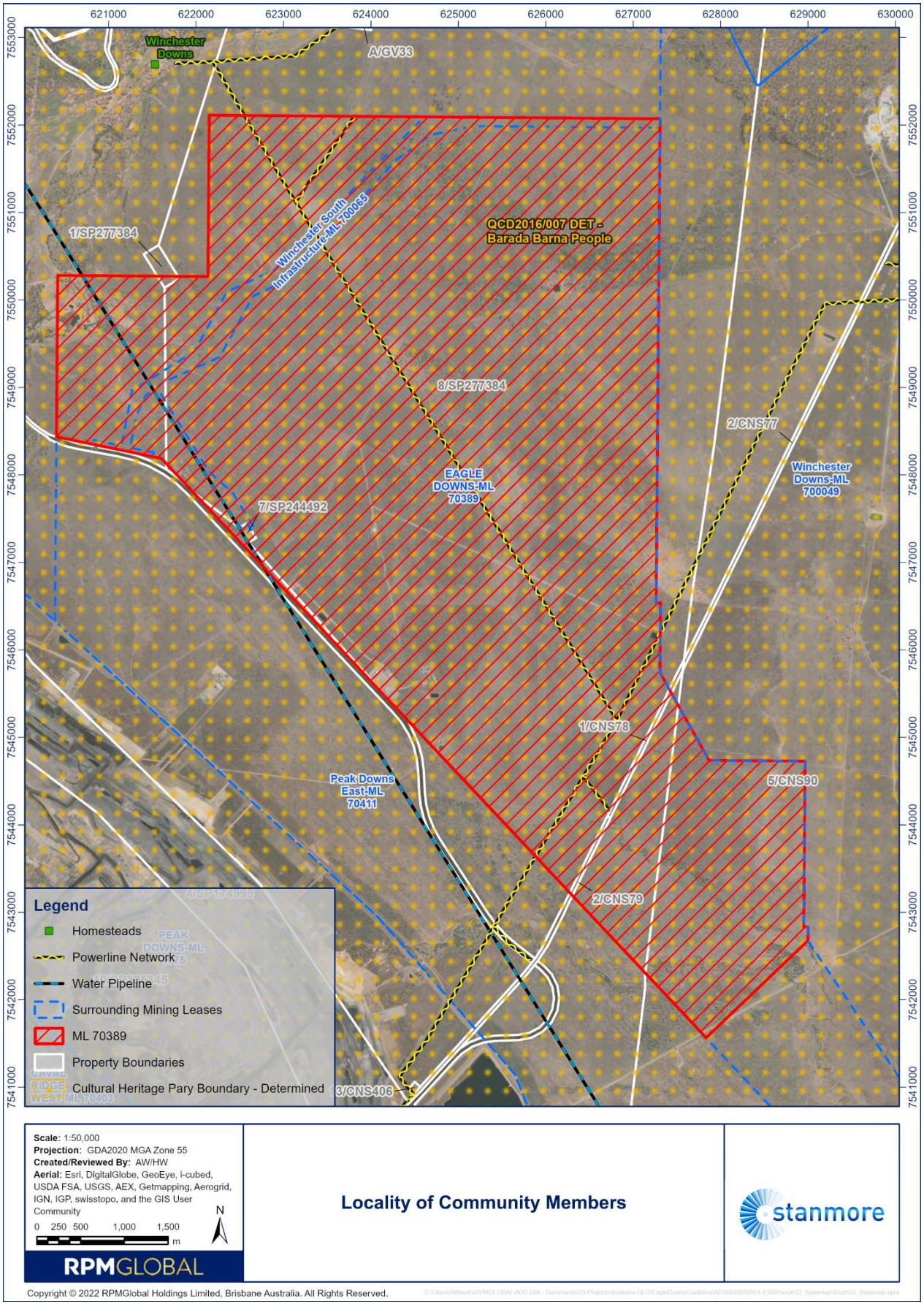


Figure 24 Locality of Community Members

Proposed Consultation Frequency

The frequency of consultation required for each community member varies on their degree of interest and level of influence to the EDCM project. Prior to any amendments to the PRC Plan schedule, community members should be approached to discuss potential impacts of rehabilitation and closure activities.

Information to be Released for Community Consultation

Updates on the Mine will be provided to community members as will any changes to the PRC Plan schedule. Examples of information to be released for community consultation may include (but not limited to):

- Existing approved PMLU for EDCM;
- Proposed rehabilitation methods, management plans and mitigation strategies to ensure successful rehabilitation and closure;
- Proposed final landforms at EDCM; and
- Progressive rehabilitation and closure timeframes.

The type of information and proposed frequency of consultation to the various community members is provided in **Table 23**.

How Feedback / Comments will be Considered

It is expected that the CSEP will evolve as changes occur in community expectations, LoM plans, regulatory environment, and rehabilitation knowledge and standards.

EDCM will seek engagement opportunities with community members to discuss aspects of proposed rehabilitation and closure activities and equally, and to welcome feedback opportunities. Community Member meetings will be held at appropriate stages in the development of the closure planning process to ensure community member involvement with the process and assist EDCM in managing community expectations and address enquiries, complaints or issues in a timely manner.

Once feedback and or comments are received, they will be documented in the Community Consultation Register (CCR) as required by section 126C(1) (iii) of the EP Act. EDCM will ask the community member about their expectations and suggestions for resolution. EDCM will conduct an initial assessment to identify, classify and / or determine the origin of the community members' concern and identify actions to address it.

Table 23 Community Member Consultation Plan

Community Member		Objective	Engagement (Consultation) Type	Proposed Consultation Frequency	Released Information	How Feedback / Comments are Considered
Underlying landholder	Single private landowner with exception of two small tracts of crown land leased by Queensland Rail	Advise PRC Plan is approved. Provide updates on development and operation of the mine. Provide updates on rehabilitation progress against the PRC Plan and discuss any feedback.	In writing. EDCM representative to meet, email or phone call. EDCM representative to meet in person.	Once off. As required. Annual, once rehabilitation commences.	Copy of PRC Plan. Community Information Sheet. To be determined.	Tracked in the CCR. Information to be considered and incorporated into PRC Plan if applicable, along with the feedback provided to the stakeholder.
Neighbouring ML landholders	The neighbouring landholder is the same landholder as the ML	Provide update on development and operation of the mine.	EDCM representative to meet, email or phone call.	As required. Annual, once rehabilitation commences.	Community Information Sheet.	Tracked in the CCR. Information to be considered and incorporated into PRC Plan if applicable, along with the feedback provided to the stakeholder.
Traditional Owners	Barada Barna Kabalbara and Yetimarla People #4	Provide update on development and operation of the mine. Provide updates on rehabilitation progress against the PRC Plan and discuss any feedback.	EDCM representative to meet with Barada Barna Kabalbara and Yetimarla People #4.	As required. Annual, once rehabilitation commences.	To be determined at time of consultation.	Tracked in the CCR. Information to be considered and incorporated into PRC Plan if applicable, along with the feedback provided to the stakeholder.
Environmental Groups	Capricorn Conservation Council Fitzroy Basin Association Mackay Conservation Group	Provide update on development and operation of the mine.	EDCM representative to meet, email or phone call.	As required. Annual, once rehabilitation commences.	Community Information Sheet.	Tracked in the CCR. Information to be considered and incorporated into PRC Plan if applicable, along with the feedback provided to the stakeholder.
Community Groups	Queensland Fire and Rescue Service Moranbah Moranbah Police	Provide update on development and operation of the mine.	EDCM representative to meet, email or phone call.	As required. Annual, once rehabilitation commences.	Plan for intersections / vehicle movement / volume on public access roads, mine plan, mine access points, fire breaks, location of hazardous materials storage.	Tracked in the CCR. Information to be considered and incorporated into PRC Plan if applicable, along with the feedback provided to the stakeholder.
Government / Entity	Isaac Regional Council (IRC) Department of Environment (DES) Department of Resources (DoR) Powerlink - 132 kV Moranbah to Dysart Transmission Line Eungella Water Pipeline Pty Ltd - Eungella Water Pipeline Southern Extension	Provide updates on rehabilitation progress against the PRC Plan and discuss any feedback.	EDCM representative to meet in person.	As required, at least annually. As per statutory notification periods or as required.	To be determined at time of consultation.	Tracked in the CCR. Information to be considered and incorporated into PRC Plan if applicable, along with the feedback provided to the stakeholder.

Community Member		Objective	Engagement (Consultation) Type	Proposed Consultation Frequency	Released Information	How Feedback / Comments are Considered
	Queensland Rail - Norwich Park Branch Railway Line					
Others not formally identified		Provide updates for project progress.	EDCM website and Linked in.	As required.	Community Information Sheet.	Tracked in the CCR.

3.3.2 Community Consultation Register

A Community Consultation Register (CCR) has been developed to capture communication with community members regarding rehabilitation and closure activities at EDCM. This is provided in **Table 24**. As per the requirements of the PRC Plan Guidelines, the CCR includes:

- Consultation dates;
- The identification of community members;
- Consultation type;
- Information provided;
- Issues raised / discussed; and
- How issues were considered by EDCM, decisions / outcomes of engagement and commitments made by EDCM.

Table 24 PRC Plan Community Consultation Register

Consultation Date	Community Member(s) (Full Name(s))	Type of Community Member(s)	Consultation Type	Information Provided to Community Members	Issues Discussed by Community Members	How the Issues Have Been Considered by the EA Holder	Decisions / Outcomes of Engagement	Commitments Made by the EA Holder
March 2008	All	All	Community Information Sheet	Community Information Sheet 1 - Brief introduction to the proponent, an overview of the project and the associated approval process, as well as the EIS and community consultation process.	To be discussed in meetings.	To be discussed in meetings.	To be discussed in meetings.	A stakeholder consultation program will be conducted as part of the EIS process. The first phase of consultation will involve meetings with stakeholders to provide information about the project and the EIS process, and to identify any issues associated with the project. These meetings will take place in March and April 2008.
March - April 2008	NA	Local Government	In Person Meeting	Community Information Sheet 1 - Brief introduction to the proponent, an overview of the project and the associated approval process, as well as the EIS and community consultation process.	Scoping Meeting	To be discussed in meetings.	To be discussed in meetings.	As above
March - April 2008	NA	Commonwealth Government	In Person Meeting	Community Information Sheet 1 - Brief introduction to the proponent, an overview of the project and the associated approval process, as well as the EIS and community consultation process.	Scoping Meeting	To be discussed in meetings.	To be discussed in meetings.	As above
March - April 2008	NA	Community Group	In Person Meeting	Community Information Sheet 1 - Brief introduction to the proponent, an overview of the project and the associated approval process, as well as the EIS and community consultation process.	Scoping Meeting	To be discussed in meetings.	To be discussed in meetings.	As above
2008	Environmental Protection Agency (EPA)	State Government	In Person Meeting	Not available - no information on file.	Provide an overview of the project, give an update of the progress of the EIS process and to discuss issues of special interest.	To be discussed in meetings.	To be discussed in meetings.	As above
2008		State Government	In Person Meeting	Not available - no information on file.	Provide an overview of the project, give an update of the progress of the EIS process and to discuss issues of special interest.	To be discussed in meetings.	To be discussed in meetings.	As above
2008	Department of Minerals and Energy (DME)	State Government	In Person Meeting	Not available - no information on file.	Provide an overview of the project, give an update of the progress of the EIS process and to discuss issues of special interest.	To be discussed in meetings.	To be discussed in meetings.	As above

Consultation Date	Community Member(s) (Full Name(s))	Type of Community Member(s)	Consultation Type	Information Provided to Community Members	Issues Discussed by Community Members	How the Issues Have Been Considered by the EA Holder	Decisions / Outcomes of Engagement	Commitments Made by the EA Holder
2008	Isaac Regional Council (IRC) - including representatives of the former Nebo, Broadsound and Belyando Shires.	Local Government	In Person Meeting	Not available - no information on file.	Provide an overview of the project, give an update of the progress of the EIS process and to discuss issues of special interest.	To be discussed in meetings.	To be discussed in meetings.	As above
October 2008	All	All	Email	Community Information Sheet 2 - Provided summary of the key issues raised during issues scoping, a list of frequently asked questions and responses.	Socio-economic issues: · Housing availability and affordability; · Impact of camps; · Impacts on service provision; · Workplace arrangements; · Regional impacts; and · Local investment opportunities. Environmental Issues: · Impact of mining on water quality; · Impact of mining on flora and fauna; · Impact of noise levels from the project; · Extent of subsidence and its associated impacts; and · Impact of increased traffic flows along Winchester Road and current traffic safety at the intersection of Winchester Road and Peak Downs Highway.	Identified issues will be addressed in the development of the project plan and in the EIS.	A specialist socio-economic study will be undertaken as part of the EIS and will assess the potential socio-economic impacts and identify measures to address and mitigate these impacts. Issues will be taken into account in the specialist studies currently being undertaken for the project.	Future consultation will focus on addressing the issues discussed in this information sheet. This will include providing feedback to stakeholders on the results of the EIS studies once they are available. It is anticipated that the EIS will be available to the public in early 2009.
2008	Department of Environment and Resources Management (DERM)	State Government	Formal Approval	Environmental Impact Statement (EIS) submission	Submission only.	TBA	EIS submitted	Follow formal submission and assessment process.
2008	Barada Barna Kabalbara and Yetimarla People #4 (BBKY #4)	Traditional Owner	Information not available	Information not available	Negotiating a CHMP with the BBKY #4 endorsed party, in accordance with the requirements of the ACH Act.	Information not available	To be discussed in meetings.	CHMP will be agreed with the BBKY #4 endorsed party, and approved under the ACH Act, for the project area in advance of any project activity that may cause harm to Aboriginal cultural heritage.
2008	Beryl Neilsen Ken Braithwaite	Underlying Landholder	Information not available	Non-indigenous Cultural Heritage Sites.	Gather as much information as possible regarding the history and probable location of non-indigenous historical cultural heritage sites within the project area.	Enabled the field inspection to be targeted to maximise the possibility of identifying sites.	Both unaware of any non-indigenous cultural heritage sites within the project area.	Based on the information gathered during the landholder meetings and associated library research, a targeted one-day field inspection was carried out.

Consultation Date	Community Member(s) (Full Name(s))	Type of Community Member(s)	Consultation Type	Information Provided to Community Members	Issues Discussed by Community Members	How the Issues Have Been Considered by the EA Holder	Decisions / Outcomes of Engagement	Commitments Made by the EA Holder
Not available	Barada Barna Kabalbara and Yetimarla People #4 (BBKY #4)	Traditional Owner	Information not available	Information not available.	Information not available.	Information not available.	Information not available.	Information not available.
2010	Department of Environment and Resources Management (DERM)	State Government	Formal Approval	DERM Assessment of EIS submission.	· Rehabilitation. · Matters of National Significance. · Geochemical characterisation. · Subsidence. · Soils and Land Capability.	EIS response to DERM.	· Responses provided to DERM. · Items discussed included as Environmental Authority conditions.	Staged DREA development. Rehabilitation trials on DREA. Environmental Offsets to be obtained for blugrass and brigalow. Further characterisation of waste., development of Mining Waste Management Plan, monitoring of DREA infiltration, runoff monitoring. Flood modelling and monitoring of subsidence. Further investigation of soils.
Sep 2019	Barada Barna	Traditional Owner	In person	None	Barada Barna have a membership programme to assist with finding employment. Barada Barna group have a major interest in rehabilitation	Enabled continuation of consultation with TO	Aware of membership program	No current vacancies however will keep in mind for future opportunities.
Dec 2019	Barada Barna	Traditional Owner	In person	None	Project is in Feasibility Phase Cultural clearances have been conducted with Barada Barna onsite during the year with more clearances to be undertaken next week NAIDOC week	Enabled continuation of consultation with TO	Should the project proceed EDCM would like a diverse and inclusive workforce representative of the community	EDCM would engage Barada Barna in this process
May 2021	Barada Barna	Traditional Owner	In person	None	Feasibility Study complete end of Q3 Jan 21 Project was placed on hold Site remains in Care and Maintenance In 2020, the scarred trees identified during 2008 were inspected and photos were taken	Enabled continuation of consultation with TO	Photos of inspected scarred trees sent through	Should further cultural heritage surveys be required S32 will engage Barada Barna
2022	Department of Environment and Science (DES)	State Government	Video Conference Meeting	Powerpoint with update and progress	EA Amendment	To be discussed in meetings.	To be discussed in meetings.	Changes and agreement on conditions made and EA updated.
2022	Department of Environment and Science (DES)	State Government	Video Conference Meeting	Powerpoint with update and progress	PRC Plan Transitional Notice	To be discussed in meetings.	To be discussed in meetings.	PRCP update and on track

Consultation Date	Community Member(s) (Full Name(s))	Type of Community Member(s)	Consultation Type	Information Provided to Community Members	Issues Discussed by Community Members	How the Issues Have Been Considered by the EA Holder	Decisions / Outcomes of Engagement	Commitments Made by the EA Holder
2022	Department of Environment and Science (DES)	State Government	Video Conference Meeting	Powerpoint with update and progress	Pre-lodgment meeting	To be discussed in meetings.	To be discussed in meetings.	Lodgment made in line with requirements.
2022	Department of Environment and Science (DES)	State Government	Video Conference Meeting	Powerpoint with update and progress	PRC Plan regular meeting	To be discussed in meetings.	To be discussed in meetings.	PRCP on track
2022	Department of Environment and Science (DES)	State Government	Video Conference Meeting	Powerpoint with update and progress	PRC Plan regular meeting	To be discussed in meetings.	To be discussed in meetings.	PRCP on track
28/3/2023	Lieze Van Ostaeyen Juliana Mccosker - Department of Environment and Science (DES)	State Government	Video Conference Meeting	Proposed PMLUs	Proposed PMLUs.	PMLUs required as part of the PRC Plan process.	PMLUs to be revised to consider the approved PMLUs in the EA table (Row-Post-mine land use); and prepared only for the disturbance footprint, rather than the entire ML.	S32 to adjust PMLUs to align with EA.
6/4/2023	Jeremy Aldred	Australian Government DCCEEW	Email	Registering Proponent	Approval Proponent Information	n/a	n/a	n/a
August 2023	Barada Barna Winchester Downs	Traditional Owner Underlying Landholder	Email	Update of information relating to progressive rehabilitation and closure (PRC) plan for the mine	None received to date	n/a	n/a	BCC will address any further information on the status of the project or PRC process if required.

3.4 Non-Use Management Areas

There are no non-use management areas proposed for the Project.

3.5 Rehabilitation Management Methodology

In accordance with section 126C(1)(e) and (i) of the EP Act, the rehabilitation planning part of the PRC Plan must:

Legislative Requirements	Compliance
For each proposed post-mining land use for land, state the proposed methods or techniques for rehabilitating the land to a stable condition in a way that supports the rehabilitation milestones under the proposed PRC PLAN schedule.	Section 3.5.1
For each proposed non-use management area, state the proposed methodology for achieving best practice management of the area to support the management milestones under the proposed PRC Plan schedule for the area.	N/A

3.5.1 General Rehabilitation Practices

This section outlines the information considered necessary to underpin the development of the rehabilitation and management methodologies applicable to the EDCM mine for the various identified domains.

The post closure rehabilitated landscape will be predominately returned to grazing with patches of rehabilitated, undisturbed or moderately disturbed remnant vegetation in line with the current surrounding use of the land. All operational surface infrastructure will be removed, and areas classed as contaminated remediated in line with PRCP Guideline requirements. Underground workings will be sealed, and remaining subsidence rehabilitated as described in Section 3.5.4. The final landforms will be the DREA and intermittent cattle watering holes as described in Section 3.5.1.5 and Section 3.5.1.6.

Figure 25 shows the following final design features as described throughout Section 3.5:

- The maximum disturbance footprint;
- Resource tenure boundaries;
- PMLU(s) and NUMA(s) for the land within the resource tenure(s); and
- Flood plain extent.

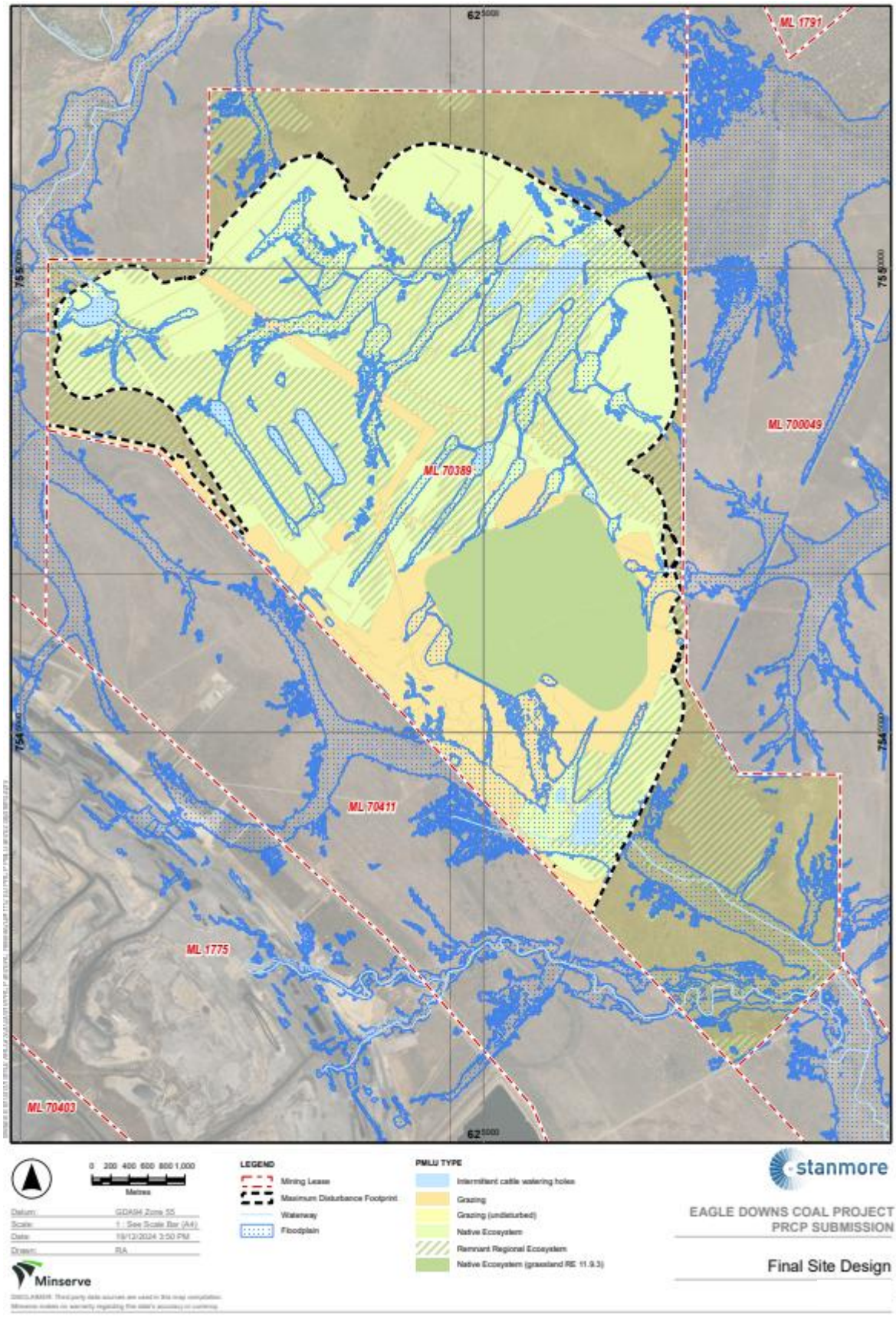


Figure 25 Final Site Design

3.5.1.1 Hydrogeology

A Groundwater Impact Assessment was undertaken by AGE (2022) and is provided in Appendix F.

Groundwater Occurrence

There are two aquifer systems within the EDCM Project area:

- a shallow aquifer associated with the upper weathered/fractured rock; and
- aquifers associated with the Permian formations.

The pre-existing groundwater conditions are described in Section 3.1.1.5.

Groundwater occurs within the shallow weathered / fractured rock and are monitored at locations provided in **Table 6**. The water table is generally within the weathered fractured rock zone. Available information on landholder bores suggest that the base of the shallow aquifer does not extend beyond 80 m depth. AGE (2022) and AGE (2008) report that groundwater levels from 2013 to 2020 declined, responding to rainfall levels until 2015. However, between 2015 and 2017 there was a departure from the corresponding trend between rainfall and groundwater levels, with the exception of MB1 that recorded a less than 5 m decline (attributed to landholder bore usage) and MB3 that recorded a slight increase of a few metres (attributed to a reduction in monitoring frequency influencing groundwater levels due to slow recovery) as is shown in **Figure 28**. The overall decline in groundwater levels, amounting to 2.4 meters between 2008 and 2020, is evident. MB1, situated 825 meters southwest of landholder bore LHB8, is impacted by various factors. The pumping activity in LHB8 likely contributes to the declining levels in MB1, alongside rainfall fluctuations. This decline could be attributed to local bore usage and drawdown from neighbouring operations, compounded by rainfall patterns. Notably, the decrease in water levels since 2018 aligns with below-average rainfall until mid-2021. However, a recent slight increase in water level corresponds to above-average rainfall, indicating the dynamic interplay between precipitation and groundwater levels.

The Permian coal seam aquifers are deep and confined beneath the project area, but subcrop to the west. Groundwater storage and movement occurs within the coal seam cleats and fissures and in open fractures

that intersect the seams (AGE, 2022). As shown in



Figure 10, VWP monitoring bores are installed across the Project ML to measure groundwater levels in the deeper Permian coal measures. Data shows that in general the piezometric elevations measured at the VWPs are in the order of 170 mAHD to 210 mAHD (**Figure 26).**

There are no deep Quaternary or Tertiary palaeo-channels present within the project ML. Similarly, there are no alluvial aquifers within the ML boundary, although they do occur outside and are associated with sand and gravel deposits along Cherwell Creek and the Isaac River.

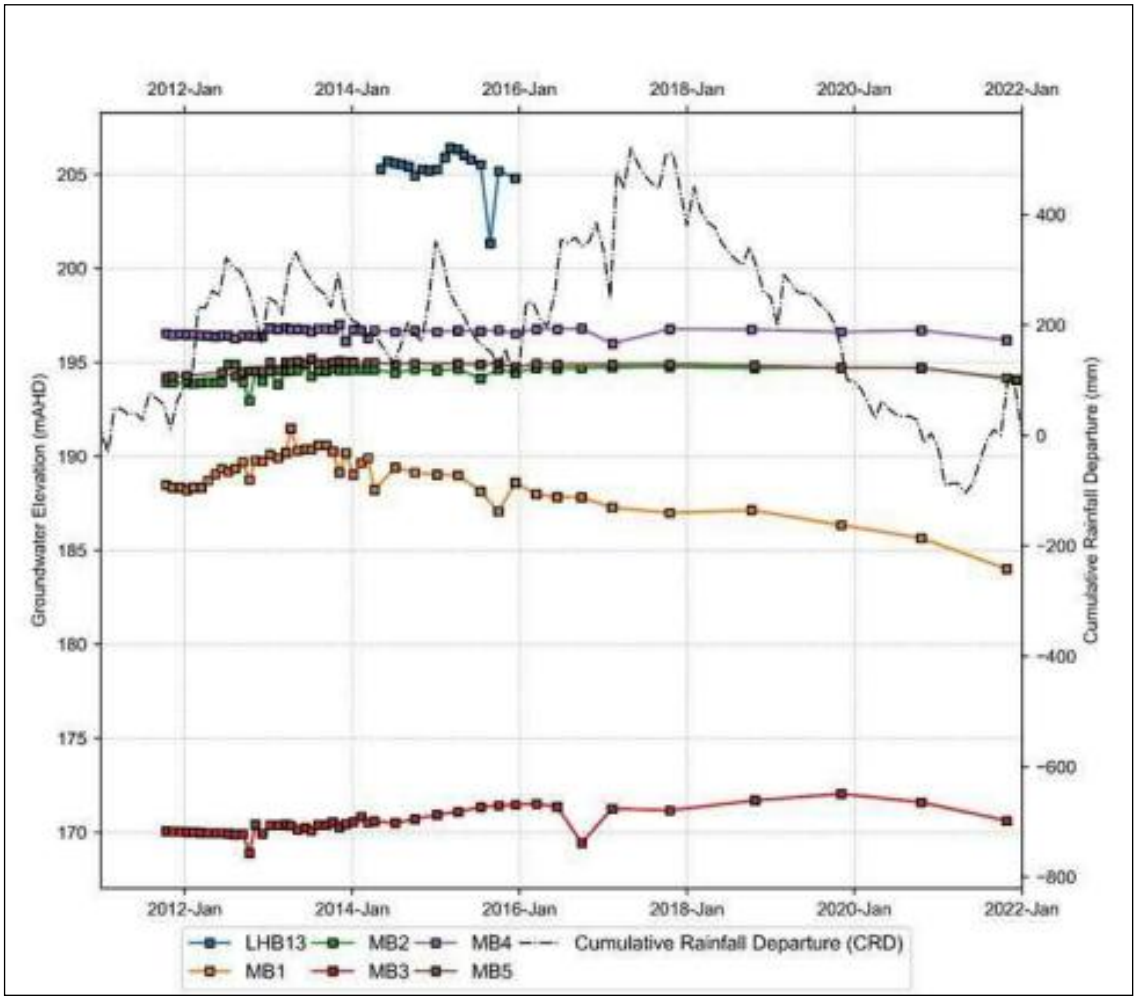


Figure 26 Groundwater Levels in the Shallow Weathered Aquifer (AGE, 2022a)

Groundwater Recharge and Discharge Locations

The shallow aquifer is recharged by rainfall and potentially by upwards seepage along fractures from the deeper coal seam aquifers. The water table contours are at a general lower elevation, 188 to 197 mAHD compared to the coal seam aquifers, where the potentiometric surface is between about 206 to 212 mAHD within the Project area. This indicates that there is minimal hydraulic connection between the aquifers, however there is potential for upward flow and discharge from the coal seams to the base of the shallow aquifer (AGE, 2022a).

Recharge to the shallow and near surface strata is considered to be mostly from drainage flow patterns or flooding, with direct infiltration of rainfall also occurring where there are no substantial clay barriers in the shallow sub-surface.

On a regional scale, discharge is via evapotranspiration from vegetation growing along creek beds and minor short duration baseflow events after significant rainfall/flooding. Infiltration to underlying formations is limited to areas with relatively high hydraulic conductivity units (e.g., coal seams).

General downwards recharge to deeper units is limited by the low hydraulic conductivity (confining) Rewan Group and coal measure interburden sequences (AGE, 2022a).

The chloride concentrations in the monitoring bores were compared to the rainfall chloride concentration, to calculate recharge using the chloride mass-balance method2F[6]. Rainfall chloride concentrations were

[6] *Chloride is regarded as a suitable environmental tracer since it is highly soluble, conservative, and not substantially absorbed by vegetation. Chloride concentration of rainfall is divided by the groundwater chloride concentrations and multiplied by 100 to present a percentage of rainfall recharge.*

reported by Crosbie et al. (2012), ranging between 2.59 to 0.38 mg/L for rainfall analyses for inland and coastal, eastern Australia. The rainfall chloride concentration range was applied in conjunction with the Project groundwater analyses and presented in **Figure 27**. The recharge estimation is between <0.05% to 1.2% for the shallow weathered aquifer systems. Analysis of two groundwater samples for the coal seams (E795017 and E795044) reveals potential recharge of <0.2% (AGE, 2022a).

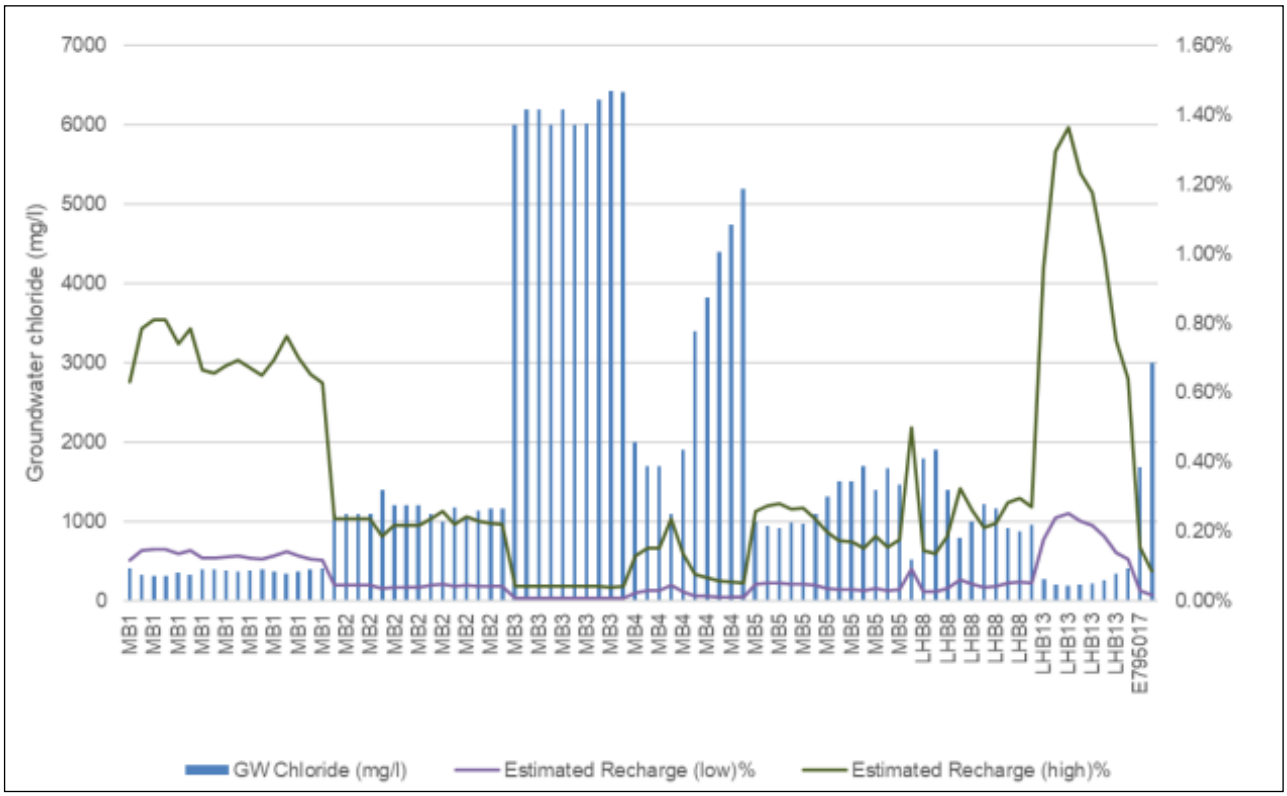


Figure 27 Chloride Mass Balance Recharge Estimation, Eagle Downs Monitoring Bores (AGE, 2022a)

Figure 28 shows recharge estimates for groundwater chloride concentrations from the Winchester South project. Analysis of samples from the three Isaac River alluvium bores, Knob Hill 1 and 2 and Winnet Bore, reveals higher groundwater recharge potential when compared to the Permian Coal Measures (SLR, 2021; AGE, 2022a).

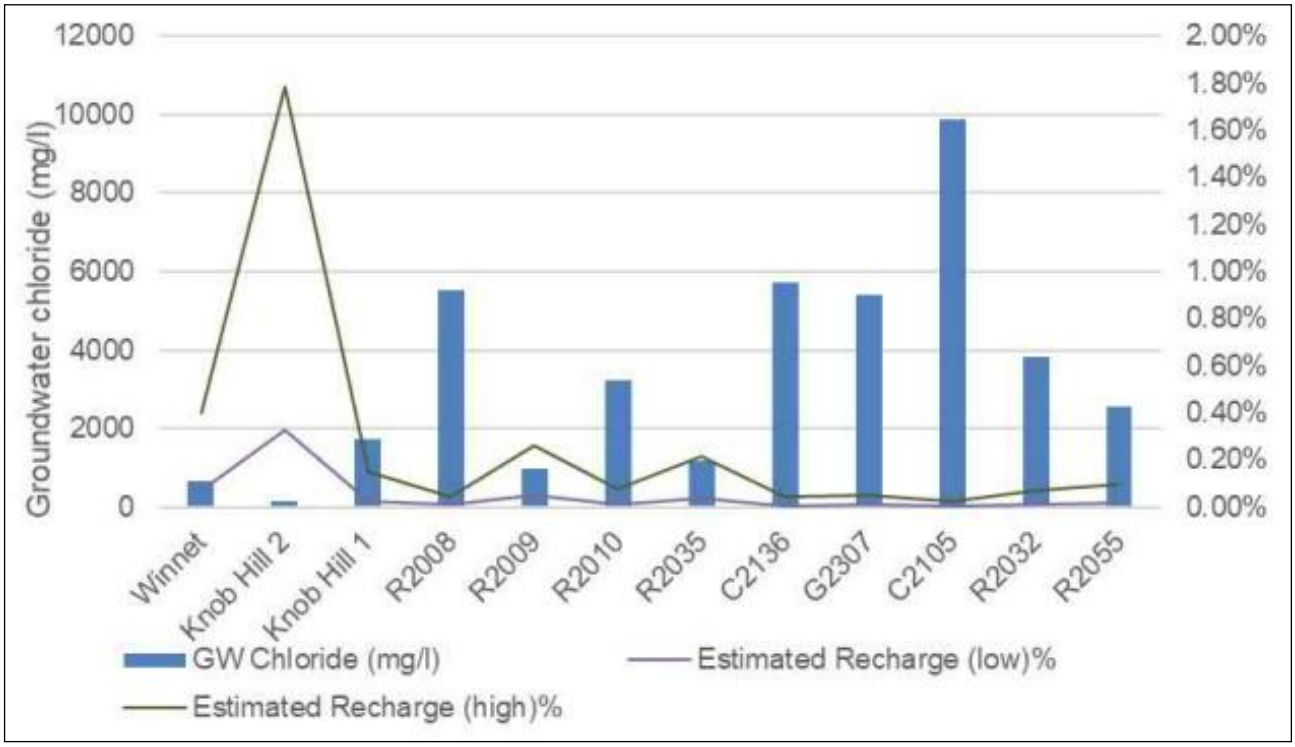


Figure 28 Chloride Mass Balance Recharge Estimation, Winchester South Monitoring Bores (SLR, 2021)

Groundwater Quality

Groundwater quality sampling has been conducted since late 2011 and has found monitoring bores to be brackish to saline. Monitoring bores MB1 and MB3 indicate electrical conductivity (EC) ranges from 1,673 µS/cm to a maximum of 24,480 µS/cm respectively. Overall, the groundwaters associated with the shallow Permian sediments are more saline than the coal seam waters. This suggests that the groundwaters associated with the sediments are concentrated through evapotranspiration. Field pH over this is slightly acidic to mildly alkaline ranging from pH 5.79 (MB4) to pH 8.68 (MB1). Dissolved metals analysis has shown that most samples are generally low and below the laboratory detection limit. As no longwall mining or surface coal processing activities has occurred yet, it can be concluded that the exiting groundwater monitoring database represents pre-mining baseline data (AGE, 2022a).

The EDCM EA EPML00586713 (DES, 2023a) specifies groundwater monitoring is to be conducted at five site bores (MB1, MB2, MB3, MB4 and MB5), along with three landholder bores (LHB8, LHB11 and LHB13). The EA also includes a requirement to install two additional bores (MB6 and MB7), 12 months prior to the commencement of longwall mining.

No wetland springs or surface expressions are identified in the Project area.

Current and potential future uses of groundwater, including groundwater extraction bores

Salinity is the key constraint to groundwater use and can be described by total dissolved solid (TDS) concentrations. Pre-mining baseline data results of groundwater at the Project falls between brackish and moderately saline classifications. This means that much of this groundwater (moderately saline) is unsuitable for more sensitive uses such as human consumption and irrigation.

The data does indicate, however, that groundwater at MB1, MB2 and MB5 has salinity levels that could be tolerated by stock - specifically beef cattle, as shown in **Figure 29** (AGE, 2022).

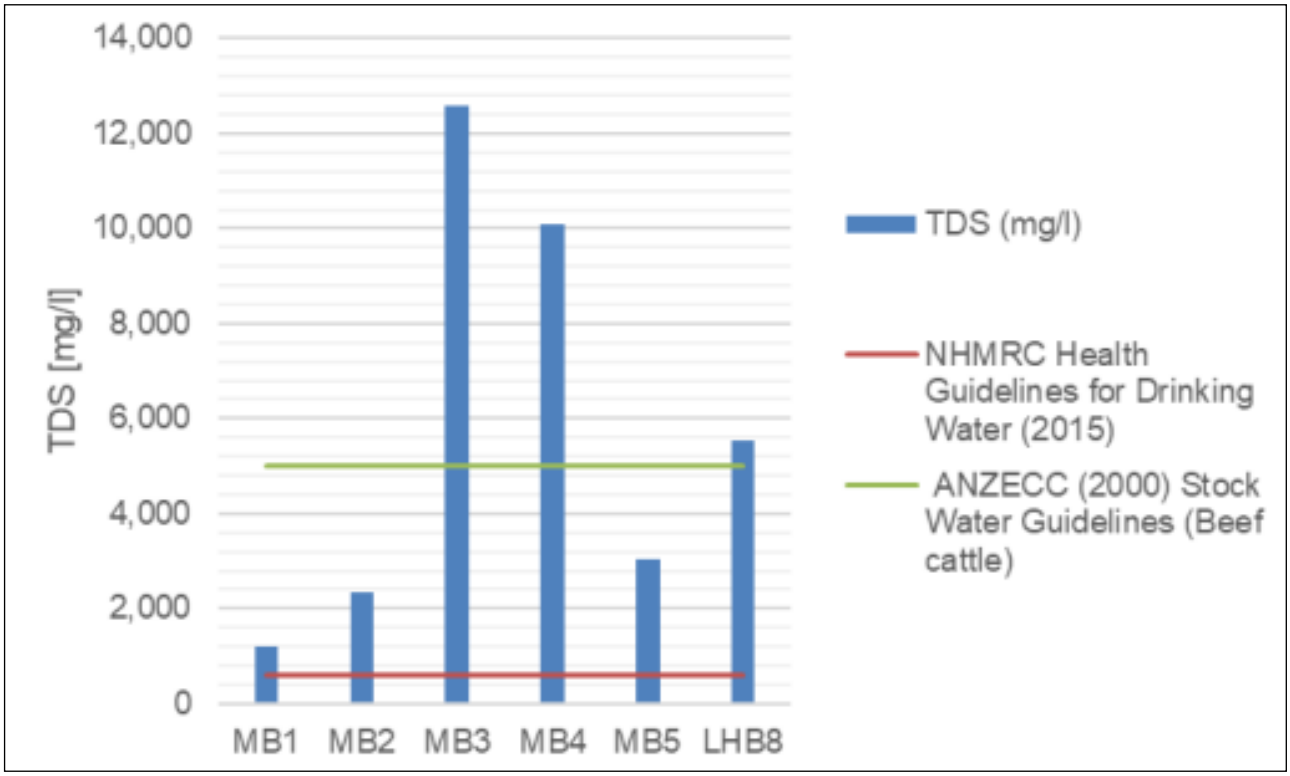


Figure 29 TDS Concentrations and Beneficial Use Limits

An assessment of groundwater dependant assets, utilising the Bureau of Meteorology (BoM) Groundwater Dependent Ecosystem (GDE) Atlas was undertaken by AGE (2022) (**Figure 30**). The Project is unlikely to significantly impact GDEs. A summary of potential GDEs is provided:

- No spring wetlands are located in the mining lease area (EcoSM, 2021).
- Terrestrial groundwater dependant ecosystems (GDEs) - Some vegetated areas are mapped as having low potential to interact with groundwater (JB Gully in the north-west and along Ripstone Creek (western tributary) in the south).
- Aquatic GDEs –Cherwell Creek to the north / north-west and the Isaac River to the north-east of the ML boundary are mapped as having high potential aquatic GDEs (**Figure 32**). A small high potential aquatic GDE is mapped along a drainage line within the north-western part of the mine lease boundary. This area is associated with seasonal run-off contained in a small farm catchment dam and is unlikely to be associated with shallow groundwater. It is not mapped as remnant vegetation by the Queensland Government.
- Groundwater Interaction with watercourses - no significant alluvial aquifers have developed along the drainage lines associated with the Project area. As groundwater levels are between 12 and 31 mbgl, it is unlikely that shallow baseflow occurs within the Project area.

A search of the Queensland Government's Groundwater Bore Database (GWBD) and BoM's National groundwater information system (NGIS) was carried out for registered bores within the Project area. The search indicated that there are 240 registered bores within the Project groundwater model domain, of which 175 bores (73%) are used for groundwater monitoring and investigations, and 31 bores (13%) are used for water supply. The remainder of bores have been used for sub-artesian monitoring and unknown use or resulted from exploration activities. **Figure 31** shows the locations of the registered bores and the 5 km and 10 km Project radius lines (AGE, 2022). A bore census was undertaken in 2007 in order to confirm the level of groundwater use in the area for the original EIS (Hansen Bailey, 2010) and documented in AGE (2008). Three privately owned landholder bores were identified for ongoing monitoring (LB08, LB11 and LB13) and are monitored in line with EDCM EA (DES, 2023a) groundwater conditions. There are no other privately owned groundwater supply bores located in or close to the ML (AGE, 2022).

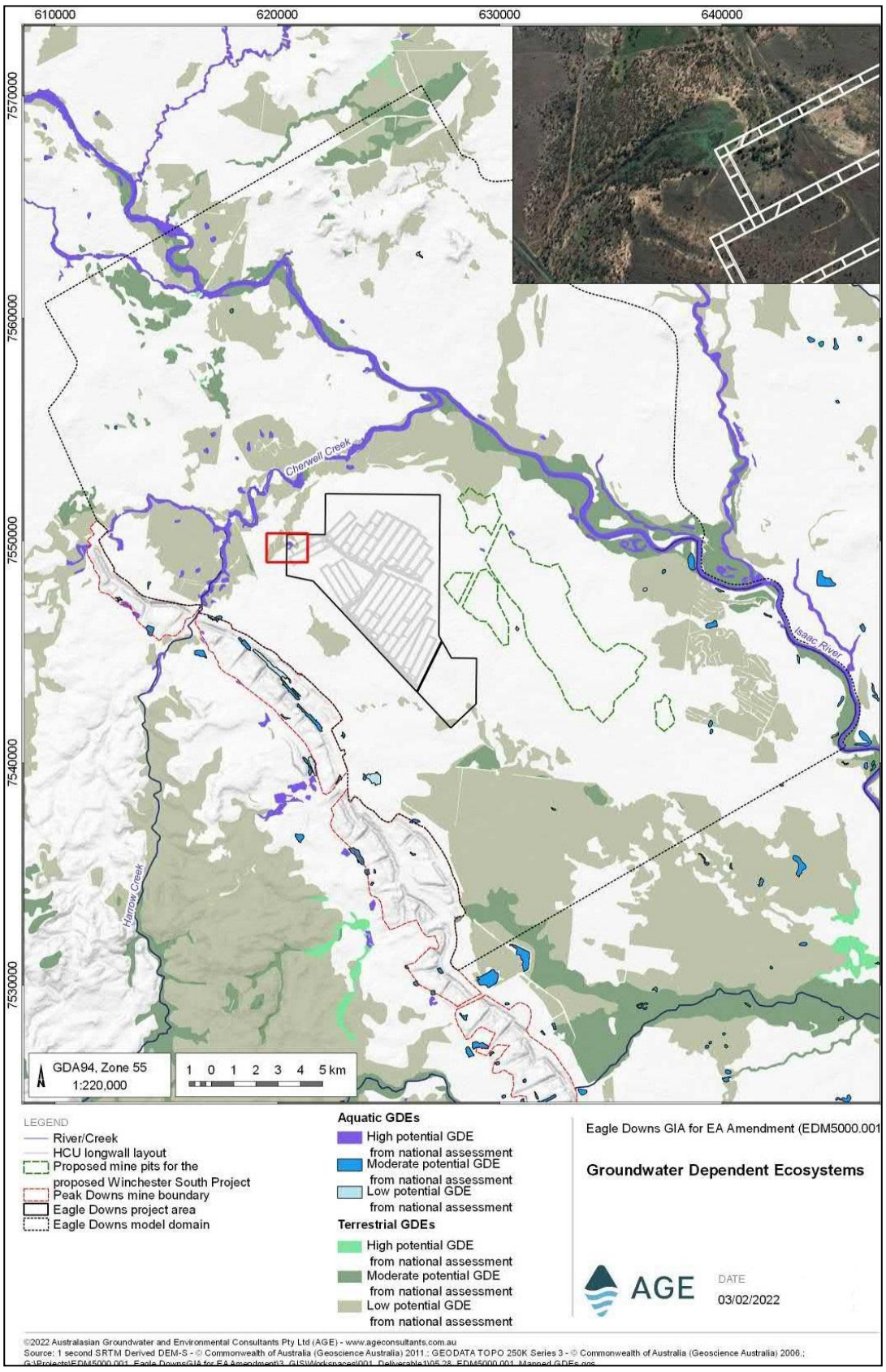


Figure 30 Groundwater Dependant Ecosystems (AGE, 2022)

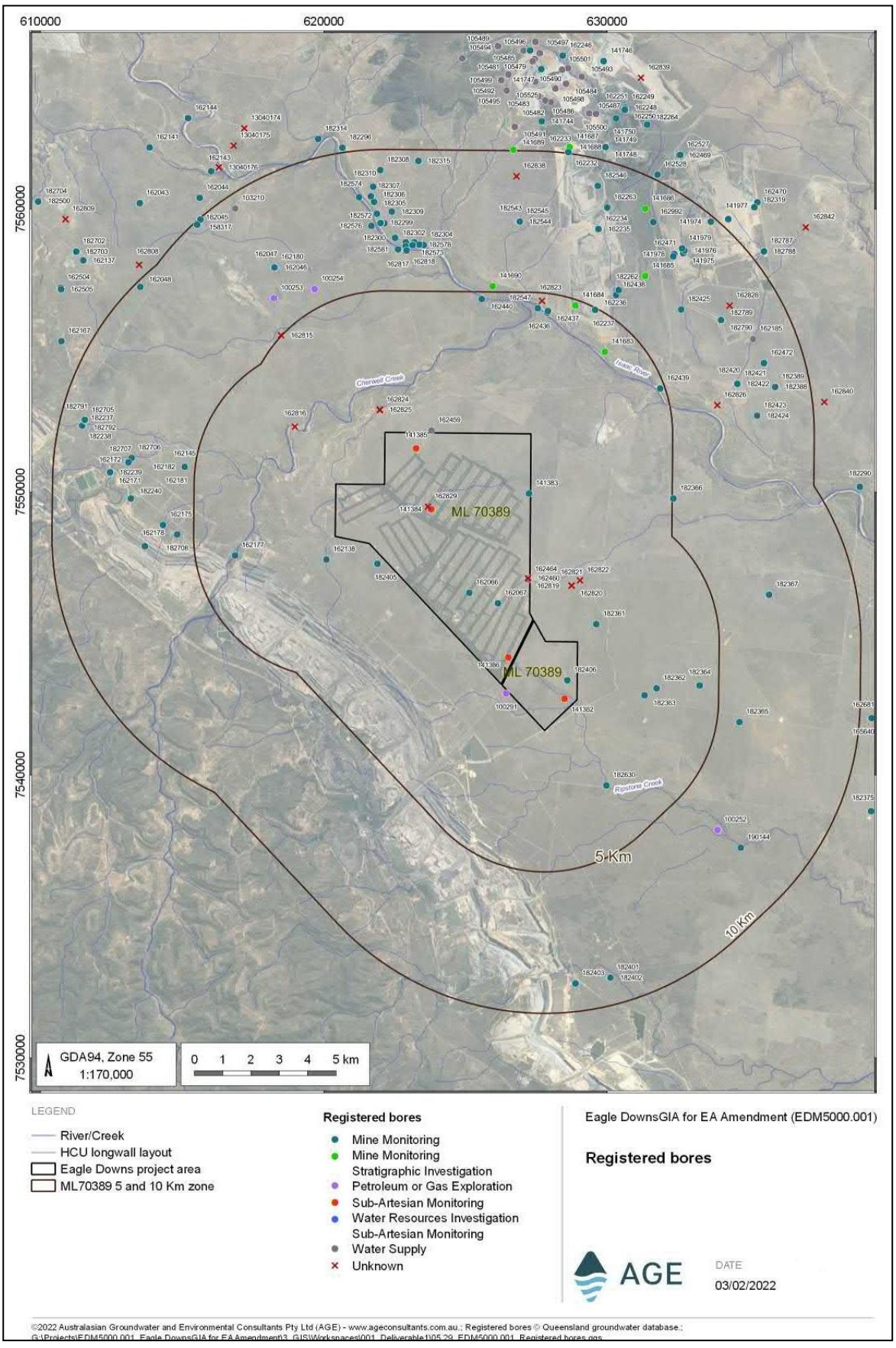


Figure 31 Registered Bores (AGE, 2022)

Groundwater Flow, Direction and Velocity

Figure 32 indicates groundwater levels (as well as subsequent flow and direction) within the shallow weathered/fractured rock aquifer with contours being presented in mAHD.

A groundwater high is observed near the centre of the eastern ML boundary, at around 204.8 mAHD. To the west of this groundwater high, flow is towards the Peak Downs open cut mine, probably reflecting depressurisation of the seams as a result of pit dewatering (AGE, 2022). In the northern region of the ML boundary, gradient flow is towards the north, potentially influenced by pumping from landholder bore LHB8.

Further information on LHB8 are as follows (AGE, 2008):

- Casing diameter (PVC) approximately 125 mm;
- Drilled in 2005 and 85 m deep.
- Yield is approximately 15.7 L/s and the approximate usage was 40 m^3/day.
- Water level was approximately 22 mbgl.
- Comment: “Waters about 800-1200 head of cattle (cattle drink ~50l/d)”.

Groundwater contours in the southern region of the ML (between MB4 and MB5) indicate a slight gradient to the south following topography, and potentially influenced by drawdown towards Peak Downs to the west (AGE, 2022).

Under pristine conditions, flow would be expected to be to the east away from the seam sub-crop recharge zones. In the north-eastern side of the project area, groundwater flow is to the north-east. Discharge from the coal seams is to the open cut pits, to the shallow weathered/fractured rock aquifer and to the Isaac River alluvium via upward flow along fractures (AGE, 2022).

The original groundwater impact assessment for the Project (AGE, 2008) used a uniform hydraulic conductivity value, rather than testing, for the shallow aquifer as hydraulic parameters of the shallow aquifer were assessed to have low permeability and be quite variable due to the fractured nature of aquifer. A rock mass hydraulic conductivity of 1 m/day was assumed for numerical modelling that resulted in a reasonable calibration between simulated and observed groundwater levels, and was considered conservative (AGE, 2008).

Using publicly available falling head test data for the Winchester South coal project (located directly east to south-east of the Project area, and in the EDCM Project numerical groundwater model domain), AGE (2022) determined that the field results fall within the range of field data collected through other studies across the Bowen Basin. Hydraulic conductivity data from falling head tests used in the numerical groundwater model domain is detailed in **Table 25**.

Table 25 Hydraulic Conductivity Data from Falling Head Tests (SLR, 2021)

Hole ID	Easting	Northing	RLGS1 (mAHD)	Test Interval	From / to (m)	K (m/day)
C2105	634556.4	7541688.0	208.28	Leichhardt Seam	55.2 to 60.2	9.0×10^{-3}
C2131	629953.8	7545413.5	212.33	Inter Seam Sediments	35.3 to 53.5	2.2×10^{-3}
G2304	633149.5	7542982.4	215.55	Vermont Seam	54.1 to 59.1	1.9×10^{-2}
G2307	630769.4	7547665.4	194.42	Vermont Seam	74.0 to 79.0	8.2×10^{-3}
R2008	630767.2	7542394.3	220.32	Vermont Seam	61.0 to 66.0	4.0×10^{-4}
R2009	631202.6	7542630.2	219.72	Inter Seam Sediments	75.8 to 80.8	6.7×10^{-5}

[1] Reduced Level of Ground Surface

The Rewan Group sediments exhibit a low hydraulic conductivity, typically less than 10^{-4} m/day, similar to the interburden/overburden material of the Rangal Coal Measures. Packer testing hydraulic conductivity results from bore WS3182 ranged from 9.48 x 10^{-4} to 1.02 x 10^{-3} m/day. Drill hole WS3189 reported hydraulic conductivity results ranging between 6.93 x 10^{-5} and 2.07 x 10-3 m/day (**Table 26**). These results represent relatively low hydraulic conductivity values that indicate the faulting zones intercepted and tested are 'healed' and are not pathways for preferential flow. It is assumed the localised fault zones identified within the EDCM project area will have similar characteristics (AGE, 2022).

Table 26 Winchester South Packer Testing Results (SLR, 2021)

Bore ID	Interval Tested	Formation	Hydraulic Conductivity (m/d)
WS3182	87-99	Mudstone and carbonaceous mudstone clasts, brecciated within sandstone matrix	9.48 x 10^{-4}
	89-91	Mudstone, fractured and broken, slickensides	9.48 x 10^{-4}
	93-95	Mudstone and minor siltstone, unfractured, massive	1.02 x 10^{-3}
WS3189	35-37	Coal	2.07 x 10^{-3}
	41-43	Mudstone, minor fracturing, calcite infill	1.02 x 10^{-4}
	48-50	Mudstone, minor fracturing, calcite infill	6.93 x 10^{-5}
	54-56	Coal, sandstone, siltstone and mudstone, slickensides, calcite infill	8.60 x 10^{-5}
	57-59	Siltstone and sandstone, relatively unfractured	2.22 x 10^{-4}

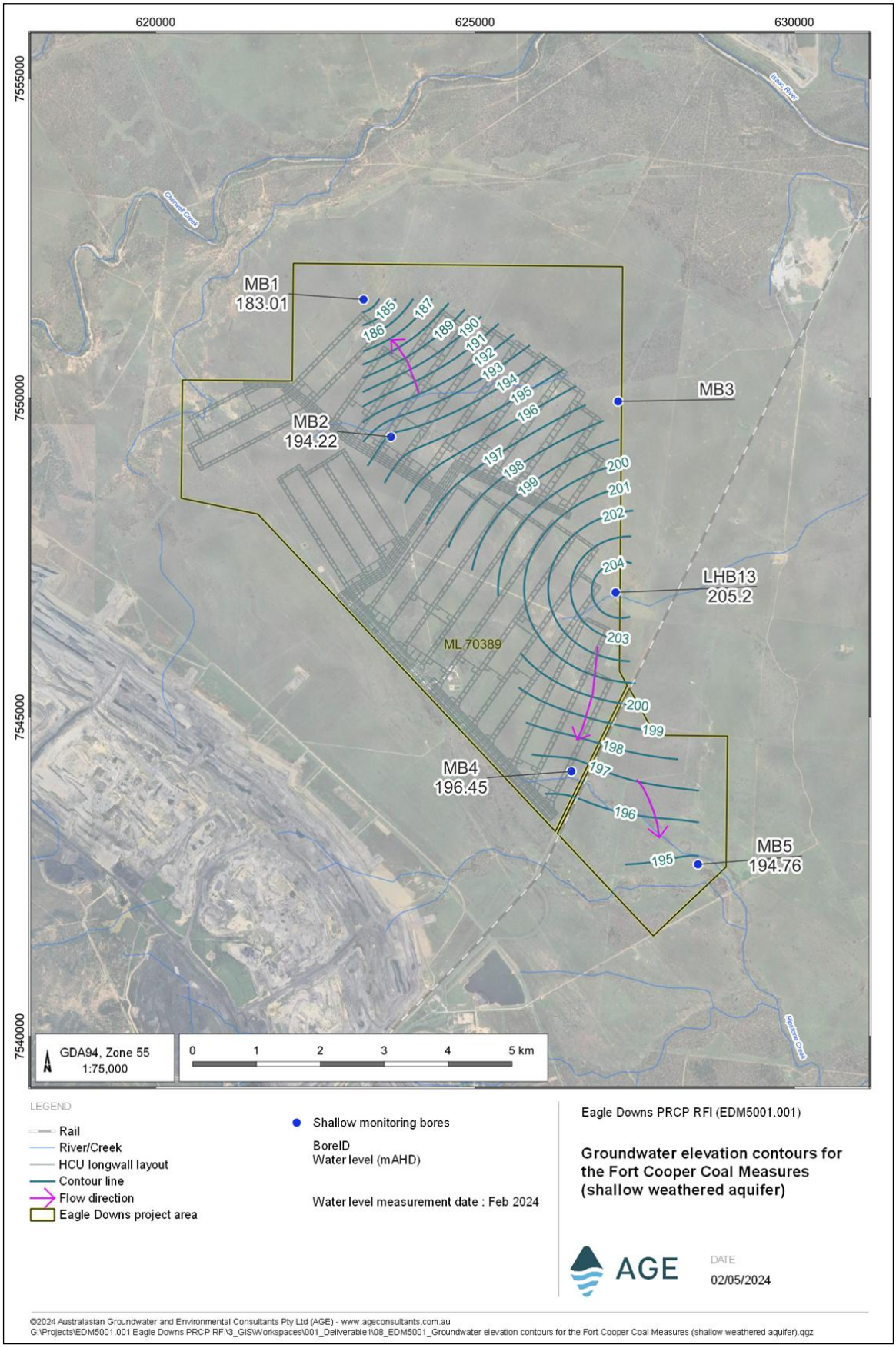


Figure 32 Groundwater Elevation Contours for Shallow Weathered Aquifer (AGE, 2022)

Recent test work in the Permian aquifer (conducted by Pro-Test Well Services, (Towler Well, 2020)) involved four drill stem tests (DST) and six Lugeon tests on bore ED0328B; and four DSTs and seven Lugeon tests on bore ED0331 with Towler Well (2020) completing the analyses of the data as provided in **Table 27** and **Table 28**.

Results of the Lugeon tests for bore ED0331 are summarized in **Table 28** indicate low conductivity in all the intervals. All of the Lugeon tests for borehole ED0328B were conducted over the inter-burden between the coal seams. The volumes injected were below flow meter resolution and found to be exceptionally low. The calculation of lugeon values and conductivity were not possible for bore ED0328B (AGE, 2022). The other results indicate that recent hydraulic conductivity results for the coal seams are similar to historical test results and the HCU seam has the highest values (although the recent test results for the interburden sections, shown in **Table 28**, indicate lower values when comparing to the historical test results) (AGE, 2022).

Overall, the Permian coal measures generally recorded higher hydraulic conductivity than the majority of the interburden/overburden tests. This is due to the dual porosity of the coal seams, with a primary matrix porosity and a secondary (dominant) porosity provided by fractures (joints and cleats) and supports the concept of the coal seams themselves forming the dominant groundwater bearing zones of the Permian units (AGE, 2022).

Figure 33 indicates the contours of the potentiometric surface interpolated from groundwater levels within the Permian coal seam aquifer. Groundwater flow is to the west with a potentiometric surface between about 206 to 212 mAHD, that is, towards the Peak Downs open cut mine, probably reflecting depressurisation of the seams as a result of pit dewatering (AGE, 2022).

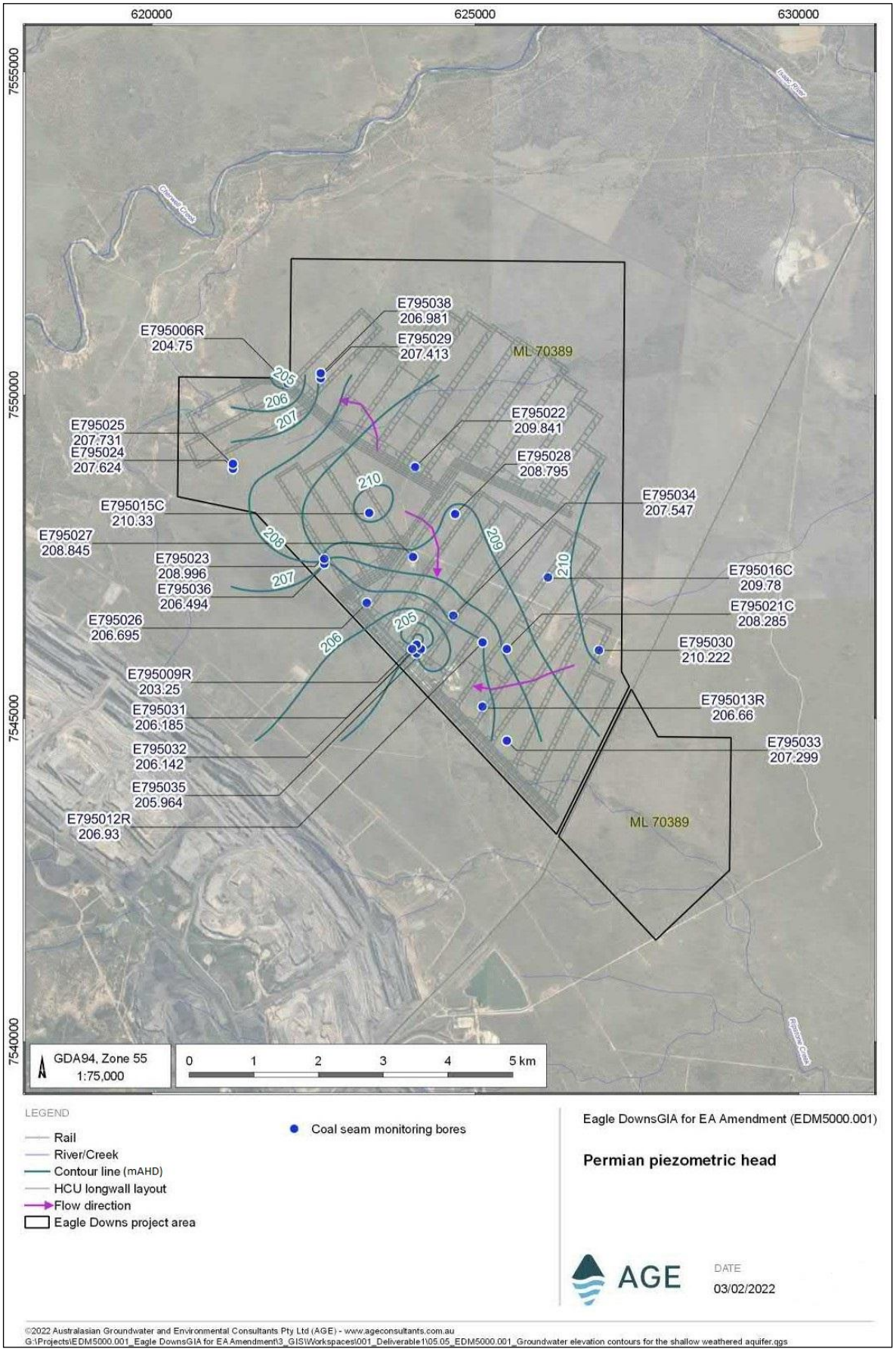


Figure 33 Permian Piezometric Head (AGE, 2022)

Table 27 Permeability Results (ED0328B and ED0331)

Bore No.	DST No.	Coal Seam	Thickness (m)	Gauge Depth (m)	Kh (mD-m)	k (mD)	Hydraulic Conductivity (m/d)
ED0328B	DST-1	HCL	8.92	418.6	96.657	10.836	9.04^{-03}
ED0328B	DST-2	PUU, PUL, PLU, PLL	2.71	330.6	89.098	32.877	2.74^{-02}
ED0328B	DST-3	HCU	3.91	365.6	168.451	43.082	3.60^{-02}
ED0328B	DST-4	Q	2.41	260.6	16.041	6.656	5.55^{-03}
ED0331	DST-1	HCL	7.88	393.1	77.43	9.83	8.20^{-03}
ED0331	DST-2	PU, PT, PL, PLL	2.64	300.6	56.81	16.2	1.35^{-02}
ED0331	DST-3	HCU	3.68	334.6	198.38	51.46	4.29^{-02}
ED0331	DST-4	Q	2.37	233.1	41.33	17.44	1.46^{-02}

Table 28 Lugeon Test Results for Interburden in Borehole ED0331

Test No.	Pecker Top (m)	Packer Bottom (m)	Interval Thickness (m)	Average Conductivity (m/s)	Average Conductivity (m/d)
1	380.00	390.21	10.21	2.0^{-10}	1.735^{-05}
2	350.00	360.21	10.21	1.2^{-10}	1.04^{-05}
3	320.00	330.21	10.21	3.60^{-10}	3.11^{-05}
4	300.00	310.21	10.21	8.80^{-10}	7.60^{-05}
5	250.00	260.21	10.21	2.80^{-10}	2.42^{-05}
6	240.00	250.21	10.21	4.80^{-11}	4.15^{-06}
7	215.00	220.21	5.21	3.60^{-10}	3.11^{-05}

Groundwater Modelling

A typical stratigraphic column (cross section) for the EDCM project area is presented in **Figure** 5, whilst potentiometric mapping is presented for both the shallow weathered / fractured rock and Permian coal seam aquifer in **Figure 34** and **Figure 35**.

A conceptual groundwater model of the Project area was prepared by AGE (2022) and is shown in **Figure 34**. The model is based on geological and topographical maps of the project area, geological information from coal exploration bores drilled across the Project area, installing monitoring bores in the shallow aquifer, results from previous hydrogeological investigations; and relevant data from the DERM groundwater database (AGE, 2022).

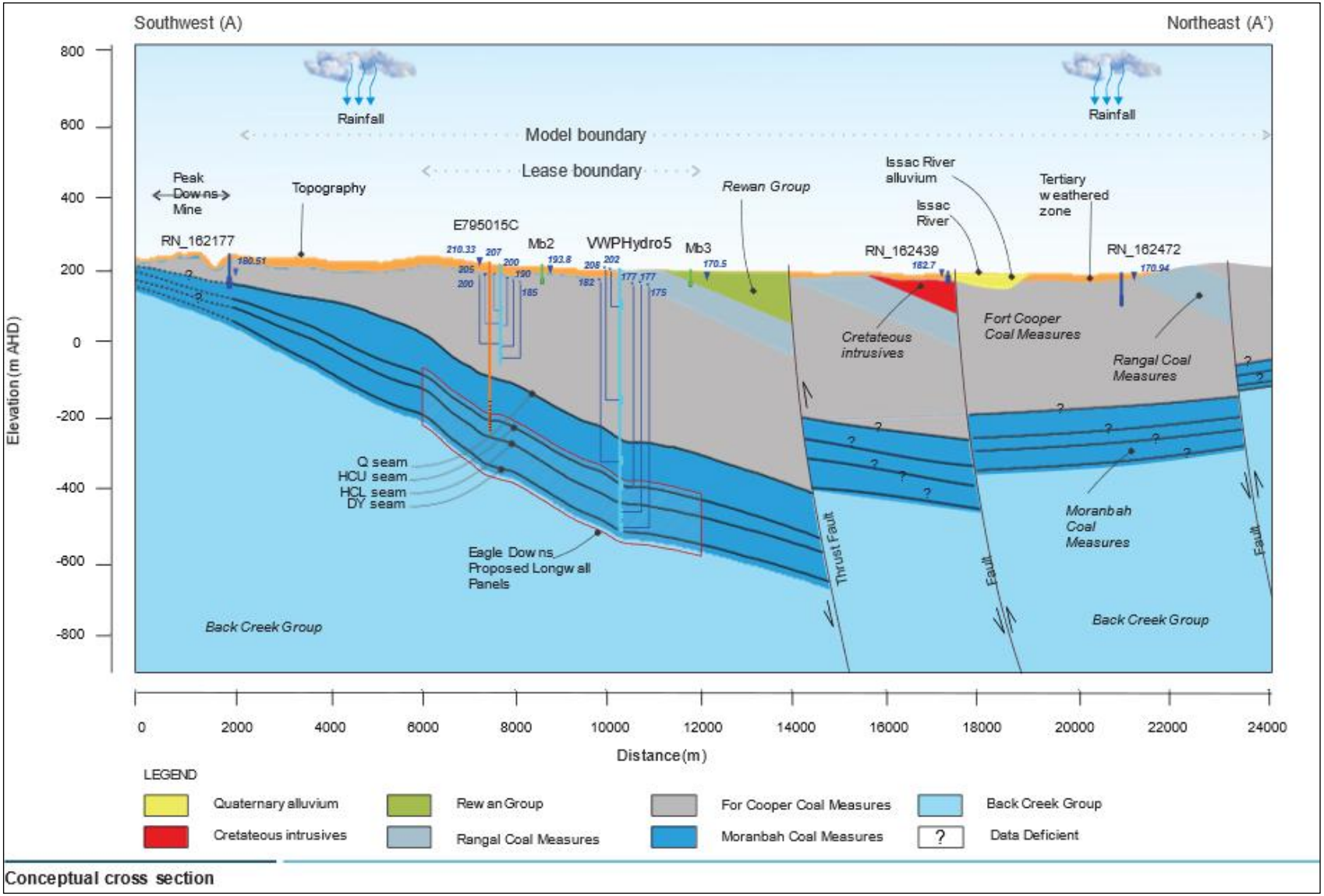


Figure 34 Conceptual Groundwater Model

Alluvial aquifers have the highest hydraulic conductivity, but the spatial distribution and extent of these alluvial aquifers is limited to areas around Cherwell Creek and the Isaac River and occur outside the ML boundary. The alluvium is recharged by rainfall and by seepage from the river during periods of flow, and during drier periods, discharges as baseflow to the river from the shallow weathered rock aquifer (AGE, 2022).

The Permian strata hydraulic conductivity is low and decreases with depth and is generally one to two orders of magnitude lower in the interburden compared to the coal seams. Yields from the coal seams are likely to be relatively low and probably less than 1 L/s. Hydraulic conductivity of the shallow weathered rock would be low and likely spatially variable depending on the degree of weathering of the bedrock. Groundwater yield from the shallow weathered rock aquifer is variable but quite low and at best can only provide stock water supplies (AGE, 2022).

The shallow weathered fractured rock hosts the groundwater table and is slightly lower in elevation than the Permian coal seam piezometric heads indicating that the coal seam aquifers and shallow weathered fractured have limited hydraulic connectivity. The groundwater table contours indicate a gradient to the east to the Isaac River and associated alluvium, which form a natural discharge zone to the shallow aquifer system. The gradient and groundwater flow in the shallow aquifer are opposite to the direction of flow in the deep Permian coal seams which has been reversed due to the extensive Peak Downs open cut mine pits along the western sub-outcrop acting as groundwater sinks. Discharge from the coal seams is to the open cut pits, to the shallow weathered/fractured rock aquifer and to the Isaac River alluvium via upward flow along fractures (AGE, 2022).

Consideration of rehabilitation and closure activities must also take into account mine induced subsidence and fracturing. With the HCU and HCL seam longwalls to be extracted using an offset chain pillar layout, by the time that DY seam workings are being developed, the entire overburden above the HCU seam is expected to be fully collapsed as shown in **Figure 35**(AGE, 2022).

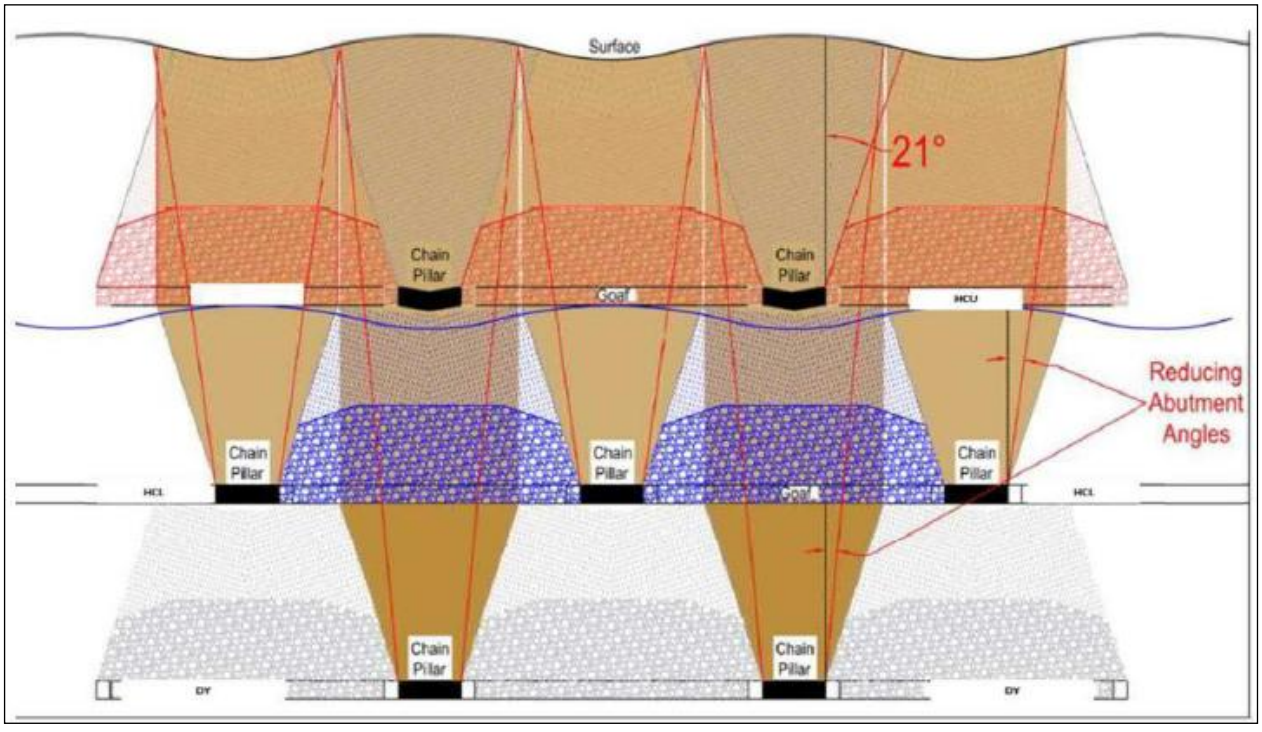


Figure 35 Multiple Stacked Longwalls with Decreasing Abutment Angles due to Overlying Goaf (South32, 2020)

With the proposed longwall mining layout for the three seams virtually overlapping, (offset of approximately 30 m), a maximum subsidence of 10 m is predicted in the shallower south-western part of the mining area as shown in **Figure 36**.

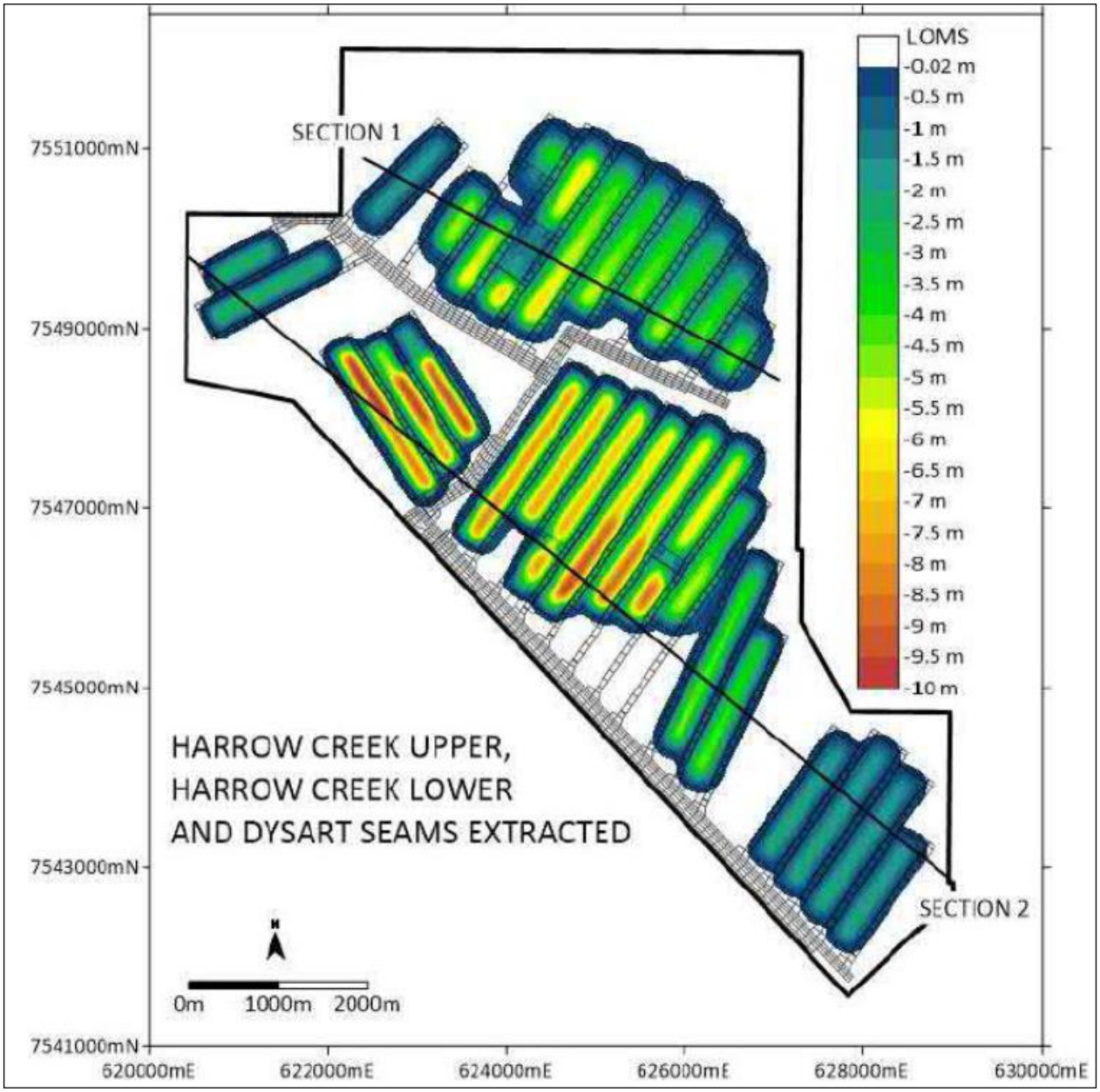


Figure 36 Subsidence after Extraction of the HCU, HCL and DY Seams (m) (Gordon Geotechniques, 2021)

Fracturing is caused by the removal of coal resulting in subsidence of the overburden into the spent longwall void (goaf). The resultant strain imposed on the rock strata develops a fracture network of varying connectivity according to the height above the longwall panel. The thickness of the mined section, the effective width of the longwall panel, and the geological properties of the overburden influence the degree of fracturing that results from the collapsing of the longwall panel (post mining) (AGE, 2022).

Various literature on subsurface subsidence cracking effects on groundwater and surface water, within Australia and in the United Kingdom (UK), was consulted as part of the AGE (2022) groundwater impact assessment, including the model (Bai and Kendorski, 1995), Gale (2008) as well as Ghabraie and Ren (2014) AGE (2022) determined that the height of continuous cracking (assessed in the literature review) compares well with the data used during the initial groundwater modelling for the Project in 2008 (AGE, 2008). The estimate of fracture heights is summarized in **Table 29**, and is expected to be up to 120 m above the HCU Coal Seam.

Table 29 Estimates of Continuous Fracture Heights in Overburden / Interburden after DY Seam Extraction (AGE, 2008)

Overburden/ Interburden	Thickness (m)	Height of Continuous Fracturing (m)		Comments
		IMC (2008)	Cendrowski (1993)	
HCU	-	62 - 91	96 - 120	Hydraulic connection between Q and HCU longwalls/goaf
HCL - HCU	60	73 - 91	173 - 216	Hydraulic connection between HCU and HCL longwalls/goaf
Dysart - HCL	67	83 - 91	105 - 132	Hydraulic connection between HCL and Dysart longwalls/goaf

Table 29 indicates that for the Project; undermining of the HCU, HCL and Dysart Seams, will result in hydraulic connection between the longwalls / goaf of each of the four seams; and the height of continuous fracturing at completion of mining, that is, the height to which water bearing strata will drain to the goafed area after all seams have been extracted, will extend to about 100 to 120 m above the HCU Seam. Any aquifers that occur more than 100 m above the HCU Seam will not drain to the mine via vertical continuous fracturing associated with the goaf (AGE, 2022).

Subsidence Modelling (Appendix L)

The subsidence above longwall panels is comprised of two main components namely sag and strata compression. Depending on the depth of cover and width of extraction, these components combine in various proportions.

In the deeper part of the Eagle Downs longwall mining area, where the panel width: depth of cover ratios are <1.2 (critical), the total subsidence is anticipated to be a combination of both sag and a component of strata compression, as shown in **Figure 37**. In the shallower areas where the panel width: depth of cover ratios are >1.2 (supercritical), the majority of the subsidence is anticipated to be due to sag.

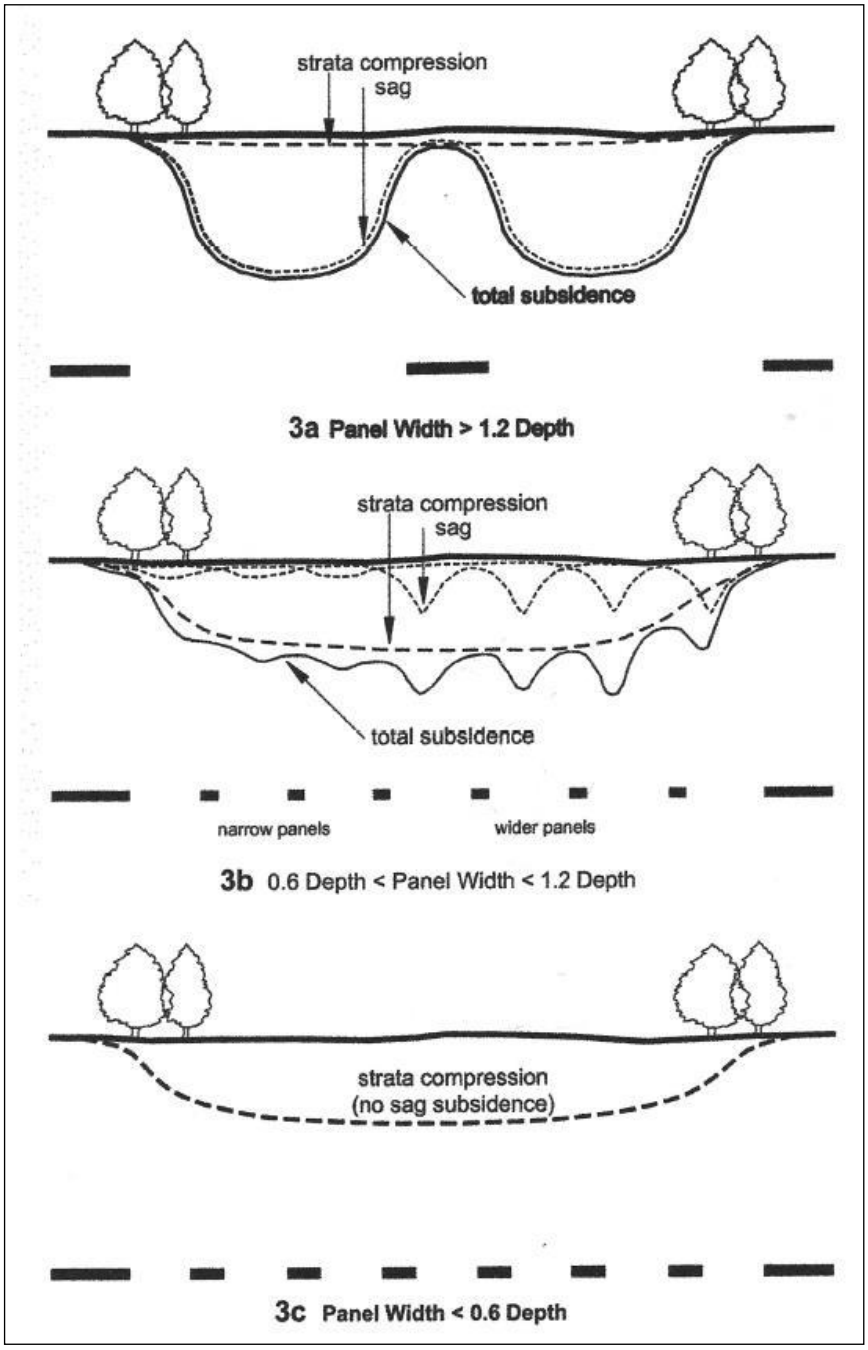


Figure 37 Effect of Panel Width (AUSIMM, 2009)

The general shape of a cross section through a subsidence bowl (**Figure 38**) reveals a number of key features that can be used as a frame of reference:

The areal extent of subsidence is defined by the angle of draw. The angle of draw is measured from the edge of the extraction void to the limit of measurable subsidence (LOMS). Conventionally, the LOMS is the point of 20 mm of vertical substance (not zero). Substance less than 20 mm will have a negligible effect, as it cannot be differentiated from natural ground surface variations due to soil moisture changes.

- Maximum tilt should correspond with zero strain.
- The subsidence at the point of maximum tilt and zero str should be half of the maximum vertical movement.
- The maximum tilts or strains do not necessarily correspond with the edge of the extraction.
- The typical subsidence profile is smooth over the cross section.

The prediction of subsurface subsidence cracking above single seam extraction longwall panels has been extensively studied using both empirical and numerical modelling methods (Gordon Geotechniques, 2021).

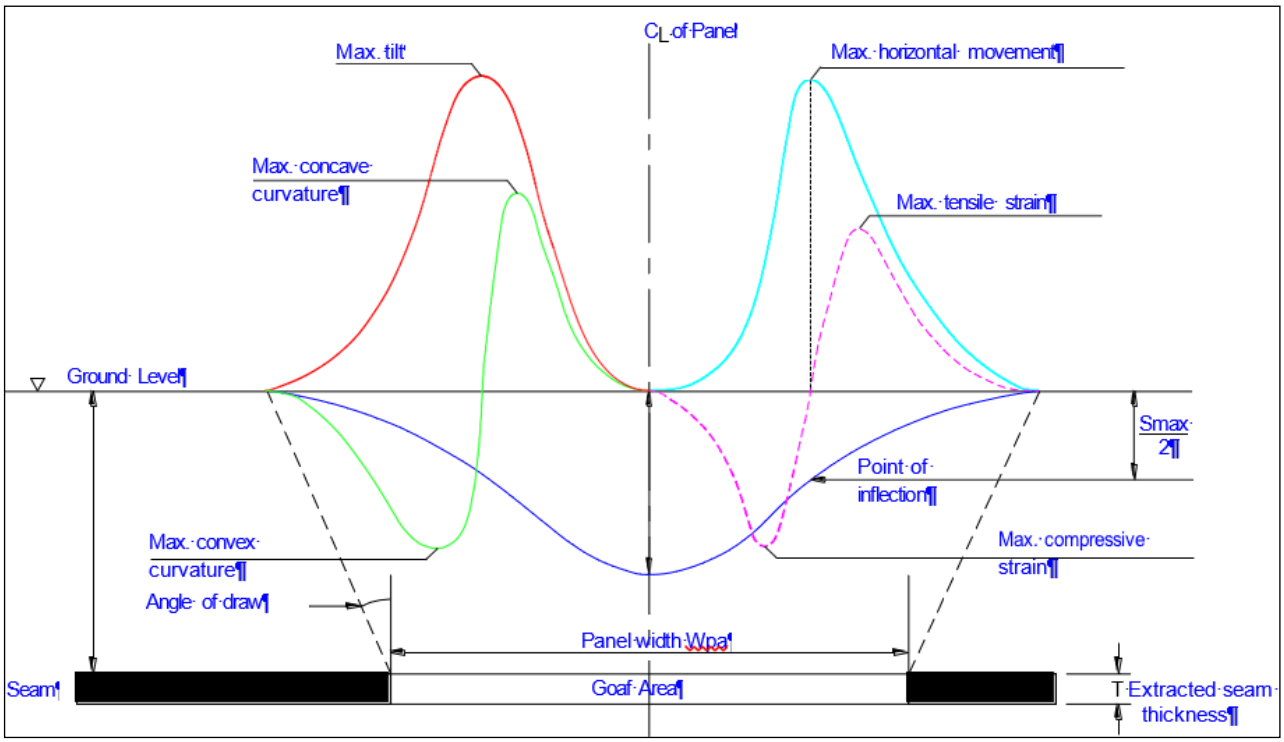


Figure 38 General Characterisation of a Subsidence Cross Line (Gordon Geotechniques, 2021)

The most commonly cited empirical model developed for predicting subsurface subsidence cracking effects on groundwater and surface water is the Bai and Kendorski (1995) model (**Figure 39**). The key principle of this model is that subsurface subsidence cracking can be characterised by the following zones:

- Constrained zone – unaffected by subsurface subsidence cracking.
- Dilated (or discontinuous cracking) zone – no changes in vertical permeability, possible changes in horizontal permeability and storativity.
- Fractured (or continuous cracking) zone – changes in vertical and horizontal permeability are possible.

In this model, cracking within the dilated (or discontinuous cracking) zone is dominantly horizontal, with negligible vertical cracks. In this zone, there may be an increase in horizontal permeability, but this is not likely to result in significant inflows to the underground workings.

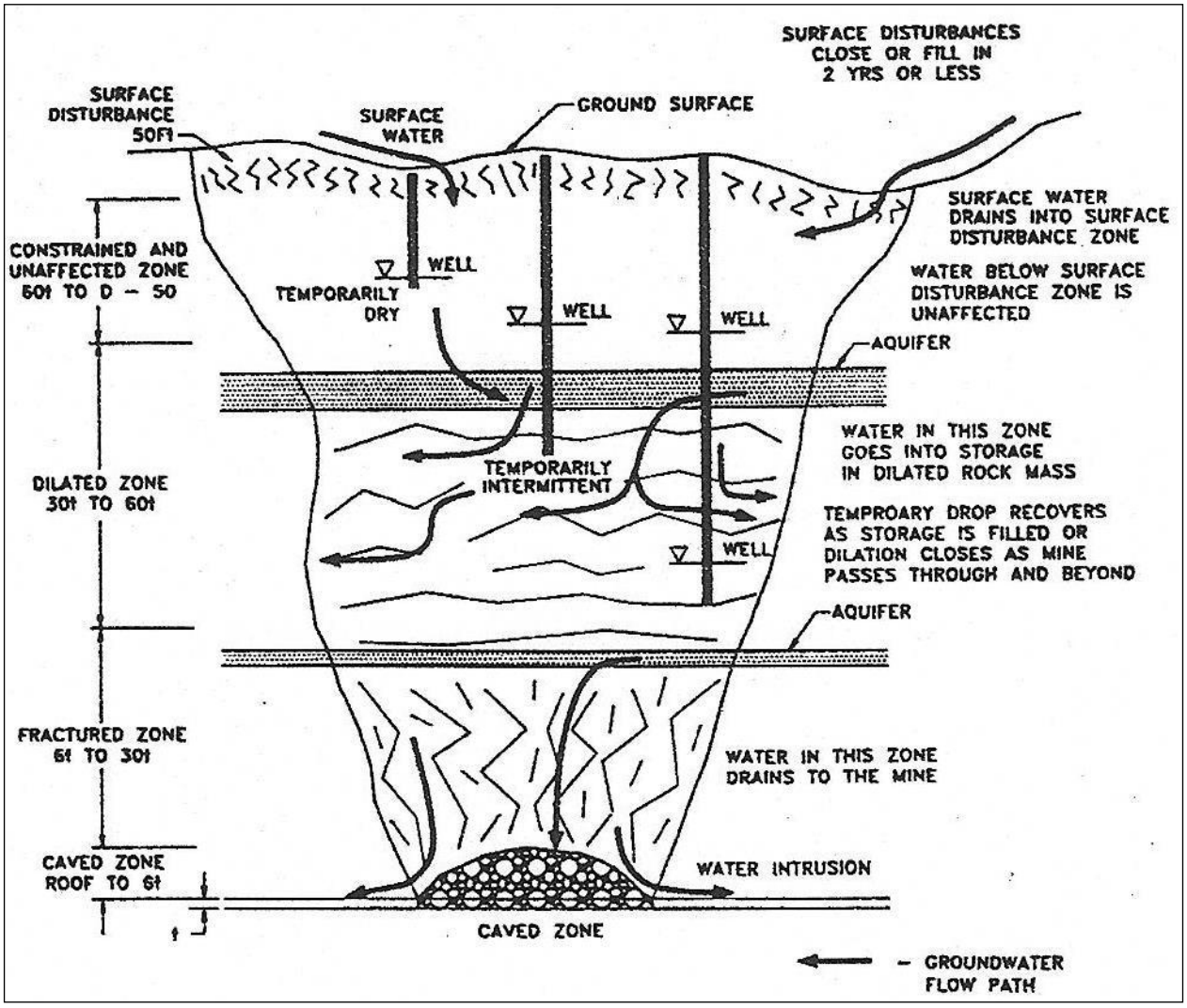


Figure 39 Hydrogeological Model for Fracturing above Longwells (Bai and Kendorski, 1995)

Seedsman and Dawkins (2006) provide a comprehensive summary of subsurface subsidence cracking and water inflow events in the Bowen Basin. They report that:

- No major surface water inflows to longwall mining areas have occurred in the Bowen Basin where the depth of cover has exceeded 120 m; and
- No major groundwater inflows to longwall mining areas have occurred in the Bowen Basin where the distance from the seam to the aquifers is more than approximately 90 m.

Based upon the measured data, microseismic monitoring and empirical guidelines the subsurface subsidence cracking predictions due to single seam longwall extraction in the Eagle Downs area can be summarised as (Gordon Geotechniques, 2021):

- A zone of continuous cracking extending up to approximately 120 m above the extracted seam; and
- A zone of discontinuous cracking extending no higher than 180 m above the extracted seam.

This is consistent with the available data from other longwall mining operations in QLD, NSW and overseas and hence provides a robust basis for the assessment of potential groundwater impacts associated with continuous cracking in single seam longwall mining areas.

In agreement with the conceptual groundwater model of the area, a numerical groundwater model, using the advanced MODFLOW-USG modelling software, has been prepared for the EDCM project and represents the two aquifer systems (AGE, 2022). The lower aquifer system comprises four coal seams (Q, HCU, HCL and DY seams), of which the HCU, HCL and DY are to be mined in sequence. The coal seam aquifers are

represented by individual model layers, with each seam separated by three layers of homogenous low permeability interburden. Similarly, the uppermost shallow weathered/fractured rock aquifer was represented by a model layer (AGE, 2022).

The numerical model accounts for:

- Updates to the mine plan (to reflect the current proposed layout of the longwall panels and adjoining roads);
- Refined model extent and mesh (for improved representation of the updated longwall layout. The model domain was discretised and arranged into 18 layers);
- Elevation data (to improve model stability);
- Floor elevations and thickness data for all four coal seams;
- Boundary conditions (no flow, general head and river boundaries);
- System stressors (rainfall and recharge, discharge);
- Hydraulic parameters (vertical and horizontal conductivity of each model layer); and
- Updated fracture height (using the Ditton-Merrick equation (Ditton and Merrick, 2014) to determine the height of connected fracturing).

The shallowest depth of extraction in the Eagle Downs area is 270 m in the western Harrow Creek Upper Seam area. As such, connective cracking to the surface is not anticipated as illustrated by the simplified conceptual cross-section in **Figure 34**. As mentioned earlier, the continuous subsurface fracturing will not extend to the base of the shallow aquifer, and landholder bores do not extend beyond 80 m depth, as simulated in the model (AGE, 2022). Therefore, no impact to bores from fracturing is expected.

Following a calibration period, the model simulation was extended to include the remainder of the drift development followed by mining of the HCU, HCL and DY seams. Mining was complete by mid-2068, with the simulation finished at the close of 2075. The model predictions were made monthly for first ten years of mining then quarterly for the remainder of the simulation. The development of the gate roads and longwall panels was aligned to a mining schedule provided by South32 (now Stanmore).

The predicted inflows peaks after 10 years of mining, with 82 L/s expected to enter the underground workings, before declining to the end of the DY seam (**Figure 40**). A detailed view of the first 10 years of mining can be observed in **Figure 41**. The maximum predicted inflow from the numerical groundwater model used for the EIS was in the order of 52 L/s. The main reason for the higher predicted inflow for the new proposed mine plan is because of the improved conceptual model, fractured height predictions and longwall layout. It is considered the changes in model setup for this latest model version provide more realistic inflows to the seams than previous iterations, namely for the changes to interburden and the variation in vertical hydraulic conductivity within the fracture zone above the longwalls.

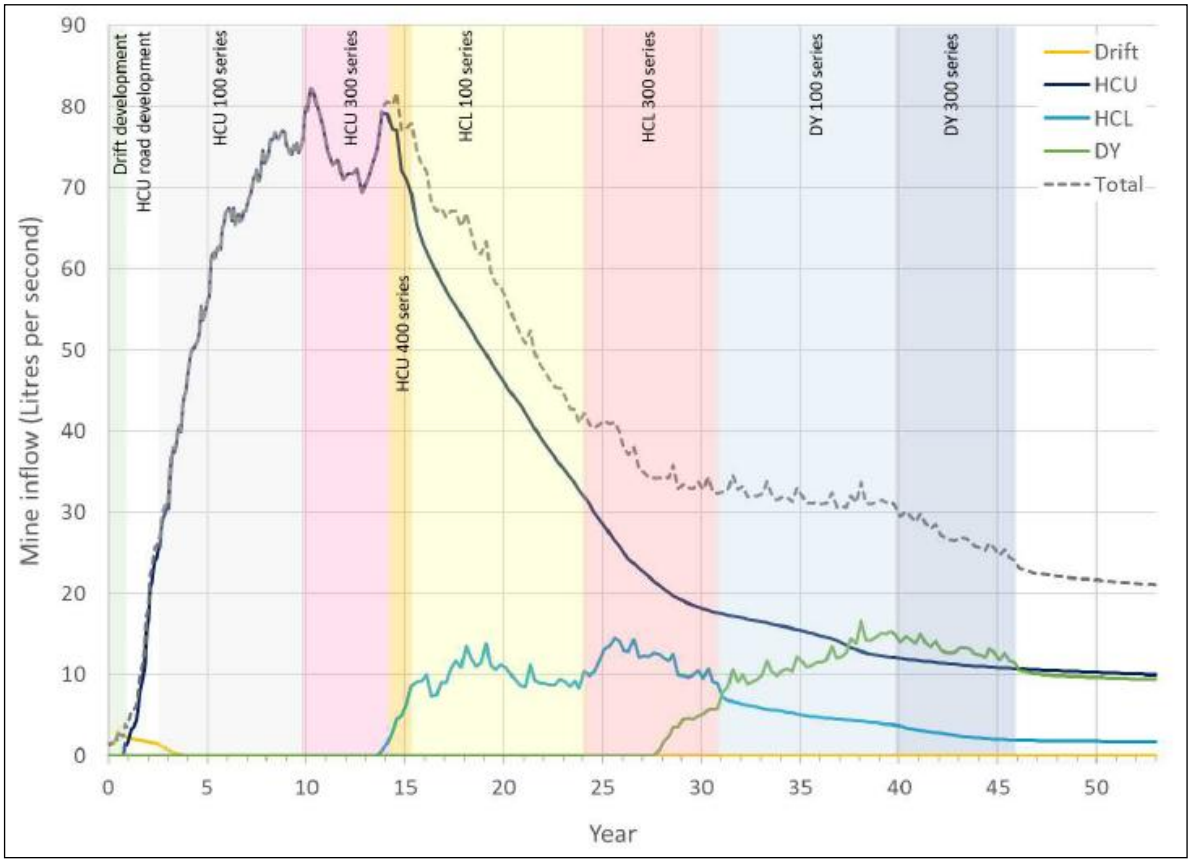


Figure 40 Total Predicted Inflow from Coal Seams (AGE, 2022)

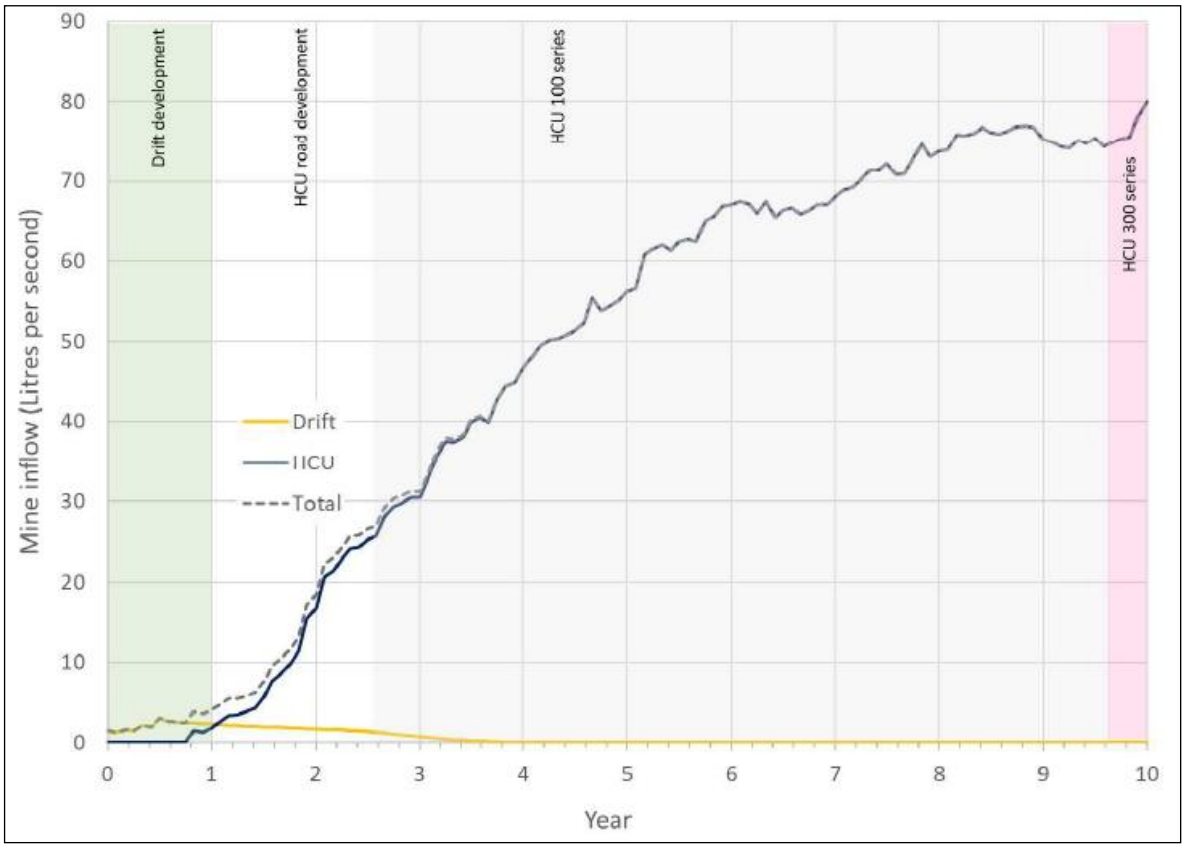


Figure 41 Predicted Inflow for the First 10 Years of Mining (AGE, 2022)

Figure 42 to **Figure 45** show the maximum drawdowns predicted to occur during mining in layers 1 (weathered tertiary strata), 9 (HCU seam), 13 (HCL seam) and 17 (DY seam). The shallow aquifer (**Figure 44**) experiences minor drawdown (~10 to 20 m) where near surface tertiary strata is saturated over the north and south-east of the mine footprint. This is expected since the height of fracturing above the coal seam does not extend to the tertiary strata, limiting connectivity between the shallow aquifer and deep coal seam layers.

Figure 43 to **Figure 45** show that similar drawdown extents occur in each of the coal seams. The maximum predicted drawdown occurs in the mine footprint, which reduces with increasing distance from the mine to 1 m drawdown around 4 km from the nearest panel.

The predicted drawdown in the EIS groundwater assessment was less than the current predictions for the shallow weathered aquifer. The maximum predicted drawdown in the weathered aquifer was about 5 m and it can be seen from **Figure 42** that the maximum drawdown is in the order of 20 m for the updated numerical simulations. The zone of influence, based on the 1 m drawdown contour line for Layer 1 is also slightly bigger in the updated model when comparing to the 2008 model predictions (AGE, 2022).

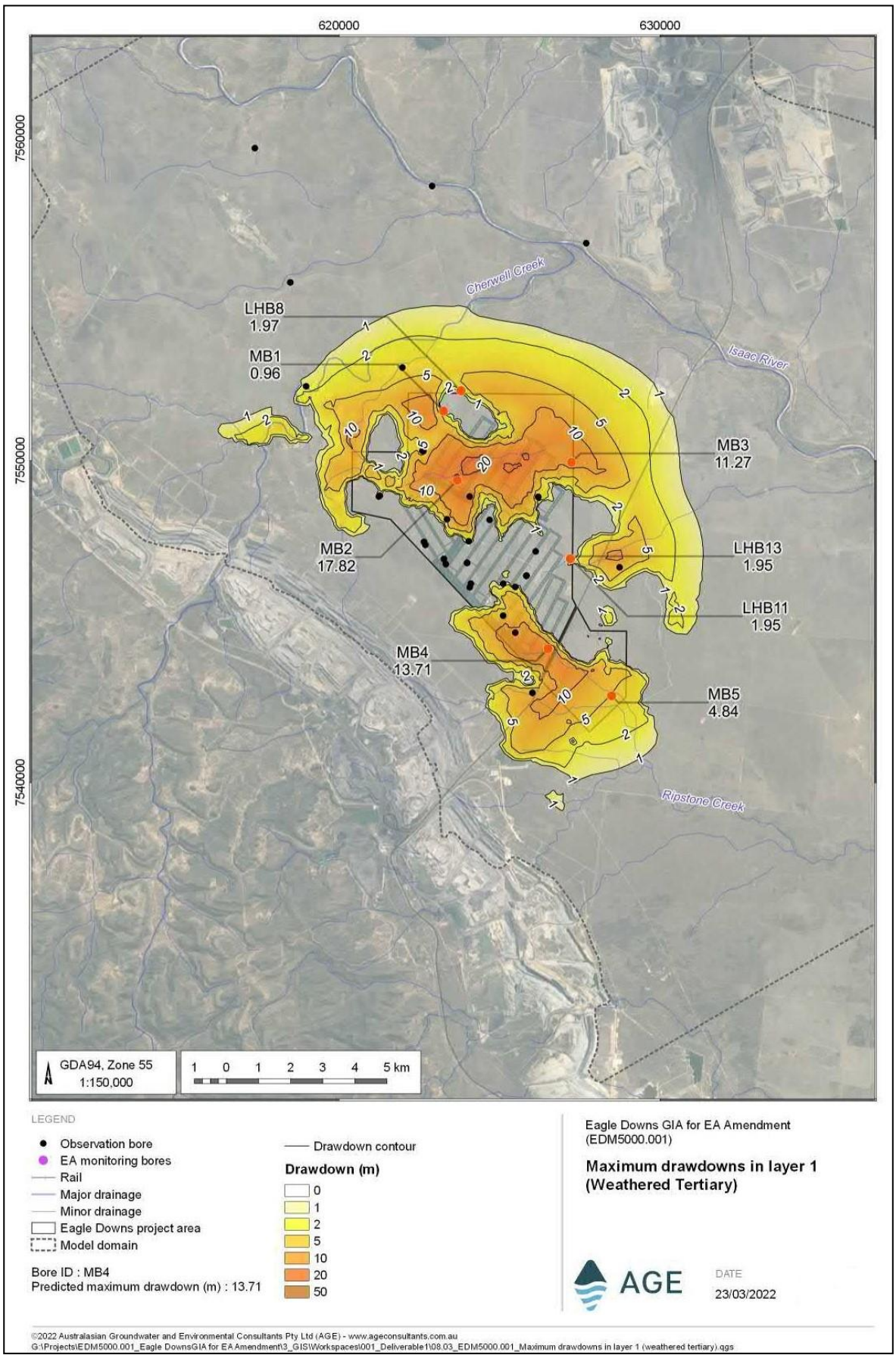


Figure 42 Maximum drawdowns in weathered tertiary – shallow aquifer (AGE, 2022a)

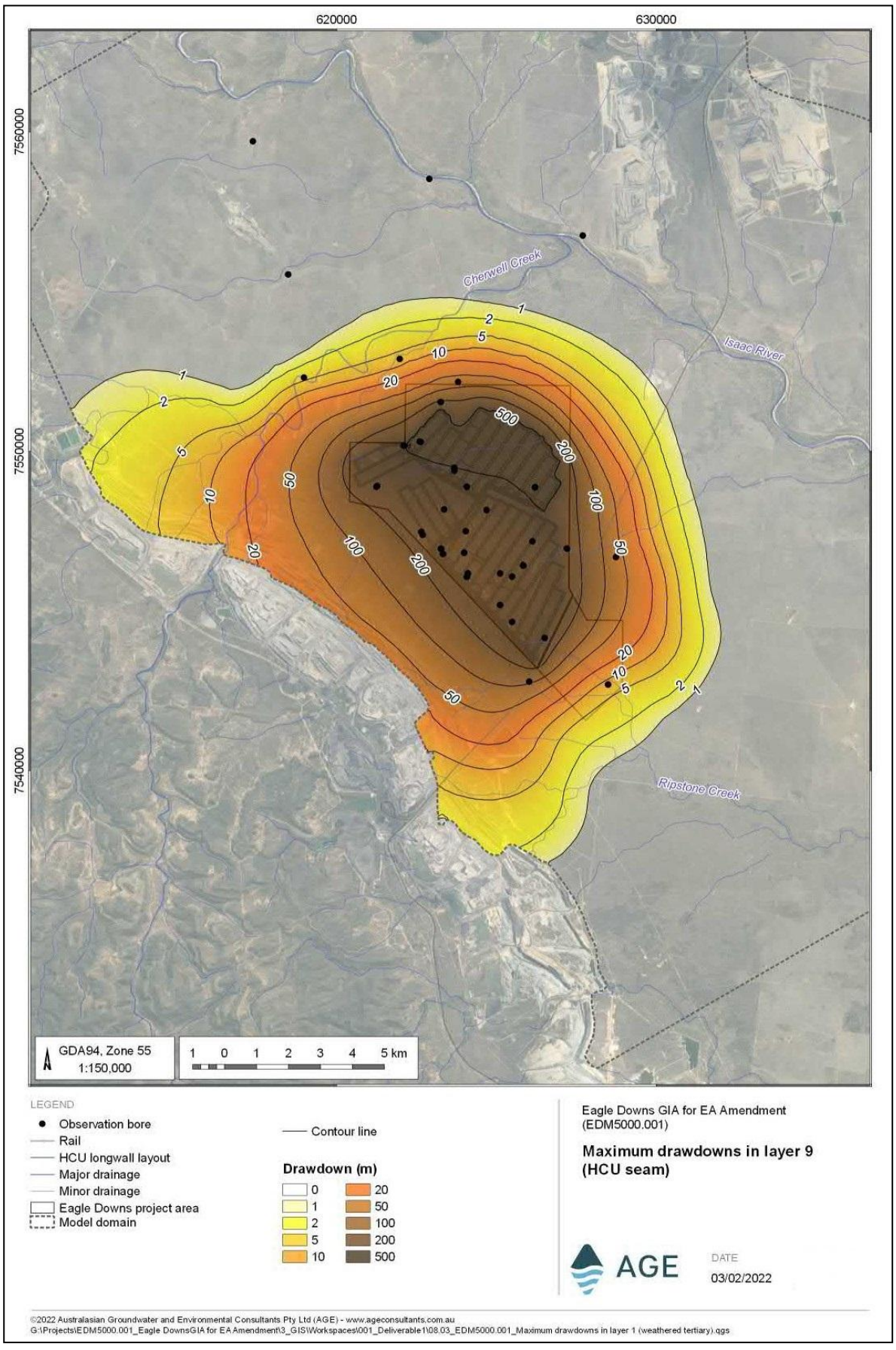


Figure 43 Maximum Drawdowns in HCU Seam (AGE, 2022)

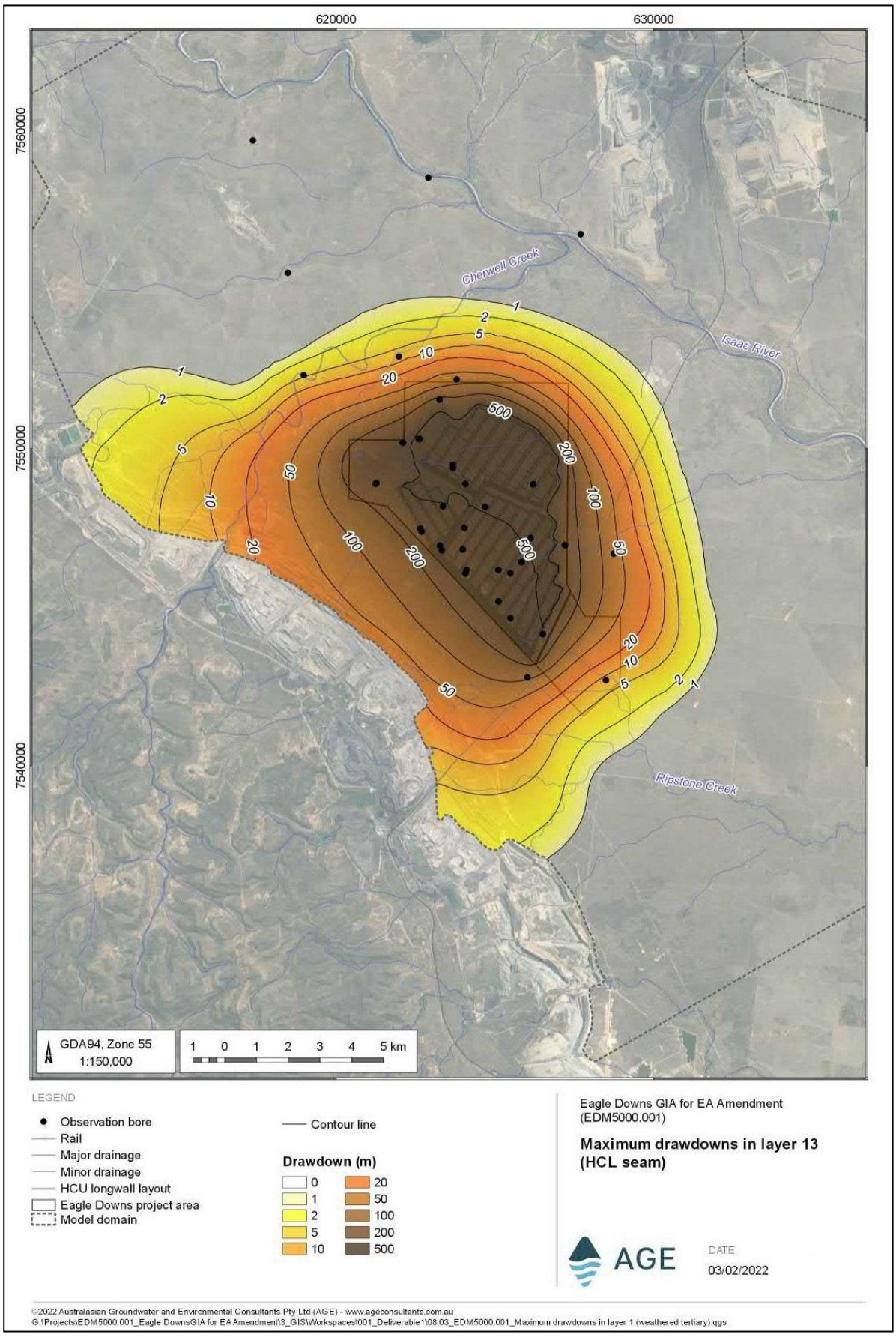


Figure 44 Maximum Drawdown in HCL Seam (AGE, 2022)

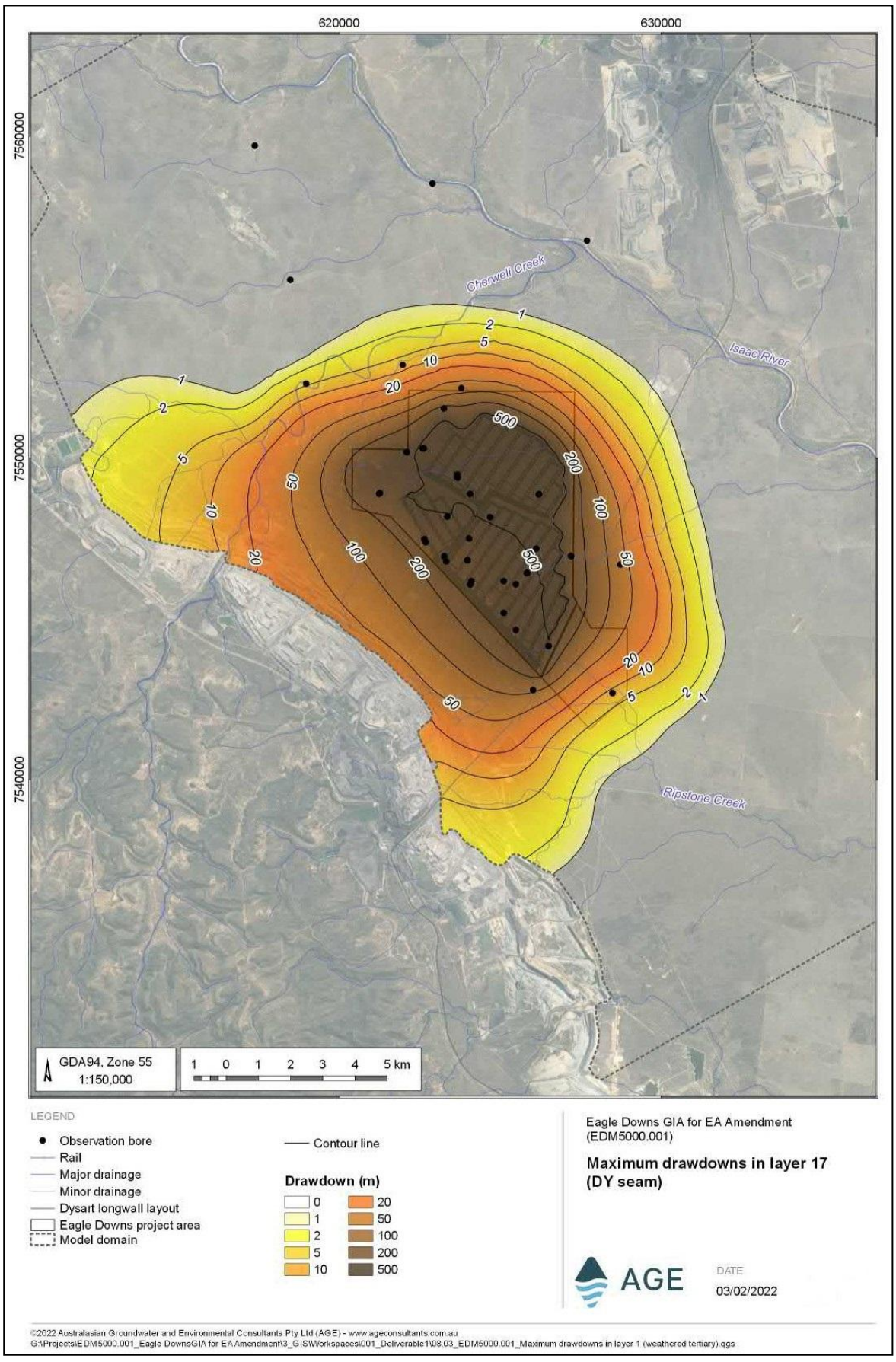


Figure 45 Maximum Drawdown in DY Seam (AGE, 2022)

The Groundwater Impact Assessment (GIA) (conducted by AGE (2022)) identified the following potential impacts for the EDCM Project:

- Subsidence, surface cracking and subsurface cracking from longwall mining;
- Water supply bores;
- Groundwater dependant ecosystems;
- Groundwater quality; and
- Cumulative impacts.

These are discussed in more detail in the following sections.

Subsidence, Surface Cracking and Subsurface Cracking from Longwall Mining

The shallowest depth of extraction in the Eagle Downs area is 270 m in the western Harrow Creek Upper Seam area. As such, connective cracking to the surface is not anticipated. The continuous subsurface fracturing will not extend to the base of the shallow aquifer, which farm bores suggest does not extend beyond 80 m depth, as simulated in the model (AGE, 2022).

As a result of the continuous subsurface cracking, extraction of groundwater by mine dewatering will lower the elevation of the piezometric surface of the coal seam aquifers and create a cone of depression around the mine (AGE, 2022).

Although the mine workings will not be in direct hydraulic connection with the shallow aquifer dewatering of the coal seams, the mine workings are predicted to have an impact on the shallow aquifer due to the inherent very low permeability of the material separating the shallow aquifer from the zone of continuous fracturing. The maximum drawdown in the shallow aquifer is predicted to be less than 23 m over the centre of the longwall panels (**Figure 42**) (AGE, 2022).

In all subsided areas there may be shallow surface cracking which suggests extends to a maximum of 1 5 m below surface. Where this zone of increased permeability occurs beneath the shallow aquifer it may lead to a temporary lowering of groundwater levels that will only persist for as long as is required to fill the new void cracks. On the basis that there is no new discharge route for the shallow groundwater, that is, there is no connection via surface cracking to the underground mine voids or connection with the subsurface zone of continuous cracking, groundwater levels and/or surface flow will generally be resurrected quite quickly as the cracks are filled. These findings are consistent with the 2008 GIA findings (AGE, 2008) and the approved EA (AGE, 2022).

The subsidence data and predictive modelling indicates that although there is a significant impact on the potentiometric surface of the deep coal seam aquifers; the impact of mining and dewatering the coal seams on the shallow aquifer is minimal (AGE, 2022). This is due to the essentially impermeable nature of the Fort Cooper Coal Measures that separate the aquifers; and that continuous fracturing resulting from goafing will only extend to a maximum height of about 120 m above the HCU Seam. A cover thickness of 270 to 450 m above the HCU Seam indicates that continuous fracturing will not intercept the base of the shallow aquifer and provide drainage pathways to the mine. Similarly surface cracking will not result in hydraulic connection with the mine. There will however be some minor seepage via natural fractures and joints (the inherent permeability), from the shallow aquifer to the underlying depressurized mining domain, resulting in the cone of depression in the water table. Predictive modelling indicates that there will be no impact to the alluvial aquifer associated with the Isaac River (AGE, 2022).

Overall, an increased groundwater recharge rate to the shallow aquifer may occur where surface cracks are open for periods extended over one or more rainy seasons (AGE, 2022).

Water Supply Bores

Although there are no operational landholder bores overlying the longwall panels or in the Project area, there is the potential that dewatering will result in some drawdown. Landholder farm borehole LHB08 is about 200 m from the northern boundary of the ML, whilst landholder farm bores LHB11 and LHB13 exist on the eastern boundary. Updated predictive modelling to determine the impacts of dewatering on landholder- farm boreholes indicate the water level in LHB08 and LHB13 could be reduced by about 2 m as a result of mining.

This, however, should have minimal impact on bore yields and these bores are part of the groundwater monitoring network currently (AGE, 2022).

Groundwater Dependant Ecosystems

There are no groundwater dependent ecosystems that are likely to be impacted by the Project. The coal seams are very deep and while the radius of influence of depressurisation of the coal seams will extend towards the Isaac River, predictive modelling indicates that it is unlikely to extend to beneath the alluvium. If depressurisation did extend to beneath the alluvium, discharge of poor-quality coal seam water to the base of the alluvium would locally cease.

Groundwater Quality

The potential for groundwater contamination may occur as a result of:

- Dry rejects disposal, workshops, waste disposal – shallow aquifer; and
- Mining and goafing – coal seam aquifer.

In assessing the potential impact to groundwater quality, a geochemical assessment by RGS (2008) was undertaken. RGS evaluated the drift spoil and reject materials. With respect to the drift spoil RGS concluded that:

- Acid generation from the drift spoil is extremely unlikely;
- The concentration of metals in the drift spoil materials are well below applied guideline criteria for soils and are unlikely to present any environmental issues associated with revegetation and rehabilitation and any spoil and rejects storage facility; and
- The concentration of soluble metals and salts in runoff and seepage from drift spoils is likely to remain within applied water quality guideline criteria and is unlikely to present any environmental risks for on-site or downstream water quality.

With respect to the reject material RGS concluded that:

- Rejects generated by the Project are likely to be relatively benign and will generate mildly alkaline and relatively fresh (non-saline) runoff and seepage following surface exposure.
- Despite two samples being classified as Potentially Acid Forming (PAF); acid generation from rejects is unlikely given the lack of sulfur.
- All rejects material is strongly sodic and, as a consequence, may present surface storage engineering problems related to erosion and dispersion if it was to be used as a potential growth layer for rehabilitation. However, there is no proposal to use rejects material in this manner. The rejects emplacement area would be capped with benign material and covered in topsoil prior to being vegetated. This would eliminate any issues associated with the suitability of the underlying rejects material as a potential growth layer for rehabilitation.
- Water extract tests indicate that despite some marginally elevated concentrations of soluble Mo and As in a small number of samples, the concentration of soluble metals and salts in runoff and seepage from rejects is likely to remain within applied water quality guideline criteria and is unlikely to present any environmental risks for on-site or downstream water quality.

Considering the conclusions reached by RGS following geochemical assessment of the drift spoil and rejects material, it is considered unlikely that leachate generated from these materials will adversely impact groundwater quality. As discussed, the groundwater quality of the coal seam aquifers is poor (brackish to saline) and is marginally suitable for stock use only. There are no landholder farm bores in the area sourcing water from the coal seams. While longwall mining will fracture the overlying strata providing larger surface areas and exposure of the rock surface to air, RGS (2008) suggests that this will not result in poorer quality water in the aquifer systems as groundwater levels recover and the mine workings flood following cessation of mining (AGE, 2022).

Similarly, any seepage of leachate generated from the DREA is unlikely to adversely impact the naturally occurring reasonable to poor quality groundwater of the shallow aquifer, although surface cracking to an estimated maximum depth of 15 m may enhance the rate of infiltration of leachate to the shallow aquifer. The

monitoring bores in the shallow aquifer, described in the Section 3.1.1.5 will enable detection of any impact of the DREA (AGE, 2022).

There is potential for spills and contamination by metals and hydrocarbons from mine workshops, waste disposal and fuel storage areas, however adequate bunding and immediate clean-up of spills which is standard practice and a prescribed requirement at mine sites, should prevent contamination of shallow groundwater systems (AGE, 2022).

Cumulative Impacts

In the context of cumulative impacts, and based on the modelling results, there is some interaction between the mines situated to the west along the Permian MCM sub-outcrop (Peak Downs Mine). The predicted drawdown is mainly in the MCM and less in the shallow weathered Permian as a result of the Project. The predicted impact on the shallow weathered aquifer is limited to the Eagle Downs ML. No major alluvial zones are impacted on as a result of the Project.

3.5.1.2 Flooding

There are no voids proposed to be located in the floodplain for the Project.

Location of Domains in Relation to Potential Flood Levels

WRM (2022) was commissioned to conduct a flood impact assessment for the EDCM Project to address the requirements of the PRC Plan and to define the potential impacts on the receiving environment throughout and post-mining life.

The following methodology was adopted:

- A TUFLOW two-dimensional hydrodynamic model was used to estimate the flood characteristics (depths, levels, and velocities) in the Project boundary;
- The rain-on-grid (ROG) modelling approach was adopted (grid cell size of 10 m) to provide an accurate representation of the catchment topography of Project area; and
- In the absence of historical flood event information, estimated design discharges were validated against the Regional Flood Frequency Estimation (RFFE) model and Rational Method estimates.

To understand how flooding may impact rehabilitation activities at EDCM, flood modelling was undertaken for the following conditions:

- Existing conditions (including existing mine infrastructure);
- Mine infrastructure conditions (in Feature 3 catchment, as shown in **Figure 9**);
- Proposed fully subsided conditions (no mitigation); and
- Proposed final landform conditions.

The existing conditions hydraulic model extent and hydraulic resistance (i.e., vegetation type and land use) across the EDCM Project area are shown in **Figure 46**. The model covers an area of 107.2 km2 that includes the Project area and downstream waterway catchments (WRM, 2022). The topography for the fully subsided conditions and final landform conditions are depicted in **Figure 47**.

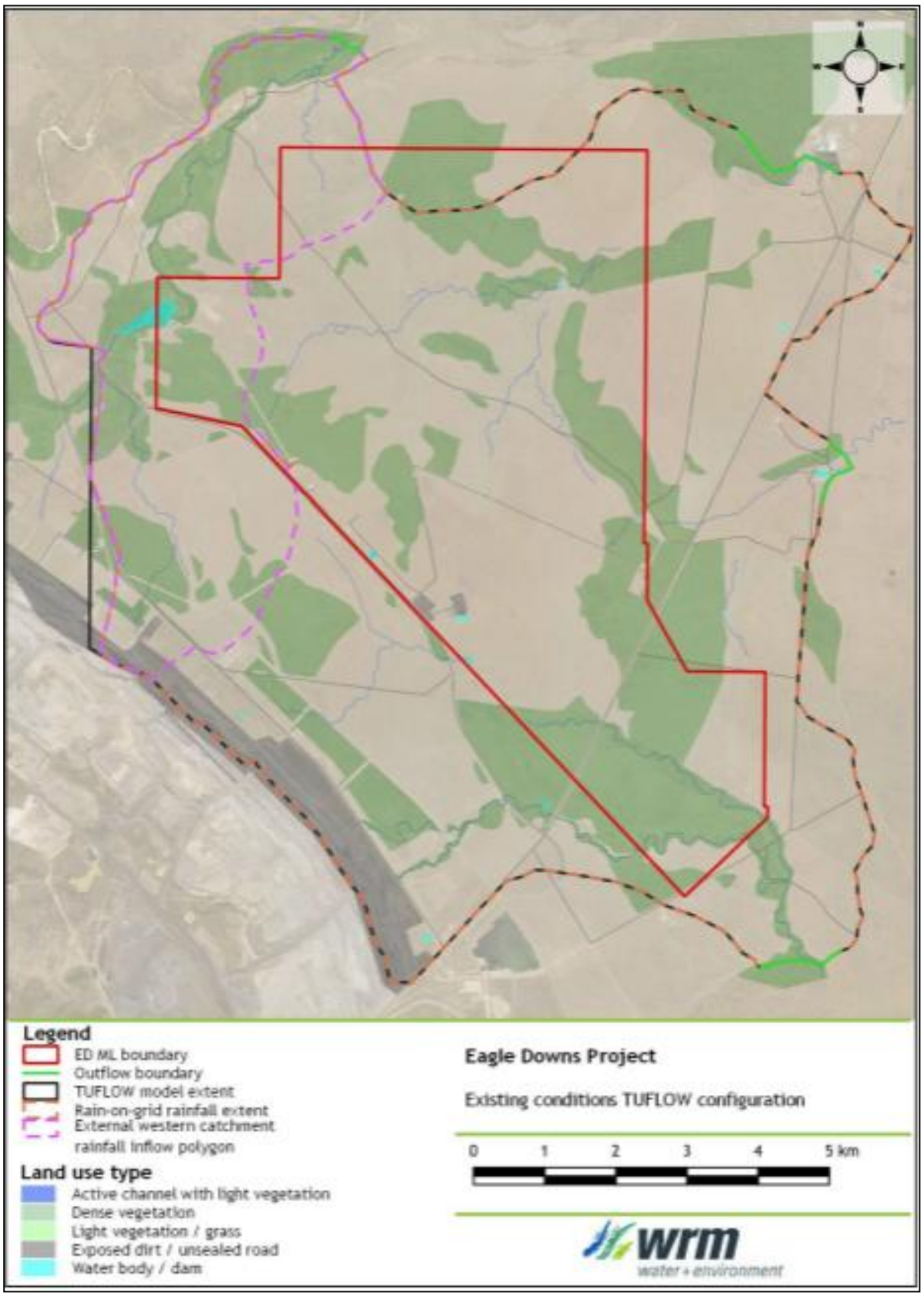


Figure 46 Existing Conditions TUFLOW Model Configuration (WRM, 2022)

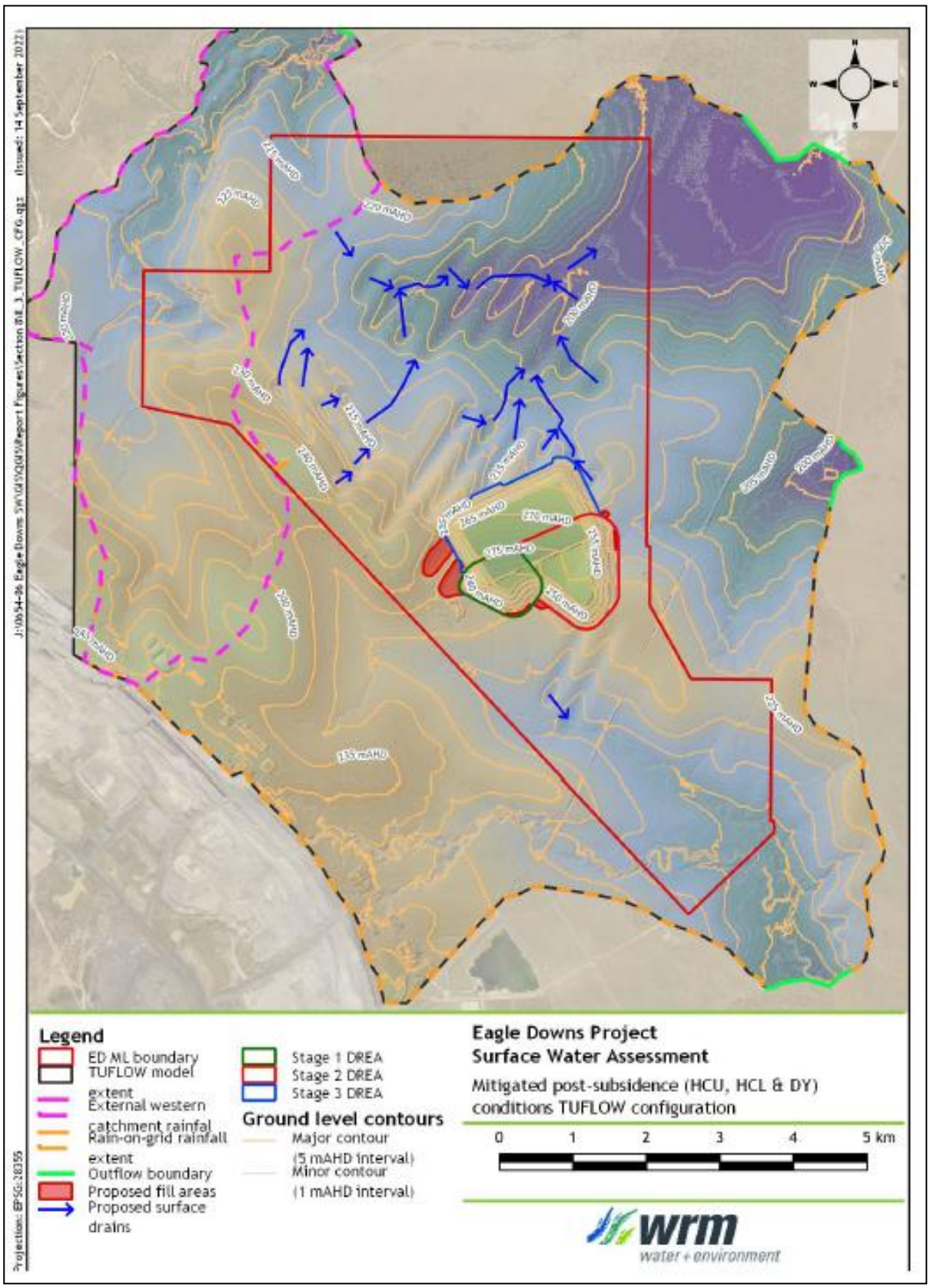


Figure 47 Topography of Subsided Conditions and Final Landform Conditions

Model of Flood Levels for a Range of Design Storm Events

Flood modelling for existing conditions at the EDCM Project (including mine infrastructure) for selected design events (63%, 50%, 10%, 1, 0.1% AEP and probable maximum flood (PMF) modelled scenarios) is shown in **Figure 48** to **Figure 54**.

An assessment of flood susceptibility and influence across site conducted by WRM (2022) found that (for existing and mine infrastructure conditions):

- For the 1 year and 2-year ARI event:
  - There would be no impact on the neighbouring property.
- For the 10% AEP event:
  - There would be increases in flood levels of up to 0.30 m on the western side of the ML boundary due to the proposed rail.
  - There would also be a decrease in flood levels greater than 0.1 m directly upstream of the rail embankment due to the removal of the existing dams and returning the topography to existing conditions.
  - There would be no flood level increases downstream the mine infrastructure area.
- For the 2% AEP event:
  - There would be increases in flood levels up to 0.4 m on the western side of the ML boundary.
  - There would be no flood level increases downstream the mine infrastructure area.
- For the 1% AEP event:
  - There would be increases in flood levels up to 0.5 m on the western side of the ML boundary.
  - There would be no flood level increases downstream the mine infrastructure area.
- For the 0.1% AEP event:
  - There would be increases in flood levels up to 1.0 m on the western side of the ML boundary.
  - There would be reductions in flood levels up to 0.1 m downstream of the Goonyella rail embankment.
- For the PMF event:
  - There would be increases in flood levels greater than 1.0 m on the western side of the ML boundary.
  - There would be reductions in flood levels greater than 0.10 m downstream of the Goonyella Rail embankment.
- Drains are proposed to divert clean catchment runoff around the mine infrastructure area. The results of the mine infrastructure modelling show that there would be a flood level increase immediately upstream of the proposed rail spur, which may be mitigated by upgrading the proposed rail infrastructure. The ponding caused by the upstream ponding, would marginally reduce downstream flood levels (WRM, 2022).

Existing Conditions

Mine Infrastructure - Developed Conditions

Flood Impact – Mine Infrastructure Minus Existing Conditions

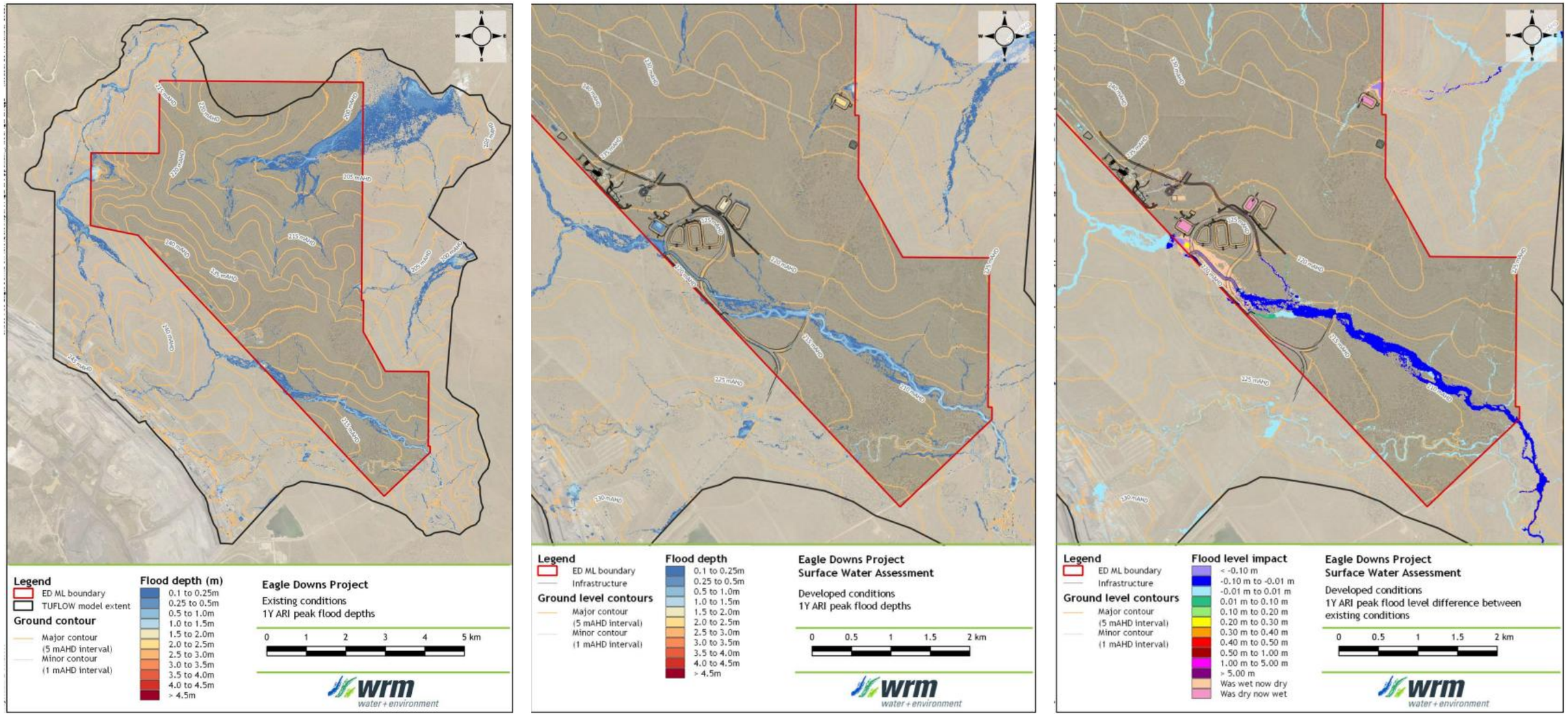
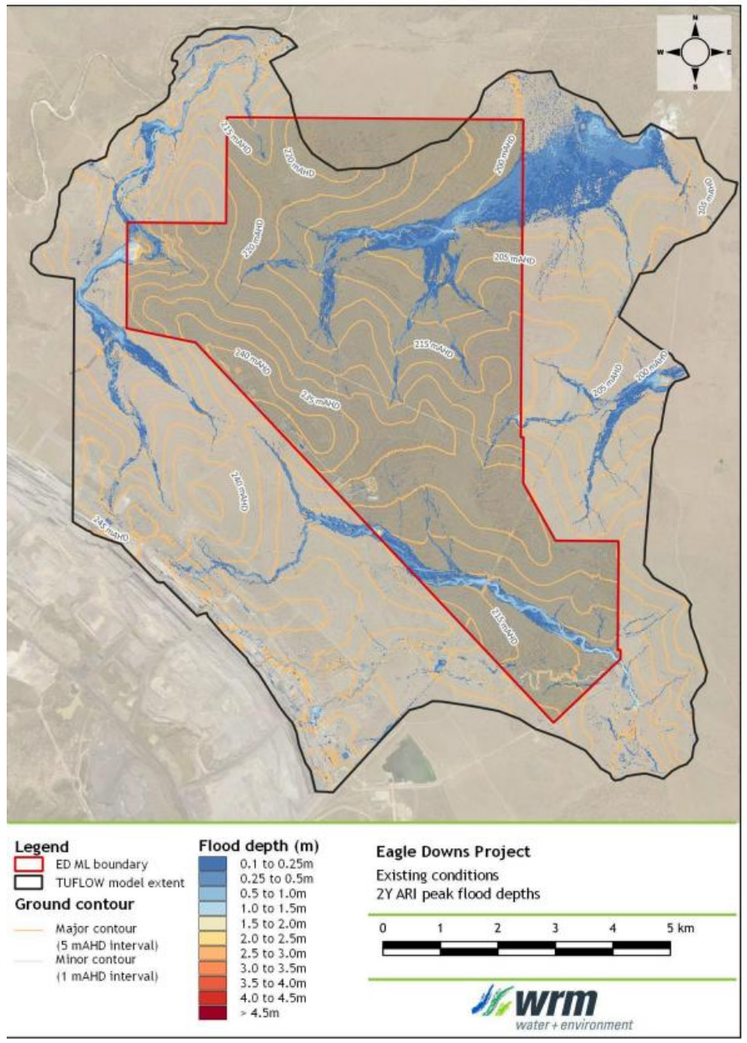
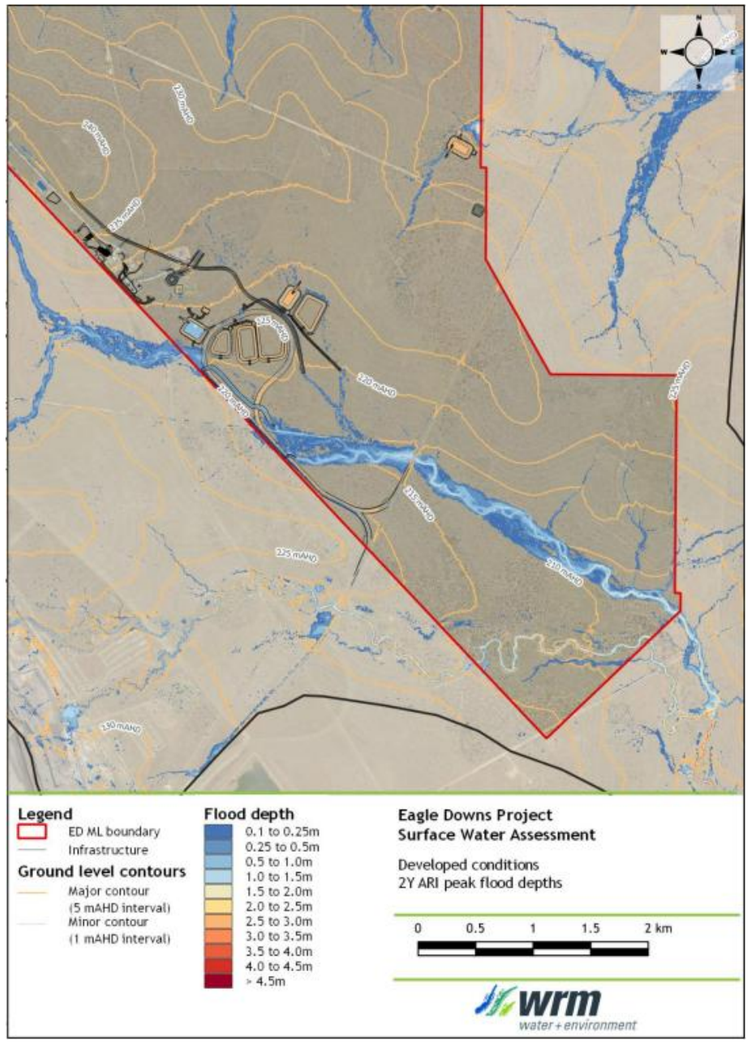


Figure 48 63% AEP Flood Depths (Existing Conditions and Mine Infrastructure)

Existing Conditions



Mine Infrastructure - Developed Conditions



Flood Impact – Mine Infrastructure Minus Existing Conditions

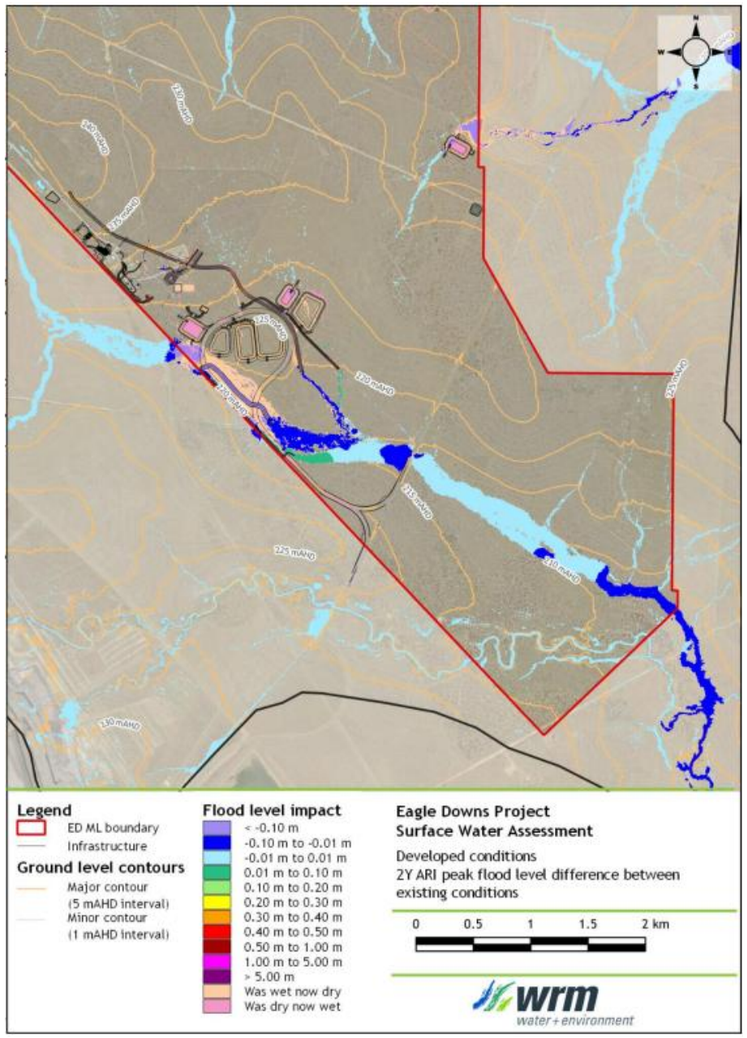


Figure 49 50% AEP Flood Depths (Existing Conditions and Mine Infrastructure)

Existing Conditions

Mine Infrastructure - Developed Conditions

Flood Impact – Mine Infrastructure Minus Existing Conditions

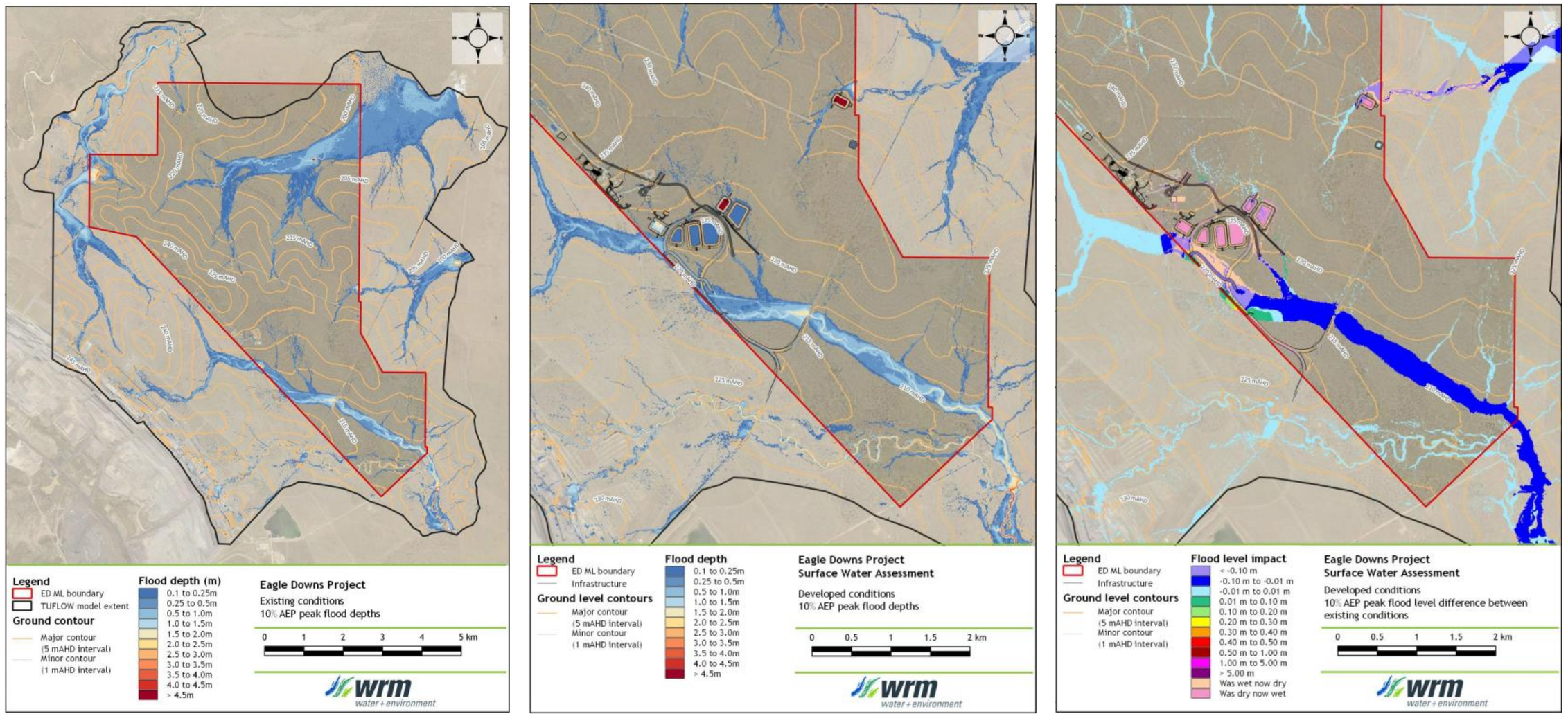


Figure 50 10% AEP Flood Depths (Existing Conditions and Mine Infrastructure)

Existing Conditions

Mine Infrastructure - Developed Conditions

Flood Impact – Mine Infrastructure Minus Existing Conditions

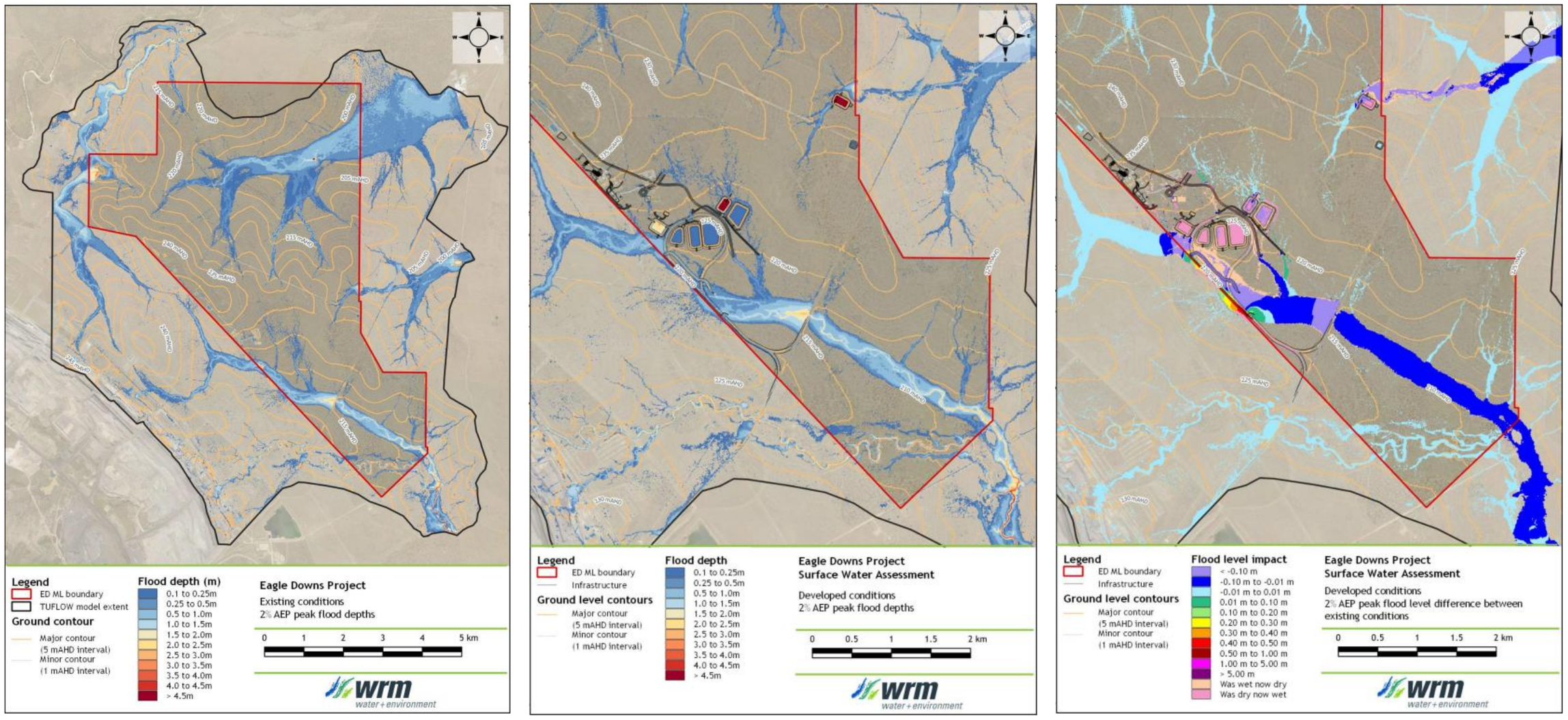


Figure 51 2% AEP Flood Depths (Existing Conditions and Mine Infrastructure)

Existing Conditions

Mine Infrastructure - Developed Conditions

Flood Impact – Mine Infrastructure Minus Existing Conditions

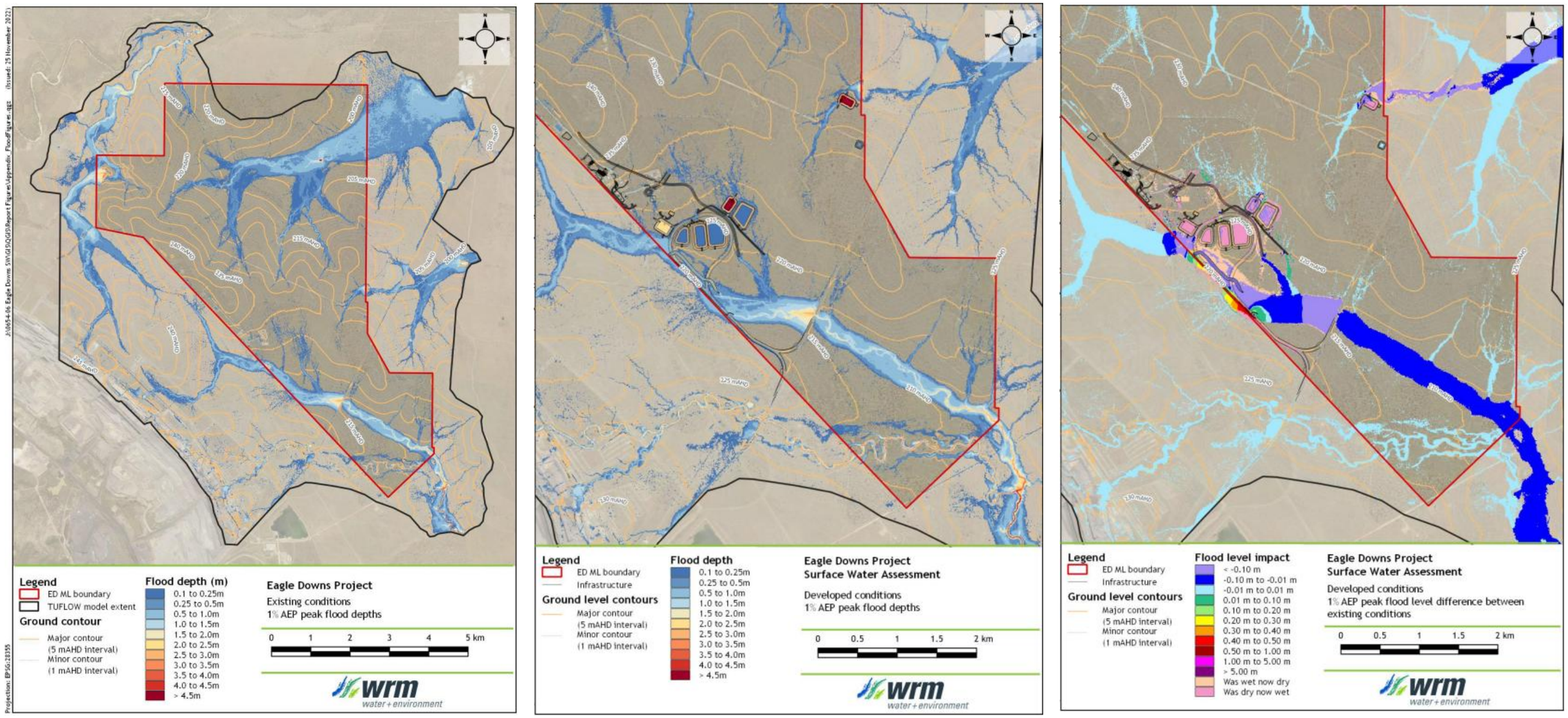
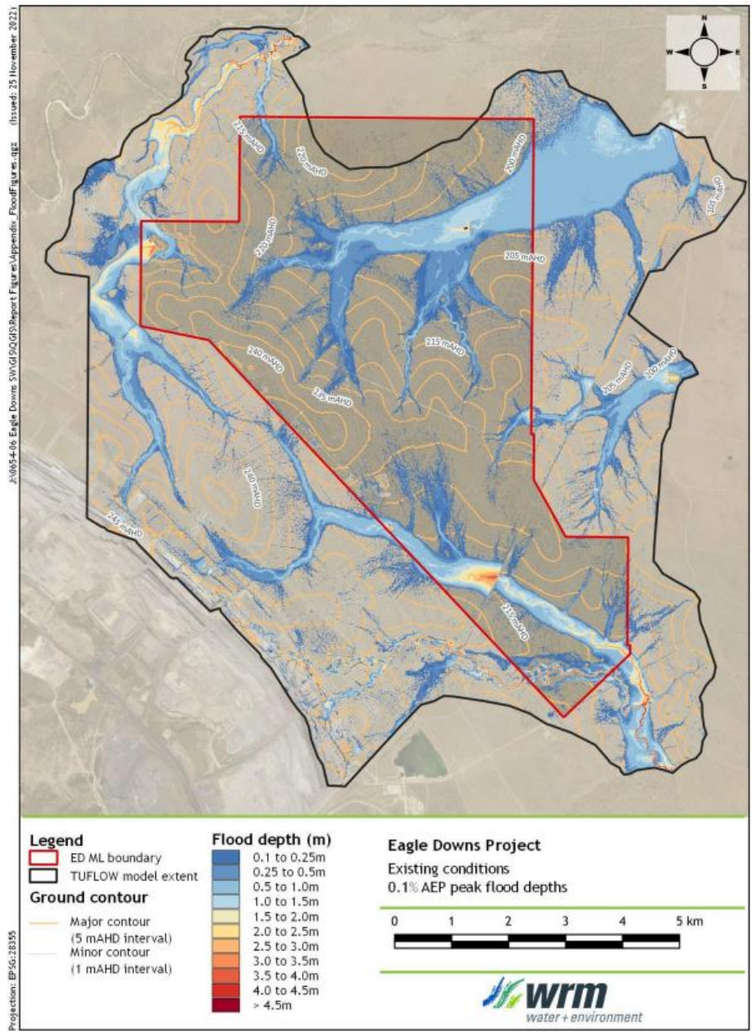
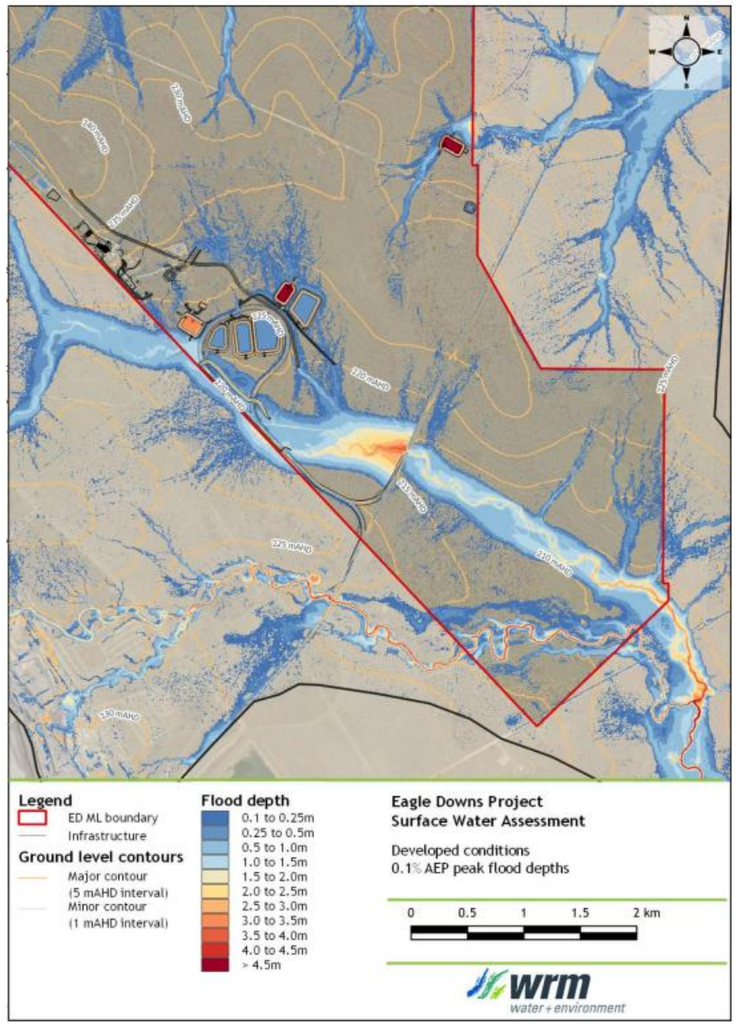


Figure 52 1% AEP Flood Depths (Existing Conditions and Mine Infrastructure)

Existing Conditions



Mine Infrastructure - Developed Conditions



Flood Impact – Mine Infrastructure Minus Existing Conditions

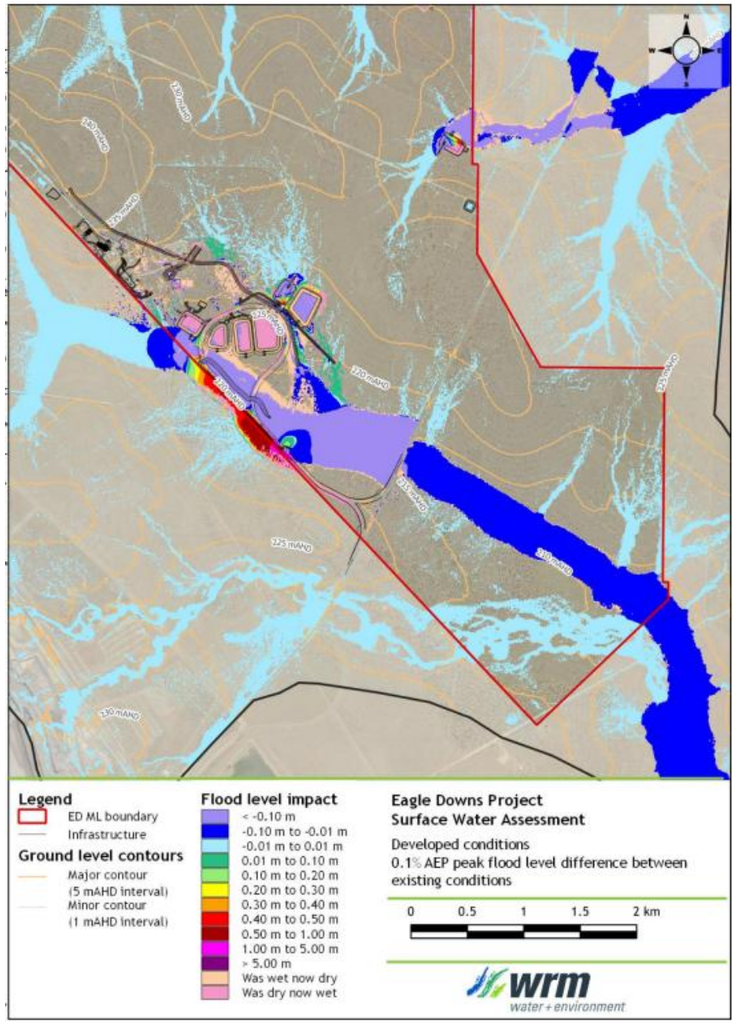
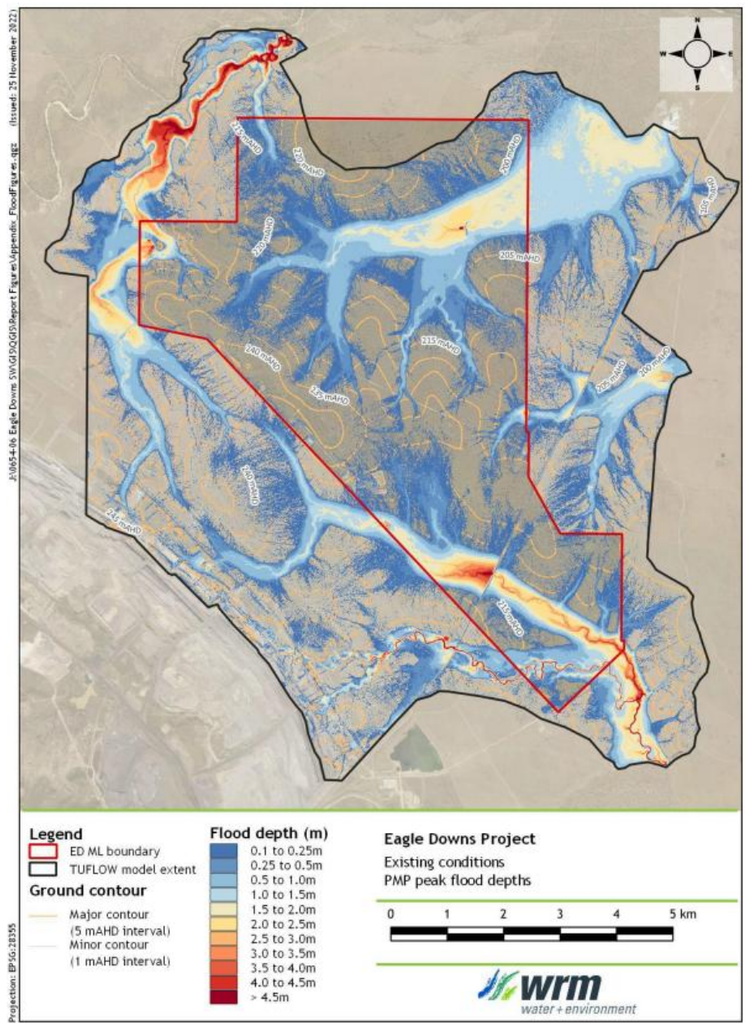
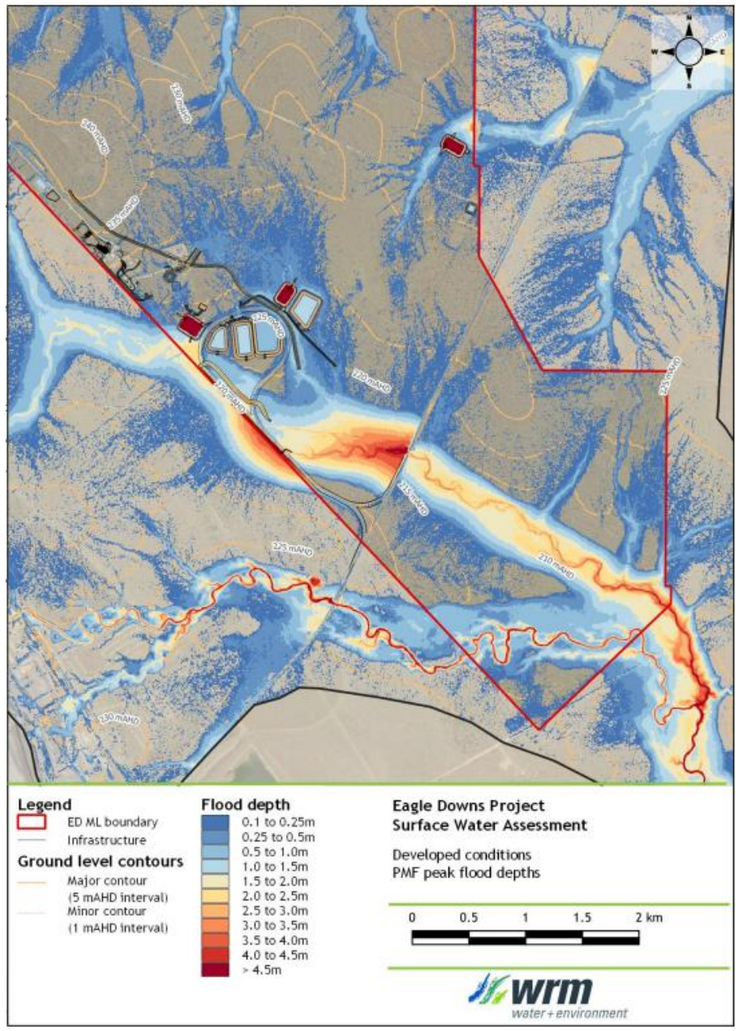


Figure 53 0.1% AEP Flood Depths (Existing Conditions and Mine Infrastructure)

Existing Conditions



Mine Infrastructure - Developed Conditions



Flood Impact – Mine Infrastructure minus Existing Conditions

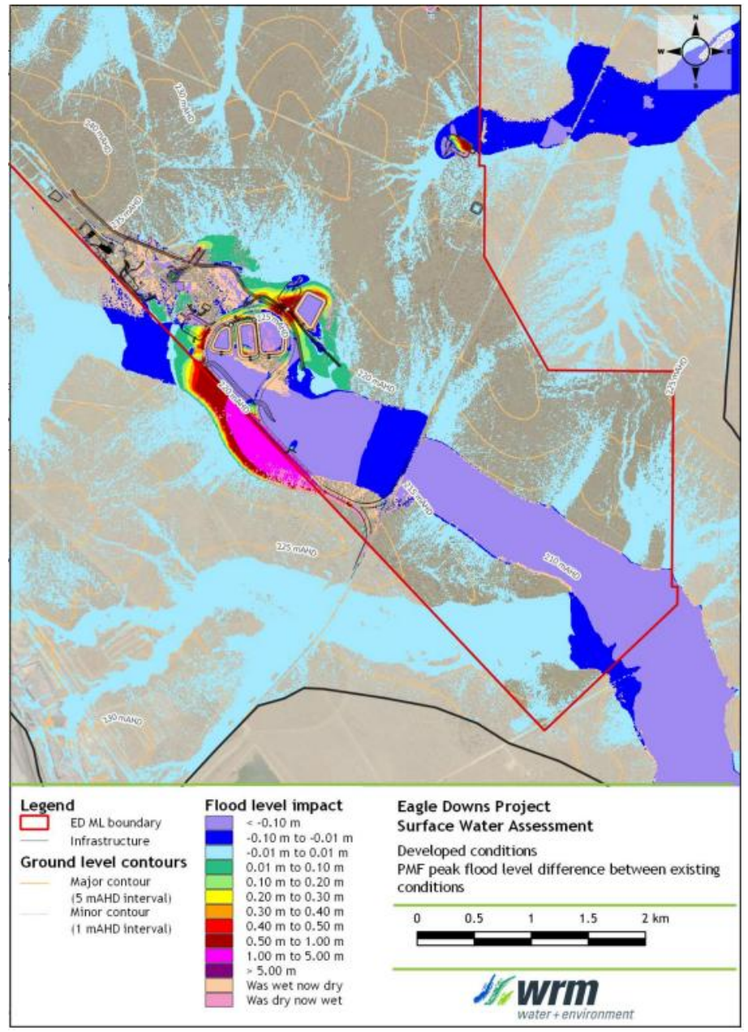


Figure 54 PMF Flood Depths (Existing Conditions and Mine Infrastructure)

Flood modelling for fully subsided conditions and final landform conditions for selected design events (63%, 50%, 10%, 1, 0.1% AEP and probable maximum flood (PMF) modelled scenarios) is shown in **Figure 55** to **Figure 61**.

Post-Subsidence Conditions

Flood Impact – Subsided (HCU, HCL & DY) minus Existing Conditions

Final Landform Conditions – Mitigated (Ultimate) Conditions

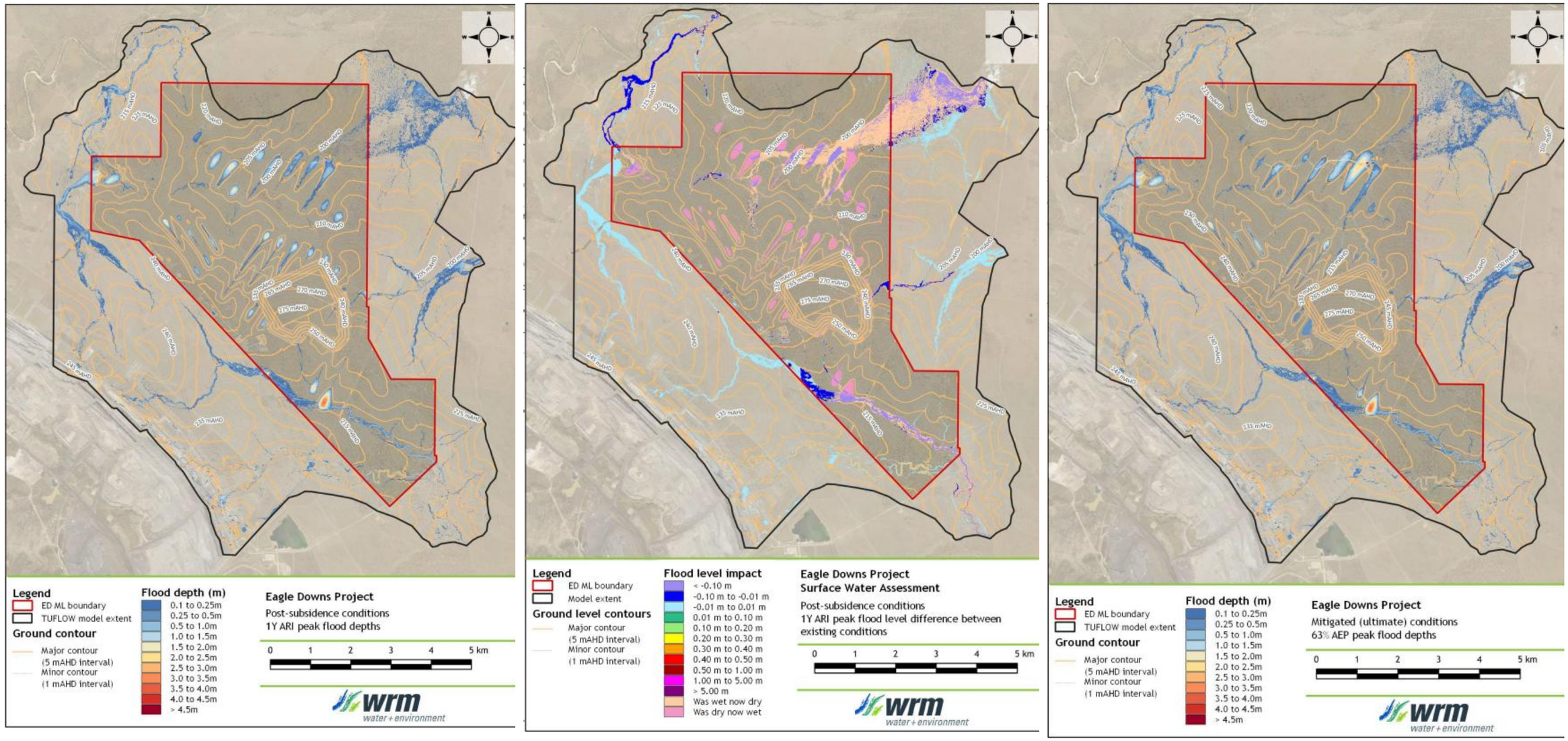


Figure 55 63% AEP Flood Depths (Subsided Conditions)

Post-Subsidence Conditions

Flood Impact – Subsided (HCU, HCL & DY) minus Existing Conditions

Final Landform Conditions – Mitigated (Ultimate) Conditions

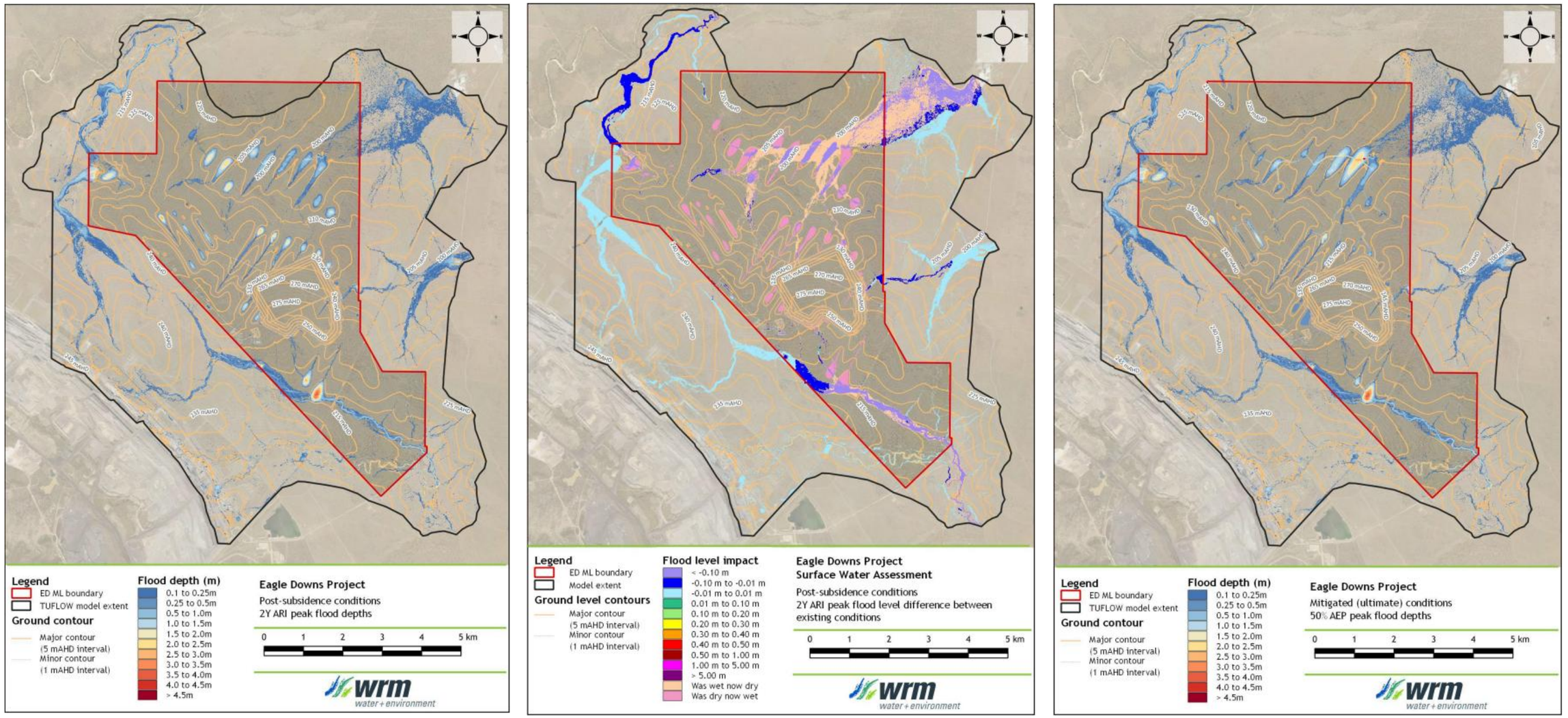
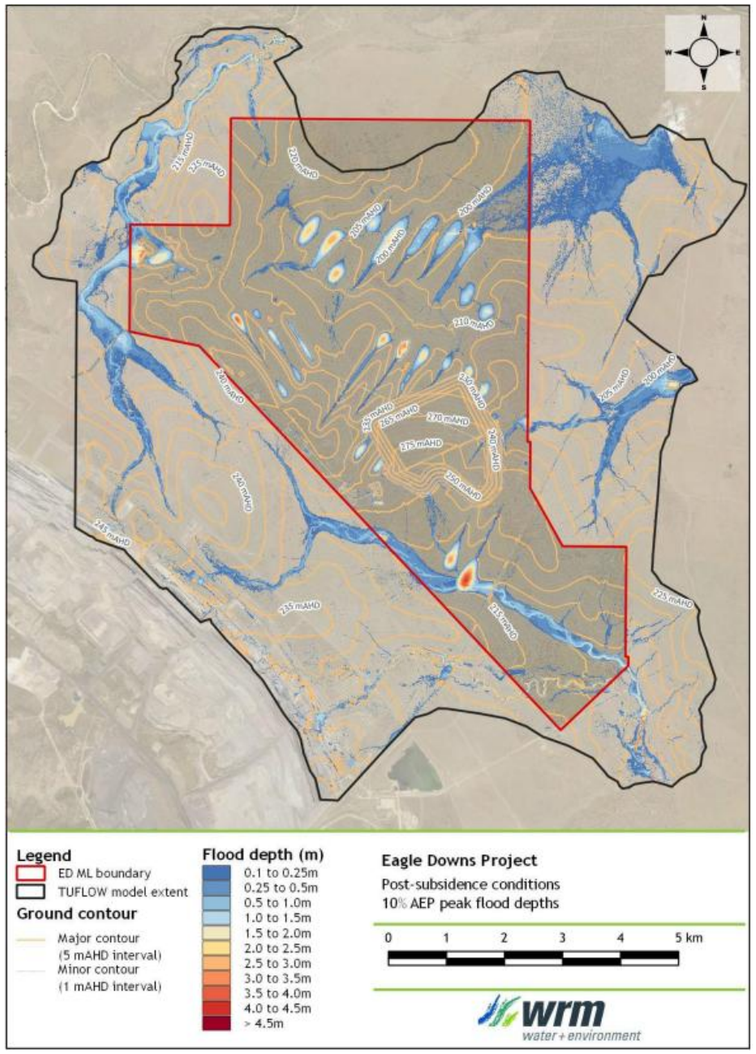
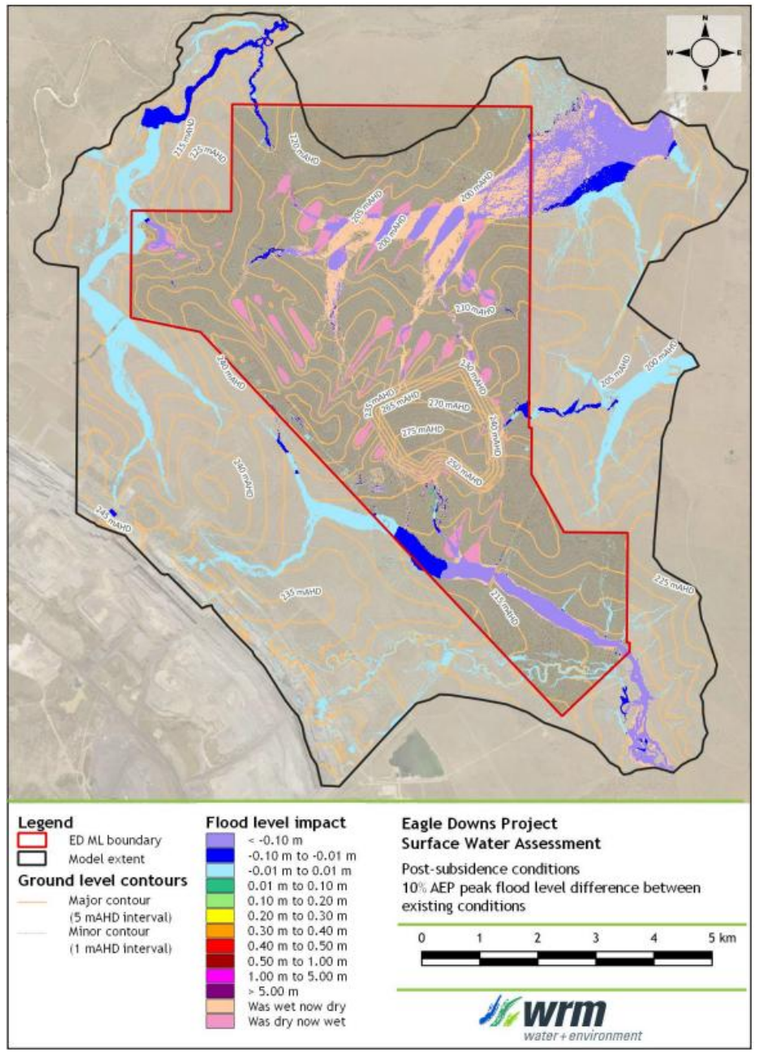


Figure 56 50% AEP Flood Depths (Subsided Conditions)

Post-Subsidence Conditions



Flood Impact – Subsided (HCU, HCL & DY) minus Existing Conditions



Final Landform Conditions – Mitigated (Ultimate) Conditions

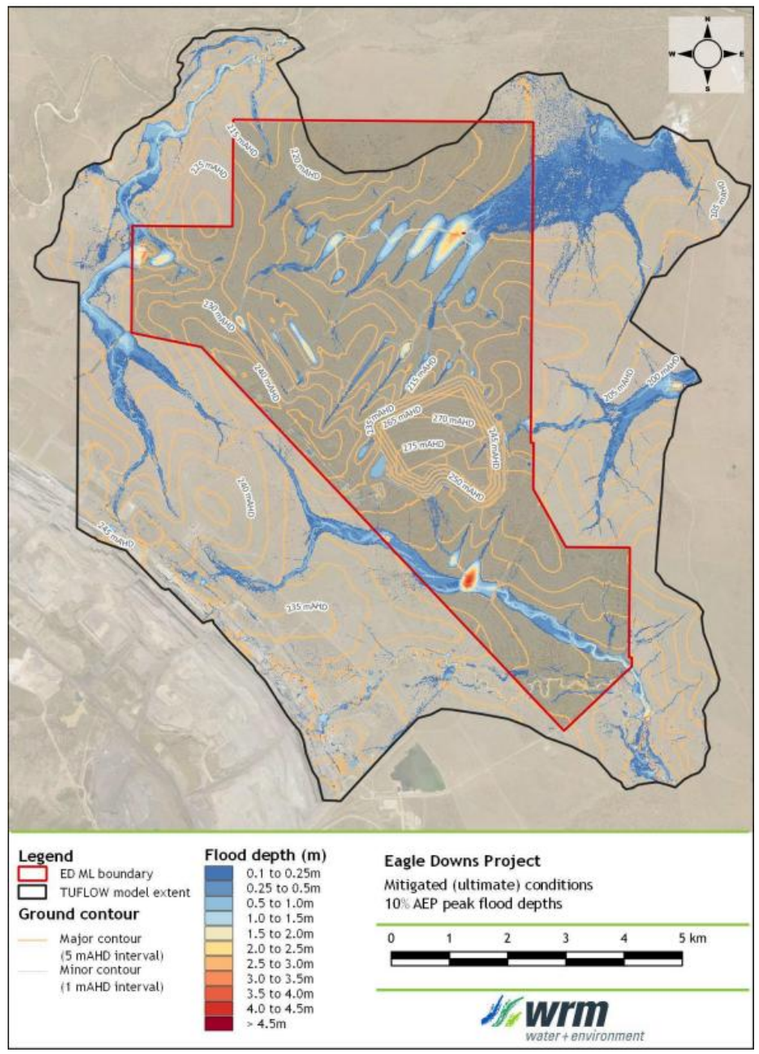


Figure 57 10% AEP Flood Depths (Subsided Conditions)

Post-Subsidence Conditions

Flood Impact – Subsided (HCU, HCL & DY) minus Existing Conditions

Final Landform Conditions – Mitigated (Ultimate) Conditions

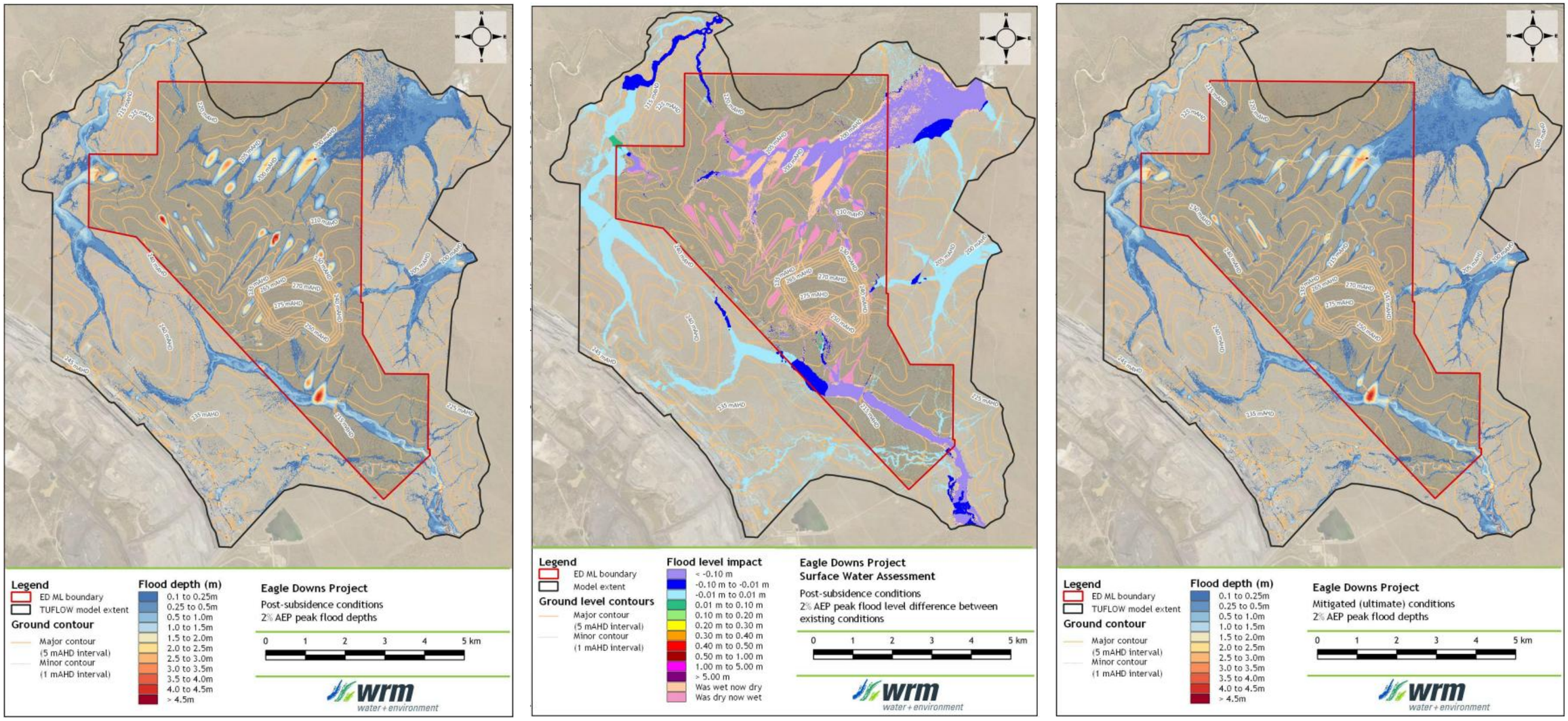


Figure 58 2% AEP Flood Depths (Subsided Conditions)

Post-Subsidence Conditions

Flood Impact – Subsided (HCU, HCL & DY) minus Existing Conditions

Final Landform Conditions – Mitigated (Ultimate) Conditions

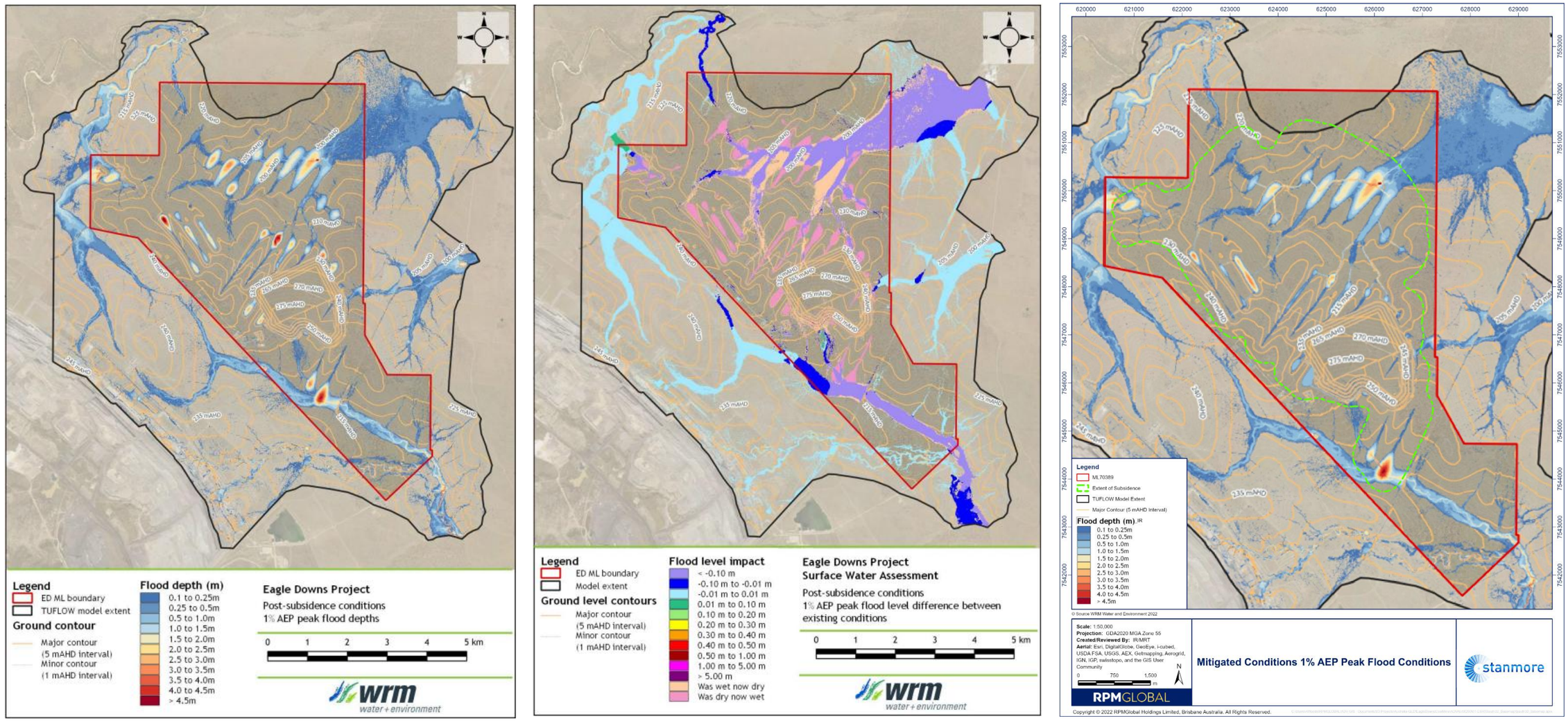


Figure 59 1% AEP Flood Depths (Subsided Conditions)

Post-Subsidence Conditions

Flood Impact – Subsided (HCU, HCL & DY) minus Existing Conditions

Final Landform Conditions – Mitigated (Ultimate) Conditions

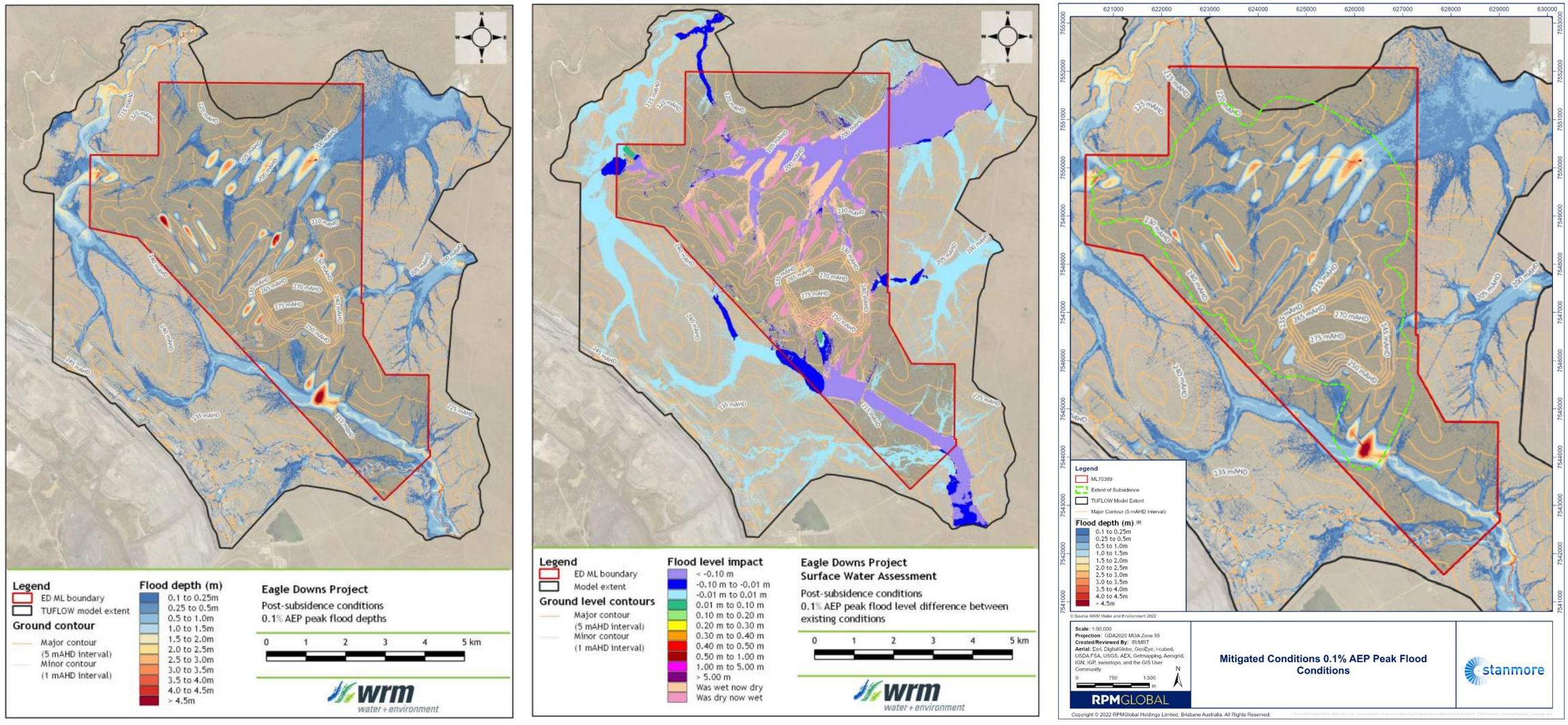
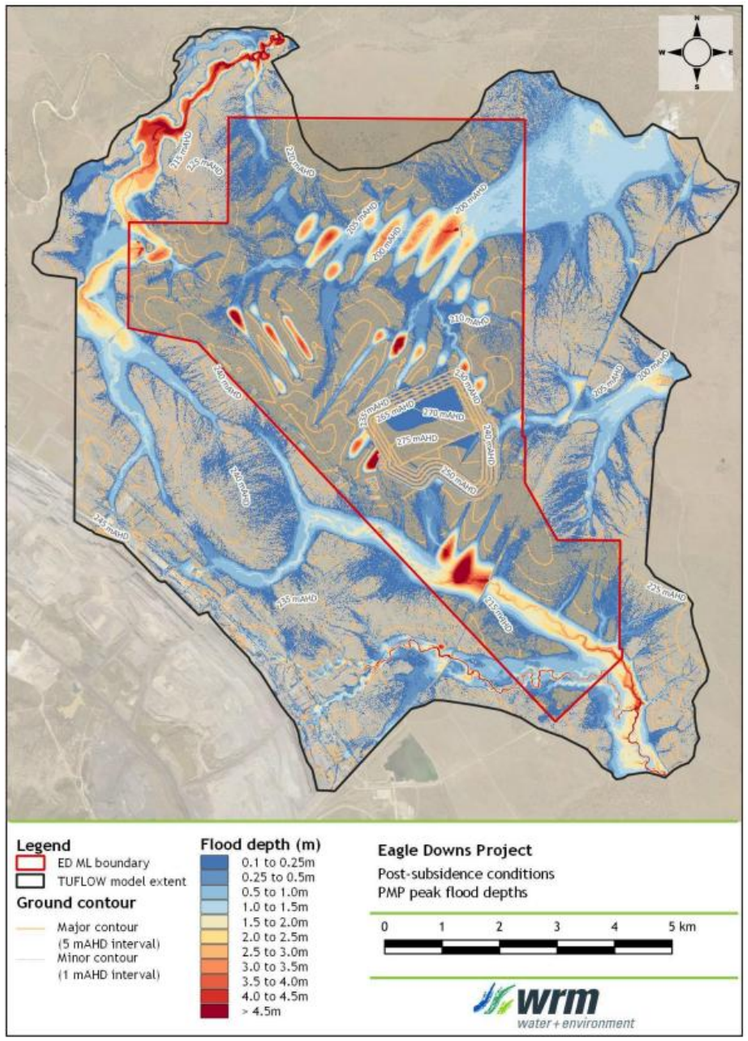
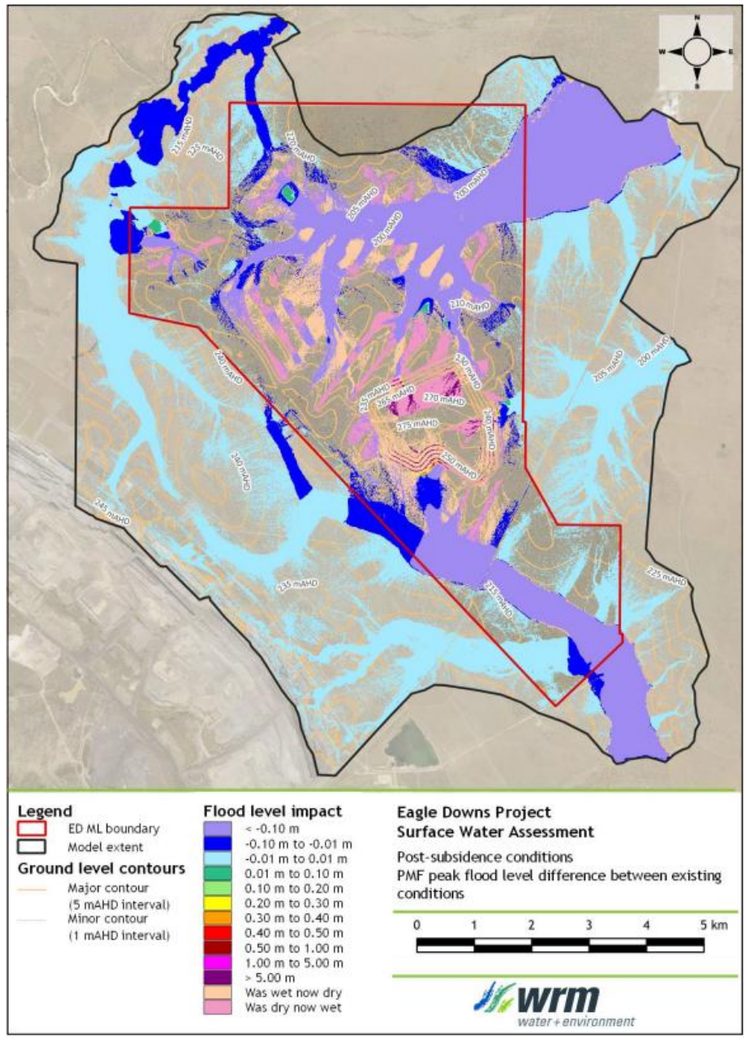


Figure 60 0.1% AEP Flood Depths (Subsided Conditions)

Post-Subsidence Conditions



Flood Impact – Subsided (HCU, HCL & DY) minus Existing Conditions



Final Landform Conditions – Mitigated (Ultimate) Conditions

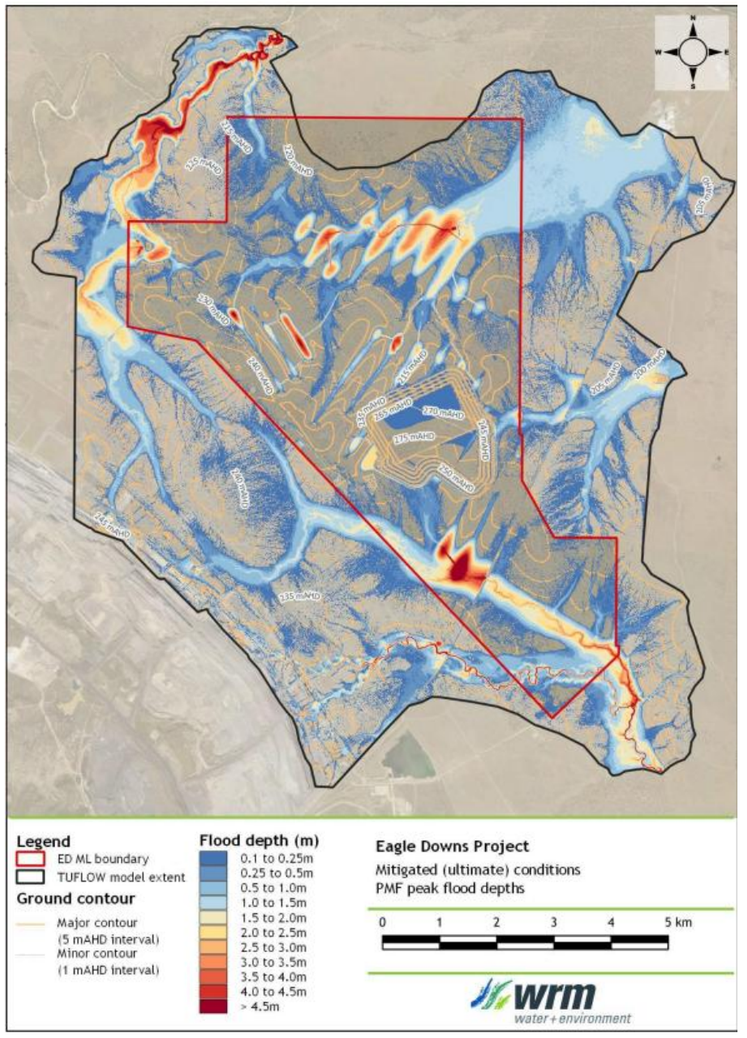


Figure 61 PMF Flood Depths (Subsided Conditions)

Alteration of Flow Upstream and Downstream

As part of WRM (2022) Surface Water Assessment (Appendix G), a downstream peak flow impact assessment was conducted (**Table 30**), by comparing existing and proposed final landform peak discharges at the Project boundary for Isaac River – "Feature 1" and Ripstone Creek catchment – "Feature 3" (noting that the impacts on "Feature 2" were observed as being minimal and therefore not shown) (Refer to **Figure 62**). The assessment assumes that ponding areas are empty at the commencement of the storm event.

Table 30 Comparison of Predicted Peak Discharges at Key Locations

Storm Event (% AEP)	Peak Design Discharges (m3/s)					
	Reach 1			Reach 3		
	Existing	Final Landform	% Difference	Existing	Final Landform	% Difference
63%	57.6	5.3	-91%	36.8	21.9	-41%
50%	88.5	11.0	-88%	59.1	41.1	-30%
10%	180.8	51.7	-71%	104.5	76.1	-27%
2%	273.0	96.3	-65%	163.9	135.0	-18%
1%	309.6	114.1	-63%	184.7	157.6	-15%
0.1%	607.4	240.2	-60%	328.1	264.6	-19%

An assessment of flood susceptibility and influence across site conducted by WRM (2022) found that (for subsided areas and final landform conditions):

- There would be a significant reduction in peak flows at the downstream boundary of the ML, particularly for the more frequent events. The flood peak is also significantly delayed due to the volume that the subsidence captures before releasing to the environment.
- "Feature 1", which is not a watercourse, drains in an ill-defined manner across the Winchester South MLA to the Isaac River. The reduction in peak flow will be significant (when the ponding areas are assumed to be empty) and is a residual impact of the Project.
- "Feature 3", which also is not a watercourse, drains into the Ripplestone/Ripstone Creek catchment. The proposed mining area occupies about 1,306 ha, or approximately 4.3% of the total Ripstone Creek catchment.
- The impacts on Isaac River catchment flows are not expected to be significant. The total disturbance footprint for the Project is 30.6 km^2 compared to around 4,100 km^2 in the Project area. There are also no baseflows in the Isaac River that would be impacted, and these catchments do not flow with baseflow.

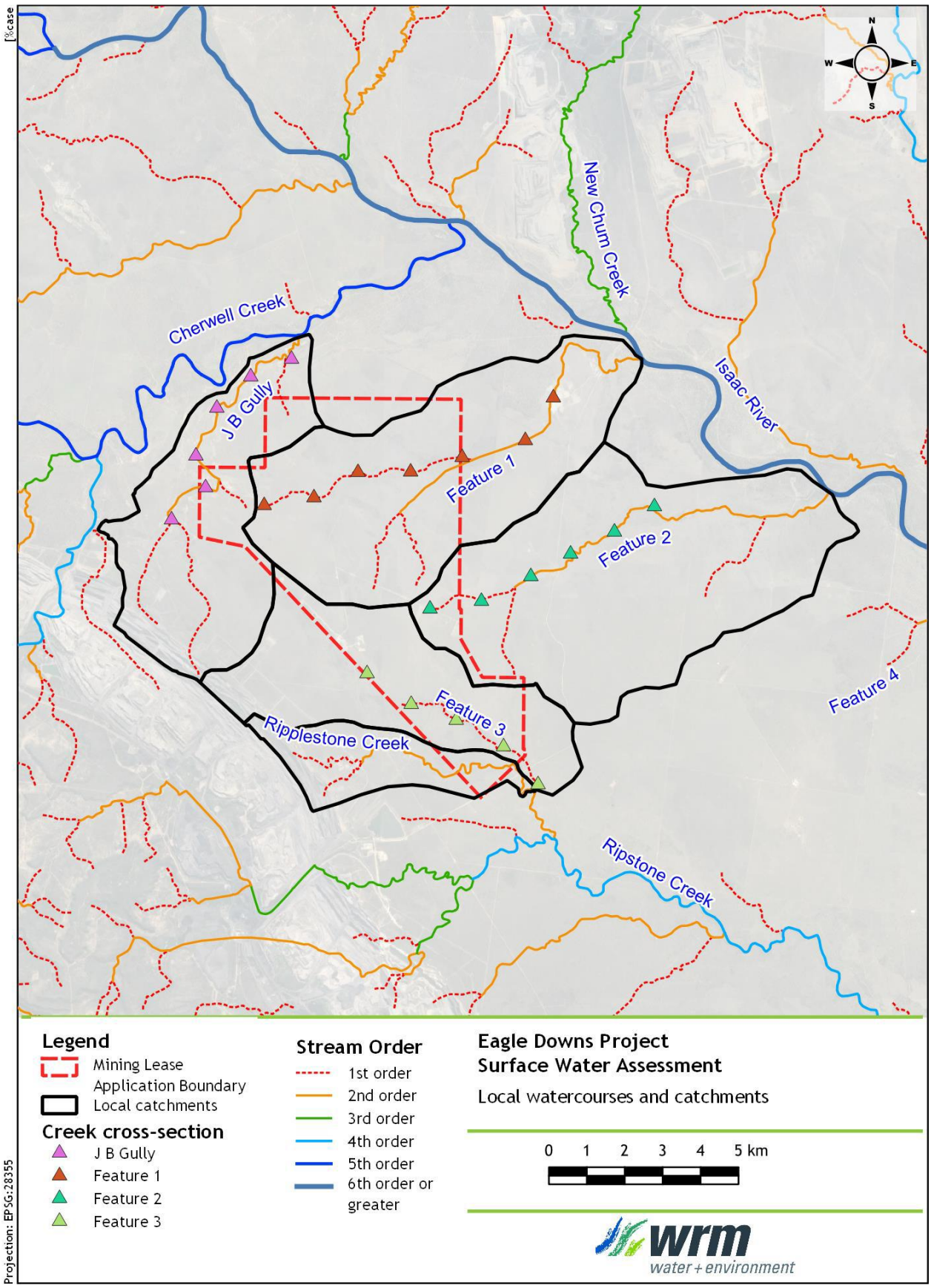


Figure 62 Local Waterway Catchments

Flood Risk Profile

The flood risk profile for EDCM is generally considered low based on modelling undertaken (WRM, 2022), but varies based on conditions. A TUFLOW two-dimensional hydrodynamic model was used to estimate the following flood characteristics consisting of depth, level and velocity for the Project area, and was undertaken for the following conditions:

- Existing conditions, which includes the existing mine infrastructure;
- Mine infrastructure conditions (in the Feature 3 catchment);
- Proposed fully subsided conditions (no mitigation); and
- Proposed final landform conditions.

Extract detailed outputs of the TUFLOW hydraulic flood model were developed for the post subsided landform, including:

- Water level;
- Depth; and
- Velocity.

Results of the flood modelling for mine infrastructure conditions show that flood levels would increase immediately upstream of the proposed rail spur. It is possible that this increase can be mitigated by upgrading this rail system. Upstream ponding would reduce downstream flood levels, though by only a small amount.

Modelling for final landform conditions with mitigation measures in place (subsidence drainage) indicate an increase in downstream peak flows, especially for Feature 1 where the majority of subsidence ponding occurs. The proposed drainage mitigation is expected to be responsible for this increase.

Risks/Impacts of Ponded Areas:

The revised mine plan will result in a total ponding area of 282.4 ha occurring during operations. Mitigation measures have been conceptualised to reduce the amount of water ponding to 77.5 ha. These include:

- The construction of drainage channels between areas of ponding; and
- The filling of ponded areas where the drainage channels may not be either practical or possible.

These measures will be undertaken following mining the HCL seam, which will result in the majority of subsidence, and therefore related ponding.

- A total of 206 ha of ponded area would be produced, with 180.6 ha mitigated by the construction of drainage channels, and the remaining 25.4 ha by filling.
- Residual ponding following mining of the HCL seam with the construction of drainage channels is expected to be 23.4 ha.
- Under proposed final landform conditions, residual ponding is expected to total 76.4 ha.

There are no watercourses that would be impacted by expected subsidence, however it has the potential to cause damage to vegetation through localised ponding. Changes in the water quality of ponded areas may occur through evapo-concentration, which may impact downstream overflows. Further detail on ponding mitigation measures are provided in Section 3.5.1.7.

The water balance model developed for the water management system assessment was extended to determine the ponded water quality and subsequent impacts on downstream flows. The model found the following:

- Residual ponds resulting from final landform depressions would contain <1 ML of water, 50% of the time with ponded water being lost through evaporation and soil infiltration.
- Salinity concentration of ponded water would not be above the threshold for drinking water quality for cattle.

- There would be no significant impact to the flows of JB Gully and Ripplestone Creek.
- The stream flow of Feature 1 along the lease boundary is expected to reduce by 33%, from 729 ML/year to 486 ML/year. Though there is a substantial impact to this feature, it is not a watercourse with defined beds and banks.

3.5.1.3 Soil and Capping Material Assessment

Soil Assessment

The DREA and mine infrastructure area are the two largest areas requiring topsoil stripping and material capping during rehabilitation.

An assessment of soil in the EDCM Project area was conducted by RGS in 2022. The assessment was done in accordance with recognised standards and guidelines (DME, 1995; AMIRA, 2002; DEHP, 2013; CoA, 2016; INAP, 2022).

Utilising existing soil survey and geological data as background information, RGS developed a soil sampling and analysis program (SSAP) to assist with characterising soil materials based on their geochemical, nutrient and physical properties. Seven topsoil stockpiles were established in the first phase of construction, prior to 2019 (listed in **Table 31**). In addition to these previously established topsoil stockpiles, soil samples deemed to be representative of materials to be used in soil covers during the rehabilitation phase at EDCM were also identified (listed in **Table 32** and shown in **Figure 63**).

Table 31 Topsoil Stockpile Sample Selection Program

Location	Stockpile Volume	Material Type	Depth	Number of Samples
EDC TS 01	31,538.0 m^3	Topsoil stockpile	0 - 0.2 m	5
EDC TS 02	11,301.0 m^3	Topsoil stockpile	0 - 0.2 m	2
EDC TS 03	11,301.0 m^3	Topsoil stockpile	0 - 0.2 m	2
EDC TS 04	3,920.5 m^3	Topsoil stockpile	0 - 0.2 m	2
EDC TS 05	7,378.5 m^3	Topsoil stockpile	0 - 0.2 m	3
EDC TS 06	1,300 m^3	Topsoil stockpile	0 - 0.2 m	1
EDC TS 07	5,000 m^3	Topsoil stockpile	0 - 0.2 m	2
Total				**17**

Table 32 Summary of Topsoil Sampling

Sampling Area	Sample Type	Number of Samples	Client ID
Topsoil stockpiles	Topsoil stockpile	17	TS01-1 to TS07-17
Underground portal area	In-situ	4	Natural 26-29
Undisturbed, vegetated areas	In-situ	3	Natural 30-32
DREA – 5 and 20 year shell	In-situ	5	DREA-21 to DREA-25
DREA – 50 year shell	In-situ	3	DREA-18 to DREA-20
Total		**32**	



Figure 63 Topsoil Surveyed Locations

Quantity and Quality of Soil Resources

The RGS (2022) report references a soil and land suitability assessment of ML 70389, conducted by GJR (2008) indicating that nine soil types are present across the EDCM project area. After collating and interpretation of soil test information, RGS (2022) identified that the two most appropriate classifications were 6-8 and 7-8g. These are summarised in **Table 33**. As surface geology of the project area influences the soil types that form through weathering, these are provided in **Table 34**. Soil classification in relation to surface geology is shown in **Figure 64**.

The locations of the DREA and underground portal sampling areas are also depicted in **Figure 64**. The DREA may contain up to four different soil types, whereas the underground portal area contains only one soil type. As identified in the detailed soil survey by GJR (2008), soils in the proposed five, twenty (20), and fifty (50) year DREA area layout are predominantly deep uniform clays (7-8 g) with the occasional duplex soils/cracking clays (6-8), loamy soils with heavy clay subsoils (6) and minimal black cracking clay (8).The soils in the underground portal area appear to be uniform and are comprised of deep uniform clays (7-8 g).

Table 33 Soil Classifications

Soil Type	Description	Australian Soil Classification (ASC)	Soil Classification	Overall Soil Quality	Limitations
6-8	Thin fine sandy to silt loamy surface with yellow-brown alkaline sodic medium to heavy clay subsoils, in association with dark grey or dark brown cracking clay soils.	Chromosols, Sodosols or Calcarosols (Type 6) **Vertosols (Type 8)**	NAT-31	Very good to excellent	None
7-8 g	Association of medium to deep uniform or gradational clays with hard coarse-structured subsoils and dark grey to dark brown with locally intensive linear gilgai formation.	Dermosols or Hydrosols (Type 7) **Vertosols (Type 8)**	TS01 to TS07, NAT-26 to NAT-30, and all DREA	Excellent Class 2A	None

Table 34 Surface Geology

Geological Code	Description
Qr	Quaternary Colluvial and Slopewash Deposits and Alluvium on watercourses, terraces and minor floodplains.
Qrb	Quaternary residual Soil and Colluvial Deposits mainly black soils derived from basalt
TQa	Tertiary-Quaternary Older Alluvial Deposits in tributary and major stream valleys, comprising poorly consolidated sediments, sand, silt, clay and minor gravel
TQr	Tertiary-Quaternary Residual Soils and Colluvial Deposits clay, silt, sand and gravel
Rr	Triassic Rewan Group lithic sandstone, pebbly lithic sandstone, green to reddish-bown mudstone and minor volcanilithic (basal) pebble conglomerate
Pwi	Permian Rangal Coal Measures calcareous sandstone, calcareous shale, mudstone, coal, and some concretionary limestone
Pwt	Late Permian Fort Cooper Coal Measures (Pwt): lithic sandstone, conglomerate, mudstone, carbonaceous shale, coal and tuffaceous (cherty) mudstone.

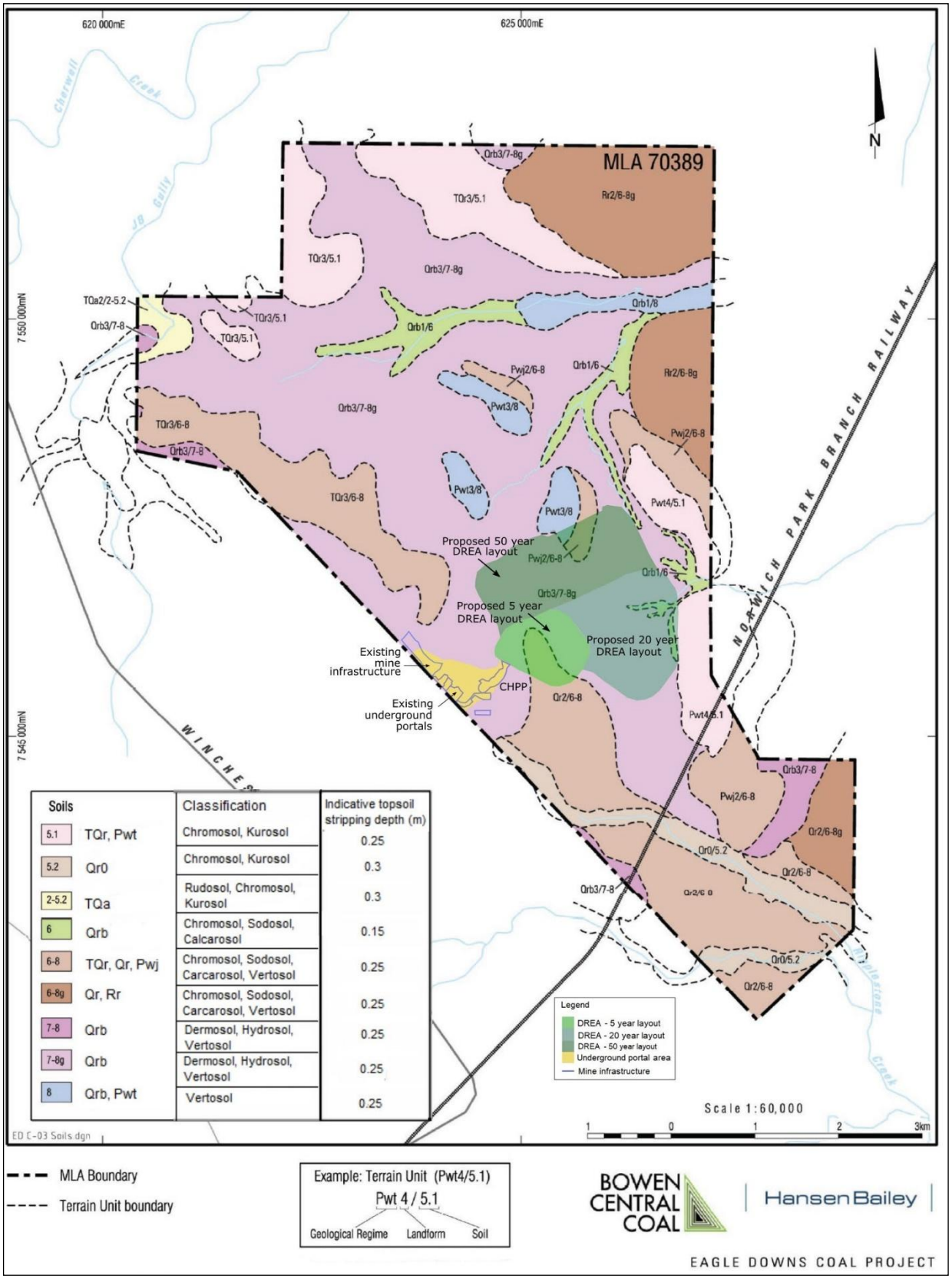


Figure 64 Location of DREA and Underground Portal Sampling Areas Relative to Soil Survey (RGS, 2022)

Figure 65 shows the location of topsoil stockpiles sampled. Topsoil stockpile EDC TS 01 soil type is duplex soils/cracking clays (6-8) whilst stockpiles EDC TS 02 to EDC TS 07 is characteristic of deep uniform clays (7-8 g).

Based on proposed site disturbance, the site has approximately:

- 54,000 m^3 of topsoil available from construction and infrastructure disturbance; and
- 1.08 Mm^3 of topsoil resulting from the progressive construction of the DREA area.

This results in a total topsoil volume of approximately 1.13 Mm^3. Section 3.5.1.5 estimates that 1.7 Mm^3 will be required for the DREA, leaving a shortfall of 0.57 Mm^3, not including the other infrastructure areas.

Soil material that is currently considered marginal for use as topsoil (on its own) exists, and this material may be used to supplement topsoil volumes (GJR, 2008). ATCW (2023) also anticipates that a topsoil rock mix (30% rock cover), that can be sourced from mine spoils, will be suitable for using as growth medium.

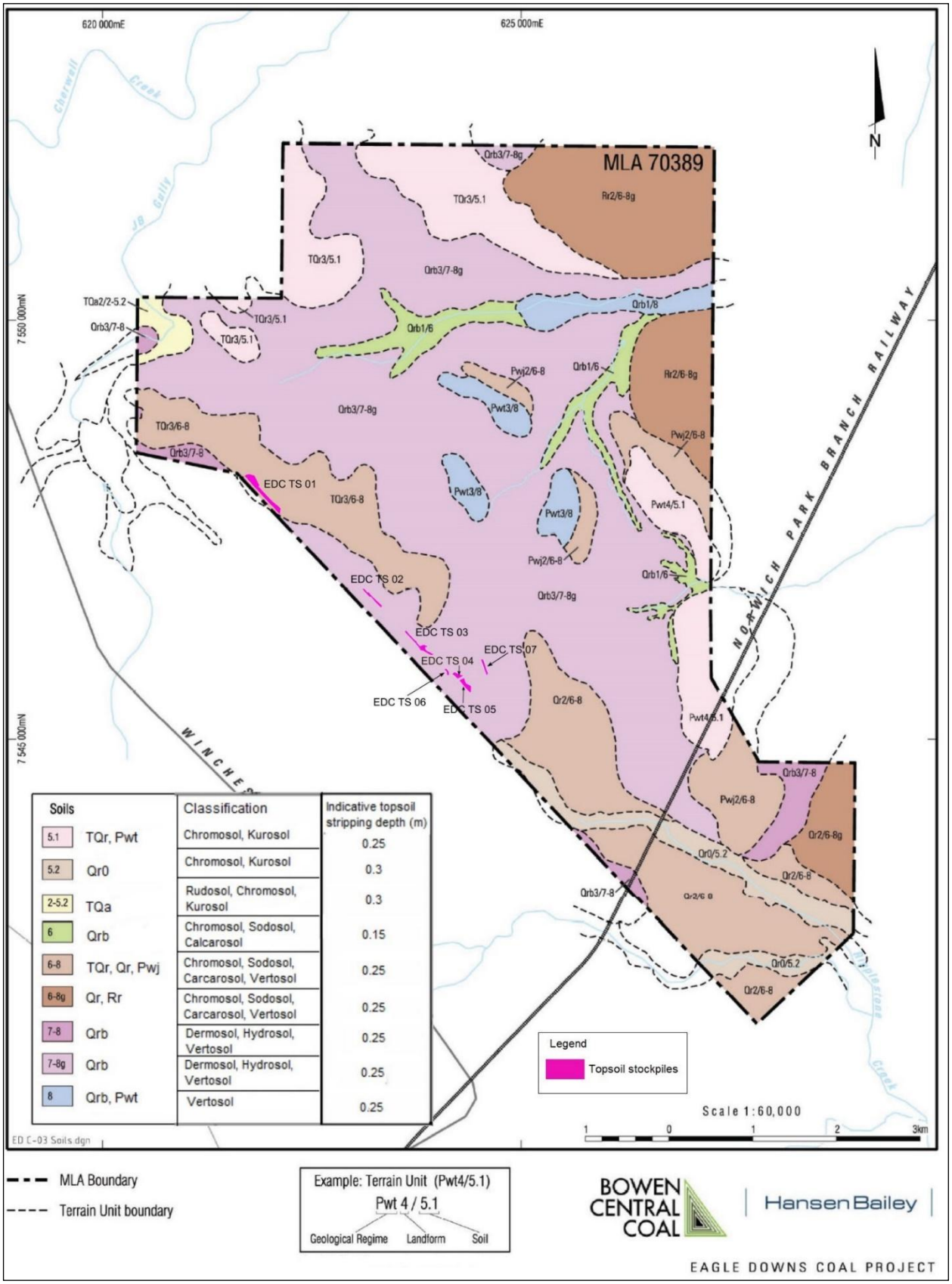


Figure 65 Location of Topsoil Stockpiles Relative to Soil Survey

Location and Accessibility of Cover Material

The topsoil stockpile locations are provided in **Figure 65**. Cover material will be sourced from underground waste material.

Prior to moving topsoil onsite, the EDCM Topsoil Management Plan and Sediment and Erosion Control Plan (Eagle Downs Coal, 2015) will be consulted.

All topsoil and cover material is located on the EDCM ML and no other approvals are required. With respect to haul distance, the EDCM MCP indicates that topsoil stockpiles will be located an average of 1 km from areas requiring topsoil return.

Topsoil Stripping

All land clearing activities will be conducted on a progressive basis. Clearing of vegetation will be conducted using dozers and, where appropriate, woody vegetation will be stockpiled for later use in rehabilitation activities.

- A topsoil stripping assessment must be carried out in advance of topsoil stripping to confirm the accuracy of the pre-mine topsoil survey data. If the topsoil assessment identifies discrepancies against pre-activity data, further survey work may be required, including:
  - Topsoil depth confirmation;
  - Possible additional laboratory analysis to confirm suitability (pH, EC, Cl-, Cation Exchange Capacity (CEC) and Cations); and
  - Dispersion characteristics for erosion potential.
- The results of the topsoil stripping assessment are required to develop the Topsoil Stripping Plan. This plan is mandatory for each stripping regime to ensure that the maximum amount of soil can be stripped for future use in rehabilitation activities and minimise the mixing of topsoil with subsoil materials in stockpiles.
  - The Topsoil Stripping Plan will detail volume calculations and either direct placement or stockpiling locations.

Topsoil Stockpiling

Stockpiles will be located away from mine traffic, cattle and the flooding zone of drainage lines and waterways.

- Topsoil will be segregated into stockpiles may contain at least some native seed source.
- Topsoil stockpiles that potentially contain significant native seed (i.e. from non-pasture improved areas) will be used in preference to other stockpiled resources, wherever possible, to obtain maximum benefit from the available seed stores; providing this fits with the rehabilitation plan of soil and cover types required.
- Topsoil stockpiles containing predominantly surface soil material (typically material stripped from the upper 0.1m-0.3m soil depths) will be formed no more than 1.5m in height where the stockpile area is available and no more than 3m in height where area is not available and should be immediately deep ripped and seeded to native species (not pasture improved species) following laydown.
- All topsoil stockpiles will be regularly surveyed and recorded in the topsoil stockpile inventory, which identifies their age, date of stockpiling, information relating to treatment such as species sown and fertiliser, and soil unit.
- Soil erosion and dust generation on topsoil stockpiles will be minimised by the following measures:
  - Encouraging vegetation especially groundcover species to become established on the upper surface and batters of stockpiles.
  - The soil seed will be allowed to become established.
  - Stockpiles will not be constructed in waterways and where possible will be located across the slope.
  - In the unlikely event that topsoil stockpiles become significant sources of dust, a water truck fitted with a water cannon or side sprays will be used to suppress dust generation.

  - Topsoil stockpiles will be located away from vehicle traffic and driving on stockpiles will be prohibited. Cattle and other grazing animals will be excluded from gaining access to the stockpiles.
  - All topsoil stockpiles will be located within the flood protection levee and will be constructed with adjacent sediment dams to collect and return settled sediment.
- Stripped materials (whether topsoil or root zone material) will be segregated into stockpiles, which have similar reuse characteristics. Soils with good surface physical characteristics should not be stockpiled with soils where poorer physical attributes are indicated.
- Stripped materials (whether topsoil or root zone material) will be segregated into stockpiles, which have similar textural characteristics (i.e. clays should not be stockpiled with loams or sands).
- Root zone material will be salvaged from all disturbed areas where suitable material has been identified, and stockpiled separately from the topsoil.
- Root zone material can be stockpiled to greater depths than those specified for topsoil; and
- Root zone stockpiles will only be constructed in areas from which topsoil has first been stripped. Stockpiles will be ripped and seeded following laydown to stabilise and protect the material.

Topsoil Assessment

Laboratory analysis conducted as part of the topsoil stripping process will be used to selectively place topsoils. More erodible soils will be placed on flatter areas or treated with additives that stabilise the landform. Soils that lack a suitable growth medium may be treated with additives to assist in vegetation establishment.

Topsoil Application

Reject material will be reshaped to final landform. This will include the construction of erosion and sediment control structures in accordance with the EDCM Erosion and Sediment Control Plan.

- Dependent on subsoil and topsoil availability, first place subsoil followed by topsoil to a depth as prescribed in the topsoil reconciliation. In general, all soils used in rehabilitation will be applied with a minimum thickness of 200mm.
- Selectively place more erodible topsoil material on flatter areas and not on steeper slopes, to minimise the potential for erosion.
- Treat topsoil for any unstable properties, including the application of gypsum.
- Contour rip to encourage rainfall infiltration and minimise run-off.
- Soon after respreading, if natural germination does not occur, seed with sterile cover crops and pasture grasses and/or native tree species to establish revegetation cover.
- Regularly inspect rehabilitation areas for landform stability, erosion, weeds and suitable species diversity.
- Manage accordingly.

Ameliorants and Fertilisers

RGS (2022) characterised soil materials based on their geochemical, nutrient, and physical properties to determine the need for ameliorants and fertilisers. The key study findings are summarised as follows:

- The static geochemical test results demonstrate that the soil samples have negligible potential to generate acid and generally have excess buffering capacity. Soil samples are classified as Non-Acid Forming (NAF) (Barren).
- Geochemically, inherent acid-producing minerals are low, but there is some minor variation in buffering capacity based on calcite content.
- Soil samples do not contain any significantly enriched concentrations of total metal/metalloid concentrations compared to applied guideline values and/or un-mineralised soils.
- The concentration of dissolved trace metals/metalloids released into initial contact water is low and typically below the laboratory Limit of Reporting (LOR). A minor exception is Fluorine (F) that has a

dissolved concentration in a few soil samples slightly above the applied Livestock Drinking Water guideline value (ANZG, 2018), but is likely to be naturally occurring.

- The soil quality assessment verifies that the soils have moderate cation exchange capacity, are non-sodic, and contain sufficient exchangeable cations and nutrients for plant growth.
- The soils classify as Class 2A soils based on salinity and sodicity and have no expected limitations.
- Physically, the soils are rich in clay with lesser proportions of silt and sand, and therefore have good moisture and stability characteristics suitable for most earthworks.
- All soil samples are classified as Vertosols and contain shrink/swell clays (montmorillonite) that may show some cracking when dry.
- Topsoil stockpiles show a slight increase in potential nutrients and buffering capacity over in-situ soil samples from the underground portal and DREA areas.
- All soil samples assessed are expected to be suitable for use as rehabilitation materials.

According to RGS (2022), the predominant soil type across EDCM project area (that will be recovered, stockpiled, and reapplied for rehabilitation purposes) are vertosols. Vertosols are defined as soils with a clay texture of 35% or more clay with thin surface crusty horizons 0.03 m thick. These clay soils have strong shrink-swell properties that exhibit cracking when dry, as well as slickensides and/or lenticular peds and may exhibit gilgai microrelief. Vertosols are very common in Australia and are often calcareous throughout.

Relationship Between Soils and Vegetation Ecosystems

As summarized in the preceding section, the topsoil material to be utilised for revegetating the areas on the EDCM are vertosols that have high soil fertility, a large water holding capacity, and a good ability to supply plant nutrients. The soil samples indicate the growing material to be suitable for growing plants. Vertosols are prized for their agricultural value and make excellent rehabilitation soils (QLD Govt, 2013).

An assessment by an AQP to determine the need for ameliorants and fertilisers will be done prior to sowing seed, to establish necessary soil amendments. There are currently no guidelines on soil fertility for mining soils. Instead, mining sites should compare the nutrient quality of soils from undisturbed areas (e.g., soil survey data) with topsoil stockpiles to verify whether the disturbance and long-term storage has adversely impacted their nutrient content.

The revegetation species selected for the site (Section 3.5.1.8) and the PMLUs are species selected from locally derived regional ecosystems occurring on the site. These species have been selected to have a high likelihood of successful germination, growth, and reproduction on the site.

3.5.1.4 Waste Characterisation

Adequacy of Waste Characterisation Sampling

RGS (2022) completed a geochemical and physical characterisation of drift spoil, coal and coal reject materials as part of baseline studies and to provide input into the PRC Plan for the EDCM project (Appendix H). Sampling and geochemical characterisation of the materials from the Project were guided by Australian technical guidelines for the geochemical assessment of mine materials (RGS, 2022). Subsequently, RGS and EDCM personnel adopted the following strategy to collect and geochemically characterise representative samples for the EDCM Project:

- Drift spoil samples comprising overburden, interburden, roof and floor were collected;
- Coal samples were obtained from selected drill holes (and sent to RGS to coordinate a series of geochemical and physical tests at RGS and commercial laboratories); and
- Coal reject samples were prepared by ALS Richlands coal quality laboratory from drill core representing working sections of target coal seams.

Sample materials collected (57 in total) to perform geochemical testing of the EDCM Project area are described in **Table 35**.

Table 35 Sample Materials Used for Geochemical Testing

Sample Description	Drill Hole ID	Min. Depth (m)	Max Depth (m)	Number of Samples
Coarse Reject	ED0318, ED0321, ED0322, ED0324, ED0326, ED0329, ED0330	Unknown	Unknown	22
Fine Reject	ED0322, ED0326, ED0329 ED0330, ED0332, ED0333	Unknown	Unknown	10
Overburden	ED0109	101.5	230.9	6
Interburden		254.5	406.8	9
Roof/Floor		281.5	414.8	6
Coal		173.9	375.0	4
Total				**57**

As indicated by RGS (2022), 32 raw float-sink samples (22 coarse reject and 10 fine reject samples) from the coal quality laboratory were amassed from nine drill holes providing lateral coverage of the underground mining area. They were selected to best represent the coal reject materials (mixed coarse reject and fine reject) likely to be produced at the mine and report to the coal reject surface storage area.

A total of 25 drift spoil and coal samples consisting of overburden, interburden, roof, floor and coal samples were obtained from an existing geotechnical drill hole (RGS, 2022). The location of the 10 drill holes sampled at the Project is provided in Figure 66. The coal reject samples were processed from working sections of the HCU and HCL seams. The drift spoil samples from the geotechnical drill hole consisted of:

- Overburden and interburden from sandstone, siltstone, and mudstone lithologies, with carbonaceous and coal inclusions in sandstone;
- Siltstone and mudstone characteristic of the roof and floor; and
- Uneconomic coal samples encountered in the drill hole from non-target seams (RGS, 2022).

The drift spoil, coal and coal reject samples were crushed and sub-sampled, and the sub-samples then pulverised to pass a 75 µm sieve size for static Acid Base Account geochemical testing. This standard laboratory procedure provides a homogenous sample, but also generates a large sample surface area in contact with the resultant assay solution, thereby providing greater potential for dissolution and reaction, and represents an assumed initial 'worst case' pore water scenario for these materials (RGS, 2022). A summary of the methodology used to complete the assessment involved (RGS, 2022):

- An assessment of previous soil survey and geological data for site - to inform the sampling and analysis program;
- A static and kinetic geochemical testing program; including acid base accounting (ABA), multi-element testing, assessment of element enrichment in solids, multi-elements in solution and water quality kinetic tests - to better understand geochemical characteristics and any potential issues relating to acid and metalliferous mine drainage (AMD), specifically.

  Static Testing:

  – ABA parameters:
    - pH (1:5 sample:water (w:v)) (AMIRA, 2002);
    - Electrical Conductivity (EC) (1:5 sample:water (w:v)) [electrometric];
    - Total sulfur [High temperature combustion method];
    - Sulfide sulfur (Chromium Reducible Sulfur (Scr)) [AS 4969.7, 2008 method]; and

- Acid Neutralising Capacity (ANC) [Sobek method].

– Multi-element analysis:
  - Total metals/metalloids: (Al, As, B, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Sb, Se, Th, U, V, Zn) [HCl and HNO3 acid digest followed by FIMS and/or ICP-AES/MS];
  - Total cations (Ca, Mg, Na and K) [HCl and HNO3 acid digest followed by ICP-AES/MS];
  - Soluble metals/metalloids (Al, As, B, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Sb, Se, Th, U, V, Zn) [ICP-AES/ MS and FIMS (1:5 w:v water extracts)];
  - Major cations (Ca, Mg, Na and K) [ICP-AES/MS (1:5 w:v water extracts)];
  - Major anions (Cl, F and SO4) [ICP-AES/MS and PC TitratorTM (1:5 w:v water extracts)]; and
  - Titratable alkalinity and acidity [automatic titrator measured as CaCO3].

Kinetic Testing:

– Kinetic Leach Column (KLC) tests:
  - pH and EC;
  - Acidity and alkalinity [PC Titrator];
  - Dissolved metals/metalloids (Al, As, B, Cd, Cr, Co, Cu, Fe, Pb, Mn, Mo, Ni, Sb, Se, Th, U, V, Zn) [ICPAES/MS];
  - Dissolved major cations (Ca, Mg, Na and K) [ICP-AES/MS]; and
  - Dissolved major anions (Cl, F, SO4, alkalinity) [ICP-AES/MS].

- Soil class characterisation; including cation exchange capacity (eCEC), exchangeable sodium percentage (ESP) and sodicity and soil classification plots;
- Physical characterisation of selected drill core samples (drift spoil materials consisting of overburden, interburden, roof, floor and coal samples); including particle size distribution (PSD), soil texture, Emerson Aggregate class test, point load strength, sodium soundness and semi – quantitative x-ray diffraction - to understand the stability of materials to be used in the final landform (ensuring they are safe, stable and sustainable); and
- Coal quality database assay data provided for three target coal seams from Harrow Coal Upper (HCU), Harrow Coal Lower (HCL) and Dysart (DY) seams of the MCM from the principal economic coal resources of the EDCM Project – to plot statistical analysis, histogram distribution and boxplots of total sulfur results.

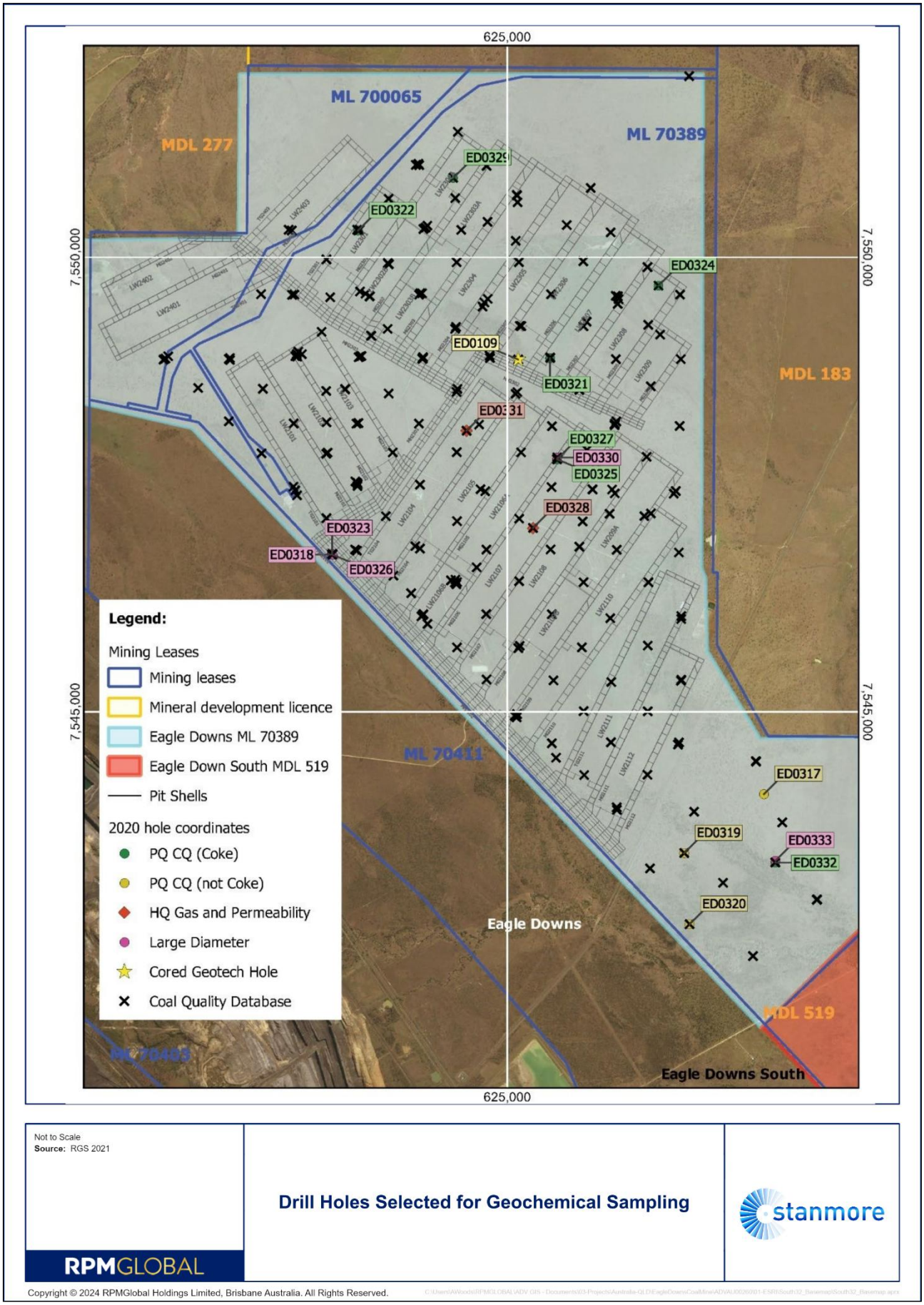


Figure 66 Drill Holes Selected for Geochemical Sampling

Mine Materials and Waste to be Generated

The main findings of the geochemical and physical assessment (i.e., mine materials likely to be generated at the EDCM Project (RGS, 2022)) are:

- The overburden and interburden (drift spoil) materials are typically classified as NAF Barren, have excess acid neutralizing capacity (ANC) and are essentially devoid of sulfide sulfur. These samples have a very low risk of acid generation and a high factor of safety with respect to potential for acid mine drainage (AMD).
- The roof, floor, coal and coal reject samples can have slightly higher sulfide sulfur content and generally have excess ANC and are mostly classified as non-acid forming (NAF). As a bulk material, these sample types have a relatively low risk of acid generation and a high factor of safety with respect to potential for AMD. Some samples have an elevated sulfur content compared to background concentrations (and may be a source of sulfate and neutral mine drainage (NMD) in pore water and potentially contact water).
- Initial and ongoing surface runoff and seepage from mine materials are expected to be pH neutral to moderately alkaline and have a low to moderate level of salinity. The salinity of leachate from materials with elevated sulfide content could increase over time if left unmanaged and exposed to oxidising conditions and could be a source of dissolved sulfate and NMD.
- Comparing the results with National Environment Protection Council (NEPC) guideline values and median crustal abundance values indicates that the mine materials are not significantly enriched with metals/metalloids.
- Most metals/metalloids are sparingly soluble at the pH neutral to moderately alkaline pH of the leachate from mining materials.
- Overall, the potential risk of any significant impact on the quality of surface water and groundwater from water in contact with material represented by the samples tested at the Project will be low.
- Overburden and interburden (spoil) materials should be amenable to revegetation as part of rehabilitation activities.
- For sodic materials, the addition of gypsum, fertiliser and organic matter and topsoil may need to be considered on steeper slopes of final landforms to limit the potential for dispersion and erosion and to provide a reasonable growth medium for revegetation and rehabilitation.
- Some consideration should also be given to the merits of contour ripping and rock mulching on steeper slopes.

Particle Size Distribution

RGS (2022) conducted particle size distribution (PSD) testing of four composite samples (comprised of 57 samples). The results of the four composite samples are provided in **Figure 67**. Results indicates that KLC 2 (fine rejects) has a finer particle size (Φ50% = 0.10 mm) compared to KLC 1, 2 and 3 (Φ50% between 1.15 mm - 1.88 mm).

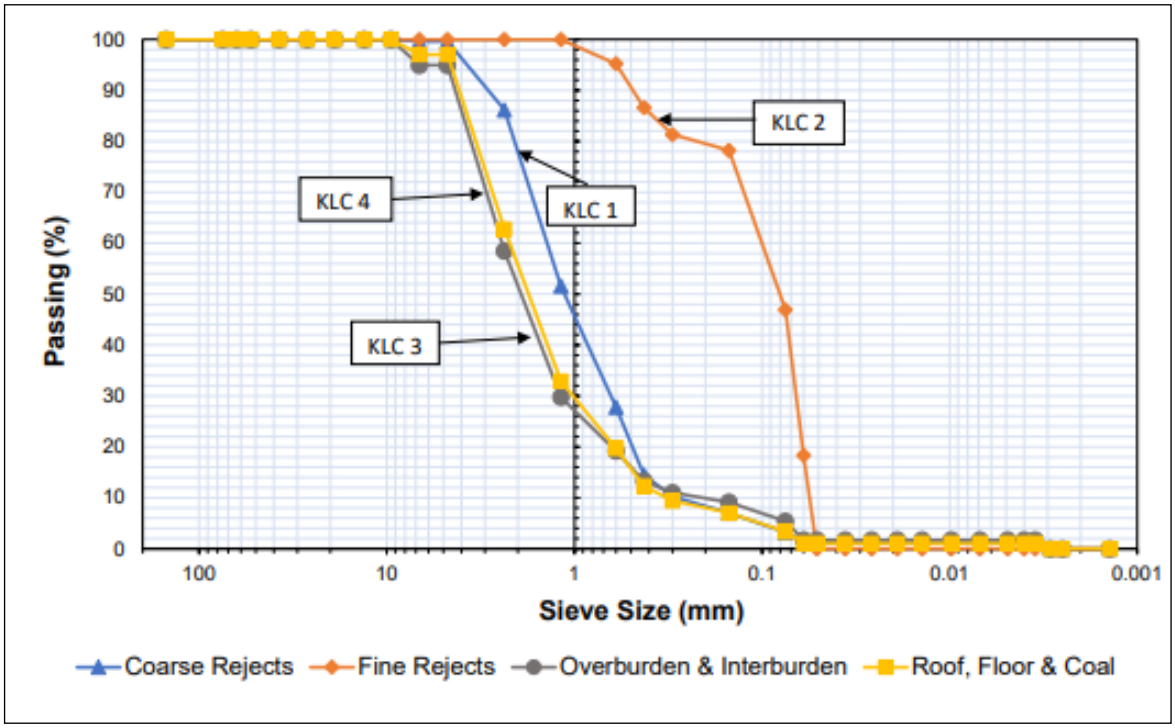


Figure 67 Particle Size Distribution of Composite Samples (RGS, 2022)

KLC = Kinetic Leach Column. Leaching setup that generates time-dependent data on the kinetics and rate of acid generation and acid neutralising reactions under laboratory controlled (or onsite conditions).

Moisture Content and Density

As reported by Golder (2011), the anticipated moisture content and density of rejects at EDCM will be as per **Table 36**.

Table 36 Summary of Rejects Geotechnical Testing (Golder, 2011)

Test	Result
Initial Dry Density (t/m^3)	0.96 – 1.0
Initial Moisture Content (%)	42.2 – 43.3
Initial % Solids (%)	69.8 – 70.2
End of Overnight Consolidation Dry Density (t/m3)	1.00 – 1.29
Final Dry Density (t/m^3)	1.07 – 1.32
Final Moisture Content (%)	21.0 – 25.9
Final % Solids (%)	79.4 – 82.6

Shear Strength Testing of Rejects

Shear strength conditions of EDCM dry rejects were assessed utilising a combined sample from the reference project (from a nearby coking coal operation, located within a distance of 30 km from the EDCM project) being subject to direct shear testing.

The primary difference between the tested reference sample and the expected EDCM rejects was that the tested sample contained around 40 % fine reject, compared to around 10% for EDCM. Friction angles from the direct shear testing on the reference samples indicated friction angles between 35.5% and 41.5 %, with cohesion taken as 0 kPa. A unit weight of 14.7 kN/m^3 was also adopted (ATCW, 2023).

ATCW (2023) states that despite the marked difference in fine reject content between the reference and EDCM materials, these shear strength parameters could be conservatively applied for the EDCM project. Notwithstanding, with reference to the Condition F10(a) of the EA, this testing confirms that the proposed EDCM dry reject will be suitable for emplacement within the DREA.

Soil Water Characteristics of Coal Rejects (Water Retention)

Using the PSD results and proportions (0 – 100 %) of clay, silt, and sand, the four composite KLC samples representing the various mine materials (as discussed above in particle size distribution) were plotted on a soil texture classification triangle, as is illustrated in **Figure 68**. The results indicate soil texture are high in sand particles found in all composite samples (RGS, 2021).

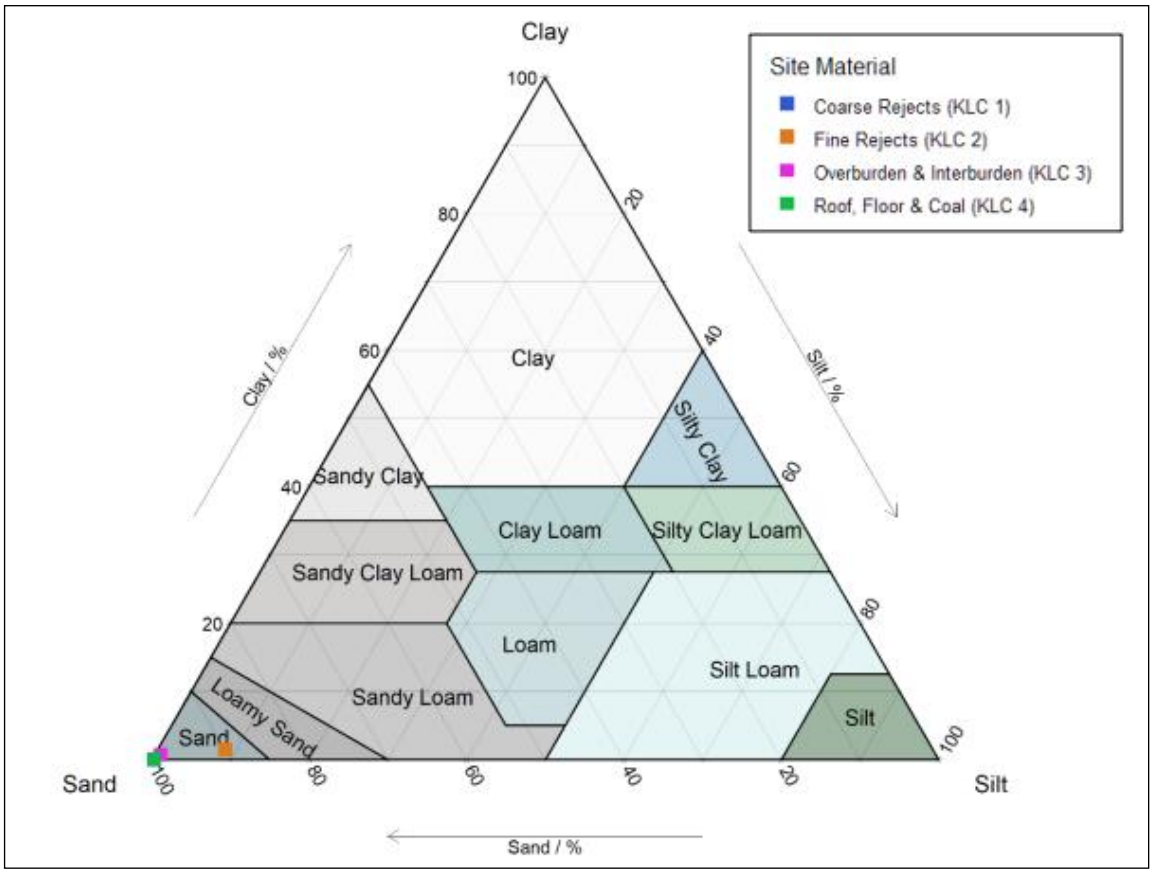


Figure 68 Soil Texture Classification Triangle for EDCM (RGS, 2021)

Note = Coarse Rejects (KLC 1) is not visible on triangle; however its soil textural class is similar to KLC 3 and KLC 4 (>98% - mostly sand).

Details regarding DREA design and the development and implementation of a QA/QC program are covered in Section 3.5.1.5.

Classification of Mine Waste Streams

RGS has established that mine materials with a total sulfur content of less than 0.25% is classified as NAF, assuming that the material has the capacity for acid neutralising capacity (ANC) buffering. Mine materials with a total sulfur content of less than 0.5% can be classed as having a low potential for forming acids and generating soluble salts, especially if these materials have ANC capacity.

A total of 89% of drift spoil and rejects samples taken from EDCM had a total sulfur content below 0.25%, and only two samples had a content greater than 0.5%.

Assessing the total sulfur content of drift spoils and rejects is a cost-effective method to determine the potential for acid formation. It is acknowledged that caution must be taken as some NAF materials with a sulfur content above 0.25% and significantly available ANC may be incorrectly classified as PAF materials.

A Mining Waste Management Plan (MWMP) will be prepared during operations when the material will be available for sampling, as required by EA EPML00586713 (condition F18) as part of the Development Plan so that EDCM is able to confidently classify mine waste streams based on environmental risk and management requirements.

Block Modelling and Volume Estimates of Mine Waste

The DREA has been designed for a capacity of approximately 110 million cubic metres (Mm3) waste material (ATCW, 2023). Characterisation of mine waste materials is critical for DREA construction and operational planning purposes, in terms of controls applied in material handling process, and encapsulation requirements. Material characterisation will form part of the short to medium mine planning process as the Project moves out of the care and maintenance stage. Characterisation and volume estimating will be undertaken as an ongoing operational process during mine operations.

A Mining Waste Management Plan (MWMP) will be prepared during operations when the material will be available for sampling, as required by EA EPML00586713 (condition F18) as part of the Development Plan so that EDCM is able to generate block models and estimating the volume of mine waste based on waste type (i.e., level of environmental risk).

Management and Mitigation of Waste Streams

As a result of the geochemical (and physical) assessment work completed on mine materials at the project, RGS (2022) provided recommendations to be adopted to minimise the risk of any significant environmental harm to the immediate and downstream environment. These include:

- Operational sampling and geochemical testing of representative samples of mine material to be completed as required when the mine is operational to verify the geochemical and physical findings.
- Roof, floor, coal and coal reject materials to not report to the external surface of any final rehabilitated landforms.
- The most appropriate methodology for beneficially re-using overburden and interburden (spoil) materials at the site as part of infrastructure development and site rehabilitation activities to be investigated when the mine is operational and bulk materials become available as part of field trials.
- Surface water and seepage from areas used for stockpiling and/or storage, and rehabilitation of mine materials to be monitored to ensure that key water quality parameters remain within appropriate criteria. Water quality monitoring parameters to include pH, EC, total suspended solids (TSS) on a quarterly basis and the suite of water quality analyses sampled opportunistically, and at least on an annual basis.

3.5.1.5 Landform Design

The topography of the EDCM project site is described as generally flat to undulating and is traversed by a number of minor ephemeral drainage lines. Local relief ranges from approximately 235 m AHD in the west to 200 m AHD in the east.

Therefore, key considerations of rehabilitation and closure planning are mainly concerned with those mine-related activities that will have the most impact on final landform design for the PMLUs– those being: subsidence (residual ponded landforms) and the DREA.

The overall objectives for final landform development are to:

- Be safe;
- Be stable;
- Be non-polluting; and

- Sustain the defined post-mining land use.

Landform design for the domains for mining infrastructure, stockpiles and tracks will be reinstating the land to pre-existing slopes, reinstating any surface drainage, and implementing erosion and sediment control plans as outlined in Section 3.1.3. The landforms that will form as a result of subsidence will be formed during the operational phase and managed by the Subsidence Management Plan. The DREA requires landform design which is discussed in the following sections.

DREA

The DREA will be formed as a mining-related landform with an approved PMLU of native ecosystem (grassland).

The DREA development will be subject to documentation to ensure the DREA is safe, stable, does not cause environmental harm, and is sustainable:

- Technical Specification for construction of the DREA (ATCW, 2020a); and
- Operational Management Plan (OMP) for operation of the DREA (ATCW, 2020b).

Fencing will be installed to exclude livestock from DREA landform.

An AQP certifies that the constructed landform achieves design criteria for geotechnical stability with a Factor of Safety (FOS) ≥ 1.5.

Structure Location, Footprint and Height

The DREA structure is to be located approximately 390 m from the eastern ML boundary, within the control points listed in Table F1 of EA EPML00586713 (**Figure 15**).

In accordance with Table E1 of EA EPML00586713, the maximum DREA footprint will be 385 ha with an estimated maximum (post closure) height of 40 m.

The DREA has been designed to be constructed in three stages over a 50-year period. The Mined Land Rehabilitation Policy emphasizes the importance of progressive rehabilitation of land disturbed by mining activities. However rehabilitation activities associated with the staged construction of the DREA's final landform cannot commence until all subsidence has ceased to ensure the land has appropriately settled. This approach of allowing natural subsidence to complete before reshaping minimizes the risk of rework and potential environmental impacts associated with ground movement. Therefore, bulk earthworks required for reshaping the landform of the DREA will commence in 2066 as reflected in RA6 of the PRC Plan Schedule (Appendix B). The year 2066 is when all mining underneath the DREA has completed, which will allow sections of the DREA to be gradually reshaped until the last coal is processed up to a year post cessation of mining. RA6 reflects the staged reshaping of the DREA landform from 2066 to 2076. Capping activities as defined by RM4 will start in 2070 and be completed by 2080.

Requirement for Liner or Seepage Collection System

Although the DREA design was completed to be a water-shedding landform, it is expected that infiltration of stormwater into the DREA will occur, and seepage expression or release of this infiltration (as leachate) to external batters will result. It is expected, however, based on the current understanding of rejects geochemistry (Section 3.5.1.4), that the quality of leachate from the DREA will not exceed appropriate water quality guidelines (ATCW, 2023).

A feasibility design report for the DREA, prepared by ATCW (2020b) included a seepage analysis, to assess the potential for migrating leachate in the DREA to reach groundwater. The analysis incorporated a clay liner of varying thickness, which indicated that under model conditions, the potential for vertical downward migration of leachate would be very low (of the order of 10^{-8} m^3/s per square metre of DREA footprint). This is equivalent to a seepage rate of less than 0.1 L/s per ha. This seepage rate is also tempered by the considerable depth between the base of the DREA and the upper groundwater aquifer (greater than 10 m depth (ATCW, 2023)).

As a result, ATCW (2023) indicates that, based on the classification of the risk of contamination from the DREA, an engineered liner for the DREA is not warranted, however a dirty water diversion drain at the toe of the DREA is designed for collecting DREA surface runoff and minimal horizontal seepage.

Key mitigation and control measures to address leachate generation and release via external DREA surfaces or DREA foundation are provided by ATCW (2023), and will include:

- Specific foundation preparation works:
  - Construct clay liner during the dry season;
  - General sub-excavation within the DREA footprint to remove topsoil and any weak or loose subgrade soils;
  - Moisture conditioning and compaction with a target depth of 0.5 m, to reduce foundation permeability (thus reducing potential for infiltration to groundwater);
- Appropriate construction methods, including Quality Assurance/Quality Control (QA/QC) provisions (reducing permeability of the emplaced reject):
  - Rejects placed to form 1 m lifts in 0.3 m compacted lifts, to minimise permeability across the footprint, with the surface of the lift graded to promote lateral drainage;
  - Effective geochemical characterisation of reject material regarding potential contaminant migration;
  - Ongoing compaction control for dry rejects for the full thickness of the DREA;
  - Erosional stability assessment for design of capping layer to reduce erosion potential;
- Stormwater diversion and drainage measures;
- Effective shaping of landform during operation and post-completion;
- Prompt repair of landform subject to subsidence impacts, including surface water drainage pathways; and
- Implementing monitoring including:
  - Standpipes;
  - Piezometers;
  - Settlement monuments;
  - Soil moisture probes; and
  - Temperature probes.

Identification of Materials Available for Landform Rehabilitation to Achieve the Required Landform Design Outcomes

To determine the composition of DREA material, EDCM coal seam reject core samples were assessed against a nearby coking coal operations' samples (located within a distance of 30 km from the EDCM project) by Golder (2011) for a range of analyses. These included: bench scale process testing, classification testing and shear strength testing.

The following observations were made:

- The fine reject plots as a medium plasticity clay, grading to a low Liquid Limit silt;
- Fines fraction (less than 75 µm size) falls generally between 60 and 70 % (by weight); and
- Proposed EDCM dry reject will be suitable for emplacement within the DREA.

According to ATCW (2023), these characteristics correlate generally with expected properties for fine rejects within the Bowen Basin. However, during mine construction, material properties assumed in the DREA geotechnical and erosional stability modelling are to be confirmed once the materials become available and where required, the stability assessments are to be completed with the updated parameters (ATCW, 2023).

Erosion Assessment

As per the EDCM Rehabilitation Management Plan (Eagle Downs Coal, 2015), a key design philosophy for DREA rehabilitation is to provide an erosion resistant cover using rock and a rock/soil subsurface mulching layer to support vegetation.

A Landform Evolution / Erosional Stability Assessment (utilising SIBERIA specialist software) was prepared by Landloch (2023), to predict the long-term, three-dimensional development of channels and hillslopes (e.g., landform batters) on the basis of runoff, erosion and deposition. The model adopted the nominated cover configuration, and used geochemical and physical information of drift spoil, coal and coal rejects materials presented in RGS (2022a) and the topsoil quality assessment presented in RGS (2022b) for input to the DREA final landform design.

Adopted performance targets for the landform evolution model, as described in ATCW (2023) are:

- Erosion rate for EDCM is 5 t/ha/y (i.e., Moranbah region is considered moderate due to relatively high rainfall erosivity);
- Maximum gully depth (m): maximum permissible depth of gully erosion of 0.3 m at any given point on the landform; and
- Vegetation cover (%): 70% vegetation cover (as per EA EPML00586713 which will improve the overall erosional performance of the DREA).

Additionally, it is important to note that under RM8 of the schedule (Appendix B), the target for the DREA is to ensure that no rills are present or gully erosion do not exceed a depth of 0.3 m.

A summary of the results of the SIBERIA model are provided (refer to **Table 37**).

- Erosion is predicted to be at a long-term average of 4.9 t/ha/y by Year 50, decreasing to 3.4 t/ha/y by Year 300 (i.e., less than the target 5 t/ha/y);
- The maximum predicted gully erosion of approximately 0.7 m (Year 300) is not likely to erode through the proposed cover layer thickness of 1.25 m and into the dry rejects;
- The proposed capping layer profile (capping the rejects with 250 mm of topsoil overlying 1 m of subsoil) is generally erosionally stable and will not result in erosion that would penetrate the cover layer and expose the underlying dry rejects within the modelled period of 300 years.

Table 37 Maximum Gully Depth, Average Annual Erosion and Cumulative Erosion on DREA Batter Slopes

Simulation Year	Maximum Gully Depth (m)	Average Erosion (t/ha/yr)	Cumulative Erosion (mm)
50	-	4.9	16
100	0.3	4.0	30
150	0.4	3.7	42
200	0.5	3.6	54
250	0.6	3.5	66
300	0.7	3.4	77

The Safety in Design (SiD) Risk assessment conducted by ATCW (2023) outlined risk mitigation measures to be considered in design to support the design of the DREA and final landform design objectives covered in the EDCM Rehabilitation Management Plan (South32, 2020) and EDCM Mine Closure Plan (South32, 2020). As a result, the batter slopes of the final DREA landform will be re-profiled to achieve the final landform batter slopes, with a final minimum slope of approximately 1V:9H and maximum slope of 1V:8H.

As the mine develops, it is expected that additional data will be collected that can be used to revise the landform evolution model and adjust the final landform design.

Settling and Subsidence That May Impact Availability of Rehabilitation

According to ATCW (2023), two critical indicators for the commencement of rehabilitation are:

- The substantial completion of subsidence and associated displacement in that area; and
- Completing subsidence correction, in the form of reprofiling, in-filling and/or reshaping.

Although it is understood progressive longwall mining within the DREA footprint will result in irregular subsidence patterns causing displacement in the DREA foundation (and as such, the emplacement) - the extent of such displacements (and associated adjustments) cannot be predicted at this stage.

The Subsidence Management Plan (required by condition E4 of EA EPML00586713) will be implemented during the operational phase of the mine to mitigate environmental impacts resulting from subsidence. If required, reinstating the required surface profile and landform design configuration of the DREA to meet PMLU milestones during rehabilitation and closure may include:

- Depressions will be infilled;
- Surfaces will be re-aligned (i.e., reprofiled) to maintain stability; and
- Surface water drainage pathways will be reformed (to allow for free draining within the bench drains and chutes to the receiving environment, to prevent ponding of runoff on the surface of the landform).

The baseline condition of each subsidence panel will be assessed prior to mining each mining panel. The baseline condition will include, but will not be limited to:

- Site hydrology and fluvial networks;
- Soil types, properties and productivity;
- Flora species composition and structure;
- Land stability (pre-existing degradation/erosion and predisposition to ongoing stability issues); and
- Regional ecosystem details, if remnant, and its BioCondition assessed in accordance with latest version of the BioCondition Assessment Methodology (Queensland Herbarium*).

The methodology to assess baseline conditions may include digital surface model or terrain model generated via LiDAR survey.

Components of the baseline condition will be informed by the latest version of the Eagle Downs PRC planning part (underground mines) and where relevant, the Eagle Downs Subsidence management plan with consideration of the following:

- Assessment of subsidence impacts on vegetation;
- Subsidence analysis and modelling;
- Surface ponding and cracking mitigation measures; and
- Post-subsidence stabilisation requirements

Hydrological Assessment

A preliminary hydraulic design, for the sizing of the proposed chutes and cross drainage structures on the DREA was undertaken by ATCW (2020a). The 0.1% AEP event was adopted as the design standard for the chutes, bench drains and bunds to ensure the proposed geometry has sufficient capacity to convey runoff, whilst the 5% AEP design event was adopted for the hydraulic design and capacity check of the proposed cross drainage culverts (ATCW, 2023).

As the size and configuration of drainage structures, both under operational and rehabilitation conditions are key design aspects of the DREA landform, a number of design analyses were undertaken to estimate peak flows for drainage structures based on a design event of 5% AEP, 1% AEP and 0.1% AEP. ATCW (2020a) indicated that drainage structures on the DREA are designed to accommodate a peak flow of 22.2 m^3/s.

Proposed chutes and cross drainage structures for the DREA are provided in **Figure 69**.

Flood modelling within the EDCM ML (including the DREA) is provided in Section 3.5.1.2. As the project is not located within the floodplain of a significant watercourse (and 100-year ARI flood modelling does not extend to the location of the DREA) flooding is not considered a credible risk to the landform.

Hydrogeological Assessment

Two aquifer systems exist within the EDCM ML, those being (described in Section 3.1.1.5):

- Deeper aquifers associated with Permian formations; and
- A shallow aquifer associated with upper weathered/ fractured rocks.

Measured groundwater levels reported by AGE (2019) indicate that the shallow fractured rock aquifer exists at approximately 10 to 20 m below ground level, whilst the elevation of groundwater within the Permian coal seam is approximately 20 m lower than the shallow aquifer. Therefore, the two aquifers are not considered to be hydraulically connected.

The groundwater is described as being fresh (brackish) to saline, EC up to 25,000 µS/cm, pH neutral ranging from pH 6 to 9 with low levels of metalloids in solution (Section 3.5.1.1). As waste material to be used in DREA construction is mostly classified as NAF, it has a relatively low risk of acid generation and a high factor of safety with respect to potential for AMD. Similarly, topsoil and capping material planned for use in DREA rehabilitation is considered benign, so risks associated with contaminant migration are considered to be low.

Potential hydrological and hydrogeological risks (i.e., leachate, run off, release from the DREA reaching regional receiving surface water environments) will be managed through material characteristation (prior to material being placed on the DREA) and water monitoring (as later discussed in Section 3.7.3.4).

Waste Placement Strategy

Prior to the recommencing operations, a Mining Waste Management Plan will be developed by EDCM and certified by an AQP as required by condition F18 of EA EPML00586713.

Specific Landform Requirements

Specific landform requirements for the EDCM DREA landform have been provided in the EIS and EA EPML00586713 (**Table 38** and **Table 39**).

Table 38 EIS and other Commitments Used for Landform Design

DREA Capacity	110 Million Cubic Metres (Mm^3)
• External Surfaces (post-construction) – Batter Slopes (Maximum slope lengths) – Top Surface/Plateau Grade/Slope	– 15% (maximum) – 100 m (maximum) – 2% (maximum)
• Maximum height (post-subsidence)	– 40 m (maximum)
• Soil cover thickness	– 1 m (minimum)
• Topsoil thickness	– 0.25 m (minimum)
• Factor of Safety (FOS)	– >= 1.5

Table 39 Specific Landform Requirements Related to DREA

Condition Number	Condition
Rehabilitation Landform Criteria	
E11	The environmental authority holder must develop a Rehabilitation Management Plan prior to commencement of longwall mining activities and submit to the administering authority for review and comment.
E12	The Rehabilitation Management Plan must be implemented and include: • Map existing areas of rehabilitation; • Develop design objectives for rehabilitation of disturbed areas and post-mining land uses across the mine; • Specify spoil characteristics, soil analysis, soil separation for use on rehabilitation; • Detail rehabilitation methods applied to areas; • Contain landform design criteria including end of mine design; • Detail how landform designs will be consistent with the surrounding topography; • Identify success criteria for areas and itemise revegetation criteria; • Explain planned native vegetation rehabilitation areas and corridors; • Identify at least a minimum of three (3) reference and three (3) rehabilitation sites to be used to develop rehabilitation success criteria; • Describe rehabilitation indicators and the monitoring program to be used; • Develop a contingency plan for rehabilitation maintenance or redesign; • Describe end of mine landform design plan and post-mining land uses across the mine; and • Include a cost benefit analysis/triple bottom line assessment (or an alternative assessment method) of the proposed final landform design criteria and alternatives.
E13	Interim Completion Criteria Land disturbed by mining must be rehabilitated in accordance with Table E1 (Final land use and rehabilitation approval schedule).
Final Completion Criteria	

Condition Number	Condition
E14	Completion criteria must be developed and amended in Attachment 1: • Rehabilitation requirements prior to the commencement of longwall mining.
E15	Progressive rehabilitation must commence when areas become available within the operational land
E16	Development of acceptance criteria in accordance with condition E12 is to consider the reestablishment of representative regional ecosystems (reference sites or another suitable alternative approved by the administering authority) and functioning habitat of areas of equal to or greater than areas to be cleared and specific revegetation performance descriptors (e.g., rehabilitated areas are to display characteristics of the existing (pre-mining) regional ecosystems).
E17	Areas which are to be rehabilitated to native ecosystem must achieve a self-sustaining native ecosystem with species composition and distribution similar to an analogue/ reference site or another suitable alternative approved by the administering authority.
E18	Where reasonable and practicable, areas of the site where grazing is nominated as the post-mine land use must include native grass species endemic to the area.
Dry Rejects Emplacement Area (DREA)	
F10	Waste from the Coal Handling and Preparation Plant shall be disposed of: • In accordance with conditions G1 to G18 (Dams) of this environmental authority if the shear strength of the waste is less than 1000 Pascals when deposited; or • In accordance with conditions F11 to F16 if the shear strength of the waste is equal or more than 1000 Pascals when deposited.
F11	DREA – certification and operation. The authorised DREA used for the disposal of waste is located within the control points defined in Table F1 (Location of DREA).
F12	DREA shall be designed to prevent environmental harm arising from contaminants being generated in the facility, leachate and runoff from the facility or other sources.
F13	The authorised DREA must be constructed and maintained in accordance with certified plans submitted to the administering authority.
F14	Design plans for the authorised DREA must include performance indicators, such that: • During operations of the DREA will be operated with minimal or no potential for adverse environmental harm resulting from collapse of any component of facility; • The potential for leachate generation will be minimal or non-existent; • Adequate drainage structures, erosion protection and storage are provided to manage seasonal and rare rainfall events with minimal or no environmental harm; and • Decommissioning and rehabilitation strategies for the DREA that demonstrate consistency with the conditions of this environmental authority.
F15	Construction of any DREA detailed in Table F1 (Location of DREA) must not commence unless:

Condition Number	Condition
	• The environmental authority holder has submitted to the administering authority two copies of a design plan; • Certification from a suitably qualified and experienced person that the design of the DREA will deliver the performance stated in that design plan and that it will be compliant in all other respects with this environmental authority; • At least twenty (20) business days has passed since the receipt of those documents by the administering authority; • The administering authority notifies the environmental authority holder that a design plan and certification has been submitted for that disposal facility.
Operational Plan - DREA	
F16	An operational plan must be developed and maintained for the DREA. The operational plan must include but not be limited to: • Description of landform development stages of the DREA; • Placement technique for spoil and waste material from the coal handling and processing plant on the mine site; • Management of any containment structures within the DREA designed to contain materials from the coal handling and processing plant on the mine site; • Demonstration of how operations of the DREA are consistent with the accepted design plan for the facility; and • Decommissioning and rehabilitation strategies for the DREA that demonstrate consistency with conditions of this environmental authority.

Monitoring to Determine Control Measures

The monitoring requirements of the DREA during operations are stipulated in the EDCM Operations Management Plan (EDC-FS-26000-OP-PLN-2000) (ATCW, 2020b).

During rehabilitation and closure, the following monitoring, inspection and surveillance activities of the DREA (ATCW, 2023) will be undertaken and are summarised below:

- *Clay liner monitoring:* Confirm performance objectives for the clay liner have been met during construction to ensure the risk of cracks has been reduced in closure.
- *Movement monitoring* (vertical and horizontal): utilising survey monuments and monitoring prisms to detect surface displacements of DREA. Note: survey monuments destroyed during the rehabilitation of the DREA will be reinstated upon completion of the rehabilitation.
- *Temperature monitoring*: temperature probes installed in the DREA to monitor temperature and predict the potential for spontaneous combustion in accordance with the trigger action response plan (TARP).
- *Pore Pressure monitoring*: instruments to be installed include standpipe piezometers and VWPs for the purposes of monitoring foundation sub-surface and DREA pore pressures, groundwater levels and water quality. Note: VWP cables will be sufficient to extend to the final landform design surface upon completion of rehabilitation.
- *Soil Moisture monitoring*: soil moisture probes installed to monitor moisture conditions within the rejects as the landform is constructed and upon completion of rehabilitation (as the moisture content to the rejects is critical to the design, operation and closure of the DREA).

In addition to the monitoring, regular inspections and maintenance of stormwater and seepage collection infrastructure will be conducted.

As stated in the EDCM Operations Management Plan (ATCW, 2020b) if major seepage expressing from the DREA is observed, the DREA will require inspection by a suitably qualified and experienced geotechnical engineer who may provide recommendations to install a suitable seepage management system.

3D Design Plan for the DREA

A 3D design output for the DREA development (Figure 69) was prepared by ATCW (2023) that was based on the criteria in **Table 38** and **Table 39.**

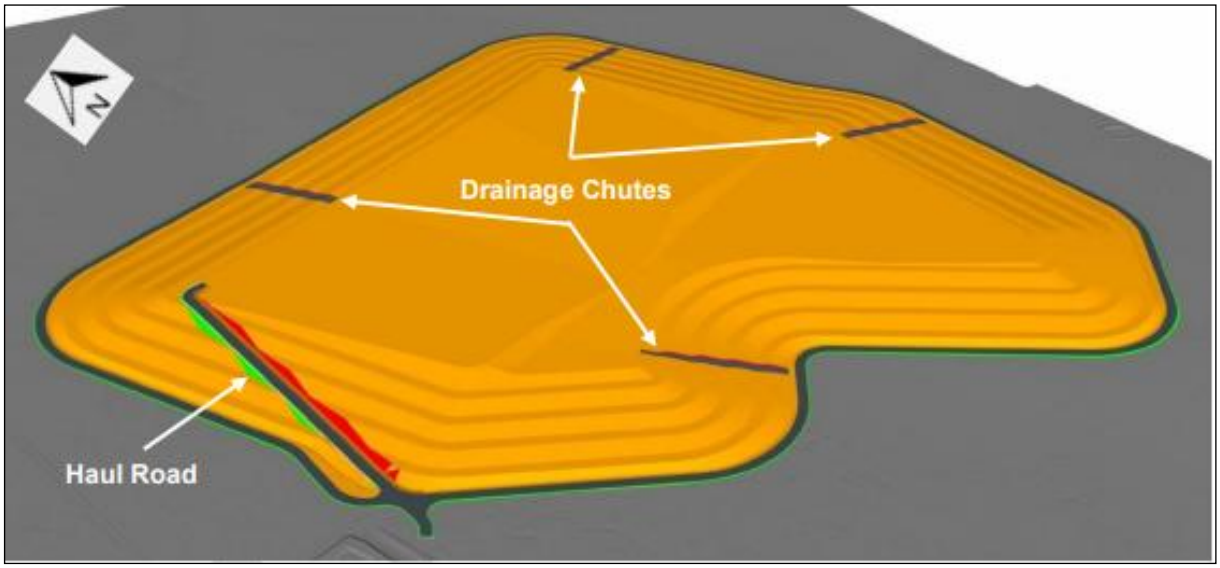


Figure 69 DREA 3D Design

Method of Determining Landform Design

As part of the 2019 feasibility study, ATC Williams Pty Ltd (ATCW) was engaged by EDCM to complete the DREA feasibility-level design with the report presented in ATCW (2020a). The study addressed the final landform design for the DREA, operational methodologies and general rehabilitation requirements. The DREA feasibility design was based on a Life of Mine (LoM) rejects emplacement capacity of 110 Mm^3 in relation to the following stages of waste material:

- Stage 1: 0 – 5 years;
- Stage 2: 5 – 20 years; and
- Stage 3: 20 – 50 years.

The premise of this staged development approach was to achieve enhancements in construction, quality control and quality assurance on emplacement construction and operation, and efficient use of available materials.

The most recent ATCW (2023) landform design (Appendix I) is a refinement of the design, construction, operational and rehabilitation elements of the DREA development stages, and considers recently acquired project data such as:

Dry Reject Production

- Nominal Daily Production Rate: Up to 10,000 tonnes per day (tpd)
- Nominal emplaced dry density: 1.1 t/m3
- Dry reject moisture content: Approximately 20 – 25%
- Bulk density: Between 1.3 and 1.4t/m3
- Equivalent DREA capacity demand: 7,200 m3 per day
- Critical factors: Residual shear strength of dry rejects (fine only, coarse only or combined fine and coarse) must be greater than 1 kPa for placement within the DREA (otherwise disposal within a regulated dam would be required).

DREA Capacity

- Nominal Life of Mine: 50 years
- Nominal DREA capacity demand: 7,200m^3 per day
- Nominal total capacity demand: 110 Mm^3 (based on density of 1.1 t/m^3)

DREA Reprofiling

- DREA Footprint 385 ha
- Batter Slope (subject to rehabilitation) 1V:9H

The basis for landform design for each of the development stages is provided in **Table 40**, which provides an indication of the scale of the DREA. Additional considerations of the landform design, that are discussed within this PRC Plan included the local topography, flooding hazards, local surface and groundwater users and foundation (geological) conditions.

Table 40 Basis of Design DREA Landform Development

Aspect	Stage 1	Stage 2	Stage 3
DREA Height (Total)	45 m	45 m	45 m
DREA Footprint Area	70.3 ha	149.0 ha	167.4 ha
Stage DREA Capacity	11.8 Mm^3	36.0 Mm^3	63.5 Mm^3
Stormwater Drainage and chutes	Southeast corner	Northeast corner	Northeast corner and central north batter

Modelling for Long-Term Stability of Final Landform

Slope stability modelling in relation to the proposed DREA final landform design slope was completed using the SLOPE/W computer package, which uses limit equilibrium theory to solve for the factor of safety of the slope. The model calculates a factor of safety for a two-dimensional section, satisfying both moment and force equilibrium. The limit equilibrium method by Morgenstern-Price method of analysis has been adopted using a circular failure surface (ATCW, 2023).

Three cross sections were used in the slope stability assessment (selected as being representative of the DREA final landform) (**Figure 70**). The cross sections were analysed for short term (end of construction), long-term and post seismic stability in accordance with Australian National Committee on Large Dams

(ANCOLD) recommendations (ANCOLD, 2019) guidelines for tailings dams. A detailed summary of batter stability criteria (factors of safety), parameters for static and post-seismic stability analysis (material strength) and piezometric (seepage) conditions is provided in (ATCW, 2023).

The conclusion provided by (ATCW, 2023) is that results demonstrate all calculated factors of safety comply with the minimum requirements, and therefore the proposed DREA configuration meets best practice requirements under both short, long-term and earthquake conditions.

Furthermore, it is expected that rehabilitation activities on the external DREA batters (i.e., reprofiling to minimum 1V:9H slopes and maximum 1V:8H slopes) will improve the overall stability of the DREA landform.

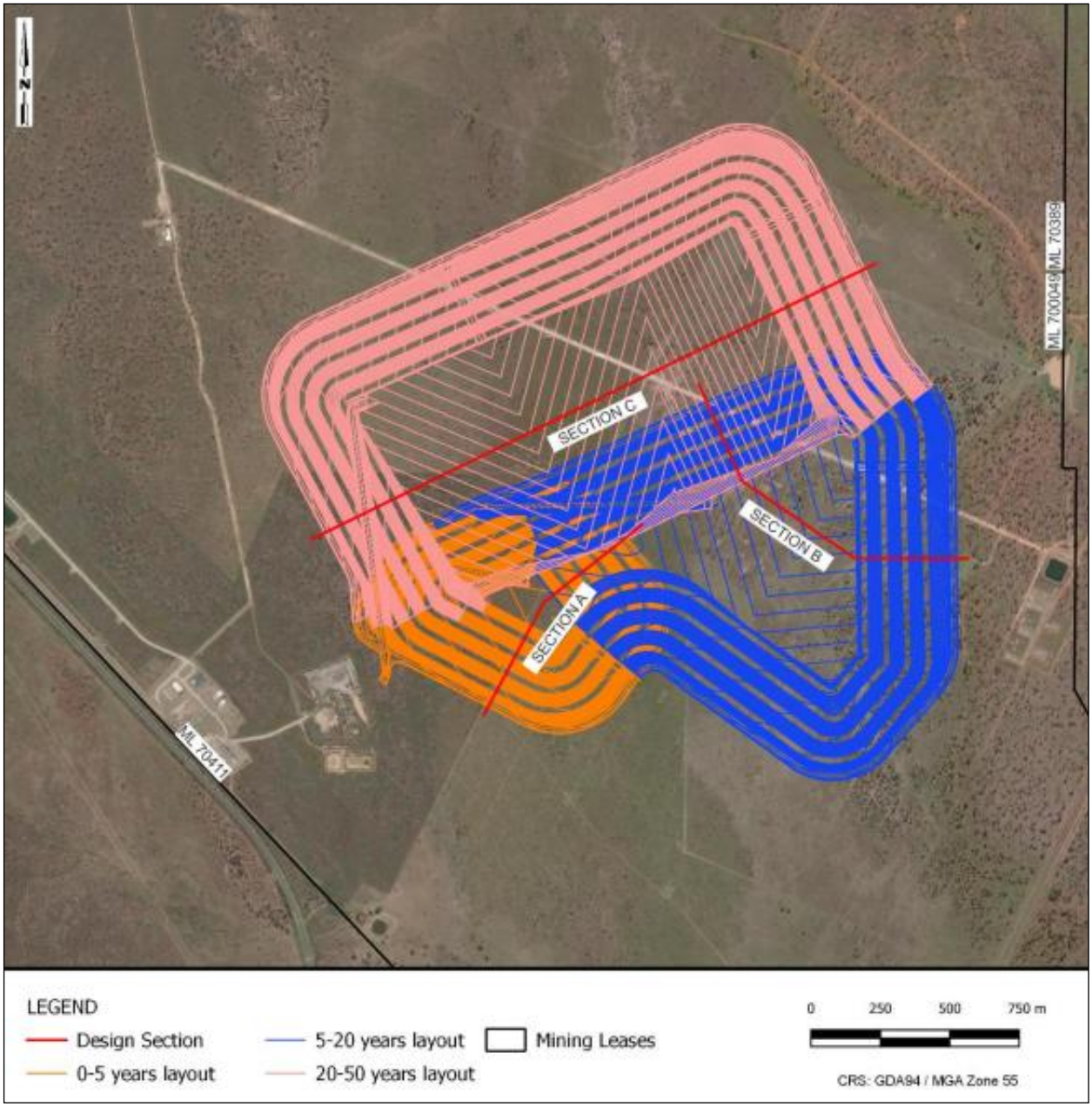


Figure 70 Location of Design Cross Sections for Stability Assessment

Method of DREA Construction

The method adopted for DREA construction was based on a qualitative SiD risk assessment, conducted by ATCW (2023), that highlighted key design management principals to be adopted for DREA construction. They are:

- Principal 1: Dry Rejects Characterisation - ensure that dry rejects are effectively characterised to avoid the need for special handling or burial/isolation protocols.
- Principal 2: DREA Construction - foundation preparation to be completed following topsoil stripping and the necessary foundation excavations.
- Principal 3: Movement of Dry Reject - appropriate methods to be used such that all material arrives at the appropriate location to enable staged development of the DREA, with consideration also to reduce the risk of exposure to any receiving environments.
- Principal 4: Dry Reject Placement - Placement of dry reject will be undertaken in accordance with the ECM Operational Management Plan.
- Principal 5: Landform Development - landform to be developed pre-rehabilitation, which will comprise benched outer batters. Outer batter reprofiling and rehabilitation shall commence once subsidence has ceased.
- Principal 6: Off-site Movement - No bulk quantities of dry reject, regardless of their physical or geochemical characteristics can be taken off-site for any reason without appropriate permitting.
- Principal 7: Water Management –
  - install bunding on the perimeter of the DREA to divert/manage stormwater runoff is in place as part of development works.
  - effective stormwater management system across all surfaces of the DREA, using haul roads, external benches and engineered batter drainage structures at appropriate locations to convey stormwater to beyond DREA footprint. This system is to report to appropriate outlet structures for controlled release to the environment.
  - any ponded/surface water occurring within or adjacent to the DREA is promptly removed to minimise exposure to dry rejects material.
  - provide a drainage system comprising graded slopes and formed drainage pathways to convey stormwater from rehabilitated surfaces.
- Principal 8: Rehabilitation –
  - reprofile final surfaces (batters and plateau) to achieve the final landform design and to apply final capping layers.
  - accommodate stormwater management (all rehabilitated DREA surfaces are to be free-draining).
- Principal 9: Dust Suppression - Use dust suppression techniques to minimise dust generation.
- Principal 10: Monitoring - monitoring program maintained to confirm that the DREA is not impacting on receiving environments.

An indication of the DREA footprint placement approach (shown as a series of cells) for Stage 1 (0 to 5 years) is illustrated in **Figure 71** . Each section represents approximately 3.5 ha and although the placement strategy for Stages 2 and 3 of the DREA is not available, these will be optimised based on the outcome of the Stage 1 construction.

General Construction of DREA

The proposed methodology for DREA landform construction is described (refer to **Figure 72**):

- Stripping and clearing of topsoil and vegetation will be undertaken from within the footprint.
- Moisture conditioning, ripping (minimum 0.5 m) and compaction of in situ subsurface materials will be undertaken to form a clay layer over the DREA footprint during the dry season.
- Construction of the clay layer would be completed in cells to align with rejects placement such that the clay surface is not left exposed for extended periods of time prior to the placement of rejects.

- During construction consider the behaviour of the four soil types that be interacted with during construction in terms of surface loading (structural integrity) and drying (cracking) under low moisture conditions to ensure that prolonged exposure of the liner does not impact structural integrity through the development of performance objectives.
- Compacting the first 1 m of rejects material over the clay layer.
- Placing rejects by paddock dumping using haul trucks for transport from the CHPP and compactors for spreading and compaction of the dumped rejects (similar to an out-of-pit spoil dump constructed by trucks and dozers).
- Constructing the DREA in a series of 10 m high benches, with side slopes at the natural angle of repose of the material and bench widths designed to produce an overall outer slope of <13%.
- Constructing temporary and permanent drainage structures for management of stormwater (including collection drains and catch dams around the perimeter of the active DREA to collect and contain surface runoff).
- Ensuring haul roads have a maximum longitudinal grade of 2.3% and located to minimise total DREA footprint.
- Rehabilitating external surfaces as the DREA is formed.

General DREA Configuration

- Capacity: 110 Mm^3
- Maximum bench height: 10 m
- Minimum inter-bench slope (post closure): 30°

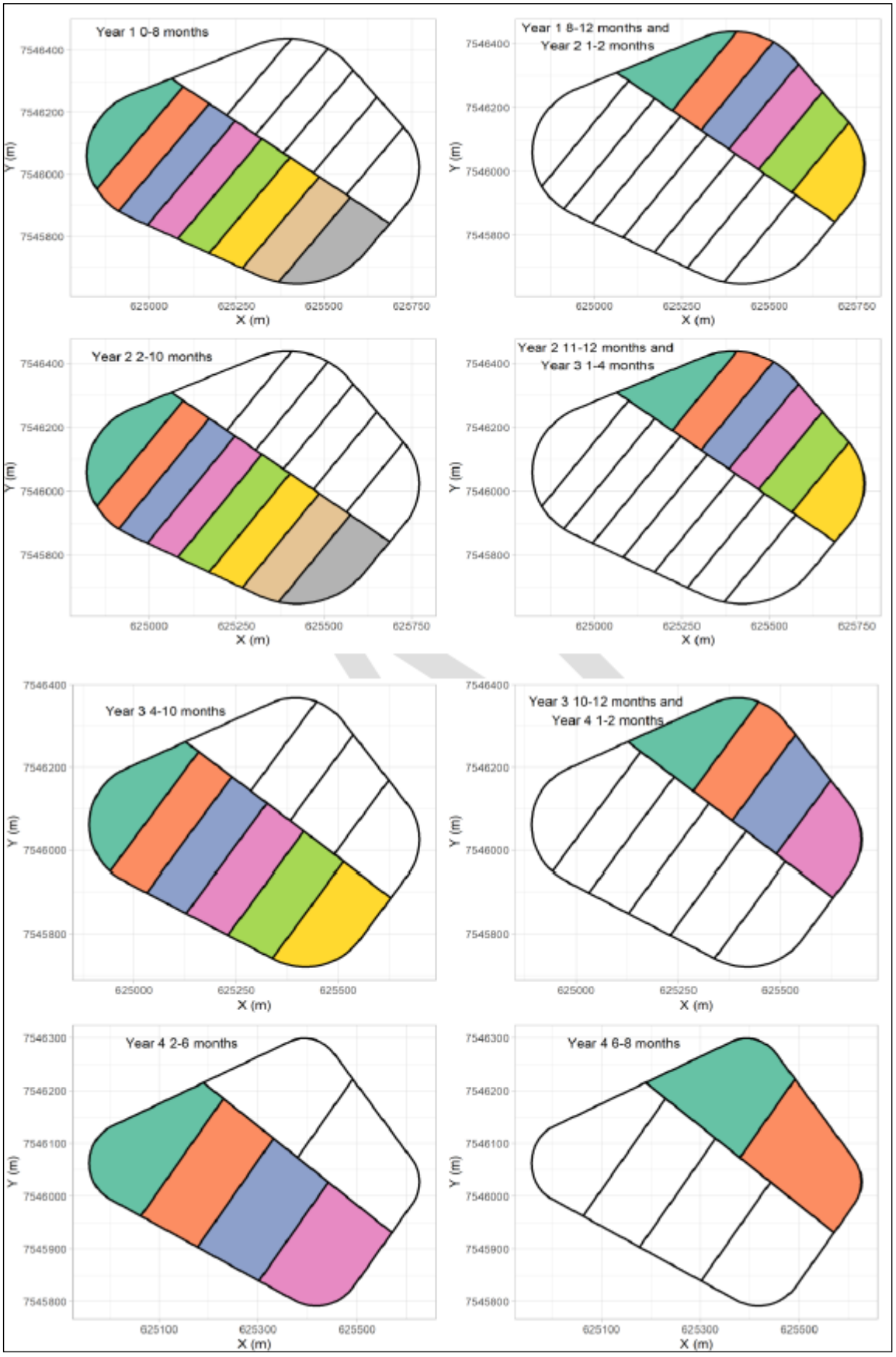


Figure 71 Diagram of Placement Planning for Year 1 into Year 4 from Commissioning

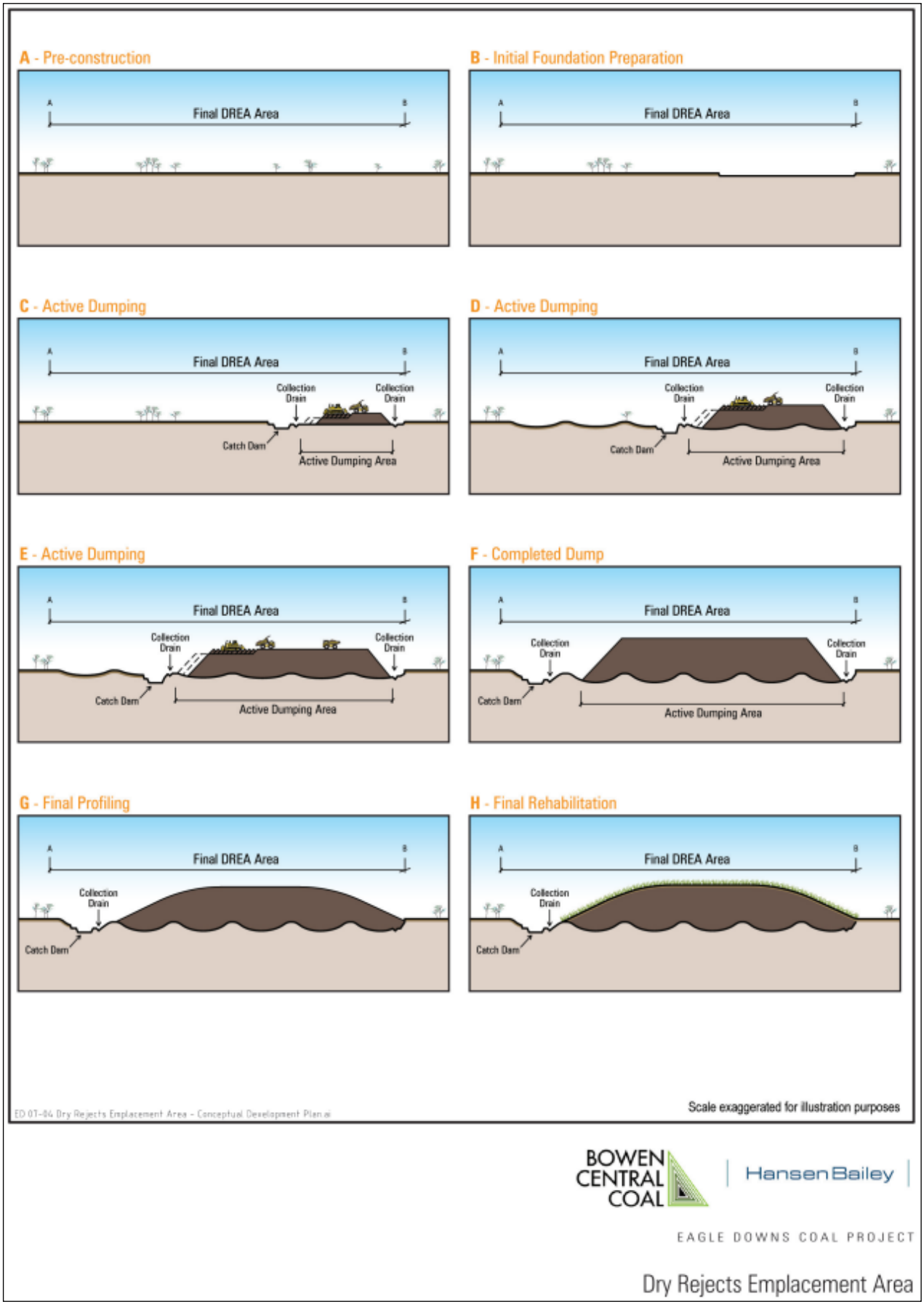


Figure 72 DREA Construction

QA / QC

To ensure the final DREA landform (including all development stages) is constructed in accordance with the quality management systems requirements of AS/NZS ISO 9001:2000 and the Technical Specification (ATCW, 2020a), EDCM will develop an approved Quality Assurance Plan.

The following (minimum requirements) of this Plan (as set out by ATCW (2023)) will include:

- A project organisational chart;
- Qualifications of key personnel;
- Inspection and test plans;
- A copy of the National Association of Testing Authorities (NATA) registration for the compliance testing laboratory; and
- Project operating procedures.

EDCM considers the identification and tracking of work conducted during DREA construction as critical processes that underpin the QA/QC process. QA/QC will be achieved by the division of works into nominated lots and aligning them with construction staging and landform development profiles.

The quality assurance elements of the Plan (as outlined by ATCW (2023)) include:

- Conformance reporting;
- Non-conformance reporting;
- Compliance inspection and testing by NATA registered laboratory; and
- Project quality records including surveys of the works.

Final Landform Trials

To optimise the placement approach and ensure appropriate performance outcomes of the DREA, EDCM propose that a rejects placement and compaction trial be conducted prior to the commencement of Stage 1. The trial would be situated in an area within the DREA footprint of Year 1 (0-8 months) as is shown in **Figure 71**.

As provided in ATCW (2023), the trial will focus on:

- Placing rejects by paddock dumping using haul trucks;
- Spreading rejects and compacting dumped rejects;
- Confirming the number of compaction passes of rollers to achieve adequate compaction; and
- Confirming the effect of the moisture content of the rejects on achieving adequate compaction.

Limitation and Assumptions of the Landform Design

Potential rehabilitation constraints for the DREA landform (ATCW, 2023) are summarised in the following sections.

Design Geometry

At closure, as is shown in **Figure 69**, four drainage pathways are planned for the final landform to manage stormwater runoff. The presence of these structures, and deterioration over time may impact on long term erosional stability to create uncontrolled concentrated stormwater discharges (ATCW, 2023). To ensure drainage pathways are maintained to maximise performance and integrity, rock armouring (or shotcreting) of the drainage pathways will be required and a review of their performance during rehabilitation and into closure will be required.

Availability of Growth Media

Given EDCM is an underground operation, the availability of mine spoil for rehabilitation purposes (i.e., growth media) is limited and an alternate source will be required. It is anticipated that required volumes (in the order of 1.5M BCM) of local soils and sub-soils will be suitable for this task. Prior to applying any material as growth media, an assessment of soil nutrition will be undertaken.

Plant Available Water (PAW)

A constraint to achieving the rehabilitation and final closure objectives is the provision of enough plant available water (PAW). Material borrowed locally and placed for reuse as growth media will still be a meta-soil with very little soil structure and with very poor moisture retaining capacity (ATCW, 2023).

3.5.1.6 Cover Design

Details of the cover system design for the DREA are described below.

Geotechnical Characterisation

Material earmarked for the DREA cover system, as reported in the EDCM EIS (Hansen Bailey, 2010a), is assumed to comprise of a sandstone/topsoil mix with a vegetative groundcover percentage of 50%. Sandstone will be sourced from capping stockpiles (comprised of interburden and overburden), whilst the topsoil will be sourced from stockpiles accumulated from local soil resources (recovered prior to DREA foundation preparation).

As provided in RGS (2022b), topsoil availability and management indicated that:

- Topsoil can generally be classified as Non-Acid Forming (NAF);
- Available soils have moderate cation exchange capacity, are non-sodic and contain sufficient exchangeable cations and nutrients for plant growth;
- Physically, soils are rich in clay with lesser proportions of silt and sand, and therefore have good moisture and stability characteristics; and
- Soils are expected to be suitable for use in rehabilitation capping works. It has been concluded that available topsoil stockpiles on site are suitable as soil capping.

The erosion modelling assumed that the cover layer will be comprised of a rock armour (sandstone assumed) mixed with topsoil such that a 30% rock cover is produced once the surface is armoured under rain (ATCW, 2023).

Further characterisation of soils for the EDCM project are discussed in Section 3.5.1.3.

Type and Physical Characteristics of Material Being Covered

As described in the EIS (Hansen Bailey, 2010a), the DREA has the capacity to store the life of mine rejects volume (110 Mm3). Approximately half of the spoil from drift and shaft excavations (125,000 m^3) will also be stored in the DREA. The other half of the spoil from the drift and shaft excavations will be suitable to use as foundation material for surface infrastructure.

Geochemical characterisation of the rejects material and drift and shaft spoil was completed as part of the EDCM EIS (Hansen Bailey, 2010) and more recently, through a geochemical assessment conducted by RGS (2021). Both assessments concluded that the rejects and spoil material are likely to be relatively benign, and will generate mildly alkaline, relatively fresh (non-saline) runoff and seepage following surface exposure and therefore unlikely to present any environmental risks for on site or downstream water quality. Additionally, on the basis of Acid-Base testing, acid generation from the material is considered unlikely.

Site Conditions

The site has a semi-arid climate with warm, dry winters and hot, humid summers. The average annual site rainfall is 577 millimetres (mm). The cover design for the DREA has been designed to be a water shedding design that concentrates runoff down the four drainage structures.

Availability of Suitable Cover Materials

Overburden and interburden (spoil) materials should be amenable to supporting revegetation as part of rehabilitation activities. Managing sodic material by adding gypsum, fertiliser, organic matter, and topsoil may need to be considered on steeper slopes of final landforms to limit the potential for dispersion and erosion (RGS, 2021).

Criteria for Discharge

As is stated in the EDCM Rehabilitation Management Plan (Eagle Downs Coal, 2015), the active DREA will be operated as a nil release system, however a water perimeter collection drain and associated sediment dams will be constructed over the life of the mine.

Post-mine rehabilitation phase, contour drains will be constructed at a spacing of approximately 30 m up the slopes, discharging into permanent runoff flumes constructed down the slopes. It is proposed these contour drains are built at a gradient of approximately 1% and designed to manage the runoff from the relative catchment for a 1:20 year design event.

Monitoring of environmental values will continue during rehabilitation and closure activities to ensure the goals and objectives of PMLUs (i.e., non-polluting) are met. Success criteria for water quality relating to rehabilitation is tied to a no net deterioration in water quality target (Hansen Bailey, 2010). These targets are provided in EA EPML00586713.

Suitable Vegetation

As stated in ATCW (2023), it is vital that vegetation is established rapidly following rehabilitation as the cover layer is prone to erosion. Achieving the 70% vegetation cover (as conditioned in EA EPML00586713) will improve the overall erosional performance of the final landform. Erosion modelling used 50% vegetation cover as the cover criteria, to ensure the landform could conservatively remain stable (ATCW, 2023).

The vegetation ground cover species intended for the DREA, will be conducive to the pre-approved PMLU of a native ecosystem, comprising native grasses that are well adapted to the climate and landform soil properties.

Identification and Specification of the Cover System

A cover design is required for the surface treatment of the DREA landform. Erosional stability will underpin the success of the cover system for the DREA and is dependent on the type and size of the rock, as well as the physical and chemical properties of the fines. Erosional stability will assist the cover system to promote vegetation growth, minimise dust emissions and achieve the intended land use (i.e., the PMLU).

Cover Design (Including Thickness of Each Layer)

According to ATCW (2023), the assumed cover layer for the DREA was modelled to include:

- Rock armour (sandstone has been assumed) that is:
  - Geochemically benign;
  - Fresh or slightly weathered; and
  - Durable.
- Topsoil mixed to produce 30% rock cover once armoured; and
- Minimum vegetative cover of 50% establishment on the overall final landform.

Commitments made within the EDCM EIS, in relation to cover material thickness are provided below:

- Soil cover thickness: 1 m (minimum); and

- Topsoil thickness: 250 mm (minimum).

The construction methodology for the DREA cover system is described in the EDCM EIS (Hansen Bailey, 2010) and is summarised below:

- The reshaped DREA will be rehabilitated with a 1 m cover layer of sub-soil stripped from the foundation area (placed over waste material), that will act as a growth medium for deep rooted grasses and shrubs.
- Topsoil from the foundation area will be replaced on the cover layer to a depth of approximately 200 mm.
- The finished surface will then be ripped, fertilised, and seeded.
- The area will be ripped on the contour to a depth of 600 mm.
- Seeding will include mixture of grasses, legumes, and native shrubs.
- Fertiliser will be spread to encourage establishment of a dense pasture cover for erosion control.

Location and Quantity of Proposed Capping Material

One designated area is proposed for the stockpiling of capping material, as is shown in **Figure 73**.

The quantity of capping material will be made available from the underground mine material.is 3,984,747 m^3.

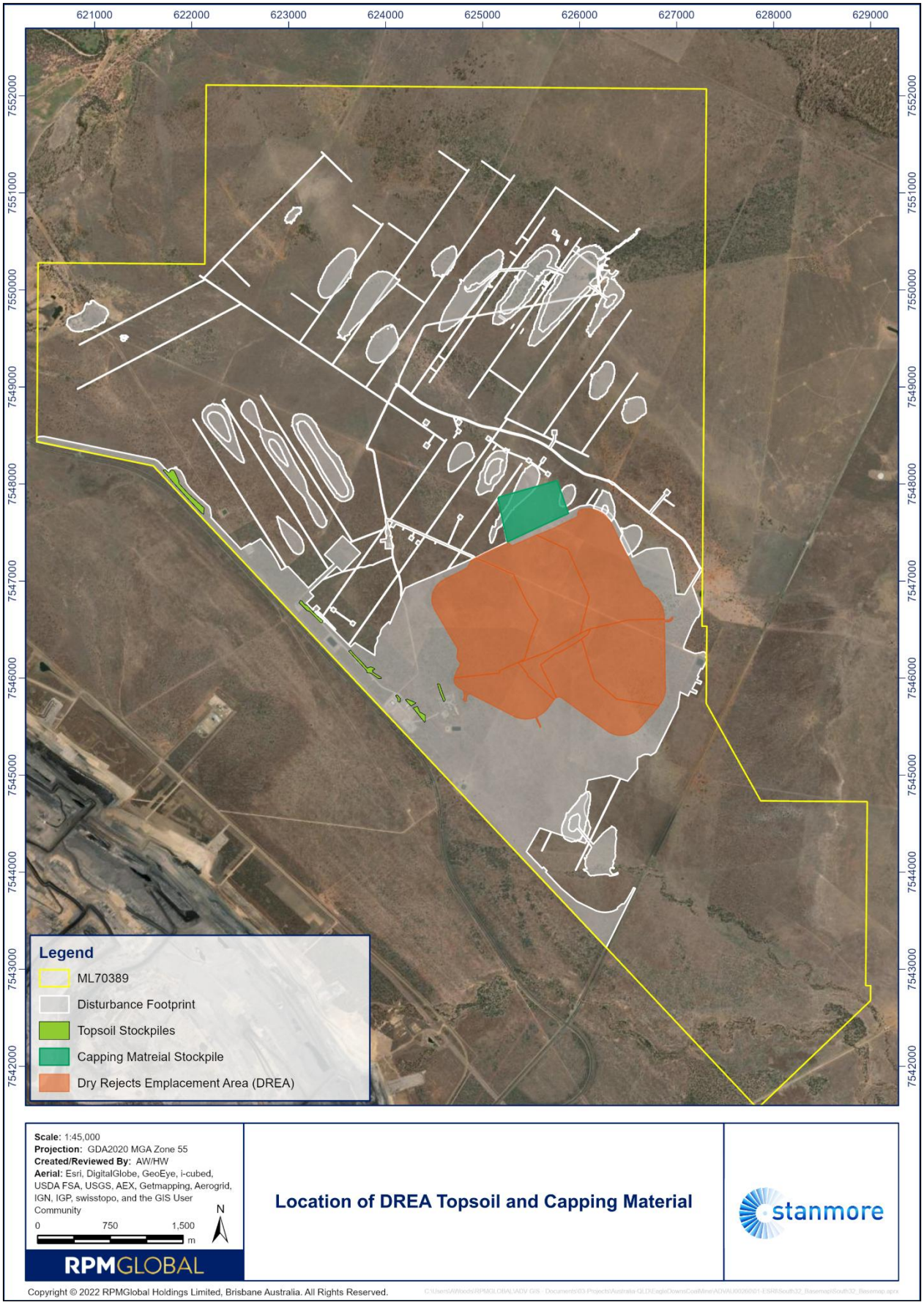


Figure 73 Location of DREA Topsoil and Capping Material

Quality Assurance / Quality Control (QA/QC) for Cover System

Conformance to design specifications for the cover design system will be achieved by a number of processes and systems:

- Operator and supervisor training, to ensure they are appropriately skilled in undertaking rehabilitation earthworks;
- Relevant procedures established that outline cover design system specifications (i.e., depth, slopes, contours, drainage, amelioration rates);
- Rehabilitation earthmoving equipment fitted with high-precision GPS tools to assist in the development of the landform;
- On the ground, regular supervision of landform rehabilitation works against PRC PLAN Schedule;
- Survey confirmation to ensure compliance with design specifications, record keeping and 'as built' acceptance by an AQP;
- Corrective actions register established to ensure defective work is remediated (including due date and acceptance by an appropriate EDCM representative); and
- Records of rehabilitation earthworks retained to demonstrate QA/QC processes have been met.

3.5.1.7 Water Management

EDCM operates under the EDCM Water Management Plan (WMP) (South32, 2023). The WMP addresses managing water associated with the constructing, operating and closure of the Project in accordance with the project's environmental authority (EA) EPML00586713.

The WRM (2022) Surface Water Assessment identifies the main water types that require management. These include:

- Raw Water (pumped to site by Sunwater);
- Potable Water (trucked to site and stored onsite in water tanks);
- Mine Affected Water - pit water, tailings dam water, processing plant water, water contaminated by mining activities, rainfall runoff that has been in contact with disturbed areas that are not yet rehabilitated, groundwater that has been in contact with disturbed areas that are not yet rehabilitated, groundwater from the mine's dewatering activities;
- Wastewater (treated effluent from site sewage treatment plant (STP)); and
- Stormwater (Clean – diverted around mine and can be discharged to the environment or Dirty – captured by surface water infrastructure and re-used onsite).

A conceptual surface water management system was prepared by WRM (2022) that calculated sizes and catchment area of the surface water storages. At detailed design stage, each water management storage facility will be assessed for their consequence category by a suitably qualified person in accordance with the Manual for Assessing Consequence Categories and Hydraulic Performance of Structure (ESR/2016/1933) (the Manual). Once determined, Regulated Structures will be designed, constructed, and managed according to the Manual and EA EMPL00586713.

A reverse osmosis (RO) plant to manage large volumes of water is proposed to manage dewatering the underground mining operation, classified as mine affected water. Brine produced from the water treatment facility will be transferred to a Brine Storage Dam, where the dam will be used to store and evaporate the brine.

An overview of proposed water management infrastructure at the EDCM project are shown in **Figure 74** whilst the conceptual water management schematic is shown in **Figure 75** and listed below:

- Mine affected water management dams:
  - Surface to in-seam (SIS) Dewatering Dam (DM401A-C);
  - Mine Water Dam (DM501A);
  - Brine Storage Dam (DM501C, E-I);

  - Drift Excavation Sediment Dam Cell 1 (DM901A) (To be decommissioned);
  - Drift Excavation Sediment Dam Cell 2 (DM901B) (To be decommissioned); and
  - ROM & CHPP Sediment Dam (DM701A).
- ESC water management dams (dirty stormwater)
  - DREA Stage 1 Sediment Dam (DM902A);
  - DREA Stage 2 Sediment Dam (DM902B);
- Raw water management dams:
  - Raw Water Dam (DM502);
  - Mine Process Water Storage Dam (DM501B).
- Underground Operations Area; and
- Water Treatment Facility.

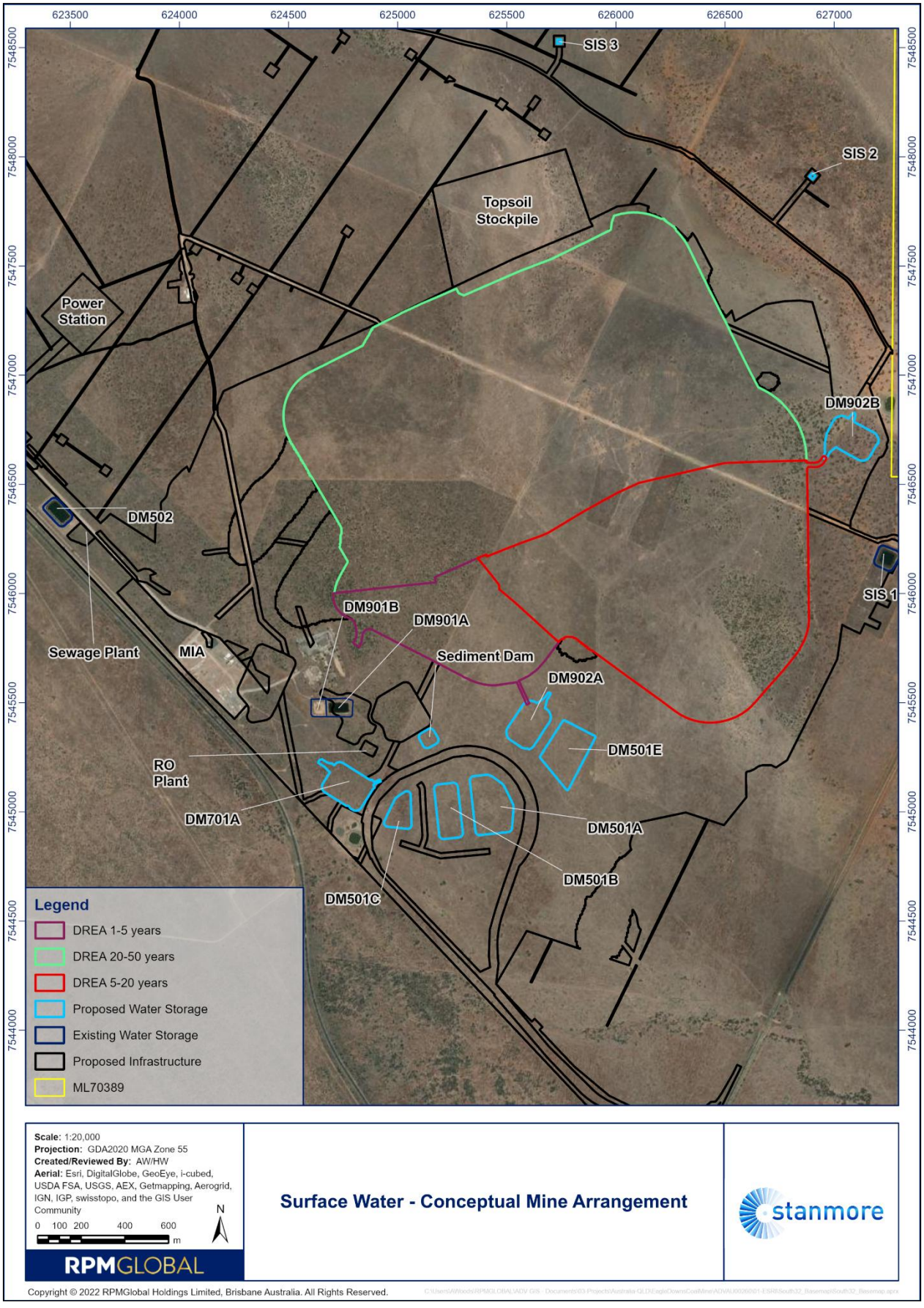


Figure 74 Surface Water - Conceptual Mine Arrangement

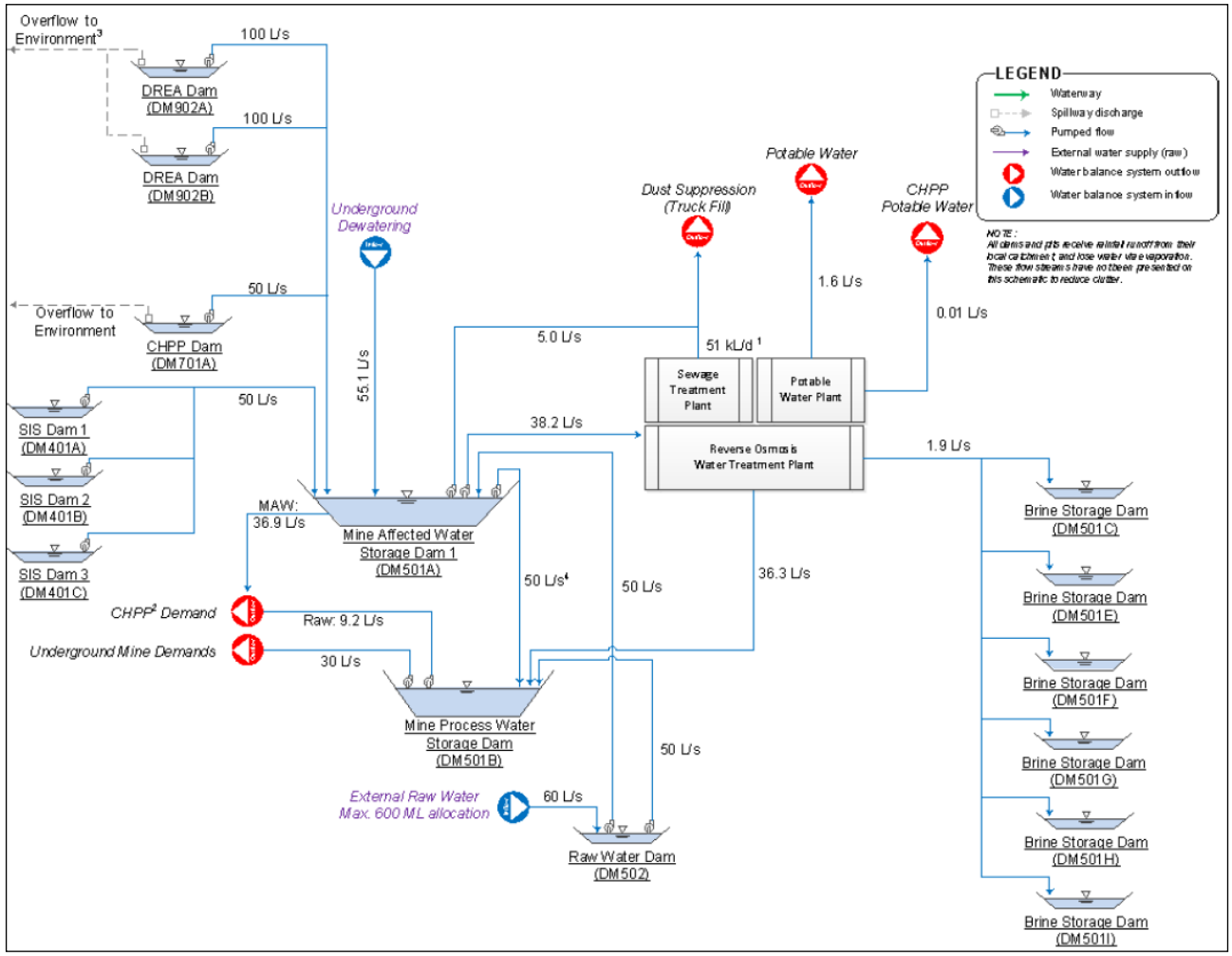


Figure 75 EDCM Conceptual Water Management Schematic

Contaminants – Description, Source, Pathway and Fate

Sources of potential water contamination, description of contamination, fate and containment strategies identified in the water management plan (South32, 2023) are outlined in **Table 41**.

Table 41 Potential Surface Water Contamination

Source	Description of Contaminants	Potential Fate	Containment Strategy
Spills (including equipment leaks) and contamination by metals and hydrocarbons from mine workshop, waste disposal and fuel storage areas	Spills and contamination by metals and hydrocarbons, waste disposal, fuel, sediment, hydrocarbons, or other chemicals	Impact soil, surface waters (run-off) and groundwater.	Sumps to collect hydrocarbon runoff and direct oil/water separator. Adequate bunding. Spill kits. Personnel training. MIA isolated from the receiving environment via drainage system which drains to mine water storage dams (no release). Recovered oil removed from site by a licenced regulated waste disposal contractor.
Mine Dewatering from coal seam.	Brackish and slightly alkaline with pH ranging from 7.8 to 8.4. Salinity, represented as electrical conductivity (EC), between 6,000 µS/cm to 12,000 µS/cm. Suspended sediment.	Contamination of receiving environment. Depletion of water resource.	Piping and pumping systems monitored and maintained to ensure no leakages to ground. Flow meter installed to measure the volume of water taken during dewatering. Mine affected water stored onsite in dams designed for that purpose (no release). Groundwater monitoring.
Run-off from onsite mine infrastructure area	Elevated levels of suspended sediment and possibly hydrocarbons or other chemicals.	Contamination of stormwater and receiving environment.	MIA isolated from the receiving environment via drainage system which drains to mine water storage dams (no release). Implement Erosion and Sediment Control Plan. Water Monitoring.

Source	Description of Contaminants	Potential Fate	Containment Strategy
Treated Sewage Effluent	Increased nutrients.	Irrigated to land. Impact to human health.	Monthly monitoring of effluent quality. Separation distance requirements from groundwater bores and surface waters. Disposal of STP sludge removed by licenced waste contractor.
Handling and storage of drift and spoil material	Acid generation from the drift spoil (unlikely). Soluble metals and salts in runoff and seepage from drift spoils (unlikely).	Groundwater contamination.	Groundwater monitoring network.
DREA run off	Erosion and sedimentation	Enter surface water drainage lines and reduce holding capacity of storage dams.	Erosion and Sediment Control Plan. Runoff isolated from the receiving environment via a drainage system - directing runoff to designated storage dams (DM902A and DM902B) (no release).

Infiltration and Seepage – Intervention and Collection Control

The concentration of soluble metals and salts in runoff and seepage from drift spoils is unlikely to present any environmental risks for on site or downstream water quality (EDCM WMP (South32, 2023)).

Water Diversions and Long-Term Management Requirements

There are no watercourse diversions required on site.

To reduce the area of ponding caused by subsidence, drainage channels will be constructed, and some areas will be filled (Refer to Section 3.5.1.2). These are authorized by EA EPMN00586713.

Dewatering Requirements

Dewatering requirements during operations at EDCM are outlined in Table 4.3 of the Surface Water Assessment (WRM, 2022). During decommissioning and closure of the EDCM, existing mine affected water (MAW) infrastructure (including MAW dams), will be dewatered and decommissioned prior to closure. MAW recovered from the MAW dams will be dewatered and pumped/transferred to the underground workings.

The MAW dams will then be reshaped, so that the final landform does not allow retention of water within any storage in closure. Any retention of dam infrastructure will be done through the necessary consultation with the landholder.

Ongoing Water Management and Reduction Requirements

Subsidence - Drainage and Ponding

The Eagle Downs Project proposes to target three seams (HCU, HCL and DY) by longwall mining. Longwall mining typically results in subsidence which leads to progressive development of shallow, trough-like depressions on the surface above each extracted longwall panels. The trough-like depressions have gentle grades and develop relative to the natural surface (WRM, 2022), and create localised ponding.

Ponding mitigation measures that have been considered include:

- The construction of drainage channels between the ponded areas; and
- The filling of ponded areas where drainage may not be possible or practical.

Following the mining of the HCU seam, no mitigation measures are proposed because the ponded area would be less than approved. However, mitigation measures would generally be required after mining the HCL seam. The residual ponding area after mining the HCL seam and constructing the mitigation drains is predicted to be 23.4 ha.

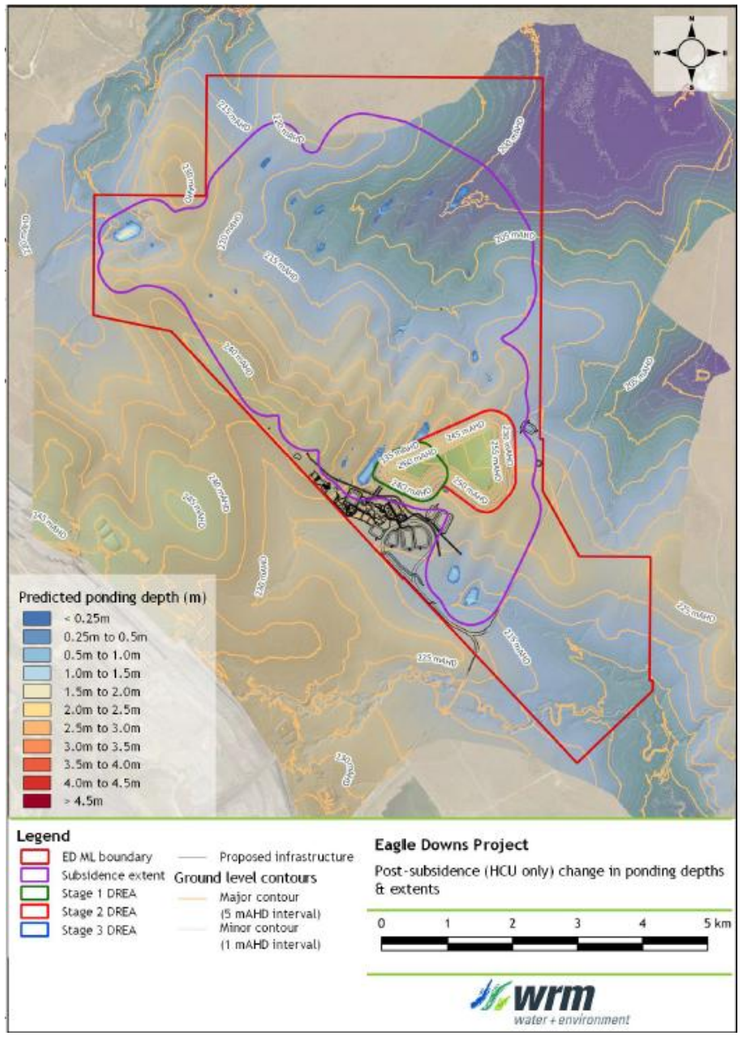
Under the proposed final landform conditions:

- The residual ponding disturbance area would be 76.4 ha, which is less than the currently approved ponding disturbance area of 77.5 ha.
- A total of 206 ha of ponded area would be reduced, with 180.6 ha mitigated by drainage works and 25.4 ha mitigated by filling.

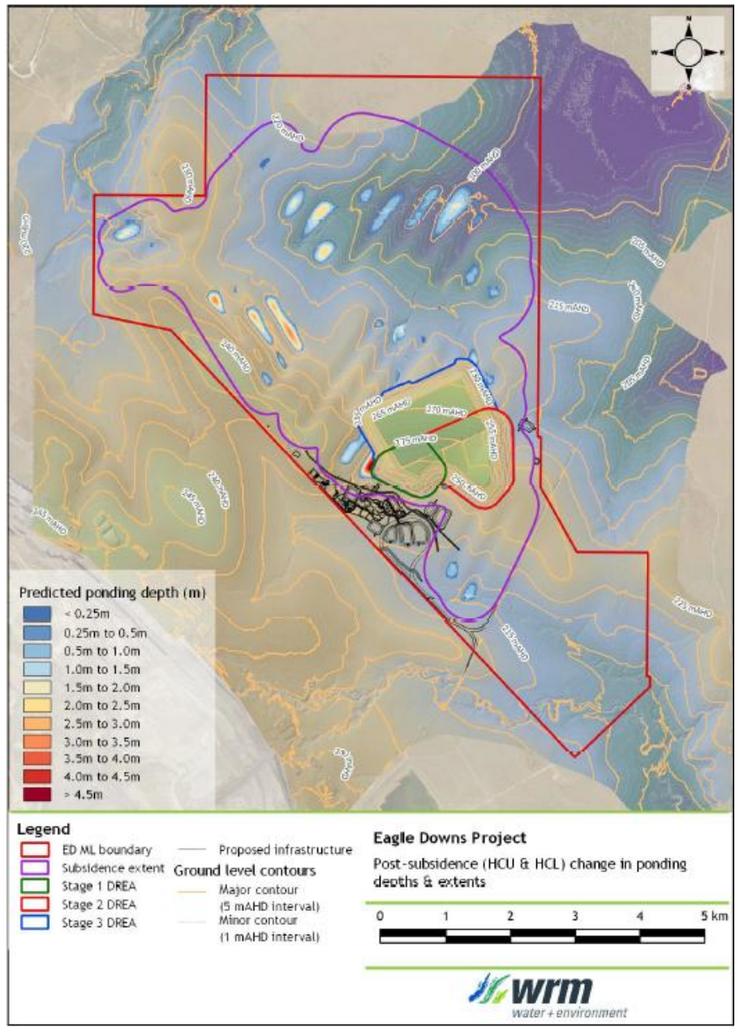
The 206 ha of reduced ponded area includes the 76.4 ha of residual ponding disturbance area.

Ponded areas supporting the PMLU of grazing will form part of the overall final landform. **Figure 76** shows post subsidence ponding modelled depths and extents created for each seam progression at EDCM.

HCU only



HCU and HCL



HCU, HCL and DY

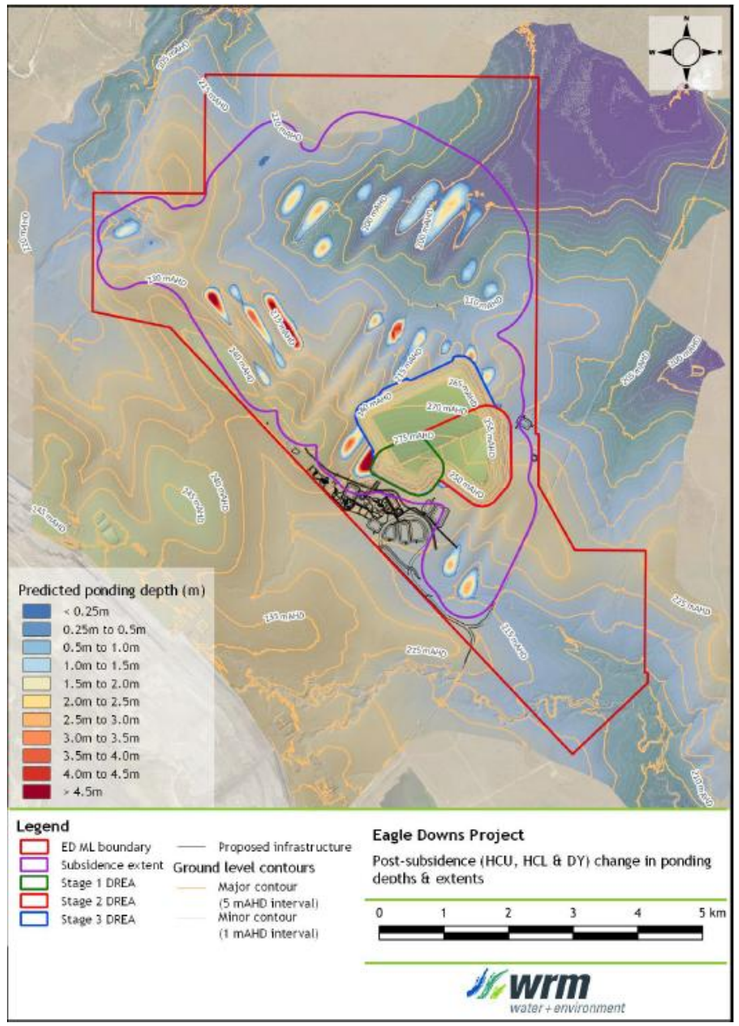


Figure 76 Modelled Post Subsidence Ponding Depths and Extents

For the final landform conditions, there will be a residual ponding disturbance area of 76.4 ha, and 25.4 ha mitigated by filling (WRM, 2022). Predicted ponded areas adjacent to the DREA stockpile are proposed to be filled to improve the geotechnical stability of the stockpile.

Figure 77 shows the locations of the proposed ponding mitigation measures and the predicted changes in ponding for each seam progression. No measures are proposed for the HCU seam only, as the ponded area would be less than approved (WRM, 2022). The majority of the mitigation measures will be required following the mining of the HCL seam via a network of drains. The residual ponding area following the mining of the HCL seam, and the construction of the drains is predicted to be 23.4 ha (WRM, 2022).

To predict the volume of water held in the subsidence areas, a ponding impact assessment was conducted by WRM (2022) using the GOLDSIM simulation model (Goldsim Technology Group, 2015), using 132 years of historical rainfall and evaporation data obtained from SILO. The model simulated rainfall runoff and overflows of the subsidence system and estimate a complete account of pond volumes and representative water quality on a daily timestep. An assessment was made on the water quantity and water quality of the subsidence ponds in the final landform after the mitigation measures have been implemented. Catchment areas of final landform residual pond characteristics are shown in **Figure 78** and provided in **Table 42**.

Table 42 Final Landform Residual Pond Characteristics

ID	Maximum Volume (ML)	Catchment Area (ha)		
		Natural	Stockpile	Total
Pond 1	82.3	16	-	160
Pond 2	54.5	98	-	98
Pond 3	7.7	28	-	28
Pond 4	165.4	106	-	106
Pond 5	21.8	190	-	190
Pond 6	1.4	35	51	86
Pond 7	216.4	1,453	147	1,600
Pond 8	172.1	1,413	103	1,517
Total	**721.6**	**3,483**	**301**	**3,785**

HCU only

HCU and HCL

HCU, HCL and DY

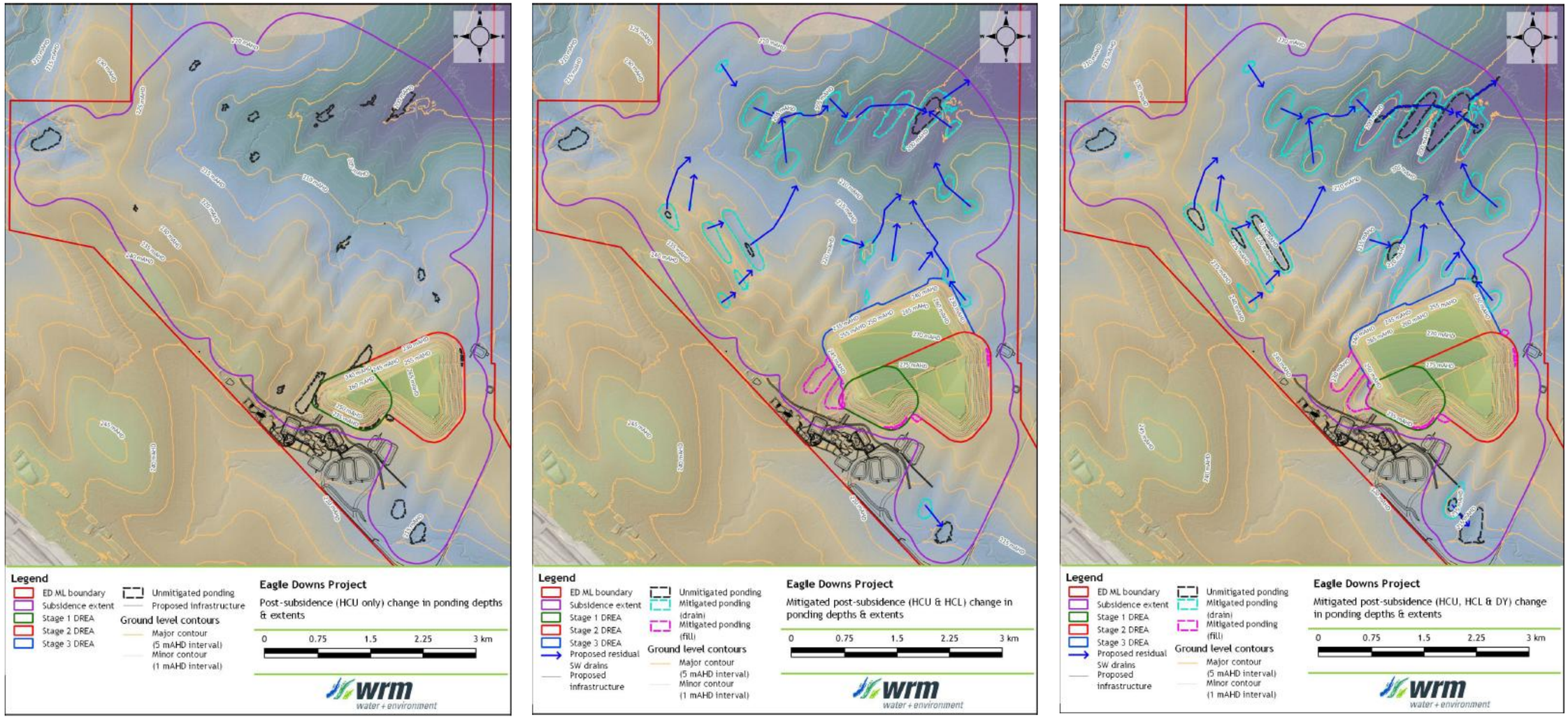


Figure 77 Predicted Mitigated Post-Subsidence Change in Ponding Depths and Extents

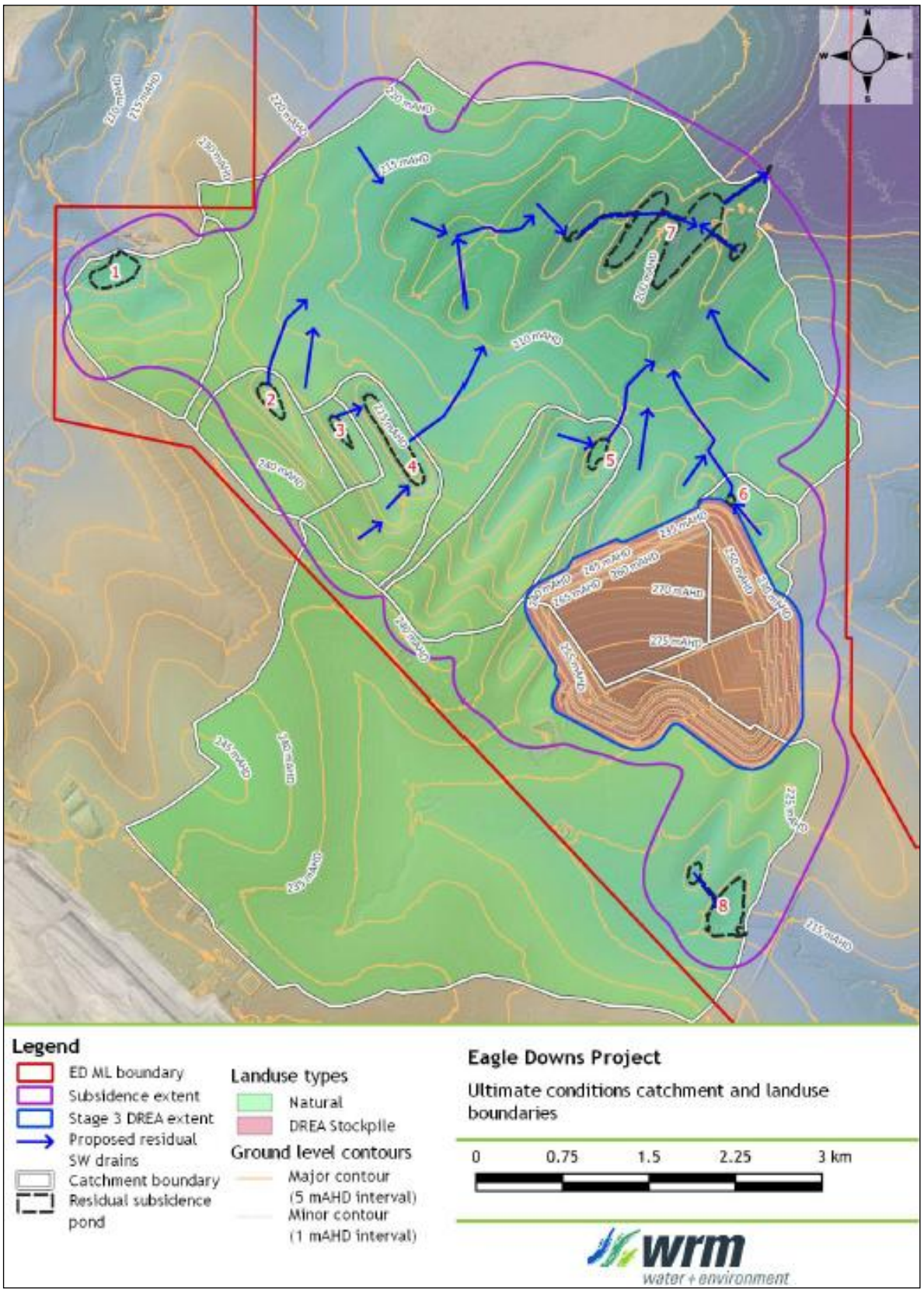


Figure 78 Ultimate Conditions Catchment and Land Use Boundaries (WRM, 2022)

Ponded Area Water Quality and Quantities

The predicted salinity (EC) concentrations in each depression for the proposed final landform conditions was assessed through a ponding impact assessment (WRM, 2022). These results have been reported for stored volumes above 0.001 ML in each depression (noting a concentration cannot be reported for a zero volume). The range of predicted storage volumes is in **Table 43**.

As the residual ponded areas are expected to be used as intermittent cattle watering holes, the recommended tolerance levels (without any adverse effects on cattle condition) is 4,000 mg/L for beef cattle (ANZECC and ARMCANZ, 2000a). The upper tolerance level limit (without any adverse effects on cattle livestock) is 5,000 mg/L for beef cattle. According to ANZECC and ARMCANZ (2000) cattle will have a reluctance to drink water with salinities between the 4,000 – 5,000 mg/L range, however, are expected to adapt without loss of production.

The predicted water quality and quantity associated with the final landform residual subsidence ponds are summarised below (WRM, 2022):

- Residual Pond 1:
  - would contain water approximately 50% of all days.
  - salinity concentrations would range from 128 mg/L to 2,225 mg/L.
  - The predicted median salinity would be approximately 282 mg/L.
- Residual Pond 2:
  - would contain water approximately 50% of all days.
  - salinity concentrations would range from 117 mg/L to 2,480 mg/L.
  - the predicted median salinity would be approximately 242 mg/L.
- Residual Pond 3:
  - would contain water approximately 50% of all days.
  - salinity concentrations would range from 102 mg/L to 2,089 mg/L.
  - the predicted median salinity would be approximately 231 mg/L.
- Residual Pond 4:
  - would contain water approximately 50% of all days.
  - salinity concentrations would range from 136 mg/L to 1,862 mg/L.
  - the predicted median salinity would be approximately 277 mg/L.
- Residual Pond 5:
  - would contain water approximately 50% of all days.
  - salinity concentrations would range from 118 mg/L to 2,459 mg/L.
  - the predicted median salinity would be approximately 248 mg/L.
- Residual Pond 6:
  - would contain water approximately 10% of all days.
  - salinity concentrations would range from 107 mg/L to 3,086 mg/L.
  - the predicted median salinity would be approximately 355 mg/L.
- Residual Pond 7:
  - would contain water approximately 95% of all days.
  - salinity concentrations would range from 172 mg/L to 2,606 mg/L.
  - the predicted median salinity would be approximately 312 mg/L.
- Residual Pond 8:
  - would contain water approximately 50% of all days.
  - salinity concentrations would range from 151 mg/L to 3,748 mg/L.
  - the predicted median salinity would be approximately 271 mg/L.

- Pond water quality can fall below the natural background concentrations of 200 mg/l when direct rainfall falling on the ponds is the dominant inflow.
- Based on the above salinity concentrations, cattle would have no hesitancy in drinking the residual ponded water.

Ponded Area Overflow

The ponding impact assessment identified potential overflow from three ponded areas (residual pond 1, 7 and 8) and the predicted the salinities of overflow water. **Table 43** shows results of overflow salinity concentrations – which are reflective of background water quality and lower than the Isaac River salinity water quality objectives (WQOs) (WRM, 2022).

Table 43 Predicted Final Landform Overflow Salinity Concentration into Receiving Environments

Pond ID	Receiving Waterway	Total Dissolved Solids (Salinity) (mg/L)								
		Max	99%	95%	90%	50%	10%	5%	1%	Min
1	J B Gully (Cherwell Creek)	199	199	198	197	194	190	189	186	183
7	Feature 1 (Isaac River)	253	238	228	221	212	206	204	199	191
8	Feature 3 (Ripplestone Creek)	234	232	227	221	208	204	204	202	197

The GOLDSIM model was also used to determine stream flow impact (existing vs final landform conditions daily flow) to the receiving waterways (**Figure 79** to **Figure 81**).

Overall, an assessment of stream flow impact and overflow quality (WRM, 2022) showed that:

- Residual Pond 1 (J B Gully):
  - Would overflow into the receiving environment approximately 0.3% of the time.
  - The mean annual stream flow volume at the lease boundary would change from 367 ML/yr to 346 ML/yr, a 6% reduction.
  - The frequency of daily flows do not change significantly due to the upstream catchment, which is not impacted by the project.
  - The frequency of flows of at least 100 ML/d would change from 0.25% to 0.24% of days, which is not significant. A flow of 100 ML/d would equate to a peak discharge of 1.1 m3/s, which is considered a low flow.
  - The salinity concentration of overflows ranges from 183 mg/L to 199 mg/L (EC 344 µS/cm to 374 µS/cm), which are under the WQOs for the receiving environment.
- Residual Pond 7 (Feature 1):
  - Would overflow into the receiving environment approximately 0.6% of the time.
  - The mean annual stream flow volume at the lease boundary would change from 729 ML/yr to 486 ML/yr, 33% reduction.
  - The frequency of flows of at least 100 ML/d would change from 0.37% to 0.3% of days due to mine subsidence.
  - The frequency of very low flows would reduce significantly due to the project. However, given that Feature 1 at the project lease boundary flows along a broad flow path with no channel, the change in flows would be imperceptible.
  - Feature 1 drains into the Winchester South MLA who propose to divert the waterway to allow for mining. Should Winchester South be approved, the reduced flows will be of benefit to Winchester South.

  - The salinity concentration of overflows range from 191 mg/L to 253 mg/L (EC 358 µS/cm to 475 µS/cm), which are under the WQOs for the receiving environment.
- Residual Pond 8 (Feature 3):
  - Would overflow into the receiving environment approximately 0.7% of the time.
  - The mean annual stream flow volume at the lease boundary would change from 939 ML/yr to 789 ML/yr, a 16% reduction.
  - The frequency of flows of at least 100 ML/d would change from 0.45% to 0.39% of days due to mine subsidence.
  - Impacts would reduce about 2 km downstream of the lease boundary when Ripplestone Creek converges with Ripstone Creek. Ripstone Creek has a catchment area of 45 km2 to the Ripplestone Creek confluence, which would double catchment runoff.
  - The salinity concentration of overflows ranges from 197 mg/L to 234 mg/L (EC 370 µS/cm to 439 µS/cm), which are under the WQOs for the receiving environment.

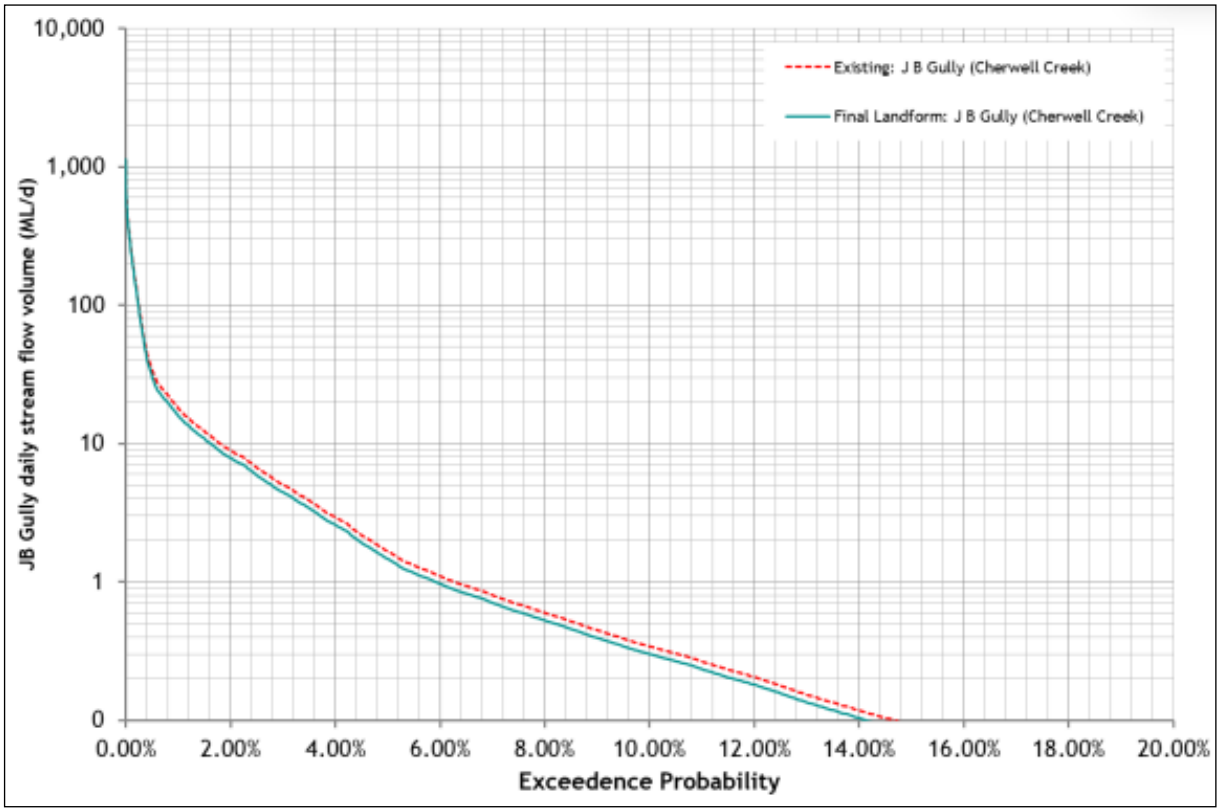


Figure 79 JB Gully Daily Flow Exceedance Curve at the Lease Boundary, Existing and Final Landform Conditions

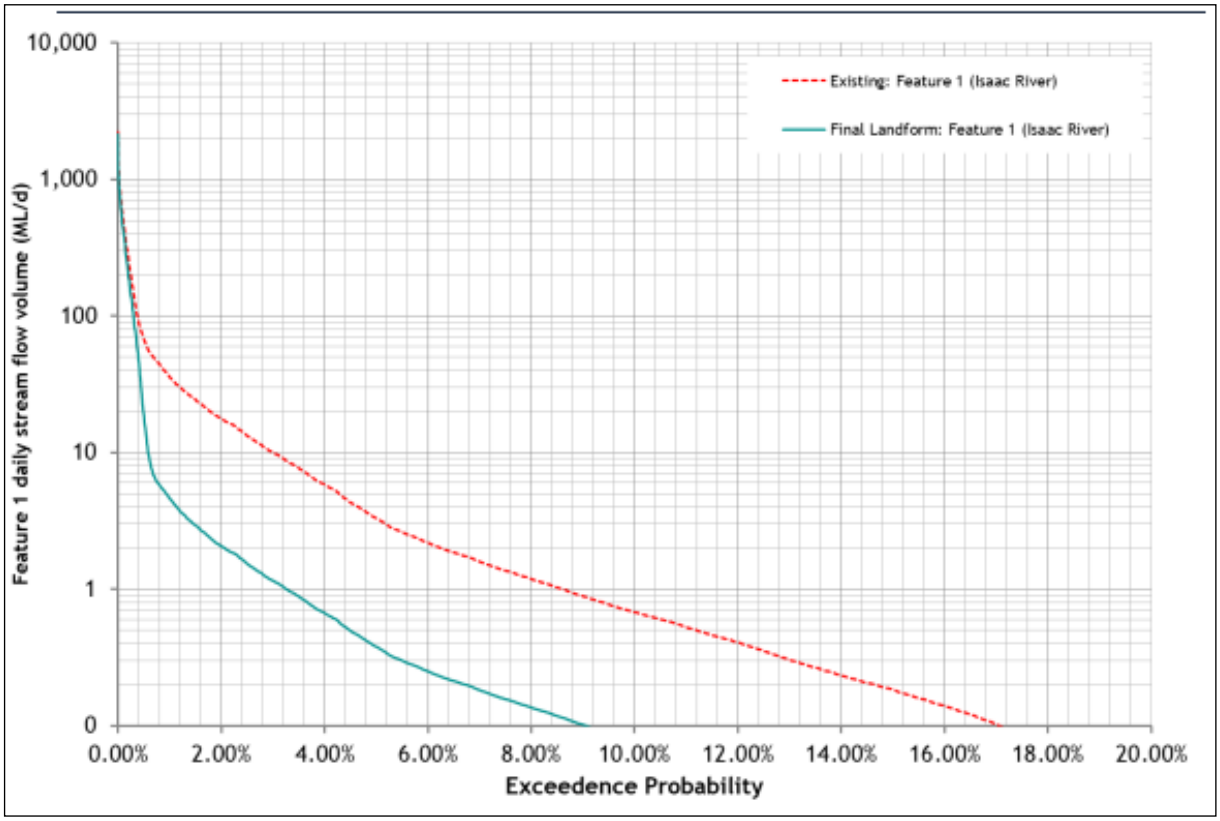


Figure 80 Feature 1 Daily Flow Exceedance Curve at the Lease Boundary, Existing and Final Landform Conditions

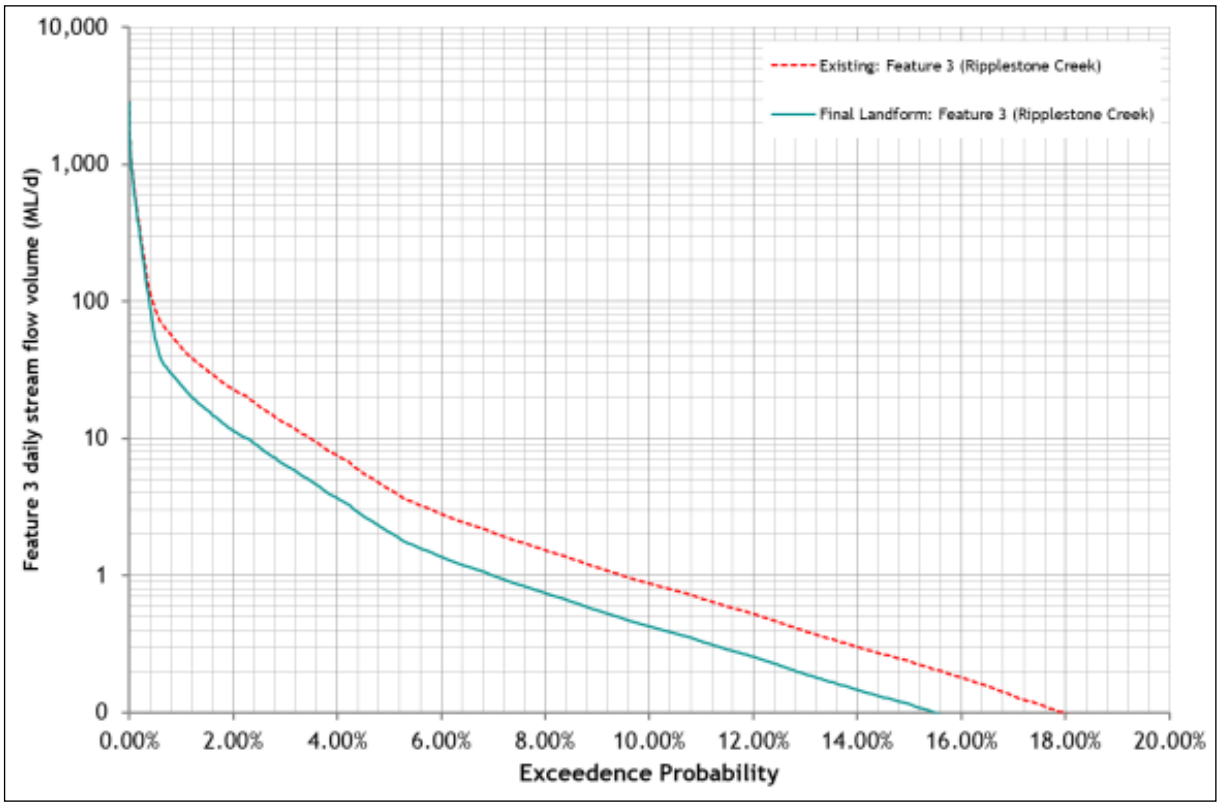


Figure 81 Feature 3 Daily Flow Exceedance Curve at the Lease Boundary, Existing and Final Landform Conditions

3.5.1.8 Revegetation

Revegetation Objectives

To achieve the PMLUs, EDCM has developed revegetation objectives (**Table 44**) consistent with the PMLUs and rehabilitation milestones identified in the PRC Plan schedule. There is no infrastructure required to protect vegetation, however fencing will be installed around the DREA, and areas as they undergo revegetation.

Table 44 Revegetation Requirements for Rehabilitation Objectives

Revegetation objective	Rehabilitation area	Revegetation Type	Completion Criteria
Native Ecosystem	• RA 2 Subsidence areas (dry) • RA 3 Subsidence • RA 6 DREA	Native grassland	• Prior to placement of soil material for rehabilitation, growth media[1] health and suitability must be assessed and certified by an AQP as suitable for native grassland. • Where growth media health and suitability assessment identify that growth media criteria below are not met, a recommendation is made for ameliorants and fertilisers prior to sowing seed, growth media to meet the following: (a) ECe ≤4 dS/m (b) Soil pH ≥5 and ≤9 (c) Exchangeable Sodium Percentage (ESP%) ≤6%. • Ameliorants such as fertiliser, gypsum and/or organic matter applied at rates determined by an AQP. • A minimum depth of 200 mm topsoil applied to cover surface for a plant growth medium. • Complete seeding of DREA surfaces using a rehabilitation seed mix comprising only the species permitted by **Table 46**. • For DREA, seed with native grassland species applicable to RE 11.9.3 at 12kg/ha. • For subsidence areas, complete seeding of topsoil surfaces for disturbed areas using a seed mix that aligns with the species composition identified in the baseline condition assessment. • Areas achieve ≥50% established and persistent vegetative groundcover. • Species used in revegetation (listed in **Table 46**) remain present and showing evidence of natural recruitment in rehabilitation monitoring data. • Weed presence is a maximum of 10% of total vegetative groundcover confirmed by an AQP in annual monitoring. Weed management recommendations to be provided in annual reports.

			• Less than 5% of total vegetative groundcover is declared weeds (as defined in the Biosecurity Act 2014). • No evidence of erosion classified as 'moderate' or 'severe' as defined by **Table 67**. • A third party AQP certifies that any erosion present will not compromise the achievement of a PMLU to a stable condition. **For DREA:** • Native vegetation communities must achieve ≥18/30 of values from reference benchmark criteria of mapped pre-clear regional ecosystem for RE 11.9.3 as per **Table 53**, when measured by an AQP using the BioCondition Assessment Methodology. • Updated landform evolution modelling confirms erosional stability of subsided DREA landform has not been compromised relative to original LEM predictions
Grazing	• RA 4 Infrastructure and parcel development. • RA 5 sediment and supply dams	Pasture species	• Prior to placement of soil material for rehabilitation, growth media[1] health and suitability must be assessed and certified by an AQP as suitable for native grassland. • Where growth media health and suitability assessment identify that growth media criteria below are not met, a recommendation is made for ameliorants and fertilisers prior to sowing seed, growth media to meet the following: (a) ECe ≤4 dS/m (b) Soil pH ≥5 and ≤9 (c) Exchangeable Sodium Percentage (ESP%) ≤6%. • Ameliorants such as fertiliser, gypsum and/or organic matter applied at rates determined by an AQP. • The application of a minimum 200mm growth medium on rehabilitated areas is able to support grazing pasture. • Nitrogen fixing Legume species included in seed mix • Complete seeding of all topsoil surfaces using a rehabilitation seed mix comprising only the species permitted as per **Table 45**. • Native or introduced pasture grass seed species used to control erosion applied at 12 kg/ha. • Vegetation ground cover >70%. • 3P (perennial, persistent and palatable) pasture species listed in **Table 45**, including legumes and grasses, remain

			present and showing evidence of natural recruitment in rehabilitation monitoring data. • Weed presence is a maximum of 10% of total vegetative groundcover confirmed by an AQP in annual monitoring. Weed management recommendations to be provided in annual reports and completed. • Less than 5% of total vegetative groundcover is declared weeds (as defined in the Biosecurity Act 2014). • Certification of rehabilitation to Grazing Class 3 by an AQP. • No evidence of erosion classified as 'moderate' or 'severe' as defined by **Table 67**. • A third party AQP certifies that any erosion present will not compromise the achievement of a PMLU to a stable condition.
Intermittent cattle watering holes	RA 1 Residual ponding areas	Water available to cattle	• Ponds area safe for native animals and stock access and have vegetated banks. • Water storages to be assessed and approved as safe and stable by an AQP.

[1]Growth media is defined as all soil and soil-like material that will support the final vegetation cover. This includes the topsoil and subsoil where these materials are applied independently. Where the topsoil is incorporated into the underlying subsoil/spoil, topsoil refers to the depth of incorporation and the remaining depth is regarded as subsoil. The total depth of growth media is nominally considered to be the effective plant root zone

Key Flora Species

An integral component of achieving PMLUs for the site, is to identify key flora species (including pasture plants and tree and shrub species) that are suitable for revegetating the areas, which will generally be by seeding. Some planting may be required, where seeding is unsuccessful, in the first instance.

Pasture Species for PLMU Grazing

The proposed key flora species mix and seeding rates for establishment of pasture to support the post-mining land use of grazing are shown in **Table 45.** An adjustment to the below seed mix composition and seeding rates may occur based on rehabilitation monitoring results.

Table 45 Pasture Species Mix

Common Name or Variety	Scientific Name	Indicative Rate (kg/ha)
Kangaroo Grass	*Themeda triandra*	1
Queensland Bluegrass	*Dicanthium sericeum*	2
Japanese Millet	*Echinochloa esculenta*	2
Sabi Grass	*Urochloa mosambicensis*	2
Fine Cut Rhodes Grass	*Chloris gayana*	2
Forest Bluegrass	*Bothriochloa bladhii*	0.5
Seca Stylo	*Stylsanthes scabra*	0.5
Minimum total sowing rate		**12**

Species for Native Ecosystem PMLUs

The indicative proposed key flora species mix and seeding rates for establishment of vegetation to support the post-mining land use of native ecosystems are shown in **Table 46**. Where possible, native plant seed will be sourced locally to maximise rehabilitation success (as they are acclimatised to local climatic and soil conditions).

Monitoring reference sites have been selected for representative regional ecosystems in the Project area. They utilise the vegetations assessment sites established by EcoSM (2022a). The sites will be supported by Queensland Government biocondition site data. Two reference sites have been selected to compare the DREA and subsidence (dry) areas of revegetation: HQP11; and HQP6. Refer to **Table 54** and **Figure 91** for their location.

Table 46 Species Mixes for Native Ecosystem PMLUs (RE 11.9.3)

Common Name or Variety	Scientific Name	Indicative Rate (kg/ha)
Queensland Bluegrass	*Dicanthium sericeum*	2
Curly Mitchell grass	*Astrebla lappacea*	1.5
Hoop Mitchell grass	*Astrebla elymoides*	1.5
Bull Mitchell grass	*Astrebla squarrosa*	1
Black Speargrass	*Heteropogon contortus*	2
Kangaroo Grass	*Themeda trianda*	1
Satintop Grass	*Bothriochloa erianthoides*	0.5
Native Millet	*Panicum decompositum*	0.5
Minimum total sowing rate		**12**

* Sterile cover crops can be seeded to support initial establishment

Growth Medium

As described in Section 3.5.1.3, EDCM will have topsoil material that is suitable for growing the nominated pastures and native ecosystems.

Topsoil Depth

Prior to topsoil application, a topsoil quality assessment will be conducted (i.e., laboratory analysis) to confirm the suitability of soil to sustain the PMLU. In line with the EDCM Topsoil Management Plan, topsoil shall be spread at a minimum thickness of 200 mm. The outcomes of rehabilitation trials will determine the strategies to address the topsoil deficit (i.e., amelioration of spoil).

Site (Seedbed) Preparation and Timeframe for Works

Identified seed suppliers should be provided with the required viability standards and issue test certificates that demonstrate seed meets quality requirements. To ensure seed viability is maintained during storage and prior to use, seed should be stored at low temperatures and humidity (<10% relative humidity). It is crucial that seed stock have limited exposure to pathogens and pests, and that seed is less than two years old when applied to rehabilitation.

Once topsoil has been spread on rehabilitated areas, seedbed preparation shall commence as soon as practicable to promote growth, maximise stability and minimise erosion. Seedbed preparation involves ripping the surface along the contour to promote water infiltration and prevent excessive runoff. Ripping depth will vary between 0.4 m and 1 m and done on the contour to reduce erosion potential. It is crucial that the soil's surface remains uncompacted.

Several methods may be adopted to spread seed, fertiliser, and other ameliorants on rehabilitation areas. These include:

- Direct application using appropriately modified machinery (dozer with three tynes);
- Casting using ground-based spreaders (mounted seeder on conventional tractor or mining equipment); and
- Aerial application over the prepared seedbed using light aircraft or drones.

The timing of seed and fertiliser (or any other soil ameliorant) application should aim for early August to late October each year; however, this is heavily dependent on the likelihood of rainfall, availability of suitably prepared rehabilitation areas and availability of suitable seed. Seed shall be applied at rates indicated in **Table 45** and **Table 46**.

If vegetation growth is poor, four weeks post-germination, the application of diammonium phosphate (DAP) fertiliser shall be evaluated (for grazing PMLU), and if required, applied at a rate of approximately 100 kg/ha.

To ensure rehabilitation is given the highest chance of establishment and long-term success, regular weed prevention strategies (as per the EDCM Weed Management Plan) shall be carried out, and livestock shall be excluded from rehabilitated areas by means of hard barriers (i.e., fencing) for at least two seasons.

Species of Conservational Significance

A Review of Matters of State Environmental Significance report was prepared by EcoSM (2022b) for the EDCM project (Appendix J). Approximately half of the ecology study area was found to support remnant vegetation and high-value regrowth vegetation. The balance of the ecology study area supports non-remnant vegetation including cleared grazing paddocks, cultivation areas, farm infrastructure and roads. Pre mining clearing for agricultural land uses and mining activities has resulted in fragmented remnant vegetation, particularly in the south-eastern and northern areas. Field-validated remnant regional ecosystem (RE) mapping is provided in **Figure 82**, whilst **Table 47** lists REs in the EDCM project area (EcoSM, 2022b).

Table 47 Remnant Regional Ecosystems (RE) in the Project Area

RE Code	Short Description[1]	Status[1]		Remnant Area (ha)
		VM Act	Biodiversity Status	
11.3.1	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains	Endangered	Endangered	27.7
11.3.2	*Eucalyptus populnea* woodland on alluvial plains	Of concern	Of concern	7.4
11.3.3	*Ecualytpus coolabah* woodland on alluvial plains	Of concern	Of concern	82.8
11.3.7	*Corymbia* spp. Open woodland on alluvial plains	Least concern	Of concern	2.5
11.3.21	*Dichanthium sericeum* and/or *Astrebla* spp. grassland on alluvial plains. Cracking clay soils	Of concern	Endangered	42.4
11.3.25	*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines	Least concern	Of concern	28.3
11.4.8	*Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains	Endangered	Endangered	7.2
11.4.9	*Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains	Endangered	Endangered	5.4
11.5.3	*Eucalyptus populnea* +/- *E. melanophloia* +/- *Corymbia clarksoniana* woodland on Cainozoic sand plains and/or remnant surfaces	Least concern	No concern at present	11.0
11.9.2	*Eucalyptus melanophloia* +/- *E. orgadophila* woodland to open woodland on fine-grained sedimentary rocks	Least concern	No concern at present	727.6
11.9.3	*Dichanthium* spp., *Astrebla* spp. grassland on fine-grained sedimentary rocks	Least concern	No concern at present	1272.6
11.9.5	*Acacia harpophylla* and/or *Casuarina cristata* open forest to woodland on fine-grained sedimentary rocks	Endangered	Endangered	54.0

[1]Short description, VM Act status and Biodiversity status taken from the REDD (Queensland Herbarium, 2021).

Matters of National Environmental Significance

There are two EPBC listed threatened ecological communities occurring in the area to be disturbed (**Table 48**).

Table 48 EPBC Listed Threatened Ecological Communities

MNES	Total Area disturbed by Revised Layout (ha)
Natural Grasslands of the Queensland Central Highlands (formerly Bluegrass *Dichanthium spp)*	95
Brigalow (*Acacia harpophylla* dominant and subdominant communities)	52

One threatened flora species, King Bluegrass (*Dichanthium queenslandicum*), which is EPBC and NC Act Vulnerable listed, is considered to have a moderate likelihood to occur in the EDCM project area and its occurrence is associated with REs 11.3.21 and 11.9.3. Potential habitat of the King Bluegrass is shown in **Figure 83**.

A study by Frazier (2015) in Brigalow and Bluegrass threatened ecological communities in the Brigalow Belt, Queensland using satellite imagery, LiDAR derived datasets, field survey and statistical comparisons was undertaken in area impacted by long wall mining subsidence. It found no significant impact on Brigalow threatened ecological community (TEC) condition as a result of long wall mining subsidence. The study found that both historical and current surface land management have a greater impact on extent, distribution and condition of the TEC. The study found the following for Brigalow communities:

- The nature of subsidence from long wall mining is such that the impact is likely to be minimal in the short term, if at all.
- There was no evidence on the impact of Brigalow that could be attributed to altered floodplain hydrology.
- Altered water regimes, especially ponding of water may pose a threat on flat, flood-prone environments.

The study found the following for Bluegrass communities:

- No significant impacts on the community condition linked to subsidence.
- Land management, through selective grazing had led to the TEC recovering to a good condition.

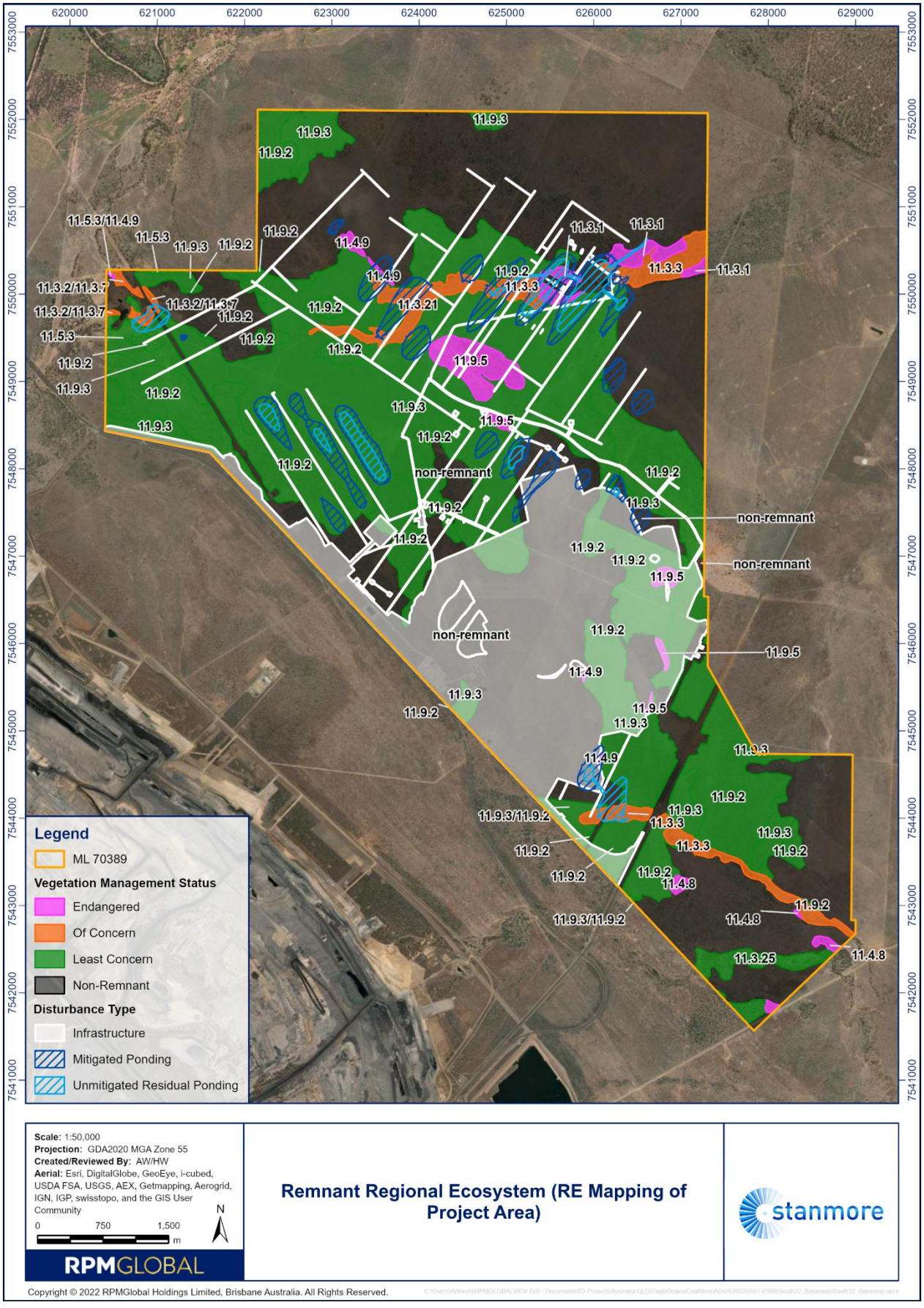


Figure 82 Remnant Regional Ecosystem (RE) Mapping of Project Area

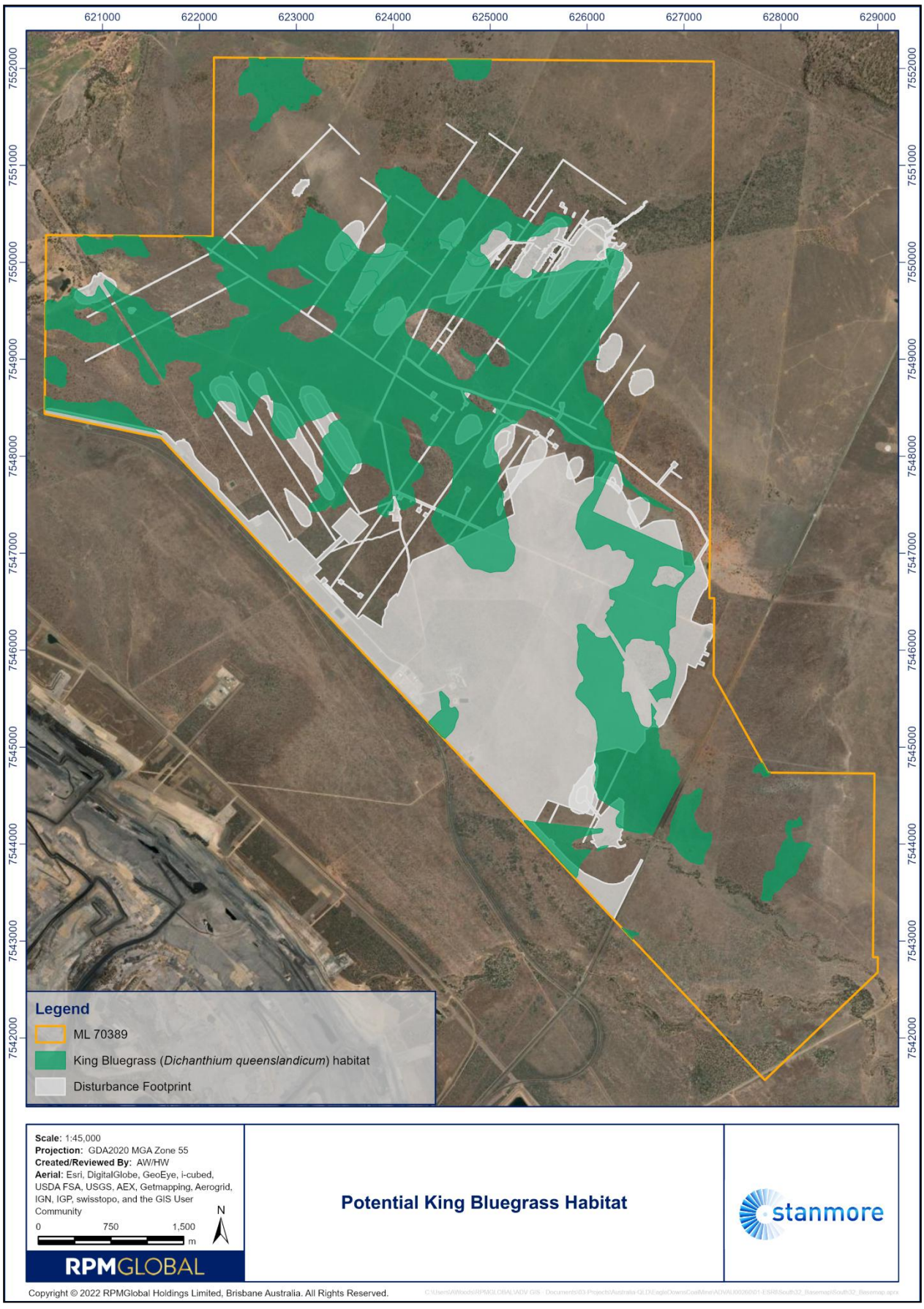


Figure 83 Potential King Bluegrass Habitat

Fauna Habitat

The maintenance of landscape connectivity between patches of habitat is a fundamental aspect of conservation ecology (Endler, 1977; Forman, 1995). Habitat corridors are often recommended to maintain and/or enhance landscape connectivity (Bennett, 1999).

A considerable amount of land within the EDCM ML and surrounding area has historically been cleared of native vegetation. This has resulted in a limitation of connectivity to the north of the ML, where vegetation communities within the ecology study area connect with woodlands on sand plains and riparian communities along Cherwell Creek and its tributaries. Connectivity of these communities ultimately extend to the north-east and meet with vegetation associated with the Isaac River and to the west and meet with extensive remnant communities associated with the Cherwell and Harrow Ranges (EcoSM, 2022b).

Vegetation associated with the smaller order drainage features is highly fragmented or cleared, therefore these features form limited landscape connectivity. Extensive landscape clearing for mining and agricultural purposes has occurred in the local landscape to the south-west and south-east of the ecology study area (EcoSM, 2022b).

Although habitat was considered to be heavily disturbed resulting in fragmented connectivity across the EDCM ML, the remnant and regrowth vegetation communities present provide habitat for a range of native fauna species, including species of conservation significance.

EcoSM (2022b) identified existing fauna habitats for threatened fauna species (Refer to **Table 10**). Threatened fauna species known to occur in EDCM ML:

- Squatter Pigeon (southern) (vulnerable).
- Ornamental Snake (vulnerable).

Threatened fauna species with moderate to high likelihood of occurring in EDCM ML:

- Australian Painted Snipe (endangered) – high.
- Greater Glider (southern) (endangered) – high.
- Koala (endangered) – high.
- White-throated Needletail (vulnerable) – moderate.

Special least concern fauna species known to occur in EDCM ML:

- Short-beaked Echidna.

Figure 84 to **Figure 90** show fauna habitat and use requirements within the EDCM project area for the above-mentioned fauna species.

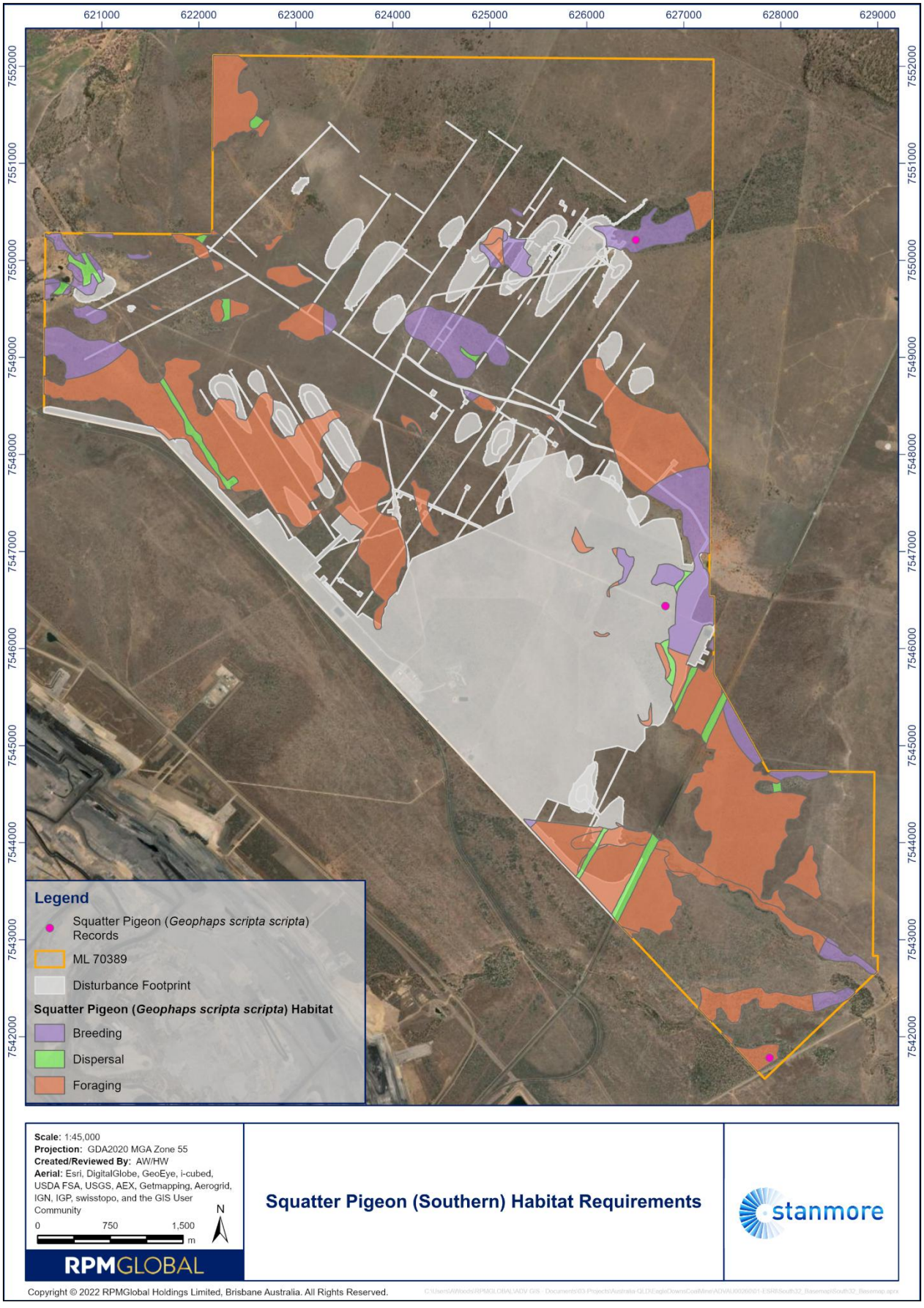


Figure 84 Squatter Pigeon (Southern) Habitat Requirements within EDCM Project Area

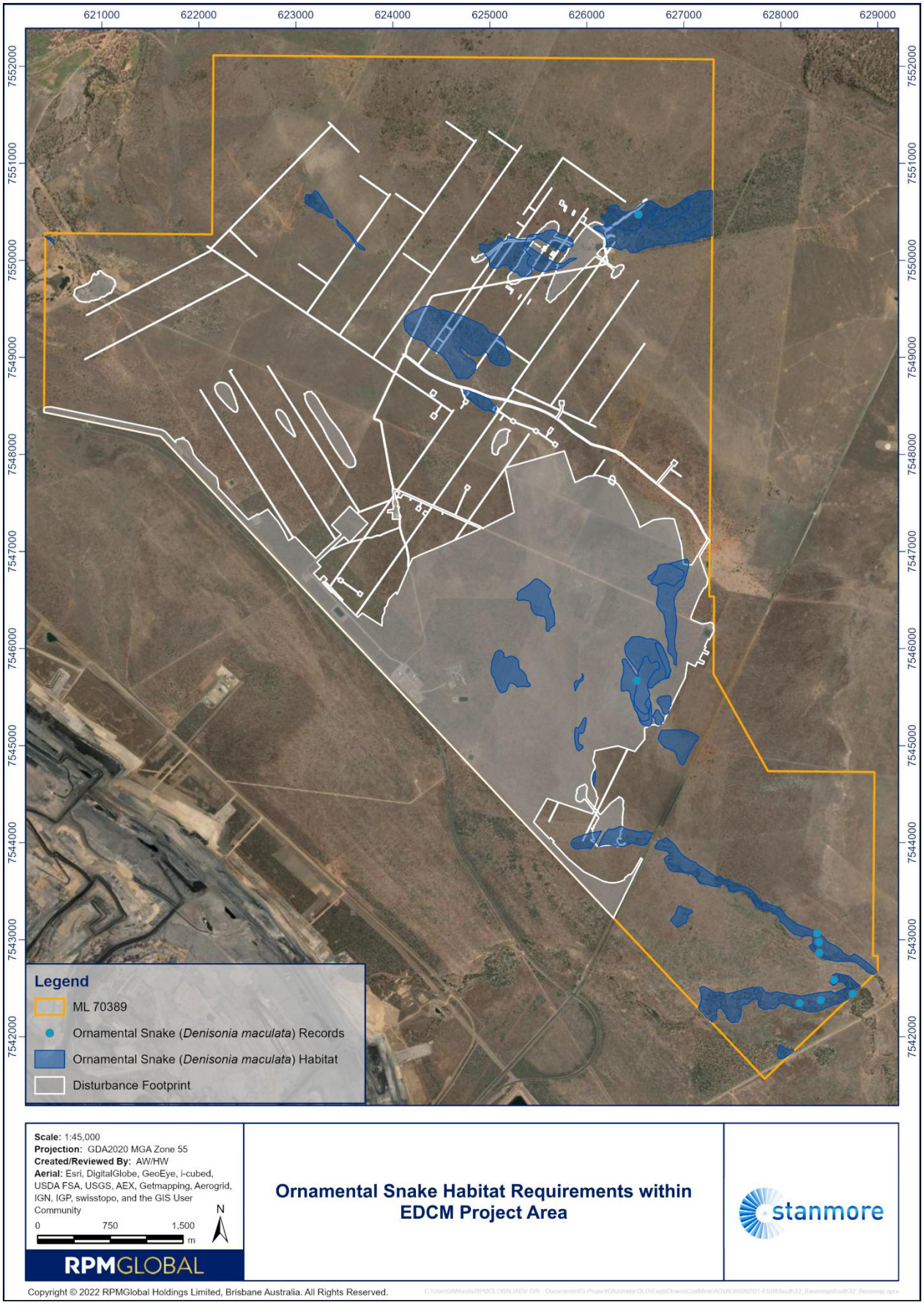


Figure 85 Ornamental Snake Habitat Requirements within EDCM Project Area



Figure 86 Australian Painted Snipe Habitat Requirements within EDCM Project Area

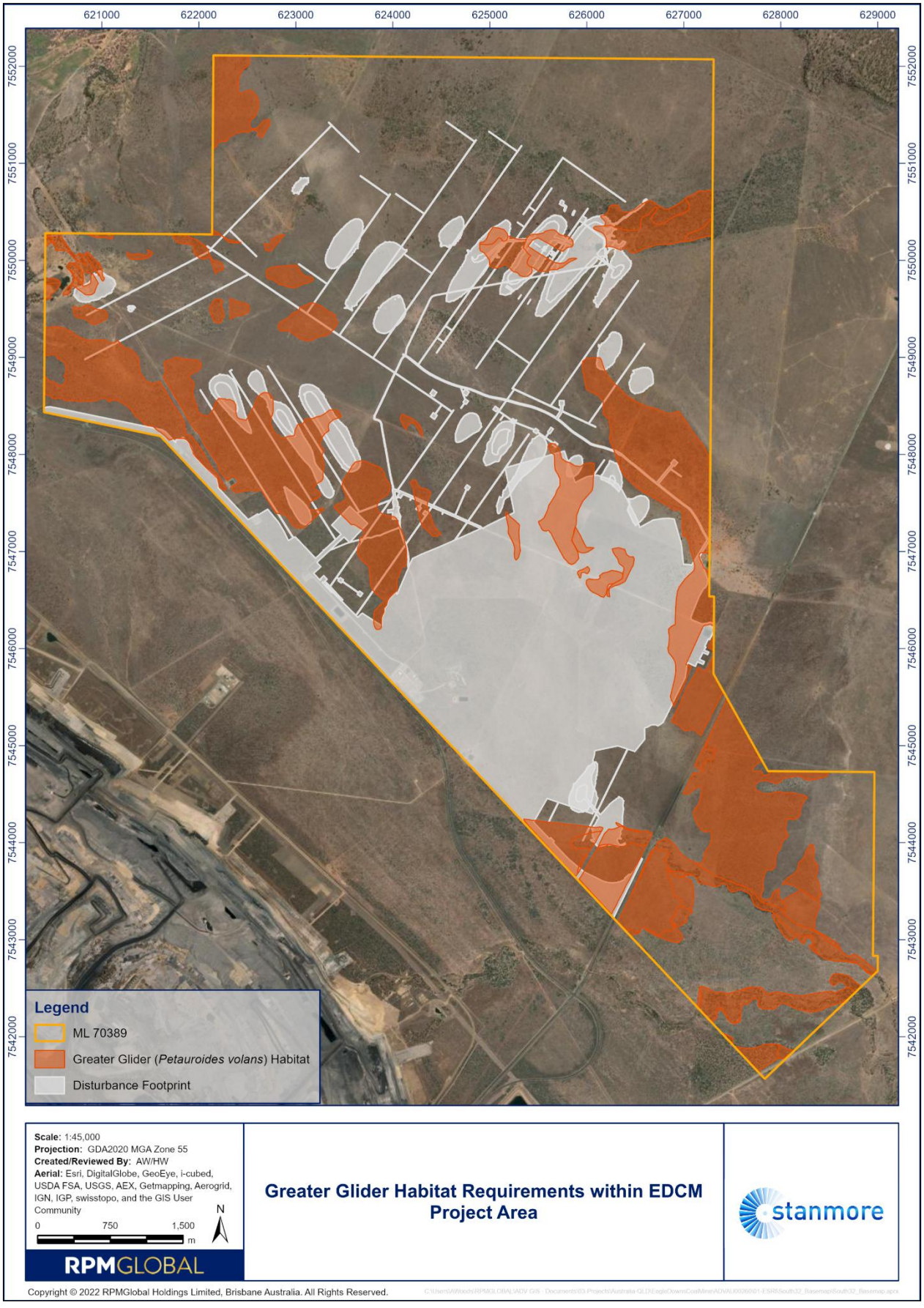


Figure 87 Greater Glider Habitat Requirements within EDCM Project Area

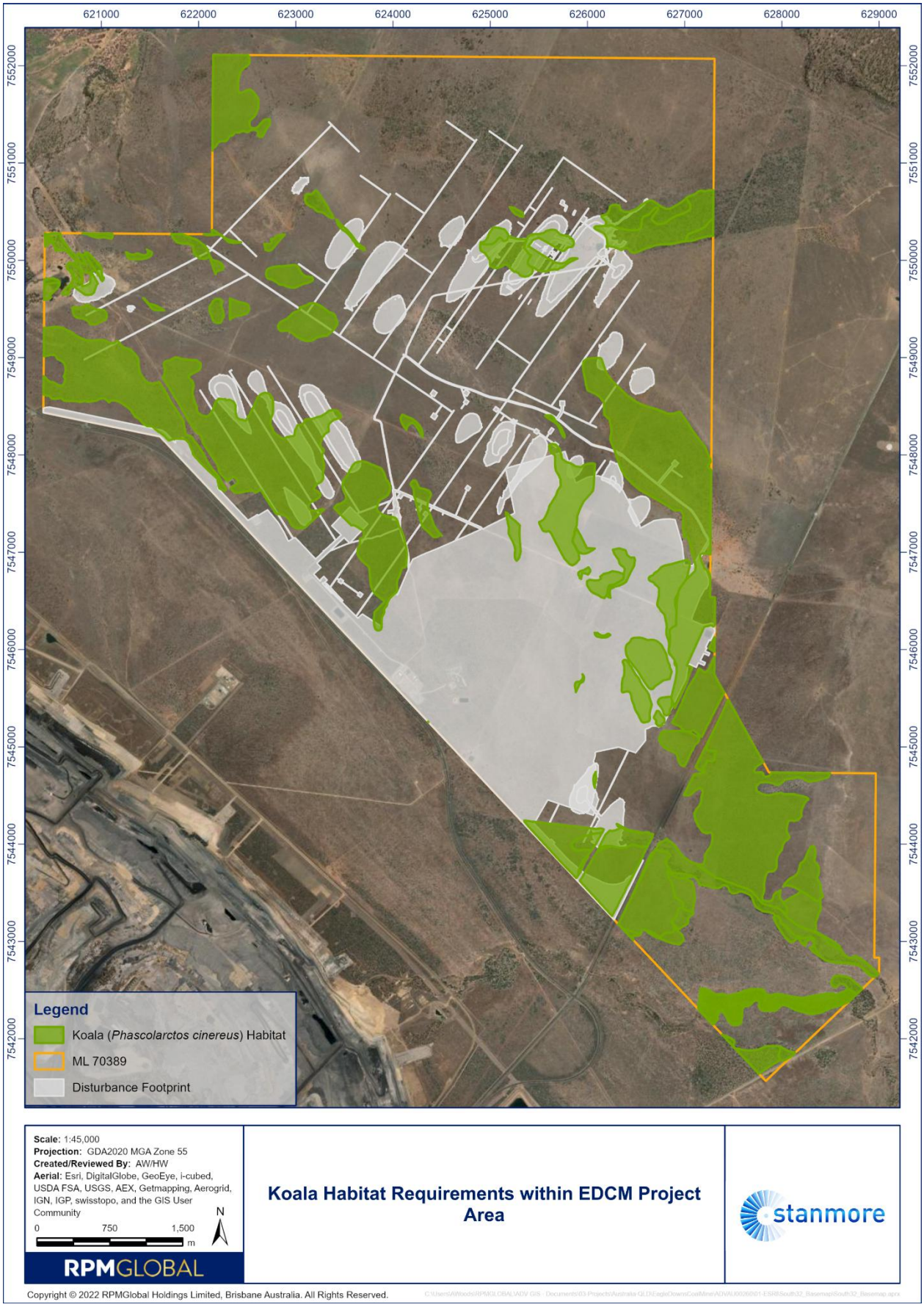


Figure 88 Koala Habitat Requirements within EDCM Project Area

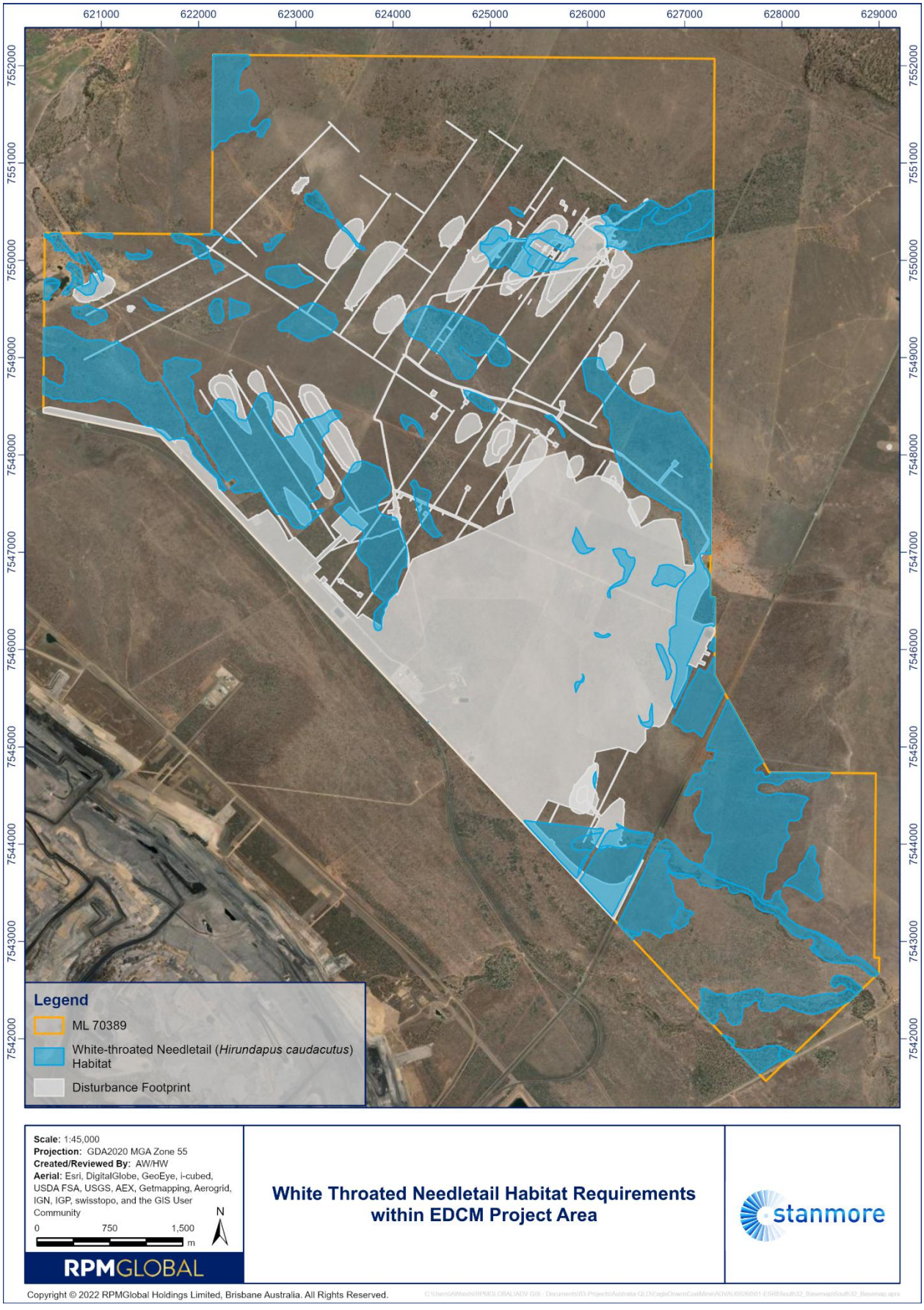


Figure 89 White-Throated Needletail Habitat Requirements within EDCM Project Area

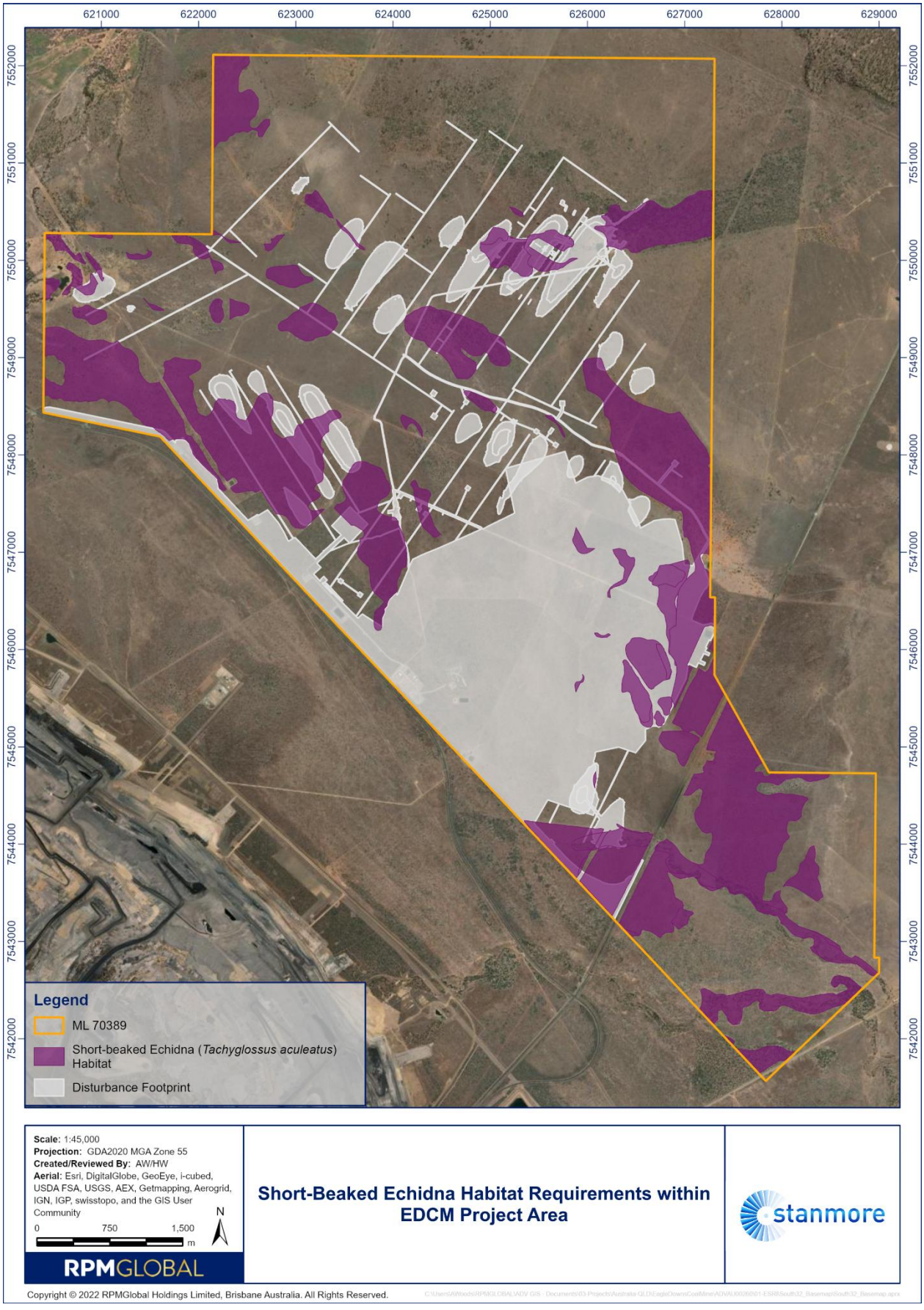


Figure 90 Short-beaked Echidna Habitat Requirements within EDCM Project Area

3.5.2 Tailings Storage Facility

There is no Tailings Storage Facility proposed to be located at the site.

The extraction of the resources has not yet commenced. The CHPP will produce two reject streams, coarse reject (comprising coarse and mid-size material, greater than 0.25mm size) and fine reject (less than 0.25mm size). Under anticipated operating conditions, the expected coarse to fine reject split will be likely to be around 10:1. Coarse and fine reject will be co-mingled to produce a 'dry reject' stream to be contained in the DREA. Fine rejects will exit the CHPP as a low-density solids concentration slurry that will be thickened and then further dewatered through belt press filters to produce a dry fine product (with water content around 40%) (ATCW, 2023). The dry fine reject will be mixed with coarse rejects to form the 'dry rejects' prior to transportation by truck from the CHPP to the Dry Rejects Emplacement Area (DREA). Landform design considerations for the 'dry rejects' are discussed in Section 3.5.1.5.

3.5.3 Voids

There are no voids located at the site, and therefore no voids proposed for a floodplain.

3.5.4 Underground Mining

Rock Doctors (2022) was engaged to prepare a geotechnical assessment to ensure that the closure of the mine complies with regulatory requirements, to include as part of the closure plan. The assessment involved a review of proposed and current underground workings from the perspective of final closure of the mining operations - with emphasis on the long-term impacts on surface subsidence and the ability to ensure the underground mining operations remain securely sealed in perpetuity.

The long-term stability of the workings and any impacts due to instability of the roadways or extracted areas, manifesting on the surface topography (above that modelled by Gordon Geotechniques (2021)), are not considered to be of concern in the long term (Rock Doctors, 2022).

Groundwater

Current groundwater flows and levels are impacted by adjacent mining and gas extraction operations, with flow generally towards operating mines in the vicinity. Inflow values from mines within 5 km of site estimate average inflows of between 0.8 ML/day and 175 ML/day. This is a large variation, however, using the mean of 88 ML/day into the combined void created by the three seams, will take approximately 6.2 years to fill to the level of the current bores (where they are screened) (Rock Doctors, 2022).

The average current (historical) height of groundwater observed in the bores at EDCM is ± 25 m below the collar of the bore. Assuming connectivity through shafts, bores, gas management holes and subsidence fracturing, it is highly likely that this level of standing water in the bores will lead to flooding of the mining operations once pumping from underground stops and the underground is sealed off (Rock Doctors, 2022).

Flooding of the underground workings will assist with:

- Exclusion of oxygen and reduction of flammable gas release rates and volumes in the workings, increasing the pore pressure and reducing the stress on the coal that form up the underground pillars;
- Provide confinement of pillars and increase pilar load carrying capacity;
- Reduce oxidation and weathering of coal in the pillars, thereby increasing anticipated pillar life; and
- Prevent spontaneous combustion of the coal when exposed to air.

Rock Doctors (2022) indicate that groundwater will stabilise in the workings and over time, become a net ground water source for recharge of the aquifers in the area.

A hydrogeological conceptual model is available in Section 3.5.1.1.

The impact on vegetation of subsidence is expected to be low. This is discussed in Section 3.5.1.8.

Subsidence

Gordon Geotechniques (2021) was engaged by EDCM to undertake a Subsidence Prediction Report for the project (Appendix L) which included a detailed subsidence study using the Surface Deformation Prediction System (SDPS) program, a methodology used widely throughout QLD and NSW to predict longwall mining subsidence (potential and impact). Due to the depth of workings and the nature of the material above the seams, modelling indicates that subsidence is unlikely to lead to direct connections between the surface and the sealed underground workings.

Regular monitoring of subsidence during mining operations will allow personnel to compare modelled subsidence against actual subsidence. At closure, subsidence will be confirmed to determine if additional subsidence and or pillar failure impacts has occurred.

Sealing of Underground Workings

As part of rehabilitation and closure requirements, all major openings between the surface and the underground workings will be sealed to ensure long term stability, and prevention of access by personnel or animals. As a requirement of the Queensland Coal Mining Safety and Health Regulations 2020 (regulation 325) all openings from surface into the underground workings must be sealed with a type E seal and verified by the underground mine manager. A type E seal" means a ventilation control device capable of withstanding an overpressure of 70 kPa.

A number of various shafts and boreholes are required to support underground workings at EDCM. These include main ventilation shafts, fresh air and return raises, large diameter dropholes (>300 mm diameter), exploration / dewatering / surface gas drainage boreholes and declines. A Seal Construction and Management Plan will be developed for shafts and boreholes at EDCM to include traffic management, seal design, shaft seal construction, design controls and monitoring and QA/QC requirements.

The general process for sealing ventilation shafts, boreholes, mine shafts / mine declines and surface gas drainage, when no longer required, is provided below:

Ventilation Shafts and Large Bore Shafts

1. Formal Risk Assessment and sign off.
2. For those shafts with multiple access points into underground workings - construct light weight stopper (sprayed gypsum or similar, 100 mm thick).
3. Remove all cables, steelwork or conductive materials in the shaft or underground workings.
4. Fill shaft with a fine gravel (at least 2 m above the top of any entries).
5. Pump low strength (7% cement) high slump concrete into the shaft (3 x bore diameter).
6. Fill remainder of shaft with clean fill (constantly wet down to assist with compaction).
7. Top off with a minimum of 5 mof topsoil. Top up fill as required so it aligns with surface level.
8. Certification from a suitably qualified person that the construction was completed in accordance with the design.

Surface to Seam Exploration Boreholes (i.e., exploration, water monitoring etc with diameter up to 300 mm, including dewatering boreholes)

Site Geologist / Geotechnical Engineer to sign off that borehole is not required for further data gathering, or geotechnical measurements.

1. Formal Risk Assessment and sign off.
2. Remove temporary borehole casing, to a minimum depth of 30 m, or to the length of the casing installed (remove steel or other conductive material in the hole for a minimum of five meters).

3. Install packing or wadding into the hole, at a minimum depth of 30 m below the collar RL for the borehole.

4. Pump a minimum of 10 m of cement-based grout (minimum cement ratio 20%, be able to flow with slump +350 mm).

5. Fill remainder of borehole with soil from the surrounding area.

6. Rehabilitate area surrounding borehole, including all sumps and pits.

7. Insert survey peg in the area of the borehole for later reference.

8. Certification from a suitably qualified person that the construction (borehole remediation) was completed in accordance with the design.

9. Update Acquire database with bore rehabilitation information.

Six months prior to EDCM mine closure, all exploration boreholes must be examined in the Acquire database. Any hole that is still un-grouted and not being used must be grouted and entered into the database as completely sealed.

Mine Shafts and Declines

Formal Risk Assessments and sign off.

1. Prepare and submit a Mine Closure and Sealing Plan to the Mining Inspectorate for sign off.

2. Remove infrastructure while mine workings are still ventilated.

3. Monitor atmosphere and control water during sealing process.

4. Install temporary seals (2 seals per drift) to provide a chamber filled with innertising gasses or permanent seals (to be rated 50 psi (350 kPa) as per Sealing Plan.

Surface Gas Drainage Boreholes

A nine well surface-to-inseam (SIS) gas drainage program and associated infrastructure is also planned as part of EDCM operations.

All gas risers, goaf holes and gas wells will be plugged and abandoned as per the requirements of the *Coal Mine Safety and Health Act 1999* and the latest edition of the Code of Practice for construction and abandoning coal seam gas wells and associate bores in Queensland, prior to surface rehabilitation works being undertaken.

Surface Ponding and Cracking

Longwall mining methods can induce a range of subsurface subsidence effects. In the context of changes to the hydrogeological regime, the key issue associated with longwall subsidence is the creation of subsurface subsidence cracks in the rock mass. These cracks can provide new flow paths for groundwater and alter the permeability of the strata overlying longwall mining areas (Rock Doctors, 2022).

This information can be correlated to measured changes in the water regime, for example, decreases in groundwater levels in boreholes or inflows to underground mining areas. This provides accurate site-specific data on the known characteristics and impacts of subsurface subsidence cracking within the geological sequence.

To mitigate subsurface subsidence cracking, EDCM will measure key characteristics during normal mining operations on a regular basis (including the height of cracking above the extracted coal seam). A range of methodologies may be used to determine the heights of subsurface subsidence cracking associated with EDCM mining operations.

These include:

- Borehole extensometers;
- Piezometer records;
- Drilling records;
- Comparison of permeability testing; and
- Microseismic monitoring.

Closure and rehabilitation activities relevant to the surface subsidence area include:

- Contour ripping and erosion control in the steepened areas;
- Where necessary rehabilitation of surface cracks and remedial drainage works may be required including ripping/ploughing or excavating and backfilling, and reseeding;
- Repair of surface buckling may be achieved by grading and re-spreading excess material, however care must be taken to maintain a suitable growth media prior to reseeding;
- Remedial drainage earthworks to redirect drainage paths and earthworks to re-establish free drainage in depression/ponding areas;
- Disturbed areas will be reseeded with native and naturalised grasses, legumes, shrub and tree species; and
- Monitoring of the subsided ponded areas following large rainfall events to determine whether the subsidence slopes or vegetation were impacted from the event.

Stabilisation of Underground Workings

All pillars left in place in the EDCM underground workings, from those close to the longwall workings, through to those in the outbye areas will be assessed for long term stability.

HCU Seam

Pillars in the Feasibility Study (RPM, 2020) have been designed to ensure long term stability of the workings. All mains pillars have Factors of Safety (FoS) of over 2.5 for the deeper 300 areas and in excess of 4.5 in the shallower 100 and 200 areas. The FoS for chain pillars (designed to ensure gateroad stability at the deepest part of each longwall block (inbye end)) varies between 1.3 and 1.6 at the inbye end of the panels. For the highest stressed zone, the tailgate corner, these drop to close to 1.0 (Rock Doctors, 2022).

The areas with a final FoS of below 1.5 are likely to fail over the long term, however as all these are close to the longwall workings, the roof deflections will have been captured as part of the subsidence analysis by Gordon Geotechniques. It is highly unlikely that any additional surface subsidence will be reflected as a result of these localised pillars, which will generally crush, lowering the roof by less than 2 m in the area (Rock Doctors, 2022).

The Mains roadway pillars will have a FoS of over 5 in all instances, indicating long term stability, however; support and protection from damage will be required during mining activities to ensure the dimensions are retained.

As selected by the Feasibility Study (RPM, 2020) in order to mine the HCL and DY seams (beneath the previously goafed HCU and then HCL seams) the HCL seam and DY seams will be mined in semi offset (30 m) longwalls. This is to provide the best geotechnical outcomes and increase long term pillar stability.

With the progression of time, pillar collapse will occur, with some of the pillars in the deeper areas and close to the longwall take off faces being the most likely to fail. Pillars generally spall from the ribs, which then fills the roadway with broken material, providing confinement for the remnant pillars, resulting in marginal vertical deformation of the roof. In the case of EDCM, this will be in the order of 0.5m to 3.5m, and only in localised areas (Rock Doctors, 2022).

3.5.5 Built Infrastructure

Condition E27 of EA EPML00586713 requires that all infrastructure constructed by or for the environmental authority holder during the licensed activities including water storage structures must be removed from the site prior to surrender, except where agreed in writing by the post mining land owner/holder. Gas related infrastructure must be removed from the site prior to surrender, except where approval is granted by the administering authority.

The intended PMLU of infrastructure areas is cattle grazing. At the completion of mining activities, all infrastructure constructed by, or for the operation of, EDCM will be removed from the site prior to surrender, except where agreed in writing by the post mining land owner/holder and the administering authority. Areas where infrastructure is removed, or those areas surrounding infrastructure that will remain, will be returned to grazing area with patches of undisturbed remnant vegetation consistent with the pre-mining and surrounding environment and PMLU. The slope of rehabilitated infrastructure areas will be less than 5%.

At all times throughout the decommissioning process at EDCM, the removal of infrastructure will adhere to the waste management hierarchy (i.e., in order of preference: reuse, recycle, energy recovery and disposal).

Contaminated land assessments will be undertaken to identify potential remediation requirements.

Infrastructure to be removed at closure will follow a methodology for decommissioning, as discussed in the following sections.

Surface Infrastructure

Surface infrastructure to be decommissioned at EDCM at closure include: a portable concrete batching plant, carparks and laydown areas, access tracks (including haul roads), construction offices, workshop, refuelling facilities, bulk oil storage (fuel and chemicals) and washdown facilities, Wastewater treatment Plant (WWTP), Reverse osmosis (RO) plant, coal handling processing plant (CHPP), core shed and store and associated pipelines.

The methodology used to decommission and rehabilitate the abovementioned infrastructure is described below:

- Disconnect and terminate (i.e., de-energise) plant and equipment to make safe;
- Remove all liquids, fuels, lubricants and decontaminate plant and equipment;
- Decommission and remove all surface infrastructure, unless requested otherwise in writing by the underlying land holder (underground services will remain buried and surface interface points will be sealed);
- Assess areas for contaminated lands and remediate identified areas;
- Deep rip to aerate the compacted soil material; and
- Seed disturbed areas with suitable pasture species.

Water Storages (Sediment, Supply and Brine Dams) and Drains

Sediment Supply Dams post-mine landform will be designed so as not to cause any serious environmental harm to land, surface waters or any recognised groundwater aquifer, upon mine closure.

The methodology used to decommission and rehabilitate redundant water storages is described below:

- Dams to be dewatered;
- Contaminated (silt or salt) material in dams and drains to be removed by authorised (licenced) waste contractor for correct disposal;
- Brine and dam liners to be removed and disposed of at a licenced waste facility;
- Dam walls and drains reshaped to tie into adjacent ground levels; and
- Landform topsoiled and seeded with suitable pasture species.

Train Load Out and Rail Loop

Prior to closure, stakeholder consultation will be undertaken to determine if there is an opportunity to divest the train load out and rail loop infrastructure to a third party. If there is no interest and the infrastructure is redundant, the methodology used to decommission and rehabilitate the train load out and rail loop is described below:

- Decommissioning and removal of the TLO and rail loop (includes onsite reuse or disposal of ballast and other construction material);
- Reshape landform to integrate into adjacent ground levels;
- Deep rip to aerate the compacted soil material; and
- Seed disturbed areas with suitable pasture species.

Surface to Seam Infrastructure

The methodology used to decommission and rehabilitate exploration boreholes, ventilation shafts, declines. a nine well surface-to-inseam (SIS) gas drainage program / associated infrastructure and dewatering bores is covered in Underground Mining rehabilitation methodologies (refer **Section 3.5.4**).

Power Station, Electricity Substation and Powerlines

Prior to closure, stakeholder consultation will be undertaken to determine if there is an opportunity to divest the gas-fired power station and associated infrastructure to a third party. If there is no interest and the infrastructure is redundant, the methodology used to decommission and rehabilitate the power station, electricity substation and powerlines is described below:

- Infrastructure decommissioned and demolished;
- Contaminated land assessment undertaken to identify potential remediation requirements;
- Contaminated material removed and processed as required; and
- Ground surface shallow ripped and then seeded with suitable pasture species.

EDCM generated infrastructure that will (or is likely to) remain post rehabilitation include:

- DREA (rehabilitated landform);
- Residual Ponding Areas (to be used as intermittent cattle watering holes);
- Nominated Sediment / Supply Dams (to be used as intermittent cattle watering holes);
- Fencing around native ecosystem PMLUs (i.e., DREA and some subsidence); and
- Various roads and tracks.

Only when the landowner has accepted the condition of infrastructure and formally accepted the transfer of ownership (by means of a formal agreement / sign off), will components of the abovementioned infrastructure be left to remain.

Some of the life-of-mine footprint of the DREA is above the underground mine workings and will be impacted by subsidence. The management of runoff from the DREA, including the ongoing maintenance requirements and management of subsidence of the DREA drainage system, is addressed in Section 3.5.1.2.

Other infrastructure (owned by third-party operators) that will remain post rehabilitation on the EDCM ML include:

- Eungella Water Pipeline Pty Ltd - Eungella Water Pipeline Southern Extension;
- Powerlink - 132 kV Moranbah to Dysart Transmission Line;
- Queensland Rail - Norwich Park Branch Railway Line; and
- Proposed Central Queensland Gas Pipeline jointly owned by Arrow Energy and AGL.

The railway line is outside the area that will be impacted by surface subsidence. Approximately 2.3 km of the powerline and water pipeline cross the northern area of the underground mining area and are predicted to be

affected by subsidence. Ongoing maintenance requirements and management techniques will be implemented in negotiation with, and agreement from the owners.

3.6 Risk Assessment

In accordance with section 126C(1)(f) of the EP Act, the rehabilitation planning part of the PRC Plan must:

Legislative Requirements	Compliance
Identify the risks of a stable condition for land described as a post-mining land use not being achieved, and how the applicant intends to manage or minimise risks.	Section 3.6.3

3.6.1 Identifying, Assessing and Treating Risks

The EDCM closure risk assessment supports the milestone criteria in the proposed PRC Plan Schedule. Additionally, it identifies and provides the following:

- Risks specific to rehabilitation and closure (i.e., achieving a stable condition for a PMLU); and
- Actions identified to control a risk to achieving a rehabilitation or management milestone.

To ensure the EDCM closure plan risk assessment remains current, it will be reviewed periodically so that changes to the project knowledge base (such as changes in the mine plan, research results, learnings from progressive closure, monitoring data and input from ongoing stakeholder consultation) may be incorporated.

3.6.2 Methodology

A quantitative risk assessment was undertaken by a team comprising of RPM Global Closure Specialists with inputs from EDCM managers, closure and mining specialists in May 2023. The methodology was based on the South32 EDC Risk Assessment Template and methodology (with references to several of the Standards Australia risk management guidelines and considers the Hierarchy of Controls). Consequence criteria relating to timeframes, however, has been adjusted to better represent closure timescales and address the requirements of the PRC Plan Guidelines.

The risk identification process drew upon the experience of the team and included a review of the project operations, site characteristics and the information gained from other South32 closure plans, and other closure and rehabilitation specific assessments and reports.

The assessment identified the risks of a stable condition for land described as a post-mining land use not being achieved, and how EDCM intends to manage or minimise risks.

The closure risk assessment considered and recorded:

- Risk events, risk pathways and impacts.
- Assessment of the potential consequence, likelihood of occurrence and recording of inherent Risk Rankings under existing controls and management strategies.
- Identification of additional controls and actions to be included in future operations with acknowledgment that these will be refined over time and more targeted actions implemented.
- Assessment of the potential likelihood and consequence of occurrence and recording of inherent Risk Rankings with additional controls and actions.
- A risk treatment plan (preventative and/or mitigative controls and management strategies).
- Responsibility, Resources and Timing required to implement actions to reduce residual risks.
- Closure Completion Criteria.
- Monitoring required to confirm and provide evidence for meeting completion criteria.

The criteria to assess the risk likelihood and consequence are provided in **Table 49** and **Table 50**, whilst the quantitative risk matrix is provided in **Table 51**.

Table 49 Quantitative Criteria for Likelihood

Likelihood	Description
Almost certain	Could occur more than once a year
Likely	Could occur 1:10-year timeframe
Possible	Could occur in a 1:50-year timeframe
Unlikely	Could occur in a 1:100-year timeframe
Rare	Could occur in a 1:500-year timeframe

Table 50 Qualitative Criteria for Consequence

Consequence	Description
Severe	>1 fatality or permanent impairment >30% of body to more than 10 persons. Serious or extensive impact/s (<20 years) to land, biodiversity, ecosystem services, water resources or air. Serious community health, safety or security impacts, extensive damage to >200 houses or structures/objects/places of national cultural significance.
Major	Single fatality or multiple injuries. Major environmental incident or impact with long-term (<5 years) damage to the environment, ecosystems, cultural and heritage sites. Serious community health, safety, or security impacts; extensive damage to >50 houses; moderate irreversible damage to structures/objects/places of national cultural significance.
Moderate	Major injury or other health or safety incident, restricted or lost days due to injury or illness. Moderate incident or impact on the environment with medium term damage (<1 year) to ecosystems, cultural and heritage sites. Moderate community health, safety, or security impacts.
Minor	Minor reversible injury or other health or safety incident. Isolated, environmental impact or incident with short-term impact on ecosystems (<3 months), cultural and heritage sites. Minor community health, safety or security impacts, inconvenience to livelihoods <6 months.
Low	Low-level short-term incident. Negligible environmental incident or impact with negligible impact on ecosystems, cultural and heritage sites. Low-level inconvenience <2 weeks.

Table 51 Qualitative Risk Assessment Matrix

	LIKELIHOOD				
CONSEQUENCE	**Rare**	**Unlikely**	**Possible**	**Likely**	**Almost Certain**
Severe	High	Extreme	Extreme	Extreme	Extreme
Major	High	High	Extreme	Extreme	Extreme
Moderate	Medium	High	High	Extreme	Extreme
Minor	Medium	Medium	High	High	Extreme
Insignificant	Low	Medium	Medium	High	High

3.6.3 Risk Assessment Findings

Table 52 below provides the rehabilitation and closure related risk assessment for EDCM. The final risk ranking (residual) is based on the implementation of treatment applied to address the risk and monitoring conducted to ensure the risks are being adequately managed.

Table 52 Risk Assessment Findings

Eagle Downs Coal Mine
Progressive Rehabilitation and Closure Risk Assessment

Domain	PMLU	Aspect	Closure Objective	Mine Phas	Event or Activity	Risk Pathway	Impact	Likelihood	Consequenc	Inherant Risk	Treatment	Responsibilit	Resources	Timing	Likelih	Consequence	Residual Risk	Further Controls	Completion Criteria	Monitoring
Residual Ponding Areas (wet)	Intermittent Cattle Watering Hole	Physical Stability	Landform is safe and stable for cattle access with no measurable erosion.	Closure	Landform instability.	• Failure to identify the continuation of subsidence. • Failure to identify and address erosion or cracking. • Cattle prevented from accessing water source	• Cattle unable to safely access watering hole. • Injury or death to cattle or wildlife. • Conflict with stakeholder engagement outcomes.	Possible	Insignificant	**Medium**	• LiDAR survey of ponded areas to assess stability of landform. • Implementing the EDCM Subsidence Management Plan. • Regular inspections of ponded areas and maintenance of instability to ensure safe access for cattle.	Rehabilitation Manager	Earthmoving equipment	Operations	Rare	Minor	**Medium**		• No erosion. • Subsidence monitoring indicates subsidence has ceased. • Cattle can safely access watering hole.	• Subsidence modelling. • Subsidence monitoring. • Erosion and sediment control monitoring.
Residual Ponding Areas (wet)	Intermittent Cattle Watering Hole	Chemical Stability	Residual ponding areas meet the water quality objectives for beef cattle as per the "Environmental Protection (Water) Policy 2009 Isaac River Sub-basin Environmental Values and Water Quality Objectives".	Closure	Contamination of water contained within ponded areas.	• Loss of biological processes within ponded area. • Algal bloom (i.e., eutrophication)	• Unsuitable water for cattle consumption. • Impacts to vegetation. • Conflict with stakeholder engagement outcomes.	Possible	Insignificant	**Medium**	• Water Quality sampling and analysis from NATA accredited laboratory. Results assessed by AQP against WQO guidelines. • EDCM SPill Response. • Restrict access of cattle to water - provide alternate (temporary water source if necessary). • Community consultation if water quality is below WQO guidelines.	Site Environmental Department	Site environmental officer. Monitoring equipment. Spill response kits.	Operations	Unlikely	Insignificant	**Medium**		• Water quality is consistently within WQO guidelines imits and is considered safe for cattle consumption. • Contaminated land assessment conducted by AQP. • AQP declares land free from contamination. • Signed Formal Agreement that Landowner accepts responsibility of the ponded areas.	• Surface Water Monitoring. • Rehabilitation Monitoring. • Contaminated land assessment to be completed post operations and included in the final relinquishment report.
Residual Ponding Areas (wet)	Intermittent Cattle Watering Hole	Hydrology	Runoff from upstream areas is managed effectively in residual ponding areas.	Closure	Residual ponding areas release water into surrounding environment.	• Surface flow enters residual ponding areas.	• Incremental risk of erosion. • Sedimentation of surrounding environment. • Impacts to downstream water quality.	Likely	Minor	**High**	• Design includes appropriate stormwater management - installation of long term erosion and sediment control systems/features. • LiDAR survey of landform by AQP to detect potential areas of unmitigated ponding. • Update design to mitigate potential areas identified • Monitoring points and sampling.	Rehabilitation Manager	Earthmoving equipment. Survey equipment. Completed flood modelling.	Operations	Unlikely	Minor	**Medium**	• Environmental Authority • Monitoring Program • Reporting in line with Government requirements.	• Water is retained in designated ponded areas. • Drainage follows appropriate drainage paths. • Landforms are geo-technically stable for PMLU • Certification from an AQP.	• Hydrological survey. • Erosion monitoring. • LiDAR survey by AQP.
Residual Ponding Areas (wet)	Intermittent Cattle Watering Hole	Health and Safety	Water contained in ponded areas is suitable as intermittent cattle watering holes.	Closure	• Poor water quality prevents ponded area being used as cattle water source. • Vegetation death around ponded areas.	• Contamination from operational areas not sufficiently rehabilitated (i.e., removal of contamination). • Vegetation die back due to over saturation of area.	• Loss of biodiversity. • Failure to meet PMLU (Land Class D). • Cattle unable to safely use watering hole. • Conflict with stakeholder engagement outcomes.	Unlikely	Minor	**Medium**	• Regular inspections of ponded areas. • Water quality monitoring of ponded areas. • Restrict access of cattle to water - provide alternate (temporary water source if necessary). • Community consultation if water quality is below WQO guidelines.	Rehabilitation Manager	Personnel	Operations	Rare	Minor	**Medium**		• Water quality monitoring of ponded areas indicates water quality is within WQO guideline limits and is considered safe for cattle consumption. • Signed Formal Agreement that Landowner accepts responsibility of the ponded areas.	• Water monitoring. • Water Balance Model. • Surface water monitoring.
Subsided Areas (dry)	Grazing	Physical Stability	Subsidence has ceased and rehabilitated areas are structurally safe for grazing with no major slumping or erosion.	Closure	• Ongoing subsidence post rehabilitation. • Unstable landform.	• Land subsidence, sinkholes or cracking not proactively identified, addressed and managed. • Pillar failure.	• Injury to humans, cattle or wildlife. • Failure to meet PMLU of grazing. • Failure of rehabilitation and vegetation restoration. • Delay in relinquishment.	Unlikely	Major	**High**	• Underground Pillar/Geotech design by AQP. • EDCM Subsidence Management Plan. • EDCM Rehabilitation Management Plan. • Progressive rehabilitation. • Landform designed to minimise and control stormwater and sediment. • Landform design uses non-erosive materials on the outer surfaces. • Landform constructed in accordance with QA/QC plan (survey). • Design includes appropriate stormwater management - installation of long-term erosion and sediment control systems/features.	Mine Manager	Earthmoving equipment. Specialist consultant. Survey equipment.	Operations	Rare	Moderate	**Medium**		• AQP determines subsidence has ceased. • Cattle can safely graze on subsided areas. • Landforms are geo-technically stable for PMLU - Certification from an AQP. • No active areas of rill or gully erosion. • Drainage follows appropriate drainage paths. • Contours and drains installed and certified as per design by an AQP (CPESC).	• Subsidence modelling. • Subsidence crack monitoring. • Subsidence monitoring. • Auditing of progress against PRCP Schedule. • Material / waste characteristics and inventory. • Rehabilitation Monitoring. • Subsidence (pre and post wet season). • Hydrological survey. • Erosion monitoring. • LiDAR survey by AQP.
Subsided Areas (dry)	Grazing	Hydrology	No excess ponding outside of the areas modelled and identified as mitigated.	Closure	• Large amounts of unmitigated ponding is present at closure causing erosion and instability. • Unacceptable/ unplanned degree of subsidence post rehabilitation.	• Failure to implement Landform Plan or inadequate Landform Plan.	• Decline in remnant vegetation and fauna habitat that is not identified to be directly impacted. • Failure to meet PMLU (Land Class C).	Possible	Moderate	**High**	• Implement EDCM Subsidence Management Plan. • Regular inspections of subsided areas against modelled area. • Adequate drainage constructed during reshaping of landform to discourage unmitigated ponding. • Landform constructed in accordance with QA/QC plan (survey). • Design includes appropriate stormwater management - installation of long term erosion and sediment control systems/features. • Remediate subsidence and erosion before sourcing, delivering, and spreading growth media. • LiDAR survey of landform by AQP to detect potential areas of unmitigated ponding. • Maintenance of subsided areas.	Rehabilitation Manager	Modelling actual susidence against modelled subsidence. Implement Subsidence Management Plan.	Operations	Unlikely	Minor	**Medium**	• Environmental Authority • Monitoring Program • Reporting in line with Government requirements.	• Land does not retain water other than in designated ponded areas. • AQP determines subsidence has ceased. • Landforms are geo-technically stable for PMLU - Certification from an AQP. • Drainage follows appropriate drainage paths. • Contours and drains installed and certified as per design by an AQP (CPESC).	• Regular LiDAR survey of landform by AQP. • Subsidence modelling. • Subsidence monitoring. • Hydrological survey. • Flood modelling. • Erosion and sediment monitoring.
Subsided Areas (dry)	Grazing	Physical Stability	Landforms are able to support grazing pasture with minimal weed infestation.	Closure	Insufficient pasture productivity.	• Insufficient topsoil reserves. • Poor soil characteristics. • Poor rehabilitation methodologies. • Poor seed mix / quality. • Poor seed germination. • Lack of water (i.e., rainfall). • Weed infestation via cattle or mobile equipment.	• Insufficient feed to sustain cattle. • Failure to achieve grazing PMLU (Land Class C). • Conflict with stakeholder engagement outcomes.	Unlikely	Minor	**Medium**	• Selection of reference sites. • Topsoil inventory and mapping. • Manufacture of soil substitutes (mulches and composting). • Topsoil placement as per EDCM Topsoil Management Plan. • Seed mix ratios. • Seed quality and viability testing included in procurement. • Soil amelioration. • Seeding scheduled immediately post surface preparation. • Seeding not scheduled prior to large rain events. • Grazing management. • Weed Management Plan.	Corporate Environmental Management	Personnel	Operations	Rare	Insignificant	**Low**		• Determination by AQP that Subsided areas have sufficient pasture productivity and that land classification is Land Class C. • Minimal weed presence (same or less as undisturbed surrounding areas).	• Topsoil inventory. • ERC review process - actual topsoil stockpiled vs ERC allowance. • Rehabilitation Trials. • Characterisation of materials. • Pasture performance monitoring. • Weed and pest monitoring (abundance of declared weeds is less than reference sites). • Auditing of progress against PRCP Schedule.
Subsided Areas (dry)	Grazing	Visual Amenity	Rehabilitated landforms are keyed into the topography of the surrounding environment .	Closure	Collapse of pillars from improper longwall mining will lead to visual marking on landscape reducing visual amenity.	• Poor mine planning and excecution leads to instability of underground mining longwalls. • Collapsing of surface leads to reduction in visual amenity.	• Reduced visual amenity. • Failure to achieve PMLU for grazing (Land Class C). • Conflict with stakeholder engagement outcomes.	Unlikely	Minor	**Medium**	• GPS guidance and survey (i.e., LiDAR) of rehabilitated area prior to and after reshaping landform to ensure it is appropriate to PMLU. • Stakeholder engagement of final landform outcomes.	Rehabilitation Manager	Personnel	Closure	Rare	Minor	**Medium**		• Final landform of subsided areas aligns with agreed stakeholder engagement outcomes. • Landforms meet PMLU. • Signed Formal Agreement that Landowner accepts final landform.	• LiDAR monitoring of subsided areas. • Landform modelling. • PRCP Schedule.
Fill Areas (Subsided Areas - mitigated)	Grazing	Health and Safety	Landforms are safe and stable and intended post-mine land use of light grazing will not be impacted.	Rehabilitation	Excess rockiness or depressions on rehabilitated areas.	• Inadequate surface preparation. • Localised settlement. • Erosion gullies.	• Safety hazard for humans, cattle and other wildlife.	Possible	Minor	**High**	• EDCM Rehabilitation Management Plan. • Waste characterisation of materials used in rehabilitation. • Landform constructed in accordance with QA/QC plan (survey). • Adequate surface preparation. • Remediate depressions and remove excess rockiness before sourcing, delivering, and spreading growth media.	Rehabilitation Manager	Earthmoving equipment	Operations	Unlikely	Minor	**Medium**		• Landform constructed as per the QA/QC plan. • Cattle can safely graze on filled areas. • No active areas of rill or gully erosion. • Signed Formal Agreement that Landowner accepts ML (inclusing subsidence areas) as being safe for cattle grazing.	• Inspection of fill areas to ensure rehabilitation materials / surface preparation is adequate. • Characterisation of materials. • Rehabilitation monitoring.
Fill Areas (Subsided Areas - mitigated)	Grazing	Physical Stability	Topography of rehabilitated areas is consistent with the surrounding landscape with minimal erosion.	Rehabilitation	Instability of rehabilitated area.	• Failure to reshape landform as per the QA/QC plan. • Use of erodible topsoils and subsoils. • Extreme rainfall events. • Failure to install erosion and sediment control infrastructure where necessary.	• Increased risk of erosion. • Loss of growth medium resulting in limited vegetation establishment. • Sedimentation of surrounding environment. • Impacts to downstream water quality. • Failure to meet PMLU.	Possible	Moderate	**High**	• GPS guidance and survey of rehabilitated area prior to and after reshaping to confirm slopes are within design specifications for landform. • Characterisation of rehabilitation materials ensures adequate placement of soils (i.e., topsoil/subsoils). • Landform designed to minimise and control stormwater and sediment. • Landform design uses non-erosive materials on the outer surfaces. • Landform constructed in accordance with QA/QC plan (survey). • Bulk earthworks to achieve required landform and slopes as per design. • General reshaping and pushing/trimming to achieve the final landform. • Fill in associated areas when no longer required as per updated Erosion and Sediment Control Plan (ESCP). • Design includes appropriate stormwater management - installation of long-term erosion and sediment control systems/features. • Remediate subsidence and erosion before sourcing, delivering, and spreading growth media. • Apply ameliorants and fertilisers to growth media before and after application (based on QA/QC process). • Trim/rip, apply seeding, and irrigate. • If possible, rehabilitation trials on areas that have been progressively rehabilitated.	Rehabilitation Manager	Earthmoving equipment	Closure	Unlikely	Minor	**Medium**	LiDAR survey monitorin	• Landforms are geo-technically stable for PMLU - Certification from an AQP. • No active areas of rill or gully erosion. • Drainage follows appropriate drainage paths. • Contours and drains installed and certified as per design by an AQP (CPESC).	• Subsidence modelling. • Subsidence crack monitoring. • Subsidence monitoring. • Auditing of progress against PRCP Schedule. • Material / waste characteristics and inventory. • Rehabilitation Monitoring. • Subsidence (pre and post wet season). • Hydrological survey. • Erosion monitoring. • LiDAR survey by AQP.
Fill Areas (Subsided Areas - mitigated)	Grazing	Chemical Stability	All contaminated (hazardous) material is removed so that PMLU of grazing is not compromised.	Decommissio ning	Contaminated land.	• Industrial use of land during operational phase of mine. • Failure to identify and or remove contamination.	• Land impacts (inability to revegetate). • Surface water contamination. • Groundwater contamination.	Possible	Moderate	**High**	• Waste characterisation of material placed in fill areas. • Use of clean, uncontaminated or PAF material to backfill fill areas. • Updated Contaminated Sites Register. • Contamination removal / disposal accounted for in ERC. • Contaminated Land Assessment. • EDCM Spill Response Procedure. • Report of all contamination related events (i.e., spills).	Rehabilitation Manager	Personnel	Operations	Unlikely	Minor	**Medium**		• Contaminated land assessment conducted. • AQP declares land free from contamination.	• Characterisation of material placed in fill areas. • Contaminated land assessment to be completed post operations and included in the final relinquishment report. • Contaminated Sites Register. • ERC update as required. • Earthmoving equipment maintenance (spill prevention). • Surface water monitoring. • Groundwater monitoring.
Fill Areas (Subsided Areas - mitigated)	Grazing	Hydrology	Landforms do not encourage the ponding of water or create surface flow significantly different to surrounding undisturbed areas.	Rehabilitation	Reshaping of landform during rehabilitation earthworks creates flow and retainment of water that is significantly different to the surrounding area.	• Failure to reshape landform as per the QA/QC plan. • Failure to adquately survey landscape and determine required profile to prevent water shedding away from DREA/fill areas. • Failure of earthmoving contractors to adquately backfill and reshape fill areas. • Use of incompetent material in Fill areas.	• Increased risk of erosion. • Loss of growth medium resulting in limited vegetation establishment. • Sedimentation of surrounding environment. • Impacts to downstream water quality.	Possible	Moderate	**High**	• Competent material placed in fill areas. • GPS guidance and survey of rehabilitated area prior to and after reshaping to confirm slopes are within design specifications for landform and that ponding will not occur at the base of the DREA. • EDCM Surface Water Management Plan. • EDCM Erosion and Sediment Control Plan.	Site Environmental Department	Personnel	Operations	Unlikely	Minor	**Medium**		• Fill areas do not retain water and DREA is considered free draining by AQP. • Landforms are geo-technically stable for PMLU • Certification from an AQP. • Drainage follows appropriate drainage paths. • Contours and drains installed and certified as per design by an AQP (CPESC).	• Characterisation of material placed in fill areas. • LiDAR survey prior to and after areas are filled to ensure ponding will not occur. • Hydrological survey. • Flood modelling. • Surface water quality monitoring. • Erosion and sediment control monitoring. • Inspections after rainfall to assess the performance of reshaping and rehabilitation.
Fill Areas (Subsided Areas - mitigated)	Grazing	Physical Stability	Landforms are able to support grazing pasture with minimal weed infestation.	Closure	Insufficient pasture productivity.	• Insufficient topsoil reserves. • Poor soil characteristics. • Poor rehabilitation methodologies. • Poor seed mix / quality. • Poor seed germination. • Lack of water (i.e., rainfall). • Weed infestation via cattle or mobile equipment.	• Insufficient feed to sustain cattle. • Failure to achieve grazing PMLU (Land Class C). • Conflict with stakeholder engagement outcomes.	Unlikely	Minor	**Medium**	• Selection of monitoring reference sites. • Topsoil inventory and mapping. • Manufacture of soil substitutes (mulches and composting). • Topsoil placement as per EDCM Topsoil Management Plan. • Seed mix ratios. • Seed quality and viability testing included in procurement. • Soil amelioration. • Seeding scheduled immediately post surface preparation. • Seeding not scheduled prior to large rain events. • Grazing management. • EDCM Rehabilitation Management Plan. • EDCM Weed Management Plan.	Site Environmental Department	Budget	Closure	Rare	Insignificant	**Low**		• Determination by AQP that Fill areas have sufficient pasture productivity and that land classification is Land Class C. • Minimal weed presence (same as undisturbed surrounding areas).	• Topsoil inventory. • ERC review process - actual topsoil stockpiled vs ERC allowance. • Annual Rehabilitation Monitoring. • Rehabilitation Trials. • Characterisation of materials. • Pasture performance monitoring. • Weed and pest monitoring (abundance of declared weeds is less than reference sites). • Auditing of progress against PRCP Schedule.

Topsoil and Capping Material Stockpiles	Grazing	Physical Stability	Land is safe and stable with no erosion.	Closure	Instability of rehabilitated area.	• Poor closure design results in excessive erosion and soil displacement.	• Injury to cattle. • Failure to meet closure and rehabilitation objectives.	Unlikely	Minor	**Medium**	• Design includes appropriate stormwater management - installation of long-term erosion and sediment control systems/features. • Remediate subsidence and erosion before sourcing, delivering, and spreading growth media. • Apply ameliorants and fertilizers to growth media before and after application (based on QA/QC process). • Trim/rip, apply to seed, and irrigate.	Site Environmental Department	Personnel	Closure	Rare	Insignificant	**Low**		• No active areas of rill or gully erosion. • Contours and drains installed and certified as per design by an AQP (CPESC). • Signed Formal Agreement that Landowner accepts ML as being safe for cattle grazing.	• Auditing of progress against PRCP Schedule. • Rehabilitation Monitoring. • Erosion monitoring.
Topsoil and Capping Material Stockpiles	Grazing	Chemical Stability	Removal of all contaminated or hazardous material (including PAF) to as not to compromise PMLU of grazing.	Rehabilitation	Contamination of surrounding soil and watercourses.	Improper classification of soil and rocks leads to PAF material contaminating surrounding soil and watercourses.	• Land impacts (inability to revegetate). • Surface water contamination. • Groundwater contamination.	Unlikely	Moderate	**High**	• Characterisation of rehabilitation materials ensures adequate placement of soils (i.e., topsoil/subsoils). • Contaminated Sites Register. • Contamination removal / disposal accounted for in ERC. • Contaminated Land Assessment. • EDCM Spill Response Procedure. • Report of all contamination related events (i.e., spills).	Site Environmental Department	Personnel	Closure	Rare	Minor	**Medium**		• Contaminated land assessment conducted. • AQP declares land free from contamination.	Contaminated land assessment to be completed post operations and included in the final relinquishment report. • ERC update as required. • Surface water quality monitoring. • Groundwater quality monitoring. • Rehabilitation monitoring. • Earthmoving equipment maintenance (spill prevention).
Topsoil and Capping Material Stockpiles	Grazing	Ecosystem Function	All topsoil and capping material is recovered for use in rehabilitation activities and domain is able to support grazing pasture with minimal weed infestation.	Rehabilitation	Insufficient availability of topsoil or capping material to complete rehabilitation leading to insufficient pasture productivity.	• Failure to recover available topsoil or capping material. • Insufficient topsoil reserves. • Poor soil characteristics. • Poor rehabilitation methodologies. • Poor seed mix / quality. • Poor seed germination. • Lack of water (i.e., rainfall). • Weed infestation via cattle or mobile equipment.	• Inability to provide sufficient growth media on rehabilitation areas. • Insufficient feed to sustain cattle. • Failure to achieve grazing PMLU (Land Class C or D). • Conflict with stakeholder engagement outcomes.	Possible	Moderate	**High**	• Selection of monitoring reference site. • Topsoil inventory and mapping. • Manufacture of soil substitutes (mulches and composting). • Topsoil placement as per EDCM Topsoil Management Plan. • Characterisation of soils ensures adequate identification of valuable rehabilitation materials (i.e., topsoil/subsoils) as per Mining Waste Management Plan.	Site Environmental Department	Personnel	Closure	Unlikely	Minor	**Medium**		• Determination by AQP that topsoil and capping materials stockpile areas have sufficient pasture productivity and that land classification is Land Class C or D. • Minimal weed presence (same as undisturbed surrounding areas).	• Topsoil inventory. • ERC review process - actual topsoil stockpiled vs ERC allowance. • Rehabilitation Trials. • Characterisation of materials. • Weed and pest monitoring (abundance of declared weeds is less than reference sites).
Power Station	Grazing	Health and Safety	Landform is safe of hazards and potential health risks to humans, cattle and wildlife. All contaminated (hazardous) material is removed so that PMLU of grazing is not compromised.	Rehabilitation	• Contaminated land. • Exposure of humans, cattle or wildlife to hazards.	• Industrial use of land during operational phase of mine. • Failure to identify and or remove hazards or health risks.	• Injury to humans, cattle or wildlife. • Area considered unsafe for cattle grazing. • Loss of valuable stock for Landowner.	Possible	Minor	**High**	• Asset register. • Contaminated Sites Register. • Contamination removal / disposal accounted for in ERC. • Engagement of AQP to ensure power station is decommissioned as per the relevant regulations. • Contaminated Land Assessment. • EDCM Spill Response Procedure. • Report of all contamination related events (i.e., spills). • EDCM Rehabilitation Management Plan. • EDCM PRCP Schedule.	Site Environmental Department	Budget	Decommissioning	Unlikely	Minor	**Medium**		• Asset divested or decommissioned (tbd). • Contaminated land assessment conducted. • AQP declares land free from contamination. • Landform constructed as per the QA/QC plan. • Signed Formal Agreement that Landowner accepts ML as being safe for cattle grazing. • AQP endorsement that the power station has been decommissioned as per the relevant regulations.	• Assessment of compliance against PRCP Schedule. • Rehabilitation Monitoring. • Contaminated land assessment to be completed post operations and included in the final relinquishment report. • Contaminated Sites Register. • ERC update as required. • Equipment maintenance (spill prevention).
Power Station	Grazing	Physical Stability	Topography of rehabilitated areas is consistent with the surrounding landscape with minimal erosion.	Rehabilitation	• Instability of rehabilitated area.	• Failure to reshape landform as per the QA/QC plan. • Use of erodible topsoils and subsoils. • Extreme rainfall events. • Failure to install erosion and sediment control infrastructure where necessary.	• Loss of growth medium resulting in limited vegetation establishment. • Sedimentation of surrounding environment. • Impacts to downstream water quality.	Possible	Minor	**High**	• General reshaping and pushing / trimming to achieve final landform. • Design includes appropriate stormwater management - installation of long term erosion and sediment control systems/features. • Remediate subsidence and erosion before sourcing, delivering, and spreading growth media. • Apply ameliorants and fertilisers to growth media before and after application (based on QA/QC process). • Trim/rip, apply seeding and irrigate. • If possible, rehabilitation trials on areas that have been progressively rehabilitated.	Site Environmental Department	Budget	Decommissioning	Unlikely	Minor	**Medium**		• Landforms are geo-technically stable for PMLU - Certification from an AQP . • No active areas of rill or gully erosion. • Drainage follows appropriate drainage paths. • Contours and drains installed and certified as per design by an AQP (CPESC). • Signed Formal Agreement that Landowner accepts ML as being safe for cattle grazing.	• Inspection of area prior to, during and after decommissioning of power station. • As constructed audit to confirm final landforms meet design requirements. • Auditing of progress against PRCP Schedule. • Rehabilitation Monitoring. • Erosion monitoring. • LiDAR survey by AQP. • Surface water monitoring.
Power Station	Grazing	Ecosystem Function	Landforms are able to support grazing pasture with minimal weed infestation.	Closure	Insufficient pasture productivity.	• Insufficient topsoil reserves. • Poor soil characteristics. • Poor rehabilitation methodologies. • Poor seed mix / quality. • Poor seed germination. • Lack of water (i.e., rainfall). • Weed infestation via cattle or mobile equipment.	• Insufficient feed to sustain cattle. • Failure to achieve grazing PMLU (Land Class C). • Conflict with stakeholder engagement outcomes.	Unlikely	Minor	**Medium**	• Selection of monitoring reference site. • Topsoil inventory and mapping. • Manufacture of soil substitutes (mulches and composting). • Topsoil placement as per EDCM Topsoil Management Plan. • Seed mix ratios. • Seed quality and viability testing included in procurement. • Soil amelioration. • Seeding scheduled immediately post surface preparation. • Seeding not scheduled prior to large rain events. • Grazing management. • EDCM Weed Management Plan.	Site Environmental Department	Budget	Closure	Rare	Minor	**Medium**		• Determination by AQP that rehabilitated power station area has sufficient pasture productivity and that land classification is Land Class C. • Minimal weed presence (same as undisturbed surrounding areas).	• Topsoil inventory. • ERC review process - actual topsoil stockpiled vs ERC allowance. • Rehabilitation Trials. • Characterisation of materials. • Pasture performance monitoring. • Weed and pest monitoring (abundance of declared weeds is less than reference sites). • Auditing of progress against PRCP Schedule.
Sediment and Supply Dams (rehabilitated)	Grazing	Physical Stability	Topography of rehabilitated areas is consistent with the surrounding landscape with minimal erosion.	Rehabilitation	Instability of rehabilitated area.	• Failure to reshape landform as per the QA/QC plan. • Use of erodible topsoils and subsoils. • Extreme rainfall events. • Failure to install erosion and sediment control infrastructure where necessary.	• Injury to humans, cattle or wildlife. • Increased risk of erosion. • Loss of growth medium resulting in limited vegetation establishment. • Sedimentation of surrounding environment. • Impacts to downstream water quality.	Possible	Moderate	**High**	• GPS guidance and survey of rehabilitated area prior to and after reshaping to confirm slopes are within design specifications for landform. • Characterisation of rehabilitation materials ensures adequate placement of soils (i.e., topsoil/subsoils). • Landform designed to minimise and control stormwater and sediment. • Landform design uses non-erosive materials on the outer surfaces. • Landform constructed in accordance with QA/QC plan (survey). • Bulk earthworks to achieve required landform and slopes as per design. • General reshaping and pushing / trimming to achieve final landform. • Fill in associated areas when no longer required as per updated Erosion and Sediment Control Plan (ESCP). • Design includes appropriate stormwater management - installation of long term erosion and sediment control systems/features. • Remediate subsidence and erosion before sourcing, delivering, and spreading growth media. • Adequate/effective subsoil and topsoil amelioration. • Trim/rip, apply seeding and irrigate. • If possible, rehabilitation trials on areas that have been progressively rehabilitated. • Prompt revegetation of exposed areas.	Site Environmental Department	Budget	Closure	Unlikely	Insignificant	**Medium**		• Landforms are geo-technically stable for PMLU - Certification from an AQP . • No active areas of rill or gully erosion. • Drainage follows appropriate drainage paths. • Contours and drains installed and certified as per design by an AQP (CPESC).	• Auditing of progress against PRCP Schedule. • Material / waste characteristics and inventory. • Rehabilitation Monitoring. • Hydrological survey. • Erosion monitoring. • LiDAR survey by AQP.
Sediment and Supply Dams (rehabilitated)	Grazing	Hydrology	Landform does not encourage the ponding of water or create surface flow significantly different to surrounding undisturbed areas.	Rehabilitation	Reshaping of landform during rehabilitation earthworks creates flow and retainment of water that is significantly different to the surrounding area.	Failure to reshape landform as per the QA/QC plan.	• Increased risk of erosion. • Loss of growth medium resulting in limited vegetation establishment. • Sedimentation of surrounding environment. • Impacts to downstream water quality.	Possible	Moderate	**High**	• Competent material placed on rehabilitated areas. • GPS guidance and survey of rehabilitated area prior to and after reshaping to confirm slopes are within design specifications for landform and that ponding will not occur. • EDCM Surface Water Management Plan. • EDCM Erosion and Sediment Control Plan.	Site Environmental Department	Budget	Closure	Unlikely	Insignificant	**Medium**		• Rehabilitated Sediment and Supply dams do not retain water. • Landforms are geo-technically stable for PMLU - Certification from an AQP. • Drainage follows appropriate drainage paths. • Contours and drains installed and certified as per design by an AQP (CPESC).	• Characterisation of material placed in sediment and supply dams. • LiDAR survey prior to and after areas are filled to ensure ponding will not occur. • Hydrological survey. • Flood modelling. • Surface water quality monitoring. • Erosion and sediment control monitoring. • Inspections after rainfall to assess the performance of reshaping and rehabilitation.
Sediment and Supply Dams (rehabilitated)	Grazing	Health and Safety	Landforms are safe and stable.	Rehabilitation	Injury to humans, cattle or wildlife.	• Failure to reshape landform as per the QA/QC plan.	• Landform considered unsafe for cattle grazing.	Possible	Minor	**High**	• Waste characterisation of materials used in rehabilitation. • GPS guidance and survey control during landform construction and reshaping. • Landform constructed in accordance with QA/QC plan (survey). • Adequate surface preparation. • Remediate depressions and remove excess rockiness before sourcing, delivering, and spreading growth media. • EDCM Rehabilitation Management Plan.	Site Environmental Department	Budget	Closure	Unlikely	Insignificant	**Medium**		• Landform constructed as per the QA/QC plan. • Cattle can safely graze on filled areas. • No active areas of rill or gully erosion. • Signed Formal Agreement that Landowner accepts ML (inclusing subsidence areas) as being safe for cattle grazing.	• Inspection of fill areas to ensure rehabilitation materials / surface preparation is adequate. • Characterisation of materials. • Rehabilitation monitoring.
Sediment and Supply Dams (rehabilitated)	Grazing	Chemical Stability	All contaminated (hazardous) material is removed so that PMLU of grazing is not compromised.	Decommissioning	Contaminated land.	• Industrial use of land during operational phase of mine. • Failure to identify and or remove contamination. • Inadequate rehabilitation/closure of brine dam or disposal of brine.	• Land impacts (inability to revegetate). • Surface water contamination. • Groundwater contamination.	Possible	Minor	**High**	• EDCM Spill Response Procedure. • Report of all contamination related events (i.e., spills). • Contaminated Sites Register. • Contamination removal / disposal accounted for in ERC. • Contaminated Land Assessment.	Site Environmental Department	Budget	Decommissioning	Unlikely	Insignificant	**Medium**		• Brine dam liner and brine water is disposed of appropriately. • Contaminated land assessment conducted. • AQP declares land free from contamination.	• Characterisation of material placed in sediment and supply dams. • Contaminated land assessment to be completed post operations and included in the final relinquishment report. • Contaminated Sites Register. • ERC update as required. • Earthmoving equipment maintenance (spill prevention). • Regular inspections of sediment and supply dams.
Sediment and Supply Dams (rehabilitated)	Grazing	Ecosystem Function	Landforms are able to support grazing pasture with minimal weed infestation.	Closure	Insufficient pasture productivity.	• Insufficient topsoil reserves. • Poor soil characteristics. • Poor rehabilitation methodologies. • Poor seed mix / quality. • Poor seed germination. • Lack of water (i.e., rainfall). • Weed infestation via cattle or mobile equipment.	• Insufficient feed to sustain cattle. • Failure to achieve grazing PMLU (Land Class D). • Conflict with stakeholder engagement outcomes.	Possible	Minor	**High**	• Selection of monitoring reference site. • Topsoil inventory and mapping. • Manufacture of soil substitutes (mulches and composting). • Topsoil placement as per EDCM Topsoil Management Plan. • Seed mix ratios. • Seed quality and viability testing included in procurement. • Soil amelioration. • Seeding scheduled immediately post surface preparation. • Seeding not scheduled prior to large rain events. • Grazing management. • EDCM Weed Management Plan.	Site Environmental Department	Budget	Decommissioning	Unlikely	Insignificant	**Medium**		• Determination by AQP that rehabilitated sediment and supply dams have sufficient pasture productivity and that land classification is Land Class D. • Minimal weed presence (same as undisturbed surrounding areas).	• Topsoil inventory. • ERC review process - actual topsoil stockpiled vs ERC allowance. • Rehabilitation Trials. • Materials characterisation. • Pasture performance monitoring. • Weed and pest monitoring (abundance of declared weeds is less than reference sites). • Auditing of progress against PRCP Schedule. • Characterisation of materials.
Infrastructure (ROM, stockpiles, ROWTP, Roads and Tracks)	Grazing	Health and Safety	Landforms are safe and stable. Boreholes are rehabilitated such that intended post-mine land use of grazing will not be impacted.	Rehabilitation	Excess rockiness or depressions on rehabilitated areas.	• Inadequate surface preparation. • Localised settlement. • Erosion gullies. • Unrehabilitated boreholes.	• Safety hazard for humans, cattle and other wildlife.	Possible	Minor	**High**	• Characterisation of materials used in rehabilitation. • GPS guidance and survey control during landform construction and reshaping. • Landform constructed in accordance with QA/QC plan (survey). • Adequate surface preparation. • Remediate depressions and remove excess rockiness before sourcing, delivering, and spreading growth media. • EDCM Rehabilitation Management Plan. • Regular update of borehole rehabilitation/remediation register.	Site Environmental Department	Budget	Closure	Unlikely	Minor	**Medium**		• Landform constructed as per the QA/QC plan. • Cattle can safely graze on rehabilitated areas. • No active areas of rill or gully erosion. • All boreholes no longer required at closure are rembahilitated according to Code and logged on the borehole remediation register. • Signed formal agreement with Landholder taking ownership of boreholes to remain after closure. • Signed Formal Agreement that Landowner accepts ML as being safe for cattle grazing.	• Inspection of infrastructure areas to ensure rehabilitation materials / surface preparation is adequate. • Characterisation of materials. • Rehabilitation monitoring. • Regularly monitor borehole remediation register.

Infrastructure (ROM, stockpiles, ROWTP, Roads and Tracks)	Grazing	Physical Stability	Topography of rehabilitated areas is consistent with the surrounding landscape with minimal erosion.	Rehabilitation	Instability of rehabilitated area.	• Failure to reshape landform as per the QA/QC plan. • Use of erodible topsoils and subsoils. • Extreme rainfall events. • Failure to install erosion and sediment control infrastructure where necessary.	• Injury to humans, cattle or wildlife. • Increased risk of erosion. • Loss of growth medium resulting in limited vegetation establishment. • Sedimentation of surrounding environment. • Impacts to downstream water quality.	Possible	Minor	**High**	• GPS guidance and survey of rehabilitated area prior to and after reshaping to confirm slopes are within design specifications for landform. • Characterisation of rehabilitation materials ensures adequate placement of soils (i.e., topsoil/subsoils). • Adequate/effective subsoil and topsoil amelioration. • Prompt revegetation of exposed areas. • EDCM Rehabilitation Monitoring Plan. • EDCM Erosion and Sediment Control Plan.	Site Environmental Department	Budget	Closure	Unlikely	Minor	**Medium**		• Landforms are geo-technically stable for PMLU • Certification from an AQP. • No active areas of rill or gully erosion. • Drainage follows appropriate drainage paths. • Contours and drains installed and certified as per design by an AQP (CPESC).	• Auditing of progress against PRCP Schedule. • Material / waste characteristics and inventory. • Rehabilitation Monitoring. • Hydrological survey. • Surface water monitoring. • Erosion monitoring. • LiDAR survey by AQP.
Infrastructure (ROM, stockpiles, ROWTP, Roads and Tracks)	Grazing	Chemical Stability	All contaminated (hazardous) material is removed so that PMLU of grazing is not compromised.	Decommissioning	Contaminated land.	• Industrial use of land during operational phase of mine. • Failure to identify and or remove contamination.	• Land impacts (inability to revegetate). • Surface water contamination. • Groundwater contamination.	Possible	Moderate	**High**	• Characterisation of material to be used in rehabilitation. • Use of clean, uncontaminated or PAF material to backfill fill areas. • Updated Contaminated Sites Register. • Contamination removal / disposal accounted for in ERC. • Contaminated Land Assessment. • EDCM Spill Response Procedure. • Report of all contamination related events (i.e., spills).	Site Environmental Department	Budget	Closure	Unlikely	Minor	**Medium**		• Contaminated land assessment conducted. • AQP declares land free from contamination.	• Characterisation of material placed in fill areas. • Contaminated land assessment to be completed post operations and included in the final relinquishment report. • Contaminated Sites Register. • ERC update as required. • Earthmoving equipment maintenance (spill prevention). • Surface water monitoring. • Groundwater monitoring.
Infrastructure (ROM, stockpiles, ROWTP, Roads and Tracks)	Grazing	Hydrology	Landforms do not encourage the ponding of water or create surface flow significantly different to surrounding undisturbed areas.	Rehabilitation	Reshaping of landform during rehabilitation earthworks creates flow and retainment of water that is significantly different to the surrounding area.	• Failure to reshape landform as per the QA/QC plan.	• Increased risk of erosion. • Loss of growth medium resulting in limited vegetation establishment. • Sedimentation of surrounding environment. • Impacts to downstream water quality.	Possible	Moderate	**High**	• Competent material placed on rehabilitation areas. • GPS guidance and survey of rehabilitated area prior to and after reshaping to confirm slopes are within design specifications for landform and that ponding will not occur. • EDCM Surface Water Management Plan. • EDCM Erosion and Sediment Control Plan.	Site Environmental Department	Budget	Post Closure	Unlikely	Minor	**Medium**		• Rehabilitated infrastructure areas do not retain water. • Landforms are geo-technically stable for PMLU - Certification from an AQP. • Drainage follows appropriate drainage paths. • Contours and drains installed and certified as per design by an AQP (CPESC).	• Characterisation of material. • LiDAR survey prior to and after areas are filled to ensure ponding will not occur. • Hydrological survey. • Flood modelling. • Surface water quality monitoring. • Erosion and sediment control monitoring. • Inspections after rainfall to assess the performance of reshaping and rehabilitation.
Infrastructure (ROM, stockpiles, ROWTP, Roads and Tracks)	Grazing	Ecosystem Function	Landforms are able to support light grazing pasture with minimal weed infestation.	Closure	Insufficient pasture productivity.	• Insufficient topsoil reserves. • Poor soil characteristics. • Poor rehabilitation methodologies. • Poor seed mix / quality. • Poor seed germination. • Lack of water (i.e., rainfall). • Weed infestation via cattle or mobile equipment.	• Insufficient feed to sustain cattle. • Failure to achieve grazing PMLU (Land Class C or D). • Conflict with stakeholder engagement outcomes.	Possible	Moderate	**High**	• Selection of monitoring reference site. • Topsoil inventory and mapping. • Manufacture of soil substitutes (mulches and composting). • Topsoil placement as per EDCM Topsoil Management Plan. • Seed mix ratios. • Seed quality and viability testing included in procurement. • Soil amelioration. • Seeding scheduled immediately post surface preparation. • Seeding not scheduled prior to large rain events. • Grazing management. • EDCM Rehabilitation Management Plan. • EDCM Weed Management Plan.	Site Environmental Department	Budget	Closure	Unlikely	Minor	**Medium**		• Determination by AQP that rehabilitated Sediment and Supply dams areas have sufficient pasture productivity and that land classification is Land Class C or D. • Minimal weed presence (same as undisturbed surrounding areas).	• Topsoil inventory. • ERC review process - actual topsoil stockpiled vs ERC allowance. • Annual Rehabilitation Monitoring. • Rehabilitation Trials. • Materials characterisation. • Pasture performance monitoring. • Weed and pest monitoring (abundance of declared weeds is less than reference sites). • Auditing of progress against PRCP Schedule.
Surface to Seam Workings (Gas drainage, ventilation shafts, underground communication cables, mine dewatering boreholes and other pipelines or boreholes)	Grazing	Health and Safety	No acccess to underground workings is possible. Landforms are safe and stable. Boreholes are rehabilitated such that intended post-mine land use of grazing will not be impacted.	Closure	Injury or death to humans, cattle or wildlife.	• Failure or inadequate rehabilitation of surface to seam workings. • Access to underground workings.	• Injury to human, cattle or wildlife. • Spontaneous combustion. • Failure to achieve PMLU for grazing (Land Class C).	Likely	Major	**Extreme**	• Site borehole register (including remediation status). • EDCM Sealing Management Plan. • EDCM Rehabilitation Management Plan. • Progressive rehabilitation of shafts and boreholes. • Limited access to ML.	Mine Manager	Budget	Decommissioning	Rare	Minor	**Medium**		• All boreholes no longer required at closure are rehabilitated according to Code. • AQP signs off that monitoring and modelling of closed underground environment indicates the mine is stable and not at risk of spontaneous combustion. • Signed formal agreement with Landholder taking ownership of boreholes to remain after closure.	• Regular monitoring borehole status. • Underground monitoring (i.e. gas drainage). • Auditing of borehole register. • Sign off by AQP that sealing of mine entrances and shafts have been done in accordance with regulatory requirements.
Surface to Seam Workings (Gas drainage, ventilation shafts, underground communication cables, mine dewatering boreholes and other pipelines or boreholes)	Grazing	Other	No alteration to air quality through release of underground (methane) emissions.	Closure	Release of methane emissions post closure.	• Inadequately sealed surface to seam workings. • Changes to legislation policy regarding climate change and methane emissions.	• Contribution to methane emissions to the environment.	Possible	Minor	**High**	• Regular review of legislation and policy requirements relating to methane emission management and how it may affect EDCM post closure. • EDCM Air Quality Management Plan.	Mine Manager	Budget	Decommissioning	Unlikely	Minor	**Medium**		• Sign off from AQP that surface to seam workings (with the exception of boreholes still required post closure) have been adquately sealed and decommissioned according to relevant regulation / Code.	• Regular monitoring of borehole status. • Auditing of borehole register. • Auditing against PRCP Schedule. • Air quality monitoring. • Review of relevant legislation and policy relating to emission management of underground mines.
Surface to Seam Workings (Gas drainage, ventilation shafts, underground communication cables, mine dewatering boreholes and other pipelines or boreholes)	Grazing	Hydrogeology	Groundwater level and quality do not impact beneficial uses	Closure	Contamination of groundwater or reduced groundwater availability.	• Loss of chemicals / hydrocarbon to ground or water. • Dewatering of the coal seam has a influence on groundwater levels. • Inadequate sealing of surface to seam workings.	Reduced beneficial groundwater use.	Possible	Moderate	**High**	• Mine plan is designed such that workings will not be in direct connection to the aquifer. • Groundwater monitoring program implemented to confirm modelling predictions of low risk to groundwater or to provide an early indication of potential issues.	Mine Manager	Budget	Closure	Unlikely	Minor	**Medium**		• Groundwater level monitoring indicates minimal reduction in baseline groundwater levels. • Groundwater quality monitoring indicates minimal reduction in baseline groundwater levels.	• Groundwater level monitoring. • Groundwater quality monitoring.
Surface to Seam Workings (Gas drainage, ventilation shafts, underground communication cables, mine dewatering boreholes and other pipelines or boreholes)	Grazing	Hydrology	Rehabilitated areas above surface to seam workings shed water and discourage ponding.	Closure	• Water ponds (is retained) around surface to seam workings.	• Significant flood event. • Improper management and rehabilitation of subsidence areas or inadequate understanding of the engineering design and duration and degree of subsidence. • Inadquate landform reshaping creating ponded areas around surface to seam workings. • Inadequate erosion and sediment control near surface to seam openings.	• Negative impacts on local surface water and groundwater. • Impact to success of rehabilitation to meet PMLU.	Possible	Major	**Extreme**	• Periodic reviews of overburden geotechnical characterisation. • Mapping subsidence hazards and hydrology impact studies. • Incorporation of the information derived from periodic technical reviews into the EDCM subsidence management and treatment procedures. • Development of long term regional subsidence models and incorporate into closure plan. • EDCM Subsidence Management Plan. • EDCM Rehabilitation Management Plan.	Site Environmental Department	Budget	Closure	Unlikely	Minor	**Medium**		• Rehabilitated surface to seam areas do not retain water. • Landforms are geo-technically stable for PMLU - Certification from an AQP. • Drainage follows appropriate drainage paths. • Contours and drains installed and certified as per design by an AQP (CPESC).	• Geotechnical characterisation. • Subsidence modelling. • Subsidence monitoring. • Rehabilitation monitoring. • Erosion and sediment monitoring (pre and post wet season). • Surface water monitoring. • LiDAR survey of rehabilitated areas
Surface to Seam Workings (Gas drainage, ventilation shafts, underground communication cables, mine dewatering boreholes and other pipelines or boreholes)	Grazing	Physical Stability	Rehabilitated workings are stable and structurally sound.	All	Improper longwall mining cause significant impact to surface soil profiles and pillar collapses.	• Poor mine planning and excecution leads to instability of underground mining longwalls. • Collapsing of surface leads to interconnecting pathways which leads to gas exchange and potential spontaneous combustion. • Sample set and methodology inadequate to identify the potential of spontaneous combustion.	• Human or fauna injury or death. • Landform unable to meet post closure and land use criteria.	Likely	Major	**Extreme**	• EDCM Underground Mining Management Plan. • Underground Pillar/Geotech design by AQP. • QA/QC surveys against mine design conducted by AQP.	Mine Manager	Personnel	Operations	Unlikely	Minor	**Medium**		• Surface to seam workings are sealed as per EDCM Sealing Plan. • Sign off by AQP that decommissioning of surface to seam workings has been done to the required standards. • AQP determines subsidence has ceased. • Cattle can safely graze on subsided areas. • Landforms are geo-technically stable for PMLU - Certification from an AQP. • No active areas of rill or gully erosion. • Drainage follows appropriate drainage paths. • Contours and drains installed and certified as per design by an AQP (CPESC).	• Underground workings monitoring. • Gas drainage monitoring. • Auditing of progress against PRCP Schedule. • Rehabilitation Monitoring. • Erosion monitoring. • LiDAR survey by AQP.
DREA	Native Ecosystem	Health and Safety	DREA is constructed as per "as built" design specifications and does not pose harm to humans or wildlife.	Closure	• Poor design leads to structural failure of DREA, causing injury to humans or wildlife. • Spontaneous combustion.	• Rejects not effectively capped or co-disposed with non-reactive spoil materials at a suitable depth to minimise exposure to oxygen. • Bushfire on the revegetated DREA. • Erosion of DREA cover / capping material.	• Ignition of vegetation on DREA. • Failure to meet the rehabilitation goals or completion criteria of final land use and inability to relinquish the ML.	Unlikely	Major	**High**	• DREA to be located, or set back, from open cut pits and other mine infrastructure to avoid impact on rehabilitation outcomes. • EDCM Mining Waste Management Plan. • Decommissioning and rehabilitation strategies for the DREA that demonstrate consistency with the conditions of the environmental authority. • Sampling of test results of samples taken from target coal seams. • Compaction of rejects during placement and construction of material on DREA. • Rejects are estimated to have a relatively low moisture content/field capacity due to the grading of the material. • Capping with topsoil and burial of encountered sampled material that is potentially prone to spontaneous combustion. • Develop long term capping strategy and incorporate into design. • Bushfire Prevention strategies.	Mine Manager	Personnel	Operations	Rare	Minor	**Medium**		• Landform constructed as per the QA/QC plan. • No spontaneous combustion. • Landforms are geo-technically stable for PMLU - Certification from an AQP. • PMLU is achieved.	• Inspection of DREA to ensure rehabilitation materials / surface preparation is adequate. • Characterisation of materials. • Moisture content of rejects monitored. • Fire and drought assessment. • Rehabilitation monitoring. • Spontaneous combustion monitoring.
DREA	Native Ecosystem	Chemical Stability	There is no potential for leachate generation will be minimal or non-existent.	Closure	Contamination of surrounding soil and watercourses from PAF material.	• Unsuitable materials used for capping or incorrect capping methodology. • Failure to correctly identify material properties during construction of DREA.	• Generation and release of leachate with elevated salinity. • Generation and release of leachate with elevated acidity, with or without metals/metalloids in solution. • Generation of areas of heating within the emplacement through spontaneous combustion effects, impacting on structural integrity of the placed reject or release of contaminants from burning reject in leachate. • Downstream (surface)water quality. • Groundwater quality. • Poor revegetation performance.	Unlikely	Major	**High**	• Mine waste (including problematic waste) managed in accordance with EDCM Mining Waste Management Plan. • Coal reject material progressively characterised during disposal for acid generating capacity and selected metals and salts (geochemical kinetic testing done on material whose acid producing potential has not been conclusively determined). • Records kept of coal reject disposal locations and characteristics. • Potentially acid producing covered or placed to minimise surface oxidation. • Water quality monitoring and assessment.	Mine Manager	Personnel	Operations	Rare	Minor	**Medium**		• No spontaneous combustion. • Contaminated land assessment conducted. • AQP declares land free from contamination.	• Characterisation of material placed on DREA. • Contaminated land assessment to be completed post operations and included in the final relinquishment report. • Contaminated Sites Register. • ERC update as required. • Earthmoving equipment maintenance (spill prevention). • Surface water monitoring. • Groundwater monitoring. • Rehabilitation monitoring. • Spontaneous combustion monitoring.

DREA	Native Ecosystem	Physical Stability	Landform is safe and stable with no major slumping or erosion.	Rehabilitation	Vertical displacement, tilting or slumping of DREA.	• Subsidence. • Change to the coarse: fine split or strength conditions for dry reject is lower than anticipated. • Strength conditions for dry reject is lower than anticipated. • Unsuitable materials used for capping or incorrect capping methodology. • Failure to correctly identify material properties during construction of DREA. • Poor drainage or extreme rainfall event. • Failure to assess geotechnical stability of landform during construction. • Excess rockiness or depressions on DREA surface. • Differential settlement of material on DREA. • Poor landform design includes excessively steep batter slopes resulting in excessive erosion and soil dispercement.	• Landform not geotechnically stable - potential for reduced stability of external DREA batters. • Safety hazard for humans and wildlife. • Vertical settlement of formed DREA surfaces. • Slumping of DREA batters, re-orientation of slopes or gross exposure of dry rejects. • Re-orientation of adjacent surface water drainage patterns, with the possibility that localised ponding areas adjacent to or against the DREA landform will develop, resulting in disconnection from local drainages. • Sedimentation of surrounding environment. • Impacts to downstream water quality.	Possible	Moderate	**High**	• Certified Design Plan for DREA by AQP. • Final Landform Design Report for DREA. • Operational Management Plan for DREA. • Geotechnical confirmation (testing) of capping material. • Defined control points (perimeter) for disposal of waste (as defined in Table F1 of • Materials characterisation and handling program. • EDCM Operational Plan for DREA. • Certification from an AQP that the DREA design will deliver the performance stated in the design plan and EA. • Additional foundation preparation works to address undulations and displacement areas formed by subsidence to enable effective DREA development. • Erosion mitigation strategies. • Survey control and design conformance checks. • Rehabilitation phase completion sign offs incorporated into the rehabilitation contractor Scope of Works and KPIs. • Additional rejects filling across the DREA to reform the final landform design. • Re-alignment of DREA surfaces to maintain stability. • Local excavation and reprofiling around the DREA to reform surface water drainage pathways. • Progressive rehabilitation of landform.	Specialist Consultant	Budget	Operations	Rare	Minor	**Medium**		• Demonstrated compliance with DREA Lanform Design Plan. • External batters are reprofiled to form minimum long-term permanent slopes of approximately 1V:9H and maximum permanent slopes of approximately 1V:8H. • Long Term Factor of Safety 1.5 for DREA slopes. • Demonstrated compliance with DREA Operational Plan. • AQP determines subsidence has ceased. • Final landform and rehabilitation designs clearly account for material characteristics with respect to geochemical parameters. • Landform constructed in accordance with designs. • No active areas of rill or gully erosion. • No visual evidence of ARD or other problematic drainage during rehabilitation performance monitoring. • Groundwater and surface water quality is comparable to upstream values.	• Material characterisation of DREA material. • LiDAR survey of landform. • Subsidence modelling. • Subsidence monitoring. • Erosion and sedimentation monitoring. • Rehabilitation monitoring. • Surface and ground water monitoring.
DREA	Native Ecosystem	Hydrogeology	Seepage is adequately managed with minimal and or no impact on groundwater.	Closure	Alteration of groundwater quality.	• Adverse waste rock geochemistry. • Leaching of MAW water into the groundwater.	• Impacts to groundwater quality. • Impacts to groundwater dependant ecosystems.	Possible	Minor	**High**	• Maintenance of piezometers used for groundwater monitoring. • Groundwater quality monitoring and assessment. • Effective geotechnical characterisation of reject material. • Appropriate construction methods, including QA/QC provisions. • Keep ROM coal on the ROM pad for short periods of time and testing of run off to ensure materials is NAF and runoff is within acceptable limits. • Installation of a low permeability basal liner subject to the risk of leachate generation and release (if required).	Specialist Consultant	Budget	Closure	Unlikely	Insignificant	**Medium**		• Groundwater level monitoring indicates minimal reduction in baseline groundwater levels. • Groundwater quality monitoring indicates minimal reduction in baseline groundwater levels.	• Groundwater monitoring. • Groundwater level monitoring. • Characterisation of DREA material.
DREA	Native Ecosystem	Hydrology	Surface runoff, seasonal and rare rainfall events are adequately managed with minimal and or no environmental harm.	Closure	• Inundation of DREA. • Excessive rainfall on landform releases contaminates to the surrounding environment. • Batter instability	• Ineffective drainage, containment or erosion and sediment controls on landform. • Flood waters. • Excessive rainfall allowing infiltration of precipitation into DREA.	• Erosion of exposed DREA surfaces from concentrated stormwater runoff. • Compromised stability of DREA landform. • Impacts to downstream water quality. • Sedimentation of surrounding environment. • Impact on foundation preparation or development works.	Possible	Moderate	**High**	• Operation of the DREA as a nil discharge system. • Isolation of the active DREA catchment area diversion drains. • Operational Management Plan for DREA. • Development of individual DREA drainage control plans for each longwall panel that would subside any section of the active DREA. • Appropriate construction methods, including QA/QC provisions (shaping, reducing permeability of emplaced reject). • Effective geotechnical characterisation of reject material. • Adopt industry standards (safety factors) for batter stability. • Appropriate construction methods, including QA/QC provisions. • Repair of landform subject to subsidence impacts. • Reduce risk of leachate generation. • Adequate drainage structures and erosion protection infrastructure accommodated for in DREA landform design. • Installation of containment structures surrounding the DREA to prevent loss of contaminated waters or sediment. • Prompt repair of landform subject to subsidence impacts, including surface water drainage pathways. • Receiving environment monitoring program (REMP). • Flood modelling - construct flood levee to protect DREA if required.	Specialist Consultant	Budget	Operations	Unlikely	Minor	**Medium**		• DREA is considered water shedding by AQP. • Landform is geo-technically stable for PMLU • Certification from an AQP. • Drainage follows appropriate drainage paths. • Contours and drains installed and certified as per design by an AQP (CPESC).	• Characterisation of material placed on DREA. • LiDAR survey of DREA development. • Hydrological survey. • Surface water quality monitoring. • Erosion and sediment control monitoring (pre and post wet season). • Inspections after rainfall to assess the performance of DREA landform. • Rehabilitation monitoring.
DREA	Native Ecosystem	Ecosystem Function	There is sufficient ground cover and diversity and density of native vegetation species established to support native ecosystem function with minimal weed infestation.	Rehabilitation	• Insufficient density/diversity of vegetation to achieve native PMLU. • Bushfire on the revegetated DREA.	• Insufficient topsoil reserves. • Poor soil characteristics. • Poor rehabilitation methodologies. • Poor seed mix / quality. • Poor seed germination. • Lack of water (i.e., rainfall). • Vegetation unable to establish due to grazing by native and/or domestic species. • Extended drought period inhibits vegetation establishment. • Unrealistic completion criteria. • Weed infestation via cattle or mobile equipment.	• Failure to achieve native ecosystem PMLU. • Insufficient habitat suitable for native fauna. • Loss of habitat. • Reduced visual amenity. • Increase in fugitive dust emissions. • Reduced water quality in the receiving environment.	Possible	Moderate	**High**	• Batter slopes are sufficiently shallow so that vegtation is able to establish and erosion is minimised. • Selection of monitoring reference sites. • Topsoil inventory and mapping. • Manufacture of soil substitutes (mulches and composting). • Topsoil placement as per EDCM Topsoil Management Plan. • Seed mix ratios. • Seed quality and viability testing included in procurement. • Soil amelioration. • Seeding scheduled immediately post surface preparation. • Seeding not scheduled prior to large rain events. • Installation of fencing to prevent cattle access. • EDCM Weed Management Plan. • Rehabilitation trials if required. • Install long term erosion and sediment control systems/features as per closure ESCP based on achieved groundcover and landform stability. • Remediate subsidence and erosion before sourcing, delivering, and spreading growth media.	Corporate Environmental Management	Budget	Closure	Unlikely	Minor	**Medium**		• Soil cover thickness : 1 m (minimum) • Topsoil thickness : 0.25 m (minimum) • Determination by AQP that DREA has achieved PMLU (native ecosystem). • Minimal weed presence (same as undisturbed surrounding areas). • Resilience to fire and drought.	• Topsoil inventory. • ERC review process - actual topsoil stockpiled vs ERC allowance. • Rehabilitation Trials. • Materials characterisation. • Pasture performance monitoring. • Monitoring and maintenance of fencing. • Fire and drought assessment. • Weed and pest monitoring (abundance of declared weeds is less than reference sites). • Auditing of progress against PRCP Schedule.
DREA	Native Ecosystem	Visual Amenity	DREA is constructed as per "as built" design specifications	Rehabilitation	Slope steepness exceeds design specifications (i.e., does not meet PMLU).	• Failure to adhere to RPEQ design specifications during construction of DREA.	• Safety hazard for humans and wildlife. • Conflict with stakeholder engagement outcomes. • Vegetation unable to establish on slope. • Dust emissions	Possible	Insignificant	**Medium**	• Final Landform Design for DREA. • Operational Management Plan for DREA. • Landform design appropriate to PMLU. • Landform design compliant with EA requirements and operational slope controls. • Control Points for DREA. • Planned "as built" design inspections by RPEQ throughout construction of DREA. • Dust suppression techniques.	Rehabilitation Manager	Personnel	Closure	Rare	Insignificant	**Low**		• DREA is constructed within control points. • DREA Capacity : ~ 110 million cubic metres (Mm3) • External Surfaces (post-construction) o Batter Slopes : 13% (maximum) o Maximum slope lengths : 100 m (maximum) o Top Surface/Plateau Grade/Slope : 2% (maximum) • Maximum height (post- subsidence) : 40 m (maximum) • Soil cover thickness : 1 m (minimum) • Topsoil thickness : 0.25 m (minimum) • Final landform of DREA aligns with agreed stakeholder engagement outcomes. • Landform achieves a self-sustaining native ecosystem with species composition and distribution similar to an analogue/ reference site or another suitable alternative approved by the administering authority. • Dust monitoring returns similar readings to background dust levels. • Signed Formal Agreement that Landowner accepts final landform of DREA.	• Landform modelling. • LiDAR monitoring of DREA control points. • PRCP Schedule. • Topsoil inventory. • Dust monitoring.
Other	Other	Other	Successful closure achieved consistently with PRC Plan / PRCP Schedule.	Closure	Sudden Closure	• Loss of social licence to operate. • Market pressures. • Force Majeure. • Sale of Mine.	• Inadequate costs available from provision for full closure; • Unplanned capital/asset write off. • Significant redundancies required. • Increased (unbudgeted) closure costs (i.e., take or pay arrangements). • Community impacts. • Impacts to reputation.	Possible	Minor	**High**	• Submit amendments to comply with current regulations	Rehabilitation Manager	Personnel	Other	Possible	Insignificant	**Medium**	Sudden Closure Plan prepared for EDCM.	N/A	N/A
Other	Other	Chemical & Physical Stability	Sufficient monitoring data acquired to support relinquishment of ML.	Closure	Insufficient monitoring data available.	• Suitability of equipment and contractors. • Lack of surface flow in watercourses used as reference monitoring sites. • Cost increase due to demand.	• Unable to complete rehabilitation to schedule. • Failure to meet PMLUs.	Possible	Moderate	**High**	• Progressive rehabilitation. • Rehabilitation Management Plan. • EDCM PRCP Schedule. • Include rehabilitation monitoring in work plan. • Rehabilitation and Earthworks Contracts with preferred Supplier in place.	Corporate Environmental Management	Personnel	Closure	Unlikely	Minor	**Medium**		• Monitoring data sets are extensive to support relinquishment of ML. • Determination by AQP that all PMLUs have been achieved.	• Rehabilitation monitoring. • Water monitoring. • Vegetation Monitoring. • Pasture productivity monitoring.
Other	Other	Other	Rehabilitation completed within timeframes specified in PRCP Schedule with no delays of earthmoving equipment or contractors.	Rehabilitation	Earthmoving equipment and or personnel unavailable for rehabilitation activities.	• Supply and Demand by other minesites. • Failure to plan rehabilitation activities in advance.	• Delay in relinquishment. • Failure to achieve PMLUs. • Failure to comply with PRCP Schedule. • Impacts to reputation.	Possible	Moderate	**High**	• Formal service agreements in place with earthmoving providers. • Progressive rehabilitation.	Rehabilitation Manager	Equipment, Personnel	Closure	Unlikely	Minor	**Medium**		• Determination by AQP that all PMLUs have been achieved. • Rehabilitation completed as per PRCP Schedule.	• Renewal of serive provider agreement and updating of associated rates. • Rehabilitation monitoring. • PRCP Schedule.
Other	Other	Other	Site remains safe, stable, non-polluting and supports a native ecosystem compatible with grazing.	Closure	Climate change impacts result in unacceptable closure outcomes, particularly with stability and the ability to support a self-sustaining ecosystem.	Failure to account for climate predictions when developing closure designs or strategies.	Excessive erosion. Downstream sedimentation. Poor ecosystem performance.	Possible	Moderate	**High**	Climate change considered during development of final landform and rehabilitation designs.	Rehabilitation Manager	3rd party specialist input	Operations	Rare	Moderate	**Medium**		Demonstration that final closure designs adequately account for predicted climate change scenarios.	N/A

3.6.4 Rehabilitation Trials

The EA for the Project does not stipulate rehabilitation trials are required to be undertaken, and currently there are no trials underway at EDCM.

EDCM understand that appropriate rehabilitation completion criteria are derived and supported from rehabilitation trial results and results from reference site monitoring. The objective of rehabilitation trials at EDCM will be to align trial outcomes with the assigned PMLUs (i.e., sustainable cattle grazing and native ecosystem).

Rehabilitation trials will not delay progressive rehabilitation and are not considered rehabilitation or management milestones for the proposed PRC Plan schedule.

The following trials will be undertaken.

DREA Emplacement Trial

The objective of the trial is to refine construction methods and the effect of moisture content on constructing the DREA.

As is provided in ATCW (2023), prior to commencing Stage 1, an area within the Year 1 (specifically 0-8 months) footprint is to be nominated for the completion of dry rejects emplacement trials. The trial will focus on:

- Placement of rejects by paddock dumping using haul trucks;
- The ability of the clay liner to meet the relevant performance objectives set during the design stage;
- Spreading of rejects and compaction of dumped rejects;
- Confirmation of number of compaction passes of rollers to achieve adequate compaction; and
- Confirmation of the effect of the moisture content of the rejects on achieving adequate compaction.

The methodology shall be completed with the results being incorporated into procedures and systems to optimise the operation of the DREA and incorporate learnings into rehabilitation strategies.

DREA Revegetation Trial

The objective of the trial is to improve methods to stabilise the DREA landform and develop a self-sustaining native ecosystem. The trial design will involve establishing monitoring sites for biodiversity, subsidence and land classification monitoring aligned to the program outlined in Section 3.7.3.

As stated in ATCW (2023) the south-west and eastern flanks of the DREA Stage 1 will act as a long-term testing area to ground truth capping layer configuration (as well as revegetation success to meet native ecosystem PMLU).

Key indicators for revegetation trials on the DREA will include:

- Stability of the rehabilitated final landform (rejects and capping layer) design;
- Species richness and composition of the rehabilitated areas;
- Establishment of soil function and nutrient cycling;
- Development of sustainable perennial vegetation that meets identified completion criteria.

The results will be incorporated into procedures and systems aim to optimise the operation of the DREA and incorporate learnings into rehabilitation strategies.

Other Trials Carried Out by the Proponent

There are currently no other relevant rehabilitation trials carried out by the proponent.

3.7 Monitoring and Maintenance

The intent of the rehabilitation monitoring and maintenance program, as per the PRC Plan Guidelines, is to demonstrate that progressive rehabilitation and closure is occurring and that completion criteria have been achieved. The proposed monitoring and maintenance program will help identify and quantify problems, risks and opportunities for corrective actions and adaptive management throughout the progressive rehabilitation and closure process.

The sections below describe the processes and activities that will be used to determine the biophysical state of rehabilitation and closure, by comparing rehabilitation sites to reference sites.

In line with the requirements of the PRC Plan Guidelines, the monitoring program is designed such that the measurement of certain biophysical attributes and processes is standardised and repeatable so that it can be compared against the PRC Plan Schedule.

Utilising appropriate quality assurance and data management processes and systems, multi-year comparisons will enable the evaluation of a long time series of monitoring data. This will assist EDCM to compare progress against the PRC Plan Schedule and evaluate the risk of rehabilitation failure.

3.7.1 Reference Sites

The purpose of a reference site is to serve as a benchmark for the rehabilitation of disturbed areas. A reference site should represent, as close as possible, the landform, orientation and target vegetation characteristics intended for rehabilitation areas. The selected reference sites also have similar chemical and physical characteristics including slope as the rehabilitation landform.

EDCM will establish three monitoring sites for each PMLU of grazing, and native ecosystem PLMU, and additionally use Queensland government established bioconditon sites for specific regional ecosystems evaluation. The reference sites (**Table 54**, **Figure 91**) were selected from vegetation assessment sites used for regional ecosystem validation (EcoSM, 2021). These sites will be also monitored annually using the same methodology for rehabilitation, described in Section 3.7.3.

EcoSM (2022a) conducted a BioCondition assessment, and the baseline data is available in Appendix N.

Biocondition monitoring for vegetation at the DREA will be undertaken using the methods in the BioCondition Assessment Manual (Eyre et al., 2015). The benchmarks and scores to be achieved for the completion criteria are described in **Table 53**.

Table 53 Biocondition benchmark completion criteria for the DREA

Regional Ecosystem	Weighting	11.9.3 Reference Benchmark	11.9.3 Indicative benchmark for 5 years (≥15/30)	BioCondition score	11.9.3 Indicative benchmark for 10 years (≥18/30)	BioCondition score
BioCondition attribute		**RE 11.9.3** *Dichanthium / Astrebla* grassland				
Non-native plant cover(%)	10	0%	<25% of vegetation cover	5	<25% of vegetation cover	5
Grass species richness[1]	5	10	≥25-90% of benchmark (≥ 3 spp.)	2.5	≥ 25-90% of benchmark (≥ 3 spp.)	2.5
Forbs and other species richness[1]	5	9	≥ 25-90% of benchmark (≥2 spp.)	2.5	≥ 25-90% of benchmark (≥ 2 spp.)	2.5
Native perennial grass cover (%)	5	53%	≥ 50% of benchmark (>26.5 %)	3	≥ 90% of benchmark (>47.7%)	5
Organic litter ground cover (%)	5	10%	≥ 10 - <50% of benchmark (> 1 - <5%)	3	≥ 10 - <50% of benchmark (> 1 - <5%)	3
Overall score required	**30**			**>15**		**>18**

[1] Species richness must be based on native species that occur in RE11.9.3 as per the RE technical description.

Source: *https://www.qld.gov.au/__data/assets/excel_doc/0023/170285/bioconditon-benchmark-database-table.xlsx*

The location of reference monitoring sites is provided in **Table 54**.

Table 54 Reference Monitoring Sites

Reference Site ID	Easting (GDA 2020 Zone 55)	Northing (GDA 2020 Zone 55)	PMLU Reference	Description of Reference Land Use
R_BWood1	626339	7550444	Native Ecosystem	Native Ecosystem - Brigalow Woodland
R_BWood2	626827	7550490	Native Ecosystem	Native Ecosystem - Brigalow Woodland
R_BWood3	621848	7549302	Native Ecosystem	Native Ecosystem - Brigalow Woodland
R_EWood1	621461	7548589	Native Ecosystem	Native Ecosystem - Eucalypt Woodland
R_EWood2	622590	7547830	Native Ecosystem	Native Ecosystem - Eucalypt Woodland
R_EWood3	627311	754439	Native Ecosystem	Native Ecosystem - Eucalypt Woodland
R_NatG1	621806	7549053	Native Ecosystem	Native Ecosystem - Natural Grasslands
R_NatG2	625733	7548483	Native Ecosystem	Native Ecosystem - Natural Grasslands
R_NatG3	625028	7548703	Native Ecosystem	Native Ecosystem - Natural Grasslands
R_Graz1	623237	7547140	Grazing	Non Remnant vegetation
R_Graz2	623392	7551343	Grazing	Non Remnant vegetation
R_Graz3	627100	7550799	Grazing	Non Remnant vegetation

3.7.2 Rehabilitation Sites

Rehabilitation sites are areas that have been disturbed as a result of mining activities that are intended to be re-established to a land use (PMLU) as defined in Table E1 of EA EPML00586713. Details for these are provided in **Table 54**. Rehabilitation monitoring sites will be established in rehabilitated areas to allow for an assessment to be make comparisons against reference site and completion criteria (and target PMLU).

As per condition E12(i) of EA EPML00586713, a minimum of three (3) rehabilitation sites are required to develop rehabilitation success criteria. The number of sites established will be dependent on the area (ha) to be rehabilitated and the rate at which rehabilitation activities occur. Rehabilitation sites will be located within each area being reinstated to a particular Land Class/PMLU and assessed using a randomised site selection process.

As new areas are rehabilitated, additional sites will be included in the monitoring program. The density of rehabilitation sites within a disturbed area will be based on the NSW Office of Environment and Heritage Biobanking Assessment Methodology and Credit Calculator Operational Manual (OEH, 2016) which is summarised below in **Table 55**.

Table 55 Number of Rehabilitation Monitoring Sites Required

Land Use Rehabilitation Area (ha)	Minimum Number of Rehabilitation Monitoring Sites
0 - 4	1
>4 - 20	2
>20 - 50	3
>100 - 250	4
>250 - 1000	5

The location of proposed rehabilitation and closure monitoring sites are illustrated in **Figure 91** and presented in **Table 56**.

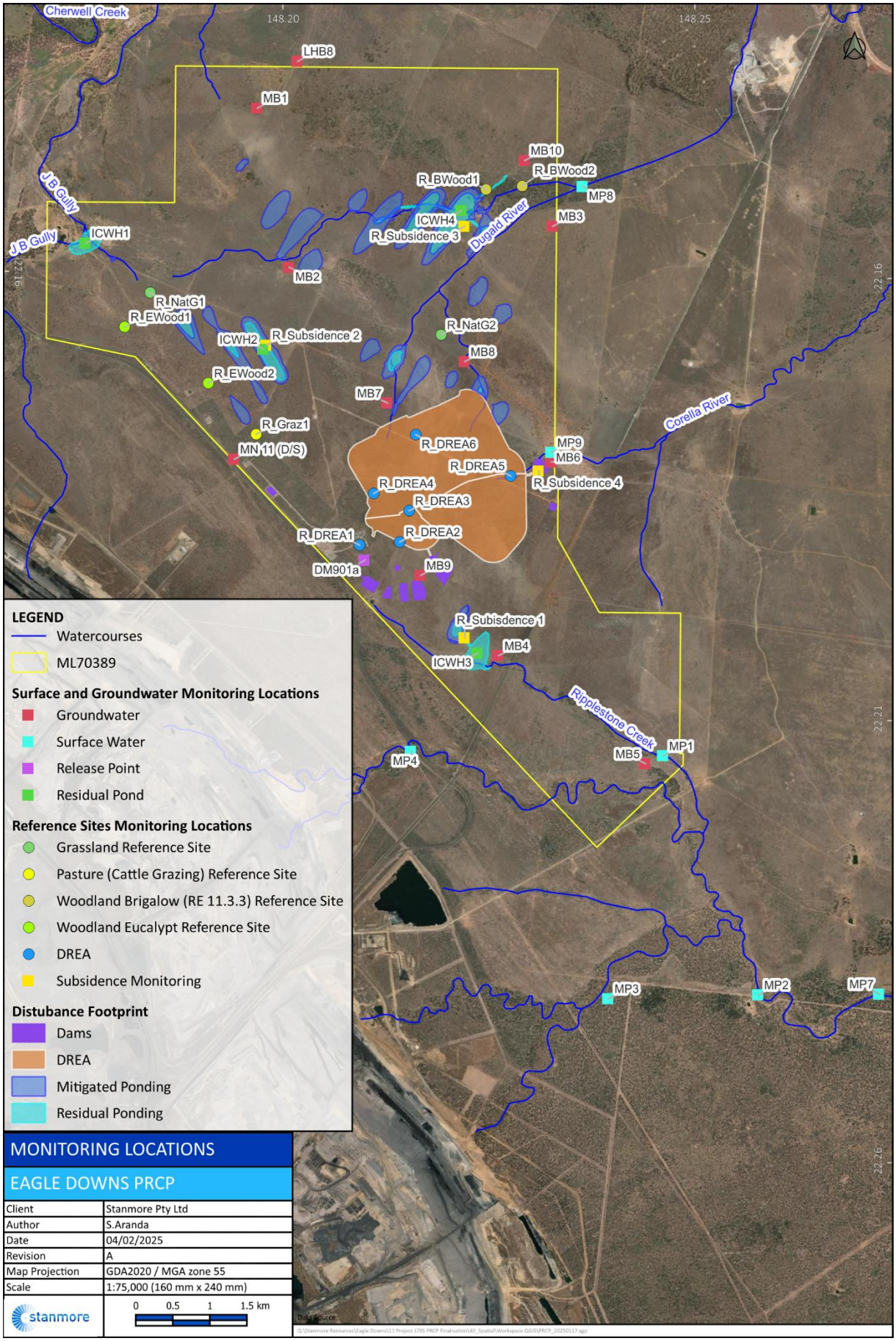


Figure 91 Rehabilitation and Closure Monitoring Site

Table 56 Rehabilitation and Closure Monitoring Sites

	Reference Sites	Latitude (decimal degree, GDA2020)	Longitude (decimal degree, GDA2020)	Eastings (GDA 2020 Zone 55)	Northing (GDA 2020 Zone 55)	Biodiversity	Subsidence	Land Classifications	Ponded Landforms	Water Quality	Final Landform
Release Point	DM901	-22.19185	148.2097	624704	7545440					✓	
Surface Water Monitoring	MP4	-22.215094	148.215969	625330	7542862					✓	
	MP3	-22.245066	148.242067	627993	7539522					✓	
	MP1	-22.215395	148.248985	628733	7542801					✓	
	MP2	-22.244427	148.261701	630017	7539576					✓	
	MP7	-22.244231	148.277524	631648	7539584					✓	
	MP8	-22.146084	148.23784	627647	7550484					✓	
	MP9	-22.178526	148.234022	627224	7546895					✓	
Ground Water Monitoring	MB1	-22.136842	148.195178	623255	7551542					✓	
	MB2	-22.156231	148.199511	623685	7549392					✓	
	MB3	-22.150961	148.233948	627240	7549946					✓	
	MB4	-22.203347	148.227295	626508	7544153					✓	
	MB5	-22.216379	148.246656	628492	7542694					✓	
	MB6	-22.131095	148.200394	623798	7552174					✓	
	MB7	-22.172665	148.212491	625009	7547562					✓	
	MB8	-22.167531	148.222581	626054	7548122					✓	
	MB9	-22.193651	148.217017	627224	7546895					✓	
	MB10	-22.142968	148.230213	626863	7550835					✓	
	MB11(D/S)	-22.179668	148.192514	622943	7546803					✓	
	LHB8	-22.131095	148.200394	623798	7552174					✓	
PMLU Reference Sites	R_BWood1	-22.14654	148.22516	626339	7550444	✓		✓			
	R_BWood2	-22.14609	148.22989	626827	7550490	✓		✓			
	R_EWood1	-22.16360	148.17800	621461	7548589	✓		✓			
	R_EWood2	-22.17040	148.18900	622590	7547830	✓		✓			
	R_Graz1	-22.1766	148.19534	623237	7547140	✓		✓			
	R_NatG1	-22.15943	148.18132	621806	7549053	✓		✓			
	R_NatG2	-22.16429	148.21944	625733	7548483						

						✓	✓			
Monitoring	R_Subisdence 1	-22.2012	148.2229	626053	7544393	✓		✓		
	R_Subsidence 2	-22.1657	148.1966	623376	7548341	✓		✓		
	R_Subsidence 3	-22.1511	148.2224	626051	7549946	✓		✓		
	R_Subsidence 4	-22.1808	148.2324	627053	7546644	✓		✓		
	R_DREA1	-22.19001	148.20897	624631	7545645		✓		✓	
	R_DREA2	-22.1896	148.21424	625174	7545686		✓		✓	
	R_DREA3	-22.18577	148.21544	625301	7546109		✓		✓	
	R_DREA4	-22.18371	148.21077	624822	7546341		✓		✓	
	R_DREA5	-22.18144	148.2287	626672	7546577		✓		✓	
	R_DREA6	-22.17649	148.21622	625390	7547135		✓		✓	

3.7.3 Monitoring and Maintenance Program

Several monitoring, management and maintenance activities are required for rehabilitated areas to ensure milestone completion criteria for PMLUs are achieved. The monitoring of rehabilitated areas should be undertaken at an early stage so results can be compared against completion criteria. Areas trending away from completion criteria will require management and or maintenance intervention to ensure completion criteria is achieved.

Fundamental aspects of EDCM rehabilitation and closure activities, that will require monitoring to demonstrate the achievement of completion criteria, are listed and detailed below:

- Biodiversity;
- Subsidence;
- Land Classification (i.e., land capability/class);
- Ponded Landforms;
- Water Quality; and
- Final Landform.

3.7.3.1 Biodiversity Monitoring

Biodiversity monitoring relates to both vegetation and fauna.

Vegetation will be monitored via field-based assessments (visual monitoring) as well as utilising GIS and remote sensing technologies. To ensure rehabilitation outcomes align with PMLUs, key vegetation types to be monitored at EDCM include grazing pastures, and native ecosystems, (open woodland, native grassland and brigalow). Vegetation parameters to be monitored include groundcover, vegetation cover (i.e., canopy), habitat availability and complexity, species composition and diversity and fire risk.

Fauna related monitoring will be conducted via field-based assessments (visual monitoring) and trapping.

Specific methodologies and standards used to conduct biodiversity monitoring, to meet PMLU completion criteria are outlined in **Table 57**.

If biodiversity monitoring results indicate a trend away from PMLU objectives (i.e., rehabilitation milestone criteria) then contingency strategies will be implemented. For vegetation related biodiversity, this may involve refinement to the species mix used in the rehabilitation process, application of additional seed and fertiliser, irrigation, application of additional topsoil, surface ripping and/or ongoing land management (such as weed control or addition of erosion and sediment control structures).

In terms of fauna biodiversity, contingency strategies will focus on the establishment of habitat (such as hollow logs to encourage fauna colonisation and connectivity to existing colonies.

Biodiversity monitoring will demonstrate that RM10 and RM13 (grazing PMLU), RM11, and RM14 (native ecosystem PMLU) relevant milestone criteria have been achieved (refer to **Table 57**).

Table 57 Biodiversity Monitoring

Monitoring Purpose	Parameter	Methodology	Frequency		Reporting Requirement
			Pre-Closure	Post Closure	
Vegetation	Species density and richness (of native ecosystem)	Vegetation Dynamics - Normalised Difference Vegetation Index (NDVI). Photographic Monitoring and general site notes. Soil Loss (measure the distance from the original ground mark to the current level and record any difference in height). Measure and record the number of all lower storey species in 8 x 1 m2 quadrat to determine density and richness. Record the start and finish foliage intercepts of mid-upper storey cover (50 m cover transect). Add and divide these intercepts by the total length (50 m), resulting in a percentage cover for the species.	Year 1, then 5 Yearly	5 Yearly	Formal report prepared by AQP.
	Groundcover	Visual observations. Vegetation Dynamics - (NDVI). Measure and record the number of all groundcover species in 8 x 1 m2 quadrat to determine density and richness. The contribution of each of the lower-storey species to the live-standing ground cover assessment will be determined. The proportion of bare ground will be assessed by default. Photographic Monitoring.			
	Grazing Pasture (if relevant)	Determine proportion of organic groundcover, density and diversity of perennial, palatable and productive (3P) pasture species.			
	Dieback	Particularly in and around ponded areas. Visual observations. Photographic Monitoring.			
	Weeds and Pests	Rapid Visual Monitoring (recorded as sparse, moderately abundant or abundant). Disturbance Photographic Monitoring.			

Monitoring Purpose	Parameter	Methodology	Frequency		Reporting Requirement
			Pre-Closure	Post Closure	
		GPS location recorded.			
	Disease or insect attack	Photographic Monitoring.			
	Fire risk - Spontaneous combustion	Geochemical characterisation of rehabilitation materials. Long term capping strategy. Visual observations.			
Fauna	Species diversity and richness.	Incidental sightings. Photographic Monitoring.			
	Habitat	Rapid Visual Monitoring – Habitat Complexity. Photographic Monitoring.			
	Colonisation	Recolonisation study by AQP prior to surrender.			
Climate	Resilience to Drought and Fire	Visual records			

3.7.3.2 Subsidence Monitoring

Subsidence monitoring is required to measure the surface effects resulting from underground mining operations.

Subsidence will be monitored as per the EDCM Subsidence Management Plan required by condition E4 of EA EPML00586713, which must be developed by an appropriately qualified person and implemented prior to the recommencement of production activities. Subsidence monitoring will be undertaken in areas above mined areas on a quarterly basis.

Proposed methodologies and standards used to conduct subsidence monitoring, to meet PMLU completion criteria are outlined in **Table 58**.

If subsidence monitoring results indicate a trend away from PMLU objectives (i.e., rehabilitation milestone criteria) then contingency strategies will be implemented that may involve:

- Stabilisation works including cross ripping and installation of contour drains to remediate any steepened areas prone to erosion;
- Rehabilitation of surface cracks by ripping/ploughing or excavating and backfilling, and reseeding;
- Repair of surface buckling by grading and re-spreading excess material and reseeding;
- Remedial drainage earthworks to redirect drainage paths; and / or
- Cut and/or fill earthworks to re-establish free drainage in depression/ponding areas.

Subsidence monitoring will demonstrate that RM5, RM8, RM9, RM10, and RM11 relevant milestone criteria have been achieved (refer to **Table 68**).

A subsidence register will be kept for detailing all longwall panels including:

- the surface area (ha) and depth within each subsided panel, including dry subsidence areas as well as areas with temporary and permanent/residual ponds;
- The locations of pre-existing drainage lines and drainage lines to be established to prevent/manage ponding;
- The locations of proposed and existing infrastructure;
- The pre-subsidence (baseline) condition of the vegetation and land condition; and
- Spatial data for each area including each temporary and permanent/residual pond modelled/predicted, and/or authorised ponded areas.

The register will be provided to the administering authority upon request. The baseline condition of each subsidence panel will be assessed prior to mining of each mining panel. The baseline condition will include:

- Site hydrology and fluvial networks;
- Soil types, properties and productivity;
- Flora species composition and structure;
- Land stability (pre-existing degradation/erosion and predisposition to ongoing stability issues); and
- Regional ecosystem details, if remnant, and BioCondition assessed in accordance with latest version of the BioCondition Assessment Methodology (Queensland Herbarium*). Methodology may include digital surface model or terrain model generated via LiDAR survey.

Table 58 Subsidence Monitoring

Monitoring Purpose	Parameter	Methodology	Frequency		Reporting Requirement
			Pre-Closure	Post Closure	
Subsidence	Extent	LiDAR survey of ML by AQP to determine extent of subsidence. Monitored using various remote sensing technology (which may include aspects such as annual high-resolution imagery, Digital Terrain Models (DTM), or synthetic aperture radio surveys.)	Year 1 then 4 Yearly	4 Yearly until AQP has certified subsidence has ceased.	Formal report prepared by AQP.
	Cessation	Geotechnical monitoring by AQP to determine when subsidence movement slows and ceases. Monitored under EDCM Subsidence Management Plan. Methodologies that may be used to determine the heights of subsurface subsidence cracking associated with EDCM mining operations, include borehole extensometers, piezometer records, drilling records, comparison of permeability testing and microseismic monitoring.			
	Cracking	Measure key subsurface subsidence cracking characteristics including the height of cracking above the extracted coal seam. This information can be correlated to measured changes in the water regime, for example, decreases in groundwater levels in boreholes or inflows to underground mining areas. This provides accurate site-specific data on the known characteristics and impacts of subsurface subsidence cracking within the geological sequence.			
	Erosional Stability	Geotechnical stability monitoring. Opportunistic observations of vegetation health, soil erosion/sediment loss, difference in soil height or presence of deposited materials. Permanent photo points (before and after subsidence).			

3.7.3.3 Land Classification Monitoring

The Guidelines for Agricultural Land Evaluation in Queensland (DSITI and DNRM, 2015) state that agriculture is a core component of the economic prosperity of Queensland, and it is therefore important to protect agricultural land so that its productive capacity is maintained.

As the most fundamental aspect that underpins the viability of agricultural land is soil, land classification monitoring is required to determine the erosivity and dispersiveness of soil in rehabilitated areas and to confirm an area of land may be used for a specific land use after the cessation of mining activities (i.e., Land Class C for grazing).

Land suitability classification in Queensland describes five land suitability classes for each specific agricultural land use. The definition of the different classes, according to the Rehabilitated mined land suitability for beef cattle grazing in the Bowen Basin is provided below:

- **Class 1:** Land highly productive requiring only simple management practices to maintain economic production.
- **Class 2:** Land with limitations that either constrain production or require more than the simple management practices of class 1 land to maintain economic production.
- **Class 3:** land with limitations that that either further constrain production or require more than those management practices of class 2 land to maintain economic production.
- **Class 4:** Currently unsuitable land. The limitations are so severe that the sustainable use of the land in the proposed manner is precluded. In some circumstances, the limitations may be surmountable with changes to knowledge, economics, or technology.
- **Class 5:** Land with extreme limitations that preclude any possibility of successful sustained use of the land in the proposed manner.

As land classification is based on key land and soil information, key parameters to be monitored include soil quality, erosion, contamination and the presence of weeds and pests.

Land classification will be monitored via field-based assessments, third-party assessments, laboratory analysis of soil parameters as well as utilising GIS and remote sensing technologies.

Specific methodologies and standards used to conduct land classification monitoring, to meet PMLU completion criteria are outlined in **Table 59**.

If land classification monitoring results indicate a trend away from PMLU objectives (i.e., rehabilitation milestone criteria) then the contingency strategies will be implemented that may involve recommendations for spoil or soil amelioration / fertilisation, fencing off areas, installation of additional erosion and sediment control infrastructure, soil treatment technologies (i.e., treatment of contamination), weed control or pest management.

Land Suitability monitoring will demonstrate that RM8, RM9, RM10, and RM11 relevant milestone criteria have been achieved (refer **Table 68**).

Table 59 Land Classification Monitoring

Monitoring Purpose	Parameter	Methodology	Frequency		Reporting Requirement
			Pre-Closure	Post Closure	
Land Capability	Productivity / Grazing	Pasture Productivity Assessment by AQP.	Year 1 then 4 Yearly	5 Yearly	Formal report prepared by AQP.
	Soil Quality	The National Committee on Soil and Terrain's Australian Soil and Land Survey Field Handbook (3rd Edition, 2009). 250g samples at start and end of transects (combine to form composite sample). Soil Analysis at NATA accredited laboratory (plant available water capacity (PAWC), nutrient deficiency, physical factors, salinity, rockiness, micro-relief, pH, exchangeable sodium percent (ESP), wetness, flooding).	Year 1 then prior to relocating from stockpile	5 yearly or if plant growth indicates trending away from PLMU criteria	
	Water Erosion	Monitor the progression of erosion features as per the Australian Soil and Land Survey – Field Handbook. 2nd ed (1990). In-field visual observations. GPS location recorded. Photographic Monitoring.	Twice Yearly (pre and post wet season) from Year 1	Twice Yearly (pre and post wet season) for 5 years, then 5 yearly	
	Soil Contamination	AQP to conduct sampling and testing. AQP to prepare investigation report, to determine if contamination exists, including remediation works required to remediate any contaminated land. AQP to issue a site suitability statement, indicating the land is not contaminated.	As required following a spill	Prior to PMLU certification	
	Weeds and Pests	Rapid Visual Monitoring (recorded as sparse, moderately abundant, or abundant). Disturbance Photographic Monitoring. GPS location recorded.	Year 1 then annually	5 Yearly	

3.7.3.4 Ponded Landform Monitoring

Ponded landform monitoring will be conducted to compare expected subsidence of areas against actual subsidence. It will enable EDCM to identify gaps and inform and support the PMLU objective (i.e., intermittent cattle watering holes) as well as verify and calibrate the projects' water balance model. Ponded landform monitoring relates to areas remaining from unmitigated ponding (residual ponding) and are identified in Figure 3 of EA EPML00586713.

Ponded landforms will be monitored via field-based assessments, water sampling as well as utilising survey technologies (i.e., LiDAR) and will be implemented as part of the ongoing EDCM Subsidence Management Plan during operations.

Specific methodologies and standards used to conduct ponded landform monitoring, to meet PMLU completion criteria are outlined in **Table 60**.

If ponded landform monitoring results indicate a trend away from PMLU objectives (i.e., rehabilitation milestone criteria) then contingency strategies will be implemented that may involve (but is not limited to) further soil sampling to identify dispersive subsoils, introduction of salt tolerant plants to assist in soil stability and act as a sediment trap or addition of fertiliser to replace surface soil nutrients.

Ponded landform monitoring will demonstrate that RM8 and RM9 relevant milestone criteria have been achieved (refer **Table 68**).

Table 60 Ponded Landform Monitoring

Monitoring Purpose	Parameter	Methodology	Frequency		Reporting Requirement
			Pre-Closure	Post Closure	
Water	Quality	Regular water quality samples from existing ponds. Measure EC and Total Suspended Solids (TSS) and Sulphate at a minimum.	Year 1 then annually	2 Yearly	Formal report prepared by AQP.
	Depth	In situ water levels of existing ponds.			
	Volume	Topographic data (LiDAR) obtained to determine storage curves for existing ponds (when dry).			
Soil	Type (i.e., dispersive)	Soil sampling and analysis to determine soil types for each ponded area. At least one soil sample per pond (minimum) to be taken, however, if possible, two samples (one from within the centre of each pond (where ponding is greatest) and one along the edges (where erosion risks are greater) would be advantageous).	Year 1	5 Yearly	
Topography	Infill rates	Survey in the centre of each pond during dry season to quantify the overland flow sediment transport rates.	Year 1 then 5 Yearly	5 Yearly	

3.7.3.5 Water Monitoring

Water monitoring is required to confirm that water contained within (or leaving) the project area (i.e., ponded areas intended for use as intermittent cattle watering holes, sediment control dams around the DREA or seepage from the DREA) does not have the potential to contaminate the surrounding environment or waterways, impact other users and is safe to humans and animals.

Water will be monitored via field-based assessments, bore sampling and geochemical testing, and will be implemented as part of the ongoing EDCM Water Management Plan during operations.

Specific methodologies and standards used to conduct water monitoring, to meet PMLU completion criteria are outlined in **Table 61**. Water monitoring (surface and groundwater) parameter, methodology, and frequency (both pre-closure and post closure) are prescribed in the relevant monitoring plans. The monitoring plans will be updated to reflect the transition from the operational to the post closure setting and capture the most relevant sources and pathways of potential contamination. The adopted quality characteristics and the receiving environment trigger levels will be based on the latest Water Quality Objectives (WQOs) relevant to the identified EVs or those approved under EPML00586713 prior to closure. Included in the monitoring program will be any residual ponds water quality and any levels and quality for sediment dams or ponds prior to rehabilitation or approved handover to the landholder.

If water monitoring results indicate a trend away from PMLU objectives (i.e., rehabilitation milestone criteria) then contingency strategies will be implemented that may involve an increased sampling regime until results return to a reliable range (within WQO Guidelines), temporary exclusion of an area to cattle (i.e., fencing), removal or encapsulation of AMD material, installation of erosion and sediment control infrastructure or a geochemical investigation.

Sediment dams that indicate poor or deteriorating water quality will be assessed on the following:

- Erosion potential of landforms reporting to their catchment; and
- Dam design for removing sediment.

This assessment will determine whether additional rehabilitation is required to the waste landform or if the sediment dams are being managed in accordance with the EDCM Erosion and Sediment Control Plan. In the event the sediment dams are not being managed accordingly, EDCM will engage a suitably qualified and experienced person to review the structure, and implement recommendations as required.

Where the groundwater monitoring program indicates adverse impacts to either draw down or contamination, EDCM will assess these with qualified guidance, so that remedial action can be taken if necessary.

Where the surface water quality at the downstream site exceeds the upstream site result, an AQP will complete an assessment of the cause and risk of rehabilitation not achieving a stable condition within the schedule timeframe and:

i. Where there is a low risk to achieving a stable condition from the ML70389 and PL485, then no further action will be taken; or
ii. Where there is a risk greater than low to achieving a stable condition, then an assessment of potential environment harm and any changes or rectification actions to rehabilitation activities will be determined and implemented.
iii. (i) can only be triggered 3 times over 5 consecutive years prior to surrender

The surface water quality assessment will be completed and provided to the administering authority within three months of receiving the relevant sampling results.

Surface and groundwater quality limits are detailed in **Table 62** and **Table 63**; and monitoring locations for surface water and groundwater bores are provided in **Table 64** and **Table 65**. Surface water monitoring locations and post closure groundwater monitoring bores are in **Figure 92** and **Figure 93**.

Water monitoring will demonstrate that RM8, RM10, and RM11 relevant milestone criteria have been achieved (refer **Table 68**).

Table 61 Water Monitoring

Monitoring Purpose	Parameter	Methodology	Frequency		Reporting Requirement
			Pre-Closure	Post Closure	
Groundwater	Quality	As per the EDCM Groundwater Monitoring Program (GMP) updated regularly and in line with post closure requirements. Sampling and testing to ensure water quality limits are not exceeded (including insitu pH, EC and suspended solids, metals/metalloids, and total petroleum hydrocarbons). Samples sent to a NATA accredited laboratory for analysis.	Annually, until longwall mining commences, then quarterly	Quarterly for 5 consecutive years, monitored	Formal report prepared by AQP.
	Level	Piezometer measurements.			
Surface Water	Quality (Ponded Areas or DREA sediment dams)	Sampling and testing of ponded areas and sediment control dams to ensure water quality limits are not exceeded (including insitu pH, EC, turbidity; selected total and dissolved metals; hydrocarbons and nutrients). If the pH of runoff from the DREA drops below pH 6.0 or the EC value increases by more than 50%, then a more comprehensive range of water quality analysis would be triggered and, if necessary, a detailed geochemical investigation will be conducted to determine the cause. Annual testing of the full suite of dissolved metals. Samples sent to a NATA accredited laboratory for analysis	Quarterly	5 Yearly	
	Quality (Receiving Waters)	As per the EDCM Receiving Environment Monitoring Program (REMP) updated regularly and in line with post closure requirements. Samples sent to a NATA accredited laboratory for analysis.	Commencement of release then weekly during release	5 Yearly	
	Surface Flow	Inspection of receiving waters. LiDAR survey. Drainage and runoff assessments to identify and rectify converging flow paths.	Opportunistic - during flow	Within 48 hours of flow, for a minimum of 5 consecutive years	

Monitoring Purpose	Parameter	Methodology	Frequency		Reporting Requirement
			Pre-Closure	Post Closure	
DREA Seepage Quality	Acid and Metalliferous Mine Drainage (AMD)	Sampling and testing to ensure water quality limits are not exceeded. Geochemical testing to determine seepage quality recovered and expressing from DREA.	Quarterly	5 Yearly	

Table 62 Surface water quality limits

Quality characteristic (units)	Limit	Comment on limit
pH	6.5-8.5	Upper Issac River catchment waters WQO
Electrical Conductivity (µS/cm)	720	Upper Issac River catchment waters WQO
Turbidity (NTU)	50	Upper Issac River catchment waters WQO
Sulphate (mg/L)	25	Upper Issac River catchment waters WQO
Aluminium - dissolved (µg/L)	55	ANZG 2018
Antimony - dissolved (µg/L)	9	ANZG 2018
Arsenic - dissolved (µg/L)	13	ANZG 2018
Iron - dissolved (µg/L)	300	ANZG 2018
Mercury - dissolved (µg/L)	0.06	ANZG 2018
Molybdenum - dissolved (µg/L)	34	ANZG 2018
Nickel - dissolved (µg/L)	11	ANZG 2018
Selenium - dissolved (µg/L)	5	ANZG 2018
Nitrate (µg/L)	1100	
Total recoverable hydrocarbons (C6-C9) (µg/L)	20	
Total recoverable hydrocarbons (C10-C36) (µg/L)	100	
Major ions (mg/L)		
Calcium, chloride, potassium, magnesium, sodium, bicarbonate, carbonate	For interpretation purposes only	
Hardness (mg/L)	For interpretation purposes only	

Notes:

- All metals and metalloids
- Limits for metals and metalloids apply to dissolved results
- DEHP (2011) Issac River Sub Basin WQO – surface water https://environment.desi.qld.gov.au/__data/assets/pdf_file/0032/88817/fitzroy_isaac_river_wqo_290911.pdf
- ANZG (2018) Aquatic ecosystem protection for moderately disturbed system (95% protection)

Table 63 Groundwater quality limits

Quality Characteristic (units)	Monitoring Bore	Limit	Comments
pH (pH units)	All bores	6 – 8.5	
Aluminium - dissolved (µg/L)	All bores	55	ANZG 2018
Antimony - dissolved (µg/L)	All bores	9	ANZG 2018
Arsenic - dissolved (µg/L)	All bores	13	ANZG 2018
Mercury - dissolved (µg/L)	All bores	0.06	ANZG 2018
Molybdenum - dissolved (µg/L)	All bores	34	ANZG 2018
Nickel - dissolved (µg/L)	All bores	11	ANZG 2018
Selenium - dissolved (µg/L)	All bores	5	ANZG 2018
Major ions (mg/L)			
Calcium, chloride, potassium, magnesium, sodium, bicarbonate, carbonate	All bores	For interpretation purposes only	
Hardness (mg/L)	All bores	For interpretation purposes only	

Quality characteristic	Bore												
	MB1	MB2	MB3	MB4	MB5	MB6	MB7	MB8	MB9	MB10	MB11S[1]	MB11D[2]	LHB8
Electrical conductivity (µS/cm)	2,100	4,270	18,700	13,200	5,740	8910	8910	8910	8910	8910	8910	16000	7,970
Sulfate (mg/L)	26	4	138	104	43	318	318	318	318	318	318	398	445
Iron - dissolved (µg/L)	800	260	5,000	240	1,800	140	140	140	140	140	140	246	1,000

[1] Environmental Protection (Water) Policy 2009 Fitzroy River Sub-basin Environmental Values and Water Quality Objectives Groundwater chemistry zone 34 shallow - https://environment.des.qld.gov.au/__data/assets/pdf_file/0037/88795/fitzroy_fitzroy_river_wqo_290911.pdf
[2] Environmental Protection (Water) Policy 2009 Fitzroy River Sub-basin Environmental Values and Water Quality Objectives Groundwater chemistry zone 34 deep - https://environment.des.qld.gov.au/__data/assets/pdf_file/0037/88795/fitzroy_fitzroy_river_wqo_290911.pdf
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.
- ANZG (2018): Aquatic ecosystem protection for moderately disturbed system (95% protection)

Table 64 Surface water monitoring locations

Monitoring Locations	Receiving waters location description	Latitude (decimal degree, GDA2020)	Longitude (decimal degree, GDA 2020)
Upstream monitoring locations			
MP3	Upstream Ripplestone Creek – flow from Peak Downs Mine	-22.245066	148.242067
MP4	Upstream Ripplestone Creek (Western Tributary)	-22.215094	148.215969
Downstream monitoring locations			
MP1	Downstream Ripplestone Creek Eastern Tributary immediately upstream of Winchester Road	-22.215395	148.248985
MP2	Downstream Ripplestone Creek	-22.244427	148.261701
MP7	Downstream Ripplestone Creek	-22.244231	148.277524
MP8	Downstream mining footprint	-22.146084	148.23784
MP9	Downstream mining footprint	-22.178526	148.234022

Table 65 Groundwater monitoring bores

Monitoring Bore	Screen geology	Latitude (decimal degree, GDA2020 -zone 55)	Longitude (decimal degree, GDA2020 -zone 55)
MB1	Upper fractured rock, Fort Cooper CM – siltstone	-22.136842	148.195178
MB2	Upper fractured rock, Fort Cooper CM – sandstone and siltstone	-22.156231	148.199511
MB3	Upper fractured rock, Rewan Group	-22.150961	148.233948
MB4	Upper fractured rock, Fort Cooper CM –coal, sandstone and siltstone	-22.203347	148.227295
MB5	Upper fractured rock, Fort Cooper CM –coal, sandstone and siltstone	-22.216379	148.246656
MB6	Shallow CM - East of DREA along drainage line	-22.179693	148.234034
MB7	Shallow CM - North of DREA along eastern drainage line flowing north	-22.172665	148.212491
MB8	Shallow CM - North of DREA along western drainage line flowing north	-22.167531	148.222581
MB9	Shallow CM - North of DREA along western drainage line flowing north	-22.193651	148.217017
Landholder Bore 8 (LHB8)	- Upper fractured rock Fort Cooper CM	-22.131095	148.200394
MB10	- Rewan Group	-22.142968	148.230213
MB11 Deep(D) /Shallow(S)	Shallow weathered fractured rock	-22.179668	148.192514

Note:
CM – Coal Measures

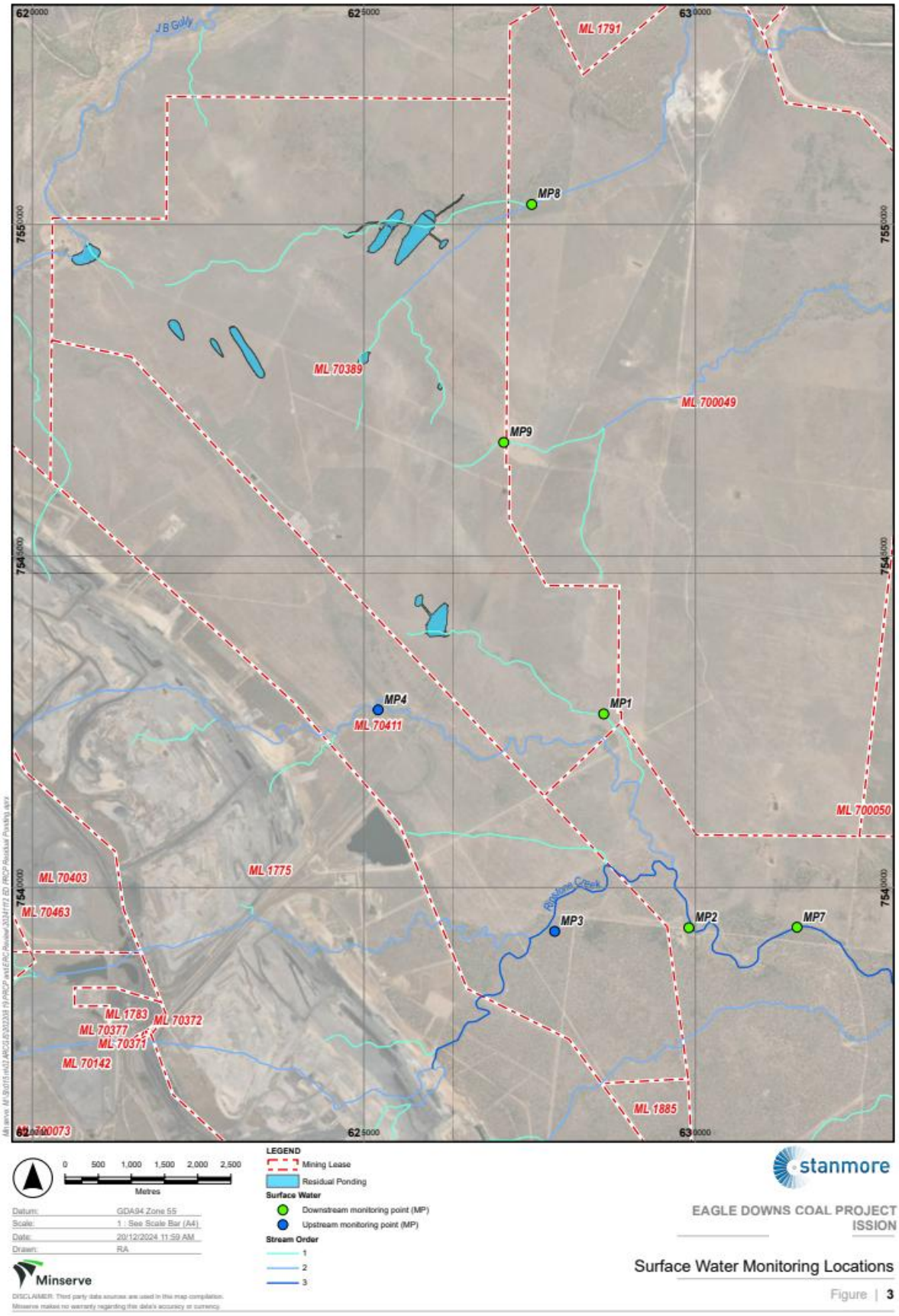


Figure 92 Surface water monitoring locations

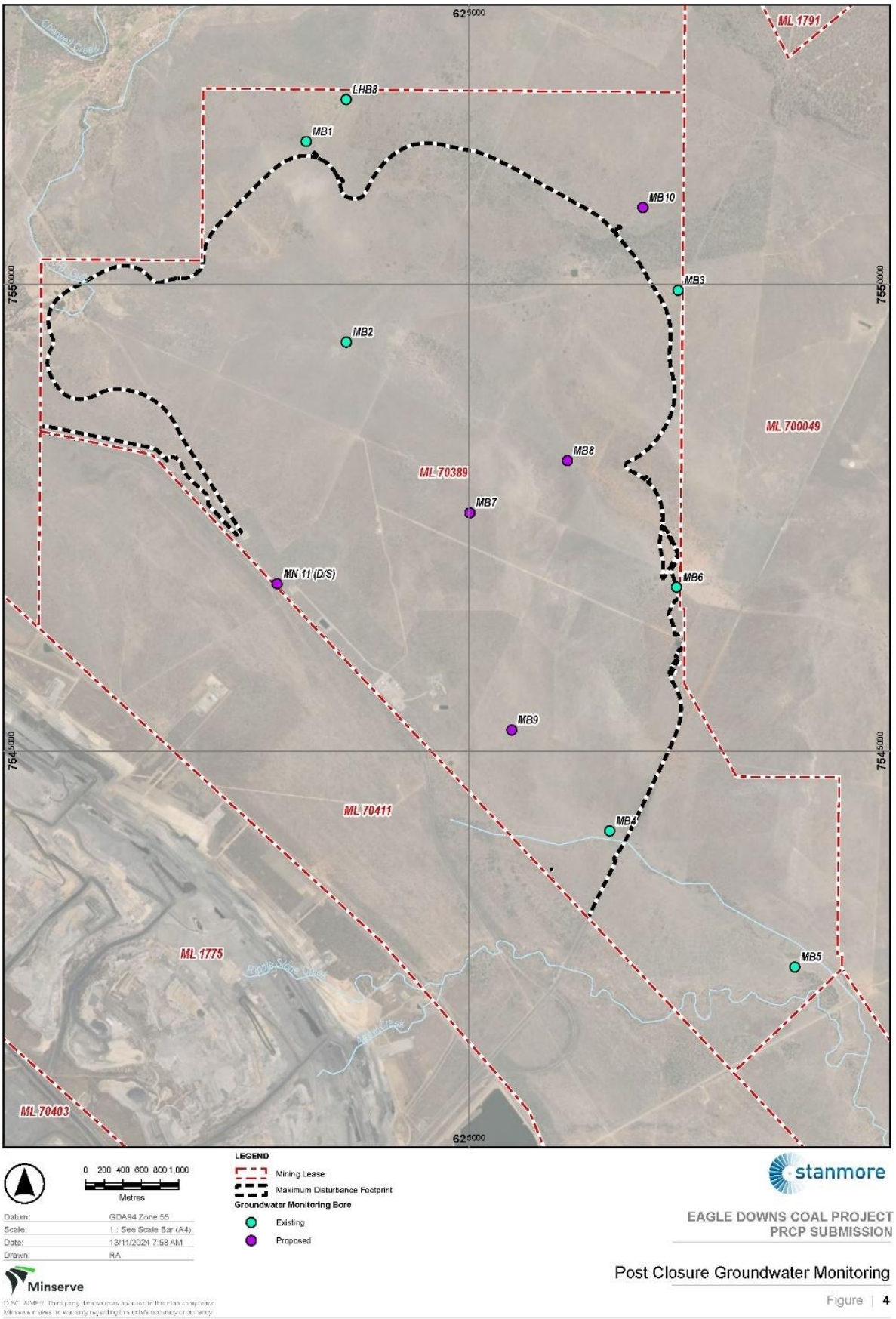


Figure 93 Post Closure Groundwater Monitoring

3.7.3.6 Final Landform Monitoring

Final landform monitoring is required to confirm that the final landform is constructed according to the RPEQ's 'as built' landform design specifications, is in line with community member expectations and intended final land use (PMLU) as well as other requirements mandated through EA EPML00586713.

Condition C49 of EA EPML00586713 requires the development of a groundwater monitoring program to effectively monitor the water pressure across the base of the Dry Rejects Emplacement Area (DREA) at the interface with the natural surface and provide the means to reduce the phreatic surface within the DREA. It is intended that a monitoring program will be developed by an AQP and will be implemented during operations to address the EA conditions.

Final landform monitoring will be conducted via field-based assessments and utilising GIS, survey, and remote sensing technologies (such as LiDAR).

Specific methodologies and standards used to conduct final landform monitoring, to meet PMLU completion criteria are outlined in **Table 66.**

Table 67 outlines the erosion classification framework (NCST, 2009) used as a benchmark for evaluating the results of the erosion monitoring process.

If final landform monitoring results indicate a trend away from PMLU objectives (i.e., rehabilitation milestone criteria) then contingency strategies will be implemented. These may involve the installation of erosion and sediment control infrastructure, reprofiling if not consistent with 'as built' landform specifications (i.e., slopes, length) and removal, encapsulation or treatment of material identified to have spontaneous combustion potential. Additional contingencies may also involve:

- Any significant settlement may require review by a suitably qualified geotechnical engineer (as described in South32 Dam Management Standard) as part of the quarterly or annual safety reviews.
- Any deviation from the design intent of higher phreatic level within the DREA will require review by a suitably qualified geotechnical engineer (as described in South32 Dam Management Standard) to include reassessment of the stability of the DREA with the measured phreatic surface level.
- Where air quality monitoring indicates exceedance of air quality limits, EDCM must address the exceedance in accordance with the relevant conditions of EA EPML00586713.

Final landform monitoring will demonstrate that RM3, RM5, RM8, RM9, RM10, and RM11 relevant milestone criteria have been achieved (refer **Table 68**).

Table 66 Final Landform Monitoring

Monitoring Purpose	Parameter	Methodology	Frequency		Reporting Requirement
			Pre-Closure	Post Closure	
Visual Amenity	Visual Amenity	In-field visual observations of overall condition. Assessment of Final Landform against commitments made during Community Consultation. Survey of landform against 'as built' landform design specifications.	Not required	5 Yearly	Internal QA/QC
DREA	Profile	LiDAR survey (control points, slope gradient, slope length) as specified in EA EPML00586713. Generation of 'as constructed' digital terrain models and/or plans. Assessment by AQP to establish compliance with the 'as built' landform specifications.	Year 1 then annually	5 Yearly	Formal report prepared by AQP.
	Structural Integrity (Stability and Safety)	Geotechnical stability monitoring. Periodic surveys (of sufficient density) undertaken so that all constructed surfaces can be suitably measured and compared with previous survey to determine placed volumes, constructed landform, identification of drainage structures, constructed roads and differences in landforms between survey events (settlement, creep etc). Reject parameters - total moisture content and in-situ densities. Real time monitoring survey on completed surfaces on DREA (against permanent (and additional settlement) benchmarks located on the DREA). Rate of settlement to be compared from survey results. Review of rejects production, deposition and DREA management.	6 monthly	5 Yearly	
	Erosion	In-field visual observations, with particular focus on scattering batter tows due to high velocity flood events. Monitor the progression of erosion features as per Australian Soil and Land Survey - Field Handbook. 3rd ed (2009). Quantified Sediment deposition.	Twice Yearly (pre and post wet season) from Year 1	Twice Yearly (pre and post wet season) or 5 years, then 5 yearly	

Monitoring Purpose	Parameter	Methodology	Frequency		Reporting Requirement
			Pre-Closure	Post Closure	
	Piezometric Levels	Real time monitoring of piezometric levels via open hole piezometers to measure phreatic surface level within the rejects, which provides validation of the DREA design assumptions and/ or intent and efficient means of assessing geotechnical stability of the DREA. Piezometric measurements plotted to make a broad assessment of the rate of water level and movement.	TBA by AQP	TBA by AQP	
	Temperatur e	Temperature probes installed to monitor temperature of rejects to ensure spontaneous combustion of rejects is mitigated against.	Continuous monitoring		
	Air Quality	Continuous monitoring to ensure EA EPML00586713 Conditions B2 – B7 are met.			
Landform Other	Shaft / decline drift, borehole and surface to seam workings remediation availability.	Consult register and exploration/mining/environmental teams to confirm what bores/ workings are available for remediation. Borehole remediation (refer s3.5.4). Certification from a suitably qualified person that remediation was completed in accordance with the design. Update Acquire database with bore rehabilitation information.	Year 1 then annually	5 Yearly	

Table 67 Erosion Classification Framework

Erosion classification	Minor	Moderate	Severe
Sheet erosion	Shallow soil deposits downslope	Partial exposure of roots; moderate soil deposits downslope.	Loss of surface horizon; subsoil exposure; root exposure; substantial soil deposits downslope
Rill/gully erosion	<15 rills/transect[1] and <0.3m deep	15-30 rills/transect[1] and <0.3m deep	>30 rills-transect[1] and/or any >0.3m deep
Tunnel erosion	Absent	Absent	Present
Mass movement	Absent	Absent	Present

[1] Transect 100m across the contour

Source: Tongway, D. J. and Hindley, N. L. 2005. Landscape Function Analysis: Procedures for Monitoring and Assessing Landscapes. CSIRO Publishing, Canberra, Australia.

3.7.4 Monitoring Schedule

3.7.4.1 Timing and Frequency

PRC Plan monitoring will be conducted by an appropriately qualified person (AQP) at locations indicated above (see Sections 3.7.1 and 3.7.2). As is required by condition E19 of EA EPML00586713, EDCM must conduct a Rehabilitation Monitoring Program on a yearly basis (with sufficient spatial and temporal replication) so that site is able to determine if they are trending towards performance criteria of PMLUs.

Reference and rehabilitation sites will be monitored during the same survey, at the same time every year to avoid seasonal variations. This will ensure the collection of relevant, statistically valid data, that is repeatable year on year, to enable statistically valid conclusions as established under the rehabilitation program.

The monitoring schedule for Rehabilitation Milestones is provided in **Table 68**.

3.7.5 Monitoring Report and Review Process

As per condition E21 of EA EPML00586713, details on how the rehabilitation objectives will be achieved, as well as verification of rehabilitation success (monitoring results and key findings) will be described in the Rehabilitation Monitoring Program. Rehabilitation monitoring will be documented in the Annual Rehabilitation Monitoring Program Progress Report.

The rehabilitation monitoring program will be reviewed each year and benchmarked against reference sites. The culmination of multi-year monitoring will allow comparison trends to be detected. If monitoring results indicate a trend away from PMLU objectives (i.e., rehabilitation milestones) then contingency strategies will be implemented as is described in the following sections.

3.8 Reporting and record management

3.8.1 Risk Register

A risk register will be maintained that identifies the risks to not achieving a stable condition for post-mining land uses, and how the risks will be managed or minimised. The risk register will be reviewed annually.

3.8.2 Record keeping

Records will be regularly updated and maintained for the following aspects:

- Achieving and maintenance for achieving each rehabilitation milestone criteria
- Rehabilitation activities and the results of those activities (including but not limited to, actions taken, date, location, methods, data collected, QA/QC, photos, waste tracking and disposal records, appropriately qualified person details and assumptions);
- Maintenance of rehabilitation and the results of maintenance activities;
- Monitoring rehabilitation and the results of monitoring;
- Details and results of rehabilitation trials;
- Designs, drawings, specifications and any similar documents developed in accordance with good professional practice in relation to rehabilitation milestones or milestone criteria;
- All documents in relation to the requirements of the PRC schedule (approval), including reports (e.g. site investigation report), statements (e.g. site suitability statement), certifications, assessments, investigations, inspections, audits or any similar documents developed in relation to rehabilitation milestones or milestone criteria;
- Landholder agreements; and
- Details of community consultation in the community consultation register relating to rehabilitation and closure activities.

The records will be kept until the environmental authority has been surrendered or cancelled. The records will be provided to the administering authority in the specified format within 10 business days of a written request.

3.9 Audits

An audit of the PRC schedule will be undertaken by a rehabilitation auditor for the following periods (audit period):

- The 3-year period starting on the day the schedule takes effect; and
- Each 3-year period starting on the day after the previous audit period ended.

Within four months after the end of each audit period, the EDCM will give the administering authority:

- The rehabilitation auditor's report about the audit; and
- A declaration by the authorised representative of the holder, for the audit report stating the EA holder:
  - Has not knowingly given false or misleading information to the rehabilitation auditor; and
  - Has given all relevant information to the rehabilitation auditor.

The audit report for the PRCP schedule will include the following:

- A statement about whether EDCM has complied with the schedule during the audit period, including:
  - Details of actions the holder has taken, or failed to take, in relation to the rehabilitation milestones and management milestones under the schedule; and
  - Whether the holder has complied, or failed to comply, with conditions imposed on the schedule; and
  - Whether information given to the administering authority under this Act about rehabilitation carried out under the schedule is accurate;
- An assessment of whether the post-mining land use for land the subject of the schedule is likely to be achieved, having regard to the rehabilitation that has been and is to be carried out under the schedule; and
- Recommendations about actions EDCM should take to ensure rehabilitation milestones and management milestones are achieved or conditions of the schedule are complied with.

A peer review will be undertaken, followed by an independent AQP assessment, within two years prior to the earliest commencement of any rehabilitation milestone. This will be to certify that existing and proposed permanent Erosion and Sediment Control (ESC) structures, drainage structures and creek diversions on site are appropriate to the landform, materials and the PMLU, with consideration given to their performance, stability, maintenance requirements, and residual risk post-closure; and finally that a stable condition can be achieved as per the *Environmental Protection Act 1994.*

Table 68 Schedule of Monitoring, Reporting and Review for Rehabilitation Milestones

Milestone reference	Rehabilitation milestone	Milestone criteria	Monitoring and Validation Methodology	Frequency (Pre and Post Closure)	Reporting Requirement
RM1	Infrastructure decommissioning and removal	1.1 RM1 does not apply to infrastructure required for rehabilitation. **Built Infrastructure** 1.2 All services disconnected, terminated and removed offsite. 1.1 All buildings, and associated infrastructure (including concrete slabs and footings) demolished or removed offsite. 1.4 All roads (bitumen, blue metal, aggregate) removed. 1.5 All fencing not included in the PMLU removed offsite. 1.6 Machinery and equipment removed offsite. 1.7 All waste removed offsite. 1.8 All pipelines drained and removed. 1.9 All surface drainage infrastructure removed. **Gas Drainage Boreholes** 1.10 Borehole decommissioning completed in accordance with the Code of Practice for the Construction and Abandonment of Petroleum wells and associated bores in Queensland (the Code) (Department of Resources, 2019) latest edition. 1.11 An appropriately qualified person (AQP) has certified the borehole has been remediated in accordance with the Code. **Surface to Seam Boreholes**	Visual monitoring. Certification by AQP	Year 1	A report will be compiled of the infrastructure removed and disposal process.

Milestone reference	Rehabilitation milestone	Milestone criteria	Monitoring and Validation Methodology	Frequency (Pre and Post Closure)	Reporting Requirement
		1.12 For all surface to seam boreholes (including but not limited to, exploration bores, water monitoring bores, dewatering bores and bores with diameter up to 300mm): (f) Boreholes grouted and/or plugged. (g) Boreholes capped 0.5 m below surface. (h) Decommission of exploration bores completed in accordance with 'Eligibility Criteria and Standard Conditions for Exploration and Mineral Development Projects'.			
RM2	Identification, remediation and removal of contaminated land	2.1. Contaminated sediments and liners removed or incorporated into the final landform of the Dry Rejects Emplacement Area (DREA). 2.2. Brine disposed at a licenced waste facility. 2.3 Contaminated Land Investigation Document completed in accordance with the *Environmental Protection Act 1994*, including a site investigation report, and, where required, a Validation Report and/or a draft Site Management Plan. 2.4 Contaminated and hazardous material either remediated in-situ or removed/transported to an approved landfill for disposal and waste tracking information recorded and submitted. 2.5 A declaration from a Suitably Qualified Person (SQP) that no contamination unsuitable for the post-mining land use remains.	Contaminated Land Assessment Declaration by SQP	Year 1	A report will be compiled by an AQP to certify that the land is not contaminated.
RM3	Landform reshaping and final contouring	**All areas (excluding RA6)** 3.1 Dams dewatered and desilted. 3.2 Liners from dams removed.	LiDAR Assessment. Geotechnical Monitoring. Certified by AQP	Year 1 then 4 yearly	Formal sign off from internal AQP and earthworks supervisor that landform reshaping

Milestone reference	Rehabilitation milestone	Milestone criteria	Monitoring and Validation Methodology	Frequency (Pre and Post Closure)	Reporting Requirement
		3.3 Rehabilitated areas stabilised and reshaped to a slope of less than 5%. 3.4 All major earthworks completed, slopes and general reshaping and pushing/trimming completed to achieve final landform. 3.5 An AQP certifies that the constructed landform achieves design criteria for geotechnical stability with a Factor of Safety (FOS) ≥ 1.5. **DREA (RA6)** 3.6 Closure and decommissioning plan has been reviewed and detailed design completed and certified by a third-party AQP. 3.7 Batter slopes reshaped following cessation of subsidence in accordance with the AQP design. 3.8 Batter slopes reshaped to ≤15%. 3.9 Free-draining top surface graded to 2%. 3.10 All major earthworks completed. 3.11 Fencing to exclude livestock installed. 3.12 An AQP confirms that performance objectives for the DREA clay liner have been achieved during construction, maintained during operations and are suitable for closure. 3.13 An AQP certifies that the constructed landform achieves design criteria for geotechnical stability with a Factor of Safety (FOS) ≥ 1.5.			and contouring have been done as per landform design specifications (including survey and geotechnical monitoring results).
RM4	Installation of a cover system (DREA)	4.1 Installation of a cover system in accordance with the AQP design. 4.2 Confirmation by an AQP that the cover system has been installed as per the design and	Certification by AQP	Year 1	Formal sign off from AQP that the installed cover is effective in mitigating the potential for

Milestone reference	Rehabilitation milestone	Milestone criteria	Monitoring and Validation Methodology	Frequency (Pre and Post Closure)	Reporting Requirement
		displays erosional stability, is geotechnically stable and supports the PMLU. 4.3 Confirmation from AQP that the installed cover is effective in mitigating the potential for migration of contaminants from the DREA to the receiving environment.			migration of contaminants from the DREA to the receiving environment.
RM5	Surface preparation	**All rehabilitation areas** 5.1 Any erosion or effects of subsidence remediated as per the closure conditions of the latest version of the Subsidence Management Plan and to ensure maintenance of the baseline condition (latest assessed) as determined in section 3.5.1.5. 5.2 Remediate any erosion or subsidence by, but not limited to, addition of rock and/or log cover to assist erosion resistance of eventual vegetative groundcover. 5.3 Prior to placement of soil material for rehabilitation, growth media[7] health and suitability must be assessed and certified by an AQP as suitable for PMLU and target vegetation and to determine the need for ameliorants and fertilisers prior to sowing seed. 5.4 Where growth media health and suitability assessment identify that growth media criteria below are not met, a recommendation is made for ameliorants and fertilisers prior to sowing seed, growth media (to meet the following:	Erosion monitoring. Soil monitoring. Water monitoring. Certified by AQP.	Year 1 then 5 yearly Year 1 then 5 yearly	Formal sign off from internal AQP and earthworks supervisor that surface has been suitably prepared for rehabilitation (including topsoil volumes, depth and details of installed erosion and sediment control infrastructure).

[7] Growth media is defined as all soil and soil-like material that will support the final vegetation cover. This includes the topsoil and subsoil where these materials are applied independently. Where the topsoil is incorporated into the underlying subsoil/spoil, topsoil refers to the depth of incorporation and the remaining depth is regarded as subsoil. The total depth of growth media is nominally considered to be the effective plant root zone

Milestone reference	Rehabilitation milestone	Milestone criteria	Monitoring and Validation Methodology	Frequency (Pre and Post Closure)	Reporting Requirement
		(d) ECe ≤4 dS/m (e) Soil pH ≥5 and ≤9 (f) Exchangeable Sodium Percentage (ESP%) ≤6%. 5.5 Ameliorants such as fertiliser, gypsum and/or organic matter applied at rates determined by an AQP. 5.6 The surface and groundwater monitoring network, including, but not limited, to those locations identified in **Table 64** and **Table 65**, is installed and monitoring underway (one year of sampling undertaken). 5.7 At least 200mm of topsoil placed over disturbed areas[8]. **DREA (RA6)** 5.8 Rainfall infiltration ≤5% on top-surface and batters. **Surface Openings** 5.9 Construction of seal from surface into the underground workings complies with regulation 325 of the Queensland Coal Mining Safety and Health Regulations 2020 (CMSHR) and Registered Professional Engineer of Queensland (RPEQ) design. 5.10 Type E seal (ventilation control device capable of withstanding an overpressure of 70 kPa (CMSHR, 2020)) installed. 5.11 AQP has prepared an As-Constructed Report that details the works undertaken, and certified that construction and			AQP has prepared an As-Constructed Report that details the works undertaken, and certified that construction and backfilling of underground openings met the design intent.

[8] Disturbed area is defined as any area where activities authorised under Environmental Authority EPML00586713 has resulted in ground disturbance. Disturbance may include removal of vegetation, groundcover or soil material from an area.

Milestone reference	Rehabilitation milestone	Milestone criteria	Monitoring and Validation Methodology	Frequency (Pre and Post Closure)	Reporting Requirement
		backfilling of underground openings met the design intent. **Subsidence Areas (RA1, RA2, RA3)** 5.12 The cessation of subsidence confirmed by AQP. 5.13 Subsidence cracks do not exceed ≥25 mm in subsided areas. 5.14 Depression/ ponding areas are free draining and require no further drainage works. 5.15 Assessment of permanent ponds is completed by an AQP and identified sediment and water management actions are completed. 5.16 Ponds are safe for native animals and stock access and have vegetated banks. 5.17 Water storages to be assessed and approved as safe and stable by an AQP.			Assessment of permanent ponds is completed by an AQP and identified sediment and water management actions are completed.
RM6	Revegetation - pasture grass	6.1 Nitrogen fixing Legume species included in seed mix. 6.2 Complete seeding of all topsoil surfaces using a rehabilitation seed mix comprising only the species permitted by **Table 45**. 6.3 Native or introduced pasture grass seed species used to control erosion applied at 12 kg/ha.	Vegetation monitoring. Erosion monitoring	Year 1 then 5 yearly Year 1 then 5 yearly	Formal sign off from internal AQP and earthworks supervisor that area has been revegetated (including seed mix, application method, any amelioration undertaken).
RM7	Revegetation - native grasslands	7.1 Nitrogen fixing legume species included in seed mix. **DREA (RA6)** 7.2 Complete seeding of DREA surfaces using a rehabilitation seed mix comprising only the species permitted by **Table 46** (RE 11.9.3).	Vegetation Monitoring. Erosion Monitoring.	Year 1 then 5 yearly Year 1 then 5 yearly	Formal sign off from internal AQP and earthworks supervisor that area has been revegetated (including seed

Milestone reference	Rehabilitation milestone	Milestone criteria	Monitoring and Validation Methodology	Frequency (Pre and Post Closure)	Reporting Requirement
		7.3 Seed with native grassland species applicable to RE 11.9.3 at 12kg/ha. **Subsidence Areas (RA3)** 7.4 Complete seeding of topsoil surfaces for disturbed areas using a seed mix that aligns with the species composition identified in the baseline condition assessment as described by section 3.5.1.5.			mix, application method, any amelioration undertaken).
RM8	Achievement of surface requirement	8.1 Vegetative groundcover of 70% for native ecosystem PMLU. 8.2 Groundcover 60% perennial pasture biomass for grazing PMLU. 8.3 Less than 5% of declared weeds (as defined in the *Biosecurity Act 2014*). 8.4 Weed presence is a maximum of 10% of total vegetative groundcover confirmed by an AQP in annual monitoring. 8.5 No evidence of erosion classified as 'moderate' or 'severe' as defined by **Table 67**. 8.6 Areas free of hazardous materials or are rendered safe. 8.7 Surface water runoff is non-polluting to receiving waters and complies with **Table 62.** 8.8 A third party AQP certifies that any erosion present will not compromise the achievement of a PMLU to a stable condition. 8.9 Growth media to meet the following: (a) ECe ≤4 dS/m (b) Soil pH ≥5 and ≤9 (c) Exchangeable Sodium Percentage (ESP%) ≤6%.	Rehabilitation monitoring	Between Year 50 and Year 65	A third party AQP certifies that any erosion present will not compromise the achievement of a PMLU to a stable condition. A progressive certification report (or final rehabilitation report as part of the requirements of an application to surrender an environmental authority) will be compiled and submitted to DES.

Milestone reference	Rehabilitation milestone	Milestone criteria	Monitoring and Validation Methodology	Frequency (Pre and Post Closure)	Reporting Requirement
		DREA (RA6) 8.10 Native vegetation communities must achieve ≥15/30 from reference benchmark criteria of mapped pre-clear regional ecosystem for RE 11.9.3 as per **Table 53** when measured by an AQP using the BioCondition Assessment Methodology. 8.11 Average soil loss rates of ≤5t/ha/y on outer slope batters, with a maximum erosion rate of 10/t/ha/y. 8.12 No rills or gully erosion present ≥0.3m deep. **Subsidence Areas (RA1, RA2, RA3)** 8.13 No bed and bank erosion within drainage structures or watercourses as a result of subsidence or subsidence management 8.14 No cracking or destabilisation present in beds or bands of drainage structures or watercourses as a result of subsidence or subsidence management. 8.15 Excavated drainage channels do not expose highly erodible material. 8.16 Subsidence areas intersecting flood-prone zones must be designed to withstand flood events without compromising the stability of drainage structures or causing erosion.			
RM9	Achievement of PMLU intermittent cattle watering hole to stable condition	9.1 No evidence of erosion classified as 'moderate' or 'severe' as defined by **Table 67**. 9.2 A third party AQP certifies that any erosion present will not compromise the	Water monitoring Erosion monitoring	Year 1 then 5 yearly Year 1 then 5 yearly	A third party AQP certifies that any erosion present will not compromise the achievement of a

Milestone reference	Rehabilitation milestone	Milestone criteria	Monitoring and Validation Methodology	Frequency (Pre and Post Closure)	Reporting Requirement
		achievement of a PMLU to a stable condition. 9.3 All watering holes to be assessed and approved as safe and stable by an AQP. 9.4 Watering holes contain water of a suitable quality for native wildlife and/or livestock ingestion.			PMLU to a stable condition. All watering holes to be assessed and approved as safe and stable by an AQP. A progressive certification report (or final rehabilitation report as part of the requirements of an application to surrender an environmental authority) will be compiled and submitted to DES.
RM10	Achievement of PMLU grazing to stable condition	10.1 Vegetation ground cover >70%. 10.2 3P (perennial, persistent and palatable) pasture species listed in **Table 45**, including legumes and grasses, remain present and showing evidence of natural recruitment in rehabilitation monitoring data. 10.3 Weed presence is a maximum of 10% of total vegetative groundcover confirmed by an AQP in annual monitoring. Weed management recommendations to be provided in annual reports and completed. 10.4 Less than 5% of total vegetative groundcover is declared weeds (as defined in the *Biosecurity Act 2014*). 10.5 Certification of rehabilitation to Grazing Class 3 by an AQP.	Water monitoring Erosion monitoring	Year 1 then 5 yearly Year 1 then 5 yearly	A third party AQP certifies that any erosion present will not compromise the achievement of a PMLU to a stable condition. A progressive certification report (or final rehabilitation report as part of the requirements of an application to surrender an environmental

Milestone reference	Rehabilitation milestone	Milestone criteria	Monitoring and Validation Methodology	Frequency (Pre and Post Closure)	Reporting Requirement
		10.6 No evidence of erosion classified as 'moderate' or 'severe' as defined by **Table 67**. 10.7 A third party AQP certifies that any erosion present will not compromise the achievement of a PMLU to a stable condition. 10.8 The slope of rehabilitated infrastructure areas is less than 5%. 10.9 Surface water runoff is non-polluting to receiving waters and complies with **Table 62.** 10.10 Surface water quality results monitored within 48 hours of flow, but not limited to, downstream locations specified in **Table 64**, must not exceed the limits in **Table 62**, for a minimum of 5 consecutive years. 10.11 If the surface water quality exceeds criteria above, the applicable upstream site must be compared to the downstream site result. 10.12 For a minimum of five consecutive years groundwater quality must be monitored quarterly at, but not limited to, bores specified in **Table 65**, for all quality characteristics listed in **Table 63**. 10.13 Groundwater quality results must not exceed the limits in **Table 63**, for 3 consecutive results. 10.14 Exploration activities outside approved disturbance area shown in **Figure 25** are rehabilitated in accordance with the latest version of the Eligibility Criteria and Standard Conditions for Exploration and			authority) will be compiled and submitted to DES.

Milestone reference	Rehabilitation milestone	Milestone criteria	Monitoring and Validation Methodology	Frequency (Pre and Post Closure)	Reporting Requirement
		Mineral Development Projects (ESR/2016/1985). 10.15 All remaining infrastructure removed.			
RM11	Achievement of PMLU native ecosystem to stable condition	11.1 Areas achieve ≥50% established and persistent vegetative groundcover. 11.2 Species used in revegetation (listed in **Table 46)** remain present and showing evidence of natural recruitment in rehabilitation monitoring data. 11.3 Weed presence is a maximum of 10% of total vegetative groundcover confirmed by an AQP in annual monitoring. Weed management recommendations to be provided in annual reports. 11.4 Less than 5% of total vegetative groundcover is declared weeds (as defined in the Biosecurity Act 2014). 11.5 No evidence of erosion classified as 'moderate' or 'severe' as defined by **Table 67.** 11.6 A third party AQP certifies that any erosion present will not compromise the achievement of a PMLU to a stable condition. 11.7 Surface water runoff is non-polluting to receiving waters and complies with **Table 62.** 11.8 Surface water quality results monitored within 48 hours of flow at, but not limited to, downstream locations specified in **Table 64**, must not exceed the limits in **Table 62**, for a minimum of 5 consecutive years. 11.9 If the surface water quality exceeds criteria 11.8, the applicable upstream site	Water monitoring Erosion monitoring	Year 1 then 5 yearly Year 1 then 5 yearly	A third party AQP certifies that any erosion present will not compromise the achievement of a PMLU to a stable condition. Weed management recommendations to be provided in annual reports. A progressive certification report (or final rehabilitation report as part of the requirements of an application to surrender an environmental authority) will be compiled and submitted to DES.

Milestone reference	Rehabilitation milestone	Milestone criteria	Monitoring and Validation Methodology	Frequency (Pre and Post Closure)	Reporting Requirement
		must be compared to the downstream site result. 11.10 For a minimum of five consecutive years groundwater quality must be monitored quarterly at, but not limited to, bores specified in **Table 65**, for all quality characteristics listed in **Table 63**. 11.11 Groundwater quality results must not exceed the limits in **Table 63**, for 3 consecutive results. 11.12 Exploration activities outside approved disturbance area show in **Figure 25** are rehabilitated in accordance with the latest version of the Eligibility Criteria and Standard Conditions for Exploration and Mineral Development Projects (ESR/2016/1985). 11.13 All remaining infrastructure removed. **Subsidence Areas (RA1, RA2, RA3)** 11.14 No change to baseline vegetation species composition and structure to the latest baseline condition that has been assessed under condition described in section 3.5.1.5. **DREA (RA6)** 11.15 Native vegetation communities must achieve ≥18/30 of values from reference benchmark criteria of mapped pre-clear regional ecosystem for RE 11.9.3 as per **Table 53**, when measured by an AQP using the BioCondition Assessment Methodology.			

Milestone reference	Rehabilitation milestone	Milestone criteria	Monitoring and Validation Methodology	Frequency (Pre and Post Closure)	Reporting Requirement
		11.16 Updated landform evolution modelling confirms erosional stability of subsided DREA landform has not been compromised relative to original LEM predictions.			

4. APPENDICES AND ATTACHMENTS

Appendix A. Environmental Authority EPML00586713

Permit

Environmental Protection Act 1994
Environmental authority EPML00586713

This environmental authority is issued by the administering authority under Chapter 5 of the Environmental Protection Act 1994.

Environmental authority number: EPML00586713

Environmental authority takes effect on 27 February 2023

Environmental authority holder(s)

Name(s)	Registered address
AQUILA COAL PTY LTD	Level 14 225 St Georges Tce PERTH WA 6000 Australia
SOUTH32 EAGLE DOWNS PTY LTD	108 St Georges Tce PERTH WA 6000 Australia

Environmentally relevant activity and location details

Environmentally relevant activity/activities	Location(s)
Schedule 3 13: Mining black coal	ML70389
Schedule 3 08: A petroleum or GHG storage activity, other than items 1 to 7, that includes an activity from Schedule 2 with an AES	PL485
Ancillary 08 - Chemical Storage 1: Storing a total of 50t or more of chemicals of dangerous goods class 1 or class 2, division 2.3 under subsection (1)(a)	ML70389, PL485
Ancillary 14 - Electricity Generation 1: Generating electricity by using gas at a rated capacity of 10MW electrical or more	ML70389, PL485
Ancillary 15 - Fuel burning Using fuel burning equipment that is capable of burning at least 500kg of fuel in an hour	ML70389, PL485

ABN 46 640 294 485

Queensland Government

Environmentally relevant activity/activities	Location(s)
Ancillary 31 - Mineral processing 2: Processing, in a year, the following quantities of mineral products, other than coke (b) more than 100,000t	ML70389, PL485
Ancillary 62 - Resource recovery and transfer facility operation 1: Operating a facility for receiving and sorting, dismantling, baling or temporarily storing- (d) category 1 regulated waste	ML70389, PL485
Ancillary 62 - Resource recovery and transfer facility operation 1: Operating a facility for receiving and sorting, dismantling, baling or temporarily storing- (c) category 2 regulated waste	ML70389, PL485
Ancillary 63 - Sewage Treatment 1: Operating sewage treatment works, other than no-release works, with a total daily peak design capacity of (b-i) more than 100 but not more than 1500EP if treated effluent is discharged from the works to an infiltration trench or through an irrigation scheme	ML70389, PL485
Ancillary 64 - Water treatment 2: Desalinating, in a day, the following quantity of water, allowing the release of waste to waters other than seawater (a) more than 0.5ML but not more than 5ML	ML70389, PL485

Additional information for applicants

Environmentally relevant activities

The description of any environmentally relevant activity (ERA) for which an environmental authority (EA) is issued is a restatement of the ERA as defined by legislation at the time the EA is issued. Where there is any inconsistency between that description of an ERA and the conditions stated by an EA as to the scale, intensity or manner of carrying out an ERA, the conditions prevail to the extent of the inconsistency.

An EA authorises the carrying out of an ERA and does not authorise any environmental harm unless a condition stated by the EA specifically authorises environmental harm.

A person carrying out an ERA must also be a registered suitable operator under the *Environmental Protection Act 1994* (EP Act).

Contaminated land

It is a requirement of the EP Act that an owner or occupier of contaminated land give written notice to the administering authority if they become aware of the following:

- the happening of an event involving a hazardous contaminant on the contaminated land (notice must be given within 24 hours); or
- a change in the condition of the contaminated land (notice must be given within 24 hours); or

- a notifiable activity (as defined in Schedule 3) having been carried out, or is being carried out, on the contaminated land (notice must be given within 20 business days)

that is causing, or is reasonably likely to cause, serious or material environmental harm.

For further information, including the form for giving written notice, refer to the Queensland Government website www.qld.gov.au, using the search term 'duty to notify'.

Take effect

Please note that, in accordance with section 200 of the EP Act, an EA has effect:

a) if the authority is for a prescribed ERA and it states that it takes effect on the day nominated by the holder of the authority in a written notice given to the administering authority – on the nominated day; or

b) if the authority states a day or an event for it to take effect – on the stated day or when the stated event happens; or

c) otherwise – on the day the authority is issued.

However, if the EA is authorising an activity that requires an additional authorisation (a relevant tenure for a resource activity, a development permit under the *Planning Act 2016* or an SDA Approval under the *State Development and Public Works Organisation Act 1971*), this EA will not take effect until the additional authorisation has taken effect.

If this EA takes effect when the additional authorisation takes effect, you must provide the administering authority written notice within 5 business days of receiving notification of the related additional authorisation taking effect.

The anniversary day of this environmental authority is the same day each year as the effective date. The payment of the annual fee will be due each year on this day. An annual return will be due each year on 01 April.

If you have incorrectly claimed that an additional authorisation is not required, carrying out the ERA without the additional authorisation is not legal and could result in your prosecution for providing false or misleading information or operating without a valid environmental authority.

Juliana McCosker
Department of Environment and Science
Delegate of the administering authority
Environmental Protection Act 1994

Enquiries:
Business Centre Coal
Department of Environment and Science
Phone: 07 4987 9320
Email: CRMining@des.qld.gov.au

Date issued: 27 February 2023

Privacy statement

Pursuant to section 540 of the EP Act, the Department is required to maintain a register of certain documents and information authorised under the EP Act. A copy of this document will be kept on the public register. The register is available for inspection by members of the public who are able take extracts, or copies of the documents from the register. Documents that are required to be kept on the register are published in their entirety, unless alteration is required by the EP Act. There is no general discretion allowing the Department to withhold documents or information required to be kept on the public register. For more information on the Department's public register, search 'public register' at www.qld.gov.au. For queries about privacy matters please email privacy@des.qld.gov.au or telephone 13 74 68.

Obligations under the *Environmental Protection Act 1994*

In addition to the requirements found in the conditions of this environmental authority, the holder must also meet their obligations under the EP Act, and the regulations made under the EP Act. For example, the holder must comply with the following provisions of the Act:

- general environmental duty (section 319)
- duty to notify environmental harm (section 320-320G)
- offence of causing serious or material environmental harm (sections 437-439)
- offence of causing environmental nuisance (section 440)
- offence of depositing prescribed water contaminants in waters and related matters (section 440ZG)
- offence to place contaminant where environmental harm or nuisance may be caused (section 443)

Conditions of environmental authority

Agency Interest - General	
Condition number	**Condition**
A1	**Scope of Activity** This environmental authority authorises the mining of up to 11 million tonnes of run of mine (ROM) coal per annum.
A2	Disturbance from mining activities conducted under this environmental authority must not exceed the maximum disturbance areas (ha) of **Table E1 (Final land use and rehabilitation approval schedule)** and must comply with the disturbance areas depicted in **Figure 2 (Maximum disturbance area).**
A3	Notwithstanding condition **H1**, the spatial location of residual ponding is authorised to vary from that depicted in **Figure 2 (Maximum disturbance area)**, within the limit of subsidence. The maximum disturbance area (ha) for Residual Ponding Areas in **Table E1 (Final land use and rehabilitation approval schedule)** must not be exceeded.
A4	**Exploration** Exploration activities outside the approved disturbance area shown in **Figure 2 (Maximum disturbance area)** must be conducted in accordance with the Eligibility Criteria and Standard Conditions for Exploration and Mineral Development Projects.
A5	**Maintenance of measures, plant and equipment** The environmental authority holder must ensure: a) that all measures, plant and equipment necessary to ensure compliance with the conditions of this environmental authority are installed; b) that such measures, plant and equipment are maintained in a proper condition; and c) that such measures, plant and equipment are operated in a proper manner.
A6	**Monitoring and records** Record, compile and keep for a minimum of five years all monitoring results required by this environmental authority and make available for inspection all or any of these records upon request by the administering authority.
A7	Where monitoring is a requirement of this environmental authority, ensure that a competent person(s) conducts all monitoring.
A8	**Notification of emergencies, incidents and exceptions** The holder of this environmental authority must notify the administering authority by written notification within **Twenty-four (24) hours**, after becoming aware of any emergency or incident which results in the release of contaminants not in accordance, or reasonably expected to be not in accordance with the conditions of this environmental authority.

A9	Within **ten (10) business days** following the initial notification of an emergency or incident, or receipt of monitoring results, whichever is the latter, further written advice must be provided to the administering authority, including the following: a) Results and interpretation of any samples taken and analysed; b) Outcomes of actions taken at the time to prevent or minimise unlawful environmental harm; c) Proposed actions to prevent a recurrent of the emergency or incident.
A10	**Complaints** The environmental authority holder must record all environmental complaints received about the mining activities including: a) Name, address and contact number of the complainant; b) Time and date of complaint; c) Reasons for the complaint; d) Investigations undertaken; e) Conclusions formed; f) Actions taken to resolve the complaint; g) Any abatement measures implemented; and h) Person responsible for resolving the complaint.
A11	The environmental authority holder must, when requested by the administering authority, undertake relevant specified monitoring within a reasonable timeframe nominated or agreed to by the administering authority to investigate any complaint of environmental harm. The results of the investigation (including an analysis and interpretation of the monitoring results) and abatement measures, where implemented, must be provided to the administering authority within **ten (10) business days** of completion of the investigation, or no later than **ten (10) business days** after the end of the timeframe nominated by the administering authority to undertake the investigation.
A12	**Recommencement of production activities** Prior to the recommencement of production activities, the environmental authority holder must provide the administering authority with written notice of its intention to recommence production activities under this environmental authority.

Agency Interest – Air	
Condition number	**Condition**
B1	**Dust nuisance** Subject to conditions **B2** and **B3** the release of dust or particulate matter or both resulting from the mining activity must not cause an environmental nuisance, at any sensitive or commercial place.
B2	When requested by the administering authority, dust and particulate monitoring must be undertaken within a reasonable and practicable timeframe nominated by the administering authority to investigate any complaint (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the authorised officer) of environmental nuisance at any sensitive or commercial place, and the results must be notified within **fourteen (14) days** to the administering authority following completion of monitoring.
B3	If the environmental authority holder can provide evidence through monitoring that the following limits are not being exceeded then the holder is not in breach of condition **B1**: a) dust deposition of 120 milligrams per square metre per day, averaged over one month, when monitored in accordance with AS 3580.10.1 *Methods for sampling and analysis of ambient air – Determination of particulates – Deposited matter – Gravimetric method* of 2003 (or more recent editions); or b) a concentration of particulate matter with an aerodynamic diameter of less than ten (10) micrometre (µm) (PM10) suspended in the atmosphere of 50 micrograms per cubic metre over a twenty-four (24) hour averaging time, (can be exceeded no more than five (5) times per year) at a sensitive or commercial place downwind of the operational land, when monitored in accordance with: i) particulate matter – Determination of suspended particulate PM_{10} high-volume sampler with size-selective inlet – Gravimetric method, when monitored in accordance with AS 3580.9.6 of 2003 (or more recent editions) *Ambient air – particulate matter – Determination of suspended particulate PM_{10} high volume sampler with size-selective inlet – Gravimetric method*; and ii) any alternative method of sampling PM_{10}, which may be permitted by the *Air Quality Sampling Manual* as published from time to time by the administering authority.
B4	If monitoring indicates exceedance of the relevant limits in condition **B3**, then the environmental authority holder must: a) address the complaint including the use of appropriate dispute resolution if required; and b) immediately implement dust abatement measures so that emissions of dust from the activity do not result in further environmental nuisance.
B5	**Odour nuisance** The release of noxious or offensive odour(s) or any other noxious or offensive airborne contaminant(s) resulting from the mining activity must not cause an environmental nuisance at any nuisance sensitive or commercial place.

B6	When requested by the administering authority, odour monitoring must be undertaken within a reasonable and practicable timeframe nominated by the administering authority to investigate any complaint (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the authorised officer) of environmental nuisance at any sensitive or commercial place, and the results must be notified within **fourteen (14) days** to the administering authority following completion of monitoring.
B7	If the administering authority determines the odour released to constitute an environmental nuisance, in accordance with the latest version of the administering authority's guideline *Odour Impact Assessment from Developments* (2004), then the environmental authority holder must: a) address the complaint including the use of appropriate dispute resolution if required; and b) immediately implement odour abatement measures so that emissions of odour from the activity does not result in further environmental nuisance.

Agency Interest – Water	
Condition number	**Condition**
C1	**Contaminant release** Contaminants must not be released to the environment except as permitted under the conditions of this environmental authority.
C2	The environmental authority holder must provide written confirmation of, and with reasonable information to support the TBCs listed in the following tables to the administering authority at least **three (3) months** prior to the recommencement of production activities: a) Table C2 (Mine affected water release limits); b) Table C4 (Mine affected water release during flow events); and c) Table C9 (Receiving waters contaminant trigger levels).
C3	The release of mine affected water to waters must only occur from the release points specified in **Table C1 (Mine affected water release points, sources and receiving waters)** and depicted in **Figure 1 (Surface Water Release Points and Groundwater Monitoring Locations)** attached to this environmental authority.
C4	The release of mine affected water to internal water management infrastructure installed and operated in accordance with a water management plan that complies with condition **C36** is permitted.
C5	The release of mine affected water to waters in accordance with condition **C3** must not exceed the release limits stated in **Table C2 (Mine affected water release limits)** when measured at the monitoring points specified in **Table C1 (Mine affected water release points, sources and receiving waters)** for each quality characteristic.

Table C1 (Mine affected water release points, sources and receiving waters)

Release point (RP)	Easting (GDA2020)	Northing (GDA2020)	Contaminant source and location	Monitoring point	Receiving waters
RP 1 – DREA Catch Dam	TBC*	TBC*	DREA runoff	Spillway	Ripplestone Creek (Eastern Tributary)
RP 2 – Mine Water Dam	TBC*	TBC*	Dam water	Spillway	Ripplestone Creek (Eastern Tributary)
RP 3 – DM901a Sediment Dam	624704	7545440	DREA runoff	Spillway	Ripplestone Creek (Eastern Tributary)

*Note: *To be updated in accordance with condition C17.*

C6	The release of mine affected water to waters must be monitored at the locations specified in **Table C1 (Mine affected water release points, sources and receiving waters)** for each quality characteristic and at the frequency specified in **Table C2 (Mine affected water release limits)** and **Table C3 (Mine affected water trigger investigation levels)**.

Table C2 (Mine affected water release limits)

Quality characteristic	Release limits	Monitoring frequency
Electrical conductivity (µS/cm)	Release limits specified in **Table C4** for variable flow criteria	Daily during release
pH (pH Unit)	6.5 (minimum) 9.0 (maximum)	Daily during release
Turbidity (NTU)	TBC*	Daily during release
Suspended solids (mg/L)	TBC*	Daily during release
Sulphate (SO_4^{2-}) (mg/L)	1000	Daily during release
Calcium** (Ca) (mg/L)	5 (minimum)	Daily during release

*Note: *To be updated in accordance with condition C2.*

*Note: ** Only applicable when releasing any RO product water*

Table C3 (Mine affected water trigger investigation levels)

Quality characteristic	Trigger levels (µg/L)	Comment on trigger level	Monitoring frequency
Aluminium	55	*For aquatic ecosystem protection, based on SMD guideline*	Commencement of release and thereafter weekly during release
Arsenic	13	*For aquatic ecosystem protection, based on SMD guideline*	
Cadmium	0.2	*For aquatic ecosystem protection, based on SMD guideline*	
Chromium	1.0	*For aquatic ecosystem protection, based on SMD guideline*	
Copper	2.0	*For aquatic ecosystem protection, based on LOR for ICPMS*	
Iron	300	*For aquatic ecosystem protection, based on low reliability guideline*	
Lead	10	*For aquatic ecosystem protection, based on SMD guideline*	
Mercury	0.2	*For aquatic ecosystem protection, based on LOR for CV FIMS*	
Nickel	11	*For aquatic ecosystem protection, based on SMD guideline*	
Zinc	8.0	*For aquatic ecosystem protection, based on SMD guideline*	
Boron	370	*For aquatic ecosystem protection, based on SMD guideline*	
Cobalt	90	*For aquatic ecosystem protection, based on low reliability guideline*	
Manganese	1900	*For aquatic ecosystem protection, based on SMD guideline*	
Molybdenum	34	*For aquatic ecosystem protection, based on low reliability guideline*	
Selenium	10	*For aquatic ecosystem protection, based on LOR for ICPMS*	
Silver	1.0	*For aquatic ecosystem protection, based on LOR for ICPMS*	
Uranium	1.0	*For aquatic ecosystem protection, based on LOR for ICPMS*	
Vanadium	10	*For aquatic ecosystem protection, based on LOR for ICPMS*	
Ammonia	900	*For aquatic ecosystem protection, based on SMD guideline*	
Nitrate	1100	*For aquatic ecosystem protection, based on ambient Qld WQ Guidelines (2006) for TN*	
Petroleum hydrocarbons (C6-C9)	20		
Petroleum hydrocarbons (C10-C36)	100		
Fluoride (total)	2000	*Protection of livestock and short term irrigation guideline*	

Note: *All metals and metalloids must be measured as total (unfiltered) and dissolved (filtered). Trigger levels for metal/metalloids apply if dissolved results exceed trigger.*

C7	If quality characteristics of the release exceed any of the trigger levels specified in **Table C3 (Mine affected water trigger investigation levels)** during a release event, the environmental authority holder must compare the downstream results in the receiving waters to the trigger values specified in **Table C3 (Mine affected water trigger investigation levels)** and: a) where the trigger values are not exceeded then no action is to be taken; b) where the downstream results exceed the trigger values specified in **Table C3 (Mine affected water trigger investigation levels)** for any quality characteristic, compare the results of the downstream site to the data from background monitoring sites; and i) if the result is less than the background monitoring site data, then no action is to be taken; or ii) if the result is greater than the background monitoring site data, complete an investigation into the potential for environmental harm and provide a written report to the administering authority via WaTERS within 90 days of receiving the result, outlining: 1) details of the investigations carried out; and 2) actions taken to prevent environmental harm.
C8	If an exceedance in accordance with condition **C6 b) ii)** is identified, the holder of the authority must notify the administering authority in writing via WaTERS within **24 hours** of receiving the result.
C9	**Contaminant release events** The holder must install, operate and maintain a stream flow gauging station to determine and record stream flows downstream of the release point locations as specified in **Table C4 (Mine affected water release during flow events)**.

Table C4 (Mine affected water release during flow events)

Receiving waters/ streams	Release point (RP)	Gauging station	Gauging station Easting (GDA2020)	Gauging station Northing (GDA2020)	Receiving water flow recording frequency	Receiving water flow criteria for discharge (m^3/s)	Maximum release rate (for all combined RP flows)	Electrical conductivity release limits
Ripplestone Creek (Eastern Tributary)	RP1 RP2 RP3	Gauging Station 1	TBC*	TBC*	Continuous (minimum daily)	TBC*	TBC*	TBC*

*Note: *To be updated in accordance with condition C2.*

C10	The release of mine affected water to waters in accordance with condition **C3** must only take place during periods of natural flow in accordance with the receiving water flow criteria for discharge specified in **Table C4 (Mine affected water release during flow events)** for the release point(s) specified in **Table C1 (Mine affected water release points, sources and receiving waters)**.
C11	The flow rate for the release of mine affected water to receiving waters in accordance with condition **C3** must not exceed 20% of the receiving water flow rate.
C12	During a release event, the daily quantity of mine affected water released from each release point must be measured and recorded at the monitoring points in **Table C1 (Mine affected water release points, sources and receiving waters)** and provided to the administering authority on request.
C13	Releases to waters must be undertaken so as not to: a) cause erosion of the bed and banks of the receiving waters; b) cause a material build-up of sediment in the receiving waters; and c) occur during no flow conditions.
C14	Brine produced by the ROWTP must: a) be stored within the Brine Dam specified in **Table C5 (Reverse osmosis brine waste product storage)**; and b) not be released to land or waters.
C15	Brine produced by the ROWTP must be removed and transported from the licensed place: a) by a person who holds a current authority to transport such wastes; and b) to a facility that is lawfully able to accept the waste.
C16	The Brine Dam must: a) be fully lined with a polyethylene liner; and b) maintain and operate a freeboard of at least one (1) metre below the spillway level.
C17	The environmental authority holder must provide written confirmation of the TBCs listed in the following tables with supporting information to the administering authority within two (2) months following the completion of design reports for the relevant structures: a) **Table C1 (Mine affected water release points, sources and receiving waters**); b) **Table C5 (Reverse osmosis brine waste product storage);** and c) **Table C6 (Water storage monitoring).**

Table C5 (Reverse osmosis brine waste product storage)

Water storage description	Easting (GDA2020)	Northing (GDA2020)
Brine Dam	TBC*	TBC*

*Note: *To be updated in accordance with condition C17.*

C18	**Notification of release event** The environmental authority holder must notify the administering authority via WaTERS within **twenty-four (24) hours** after commencing to release mine affected water to the receiving environment. Notification must include the submission of written advice to the administering authority of the following information: a) release commencement date/time; b) details regarding the compliance of the release with the conditions of Agency Interest: Water of this environmental authority (that is, contaminant limits, natural flow, discharge volume); c) expected release cessation date and time; d) release point/s; e) release rate; f) release volume (estimate); g) available release water quality results for monitoring conducted under condition **C6**; h) release salinity; and i) receiving water/s including the natural flow rate. *Note: Successive or intermittent releases occurring within **24 hours** of the cessation of any individual release can be considered part of a single release event and do not require individual notification for the purpose of compliance with this condition provided the relevant details of the release are included within the notification provided.*
C19	The environmental authority holder must notify the administering authority, via WaTERS, as soon as practicable and within **twenty-four (24) hours** after cessation of a release notified under **Condition C18**. Note: Successive or intermittent releases occurring within **twenty-four (24) hours** of the cessation of any individual release can be considered part of a single release event and do not require individual notification for the purpose of compliance with **Conditions C18**, **C19** and **C20**, provided the relevant details of the release are included within the notification provided in accordance with **Conditions C18, C19 and C20**.
C20	The holder of this environmental authority must within **twenty-eight (28) days** after cessation of a release event notified under **Condition C18** provide a report to the administering authority via WaTERS, which must include the following information: a) release cessation date/time; b) release points; c) release rates; d) available release water quality results for monitoring conducted under condition **C6**; e) total volume of water released; f) natural flow rate in the receiving water; and g) details regarding the compliance of the release with the conditions of Agency Interest – Water of this environmental authority. h) all continuous and in-situ water quality monitoring results (including laboratory analyses); and i) any further matters pertinent to the water release event.

C21	**Notification of release event exceedance** If the release limits defined in **Table C2 (Mine affected water release limits)** are exceeded, the environmental authority holder must notify the administering authority via WaTERS within **twenty-four (24) hours** of receiving the results.
C22	The environmental authority holder must, within **twenty-eight (28) days** of a release that is not compliant with the conditions of this authority, provide a report to the administering authority via WaTERS detailing: a) the reason for the release; b) the location of the release; c) the volume of the water released and which (if any) part of this volume was non-compliant; d) the total duration of the release and which (if any) part of this period was non-compliant; e) the quality of the water released for all parameters monitored in accordance with this environmental authority; f) the quality of water in the receiving environment for any parameters recorded during the release; g) the cause of the exceedance; and h) any other matters pertinent to the water release event.
C23	**Monitoring of water storage quality** Water storages stated in **Table C6 (Water storage monitoring)** which are associated with the release points must be monitored for the water quality characteristics specified in **Table C7 (Onsite water storage contaminant limits)** at the monitoring locations and at the monitoring frequency specified in **Table C6 (Water storage monitoring)**.

Table C6 (Water storage monitoring)

Water storage description	Easting (GDA2020)	Northing (GDA2020)	Monitoring location	Monitoring frequency
Catch Dam	TBC*	TBC*	TBC*	Quarterly
Mine Water Dam	TBC*	TBC*	TBC*	Quarterly
DM901a Sediment Dam	624,704	7,545,440	Spillway	Quarterly

**To be updated in accordance with condition C17.*

Table C7 (Onsite water storage contaminant limits)

Quality characteristic	Test value	Contaminant limit
pH (pH unit)	Range	Greater than 4, less than 9
EC (µS/cm)	Maximum	5970
Sulphate (mg/L)	Maximum	1000
Fluoride (mg/L)	Maximum	2.0
Aluminium (mg/L)	Maximum	5.0
Arsenic (mg/L)	Maximum	0.5
Cadmium (mg/L)	Maximum	0.01
Cobalt (mg/L)	Maximum	1.0
Copper (mg/L)	Maximum	1.0
Lead (mg/L)	Maximum	0.1
Nickel (mg/L)	Maximum	1.0
Zinc (mg/L)	Maximum	20

Note: Total measurements (unfiltered) must be sampled and analysed.

C24	In the event that water storages defined in **Table C6 (Water storage monitoring)** exceed the contaminant limits defined in **Table C7 (Onsite water storage contaminant limits)**, the environmental authority holder must implement measures, where practicable, to prevent access to waters by all livestock.
C25	**Receiving environment monitoring and contaminant trigger levels** The quality of the receiving waters must be monitored at the locations specified in **Table C8 (Receiving water upstream background sites and downstream monitoring points)** for each quality characteristic and at the monitoring frequency stated in **Table C9 (Receiving waters contaminant trigger levels)**.

Table C8 (Receiving water upstream background sites and downstream monitoring points)

Monitoring points	Receiving waters location description	Easting (GDA2020)	Northing (GDA2020)
Upstream background monitoring points			
Monitoring point 3	The most downstream Ripstone Creek location (MP3), where the upper Ripstone Creek tributary flows from Peak Downs Mine.	627,993	7,539,522
Monitoring point 4	Upstream Ripplestone Creek (Western Tributary) MP4 at a pooling area which should be suitable for safe access for water sampling and Macroinvertebrate sampling.	625,330	7,542,862
Downstream monitoring points			
Monitoring point 1	Upstream Ripplestone Creek (Western Tributary) MP1, the Eastern Tributary immediately upstream off the Winchester Road.	628,733	7,542,801
Monitoring point 2	Downstream Ripstone Creek	630,017	7,539,576
Monitoring point 7	Downstream Ripstone Creek	631,648	7,539,584

Notes:

a) The upstream monitoring point should be within 5km of the release point.

b) The downstream point should not be greater than 5km from the release point.

c) The data from background monitoring points must not be used where they are affected by releases from other mines.

Table C9 (Receiving waters contaminant trigger levels)

Quality characteristic	Trigger level	Monitoring frequency
pH	6.5 – 8.0	Daily during the release
Electrical conductivity (μS/cm)	1000	
Suspended solids (mg/L)	TBC*	
Sulphate (SO_4^{2-}) (mg/L)	1000	

**To be updated in accordance with condition C2.*

C26	If quality characteristics of the receiving water at the downstream monitoring points exceed any of the trigger levels specified in **Table C9 (Receiving waters contaminant trigger levels)** during a release event the environmental authority holder must compare the downstream results to the upstream results in the receiving waters and: a) where the downstream result is the same or a lower value than the upstream value for the quality characteristic then no action is to be taken; b) where the downstream results exceed the upstream results complete an investigation into the potential for environmental harm and provide a written report to the administering authority via WaTERS within 90 days outlining: i) details of the investigations carried out; and ii) actions taken to prevent environmental harm.
C27	**Receiving environment monitoring program (REMP)** A REMP must be developed and implemented by the environmental authority holder to monitor and record the effects of the release of contaminants on the receiving environment periodically and whilst contaminants are being discharged from the site, with the aims of identifying and describing the extent of any adverse impacts to local environmental values, and monitoring any changes in the receiving water. A copy of the REMP must be provided to the administering authority prior to its implementation and due consideration given to any comments made on the REMP by the administering authority. For the purposes of the REMP, the receiving environment is the waters of Ripplestone Creek (Eastern Tributary) and connected waterways within 20km downstream of the release.

C28	The REMP must address (but not necessarily be limited to) the following: a) must be undertaken in accordance with the Department of Environment and Science *Guideline Receiving environment monitoring program guideline; and* b) description of potentially affected receiving waters including key communities and background water quality characteristics based on accurate and reliable monitoring data that takes into consideration any temporal variation (e.g. seasonality); c) description of applicable environmental values and water quality objectives to be achieved (i.e. as scheduled pursuant to the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019*); d) any relevant reports prepared by other governmental or professional research organisations that relate to the receiving environment within which the REMP is proposed; e) water quality targets within the receiving environment to be achieved, and clarification of contaminant concentrations or levels indicating adverse environmental impacts during the REMP; f) monitoring for any potential adverse environmental impacts caused by the release; g) monitoring of stream flow and hydrology; h) monitoring of toxicants should consider the indicators specified in **Table C3 (Mine affected water trigger investigation levels)** to assess the extent of the compliance of concentrations with water quality objectives and/or the ANZECC & ARMCANZ 2000 guidelines for slightly to moderately disturbed ecosystems; i) monitoring of physical chemical parameters as a minimum those specified in **Table C2 (Mine affected water release limits)** (in addition to dissolved oxygen saturation and temperature); j) monitoring biological indicators (for macro invertebrates in accordance with the AusRivas methodology) and metals/metalloids in sediments (in accordance with ANZECC & ARMCANZ 2000, BATLEY and/or the most recent version of AS5667.*1 Guidance on Sampling of Bottom Sediments*) for permanent, semi-permanent water holes and water storages; k) the locations of monitoring points (including the locations specified in **Table C8 (Receiving water upstream background sites and downstream monitoring points)** which are background and downstream impacted sites for each release point); l) the frequency or scheduling of sampling and analysis sufficient to determine water quality objectives and to derive site specific reference values within two years (depending on wet season flows) in accordance with the *Queensland Water Quality Guidelines 2009*. For ephemeral streams, this should include periods of flow irrespective of mine or other discharges; m) specify sampling and analysis methods and quality assurance and control; n) any historical datasets to be relied upon; o) description of the statistical basis on which conclusions are drawn; and p) any spatial and temporal controls to exclude potential confounding factors.

C29	A report outlining the findings of the REMP, including all monitoring results and interpretations must be prepared annually and made available on request to the administrating authority. This report must include: a) an assessment of background reference water quality; b) the condition of downstream water quality compared against water quality objectives; and c) the suitability of current discharge limits to protect downstream environmental values.
C30	**Water reuse** Mine affected water may be piped or trucked or transferred by some other means that does not contravene the conditions of this environmental authority and deposited into artificial water storage structures, such as farm dams or tanks, or used directly at properties owned by the environmental authority holder or a third party (with the consent of the third party).
C31	**Water general** All determinations of water quality must be: a) performed by a person or body possessing appropriate experience and qualifications to perform the required measurements; b) made in accordance with methods prescribed in the latest edition of the administering authority's *Monitoring and Sampling Manual;* c) collected from the monitoring locations identified within this environmental authority, within **ten (10) hours** of each other where possible; d) carried out on representative samples; and e) laboratory testing must be undertaken using a laboratory accredited (e.g. NATA) for the method of analysis being used. Note: *Condition **C31** requires the Monitoring and Sampling Manual to be followed and where it is not followed because of exceptional circumstances this should be explained and reported with the results.*
C32	The release of contaminants directly or indirectly to waters: a) must not produce any visible discolouration of receiving waters, and b) must not produce any slick or other visible or odorous evidence of oil, grease or petrochemicals nor contain visible floating oil, grease, scum, litter or other objectionable matter.

C33	**Annual water monitoring reporting** The following information must be recorded in relation to all water monitoring required under the conditions of this environmental authority and submitted to the administering authority in the specified format with each annual return: a) the date on which the sample was taken; b) the time at which the sample was taken; c) the monitoring point at which the sample was taken; d) the measured or estimated daily quantity of the contaminants released from all release points; e) the release flow rate at the time of sampling for each release point; f) the results of all monitoring and details of any exceedance with the conditions of this environmental authority; g) and water quality monitoring data must be provided to the administering authority in the specified electronic format upon request.
C34	**Temporary interference with waterways** Temporarily destroying native vegetation, excavating, or placing fill in a watercourse, lake or spring necessary for and associated with mining operations must be undertaken in accordance with Department of Natural Resources and Mines (or its successor) *Guideline – Activities in a Watercourse, Lake or Spring associated with Mining Activities.*
C35	**Water Management Plan** A Water Management Plan must be developed by an appropriately qualified person and implemented.
C36	The Water Management Plan must provide for effective management of actual and potential environmental impacts resulting from water management associated with the mining activity carried out under this environmental authority, and must include: a) a study of the source of contaminants; b) a water balance model for the site; c) a water management system for the site; d) measures to manage and prevent saline drainage; e) details of the management methodology for brine produced by the ROWTP once constructed; f) measures to manage and prevent acid rock drainage; g) contingency procedures for emergencies; and h) a program for monitoring and reviewing the effectiveness of the Water Management Plan.
C37	Each year the environmental authority holder must undertake a review of the water management plan prior to the wet season (i.e. by **1 November**) and a further review following the wet season (i.e. by **1 May** the following year) to ensure that proper and effective measures, practices or procedures are in place so that the mine is operated in accordance with the conditions of this environmental authority and that environmental harm is prevented or minimised.

C38	A copy of the water management plan and/or a review of the water management plan must be provided to the administering authority on request.
C39	**Saline drainage** The environmental authority holder must ensure proper and effective measures are taken to avoid or otherwise minimise the generation and/or release of saline drainage.
C40	**Acid rock drainage** The environmental authority holder must ensure proper and effective measures are taken to avoid or otherwise minimise the generation and/or release of acid rock drainage.
C41	**Stormwater and water sediment controls** An Erosion and Sediment Control Plan must be developed by an appropriately qualified person and implemented for all stages of the mining activities on the site to minimise erosion and the release of sediment to receiving waters and contamination of stormwater.
C42	The Erosion and Sediment Control Plan must include: a) all clean waters, from undisturbed areas, are kept separate from mine affected waters from disturbed areas; b) water from disturbed catchments are diverted into the mine water management system or sedimentation dams; c) new sedimentation dams are designed to capture the sediment volume calculated for the catchment area for an appropriate design storm event; and d) sediment shall be excavated from sediment dams as required to maintain design capacity.
C43	The maintenance and cleaning of any vehicles, plant or equipment must not be carried out in areas from which contaminants can be released into any receiving waters.
C44	Any spillage of wastes, contaminants or other materials must be cleaned up as quickly as practicable to minimise the release of wastes, contaminants or materials to any stormwater drainage system or receiving waters.
C45	**Groundwater** Groundwater affected by the mining activities must be monitored at the locations shown in **Figure 1 (Surface Water Release Points and Groundwater Monitoring Locations)** and at the locations and frequencies specified in **Table C10 (Groundwater monitoring locations and frequency)** and condition **C46** and be carried out in accordance with the latest edition of the administering authority's *Monitoring and Sampling Manual*.

Table C10 (Groundwater monitoring locations and frequency)

Monitoring point	Easting (GDA2020)	Northing (GDA2020)	Monitoring frequency
MB1	623,254	7,551,541	Annually, until longwall mining commences, where monitoring must then be conducted quarterly
MB2	623,684	7,549,392	
MB3	627,241	7,549,947	
MB4	626,508	7,544,153	
MB5	628,491	7,542,694	
MB6	To be installed 12 months prior to the commencement of longwall mining.	To be installed 12 months prior to the commencement of longwall mining.	
MB7	To be installed 12 months prior to the commencement of longwall mining.	To be installed 12 months prior to the commencement of longwall mining.	
Landholder Bore 8 (LHB8)	623,798	7,552,174	
Landholder Bore 11 (LHB11)	627,206	7,546,950	
Landholder Bore 13 (LHB13)	627,201	7,546,953	

C46	The environmental authority holder is permitted to monitor groundwater annually until commencement of longwall mining activities begins. Once longwall mining commences, groundwater monitoring must be conducted quarterly.
C47	The environmental authority holder must develop and implement a groundwater monitoring program.
C48	The program must be able to detect a significant change to ground water quality values (consistent with the current suitability of the groundwater for beneficial uses) due to activities that are part of this mining project.
C49	The program must effectively monitor the water pressure across the base of the Dry Rejects Emplacement Area (DREA) at the interface with the natural surface and provide the means to reduce the phreatic surface within the DREA, where monitoring indicates this is necessary.
C50	The environmental authority holder must report the results and analysis of groundwater monitoring to the administering authority on request.
C51	Subject to condition **C52** groundwater levels must be monitored and groundwater draw down fluctuations in landowner bores in excess of two metres per year, not resulting from the pumping of licensed bores, must be notified as per conditions **A10 to A11**.
C52	Groundwater affected by the mining activities must be monitored at the locations and frequencies defined in **Table C10 (Groundwater monitoring locations and frequency)** and as shown in **Figure 1(Surface Water Release Points and Groundwater Monitoring Locations)** attached to this environmental authority.

C53	If the groundwater contaminant trigger values defined in **Table C11 (Groundwater contaminant trigger values)** are exceeded then the environmental authority holder must complete an investigation into the potential for environmental harm and notify the administering authority within **twenty-eight (28) days** of receiving the analysis results.

Table C11 (Groundwater contaminant trigger values)

Water Quality Indicator	Unit	Monitoring Bore Trigger Levels									
		MB1	MB2	MB3	MB4	MB5	MB6	MB7	LHB08	LHB11	LHB13
Aluminium	µg/L	5,000					5,000	5,000	5,000	5,000	5,000
Antimony	µg/L	2	1	4	2	1	4.8	4.8	4.8	4.8	4.8
Arsenic	µg/L	500					500	500	500	500	500
Calcium	mg/L	77	42	694	82	69	1,000	1,000	1,000	1,000	1,000
Chloride, Cl	mg/L	389	1,300	6,980	1,900	1,500	9,050	9,050	9,050	9,050	9,050
CO_3	mg/L	3					800	800	800	800	800
Dissolved Solids (Total)	mg/L	1,200	2,310	16,000	3,490	2,700	TBA	TBA	4,420	4,420	1,200
Electrical Conductivity	µS/cm	2,100	4,200	18,000	6,200	4,800	TBA	TBA	6320	6320	2018
HCO_3	mg/L	780	780	780	780	780	780	780	780	780	780
Iron	µg/L	4,600	747	5,590	7,050	2,350	9,985	9,985	9,985	9,985	9,985
Magnesium – Dissolved	mg/L	500					500	500	500	500	500
Mercury	µg/L	2					5.66	5.66	5.66	5.66	5.66
Molybdenum	µg/L	150					150	150	150	150	150
Petroleum Hydrocarbons (Total)	µg/L	450					450	450	450	450	450
pH	pH Units	5.0 – 8.5					5.0 – 8.5	5.0 – 8.5	5.0 – 8.5	5.0 – 8.5	5.0 – 8.5
Selenium	µg/L	20					20	20	20	20	20
Silver	µg/L	2					11	11	11	11	11
SO_4	mg/L	1,000					1,000	1,000	1,000	1,000	1,000
Sodium	mg/L	320	1,000	3,800	1,400	1,000	9,050	9,050	9,050	9,050	9,050
TPH (as total)	µg/L	264	263	459	260	260	450	450	450	450	450

C54	**Background groundwater monitoring program** A background groundwater monitoring program must be kept up to date with new reference boreholes as construction of the mine begins. These include reference bore(s) that are located an appropriate distance from potential sources of impact from mining activities to provide the following: a) representative groundwater samples from the aquifers potentially affected by mining activities; b) at least twelve sampling events (monthly sampling) to determine background groundwater quality as far as practicable; c) background groundwater quality in hydraulically isolated background bore(s) that have not been affected by any mining activities; and d) final groundwater contaminant trigger levels and limits required in condition **C56**.
C55	The groundwater monitoring data must be reviewed on an annual basis. The review must include the assessment of groundwater levels and water quality data, and the suitability of the monitoring network. The assessment must be submitted to the administering authority within **twenty-eight (28) days** of receiving the report.
C56	Groundwater contaminant trigger levels as per **Table C11 (Groundwater contaminant trigger values)** must be finalised based on a background groundwater monitoring program defined in condition **C54** and submitted to the administering authority prior to commencement of longwall mining.
C57	The following information must be recorded in relation to all groundwater water sampling: a) the date on which the sample was taken; b) the time at which the sample was taken; c) the monitoring point at which the sample was taken; and d) the results of all monitoring.
C58	**Acid rock drainage and leachate management** Subject to the release limits defined in Agency Interest: Water, all reasonable and practicable measures must be implemented to prevent hazardous leachate being directly or indirectly released or likely to be released as a result of the activity to any groundwater.
C59	**Sewage effluent** All effluent released from the treatment plant must be monitored at the frequency and for the parameters specified in **Table C12 (Sewage treatment effluent quality targets for dust suppression and irrigation)**.

Table C12 (Sewage treatment effluent quality targets for dust suppression and irrigation)

Monitoring point (MP)	Quality characteristics	Release limits (Maximum)	Frequency
MP5 Treated effluent storage pond	5 day Biological oxygen demand (mg/L)	20	Monthly
	Suspended solids (mg/L)	30	
	Thermotolerant coliforms (cfu/100mL)	1000	
	Total phosphorous (mg/L)	15	
	Total nitrogen (mg/L)	30	
	pH	6.5 to 8.5	

C60	Sewage effluent used for dust suppression or irrigation must not exceed sewage effluent release limits defined in **Table C12 (Sewage treatment effluent quality targets for dust suppression and irrigation)**.
C61	Sewage effluent used for dust suppression or irrigation must not cause spray drift or over spray to any sensitive or commercial place.
C62	Subject to conditions **C59 to C61** inclusive, sewage effluent from sewage treatment facilities must be reused or evaporated and must not be directly released from the sewage treatment plant to any waters or the bed and banks of any waters.
C63	The effluent irrigation areas must have a separation distance of at least thirty (30) metres from any groundwater bores and surface waters.
C64	The irrigation of treated effluent must be carried out in a manner such that: a) vegetation is not damaged; b) soil erosion and soil structure damage is avoided; c) there is no surface ponding of treated effluent; d) percolation of treated effluent beyond the plant root zone is minimized; e) the capacity of the land to assimilate nitrogen, phosphorus, salts, water and organic matter (as measured by oxygen demand) is not exceeded; and f) the quality of groundwater is not adversely affected.
C65	Notices must be prominently displayed on any treated effluent irrigation area warning staff and the public that the area is irrigated with treated effluent and not to use or drink the treated effluent. These notices must be maintained in a visible and legible condition.
C66	The daily volume of contaminants released to land must be determined by an appropriate method, for example a flow meter and records kept of such determinations.

Agency Interest – Noise and Vibration	
Condition number	**Condition**
D1	**Noise nuisance** Noise from the mining activity must not cause an environmental nuisance, at any sensitive or commercial place.
D2	**Noise monitoring and air blast overpressure** When requested by the administering authority, noise monitoring and air blast overpressure must be undertaken within a reasonable and practicable timeframe nominated by the administering authority to investigate any complaint (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the authorised officer) of environmental nuisance at any sensitive or commercial place, and the results must be notified within **fourteen (14) days** to the administering authority following completion of monitoring.
D3	If the environmental authority holder can provide evidence through monitoring that the limits defined in **Table D1 (Noise limits)** and **Table D2** (**Airblast overpressure level)**, are not being exceeded then the holder is not in breach of condition **D1**. Monitoring must include: a) $L_{A,}$ 10, adj, 10 mins; b) $L_{A,}$ 1, adj, 10 mins; c) relevant background sound level; d) the level and frequency of occurrence of impulsive or tonal noise; e) atmospheric conditions including wind speed, direction and temperature; f) location of blasts (as appropriate); and g) location, date and time of recording.

Table D1 (Noise limits)

Noise level dB(A)	**Monday to Sunday (including public holidays)**		
	7am – 6pm	**6pm – 10pm**	**10pm – 7am**
	Noise measured at a 'sensitive receptor'		
$L_{A10, adj, 10 mins}$	B/g + 5	B/g + 5	B/g + 3
$L_{A1, adj, 10 mins}$	B/g + 10	B/g + 10	42
Noise measured at a 'Commercial place'			
$L_{A10, adj, 10 mins}$	B/g + 10	B/g + 10	B/g + 5

Note: Where "Background" means background sound pressure level measured in accordance with the latest edition of the administering authority's Noise Measurement Manual. Table D1 (Noise limits does) not purport to set operating hours for the mining activities.

Table D2 (Airblast overpressure level)

Parameter	Airblast overpressure measured at a sensitive or commercial place	
	Monday to Sunday 9am – 7pm	**Other times and public holidays***
Air blast overpressure level (dB [Lin] Peak)	Maximum 115 dB for 4 out of 5 consecutive blasts	No blasting to occur
Air blast overpressure level (dB [Lin] Peak)	120 dB maximum	No blasting to occur

*Note: Table D2 (Airblast overpressure level) does not purport to set limits applicable to any particular explosive blast, rather sets design criteria for every explosive blast. *This restriction regarding blasting times and days are only applicable to near surface blasting and do not apply to blasting undertaken as part of underground mining or development works.*

D4	If monitoring indicates exceedance of the limits in **Table D1 (Noise limits)** and **Table D2 (Airblast overpressure level)**, then the environmental authority holder must: a) address the complaint including the use of appropriate dispute resolution if required; and b) immediately implement noise abatement measures so that emissions of noise from the activity do not result in further environmental nuisance.
D5	The method of measurement and reporting of noise levels must comply with the latest edition of the administering authority's *Noise Measurement Manual*.
D6	**Vibration nuisance** Vibration from the mining activity must not cause an environmental nuisance, at any sensitive place.
D7	When requested by the administering authority, vibration monitoring must be undertaken within a reasonable and practicable timeframe nominated by the administering authority to investigate any complaint (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the authorised officer) of environmental nuisance at any sensitive or commercial place, and the results must be notified within **fourteen (14) days** to the administering authority following completion of monitoring.
D8	If the environmental authority holder can provide evidence through monitoring that the limits defined in **Table D3 (Vibration limits)**, are not being exceeded then the holder is not in breach of condition **D6**. Monitoring must include: a) peak particle velocity (mm/s); b) air blast overpressure level (dB linear peak); c) location of the blast/s within the mining area (including which bench level); d) atmospheric conditions including temperature, relative humidity and wind speed and direction; and e) location, date and time of recording.

Table D3 (Vibration limits)

Vibration parameter	Vibration measured at a sensitive place	
	Monday to Sunday 9am – 7pm	**Other times and public holidays***
Peak particle velocity (mm/s)	Maximum 5 mm/s for 4 out of 5 consecutive blasts	No blasting to occur
Peak particle velocity (mm/s)	10 mm/s maximum	No blasting to occur

Note: The method of measurement and reporting of vibration levels must comply with the latest edition of the administering authority's vibration and air blast overpressure monitoring guideline.

** This restriction regarding blasting times and days are only applicable to near surface blasting and do not apply to blasting undertaken as part of underground mining or development works.*

D9	For the purposes of condition **D6** the mining activities will not cause environmental nuisance where vibration from the mining activities does not exceed the criteria specified in **Table D3 (Vibration limits)**.
D10	If monitoring indicates exceedance of the limits in **Table D3 (Vibration limits)**, then the environmental authority holder must: a) address the complaint including the use of appropriate dispute resolution if required; and b) immediately implement vibration abatement measures so that vibration from the activity does not result in further environmental nuisance.
D11	Every explosive blast for the mining activity shall be designed by a competent person to achieve the criteria specified in **Table D2 (Airblast overpressure level)** and **Table D3 (Vibration limits)**.
D12	All relevant information pertaining to the design of every explosive blast for the mining activity in relation to the criteria specified in **Table D2 (Airblast overpressure level)** and **Table D3 (Vibration limits)** shall be kept in written and diagrammatic form.

Agency Interest – Land	
Condition number	**Condition**
E1	**Preventing contaminant release to land** Contaminants must not be released to land in manner which constitutes nuisance, material or serious environmental harm.
E2	**Topsoil** Topsoil must be strategically stripped ahead of mining in accordance with a topsoil management plan.
E3	A topsoil inventory which identifies the topsoil requirements for the Eagle Downs Coal Mine and availability of suitable topsoil on site must be developed, implemented and updated annually and provided to administering authority upon request.
E4	**Subsidence Management Plan** A Subsidence Management Plan must be developed by an appropriately qualified person and implemented prior to the *recommencement of production activities* and must be made available to the administering authority upon request.

E5	The Subsidence Management Plan must provide for effective management of actual and potential environmental impacts resulting from subsidence associated with the mining activity carried out under this environmental authority, and must include: a) Impact assessment The expected (and observed – when activities commence) impact of subsidence on any land, waterways, ground water and floodplain including but not limited to: i) Physical condition of surface drainage 1) erosion; 2) areas susceptible to higher levels of erosion such as waterways confluences; 3) incision processes; 4) stream widening; 5) tension cracking; 6) lowering of bed and banks; 7) creation of instream waterholes; 8) changes to local drainage patterns ii) Overland flow. 1) capture of overland flow by subsided long-wall panels; 2) increased overbank flows due to lowering of high bank of waterways; 3) the portion of local and large scale catchment likely to be captured by subsided long- wall panels and the associated impacts on downstream users; iii) Water quality 1) surface water (including overland flow and ponding) 2) groundwater; iv) Land condition: current land condition to be impacted by subsidence v) Infrastructure: detail of existing and planned infrastructure where there is a potential impact from effects of land subsidence vi) Groundwater vii) Erosion viii) Floods b) Measures to manage, monitor and prevent residual ponding; c) Water quality management and monitoring program for subsidence ponding areas; d) Risk assessment e) Mitigation measures (including option analysis, design requirements and implementation) for each potential impact f) Trigger action response plan to ensure achievement of condition **E8**, **E9** and **E10** and to address each potential impact g) Monitoring and review program of mitigation measures and subsidence areas to assure that any subsidence impacts are addressed in a timely manner h) Contingency procedures for emergencies i) A program for monitoring and review of the effectiveness of the Subsidence Management Plan

E6	The Subsidence Management Plan must be reviewed each calendar year, following the *recommencement of production activities*, until it can be demonstrated that subsidence is no longer occurring and mitigation measures for each environmental impact, as identified by the Subsidence Management Plan, have been implemented and do not require ongoing maintenance. The report must be prepared by an appropriately qualified person. The report must: a) assess the plan against the requirements under condition **E5**; b) include recommended actions to ensure actual and potential environmental impacts are effectively managed for the coming year; and c) identify any amendments made to the Subsidence Management Plan following the review.
E7	**Subsidence monitoring** Following the commencement of mining activities resulting in subsidence, subsidence must be monitored, on a regular basis as set out in the Subsidence Management Plan as required by condition **E4**.
E8	**Drainage lines** Drainage lines must be installed in subsidence areas where the accumulation of surface water (ponding) is expected to occur beyond that depicted in **Figure 2 (Maximum disturbance area).** The drainage lines must designed by an appropriately qualified person and installed to achieve long term stability, effective drainage of the area and maintenance of the pre-disturbance land use.
E9	**Pond overflow water quality** The Electrical Conductivity (baseflow), turbidity, suspended solids, pH and sulphate of any overflow from subsidence areas must meet the water quality objectives for the Upper Isaac River catchment waters for aquatic ecosystems as per the latest version of the "Environmental Protection (Water) Policy 2009 Isaac River Sub-basin Environmental Values and Water Quality Objectives".
E10	**Pond water quality** The residual ponding areas must meet the water quality objectives for beef cattle as per the "Environmental Protection (Water) Policy 2009 Isaac River Sub-basin Environmental Values and Water Quality Objectives". The relevant salinity limit is 'no adverse effects on animals'.
E11	The environmental authority holder must develop a Rehabilitation Management Plan prior to commencement of longwall mining activities and submit to the administering authority for review and comment.

E12	**Rehabilitation landform criteria** The Rehabilitation Management Plan must be implemented and include: a) map existing areas of rehabilitation; b) develop design objectives for rehabilitation of disturbed areas and post-mining land uses across the mine; c) specify spoil characteristics, soil analysis, soil separation for use on rehabilitation; d) detail rehabilitation methods applied to areas; e) contain landform design criteria including end of mine design; f) detail how landform designs will be consistent with the surrounding topography; g) identify success criteria for areas and itemise revegetation criteria; h) explain planned native vegetation rehabilitation areas and corridors; i) identify at least a minimum of three (3) reference and three (3) rehabilitation sites to be used to develop rehabilitation success criteria; j) describe rehabilitation indicators and the monitoring program to be used; k) develop a contingency plan for rehabilitation maintenance or redesign; l) describe end of mine landform design plan and post-mining land uses across the mine; and m) include a cost benefit analysis/triple bottom line assessment (or an alternative assessment method) of the proposed final landform design criteria and alternatives.
E13	**Interim Completion Criteria** Land disturbed by mining must be rehabilitated in accordance with **Table E1 (Final land use and rehabilitation approval schedule).**

Table E1 (Final land use and rehabilitation approval schedule)

Details	Disturbance type						
	Residual Ponding Areas	**Fill Areas**	**Extent of subsidence**	**DREA (Including Topsoil and Capping Material Stockpiles)**	**Power Station**	**Sediment / Supply dams**	**Infrastructure (Including ROM Stockpiles, ROWTP and Roads/ Tracks)**
Maximum disturbance area (ha)	76.4	25.1	2771.7	621.4 (The maximum DREA footprint is 385 ha)	8.4	25.3	300.4
Map reference	As per figure 3	As per figure 3	As per figure 3	As per figure 3	As per figure 3	As per figure 3	As per figure 3
Pre-mine land use	Grazing	Grazing	Grazing	Grazing	Grazing	Grazing	Grazing
Post-mine land use	Intermittent cattle watering holes	Grazing	Grazing and native ecosystem	Native Ecosystem for DREA and grazing for topsoil and capping material stockpiles	Grazing	Grazing or to remain as water storage upon agreement with landholder	Grazing or roads/tracks may remain as farm access upon agreement with the landholder
Post-mine land capability classification	Class D Agricultural Land	Class C Agricultural Land	Class C Agricultural Land	Class C and Class D Agricultural Land	Class C Agricultural Land	Class D Agricultural Land	Class C and Class D Agricultural Land
Projective cover range (%)	N/A	70%	70%	70%	70%	N/A	70%

Note: Gas drainage, subsidence crack rehabilitation, remedial drainage, ventilation shafts, underground communication cables, mine dewatering boreholes and associated pipelines and other access boreholes are permitted within the limit of subsidence as shown on Figure 2 (Maximum disturbance area).

E14	**Final Completion Criteria** Completion criteria must be developed and amended in **Attachment 1: Rehabilitation requirements** prior to the commencement of longwall mining.
E15	Progressive rehabilitation must commence when areas become available within the operational land.
E16	Development of acceptance criteria in accordance with condition **E12** is to consider the reestablishment of representative regional ecosystems (reference sites or another suitable alternative approved by the administering authority) and functioning habitat of areas equal to or greater than areas to be cleared and specific revegetation performance descriptors (e.g. rehabilitated areas are to display characteristics of the existing (pre-mining) regional ecosystems).
E17	Areas which are to be rehabilitated to native ecosystem must achieve a self-sustaining native ecosystem with species composition and distribution similar to an analogue/reference site or another suitable alternative approved by the administering authority.
E18	Where reasonable and practicable, areas of the site where grazing is nominated as the post-mine land use must include native grass species endemic to the area.
E19	**Rehabilitation monitoring program** Once rehabilitation has commenced, the environmental authority holder must conduct a Rehabilitation Monitoring Program on a yearly basis, which must include sufficient spatial and temporal replication to enable statistically valid conclusions as established under the rehabilitation program.
E20	The Rehabilitation Monitoring Program must be developed and implemented by a person possessing appropriate qualifications and experience in the field of rehabilitation management, nominated by the environmental authority holder.
E21	The Rehabilitation Monitoring Program must be developed, implemented and updated as necessary and provided to administering authority upon request, describing a) how the rehabilitation objectives as per condition **E12** will be achieved; and b) verification of rehabilitation success.
E22	**Post closure management plan** A Post Closure Management Plan for the site must be prepared at least 18 months prior to the final coal processing on site and implemented for a nominal period of: a) at least thirty (30) years following final coal processing on site b) a shorter period if the site is proven to be geotechnically and geochemically stable and it can be demonstrated to the satisfaction of the administering authority that no release of contaminants from the site will result in environmental harm.

E23	The Post Closure Management Plan must include the following elements: a) operation and maintenance of: i) wastewater collection and reticulation systems; ii) wastewater treatment systems; iii) the groundwater monitoring network; iv) final cover systems; v) vegetative cover; b) monitoring of: i) surface water quality; ii) groundwater quality; iii) seepage rates; iv) erosion rates; v) the integrity and effectiveness of final cover systems; and vi) the health and resilience of native vegetation cover.
E24	Complete an assessment report, to be undertaken by a Registered Professional Engineer of Queensland (RPEQ), of geotechnical issues and erosivity of the proposed final landforms, including final voids, prior to the commencement of longwall mining. This will demonstrate long-term landform stability. Reference is to be made to the Queensland Mining Guidelines (or subsequent reprints) in making this assessment.
E25	**General** The report required by condition **E24** must be given to the administering authority upon request.
E26	Cleared vegetation from the site must be managed in accordance with the following hierarchy: a) reuse, e.g. use of logs and tree stumps as shelter for fauna in rehabilitated areas; b) recycle, e.g. mulching of vegetation and use in rehabilitation on the site; and c) other alternative management options implemented in a way that causes the least amount of environmental harm.
E27	**Infrastructure** All infrastructure constructed by or for the environmental authority holder during the licensed activities including water storage structures must be removed from the site prior to surrender, except where agreed in writing by the post mining land owner / holder. Gas related infrastructure must be removed from the site prior to surrender, except where approval is granted by the administering authority.
E28	**Storage and handling of flammable and combustible liquids** All flammable and combustible liquids must be contained within an on-site containment system and controlled in a manner that prevents environmental harm and maintained in accordance with the current version of *AS 1940 – Storage and Handling of Flammable and Combustible Liquids.*
E29	Spillage of all flammable and combustible liquid must be controlled in a manner that prevents environmental harm.

E30	**Storage and handling of chemicals** All chemicals must be contained within an on-site containment system and controlled in a manner that prevents environmental harm and maintained in accordance with the current version of the relevant Australian Standard.
E31	Spillage of all chemicals must be controlled in a manner that prevents environmental harm.

Agency Interest – Waste Management	
Condition number	**Condition**
F1	**Storage of tyres** Scrap tyres stored awaiting disposal or transport for take-back and recycling, or waste-to-energy options must be stored in stable stacks and at least **ten (10) metres** from any other scrap tyre storage area, or combustible or flammable material, including vegetation.
F2	All reasonable and practicable fire prevention measures must be implemented, including removal of grass and other materials within a **ten (10) metre** radius of the scrap tyre storage area.
F3	**Waste Management** A Waste Management Plan must be developed and implemented by the environmental authority holder and must: a) describe how the Eagle Downs Coal Mine recognises and applies the waste management hierarchy; b) identify characterizations of wastes generated from the project and general volume trends over the past **five (5) years** c) include a program for safe recycling or disposal of all wastes – reusing and recycling where possible; d) include waste commitments with auditable targets to reduce, reuse and recycle; e) include the waste management control strategies that must consider: i) the types of wastes; ii) segregation of the wastes; iii) storage of the wastes; iv) transport of the wastes; v) monitoring and reporting matters concerning the waste; vi) emergency response planning; and vii) disposal, reused and recycling options. f) identify the potential adverse and beneficial impacts of the wastes generated; g) detail the hazardous characteristics of the waste generated (if any); i) cover a disposal procedure for hazardous wastes; ii) outline the process to be implemented to allow for continuous improvement of the waste management systems; iii) identify responsible staff (positions) for implementing, managing and reporting the Waste Management Plan; and iv) cover a staff awareness and induction program that encourages re-use and recycling.
F4	Waste must not be burned.

F5	Where possible and practical, vegetation waste from clearing shall be spread on rehabilitated areas. Vegetation waste only may be burnt as a last resort and only if there is minimal risk of causing nuisance to the neighbouring sensitive receptors.
F6	A designated area must be set aside for the segregation of economically viable, recyclable solid and liquid waste.
F7	Records must be kept for five years, and must include the following information: a) date of pickup of waste; b) description of waste; c) cross reference to relevant waste transport documentation; d) quantity of waste; e) origin of the waste; f) destination of the waste; and g) intended fate of the waste, for example, type of waste treatment, reprocessing or disposal.
F8	All regulated waste received at and removed from the site must be transported by a person who holds a current authority to transport such waste.
F9	Except as otherwise provided by the conditions of this authority, all waste removed from the site must be taken to a facility that is lawfully allowed to accept such waste.
F10	**Dry Reject Emplacement Area (DREA)** Waste from the Coal Handling and Preparation Plant shall be disposed of: a) in accordance with conditions **G1 to G18** (Dams) of this environmental authority if the shear strength of the waste is less than 1000 Pascals when deposited; or b) In accordance with conditions **F11 to F16** if the shear strength of the waste is equal or more than 1000 Pascals when deposited.
F11	**DREA - certification and operation** The authorised DREA used for the disposal of waste is located within the control points defined in **Table F1 (Location of DREA)**.

Table F1 (Location of DREA)

Name of regulated area	Easting (GDA2020)	Northing (GDA2020)
Dry Reject Emplacement Area	625,992	7,547,730
	625,974	7,547,664
	625,336	7,547,367
	625,269	7,547,396
	624,885	7,547,216
	624,841	7,547,137
	624,585	7,547,006
	624,494	7,546,900
	624,491	7,546,736
	624,728	7,546,325
	624,772	7,546,146
	624,713	7,546,022
	624,804	7,545,863
	624,796	7,545,773
	624,824	7,545,754
	624,847	7,545,827
	625,299	7,545,620
	625,546	7,545,594
	625,591	7,545,491
	625,603	7,545,496
	625,555	7,545,601
	625,615	7,545,634
	625,748	7,545,790
	625,874	7,545,752
	626,247	7,545,479
	626,403	7,545,410
	626,583	7,545,454
	626,879	7,545,849
	626,882	7,546,580
	626,966	7,546,622
	626,952	7,546,630
	626,874	7,546,599
	626,850	7,546,735
	626,663	7,546,939
	626,321	7,547,607
	626,237	7,547,699

F12	DREA shall be designed to prevent environmental harm arising from contaminants being generated in the facility, leachate and runoff from the facility or other sources.
F13	The authorised DREA must be constructed and maintained in accordance with certified plans submitted to the administering authority.
F14	Design plans for the authorised DREA must include performance indicators, such that: a) during operations the DREA will be operated with minimal or no potential for adverse environmental harm resulting from collapse of any component of facility; b) the potential for leachate generation will be minimal or non-existent; c) adequate drainage structures, erosion protection and storage are provided to manage seasonal and rare rainfall events with minimal or no environmental harm; and d) decommissioning and rehabilitation strategies for the DREA that demonstrate consistency with the conditions of this environmental authority.
F15	Construction of any DREA detailed in **Table F1 (Location of DREA)** must not commence unless: a) the environmental authority holder has submitted to the administering authority two copies of a design plan; b) certification from a suitably qualified and experienced person that the design of the DREA will deliver the performance stated in that design plan and that it will be compliant in all other respects with this environmental authority; c) at least **twenty (20) business days** has passed since the receipt of those documents by the administering authority; d) The administering authority notifies the environmental authority holder that a design plan and certification has been submitted for that disposal facility.
F16	**Operational plan – DREA** An operational plan must be developed and maintained for the DREA. The operational plan must include but not be limited to: a) description of landform development stages of the DREA; b) placement technique for spoil and waste material from the coal handling and processing plant on the mine site; c) management of any containment structures within the DREA designed to contain materials from the coal handling and processing plant on the mine site; d) demonstration of how operations of the DREA are consistent with the accepted design plan for the facility; and e) decommissioning and rehabilitation strategies for the DREA that demonstrate consistency with conditions of this environmental authority.

F17	**Tailings/coal rejects** The management of tailings disposal must be in accordance with the following: a) all tailings material must be progressively characterised during disposal for acid generating capacity and selected metals and salts. Samples shall be tested for: pH, Electrical Conductivity (EC), Acid Neutralising Capacity (ANC), Net Acid Generation (NAG) (reporting NAG capacity and NAG pH after oxidation), Total Sulphur (S), Chromium Reducible Sulphur (CRS), Boron (B) Cadmium (Cd), Iron (Fe), Aluminium (Al), Copper (Cu), Magnesium (Mg), Manganese (Mn), Calcium (Ca), Sodium (Na), Zinc (Zn) and Sulphate (SO4); b) one (1) tailing sample will be collected each and every week while the mine coal processing plant is operational and the sample will be stored. After four (4) samples have been collected the samples will be composited and the composite sample characterised as outlined in (a) above. A minimum of one composite tailing sample will undergo characterisation per month. A minimum of twelve (12) composite tailing samples will undergo characterisation per year; c) records must be kept of the tailings disposal to indicate locations and characteristics of tailings stored within the tailings storage facility; d) where the acid producing potential of tailings material has not been conclusively determined, geochemical kinetic testing must be conducted to indicate oxidation rates, potential reaction products and effectiveness of control strategies; and e) tailings identified as potentially acid producing will be covered or placed to minimise surface oxidation. The maximum duration of surface exposure of these materials is one month.
F18	**Mine waste** A Mining Waste Management Plan together with the certification by an appropriately qualified person must be developed and implemented during the continuation of the environmental authority. The Mining Waste Management Plan must at a minimum include: a) characterisation programs to ensure that all mining waste is progressively characterised during disposal for net acid producing potential, salinity and the following contaminants: pH, Electrical Conductivity (EC), Acid Neutralising Capacity (ANC), Net Acid Generation (NAG) (reporting NAG capacity and NAG pH after oxidation), Total Sulphur (S), Chromium Reducible Sulphur (CRS), Boron (B) Cadmium (Cd), Iron (Fe), Aluminium (Al), Copper (Cu), Magnesium (Mg), Manganese (Mn), Calcium (Ca), Sodium (Na), Zinc (Zn) and Sulphate (SO4); b) characterisation programs to ensure that the physical properties of the mining waste is progressively characterised during disposal; c) the availability or leachability of metals from the mining waste; d) quantification of PAF from mining waste present; e) review impacts of the PAF mining waste on the rehabilitation; f) management actions for mining waste that has been identified as having a high availability or leachability of metals; g) management actions for mining waste that has been defined as PAF; h) identification of environmental impacts and potential environmental impacts; i) control measures for routine operations to minimise likelihood of environmental harm; j) contingency plans and emergency procedures for non-routine situations; and k) periodic review of environmental performance and continual improvement.

Agency Interest – Regulated Structures	
Condition number	**Condition**
G1	**Assessment of Consequence Category** The **consequence category** of any structure must be **assessed** by a **suitably qualified and experienced person** in accordance with the Manual for Assessing Consequence Categories and Hydraulic Performance of Structure (ESR/2016/1933) at the following times: a) prior to the design and **construction** of the **structure**, if it is not an **existing structure**; or b) prior to any change in its purpose or the nature of its stored contents.
G2	A **consequence assessment** report and **certification** must be prepared for any **structure assessed** and the report may include a consequence assessment for more than one structure.
G3	Certification must be provided by the suitably qualified and experienced person who undertook the assessment, in the form set out in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1933).*
G4	**Design and Construction of a Regulated Structure** Conditions **G5** to **G9** inclusive do not apply to existing structures.
G5	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 *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1933).*
G6	Construction of a regulated structure is prohibited unless: a) the holder has submitted a consequence category assessment report and certification to the administering authority; and b) certification for the design, design plan and the associated operating procedures has been certified by a suitably qualified and experienced person in compliance with the relevant condition of this authority.
G7	Certification must be provided by the suitably qualified and experienced person who oversees the preparation of the design plan in the form set out in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1933)*, and must be recorded in the Register of Regulated Structures.
G8	**Regulated structures** must: a) be designed and constructed in compliance with the *Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933);* b) be designed and constructed with due consideration given to ensuring that the design integrity would not be compromised on account of: i) floodwaters from entering the **regulated dam** from any **watercourse** or drainage line; and ii) wall failure due to erosion by floodwaters arising from any watercourse or drainage line. c) for regulated dams that are dams associated with a 'failure to contain – seepage': have the floor and sides of the dam designed and constructed to prevent or minimise the passage of the wetting front and any entrained contaminants through either the floor or sides of the dam during the operational life of the dam and for any period of decommissioning and rehabilitation of the dam.

G9	Certification by the suitably qualified and experienced person who supervises the construction must be submitted to the administering authority on the completion of construction of the regulated structure, and state that: a) the 'as constructed' drawings and specifications meet the original intent of the design plan for that regulated structure; and b) construction of the regulated structure is in accordance with the design plan.
G10	**Notification of affected persons** All affected persons must be provided with a copy of the emergency action plan in place for each regulated structure a) for existing structures that are regulated structures, within 10 business days of this condition taking effect; b) prior to the operation of the new regulated structure; and c) if the emergency action plan is amended, within 5 business days of it being amended.
G11	**Operation of a Regulated Structure** Operation of a regulated structure, except for an existing structure, is prohibited unless the holder has submitted to the administering authority; a) one paper copy and one electronic copy of the design plan and certification of the 'design plan' in accordance with condition **G7** b) a set of 'as constructed' drawings and specifications; c) certification of those 'as constructed drawings and specifications' in accordance with condition **G9**, d) where the regulated structure is to be managed as part of an integrated containment system for the purpose of sharing the design storage allowance (DSA) volume across the system, a copy of the certified system design plan e) the requirements of this authority relating to the **construction** of the regulated structure have been met; f) the holder has entered the details required under this **authority**, into a Register of Regulated Structures; and g) there is a current operational plan for the regulated structures.
G12	For existing structures that are regulated structures: a) where the existing structure that is a regulated structure is to be managed as part of an **integrated containment system** for the purpose of sharing the DSA volume across the system, the holder must submit to the administering authority within twelve (12) months of the commencement of this condition a copy of the certified **system design plan** including that structure; and b) there must be a current operational plan for the existing structures.
G13	Each regulated structure must be maintained and operated, for the duration of its operational life until decommissioned and rehabilitated, in compliance with the current operational plan and, if applicable, the current design plan and associated certified 'as constructed' drawings.
G14	**Mandatory Reporting Level** Conditions **G15** to **G18** inclusive only apply to regulated structures which have not been certified as low consequence category for 'failure to contain – overtopping'.
G15	The **Mandatory Reporting Level** (the **MRL**) must be marked on a regulated dam in such a way that during routine inspections of that dam, it is clearly observable.
G16	The holder must, as soon as practical and within forty-eight (48) hours of becoming aware, notify the administering authority when the level of the contents of a regulated dam reaches the **MRL**.

G17	The holder must, immediately on becoming aware that the **MRL** has been reached, act to prevent the occurrence of any unauthorised discharge from the regulated dam.
G18	The holder must record any changes to the **MRL** in the Register of Regulated Structures.
G19	**Design Storage Allowance** The holder must assess the performance of each regulated dam or linked containment system over the preceding **November** to **May** period based on actual observations of the available storage in each regulated dam or linked containment system taken prior to **1 July** of each year.
G20	By **1 November** of each year, storage capacity must be available in each regulated dam (or network of linked containment systems with a shared DSA volume), to meet the DSA volume for the dam (or network of linked containment systems).
G21	The holder must, as soon as possible and within **forty-eight (48) hours** of becoming aware that the regulated dam (or network of linked containment systems) will not have the available storage to meet the DSA volume on **1 November** of any year, notify the administering authority.
G22	The holder must, immediately on becoming aware that a regulated dam (or network of linked containment systems) will not have the available storage to meet the DSA volume on **1 November** of any year, act to prevent the occurrence of any unauthorised discharge from the regulated dam or linked containment systems.
G23	**Annual Inspection Report** Each regulated structure must be inspected each calendar year by a suitably qualified and experienced person.
G24	At each annual inspection, the condition and adequacy of all components of the **regulated structure** must be assessed and a suitably qualified and experienced person must prepare an **annual inspection** report containing details of the assessment and include recommended actions to ensure the integrity of the regulated structure or a positive statement that no recommendations are required**.**
G25	The suitably qualified and experienced person who prepared the annual inspection report must certify the report in accordance with the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1933)*
G26	The holder must within twenty (20) business days of receipt of the annual inspection report, provide to the administering authority; a) The recommendations section of the annual inspection report; and b) If applicable, any actions being taken in response to those recommendations; and c) If, following the receipt of the recommendations and (if applicable) actions, the administering authority requests a full copy of the annual inspection report from the holder, provide this to the administering authority within ten (10) business days of receipt of the request. Note: That for some model conditions, such as model conditions for dams associated with a resource activity - non mining activity, the notification requirements may be located in a separate part of the conditions of an environmental authority (e.g. under notification requirement conditions).

G27	**Transfer Arrangements** The holder must provide a copy of any reports, documentation and certifications prepared under this authority, including but not limited to any Register of Regulated Structures, consequence assessment, design plan and other supporting documentation, to a new holder on transfer of this authority.
G28	**Decommissioning and Rehabilitation** Dams must not be abandoned but be either: a) decommissioned and rehabilitated to achieve compliance with condition **G29**; or b) be left in-situ for a beneficial use(s) provided that: i) it no longer contains contaminants that will migrate into the environment; and ii) it contains water of a quality that is demonstrated to be suitable for its intended beneficial use(s); and c) the holder of the environmental authority and the landholder agree in writing that the i) dam will be used by the landholder following the cessation of the environmentally relevant activity(ies); and ii) Landholder is responsible for the dam, on and from an agreed date.
G29	Before surrendering this environmental authority, the site must be rehabilitated to achieve a safe, stable, non-polluting landform and the following; a) the landform is safe for humans and fauna; b) the landform is stable with no subsidence or erosion gullies for at least three (3) years; c) any contaminated land (e.g. contaminated soils) is remediated and rehabilitated; d) not allowing for acid mine drainage; or e) there is no ongoing contamination to waters (including groundwater); f) rehabilitation is undertaken in a manner such that any actual or potential acid sulfate soils on the area of significant disturbance are treated to prevent or minimise environmental harm in accordance with the *Instructions for the treatment and management of acid sulfate soils* (2001); g) all significantly disturbed land is reinstated to the pre-disturbed land suitability class; h) for land that is not being cultivated by the landholder: i) groundcover, that is not a declared pest species is established and self-sustaining; ii) vegetation of similar species richness and species diversity to pre-selected analogue sites is established and self-sustaining; iii) the maintenance requirements for rehabilitated land is no greater than that required for the land prior to its disturbance caused by carrying out the mining activity(ies);and iv) for land that is to be cultivated by the landholder, cover crop is revegetated, unless the landholder will be preparing the site for cropping within three (3) months of mining activities being completed.
G30	**Register of Regulated Structures** A Register of Regulated Structures must be established and maintained by the holder for each regulated structure.

G31	The holder must provisionally enter the required information in the Register of Regulated Structures when a design plan for a regulated dam is submitted to the administering authority.
G32	The holder must make a final entry of the required information in the Register of Regulated Structures once compliance with conditions **G11** and **G12** has been achieved.
G33	The holder must ensure that the information contained in the Register of Regulated Structures is current and complete on any given day.
G34	All entries in the Register of Regulated Structures must be approved by the chief executive officer for the holder of this authority, or their delegate, as being accurate and correct.
G35	The holder must, at the same time as providing the annual return, supply to the administering authority a copy of the records contained in the Register of Regulated Structures, in the electronic format required by the administering authority.

Agency Interest – Biodiversity	
Condition number	**Condition**
H1	**Environmental offsets** Significant residual impacts to prescribed environmental matters, are not authorised under this environmental authority or the *Environmental Offsets Act 2014* unless the impacts are specified in **Table H1 (Significant residual impacts to prescribed environmental matters)** and are within the maximum disturbance area shown in **Figure 2 (Maximum disturbance area).**
H2	An environmental offset made in accordance with the *Environmental Offsets Act 2014* and Queensland Environmental Offsets Policy, as amended from time to time, must be undertaken for the maximum extent of impact to each prescribed environmental matter authorised in **Table H1 (Significant residual impacts to prescribed environmental matters)**.
H3	Records demonstrating that each impact to a prescribed environmental matter not listed in **Table H1 (Significant residual impacts to prescribed environmental matters)** did not, or is not likely to, result in a significant residual impact to that matter must be: a) completed by an appropriately qualified person; and b) kept for the life of the environmental authority.

Table H1 (Significant residual impacts to prescribed environmental matters)

Prescribed Environmental Matter	Location	Maximum extent of impact	Offset required (State)
Regulated Vegetation			
Bluegrass (*Dichanthium spp)* dominant grasslands of the Brigalow Belt Bioregions (North and South) endangered ecological community*	Figure 5	36ha	No*
Brigalow (*Acacia harpophylla* dominant and co-dominant) endangered ecological community*	Figure 5	35ha	No*
Endangered regional ecosystem - RE11.3.1 *Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains	Figure 6	5.8ha	No**
Endangered regional ecosystem - RE 11.9.5 *Acacia harpophylla* and/or *Casuarina cristata* open forest to woodland on fine-grained sedimentary rocks- Endangered	Figure 6	9.8ha	No**
Of concern regional ecosystem - RE 11.3.3 Eucalyptus coolabah woodland on alluvial plains	Figure 6	8.6ha	Yes
Prescribed regional ecosystem - remnant vegetation within prescribed distance of a watercourse			
Endangered regional ecosystem - RE11.3.1 *Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains	Figure 6	0.8 ha	No**
Protected wildlife habitat			
Habitat for an animal that is vulnerable wildlife – ornamental snake – *Denisonia maculata*	Figure 10 Figure 10	35ha 51.3ha	No* No**
Habitat for an animal that is vulnerable wildlife – Squatter pigeon (southern subspecies) – *Geophaps scripta scripta*	Figure 7	92.3ha	No**
Habitat for an animal that is vulnerable wildlife – White throated needletail – *Hirundapus caudacutus*	Figure 8	91.1ha	No**
Habitat for an animal that is endangered wildlife – Koala – *Phascolarctos cinereus*	Figure 9	161.8ha	No**
Habitat for an animal that is endangered wildlife – Greater Glider – *Petauroides Volans*	Figure 8	117.6ha	No**
Habitat for an animal that is endangered wildlife – Australian painted snipe – *Rostratula australis*	Figure 8	29.7ha	No**
Habitat for an animal that is Special Least Concern wildlife – Short-beaked Echidna - *Tachy-glossus aculaeatus*	Figure 7	127.9ha	No

* Offsets have been provided under the *Environment Protection and Biodiversity Conservation Act 1999* approval 2008/3945.
** These matters are to be assessed under the *Environment Protection and Biodiversity Conservation Act 1999 .*

END OF CONDITIONS

Definitions

Key terms and/or phrases used in this document are defined in this section. Applicants should note that where a term is not defined, the definition in the *Environmental Protection Act 1994*, its regulations or environmental protection policies must be used. If a word remains undefined it has its ordinary meaning.

"20th percentile flow" means the 20th percentile of all daily flow measurements (or estimations) of daily flow over a 10 year period for a particular site. The 20th percentile calculation should only include days where flow has been measured (or estimated), i.e. not dry weather days.

"acceptance criteria" means the measures by which the actions implemented to rehabilitate the land are deemed to be complete. The acceptance criteria indicate the success of the rehabilitation outcome or remediation of areas which have been significantly disturbed by the mining activities. Acceptance criteria may include information regarding:

a) vegetation establishment, survival and succession;

b) vegetation productivity, sustained growth and structure development;

c) fauna colonisation and habitat development;

d) ecosystem processes such as soil development and nutrient cycling, and the recolonisation of specific fauna groups such as collembola, mites and termites which are involved in these processes;

e) microbiological studies including recolonisation by mycorrhizal fungi, microbial biomass and respiration;

f) effects of various establishment treatments such as deep ripping, topsoil handling, seeding and fertiliser application on vegetation growth and development;

g) resilience of vegetation to disease, insect attack, drought and fire; and

h) vegetation water use and effects on ground water levels and catchment yields.

"acid rock drainage" means any contaminated discharge emanating from a mining activity formed through a series of chemical and biological reactions, when geological strata is disturbed and exposed to oxygen and moisture.

"**administering authority"** is the agency that administers the *Environmental Protection Act 1994*.

"AEP" means the Annual Exceedance Probability, which is the probability that at least one event in excess of a particular magnitude will occur in any given year.

"affected person" is someone whose drinking water can potentially be impacted as a result of discharges from a dam or their life or property can be put at risk due to dwellings or workplaces being in the path of a dam break flood.

"airblast overpressure" means energy transmitted from the blast site within the atmosphere in the form of pressure waves. The maximum excess pressure in this wave, above ambient pressure is the peak airblast overpressure measured in decibels linear (dBL).

"annual inspection report" means an assessment prepared by a suitably qualified and experienced person containing details of the assessment against the most recent consequence assessment report and design plan (or system design plan):

a) against recommendations contained in previous annual inspections reports;
b) against recognised dam safety deficiency indicators;
c) for changes in circumstances potentially leading to a change in consequence category;
d) for conformance with the conditions of this authority;
e) for conformance with the 'as constructed' drawings;

f) for the adequacy of the available storage in each regulated dam, based on an actual observation or observations taken after 31 May each year but prior to 1 November of that year, of accumulated sediment, state of the containment barrier and the level of liquids in the dam (or network of linked containment systems);
g) for evidence of conformance with the current operational plan.

"ANZECC" means the *Australian and New Zealand Guidelines for Fresh Marine Water Quality 2000*.

"appropriately qualified person" means a person who has professional qualifications, training, skills or experience relevant to the nominated subject matter and can give authoritative assessment, advice and analysis on performance relative to the subject matter using the relevant protocols, standards, methods or literature.

"authority" means environmental authority under the *Environmental Protection Act 1994*.

"assessed" or "assess" by a suitably qualified and experienced person in relation to a consequence assessment of a regulated structure, means that a statutory declaration has been made by that person and, when taken together with any attached or appended documents referenced in that declaration, all of the following aspects are addressed and are sufficient to allow an independent audit at any time:

a) exactly what has been assessed and the precise nature of that assessment;

b) the relevant legislative, regulatory and technical criteria on which the assessment has been based;

c) the relevant data and facts on which the assessment has been based, the source of that material, and the efforts made to obtain all relevant data and facts; and

d) the reasoning on which the assessment has been based using the relevant data and facts, and the relevant criteria.

"associated works" in relation to a dam, means:

a) operations of any kind and all things constructed, erected or installed for that dam; and
b) any land used for those operations.

"authority" means an environmental authority or a development approval.

"bed and banks" for a waters, river, creek, stream, lake, lagoon, pond, swamp, wetland or dam means land over which the water of the waters, lake, lagoon, pond, swamp, wetland or dam normally flows or that is normally covered by the water, whether permanently or intermittently; but does not include land adjoining or adjacent to the bed and banks that is from time to time covered by floodwater.

"beneficial use" in respect of dams means that the current or proposed owner of the land on which a dam stands, has found a use for that dam that is:

a) of benefit to that owner in that it adds real value to their business or to the general community;

b) in accordance with relevant provisions of the *Environmental Protection Act 1994;*

c) sustainable by virtue of written undertakings given by that owner to maintain that dam; and

d) the transfer and use have been approved or authorised under any relevant legislation.

"**blasting"** means the use of explosive materials to fracture:

a) rock, coal and other minerals for later recovery; or

b) structural components or other items to facilitate removal from a site or for reuse.

"certification" or "certified" means assessment and approval must be undertaken by a suitably qualified and experienced person in relation to any assessment or documentation required by the *Manual for assessing consequence categories and hydraulic performance of structures*, including design plans, 'as constructed' drawings and specifications, construction, operation or an annual report regarding regulated structures,

undertaken in accordance with the Board of Professional Engineers of Queensland Policy Certification by Registered Professional Engineers of Queensland.

"chemical" means:

a) an agricultural chemical product or veterinary chemical product within the meaning of the *Agricultural and Veterinary Chemicals Code Act 1994* (Commonwealth); or

b) a dangerous good under the dangerous goods code; or

c) a lead hazardous substance within the meaning of the *Workplace Health and Safety Regulation 1997; or*

d) a drug or poison in the Standard for the Uniform Scheduling of Drugs and Poisons prepared by the Australian Health Ministers' Advisory Council and published by the Commonwealth; or

e) any substance used as, or intended for use as:

   i) a pesticide, insecticide, fungicide, herbicide, rodenticide, nematocide, miticide, fumigant or related product; or

   ii) a surface active agent, including, for example, soap or related detergent; or

   iii) a paint solvent, pigment, dye, printing ink, industrial polish, adhesive, sealant, food additive, bleach, sanitiser, disinfectant, or biocide; or

   iv) a fertiliser for agricultural, horticultural or garden use; or

   i) mineral processing or treatment of metal, pulp and paper, textile, timber, water or wastewater; or

   ii) manufacture of plastic or synthetic rubber.

"commercial place" means a work place used as an office or for business or commercial purposes, which is not part of the mining activity and does not include employees accommodation or public roads.

"competent person" means a person with the demonstrated skill and knowledge required to carry out the task to a standard necessary for the reliance upon collected data or protection of the environment.

"consequence" in relation to a structure as defined, means the potential for environmental harm resulting from the collapse or failure of the structure to perform its primary purpose of containing, diverting or controlling flowable substances.

"consequence category" means a category, either low, significant or high, into which a dam is assessed as a result of the application of tables and other criteria in the *Manual for assessing consequence categories and hydraulic performance of structures.*

"construction" or **"constructed"** in relation to a dam includes building a new dam and modifying or lifting an existing dam, but does not include investigations and testing necessary for the purpose of preparing a design plan.

"contaminate" means to render impure by contact or mixture.

"contaminated" means the substance has come into contact with a contaminant.

"contaminant" – as defined in section 11 of the *Environmental Protection Act 1994*.

"control measure" means any action or activity that can be used to prevent or eliminate a hazard or reduce it to an acceptable level.

"dam" means a land-based structure or a void that contains, diverts or controls flowable substances, and includes any substances that are thereby contained, diverted or controlled by that land-based structure or void and associated works.

"design plan" is a document setting out how all identified consequence scenarios are addressed in the planned design and operation of a regulated structure.

"design storage allowance" or "DSA" means an available volume, estimated in accordance with the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (*ESR/2016/1933*) published by the administering authority, must be provided in a dam as at 1 November each year in order to prevent a discharge from that dam to an annual exceedance probability specified in that manual.

"disturbed" means any area that has had its natural state altered by the action or interference of carrying out an activity associated with the exploration project.

"disturbance" of land includes:

a) compacting, removing, covering, exposing or stockpiling of earth
b) removal or destruction of vegetation or topsoil or both to an extent where the land has been made susceptible to erosion
c) carrying out mining within a watercourse, waterway, wetland or lake
d) the submersion of areas by tailings or hazardous contaminant storage and dam/structure walls
e) temporary infrastructure, including any infrastructure (roads, tracks, bridges, culverts, dam/structures, bores, buildings, fixed machinery, hardstand areas, airstrips, helipads etc.) which is to be removed after the mining activity has ceased
f) releasing of contaminants into the soil, or underlying geological strata.

However, the following areas are not included when calculating areas of 'disturbance'.

a) Areas off lease (e.g. roads or tracks which provide access to the mining lease)
b) Areas previously disturbed which have achieved the rehabilitation outcomes
c) By agreement with the administering authority, areas previously disturbed which have not achieved the rehabilitation objective(s) due to circumstances beyond the control of the mine operator (such as climatic conditions)
d) Areas under permanent infrastructure. Permanent infrastructure includes any infrastructure (roads, tracks, bridges, culverts, dam/structures, bores, buildings, fixed machinery, hardstand areas, airstrips, helipads etc.) which is to be left by agreement with the landowner.
e) Disturbance that pre-existed the grant of the tenure.

"effluent" means treated waste water discharged from sewage treatment plants.

"emergency action plan" means documentation forming part of the operational plan held by the holder or a nominated responsible officer, that identifies emergency conditions that sets out procedures and actions that will be followed and taken by the dam owner and operating personnel in the event of an emergency. The actions are to minimise the risk and consequences of failure, and ensure timely warning to affected persons and the implementation of protection measures. The plan must require da owners to annually review and update contact information where required.

"environmental authority" means an environmental authority granted under the *Environmental Protection Act 1994*.

"environmental authority holder" means the holder of this environmental authority.

"environmentally relevant activity" means an environmentally relevant activity as defined under Section 18 of the *Environmental Protection Act 1994* and listed under Schedule 2 or Schedule 2A of the *Environmental Protection Regulation 2008.*

"fill areas" are areas that as a result of longwall mining activity, experience a vertical displacement of the ground surface and are mitigated by filling.

"flare pit" means containment area where any hydrocarbon that is discovered in an over-pressured reservoir during a drilling operation is diverted to, and combusted. The flare pit is only used during the drilling and work over process on a petroleum well.

"flowable substance" means matter or a mixture of materials which can flow under any conditions potentially affecting that substance. Constituents of a flowable substance can include water, other liquids fluids or solids, or a mixture that includes water and any other liquids fluids or solids either in solution or suspension.

"general waste" means waste other than regulated waste.

"hazardous waste" means a substance, whether liquid, solid or gaseous that, if improperly treated, stored, disposed of or otherwise managed, is likely to cause environmental harm.

"hydraulic performance" means the capacity of a regulated dam to contain or safely pass flowable substances based on the design criteria for the relevant consequence category in the *Manual for assessing consequence categories and hydraulic performance of structures*.

"infrastructure" means water storage dams, levees, roads and tracks, buildings and other structures built for the purpose of the mining activity.

"$L_{A\ 10,\ adj,\ 10\ mins}$" means the A-weighted sound pressure level, (adjusted for tonal character and impulsiveness of the sound) exceeded for 10% of any 10-minute measurement period, using Fast response.

"$L_{A\ 1,\ adj,\ 10\ mins}$" means the A-weighted sound pressure level, (adjusted for tonal character and impulsiveness of the sound) exceeded for 1% of any 10-minute measurement period, using Fast response

"$L_{A,\ max\ adj,\ T}$" means the average maximum A-weighted sound pressure level, adjusted for noise character and measured over any 10 minute period, using Fast response.

"land" in the "land schedule" of this document means land excluding waters and the atmosphere., that is, the term has a different meaning from the term as defined in the *Environmental Protection Act 1994*. For the purposes of the *Acts Interpretation Act 1954*, it is expressly noted that the term 'land' in this environmental authority relates to physical land and not to interests in land.

"land capability" as defined in the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland (DME 1995)*.

"land suitability" as defined in the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland (DME 1995)*.

"land use" means the selected post mining use of the land, which is planned to occur after the cessation of mining operations.

"low consequence dam" means any dam that is not a high or significant consequence category as assessed using the *Manual for assessing consequence categories and hydraulic performance of structures.*

"mandatory reporting level" or "MRL" means a warning and reporting level determined in accordance with the criteria in the *Manual for assessing consequence categories and hydraulic performance of structures.*

"manual" means the *Manual for assessing consequence categories and hydraulic performance of structures published by the administering authority, as amended from time to time.*

"mg/L" means milligrams per litre.

"Mine affected water"

a) means the following types of water:

i. pit water, tailings dam water, processing plant water;

ii. water contaminated by a mining activity which would have been an environmentally relevant activity under Schedule 2 of the Environmental Protection Regulation 2019 if it had not formed part of the mining activity;

iii. 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;

iv. groundwater which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated;

v. groundwater from the mine's dewatering activities; or

vi. a mix of mine affected water (under any of paragraphs i to v) and other water.

b) does not include surface water runoff which, to the extent that it has been in contact with areas disturbed by mining activities that have not yet been completely rehabilitated, has only been in contact with:

i. land that has been rehabilitated to a stable landform and either capped or revegetated in accordance with the acceptance criteria set out in the environmental authority but only still awaiting maintenance and monitoring of the rehabilitation over a specified period of time to demonstrate rehabilitation success; or

ii. land that has partially been rehabilitated and monitoring demonstrates the relevant part of the landform with which the water has been in contact does not cause environmental harm to waters or groundwater, for example:

a. areas that are been capped and have monitoring data demonstrating hazardous material adequately contained with the site;
b. evidence provided through monitoring that the relevant surface water would have met the water quality parameters for mine affected water release limits in this environmental authority, if those parameters had been applicable to the surface water runoff; or

iii. both.

"mine water" means process water and contaminated stormwater.

"natural flow" means the flow of water through waters caused by nature.

"native vegetation" means vegetation that occurs naturally in a certain area.

"noxious" means harmful or injurious to health or physical well-being.

"offensive" means causing reasonable offence or displeasure; is disagreeable to the sense; disgusting, nauseous or repulsive, other than trivial harm.

"operational land" means the land associated with the project for which this environmental authority has been issued.

"operational plan" includes:

a) Normal operating procedures and rules (including clear documentation and definition of process inputs in the DSA);
b) Contingency and emergency action plans including operating procedures designed to avoid and/or minimise environmental impacts including threats to human life resulting from any overtopping or loss of structural integrity of the regulated structure.

"peak particle velocity (ppv)" means a measure of ground vibration magnitude which is the maximum rate of change of ground displacement with time, usually measured in millimetres/second (mms^{-1}). **"progressive**

rehabilitation" means rehabilitation (defined below) undertaken progressively or a staged approach to rehabilitation as mining operations are ongoing.

"receiving environment" means all groundwater, surface water, land, and sediments that are not disturbed areas authorised by this environmental authority.

"receiving waters" means the waters into which this environmental authority authorises releases of mine affected water.

"recommencement of production activities" means the following on the mining tenures relevant to the Environmentally Relevant Activity and the location details of this environmental authority:

a) mining coal from the coal measures;
b) rehabilitation activities with the exception of rehabilitation of disturbance resultant from exploration activities; and
c) the commencement of operation of the ROWTP, mine water dam, brine dam or the DREA catch dam.

For the avoidance of doubt, this definition does not include any activities required for the continued management of the site the subject of the environmental authority in care and maintenance, the construction of any temporary infrastructure or the recommencement of construction of the underground mine drifts.

"reference site" (or analogue site) may reflect the original location, adjacent area or another area where rehabilitation success has been completed for a similar biodiversity. Details of the reference site may be as photographs, computer generated images and vegetation models etc.

"register of regulated structures" includes:

a) Date of entry in the register;
b) Name of the structure, its purpose and intended/actual contents;
c) The consequence category of the dam as assessed using the *Manual for assessing consequence categories and hydraulic performance of structures;*
d) Dates, names, and reference for the design plan plus dates, names, and reference numbers of all document(s) lodged as part of a design plan for the dam;
e) Name and qualifications of the suitably qualified and experienced person who certified the design plan and 'as constructed' drawings;
f) For the regulated dam, other than in relation to any levees –
    i. The dimensions (metres) and surface area (hectares) of the dam measured at the footprint of the dam;
    ii. Coordinates (latitude and longitude in GDA94) within five metres at any point from the outside of the dam including its storage area;
    iii. Dam crest volume (megalitres);
    iv. Spillway crest level (metres AHD);
    v. Storage rating table of stored volume versus level (metres AHD);
    vi. Design storage allowance (megalitres) and associated level of the dam (metres AHD)'
    vii. Mandatory reporting level (metres AHD).
g) The design plan title and reference relevant to the dam;
h) The date construction was certified as compliant with the design plan;
i) The name and details of the suitably qualified and experienced person who certified that the constructed dam was compliant with the design plan;
j) Details of the composition and construction of any liner;
k) The system for the detection of any leakage through the floor and sides of the dam;
l) Dates when the regulated dam underwent and annual inspection for structural and operational adequacy, and to ascertain the available storage volume for 1 November of any year;
m) Dates when recommendations and actions arising from the annual inspection were provided to the administering authority;

n) Dam water quality as obtained from any monitoring required under this authority as at 1 November of each year.

"regulated structure" means any structure in the significant or high consequence category as assessed using the *Manual for assessing consequence categories and hydraulic performance of structures* published by the administering authority. A regulated structure does not include:

- A fabricated or manufactured tank or container, designed and constructed to an Australian Standard that deals with strength and structural integrity of that tank or container;
- A sump or earthen pit used to store residual drilling material and drilling fluid only for the duration of drilling and well completion activities;
- A flare pit.

"regulated waste" as defined within the *Waste Reduction and Recycling Act 2011*.

"rehabilitation" the process of reshaping and revegetating land to restore it to a stable landform.

"release event" means a surface water discharge from mine affected water storages or contaminated areas on the licensed place**.**

"representative" means a sample set which covers the variance in monitoring or other data either due to natural changes or operational phases of the mining activities.

"residual drilling material" means waste drilling materials including muds and cuttings or cement returns from well holes and which have been left behind after the drilling fluids are pumped out.

"**residual ponding areas**" as depicted in Figure 3, are areas that as a result of longwall mining activity, experience a vertical displacement of ground surface and will result in ponding of surface water for more than 10% of a 12 month period.

"RO product water" reverse osmosis product water from the Reverse Osmosis Water Treatment Plant.

"ROWTP" means Reverse Osmosis Water Treatment Plant.

"saline drainage" the movement of waters, contaminated with salt(s), as a result of the mining activity.

"self-sustaining" means not requiring on-going intervention and maintenance to maintain functional riverine processes and characteristics.

"sensitive place" means:

a) a dwelling, residential allotment, mobile home or caravan park, residential marina or other residential premises;

b) a motel, hotel or hostel;

c) an educational institution;

d) a medical centre or hospital;

e) a protected area under the *Nature Conservation Act 1992*, the *Marine Parks Act 2004* or a World Heritage Area; or

f) a public park or gardens.

Note: The definition of 'sensitive place' and 'commercial place' is based on Schedule 1 of the *Environmental Protection (Noise) Policy 2008.*

"sewage" means the used water of person's to be treated at a sewage treatment plant.

"spillway" means a weir, channel, conduit, tunnel, gate or other structure designed to permit discharges form the dam, normally under flood conditions or in anticipation of flood conditions.

"stable" in relation to land, means land form dimensions are or will be stable within tolerable limits now and in the foreseeable future. Stability includes consideration of geotechnical stability, settlement and consolidation allowances, bearing capacity (trafficability), erosion resistance and geochemical stability with respect to seepage, leachate and related contaminant generation.

"stormwater" means all surface water runoff from rainfall.

"**suitably qualified and experienced person"** means a person who is a Registered Professional Engineer of Queensland (RPEQ) under the provisions of the *Professional Engineers Act* 2002, and has demonstrated competency and relevant experience:

- for regulated dams, an RPEQ who is a civil engineer with the required qualifications in dam safety and dam design
- for regulated levees, an RPEQ who is a civil engineer with the require qualifications in the design of flood protection embankments.

Note: It is permissible that a suitably qualified and experienced person obtain subsidiary certification from an RPEQ who has demonstrated competence and relevant experience in either geomechanics, hydraulic design or engineering hydrology.

"system design plan" means a plan that manages an integrated containment system that shares the required DSA and/or ESS volume across the integrated containment system.

"void" means any constructed, open excavation in the ground.

"waste" as defined in section 13 of the *Environmental Protection Act 1994*.

"waste management hierarchy" has the meaning given by the *Waste Reduction and Recycling Act 2011*.

"water" is defined under Schedule 4 of the *Water Act 2000*

"waste water" means used water from the activity, process water or contaminated storm water.

"water quality" means the chemical, physical and biological condition of water.

"waters" includes all or any part of a river, stream, lake, lagoon, pond, swamp, wetland, unconfined surface water, unconfined natural or artificial watercourse, bed and bank of any waters, dams, non-tidal or tidal waters (including the sea), storm water channel, storm water drain, roadside gutter, storm water runoff, and groundwater.

"WaTERS" means the administering authority's Water Tracking and Electronic Reporting System (WaTERS) to submit surface and ground water monitoring and tracking data online, which can be accessed via following web link - www.business.qld.gov.au/industries/mining-energy-water/water/maps-data/submit-data.

"wet season" means the time of year, covering one or more months, when most of the average annual rainfall in a region occurs. For the purposes of DSA determination this time of year is deemed to extend from 1 November in one year to 31 May in the following year inclusive.

"µg/L" means micrograms per litre.

END OF DEFINITIONS

ATTACHMENTS

Attachment 1: Rehabilitation Requirements

Mine Domain	Rehabilitation Goal	Rehabilitation Objective	Indicator	Completion Criteria
Dry Rejects Emplacement Area (DREA) and ROM Areas.	Safe	TBD	TBD	TBD
	Non-polluting	TBD	TBD	TBD
	Stable landform	TBD	TBD	TBD
	Sustainable land use	TBD	TBD	TBD
Roads and Tracks, and Infrastructure.	Safe	TBD	TBD	TBD
	Non-polluting	TBD	TBD	TBD
	Stable landform	TBD	TBD	TBD
	Sustainable land use	TBD	TBD	TBD
Subsided Areas, Ponded Areas, and Sediment Supply Dams.	Safe	TBD	TBD	TBD
	Non-polluting	TBD	TBD	TBD
	Stable landform	TBD	TBD	TBD
	Sustainable land use	TBD	TBD	TBD

Figure 1 (Surface Water Release Points and Groundwater Monitoring Locations)

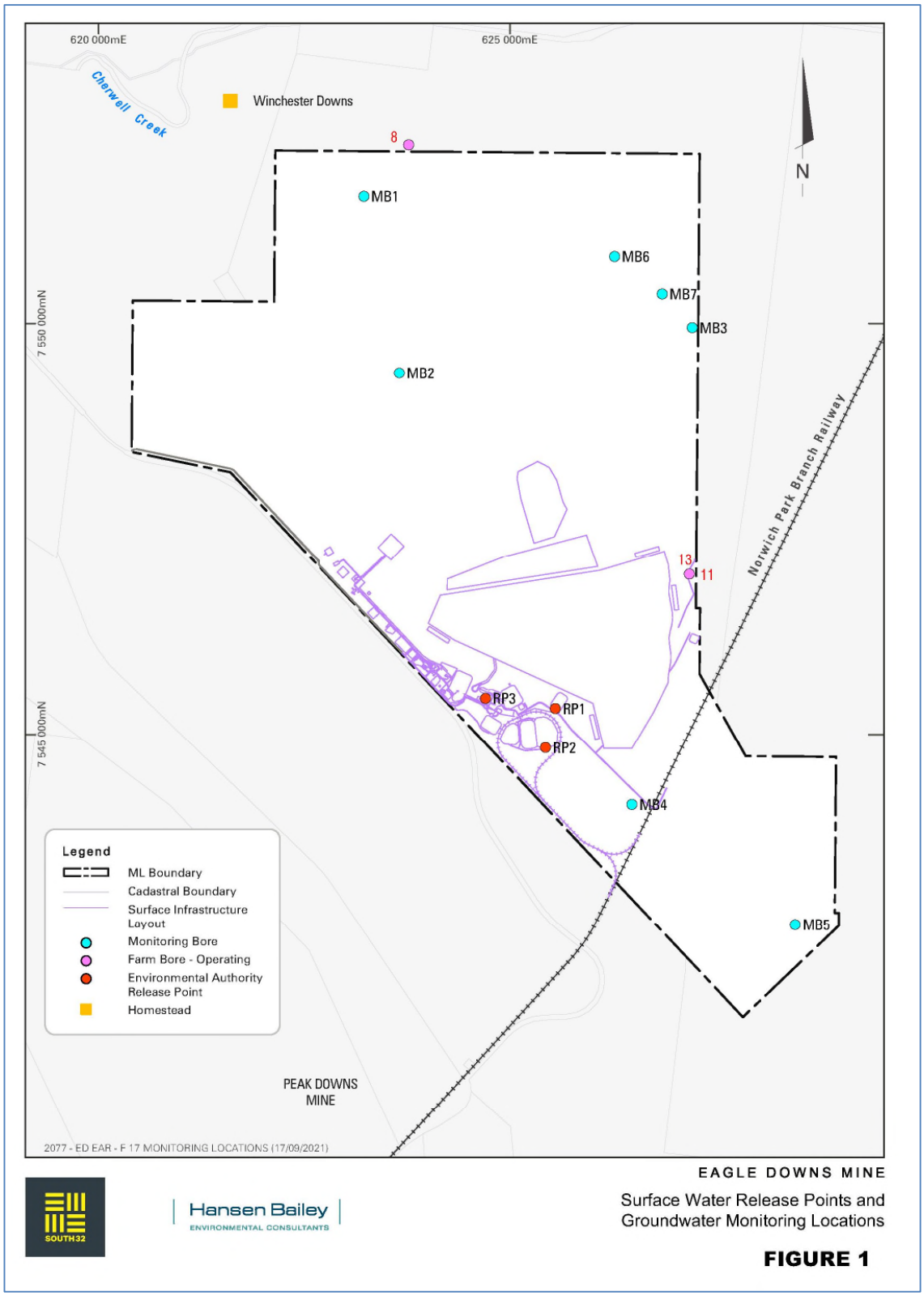


Figure 2 (Maximum disturbance area)

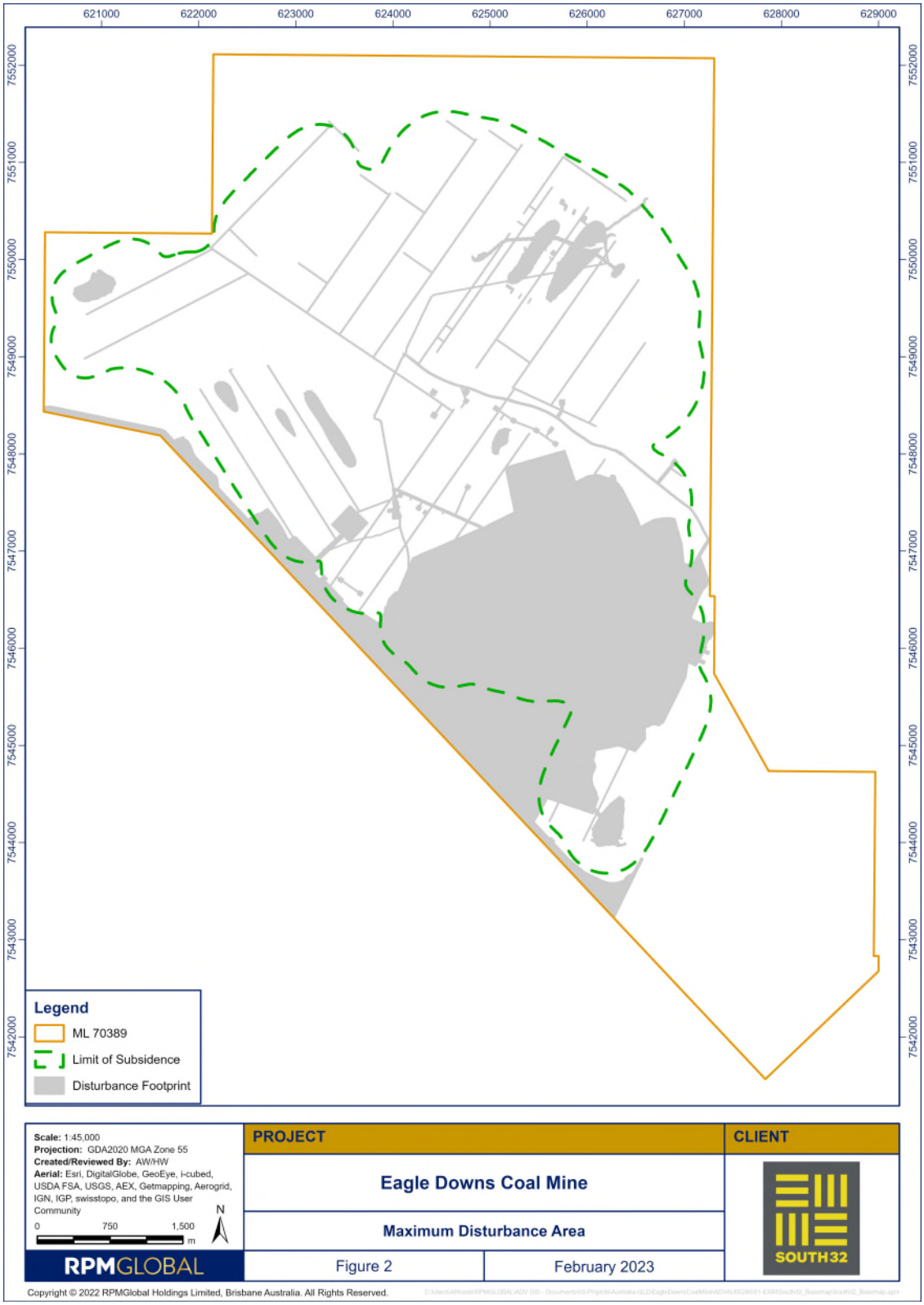


Figure 3 (Maximum disturbance area – detail)

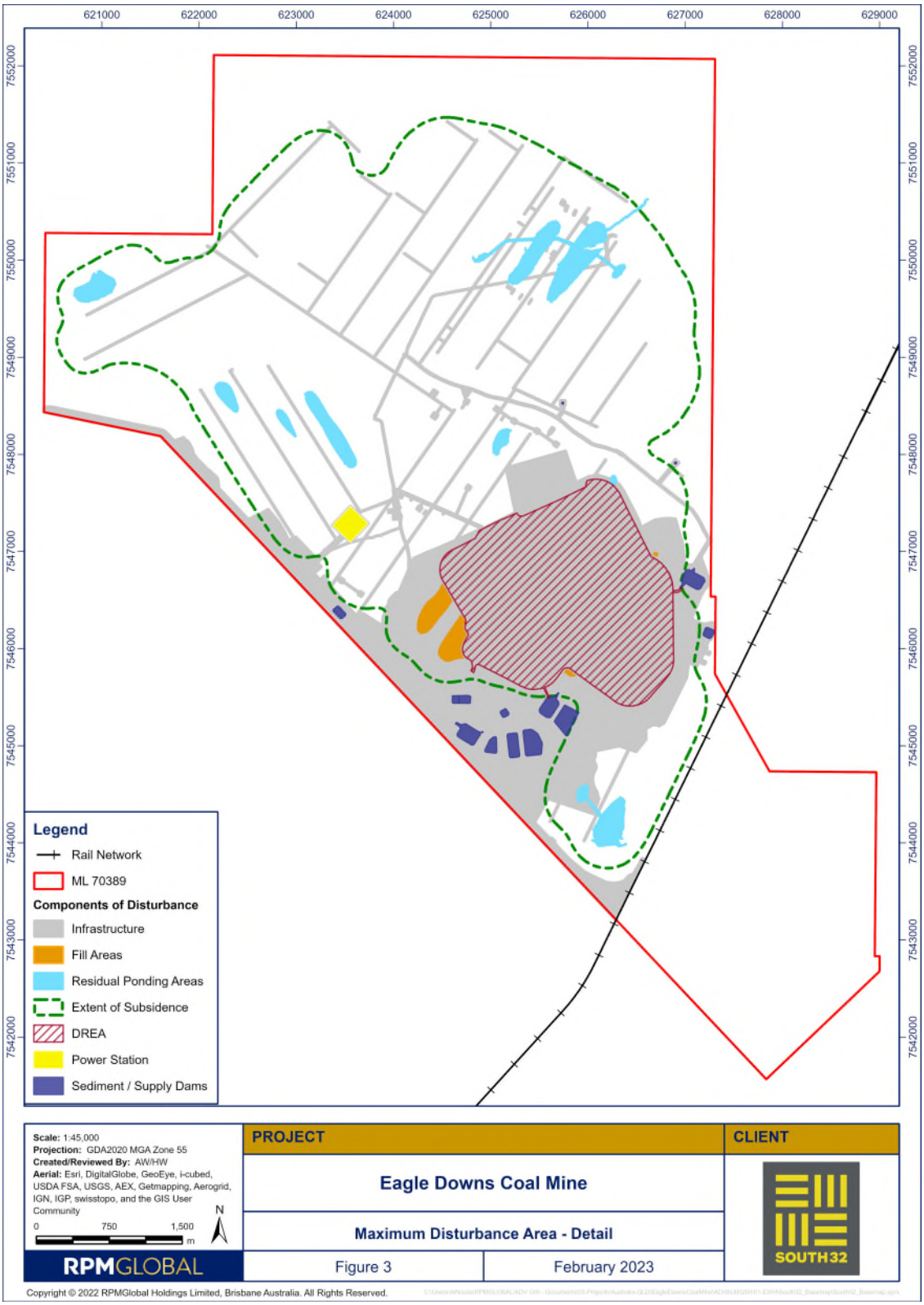


Figure 4 (Monitoring Points)

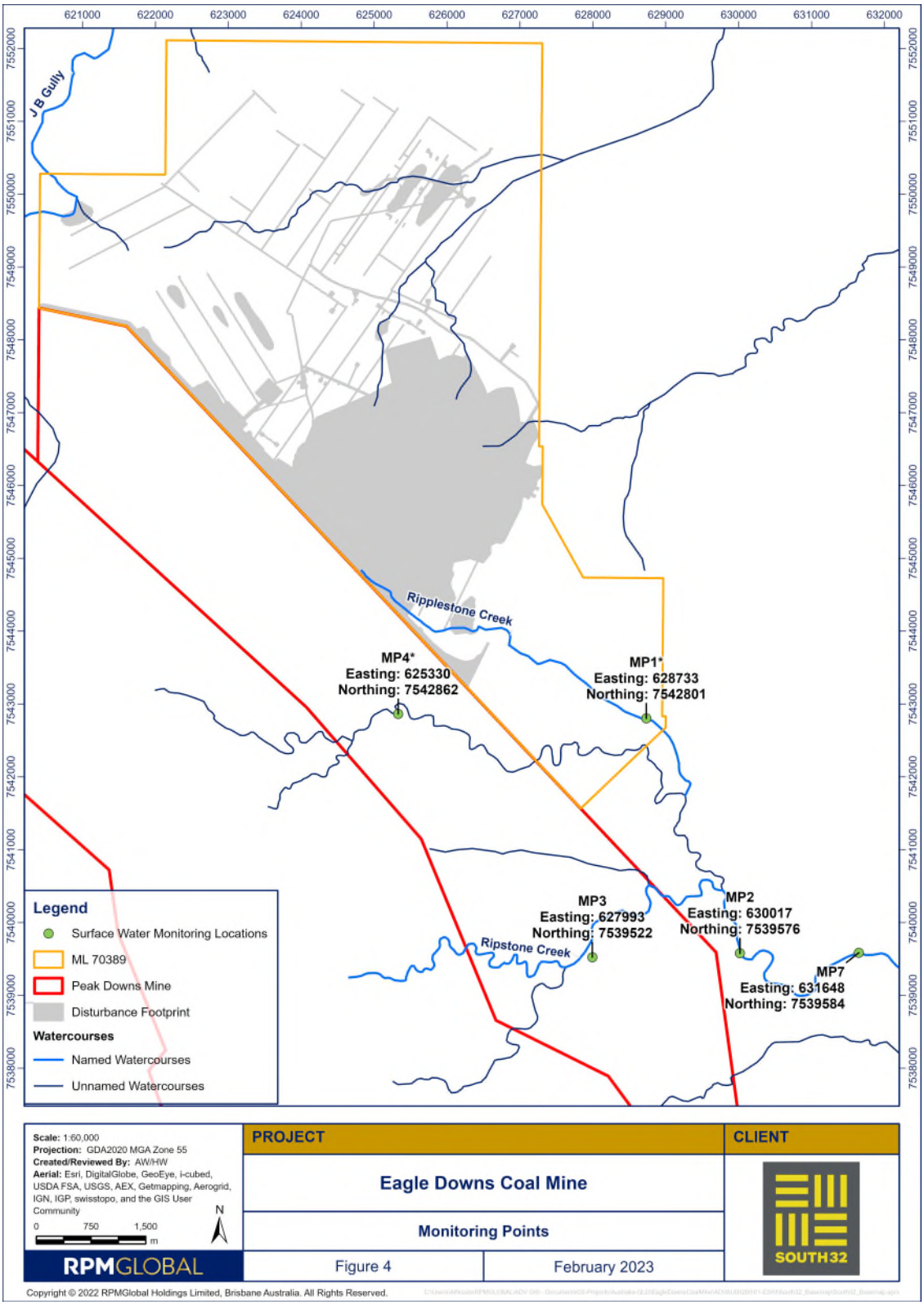


Figure 5 (Bluegrass and Brigalow Threatened Ecological Communities)

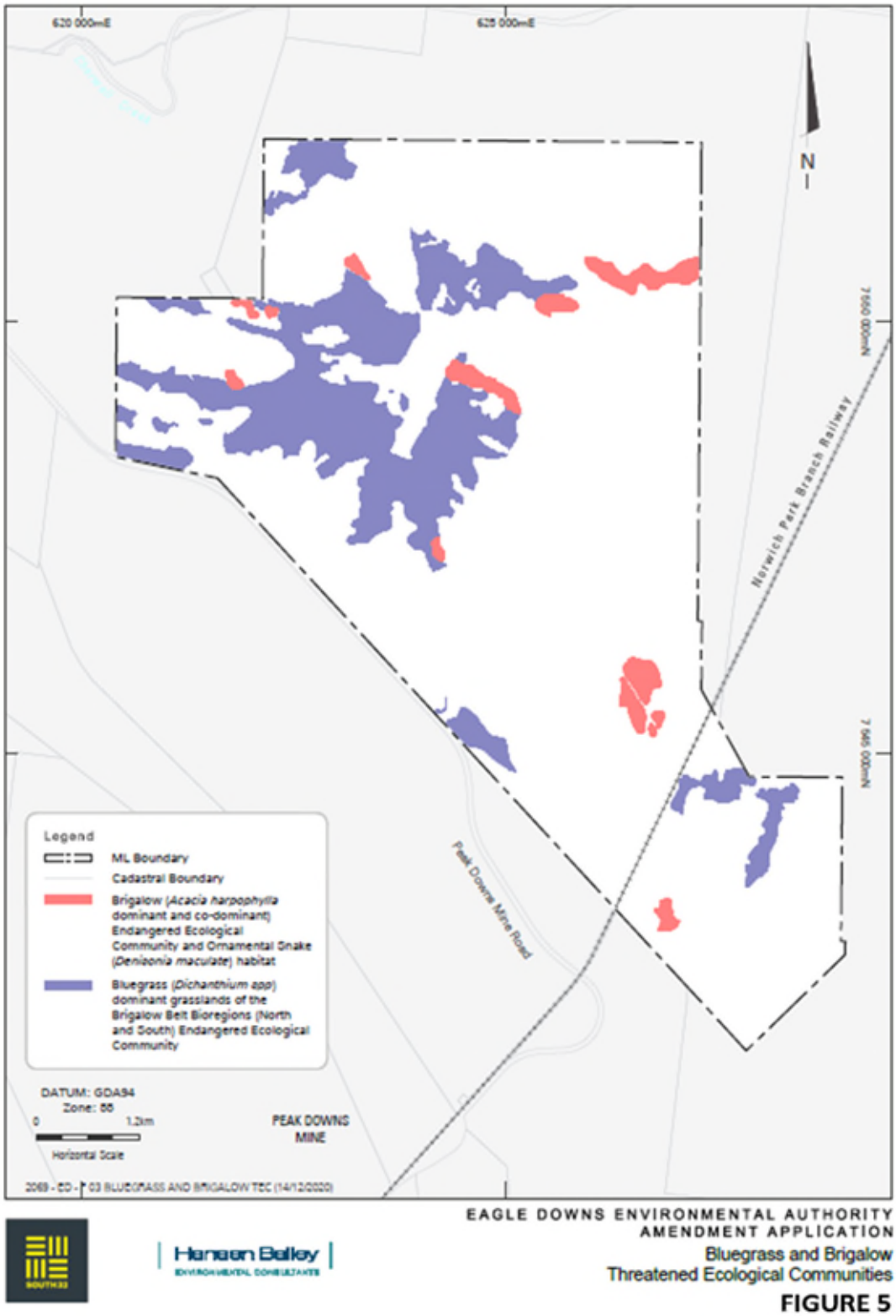


Figure 6 (Prescribed Environmental Matter – Regional Ecosystems)

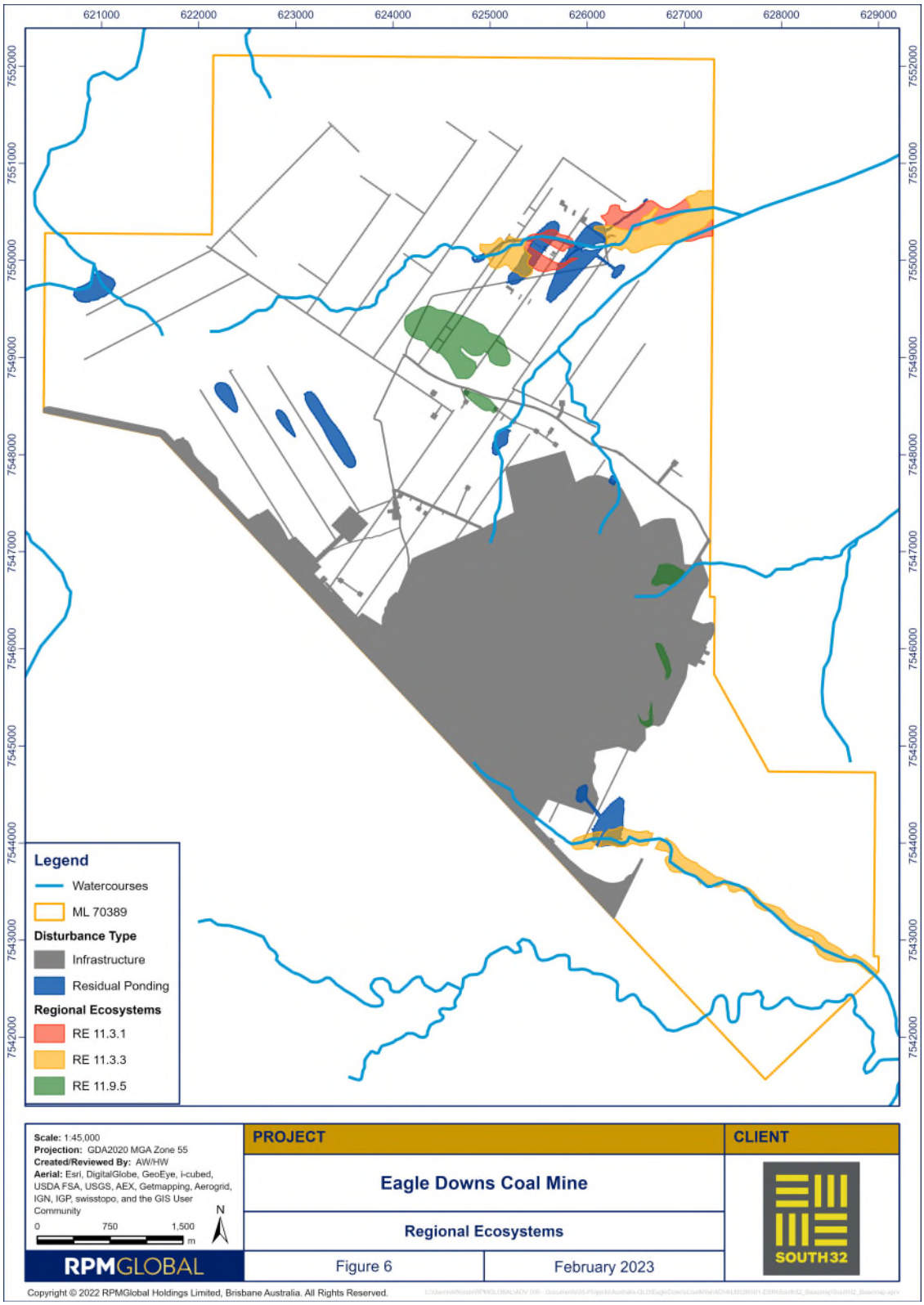


Figure 7 (Prescribed Environmental Matter – Short-Beaked Echidna, Squatter Pigeon)

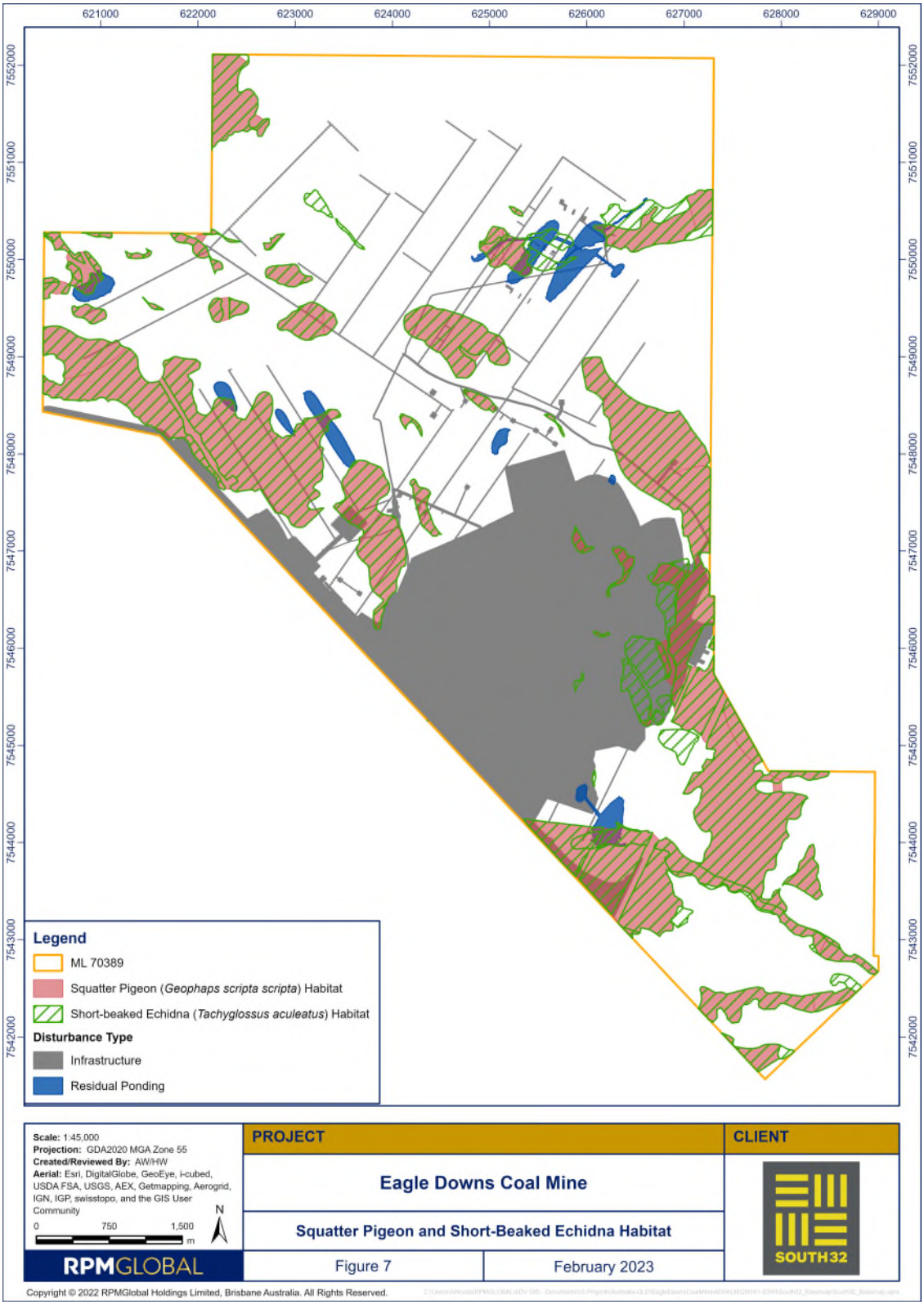


Figure 8 (Prescribed Environmental Matter – Australian Painted Snipe, Greater Glider and White-throated Needletail)

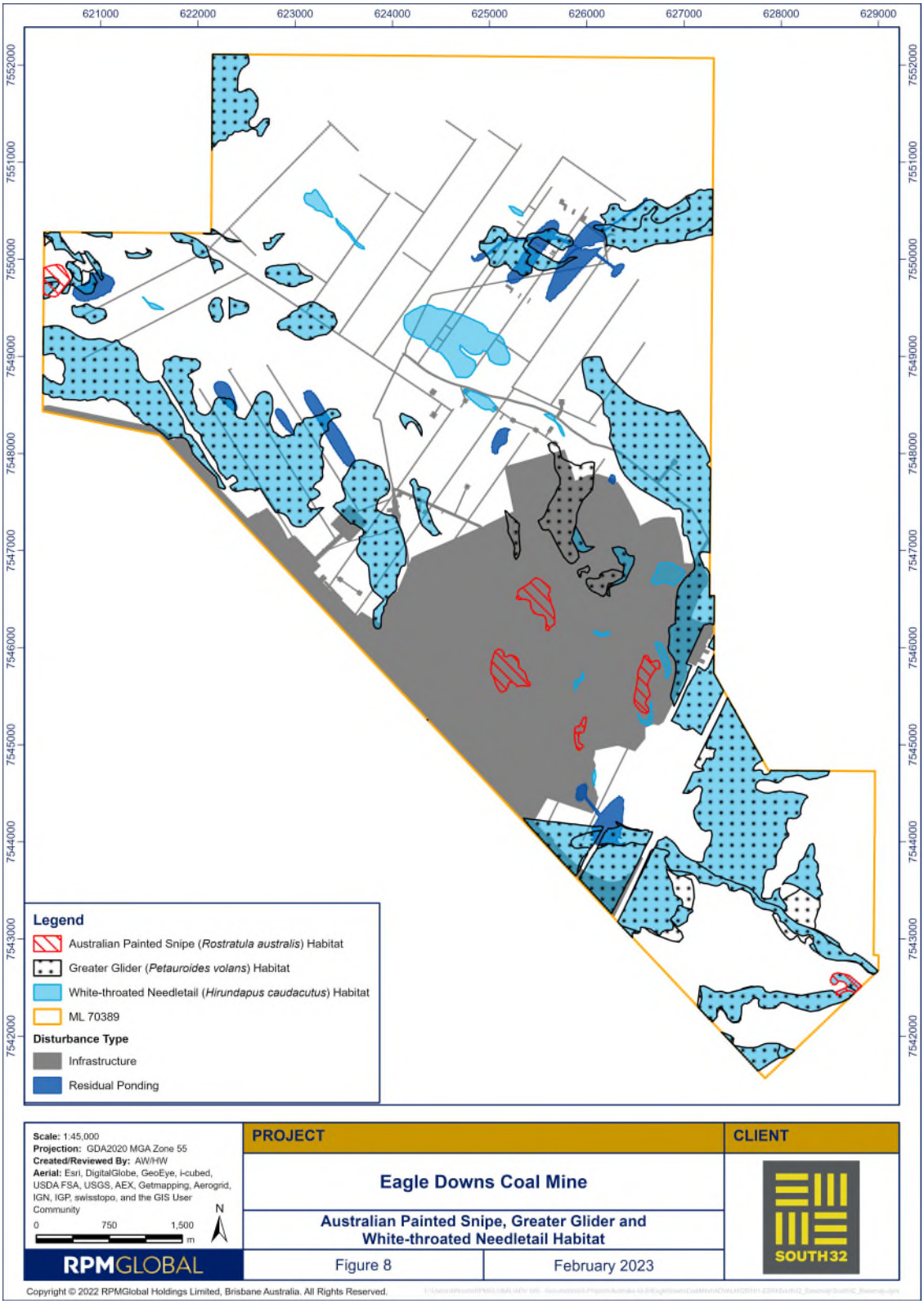


Figure 9 (Prescribed Environmental Matter – Koala)



Figure 10 (Prescribed Environmental Matter – Ornamental Snake)



END OF ENVIRONMENTAL AUTHORITY

Appendix B. PRCP Schedule

PRCP schedule

Environmental Protection Act 1994

PRCP schedule P-PRCP-100812653_V1

This is the approved form for a PRCP schedule issued by the administering authority under Chapter 5 of the Environmental Protection Act 1994*.*

PRCP schedule: P-PRCP-100812653_V1

PRCP schedule holder(s)

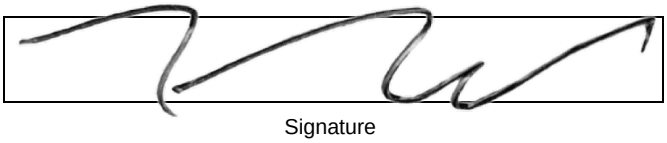
Name(s)	Registered address
AQUILA COAL PTY LTD	Level 12 225 St Georges Tce PERTH WA 6000 Australia
SOUTH32 EAGLE DOWNS PTY LTD	108 St Georges Tce PERTH WA 6000 Australia

Location details

Location(s)
Mining Lease (ML)70389, Petroleum Lease (PL) 485

Take effect

In accordance with section 202B of the *Environmental Protection Act 1994* (EP Act), the PRCP schedule has effect on the day the environmental authority for carrying out relevant activities on land to which the schedule relates takes effect. Pursuant to section 202C of the EP Act, a PRCP schedule continues in force until the environmental authority for the relevant activities to which the PRCP schedule relates is cancelled or surrendered, even if the resource tenure expires or is cancelled and even if the relevant environmental authority is suspended under Chapter 5, part 11 or 11A of the EP Act.



Signature

17 February 2025

Date

Ben Byrd
Department of the Environment, Tourism, Science and Innovation
Delegate of the administering authority
Environmental Protection Act 1994

Enquiries:
Business Centre Coal
Department of the Environment, Tourism, Science and Innovation
PO Bo 3028, Emerald QLD 4720
Phone: (07) 4987 9320
Email: CRMining@des.qld.gov.au

Queensland Government

Obligations under the *Environmental Protection Act 1994*

Pursuant to section 202E of the EP Act, if there is an inconsistency between an environmental authority and a PRCP schedule, the environmental authority prevails to the extent of the inconsistency.

Pursuant to section 285 of the EP Act:

- the holder of a PRCP schedule must commission an audit of the schedule by a rehabilitation auditor for the following periods (each an audit period) —
    (a) the 3-year period starting on the day the schedule takes effect
    (b) each 3-year period starting on the day after the previous audit period ended.
- the holder must, within 4 months after the end of each audit period, give the administering authority -
    (a) the rehabilitation auditor's report (an audit report) about the audit that complies with section 286 of the EP Act, and
    (b) a declaration for the audit report that complies with section 285 of the EP Act.

In addition to the requirements found in the conditions of this PRCP schedule, the holder must also meet their obligations under the environmental authority, the EP Act, and the regulations made under the EP Act. For example, the holder must comply with the following provisions of the EP Act:

- general environmental duty (section 319)
- duty to notify environmental harm (section 320-320G)
- offence of causing serious or material environmental harm (sections 437-439)
- offence of causing environmental nuisance (section 440)
- offence of depositing prescribed water contaminants in waters and related matters (section 440ZG)
- offence to place contaminant where environmental harm or nuisance may be caused (section 443).

PRCP schedule

The PRCP schedule incorporates the following sections:

- Section A - Conditions of PRCP schedule
- Section B - Final site design and reference maps
- Section C - Post mining land uses

Section A - Conditions of PRCP schedule

Pursuant to section 206A of the EP Act:

- it is a condition of this 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 carrying out the activity.
- it is a condition of this 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.

General Conditions

PRCP1 For each rehabilitation area, the holder must achieve the rehabilitation milestone criteria (milestone reference):

i. for the cumulative area available specified in this schedule; and

ii. by the milestone completion date specified in this schedule.

PRCP2 Where land becomes 'available for rehabilitation' earlier than the date nominated in this schedule, the holder must:

i. notify the administering authority in writing within 30 days of the land becoming 'available for rehabilitation'. The written notification must include precise details of the relevant land area and the date when that land became 'available for rehabilitation'; and

ii. within 90 days of the land becoming 'available for rehabilitation', apply to the administering authority to amend this schedule in a way that maximises the progressive rehabilitation of the land to a stable condition.

Note: reference to "earlier than the nominated date in the schedule" means a date that is greater than 1 year prior to the date nominated in the schedule.

PRCP3 Where an area achieves a rehabilitation milestone, the holder must continue to achieve the milestone criteria until a surrender for the area is approved.

PRCP4 The holder must maintain a risk register that identifies the risks to not achieving a stable condition for post-mining land uses, and how the risks are being managed or minimised. The risk register must be reviewed annually.

PRCP5 The holder must undertake monitoring and maintenance as described in this schedule and the rehabilitation planning part for the activity. Where there is any inconsistency between this schedule and the rehabilitation planning part the schedule criteria prevail to the extent of the inconsistency.

PRCP6 The holder must make and keep up to date records on:

i. Achievement and maintenance of achievement of each rehabilitation milestone criteria of this schedule.

ii. Rehabilitation activities and the results of those activities (including but not limited to, actions taken, date, location, methods, data collected, Quality Assurance/Quality Control, photos, waste tracking and disposal records, appropriately qualified person details and assumptions);

iii. Maintenance of rehabilitation and the results of maintenance activities;

iv. Monitoring of rehabilitation and the results of monitoring;

v. Details and results of rehabilitation trials;

vi. Designs, drawings, specifications and any similar documents developed in accordance with good professional practice in relation to rehabilitation milestones or milestone criteria;

vii. All documents in relation to the requirements of this schedule, including reports (e.g. site investigation report), statements (e.g. site suitability statement), certifications, assessments, investigations, inspections, audits or any similar documents developed in relation to rehabilitation milestones or milestone criteria;

viii. Landholder agreements;

ix. Details of community consultation in the community consultation register relating to rehabilitation and closure activities.

PRCP7 Records made under PRCP6 must be kept until the relevant environmental authority has been surrendered or cancelled.

PRCP8 Records made under PRCP6 must be provided to the administering authority in the specified format within 10 business days of a written request.

PRCP9 Chapter 5, Part 12, Division 1 of the *Environmental Protection Act 1994* prevails over condition **PRCP10** to **PRCP12** inclusive to the extent of any inconsistency.

PRCP10 The holder of a PRCP schedule must commission an audit of the schedule by a rehabilitation auditor for the following periods (each an ***audit period***)

i. The 3-year period starting on the day the schedule takes effect; and

ii. Each 3-year period starting on the day after the previous audit period ended.

PRCP11 The holder, within 4 months after the end of each audit period, gives the administering authority:

i. The rehabilitation auditor's report (an ***audit report***) about the audit, that complies with **PRCP12**, and

ii. A declaration by the authorised representative of the holder, for the audit report stating the holder –

a. Has not knowingly given false or misleading information to the rehabilitation auditor; and

b. Has given all relevant information to the rehabilitation auditor

PRCP12 An audit report for a PRCP schedule must be in the approved form, and include the following:

i. A statement about whether the holder has complied with the schedule during the audit period, including –

a. Details of actions the holder has taken, or failed to take, in relation to the rehabilitation milestones and management milestones under the schedule; and

b. Whether the holder has complied, or failed to comply, with conditions imposed on the schedule; and

c. Whether information given to the administering authority under this Act about rehabilitation carried out under the schedule is accurate;

ii. An assessment of whether the post-mining land use for land the subject of the schedule is likely to be achieved, having regard to the rehabilitation that has been and is to be carried out under the schedule;

iii. Recommendations about actions the holder should take to ensure rehabilitation milestones and management milestones are achieved or conditions of the schedule are complied with;

PRCP13 At least 2 years prior to the earliest commencement of any rehabilitation milestone, an independent AQP, following peer review, certifies that existing and proposed permanent Erosion and Sediment Control (ESC) structures and drainage structures on site are appropriate to the landform, materials and the PMLU, with consideration given to their performance, stability, maintenance requirements, and residual risk post-closure; and provides for the achievement of stable condition as per the *Environmental Protection Act 1994.*

PRCP14 The certification by the AQP under PRCP13 must make an assessment of whether the installation of such structures would result in greater environmental harm than the ponding of the landform.

PRCP15 Where a structure would result in greater environmental harm, an amendment to EA EPML00586713 and the PRCP Schedule must be sought.

PRCP16 The extent of ponding the result of the outcomes of **PRCP14** and **PRCP15** must not exceed the extent of RA2 depicted in Figure 2 Rehabilitation Areas.

PRCP17 All AQP designs, specifications, certifications, assessments and any similar documents developed in accordance with good professional practice must include documented consideration of any relevant guideline or publication material.

PRCP18 For surface water quality monitoring conducted under RM10 and RM11, where the surface water quality at the downstream site exceeds the upstream site result, an AQP must complete an assessment of the cause and risk of rehabilitation not achieving a stable condition within the schedule timeframe and:

i. Where there is a low risk to achieving a stable condition from the ML70389 and PL485, then no further action is to be taken; or
ii. Where there is a risk greater than low to achieving a stable condition, then an assessment of potential environment harm and any changes or rectification actions to rehabilitation activities must be determined and implemented.
iii. PRCP18(i) can only be triggered 3 times over 5 consecutive years prior to surrender.

PRCP19 The assessment under condition PRCP18 must be completed and provided to the administering authority within three (3) months of receiving the relevant sampling results.

PRCP20 If condition PRCP18(ii) is triggered, the relevant 5-year timeframe under criteria RM10.10 or RM11.8 is reset.

PRCP21 ***Subsidence register***

The holder must keep a register of all longwall panels detailing:

a) the surface area (ha) and depth within each subsided panel, including dry subsidence areas as well as areas with temporary and permanent/residual ponds;
b) The locations of pre-existing drainage lines and drainage lines to be established to prevent/manage ponding;
c) The locations of proposed and existing infrastructure;
d) The pre-subsidence (baseline) condition of the vegetation and land condition; and
e) Spatial data for each area including each temporary and permanent/residual pond modelled/predicted, and/or authorised ponded areas.

The register must be provided to the administering authority upon request.

PRCP22 The baseline condition of each subsidence panel must be assessed prior to mining of each mining panel. The baseline condition must include, but is not limited to,

a) Site hydrology and fluvial networks;
b) Soil types, properties and productivity;
c) Flora species composition and structure;
d) Land stability (pre-existing degradation/erosion and predisposition to ongoing stability issues); and
e) Regional ecosystem details, if remnant, and BioCondition assessed in accordance with latest version of the BioCondition Assessment Methodology (Queensland Herbarium*). Methodology may include digital surface model or terrain model generated via LiDAR survey.

Components of the baseline condition should be informed by the latest version of the Eagle Downs PRC planning part (underground mines) and where relevant, the Eagle Downs Subsidence management plan with consideration of the following:

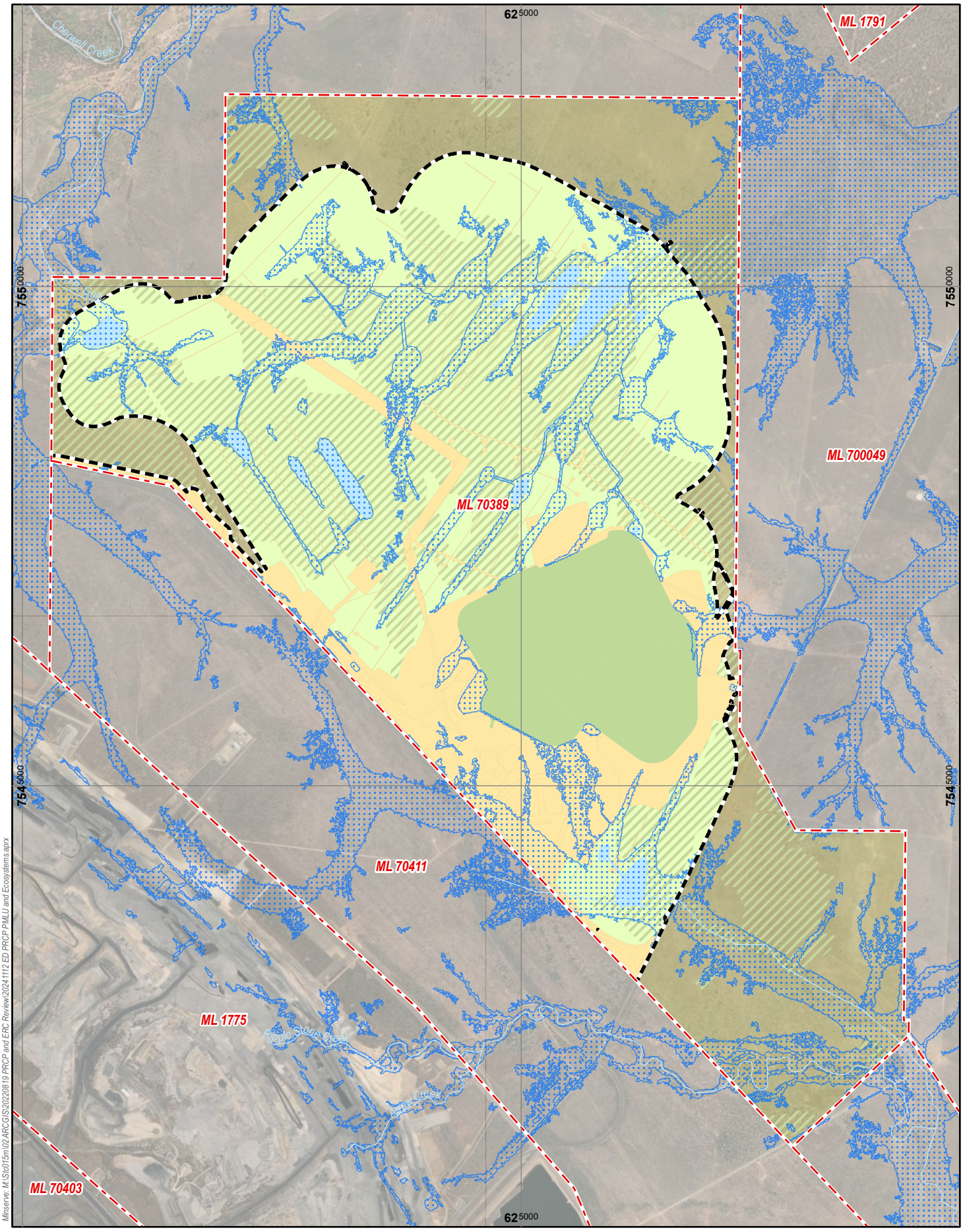
i. Assessment of subsidence impacts on vegetation;
ii. Subsidence analysis and modelling;
iii. Surface ponding and cracking mitigation measures; and
iv. Post-subsidence stabilisation requirements

The other information the administering authority considers necessary to decide whether to take action to amend the schedule under part 6 of the *Environmental Protection Act 1994* (QLD) (EP Act).

END OF CONDITIONS

* Eyre, T.J., Kelly, A.L, Neldner, V.J., Wilson, B.A., Ferguson, D.J., Laidlaw, M.J. and Franks, A.J. (2015). BioCondition: A Condition Assessment Framework for Terrestrial Biodiversity in Queensland. Assessment Manual. Version 2.2. Queensland Herbarium, Department of Science, Information Technology, Innovation and Arts, Brisbane.

Section B - Final site design and reference maps



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Minserve

DISCLAIMER: Third party data sources are used in this map compilation. Minserve makes no warranty regarding this data's accuracy or currency.

LEGEND

- Mining Lease
- Maximum Disturbance Footprint
- Waterway
- Floodplain

PMLU TYPE

- Intermittent cattle watering holes
- Grazing
- Grazing (undisturbed)
- Native Ecosystem
- Remnant Regional Ecosystem
- Native Ecosystem (grassland RE 11.9.3)

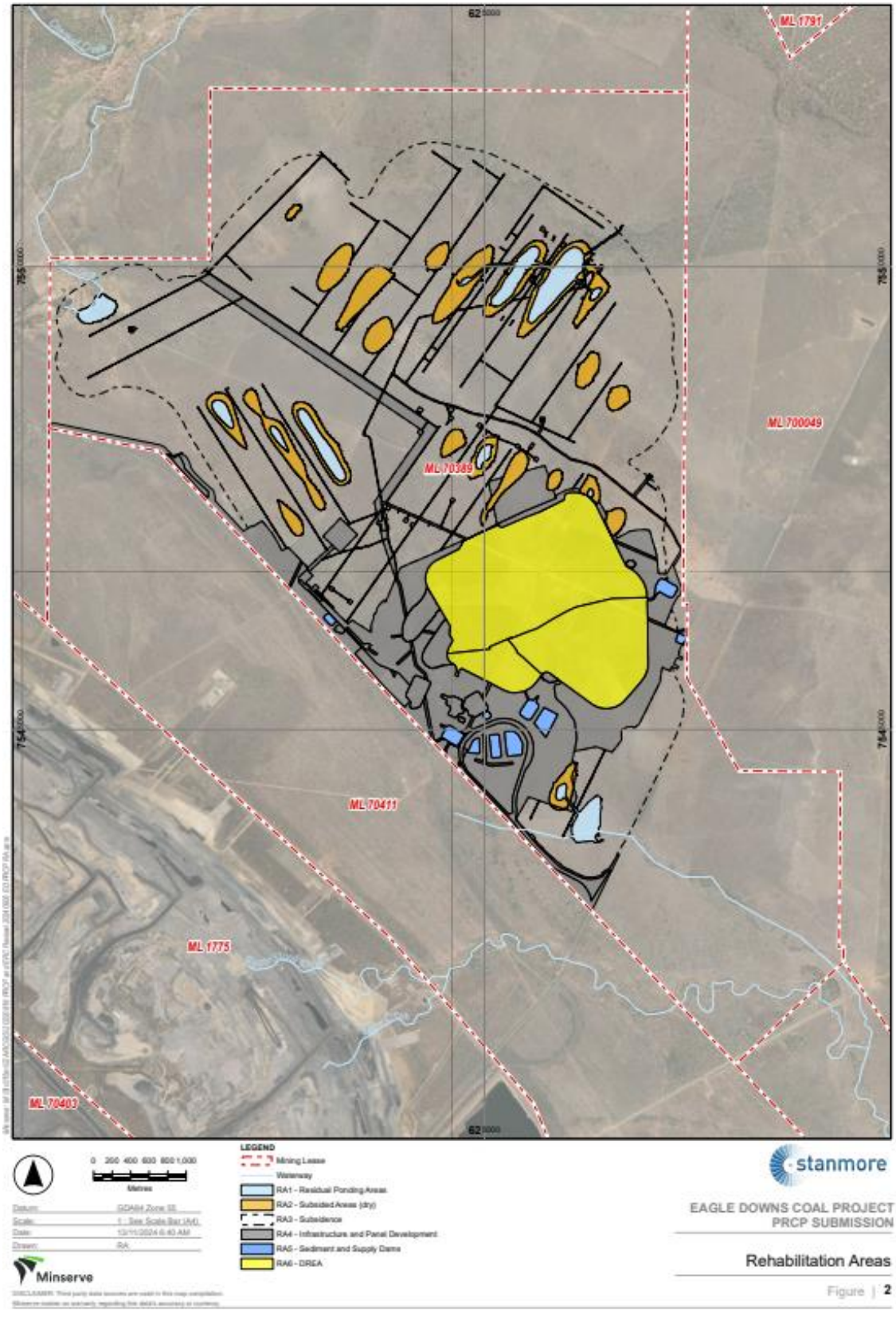
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EAGLE DOWNS COAL PROJECT
PRCP SUBMISSION

Final Site Design

Figure | 1

Figure 2: Rehabilitation Areas



Section C – Post mining land uses

(RA1) Rehabilitation area 1

Post-mining land uses (PMLU)										
Rehabilitation area	RA1									
Relevant activities	Residual Ponding Areas									
Total rehabilitation area size (ha)	76.4 ha									
Commencement of first milestone: RM1	2045									
PMLU	Intermittent cattle watering holes									
Date area is available	1/01/2045	10/12/2045	10/12/2050	10/12/2055	10/12/2060	10/12/2065	10/12/2070	10/12/2075	10/12/2080	10/12/2085
Cumulative area available (ha)	8.0	8.0	8.0	8.0	27.7	41.1	41.1	76.4	76.4	76.4
Milestone completed by	10/12/2045	10/12/2050	10/12/2055	10/12/2060	10/12/2065	10/12/2070	10/12/2075	10/12/2080	10/12/2085	10/12/2090
Milestone Reference	**Cumulative area achieved (ha)**									
RM1	8.0				27.7	41.1		76.4		
RM3		8.0			27.7	41.1		76.4		
RM5		8.0			27.7	41.1		76.4		
RM8			8.0			27.7	41.1		76.4	
RM9				8.0			27.7	41.1		76.4

(RA2) Rehabilitation area 2

Post-mining land uses (PMLU)											
Rehabilitation area	RA2										
Relevant activities	Subsided Areas (dry)										
Total rehabilitation area size (ha)	180.5										
Commencement of first milestone: RM1	2045										
PMLU	Native ecosystem										
Date area is available	1/01/2045	10/12/2045	10/12/2050	10/12/2055	10/12/2060	10/12/2065	10/12/2070	10/12/2075	10/12/2080	10/12/2085	10/12/2090
Cumulative area available (ha)	1.7	1.7	1.7	1.7	41.2	78.9	119.2	180.5	180.5	180.5	180.5
Milestone completed by	10/12/2045	10/12/2050	10/12/2055	10/12/2060	10/12/2065	10/12/2070	10/12/2075	10/12/2080	10/12/2085	10/12/2090	10/12/2095
Milestone Reference	**Cumulative area achieved (ha)**										
RM1	1.7				41.2	78.9	119.2	180.5			
RM3		1.7			41.2	78.9	119.2	180.5			
RM5		1.7				41.2	78.2	119.2	180.5		
RM7		1.7				41.2	78.2	119.2	180.5		
RM8			1.7				41.2	78.2	119.2	180.5	
RM11				1.7				41.2	78.2	119.2	180.5

(RA3) Rehabilitation area 3

Post-mining land uses (PMLU)											
Rehabilitation area	RA3										
Relevant activities	Subsidence										
Total rehabilitation area size (ha)	1914.1										
Commencement of first milestone:RM1	2042										
PMLU	Native Ecosystem (Remnant vegetation)										
Date area is available	10/12/2042	10/12/2045	10/12/2050	10/12/2055	10/12/2060	10/12/2065	10/12/2070	10/12/2075	10/12/2080	10/12/2085	10/12/2090
Cumulative area available (ha)	36	109	320	580	890	1210	1551	1914.1	1914.1	1914.1	1914.1
Milestone completed by	10/12/2045	10/12/2050	10/12/2055	10/12/2060	10/12/2065	10/12/2070	10/12/2075	10/12/2080	10/12/2085	10/12/2090	10/12/2095
Milestone Reference	**Cumulative area achieved (ha)**										
RM1	36	109	320	580	890	1210	1551	1914.1			
RM3	36	109	320	580	890	1210	1551	1914.1			
RM5		36	109	320	580	890	1210	1914.1			
RM7		36	109	320	580	890	1210	1551	1914.1		
RM8			36	109	320	580	890	1210	1551	1914.1	
RM11				36	109	320	580	890	1210	1551	1914.1

(RA4) Rehabilitation area 4

Post-mining land uses (PMLU)										
Rehabilitation area	RA4									
Relevant activities	Infrastructure									
Total rehabilitation area size (ha)	570.6									
Commencement of first milestone:RM1	2065									
PMLU	Grazing									
Date area is available	10/12/2065	10/12/2070	10/12/2075	10/12/2080	10/12/2085	10/12/2090				
Cumulative area available (ha)	85	160	570.6	570.6	570.6	570.6				
Milestone completed by	10/12/2070	10/12/2075	10/12/2080	10/12/2085	10/12/2090	10/12/2095				
Milestone Reference	**Cumulative area achieved (ha)**									
RM1	85	160	570.6							
RM2	85	160	570.6							
RM3	85	160	570.6							
RM5		85	160	570.6						
RM6		85	160	570.6						
RM8			85	160	570.6					
RM10				85	160	570.6				

(RA5) Rehabilitation area 5

Post-mining land uses (PMLU)										
Rehabilitation area	RA5									
Relevant activities	Sediment and Supply Dams									
Total rehabilitation area size (ha)	25.3									
Commencement of first milestone: RM1	2075									
PMLU	Grazing									
Date area is available	10/12/2075	10/12/2080	10/12/2085	10/12/2090						
Cumulative area available (ha)	25.3	25.3	25.3	25.3						
Milestone completed by	10/12/2080	10/12/2085	10/12/2090	10/12/2095						
Milestone Reference	**Cumulative area achieved (ha)**									
RM1	25.3									
RM2	25.3									
RM3	25.3									
RM5		25.3								
RM6		25.3								
RM8			25.3							
RM10				25.3						

(RA6) Rehabilitation area 6

Post-mining land uses (PMLU)										
Rehabilitation area	RA6									
Relevant activities	DREA									
Total rehabilitation area size (ha)	384.7									
Commencement of first milestone: RM1	2065									
PMLU	Native Ecosystem (Grassland)									
Date area is available	10/12/2065	10/12/2070	10/12/2075	10/12/2080	10/12/2085	10/12/2090				
Cumulative area available (ha)	120	384.7	384.7	384.7	384.7	384.7				
Milestone completed by	10/12/2070	10/12/2075	10/12/2080	10/12/2085	10/12/2090	10/12/2095				
Milestone Reference	**Cumulative area achieved (ha)**									
RM1	120	384.7								
RM2	120	384.7								
RM3	120	384.7								
RM4		120	384.7							
RM5			120	384.7						
RM7				384.7						
RM8				120	384.7					
RM11					120	384.7				

Rehabilitation area milestones

Milestone reference	Rehabilitation milestone	Milestone criteria
RM1	Infrastructure decommissioning and removal	1.1 RM1 does not apply to infrastructure required for rehabilitation **Built Infrastructure** 1.2 All services disconnected, terminated and removed offsite. 1.3 All buildings, and associated infrastructure (including concrete slabs and footings) demolished or removed offsite. 1.4 All roads (bitumen, blue metal, aggregate) removed. 1.5 All fencing not included in the PMLU removed offsite. 1.6 Machinery and equipment removed offsite. 1.7 All waste removed offsite. 1.8 All pipelines drained and removed. 1.9 All surface drainage infrastructure removed. **Gas Drainage Boreholes** 1.10 Borehole decommissioning completed in accordance with the Code of Practice for the Construction and Abandonment of Petroleum wells and associated bores in Queensland (the Code) (Department of Resources, 2019) latest edition. 1.11 An appropriately qualified person (AQP) has certified the borehole has been remediated in accordance with the Code. **Surface to Seam Boreholes** 1.12 For all surface to seam boreholes (including but not limited to, exploration bores, water monitoring bores, dewatering bores and bores with diameter up to 300mm): (a) Boreholes grouted and/or plugged. (b) Boreholes capped 0.5 m below surface. (c) Decommission of exploration bores completed in accordance with ‘Eligibility Criteria and Standard Conditions for Exploration and Mineral Development Projects’
RM2	Identification, remediation and removal of contaminated land	2.1. Contaminated sediments and liners removed or incorporated into the final landform of the Dry Rejects Emplacement Area (DREA). 2.2. Brine disposed at a licenced waste facility.

		2.3 Contaminated Land Investigation Document completed in accordance with the *Environmental Protection Act 1994*, including a site investigation report, and, where required, a Validation Report and/or a draft Site Management Plan. 2.4 Contaminated and hazardous material either remediated in-situ or removed/transported to an approved landfill for disposal and waste tracking information recorded and submitted. 2.5 A declaration from a Suitably Qualified Person that no contamination unsuitable for the post-mining land use remains.
RM3	Landform reshaping and final contouring	**All areas (excluding RA6)** 3.1 Dams dewatered and desilted. 3.2 Liners from dams removed. 3.3 Rehabilitated areas stabilised and reshaped to a slope of less than 5%. 3.4 All major earthworks completed, slopes and general reshaping and pushing/trimming completed to achieve final landform. 3.5 An AQP certifies that the constructed landform achieves design criteria for geotechnical stability with a Factor of Safety (FOS) ≥ 1.5. **DREA (RA6)** 3.6 Closure and decommissioning plan has been reviewed and detailed design completed and certified by a third-party AQP. 3.7 Batter slopes reshaped following cessation of subsidence in accordance with the AQP design. 3.8 Batter slopes reshaped to ≤15%. 3.9 Free-draining top surface graded to 2%. 3.10 All major earthworks completed. 3.11 Fencing to exclude livestock installed. 3.12 An AQP confirms that performance objectives for the DREA clay liner have been achieved during construction, maintained during operations and are suitable for closure. 3.13 An AQP certifies that the constructed landform achieves design criteria for geotechnical stability with a Factor of Safety (FOS) ≥ 1.5.
RM4	Installation of a cover system (DREA)	4.1 Installation of a cover system in accordance with the AQP design. 4.2 Confirmation by an AQP that the cover system has been installed as per the design and displays erosional stability, is geotechnically stable and supports the PMLU. 4.3 Confirmation from AQP that the installed cover is effective in mitigating the potential for migration of contaminants from the DREA to the receiving environment.

RM5	Surface preparation	**All rehabilitation areas** 5.1 Any erosion or effects of subsidence remediated as per the closure conditions of the latest version of the Subsidence Management Plan and to ensure maintenance of the baseline condition (latest assessed) as determined under condition **PRCP22**. 5.2 Remediate any erosion or subsidence by, but not limited to, addition of rock and/or log cover to assist erosion resistance of eventual vegetative groundcover. 5.3 Prior to placement of soil material for rehabilitation, growth media[1] health and suitability must be assessed and certified by an AQP as suitable for PMLU and target vegetation and to determine the need for ameliorants and fertilisers prior to sowing seed. 5.4 Where growth media health and suitability assessment identifies that growth media criteria below are not met, a recommendation is made for ameliorants and fertilisers prior to sowing seed, growth media to meet the following: (a) ECe ≤4 dS/m (b) Soil pH ≥5 and ≤9 (c) Exchangeable Sodium Percentage (ESP%) ≤6%. 5.5 Ameliorants such as fertiliser, gypsum and/or organic matter applied at rates determined by an AQP. 5.6 The surface and groundwater monitoring network, including, but not limited, to those locations identified in **Appendix 6** and **Appendix 7**, is installed and monitoring underway (one year of sampling undertaken). 5.7 At least 200mm of topsoil placed over disturbed areas[2]. **DREA (RA6)** 5.8 Rainfall infiltration ≤5% on top-surface and batters. **Surface Openings** 5.9 Construction of seal from surface into the underground workings complies with regulation 325 of the Queensland Coal Mining Safety and Health Regulations 2020 (CMSHR) and Registered Professional Engineer of Queensland (RPEQ) design. 5.10 Type E seal (ventilation control device capable of withstanding an overpressure of 70 kPa (CMSHR, 2020)) installed.

[1] Growth media is defined as all soil and soil-like material that will support the final vegetation cover. This includes the topsoil and subsoil where these materials are applied independently. Where the topsoil is incorporated into the underlying subsoil/spoil, topsoil refers to the depth of incorporation and the remaining depth is regarded as subsoil. The total depth of growth media is nominally considered to be the effective plant root zone

[2] Disturbed area is defined as any area where activities authorised under Environmental Authority EPML00586713 has resulted in ground disturbance. Disturbance may include removal of vegetation, groundcover or soil material from an area.

		5.11 AQP has prepared an As-Constructed Report that details the works undertaken, and certified that construction and backfilling of underground openings met the design intent. **Subsidence Areas (RA1, RA2, RA3)** 5.12 The cessation of subsidence confirmed by AQP. 5.13 Subsidence cracks do not exceed ≥25 mm in subsided areas. 5.14 Depression/ ponding areas are free draining and require no further drainage works. 5.15 Assessment of permanent ponds is completed by an AQP and identified sediment and water management actions are completed 5.16 Ponds are safe for native animals and stock access and have vegetated banks. 5.17 Water storages to be assessed and approved as safe and stable by an AQP.
RM6	Revegetation - pasture grass	6.1 Nitrogen fixing Legume species included in seed mix. 6.2 Complete seeding of all topsoil surfaces using a rehabilitation seed mix comprising only the species permitted by **Appendix 1 – pasture grass species**. 6.3 Native or introduced pasture grass seed species used to control erosion applied at 12 kg/ha.
RM7	Revegetation - native grasslands	**All rehabilitation areas** 7.1 Nitrogen fixing legume species included in seed mix. **DREA (RA6)** 7.2 Complete seeding of DREA surfaces using a rehabilitation seed mix comprising only the species permitted by **Appendix 2 – Native grassland (RE 11.9.3)**. 7.3 Seed with native grassland species applicable to RE 11.9.3 at 12kg/ha. **Subsidence Areas (RA3)** 7.4 Complete seeding of topsoil surfaces for disturbed areas using a seed mix that aligns with the species composition identified in the baseline condition assessment as described by **PRCP22**.
RM8	Achievement of surface requirement	**All rehabilitation areas** 8.1 Groundcover 60% perennial pasture biomass for grazing PMLU. 8.2 Weed presence is a maximum of 10% of total vegetative groundcover confirmed by an AQP in annual monitoring. 8.3 Less than 5% of declared weeds (as defined in the *Biosecurity Act 2014*). 8.4 No evidence of erosion classified as 'moderate' or 'severe' as defined by **Appendix 3 – Erosion classification framework**. 8.5 Areas free of hazardous materials or are rendered safe. 8.6 Surface water runoff is non-polluting to receiving waters and complies with **Appendix 5 – Surface water quality limits.**

		8.7 A third party AQP certifies that any erosion present will not compromise the achievement of a PMLU to a stable condition. 8.8 Growth media to meet the following: (a) ECe ≤4 dS/m (b) Soil pH ≥5 and ≤9 (c) Exchangeable Sodium Percentage (ESP%) ≤6%. **DREA (RA6)** 8.9 Native vegetation communities must achieve ≥15/30 from reference benchmark criteria of mapped pre-clear regional ecosystem for RE 11.9.3 as per **Appendix 4** Benchmarks for native vegetation communities when measured by an AQP using the BioCondition Assessment Methodology. 8.10 Average soil loss rates of ≤5t/ha/y on outer slope batters, with a maximum erosion rate of 10/t/ha/y. 8.11 No rills or gully erosion present ≥0.3m deep. **Subsidence Areas (RA1, RA2, RA3)** 8.12 No bed or bank erosion within drainage structures or watercourses as a result of subsidence or subsidence management. 8.13 No cracking or destabilisation present in beds or bands of drainage structures or watercourses as a result of subsidence or subsidence management. 8.14 Excavated drainage channels do not expose highly erodible material. 8.15 Subsidence areas intersecting flood-prone zones must be designed to withstand flood events without compromising the stability of drainage structures or causing erosion.
RM9	Achievement of PMLU intermittent cattle watering hole to stable condition	9.1 No evidence of erosion classified as 'moderate' or 'severe' as defined by **Appendix 3 – Erosion classification framework**. 9.2 A third party AQP certifies that any erosion present will not compromise the achievement of a PMLU to a stable condition. 9.3 All watering holes to be assessed and approved as safe and stable by an AQP. 9.4 Watering holes contain water of a suitable quality for native wildlife and/or livestock ingestion.
RM10	Achievement of PMLU grazing to stable condition	10.1 Vegetation ground cover >70%. 10.2 3P (perennial, persistent and palatable) pasture species listed in **Appendix 1**, including legumes and grasses, remain present and showing evidence of natural recruitment in rehabilitation monitoring data.

		10.3 Weed presence is a maximum of 10% of total vegetative groundcover confirmed by an AQP in annual monitoring. Weed management recommendations to be provided in annual reports and completed. 10.4 Less than 5% of total vegetative groundcover is declared weeds (as defined in the *Biosecurity Act 2014*). 10.5 Certification of rehabilitation to Grazing Class 3 by an AQP. 10.6 No evidence of erosion classified as 'moderate' or 'severe' as defined by **Appendix 3 – Erosion classification framework**. 10.7 A third party AQP certifies that any erosion present will not compromise the achievement of a PMLU to a stable condition. 10.8 The slope of rehabilitated infrastructure areas is less than 5%. 10.9 Surface water runoff is non-polluting to receiving waters and complies with **Appendix 5 – Surface water quality limits.** 10.10 Surface water quality results monitored within 48 hours of flow, but not limited to, downstream locations specified in **Appendix 6**, must not exceed the limits in **Appendix 5 – Surface water quality limits**, for a minimum of 5 consecutive years. 10.11 If the surface water quality exceeds criteria 10.10, the applicable upstream site must be compared to the downstream site result. 10.12 For a minimum of five consecutive years groundwater quality must be monitored quarterly at, but not limited to, bores specified in **Appendix 7**, for all quality characteristics listed in **Appendix 8**. 10.13 Groundwater quality results must not exceed the limits in **Appendix 8**, for 3 consecutive results. 10.14 Exploration activities outside approved disturbance area shown in **Figure 1: Final Site Design** are rehabilitated in accordance with the latest version of the Eligibility Criteria and Standard Conditions for Exploration and Mineral Development Projects (ESR/2016/1985). 10.15 All remaining infrastructure removed.
RM11	Achievement of PMLU native ecosystem to stable condition	**All rehabilitation areas** 11.1 Species used in revegetation (listed in **Appendix 2**) remain present and showing evidence of natural recruitment in rehabilitation monitoring data. 11.2 Weed presence is a maximum of 10% of total vegetative groundcover confirmed by an AQP in annual monitoring. Weed management recommendations to be provided in annual reports. 11.3 Less than 5% of total vegetative groundcover is declared weeds (as defined in the Biosecurity Act 2014). 11.4 No evidence of erosion classified as 'moderate' or 'severe' as defined by **Appendix 3 – Erosion classification framework.**

		11.5 A third party AQP certifies that any erosion present will not compromise the achievement of a PMLU to a stable condition. 11.6 Surface water runoff is non-polluting to receiving waters and complies with **Appendix 5 – Surface water quality limits.** 11.7 Surface water quality results monitored within 48 hours of flow at, but not limited to, downstream locations specified in **Appendix 6**, must not exceed the limits in **Appendix 5 – Surface water quality limits**, for a minimum of 5 consecutive years. 11.8 If the surface water quality exceeds criteria 11.7, the applicable upstream site must be compared to the downstream site result. 11.9 For a minimum of five consecutive years groundwater quality must be monitored quarterly at, but not limited to, bores specified in **Appendix 7**, for all quality characteristics listed in **Appendix 8**. 11.10 Groundwater quality results must not exceed the limits in **Appendix 8**, for 3 consecutive results. 11.11 Exploration activities outside approved disturbance area show in **Figure 1: Final Site Design** are rehabilitated in accordance with the latest version of the Eligibility Criteria and Standard Conditions for Exploration and Mineral Development Projects (ESR/2016/1985). 11.12 All remaining infrastructure removed. **Subsidence Areas (RA1, RA2, RA3)** 11.13 No change to baseline vegetation species composition and structure to the latest baseline condition that has been assessed under condition **PRCP22**. **DREA (RA6)** 11.14 Native vegetation communities must achieve ≥18/30 of values from reference benchmark criteria of mapped pre-clear regional ecosystem for RE 11.9.3 as per **Appendix 4** Benchmarks for native vegetation communities, when measured by an AQP using the BioCondition Assessment Methodology. 11.15 Updated landform evolution modelling confirms erosional stability of subsided DREA landform has not been compromised relative to original LEM predictions

Appropriately qualified person (AQP) means a person who has professional qualifications, training, skills or experience relevant to the nominated subject matter and can give authoritative assessment, advice and analysis on performance relating to the subject matter using the relevant protocols, standards, methods or literature.

Appendix 1 – Pasture grass species

Common Name or variety	Scientific Name	Indicative Rate (kg/ha)
Kangaroo Grass	*Themeda triandra*	1
Queensland Bluegrass	*Dicanthium sericeum*	2
Japanese Millet	*Echinochloa esculenta*	2
Sabi Grass	*Urochloa mosambicensis*	2
Fine Cut Rhodes Grass	*Chloris gayana*	2
Forest Bluegrass	*Bothriochloa bladhii*	0.5
Seca Stylo	*Stylosanthes scabra*	0.5
Minimum total sowing rate		**12**

Appendix 2* – Native grassland (RE 11.9.3)

Common Name or variety	Scientific Name	Indicative Rate (kg/ha)
Queensland Bluegrass	*Dicanthium sericeum*	2
Curly Mitchell grass	*Astrebla lappacea*	1.5
Hoop Mitchell grass	*Astrebla elymoides*	1.5
Bull Mitchell grass	*Astrebla squarrosa*	1
Black Speargrass	*Heteropogon contortus*	2
Kangaroo Grass	*Themeda triandra*	1
Satintop grass	*Bothriochloa erianthoides*	0.5
Native Millet	*Panicum decompositum*	0.5
Minimum total sowing rate		**12**

*Sterile cover crops can be seeded to support initial establishment

Appendix 3 - Erosion classification framework

Erosion classification	Minor	Moderate	Severe
Sheet erosion	Shallow soil deposits downslope.	Partial exposure of roots; moderate soil deposits downslope.	Loss of surface horizon; subsoil exposure; root exposure; substantial soil deposits downslope.
Rill/gully erosion	<15 rills/transect* and <0.3m deep	15-30 rills/transect* and <0.3m deep	>30 rills/transect* and/or any >0.3m deep
Tunnel erosion	Absent	Absent	Present
Mass movement	Absent	Absent	Present

Source: NCST (2009) *Australian Soil and Land Survey Field Handbook, 3rd edition*. The National Committee on Soil and Terrain. CSIRO Publishing, Collingwood, Australia.

*Transect 100 m across the contour (Source: Tongway, D. J. and Hindley, N. L. 2005. Landscape Function Analysis: Procedures for Monitoring and Assessing Landscapes. CSIRO Publishing, Canberra, Australia.)

Appendix 4 – BioCondition Benchmark Criteria

Regional Ecosystem		11.9.3 Reference Benchmark	11.9.3 Indicative benchmark for 5 years(≥15/30)	BioCondition score	11.9.3 Indicative benchmark for 10 years (≥18/30)	BioCondition score
BioCondition attribute	**Weighting**	**RE 11.9.3** *Dichanthium / Astrebla* grassland				
Non-native plant cover(%)	10	0%	<25% of vegetation cover	5	<25% of vegetation cover	5
Grass species richness*	5	10	≥25 – 90% of benchmark (≥ 3 spp.)	2.5	≥ 25 – 90% of benchmark (≥ 3 spp.)	2.5
Forbs and other species richness*	5	9	≥ 25 – 90% of benchmark (≥2 spp.)	2.5	≥ 25 – 90% of benchmark (≥ 2 spp.)	2.5
Native perennial grass cover (%)	5	53%	≥ 50% of benchmark (>26.5 %)	3	≥ 90% of benchmark (>47.7%)	5
Organic litter ground cover (%)	5	10%	≥ 10 – <50% of benchmark (> 1 – <5%)	3	≥ 10 – <50% of benchmark (> 1 – <5%)	3
Overall score required	**30**			**>15**		**>18**

* Species richness must be based on native species that occur in RE11.9.3 as per the RE technical description

[5] *Source:* *https://www.qld.gov.au/__data/assets/excel_doc/0023/170285/bioconditon-benchmark-database-table.xlsx*

Additional criteria: grass species to include at least 3 'indicator' species listed for Natural Grasslands of the Queensland Central Highlands and the Northern Fitzroy Basin (Commonwealth of Australia 2012; https://www.dcceew.gov.au/sites/default/files/documents/bio237-0512-natural-grasslands-guide.pdf) that occur in RE 11.9.3: *Aristida latifolia, Aristida leptopoda, Astrebla lappacea, Bothriochloa erianthoides, Dichanthium sericeum, Panicum decompositum, Paspalidium globoideum*

Appendix 5. Surface water quality limits

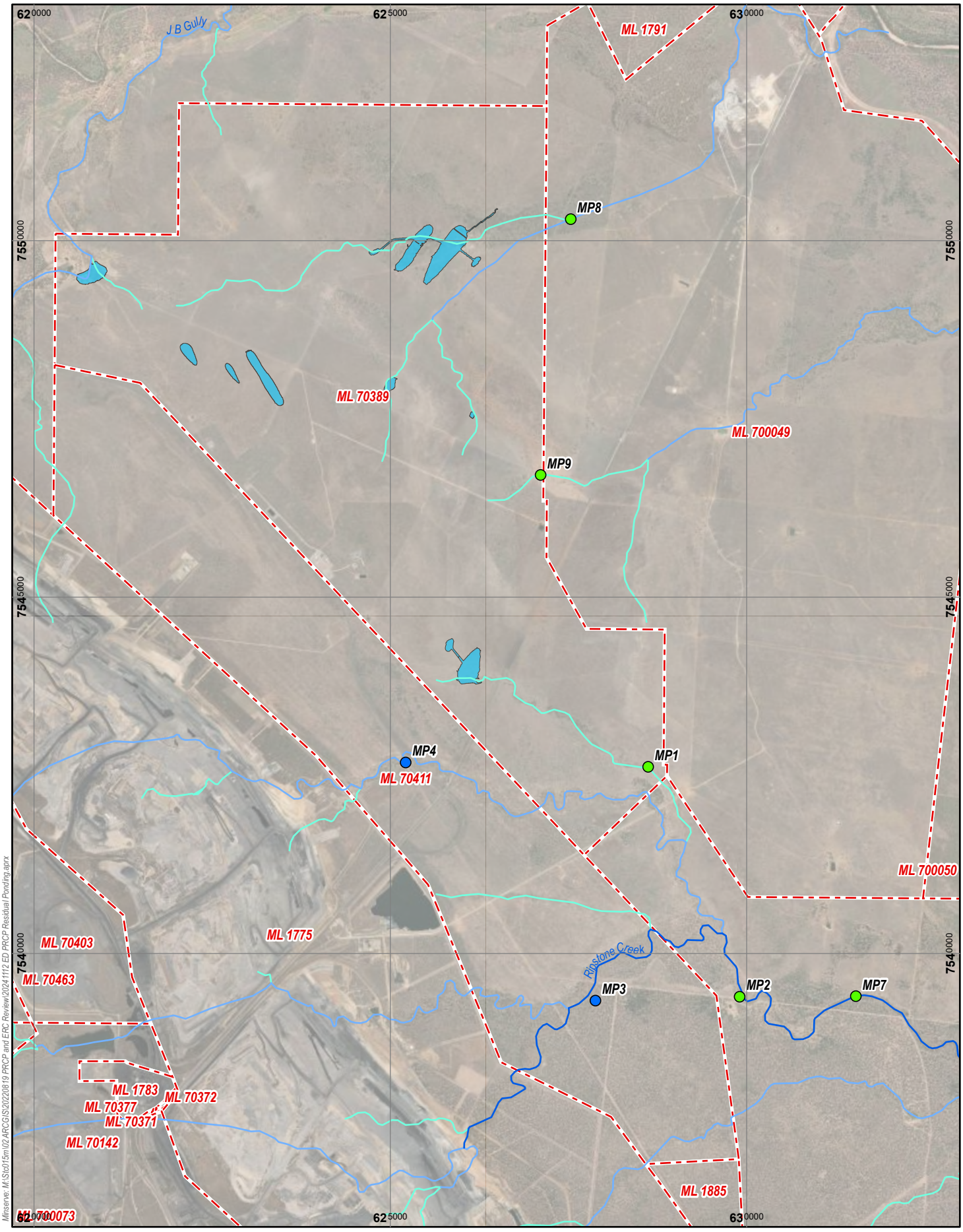
Quality characteristic (units)	Limit	Comment on limit
pH	6.5-8.5	Upper Isaac River catchment waters WQO
Electrical Conductivity (µS/cm)	720	Upper Isaac River catchment waters WQO
Turbidity (NTU)	50	Upper Isaac River catchment waters WQO
Sulphate (mg/L)	25	Upper Isaac River catchment waters WQO
Aluminium - dissolved (µg/L)	55	ANZG 2018
Antimony - dissolved (µg/L)	9	ANZG 2018
Arsenic - dissolved (µg/L)	13	ANZG 2018
Iron - dissolved (µg/L)	300	ANZG 2018
Mercury - dissolved (µg/L)	0.06	ANZG 2018
Molybdenum - dissolved (µg/L)	34	ANZG 2018
Nickel - dissolved (µg/L)	11	ANZG 2018
Selenium - dissolved (µg/L)	5	ANZG 2018
Nitrate (µg/L)	1100	
Total recoverable hydrocarbons (C6-C9) (µg/L)	20	
Total recoverable hydrocarbons (C10-C36) (µg/L)	100	
Major ions (mg/L) Calcium, chloride, potassium, magnesium, sodium, bicarbonate, carbonate	For interpretation purposes only	
Hardness (mg/L)	For interpretation purposes only	

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.
- DEHP (2011) Isaac River Sub Basin WQO – surface water <https://environment.desi.qld.gov.au/__data/assets/pdf_file/0032/88817/fitzroy_isaac_river_wqo_290911.pdf>
- ANZG (2018) Aquatic ecosystem protection for moderately disturbed system (95% protection)

Appendix 6. Surface water monitoring locations

Monitoring Locations	Receiving waters location description	Latitude (decimal degree, GDA2020)	Longitude (decimal degree, GDA2020)
Upstream monitoring locations			
MP3	Upstream Ripplestone Creek – flow from Peak Downs Mine	-22.245066	148.242067
MP4	Upstream Ripplestone Creek (Western Tributary)	-22.215094	148.215969
Downstream monitoring locations			
MP1	Downstream Ripplestone Creek Eastern Tributary immediately upstream of Winchester Road	-22.215395	148.248985
MP2	Downstream Ripplestone Creek	-22.244427	148.261701
MP7	Downstream Ripplestone Creek	-22.244231	148.277524
MP8	Downstream mining footprint	-22.146084	148.23784
MP9	Downstream mining footprint	-22.178526	148.234022



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0 500 1,000 1,500 2,000 2,500
Metres

Datum:	GDA94 Zone 55
Scale:	1 : See Scale Bar (A4)
Date:	20/12/2024 11:59 AM
Drawn:	RA

Minserve

DISCLAIMER: Third party data sources are used in this map compilation.
Minserve makes no warranty regarding this data's accuracy or currency.

LEGEND

- Mining Lease
- Residual Ponding

Surface Water

- Downstream monitoring point (MP)
- Upstream monitoring point (MP)

Stream Order

- 1
- 2
- 3

stanmore

EAGLE DOWNS COAL PROJECT
PRCP SUBMISSION

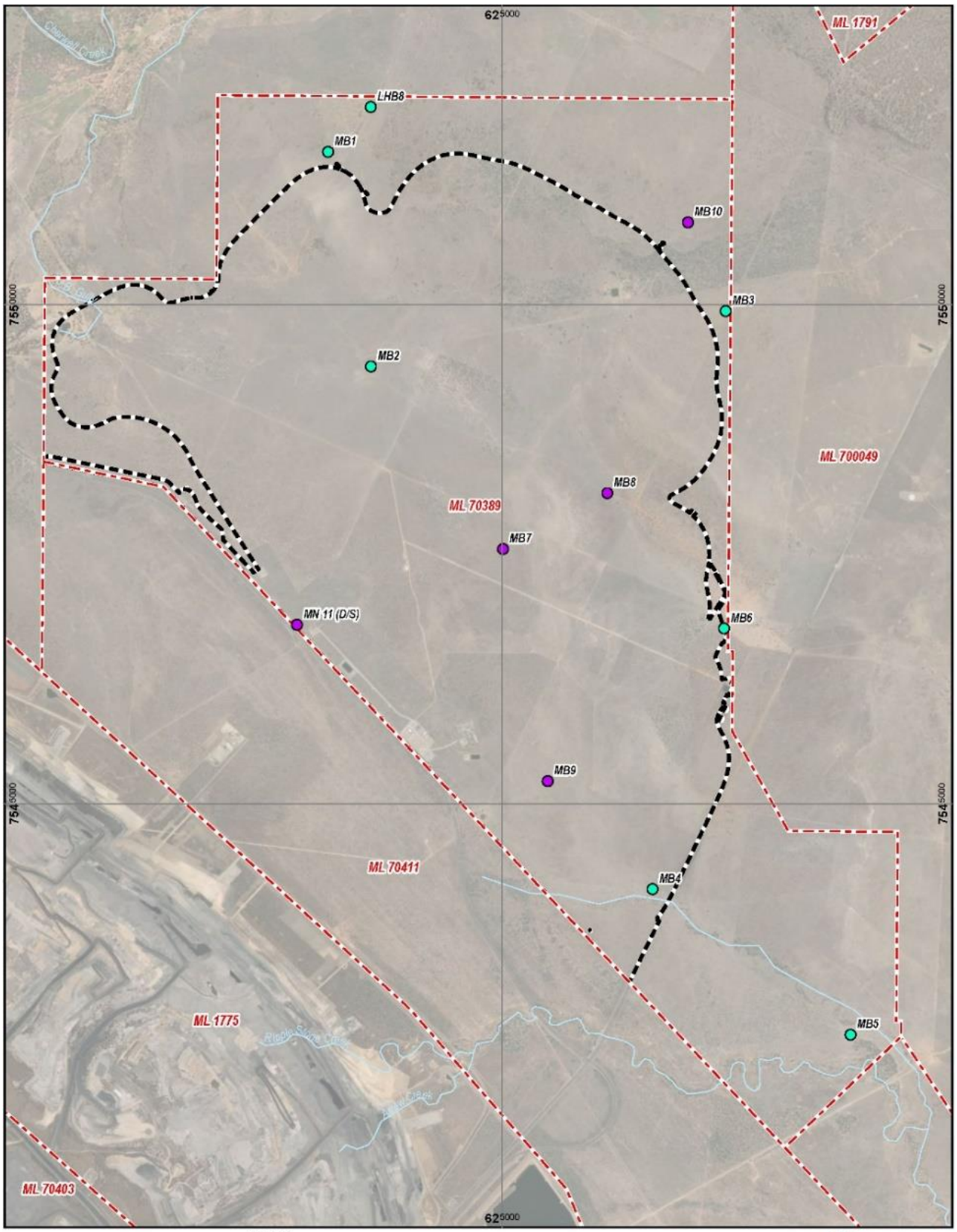
Surface Water Monitoring Locations

Figure | 3

Appendix 7. Groundwater monitoring bores

Monitoring Bore	Screen geology	**Location**	
		Latitude (decimal degree, GDA2020)	**Longitude (decimal degree, GDA2020)**
MB1	Upper fractured rock, Fort Cooper CM - siltstone	-22.136842	148.195178
MB2	Upper fractured rock, Fort Cooper CM – sandstone and siltstone	-22.156231	148.199511
MB3	Upper fractured rock, Rewan Group	-22.150961	148.233948
MB4	Upper fractured rock, Fort Cooper CM –coal, sandstone and siltstone	-22.203347	148.227295
MB5	Upper fractured rock, Fort Cooper CM –coal, sandstone and siltstone	-22.216379	148.246656
MB6	Shallow CM - East of DREA along drainage line	-22.179693	148.234034
MB7	Shallow CM - North of DREA along eastern drainage line flowing north	-22.172665	148.212491
MB8	Shallow CM - North of DREA along western drainage line flowing north	-22.167531	148.222581
MB9	Shallow CM - North of DREA along western drainage line flowing north	-22.193651	148.217017
Landholder Bore 8 (LHB8)	- Upper fractured rock Fort Cooper CM	-22.131095	148.200394
MB10	- Rewan Group	-22.142968	148.230213
MB11 Deep(D)/Shallow(S)	Shallow weathered fractured rock	-22.179668	148.192514

Notes:
Coordinates GDA20 zone 55
CM – Coal Measures


625000
ML 1791
LHB8
MB1
MB10
MB3
755000
MB2
ML 700049
MB8
ML 70389
MB7
MN 11 (D/S)
MB6
MB9
754000
ML 70411
MB4
ML 1775
MB5
ML 70403
625000
0 200 400 600 800 1,000
Metres
LEGEND
Mining Lease
Maximum Disturbance Footprint
Groundwater Monitoring Bore
Existing
Proposed
Datum: GDA94 Zone 55
Scale: 1 : See Scale Bar (A4)
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EAGLE DOWNS COAL PROJECT
PRCP SUBMISSION
Post Closure Groundwater Monitoring
Figure | 4

Appendix 8. Groundwater quality limits

Quality characteristic (units)	Monitoring Bore	Limit	Comments
pH (pH units)	All bores	6 – 8.5	
Aluminium - dissolved (µg/L)	All bores	55	ANZG 2018
Antimony - dissolved (µg/L)	All bores	9	ANZG 2018
Arsenic - dissolved (µg/L)	All bores	13	ANZG 2018
Mercury - dissolved (µg/L)	All bores	0.06	ANZG 2018
Molybdenum - dissolved (µg/L)	All bores	34	ANZG 2018
Nickel - dissolved (µg/L)	All bores	11	ANZG 2018
Selenium - dissolved (µg/L)	All bores	5	ANZG 2018
Major ions (mg/L) Calcium, chloride, potassium, magnesium, sodium, bicarbonate, carbonate	All bores	For interpretation purposes only	
Hardness (mg/L)	All bores	For interpretation purposes only	

	MB1	MB2	MB3	MB4	MB5	MB6*	MB7*	MB8*	MB9*	MB10*	MB11S*	MB11D#	LHB8
Electrical conductivity (µS/cm)	2,100	4,270	18,700	13,200	5,740	8910	8910	8910	8910	8910	8910	16000	7,970
Sulfate (mg/L)	26	4	138	104	43	318	318	318	318	318	318	398	445
Iron - dissolved (µg/L)	800	260	5,000	240	1,800	140	140	140	140	140	140	246	1,000

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.
- ANZG (2018): Aquatic ecosystem protection for moderately disturbed system (95% protection)
- * Environmental Protection (Water) Policy 2009 Fitzroy River Sub-basin Environmental Values and Water Quality Objectives Groundwater chemistry zone 34 shallow - <https://environment.des.qld.gov.au/__data/assets/pdf_file/0037/88795/fitzroy_fitzroy_river_wqo_290911.pdf>
- # Environmental Protection (Water) Policy 2009 Fitzroy River Sub-basin Environmental Values and Water Quality Objectives Groundwater chemistry zone 34 deep - <https://environment.des.qld.gov.au/__data/assets/pdf_file/0037/88795/fitzroy_fitzroy_river_wqo_290911.pdf>

END OF **PRCP** SCHEDULE

Appendix C. Glossary

Abbreviation	Meaning
ABA	Acid base accounting
AEP	Annual exceedance probability
AET	Actual Evapotranspiration
ALC	Agricultural land class
AMD	Acid Mine Drainage
ANC	Acid Neutralising Capacity
AQP	Appropriately qualified person (also known as suitably qualified person (SQP))
ARI	Average Recurrence Interval
ASC	Australian soil classification
BBKY #4	Barada Barna Kabalbara and Yetimarla People #4
BOM	Bureau of Meteorology
CCR	Community Consultation Register
CHPP	Coal handling and preparation plant
CQSS2030	Central Queensland Sustainability Strategy 2030
CRD	Cumulative Rainfall Departure
CSEP	Community Stakeholder Engagement Plan
DEHP	Department of Environment and Heritage Protection
DERM	Department of Environment and Resources Management
DES	Department of Environmental Science
DME	Department of Minerals and Energy
DREA	Dry rejects emplacement area
DY	Dysart Seam
EA	Environmental Authority
EC	Electrical conductivity
eCEC	Effective Cation Exchange Capacity
EDCM	Eagle Downs Metallurgical Coal Mine
EIS	Environmental Impact Statement
EP Act	*Environmental Protection Act 1994 (Queensland)*
EPA	Environmental Protection Agency
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999*
ERC	Estimated Rehabilitation Cost
ESP	Exchangeable sodium percentage
ET	Evapotranspiration
F	Fluorine
FIMS	Field Ionization Mass Spectrometry

Abbreviation	Meaning
FoS	Factor of Safety
GDE	Groundwater Dependent Ecosystem
GMP	Groundwater Monitoring Program
GWDB	Groundwater Bore Database
HCL	Harrow Creek Lower
HCU	Harrow Creek Upper
ICP-AES	Inductively coupled plasma atomic emission spectroscopy
IRC	Isaac Regional Council
LGA	Local government area
LOM	Life of Mine
LoR	Limit of Reporting
mAHD	Australian Height Datum
MAW	Mine Affected Water
MS	Mass spectrometer
mbgl	Meters below ground level
MCM	Moranbah Coal Measures
MIA	Mine Industrial Area
ML	Mining Lease
mm	millimetres
MNES	Matters of national environmental significance
MSES	Matter of State Environmental Significance
Mtpa	Million tonnes per annum
NAF	Non Acid Forming
NC Act	*Nature Conservation Act 1992 (Queensland)*
NEPC	National Environment Protection Council
NGIS	National groundwater information system
NRM	Natural Resource Management
NUMA	Non-use Management Areas
OMP	Operational Management Plan
PAF	Potentially Acid Forming
PAW	Plant available water
Pb	Back Creek Group
PET	Potential Evapotranspiration
PL	Petroleum Lease
PMF	Probable Maximum Flood
PMLU	Post Mining Land Use

Abbreviation	Meaning
PRC Plan	Progressive Rehabilitation and Closure Plan
PSD	Particle size distribution
Pwb	Moranbah Coal Measures
Pwi	Rangal Coal Measures
Pwt	Fort Cooper Coal Measures
Qa	Quaternary alluvium
QA/QC	Quality Assurance / Quality Control
RE	Regional ecosystem
RFFE	Regional Flood Frequency Estimation
RM	Rehabilitation Milestone
ROG	Rain-on-grid
ROM	Run of Mine
ROWTP	Reverse Osmosis Water Treatment Plant
RPEQ	Registered Professional Engineer of Queensland
Rr	Rewan Group
SiD	Safety in Design
SIS	Surface to in-seam
SSAP	Soil sampling and analysis program
SWL	Surface Water Level
TARP	Trigger action response plan
TDS	Total dissolved solid
TEC	Threatened Ecological Communities
TLO	Train Load Out
TSS	Total suspended solids
VM Act	*Vegetation Management Act 1999 (Queensland)*
VWP	Vibrating wire piezometer
WoNS	Weed of National Significance
WQO	Water quality objectives

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Appendix E. Legislation

	Overview	PMLU Consideration
Commonwealth		
Environmental Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act)	The EPBC Act 1999 is the Commonwealth's key piece of environmental legislation regulating Matters of National Environmental Significance (MNES), Commonwealth land, listed marine species and cetaceans, and international trade of wildlife. The EPBC Act provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities, and heritage places, defined by the EPBC Act as MNES.	The project will not perform any mining activity or cause significant disturbance to MNES areas or within the area of Commonwealth land, unless approved. The progressive rehabilitation of disturbance areas will abide to the legal framework to ensure the appropriate management of protected areas and mitigation of impacts.
Native Title Act 1993 (Cth)	The Native Titles Act 1993 recognises the traditional laws and customs of Aboriginal and Torres Strait Islanders, or 'native title'. Primarily, this Act protects and conserves native title and established a mechanism for determining native title claims. The Native Title Tribunal was established under this Act to administer the determination of native title rights and interests.	The disturbance areas will be rehabilitated to the proposed final land use with consideration of the native title rights and interests of the Barada Barna Traditional Owners who will be consulted throughout the PRCP process. Interactions will be recorded in the community consultation register and regular interactions will be guided by the Community Consultation Plan.
Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000)	The ANZECC & ARMCANZ Guideline provides the guidance and management for water quality for natural and semi-natural water resources in Australia and New Zealand.	The ANZECC & ARMCANZ Guideline will assist in the development of appropriate water management for disturbance areas that will return to a water storage as the final PMLU design. This will be incorporated into the surface water management for PMLU's in the Project area.
State		
Environmental Protection Act 1994	The *Environmental Protection Act 1994* (EP Act) is the mechanism by which the Department of Environment and Science ensure that the general duty of environmental care is taken by all mines and mine personnel, and by which proposed projects licencing	The EP Act ensures that the potential for environmental impact is minimized across the project area. The PRCP Schedule has been developed in line with the EP Act requirements which ensures the design and management of progressive rehabilitation is

	Overview	PMLU Consideration
	and Environmentally Relevant Activities are determined and assessed.	achieved in line with surrounding land use.
Environmental Protection Regulation 2019	The *Environmental Protection Regulation 2019* details the processes contained within the EP Act. The Regulation prescribes the Environmentally Relevant Activities under the EP Act and the associated application fees and annual fees.	The EP Reg 2019 requires that each selected PMLU is viable and in accordance with the existing land use of the surrounding region. It also guides the use of appropriate rehabilitation methods for contaminated land to achieve the associated PMLU.
Aboriginal Cultural Heritage Act 2003	*The Aboriginal Cultural Heritage Act 2003* (ACH Act) protects Aboriginal and Torres Strait Islander cultural heritage through recognition, protection and conservation of places and artefacts of heritage significance. Under this Act, provisions are made for the recognition of Aboriginal ownership of Aboriginal human remains, secret or sacred cultural heritage items and significant places and artefacts. This Act also establishes a duty of care for development or activities that may impact cultural heritage, and processes for management of these activities to mitigate harm to Aboriginal cultural heritage.	The ACH Act assists in the guidance and management of all cultural heritage finds and will ensure the closure activities do not disturb identified Aboriginal cultural heritage places and artefacts or create a legal mechanism for their return as part of the closure process.
Mineral Resources Act 1989	*The Mineral Resources Act 1989 (QLD)* (MR Act) establishes and regulates the process of obtaining exploration and production permits in relation to coal and other minerals in Queensland.	The MR Act under section 107(10), stipulates that the mining claim is only surrendered once improvement rehabilitation has been completed and the environmental authority has been surrendered.
Mineral and Energy Resources (Financial Provisioning) Act 2018 (MERFP Act)	*The Mineral and Energy Resources (Financial Provisioning) Act 2018* (MERFP Act) supersedes the previous financial assurance regime requirements. The purpose of the MERFP is to eliminate the risk to the Government in the event an EA holder does not achieve rehabilitation requirements.	The MERFP Act ensures the governance of the Estimated Rehabilitation Cost accounts the progressive rehabilitation achieved within the project area.

	Overview	PMLU Consideration
Nature Conservation Act 1992	*The Nature Conservation Act 1992* (NC Act) is the principal legislation that established a framework for the identification, gazettal and management of protected areas (such as National Parks) and the protection of native flora and fauna (protected wildlife) listed under the Nature Conservation (Wildlife) Regulation 2006 (NC Regulation). Under the NC Act, protected plant means a plant that is prescribed under the Act as threatened, near threatened or least concern wildlife.	In the event of any identified State listed threatened species or communities that exist within the project, the NC Act will assist in the guidance and development of a rehabilitation strategy and management plan for the given area. Revegetation will incorporate relevant principles from this Act.
Water Act 2000	*The Water Act 2000 (Qld)* (Water Act) provides a framework for the planning, allocation and use of surface water and groundwater in Queensland, including regulating major water impoundments (such as dams and weirs) and extraction through pumping for irrigation and other uses. The Water Act provides a system of interrelated plans, licences and permits for the regulation of in-stream (watercourses, lakes, and springs) and overland water flow and groundwater. The holder of an ML must prepare an Underground Water Impact Report (UWIR) in accordance with Chapter 3 of the Water Act.	The Water Act ensures the sustainable management of water and other resources. The progressive rehabilitation will be designed in consideration of the Water Act, for the regulation of surface water and groundwater properties within the project area during operation and post closure to ensure compliance with this Act.
Vegetation Management Act 1999 (VM Act)	*The Vegetation Management Act 1999* (VM Act) regulates the clearing of vegetation in Queensland. This includes vegetation associated with mapped watercourses.	In the event that regulated vegetation is identified within the project area, the project area is required to comply with State and regional vegetation. The VM Act will assist in the design and management of revegetation within the project area.
Progressive Rehabilitation and Closure Plan Guideline (ESR/2019/4964)	The Queensland Government Department of Environment and Science, developed this guideline to assist applicants in developing the PRC plan, including the statutory	Progressive rehabilitation will adhere to the specifications and conditions listed in this guideline. PMLUs have been justified through the criteria put forward in this guideline which

	Overview	PMLU Consideration
	requirement to maximise the progressive rehabilitation. The administering authority must consider this guideline when making a decision about a PRCP schedule under section 176A of the EP Act.	considers relevant criteria, technical information, and community consultation. The PRCP schedule has been developed in line with this guideline.
Planning Act 2016	The purpose of the *Planning Act* is to ensure an effective and efficient land use planning that facilitates the achievement of ecological sustainability. The Planning Act is the governing body for State and local planning instruments.	The progressive rehabilitation of disturbance areas will be consistent with the use of land permitted under the Planning Act, where State and local planning instruments will be adhered to. All disturbance for this project took place within the approved ML and no Development Approvals were required for infrastructure to support this Project.
Rehabilitation Requirements for Mining Resource Activities	The purpose of this guideline is to assist in the process of developing acceptable rehabilitation outcomes and strategies.	The guideline will assist in the development of rehabilitation performance criteria for the PMLU's within the project area.
Land Act 1994	The *Land Act (1994)* details the management of land for the benefit of the people of Queensland with incorporation of the following principles: • Sustainability • Evaluation • Development • Community Purpose • Protection • Consultation • Administration	The Land Act will ensure the non-freehold land and deeds of grant in trust are appropriately managed and where PMLU' will reflect considerations of the Acts principles.
Environmental Protection (Waters) Policy 2009	The *Environmental Protection (Waters) Policy*, describes the necessary framework to develop water quality guidelines with the objective to protect Queensland waters and prevent pollution.	The EP Water Policy will assist in the development for water quality objectives that will ensure the PMLU areas achieve an acceptable water quality standard in reference to the surrounding region.

Appendix F. Groundwater Impact Assessment

Australasian Groundwater & Environmental Consultants

Report on

Eagle Downs Groundwater Impact Assessment (GIA) Update for the Environmental Authority (EA) Amendment

Prepared for
Eagle Downs Metallurgical Coal

Project No. EDM5000.001
November 2022

ageconsultants.com.au

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Eagle Downs Groundwater Impact Assessment Update for the Environmental Authority (EA) Amendment

1 Introduction

Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) has been engaged by South32 (the client) to review and update the Groundwater Impact Assessment (GIA) for the Eagle Downs Coal Project according to proposed modifications discussed in the project overview below.

1.1 Project overview

The Eagle Downs Coal Project involves constructing, developing, and operating an underground longwall metallurgical coal mine in Queensland's Bowen Basin. Eagle Downs Coal Management Pty Ltd (EDCM) is delivering the project under a joint venture of Aquila Coal Pty Ltd and South 32 Eagle Downs Pty Ltd, the Eagle Downs Metallurgical Coal Project (EDMCP) (the Project).

The project operates under an Environmental Authority (EA), granted for Mining Lease (ML) ML 70389 in March 2011, and takes effect as per the latest approved EA on 3 December 2021 (EPML00586713). EDMCP is seeking to modify the EA conditions by proposing changes to the area north of the rail corridor in terms of surface disturbance footprint as a result of varying the longwall mining plan. The changes include extensions to the underground panels in the southern portion of the mining area and minor extensions in the north-east and south-west panels.

These variations to the mine plan will potentially change the extent of environmental impacts, which includes clearing of vegetation for gas drainage, changes to biodiversity, flora and fauna impacts, differences to the extent and location of ponding and subsidence areas, as well as changes to groundwater impacts (i.e. groundwater inflow during mining operations). The proposed EA amendment requires an alignment of the groundwater impact assessment.

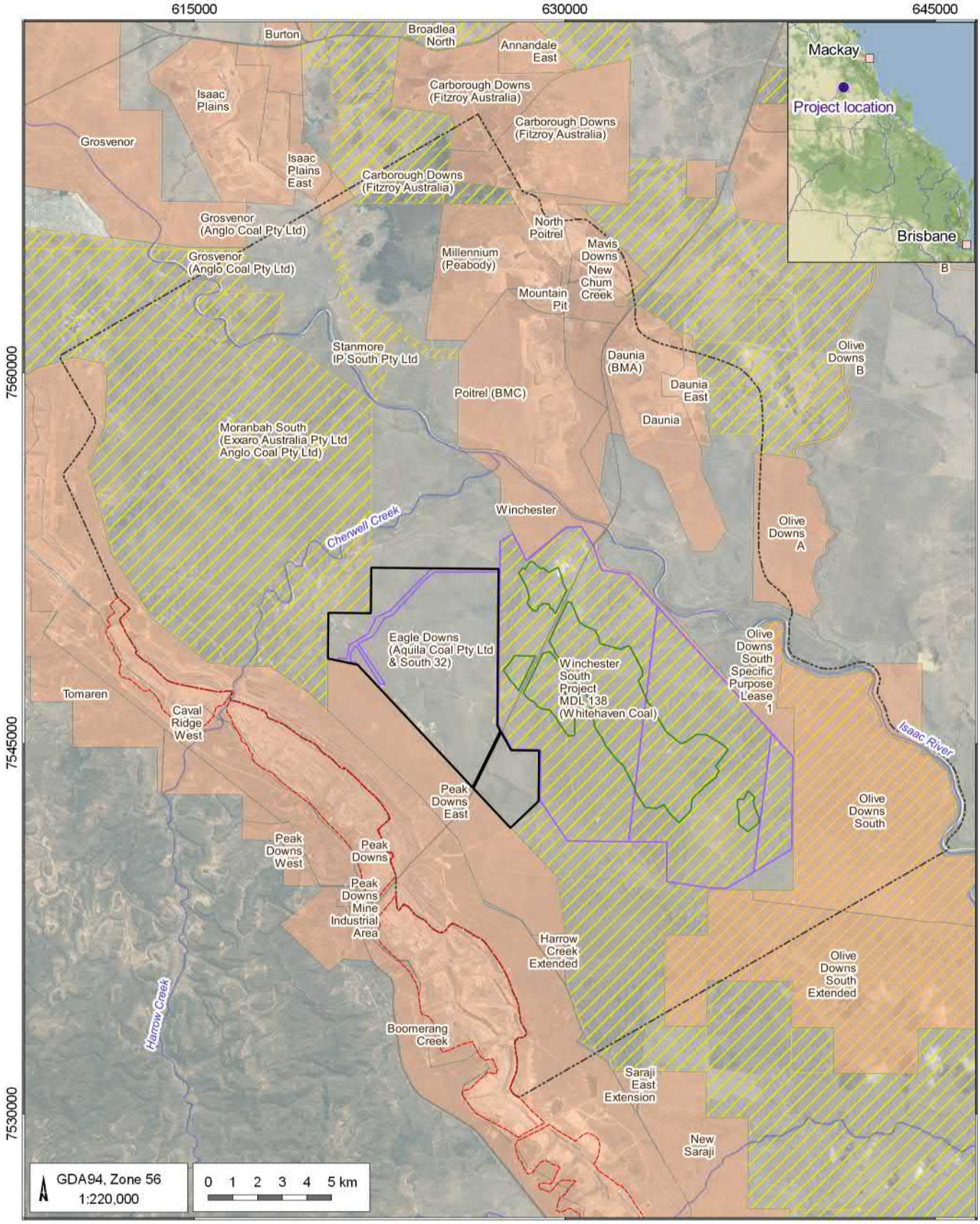
1.2 Project location

The Project area is located about 13 km south-east of the Peak Downs Highway turnoff to Moranbah, or some 25 km south-east of the township of Moranbah, in the northern part of the Bowen Basin. The ML is located to the east of Winchester Road, and Queensland Rail's Norwich Park branch railway passes through the southern end of the ML. The ML locality plan is shown on Figure 1.1.

1.3 Objectives and scope

The objective of the groundwater impact assessment was to update the previous assessment (AGE, 2008) and to assess the impact of the Project changes on the groundwater regime, in consideration of the requirements of QLD and Federal Government legislation and policies. To assess the groundwater impacts associated with the Project changes, AGE has undertaken the following scope:

- update the hydrogeological conceptual and numerical model with recent site groundwater data;
- provide outputs necessary for site-wide and regional impacts for the EA amendment;
- provide groundwater make estimates to confirm water allocation licences; and
- describe the groundwater impacts and risks related to the approved EA and the incremental changes (if any) due to the proposed Project changes (i.e. comment on any significant impact changes from the AGE 2008 GIA).



LEGEND

- Populated place
- Project location
- Rail
- Watercourse
- Eagle Downs project area
- Peak Downs mine boundary
- Mining leases
- Mineral development licences
- Eagle Downs model domain
- Proposed mine pits for the proposed Winchester South Project
- Mining lease application boundary Winchester South Project

Eagle Downs GIA for EA Amendment (EDM5000.001)

Project location

AGE

DATE 25/01/2022

FIGURE No: **1.1**

©2022 Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) - www.ageconsultants.com.au
Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
G:\Projects\EDM5000.001_Eagle DownsGIA for EA Amendment\3_GIS\Workspaces\001_Deliverable1\01.01_EDM5000.001_Project location.qgs

1.4 Overview of the proposed mining

A feasibility study was completed in 2011, which showed that the Moranbah Coal Measures are present throughout the ML area. Drift[1] construction commenced in late 2013. However, the contractor went into liquidation in late 2014, with construction at 44 % complete.

In 2015/16, a supplementary study was conducted. This study identified several trade-off studies and looked at the optimisation of the mine, the wash plant, and the surface infrastructure design. This review was only partially completed before works were put on hold. The first stage of the current feasibility study was undertaken in 2019, with a single go-forward scope and a basis for design developed. The second stage of this feasibility study, which was completed in preparation for a final investment decision in 2020.

Target coal seams in the Permian Moranbah Coal Measures (MCM) range from 200 m to more than 700 m below the surface. The current plan is that mining operations will start in the Harrow Creek Upper (HCU) seam before moving on to the Harrow Creek Lower (HCL) seam and then the Dysart (DY) seam. It is proposed to mine the three target seams using conventional longwall methods for the HCU Seam and Longwall Top Coal Caving (LTCC) of the thick HCL and DY Seams. The proposed extraction depths and thickness for each seam is:

- HCU 200 m to 600 m from surface (on average 4 m thick);
- HCL 300 m to 650 m from surface (7.2 m); and
- DY 400 m to 700 m from surface (5 m).

1.4.1 Mine plan

The mine will initially use two declines (the Drifts) extending to the HCU coal seam, 270 m vertically below surface. One decline will be used for the transportation of personnel and materials, while the other will be used for coal clearance using a conveyor. The change to mine planning, when compared to the layout that supported the Environmental Impact Statement (EIS) application, will incorporate a revised layout for underground longwall panels and include (Figure 1.2):

- reorientation and extensions to the underground panels in the southern portion of the mining area (immediately north of the existing Norwich Park Branch Railway); and
- reorientation and minor extensions in the north-east and south-west panels.

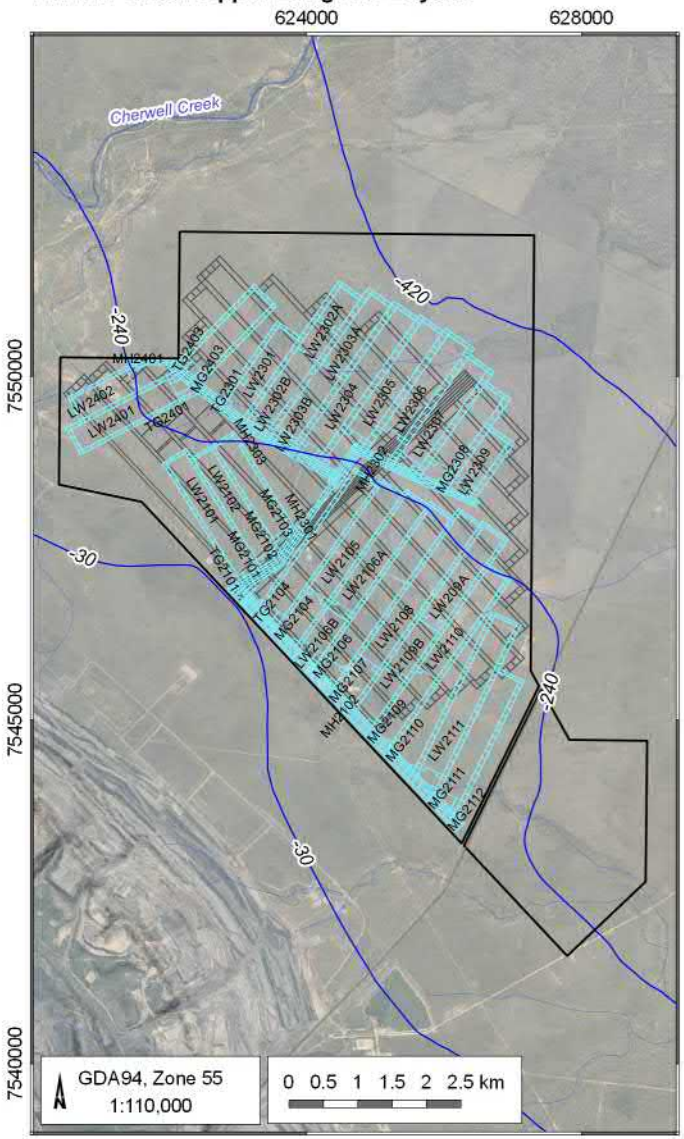
The design of the current layout increases resource recovery while improving the expected mining conditions. As a result of the layout changes, the surface disturbance area will change, and this is explained in the following sections.

The mine plan used for the EIS groundwater impact assessment (AGE, 2008, refer to Section 5.1) included the Q Seam, which is now excluded from the mine plan and only the HCU, HCL, and DY coal seams are included. A total of 23 longwall panels were proposed for each of the four coal seams, the panels oriented in a north-west, south-east direction. The updated mine plan consists of 28 longwall panels and sub-panels for the HCU Seam and 22 longwall panels for the HCL and DY seams. Some of the longwall panels are subdivided into smaller segments in response to intervening structures and mine planning requirements. The extraction scenario is based on the HCU Seam being mined first, followed by progressive mining of the HCL and DY Seams. The mine layout for each seam is an offset design where the gate roads and Mains in each seam are offset by around 80 m (also refer to Section 6.1). The original mine plan for the approved EA was an exact duplication of the longwall panels for each of the four coal seams, as indicated in Figure 1.2.

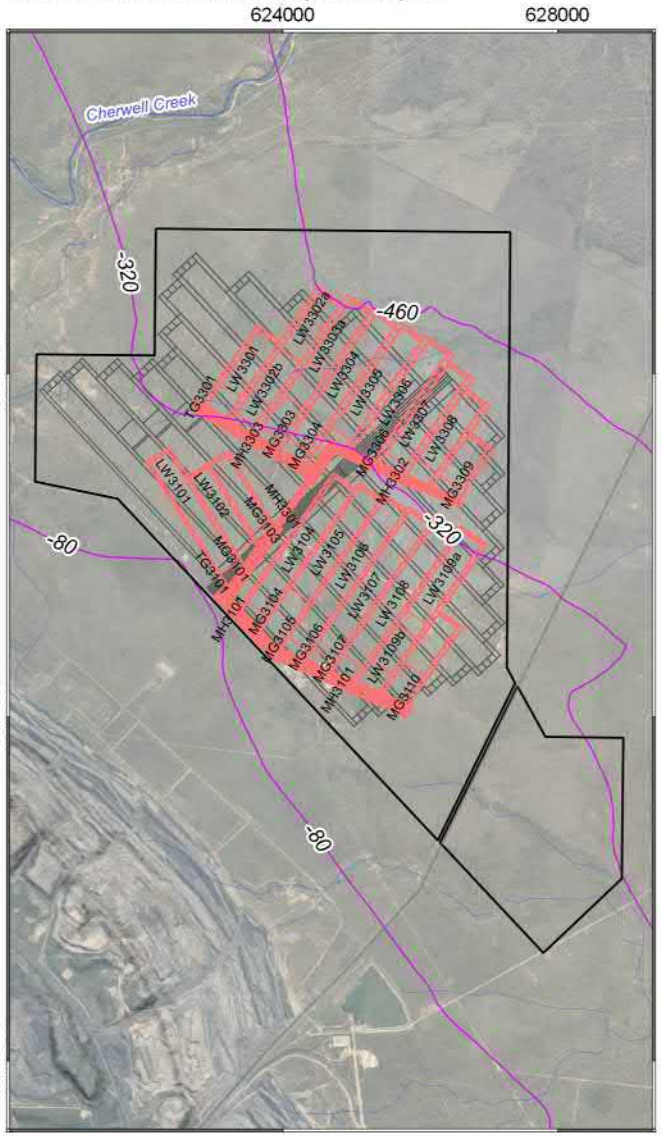
The life of mine is approximately 45 years, and a simplified representation of the mine plan is presented in Figure 1.3. The detailed life of mine schedule is attached in Appendix A. The conceptual mine schedule indicates that longwall mining of the HCU Seam will be completed after 14.5 years, the HCL Seam after 30 years, and the Dysart Seam after 45 years after the start of mining.

[1] An inclined access opening from the surface to the coal seam

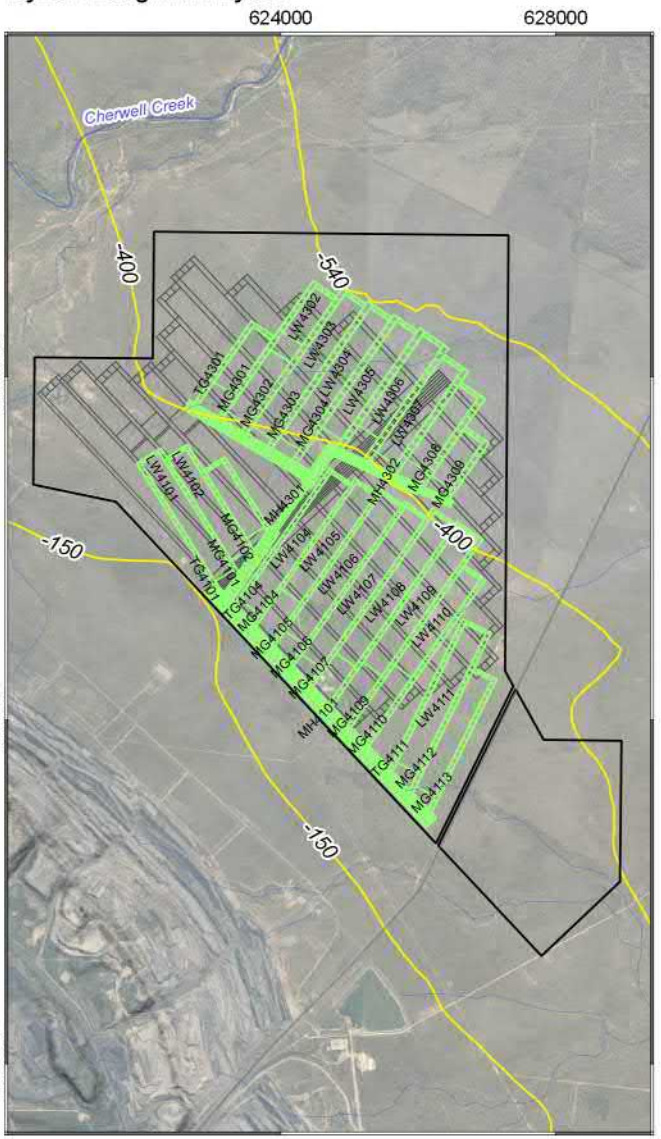
Harrow Creek Upper Longwall Layout



Harrow Creek Lower Longwall Layout



Dysert Longwall Layout



LEGEND

- Populated place
- Rail
- River/Creek
- Approved EA Longwall Panel Layouts
- Eagle Downs project area
- Harrow Creek Upper Longwall Layout
- Harrow Creek Lower Longwall Layout
- Dysert Longwall Layout

Seam Elevation Contours (mAHD)

- Harrow Creek Upper Seam
- Harrow Creek Lower Seam
- Dysert Seam

AGE

Eagle Downs GIA for EA Amendment (EDM5000.001)

Longwall layout

DATE
22/03/2022

FIGURE No:
1.2

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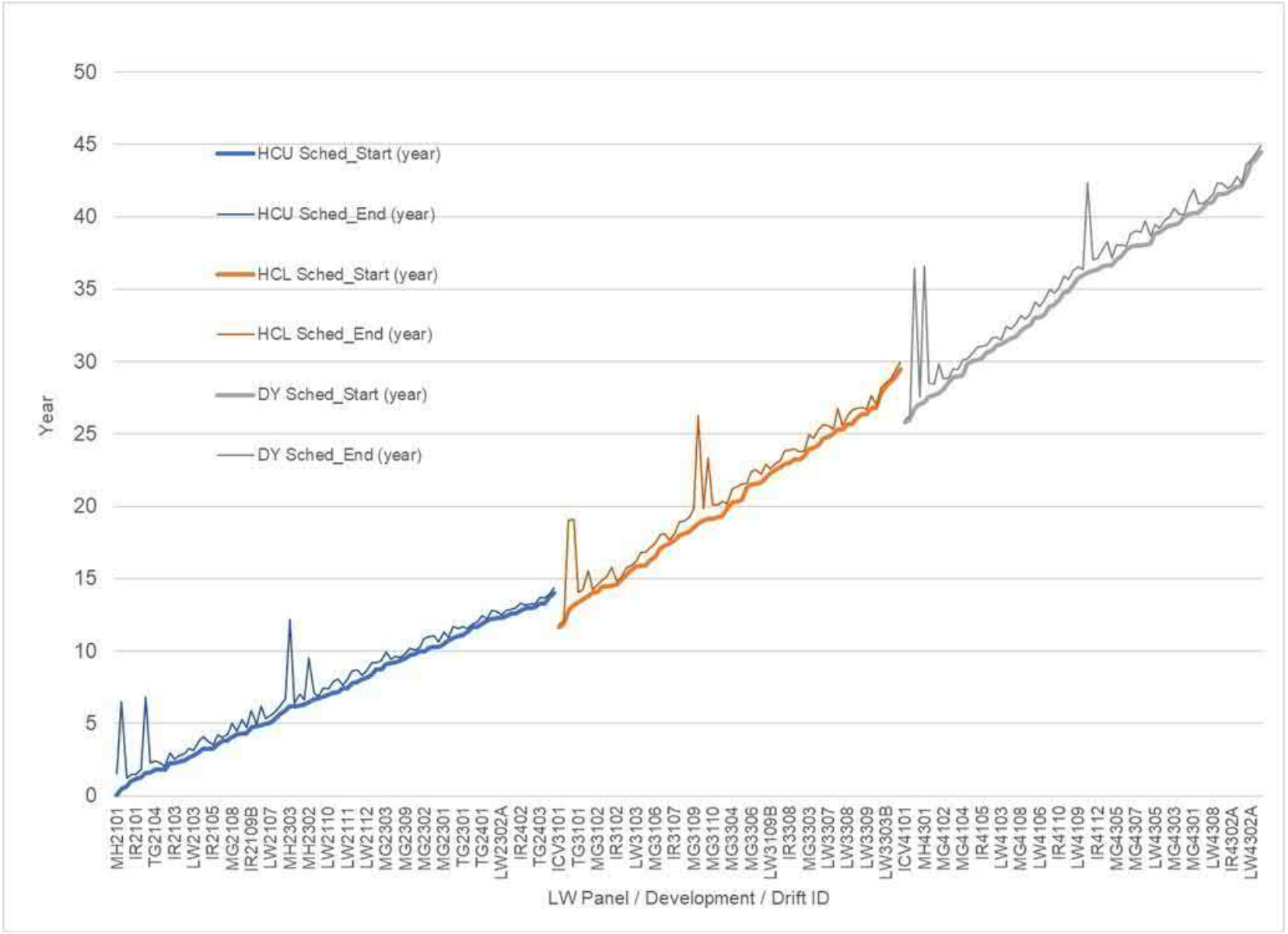
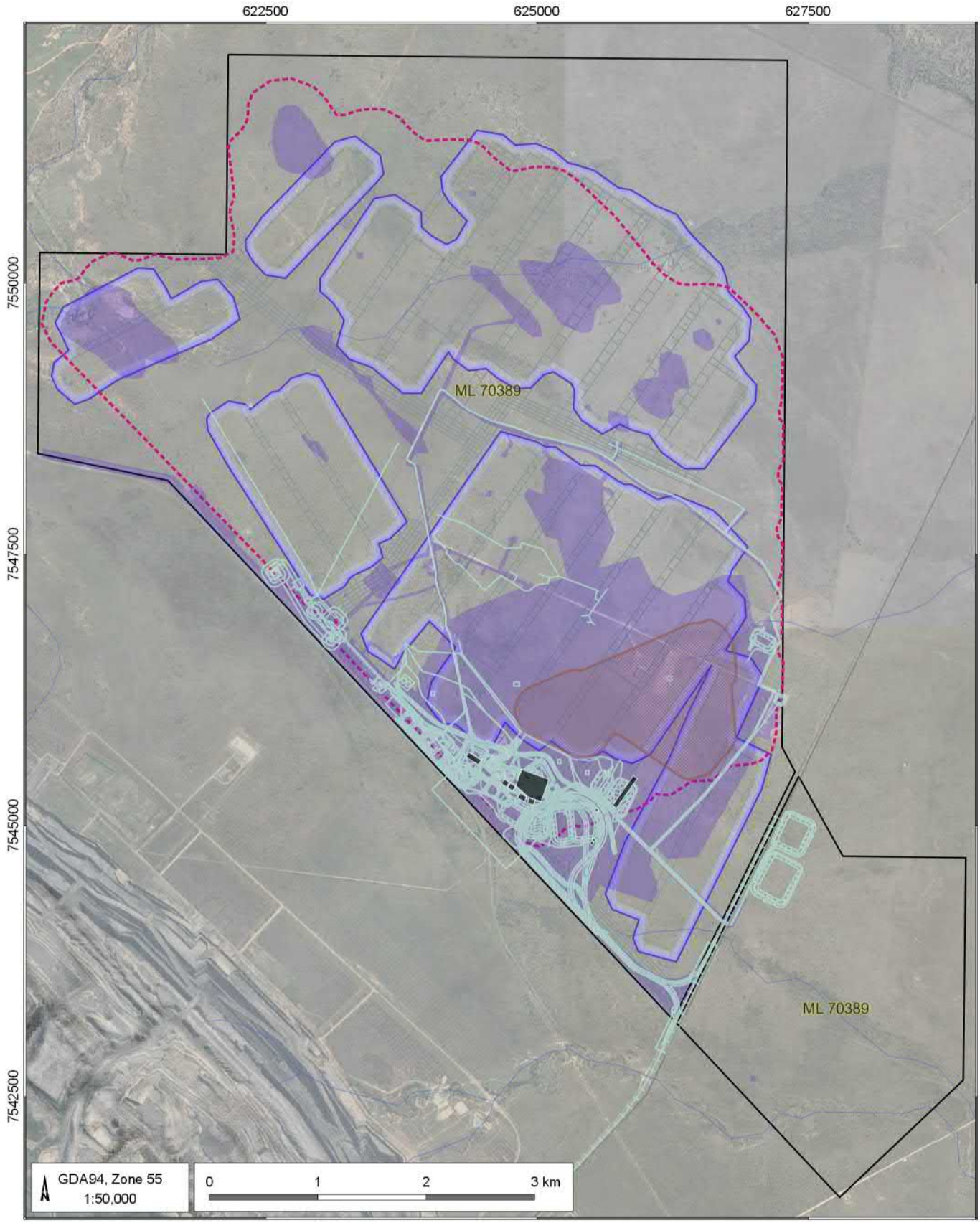


Figure 1.3 Simplified representation of the life of mine plan

1.4.2 Surface disturbance

In this configuration, the mine will produce up to eight (8) million tonnes per annum (Mtpa) run of mine coal (ROM) at full production. ROM coal will be conveyed to the surface and then stockpiled for subsequent reclaim and delivery to the coal handling and preparation plant (CHPP). The ROM coal will be washed in the CHPP to produce up to five Mtpa of product coal for export. Coarse rejects and dewatered fine rejects would be hauled by truck from the CHPP to an on-site, dry rejects emplacement area (DREA). Figure 1.4 shows the approved surface disturbance limit and the proposed disturbance zone.



LEGEND

- Rail
- Mine Infrastructures
- Eagle Downs project area
- Approved EA Limit of Subsidence
- Proposed Limit of Subsidence
- Dry Rejects Emplacement Area (DREA)
- Coal Handing and Preparation Plant (CHPP)
- Approved EA Maximum Disturbance Area

Eagle DownsGIA for EA Amendment (EDM5000.001)

Surface disturbance zone layout

AGE

DATE 22/03/2022

FIGURE No: **1.4**

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1.5 Report structure

This report is structured as follows:

- Section 1 – The introduction provides an overview of the Project, scope and objectives, and an overview of the mine plan changes.
- Section 2 – The regulatory framework describes the QLD and Commonwealth regulatory requirements for groundwater relevant to the Project.
- Section 3 – The environmental setting provides a brief overview of the climate, terrain, and land uses.
- Section 4 – The geological setting describes the regional geology and local stratigraphy.
- Section 5 – The hydrogeology section defines the existing local groundwater regime within the Project Area and surrounds.
- Section 6 – The overview of mine induced subsidence on groundwater section describes the potential fracturing zone above the mine panels and surface cracking.
- Section 7 – The numerical groundwater model describes the application of modelling to assess the impacts associated with the Project.
- Section 8 – The groundwater model predictions include the mine inflow rates, drawdown and post mining recovery.
- Section 9 – The impact assessment describes the predicted impacts of the Project on the groundwater regime and water dependent assets.
- Section 10 – The section summarises the uncertainty and sensitivity analysis undertaken on the numerical groundwater model, including details about the purpose and methodology of the assessment.
- Section 11 – The groundwater monitoring and management plan describe the proposed measures for mitigation, management and monitoring of the groundwater regime and the model validation requirements.

2 Regulatory framework

Legislative requirements and guidelines relevant to groundwater are outlined below for the Project. The relevant legislation in relation to taking or interfering with groundwater resources in the Project area includes the following:

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- Queensland *Water Act 2000* (Water Act).
  - Water Resource (Fitzroy Basin) Plan 2011.
  - Environmental Protection (Underground Water Management) and Other Legislation Amendment Act 2016.
- Queensland *Environmental Protection Act 1994* (EP Act).
  - Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (EPP Water).

The following sections summarise Commonwealth and Queensland groundwater legislation and policy relevant to the Project.

2.1 Commonwealth

2.1.1 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act is administered by the Commonwealth Department of Agriculture, Water and the Environment (DAWE). The EPBC Act is designed to protect national environmental assets, known as Matters of National Environmental Significance (MNES). Under the 2013 amendment to the EPBC Act, potentially significant impacts on groundwater resources were included where they pertain to a coal seam gas (CSG) or large coal mine development, known as the 'water trigger'.

The Project has been declared a Controlled Action by the DAWE (Reference: EPBC 2008/3945). Water was not considered in the original referral and controlling provisions do not include the water trigger as the approval was prior to the 2013 EPBC Act amendment.. Due to the Bilateral Agreement between the Commonwealth of Australia and the State of Queensland (2004), only one impact assessment is required for a project that triggers an assessment under both the EPBC Act and State legislation. This report would satisfy Commonwealth assessment criteria if the water trigger were to be considered in the future.

2.2 Queensland

2.2.1 Water Act 2000

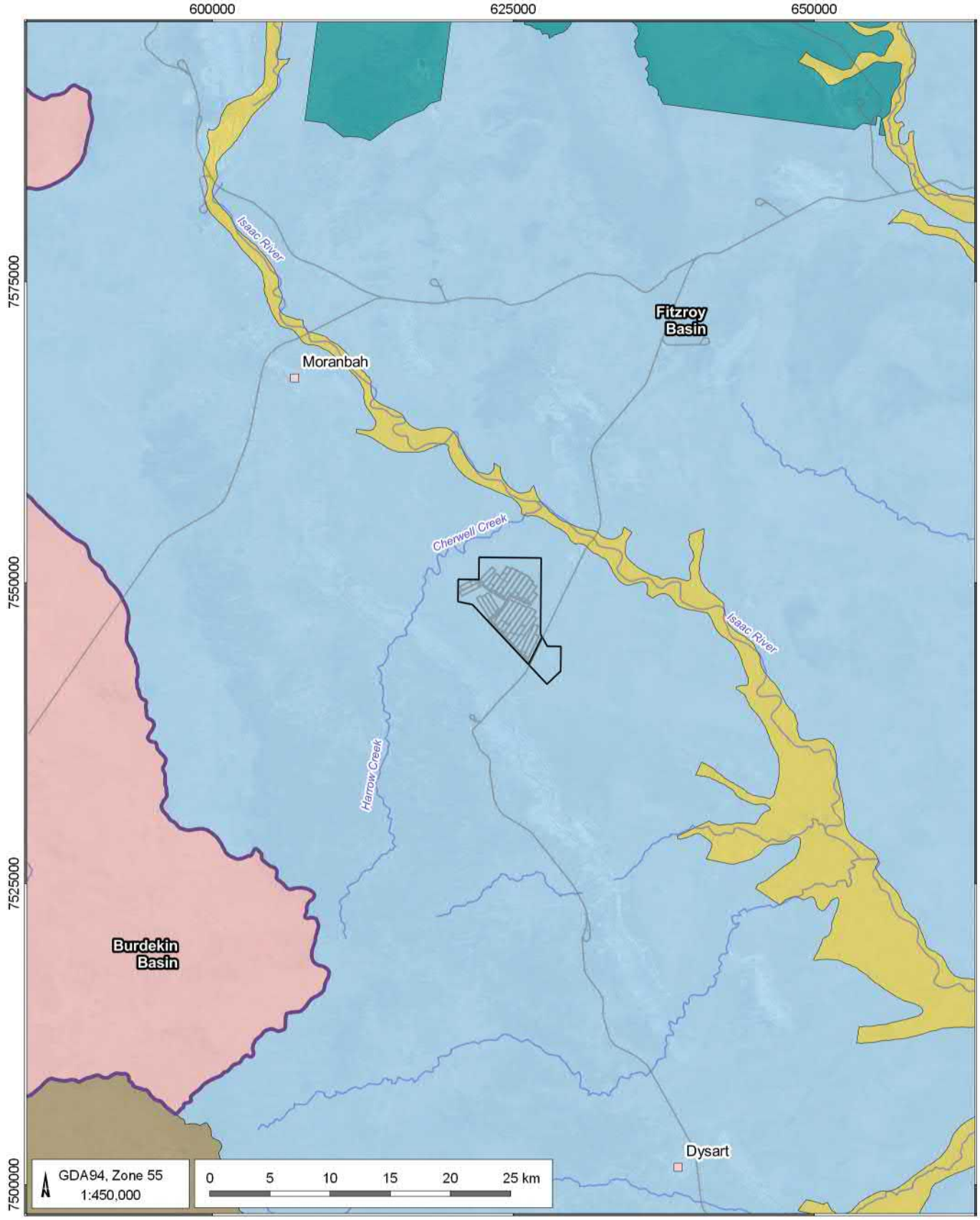
The Water Act, supported by the subordinate Water Regulation 2016, is the primary legislation regulating groundwater resources in Queensland. The Water Act aims to advance sustainable management and efficient use of water resources by establishing a system for planning, allocation, and use of water.

The Water Act is enacted under a framework of catchment specific Water Resource Plans (WRPs). A WRP provides a management framework for water resources in a plan area, and includes outcomes, objectives, and strategies for maintaining balanced and sustainable water use in that area. Resource Operations Plans (ROPs) implement the outcomes and strategies of WRPs. Groundwater Management Areas (GMAs) and their component groundwater units are defined under WRPs. Authorisation is required to take non-associated groundwater from a regulated GMA or groundwater unit for specified purposes. The specified purposes are defined under a WRP, the Water Regulation 2016 or a local water management policy.

Water resources within the Project area are captured under the Water Plan (Fitzroy Basin) 2011. The plan covers surface water (zone WQ1301) associated with Isaac River, and groundwaters (zone WQ1310 – Fitzroy Basin groundwaters).

As part of the Project, EDMCP proposes to exercise underground water rights during the period in which resource activities would be carried out within the Project Area. The Project will affect groundwater within the Isaac Connors Groundwater Management Area of the Fitzroy Basin under the Water Plan (Fitzroy Basin) 2011. The project will not affect the Quaternary alluvium. as shown in Figure 2.1. The extent of Groundwater Unit 1 (Isaac Connors Alluvium Groundwater Sub-area) is based on the mapped extent of Quaternary alluvium, which is mapped outside the Project footprint as discussed further in Section 5.3.3.

The Water Act includes criteria for determining watercourses that require authorisation under the Water Act to take water, interfere with the flow of water, take quarry material or excavate and place fill in a watercourse. The Water Act also includes criteria for drainage features that may require authorisation to take or interfere with overland flow. In the Project Area, the Isaac River is defined as a watercourse under the Water Act criteria. Several small tributaries of the Isaac River that traverse the Project Area are defined as drainage features. These declared watercourses and drainage features may be relevant to the groundwater assessment for the Project if there is a component of surface water-groundwater interaction associated with them.



LEGEND

- Populated place
- Longwall Layout
- Rail
- HCU longwall layout
- River/Creek
- Eagle Downs project area
- River regions

Groundwater management zones

- Highlands Underground Water Area
- Highlands Groundwater Management Area
- Isaac Connors Groundwater Management Area
- Isaac Connors Alluvium Groundwater Sub-Area
- Isaac Connors Groundwater Notification Area

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Groundwater management areas

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FIGURE No: **2.1**

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2.2.2 Environmental Protection Act 1994

The evaluation of the EIS process pursuant to Chapter 3 of the EP Act for the EDMCP was reported by the Department of Environment and Resource Management (DERM) in June 2010 (DERM, 2010). The assessment process was initiated by the EDMCP on 19 November 2007 by lodgement of an EA application for ML70389.

DERM notified EDMCP on 14 December 2007 that the EA application was a non-standard application requiring an EIS under Chapter 3 of the EP Act. A notice of the decision to allow the submitted EIS to proceed was issued to the EDMCP on 19 April 2010.

The project operates under EA EPML00586713 which took effect on 3 December 2021, by the administering authority under Chapter 5 of the EP Act. Legislative changes introduced by the Queensland Government in December 2016 (refer to the guideline for the information requirements under sections 126A and 227A of the EP Act, for site-specific and amendment applications) outline the mandatory information that must be included within a groundwater assessment. For resource projects which involve coal seam gas activities (CSG), section 126 of the EP Act requires additional information regarding the management of CSG water. Section 227 of the EP Act requires that this additional information be provided if the amendment would result in changes to the management of CSG water. More details of this requirement are outlined in the guideline application requirements for petroleum activities (ESR/2016/2357).

A summary of the EA Conditions related to groundwater, and where they have been addressed within this report, is provided in Appendix B.

2.3 Relevant Guidelines

There are several available guidelines designed to assist project proponents meet the relevant legislative requirements complete a groundwater assessment for coal mining proposals such as the Project. These guidelines are:

- DES (2016) - Requirements for site-specific and amendment applications – underground water rights - EP Act;
- DES (2017) - Underground water impact reports and final reports - Water Act;
- IESC (2018a) - Information guidelines for proponents preparing coal seam gas and large coal mining development proposals – EPBC Act;
- IESC (2018b) - Information Guidelines explanatory note. Uncertainty analysis—Guidance for groundwater modelling within a risk management framework – EPBC Act;
- Doody et al. (2019) - Information Guidelines Explanatory Note. Assessing groundwater-dependent ecosystems – EPBC Act; and
- Barnett et al. (2012) - Australian Groundwater Modelling Guidelines.

2.3.1 IESC Guidelines

The Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC) is a statutory committee established under the EPBC Act that provides scientific advice to the Commonwealth Environment Minister and relevant state ministers. Guidelines have been developed to assist the IESC in reviewing CSG or large coal mining development proposals that are likely to have significant impacts on water resources. This includes the completion of an independent peer review of numerical groundwater modelling in accordance with the Australian Groundwater Modelling Guidelines (Barnett et al., 2012). The IESC information requirements checklist is presented in Appendix B, with details on where aspects have been addressed and documented within the report.

3 Environmental setting

3.1 Climate

The Moranbah area can be classified as semi-arid with warm, dry winters and hot, humid summers. Rainfall is more prevalent in the summer months, with the majority falling between October and March (Table 3.1).

SILO gridded data[2] was used to assess long-term rainfall trends in the vicinity of the Project. This dataset is interpolated from quality checked observational timeseries data collected at nearby stations by the BoM[3]. Data from January 1889 until December 2019 was used for assessing the long-term rainfall trends in the vicinity of the Project. From this data, the average annual site rainfall is 577 millimetres (mm). The two highest annual rainfalls were recorded for the years 1890 and 2010, with annual rainfalls of 1250 mm and 1122 mm, respectively. The minimum annual rainfall occurred in 1902 with 222.2 mm. Monthly averages for the three stations as well as the SILO grid point are listed in Table 3.1.

Table 3.1 Summary of rainfall averages

(mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean annual
Silo rainfall	108	96	65	30	27	30	21	19	16	31	50	84	**577**
Carfax	110.9	95.3	62.5	31.8	35.6	28.0	22.3	22.5	18.5	35.7	55.3	95.2	**616**
Iffley	112.5	87.3	62.0	40.3	15.8	40.6	18.9	39.1	13.8	33.9	55.8	90.0	**561**
Moranbah Airport	86.2	103.6	97.7	26.2	27.4	17.3	29.5	8.3	7.4	24.7	42.5	56.5	**529**

Actual[4] and potential[5] evapotranspiration (ET) has been taken from BoM's Australia wide interpolation dataset at the locations of the weather stations. The potential ET in the district is about 1600 mm/year according to BoM (2005) (Table 3.2). The actual ET in the district is about 600 mm/year according to BoM (2005) (Table 3.3).

The dataset shows that the average potential monthly ET exceeds the average monthly rainfall over the entire year, often by more than double. Average actual ET is equal to or slightly less than average rainfall for all months except during the "wet" season between December and March, when the average rainfall exceeds the average actual ET.

[2] Grid reference latitude, -22.2° and longitude, 148.3° located close to the Eagle Downs Mine.

[3] The closest BoM weather station is located at Iffley (station 34100), 15 km to the south-east of the Project. This weather station has been in operation since 1998, however, there are several instances of data gaps in the monitoring record. Approximately 50 km south-east of the Project at Carfax (station 34016) a weather station has been operating since 1962. This station has a continuous record with only a few occasional months of missing data. A more recent station at Moranbah Airport (station 34035, 20 km north-west of the Project) has been open since 2012.

[4] The definition for actual ET is: "... the ET that actually takes place, under the condition of existing water supply, from an area so large that the effects of any upwind boundary transitions are negligible and local variations are integrated to an areal average". For example, this represents the predicted ET that is occurring over a large area of land under the existing (mean) rainfall conditions.

[5] The definition of potential ET is: "… the ET that would take place, under the condition of unlimited water supply, from an area so large that the effects of any upwind boundary transitions are negligible and local variations are integrated to an areal average". For example, this represents the ET which would occur over a very large wetland or large irrigated area, with a never-ending water inflow. Further to this, where the water table approaches the ground surface, ET can also approach the potential ET value.

Table 3.2 Average Monthly Potential Evapotranspiration (PET)

PET (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean annual
Carfax	187	155	170	124	96	80	81	100	126	172	189	188	**1668**
Iffley	181	151	167	122	96	80	81	99	125	172	188	184	**1646**
Moranbah	175	147	163	120	95	80	81	98	124	171	186	179	**1619**

Table 3.3 Average Monthly Actual Evapotranspiration (AET)

AET (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean annual
Carfax	72	64	70	45	33	29	29	29	34	55	67	67	**594**
Iffley	70	65	71	46	35	31	30	29	33	54	67	66	**597**
Moranbah	63	62	65	43	33	29	27	25	28	47	62	60	**544**

Monthly rainfall records were used to calculate the Cumulative Rainfall Departure (CRD). The CRD shows graphically trends in recorded rainfall compared to long-term averages and provides a historical record of relatively wet and dry periods. A rising trend in slope in the CRD graph indicates periods of above average rainfall, whilst a declining slope indicates periods when rainfall is below average. A level slope indicates average rainfall conditions (Bredenkamp, et al. 1995).

The CRD in Figure 3.1 was calculated from the Silo gridded data, and indicates that the Millennium Drought occurs until 2007, when rainfall began to increase until 2013. Average to above average rainfall patterns occurred between 3013 and 2016. A severe drought period followed until about the late 2020's from where above average rainfall occurred to the present. Figure 3.1 also supplies an overview of the variability in rainfall patterns where the maximum recorded monthly rainfall was close to 300 mm.

The climatic data indicates that groundwater recharge is unlikely to be high due to the high evaporation rates at the site relative to rainfall. Recharge rates depend on a range of factors including soil type, geology, topography, vegetation and dominant land use. Despite the high average evaporation rates, recharge will occur sporadically when rainfall promotes saturation of the soil profile and evapotranspiration is insufficient to remove the soil moisture. During these periods there is potential for deep drainage of water to underlying groundwater systems. In the context of a groundwater assessment, above average CRD may represent periods of above average recharge to groundwater systems and below average periods lower groundwater recharge. This could correspond to naturally trends in groundwater levels in the Project aquifer systems, refer to Section 5.6 for the groundwater level discussion.

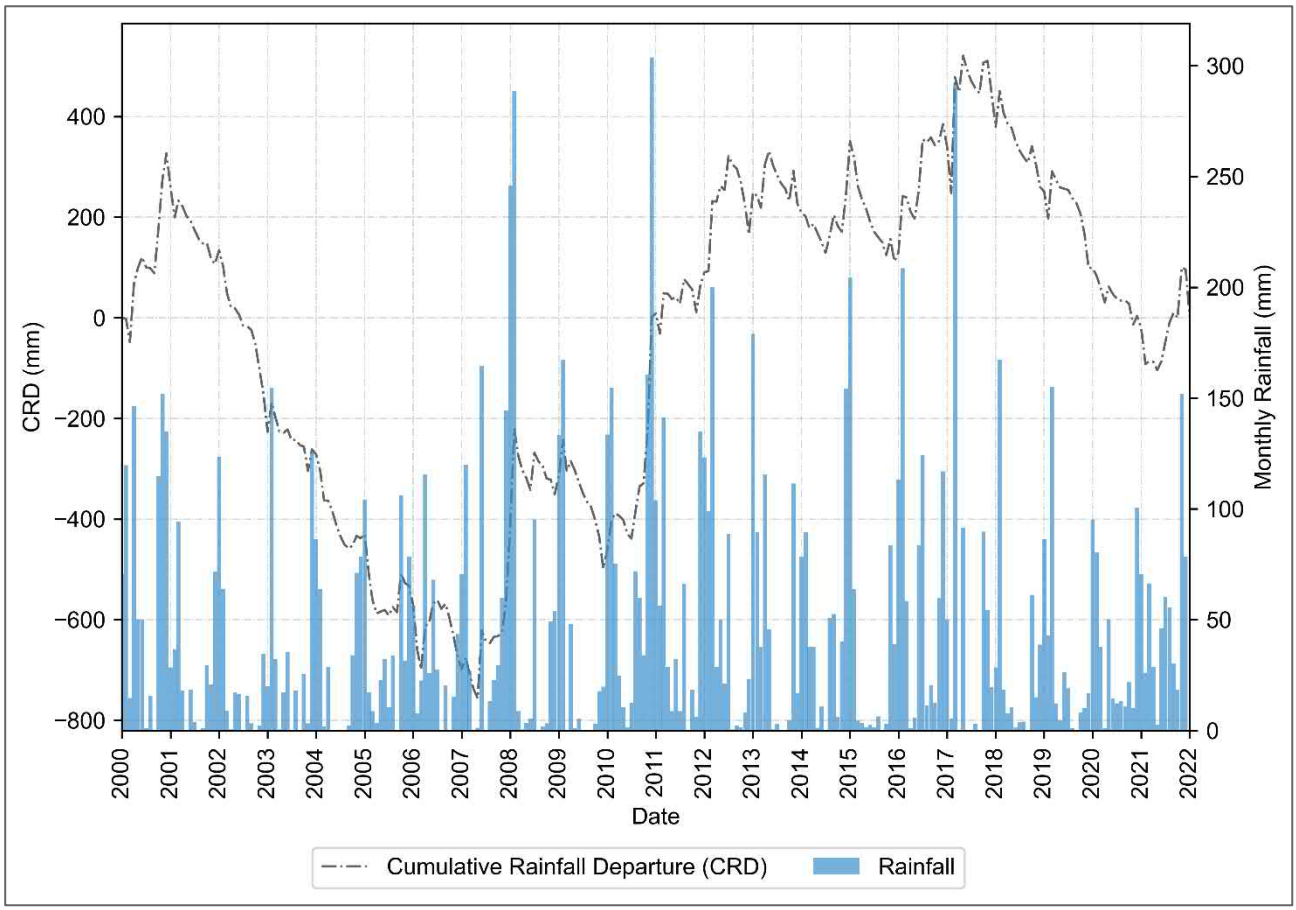
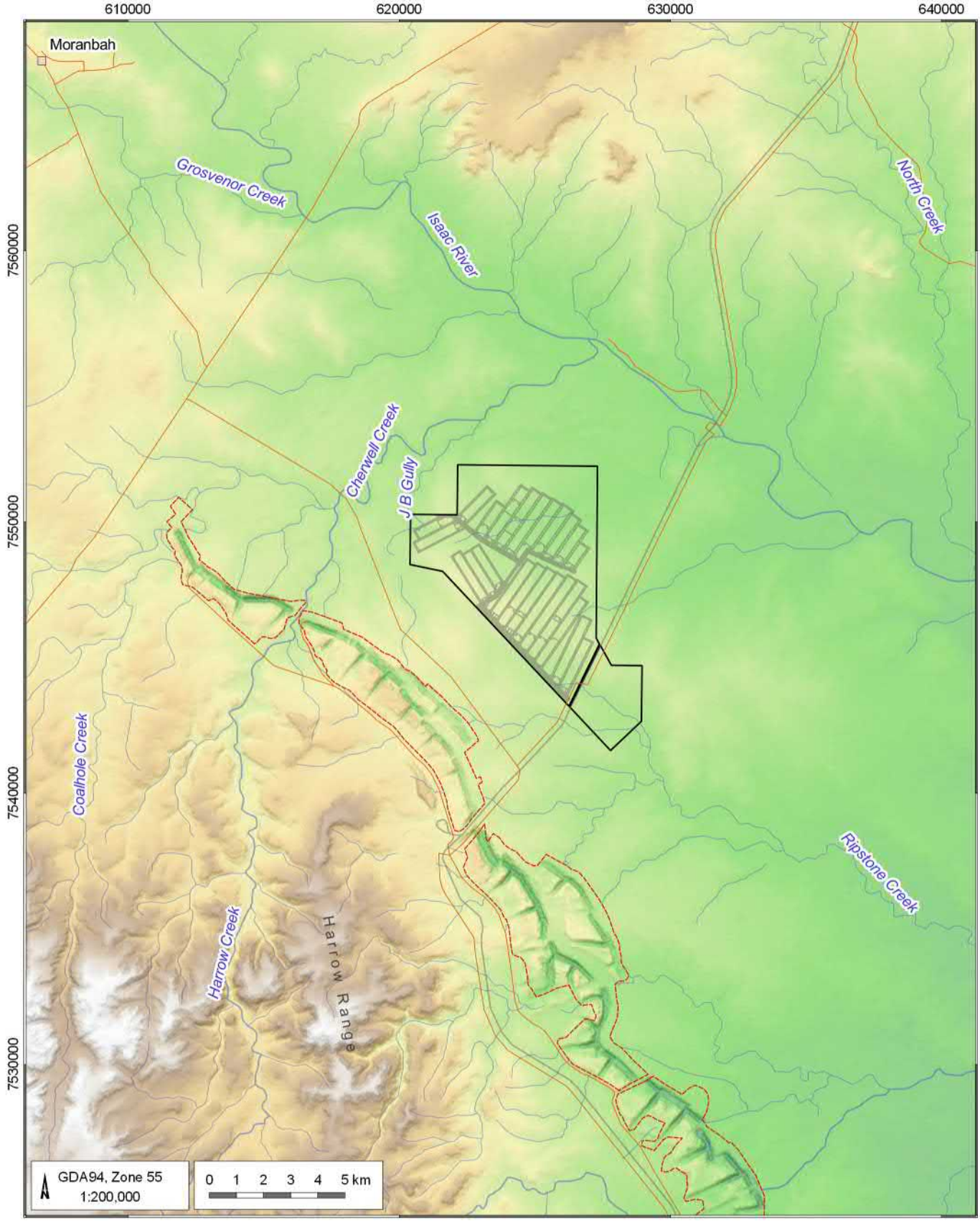


Figure 3.1 Cumulative Rainfall Departure (2000-2021)

3.2 Terrain and drainage

The Project is located between the Harrow Range to the west and the Isaac River to the east. The topography consists of gently undulating terrain with an overall gradient to the east, towards the Isaac River. Local relief ranges from approximately 235 metres above Australian Height Datum (mAHD) in the west to 200 mAHD in the east.

The Isaac River flows in a south-eastern direction and is approximately 4 km north-east of the Project ML at its closest point. Several smaller drainage channels traverse the site and flow in an east or south-easterly direction towards the Isaac River. These drainage features are all ephemeral systems. Some drainage features, like the JB Gully drain to Cherwell Creek, which is approximately 1.5 km north of the northern boundary of the ML and flows in an easterly direction to discharge into the Isaac River (Figure 3.2). Other gullies drain east and dissipate before reaching the Isaac River. Ripstone Creek, which constitutes the southerly gully draining the ML, flows to the south-east and further downstream to the Isaac River. This feature is also the receiving waters for an approved EA release point for the Peak Downs Coal Mine to the west of Eagle Downs.



LEGEND

- Populated place
- RIver/Creek
- Road
- Rail
- HCU longwall layout
- Eagle Downs project area
- Peak Downs mine boundary

Elevation (mAHD)

- 150
- 200
- 250
- 300
- 350
- 400

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Terrain and drainage

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DATE 15/02/2022

FIGURE No: **3.2**

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3.3 Land use and mining

ML70389 is located on Lot 8 on SP277384 and is approximately 4559 ha in area. The land is freehold and forms part of the Winchester Downs property. It has been extensively cleared for cattle grazing with some minor remnant vegetation areas. Within ML70389, some initial mine development activities were undertaken, though no works have been progressed since 2015 with the mine placed into care and maintenance. Completed development activities include a small boxcut approximately 20 m deep (August 2013), two drifts approximately 120 m deep and 800 m long (excavated between March 2014 and September 2015), topsoil and drift excavation disposal areas, and other site infrastructure (offices, workshops, a power substation and dams). Nine pilot gas wells were installed in July 2012 to drain gas from the target coal seams (Q, HCU and HCL) as part of the hazard management for the underground mine (SLR, 2021b). These wells operated until July 2015.

The surrounding land use includes cattle grazing and mining. The closest mine operations to the site are BHP's Peak Downs and Caval Ridge open-cut coal mines, which target the Moranbah Coal Measures where they occur at sub-crop (up-gradient) to the west of the site. There is also an approved project adjacent to the north (Moranbah South). Eagle Downs lies within predicted groundwater impact area presented within groundwater assessments for approvals for projects local to the mine, including:

- Caval Ridge (URS, 2009);
- Moranbah South Project (DEHP, 2014); and
- Moranbah Gas Project UWIR (Arrow Energy, 2016).

The proposed Winchester South project (Whitehaven Coal Limited) is located 2 km south-west and still under the approval process. The project will consist of a maximum of six open cut pits targeting the Rangal Coal Measures (targeting the Leichhardt and Vermont Upper Seams) (SLR, 2021).

Further to the north-east (>5 km) are a number of coal mines and the closest to the Project is the Poitrel Mine which adjoins Millennium Coal Mine's leases to the south. The Poitrel Mine owned by BHP Mitsui Coal Pty Ltd (BMC) is located 25 km east south-east of Moranbah. The Poitrel Mine is an open cut mine targeting the Leichhardt and Vermont Seams within the Rangal Coal Measures, which consists of 79 Mt of resources. The Poitrel Mine is projected to produce up to 5 Mtpa of ROM coal for at least 20 years (Environmental Protection Agency [EPA], 2005).

The location of the project in relation to surrounding tenure holders and mines is shown on Figure 1.1. Table 3.4 summarises the nearby resource extraction operations and projects.

Table 3.4 Proposed and current operations near to the Project

Operation	Status	Type	Planned start	Planned end	Distance from Project	Target coal resource
Bowen Gas Project	Proposed	CSG[1]	~2017[2] (on hold)	2055	Proposed wells south-east of Project	Rangal Coal Measures, Moranbah Coal Measures
Winchester South	Proposed	Open cut	2022	2052	Adjacent east of the Project	Rangal Coal Measures and Fort Cooper Coal Measures
Olive Downs Project	Construction/ Proposed	Open cut	2020	2099	East and south-east of Winchester South	Rangal Coal Measures
Saraji East	Proposed	Underground - Longwall	TBD	TBD	12 km south	Moranbah Coal Measures
Peak Downs	Operating	Open cut	1972	2075	5 km, west	Moranbah Coal Measures
Poitrel	Operating	Open cut	2006	2026	10 km north-east	Rangal Coal Measures
Daunia	Operating	Open cut	2011	2034	15 km north-east	Rangal Coal Measures
Millennium	Operating	Open cut	2005	2027	17 km north-east	Rangal Coal Measures
Moorvale South Project	Proposed	Open cut	2021	2031	4 km east of the proposed Winchester South	Rangal Coal Measures, Fort Cooper Coal Measures
Caval Ridge	Operating	Open cut	2013	2043	10 km north-west	Moranbah Coal Measures
Isaac Downs	Construction/ Proposed	Open cut	2022	2037	16 km north	Rangal Coal Measures

Notes: [1] Coal Seam Gas.

[2] On Hold – Projects approved and proposed to commence but have not yet commenced. The Bowen Gas Project is a CSG development by Arrow Energy Pty Ltd (Arrow), targeting gas within coal seams of the Rangal Coal Measures and Moranbah Coal Measures. The Bowen Gas Project proposes to extract approximately 270 gigalitres (GL) of associated water with the gas over a period of 55 years from 6,000+ extraction wells covering and area of 9,500 square kilometres (km^2). Arrow has identified an extraction wellfield targeting the Rangal Coal Measures and Moranbah Coal Measures in the vicinity of the Project. While the final well locations and relative timing of these activities are yet to be finalised.

4 Geological Setting

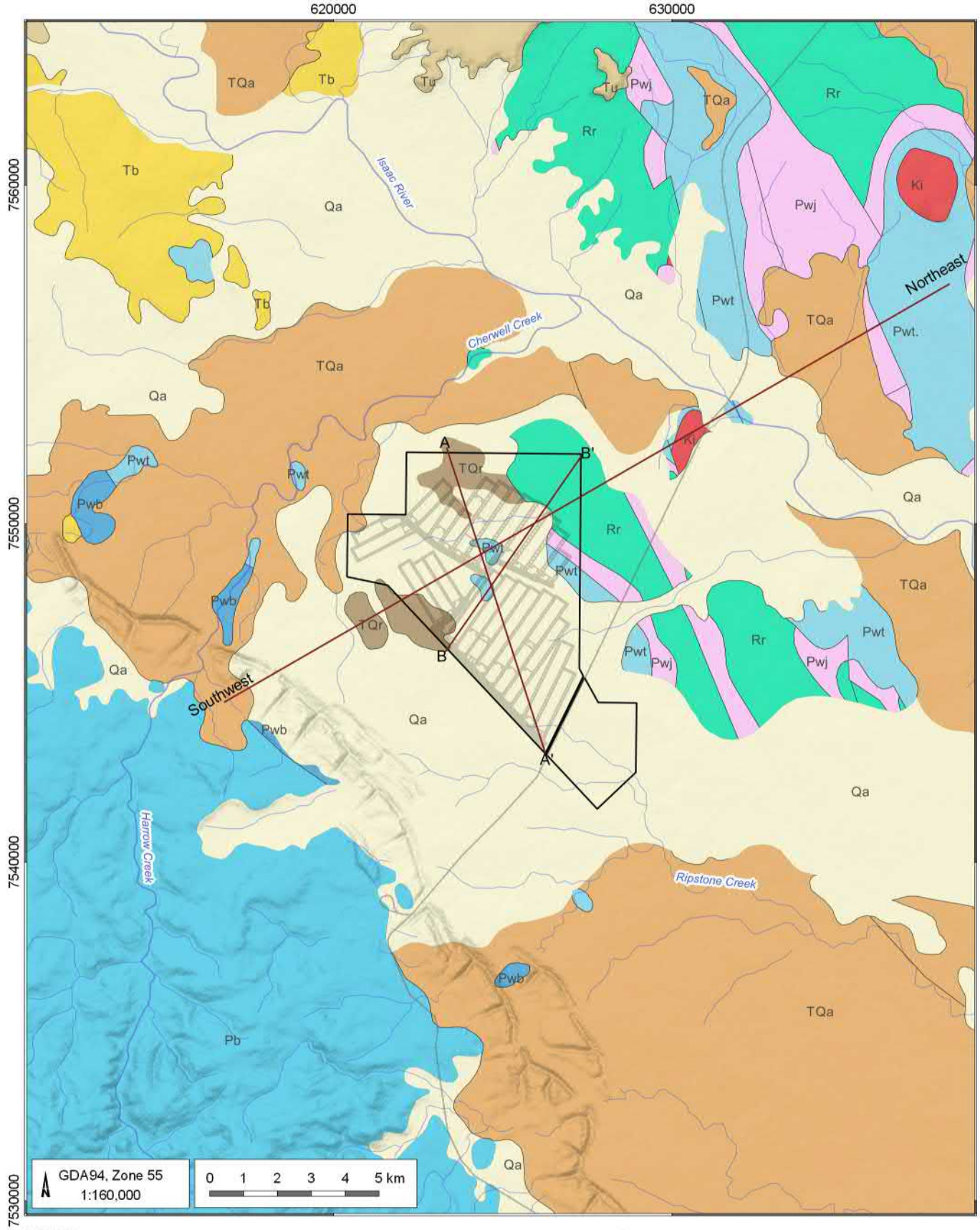
The Eagle Downs resource is in the northern part of the Permo-Triassic Bowen Basin, which contains principally fluvial and some marine sediments. The Bowen Basin is divided into several tectonic units comprising NNW-SSE trending platforms separated by sedimentary troughs. The stratigraphy of the ML and surrounds is summarized in Table 4.1 and a surface geological map for the area is shown on Figure 4.1 and the solid geology and sub-outcrop zones depicted on Figure 4.2. The two cross-section lines shown on Figure 4.1 is discussed in Section 4.1.

Economic coal seams in the area belong to the wholly terrestrial Moranbah Coal Measures, which the Fort Cooper Coal Measures overlie. The coal measures are of Upper to Middle Permian age. Older alluvial (TQa) sediments are distributed extensively across the region. The Fort Cooper Coal Measures are unconformably overlain by a thin veneer of unconsolidated to semi-consolidated Tertiary sediments and localized unconsolidated Quaternary sediments (Qr and Qr\b).

The stratigraphic profile across the Project area therefore comprises two distinct units namely a Permian sandstone/siltstone/mudstone/coal sequence (the Coal Measures) which are overlain by a thin Tertiary clay, sandy clay, clayey sand sequence. The Permian rocks form a regular layered sedimentary sequence that subcrop to the west of the Eagle Downs area and dip at three to eight degrees to the east, while the Tertiary materials are more complex and irregular.

Table 4.1 Summary of site stratigraphy

Period	Stratigraphic unit	Description	Distribution	Max thickness (m)
Cainozoic	Isaac River Quaternary alluvium (Qa)	Flood plain alluvium comprising clay, silt, sand and gravel.	Surficial cover localised along Isaac River. NOT occur within the Eagle Downs ML as indicated on the geology map in Figure 4.1.	~50
	Regolith - alluvium, colluvium and other sediments in floodplains, alluvial fans, and high terraces (Qa, Qr, Qr\b and TQa)	Colluvial and residual deposits comprising poorly sorted clay, silt, sand, gravel and black soils, silts and muds derived from weathered basalts.	Associated Cherwell Creek and Ripstone Creek	0 to 15
Triassic	Mimosa Group: Rewan Group (Rr) (Rewan Formation and Sagittarius Sandstone)	Rewan Formation: green lithic sandstone, pebbly lithic sandstone, green to reddish brown mudstone and minor volcanolithic pebble conglomerate (at base). Sagittarius Sandstone: lithic sandstone interbedded with mudstones and siltstones with scattered carbonaceous plant material.	Outcrops or subcrops within the Study Area, and central and northern zones of the Project.	~200
Permian (late)	Blackwater Group: Rangal Coal Measures (Pwj)	Coal seams, carbonaceous shale and mudstone, tuff, siltstone and mudstone.	Within Project Area; isolated Outcrops in the eastern zones of the Project.	~200
	Blackwater Group: Fort Cooper Coal Measures (Pwt) (Fair Hill Formation)	Coal, brown and green sandstone, conglomerate, carbonaceous shale, tuff.	Within Project Area; isolated outcrops and subcrops most of the Project.	~350
	Blackwater Group: Moranbah Coal Measures (Pwb)	Quartzose to sublabile locally argillaceous sandstone, siltstone, mudstone, carbonaceous mudstone and coal.	Within/underlies the Project; Outcrops or subcrops in the west of the study area.	~400
Permian (early to middle)	Back Creek Group (Pb)	Quartzose to lithic sandstone, siltstone, carbonaceous shale, minor coal and sandy coquinite.	Within/underlies Project; Outcrops in the west of the Study Area.	~400



LEGEND

- Rail
- HCU longwall layout
- Cross section line
- River/Creek
- Eagle Downs project area

Surface geology(1:85k)

- Qa - Quaternary alluvium
- Tb - Tertiary basalt
- TQa - Tertiary Quaternary alluvium
- TQr - Tertiary Quaternary residual soils
- Tu - Duaringa and Suttor formations
- Ki - Cretaceous intrusives
- Pb - Back Creek Group
- Pwb - Moranbah Coal Measures
- Pwj - Rangal Coal Measures
- Pwt - Fort Cooper Coal Measures
- Rr - Rewan Group

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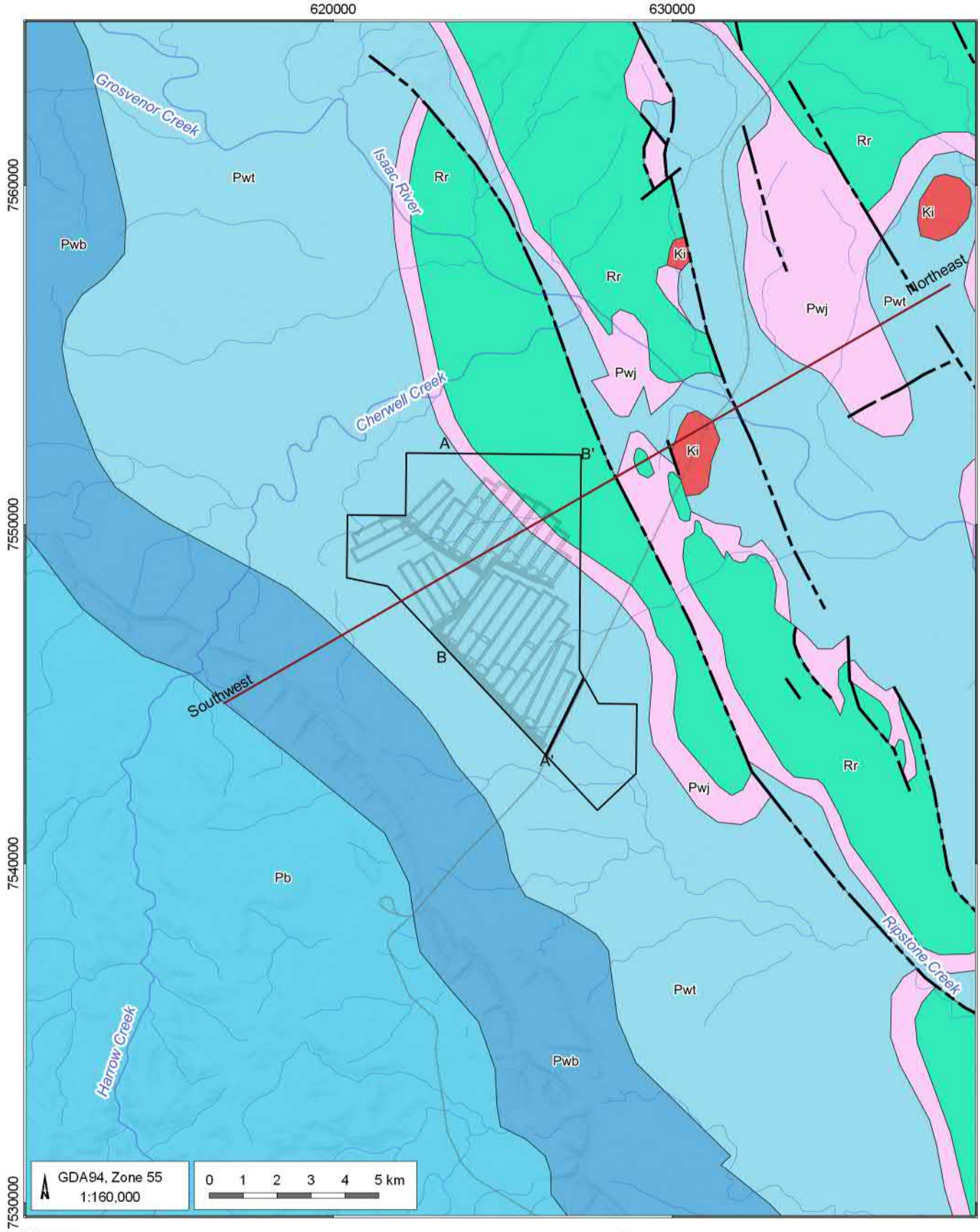
Surface geology

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FIGURE No: **4.1**

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LEGEND

- Rail
- HCU longwall layout
- Cross section location
- River/Creek
- Eagle Downs project area

Structure geology

- Fault

Solid geology

- Ki - Cretaceous intrusives
- Pb - Back Creek Group
- Pwb - Moranbah Coal Measures
- Pwj - Rangal Coal Measures
- Pwt - Fort Cooper Coal Measures
- Rr - Rewan Formation

Eagle DownsGIA for EA Amendment (EDM5000.001)

Solid geology

AGE

DATE 03/02/2022

FIGURE No: **4.2**

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4.1 Permian

4.1.1 Moranbah Coal Measures

The Moranbah Coal Measures (MCM) consist of sandstone, siltstone, claystone and mudstone, coal, coal parting materials and sub-coal (under-burden) strata. There are six coal bearing horizons, however, significant reserves are restricted to the Q Seam, Harrow Creek Upper and Lower Seams and the Dysart Seam which form the principal economic coal resource of the Eagle Downs project. Refer to Figure 4.3 for a typical stratigraphic column, after JB Mining Services (2007) for exploration bore 26C.

In the south of the project area, the HCU and HCL seams coalesce to form a single 12 m to 15 m thick seam. Only the HCU can practically be mined in this area, although the longwall is able to cut to maximum height through this area. Non-coal sediments consist of moderately weak to strong sandstones, siltstones and minor mudstones. Sandstone and siltstone are codominant.

Figure 4.1 shows two cross-section locations: Figure 4.4 and Figure 4.5 present diagrammatic sections of the typical seam stratigraphy of the area (South32, 2020). The HC seam on the Eagle Downs site is split into two separate seams. These are the Harrow Creek Upper (HCU) and Harrow Creek Lower (HCL) seams, and each also has sub-plies.

The HCU seam is the main target seam at the Eagle Downs site, lying approximately 110 m below the Q seam. It averages 4 m in thickness and ranges in depth from 250 m in the south-west to more than 600 m in the north-east. The immediate roof of the HCU seam is a predominantly siltstone-based material that is interspersed with varying proportions of sandstone and mudstone, the latter typically presenting as sub-horizontal bedding. A review of the boreholes, previous reports and geophysical logs indicate small areas where the combined sandstone thickness in the immediate 50 m of overburden is up to 22 m, however these appear to be laminated and not massive.

The shallowest coal in the HCL seam is approximately 300 m below the surface, reaching 600 m towards the north-east. The seam thickness ranges from 6.3 m to over 10.0 m. It averages 8 m in the central and northern regions of the project area and thins to 6 m in the 200 series area, where it coalesces with the HCU seam. The single thick seam will be mined as part of the HCU 200's mining layout.

The interburden between the HCU and the HCL seams rapidly thickens away from the coalescence zone in the south. Towards the north, it thickens to approximately 50 m and reaches 75 m thick in some places. The interburden contains two major sandstone channels, the HSL14 and HSL12, that vary in thickness across the lease, exceeding 55 m thick where they join to form the HSL10, towards the centre of the lease.

A number of boreholes in the area were reviewed, with core physically examined on site. This showed a generally thick sandstone, with few natural planes of weakness. This material is unlikely to readily delaminate and is likely to cave in large, strong blocks, or thick slabs.

As detailed in the writeup above regarding the HCL seam, the DY seam structure and stress regime can be translated down from the HCU and HCL seams, with obvious offsets for the dip of any structure. The interburden between the seams varies between 50 m thick to the east and 100 m thick to the north-west.

The depth of the DY seam is greater than the HCL seam, the average interburden thickness between the HCL and DY seams is around 60 m to 70 m, without any of the thick and strong sandstone channels found between the HCU and HCL seams.

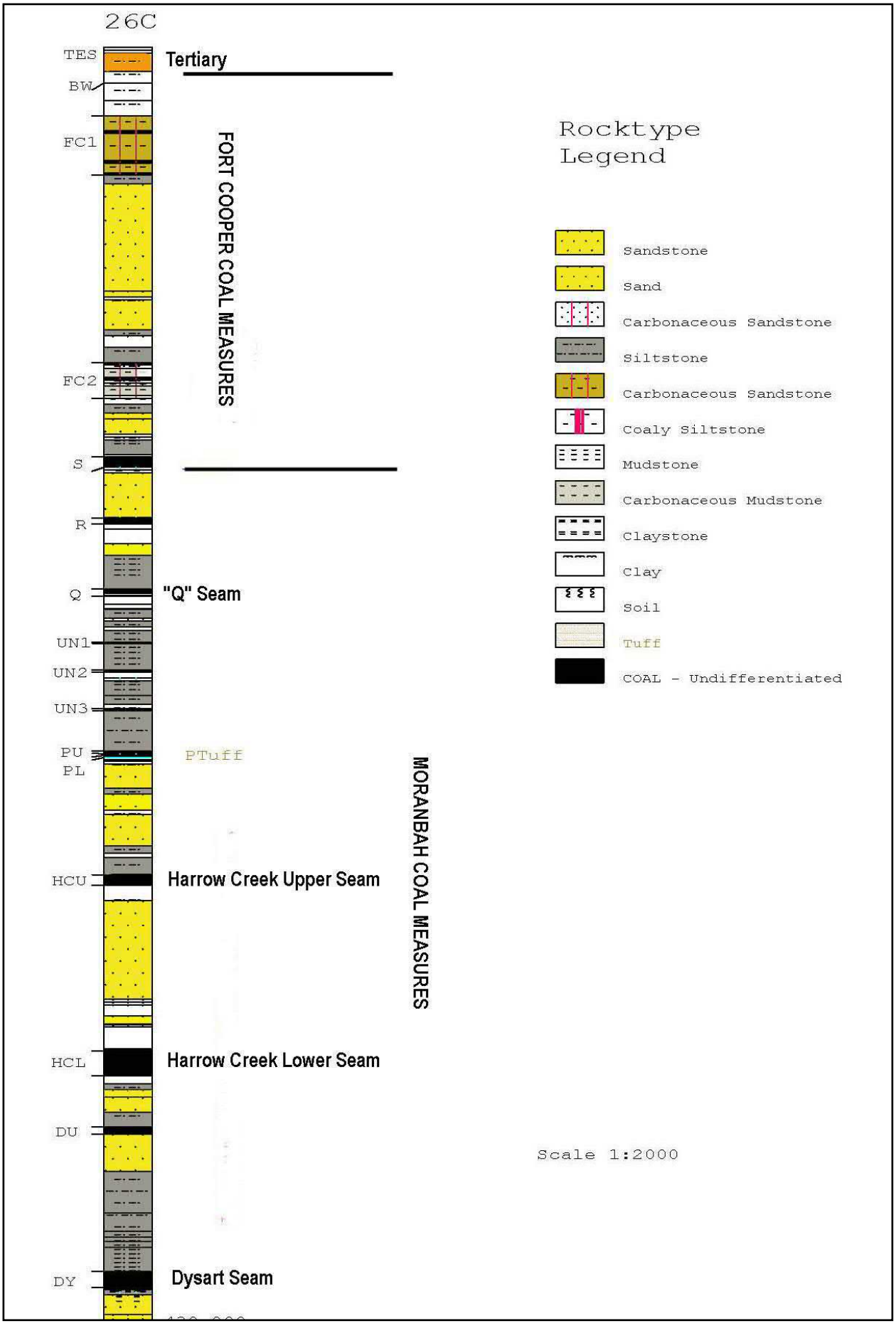


Figure 4.3 Typical Stratigraphic Column (Hole 26C)

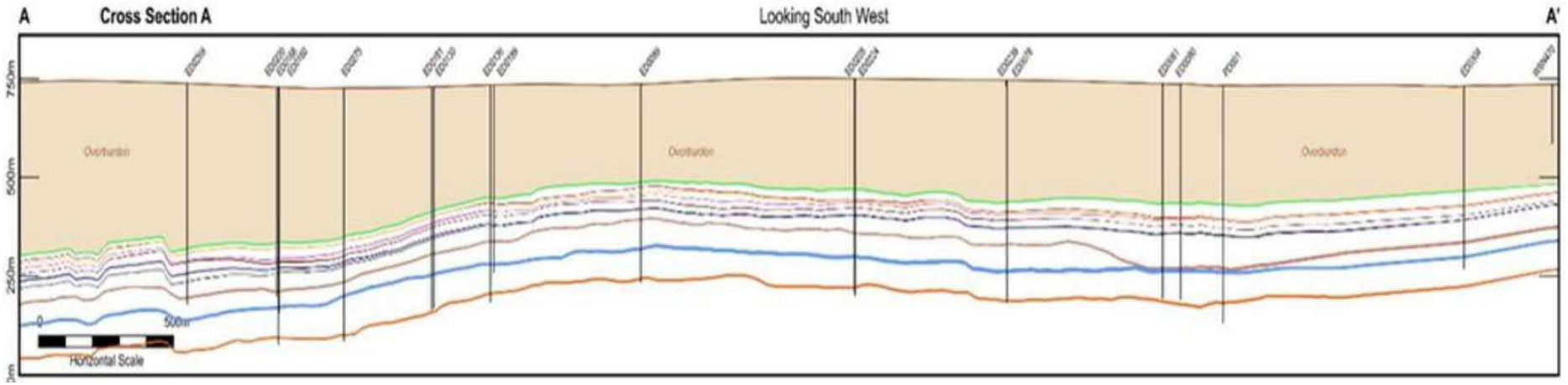


Figure 4.4 Cross-sections A-A' (South32, 2020)

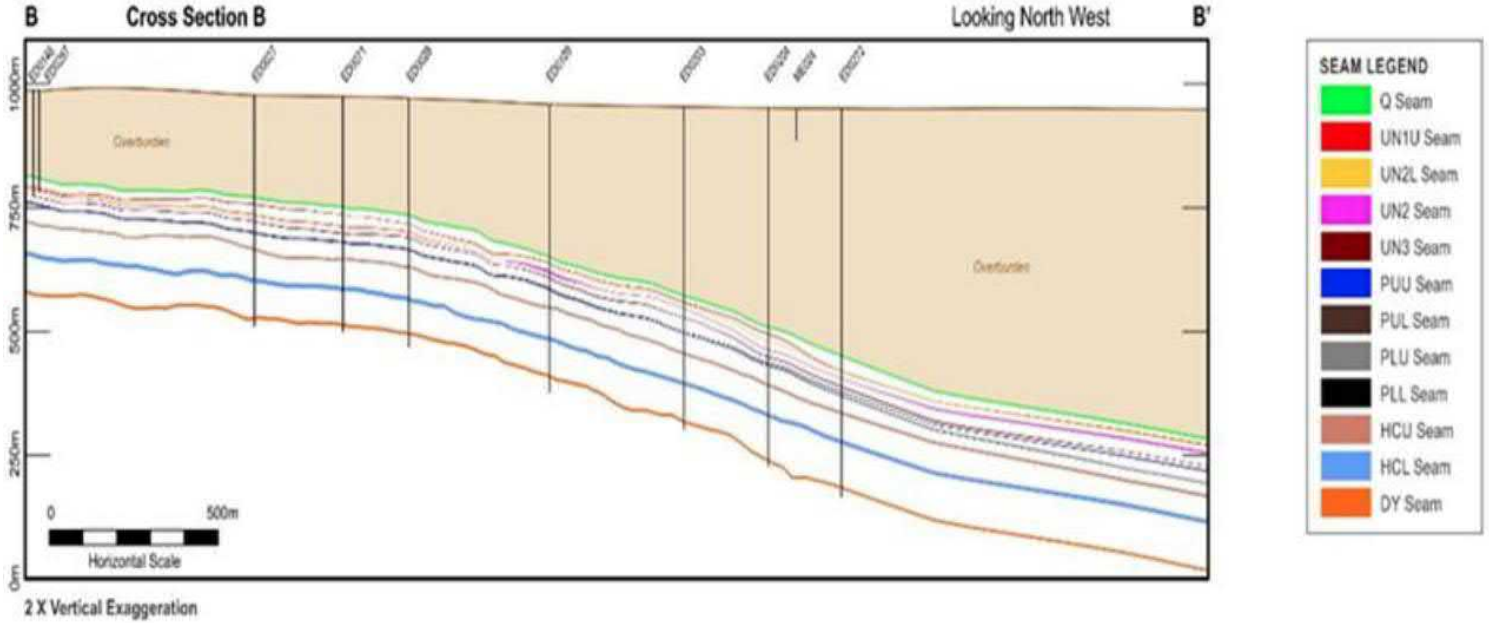


Figure 4.5 Cross-sections B-B' (South32, 2020)

4.1.2 Structural geology

There is a large-scale thrust system, the Isaac Thrust, east of the Isaac River. While not measured, some localised stress changes may impact the mine due to this structured zone. The north-west south-east trending thrust faults have up to 100 m throw with Permian sediments displaced upwards by these faults to the east. Faults are interpreted to extend up to the base of weathering beneath the Isaac River. The locations of these faults are shown on Figure 4.2.

The Geological structures are well defined by 500m spaced drilling, which complements 2D and 3D seismic surveys, which have identified a mixture of normal faults, thrust faults and seam rolls, with varying confidence levels across the project resource area. These are shown in Figure 4.6 (South32, 2020).

There are two main orientations of faulting, NE–SW and NW–SE, which fits in with the regional structural framework. The principal structural features (faults with throw greater than 10m) are:

- Two normal faults in the centre of the project area, oriented NW–SE, with throws of up to 17 m.
- A NE–SW oriented normal fault, almost parallel to the railway line (in the series 200 area), with a maximum throw of 17 m.

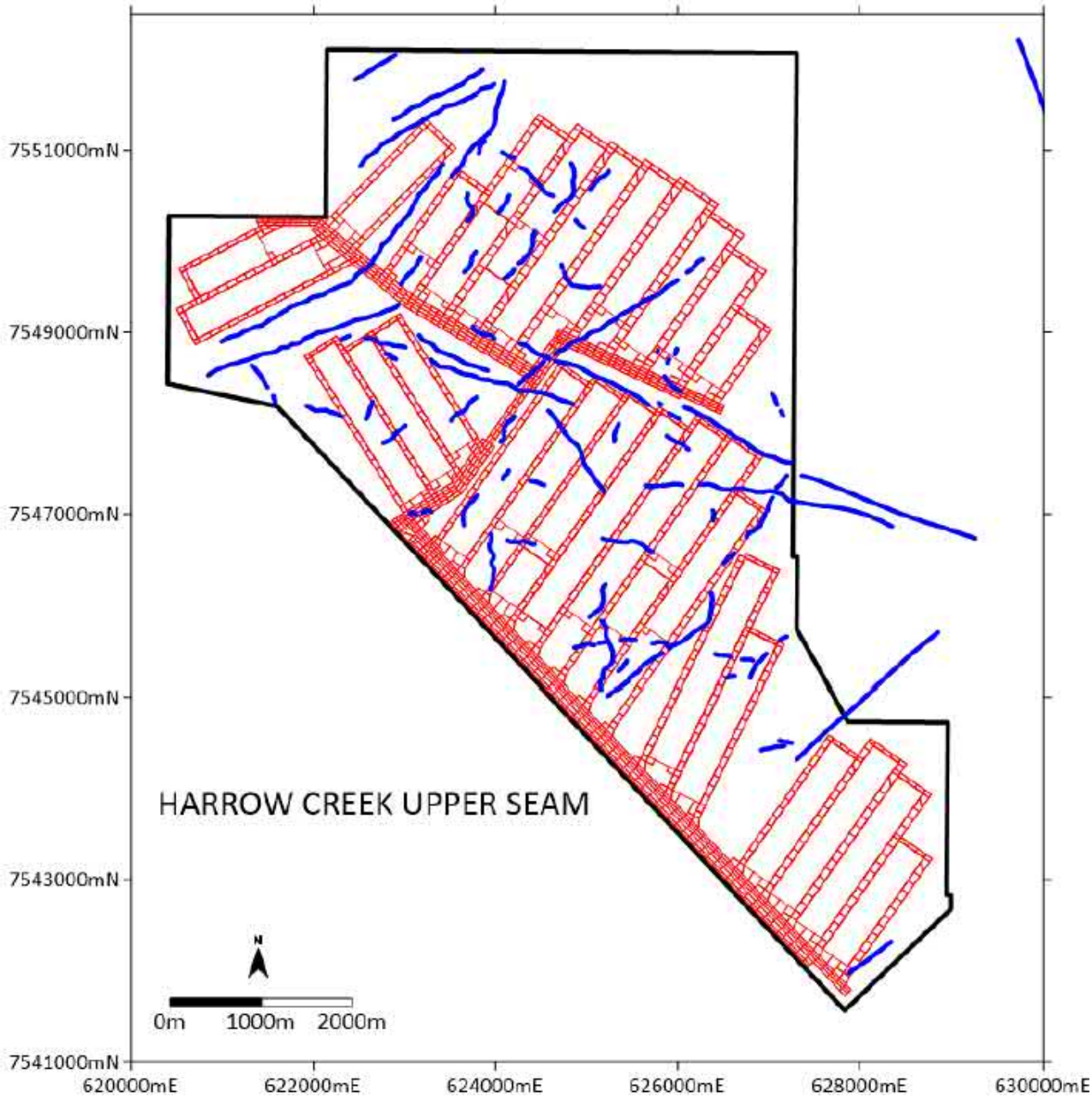


Figure 4.6 Fault interpretation projected on the HCU seam (South32, 2020)

4.1.3 Permian weathering

The depth of weathering in the mining area ranges from 14 to 34 m and averages about 22 m (Figure 4.7). As the sub-crop of the seams is well to the west of the project area, they lie at depth beneath the Project area and the coal seams are not impacted by weathering.

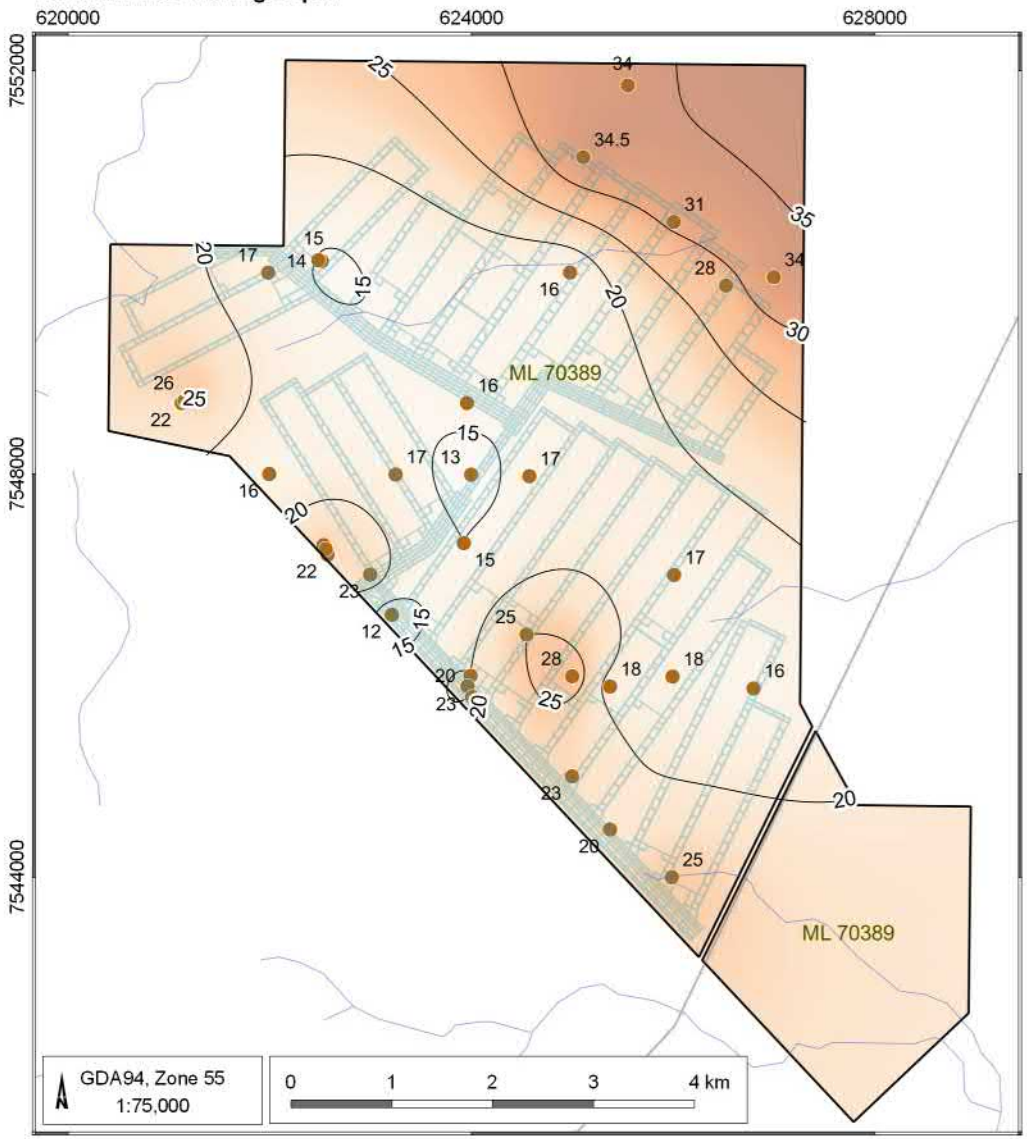
4.1.4 Fort Cooper Coal Measures

The Fort Cooper Coal Measures typically contain tuffaceous sandstone, siltstone, mudstone, carbonaceous shale, coal, and tuff. The coal seams are typically highly stone banded seams of high ash coal and are currently considered uneconomic to mine. The transition between the MCM and overlying Fort Cooper Coal Measures is difficult to identify with certainty and usually corresponds to the absence of tuffaceous coaly bands and the presence of more lithic sandstones in the MCM.

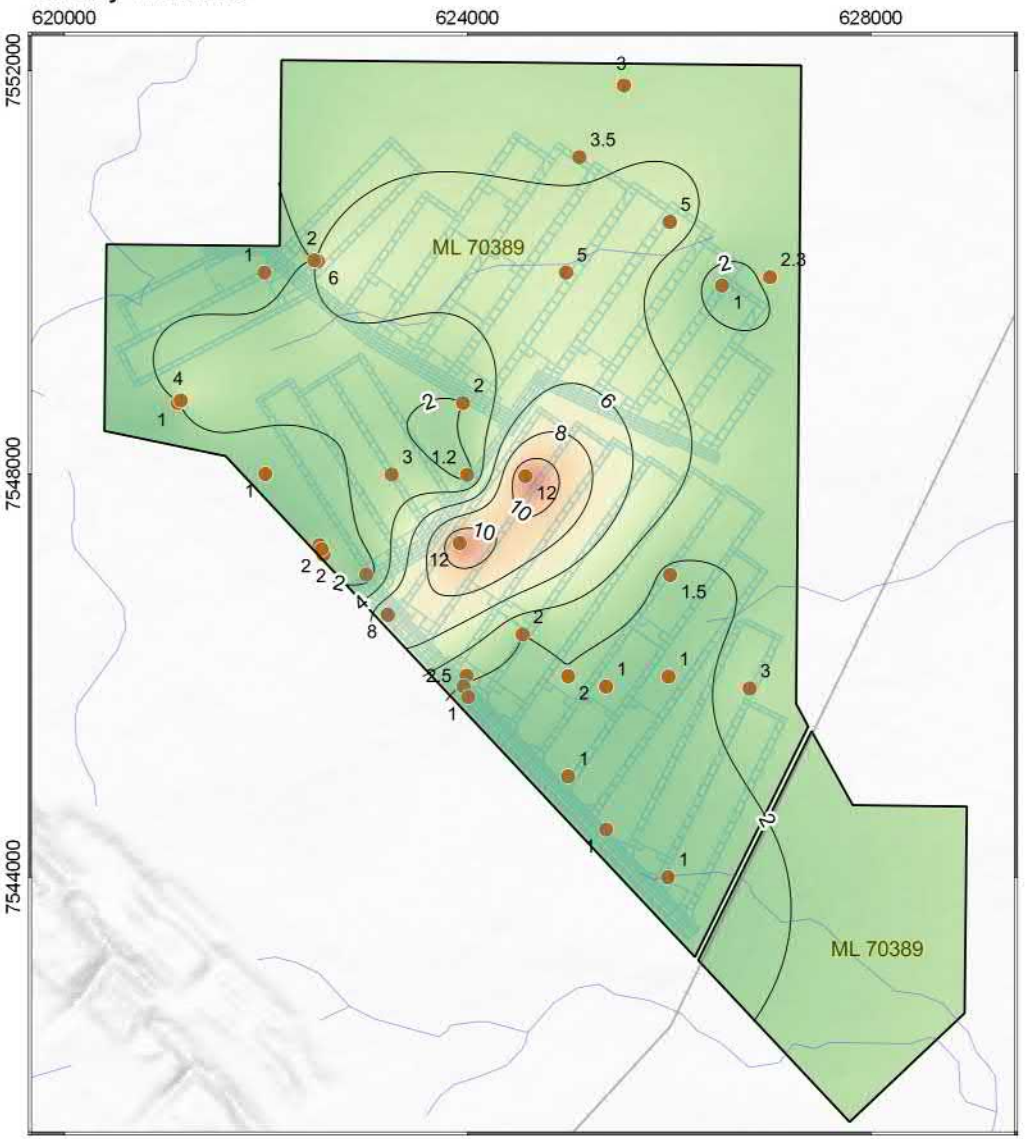
4.2 Tertiary

The Tertiary deposits covering the Eagle Downs ML are quite thin with a thickness range of 1 to 12 m and an average of about 2.5 m, as shown on Figure 4.7. That is, the Tertiary deposits generally form a thin veneer over the Permian strata. In general, the Tertiary sediments comprise unconsolidated to semi consolidated fluvial sediments of clay, silty clay, sandy clay, and clayey sand, that is, the Tertiary sediments are dominated by clay. The base of the Tertiary deposit is defined by an unconformity, that is, an erosion surface which formed the Permian topography prior to deposition of the Tertiary sediments.

Permian weathering depth



Tertiary Thickness



LEGEND

- G1409_weathering depths
- Rail
- Watercourse
- Contour line
- HCU longwall layout
- Eagle Downs project area

Base of weathering depth (m)

14, 18, 22, 26, 30, 34, 38

Tertiary thickness (m)

0, 2, 4, 6, 8, 10, 12

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Permian weathering depth and Tertiary thickness

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FIGURE No:
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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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4.3 Quaternary

The main regional alluvial deposits are associated with the Isaac River to the east of the ML and to a lesser degree Cherwell Creek to the north, both of which are deeply eroded channels within the plain. The alluvial sediments comprise unconsolidated clay, silt, sand, and gravel. Generally, the base of the creek and river consist of sand and gravel with silt and clay being over-bank deposits. The alluvial plain of the Isaac River may extend up to 750m from the river but does not occur within the ML. The surficial cover is localised along the Isaac River and to a certain extent the Cherwell Creek and NOT occur within the Eagle Downs ML as indicated on the geology map in Figure 4.1. This is supported by the exploration drilling data.

In contrast, the drainage lines within the ML consist of shallow gullies. The gullies contain silt from the surrounding plains. Thick alluvial deposits have not developed in the gullies and there are no deposits of sand and gravel. Typical gullies on the site are shown on Figure 4.8 and Figure 4.9.



Figure 4.8 Ripstone Creek upstream of the Project area looking east (Google Earth Street view)



Figure 4.9 JB Gully upstream of the Project area looking north-east (Google Earth Street view)

5 Hydrogeology

5.1 Historical hydrogeological assessments

The following lists the previous hydrogeological assessments for the Project. The groundwater impacts and risks related to the approved EA and the incremental changes (if any), as a result of the proposed Project changes, are discussed in Section 9.

- The initial groundwater assessment for the site was completed as part of the EIS in 2007/2008[6]. The study included reviewing existing baseline data, installing monitoring bores, constructing the numerical model and simulating the impact of mining on the groundwater regime.
- In 2011[7], the numerical groundwater model was updated as part of the Front End Loading (FEL3) and Definitive Feasibility Study (DFS). This included representing a new mine plan, adding layers to the model and recalibration with new water level and permeability data (collected since the EIS).
- In 2015/2016[8], the 2011 FEL3/DFS study was updated to assess the Project's feasibility and aligned with the objectives of the joint venture parties. The addendum study considered mining of a single seam, the HCU seam. As part of this study, the numerical model was updated with hydrogeological data collected from the monitoring bore network, vibrating wire piezometers (VWPs) and information from the inseam gas drainage pilot program.
- In 2019, AGE was engaged to undertake further groundwater modelling for an updated mine plan. The updated mine plan extending into the southern part of ML70389 and outside of the previously refined model mesh, so the model mesh was updated to ensure the entire mine plan was captured in the refined area of the mesh. The model simulated mining in HCU, HCL and the Dysart seams and provided predictions of mine inflow and groundwater drawdowns. Uncertainty analysis was also undertaken to explore the range of expected inflows, given the uncertainty in the calibrated model parameters.
- In 2021, (AGE) was engaged to report on the predicted mine inflows and impacts for an updated HCU seam mining configuration and overall revised mine schedule. This required changes to model input to reflect the new HCU mining layout and adjusting the sequencing of the proposed continued mining into the HCL and Dysart seams.

No previous hydrogeological investigations have been undertaken prior to the initial assessment in 2007 within the Project area. For this reason, data has been obtained from the Integrated Isaac Plains Project (IIPP) to the immediate north that proposes to mine coal seams in the younger Rangal Coal Measures, and from the Saraji Mine to the south which mines the same MCM as are proposed for mining within the Eagle Downs application during the 2007 assessment.

For this update, data from the proposed Winchester South project, situated directly east and south-east of the Project area, was also considered. As indicated in Section 3.3, the Winchester South project will consist of a maximum of six open cut pits targeting the Rangal Coal Measures (targeting the Leichhardt and Vermont Upper Seams) (SLR, 2021).

[6] Australasian Groundwater & Environmental Consultants Pty Ltd, (December 2008), "Eagle Downs Coal Mine Project – Groundwater Impact Assessment", Project No. G1409.

[7] Australasian Groundwater & Environmental Consultants Pty Ltd, (March 2011), "Eagle Downs FELS/DFS – Groundwater Modelling and Reporting", Project No. G1545.

[8] AGE. (2016). G1765.Eagle Downs groundwater model update.

5.2 Groundwater occurrence

There are two aquifer systems within the Project area:

- a shallow aquifer associated with the upper weathered/fractured rock; and
- aquifers associated with the Permian formations.

Alluvial aquifers associated with sand and gravel deposits along Cherwell Creek and the Isaac River occur outside of the ML boundary and are briefly discussed below. As indicated earlier, the shallow geology map of the area is shown in Figure 4.1 demarcating the Quaternary to be across most of the ML. This is incorrect as there are no reported deep Quaternary or Tertiary palaeo-channels on this site. The Quaternary and Tertiary deposits within the Eagle Downs ML and surrounds consist of a relatively thin veneer of clayey sediments.

5.3 Hydrostratigraphic units

5.3.1 Permian shallow weathered/fractured aquifer

The weathered zone of the Fort Cooper Coal Measures exists across the Project area and averages about 22 m in thickness. It is connected to the Permian coal seam aquifers, where the coal seams are shallow and weathered, and by deeper open fractures that intersect the coal seams at depth. The weathered zone occurs across the whole of the area, generally from surface level, but to the east of the ML, it underlies the alluvium of the Isaac River. The water table is generally within weathered fractured rock zone. Available information on farm bores suggest that the base of the shallow aquifer does not extend beyond 80 m depth (AGE, 2008).

5.3.2 Permian coal seam aquifers

Similar to the rest of the Bowen Basin, the coal seams are the principal aquifers within the Permian sequence. The overburden and inter-burden rocks are of significantly lower permeability than the coal, with the exception of areas where significant fracture systems exist below the standing water level.

The coal seam aquifers are deep and confined beneath the project area, but subcrop to the west. Groundwater storage and movement occurs within the coal seam cleats and fissures and within open fractures that intersect the seams. Other sediments in the coal overburden and inter-burden sequence are of significantly lower permeability and form aquitards. The Permian strata may therefore be categorized into the following hydrogeological units:

- hydraulically “tight” and hence very low yielding to essentially dry sandstone, siltstone and shale that comprise the majority of the Permian inter-burden/overburden;
- low to moderately permeable coal seams which are the prime water bearing strata within the Permian sequence; and
- localised fracture or fault systems which are open and have not been healed by carbonate or iron deposition.

5.3.3 Alluvial Aquifers

There are no alluvial aquifers within the Eagle Downs ML. Alluvium occurs outside of the ML along the Isaac River and to a lesser degree along Cherwell Creek. The lateral extent is highly variable, but sections along the Isaac River the deposit may be up to 750 m wide. There are few stock bores within the alluvium indicating unsaturated or thinly saturated conditions. The alluvium is recharged by rainfall and by seepage from the river during periods of flow. During drier periods, the alluvium discharges as baseflow to the river.

5.4 Groundwater monitoring and monitoring locations

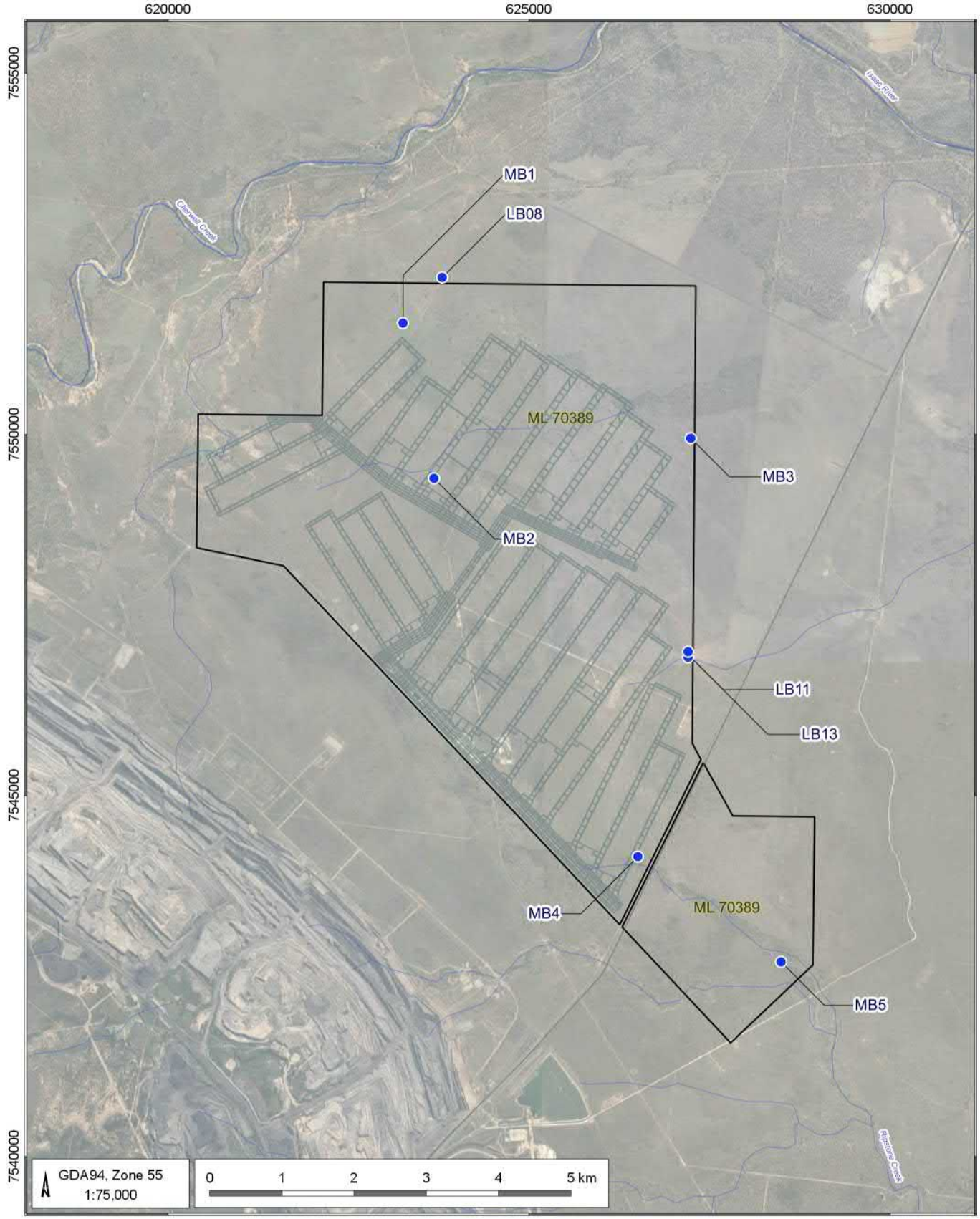
Eagle Downs has an existing groundwater monitoring network in place to monitor groundwater conditions in line with the EA. Groundwater monitoring is currently completed annually up until commencement of longwall mining activities begins. Once longwall mining commences, groundwater monitoring will be conducted quarterly (EA Condition C46).

The groundwater monitoring network consists of eight monitoring bores, three of which are landholder stock bores. Table 5.1 summarises the current groundwater monitoring network with sites shown on Figure 5.1. The proposed amendments to the groundwater monitoring plan are discussed in Section 11.

Table 5.1 EA Monitoring bore details

Name	Easting (m)	Northing (m)	Elevation (mAHD)	Total Depth (m)	Screen		Aquifer	Year monitoring started
					From (m)	To (m)		
MB1	623254	7551541	220.87	50.5	47.5	50.5	Upper fractured rock Fort Cooper Coal Measures - siltstone	Oct-11
MB2	623684	7549391	210.17	50.5	47.5	50.5	Upper fractured rock Fort Cooper Coal Measures – sandstone and siltstone	Oct-11
MB3	627240	7549946	203.11	51.4	48.4	51.4	Upper fractured rock Rewan Group	Oct-11
MB4	626507	7544152	214.89	51	48	51	Upper fractured rock Fort Cooper Coal Measures – coal, sandstone and siltstone	Oct-11
MB5	628491	7542693	208.83	51.5	48.5	51.5	Upper fractured rock Fort Cooper Coal Measures – coal, sandstone and siltstone	Oct-11
LHB8	623797	7552173	-	-	-	-	Upper fractured rock Fort Cooper Coal Measures	May-14
LHB11	627205	7546949	-	-	-	-	Upper fractured rock Fort Cooper Coal Measures	Jun-06
LHB13	627200	7546952	-	-	-	-	Upper fractured rock Fort Cooper Coal Measures	May-14

Note: Coordinates GDA94 zone 55



LEGEND

- Rail
- Major drainage
- Minor drainage
- HCU longwall layout
- Eagle Downs project area
- EA monitoring bores

Eagle Downs GIA for EA Amendment (EDM5000.001)

EA Monitoring bore network

AGE

DATE 03/02/2022

FIGURE No: **5.1**

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5.5 Hydraulic properties

5.5.1 Previous studies – Permian aquifer

Permeability data reported by Palgas (Palgas, 2015), Pells Sullivan Meynink (PSM, 2011) and Sigra (Sigra Pty Ltd, 2008) for the Eagle Downs Project area was used for the groundwater assessment (AGE, 2016) and the 2019 model update (AGE, 2019).

Permeability testing was performed in 2015 (Palgas, 2015) included packer tests at different locations and depths in the Q, HCU and HCL coal seams. Graphs of the data indicate a general decrease in hydraulic conductivity with depth, aligned with several studies in the public domain for the Bowen Basin.

A number of packer tests were previously carried out in 2011 (PSM, 2011) on various coal seams and Permian interburden in bore EDO250. The permeability data derived from testing was assessed and individual metre per day conductivity values per tested aquifer unit were assessed. Packer testing carried out on the Permian interburden in the absence of coal (206.5 m to 210.4 m), suggesting interburden hydraulic conductivity values of approximately 2.1 x 10^{-3} m/day. A summary of their packer testing results is presented in Table 5.2.

Table 5.2 Adjusted packer test data (PSM, 2011)

Avg depth (m)	Test interval (m)	Interburden interval (m)	Coal interval (m)	Transmissivity (m^2/day)	Adjusted horizontal hydraulic conductivity of coal (m/day)
156.22	12.44	10.44	2	1.59 x 10^{-2}	6.91 x 10^{-3}
176.22	8.44	6.44	2	1.31 x 10^{-2}	5.73 x 10^{-3}
236.22	8.44	5.44	3	2.14 x 10^{-2}	6.70 x 10^{-3}
279.22	6.44	5.94	0.5	4.17 x 10^{-3}	4.47 x 10^{-3}
342.72	11.44	3.94	7.5	1.40 x 10^{-2}	1.76 x 10^{-3}
366.22	12.44	11.44	1	3.01 x 10^{-3}	1.08 x 10^{-3}
416.61	7.67	1.47	6.2	1.03 x 10^{-2}	1.59 x 10^{-3}

Permeability testing of the coal seams in the Eagle Downs ML was also undertaken on bore E795041 using straddle packers. The tests were carried out by Sigra Pty Ltd (Sigra, 2008) who reported the results of the analysis in February 2008 as summarized in Table 5.3.

Table 5.3 Summary of coal seam permeability test for bore E795041(Sigra Pty Ltd, 2008)

Seam	Test zone depth (m)	Interval thickness (m)	Permeability (md)	Adjusted horizontal hydraulic conductivity of coal (m/day)
Q	373.9 – 380.9	7	4.23	3.53 x 10^{-3}
HCU	493.9 – 500.9	7	15.1	1.26 x 10^{-2}
HCL	535.9 – 546.9	11	3.7	3.09 x 10^{-3}
DY	616.9 – 630.3	13.4	0.0118	9.85 x 10^{-6}

Note: 1 md (millidarcy) ≈ 8.346x10^{-4} m/day.

The data suggests that the HCU has the highest permeability of 1.26 x 10^{-2} m/day with the Q and HCL Seams being similar at about 3 x 10^{-3} m/day and the deeper Dysart Seam being of the lowest permeability at 9.85 x 10^{-6} m/day. The data is from one borehole and therefore may not be representative of the site as a whole. The Sigra data indicates a general decrease in hydraulic conductivity with depth similar to data obtained in reports of several studies in the public domain.

Previous testing and reporting of hydraulic properties of the Permian, shallow weathered and alluvial aquifers (AGE, 2011) indicate the coal hydraulic conductivity decreases with depth as is typical of sedimentary sequences. On Figure 5.2, straight short lines at the top represent fixed values assumed for Alluvium and regolith materials. Dotted lines represent the equations defining permeability and depth according to the original Palgas study (permeability in Darcys displayed as Hydraulic Conductivity in m/day), adjusted to the general form:

$$\text{Permeability} = A * \text{Depth}^{B}$$

However, as observed, permeability values obtained from these equations are very high near the surface (at depths shallower than 200 m or 100 m). These values are not believed to correspond with background knowledge from the area gathered by AGE, so the equations were re-calculated and displayed in solid lines, using the form:

$$\text{Hydraulic Conductivity} = A * e^{(B * \text{Depth})}$$

which in the log-normal graph presented are displayed as straight lines and believed to be more accurate at shallow depths while providing similar result at depth. The equations used were:

- Q seam: $0.03442 * e^{(-0.005426 * \text{Depth})}$
- HCU seam: $0.381352 * e^{(-0.0090833\ \text{Depth})}$
- HCL seam: $1.639874 * e^{(-0.013638 * \text{Depth})}$
- Interburden: Q seam reduced by one order of magnitude (with Hydraulic Conductivity in m/d and depth in m).

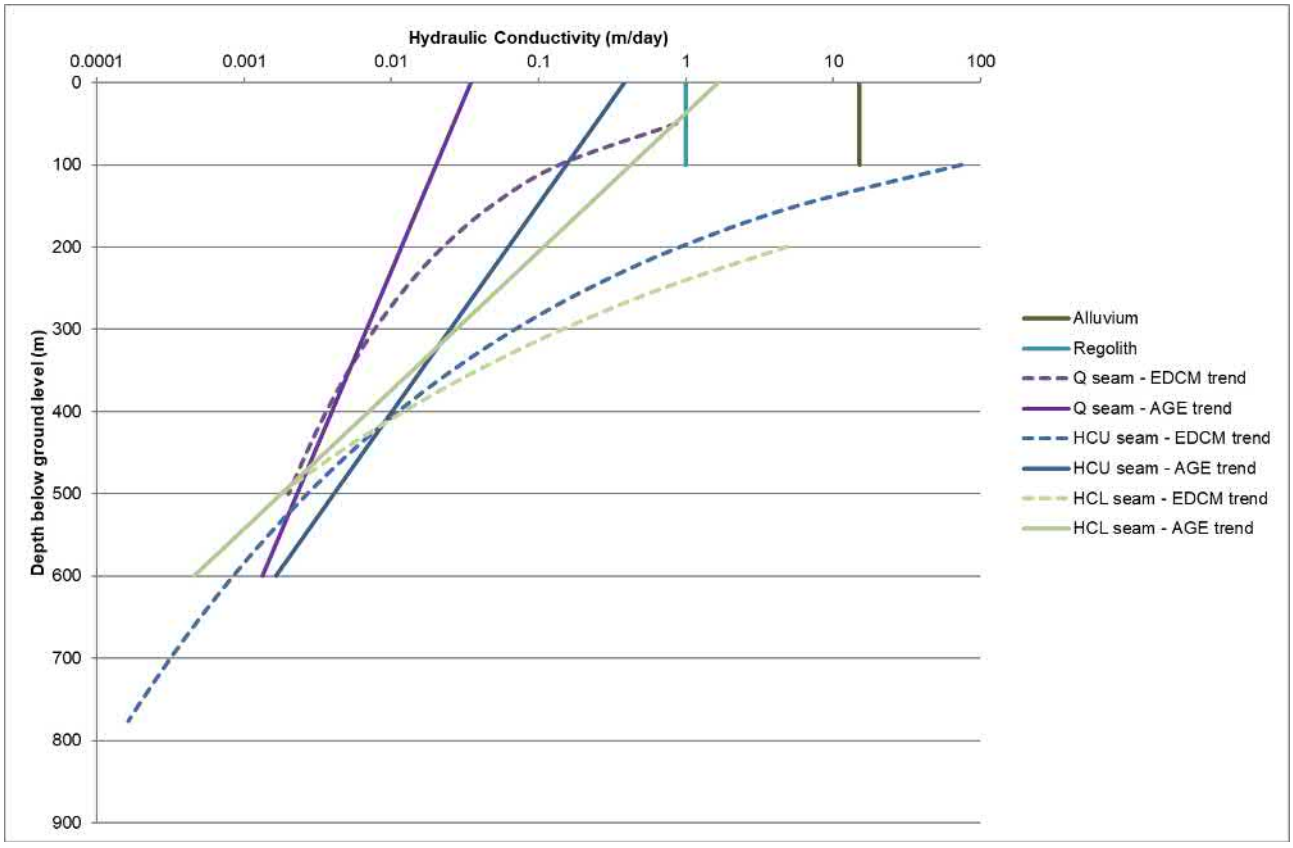


Figure 5.2 Permian horizontal hydraulic conductivity vs depth (AGE, 2016)

5.5.2 Recent test work – Permian aquifer

Pro-Test Well Services conducted four drill stem tests (DST) and six Lugeon tests on bore ED0328B and four DSTs and seven Lugeon tests on bore ED0331 in November 2020. Towler Well Test Analysis Pty Ltd (2020a and 2020b) completed the analyses of the data as depicted in Table 5.4 and Table 5.5.

The result summary of the Lugeon tests for bore ED0331 are summarized in Table 5.5 and indicates low conductivity in all the intervals. All of the Lugeon tests for borehole ED0328B were conducted over the inter-burden between the coal seams. The volumes injected were below flow meter resolution and found exceptionally low and, calculation of lugeon values and conductivity were not possible for bore ED0328B.

The recent hydraulic conductivity results for the coal seams are similar when comparing to the historical tests results and the HCU seam has the highest values. However, the recent test results for the interburden sections (Table 5.5) indicates lower values when comparing to the historical tests results discussed above.

Overall, the Permian coal measures generally record higher hydraulic conductivity than the majority of the interburden/overburden tests. This is due to the dual porosity of the coal seams, with a primary matrix porosity and a secondary (dominant) porosity provided by fractures (joints and cleats) and supports the concept of the coal seams themselves forming the dominant groundwater bearing zones of the Permian units.

Table 5.4 Permeability results, ED0328B and ED0331

Bore no	DST no	Coal Seam	Thickness (m)	Gauge Depth (m)	Kh (mD-m)	k (mD)	Hydraulic Conductivity (m/d)
ED0328B	DST-1	HCL	8.92	418.6	96.657	10.836	9.04E-03
ED0328B	DST-2	PUU, PUL, PLU, PLL	2.71	330.6	89.098	32.877	2.74E-02
ED0328B	DST-3	HCU	3.91	365.6	168.451	43.082	3.60E-02
ED0328B	DST-4	Q	2.41	260.6	16.041	6.656	5.55E-03
ED0331	DST-1	HCL	7.88	393.1	77.43	9.83	8.20E-03
ED0331	DST-2	PU, PT, PL, PLL	2.64	300.6	56.81	16.2	1.35E-02
ED0331	DST-3	HCU	3.68	334.6	198.38	51.46	4.29E-02
ED0331	DST-4	Q	2.37	233.1	41.33	17.44	1.46E-02

Notes: Kh: Transmissibility for interval, k: permeability (m/day), Hydraulic Conductivity (m/d) adjusted from permeability (1 md) (millidarcy) ≈ 8.346x10-4 m/day).

Table 5.5 Lugeon Tests results for interburden in borehole ED0331

Test no	Pecker top (m)	Packer bottom (m)	Interval thickness (m)	Average conductivity (m/s)	Average conductivity (m/d)
1	380.00	390.21	10.21	2.0E-10	1.73E-05
2	350.00	360.21	10.21	1.2E-10	1.04E-05
3	320.00	330.21	10.21	3.60E-10	3.11E-05
4	300.00	310.21	10.21	8.80E-10	7.60E-05
5	250.00	260.21	10.21	2.80E-10	2.42E-05
6	240.00	250.21	10.21	4.80E-11	4.15E-06
7	215.00	220.21	5.21	3.60E-10	3.11E-05

5.5.3 Shallow weathered / fractured rock aquifer

The original groundwater impact assessment for the Project (AGE, 2008) used a uniform hydraulic conductivity value for the shallow aquifer since hydraulic parameters of the shallow aquifer were not tested. A rockmass hydraulic conductivity of 1 m/day was assumed for numerical modelling.

5.5.4 Public domain data – Permian and shallow aquifers

5.5.4.1 Winchester South

The proposed Winchester South coal project, located directly to the east and south-east of the Project area and within the Project numerical groundwater model domain completed falling head tests for the project EIS (SLR 2021) on the shallower Rangal Coal Measures. The assessment shows that the field results (Table 5.6) fall within the range of field data collected through other studies across the Bowen Basin.

Table 5.6 Hydraulic conductivity data from falling head tests (Winchester South GIA, SLR, 2021)

Hole ID	Easting	Northing	RLGS (mAHD)	Test interval	From/ to (m)	K (m/day)
C2105	634556.4	7541688.0	208.28	Leichhardt Seam	55.2 to 60.2	9.0×10^{-3}
C2131	629953.8	7545413.5	212.33	Inter seam sediments	35.3 to53.5	2.2×10^{-3}
G2304	633149.5	7542982.4	215.55	Vermont Seam	54.1 to 59.1	1.9×10^{-2}
G2307	630769.4	7547665.4	194.42	Vermont Seam	74.0 to 79.0	8.2×10^{-3}
R2008	630767.2	7542394.3	220.32	Vermont Seam	61.0 to 66.0	4.0×10^{-4}
R2009	631202.6	7542630.2	219.72	Inter seam sediments	75.8 to 80.8	6.7×10^{-5}

The Rewan Group sediments exhibit a low hydraulic conductivity, typically less than 10^{-4} m/day, similar to the interburden/overburden material of the Rangal Coal Measures. Packer testing hydraulic conductivity results from bore WS3182 ranged from 9.48×10^{-4} to 1.02×10^{-3} m/day. Drill hole WS3189 reported hydraulic conductivity results ranging between 6.93×10^{-5} and 2.07×10^{-3} m/day (Table 5.7). These results represent relatively low hydraulic conductivity values indicate that the faulting zones intercepted and tested are 'healed' and not pathways for preferential flow. It is assumed the localised fault zones identified within the Eagle Downs project area will have similar characteristics.

Table 5.7 Winchester South packer testing results (Winchester South GIA, SLR, 2021)

Bore ID	Interval Tested	Formation	Hydraulic Conductivity (m/d)
WS3182	87 - 89	Mudstone and carbonaceous mudstone clasts, brecciated within sandstone matrix	9.48×10^{-4}
	89 - 91	Mudstone, fractured and broken, slickensides	9.84×10^{-4}
	93 – 95	Mudstone and minor siltstone, unfractured, massive	1.02×10^{-3}
WS3189	35 – 37	Coal	2.07×10^{-3}
	41 – 43	Mudstone, minor fracturing, calcite infill	1.02×10^{-4}
	48 – 50	Mudstone, minor fracturing, calcite infill	6.93×10^{-5}
	54 – 56	Coal, sandstone, siltstone and mudstone, slickensides, calcite infill	8.60×10^{-5}
	57 – 59	Siltstone and sandstone, relatively unfractured	2.22×10^{-4}

5.5.4.2 IIPP – Permian and shallow aquifers

The Integrated Isaac Plains Project (IIPP) consists of the existing Isaac Plains Coal Mine to the north of Peak Down Highway and the Isaac River, and the Expansion Area which lies between Cherwell Creek and the Isaac River and is to the immediate north of the Eagle Downs ML. The EIS for the IIPP was prepared in 2008[9]. Based on exploration drilling results, it was concluded that the area has a "dryness" similar to that of nearby mines, as evidenced by an absence of groundwater in most exploration holes located within the Permian coal measures. Where groundwater was encountered in the Permian, the yields were low.

Drill holes in the alluvium of the Isaac River provided yields of up to 1 L/s suggesting that the river alluvium is likely to function as a poor to medium yielding unconfined aquifer. The drilling results indicated a sporadic nature of groundwater occurrence in the alluvium. Rising and falling head permeability tests undertaken on six monitoring bores in the area indicated the following permeability value:

- Isaac River alluvium: 2.3 to 3.6 m/day
- Coal seams: 0.0005 to 0.024 m/day
- Permian siltstone/sandstone: 0.0001 m/day

5.6 Groundwater level and flow directions

As explained in the following sections, two different types of monitoring bores exist at the Project, the shallow monitoring bores (discussed in Section 5.4) and the VWP measuring groundwater levels from the deeper Permian coal measures. The list of these sites is shown in Table 5.8. A once-off groundwater level survey was conducted from several exploration bores in 2007 and discussed in 5.6.2.1. The locations of the groundwater observation points are shown on Figure 5.3.

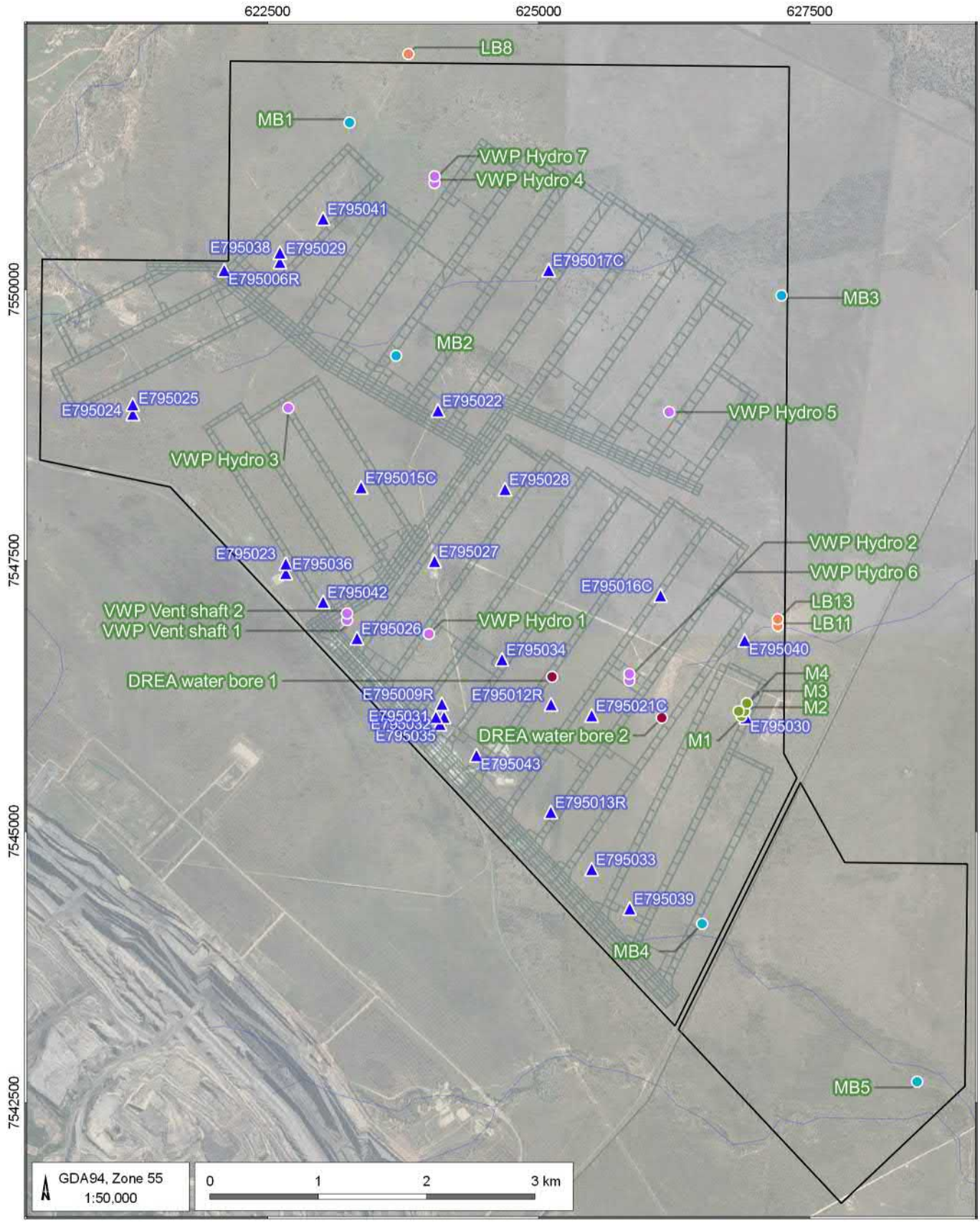
Table 5.8 Observation and monitoring bores

Bore ID	Bore name	East	North	RL m	Bore Depth (m)	Observation type
E795057	MB2	623683.3	7549390.0	210.1	51	EA monitoring bore, standpipe
E795058	MB1	623253.9	7551541.0	221.4	51.4	EA monitoring bore, standpipe
E795059	MB3	627239.6	7549945.0	203.61	51.4	EA monitoring bore, standpipe
E795060	MB4	626507.2	7544150.0	214.9	52	EA monitoring bore, standpipe
E795061	MB5	628490.5	7542693.0	209.3	52	EA monitoring bore, standpipe
LHB8	LB8	623797.0	7552173.0	222.9	-	EA monitoring landholder bore
LHB11	LB11	627210.0	7546907.0	217.0	-	EA monitoring landholder bore
LHB13	LB13	627200.0	7546952.0	217.9	-	EA monitoring landholder bore
ED0223	VWP Hydro 1	623986.6	7546823.0	239.5	472	VWP
ED0224	VWP Hydro 2	625832.5	7546422.0	230.8	551	VWP
ED0225	VWP Hydro 3	622688.3	7548908.0	223.0	497	VWP
ED0226	VWP Hydro 4	624037.9	7551014.0	220.5	720.35	VWP
ED0227	VWP Hydro 5	626202.4	7548871.0	207.8	645	VWP
ED0228	VWP Hydro 6	625837.2	7546426.0	230.6	262	VWP

[9] *Matrix Consulting, (2008),* "Integrated Isaac Plains Project Environment Impact Statement", *Appendix 7, Hydrogeology.*

Bore ID	Bore name	East	North	RL m	Bore Depth (m)	Observation type
ED0229	VWP Hydro 7	624038.7	7551014.0	220.2	-	VWP
ED0250	VWP Vent shaft 1	623264.2	7546945.0	240.4	426.48	VWP
ED0251	VWP Vent shaft 2	623196.8	7547019.0	240.5	424.79	VWP
ED0252	DREA water bore 1	625121.9	7546428.0	230.7	66	DREA water bore
ED0253	DREA water bore 2	626135.0	7546050.0	229.6	30	DREA water bore
M1	M1	626831.3	7546015.0	225.4	-	Piezo
M2	M2	626870.4	7546108.0	224.4	-	Piezo
M3	M3	626909.5	7546162.0	223.5	-	Piezo
M4	M4	626918.7	7546184.0	223.2	-	Piezo

Note: Coordinates GDA94 zone 55.



LEGEND

- Rail
- Watercourse
- HCU longwall layout
- Eagle Downs project area

Summary of the 2007 groundwater level data

- Exploration bores

Observation and monitoring bores

- DREA water bore
- EA monitoring bore, standpipe
- EA monitoring landholder bore
- Piezo
- VWP

Eagle DownsGIA for EA Amendment (EDM5000.001)

Project groundwater level observation points

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FIGURE No: **5.3**

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5.6.1 Shallow weathered aquifer

Groundwater levels were measured in the five monitoring bores installed across the Project area as part of ongoing monitoring outlined in the current EA. Table 5.9 provides an overview of the minimum maximum and average groundwater levels.

Figure 5.4 shows that groundwater levels are stable since 2011, with only MB1 showing a slight decline, although less than 5 m, and MB3 has a slight increase by a few metres.

- The continued decline in levels for MB1 is not due to site activities as no mining has been conducted. The trend is likely due to landholder bore usage and drawdown from surrounding mining.
- Groundwater levels in MB3 have increased by 1.5 m between 2008 and 2020. The bore intersects the low permeability Rewan Group, and the change in levels may reflect the reduction in monitoring frequency influencing groundwater levels due to slow recovery.

The EA monitoring bores, screened in the shallow weathered fractured rock, host the groundwater table. Two additional monitoring bores, MB6 and MB7, will be installed 12 months prior to the commencement of longwall mining as discussed further in Section 11.

Table 5.9 Summary of groundwater level data

Bore name	East	North	Collar mAHD	Bore Depth (m)	GW Level (mbgl)			Average GW elevation (mAHD)
					Ave	Min	Max	
MB1	623253.9	7551541	221.4	51.4	32.4	29.9	35.7	189.0
MB2	623683.3	7549390	210.1	51	16.3	15.8	17.7	193.8
MB3	627239.6	7549945	203.6	51.4	33.1	31.6	34.7	170.5
MB4	626507.2	7544150	214.9	52	18.8	18.4	19.4	196.1
MB5	628490.5	7542693	209.3	52	14.5	14.2	15.1	194.8
LHB13	627200	7546952	217.9	-	13.1	11.5	16.6	204.8

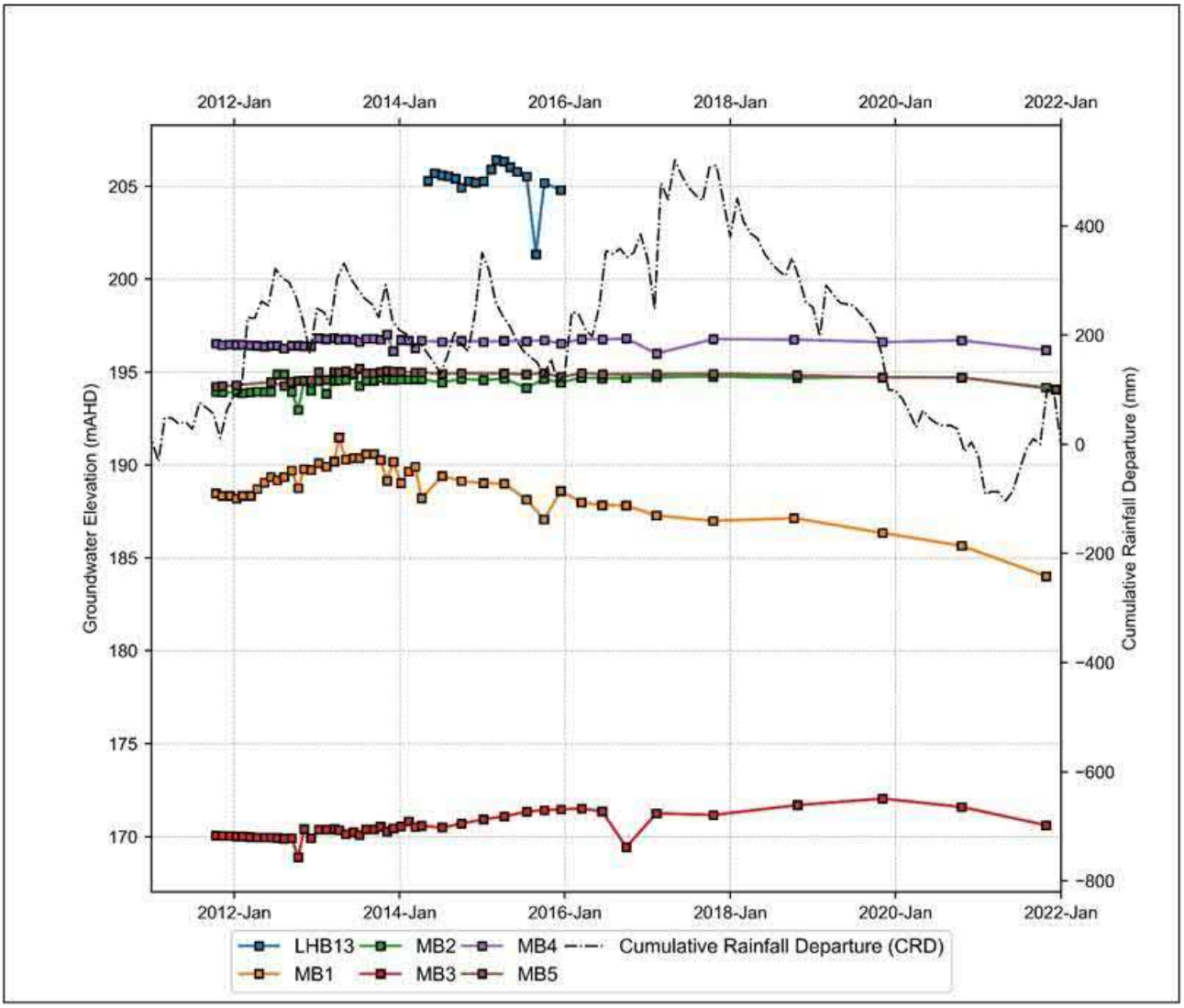
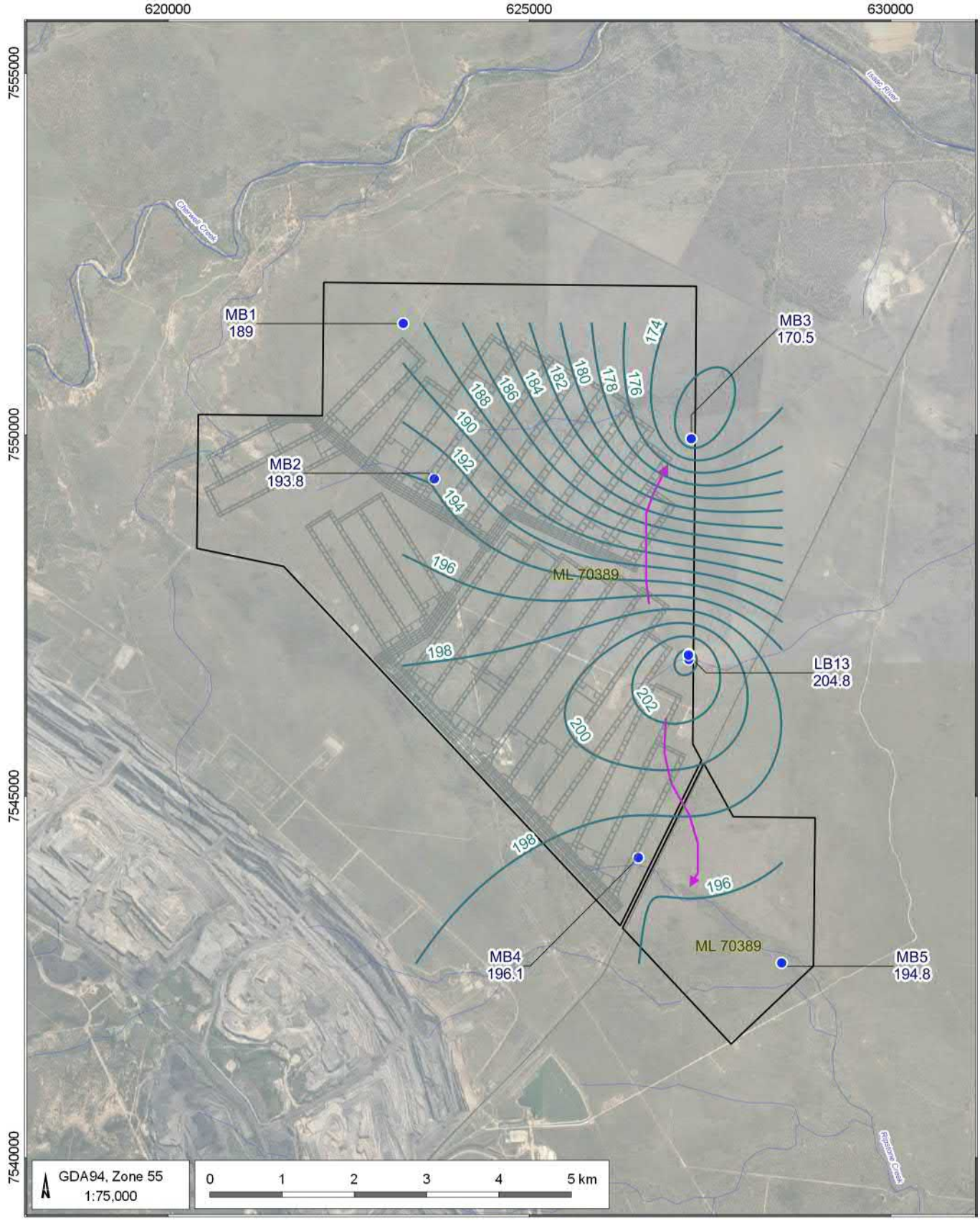


Figure 5.4 Groundwater hydrograph for the shallow weathered aquifer

There is a groundwater high near the centre of the eastern border of the Project area, at around 204.8 mAHD (Figure 5.5). On the western side of the groundwater high, groundwater flow is to the west, towards the Peak Downs open cut mine, probably reflecting depressurisation of the seams as a result of pit dewatering. At the northern boundary of EDMCP, the contours between MB1 and MB2 indicate a gradient towards the north potentially influenced by pumping from landholder bore LHB8. The flow gradient is also towards the north-west towards MB3 (although MB3 is constructed in the Rewan Group). Groundwater contours between MB4 and MB5 indicate a slight gradient to the south following topography, and potentially influenced by drawdown towards Peak Downs to the west.

Under pristine conditions, flow would be expected to be to the east away from the seam sub-crop recharge zones. In the north-eastern side of the project area, groundwater flow is to the north-east. Discharge from the coal seams is to the open cut pits, to the shallow weathered/fractured rock aquifer and to the Isaac River alluvium via upward flow along fractures.



LEGEND

- Rail
- River/Creek
- Contour line
- HCU longwall layout
- Flow direction
- Eagle Downs project area
- Shallow monitoring bores

Eagle DownsGIA for EA Amendment (EDM5000.001)

Groundwater elevation contours for the shallow weathered aquifer

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FIGURE No: **5.5**

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5.6.2 Coal seam aquifers

5.6.2.1 Standpipe bores

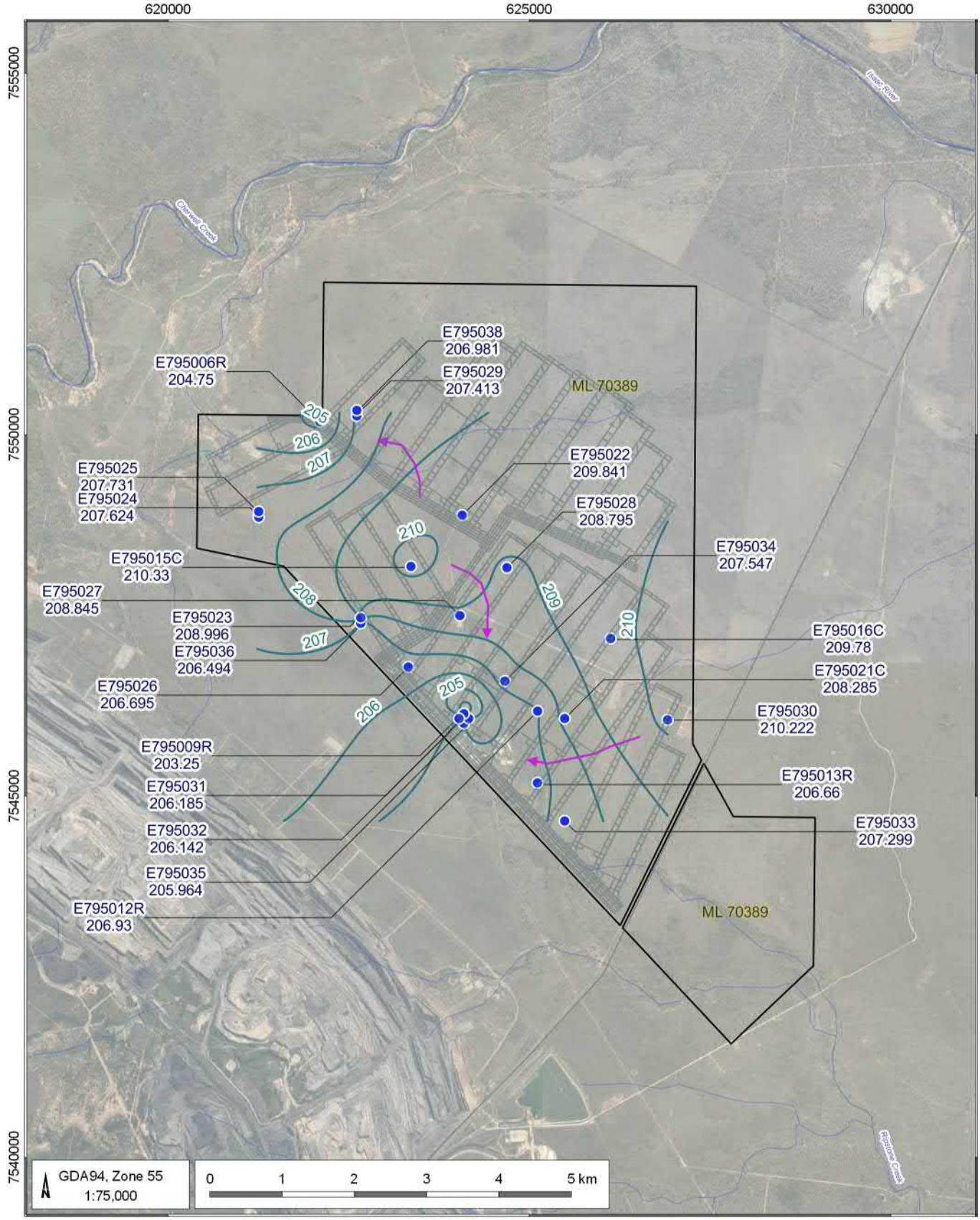
The potentiometric surface of the coal seam aquifers was obtained by measuring groundwater levels in open exploration holes in 2007. The top section of the hole is cased with steel casing to depths of between 130 m to 346 m as shown in Table 5.10. This casing in effect seals off any shallow weathered/fractured rock aquifer and the Tertiary sediments that may otherwise impact water levels of the deeper Permian sequence. The water levels measured in the open holes are a composite level of the coal seams exposed in the hole. The groundwater levels measured are summarised in Table 5.10 and the contours of the potentiometric surface interpolated from these levels are shown on Figure 5.6.

The contours indicate that within the Project area, groundwater flow within the Permian coal seams is to the west from about 212 mAHD to 206 mAHD, that is, towards the Peak Downs open cut mine, probably reflecting depressurisation of the seams as a result of pit dewatering.

Table 5.10 Summary of the 2007 groundwater level data from exploration bores

Bore	East	North	Collar (mAHD)	Hole Depth (m)	Depth Steel Casing (m)	Date	SWL (mbgL)	SWL (mAHD)
E795006R	622097.76	7550179.79	227.14	420.21	-	7/08/2007	22.39	204.75
E795009R	624105.74	7546179.17	236.41	420.22	-	7/09/2007	33.16	203.25
E795012R	625112.91	7546175.09	229.18	432.46	-	22/08/07	22.25	206.93
E795013R	625111.06	7545181.75	223.23	420.46	-	22/08/07	16.57	206.66
E795015C	623360.80	7548176.88	223.30	471.45	144.37	7/08/2007	12.97	210.33
E795016C	626123.55	7547179.61	223.53	570.23	259.83	21/7/7	13.75	209.78
E795017C	625091.00	7550180.73	203.68	640.41	195.70	7/08/2007	FLOWING	-
E795021C	625488.22	7546073.03	227.68	501.36	251.61	22/08/07	19.39	208.29
E795022	624069.41	7548885.92	213.38	527.65	209.50	7/08/2007	3.54	209.84
E795023	622646.02	7547476.15	243.39	419	119.00	26/08/07	34.39	209.00
E795024	621238.56	7548885.49	230.29	454	129.00	7/08/2007	22.67	207.62
E795025	621268.86	7548910.86	230.35	466	136.00	7/08/2007	22.62	207.73
E795026	623323.26	7546785.42	239.87	430	130.00	7/10/2007	33.17	206.70
E795027	624038.00	7547496.32	226.51	316.87	171.00	28/08/07	17.66	208.85
E795028	624688.26	7548160.08	220.88	502	208.00	7/08/2007	12.08	208.80
E795029	622627.92	7550293.79	221.34	657.9	346.00	7/08/2007	13.93	207.41
E795030	626911.94	7546054.17	225.20	-	346.00	7/09/2007	14.98	210.22
E795031	624069.99	7546065.27	235.46	371.53	152.00	7/09/2007	29.27	206.19
E795032	624074.99	7546075.79	235.61	285	180.00	7/09/2007	29.47	206.14
E795033	625488.00	7544654.59	219.77	342	230.00	7/09/2007	12.47	207.30
E795034	624660.50	7546589.76	232.72	502	218.00	21/08/07	25.17	207.55
E795035	624120.33	7545968.64	233.68	462.15	289.90	7/09/2007	27.72	205.96
E795036	622686.01	7547381.73	242.34	413	130.00	7/08/2007	35.85	206.49
E795038	622594.80	7550302.80	221.81	581	318.00	7/08/2007	14.83	206.98

Bore	East	North	Collar (mAHD)	Hole Depth (m)	Depth Steel Casing (m)	Date	SWL (mbgL)	SWL (mAHD)
E795039	625838.87	7544291.38	-	504.8	209	14/11/2007	10.41	-
E795040	626899.53	7546766.25	-	282.34	282.34	14/11/2007	6.21	-
E795041	623010.44	7550655.34	-	630.27	324.29	14/11/2007	11.18	-
E795042	623010.44	7547119.80	-	137.86	137.86	14/11/2007	34.5	-
E795043	624424.66	7545705.59	-	454.05	174.30	14/11/2007	22.43	-



LEGEND

- Rail
- River/Creek
- Contour line
- HCU longwall layout
- Flow direction
- Eagle Downs project area
- Coal seam monitoring bores

Eagle DownsGIA for EA Amendment (EDM5000.001)

Permian piezometric head

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FIGURE No: **5.6**

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5.6.2.1 VWP data

Seven VWP arrays (Hydro-1, Hydro-2, Hydro-3, Hydro-4, Hydro-5, Hydro-6, and Hydro-7,) were installed by Geotechnical Systems Australia in October and November 2010 in the area of the mine (GSA, 2011). However, the data from Hydro-1, Hydro-3, Hydro-4, and Hydro-7 were not available due to no data loggers installed. Up to eight VWP sensors at different depths were installed in each VWP array (refer to Table 5.11). Two additional VWP arrays, named Hydro Shaft 1 and Hydro Shaft 2, were installed as part of the gas drainage study in 2012. The locations of the VWPs are shown on Figure 5.3. Several battery and faulty sensors issues were identified in the most recent site visits to each of the VWPs. Accordingly, limited data were available and EDCM is currently attending to the issues.

The hydrographs of the VWP data are shown in Figure 5.7 to Figure 5.10. The data shows that in general the piezometric elevations measured at the VWPs are in the order of 170 mAHD to 210 mAHD.

Table 5.11 VWP sensor descriptions

Hole Reference	Easting	Northing	Collar Elevation (mAHD)	Bore/Sensor Depth (m)	Sensor Elevation (mAHD)	Coal Seam	Appr. WI pressure (mAHD)*
VWPHydro2	**625833**	**7546422.2**	**230.809**	**551**	**-320.2**	**-**	**-**
Sensor 1				525	-294.191	DY	195
Sensor 2				490	-259.191	DU	190
Sensor 3				430	-199.191	HCU - HCL	205
Sensor 4				365	-134.191	P - HCU	200
Sensor 5				335	-104.191	UN 3	202
Sensor 6				300	-69.191	Q - UN	195
Sensor 7				280	-49.191	Q	201
Sensor 8				255	-24.191	S	
VWPHydro5	**626202**	**7548870.9**	**207.787**	**645**	**-437.2**	**-**	**-**
Sensor 1				635	-404.191	DY	175
Sensor 2				595	-364.191	DU - DY	177
Sensor 3				562	-331.191	HCL	177
Sensor 4				520	-289.191	HCU - HCL	
Sensor 5				460	-229.191	P - HCU	182
Sensor 6				415	-184.191	UN1	
Sensor 7				375	-144.191		208
Sensor 8				340	-109.191	R	202
VWPHydro6	**625837**	**7546425.9**	**230.591**	**262**	**-31**	**-**	**-**
Sensor 1				240	-9.191	SU	
Sensor 2				225	5.809	FCA	202
Sensor 3				200	30.809	FCB - FCA	200
Sensor 4				145	85.809	FCC - FCB	
Sensor 5				110	120.809	FCD - FCC	205
Sensor 6				85	145.809	FCD - FCC	
Sensor 7				55	175.809	FCE - FCD	
Sensor 8				35	195.809	BW - FCE	

Hole Reference	Easting	Northing	Collar Elevation (mAHD)	Bore/Sensor Depth (m)	Sensor Elevation (mAHD)	Coal Seam	Appr. WI pressure (mAHD)*
VWP Shaft1	**623268**	**7546945**	**-**	**-**	**-**	**-**	**-**
Sensor 1				280	-49.191		185
Sensor 2				269.4	-38.591		190
Sensor 3				237.5	-6.691		200
Sensor 4				194.75	36.059		207
Sensor 5				174.5	56.309		205
Sensor 6				151	79.809		207
VWP Shaft2	**623197**	**7547019.1**	**-**	**-**	**-**	**-**	**-**
Sensor 1				309.3	-78.491		
Sensor 2				345	-114.191		
Sensor 3				366.4	-135.591		
Sensor 4				414.5	-183.691		
Sensor 5				421.3	-190.491		

Notes: FC: Fort Cooper Coal Measures, S: S Seam, R: R Seam, Q: Q Seam, UN: UN Seam, P: P Seam, HC: Harrow Creek, DU: Dysart Upper, DY: Dysart.

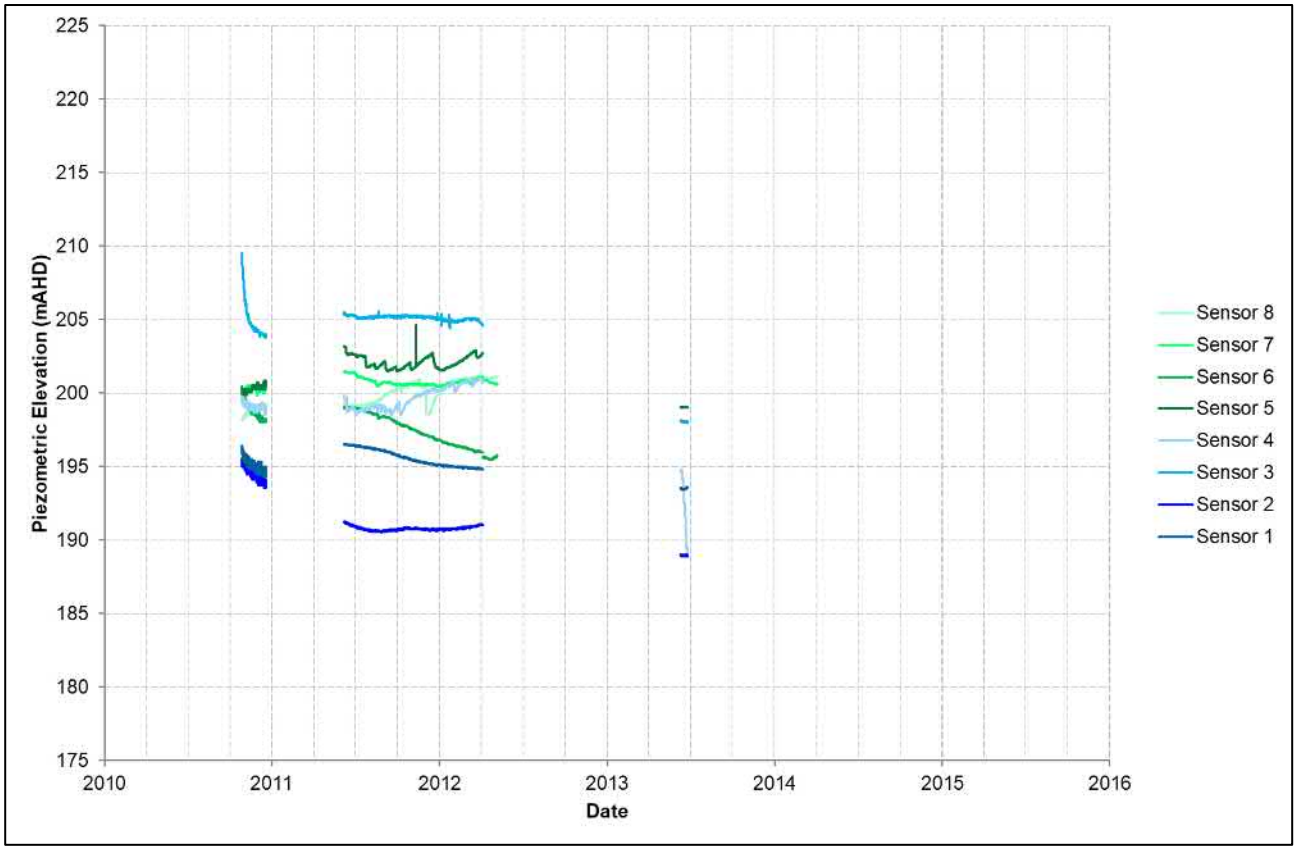


Figure 5.7 Bore VWP Hydro2 hydrograph

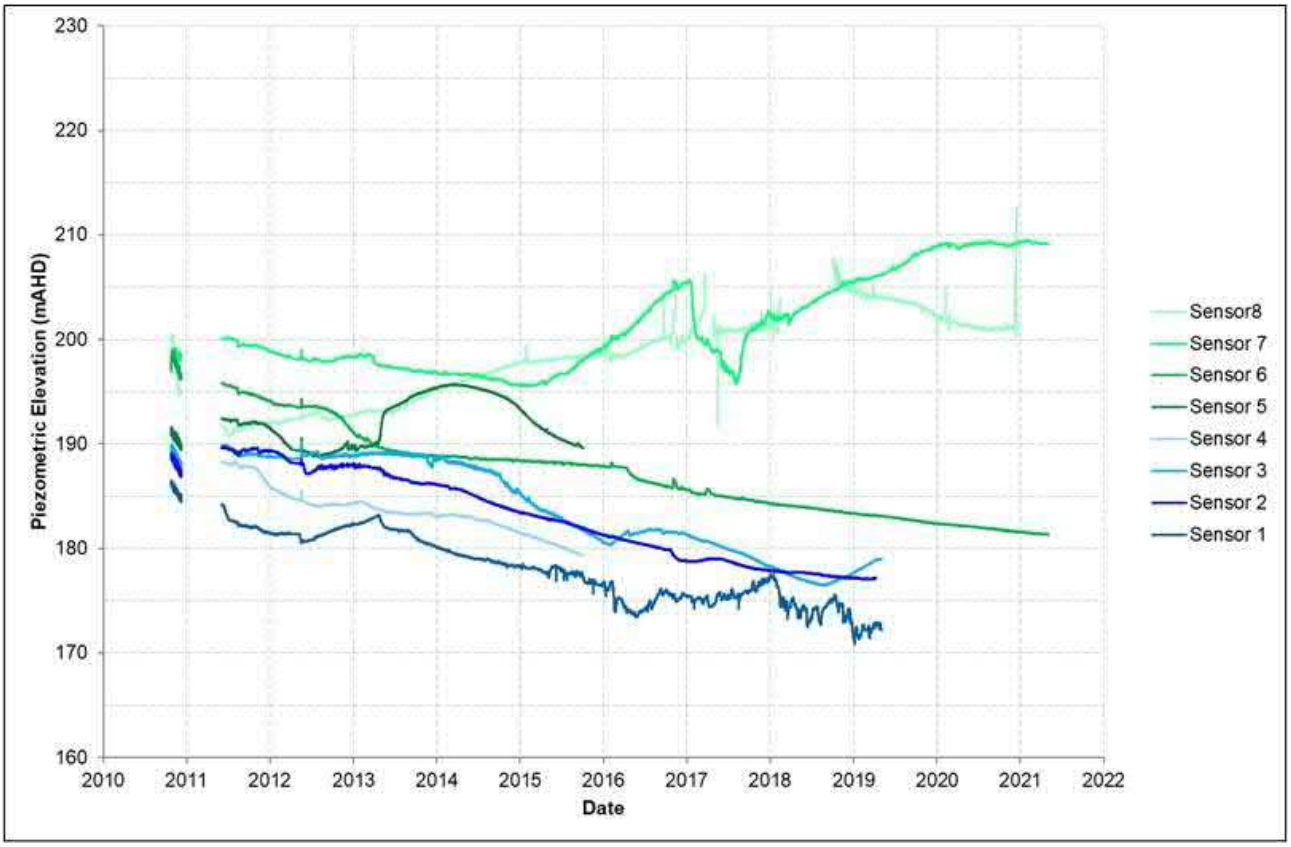


Figure 5.8 Bore VWP Hydro5 hydrograph

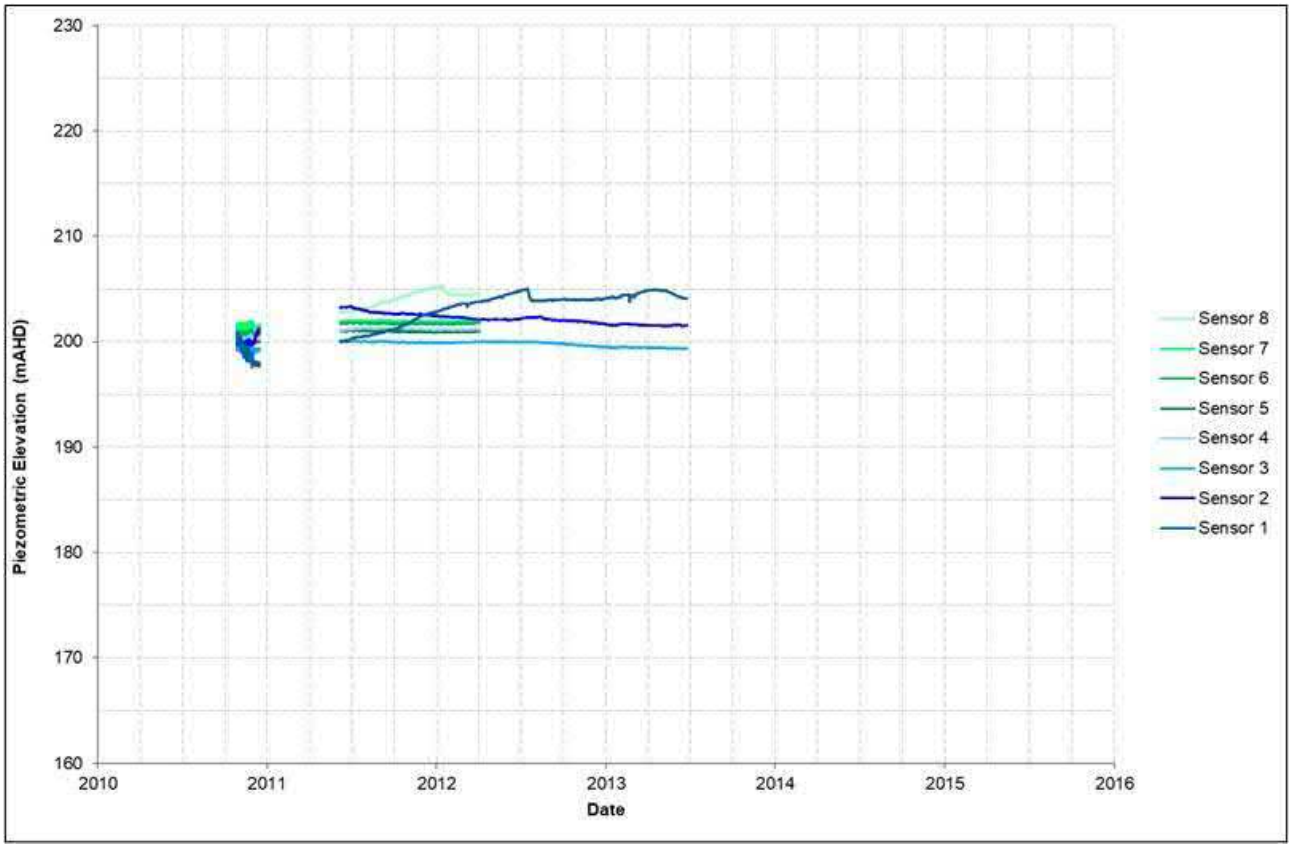


Figure 5.9 Bore VWP Hydro6 hydrograph

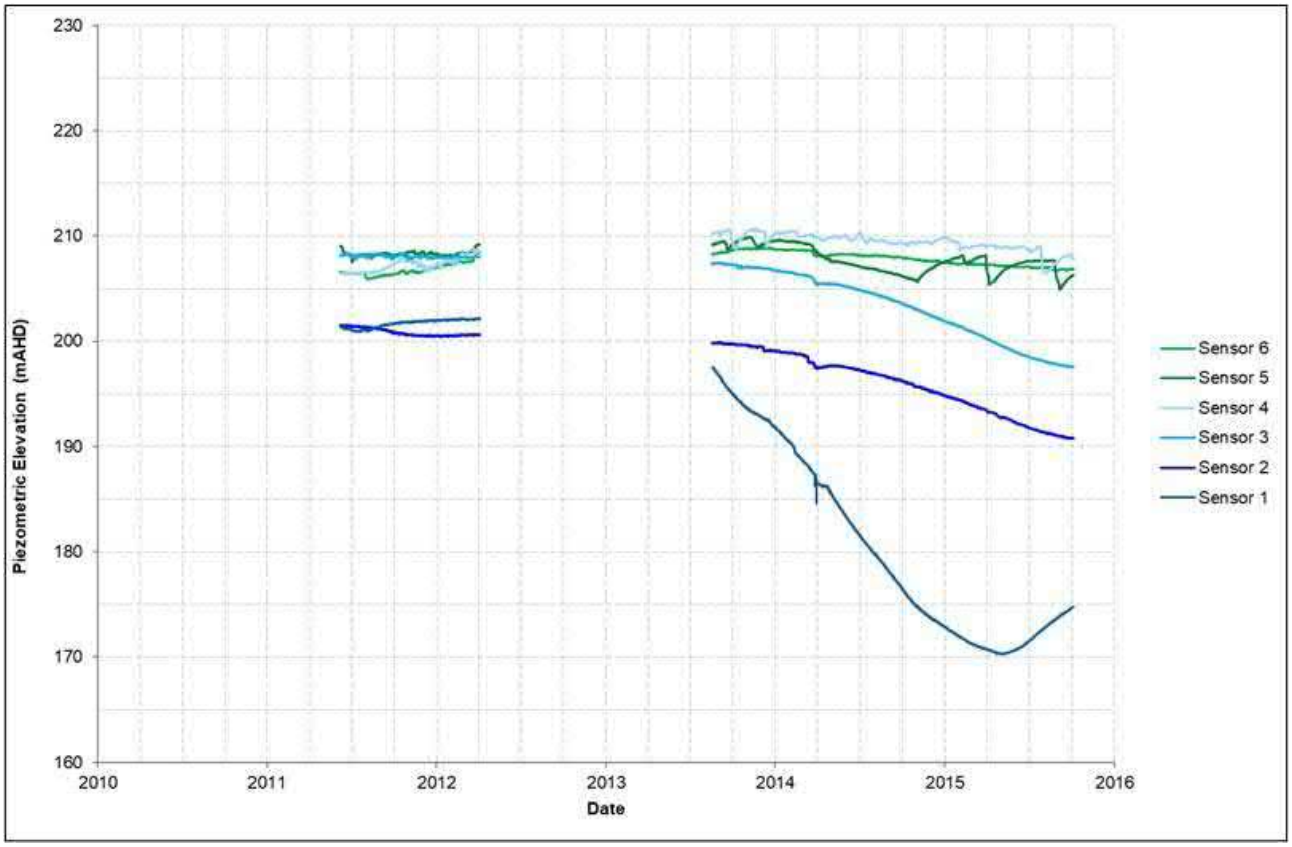


Figure 5.10 Bore VWP Shaft1 hydrograph

5.6.3 Regional data

5.6.3.1 Regional registered bores

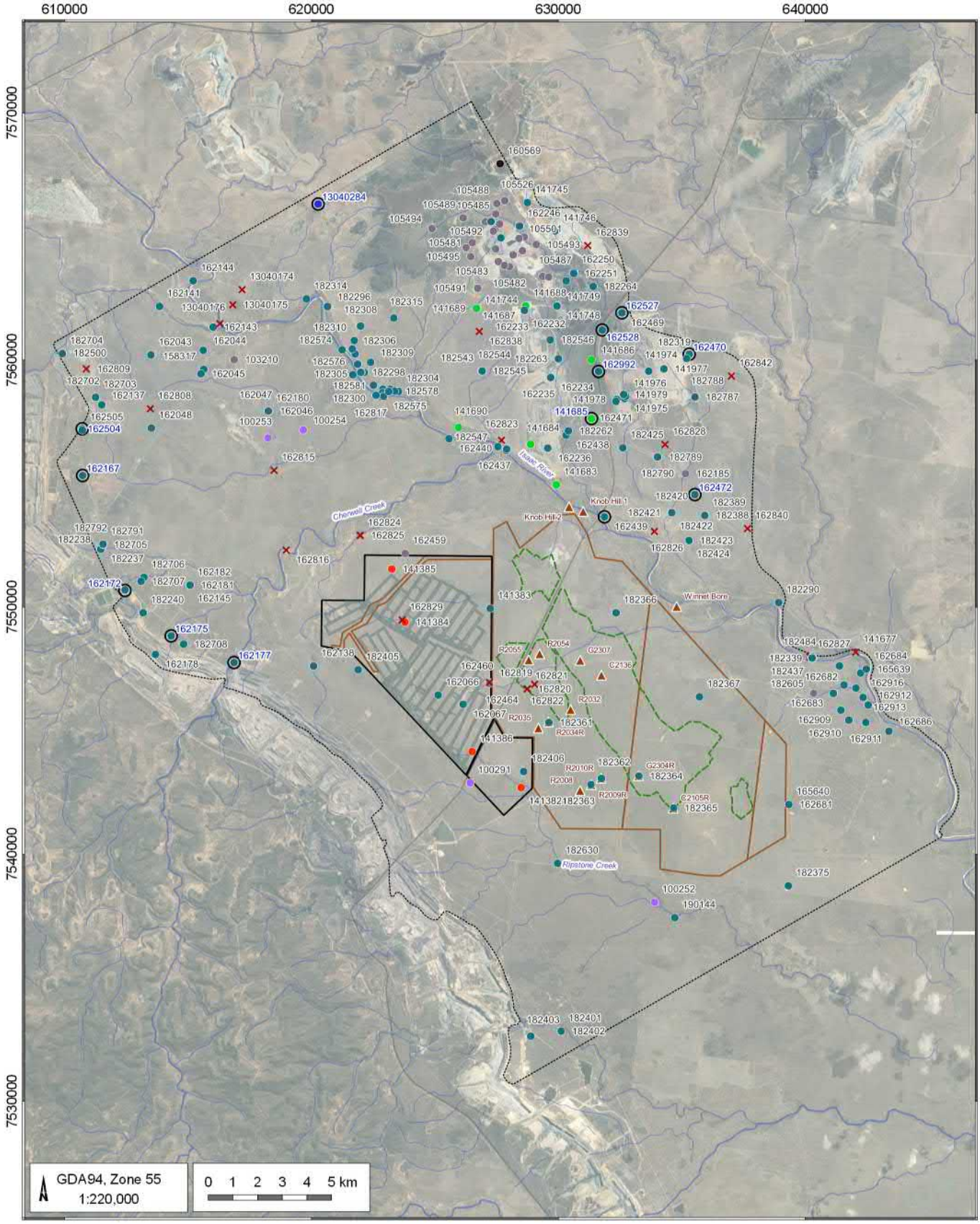
Time series groundwater data was obtained from the government database[10] for selected bores located within in the numerical groundwater domain. Table 5.12 shows the bore descriptions and the localities shown on Figure 5.11.

Table 5.12 Registered bores with time series groundwater level data

Bore ID (RN)	Date drilled	East	North	Collar Elevations (SRTM)	Bore Depth (m)	Original name	Purpose
141685	16/10/2007	631341	7557633	217.6	48	OBS 2	Mine Monitoring
162167	15/04/2008	610730	7555327	280.4	93.1	PZ04	Mine Monitoring
162172	18/05/2008	612441	7550671	234.3	44	PZ07-D	Mine Monitoring
162175	23/05/2008	614317	7548834	231.3	77	PZ09	Mine Monitoring
162177	21/05/2008	616863	7547756	223.5	58	PZ11-D, PZ11-S	Mine Monitoring
162439	16/07/2015	631867	7553655	195.2	20.5	MB08	Mine Monitoring
162470	24/03/2009	635300	7560237	233.0	87	PZ2	Mine Monitoring
162472	27/03/2009	635531	7554554	196.0	90	PZ4	Mine Monitoring

[10] http://www.bom.gov.au/water/groundwater/explorer/map.shtml

Bore ID (RN)	Date drilled	East	North	Collar Elevations (SRTM)	Bore Depth (m)	Original name	Purpose
162504	10/10/2013	610712	7557219	246.2	30.2	PZ12S	Mine Monitoring
162527	13/03/2016	632576	7561914	234.6	49	PZ5	Mine Monitoring
162528	14/03/2016	631776	7561217	225.3	56.43	PZ6	Mine Monitoring
162992	11/12/2017	631627	7559539	219.6	109	PZ07	Mine Monitoring
13040284	2/09/2004	620271	7566318	247.2	19	NAP ISAAC RIVER SITE 3	Sub-Artesian Monitoring



LEGEND

- Rail
- River/Creek
- HCU longwall layout
- Eagle Downs project area
- Proposed mine pits for the proposed Winchester South Project G1765B_Modeldomain_v01
- Proposed Winchester South Mine lease
- Wincester South Project bore
- Additional observation data

Registered bores

- Coal Seam Gas Monitoring
- Mine Monitoring
- Mine Monitoring Stratigraphic Investigation
- Petroleum or Gas Exploration
- Sub-Artesian Monitoring
- Water Resources Investigation Sub-Artesian Monitoring
- Water Supply
- Unknown

Eagle DownsGIA for EA Amendment (EDM5000.001)

Regional groundwater observation data points

AGE

DATE 03/02/2022

FIGURE No: **5.11**

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Hydrographs were developed for the following bores situated within the Project numerical groundwater model domain:

- Figure 5.12, hydrograph for a northern bore RN13040284 which is 19 m deep. The hydrograph shows seasonal variation and a close correlation with the CRD trend.
- Figure 5.13 shows the hydrographs for bores located north-east and constructed mainly within the Fort Cooper coal measures with depths ranging from 48 to 109 m. Bore 162470 (87 m deep), situated east of the Daunia East Mine shows a 7 m decline since 2014. The other bores show stable groundwater levels for the data periods.
- Figure 5.14 represents selected bores west of the Project area towards the Peak Downs and Caval Ridge mines. Two bores (RN62175 and RN162177) show declining groundwater level trends since 2021 reaching elevations between 190 and 185 mAHD and a decline in groundwater levels of between 20 and 25 m since early 2012. It is fair to assume that the opencast mines west of these locations are deeper than 185 mAHD.

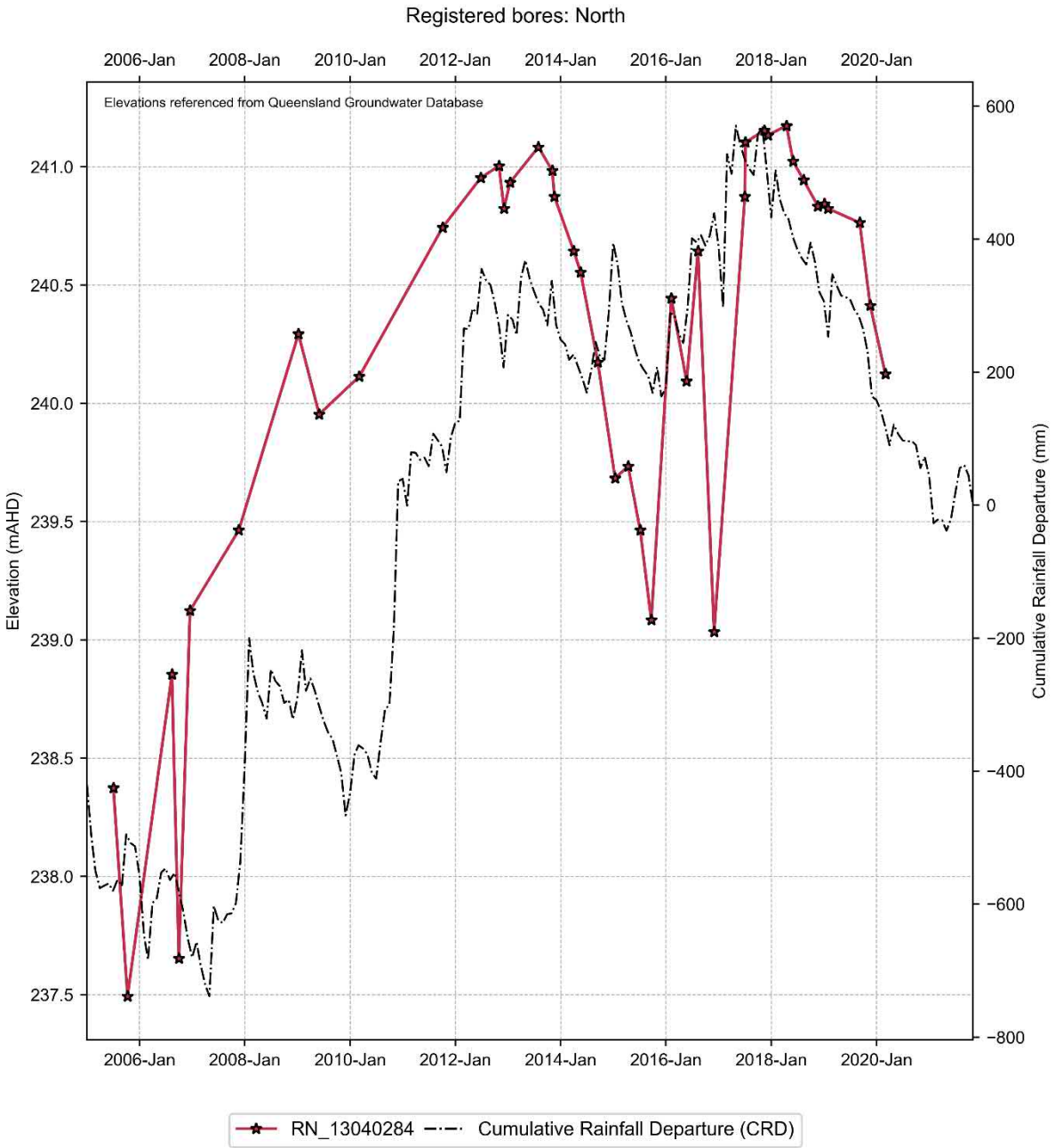


Figure 5.12 Hydrograph for RN13040284 regional registered bore (north)

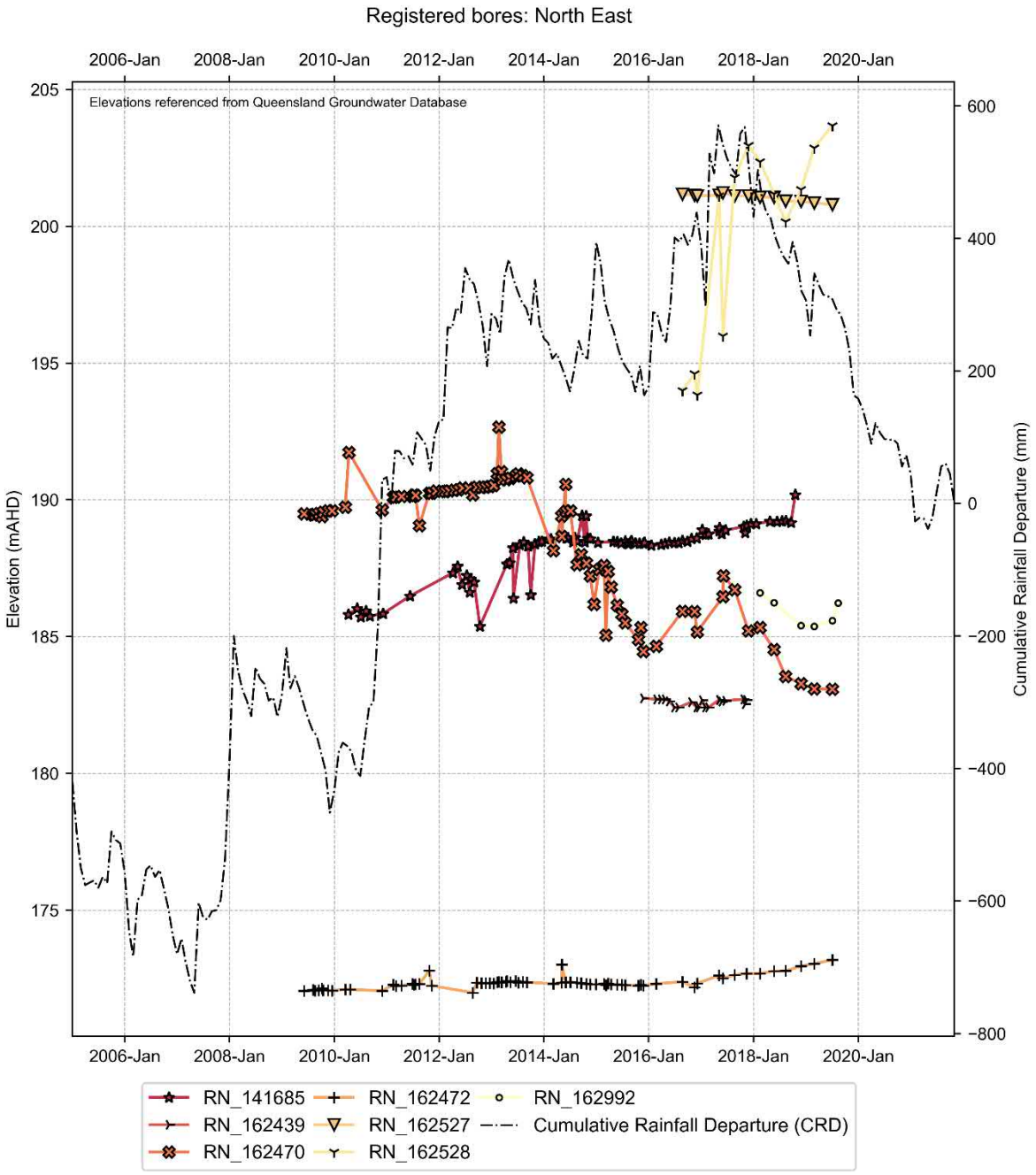


Figure 5.13 Hydrograph for regional registered bores north-east of the Isaac River

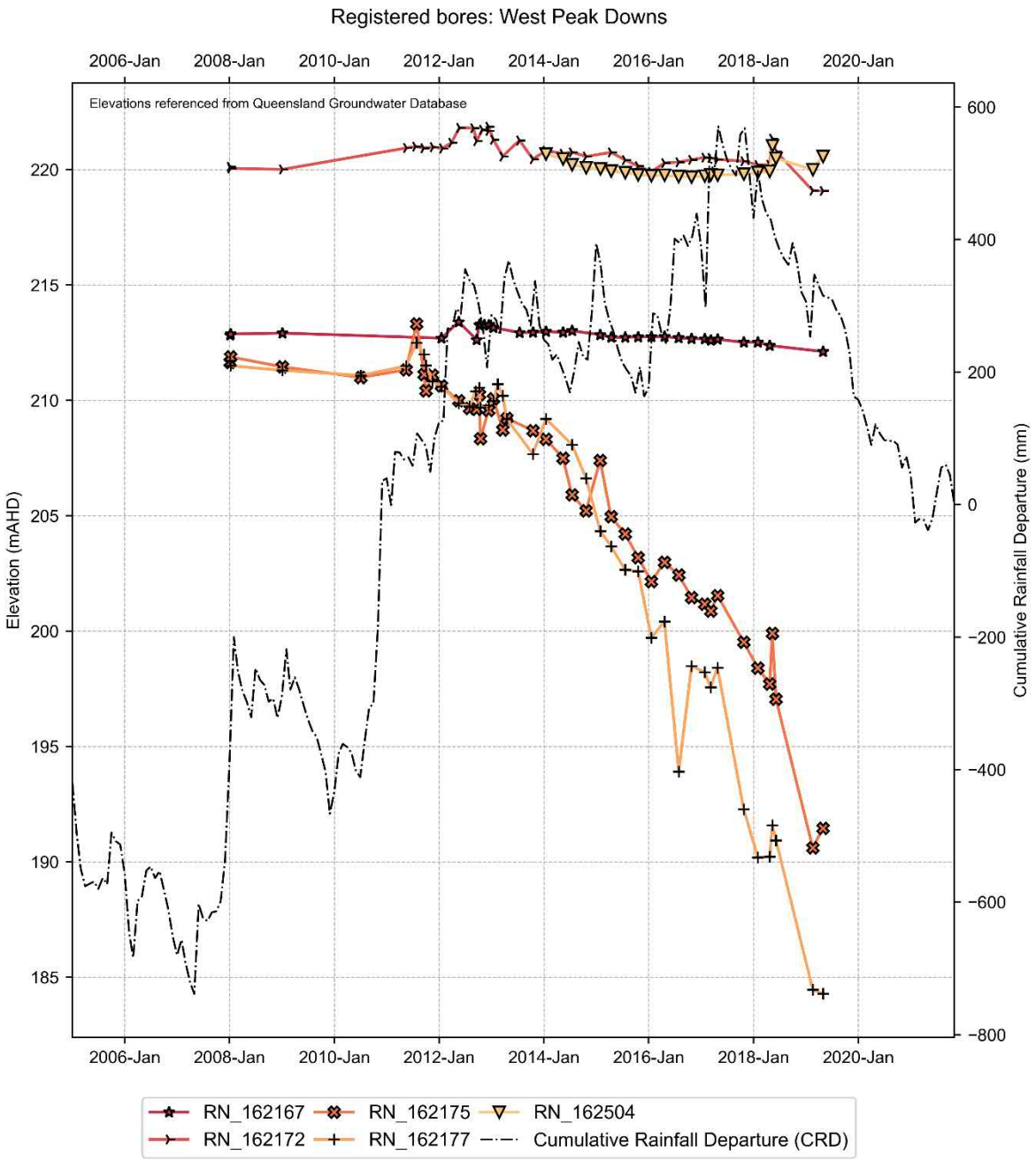


Figure 5.14 Hydrograph for regional registered bores west

5.6.3.2 Winchester South

Winchester South project[11] groundwater level data, from the recently completed groundwater assessment (SLR, 2021) indicates stable groundwater level trends. Table 5.13 supplies a summary of the bores and the locations shown on Figure 5.11. Bore depths range between 37 and 83 m for the Fort Cooper Coal Measures monitoring bores. Three of the bores monitor the Isaac River alluvium with depths around 20 m. The hydrographs are depicted in Figure 5.15 and Figure 5.16 and groundwater elevations are between 165 and 190 m AHD.

[11] https://eisdocs.dsdip.qld.gov.au/Winchester%20South/Draft%20EIS/appendix-a-groundwater-assessment-part-one.pdf.

Table 5.13 Monitoring bore descriptions for the Winchester South project (SLR, 2021)

Bore ID	Easting (GDA94 z55)	Northing (GDA94 z55)	Elevation (mAhD)	Depth (mbgl)	Monitoring unit
C2105R	634650	7541857	209.09	60	Leichhardt Seam
C2136	631742	7547243	199.39	65.6	Leichhardt Seam
G2304R	633245	7543171	216.24	56	Vermont Seam
G2307	630881	7547844	194.42	81	Vermont Seam
R2008	630879	7542573	220.32	-	Leichhardt Seam
R2009R	631332	7542812	220.24	83	Interburden
R2010R	631730	7543070	216.67	66	Leichhardt Seam
R2032	630495	7545853	205.31	81.1	Leichhardt Seam
R2034R	629598	7545346	221.6	39.5	Interburden
R2035	629190	7545103	223.54	37.4	Vermont Seam
R2054	629240	7548107	203.6	82.5	Interburden
R2055	628798	7547863	207.46	67.9	Vermont Seam
Knob Hill 1	631005	7553874	191	-	Isaac River Alluvium
Knob Hill 2	630431	7554061	193	24.3	Isaac River Alluvium
Winnet Bore	634791	7550023	187	18.12	Isaac River Alluvium



Figure 5.15 Hydrograph for monitoring bores within the Rangel CM (SLR, 2021)

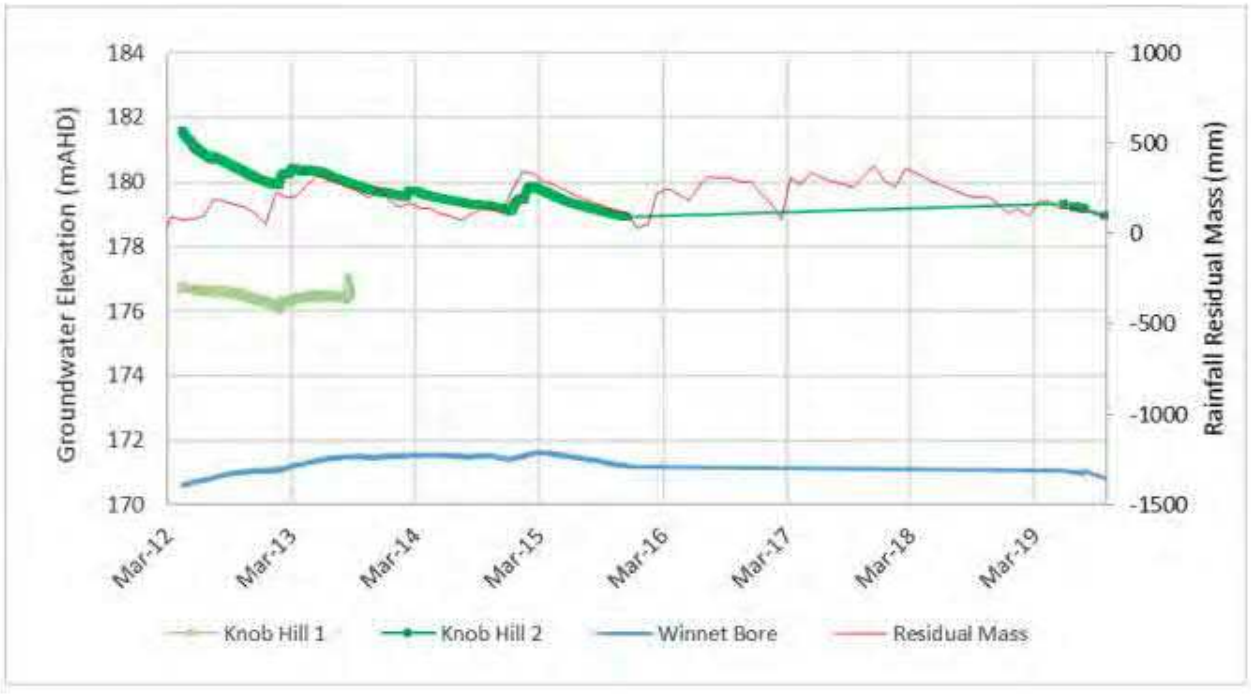


Figure 5.16 Hydrograph for the alluvial groundwater bores (SLR, 2021)

5.7 Recharge and discharge

The shallow aquifer is recharged by rainfall and potentially by upwards seepage along fractures from the deeper coal seam aquifers. The water table contours are at a general lower elevation, 188 to 197 mAHD compared to the coal seam aquifers, where the potentiometric surface is between about 206 to 212 mAHD within the Project area. This indicates that there is minimal hydraulic connection between the aquifers but that there is potential for upward flow and discharge from the coal seams to the base of shallow aquifer.

Recharge to the shallow and near surface strata is considered to be mostly from drainage flow patterns or flooding, with direct infiltration of rainfall also occurring where there are no substantial clay barriers in the shallow sub-surface. On a regional scale, discharge is via evapotranspiration from vegetation growing along creek beds and minor short duration baseflow events after significant rainfall/flooding. Infiltration to underlying formations is limited to areas with relatively high hydraulic conductivity units (e.g. coal seams). General downwards recharge to deeper units is limited by the low hydraulic conductivity (confining) Rewan Group and coal measure interburden sequences.

The chloride concentrations in the monitoring bores were compared to the rainfall chloride concentration, to calculate recharge using the chloride mass-balance method[12]. Rainfall chloride concentrations were reported by Crosbie et, al (2012), ranging between 2.59 to 0.38 mg/l for rainfall analyses for inland and coastal, eastern Australia. The rainfall chloride concentration range was applied in conjunction with the Project groundwater analyses and presented in Figure 5.17. The recharge estimation is between <0.05% to 1.2% for the shallow weathered aquifer systems. Two groundwater samples for the coal seams (E795017 and E795044) reveals potential recharge of <0.2%.

Figure 5.18 shows recharge estimates for groundwater chloride concentrations from the Winchester South project. Samples from the three Isaac River alluvium bores, Knob Hill 1 and 2 and Winnet Bore, reveals higher groundwater recharge potential when comparing to the Permian Coal Measures.

[12] Chloride is regarded as a suitable environmental tracer since it is highly soluble, conservative and not substantially absorbed by vegetation. Chloride concentration of rainfall is divided by the groundwater chloride concentrations and multiplied by 100 to present a percentage of rainfall recharge.

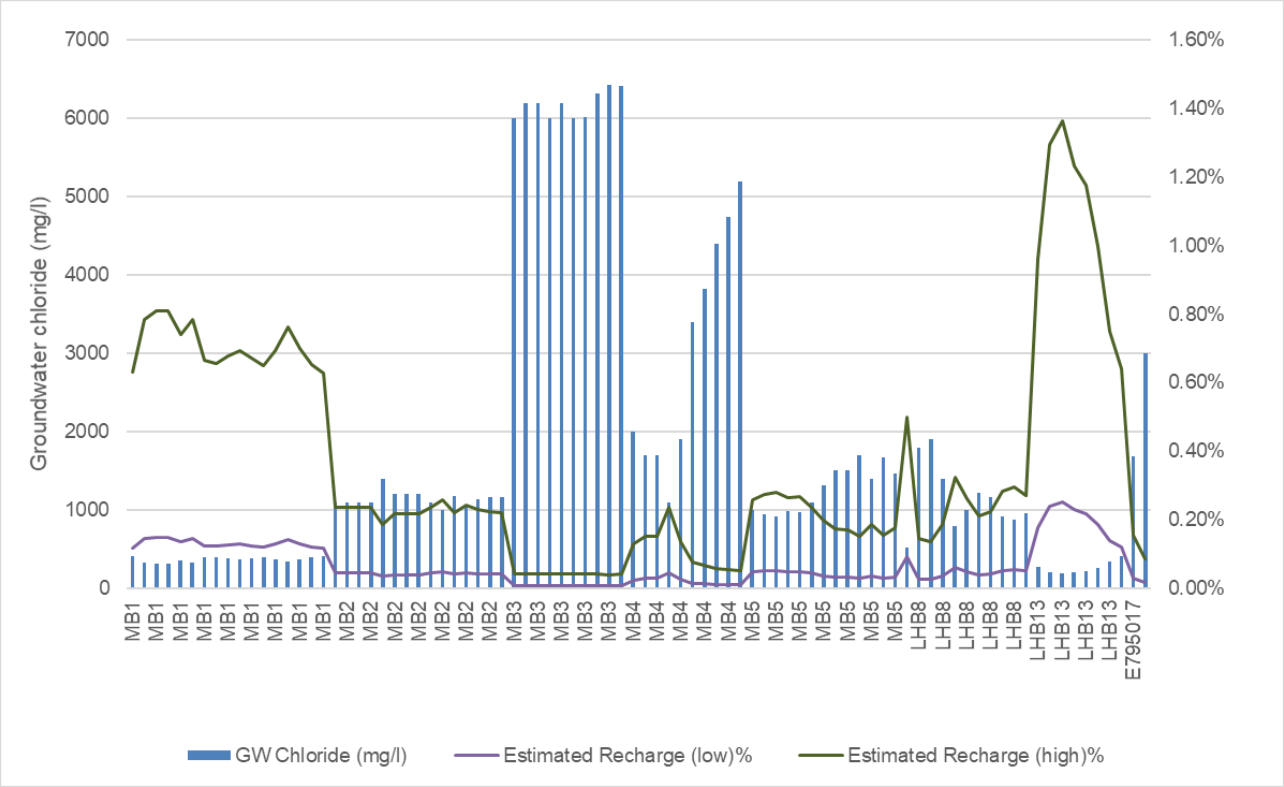


Figure 5.17 Chloride mass balance recharge estimation, Eagle Downs monitoring bores

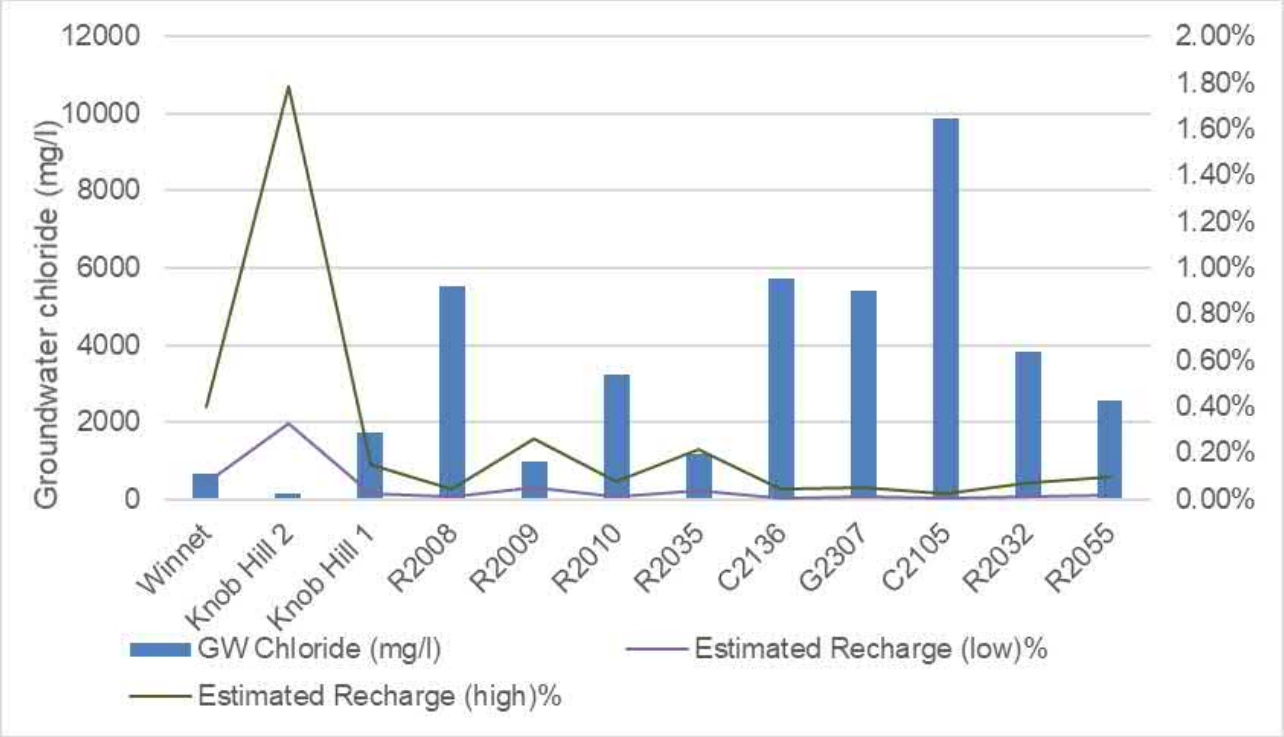


Figure 5.18 Chloride mass balance recharge estimation, Winchester South monitoring bores (SLR, 2021)

5.8 Groundwater quality and beneficial use

This section describes the water quality sampled from the monitoring bores constructed within the shallow weathered Permian sediments and beneficial use of groundwater within the shallow units.

5.8.1 Groundwater salinity and classification

Salinity is the key constraint to groundwater use and can be described by total dissolved solid (TDS) concentrations. TDS concentrations are commonly classified on a scale ranging from fresh to extremely saline. Food and Agriculture Organization of the United Nations ('FAO') (2013) provide a useful set of categories for assessing salinity based on TDS concentrations as follows:

- Fresh water: <500 mg/L (approximately 750 µS/cm).
- Brackish (slightly saline): 500 to 1,500 mg/L (approximately 750 to 2,250 µS/cm).
- Moderately saline: 1,500 to 7,000 mg/L (approximately 2,250 to 10,500 µS/cm).
- Saline: 7,000 to 15,000 mg/L (approximately 10,500 to 22,400 µS/cm).
- Highly saline: 15,000 to 35,000 mg/L (approximately 22,400 to 55,250 µS/cm).

Groundwater quality sampling has been conducted since late 2011 and has found monitoring bores to be brackish to saline, with electrical conductivity (EC) ranging from 1,673 µS/cm to a maximum of 24,480 µS/cm measured from monitoring bores MB1 and MB3 respectively (Table 5.14). Overall, the groundwaters associated with the shallow Permian sediments are more saline than the coal seam waters. This suggests that the groundwaters associated with the sediments are concentrated through evapotranspiration. Field pH over this is slightly acidic to mildly alkaline ranging from pH 5.79 (MB4) to pH 8.68 (MB1). Dissolved metals analysis has shown that most samples are generally low and below the laboratory detection limit. As no longwall mining or surface coal processing activities has occurred yet, it is fair to conclude that the exiting groundwater monitoring database represents pre-mining baseline data.

Table 5.14 provide an overview of the average, minimum and maximum field pH, and field EC for the available dataset. Groundwater quality results from 2020 are summarised in Table 5.15 through to Table 5.16.

Groundwater classifications for each monitoring bore have been tabulated in Table 5.17, presented together with a Piper diagram in Figure 5.19.

Table 5.14 Groundwater quality overview pH and EC

Bore ID	Field pH			Field EC uS/cm		
	ave	min	max	ave	min	max
MB1	7.1	6.4	8.7	2,111	1,673	2,660
MB2	7.6	7.0	8.3	4,257	3,252	5,280
MB3	6.8	6.1	7.7	18,113	9,080	24,480
MB4	7.1	5.8	8.1	7,006	73	14,600
MB5	7.3	6.2	8.4	4,590	58	6,440
LHB8	7.1	6.4	7.6	5,289	2,600	8,052

Table 5.15 Groundwater quality results (2020) – major ions

Bore ID	HCO_3	CO_3	SO4	Cl	Ca	Mg	Na	K
	mg/l							
MB1	585.6	0.6	24	413	86	60	317	5
MB2	322.08	0.6	1	1170	36	10	858	4
MB3	290.36	0.6	112	6420	633	376	3020	13
MB4	387.96	0.6	141	5200	582	262	2390	12
MB5	507.52	0.6	13	1470	83	29	1100	7
LHB8	461.16	0.6	466	2410	435	371	1060	12

Notes: Carbonate alkalinity as CO_3 (mg/L).
Bicarbonate alkalinity as HCO_3 (mg/L).

Table 5.16 Groundwater quality results (2020) – dissolved metals

Parameter	LB8	MB1	MB2	MB3	MB4	MB5
Al (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
As (mg/L)	<0.001	0.005	<0.001	0.002	0.002	0.003
Ag (mg/L)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Fe (mg/L)	1.95	1.14	0.18	4.99	4.38	2.1
Hg (mg/L)	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Mo (mg/L)	<0.001	0.002	<0.001	<0.001	<0.001	0.001
Sb (mg/L)	<0.001	0.002	<0.001	<0.001	<0.001	<0.001
Se (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Table 5.17 Groundwater quality results (2020) – water classifications

LB8	MB1	MB2	MB3	MB4	MB5
Na-Mg-Ca-Cl	Na-Ca-Cl-HCO_3	Na-Cl	Na-Ca-Cl	Na-Ca-Cl	Na-Cl

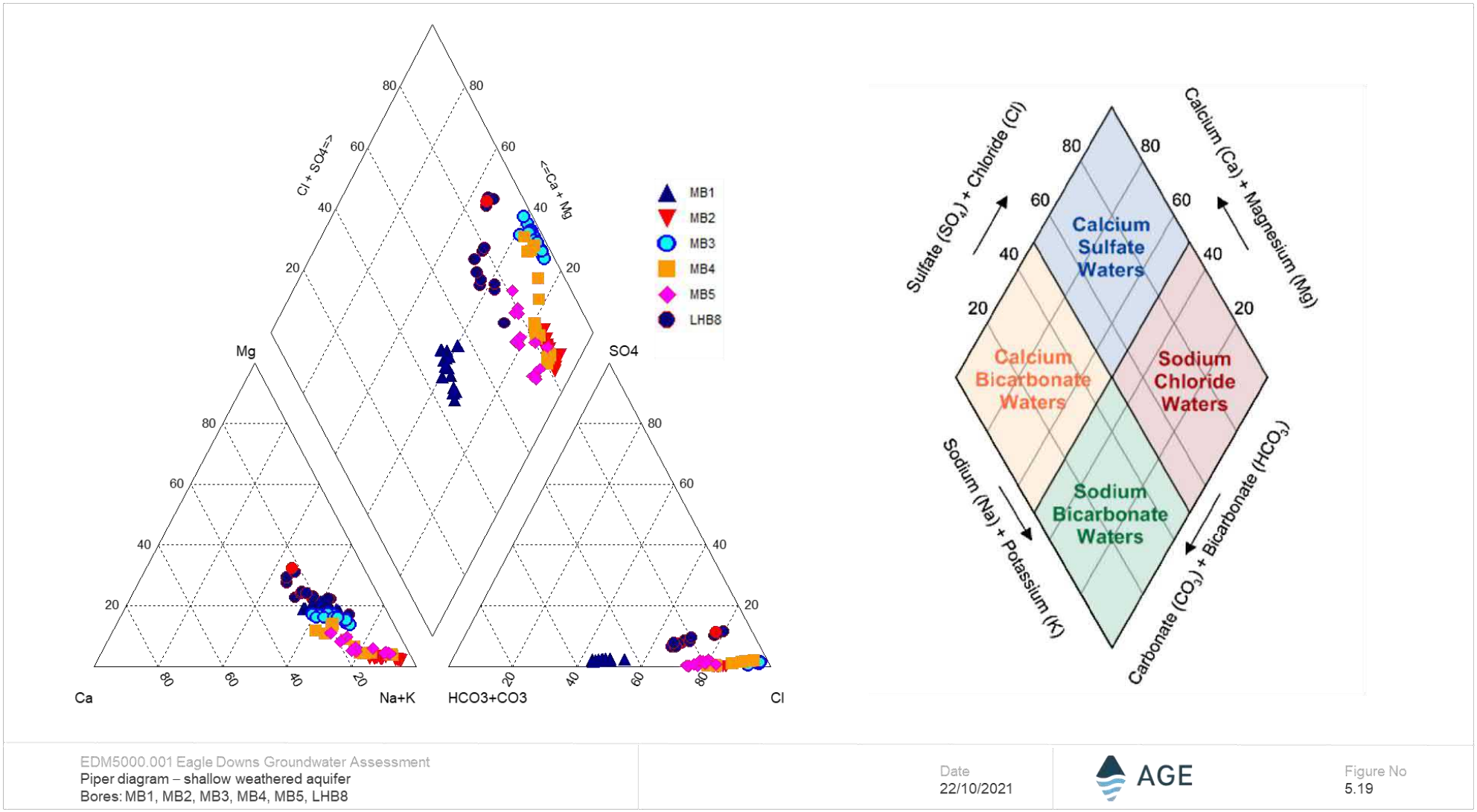


Figure 5.19 Piper diagram – shallow weathered aquifer

5.8.2 Groundwater quality time series plots

A combination of time series plots was developed for each monitoring bore for pH, Sulfate, Calcium, Magnesium, EC, Chloride, Sodium, and Iron, plotted with groundwater level and CRD data, as follows:

- Figure 5.20 (MB1) shows declining groundwater levels reflecting the CRD trend. Groundwater salinity has seasonal variations with s slight CRD correlation.
- Figure 5.21 and Figure 5.22 (MB2 and MB3) shows stable groundwater level and quality trends.
- Figure 5.23 (MB4) although stable groundwater levels occurred the overall salinity increased significantly from late 2016 corresponding to the dryer conditions.
- Figure 5.24 and Figure 5.25 (MB5 and LHB8) MB5 shows a slight declining groundwater level trend reflecting the CRD trend. Groundwater salinity has seasonal variations with s slight CRD correlation.

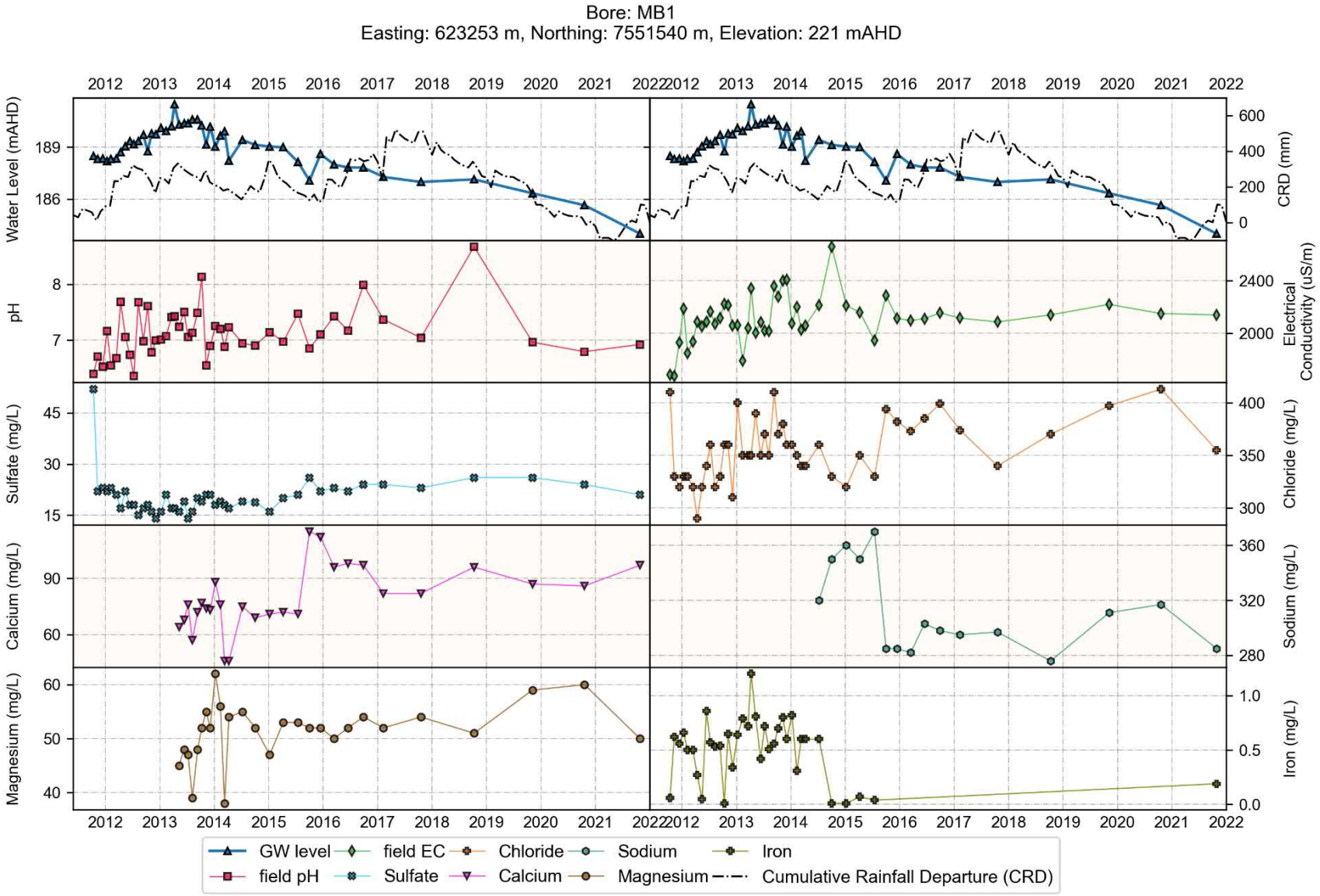


Figure 5.20 MB1 time series plots

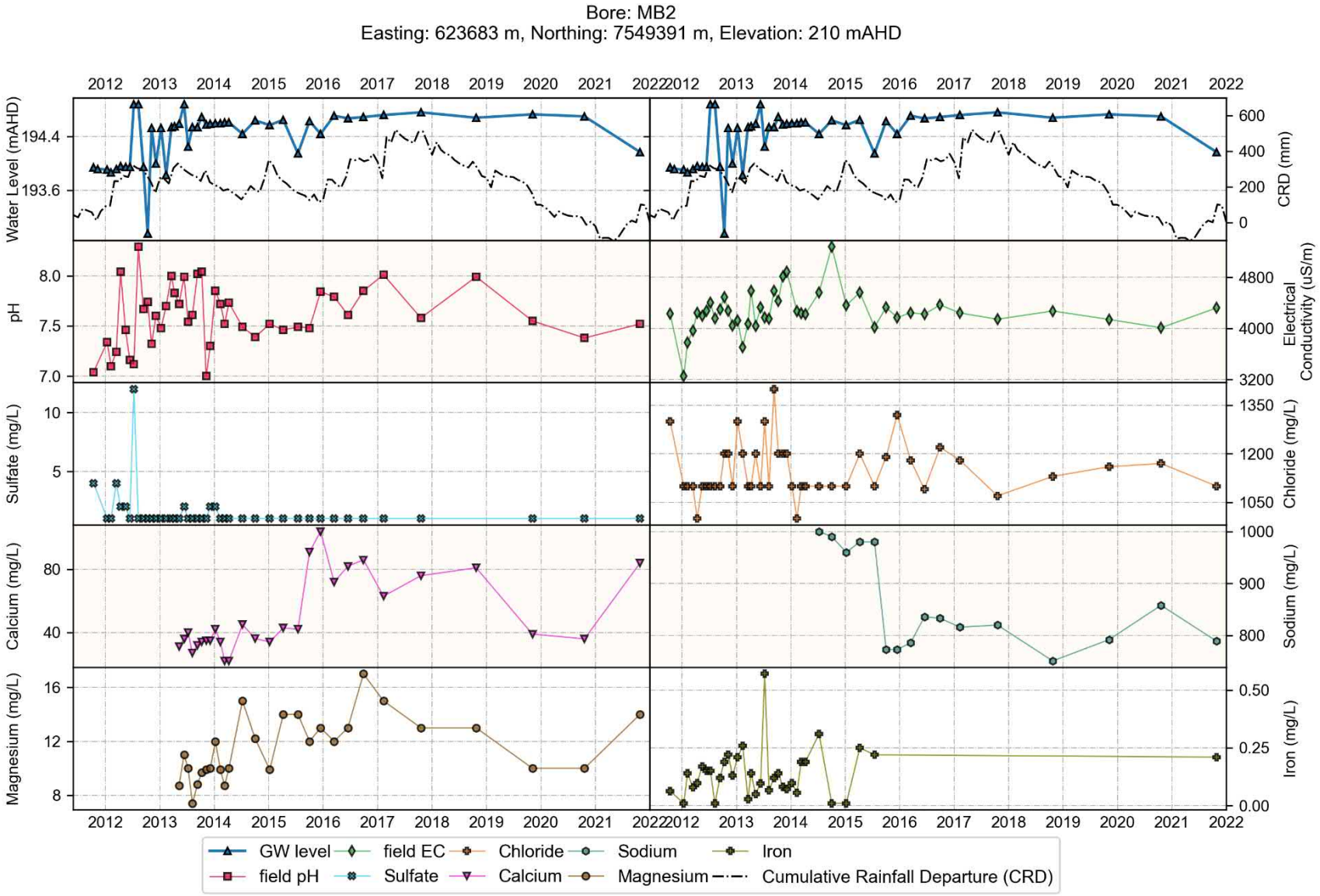


Figure 5.21 MB2 time series plots

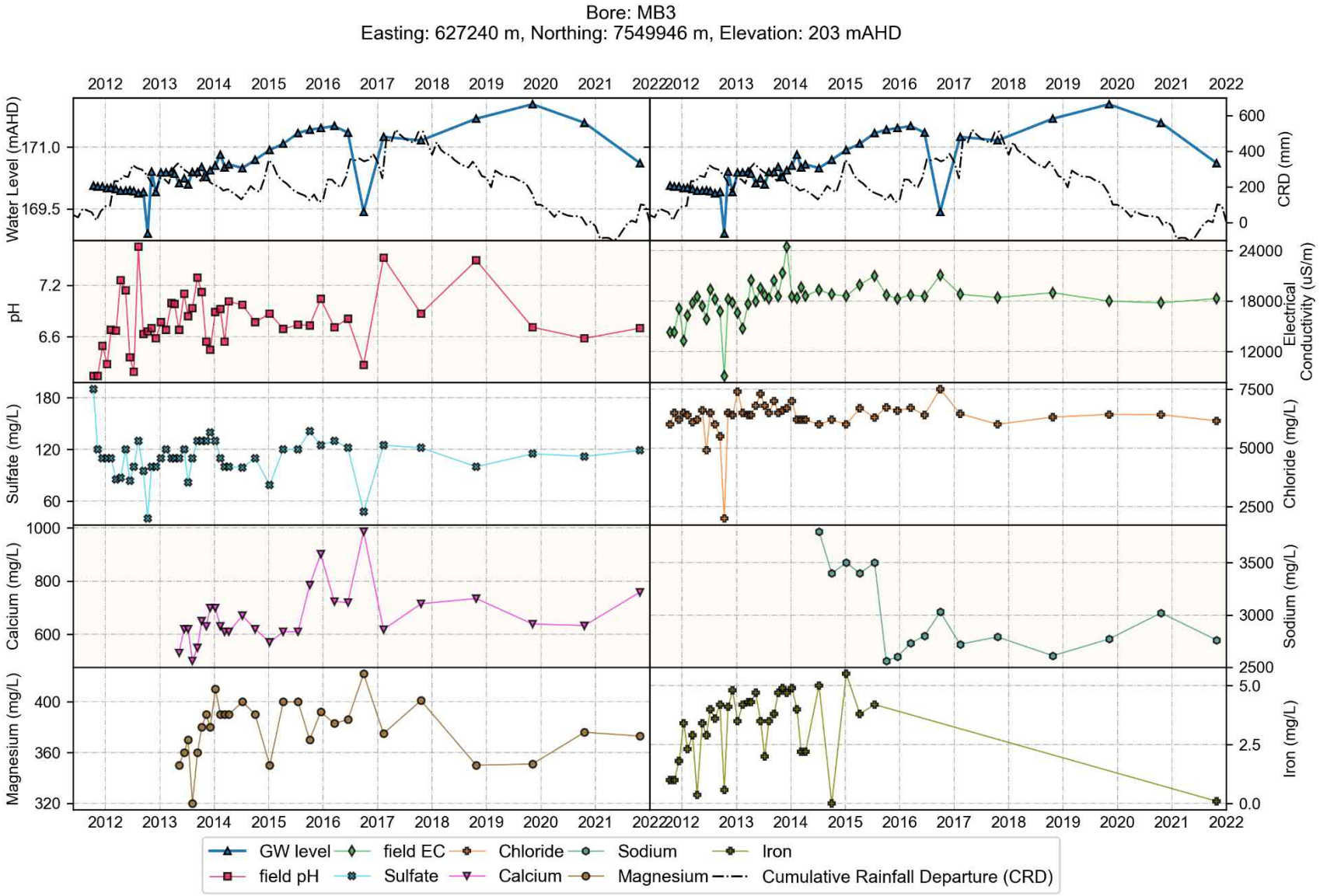


Figure 5.22 MB3 time series plots

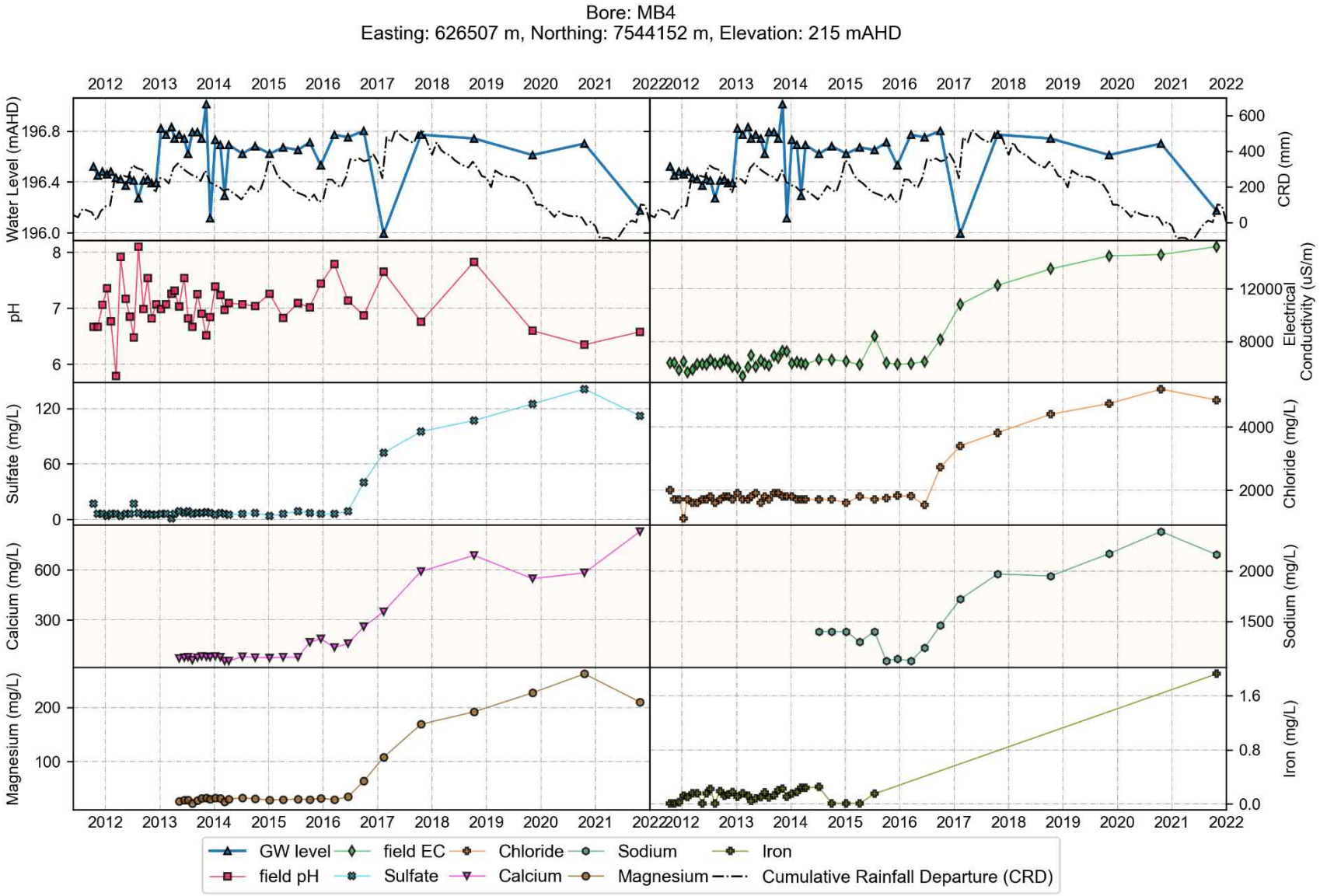


Figure 5.23 MB4 time series plots

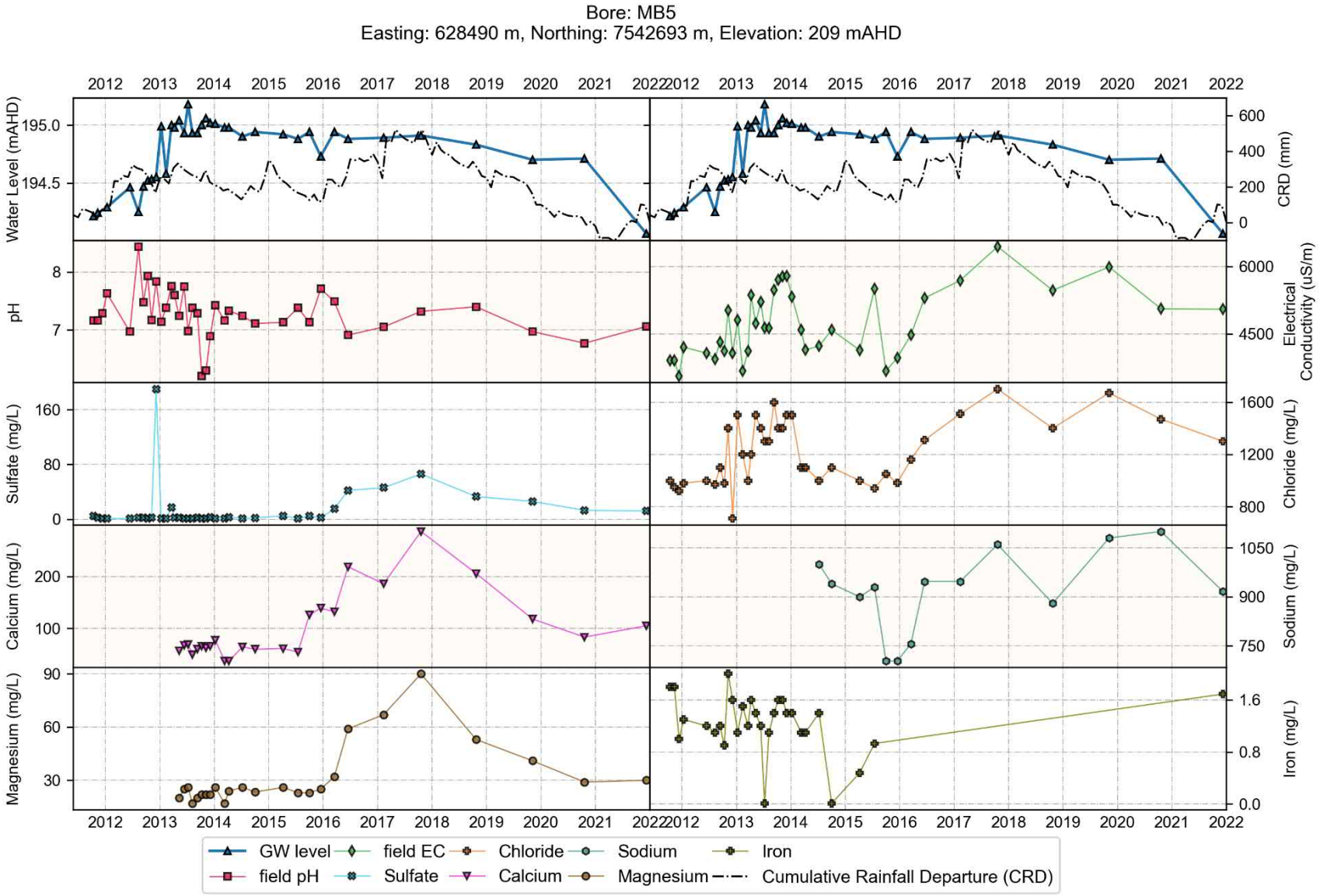


Figure 5.24 MB5 time series plots

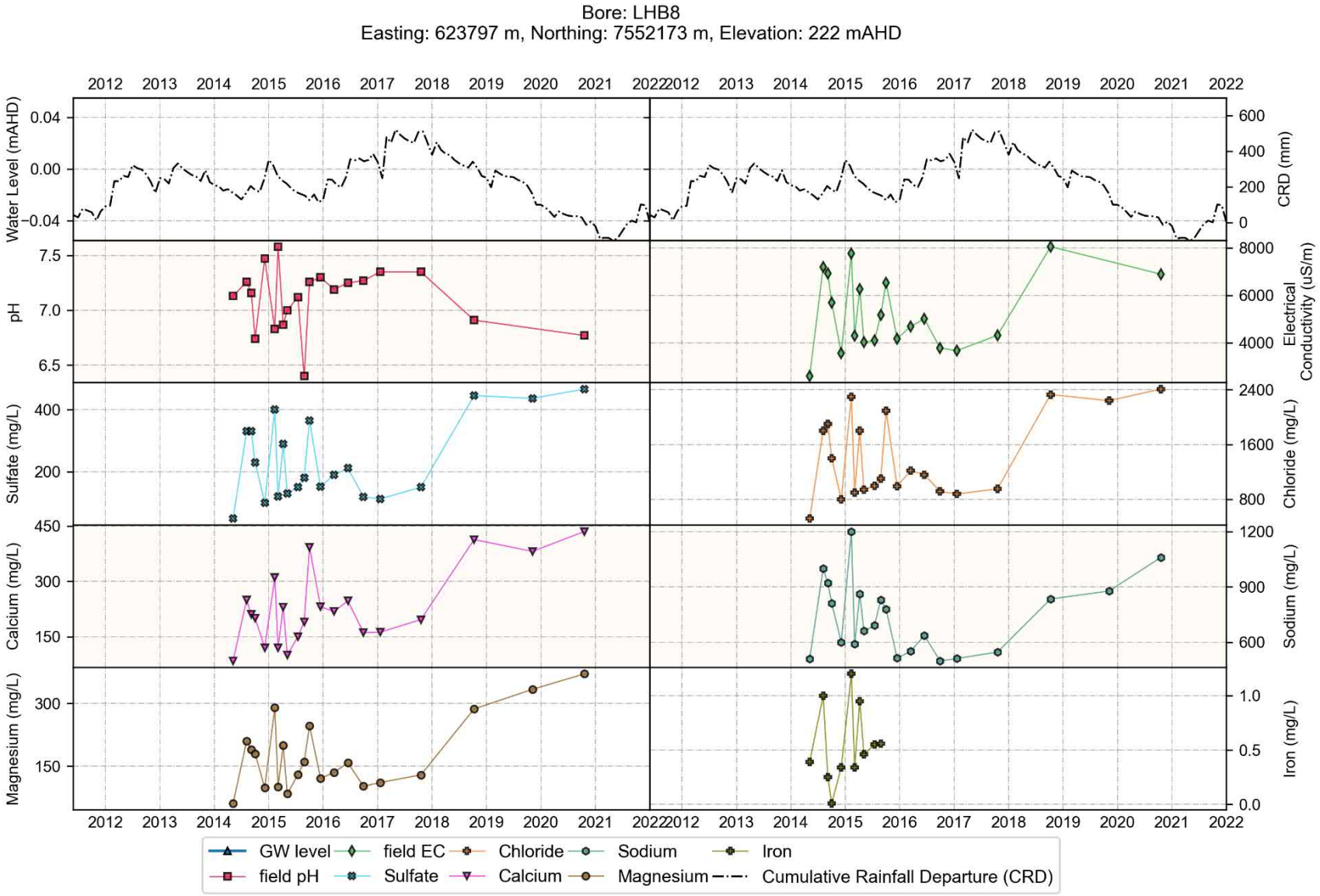


Figure 5.25 LHB8 time series plots

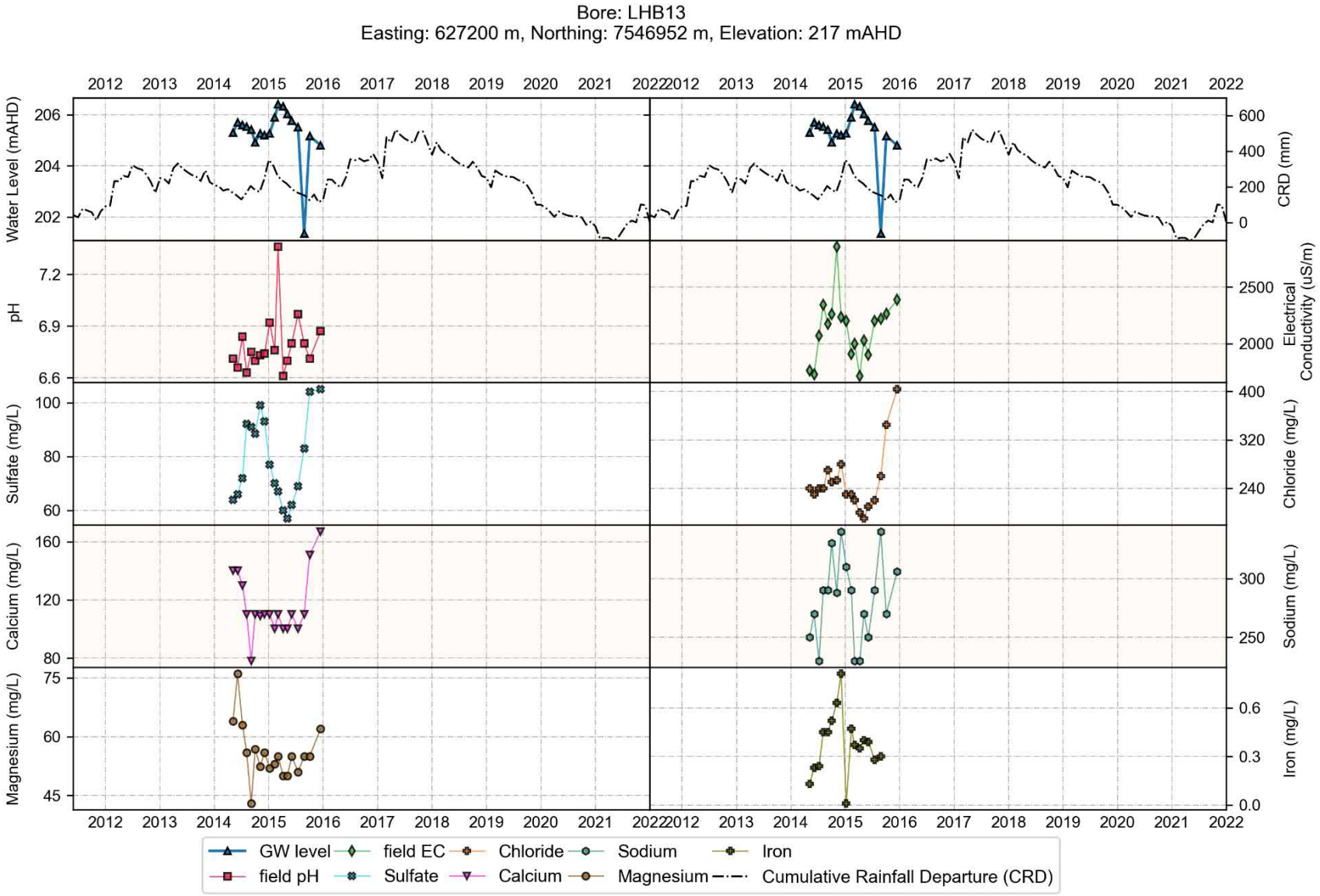


Figure 5.26 LHB13 time series plots

5.8.1 Beneficial use

As noted above, salinity is the key restriction on beneficial use of groundwater at the EDMCP. Pre-mining baseline data results of groundwater at the EDMCP falls between the brackish and moderately saline classification. This means that much of this groundwater (moderately saline) is unsuitable for more sensitive uses such as human consumption and irrigation. The data does indicate that some EDMCP groundwater has salinity levels that could be tolerated by stock and specifically beef cattle (Figure 5.27).

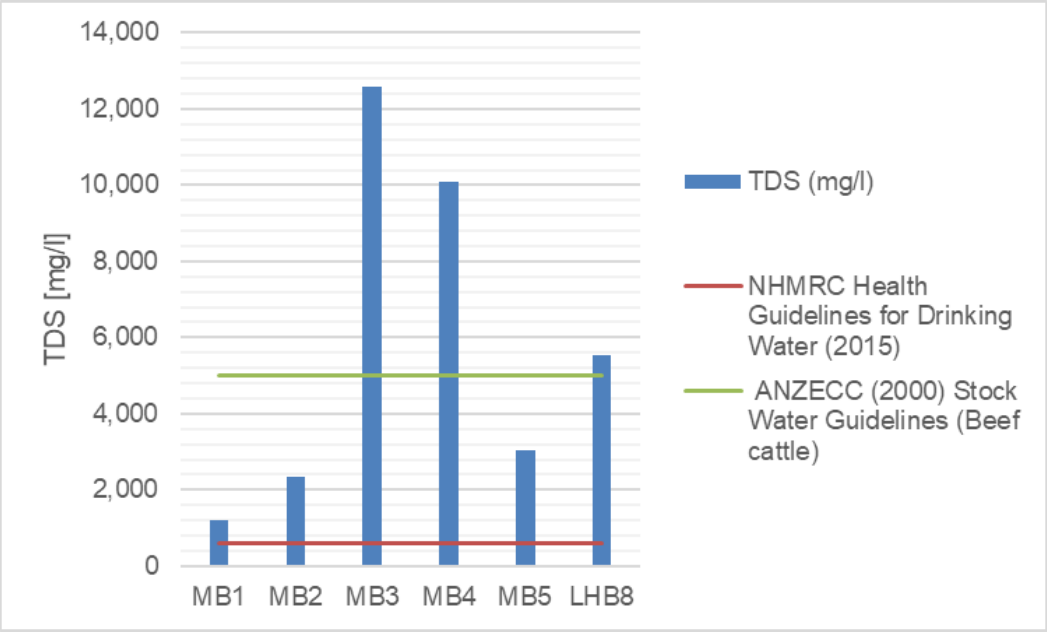


Figure 5.27 TDS concentrations and beneficial use limits

5.9 Groundwater dependent assets

5.9.1 Groundwater dependant ecosystems (GDEs)

GDEs are ecosystems that rely upon groundwater for their continued existence. GDEs may be completely dependent on groundwater, such as aquifer GDEs, or may access groundwater intermittently to supplement their water requirements, such as riparian tree species in arid and semi-arid areas (Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development [IESC], 2018).

The Commonwealth Bureau of Meteorology (BoM) has produced a Groundwater Dependent Ecosystem (GDE) Atlas, which provides ecological and hydrogeological information on potential GDEs and ecosystems that could potentially use groundwater. The GDE Atlas collates information from a number of sources into a central database, including published research and interpreted remote sensing data (Figure 5.28).

5.9.1.1 Springs

The Queensland Government has prepared the Queensland Wetland Data Springs mapping, which show the location of springs in the state. These springs are dependent on the surface expression of groundwater and their locations are used to infer the location of potential GDEs. A search of the Queensland Springs Database indicated that no spring wetlands are located within the ecology study area (Ecological, 2021).

5.9.1.2 Terrestrial GDEs

The National Atlas of Groundwater Dependent Ecosystems identified that most of the vegetation within the ecology study area has not been identified as potential GDEs. There are vegetated areas in the north-west along J B Gully and along Ripstone Creek (western tributary) in the south that are mapped as having low potential to interact with groundwater (Figure 5.28).

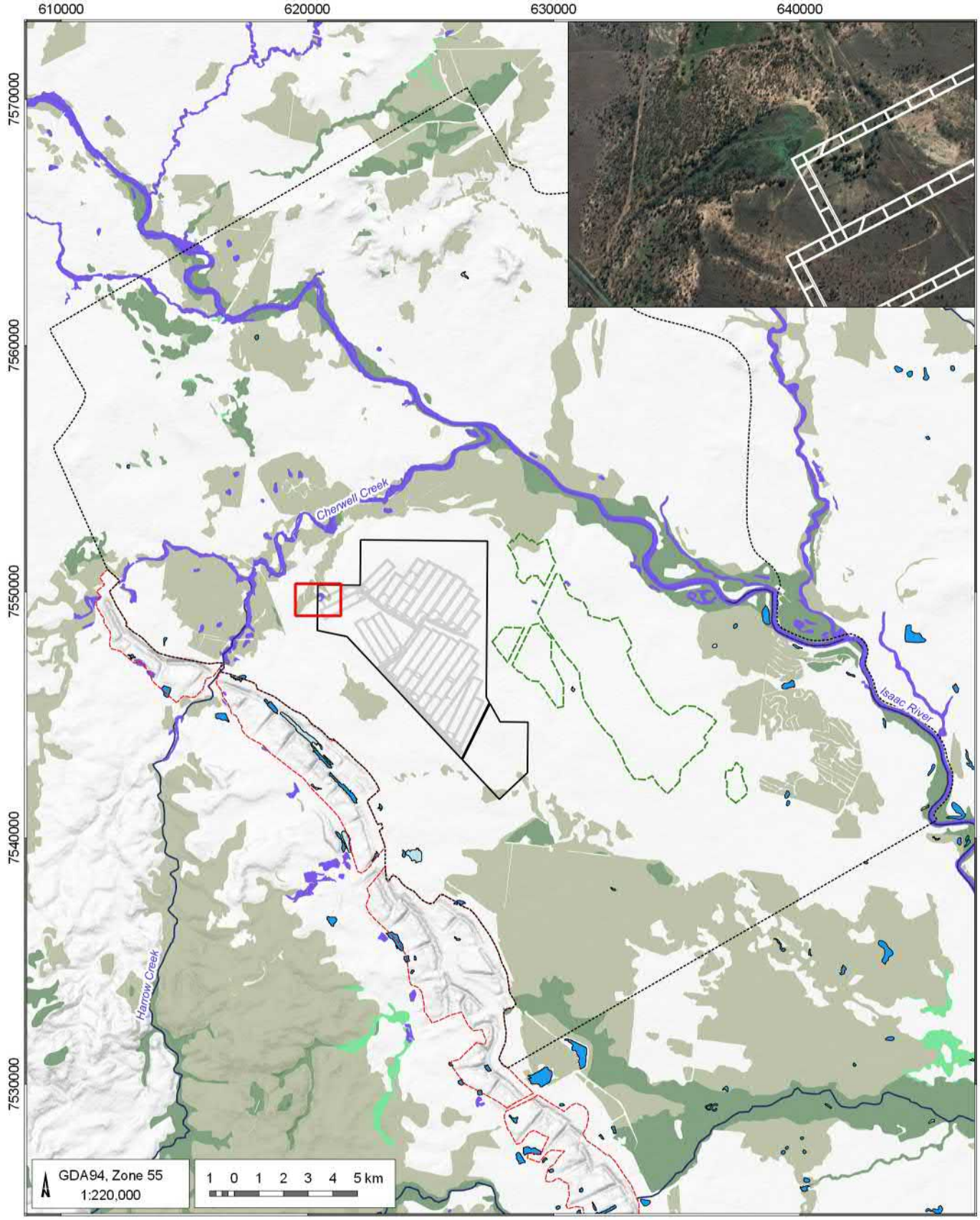
5.9.1.3 Aquatic GDEs

The Cherwell Creek north and north-west of the mine lease area and the Isaac River north-east of the of the mine lease area has high potential aquatic GDEs mapped associated with the creeks.

A small high potential aquatic GDE is mapped along a drainage line within the north-western part of the mine lease boundary (Figure 5.28). This GDE appears to be associated with seasonal run-off contained in a small farm catchment dam and is unlikely to be associated with shallow groundwater. This area is not mapped as remnant by the Queensland Government and has been dammed at some point in the past (Ecological, 2021). No other areas have been mapped as being likely to support aquatic GDEs.

5.9.1.4 Groundwater Interaction with Watercourses

As discussed in Section 5.3, no significant alluvial aquifers have developed along the drainage lines associated with the Project area and there are no deposits of sand and gravel. Groundwater levels from the shallow monitoring bores across the mine lease area indicates groundwater levels between 12 and 31 mbgl and it is unlikely that shallow baseflow occur within the Project area.



LEGEND

- River/Creek
- HCU longwall layout
- Proposed mine pits for the proposed Winchester South Project
- Peak Downs mine boundary
- Eagle Downs project area
- Eagle Downs model domain

Aquatic GDEs

- High potential GDE from national assessment
- Moderate potential GDE from national assessment
- Low potential GDE from national assessment

Terrestrial GDEs

- High potential GDE from national assessment
- Moderate potential GDE from national assessment
- Low potential GDE from national assessment

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Groundwater Dependent Ecosystems

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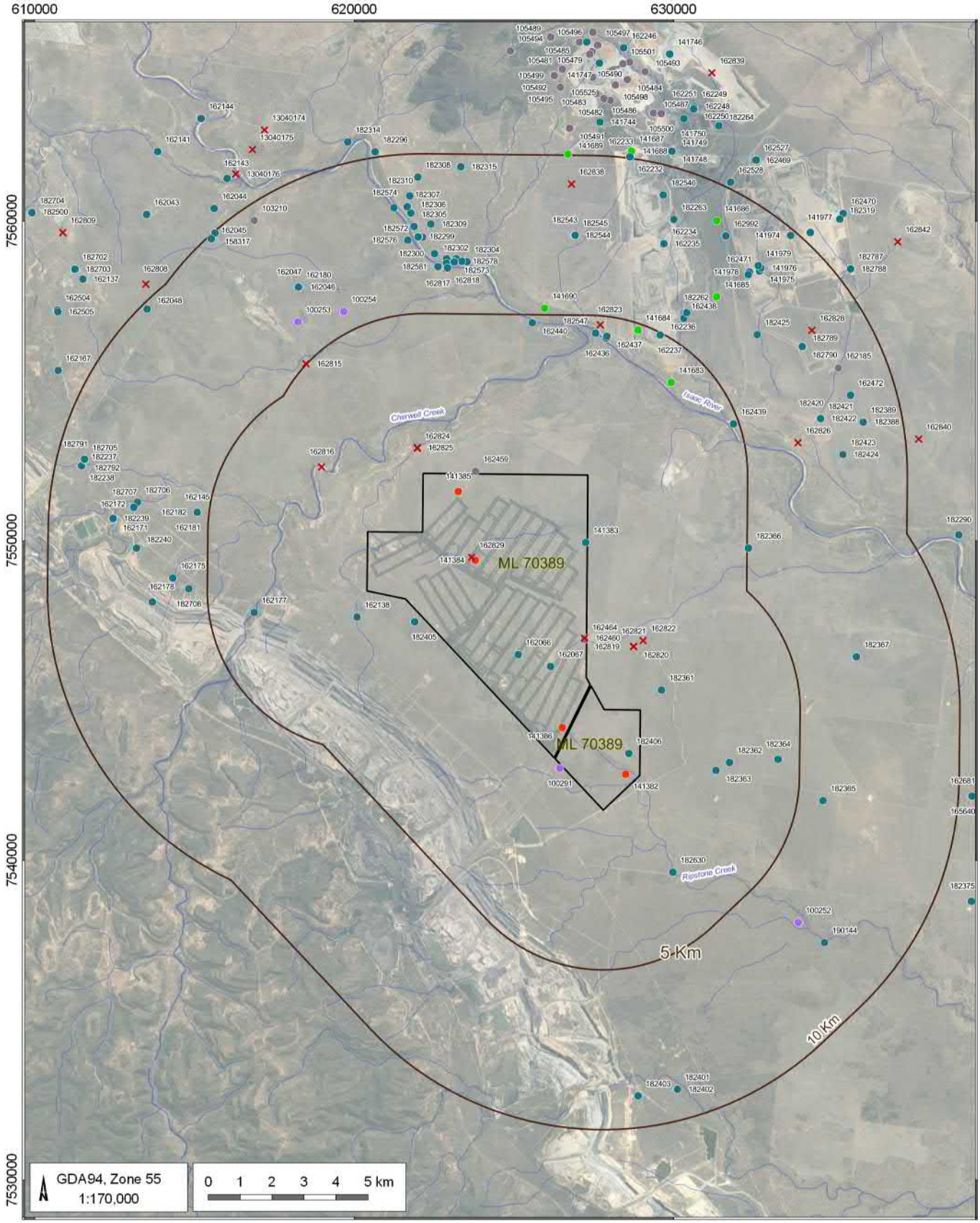
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Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
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5.9.2 Registered bores

A search of the Queensland Government's Groundwater Bore Database (GWBD) and BoM's NGIS was carried out for registered bores within the Study Area. The search indicated that there are 240 registered bores within the Project groundwater model domain, of which 175 bores (72%) are used for groundwater monitoring and investigations, and 31 bores (13%) are used for water supply. The remainder of bores have been used for sub-artesian monitoring and unknown use or resulted from exploration activities. Figure 5.29 shows the locations of the registered bores and the 5km and 10km Project radius lines.

A bore census was undertaken in 2007 in order to confirm the level of groundwater use in the area for the original EIS and documented in AGE, 2008. Three privately owned landholder bores were identified for ongoing monitoring (refer to Section 5.4). Apart from these landholder bores, it can be seen from Figure 5.29 that the recent list of registered bores does not include any additional privately owned groundwater supply bores located in or close to the ML.



LEGEND

- River/Creek
- HCU longwall layout
- Eagle Downs project area
- ML70389 5 and 10 Km zone

Registered bores

- Mine Monitoring
- Mine Monitoring
- Stratigraphic Investigation
- Petroleum or Gas Exploration
- Sub-Artesian Monitoring
- Water Resources Investigation
- Sub-Artesian Monitoring
- Water Supply
- Unknown

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Registered bores

AGE

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FIGURE No: **5.29**

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5.9.3 Stygofauna

Stygofauna are subterranean aquatic fauna that live part of or all of their lives in groundwater systems. No stygofauna surveys has been conducted for the Project area. The Winchester South Project (SLR, 2021) reported on eleven samples as follows:

- seven bores were sampled during the late wet season in May 2019 (i.e. C2136, R2009, R2010, R2032, R2035, R2054, and R2055),
- an additional two bores were sampled during the early wet season in October 2019 (i.e. Winnet Bore and Knob Hill 2); and
- sampling also was undertaken in January 2020 using the pumping method at all previously sampled bores, as well as two additional bores (i.e. Knob Hill 1 and R2008) (Ecological Service Professionals, 2021).

No stygofauna species were recorded from bores sampled during the Project field survey undertaken by Ecological Service Professionals (2021) for the Aquatic Ecology and Stygofauna Assessment. Regolith is considered to be largely unsaturated throughout the region, with the presence of highly saline water occurring in the lower elevation areas along the Isaac River (SLR, 2021). High EC of the regolith throughout the broader region suggests that the groundwater environment is not ideal for stygofauna; however, stygofauna are likely to occur in the alluvium associated with the Isaac River. Two bores in the Isaac River alluvium were sampled recently as part of the Olive Downs Coking Coal Project Aquatic Ecology Assessment. Although stygofauna were considered likely to occur in these unconsolidated sediments, none were recorded during the study (SLR, 2021).

5.10 Geochemical assessment

A Geochemical Assessment was completed by RGS in 2008 as part of the EIS (RGS, 2008) and the following supplies a summary of the assessment results:

- Drift spoil generated by the proposed Eagle Downs Project is likely to be relatively benign and will generate mildly alkaline and relatively fresh (non-saline) runoff and seepage following surface exposure.
- Acid generation from drift spoil is extremely unlikely given the lack of sulfur, excess ANC and slightly alkaline pH of these materials. Approximately 97% of drift spoil samples are classified as NAF. Only one sample was classified as PAF.
- Water extract tests indicate that, despite some marginally elevated concentrations of soluble Mo in a small number of samples, the concentration of soluble metals and salts in runoff and seepage from drift spoil is likely to remain within applied water quality guideline criteria and is unlikely to present any environmental risks for on-site or downstream water quality.
- Rejects generated by the proposed Eagle Downs Project is likely to be relatively benign and will generate mildly alkaline and relatively fresh (non-saline) runoff and seepage following surface exposure.
- Overall, despite two samples being classified as PAF, acid generation from rejects is unlikely given the lack of sulfur, excess ANC and slightly alkaline pH of these materials. Approximately 86% of rejects samples (18 out of 21) are classified as NAF; one sample was classified as Uncertain, and two samples were classified as PAF.
- Water extract tests indicate that, despite some marginally elevated concentrations of soluble Mo and As in a small number of samples, the concentration of soluble metals and salts in runoff and seepage from rejects is likely to remain within applied water quality guideline criteria and is unlikely to present any environmental risks for on-site or downstream water quality.

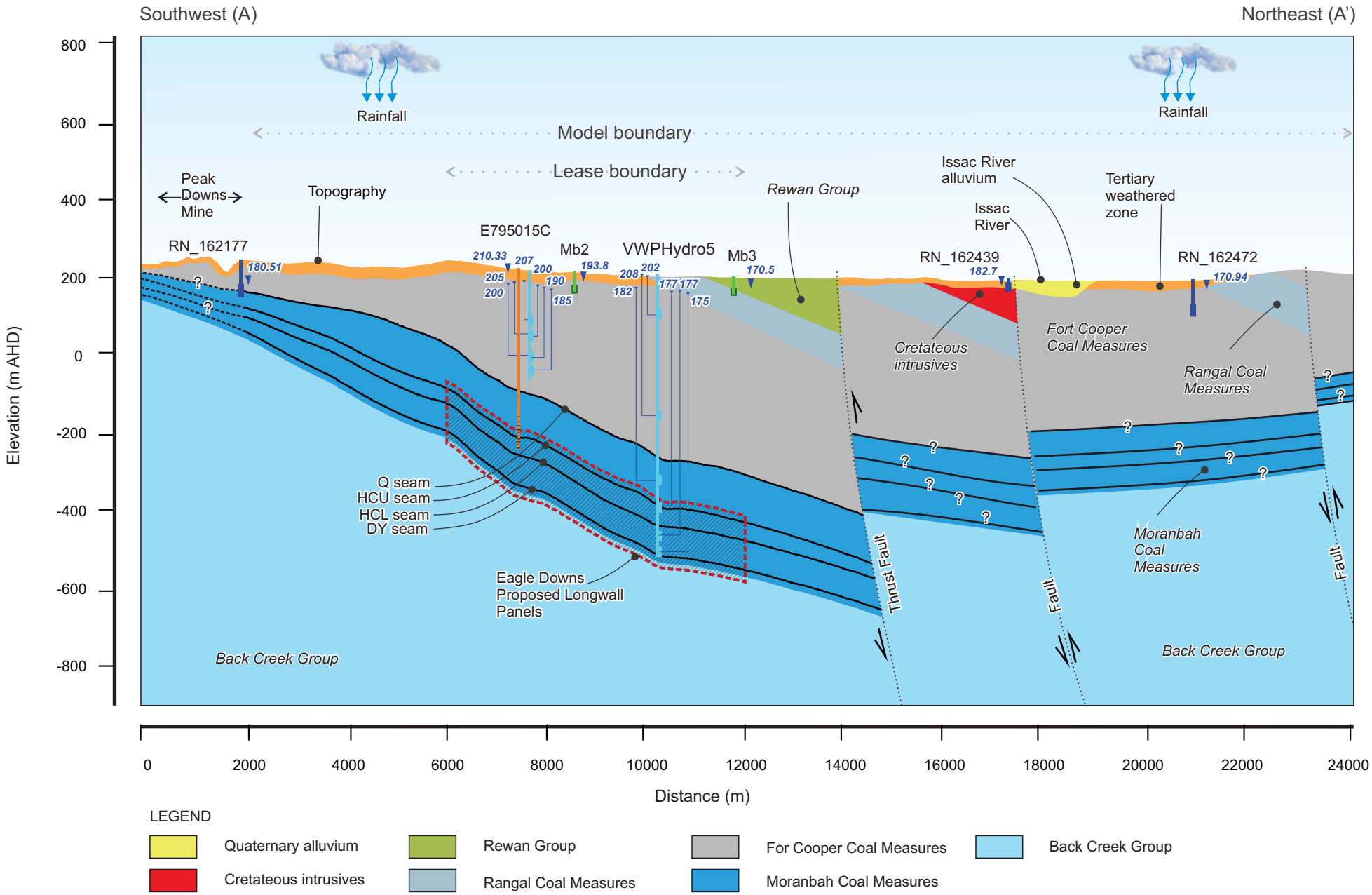
5.11 Conceptual model

The simplified conceptual groundwater model of the Project area illustrated on Figure 5.30 was developed based on geological and topographical maps of the project area, geological information from coal exploration bores drilled across the Project area, installation of monitoring bores in the shallow aquifer, results from previous hydrogeological investigations and relevant data from the DERM groundwater database, as previously described.

Alluvial aquifers having the highest hydraulic conductivity, but the spatial distribution and extent of these alluvial aquifers is limited to areas around Cherwell Creek and the Isaac River and occur outside of the ML boundary. The alluvial aquifers have few stock bores within the alluvium indicating unsaturated or thinly saturated conditions. The alluvium is recharged by rainfall and by seepage from the river during periods of flow, and during drier periods, discharges as baseflow to the river from the shallow weathered rock aquifer.

The Permian strata hydraulic conductivity is low and decreases with depth and is generally one to two orders of magnitude lower in the interburden compared to the coal seams. Yields from the coal seams are likely to be relatively low and probably less than 1 L/s. Hydraulic conductivity of the shallow weathered rock would be low and likely spatially variable depending on the degree of weathering of the bedrock. Groundwater yield from the shallow weathered rock aquifer is variable but quite low and at best can only provide stock water supplies.

The shallow weathered fractured rock hosts the groundwater table and is slightly lower in elevation than the Permian coal seam piezometric heads indicating that the coal seam aquifers and shallow weathered fractured have limited hydraulic connectivity. The groundwater table contours indicate a gradient to the east to the Isaac River and associated alluvium, which form a natural discharge zone to the shallow aquifer system. The gradient and groundwater flow in the shallow aquifer are opposite to the direction of flow in the deep Permian coal seams which has been reversed due to the extensive Peak Downs open cut mine pits along the western sub-outcrop acting as groundwater sinks. Discharge from the coal seams is to the open cut pits, to the shallow weathered/fractured rock aquifer and to the Isaac River alluvium via upward flow along fractures.



Conceptual cross section

Figure - 5.30

Eagle Downs GIA for EA Amendment (EDM5000.001)

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5.11.1 Conceptual model uncertainty

Conceptual models always have some uncertainty regarding geology, structure, climate, groundwater and surface water systems. Middlemis and Peeters (2018) indicate sources of uncertainty affecting groundwater models can be grouped as follows:

- structural/conceptual – geological structure and hydrogeological conceptualisation assumptions applied to derive a simplified view of a complex hydrogeological reality (any system aspect that cannot be changed in an automated way in a model);
- parameterisation – hydrogeological property values and assumptions applied to represent complex reality in space and time (any system aspect that can be changed in an automated way in a model via parameterisation);
- measurement error – combination of uncertainties associated with the measurement of complex system states (heads, discharges), parameters and variability (3D spatial and temporal) with those induced by upscaling or downscaling (site-specific data, climate data); and
- scenario uncertainties – guessing future stresses, dynamics and boundary condition changes (e.g. mining, climate variability, land and water use change).

The following gaps were identified for the Project conceptual model:

- limited VWP data are available for sensors installed in the coal seams. Issues with the existing VWP sensors were experienced and South32 progressing to update the sensors; and
- limited groundwater quality data is available for the Permian coal seams as all the existing Project monitoring bores are installed in the shallow weathered aquifer.

6 Overview of mine induced subsidence and fracturing

6.1 Subsidence

With the HCU and HCL seam longwalls having been extracted using an offset chain pillar layout by the time that DY seam workings are being developed, the entire overburden above the HCU seam should be fully collapsed. Figure 6.1 shows the general stacking/offsetting arrangement adopted in the Eagle Downs multi-seam layouts (South32, 2020).

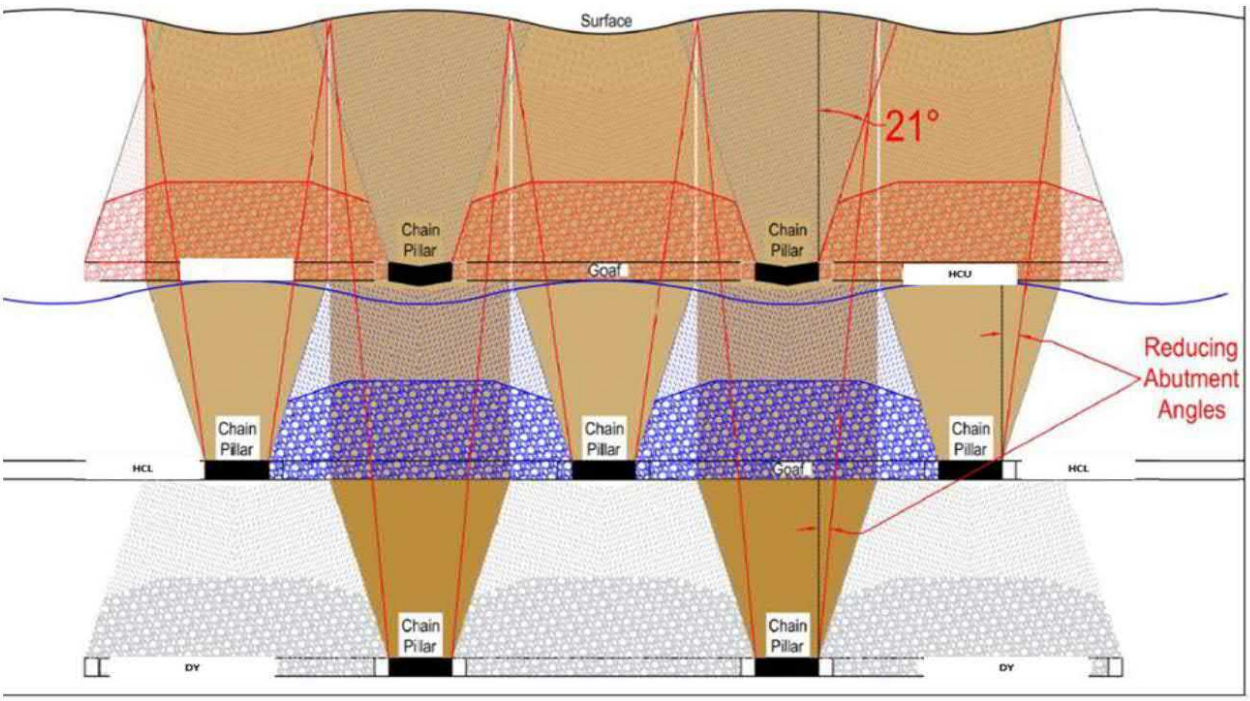


Figure 6.1 Multiple stacked longwalls with decreasing abutment angles due to overlying goaf (South32, 2020)

With the proposed longwall mining layout for the three seams virtually overlapping, (offset of approximately 30 m), the subsidence likely to be experienced on surface will be higher than if the longwalls were staggered, with a 50% offset. Modelling has been done by Gordon Geotechniques (2021). Once the extraction of all three target seams has been completed, a maximum subsidence of 10 m is predicted in the shallower south-western part of the mining area (Figure 6.2).

The areas of increased depth (north-east) will reflect less subsidence on surface while the subsidence will be more pronounced in the shallower areas (south-west) (Figure 6.2). The proposed narrower longwall panels in the HCL seam, beneath the areas with strong and thick sandstone will alter the final subsidence on surface.

Two cross sections across the northern and southern part of the area illustrate the variability in the predicted subsidence (Figure 6.3). It should be highlighted that these sections have a high vertical: horizontal scale exaggeration.

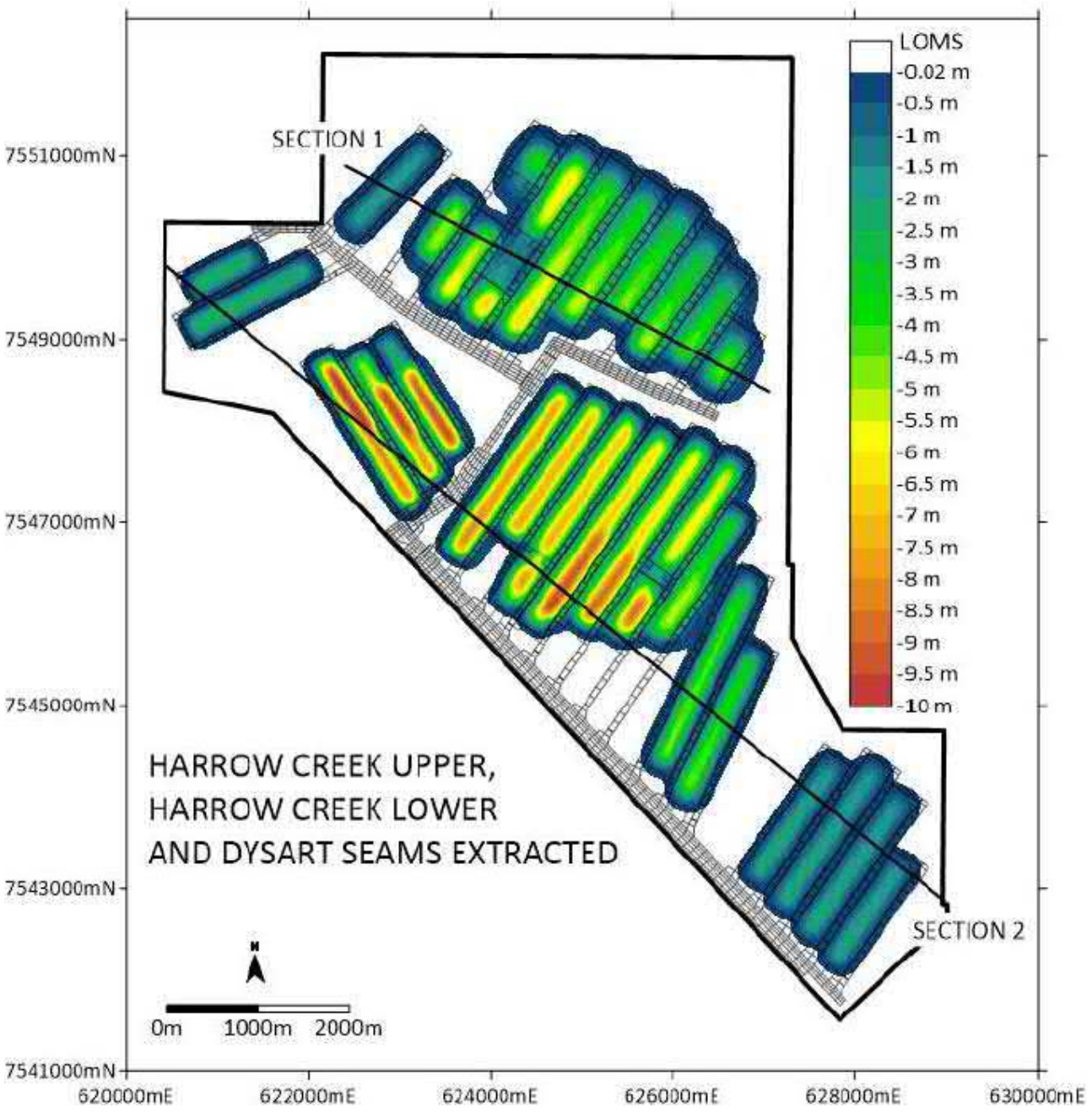


Figure 6.2 Subsidence after Extraction of the HCU, HCL and DY Seams (m) (Gordon Geotechniques, 2021)

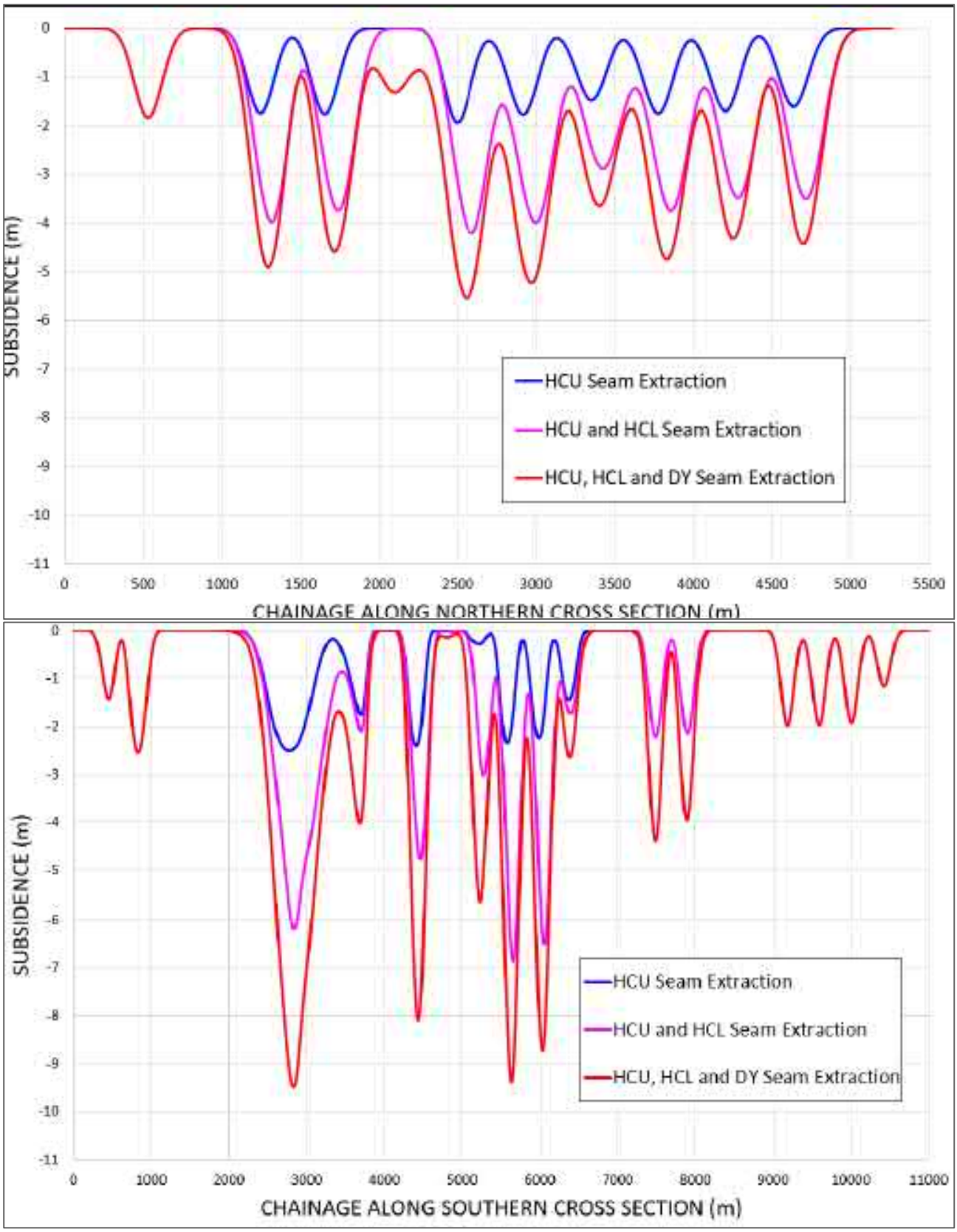


Figure 6.3 Subsidence - Northern Cross Section 1 (top) and Southern Cross Section 2 (bottom) (Gordon Geotechniques, 2021)

6.2 Fracturing

As described above, during longwall mining, the removal of coal causes the overburden to subside into the spent longwall void (goaf). The resultant strain imposed on the rock strata develops a fracture network of varying connectivity according to the height above the longwall panel. The thickness of the mined section, the effective width of the longwall panel, and the geological properties of the overburden all influence the degree of fracturing which results from the collapsing of the longwall panel (post mining). The most commonly cited empirical model developed for predicting subsurface subsidence cracking effects on groundwater and surface water is the Bai and Kendorski (1995) model (Figure 6.4). The key principle of this model is that subsurface subsidence cracking can be characterised by the following zones:

- Constrained zone – unaffected by subsurface subsidence cracking.
- Dilated (or discontinuous cracking) zone – no changes in vertical permeability, possible changes in horizontal permeability and storativity.
- Fractured (or continuous cracking) zone – changes in vertical and horizontal permeability are possible.

This hydrogeological model concludes that water will enter an underground mine or be lost from an aquifer or surface water body if:

- the zone of continuous subsurface cracking intersects the water body; or
- there is a connection between the continuous subsurface cracking zone and any surface subsidence cracking.

The heights of subsurface subsidence cracking in hydrogeological models such as that of Bai and Kendorski are related to extracted coal thickness. In Figure 6.4, the fractured zone is shown to range from 6 to 30 times the extracted seam thickness. Gordon Geotechniques, 2021 is not aware of empirical studies examining the height of subsurface cracking above multi-seam longwalls, however, some physical modelling work by Ghabraie and Ren (2014) is detailed below to provide an understanding of the subsurface strata movement in a multi-seam longwall mine.

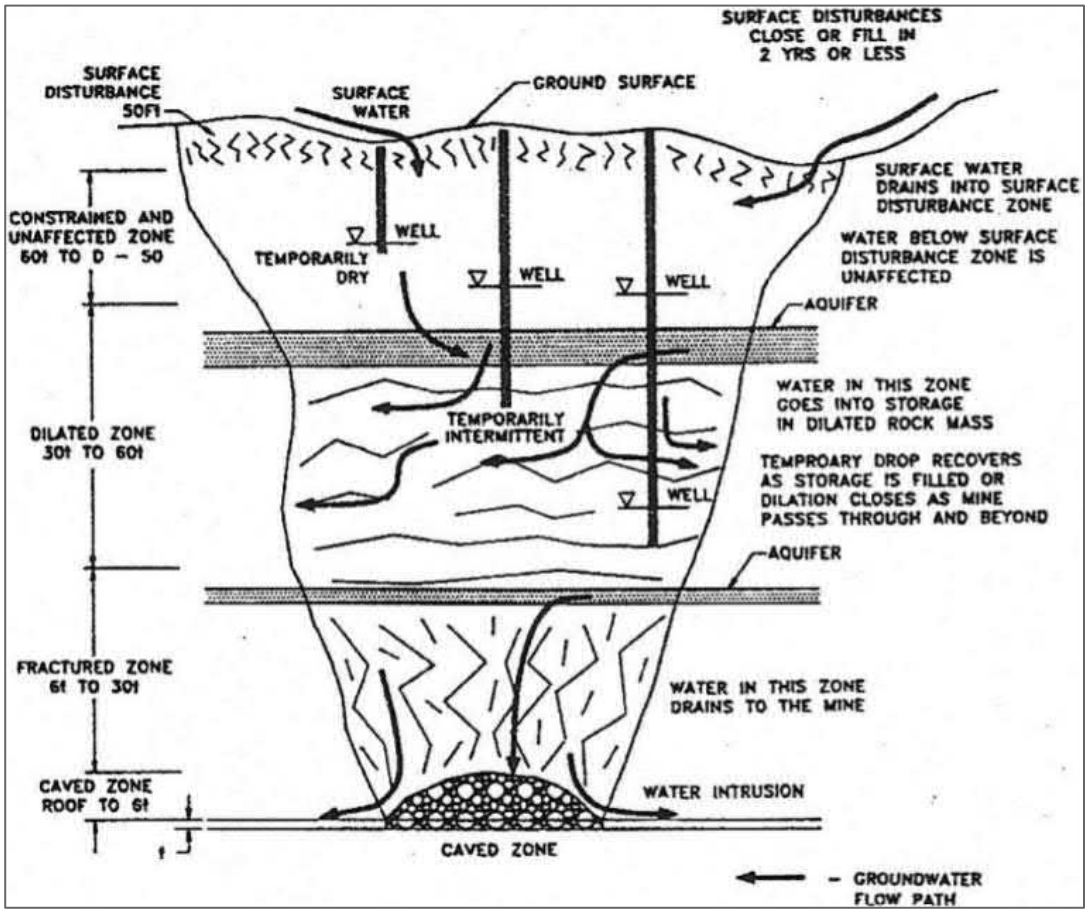


Figure 6.4 Hydrogeological Model for Fracturing above Longwalls (Bai and Kendorski, 1995)

6.3 Literature study

Published numerical modelling studies by Gale (2008) in the Oaky Creek area showed a distinct decrease in the vertical conductivity to around 10^{-6} m/s, at beyond 90 to 100 m above the coal seam (Figure 6.5). This is also consistent with the field observations described above. The progressive reduction in vertical conductivity from 1 m/s close to the extracted seam, decreasing to 10^{-4} m/s at the top of continuous cracking zone is shown in Figure 6.5.

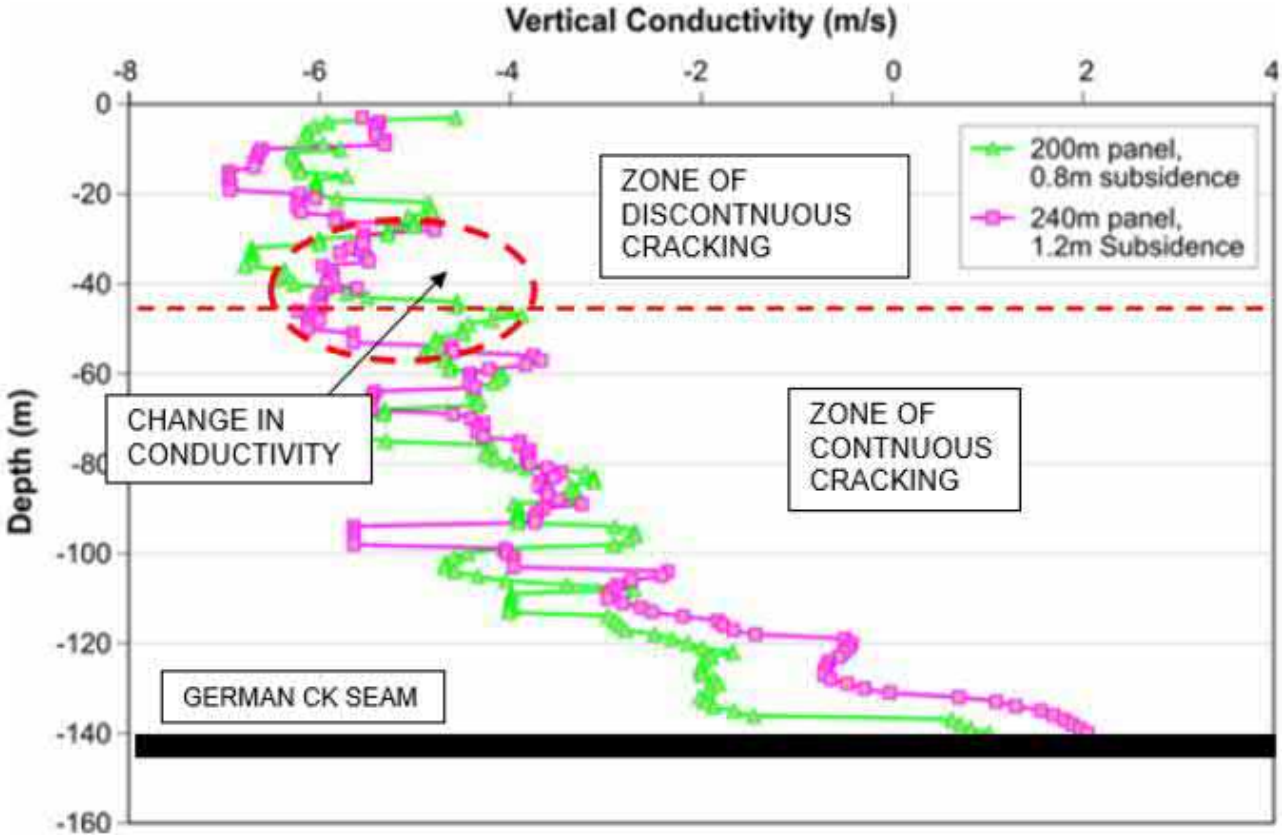


Figure 6.5 Vertical Conductivity through a Numerical Model in the Southern-Oaky Creek Area (Gale, 2008).

Field observations of heights of subsurface subsidence cracking from mines in QLD, NSW and overseas are summarised in Table 6.1. Gale (2008) also reports that 105 m of rock head is used as a standard buffer distance to minimise the risk of inflow events in the UK.

These thicknesses are consistent with monitoring conducted in NSW mines, where the potential for surface water to flow into underground longwall workings is recognised if the longwall panel is less than 100 m to 150 m below the surface.

Table 6.1 Field Observations and Guidelines for the Height of Cracking

Mining Area	Height of Continuous Cracking	Discussion/Evidence
Crinum, QLD	90-100 m	Height to overlying basalt/sand aquifers in the Tertiary (Seedsman and Dawkins, 2006).
NSW	100-150 m	The potential for surface water to flow into underground longwall workings is recognised if the longwall panel is less than 100 m to 150 m below the surface (Seedsman and Dawkins, 2006).
Oaky Creek and German Creek, QLD	<160 m	For ponded water at cover depths greater than 160 m, remedial works are generally not required and standard underground pumping systems are capable of handling minor increases in flow (Klenowski, 2000). Unrestricted inflow generally occurs to a height of about 120 m above the active mine area, with inflow rates progressively reducing as the depth of cover increases above 120 m (Klenowski, 2000).
Kestrel, QLD	<115 m	Microseismic monitoring of LW101. (Kelly and Gale, 1999
North Goonyella	<120 m	Microseismic monitoring of LW3. (Kelly and Gale, 1999).
Wyee, NSW	40-63 m	Wide panels and strong, massive roof strata (Forster and Enever, 1992).
Cooranbong, NSW	58 m	Wide panels and strong, massive roof strata (Forster and Enever, 1992).
Wistow Mine, UK	77 m	Limestone aquifer (Whittaker and Reddish, 1989).
UK	<105 m of rock head	Guideline to minimise the risk of inflow (Gale, 2008).
Northern Bowen Basin	<170-250 m	Longwalls (312 m wide and 4.5 m high) successfully extracted beneath the Isaac River.

The height of continuous cracking presented in the literature study above (Table 6.1) compares well with the data used during the initial groundwater modelling for the Eagle Downs Mine project in 2008 (AGE, 2008). The estimate of fracture heights is summarized in Table 6.2 below and expected to be up to 120 m above the HCU Coal Seam.

Table 6.2 Estimates of continuous fracture heights in overburden/interburden after DY seam extraction (AGE 2008)

Overburden/ Interburden	Thickness (m)	Height of Continuous Fracturing (m)		Comments
		IMC (2008)	Cendrowski (1993)	
HCU	-	62 – 91	96 – 120	Hydraulic connection between Q and HCU longwalls/goaf
HCL – HCU	60	73 – 91	173 – 216	Hydraulic connection between HCU and HCL longwalls/goaf
Dysart – HCL	67	84 – 91	105 – 132	Hydraulic connection between HCL and Dysart longwalls/goaf

Table 6.2 indicates that for the Eagle Downs Project undermining of the HCU, HCL and Dysart Seams will result in hydraulic connection between the longwalls / goaf of each of the four seams and that the height of continuous fracturing at completion of mining, that is, the height to which water bearing strata will drain to the goafed area after all seams have been extracted, will extend to about 100 to 120 m above the HCU Seam. Any aquifers that occur more than 100 m above the HCU Seam will not drain to the mine via vertical continuous fracturing associated with the goaf. The fracture heights used for the Project groundwater model is discussed in more detail in Section 7.7.

6.3.1 Water Inflow events in the Bowen Basin

Seedsman and Dawkins (2006) provide a comprehensive summary of subsurface subsidence cracking and water inflow events in the Bowen Basin. Seedsman and Dawkins report that:

- no major surface water inflows to longwall mining areas have occurred in the Bowen Basin where the depth of cover has exceeded 120 m; and
- no major groundwater inflows to longwall mining areas have occurred in the Bowen Basin where the distance from the seam to the aquifers is more than approximately 90 m.

Klenowski (2000) reports on the inflow of water at the Oaky Creek Mine and the German Creek mining complex in the central part of the Bowen Basin. These mines target the German Creek Coal Measures, which comprise a sequence of sandstones, siltstones, mudstones and coal seams.

Klenowski concluded that unrestricted inflow (i.e. from the zone of continuous cracking) generally occurs to a height of about 120 m above the active mine area. The inflow rates for different heights of cracking in the German Creek mining complex, as well as other comparable mining operations, extracting single seam longwalls, throughout the Bowen Basin, Australia and overseas, are plotted in Figure 6.6.

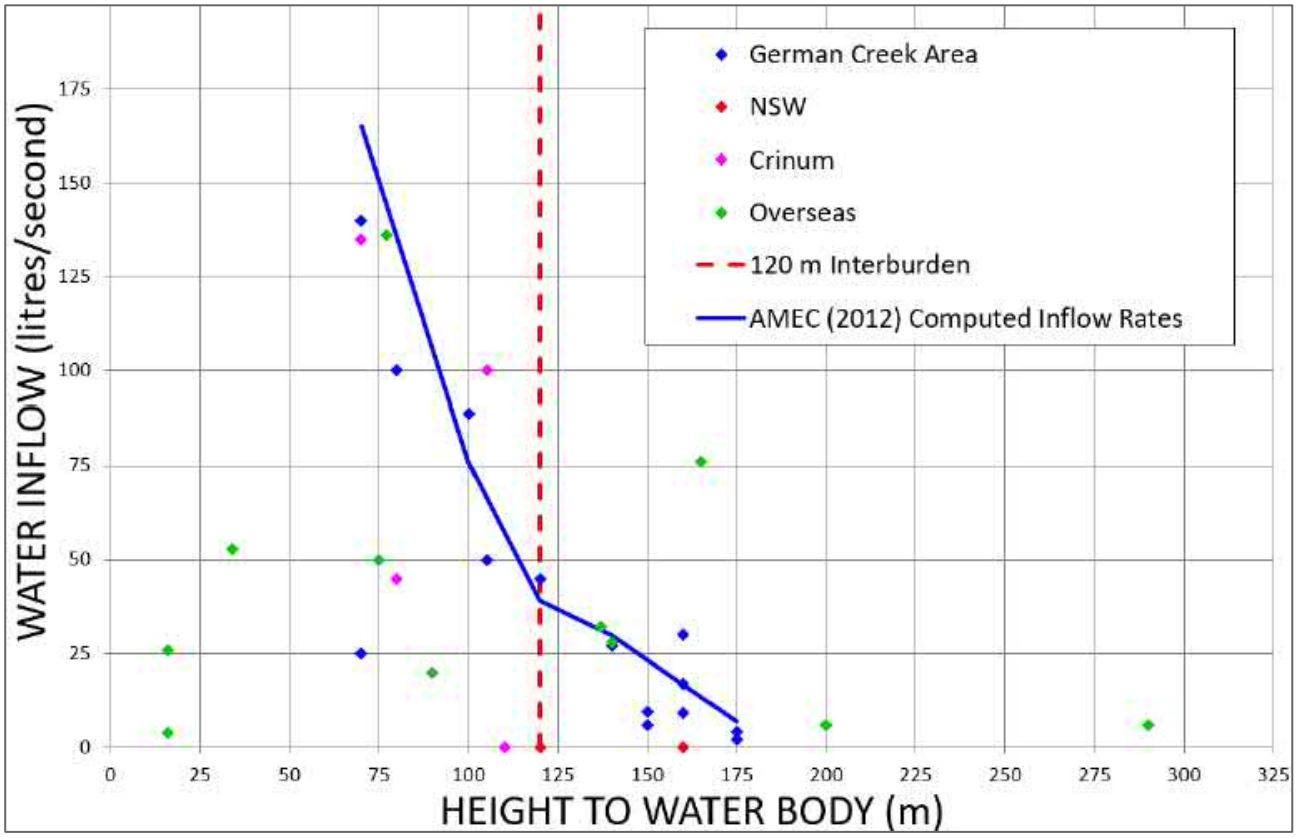


Figure 6.6 Summary of Water Inflow Events (Gordon Geotechniques, 2021).

Evidence from Crinum Mine and Kestrel Mine, suggests that the presence of Tertiary clay materials in the overburden within the cracking zone may have retarded water inflow rates to underground workings (Seedsman and Dawkins, (2006) and Gale, (2008)).

7 Numerical groundwater model

In agreement with the conceptual groundwater model of the area, the numerical model represents the two aquifer systems. The lower aquifer system comprises four coal seams (Q, HCU, HCL and DY seams), of which the HCU, HCL and DY are to be mined in sequence. The coal seam aquifers are represented by individual model layers, with each seam separated by three layers of homogenous low permeability interburden. Similarly, the uppermost shallow weathered/fractured rock aquifer was represented by a model layer. The following text provides a concise summary of the model design and construction.

This section also refers to the groundwater model used for the original GIA (AGE, 2008) and approved EA. The results and impacts are discussed in more detail in Section 9.

AGE developed the first groundwater model for the site as part of the Environmental Impact Statement (EIS) in 2007/8. As part of this project, a numerical model was constructed to simulate groundwater seepage rates and depressurisation for a four seam mining operation. The study included reviewing existing baseline data, installing monitoring bores, constructing the numerical model and simulating the impact of mining on the groundwater regime. As indicated in Section 5.1, three model update events occurred since the initial assessment in 2007/2008. In 2015/2016 the numerical model was updated with hydrogeological data collected from the monitoring bore network, VWPs, and information from the inseam gas drainage pilot program.

The objective of the model development was to:

- update the model with the recent observations and future proposed mining; and
- use the updated model to predict groundwater inflow to the mine.

The groundwater model was updated with several minor changes over the model developed for the 2015/2019 work. The following sections describe the model in its present state.

7.1 Mine Plan

The mine plan was updated to reflect the current proposed layout of the longwall panels and adjoining roads. Figure 1.2 of Section 1.4 illustrates the current mine layout, underlain by the approved EA longwall layout (in light grey). The new updated mine plan includes a reorientation and extension of underground panels north of the Norwich Park Branch Railway Corridor as illustrated in Section 1.4. The main changes are extended underground panels in the southern portion of the mining area and minor extensions in the north-east and south-west panels.

The model mesh was refined for sufficient discretisation around the mining area in the 2019 (current) model version.

7.1.1 2008 Model

The 2008 model simulated mining in the four coal seams represented, including the shallower Q Seam. Furthermore, the 2008 mine plan did not allow for any offset of the longwall panels between the coal seams and the same mine plan geometry were duplicated for all four coal seams. It is therefore expected to see significant changes in the predicted drawdown when comparing the results and Section 9 supplied more detail in this regard.

7.2 Model software

The model was developed using the unstructured version of MODFLOW, MODFLOW-USG. MODFLOW-USG uses efficient polygon-based model grids that can be finely discretised around areas of interest. Flexibility in the grid design also extends laterally, as model layers can be truncated to represent features such as coal seam sub-crops or subsurface structures.

7.2.1 2008 Model and model progression

The previous groundwater model (last updated in 2011) was constructed in MODFLOW SURFACT. This is a large regional model originally designed for the purposes of impact prediction for the EIS. There is now the need for a more detailed model that can represent the new data that has been collected.

Since 2011, there have been some significant advances in groundwater flow models. The most significant has been the introduction of MODFLOW-USG. MODFLOW-USG allows for grids that can be refined to very small cells within mining areas and comprise larger cells outside the area where detail is required.

The Eagle Downs groundwater model was converted in 2016 from MODFLOW SURFACT to MODFLOW-USG to provide a much better tool for operational issues and better estimates of water ingress rates to the underground mine. MODFLOW-USG also runs quicker which has allowed for more analysis of the predictions to be undertaken (such as uncertainty analysis of the predicted inflow rates.

The scope of the conversion from MODFLOW SURFACT to MODFLOW-USG involved:

- Converting all the model files to MODFLOW-USG.
- Developing a new model mesh that represents in more detail the decline, the drift, the gas drainage wells and the longwall panels.
- Re-calibrating the model with:
  - pumping records and permeability data from the gas drainage pilot testing program;
  - water levels from the groundwater monitoring bores; and
  - development of the drift.
- Updating the mine plan to simulate mining.
- Updating layering within the model with new geological data. This included adding more interburden layers to the model above the coal seams to improve the estimate of water leakage through the roof.

This assessment considers recent data, including groundwater levels and quality from its monitoring bore network, and considerable information from the in-seam gas drainage pilot program and provides an update of the numerical groundwater model.

7.3 Model extent and mesh

The model domain is of irregular shape, approximately 23 km wide (south-west to north-east direction) and 36 km long (north-west to south-east direction) as shown in Figure 7.1. The model grid was designed to be sufficiently extensive such that drawdown caused by mine dewatering was contained well within the model boundaries. Where appropriate, natural hydrogeological boundaries such as drainages, regional catchments, faults and nearby mine pits were adopted as boundaries in the model.

The model mesh was refined around the mining area for improved representation of the updated longwall layout (Figure 7.1). At the same time, the mesh was refined outside of the mining area to reduce the overall cell count and improve model efficiency, resulting in a cell count of 27,193 cells per layer compared to 44,447 cells from the earlier MODFLOW SURFACT models.

The model domain was discretised and arranged into 18 layers. Only the top two layers extend to the east beyond the Isaac Thrust Fault to provide a better representation of the Isaac River and recharge from the eastern area; the remaining layers were limited to the west of the fault to reduce the number of cells.

Elevation data was transferred from the previous model to the new model (AGE, 2016 and AGE, 2019), remaining identical across all the model domain, except for layer 2 east of the Isaac Thrust Fault. In the previous model this area was only represented by one thin model layer. Initial simulations showed some numerical convergence issues in this area if layer 1 became unsaturated, so layer 2, with a nominal thickness of 75 m, was added to the east of the fault to improve model stability. The model layers and representative geology are presented in Table 7.1.

Table 7.1 Model layers

Layer number	Geology
1	Alluvium/regolith
2	Interburden
3	Interburden
4	Interburden
5	Q seam
6	Interburden
7	Interburden
8	Interburden
9	HCU seam
10	Interburden
11	Interburden
12	Interburden
13	HCL seam
14	Interburden
15	Interburden
16	Interburden
17	DY seam
18	Interburden

Floor elevations and thickness data for all four coal seams were provided by EDMCP covering the mine area and the 78 km^2 area of the project area to the south-west. In the mining area where there is detailed data, the seams were positioned in the model using the roof elevations and the average seam thickness; however towards the eastern model boundary where there is little borehole data, the seams were positioned by projecting the dip of the seams to the east taking into account that all geological layers flatten to the east towards the axis of a synclinal structure.

The interburden that separates the coal seam aquifers is modelled as discrete layers in the model, which are each divided into three layers according to expected goaf fracture heights above the underlying respective coal seam. Therefore, the model consists of 18 model layers representing the groundwater bearing units, all of which cover the total model area. These 18 model layers are described in detail as follows.

The upper model layer (Layer 1) represents the shallow, weathered / fractured rock aquifer. Digital Elevation Model (DEM) data downloaded from Geoscience Australia (www.geoscience.com.au) was used to interpolate its top surface. The elevation of the surface ranges from RL 175 m in the central-east to RL 323 m in the north-east. In the previous model, the upper model layer was assigned a nominal thickness of 80 m which is based upon the depth of a local landholder bore. In this model update, CSIRO data[13] has been used to support the structure of the shallow regolith and alluvium. Model Layer 1 covers the whole of the model area and is not truncated by the Isaac Thrust fault in contrast to Layers 2 to 18.

Layers 2, 3 and 4 represent the Permian interburden and associated goaf limit overlying the Q Seam (Layer 5). The floor elevation of the Q Seam ranges from RL 67 m to RL -226 m. Layers 6, 7 and 8 represent the Permian interburden and associated goaf limit, overlying the HCU Seam (Layer 9). The HCU Seam floor elevation is within a range from about RL -35 m to RL -349 m.

[13] CSIRO Soil and Landscape Grid of Australia (http://www.clw.csiro.au/aclep/soilandlandscapegrid/index.html), viewed Dec 2015.

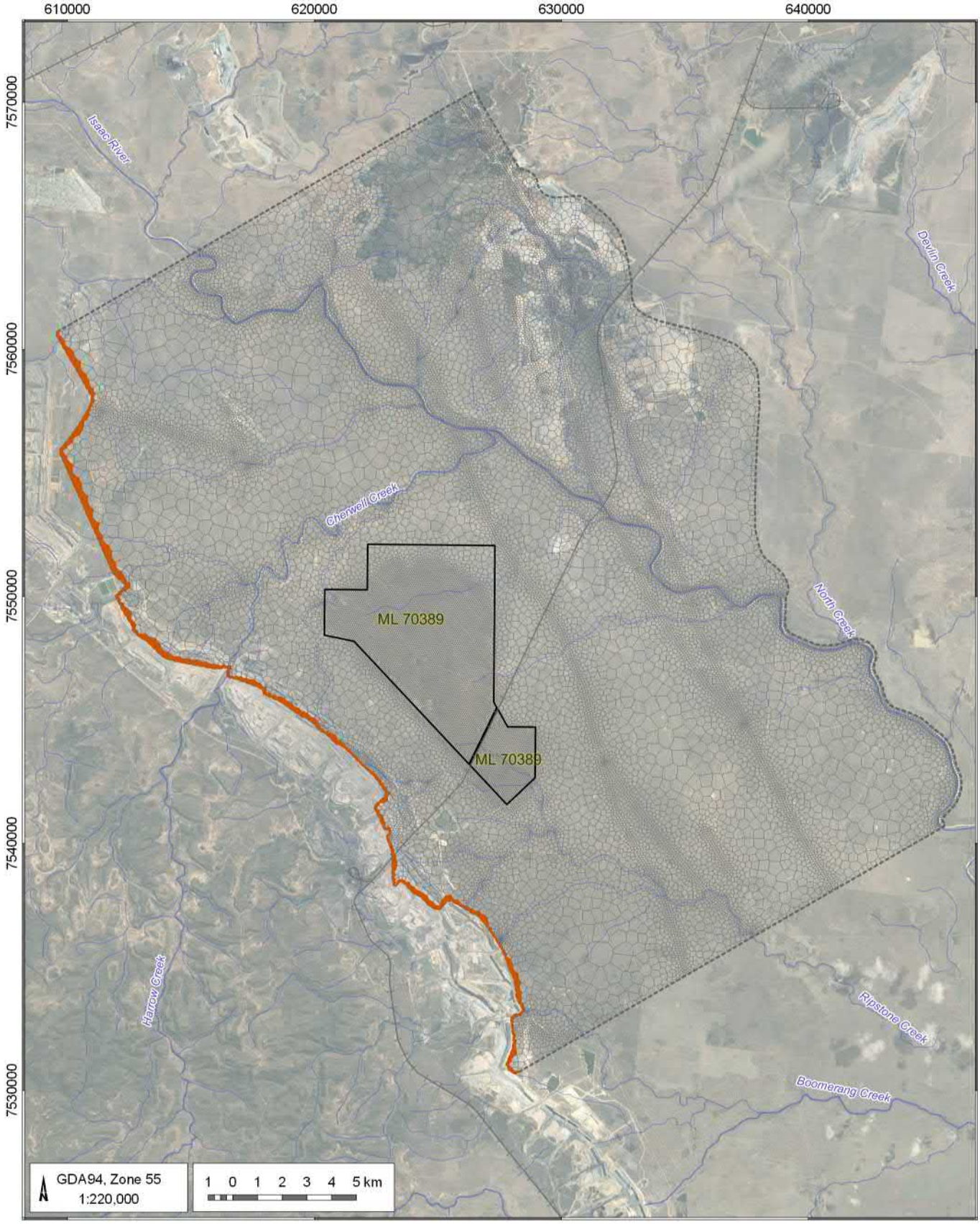
Layer 13 represents the HCL Seam which is overlain by Layers 10, 11 and 12, representing the Permian interburden and the associated goaf limit. The HCL Seam floor elevation ranges from RL -92 m to RL -408 m. The HCL and HCU Seams coalesce south of the Project area.

Layers 14, 15 and 16 represent the Permian interburden and associated goaf limit, overlying the DY Seam (Layer 17). The Dysart Seam floor elevation ranges from RL -163 m to RL -483 m. Layer 18 represents Permian interburden directly underlying the DY Seam at a nominal thickness of 20 m.

7.3.1 2008 Model

The previous model domain was discretised into rectangular cells arranged into 5 layers comprising 155 columns and 214 rows. There are 31,528 active cells in each layer with the dimensions of the cells varying from 50 m by 50 m within the mining area up to 500 m by 500 m at the extremities of the model. The model extent varies from about 15 to 20 km from west to east and is about 35 km from north to south, covering an area of approximately 621 km^2.

The geometry of the updated model has essentially not changed since the previous modelling (AGE, 2011), however additional model layers (18 compared to 14) have been included in order to better represent the interburden.



LEGEND

- Rail
- Major drainage
- Minor drainage
- Eagle Downs project area
- Model grid
- Model domain
- General head boundary

Eagle DownsGIA for EA Amendment (EDM5000.001)

Model mesh and assigned boundary conditions

AGE

DATE 15/02/2022

FIGURE No: **7.1**

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7.4 Boundary conditions

Water entering or leaving the model domain is simulated through the actions of boundary conditions. The specific boundary flows and their representation in the model are discussed below.

7.4.1 "No Flow" boundaries

With the exception of the western boundary, the model domain (northern, eastern and southern edges) is surrounded by "no flow" boundaries. A "no flow" boundary does not allow any exchange of water between the model domain and the surrounding areas. The eastern boundary is represented by the main fault of the Isaac Thrust Fault system in layers 2 to 18, and by the surface water catchment in layer 1.

There are minor faults to the west of the main fault within the model domain, but it is considered that these faults are not relevant for the level of detail of the groundwater model and are therefore not included in the model. The northern and southern boundaries are set along interpreted groundwater flow lines at a distance of approximately 14 km from the proposed mining operation, which is considered of sufficient distance to avoid the boundary having an impact on the development of the cone of depression around the mine. The base of the model was also assumed to be a "no flow" boundary.

7.4.2 General head boundary

A MODFLOW-USG 'general head boundary' condition package (GHB) was adopted for the western edge of the model, for cells adjoining the Peak Downs Mine. The base of the pit in the vicinity of the Peak Downs Mine was established as the elevation of the general head boundary, and its conductance was established in the 2011 model created by AGE. Layers above the pit base elevation were assigned this boundary condition, whereas layers below the base of the pit were not affected.

7.4.3 River boundary

A MODFLOW-USG river boundary condition (RIV) was defined in the top layer of the model to simulate rivers and creeks in the model domain, modelling them as dry rivers (using zero depth of water in the river) to represent their ephemeral nature.

7.5 System stresses

7.5.1 Rainfall and recharge

The western boundary of the model is defined by the eastern extent of the Peak Downs open cut mine and where there are no open cut voids, the model boundary corresponds to the sub-crop of the seams. Recharge to the coal seams was assumed to occur along their sub-crop zone with the exception of those areas occupied by the dewatered open cut mine pits of the Peak Downs Mine. Recharge to each coal seam was calculated by estimating the area of the seam sub-crop using the seam thickness and the length of the unmined sub-crop zone. Recharge of the sub-cropping coal seam aquifers was modelled using MODFLOW-USG's Well Package (WEL) where recharge enters the model domain through imaginary injection wells located at the centre of the assigned cells.

Recharge from rainfall was also applied to Layer 1 of the model domain (representing the weathered/fractured rock aquifer) through MODFLOW-USG's Recharge (RCH) package. Recharge to layer 1 has been segregated into alluvium and weathered fracture rock. The indicative rate of recharge to the aquifer was calculated (Section 5.7) and refined during model calibration as is described in detail in Section 7.8. The calibrated rates of recharge were 0.40% and 0.25% of the annual rainfall for the alluvium and weathered fractured rock respectively, that is, 2.37 mm/year for the alluvium and 1.48 mm/year for the weathered/fractured rock aquifer and in line with the indicative calculations in Section 5.7. While these are at the low end of the range, they are considered reasonable given the clay rich nature of the soils of the area and the nature of the shallow aquifer and are typical of recharge rates for the Bowen Basin.

Recharge estimations were based on historical rainfall measured at meteorological stations around the area of the mine as discussed in Section 3.1.

7.5.2 Discharge

The shallow weathered / fractured rock aquifer was set in model Layer 1 along the Isaac River, as an outflow from the model using RIV cells and through other identified surface drainage lines. Discharge also occurs through the western boundary representing inflow into the Peak Downs open cut pits.

During the calibration and predictive runs water is also removed from the model domain to represent either gas drainage or inflow to mine workings. The calibration period contains the pilot gas drainage study and this water is removed from the appropriate model cells at the prescribed measured flow rates. Drainage for the mine workings occur during the predictive phase representing desaturation of the coal seams for longwall mining and also during the calibration phase for the development of the drift.

7.5.3 2008 Model

The calibrated rate of recharge was 1.0% of the annual rainfall, that is, 5.8 mm/year which is significantly higher than the new model.

SURFACT "drain" cells were set at the western edge of the model domain to simulate the lowered groundwater table induced by dewatering of the Peak Downs open cut mine, with drain hydraulic conductance of 1,000 m^2/day applied to these drain cells.

7.6 Hydraulic parameters

The hydraulic conductivity of the shallow weathered/fractured rock and Permian aquifers differs significantly. The hydraulic conductivity of the shallow weathered/fractured rock aquifer was assumed to be about 1.0 m/day based on the anecdotal information provided on stock and domestic bore yields and on airlift yields from the installed monitoring bores. Matrix (2008) assessed the hydraulic conductivity of the alluvium to be of the order of 3.6 m/day based on rising and falling head permeability tests; however, the impact on the alluvial aquifer will be limited by the hydraulic conductivity of the weathered/fractured rock aquifer which underlies it, and therefore, as stated, the alluvium has not been modelled separately for permeability, but does receive a slightly higher recharge.

The hydraulic conductivity of the Permian aquifers (coal seams) is much lower than the weathered/fractured rock and is considered to decline with depth of the seams. As discussed in Section 5.5, a decrease in hydraulic conductivity of the coal seams has been observed in the data from site. The decline in hydraulic conductivity of the seams was assumed to follow the exponential decline described in Section 5.5 based on a combination of hydraulic conductivity estimates obtained for each seam by Palgas, PSM and Sigra.

The interburden between the shallow weathered/fractured rock aquifer and the Moranbah Coal Measures and between the coal seams themselves consists of "tight" sandstone, siltstone, mudstone and minor coal. Hydraulic conductivity values used in the model were derived from PSM and recent packer test data, as described in Section 5.5. The vertical hydraulic conductivity was defined as two orders of magnitude lower than the horizontal hydraulic conductivity of the Q seam depth relationship.

The assessed hydraulic parameters of the model domain as well as the 2008 values are as shown in Table 7.2.

Table 7.2 Hydraulic parameters

Layer	Parameter	Updated value	2008 Model value
Layer 1 (alluvium, shallow weathered/fractured rock aquifer)	Horizontal Hydraulic Conductivity kh (m/day)	1	1
	Vertical Hydraulic Conductivity kv (m/day)	0. 005	0.00005
	Specific Yield S_y	0.25	0.25
	Specific Storage S_s	0.001	0.001
Layers 2 - 4 Layers 6 - 8 Layers 10 - 12 Layers 14 - 16 Layer 18 (Permian interburden)	Horizontal Hydraulic Conductivity kh (m/day)	(as per equation, see Section 5.5)	-
	Vertical Hydraulic Conductivity kv (m/day)	Kh * 0.1	-
	Specific Yield S_y	0.0001	-
	Specific Storage S_s	1×10^{-5}	-
Layer 5 (Q coal seam)	Horizontal Hydraulic Conductivity kh (m/day)	(as per equation, see Section 5.5)	Layer 2: 0.2 m/day at surface level declining to 1.5×10^{-3} at a depth of approx. RL-660 m.
	Vertical Hydraulic Conductivity kv (m/day)	Kh * 0.1	Maximum of 5.9×10^{-4} at surface level and declining to 1.5×10^{-6} at a depth of approx. RL-660 m.
	Specific Yield S_y	0.01	0.01
	Specific Storage S_s	$1x10^{-5}$	1×10^{-6}
Layer 9 (HCU coal seam)	Horizontal Hydraulic Conductivity kh (m/day)	(as per equation, see Section 5.5)	Layer 3: 0.2 m/day at surface level and declining to 6.9×10^{-3} at a depth of approx. RL-770 m.
	Vertical Hydraulic Conductivity kv (m/day)	Kh * 0.1	Maximum of 3.1×10^{-4} at surface level and declining to 6.9×10^{-6} at a depth of approx. > RL-770 m.
	Specific Yield S_y	0.01	0.01
	Specific Storage S_s	1×10^{-5}	1×10^{-6}

Layer	Parameter	Updated value	2008 Model value
	Horizontal Hydraulic Conductivity kh (m/day)	(as per equation, see Section 5.5	Layers 4 and 5: 0.2 m/day at surface level and declining to 1.8 x 10^{-3} at a depth of approx. RL-800 m.
Layers 13 and 17 (HCL coal seam, DY coal seam)	Vertical Hydraulic Conductivity kv (m/day)	Kh * 0.1	Maximum of 7.9 x 10^{-5} at surface level and declining to 1.8 x 10^{-6} at a depth of approx. RL-800 m. DY: 0.2 m/day at surface level and declining to 6.0 x 10^{-6} at a depth of approx. RL-880 m. Maximum of 2.4 x 10^{-7} at surface level and declining to 6.0 x 10^{-9} at a depth of approx. RL-880 m.
	Specific Yield S_y	0.01	0.01
	Specific Storage S_s	1 x 10^{-5}	1 x 10^{-6}

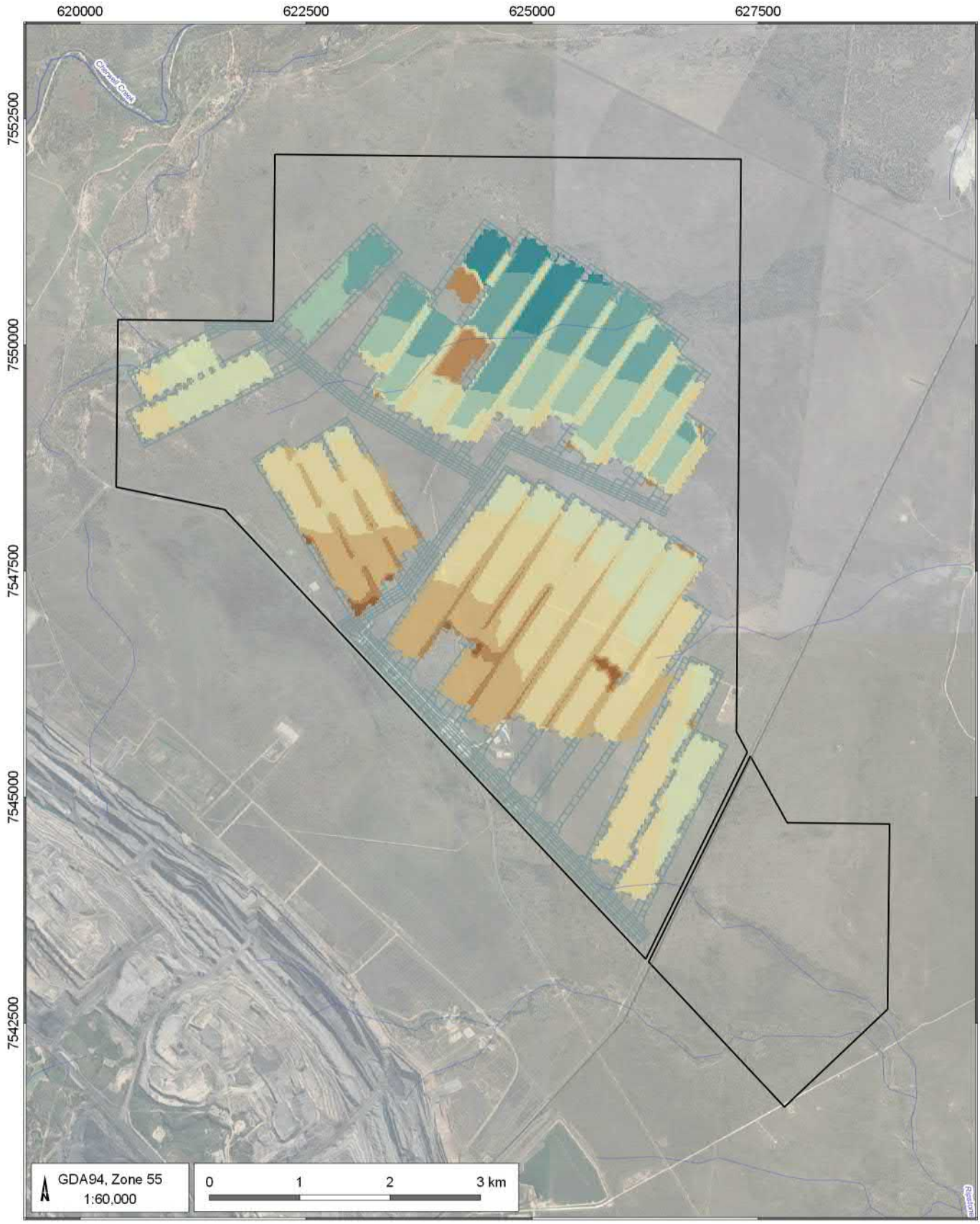
7.7 Fracture height and fracture representation

The nominal fracture height assumed in previous modelling was updated for this assessment, recent studies have demonstrated that fracture height can vary with overburden thickness. The Ditton-Merrick equation (Ditton and Merrick, 2014) was used to determine the height of connected fracturing. This approach ensured consistency with reports complied by Mine Advice (MA) (2019) and Gordon Geotechniques (2021). The Ditton-Merrick approach provides several equations based either geometry or geology considerations. While MA presented the 50th percentile (most likely) and the 95th percentile (credible worst case) estimates of fracture height based on the Ditton-Merrick geometry model, the more conservative 95th percentile geology model was applied in this work to safeguard against underprediction of potential impacts.

A contour map of the fracture height distribution applied in the numerical groundwater model is provided on Figure 7.2 and range between 140 m to 280 m comparing to the 105 m to 275 m used in the 2008 model. The resulting fracture heights remained well below the ground surface (refer to Figure 7.3) between 100 m and 370 m, and consequently there was no need to simulate surface cracking in the model.

In MODFLOW-USG, the development of the fracture zone above the mined longwall sections was simulated by increasing the hydraulic conductivity of the model layers above the coal seam, within the fracture height calculated for each mined model cell. Cells adjacent to the top of coal seam were allocated the greatest increase in hydraulic conductivity, while cells at the top of the fracture zone were allocated minimal increases.

The shallowest depth of extraction in the Eagle Downs area is 270 m in the western Harrow Creek Upper Seam area. As such, connective cracking to the surface is not anticipated as illustrated by the simplified conceptual cross-section on Figure 7.4. As mentioned earlier, the continuous subsurface fracturing will not extend to the base of the shallow aquifer, which farm bores suggest does not extend beyond 80 m depth, as simulated in the model.



LEGEND

- Rail
- Watercourse
- HCU longwall layout
- Eagle Downs project area

Fracture height above HCU Seam (m)

- 140 - 175
- 175 - 200
- 200 - 225
- 225 - 250
- 250 - 260
- 260 - 270
- 270 - 280

Eagle DownsGIA for EA Amendment (EDM5000.001)

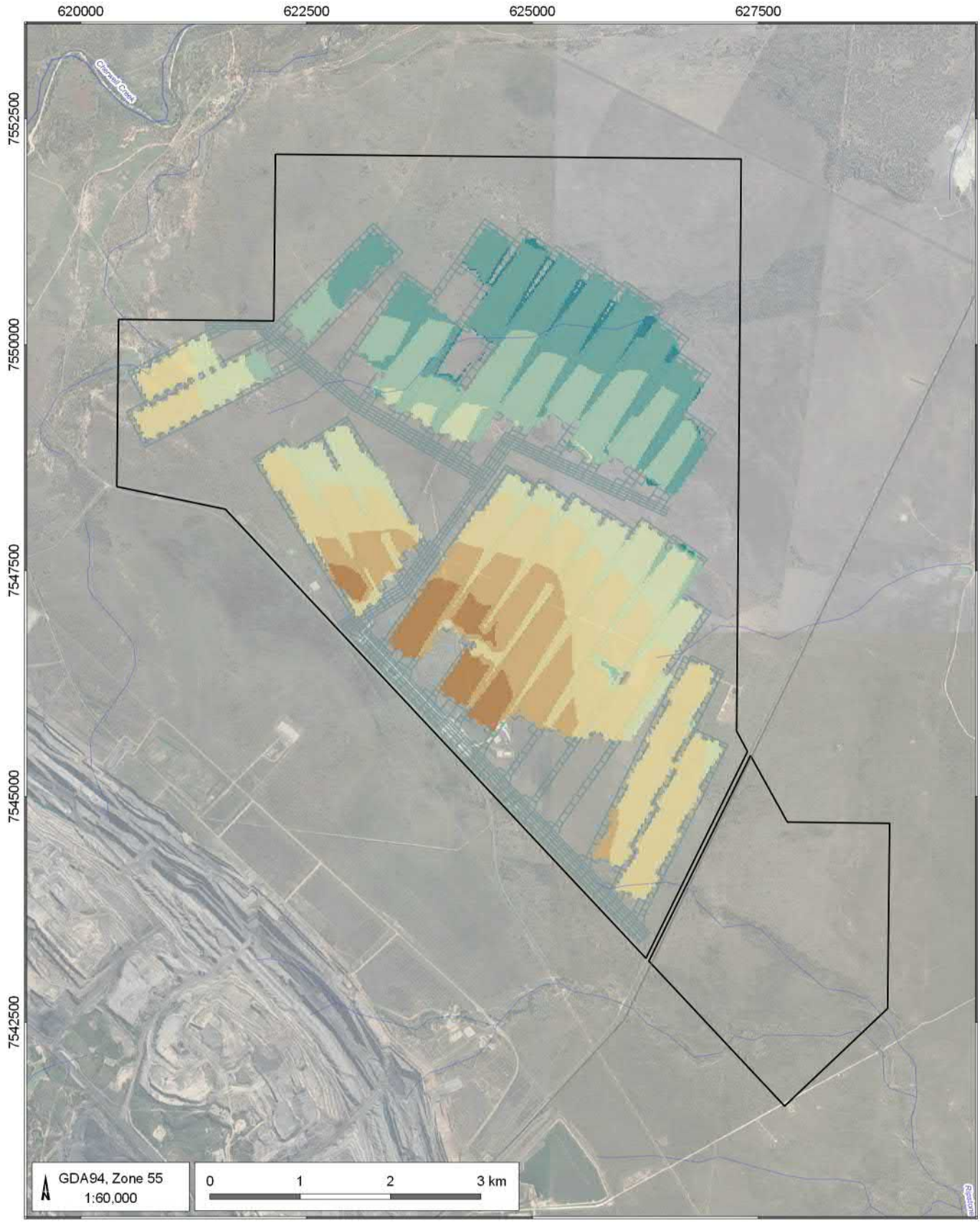
Fracture height above the HCU Coal Seam

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FIGURE No: **7.2**

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LEGEND

- Rail
- Watercourse
- HCU longwall layout
- Eagle Downs project area

Depth to top of fracture zone (m)

- 100 - 125
- 125 - 150
- 150 - 200
- 200 - 250
- 250 - 300
- 300 - 350
- 350 - 370

Eagle DownsGIA for EA Amendment (EDM5000.001)

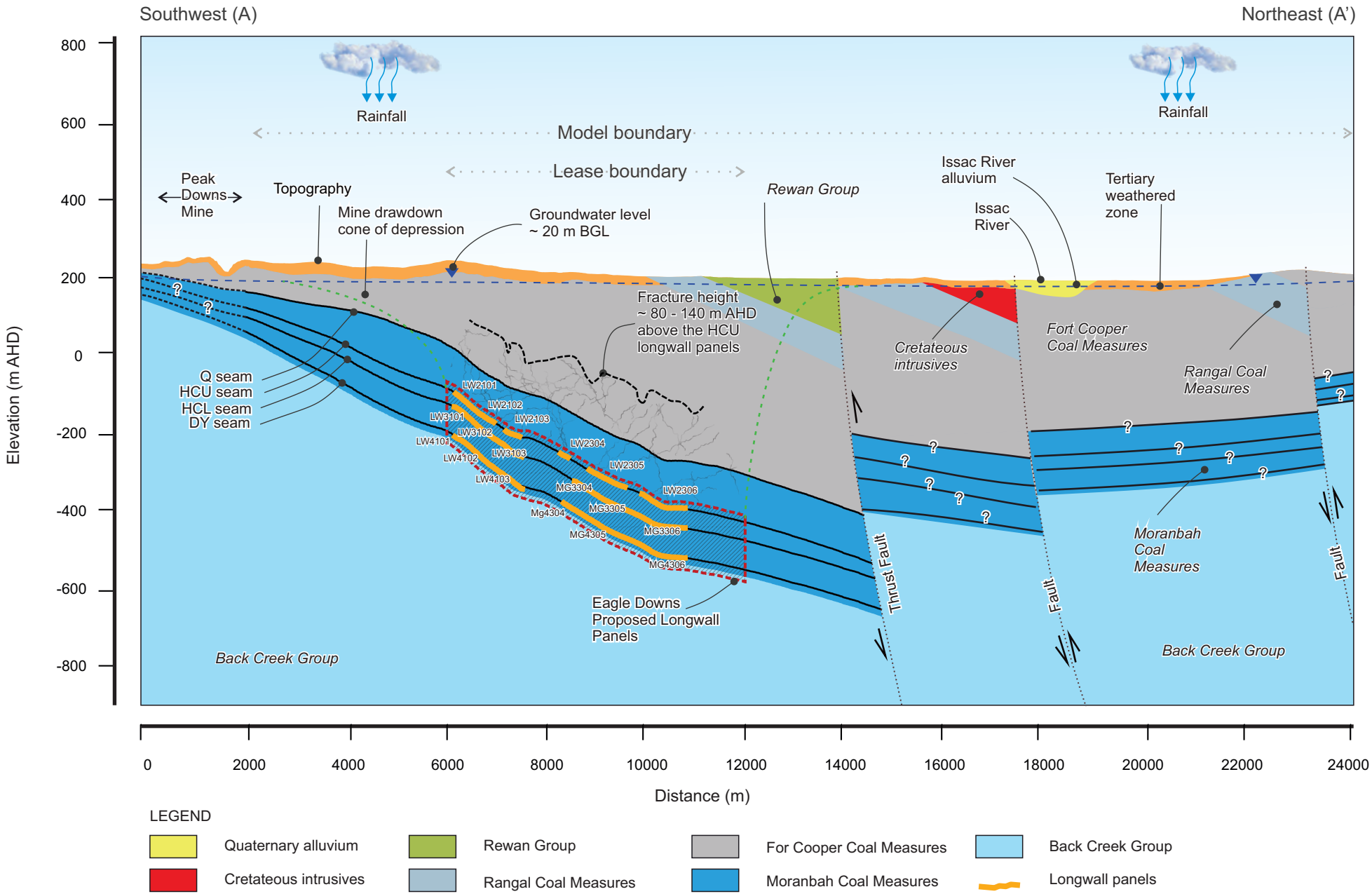
Depth to top of fracture zone

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FIGURE No: **7.3**

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Fracture height conceptual illustration

Figure - 7.4

Eagle Downs GIA for EA Amendment (EDM5000.001)

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7.8 Model calibration

The objective of model calibration was to reproduce measured groundwater levels in Layers 1 to 18. The accuracy of the model calibration depends on the quality of calibration parameters, and the data defining the model domain such as aquifer geometry, boundaries, hydraulic properties and stresses imposed on the aquifer. It is considered that the horizontal and vertical extent of the model and model boundaries are sufficiently well defined to construct and calibrate the Eagle Downs groundwater model.

Model calibration was undertaken to fit the model parameters to the observed groundwater data. To calibrate the model, it was first run in steady state to provide initial pre-mining conditions, followed by transient quarterly stress periods from January 2010. The model included simulation of historic gas drainage from June 2012 through July 2015, and the early development of the Drift from February 2013 through October 2015.

The model was calibrated by adjusting aquifer parameters, gas drainage and recharge rates to best fit the observed and simulated water levels. With regard to gas drainage, a single multiplier was used to increase the pumping rate and replicate the additional depressurisation in water level due to gas pressure changes. Automated parameterisation software (PEST, Doherty 2010) was used to determine optimal hydraulic parameters and recharge.

7.8.1 Observation data

The model simulated water levels in available monitoring bores and VWPs within the coal measures. 30 monitoring points (Table 7.3) were used to calibrate the model, including:

- 3 VWP locations from the EDMCP monitoring network; and
- 25 exploration holes with available water level data.

Table 7.3 Summary of calibration data points

Bore ID	Easting	Northing	Comment
E795006	622097.8	7550179.8	Exploration hole
E795009	624105.7	7546179.2	Exploration hole
E795012	625112.9	7546175.1	Exploration hole
E795013	625111.1	7545181.7	Exploration hole
E795015	623360.8	7548176.9	Exploration hole
E795016	626123.6	7547179.6	Exploration hole
E795021	625488.2	7546073	Exploration hole
E795022	624069.4	7548885.9	Exploration hole
E795023	622646	7547476.1	Exploration hole
E795024	621238.6	7548885.5	Exploration hole
E795025	621268.9	7548910.9	Exploration hole
E795026	623323.3	7546785.4	Exploration hole
E795027	624038	7547496.3	Exploration hole
E795028	624688.3	7548160.1	Exploration hole
E795029	622627.9	7550293.8	Exploration hole
E795031	624070	7546065.3	Exploration hole
E795032	624075	7546075.8	Exploration hole

Bore ID	Easting	Northing	Comment
E795033	625488	7544654.6	Exploration hole
E795036	622686	7547381.7	Exploration hole
E795038	622594.8	7550302.8	Exploration hole
E795057	623683.79	7549391.23	Exploration hole
E795058	623253.87	7551540.88	Exploration hole
E795059	627240.4	7549946.32	Exploration hole
E795060	626507.48	7544152.18	Exploration hole
E795061	628490.55	7542693.29	Exploration hole
F1	618483	7555539	-
F2	618975	7552309	-
F3	621972	7552893	-
F5	622899	7558531	-
F7	627698	7556755	-
F9	623671	7549482	-
F13	627200	7546952	-
F14	628737	7546686	-
F16	626023	7542786	-
cd12	617377	7559710	-
VWP Hydro 2 (ED0224)	625832	7546422	VWP location with multiple sensors
VWP Hydro 5 (ED0227)	626202	7548871	VWP location with multiple sensors
VWP Hydro 6 (ED0228)	625837	7546426	VWP location with multiple sensors

7.8.2 Calibration results

Figure 7.5 presents the observed and simulated groundwater levels graphically as a scattergram for the transient calibration, while the historic calibration hydrographs form Appendix C. The historic calibration hydrographs, showing the fit between modelled and observed groundwater levels from 2010 to 2015.

Transient calibration to VWP response from the pilot gas drainage program was difficult to reliably simulate. Groundwater abstraction rates were made available from the Palgas work; however, this volume is water only. The actual gas drainage that has occurred during the pilot study has also contributed to a depressurisation in the coals seams and it is this that is contributing most to the observed declines in the VWP transient data. The volumes of groundwater pumped are very small and therefore to get the model to fit this data would require the model to calibrate to parameter ranges outside of the observed. One methodology was devised to increase the pumping to replicate to some extent the additional depressurisation observed in the water level responses. A single multiplier was used to increase the pumping, but this method was problematic for model convergence, particularly using the permeability equations provided by Palgas. A number of multipliers were tried, however we found that 5x provided some semblance of a match in a couple of bores.

It should also be noted that when applying the multiplier some of the wells became dry. The reduced pumping that occurred from this was simulated automatically within the model, therefore the total extraction using a 5 x multiplier does not equate to 5 x the original pumping volume extracted.

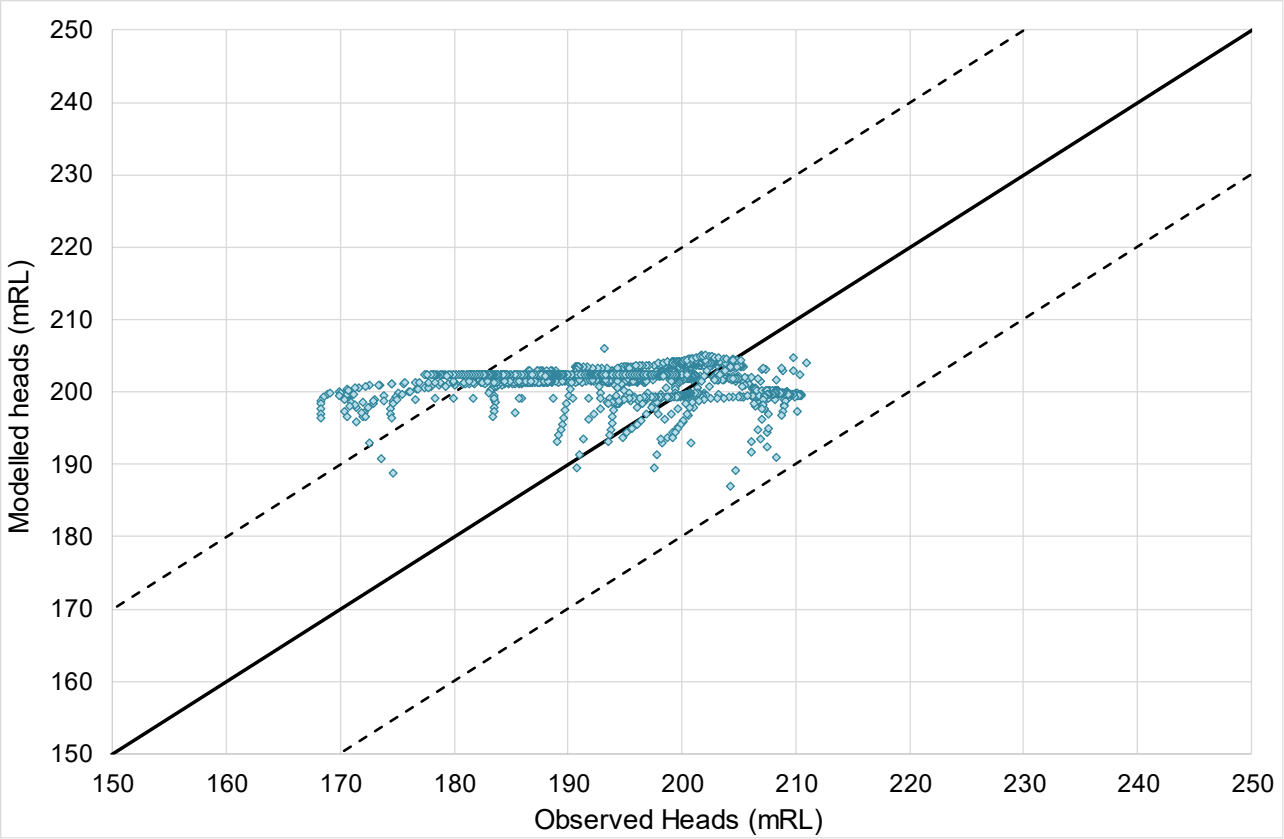
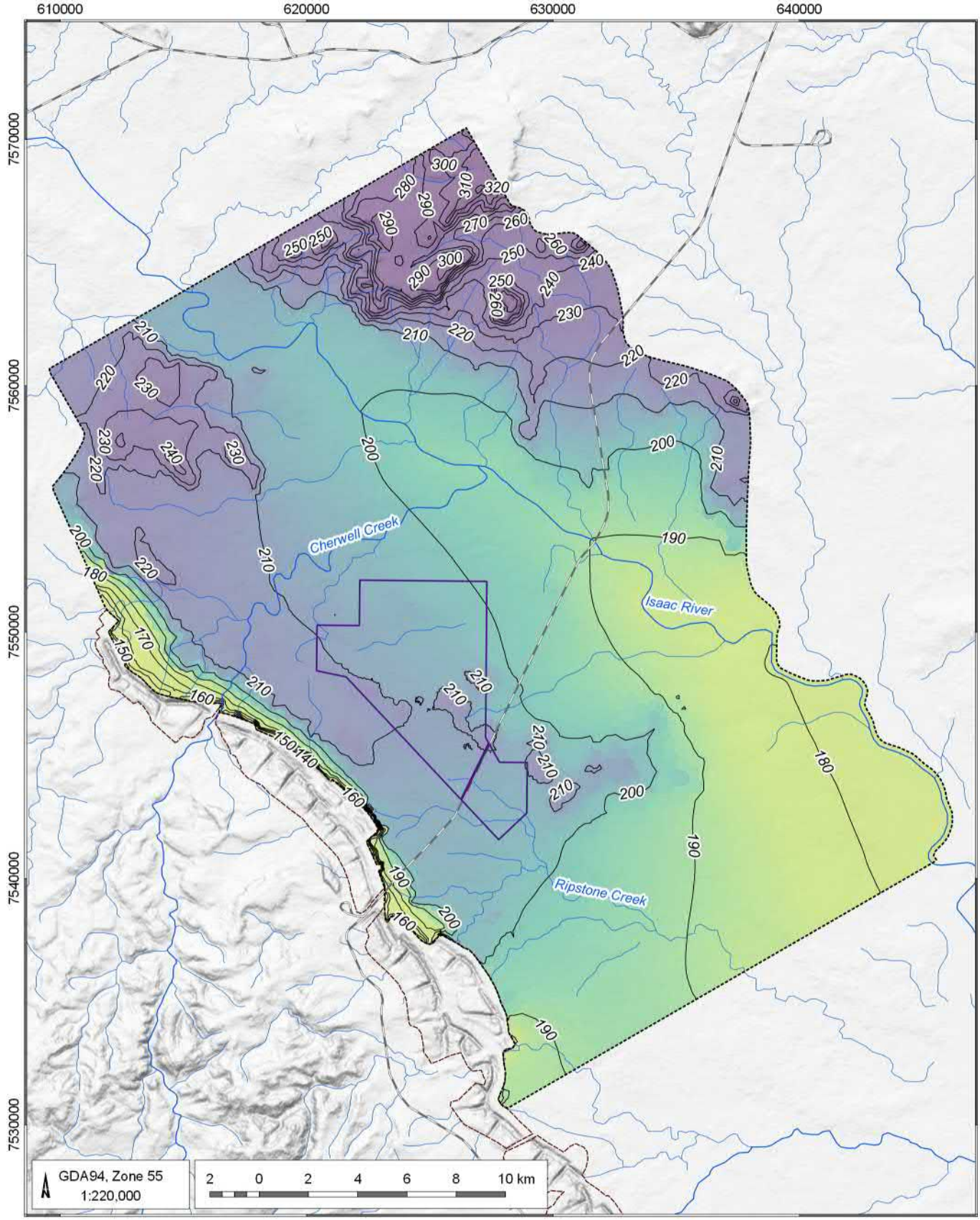


Figure 7.5 Transient calibration – modelled vs observed groundwater levels

The flat nature of the data spread above indicates that the observation data has more variability than the model is able to predict. This is because the monitoring data is a response to real-world two-phase flow at a very local level, while the model is a single water phase and it is focused more on regional impacts.

7.8.3 Calibrated heads

The calibrated heads from the steady state calibration model are presented in Figure 7.6 and Figure 7.7 for the surface aquifer (weathered/fractured rock) and the HCU coal seam. The figures show groundwater generally flows southeast to the local drainage systems. With Peak Downs in operation, the steady state has predicted local drainage back towards the open cut pits.



LEGEND

- Eagle Downs project area
- Peak Downs mine boundary
- Rail
- Major drainage
- Minor drainage
- Model extent
- Heads contour (10m interval, mAHD)

Eagle DownsGIA for EA Amendment (EDM5000.001)

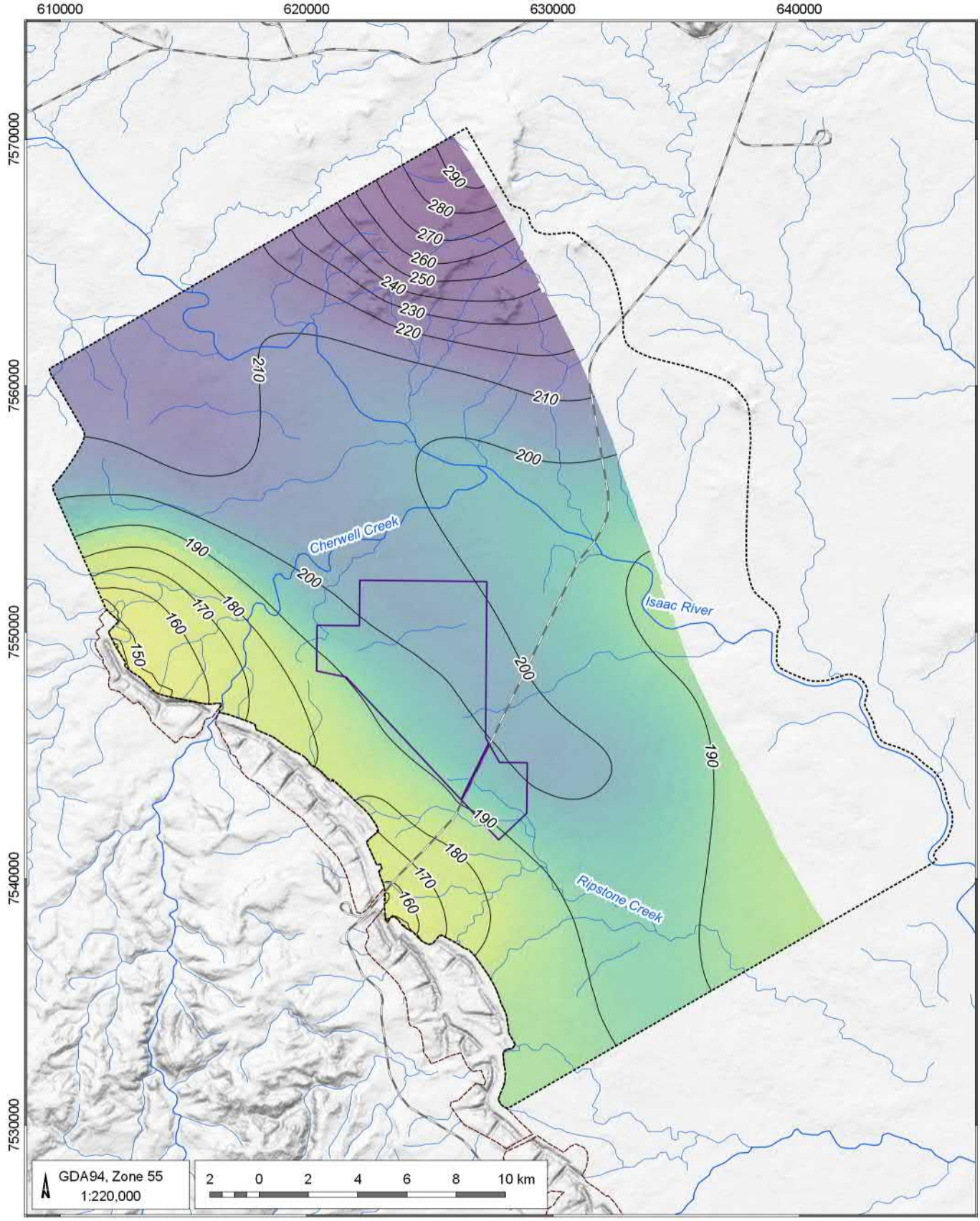
Steady state predicted groundwater levels – shallow aquifer

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FIGURE No: **7.6**

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LEGEND

- Eagle Downs project area
- Peak Downs mine boundary
- Rail
- Major drainage
- Minor drainage
- Model extent
- Heads contour (10m interval, mAHD)

Eagle DownsGIA for EA Amendment (EDM5000.001)

Steady state predicted groundwater levels - HCL seam

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DATE 24/03/2022

FIGURE No: **7.7**

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7.8.4 Calibrated hydraulic properties

Table 7.4 summarises the calibrated hydraulic conductivity and storage parameters for each of the hydrostratigraphic units within the model domain.

Table 7.4 Calibrated hydraulic properties

Model layer (s)	Lithology	Horizontal hydraulic conductivity Kh (m/day)	Vertical hydraulic conductivity factor (Kv:Kh)	Specific Yield Sy (%)	Specific Storage (m-1)
1	Alluvium	25	0.03	0.1	0.001
1	Weathered regolith	1	0.05	0.05	0.001
2,3,4,6,7,8,10,11, 12,14,15,16,18	Interburden	0.0034*	0.5	0.001	1E-6
5	Q seam	0.0344*	0.5	0.01	1E-5
9	HCU coal seam	0.381*	0.5	0.01	1E-5
13	HCL coal seam	1.64*	0.5	0.01	1E-5
17	DY coal seam	1.64*	0.5	0.01	1E-5

Note: * This is the hydraulic conductivity at ground level. The hydraulic conductivity at each cell was calculated using equations provided in section 5.5.

7.8.5 Water Budget

The mass balance error, that is, the difference between calculated model inflows and outflows at the completion of the steady state calibration was 0.00%. This value indicates that the model is stable and achieves an accurate numerical solution. Table 7.5 shows the water budget for the steady state (pre-mining) model stress period.

Table 7.5 Model budgets – steady state

Parameter	In (m^3/day)	Out (m^3/day)	In - Out (m^3/day)
Rainfall recharge	2440	0	2440
River	0	1911	-1911
Wells	0	0	0
General head boundary	37	565	-528
Total	**2477**	**2477**	**0**

The water budget indicates that recharge to the groundwater system within the model averages 2.4 ML/day, with approximately 1.9 ML/day being discharged via surface drainage, and 0.5 ML/day lost to general head boundary (as inflow to Peak Downs Mine). Table 7.6 shows the average water budget for the transient model stress periods.

Table 7.6 Average model budgets – transient

Parameter	In (m^3/day)	Out (m^3/day)
Rainfall recharge	2446	0
River	0	1909
Wells	0	464
Drains	0	3198
General head boundary	94	464

8 Groundwater model predictions

Following the calibration period, the model simulation was extended to include the remainder of the drift development followed by mining of the HCU, HCL and DY seams. Mining was complete by mid-2068, with the simulation finished at the close of 2075. The model predictions were made monthly for first ten years of mining then quarterly for the remainder of the simulation. The development of the gate roads and longwall panels was aligned to a mining schedule provided by South32.

8.1 Mine inflows

The volume of water predicted to flow into the underground workings was calculated per model stress period using the drain boundary condition in MODFLOW-USG. As mentioned in Section 7.3, the drain boundary condition represents the dewatering of the coal seams in the model and thus provides a prediction of the total inflow from the seam and overlying interburden. A lower volume would be expected to arrive at a sump for actual pumping, as the model prediction includes moisture that would either exit the mine through the ventilation system or be removed as moisture in the mined coal.

The predicted inflows peak after 10 years of mining, with 82 L/s expected to enter the underground workings, before declining to the end of the DY seam (Figure 8.1). A detailed view of the first 10 years of mining can be observed in Figure 8.2. The maximum predicted inflow from the numerical groundwater model used for the EIS and approved EA (AGE, 2008) was in the order of 52 L/s. The main reason for the higher predicted inflow for the new proposed mine plan is because of the improved conceptual model, fractured height predictions and longwall layout. It is considered the changes in model setup for this latest model version provide more realistic inflows to the seams than previous iterations, namely for the changes to interburden and the variation in vertical hydraulic conductivity within the fracture zone above the longwalls.

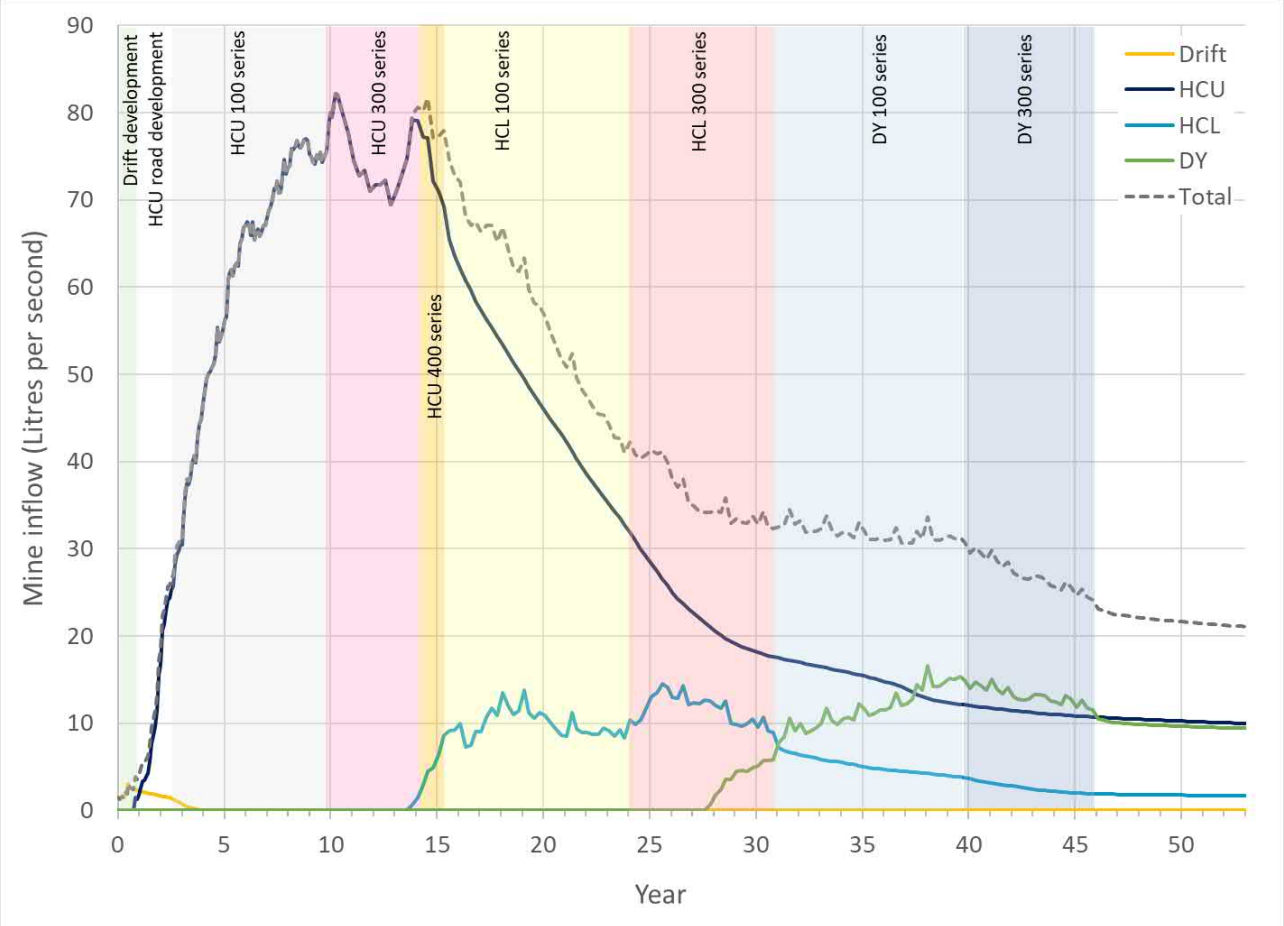


Figure 8.1 Total predicted inflow from coal seams

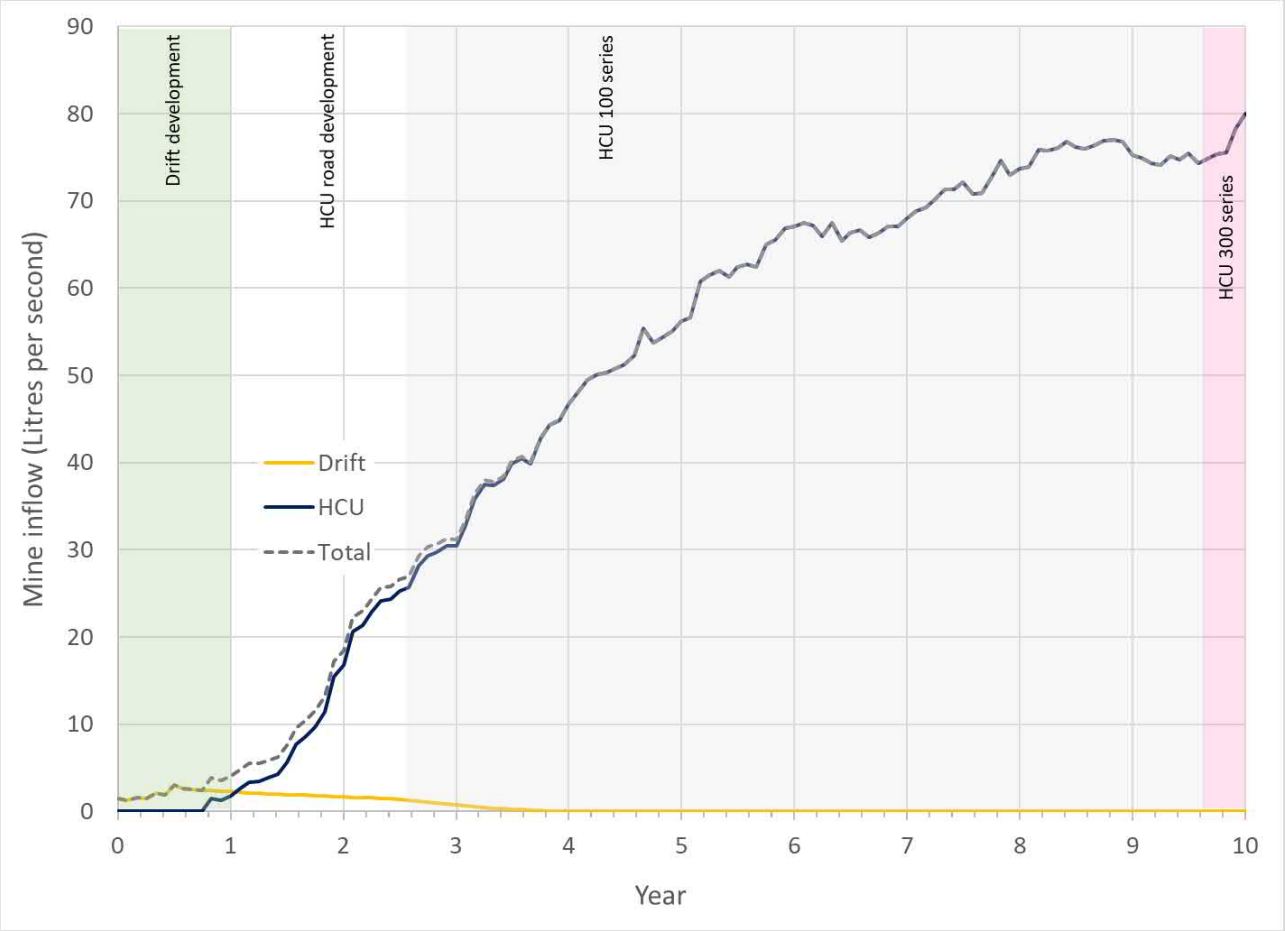


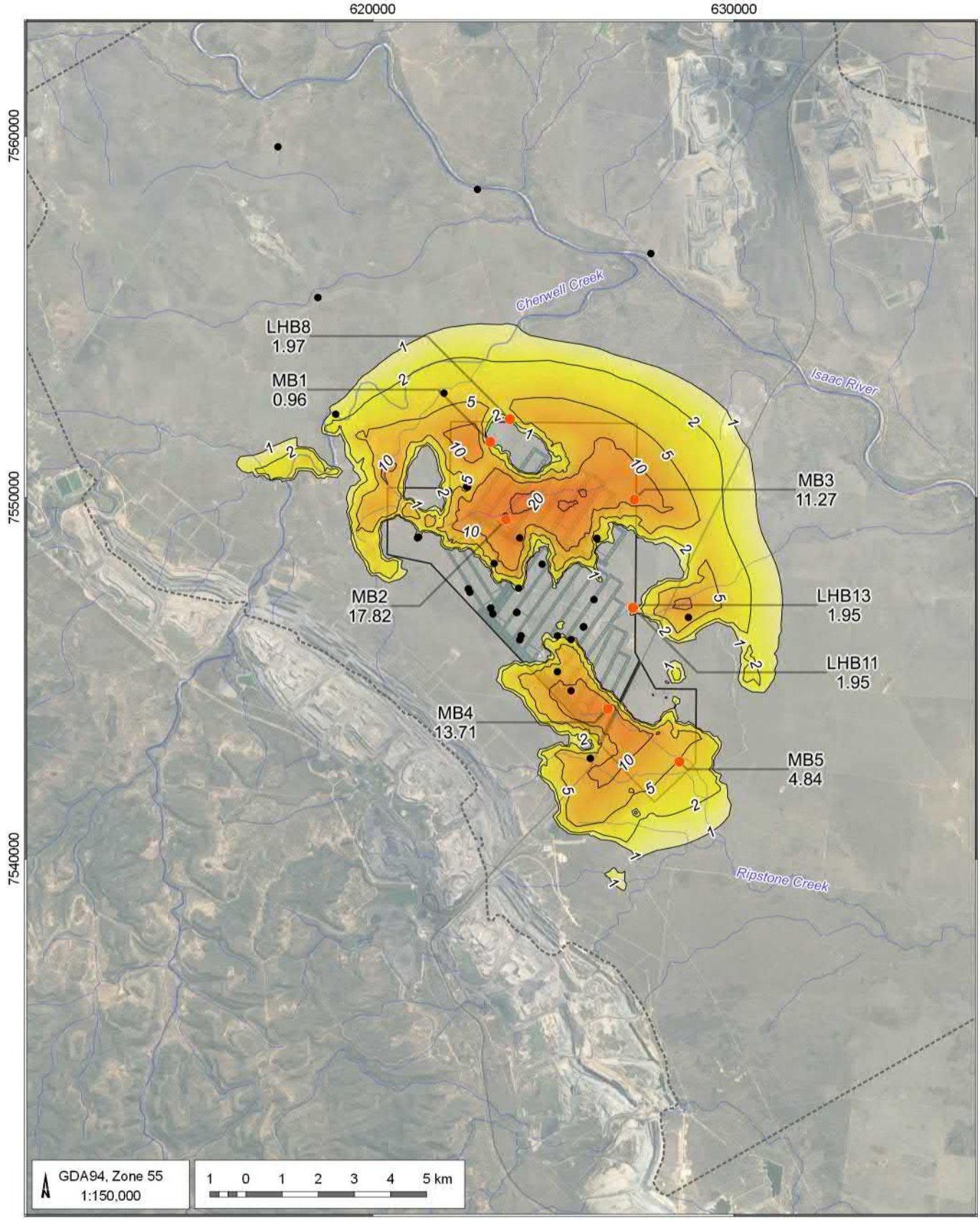
Figure 8.2 Predicted inflow for the first 10 years of mining

8.2 Drawdown during mining

Figure 8.3 to Figure 8.6 show the maximum drawdowns predicted to occur during mining in layers 1 (weathered tertiary strata), 9 (HCU seam), 13 (HCL seam) and 17 (DY seam). The shallow aquifer (Figure 8.3) experiences minor drawdown (~10 to 20 m) where near surface tertiary strata is saturated over the north and south-east of the mine footprint. This is expected since the height of fracturing above the coal seam does not extend to the tertiary strata, limiting connectivity between the shallow aquifer and deep coal seam layers.

Figure 8.4 to Figure 8.6 show that similar drawdown extents occur in each of the coal seams. The maximum predicted drawdown occurs within the mine footprint, reducing with increasing distance from the mine to 1 m drawdown around 4 km from the nearest panel.

The predicted drawdown in the EIS groundwater assessment (AGE, 2008) was less than the current predictions for the shallow weathered aquifer. The maximum predicted drawdown in the weathered aquifer was about 5 m (refer to Figure 9.2 in the next section) and it can be seen from Figure 8.3 that the maximum drawdown is in the order of 20 m for the updated numerical simulations. The zone of influence, based on the 1 m drawdown contour line for Layer 1 is also slightly bigger in the updated model when comparing to the 2008 model predictions.



LEGEND

- Observation bore
- EA monitoring bores
- Rail
- Major drainage
- Minor drainage
- Eagle Downs project area
- Model domain

Bore ID : MB4
Predicted maximum drawdown (m) : 13.71

- Drawdown contour

Drawdown (m)

- 0
- 1
- 2
- 5
- 10
- 20
- 50

Eagle Downs GIA for EA Amendment (EDM5000.001)

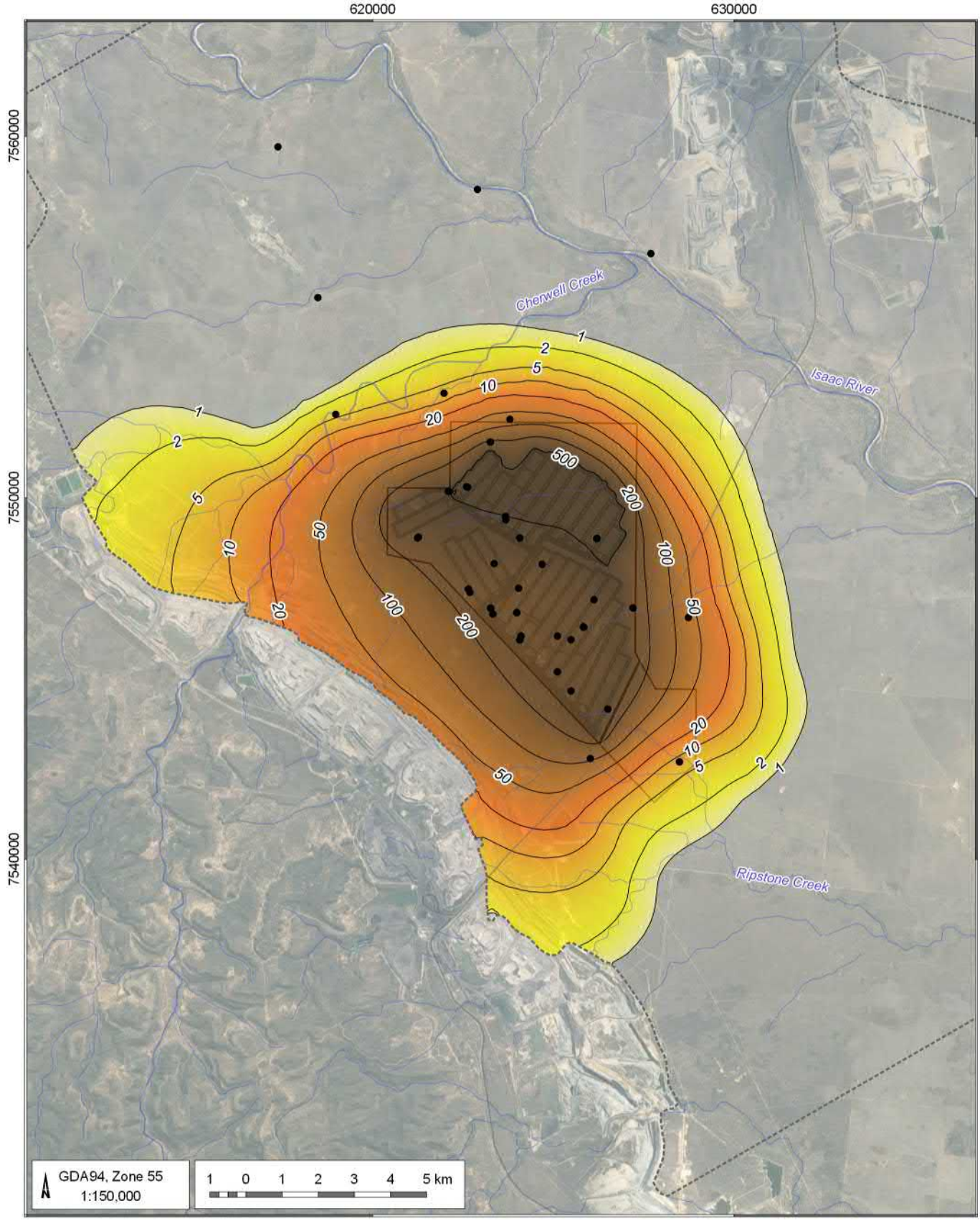
Maximum drawdowns in layer 1 (Weathered Tertiary)

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FIGURE No: **8.3**

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LEGEND

- Observation bore
- Rail
- HCU longwall layout
- Major drainage
- Minor drainage
- Eagle Downs project area
- Model domain
- Contour line

Drawdown (m)

0	20
1	50
2	100
5	200
10	500

Eagle Downs GIA for EA Amendment (EDM5000.001)

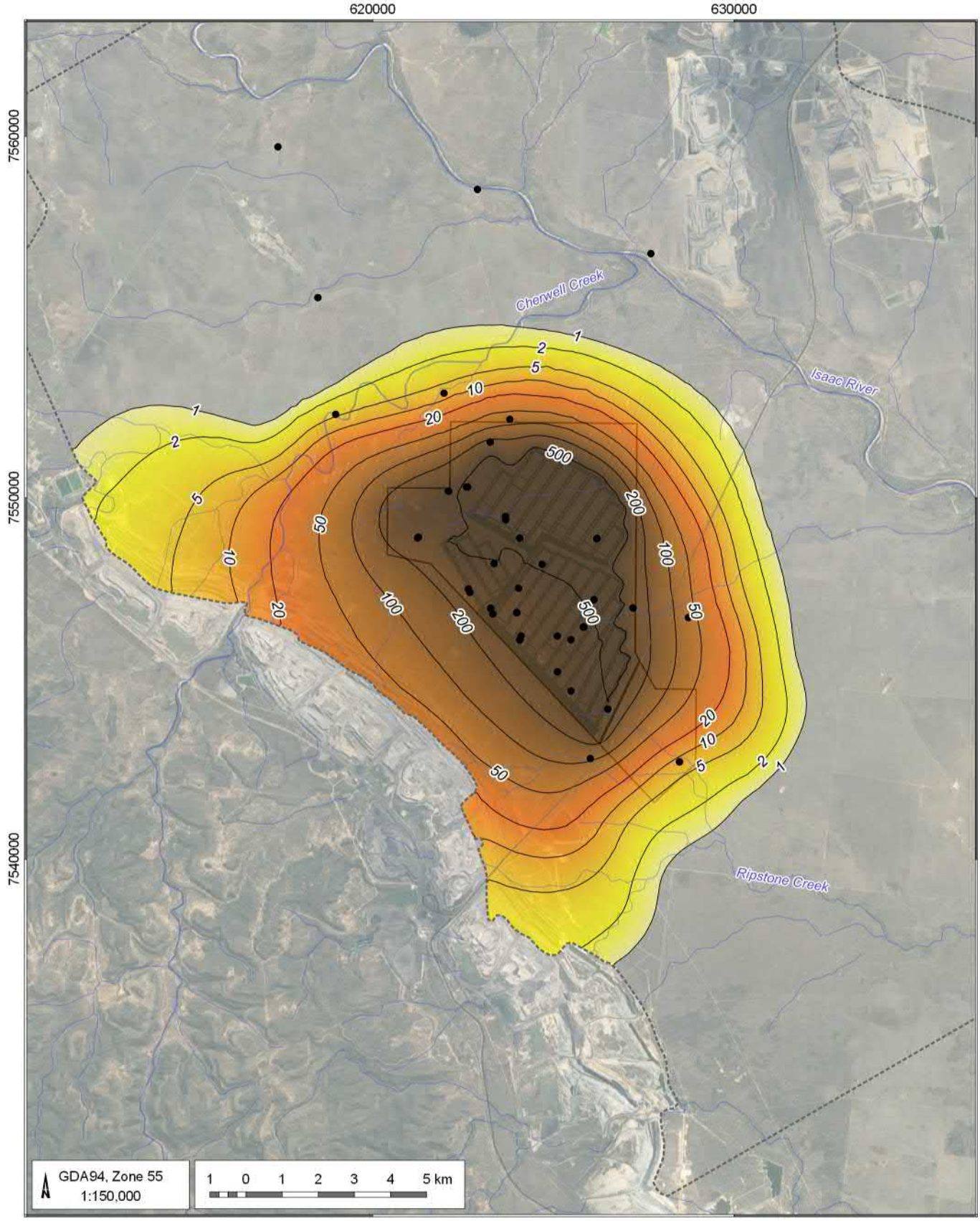
Maximum drawdowns in layer 9 (HCU seam)

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FIGURE No: **8.4**

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LEGEND

- Observation bore
- Rail
- Major drainage
- Minor drainage
- HCU longwall layout
- Eagle Downs project area
- Model domain
- Contour line

Drawdown (m)

0	20
1	50
2	100
5	200
10	500

Eagle Downs GIA for EA Amendment (EDM5000.001)

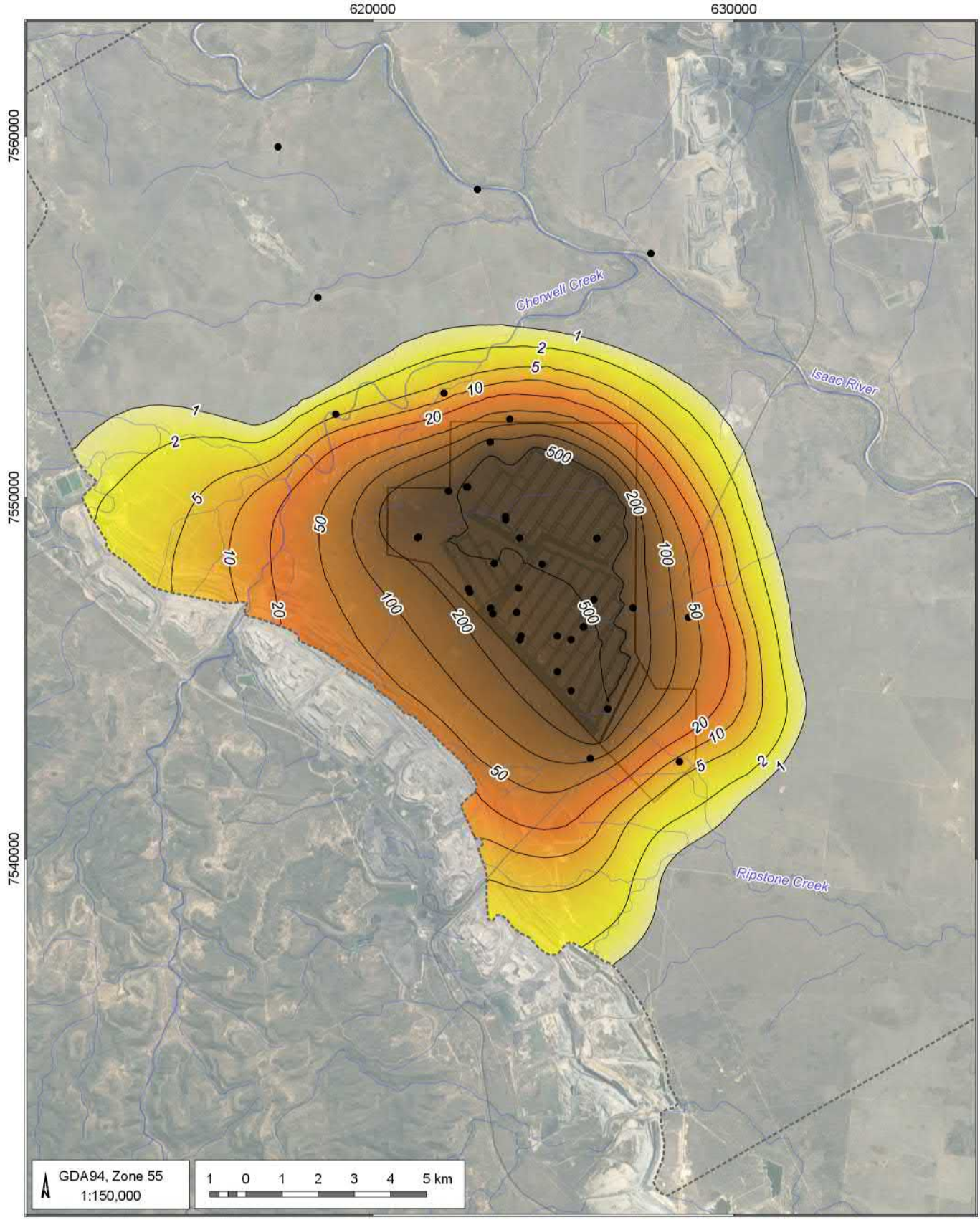
Maximum drawdowns in layer 13 (HCL seam)

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FIGURE No: **8.5**

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G:\Projects\EDM5000.001_Eagle DownsGIA for EA Amendment\3_GIS\Workspaces\001_Deliverable1\08.03_EDM5000.001_Maximum drawdowns in layer 1 (weathered tertiary).qgs



LEGEND

- Observation bore
- Rail
- Major drainage
- Minor drainage
- Dysart longwall layout
- Eagle Downs project area
- Model domain
- Contour line

Drawdown (m)

0	20
1	50
2	100
5	200
10	500

Eagle Downs GIA for EA Amendment (EDM5000.001)

Maximum drawdowns in layer 17 (DY seam)

AGE

DATE 03/02/2022

FIGURE No: **8.6**

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8.3 Cumulative drawdown

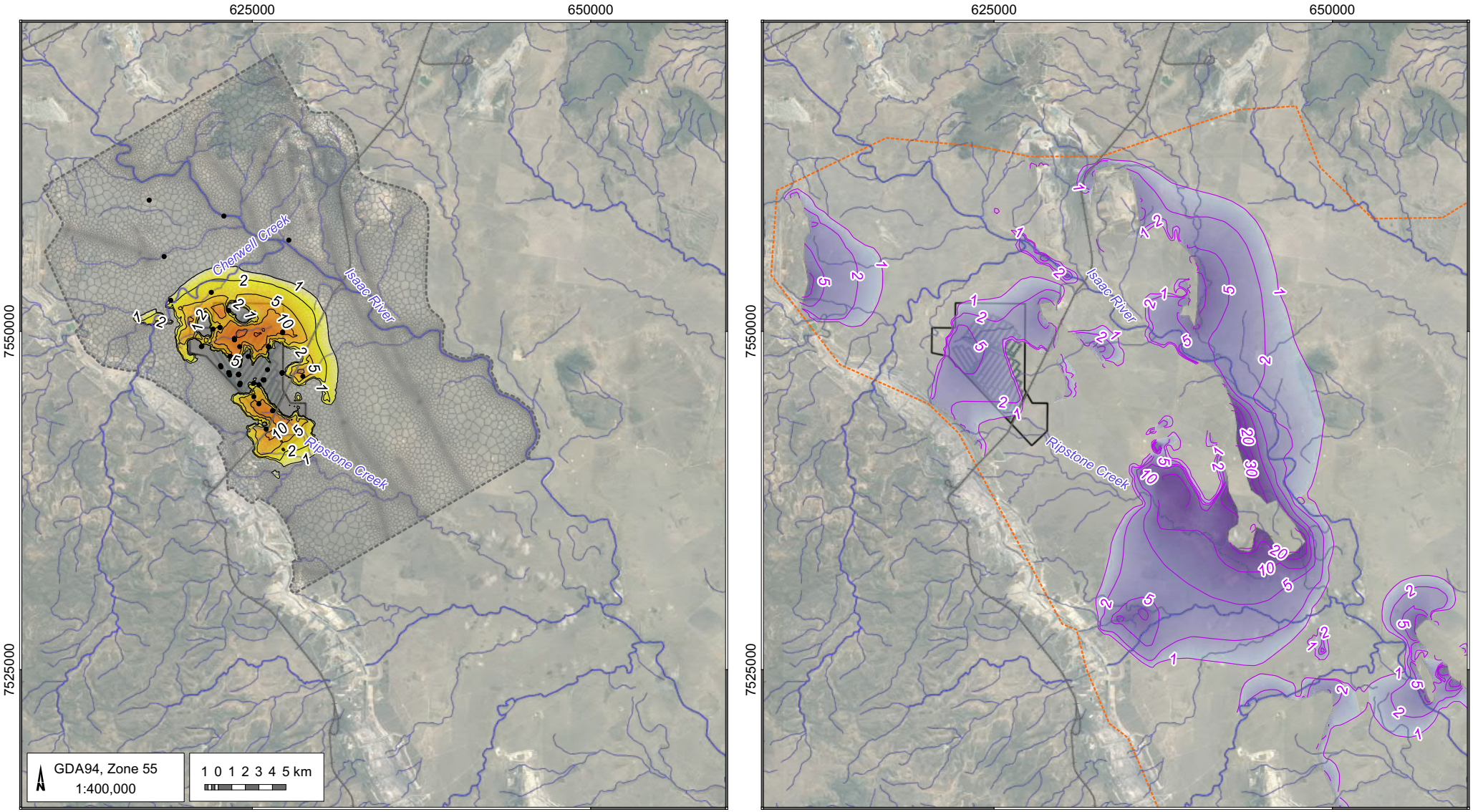
The impact of the Peak Downs open cut mine to the west has been simulated in the model by means of a general head boundary as discussed in Section 7.3. However, transient drawdown of the Peak Downs mine was not included in the model. While drawdown in the coal seam aquifers intersects, the mines are sufficiently distant to prevent cumulative impacts to the shallow aquifer.

As discussed in Section 3.3, there are several existing mines and proposed mine projects in the area to the north-east, east and south. These mines exploit the shallower Fort Cooper and Rangal Coal Measures, situated above the MCM, and it is expected that minimal interaction between the mines, which are predominantly open cut operations, will occur.

Figure 8.7 represents a combination of the Project groundwater model drawdown predictions and drawdown predictions inferred from regional studies for the weathered tertiary. The Winchester South GIA (SLR, 2021) indicates a maximum drawdown of around 5 m at Winchester South (Figure 8.7), and it is not expected that significant cumulative drawdown resulting from mining at Eagle Downs would occur.

EDM model predictions

Inferred from SLR 2021



LEGEND

- Observation bore
- Rail
- Major drainage
- Minor drainage
- Eagle Downs project area
- Model domain
- Model mesh
- SLR model boundary 2021

Drawdown contour (m)

- EDM model predictions
- Inferred from other studies

Drawdown (m)

0
1
2
5
10
20

Drawdown (m)

0
1
2
5
10
20

AGE

Eagle Downs GIA for EA Amendment (EDM5000.001)

Maximum cumulative drawdown in regolith (regional drawdown inferred from SLR, 2021)

DATE
17/02/2022

FIGURE No:
8.7

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Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
G:\Projects\EDM5000.001_Eagle DownsGIA for EA Amendment\3_GIS\Workspaces\001_Deliverable1\08.07_EDM5000.001_Maximum cumulative drawdown in regolith (regional drawdown inferred from SLR - 2021).qgs

9 Groundwater Impact Assessment

9.1 Water licence requirements

Groundwater inflow to the mining operations will occur from the coal seams and from mined longwall panels in overlying seams where goafing and fracturing connects the panels to the current mine workings. Therefore, there will be a progressive increase in dewatering volumes due to the cumulative inflow from the seam being mined and seepage via the goaf from the overlying seams and mined areas during active mining. Numerical modelling has shown that dewatering volumes will range from a few litres per second at start up, to about 82 L/s (2593 ML/year) at completion of mining the HCU 100 series panels, with the water being contributed by the unmined Q Seam, the HCU Seam and to a lesser extent, the interburden. Following the peak, inflow will decline to the end of year 50, at which time the mine will close.

The actual volume of water pumped from the mine may be less than the total predicted inflows, as some water will be removed as moisture entrained in the coal and some will be lost by evaporation to the mine ventilation system. To counter these losses, there will also be water added to the underground for use by the mining machinery. While it has been assumed that all water from overlying mined areas will drain via the goaf to the actively mined seam, some water may be retained in pockets in the prior workings, and whether this proves to be the case will not be evident until mining commences.

9.2 Potential Impacts of Subsidence, Surface Cracking and Subsurface Cracking from Longwall Mining

As discussed in Section 6, the shallowest depth of extraction in the Eagle Downs area is 270 m in the western Harrow Creek Upper Seam area. As such, connective cracking to the surface is not anticipated. The continuous subsurface fracturing will not extend to the base of the shallow aquifer, which farm bores suggest does not extend beyond 80 m depth, as simulated in the model.

As a result of the continuous subsurface cracking extraction of groundwater by mine dewatering will lower the elevation of the piezometric surface of the coal seam aquifers and create a cone of depression around the mine. The model simulated development and extent of the cone of depression in the coal seam aquifers is shown Figure 9.1. The figure indicates that while there will be a relatively steep cone of depression around the longwall panels the radius of influence will extend 4 km out from the mine footprint to the north, east and south. The radius of influence to the west is limited by the Peak Downs Mine and the subcrop of the coal seam. The 2008 predicted drawdowns for the Coal Seam layers, as depicted in Figure 9.1, covers a larger area. The smaller zone of dewatering could be attributed to the differences in model layering, recalibrated parameters, and updated conceptual model.

Although the mine workings will not be in direct hydraulic connection with the shallow aquifer dewatering of the coal seams has an impact on the shallow aquifer due to the inherent very low permeability of the material separating the shallow aquifer from the zone of continuous fracturing. A cone of depression will develop in the water table above the longwall panels with the radius of influence, as conservatively defined by the 1.0 m drawdown contour, being largely within the boundary of the ML. The 1.0 m drawdown contour was adopted in defining the radius of influence as natural water table fluctuations between wet and dry seasons are likely to be within or exceed a 1m range of fluctuation. The maximum drawdown within the shallow aquifer is predicted to be less than 23m over the centre of the longwall panels (Figure 8.3).

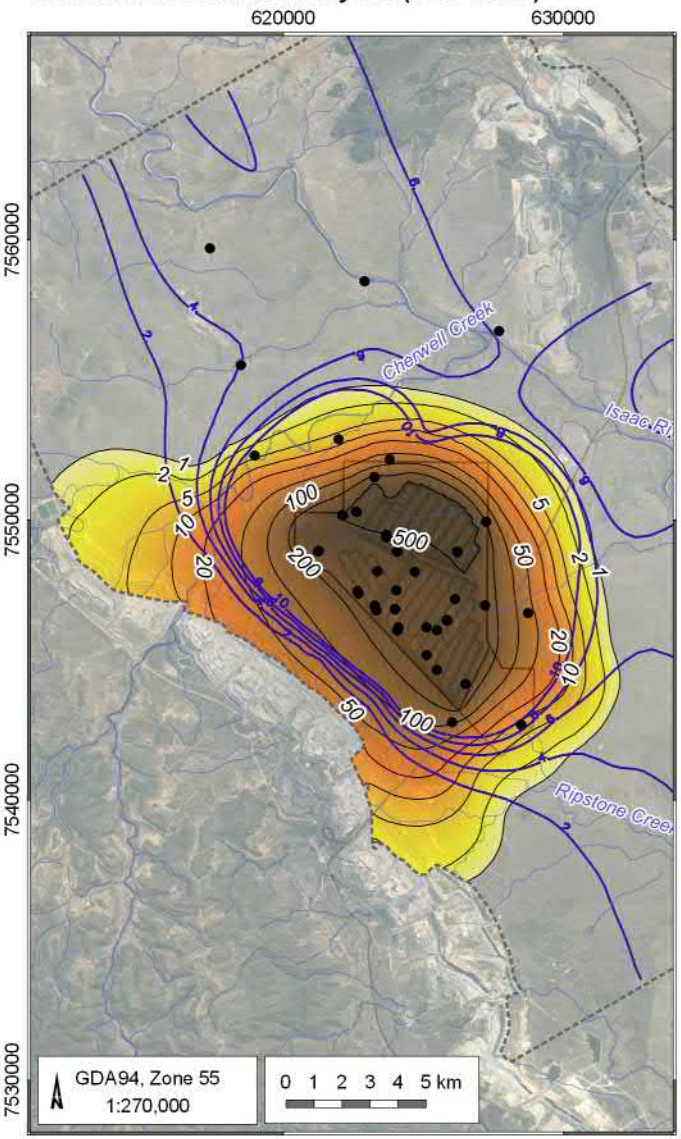
In all subsided areas there may be shallow surface cracking which Kendorski (1993) suggests extends to a maximum of 15m below surface. Where this zone of increased permeability occurs beneath the shallow aquifer it may lead to a temporary lowering of groundwater levels that will only persist for as long as is required to fill the new void cracks. On the basis that there is no new discharge route for the shallow groundwater, that is, there is no connection via surface cracking to the underground mine voids or connection with the subsurface zone of continuous cracking, groundwater levels and /or surface flow will generally be resurrected quite quickly as the cracks are filled. These findings are consistent with the 2008 GIA findings (AGE, 2008) and the approved EA.

In summary the subsidence data and predictive modelling indicates that although there is a significant impact on the potentiometric surface of the deep coal seam aquifers, the impact of mining and dewatering the coal seams on the shallow aquifer is minimal. The difference between the 2008 GIA and the updated numerical predictions are discussed in the next section (Section 9.3).

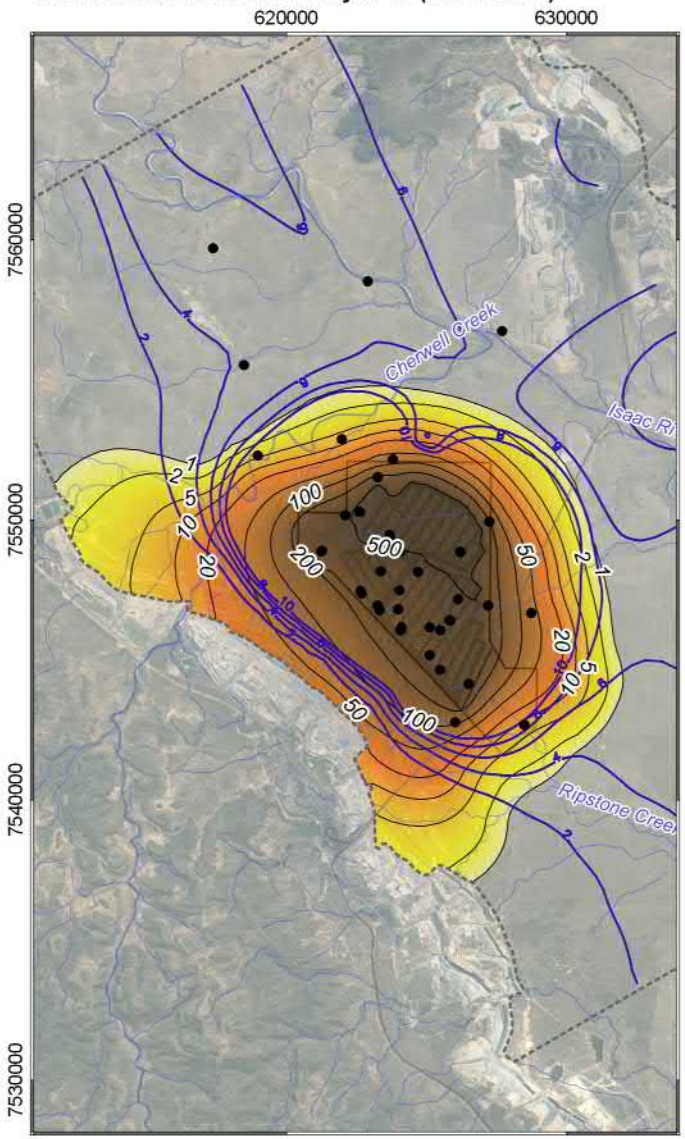
This is due to the essentially impermeable nature of the Fort Cooper Coal Measures which separate the aquifers and to the fact that continuous fracturing because of goafing will only extend to a maximum height of about 120 m above the HCU Seam, as discussed in Section 6. A cover thickness of 270 to 450 m above the HCU Seam indicates that continuous fracturing will not intercept the base of the shallow aquifer and provide drainage pathways to the mine. Similarly surface cracking will not result in hydraulic connection with the mine. There will however be some minor seepage via natural fractures and joints (the inherent permeability), from the shallow aquifer to the underlying depressurized mining domain, resulting in the cone of depression in the water table described. Predictive modelling indicates that there will be no impact to the alluvial aquifer associated with the Isaac River.

Overall, an increased groundwater recharge rate to the shallow aquifer may occur where surface cracks are open for periods extended over one or more rainy seasons.

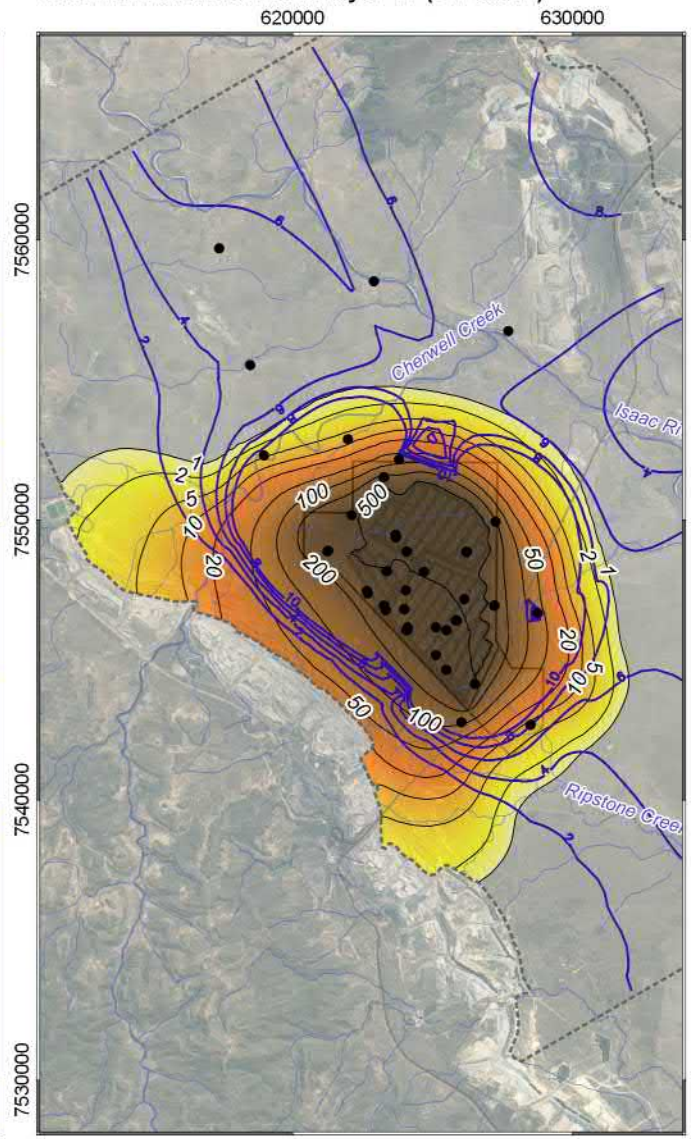
Maximum drawdowns in layer 9 (HCU seam)



Maximum drawdowns in layer 13 (HCL seam)



Maximum drawdowns in layer 17 (DY seam)



LEGEND

- Observation bore
- Rail
- Major drainage
- Minor drainage
- Eagle Downs project area
- Model domain
- Drawdown contour
- Predicted maximum drawdown contour (AGE 2008)

Drawdown (m)

0, 1, 2, 5, 10, 20, 50

AGE

Eagle DownsGIA for EA Amendment (EDM5000.001)

Maximum drawdown comparisons

DATE
25/03/2022

FIGURE No:
9.1

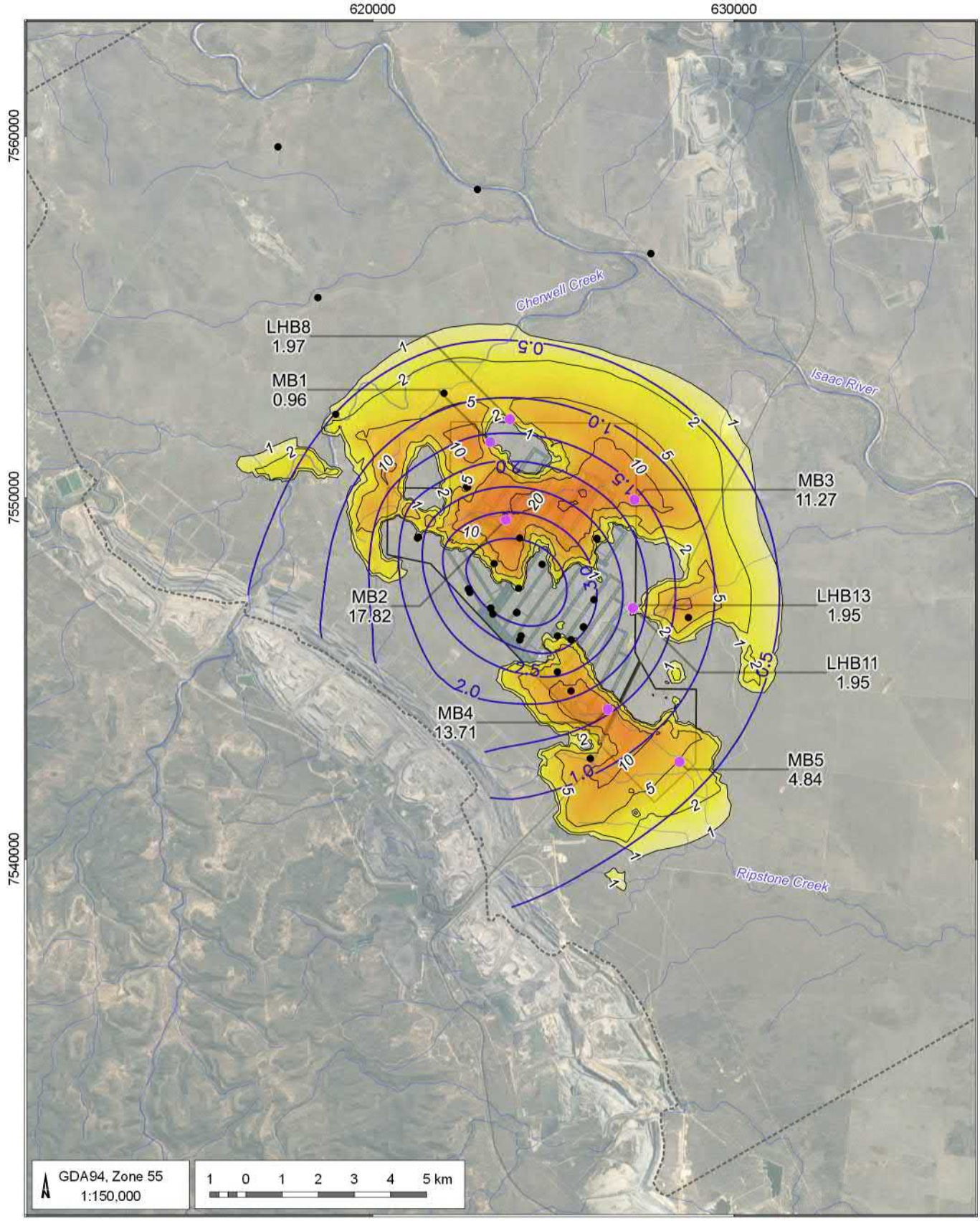
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Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.: GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.:
G:\Projects\EDM5000.001_Eagle DownsGIA for EA Amendment\3_GIS\Workspaces\001_Deliverable1\09.02_EDM5000.001_Maximum predicted drawdown in layer 1 (Weathered Tertiary).qgs

9.3 Impacts on water supply bores

As discussed in Section 8.2 mine dewatering and depressurisation resulted in almost complete desaturation of the coal seams when being mined, that is, the piezometric surface has declined to the base of the seams in the footprint of the mine in Layers 9, 13 and 17. In contrast the water table of the shallow aquifer (Layer 1) shows minor drawdown over the centre of the mine footprint but not desaturation. The water table of the shallow aquifer only shows minor drawdown as continuous fracturing above the HCU seam extends to a maximum height of 140 m to 280 m. Given that there is greater than a 100 m of cover above the HCU Seam and the shallow aquifer is within the upper 80m it is not connected to the mine via the vertical fracturing. There is however connection via the inherent although very low permeability of the overburden that occurs at a height of greater than 100 m above the Q Seam, and this leads to the minor drawdown in the water table simulated by the model.

As discussed in Section 5.9.2, there are no operational farm bores overlying the longwall panels or within the Project area. According to the AGE, 2008 GIA a high yielding bore LHB08 as shown on Figure 9.2, which is about 200 m from the northern boundary of the ML and bores LHB11 and LHB13 on the eastern boundary exists. The maximum predicted drawdown in the farm boreholes LHB08 and LHB13 were 1.3 and 2.2 m respectively in the AGE, 2008 GIA. The updated predictive modelling indicates that the water level in these bores could be reduced by about 2m as a result of mining (Figure 9.2) which is similar than the 2008 model. This should have minimal impact on bore yields and these bores are part of the groundwater monitoring network currently. However, it is evident from Figure 9.2 that the overall predicted drawdown in Layer 1 is slightly larger in terms of both depth and extent. The main reason for the larger zone of drawdown is due to the larger fracture height above the HCU Seam and the improved model layering applied. As explained the connection between the fractures and the shallow aquifer is expected to be limited and model parameters have been designated such that this is the case. If anything, they potentially over-predict this connection and provide a conservative estimate of the potential changes in the water table of the shallow aquifer. Even with the conservative approach where the degree of hydraulic connection built into the model is considered to be greater than in reality, the maximum predicted drawdown is around 20 m. The largest drawdown predicted in the shallow weathered/fractured rock aquifer is about 18 m in bore MB2. This is to be expected as this bore is located above the centre of the proposed mine footprint.

It is possible that the predicted drawdown of the water table outside the ML area, where drawdown is predicted to be less than 2 m, is within the range of natural groundwater fluctuation due to seasonal variation and extraction as discussed in Section 5.6.1 and illustrated in Table 5.9.



LEGEND

- Observation bore
- EA monitoring bores
- Rail
- Major drainage
- Minor drainage
- Eagle Downs project area
- Model domain

Bore ID : MB4
Predicted maximum drawdown (m) : 13.71

- Drawdown contour
- Predicted maximum drawdown contour (AGE 2008)

Drawdown (m)

- 0
- 1
- 2
- 5
- 10
- 20
- 50

Eagle Downs GIA for EA Amendment (EDM5000.001)

Maximum drawdowns in layer 1 (Weathered Tertiary)

AGE

DATE 25/03/2022

FIGURE No: **9.2**

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G:\Projects\EDM5000.001_Eagle DownsGIA for EA Amendment\3_GIS\Workspaces\001_Deliverable1\09.02_EDM5000.001_Maximum predicted drawdown in layer 1 (Weathered Tertiary).qgs

9.4 Impacts on groundwater dependent ecosystems

Section 5.9.1 of this report indicates that there are no groundwater dependent ecosystems that are likely to be impacted by the Eagle Downs Project. The coal seams are very deep and while the radius of influence of depressurisation of the coal seams will extend towards the Isaac River, predictive modelling indicates that it is unlikely to extend to beneath the alluvium. If depressurisation did extend to beneath the alluvium, discharge of poor-quality coal seam water to the base of the alluvium would locally cease.

The only environmental value identified for groundwater in the area is for agricultural use; stock watering, and the impact on farm bores was discussed in the previous section.

9.5 Impacts on groundwater quality

The potential for groundwater contamination may occur as a result of:

- dry rejects disposal, workshops, waste disposal – shallow aquifer; and
- mining and goafing – coal seam aquifer.

In assessing the potential impact reference is made to the geochemical assessment report prepared by RGS (RGS, 2008). RGS evaluated the drift spoil and reject materials. With respect to the drift spoil RGS concluded that:

- acid generation from the drift spoil is extremely unlikely;
- the concentration of metals in the drift spoil materials are well below applied guideline criteria for soils and are unlikely to present any environmental issues associated with revegetation and rehabilitation and any spoil and rejects storage facility; and
- the concentration of soluble metals and salts in runoff and seepage from drift spoils is likely to remain within applied water quality guideline criteria and is unlikely to present any environmental risks for on-site or downstream water quality.

With respect to the reject material RGS concluded that:

- Rejects generated by the proposed Eagle Downs Project is likely to be relatively benign and will generate mildly alkaline and relatively fresh (non-saline) runoff and seepage following surface exposure.
- Despite two samples being classified as PAF; acid generation from rejects is unlikely given the lack of sulfur.
- All rejects material is strongly sodic and, as a consequence, may present surface storage engineering problems related to erosion and dispersion if it was to be used as a potential growth layer for rehabilitation. However, there is no proposal to use rejects material in this manner. The rejects emplacement area would be capped with benign material and covered in topsoil prior to being vegetated. This would eliminate any issues associated with the suitability of the underlying rejects material as a potential growth layer for rehabilitation.
- Water extract tests indicate that despite some marginally elevated concentrations of soluble Mo and As in a small number of samples, the concentration of soluble metals and salts in runoff and seepage from rejects is likely to remain within applied water quality guideline criteria and is unlikely to present any environmental risks for on-site or downstream water quality.

Considering the conclusions reached by RGS following geochemical assessment of the drift spoil and rejects material, it is considered unlikely that leachate generated from these materials will adversely impact groundwater quality. As discussed, the groundwater quality of the coal seam aquifers is poor (brackish to saline) and is marginally suitable for stock use only, although there are no farm bores in the area which source water from the coal seams. While longwall mining will fracture the overlying strata providing larger surface areas and exposure of the rock surface to air, the RGS (2008) assessment suggests that this will not result in poorer quality water in the aquifer systems as groundwater levels recover and the mine workings flood following cessation of mining.

Similarly, any seepage of leachate generated from the dry reject emplacement area (DREA) is unlikely to adversely impact the naturally occurring reasonable to poor quality groundwater of the shallow aquifer, although surface cracking to an estimated maximum depth of 15 m may enhance the rate of infiltration of leachate to the shallow aquifer. The monitoring bores in the shallow aquifer, described in the Section 5.4, will enable detection of any impact of the DREA.

There is potential for spills and contamination by metals and hydrocarbons from mine workshop, waste disposal and fuel storage areas, however adequate bunding and immediate clean-up of spills which is standard practice or a legislated requirement at mine sites, should prevent contamination of shallow groundwater systems.

9.6 Cumulative impacts

The cumulative impact of mining occurring at the existing and proposed mining operations surrounding the Eagle Downs Mine, was considered part of the assessment (refer to Section 8.3). Based on the modelling results, there is some interaction between the mines situated to the west along the Permian MCM sub-outcrop (Peak Downs Mine). The predicted drawdown is mainly in the MCM and less in the shallow weathered Permian as a result of the Project. The predicted impact on the shallow weathered aquifer is limited to the Eagle Downs ML. No major alluvial zones are impacted on as a result of the Project.

As discussed in Section 8.3 the existing and proposed mine projects east and south exploit the shallower Fort Cooper and Rangal Coal Measures situated above the MCM. The conceptual layout of the shallower coal measures and the deeper situated MCM is graphically presented on Figure 5.30 in Section 5.11. There is minimal interaction between these mines, mainly open cast mines and the proposed Eagle Downs underground workings. There is no potential for significant cumulative impacts associated with the Project under these conditions.

10 Uncertainty analysis

Groundwater models represent complex environmental systems and processes in a simplified manner. This means that predictions from groundwater models, like so many other environmental models, are inherently uncertain. When considered in a risk management context, a single calibrated model is insufficient to fully predict the range of potential impacts and their likelihood. A robust uncertainty analysis is therefore important for regulatory decision-making to ensure management options and approaches are appropriate to the level of risk and its likelihood for any particular impact.

The sections below describe the methodology and results of the uncertainty analysis completed for the Eagle Downs underground numerical model.

10.1 Methodology

A Monte Carlo uncertainty analysis was undertaken to quantify the magnitude of uncertainty in the future impacts predicted by the model. This type of analysis produces probability distributions for the prediction by ranking a range of predicted inflows based on calibrated models with different parameter combinations.

This uncertainty analysis was undertaken as a three-part process. To begin, the logical range for each parameter was determined, and then 300 model realisations were created, each having differing values of key parameters. The realisations were tested and the models that failed to converge or could not achieve adequate calibration were rejected. Outputs from the uncertainty modelling were processed in accordance with the risk-based calibrated language proposed in Middlemis & Peeters (2018). The ranges adopted are shown in Table 10.1.

Table 10.1 Calibrated uncertainty modelling language

Narrative descriptor	Probability class	Description	Colour code
Very likely	90 – 100 %	Likely to occur even in extreme conditions	
Likely	67 – 90 %	Expected to occur in normal conditions	
About as likely as not	33 – 67 %	About an equal change of occurring as not	
Unlikely	10 – 33 %	Not expected to occur in normal conditions	
Very unlikely	0 – 10 %	Not likely to occur even in extreme conditions	

10.2 Parameter generation

A suite of 300 unique model realisations was generated, with each parameter randomly selected within the assigned range, which is documented in Table 10.2 through Table 10.5. The parameters were assumed to possess a log-normal distribution with a mean value, or the most probable value, derived from the model calibration exercise.

Table 10.2 Uncertainty range – Horizontal hydraulic conductivity (Kx)

Lithology	Horizontal hydraulic K (m/day) Lower	Horizontal hydraulic K (m/day) Optimum	Horizontal hydraulic K (m/day) Upper
Alluvium	1	25	50
Regolith	0.01	1	10
Interburden	0.0017*	0.0034*	0.0068*
Q seam	0.0172*	0.0344*	0.0688*
HCU seam	0.191*	0.381*	0.762*
HCL seam	0.82*	1.64*	2*
DY seam	0.82*	1.64*	2*

Note: *This is the HK at the surface. HK at each cell was calculated using equations provided in section 5.5.

Table 10.3 Uncertainty range – Vertical hydraulic conductivity (Kz) factor

Lithology	Vertical hydraulic K factor Lower	Vertical hydraulic K factor Optimum	Vertical hydraulic K factor Upper
Alluvium	0.01	0.03	0.1
Regolith	0.01	0.05	0.1
Interburden	0. 1	0.5	1
Q seam	0.1	0.5	1
HCU seam	0.1	0.5	1
HCL seam	0.1	0.5	1
DY seam	0.1	0.5	1

Table 10.4 Uncertainty range – Specific yield (Sy)

Lithology	Specific yield (-) Lower	Specific yield (-) Optimum	Specific yield (-) Upper
Alluvium	0.01	0.1	0.2
Regolith	0.01	0.05	0.1
Interburden	0.0001	0.001	0.0015
Q seam	0.005	0.01	0.02
HCU seam	0.005	0.01	0.02
HCL seam	0.005	0.01	0.02
DY seam	0.005	0.01	0.02

Table 10.5 Uncertainty range – Specific storage (Ss)

Lithology	Specific storage (m-1) Lower	Specific storage (m-1) Optimum	Specific storage (m-1) Upper
Alluvium	0.0001	0.001	0.005
Regolith	0.0001	0.001	0.005
Interburden	1.00E-07	1.00E-06	1E-5
Q seam	1.00E-06	1.00E-05	5E-5
HCU seam	1.00E-06	1.00E-05	5E-5
HCL seam	1.00E-06	1.00E-05	5E-5
DY seam	1.00E-06	1.00E-05	5E-5

Table 10.6 Uncertainty range – Recharge factor

Lithology	Recharge factor Lower	Recharge factor Optimum	Recharge factor Upper
Alluvium	0.0001	0.0020	0.01
Regolith	0.0001	0.0016	0.01

10.3 Results

As noted previously, a total of 300 models were generated and set to run. Of the 300 models run only 73 models did not converge or produce acceptable calibration statistics, leaving 227 models for the uncertainty calculations.

10.3.1 Groundwater inflow to the mine

Figure 10.1 shows the probability of various rates of predicted groundwater inflow to the Eagle Downs underground mine. The calibrated model inflow is predicted to be between the 33rd and 50th percentiles, or 'about as likely as not'. It is unlikely that the predicted inflows will reach 132 L/s and very unlikely that inflows of 158 L/s will occur.

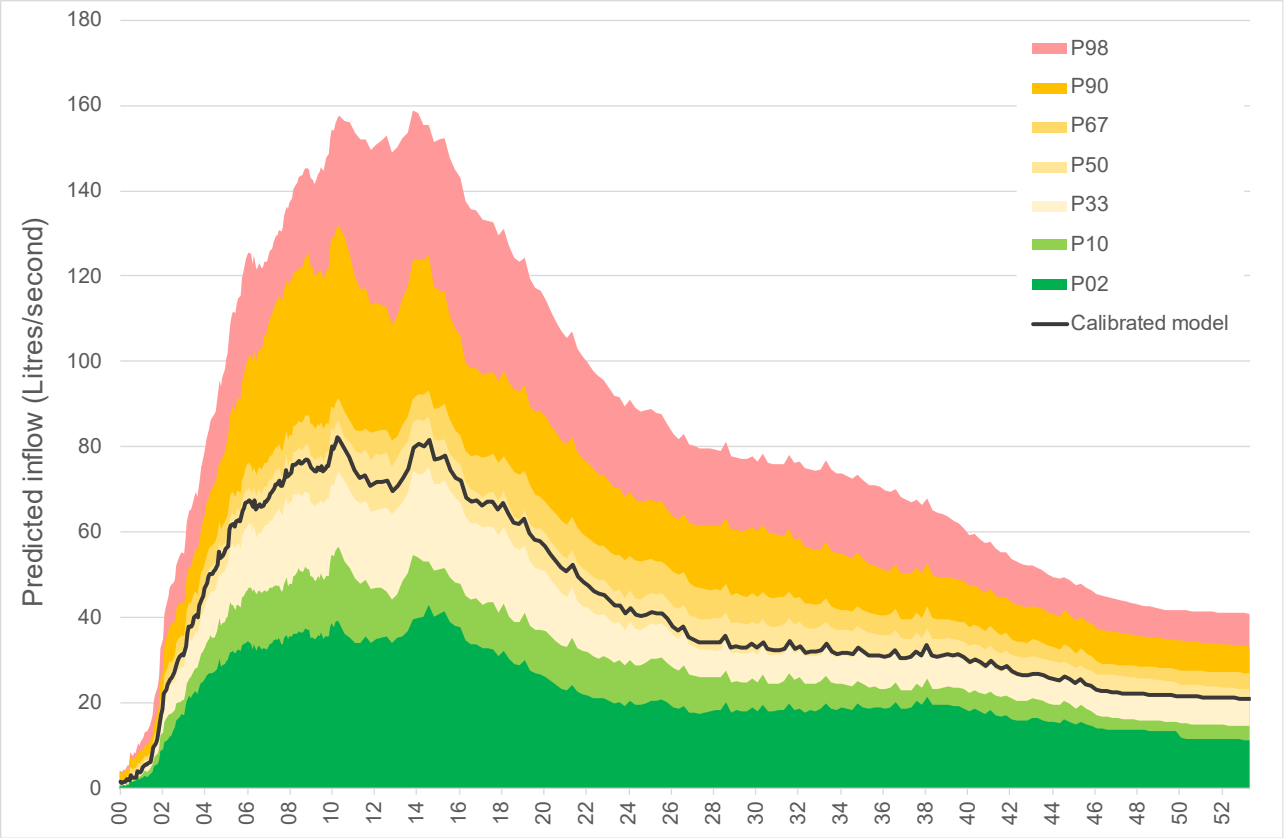


Figure 10.1 Probability of predicted groundwater inflow rates

11 Groundwater management and mitigation measures

11.1 Groundwater monitoring

EA EPML00586713 was originally issued in 2011, with a number of amendments in subsequent years. The EA includes groundwater monitoring and reporting conditions, including details on the bore network and groundwater quality triggers. The section below only supplies a broad overview of the groundwater management and monitoring program. The amendment in 2016 included a slight revision to some of the individual trigger levels and represents the approved groundwater monitoring program.

Over 2016 the site monitoring bores had exceedances for a range of analytes leading to a trigger review by SLR. The initial review considered groundwater values being limited to stock water supply (ANZECC, 2000). In March 2017 the regulator requested that the triggers and exceedances be reviewed in accordance with the then current DSITI (2017) guidelines. A groundwater trigger review was conducted by SLR in December 2017. Additional monitoring was subsequently conducted, information collected, and an addendum report was issued in April 2018 by SLR. The addendum report presented the proposed changes to the bore network and groundwater quality triggers (Umwelt, 2021).

During a follow-up meeting with Department of Environment and Science (DES) in August 2018, the following amendments to the EA were discussed and agreed on, including:

- Installation of a replacement bore between the mine operations and MB4, to be installed within the shallow coal measures and to assign the triggers developed for MB4 to enable early detection of groundwater quality changes in the area – with review of the trigger for the new bore once 12 months of data has been collected.
- Continue to monitor bores MB4 and MB5 at the same frequency but remove triggers for the bores once the replacement bore has been installed.
- Remove bore MB03 (that intersects the Rewan Group) from the groundwater monitoring program.
- Agreed proposed EC and TDS triggers as per addendum report (SLR, 2018a) were suitable.
- With triggers for EC and TDS, agreed on:
  - removal of triggers for major ions – calcium, sodium, chloride, magnesium, bicarbonate and carbonate; and
  - continue to monitor all major ions as per current monitoring program.
- Metals:
  - set trigger to laboratory limit of reporting for silver (dissolved) for existing bores; and
  - remove triggers from total metals – apply triggers to dissolved metals only.
- Total Recoverable Hydrocarbons (TRH) – agreed trigger levels set to laboratory limit of reporting, as per addendum report, where suitable and use TRH as opposed to Total Petroleum Hydrocarbons (TPH) nomenclature.
- Agreement that the requirement for background reference bores in the EA (Condition C47) is not practicable for the site due to surrounding land use.

These agreements and the proposed locally derived triggers were not formalised into the EA due to the change of management of EDCM in September 2018. The current EA is dated the 3 December 2021. Conditions C45 to C57 of the current EA contains the original 2016 groundwater conditions and triggers and does not incorporate the updates discussed in 2018. Proposed updates to the current EA are presented in the Groundwater Trigger Review report (Umwelt, 2021), based on review of more recent data and consistent with the SLR addendum report which is attached in the Umwelt 2021 report as Appendix A.

11.1.1 Groundwater monitoring network

The EA specifies groundwater monitoring to be conducted at five site bores (MB1, MB2 MB3, MB4 and MB5), along with three landholder bores (LHB8, LHB11 and LHB13). The EA also includes requirement for two additional bores (MB6 and MB7), which are to be installed 12 months prior to the commencement of longwall mining. The groundwater monitoring program for the site monitoring bores is outlined in Table 11.1 and shown in Figure 3.3. The table includes the inferred purpose of the bores, based on the current understanding of the site geology, their location and the approved mine activities (Umwelt, 2021).

Table 11.1 Monitoring bore network details

Bore ID	Easting (m)	Northing (m)	TOC (mAHD)	Total Depth (m)	Screen		Screen geology	Purpose
					From (m)	To (m)		
MB1	623254	7551541	221.37	50.5	47.5	50.5	Upper fractured rock, Fort Cooper CM - siltstone	Located on the northern side of site, between the approved extent of longwall mining and landholder bore LHB8. To detect changes in shallow groundwater conditions in response to longwall mining.
MB2	623684	7549391	210.17	50.5	47.5	50.5	Upper fractured rock, Fort Cooper CM – sandstone and siltstone	Located above approved longwall mining. To detect changes in shallow groundwater conditions in response to longwall mining.
MB3	627240	7549946	203.11	51.4	48.4	51.4	Upper fractured rock, Rewan Group	Located over 350 m north-east of approved longwall panels, within the Rewan Group. Initially intended to be installed in the coal measures not Rewan Group. Water level monitoring would show influence of Rewan Group to limit drawdown extents during mining
MB4	626507	7544152	214.89	51	48	51	Upper fractured rock, Fort Cooper CM – coal, sandstone and siltstone	Located near approved longwall panels, within 200 m of a minor gully site track and over 1.5 km from surface facilities/dams. To detect changes in shallow groundwater conditions in response to longwall mining.
MB5	628491	7542693	208.83	51.5	48.5	51.5	Upper fractured rock, Fort Cooper CM – coal, sandstone and siltstone	Located near approved longwall panels, 300 m north of Ripstone Creek. To detect changes in shallow groundwater conditions in response to longwall mining.

Bore ID	Easting (m)	Northing (m)	TOC (mAHD)	Total Depth (m)	Screen		Screen geology	Purpose
					From (m)	To (m)		
MB6	To be installed 12 months prior to the commencement of longwall mining						Shallow CM	To monitor and detect potential seepage from the DREA from changes in water level MB7 and water quality
MB7	To be installed 12 months prior to the commencement of longwall mining						Shallow CM	
LHB8	623797	7552173	-	-	-	98	Upper fractured rock Fort Cooper CM	Landholder bore, actively used for stock water supply. Monitor private bore usage and changes.
LHB11	627205	7546949	-	-	-	9.5	Upper fractured rock Fort Cooper CM	Landholder bore. Historically dry bore not in use.
LHB13	627200	7546952	-	-	-	30	Upper fractured rock Fort Cooper CM	Landholder bore. Bore not in use.

Notes: Source: Umwelt, 2021.
Coordinates GDA94 zone 55.
TOC = Top of casing.
CM = Coal Measures.

11.1.2 Groundwater monitoring program

The monitoring bores listed in Table 11.1 were monitored monthly from 2012 to 2015, changing to quarterly in 2016 and 2017 and then on an annual basis from 2018, following an amendment to the EA monitoring requirements in December 2016. Once longwall mining commences, groundwater monitoring will be conducted quarterly again.

The monitoring program details are captured in the approved EA and the following supplies a summary:

- The monitoring program includes recording field observations during sampling:
  - date and time;
  - depth to groundwater;
  - field measurements of pH, electrical conductivity (EC), oxidation and redox potential (ORP), turbidity, dissolved oxygen (DO) and temperature; and
  - observations of sample water.
- Laboratory analysis includes the following:
  - physical parameters: pH, EC and TDS;
  - major ions: Ca, Cl, K, Na, Mg, SO_4;
  - total alkalinity as $CaCO_3$, HCO_3, CO_3;
  - total and dissolved metals: Ag, Al, As, Fe, Hg, Mo, Sb, Se;
  - total petroleum hydrocarbons (TPH) with silica gel clean-up: C10-C14, C15-C28, C29-C36, C10-C30 (sum); and
  - total recoverable hydrocarbons (TRH) with silica gel clean-up: C6-C10, C6-C10 (minus BTEX), C10-C16 (minus naphthalene), >C10-C16, C16-C34 and C34-C40 and C10-C40 (sum).
- Field records and laboratory results are held within a database in accordance with the EA conditions.
- Data trends are reviewed annually to identify any trigger level exceedances.

11.1.3 Bore Triggers and additional recommendations

The following recommendations in Table 11.2 were made in the Trigger Review Report (Umwelt, 2021), this Umwelt report should be used for the proposed EA Conditions (refer to Section 4.2, Umwelt, 2021).

Table 11.2 Monitoring bore recommendations

Bore ID	Proposed Trigger		Recommendations
	pH	EC (uS/cm)/ TDS (mg/l)	
MB1	5 to 8.5	2218/ 1200	Update triggers and maintain in site operational monitoring network
MB2	-	4748/ 2480	Update triggers and maintain in site operational monitoring network.
MB3	-	-	Remove bore from trigger (normal monitoring to continue) network Installation of a replacement bore (MB8) west of MB3, to be installed within the shallow coal measures and assigned triggers developed for MB2 to enable early detection of groundwater quality changes in the area, with review of the trigger for the new bore once 12 months of data has been collected
MB4	-	-	Continue to monitor but remove groundwater triggers from the bore. Installation of a replacement bore (MB9) between the mine operations and MB4, to be installed within the shallow coal measures and to assign the triggers developed for MB4 to enable early detection of groundwater quality changes in the area, with review of the trigger for the new bore once 12 months of data has been collected. Continue to monitor 100 Series SIS Dam and review soil salinity in the area and site water management. Replace TPH with TRH as a trigger.
MB5	-	-	Continue to monitor but remove groundwater triggers from the bore.
MB6	-	-	To monitor and detect potential seepage from the DREA from changes in water level MB7 and water quality
MB7	-	-	To monitor and detect potential seepage from the DREA from changes in water level MB7 and water quality
LHB8	-	-	Continue to monitor but remove groundwater quality triggers due to influence from bore usage on water quality.
LHB11	-	-	Remove bore LHB11 from the network as the bore has been continuously dry since 2011.
LHB13	-	-	Remove bore LHB13 from the network as access is no longer available due to landholder equipment installed.
General			• Removal of triggers for major ions – calcium, sodium, chloride, magnesium, bicarbonate and carbonate, but continue to monitor all major ions and review trends and changes in water type as part of annual reporting. • Removal of triggers for major ions but continue to monitor and review trends and changes as part of annual reporting. • Clarify that metals triggers for aluminium, antimony, arsenic, mercury, molybdenum and selenium are for dissolved metals (not total) and consistently apply mg/L as the unit of measure. • Update triggers for dissolved iron for proposed replacement bores MB8 and MB9 based on baseline data for the shallow Permian coal measures, derived in accordance with DSITI (2017) guidelines • It is noted that trigger exceedances for TRH/TPH were recorded. However, analysis using silica gel clean-up (for applicable carbon fractions) removed the trigger exceedances, indicating the influence of organic matter on the results. It is also noted that in 2013 NEPM amended terminology from TPH to TRH, and it is recommended that TRH be applied in the EA and compliance reporting in future, with removal of reference to TPH. Set TRH trigger at the laboratory limit of reporting and utilise silica gel clean-up for the laboratory analysis to exclude the influence from natural organic matter.

Bore ID	Proposed Trigger		Recommendations
	pH	EC (uS/cm)/ TDS (mg/l)	
			• Dissolved silver has been recorded in the site monitoring bores, with most readings below the laboratory limit of reporting and with a maximum reading of 0.01 mg/L. Silver is not a known contaminant of concern related to the activities conducted at site. It is recommended that silver be removed as a trigger but be maintained as part of ongoing monitoring program and readings and trends reviewed as part of annual reporting. • It is also recommended that existing condition C47 be removed, due to the availability of site-specific data and the presence of mine operations surrounding the site that preclude the potential to apply a reference bore network.

Source: Umwelt, 2021

11.2 Groundwater model validation

The validity of the model predictions will be assessed against measured results on an annual basis to assess for divergence of mine induced changes to water levels. An update of the groundwater model is to occur every three years or potentially earlier if there is substantial divergence between model predictions and measured results. The model will be updated using time series groundwater level data for calibration purposes.

11.3 Mitigation strategies

11.3.1 Proactive monitoring

The EA EPML00586713 (3 December 2021) conditions related to groundwater (conditions C45 to C57) will be implemented as part of the groundwater monitoring program (as discussed in the previous sections) and mitigation strategy. Table 11.3 lists conditions C53 and C55 which will form an integral part of the mitigation strategy.

Table 11.3 EA Conditions to be applied as part of the Mitigation Strategy

EA Condition	Description
C53	*If the groundwater contaminant trigger values defined in Table C11 (Groundwater contaminant trigger values) are exceeded, then the environmental authority holder must complete an investigation into the potential for environmental harm and notify the administering authority within twenty-eight (28) days of receiving the analysis results.*
C55	*The groundwater monitoring data must be reviewed on an annual basis. The review must include the assessment of groundwater levels and water quality data, and the suitability of the monitoring network. The assessment must be submitted to the administering authority within twenty-eight (28) days of receiving the report.*

11.3.2 Mine-affected water

The proposed mine plan includes strategies to manage mine-affected water for the life of the project. Potential sources of mine-affected water include groundwater inflows into the mine workings. The mine affected water will be managed in accordance with the site Water Management Plan (WMP), including containment in mine water dams, utilisation for dust suppression, processing and controlled releases in accordance approval conditions.

11.3.3 Groundwater use

The potential impacts on groundwater users (landholder bores) are described in Section 9.3. The 'Make Good' provisions under the *Water Act 2000* would be implemented for affected landholder bores to ensure the owner has access to similar quantity and quality of water for the purpose. For the three landholder bores identified in the AE this is typically the supply of water for stock watering. The Project will provide alternate water supplies or financial compensation as per the EA.

11.3.4 Groundwater dependent assets

The groundwater monitoring program will provide early detection of impacts on the groundwater resources. As is evident from the groundwater discussion, limited GDE's occur within the ML.

11.3.5 Groundwater inflow to the mine workings

The actual volume of water pumped from the mine may be less than the volumes predicted as some water will be removed as moisture with the coal and some will be lost by evaporation to the mine ventilation system. However, there will also be an addition of water used by the mining machinery. Also, it has been assumed that all water from overlying mined areas will drain via the goaf to the seam being mined, however in reality some water may be retained in pockets in the prior workings. This is an unknown.

Groundwater inflow to the longwall panels should be controlled by strategically located sumps and pumped to surface storages. The water will be of poor quality as discussed, but consideration should be given to using it in the CHPP and for dust suppression.

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13 Glossary and acronyms

AGE	Australasian Groundwater and Environmental Consultants Pty Ltd
AHD	Australian Height Datum
AIP	Aquifer Interference Policy
ALUM	Australian Land Use Mapping
BSAL	Biophysical Strategic Agricultural Land
CSG	Coal seam gas
CRD	Cumulative Rainfall Departure
EMD	Environmental Monitoring Database
DoEE	Department of the Environment and Energy
DPI	Department of Primary Industries
GDE	Groundwater Dependent Ecosystem
IESC	Independent Expert Scientific Committee
ML	Megalitres
MNES	Matters of National Environmental Significance
Mtpa	Million tonnes per annum
SILO	SILO is a database of historical climate records for Australia
SRLU Policy	Strategic Regional Landuse Policy
TARP	Trigger Action Response Plan
TDS	Total Dissolved Solids
VWP	Vibrating wire piezometer

Appendix A

Mining Plan

Coal Seam	Type	Type ID	HCU Sched Start (year)	HCU Sched End (year)
HCU	DV	MH2101	0.0	1.6
HCU	DV	MH2301	0.5	6.5
HCU	DV	TG2101	0.6	1.2
HCU	DV	MG2101	1.0	1.5
HCU	DV	IR2101	1.2	1.5
HCU	DV	MG2102	1.2	1.8
HCU	DV	MH2102	1.6	6.9
HCU	LW	LW2101	1.6	2.3
HCU	DV	TG2104	1.8	2.4
HCU	DV	MG2103	1.8	2.3
HCU	DV	IR2102	1.8	2.0
HCU	DV	MG2104	2.2	3.0
HCU	DV	IR2103	2.3	2.5
HCU	LW	LW2102	2.4	2.8
HCU	DV	IR2104	2.4	2.9
HCU	DV	MG2105	2.6	3.3
HCU	LW	LW2103	2.8	3.2
HCU	DV	MG2106	3.0	3.8
HCU	DV	IR2106B	3.2	4.1
HCU	LW	LW2104	3.3	3.8
HCU	DV	IR2105	3.3	3.5
HCU	DV	MG2107	3.5	4.2
HCU	DV	IR2106A	3.8	4.0
HCU	LW	LW2105	3.8	4.3
HCU	DV	MG2108	4.1	5.0
HCU	DV	IR2107	4.2	4.4
HCU	DV	MG2109	4.3	5.3
HCU	LW	LW2106A	4.3	4.7
HCU	DV	IR2109B	4.8	5.9
HCU	LW	LW2106B	4.8	5.0
HCU	DV	MG2110	4.9	6.2
HCU	DV	IR2108	5.0	5.3
HCU	LW	LW2107	5.0	5.6
HCU	DV	IR2109A	5.3	5.8
HCU	LW	LW2108	5.7	6.2
HCU	DV	TG2111	5.9	6.7
HCU	DV	MH2303	6.2	12.2
HCU	DV	IR2110	6.2	6.4
HCU	DV	MG2111	6.3	7.0
HCU	LW	LW2109A	6.3	6.7
HCU	DV	MH2302	6.5	9.5

Coal Seam	Type	Type ID	HCU Sched Start (year)	HCU Sched End (year)
HCL	DV	MG3109	19.0	19.794675
HCL	DV	MH3303	19.1	26.265599
HCL	DV	IR3109A	19.1	19.85824
HCL	DV	MH3302	19.3	23.3298
HCL	DV	MG3110	19.3	20.085259
HCL	DV	IR3109B	19.9	20.094591
HCL	LW	LW3107	20.2	20.339275
HCL	DV	IR3110	20.4	20.152112
HCL	DV	MG3304	20.4	21.255634
HCL	DV	MG3305	21.3	21.324094
HCL	LW	LW3108	21.5	21.507376
HCL	DV	IR3305	21.6	21.574833
HCL	DV	MG3306	21.6	22.438071
HCL	DV	IR3306	21.9	22.521729
HCL	LW	LW3109A	22.3	22.237388
HCL	DV	MG3307	22.5	22.911707
HCL	LW	LW3109B	22.7	22.597418
HCL	DV	IR3307	22.9	22.987705
HCL	LW	LW3110	23.0	23.136613
HCL	DV	MG3308	23.2	23.817694
HCL	DV	IR3308	23.2	23.897572
HCL	LW	LW3305	23.5	23.95754
HCL	DV	MG3309	23.9	23.762441
HCL	DV	IR3309	24.1	23.837551
HCL	DV	MG3303	24.3	24.988514
HCL	LW	LW3306	24.7	24.697199
HCL	DV	MG3302	24.8	25.31136
HCL	DV	IR3303B	25.0	25.666866
HCL	LW	LW3307	25.3	25.568975
HCL	DV	IR3304	25.3	25.312243
HCL	DV	IR3302A	25.7	26.748501
HCL	DV	IR3303A	25.7	25.580029
HCL	LW	LW3308	26.1	26.256562
HCL	DV	MG3301	26.3	26.672877
HCL	DV	TG3301	26.4	26.773309
HCL	DV	IR3302B	26.8	26.813457
HCL	LW	LW3309	26.8	26.701924
HCL	LW	LW3304	27.8	27.667388
HCL	DV	IR3301	28.3	27.047641
HCL	LW	LW3303A	28.6	28.206676
HCL	LW	LW3303B	28.9	28.538482

Coal Seam	Type	Type ID	HCU Sched Start (year)	HCU Sched End (year)
HCU	DV	IR2111	6.7	7.1
HCU	LW	LW2109B	6.7	6.9
HCU	DV	MG2112	6.9	7.4
HCU	LW	LW2110	7.0	7.4
HCU	DV	MG2305	7.1	7.9
HCU	DV	MG2304	7.2	8.1
HCU	DV	IR2112	7.4	7.6
HCU	LW	LW2111	7.5	8.1
HCU	DV	MG2306	7.8	8.6
HCU	DV	IR2306	7.9	8.7
HCU	DV	IR2305	8.1	8.3
HCU	LW	LW2112	8.1	8.6
HCU	DV	MG2307	8.4	9.2
HCU	LW	LW2305	8.7	9.2
HCU	DV	MG2308	8.8	9.4
HCU	DV	MG2303	9.1	10.0
HCU	DV	IR2307	9.2	9.4
HCU	LW	LW2306	9.3	9.7
HCU	DV	IR2308	9.4	9.6
HCU	DV	MG2309	9.5	9.8
HCU	LW	LW2307	9.7	10.2
HCU	DV	IR2309	9.8	10.0
HCU	DV	IR2304	10.0	10.2
HCU	DV	MG2302	10.0	10.9
HCU	DV	IR2303A	10.2	11.0
HCU	DV	IR2303B	10.3	11.1
HCU	LW	LW2308	10.3	10.6
HCU	DV	MG2301	10.5	11.3
HCU	LW	LW2309	10.7	10.9
HCU	DV	IR2302B	10.9	11.7
HCU	LW	LW2304	11.0	11.6
HCU	DV	TG2301	11.1	11.7
HCU	DV	IR2302A	11.3	11.6
HCU	DV	IR2301	11.7	11.9
HCU	LW	LW2303A	11.7	12.0
HCU	DV	TG2401	11.9	12.4
HCU	LW	LW2303B	12.1	12.2
HCU	DV	MH2401	12.2	12.8
HCU	DV	MG2401	12.3	12.8
HCU	LW	LW2302A	12.3	12.5
HCU	DV	IR2401	12.4	12.8

Coal Seam	Type	Type ID	HCU Sched Start (year)	HCU Sched End (year)
HCL	LW	LW3302A	29.5	28.837361
HCL	LW	LW3302B	25.8	29.406895
HCL	LW	LW3301	26.0	29.947764
DY	DRIFT	ICV4101	26.8	26.011967
DY	DRIFT	ITD4101	27.1	26.268227
DY	DV	MH4101	27.2	36.4254
DY	DV	TG4101	27.6	27.608645
DY	DV	MH4301	27.7	36.618876
DY	DV	IR4101	27.8	28.516357
DY	DV	MG4101	28.1	28.4302
DY	DV	TG4104	28.5	29.837671
DY	DV	MG4102	28.9	28.814956
DY	DV	IR4102	29.0	28.88352
DY	DV	IR4103	29.0	29.493417
DY	DV	MG4103	29.8	29.432365
DY	DV	MG4104	30.0	30.135261
DY	DV	IR4104	30.1	30.203396
DY	LW	LW4101	30.2	30.572901
DY	DV	MG4105	30.7	31.004918
DY	DV	IR4105	30.7	31.073467
DY	LW	LW4102	31.1	31.113666
DY	DV	MG4106	31.2	31.654441
DY	DV	IR4106	31.4	31.713061
DY	LW	LW4103	31.6	31.511718
DY	DV	MG4107	31.7	32.471941
DY	LW	LW4104	32.1	32.281804
DY	DV	IR4107	32.4	32.540065
DY	DV	MG4108	32.5	33.214134
DY	LW	LW4105	33.1	32.968409
DY	DV	IR4108	33.1	33.281075
DY	DV	MG4109	33.3	34.150856
DY	LW	LW4106	33.8	33.837277
DY	DV	IR4109	33.9	34.248763
DY	DV	MG4110	34.2	34.971126
DY	LW	LW4107	34.8	34.763242
DY	DV	IR4110	34.9	35.027637
DY	DV	TG4111	35.4	35.944642
DY	LW	LW4108	35.8	35.65523
DY	DV	MG4111	35.9	36.278366
DY	LW	LW4109	36.2	36.535167
DY	DV	IR4111	36.3	36.336478

Coal Seam	Type	Type ID	HCU Sched Start (year)	HCU Sched End (year)
HCU	LW	LW2302B	12.6	12.9
HCU	DV	MG2403	12.6	13.0
HCU	DV	IR2402	12.8	13.3
HCU	LW	LW2301	13.0	13.2
HCU	DV	MG2402	13.0	13.2
HCU	DV	IR2403	13.0	13.2
HCU	DV	TG2403	13.3	13.7
HCU	LW	LW2401	13.3	13.7
HCU	LW	LW2402	13.7	14.0
HCU	LW	LW2403	14.0	14.4
HCL	39.01804	ICV3101	11.7	11.9
HCL	38.945238	ITD3101	11.9	12.1
HCL	39.742013	MH3101	12.9	19.0
HCL	38.701387	MH3301	13.1	19.1
HCL	39.467529	TG3101	13.3	14.0
HCL	39.204005	MG3101	13.6	14.3
HCL	39.815225	TG3104	13.8	15.6
HCL	39.95597	IR3101	14.0	14.3
HCL	40.627778	MG3102	14.1	14.6
HCL	40.154658	MG3103	14.5	14.9
HCL	40.182755	LW3101	14.5	15.2
HCL	41.14911	MG3104	14.5	15.8
HCL	41.907411	IR3102	14.6	14.8
HCL	40.930017	IR3103	14.9	15.1
HCL	40.922011	LW3102	15.2	15.7
HCL	41.22421	IR3104	15.6	15.9
HCL	41.528016	LW3103	15.8	16.2
HCL	42.331815	MG3105	15.9	16.8
HCL	42.254985	IR3105	15.9	16.9
HCL	41.945557	LW3104	16.3	17.2
HCL	42.157823	MG3106	16.5	17.4
HCL	42.771265	MG3107	17.1	18.1
HCL	42.266948	LW3105	17.3	18.1
HCL	43.576193	IR3106	17.4	17.7
HCL	43.950634	IR3107	17.7	18.1
HCL	44.411206	MG3108	18.0	18.9
HCL	44.884612	IR3108	18.1	19.0

Coal Seam	Type	Type ID	HCU Sched Start (year)	HCU Sched End (year)
DY	DV	MH4303	36.3	42.348516
DY	DV	MG4112	36.6	37.054827
DY	DV	IR4112	36.6	37.109431
DY	DV	MG4304	36.6	37.683813
DY	DV	MH4302	37.1	38.303364
DY	LW	LW4110	37.3	37.171769
DY	DV	MG4305	37.7	38.040984
DY	LW	LW4111	38.0	38.020963
DY	DV	IR4305	38.0	37.964108
DY	DV	MG4306	38.0	38.865828
DY	DV	MG4307	38.1	39.01804
DY	DV	IR4306	38.1	38.945238
DY	DV	MG4308	38.8	39.742013
DY	LW	LW4112	39.0	38.701387
DY	LW	LW4305	39.2	39.467529
DY	DV	IR4307	39.4	39.204005
DY	DV	IR4308	39.4	39.815225
DY	DV	MG4309	39.6	39.95597
DY	DV	MG4303	40.0	40.627778
DY	LW	LW4306	40.2	40.154658
DY	DV	IR4309	40.2	40.182755
DY	DV	MG4302	40.3	41.14911
DY	DV	MG4301	40.6	41.907411
DY	LW	LW4307	40.9	40.930017
DY	DV	IR4304	41.0	40.922011
DY	DV	IR4303	41.6	41.22421
DY	LW	LW4308	41.6	41.528016
DY	DV	IR4301	41.6	42.331815
DY	DV	TG4301	41.9	42.254985
DY	LW	LW4309	42.0	41.945557
DY	DV	IR4302A	42.2	42.157823
DY	LW	LW4304	42.9	42.771265
DY	DV	IR4302B	43.7	42.266948
DY	LW	LW4303	44.0	43.576193
DY	LW	LW4302A	44.5	43.950634
DY	LW	LW4302B	44.4	44.411206
DY	LW	LW4301	44.9	44.884612

Appendix B

Compliance with government policy

IESC Information Guidelines for Coal Seam Gas and Large Coal Mining Development

The Independent Expert Scientific Committee (IESC) on Coal Seam Gas and Large Coal Mining Development has information guidelines for advice on coal seam gas and large coal mining development proposals (IESC, 2018). The following tables specify where the IESC information requirements for individual proposals have been addressed within this report and related to the Project.

Table B 1 Description of the proposal (the Project)

Project Information	Addressed in section
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.	Sections 1.1, 3.3, and 5.
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
Describe how impacted water resources are currently being regulated under state or Commonwealth law, including whether there are any applicable standard conditions.	Section 2

Table B 2 Risk Assessment

Project Information	Addressed in section
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.	Sections, 6, 7, 8, and 9
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.	Sections 9 and 11
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 9
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.	Sections 9

Table B 3 Groundwater – Context and conceptualisation

Project Information	Addressed in section
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 • geological maps appropriately annotated with symbols that denote fault type, throw and the parts of sequences the faults intersect or displace.	Section 4
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 4.1.2
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.	Sections 5.5 and 7.8.2
Provide time series level and water quality data representative of seasonal and climatic cycles.	Sections 5.6 and 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.	Sections 5.6 and 7
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 5.7
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

Table B 4 Groundwater – Numerical modelling

Project Information	Addressed in section
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 7
Undertaken groundwater modelling in accordance with the Australian Groundwater Modelling Guidelines (Barnett et al. 2012), including independent peer review.	Section 7
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 7.8
Describe each hydrogeological unit as incorporated in the groundwater model, including the thickness, storage and hydraulic characteristics, and linkages between units, if any.	Section 7
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.	Sections 7 and 8

Project Information	Addressed in section
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 7
Identify the volumes of water predicted to be taken annually with an indication of the proportion supplied from each hydrogeological unit.	Section 8
Undertake model verification with past and/or existing site monitoring data.	Section 7.8
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.	Sections 5 and 7
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.	Section 7.3
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).	Section 10
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.	Section 10
Undertake an uncertainty analysis of model construction, data, conceptualisation and predictions (see Middlemis and Peeters).	Section 10
Provide a program for review and update of models as more data and information become available, including reporting requirements.	Section 11.2
Provide information on the magnitude and time for maximum drawdown and post-development drawdown equilibrium to be reached.	Section 8.2 Post development drawdown equilibrium excluded.

Table B 5 Groundwater – Impacts on water resources and water dependent assets

Project Information	Addressed in section
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, inter-aquifer connectivity and connectivity with sea water.	Section 8
• 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.	Section 9
• 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.	N/A
• the possible fracturing of and other damage to confining layers.	N/A
• 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 8 and N/A
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.	Sections 5.9 and 9.4

Project Information	Addressed in section
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 9
Describe 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
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.	Sections 8.3 and 9.6
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 11.3
Provide a description and assessment of the adequacy of proposed measures to prevent/minimise impacts on water resources and water-dependent assets.	Section 11

Table B 6 Groundwater – Data and monitoring

Project Information	Addressed in section
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 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 5
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
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).	Sections 5.4 and 11.1

Table B 7 Water dependent assets – Context and conceptualisation

Project Information	Addressed in section
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.	Section 5.9
Identify GDEs in accordance with the method outlined by Eamus *et al*. (2006). Information from the GDE Toolbox (Richardson *et al*. 2011) and GDE Atlas (CoA 2017a) may assist in identification of GDEs (see Doody *et al*. [in press]).	Section 5.9
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).	Section 5.8, Terrestrial Ecology Assessment (Ecological, 2021)

Project Information	Addressed in section
Estimate the ecological water requirements of identified GDEs and other water-dependent assets (see Doody *et al*. [in press]).	Section 9.1, and Terrestrial Ecology Assessment (Ecological, 2021)
Identify the hydrogeological units on which any identified GDEs are dependent (see Doody *et al*. [in press]).	Section 5.6.1, and Terrestrial Ecology Assessment (Ecological, 2021)
Provide an outline of the water-dependent assets and associated environmental objectives and the modelling approach to assess impacts to the assets.	Section 9.3, and Terrestrial Ecology Assessment (Ecological, 2021)
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) triggers and impact thresholds for water-dependent assets (e.g. threshold at which a significant impact on an asset may occur).	Section 11.1.3

Table B 8 Water dependent assets – Impacts, risk assessment and management of risks

Project Information	Addressed in section
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]).	Sections 9.3 and 9.4
Describe the potential range of drawdown at each affected bore, and clearly articulate of the scale of impacts to other water users.	Sections 8.2 and 9.3
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 9.5
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.	Refer to Terrestrial Ecology Assessment (Ecological, 2021), and Surface water assessment report
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.	Surface water assessment report
Assess the overall level of risk to water-dependent assets through combining probability of occurrence with severity of impact.	Refer to Terrestrial Ecology Assessment (Ecological, 2021)
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.	Refer to Terrestrial Ecology Assessment (Ecological, 2021)
Propose mitigation actions for each identified impact, including a description of the adequacy of the proposed measures and how these will be assessed.	Refer to Terrestrial Ecology Assessment (Ecological, 2021)

Table B 9 Water dependent assets – Data and monitoring

Project Information	Addressed in section
Identify an appropriate sampling frequency and spatial coverage of monitoring sites to establish pre-development (baseline) conditions, and test potential responses to impacts of the proposal (see Doody *et al*. [in press]).	Section 11.1
Consider concurrent baseline monitoring from unimpacted control and reference sites to distinguish impacts from background variation in the region (e.g. BACI design, see Doody *et al*. [in press]).	Section 11.1
Develop and describe a monitoring program that identifies impacts, evaluates the effectiveness of impact prevention or mitigation strategies, measures trends in	Refer to Terrestrial Ecology Assessment (Ecological, 2021)

Project Information	Addressed in section
ecological responses and detects whether ecological responses are within identified thresholds of acceptable change (see Doody *et al*. [in press]).	
Describe the proposed process for regular reporting, review and revisions to the monitoring program.	Section 11.1
Ensure ecological monitoring complies with relevant state or national monitoring guidelines (e.g. the DSITI guideline for sampling stygofauna [QLD Government 2015]).	Refer to Terrestrial Ecology Assessment (Ecological, 2021)

Table B 10 Water and salt balance and water management strategy

Project Information	Addressed in section
Provide a quantitative site water balance model describing the total water supply and demand under a range of rainfall conditions and allocation of water for mining activities (e.g. dust suppression, coal washing etc.), including all sources and uses.	Surface water assessment report
Describe the water requirements and on-site water management infrastructure, including modelling to demonstrate adequacy under a range of potential climatic conditions.	Refer to surface water assessment
Provide estimates of the quality and quantity of operational discharges under dry, median and wet conditions, potential emergency discharges due to unusual events and the likely impacts on water-dependent assets.	Refer to surface water assessment
Provide salt balance modelling that includes stores and the movement of salt between stores, and takes into account seasonal and long-term variation.	Refer to surface water assessment

Table B 11 Cumulative Impacts – Context and conceptualisation

Project Information	Addressed in section
Provide cumulative impact analysis with sufficient geographic and temporal boundaries to include all potentially significant water-related impacts.	Section 8.3
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 8.3

Table B 12 Cumulative Impacts – Impacts

Project Information	Addressed in section
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).	Section 9.6 Section 5 Refer to Terrestrial Ecology Assessment (Ecological, 2021), and Surface water assessment report
Assess the cumulative impacts to water resources considering: • the full extent of potential impacts from the proposed project, (including whether there are alternative options for 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 impacts; and, • opportunities to work with other water users to avoid, minimise or mitigate potential cumulative impacts.	Section 9.6

Table B 13 Cumulative Impacts – Mitigation, monitoring and management

Project Information	Addressed in section
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.	Sections 9 and 11.3. Also refer to the Environmental Authority (EA) EPML00586713
Identify measures to detect and monitor cumulative impacts, pre and post development, and assess the success of mitigation strategies.	Sections 9 and 11 Also refer to the Environmental Authority (EA) EPML00586713
Identify cumulative impact environmental objectives.	Sections 9 and 11 Also refer to the Environmental Authority (EA) EPML00586713
Describe appropriate reporting mechanisms.	Sections 9 and 11 Also refer to the Environmental Authority (EA) EPML00586713
Propose adaptive management measures and management responses.	Sections 9 and 11 Also refer to the Environmental Authority (EA) EPML00586713

Table B 14 Final landform and voids – coal mines

Project Information	Addressed in section
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, sedimentation and habitat fragmentation of water-dependent species and communities.	Refer to surface water assessment
Assess the adequacy of modelling, including surface water and groundwater quantity and quality, lake behaviour, timeframes and calibration.	Section 10 and Refer to surface water assessment
Provide an evaluation of stability of void slopes where failure during extreme events or over the long term (for example due to aquifer recovery causing geological heave and landform failure) may have implications for water quality.	N/A (underground mine). Also refer to PRCP to be completed in 2022
Evaluate mitigating inflows of saline groundwater by planning for partial backfilling of final voids.	PRCP to be completed in 2022
Provide an assessment of the long-term impacts to water resources and water-dependent assets posed by various options for the final landform design, including complete or partial backfilling of mining voids. Assessment of the final landform for which approval is being sought should consider: • groundwater behaviour – sink or lateral flow from void. • water level recovery – rate, depth, and stabilisation point (e.g. timeframe and level in relation to existing groundwater level, surface elevation). • seepage – geochemistry and potential impacts. • long-term water quality, including salinity, pH, metals and toxicity. • measures to prevent migration of void water off-site. For other final landform options considered sufficient detail of potential impacts should be provided to clearly justify the proposed option.	PRCP to be completed in 2022
Assess the probability of overtopping of final voids with variable climate extremes, and management mitigations.	Surface Water Assessment

Table B 15 Acid-forming materials and other contaminants of concern

Project Information	Addressed in section
Identify the presence and potential exposure of acid-sulphate soils (including oxidation from groundwater drawdown).	Section 5.10
Identify the presence and volume of potentially acid-forming waste rock, fine-grained amorphous sulphide minerals and coal reject/tailings material and exposure pathways.	Section 5.10
Identify other sources of contaminants, such as high metal concentrations in groundwater, leachate generation potential and seepage paths.	Section 5.10
Describe handling and storage plans for acid-forming material (co-disposal, tailings dam, and encapsulation).	Section 5.10
Assess the potential impact to water-dependent assets, taking into account dilution factors, and including solute transport modelling where relevant, representative and statistically valid sampling, and appropriate analytical techniques.	Section 5.10
Describe proposed measures to prevent/minimise impacts on water resources, water users and water-dependent ecosystems and species.	Section 5.10

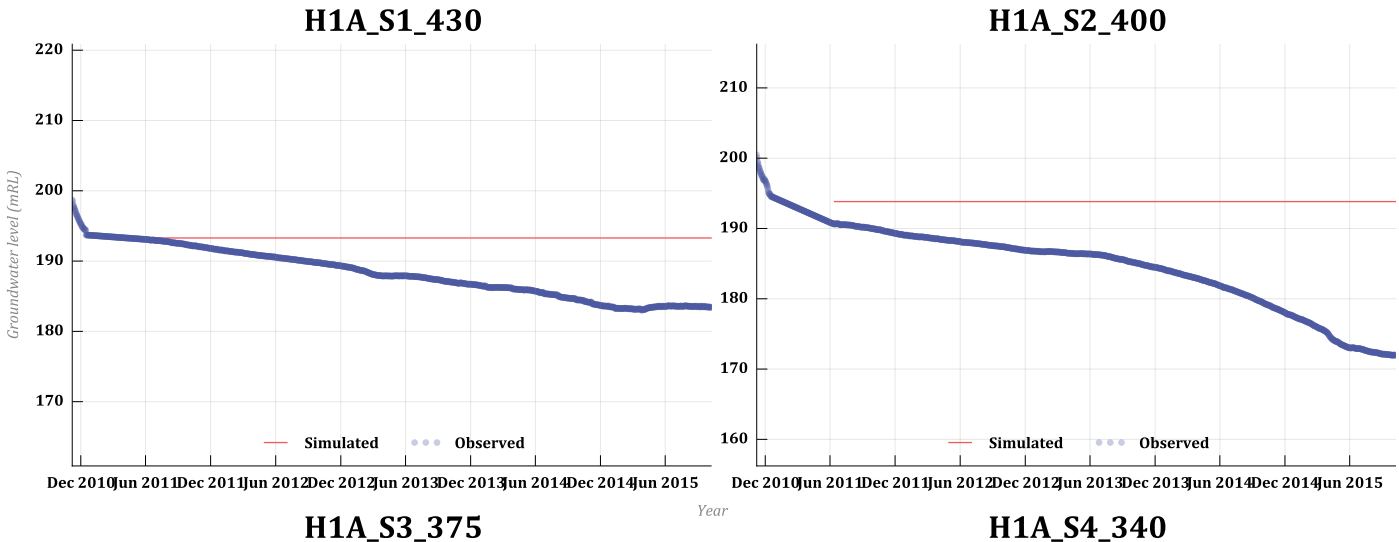
This section discusses the groundwater management conditions set out in the EA. These are a selection of conditions that refer to the specific requirements of annual review contents (SLR, 2021b).

Table B 16 EA Conditions related to groundwater

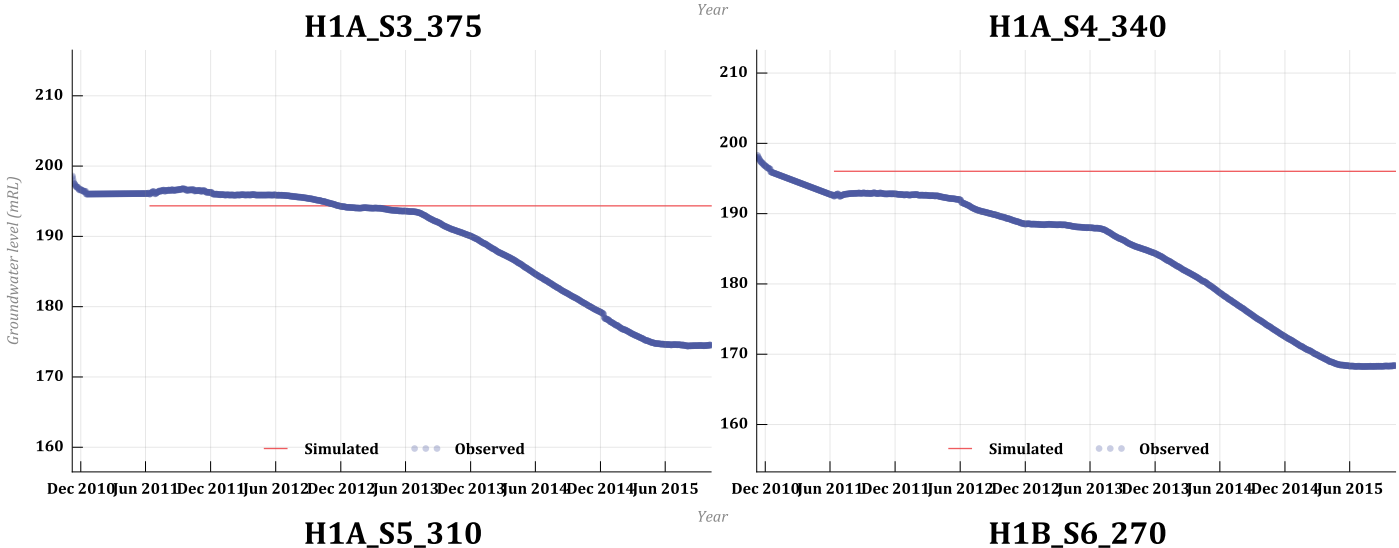
EA Condition	Addressed in section
C27 Annual water monitoring reporting	2021 Annual Review, SLR, 2021b
EA condition C38 requires that monitoring be undertaken at the following bores	Sections 5.4 and 11
EA condition C39 requires that groundwater monitoring be conducted on an annual basis until longwall mining commences.	As longwall mining has not yet commenced, this condition was met by the monitoring event conducted in November 2021.
C40 Groundwater monitoring program	Section 11.1.2
Under EA condition C41, the monitoring program must be able to detect significant change to groundwater quality values (consistent with suitability of the groundwater for beneficial uses), due to activities that are part of the mining project.	2021 Annual Review, SLR, 2021b
EA condition C42 requires the groundwater monitoring program to effectively monitor water pressure across the base of the Dry Rejects Emplacement Area (DREA) at the interface with the natural surface and provide the means to reduce the phreatic surface within the DREA where monitoring indicates this is necessary.	As longwall mining has not yet commenced, this condition is not yet relevant.
EA condition C44 requires that, subject to Condition C45 (which effectively requires groundwater to be monitored at the locations and frequencies described above), groundwater levels must be monitored and groundwater drawdown fluctuations in landowner bores in excess of two metres per year, not resulting from the pumping of licensed bores, must be notified as per EA conditions A7 to A8.	Section 9.3
EA condition C46 effectively requires that, if groundwater contaminant trigger values specified in the EA (see Table 4) are exceeded, an investigation into the potential for environmental harm must be completed and the administering authority must be notified within 28 days of receiving the analysis results.	2021 Annual Review, SLR, 2021b
Condition C47	This condition relates to ensuring the background water monitoring program is adequate as mining activities progress. As noted in SLR (2021b, it is recommended that this condition is removed from the EA. Due to the degree of mining within the region and extent of observed and predicted groundwater impacts, it is not considered possible for EDCM to establish a background reference bore network in accordance with EA condition C47.
EA condition C48 requires that groundwater monitoring data be reviewed on an annual basis. The review must include the assessment of groundwater levels and water quality data, and the suitability of the monitoring network. The assessment must be submitted to the administering authority within twenty-eight days of receiving the report.	2021 2021 Annual Review, SLR, 2021b
EA condition C49 requires that groundwater contaminant trigger levels must be finalised based on a background monitoring program defined in EA condition C47 and submitted to the administering authority by commencement of longwall mining.	As noted in SLR (2021b), it is recommended that EA conditions 47 and 49 are removed from the EA (see Section 6.7).
EA condition C50 requires the following information to be recorded in relation to all groundwater sampling: • the date and time at which the sample was taken; • the monitoring point at which the sample was taken; and • the results of all monitoring.	2021 Annual Review, SLR, 2021b

Appendix C

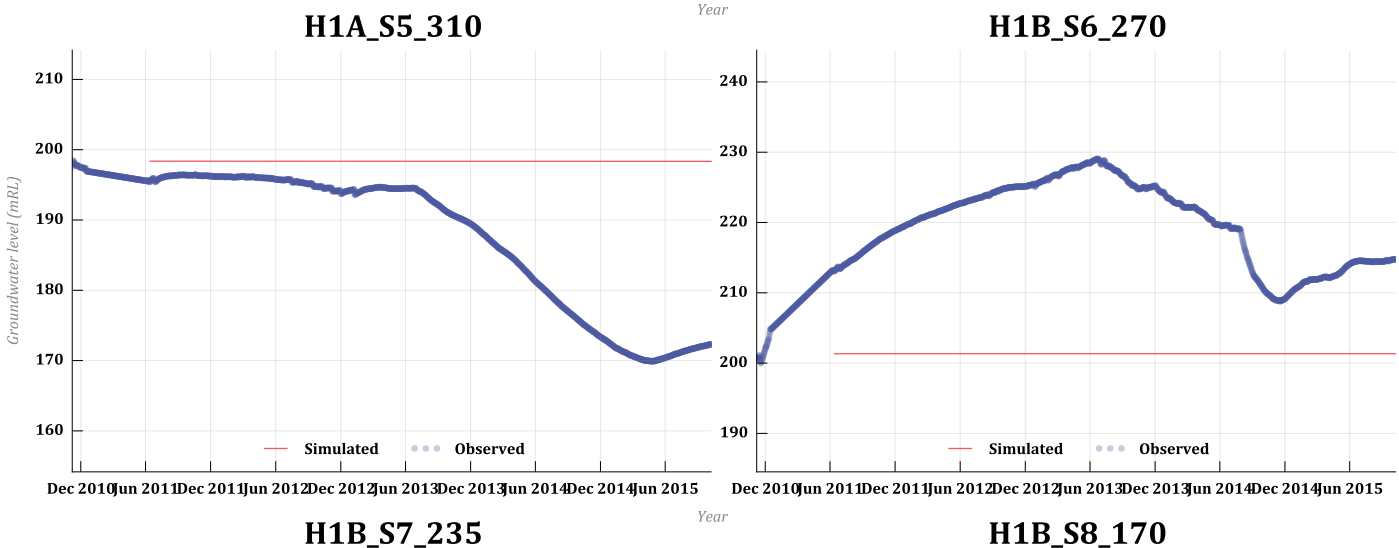
Historic calibration hydrographs


H1A_S1_430
Groundwater level (mRL)
220
210
200
190
180
170
Simulated
Observed
Dec 2010
Jun 2011
Dec 2011
Jun 2012
Dec 2012
Jun 2013
Dec 2013
Jun 2014
Dec 2014
Jun 2015
Year

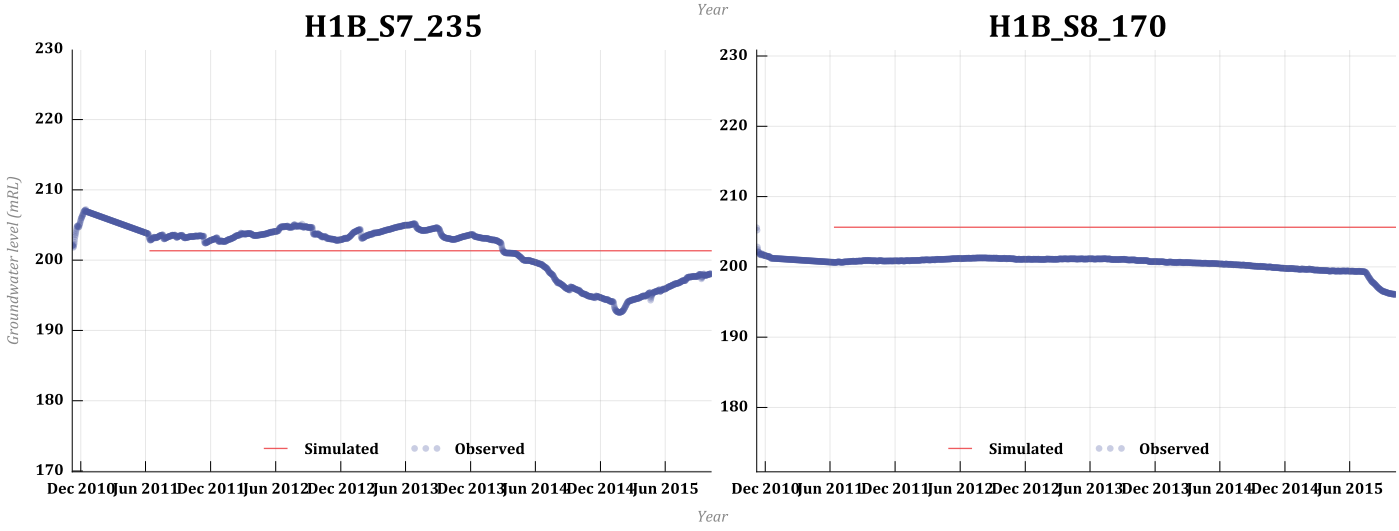
H1A_S2_400
210
200
190
180
170
160
Simulated
Observed
Dec 2010
Jun 2011
Dec 2011
Jun 2012
Dec 2012
Jun 2013
Dec 2013
Jun 2014
Dec 2014
Jun 2015


H1A_S3_375
Groundwater level (mRL)
210
200
190
180
170
160
Simulated
Observed
Dec 2010
Jun 2011
Dec 2011
Jun 2012
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Jun 2013
Dec 2013
Jun 2014
Dec 2014
Jun 2015
Year

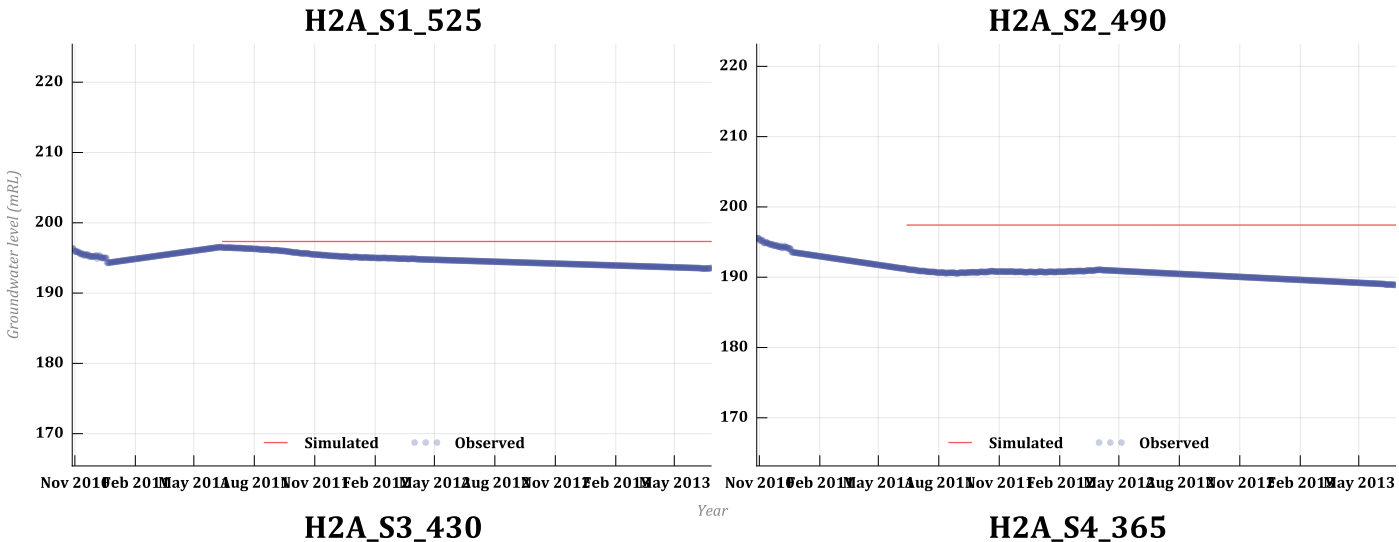
H1A_S4_340
210
200
190
180
170
160
Simulated
Observed
Dec 2010
Jun 2011
Dec 2011
Jun 2012
Dec 2012
Jun 2013
Dec 2013
Jun 2014
Dec 2014
Jun 2015


H1A_S5_310
Groundwater level (mRL)
210
200
190
180
170
160
Simulated
Observed
Dec 2010
Jun 2011
Dec 2011
Jun 2012
Dec 2012
Jun 2013
Dec 2013
Jun 2014
Dec 2014
Jun 2015
Year

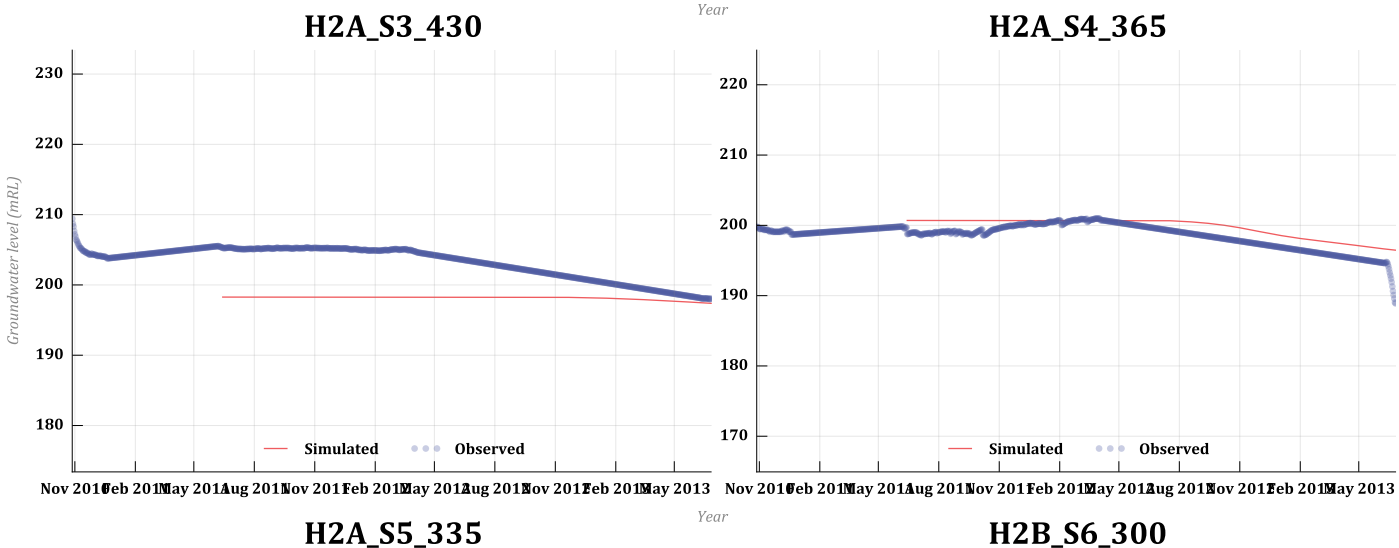
H1B_S6_270
240
230
220
210
200
190
Simulated
Observed
Dec 2010
Jun 2011
Dec 2011
Jun 2012
Dec 2012
Jun 2013
Dec 2013
Jun 2014
Dec 2014
Jun 2015


H1B_S7_235
Groundwater level (mRL)
230
220
210
200
190
180
170
Simulated
Observed
Dec 2010
Jun 2011
Dec 2011
Jun 2012
Dec 2012
Jun 2013
Dec 2013
Jun 2014
Dec 2014
Jun 2015
Year

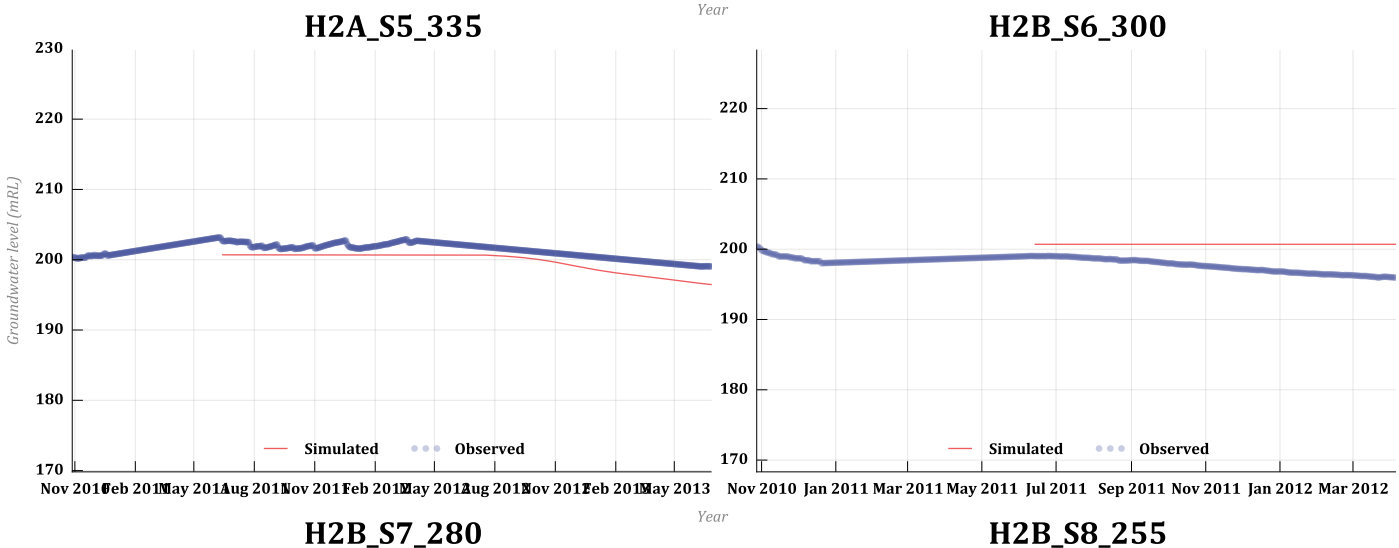
H1B_S8_170
230
220
210
200
190
180
Simulated
Observed
Dec 2010
Jun 2011
Dec 2011
Jun 2012
Dec 2012
Jun 2013
Dec 2013
Jun 2014
Dec 2014
Jun 2015


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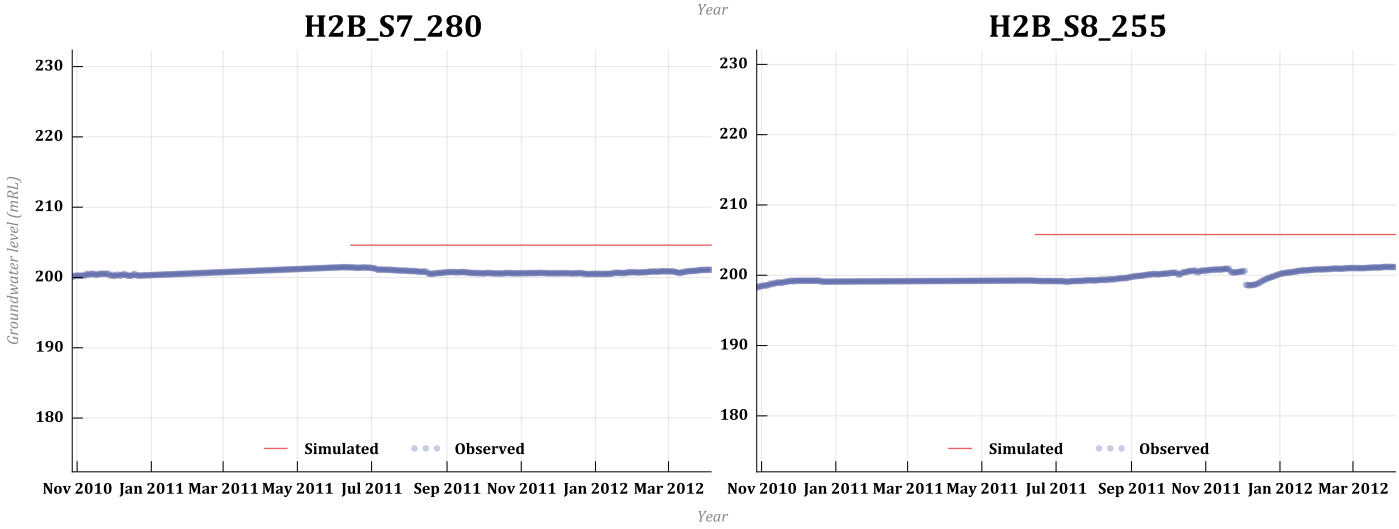
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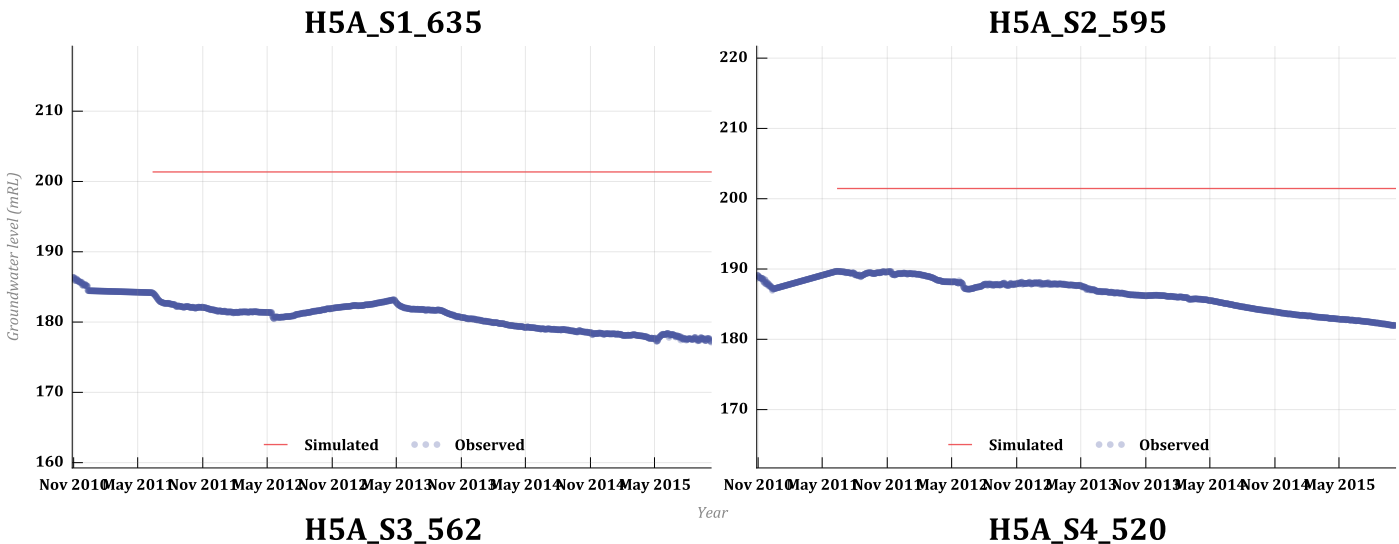
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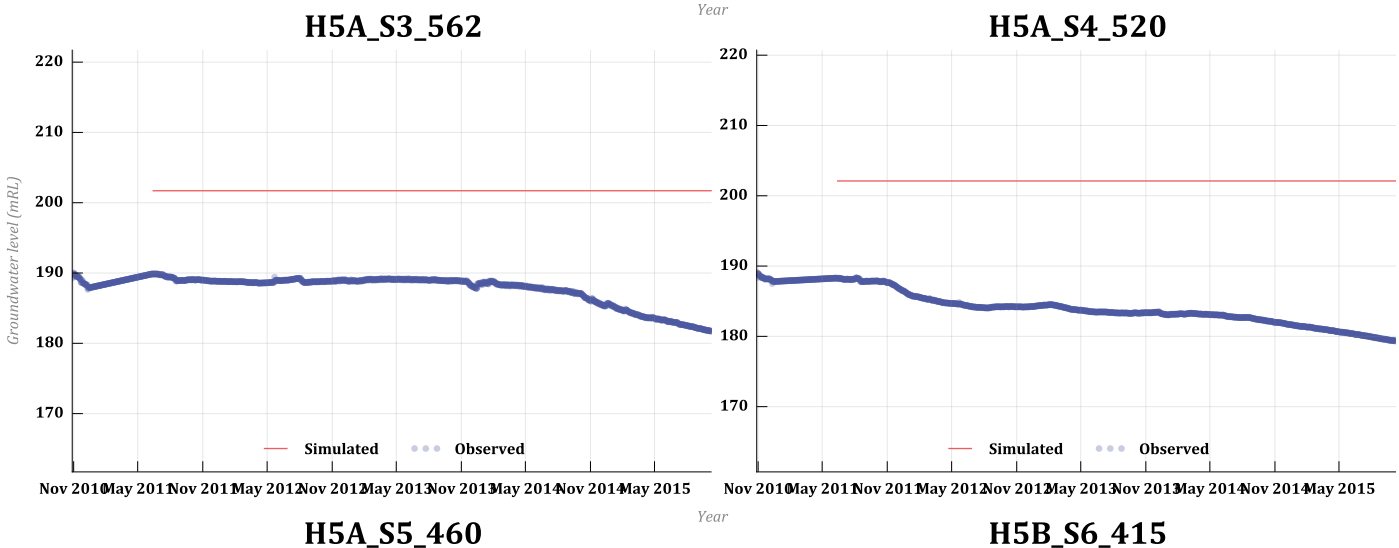
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Jan 2012
Mar 2012


H2B_S7_280
Groundwater level (mRL)
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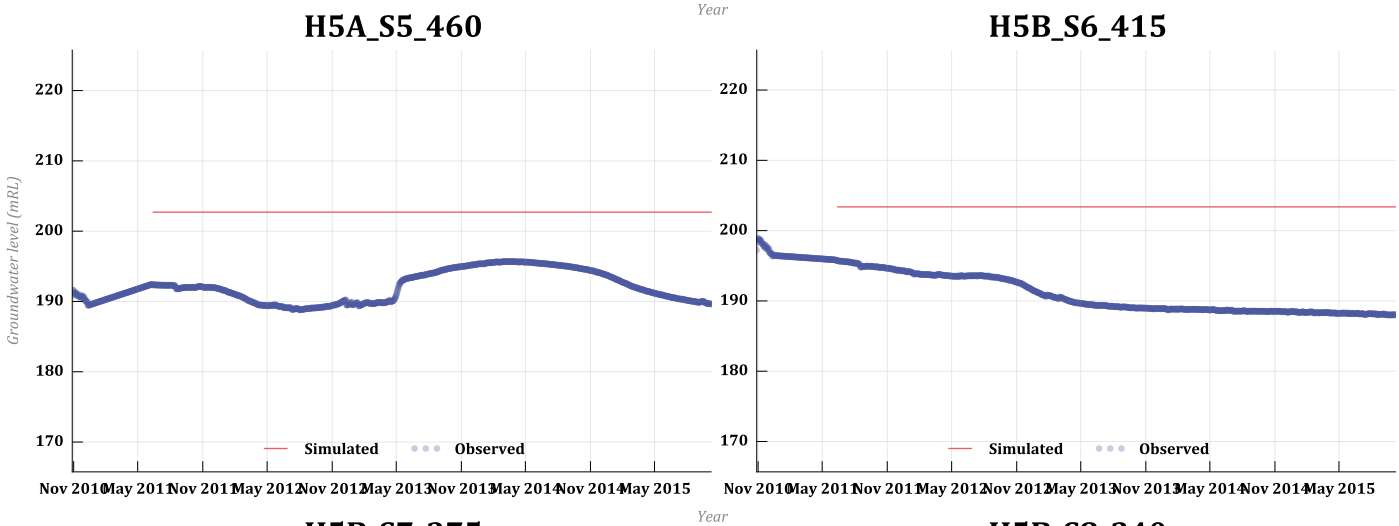
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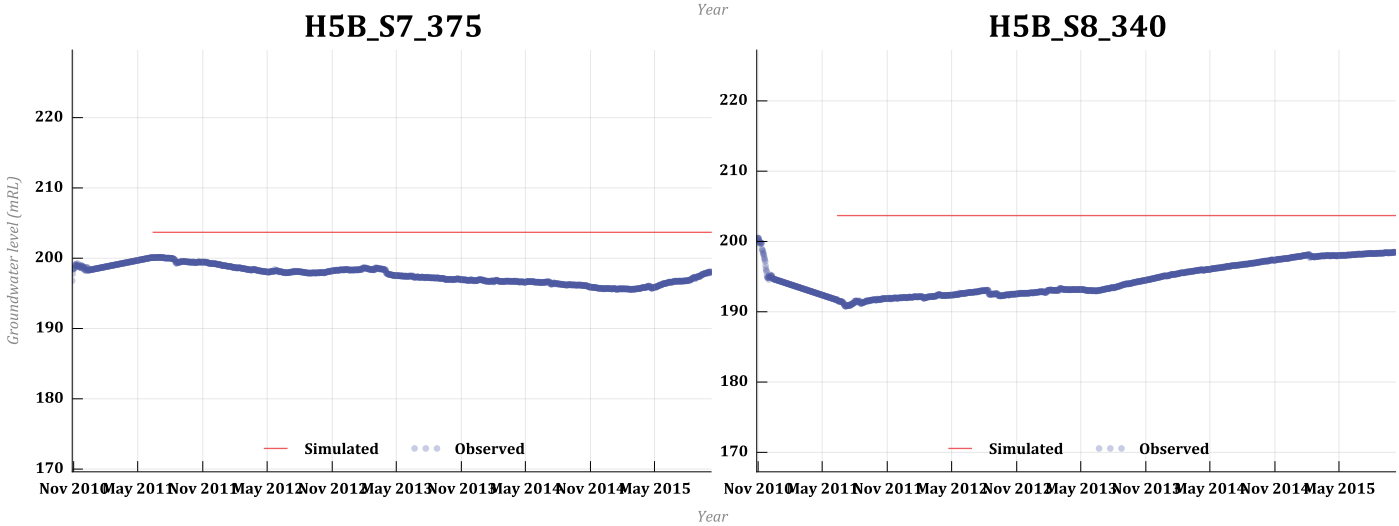
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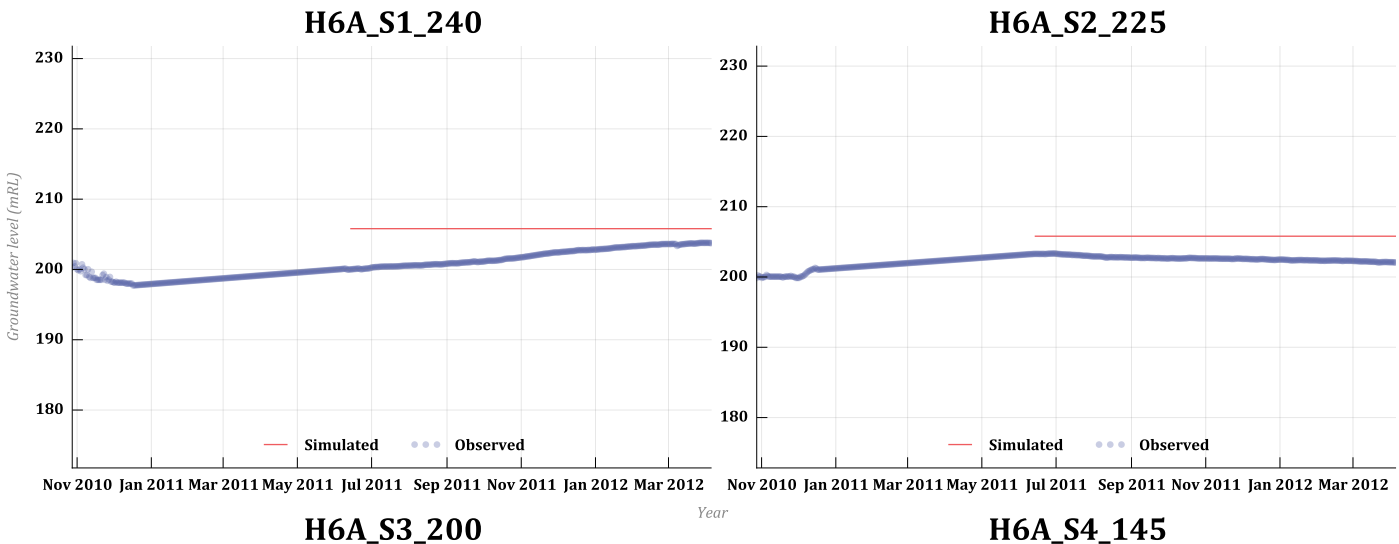
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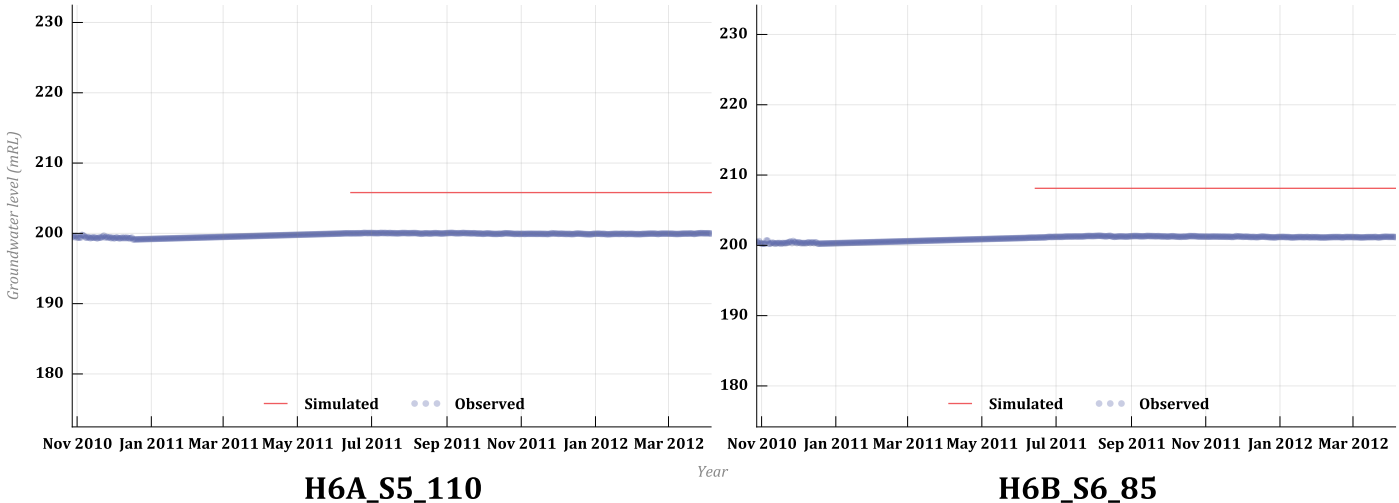
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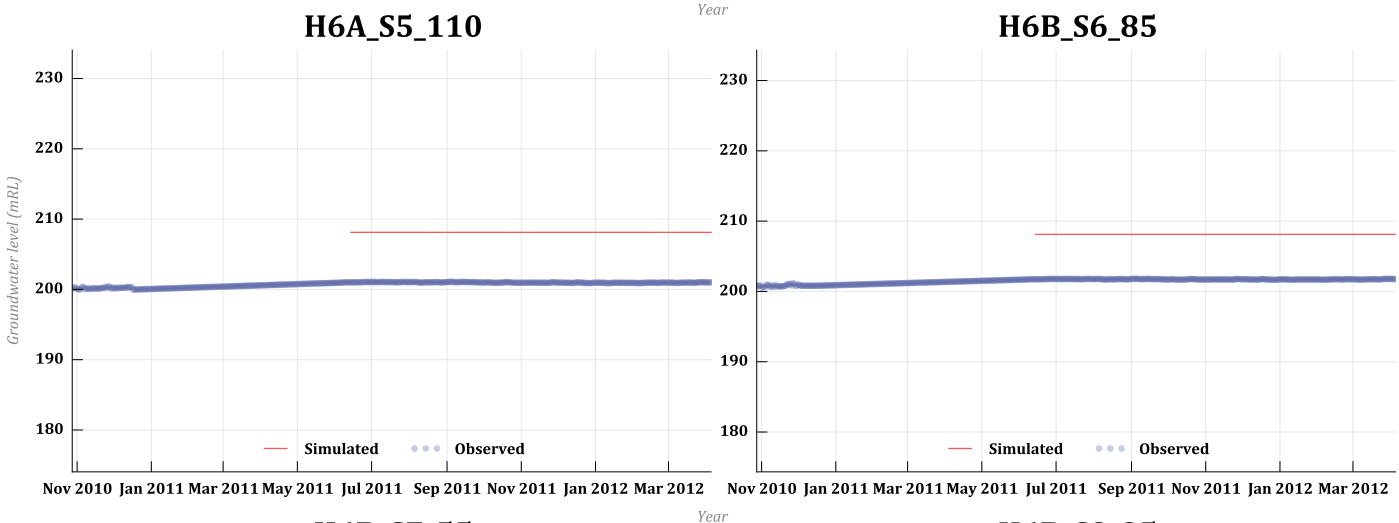
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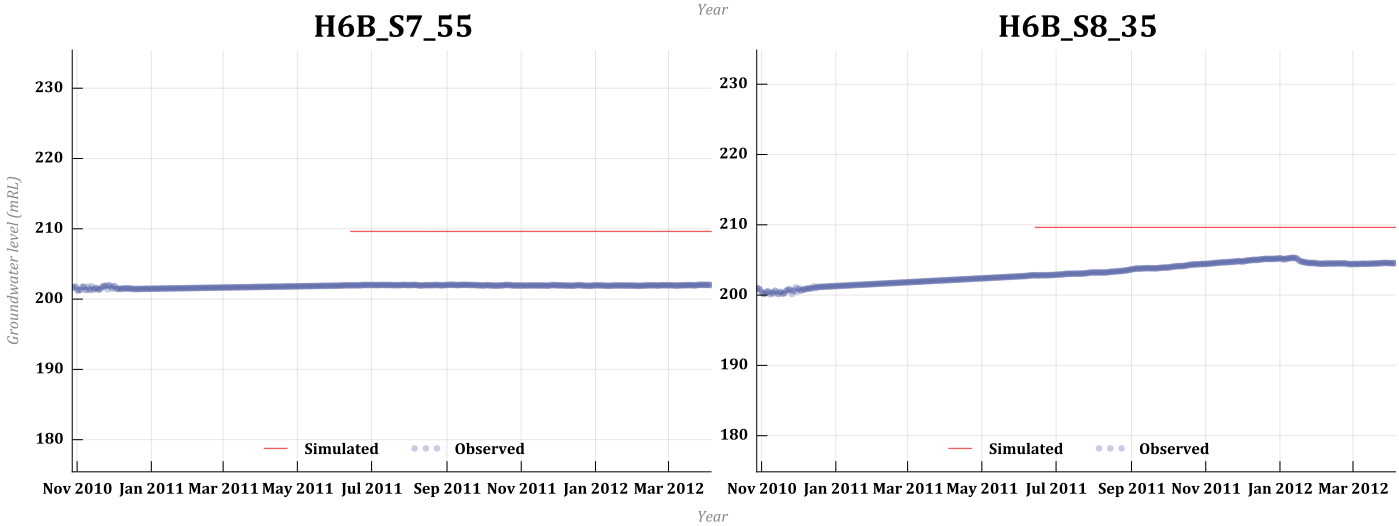
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Year



Year



Year

Appendix G. Surface Water Assessment

Eagle Downs Project

Surface Water Assessment

Eagle Downs Metallurgical Coal
0654-06-B1, 8 December 2022

Report Title	Eagle Downs Project, Surface Water Assessment
Client	Eagle Downs Metallurgical Coal
Report Number	0654-06-B1

Revision Number	Report Date	Report Author	Reviewer
0 [DRAFT]	2 December 2022	DS/KO	GR
1	8 December 2022		GR

For and on behalf of
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Tel 07 3225 0200



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Senior Principal Engineer

NOTE: This report has been prepared on the assumption that all information, data and reports provided to us by our client, on behalf of our client, or by third parties (e.g. government agencies) is complete and accurate and on the basis that such other assumptions we have identified (whether or not those assumptions have been identified in this advice) are correct. You must inform us if any of the assumptions are not complete or accurate. We retain ownership of all copyright in this report. Except where you obtain our prior written consent, this report may only be used by our client for the purpose for which it has been provided by us.

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1 Introduction

1.1 BACKGROUND

The Eagle Downs Metallurgical Coal Project (EDCP), managed by Eagle Downs Metallurgical Coal (EDMC), is an approved multi-seamed underground longwall metallurgical coal mine on a greenfield site in Central Queensland's Bowen Basin. The Project is located approximately 20 km southeast of Moranbah. The Project site is defined by the boundary of the Mining Lease (ML 70389) area and covers an area of approximately 45 km^2. The location of the Project mining lease (ML) area is shown in Figure 1.1.

An Environmental Impact Statement (EIS) was completed for the mine in 2009. The mine project was approved and an environmental authority (EA) was granted under the *Environmental Protection Act* (EP Act) in 2011. The mining lease (ML70389) and Petroleum Lease (PL485) were also granted for the project in 2011 and 2014 respectively. The EA has been amended several times since 2011 and the mine is currently operating under the EA (EPML00586713) which took effect on 3 December 2021. An approval under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (EPBC 2008/3945) was also obtained in 2011 for impacts on listed threatened species and communities within the project footprint. A surface water impact assessment was completed as part of the EIS.

WRM Water & Environment Pty Ltd (WRM) was engaged by EDMC to complete a surface water impact assessment to support an EA amendment application for a revised underground mining layout. In addition, EDCM is required to prepare a Progressive Rehabilitation and Closure Plan (PRCP). The PRCP is required to meet the requirements in sections 126C and 126D of the EP Act, pursuant to section 754 of the EP Act. The assessment will also address the requirements of the PRCP.

1.2 PROJECT DESCRIPTION

The proposed underground longwall mine intends to extract up to 11 Mtpa of Run of Mine (ROM) coal from three coal seams. Access to the mine is via a sealed road from the Peak Downs Mine Road. ROM coal from the conveyor drift portal will transfer directly onto a radial stacker and be stacked on an adjacent ROM coal stockpile. The ROM coal will be reclaimed and conveyed to an onsite Coal Handling and Preparation Plant (CHPP), where it will be crushed, sized, and washed. The underground mine entry will be via a combination of drifts and drafts. Coarse rejects and dewatered fine and ultrafine rejects will be hauled by truck from the CHPP to an on-site Dry Rejects Emplacement Area (DREA). The Life of Mine (LOM) is estimated to by 50 years.

Figure 1.2 shows the conceptual infrastructure layout and Figure 1.3 shows the proposed underground layout. The Project comprises of:

- Underground longwall mining of three coal seams;
- Drift portals and drift material stockpiles;
- Surface infrastructure including mine surface facilities, CHPP, train loading facilities, vent shafts and mine water dams;
- A DREA where dry rejects from the CHPP will be placed during the LOM;
- A nine well 'surface-to-seam' gas drainage system and associated infrastructure;
- Up to 40-Megawatt (MW) gas fired power station, 132 kV/11kV electricity substation and switchyard and 6 km of powerline;
- Mine offices, workshops, and sewage treatment plant;
- Reverse osmosis (RO) plant, brine ponds and mine and raw water dams; and
- Access roads, car parks and laydown areas.

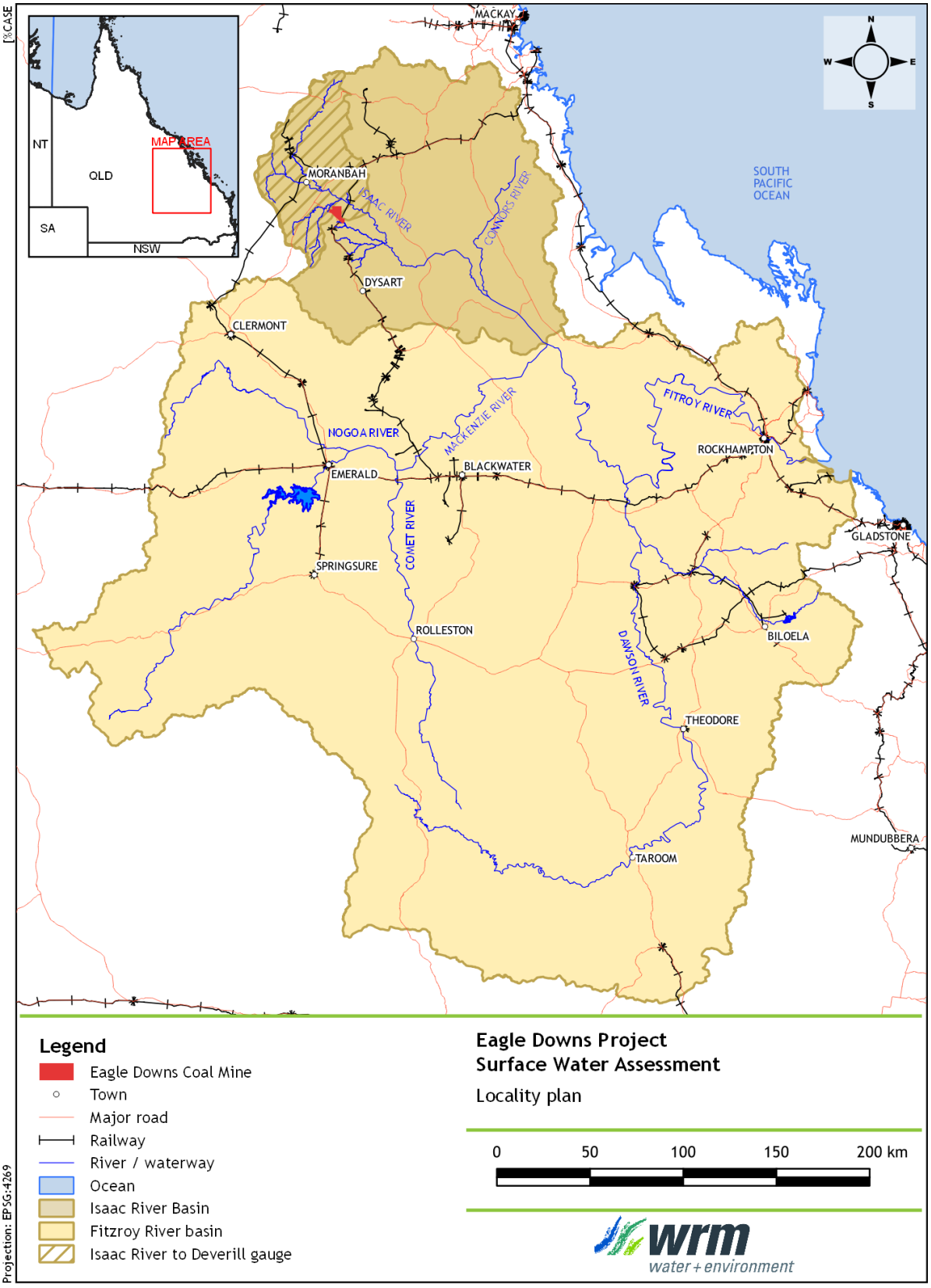


Figure 1.1 – Eagle Downs Project locality

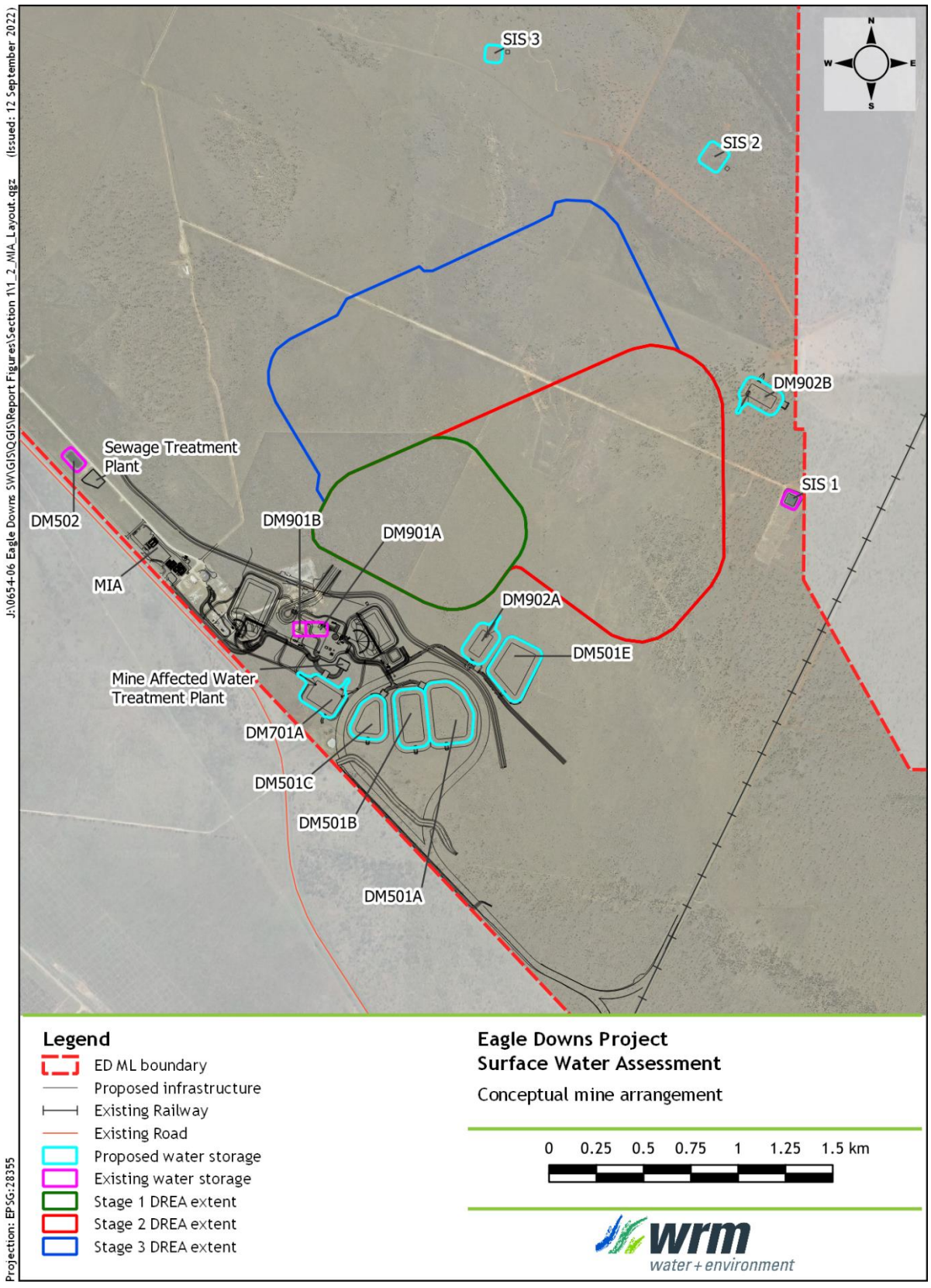


Figure 1.2 – Project conceptual mine layout

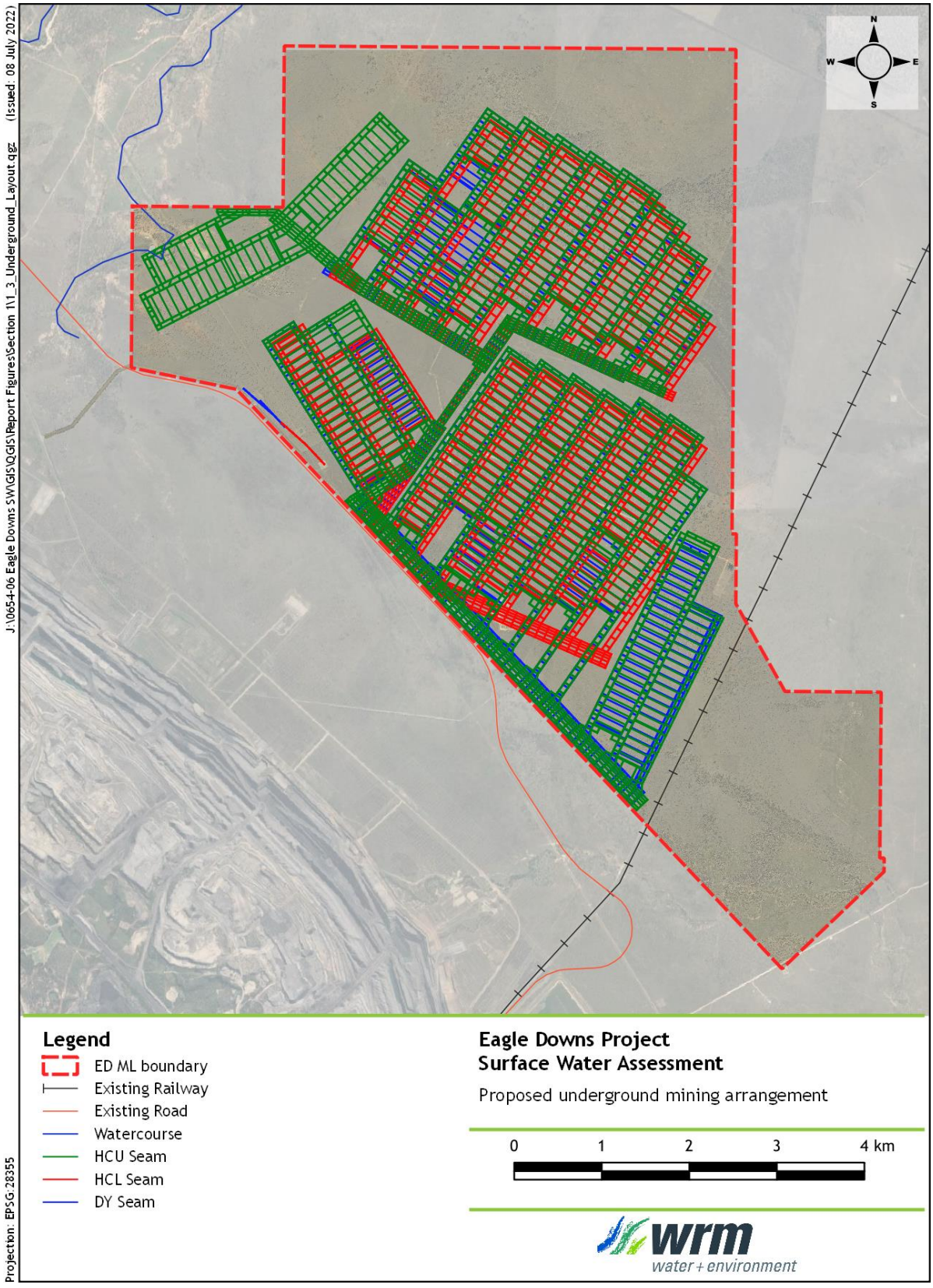


Figure 1.3 – Project underground mine layout

1.3 REPORT STRUCTURE

This report has been structured as follows:

- A description of the existing surface water environment (with reference to previous studies) and the environmental values (Section 2) of the receiving waters.
- A description of the proposed water management system (Section 3)
- Technical chapters outlining the development, calibration, and results of the water balance modelling to demonstrate that the water management strategy and proposed infrastructure can comply with the EA conditions (Section 4 and 5).
- A description of the mine subsidence impacts and the measures proposed to mitigate the impacts (Section 6);
- A technical chapter outlining the development and results of the flood modelling of the mine subsidence and mine infrastructure areas (Section 7):
- A summary of key findings (Section 8).

2 Surface water environment

2.1 GENERAL

This section describes the regional and local drainage characteristics in the vicinity of the Project. The environmental values as defined by the Queensland EP Act, Environmental Protection Policies (EPPs), Australian and New Zealand guidelines for fresh and marine water quality (ANZG, 2018) (ANZG Guidelines) and regulations of these waterways are also described.

2.2 REGIONAL DRAINAGE NETWORK

The Project is located within the Isaac sub-catchment of the greater Fitzroy Basin. The Isaac River is the main watercourse, which flows in a south easterly direction to the east of the Project.

The catchment commences at the Denham Range located about 80 km to the north of the Project. The Isaac River flows in a south westerly direction through the Carborough and Kerlong Ranges before turning in a south easterly direction upstream of Moranbah. The Connors River, which has a catchment area similar to the upstream Isaac River, flows into the Isaac River approximately 80 km southeast (downstream) of the Project. The Isaac River finally converges with the Mackenzie River a further 55 km downstream.

Ultimately, the Mackenzie River joins the Fitzroy River, which flows initially north and then east towards the east coast of Queensland and discharges into the Coral Sea southeast of Rockhampton near Port Alma. Figure 1.1 shows the location of the Project within the broader Fitzroy River catchment upstream of the Connors River confluence. Figure 2.1 shows the drainage characteristics of the Upper Isaac River to the Deverill flow gauge.

The greater Isaac-Connors sub-catchment area is approximately 22,364 square kilometres (km^2) (to the Mackenzie River confluence), out of a total Fitzroy River catchment of 142,665 km^2. That is, it represents around 15% of the overall Fitzroy River catchment.

The catchment area of the Isaac River to the Project area is around 4,100 km^2. This represents around 2.9% of the overall Fitzroy River catchment and 18.3% of the Isaac Connors sub-catchment.

The maximum Project disturbance footprint is approximately 30.6 km^2 and represents 0.02% of the overall Fitzroy River.

The Isaac River is a seasonally flowing watercourse, typically with surface flows in the wetter months from November to April, reducing to shallow subsurface flows from about May to October. All other waterways and drainage lines in the vicinity of the Project area are ephemeral and experience flow only after sustained or intense rainfall in the catchment. Stream flows are highly variable, with most channels drying out during winter to early spring when rainfall and runoff is historically low, although with some pools expected to hold water for extended periods. Therefore, physical attributes, water quality, and the composition of aquatic flora and fauna communities are also expected to be highly variable over time.

The Isaac River catchment upstream of the Project comprises mainly scattered to medium dense bushland, grazing land and the township of Moranbah. There are several existing coal mines in the upstream Isaac River catchment including Burton, North Goonyella, Grosvenor, Goonyella-Riverside, Broadmeadow, Broadlea, Isaac Plains, Isaac Downs, Carborough Downs, Caval Ridge, Peak Downs, Poitrel, Daunia, Millennium and Moranbah North.

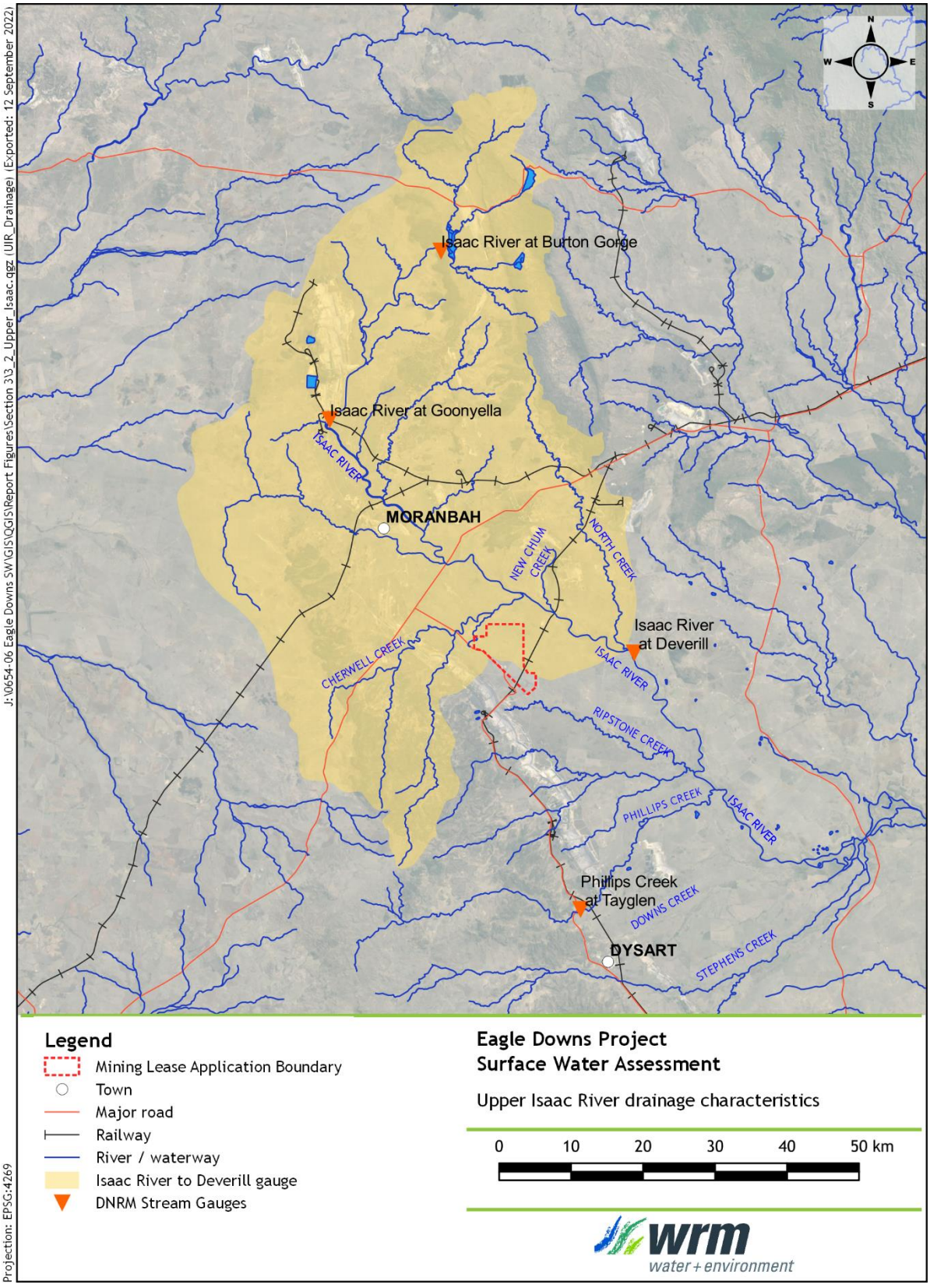


Figure 2.1 – Upper Isaac River drainage characteristics

2.3 LOCAL DRAINAGE NETWORK

2.3.1 Watercourse classification

Figure 2.2 shows the waterways (watercourses and drainage features) in the vicinity of the Project, obtained from the Queensland Government Qspatial website. This dataset is based on the GeoScience Australia 1:100,000 drainage network and has streams connected and directionalised with reaches ordered using Strahler (1957) method of stream ordering. The catchment areas of the waterways that cross the Project site are also shown. The waterways mapped within the vicinity of the Project, include:

- one waterway of (Strahler) stream order six (6) (Isaac River) to the east of the Project area;
- one waterway of stream order five (5) (Cherwell Creek), located to the north of the Project area;
- one waterway of stream order two/three (Ripstone Creek), located to the south the Project area; and
- five waterways of stream order one/two that drain within the Project area into Cherwell Creek, Ripstone Creek or the Isaac River.

The DRDMW (2022) watercourse identification map identifies the Isaac River, Cherwell Creek, Ripstone Creek, JB Gully and an unnamed tributary of Ripstone Creek (Western Branch) (also called Ripplestone Creek) as waterways that exhibit the characteristics of a watercourse as defined by the Water Act.

Ripplestone Creek and JB Gully are the only watercourses defined under the Water Act within the Project Area. The remaining waterways that drain through the Project area are identified as "drainage features" and therefore are not considered watercourses under the Water Act. For the purposes of this assessment, the drainage features have been identified as Feature 1, Feature 2 and Feature 3 as shown in Figure 2.3.

Descriptions of the watercourses and drainage features that cross the Project site are given below.

2.3.2 J B Gully

J B Gully runs north-northeast across the northwest corner of the Project area before connecting to Cherwell Creek. It commences being a defined watercourse at a farm dam at the western boundary of the mining lease with the upper reach being a drainage feature. J B Gully has a catchment area of approximately 26.8 km^2 to Cherwell Creek of which approximately 4.6 km^2 (17.2 %) is within the Project area.

Figure 2.4 shows a longitudinal profile and cross sections of J B Gully channel through the Project area. The locations of each cross section are shown in Figure 2.2. The typical dimensions of the J B Gully channel through the Project area are as follows:

- Channel bed widths of 5 m to 10 m;
- Channel top widths of 20 m to 60 m;
- Channel depths of 0.8 m to 4 m; and

The J B Gully channel will not be disturbed by the Project.

2.3.3 Feature 1

Feature 1 drains the northern portion of the Project area to the east into the Isaac River. Feature 1 has a catchment area of approximately 40.2 km^2 to the Isaac River, of which approximately 23.2 km^2 (57.7 %) is in the Project area.

Figure 2.5 shows a longitudinal profile and cross sections of Feature 1 channel through the Project area. The locations of each cross section are shown in Figure 2.2.

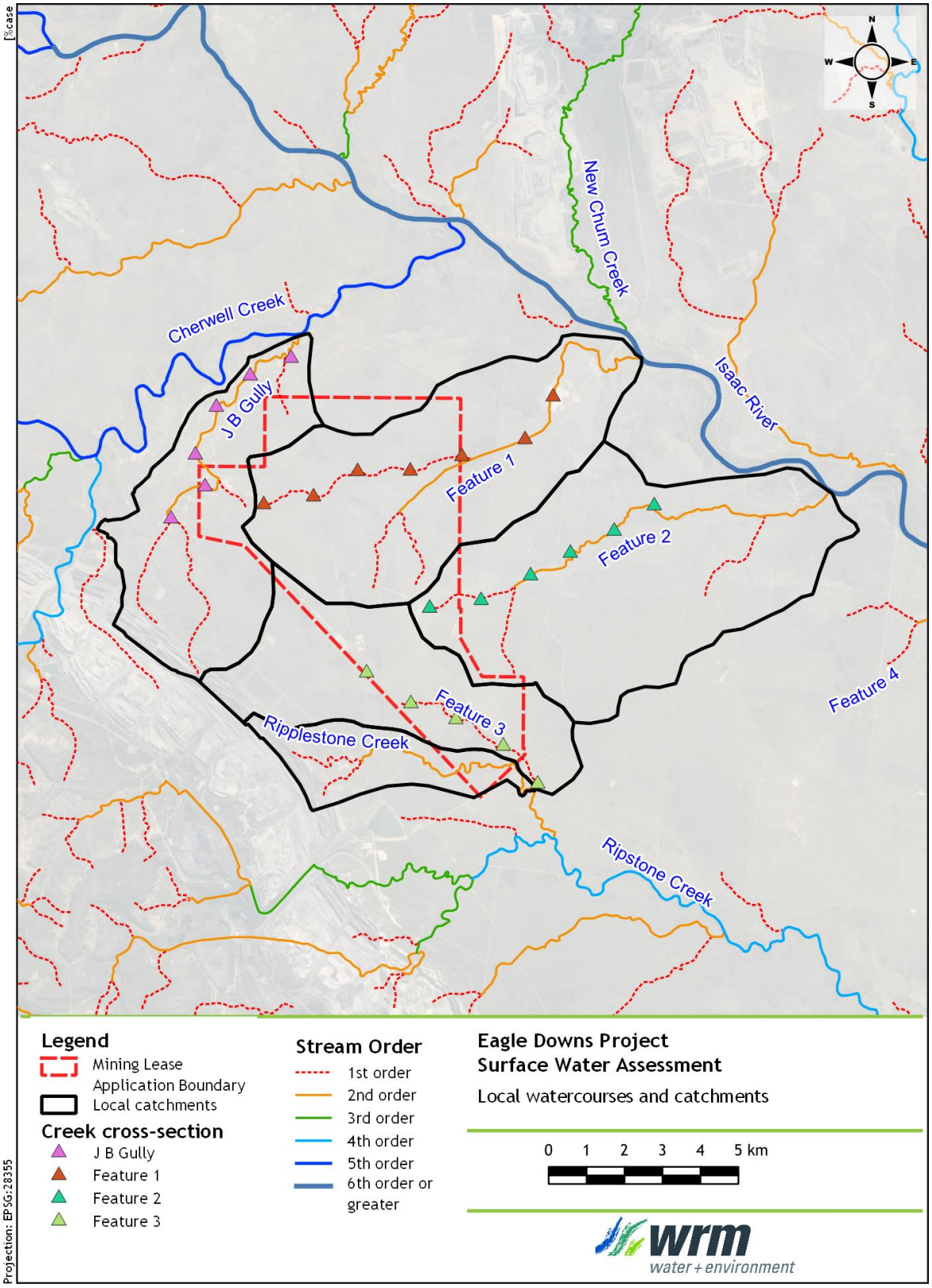


Figure 2.2 – Local waterway catchments

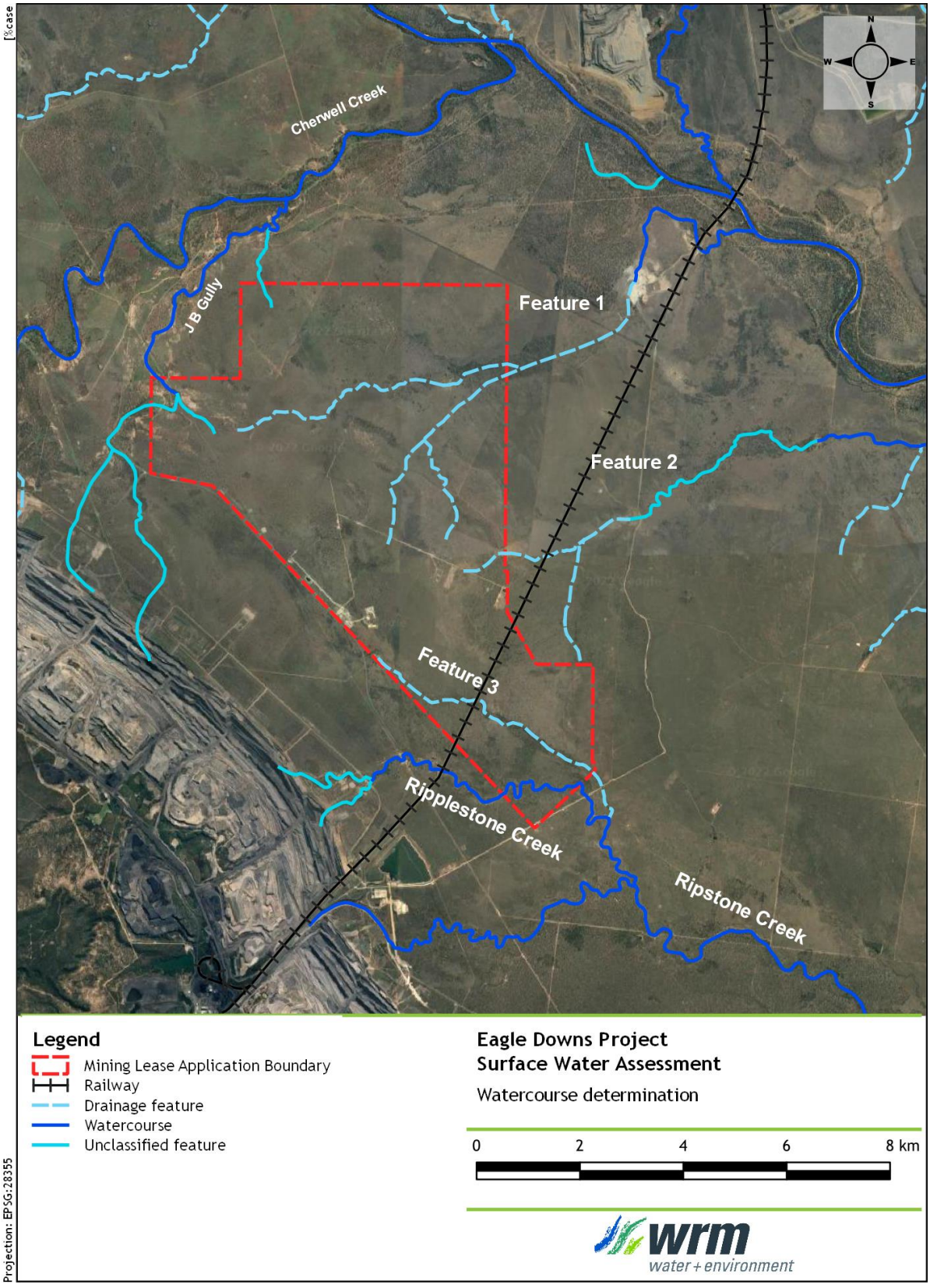


Figure 2.3 – Waterway mapping and watercourse classifications

The typical dimensions of the Feature 1 channel are:

- Channel bed widths of 5 m to 40 m;
- Channel top widths of 30 m to 60 m;
- Channel depths of 0.6 m to 1.0 m; and

As seen in Figure 2.5, the channel depth in the first 4.5 km of chainage reaches a depth of about 1 m with little to no channel. It ultimately tapers out with no channel to exhibit shallow sheet flow (in particular the chainage between 6 km and 9.3 km) before joining the Isaac River.

Feature 1 will be modified as part of the Project. Modifications to the drainage feature includes implementing several drains to assist with draining ponded areas cause by impacts from the mining subsidence.

The downstream reach of Feature 1 drains across the Winchester South MLA. If approved, the Winchester South Project will significantly alter Feature 1.

2.3.4 Feature 2

Feature 2 drains the eastern portion of the Project area to the east into the Isaac River. Feature 2 has a catchment area of approximately 48.5 km^2 to the Isaac River of which approximately 2.7 km^2 (5.6%) is in the Project area.

Figure 2.6 shows a longitudinal profile and cross sections of the Feature 1 channel through the Project area. The locations of each cross section are shown in Figure 2.2. The typical dimensions of the Feature 2 channel are:

- Channel bed widths of 5 m to 40 m;
- Channel top widths of 20 m to 100 m;
- Channel depths of 0.4 m to 0.7 m; and

Feature 2 will not be impacted by the Project. If approved, the Winchester South Project will significantly alter Feature 2.

2.3.5 Feature 3

Feature 3 drains the southeastern corner of the Project area to Ripplestone Creek and is called Ripplestone Creek (Easter Tributary) in the current EA. The Feature 3 catchment extends up to the Peak Downs Mine highwall and will eventually be consumed by Peak Downs Mining. The existing catchment area of Feature 3 to Ripplestone Creek is approximately 25 km^2, of which approximately 11.7 km^2 (46.8 %) is in the Project area.

Figure 2.7 shows a longitudinal profile and cross sections of Feature 3 through the Project area. The locations of each cross section are shown in Figure 2.2. The typical dimensions of the Feature 3 through the Project area are:

- Channel bed widths of 5 m to 20 m;
- Channel top widths of 20 m to 120 m;
- Channel depths of 0.5 m to 2 m; and

The Queensland Globe shows that Feature 3 commences being a drainage feature downstream of the mine infrastructure area. Feature 3 will be modified as part of the Project. Modifications include constructing a channel to drain ponding within mining subsidence.

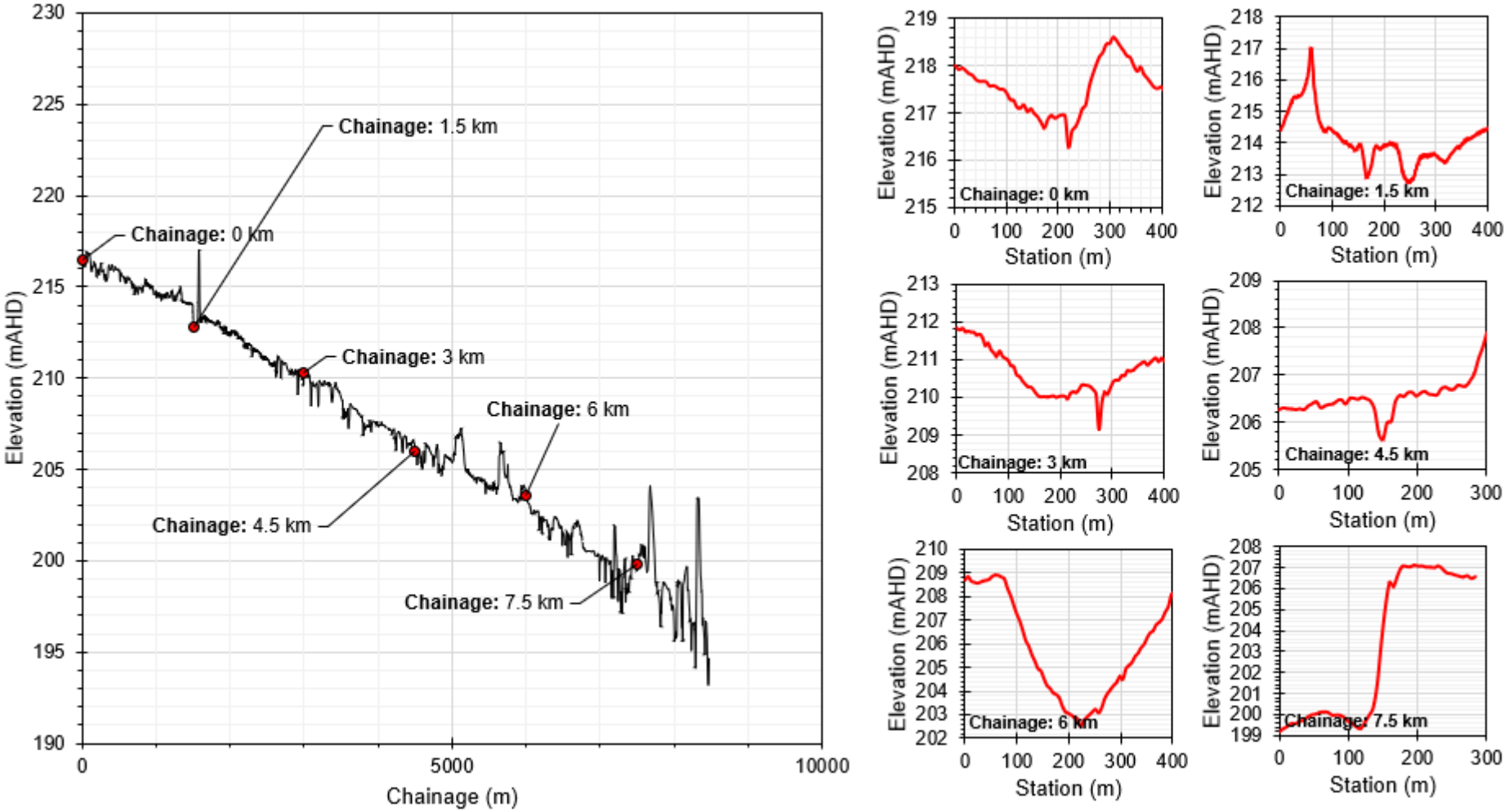


Figure 2.4 – J B Gully longitudinal profile and cross-sections

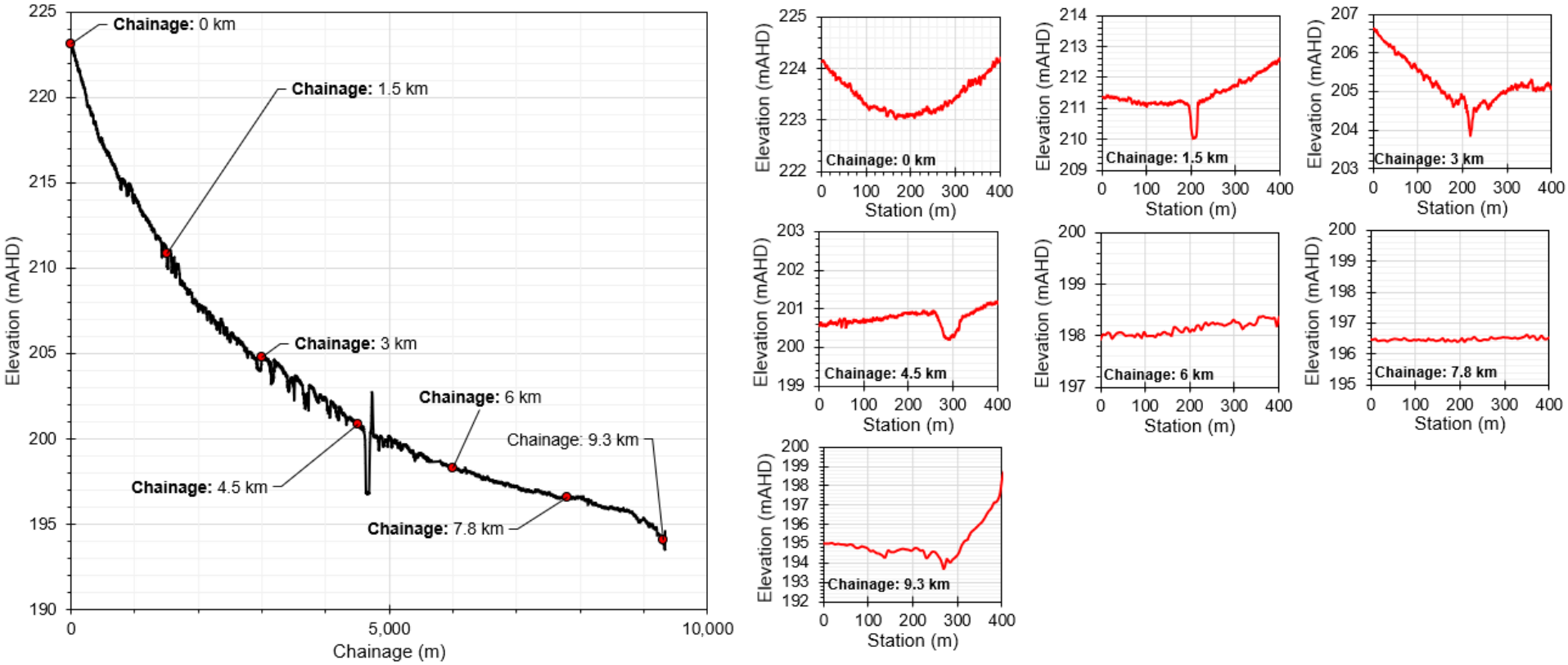


Figure 2.5 – Feature 1 longitudinal profile and cross-sections

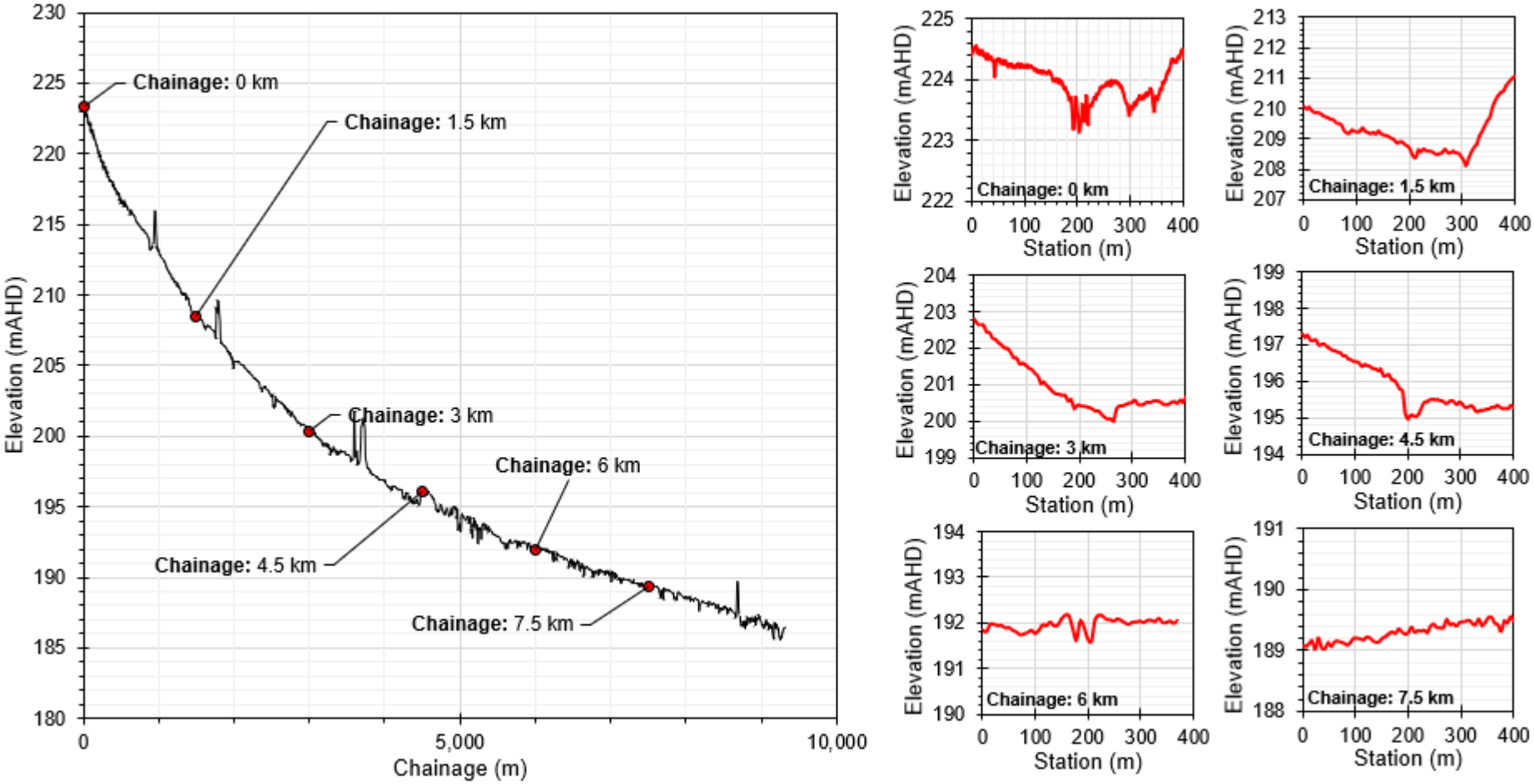


Figure 2.6 – Feature 2 longitudinal profile and cross-sections

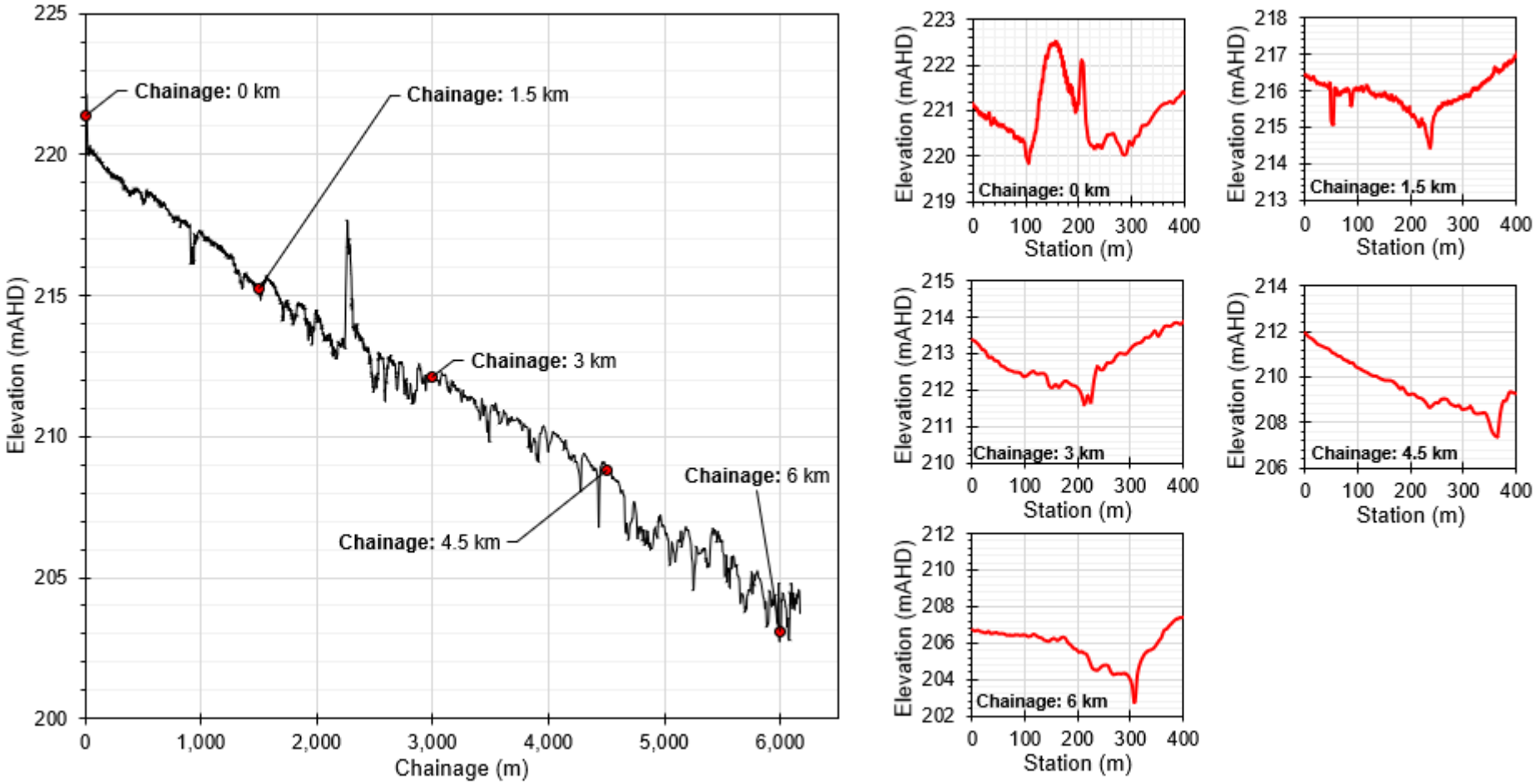


Figure 2.7 – Feature 3 longitudinal profile and cross-sections

2.3.6 Ripplestone Creek

Ripplestone Creek drains across the southern most corner of the Project area in an area that will not be disturbed by mining. The upper headwaters of Ripplestone Creek have been diverted to Ripstone Creek as part of the Peak Downs Mine. The catchment downstream of Peak Downs Mine is proposed to be consumed by Peak Downs mining. Ripplestone Creek drains to Ripstone Creek downstream of the Project area.

2.4 RAINFALL AND EVAPORATION

Long term daily evaporation and rainfall data was sourced from the DES SILO climate data service at the approximate Project coordinates (Latitude: -22.2, Longitude: 148) from January 1889 to December 2021 (i.e., 133 years of data).

Figure 2.8 shows the annual rainfall for the adopted dataset. There is significant variability in the total annual rainfall, with a range from 66 mm to 1233 mm. The mean annual rainfall of the 133 years of available data is 559 mm.

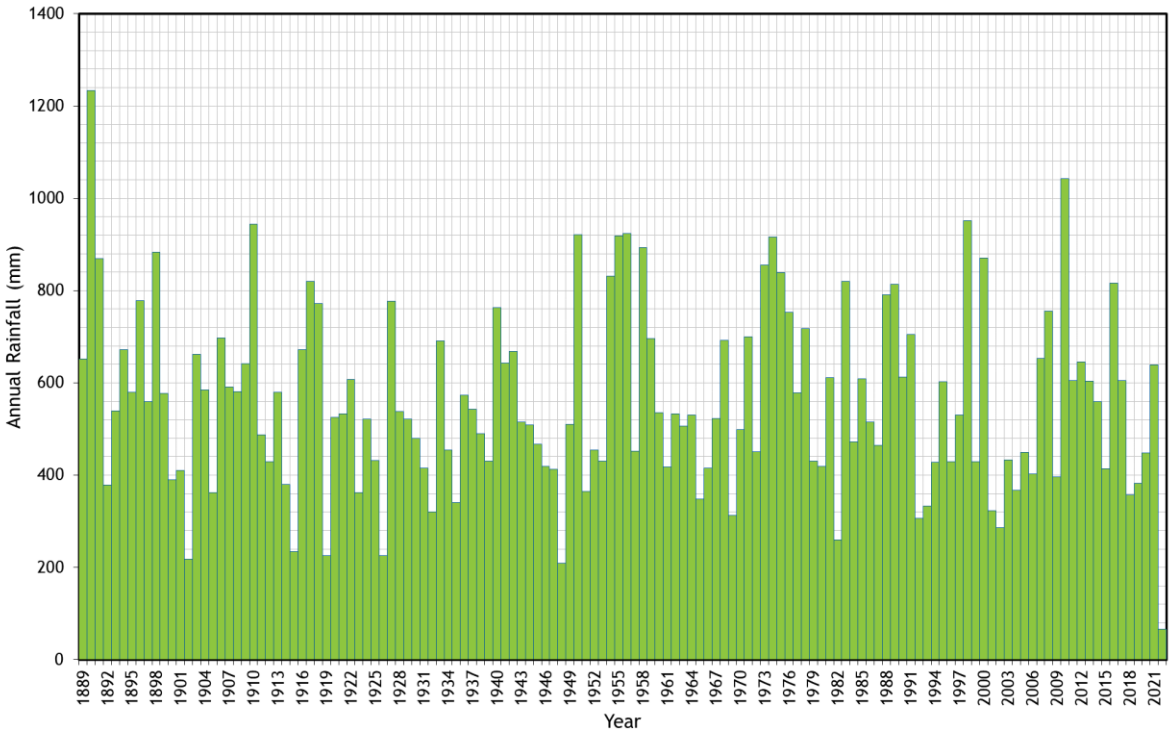


Figure 2.8 – Annual Data Drill rainfall totals

Table 2.1 shows statistics for Morton's lake evaporation and Table 2.2 shows statistics for rainfall (as mm/month and mm/year) over the historical dataset.

Figure 2.9 shows a comparison between the evaporation and rainfall. Rainfall predominantly occurs from November through to March. Evaporation rates are generally higher than rainfall throughout the year.

Table 2.1 – Evaporation (Morton's lake) statistics over the historical period (mm)

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Max	238	205	201	149	117	95	104	143	171	216	223	241	1,986
90th %ile	222	188	185	144	109	88	98	126	162	201	216	228	1,897
Median	200	167	167	132	102	81	91	119	153	190	202	213	1,807
10th %ile	172	144	150	121	93	74	83	111	143	177	182	187	1,735
Min	120	125	128	97	78	61	77	99	123	161	123	146	1,530

Table 2.2 – Rainfall statistics over the historical period (mm)

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Max	474	512	334	316	189	164	141	278	138	154	179	304	1,233
90th %ile	191	194	155	72	61	68	59	51	48	80	111	144	838
Median	87	72	38	18	13	19	5	6	8	18	40	72	533
10th %ile	21	11	5	0	0	0	0	0	0	1	7	23	350
Min	1	0	0	0	0	0	0	0	0	0	0	2	210

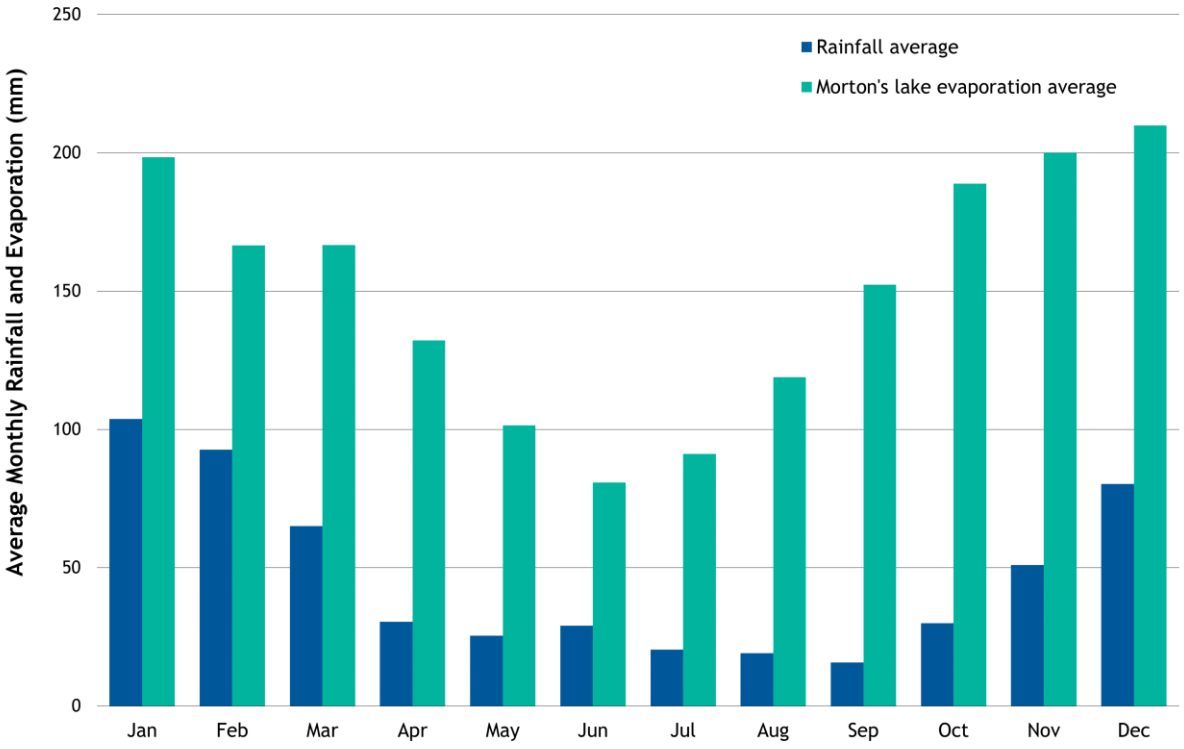


Figure 2.9 – Long term mean monthly rainfall and evaporation from SILO at the Project

2.5 STREAMFLOW

The DRDMW records Isaac River water levels at the Goonyella (upstream) and Deverill (adjacent) gauges. The details of these gauges are provided in Table 2.3. Figure 2.1 shows the Isaac River catchment to the Deverill gauging station adjacent to the Project.

Table 2.3 – DRDMW stream gauges along the Isaac River in the vicinity of the Project

Gauge no.	Gauge name	AMTD (km)	Catchment area (km^2)	Distance from Project (km)	Start	End
130414A	Goonyella	242.8	1,214	38 km NE (upstream)	24/05/1983	23/04/2021
130410A	Deverill	147.7	4,092	15 km E (adjacent)	20/05/1968	-

Historical flow and river height monitoring data at the Goonyella and Deverill gauges suggests that Isaac River flows are 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.

Figure 2.10 shows a ranked plot of the daily stream flows in the Isaac River recorded at the Goonyella and Deverill gauging stations.

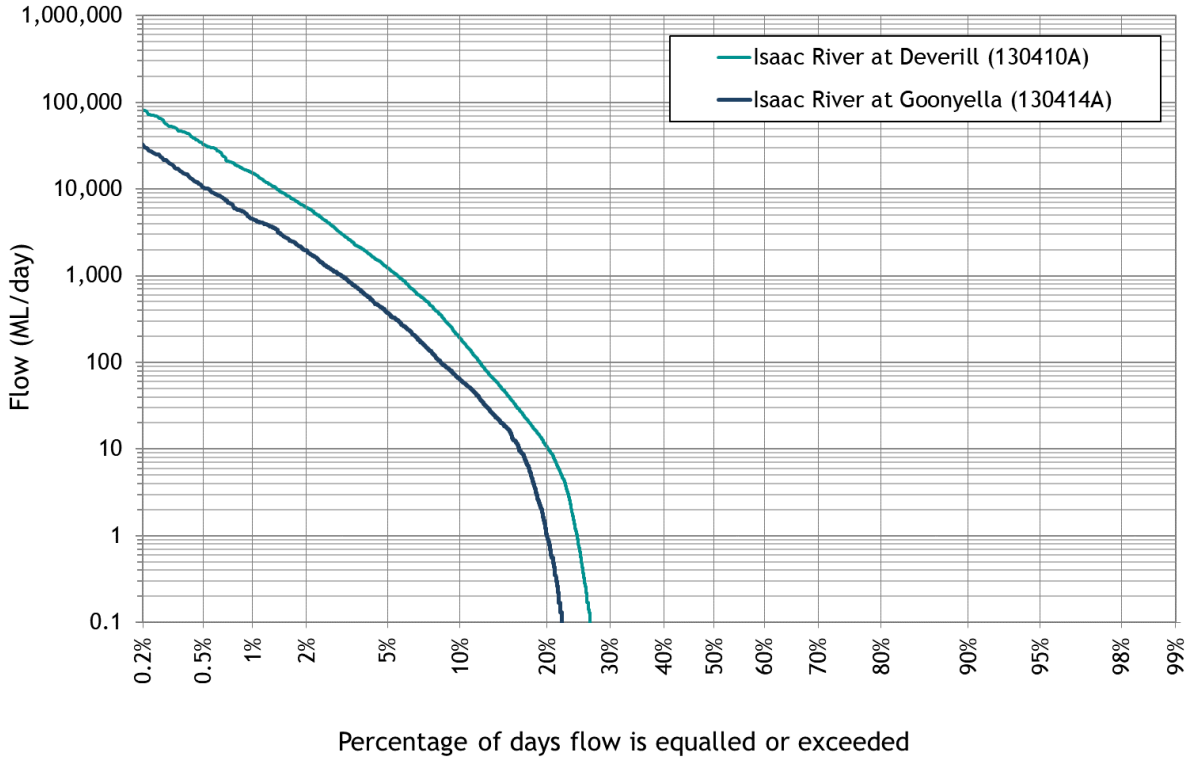


Figure 2.10 – Stream flow duration curves, Isaac River at Deverill and Goonyella gauging stations

The following is of note with respect to the recorded stream flows:

- The Isaac River is ephemeral with flows above 100 megalitres per day (ML/d) recorded less than 8.5% of days at Goonyella and 11.9% of days at Deverill. A flow of 100 ML/d is a low flow (approximately 1.1 m^3/s) and would not fully inundate the bed of the Isaac River at either location.

- The mean daily flow (all days) is 297 ML/d and 739 ML/d at Goonyella and Deverill, respectively.
- The highest recorded flow (1,734 cubic metres per second [m^3/s]) at the Goonyella gauging station occurred in January 1991, which reached a gauge height of 8.8 m. The highest recorded flow (2,638 m^3/s) at the Deverill gauge occurred in March 1988 where the river reached a gauge height of 11.4 m.

2.6 ENVIRONMENTAL VALUES

The EPP (Water), which is subordinate legislation to the EP Act, provides a framework for identifying Environmental Values (EVs) for a waterway and deciding Water Quality Objectives (WQOs) to protect or enhance those EVs. EVs for water are the qualities of water that make it suitable for supporting aquatic ecosystems and human water uses. These EVs need to be protected from the effects of habitat alteration, contaminated runoff and releases and changed flow to ensure healthy aquatic ecosystems and waterways that are safe for community use.

The main waterway in the vicinity of the Project is the Isaac River and is located within the Isaac and lower Connors River main channel region of the Isaac River Sub-Basin (WQ1301). The other waterway in the general vicinity of the Project is Ripstone Creek and is located within the Isaac western upland tributaries region of the Isaac River Sub-Basin. The EVs for this region are the same as for the main channel region, except for the addition of the aquaculture EV.

The EVs selected for protection include:

- aquatic ecosystem protection (slightly to moderately disturbed ecosystems);
- irrigation, farm use and stock watering;
- human consumption;
- primary, secondary and visual recreation;
- drinking water;
- industrial use;
- cultural and spiritual values; and
- aquaculture (Ripstone Creek only).

In summary, the key EVs for water that are to be protected are:

- physical, chemical and biological integrity of the watercourses within the catchment and their amenity as potential water sources for human use and to support aquatic ecosystems and aquaculture (Ripstone Creek only);
- the qualitive and quantitative integrity of local groundwater as a potential water source for agriculture or other suitable uses; and
- the integrity of raw water supplies and associated infrastructure in the region.

2.7 WATER QUALITY OBJECTIVES

The indicators and water quality guidelines relevant to the above EVs are listed in the WQGs and ANZG (2018). The conditions of waterways located in the vicinity of the Project are classified as slightly to moderately disturbed ecosystems under the WQGs (DEHP, 2013).

The WQOs relevant to the identified EVs are provided in Table 2.4. Where different EVs have different WQOs, the most conservative value has been adopted. WQOs are displayed for physio-chemical parameters only.

Table 2.4 – Water quality objectives, Isaac and Lower Connors River Main Channel

Parameter	WQO	Relevant EV
Ammonia N	< 0.02 mg/L	Aquatic ecosystem[b]
Oxidised N	< 0.06 mg/L	Aquatic ecosystem[b]
Organic N	< 0.42 mg/L	Aquatic ecosystem[b]
Total nitrogen	< 0.5 mg/L	Aquatic ecosystem[b]
Filterable Reactive Phosphorus (FRP)	< 0.02 mg/L	Aquatic ecosystem[b]
Total Phosphorus	< 0.05 mg/L	Aquatic ecosystem[b]
Chlorophyll a	< 0.005 mg/L	Aquatic ecosystem[b]
Dissolved oxygen	85-110% saturation	Aquatic ecosystem[b]
	> 4 mg/L at surface	Drinking water[c]
Turbidity	< 50 NTU	Aquatic ecosystem[b]
Suspended solids	< 55 mg/L	Aquatic ecosystem[b]
pH	pH 6.5-8.5	Aquatic ecosystem[b]
Conductivity (EC) baseflow	< 720 µS/cm	Aquatic ecosystem[b]
Conductivity (EC) high flow	< 250 µS/cm	Aquatic ecosystem[b]
Sulphate	< 25 mg/L	Aquatic ecosystem[b]
Total Dissolved Solids	< 2000 mg/L	Stock watering[d]
Colour	50 Hazen Units	Drinking water[c]
Total Hardness	150 mg/L as CaCO3	Drinking water[c]
Sodium	< 30 mg/L	Drinking water[c]
Aluminium	< 20 mg/L	Irrigation[g,e]
	< 5 mg/L	Stock watering[f]
	< 0.055 mg/L (pH > 6.5)	Aquatic ecosystem[a]
Arsenic	2.0 mg/L	Irrigation[g,e]
	0.5 mg/L up to 5 mg/L	Stock watering[f]
	< 0.013 mg/L	Aquatic ecosystem[b]
Beryllium	< 0.5 mg/L	Irrigation[g,e]
Boron	< 5 mg/L	Stock watering[f]
	< 0.94 mg/L	Aquatic ecosystem[k]
Cadmium	< 0.01 mg/L	Stock watering[f]
	< 0.0002 mg/L	Aquatic ecosystem[a]
Chromium	< 1 mg/L	Irrigation[g,e]
	< 1 mg/L	Stock watering[f]
	< 0.001 mg/L	Aquatic ecosystem[a]
Cobalt	< 0.1 mg/L	Irrigation[g,e]
	< 0.0014 mg/L	Aquatic ecosystem[h]
Copper	< 5 mg/L	Irrigation[g,e]
	< 1 mg/L	Stock watering (cattle)[f]
	< 0.0014 mg/L	Aquatic ecosystem[a]
Fluoride	< 2 mg/L	Irrigation[g,e]
Iron	< 10 mg/L	Irrigation[g,e]
	< 0.18 mg/L	Aquatic ecosystem[l]
Lead	< 5 mg/L	Irrigation[g,e]

Parameter	WQO	Relevant EV
	< 0.1 mg/L	Stock watering[f]
	< 0.0034 mg/L	Aquatic ecosystem[a]
Lithium	< 2.5 mg/L	Irrigation[g]
Manganese	< 10 mg/L	Irrigation[g,e]
	< 1.9 mg/L	Aquatic ecosystem[a]
Mercury	< 0.002 mg/L	Irrigation[g]
	< 0.0002 mg/L	Aquatic ecosystem[i]
Molybdenum	< 0.05 mg/L	Irrigation[g,e]
	< 0.034 mg/L	Aquatic ecosystem[h]
Nickel	< 2 mg/L	Irrigation[g,e]
	< 1 mg/L	Stock watering[f]
	< 0.011 mg/L	Aquatic ecosystem[a]
Selenium	< 0.05 mg/L	Irrigation[g,e]
	< 0.02 mg/L	Stock watering[f]
	< 0.005 mg/L	Aquatic ecosystem[a]
Silver	< 0.00005 mg/L	Aquatic ecosystem[a]
Uranium	< 0.1 mg/L	Irrigation[g,e]
	< 0.001 mg/L	Aquatic ecosystem[i]
Vanadium	< 0.5 mg/L	Irrigation[g,e]
	< 0.01 mg/L	Aquatic ecosystem[i]
Zinc	< 5 mg/L	Irrigation[g,e]
	< 0.008 mg/L	Aquatic ecosystem[a]
Nitrate as N	< 1.1 mg/L	Stock watering[j]

a/ Table 3.4.1 of ANZECC & ARMCANZ (2000): trigger values for slightly-moderately disturbed systems (95% level of protection)

b/ Table 2 of Isaac River Sub-Basin EVs and WQOs: Aquatic ecosystem – moderately disturbed

c/ Table 4 of Isaac River Sub-Basin EVs and WQOs: Drinking water EV

d/ Table 10 of Isaac River Sub-Basin EVs and WQOs: Stock watering EV: salinity

e/ short-term trigger value

f/ Table 11 of Isaac River Sub-Basin EVs and WQOs: Stock watering EV: heavy metals and metalloids

g/ Table 9 of Isaac River Sub-Basin EVs and WQOs: Irrigation EV: heavy metals and metalloids

h/ Section 8.3.7 of ANZECC & ARMCANZ (2000): low reliability guideline

i/ Based on Limit of Reporting (LOR) for ICPMS/CV FIMS analytical methods

j/ Based on ambient WQGs (2006) for total nitrogen –standard trigger value for contemporary environmental authorities in Bowen Basin

k/ Based on 95% level of protection in Toxicant default guideline values for aquatic ecosystem protection: Boron in fresh water (ANZG, 2020)

l/ Based on 95% level of protection in Toxicant default guideline values for aquatic ecosystem protection: Total iron in fresh water (ANZG, 2020)

mg/L = milligrams per litre, NTU = Nephelometric Turbidity Units, µS/cm = microSiemens per centimetre.

2.8 WATER QUALITY

The Isaac River catchment has seen significant changes in land use over the past 50 years. Widespread land clearing and coal mine development have occurred throughout the catchment. The extent to which these activities have affected water quality is difficult to ascertain. Coal mines have historically discharged mine-affected water immediately following significant rainfall events, but few records are available of the timing and quality of these releases. Typically, under normal conditions, water is conserved on-site to provide water for site use.

Water quality monitoring results in the vicinity of the Project are available from a number of gauging stations, in addition to the baseline monitoring that has been undertaken by the neighbouring Olive Downs Project. Details on the various gauges are displayed in Table 2.5 and their locations are shown in Figure 2.11.

2.8.1 Regional Isaac River water quality

Publicly available regional water quality data for the Isaac River at the Burton Gorge, Goonyella and Deverill gauging stations and at Red Hill Mining Lease (Lower and Upper Isaac River locations) have been analysed and a comparison of the water quality statistics at these sites are displayed in Table 2.6 and Table 2.7. These sites were selected because complete datasets (i.e., individual sample analysis results) are publicly available as opposed to only summary data being publicly available.

The Red Hill, Isaac River (Burton Gorge) and Isaac River (Goonyella) stations are located downstream of the Goonyella, North Goonyella, Broadlea and Burton mines and therefore measured water quality may be affected by mine releases. The Red Hill, Isaac River (Burton Gorge) and Isaac River (Goonyella) stations are about 70 km, 85 km and 50 km upstream of the Project, respectively. However, these stations provide an indication of water quality, including metal toxicants, in the Isaac River upstream of the Project.

Table 2.6 shows that some readings at the DRDMW monitoring locations along the Isaac River are at or above the regional default guideline values (DGVs) (the highlighted cells), including the following:

- Dissolved aluminium at Goonyella and Deverill (80th percentile);
- Dissolved copper at Goonyella and Deverill (median and 20th/80th percentile);
- Electrical conductivity (EC) at Goonyella and Deverill (median and 80th percentile) exceeds the high flow DGV;
- Dissolved iron at Burton Gorge (median and 80th percentile) and Goonyella (80th percentile);
- Total nitrate at all three sites (median and 80th percentile);
- Total sodium at Burton Gorge/Deverill (80th percentile) and Goonyella (median and 80th percentile);
- Sulphate at Goonyella (80th percentile);
- Total suspended solids (TSS) at all three sites (median and 80th percentile values);

The figures indicate:

- The EC for high flows greater than 200 m^3/s varies much more than at Deverill but are generally below 410 µS/cm for 100% of readings.
- The high flow EC since 2011 has generally been below the high flow WQO (92% of readings).
- The low flow EC has frequently been above the low flow WQO of 410 µS/cm (30% of readings). Figure 4.15 shows that EC rises during extended baseflow periods, which would be associated with either the Connors River or an increase in baseflow in the reach between Deverill and Yatton gauges.
- The recorded low flow EC is generally less than at Deverill.
- Turbidity at Burton Gorge (median and 20th/80th percentile) and Goonyella/Deverill (median and 80th percentile); and
- Dissolved zinc at Goonyella/Deverill (median and 20th/80th percentile).

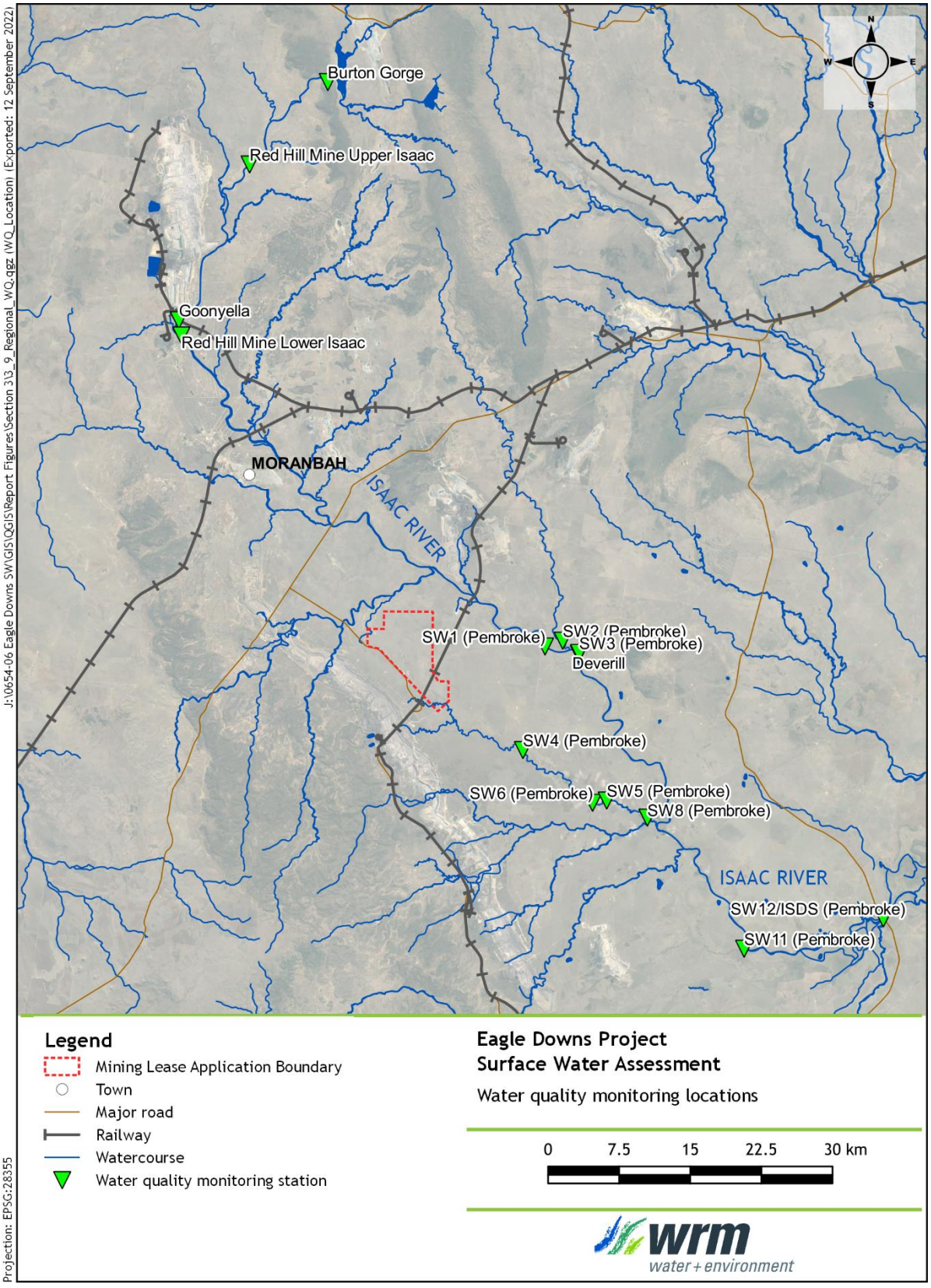


Figure 2.11 – Water quality monitoring locations

Table 2.5 – Water quality data monitoring locations

Site name	Watercourse	Location		Data source	Duration of record	No. of samples	Analytes
		Easting	Northing				
Burton Gorge	Isaac River	616,225	7,607,969	DRDMW	2 Jun 1973 – 6 Dec 1985	18	Range[1]
Goonyella	Isaac River	600,501	7,582,839	DRDMW	12 Dec 1983 – 25 Mar 2013	30	Range[2]
Deverill	Isaac River	642,713	7,548,620	DRDMW	6 Jul 1964 – 18 Mar 2020	56	Range[3]
Red Hill Mine Upper Isaac	Isaac River	607,968	7,599,274	BMA (Red Hill EIS)	18 Nov 2010 – 4 Apr 2011	45	Range[4]
Red Hill Mine Upper Isaac	Isaac River	600,772	7,581,218	BMA (Red Hill EIS)	14 Nov 2010 – 4 Apr 2011	51	Range[4]
Olive Downs ISDS	Isaac River	674,831	7,519,709	Pembroke	22 Dec 2016 - 24 Apr 2019	Continuous	Temp, EC, pH
SW1 (Pembroke)	Isaac River	639,138	7,548,409	Pembroke	15 Aug 2017 – 26 Mar 2019	10	Range[4]
SW2 (Pembroke)	Isaac River	641,008	7,549,014	Pembroke	19 Jul 2017 – 26 Mar 2019	12	Range[4]
SW3 (Pembroke)	Isaac River	642,739	7,547,772	Pembroke	15 Aug 2017 – 26 Mar 2019	18	Range[4]
SW4 (Pembroke)	Ripstone Creek	636,806	7,537,472	Pembroke	20 Jul 2017 & 13 Nov 2018	2	Range[4]
SW5 (Pembroke)	Ripstone Creek	645,648	7,532,150	Pembroke	13 Nov 2018	1	Range[4]
SW6 (Pembroke)	Ripstone Creek	644,154	7,531,910	Pembroke	20 Jul 2017 & 13 Nov 2018	2	Range[4]
SW8 (Pembroke)	Boomerang Creek	649,936	7,530,350	Pembroke	20 Jul 2017 - 14 Feb 2019	4	Range[4]
SW11 (Pembroke)	Isaac River	660,142	7,516,508	Pembroke	13 Sep 2017 - 26 Mar 2019	9	Range[4]
SW12 (Pembroke)	Isaac River	674,831	7,519,709	Pembroke	13 Sep 2017 - 26 Mar 2019	14	Range[4]

Range 1: Conductivity @ 25C , Turbidity, Colour True, pH, Total Alkalinity as CaCO3, Hydroxide as OH, Carbonate as CO3, Bicarbonate as HCO3, Hardness as CaCO3, Hydrogen as H, Total Dissolved Solids, Total Dissolved Ions, Total Suspended Solids, Calcium as Ca soluble, Chloride as Cl, Magnesium as Mg soluble, Nitrate as NO3, Potassium as K, Sodium as Na, Sulphate as SO4, Boron as B, Fluoride as F, Iron as Fe soluble, Silica as SiO2 soluble.

Range 2: Conductivity @ 25C , Turbidity, Colour True, pH, Total Alkalinity as CaCO3, Hydroxide as OH, Carbonate as CO3, Bicarbonate as HCO3, Hardness as CaCO3, Hydrogen as H, Total Dissolved Solids, Total Dissolved Ions, Total Suspended Solids, Calcium as Ca soluble, Chloride as Cl, Magnesium as Mg soluble, Nitrate as NO3, Total Nitrogen, Organic Nitrogen, Nitrate + nitrite as N soluble, Ammonia as N – soluble, Oxygen (Dissolved), Total Phosphorus as P, Total React P, Potassium as K, Sodium as Na, Sulphate as SO4, Aluminium as Al soluble, Boron as B, Copper as Cu soluble, Chromium as Cr, Copper as Cu, Cyanide as CN, Fluoride as F, Iron as Fe soluble, Lead as Pb, Manganese as Mn soluble, Mercury as Hg, Nickel as Ni, Selenium as Se, Silica as SiO2 soluble, Zinc as Zn soluble.

Range 3: Conductivity @ 25C , Turbidity, Colour True, pH, Total Alkalinity as CaCO3, Hydroxide as OH, Carbonate as CO3, Bicarbonate as HCO3, Hardness as CaCO3, Hydrogen as H, Total Dissolved Solids, Total Dissolved Ions, Total Suspended Solids, Calcium as Ca soluble, Chloride as Cl, Magnesium as Mg soluble, Nitrate as NO3, Kjeldahl Nitrogen, Total Nitrogen, Organic Nitrogen, Nitrate + nitrite as N soluble, Ammonia as N – soluble, Oxygen (Dissolved), Total Phosphorus as P, Total React P, Potassium as K, Sodium as Na, Sulphate as SO4, Aluminium as Al soluble, Boron as B, Copper as Cu soluble, Fluoride as F, Iron as Fe soluble, Manganese as Mn soluble, Silica as SiO2 soluble, Zinc as Zn soluble.

Range 4: Total Aluminium, Total Ammonia, Total Antimony, Total Arsenic, Total Barium, Total Beryllium, Total Boron, Total Cadmium, Total Calcium, Total Chloride, Total Chromium, Total Copper, Total Cyanide, Total Fluoride, Total Iron, Total Lead, Total Magnesium, Total Manganese, Total Mercury, Total Molybdenum, Total Nickel, Total Nitrate, Total Nitrite, Total Oxygen, pH, Total Potassium, Total Selenium, Total Sodium, Total Sulphate, Total Zinc, Total Ammonium, Chlorophyll a, Filterable Reactive Phosphorous, Electrical Conductivity, Total Nitrogen, Total Phosphorus, Total Dissolved Solids, Turbidity, Cobalt, Dissolved Aluminium, Dissolved Antimony, Dissolved Arsenic, Dissolved Beryllium, Dissolved Boron, Dissolved Cadmium, Dissolved Calcium, Dissolved Chromium, Dissolved Copper, Dissolved Iron, Dissolved Lead, Dissolved Magnesium, Dissolved Manganese, Dissolved Mercury, Dissolved Molybdenum, Dissolved Nickel, Dissolved Potassium, Dissolved Selenium, Dissolved Zinc, Oil and Grease, MBAS, Chemical Oxygen Demand, Bicarbonate Alkalinity, Total Alkalinity, C6-C9, C10-C14, C15-C28, C29-C36, BOD, C10-C36 Fraction, NO2+NO3, Orthophosphate as P, Dissolved Cobalt, Total Silver, Dissolved Silver, Dissolved Uranium, Total Uranium, Dissolved Vanadium, Total Vanadium.

Table 2.6 – Regional Isaac River water quality summary – DRDMW gauges

Parameter	Unit	Isaac River @ Burton Gorge				Isaac River @ Goonyella				Isaac River @ Deverill				Default Guideline Value
		No. of samples	20th %ile value	Median value	80th %ile value	No. of samples	20th %ile value	Median value	80th %ile value	No. of samples	20th %ile value	Median value	80th %ile value	(refer Table 3.1)
Aluminium (dissolved)	mg/L	-	-	-	-	13	<0.050	<0.050	0.056	14	<0.050	<0.050	0.132	< 0.055 (aquatic)
Boron (total)	mg/L	4	0.03	0.03	0.034	30	0.04	0.08	0.12	21	0.04	0.06	0.09	< 5 (stock)
Copper (dissolved)	mg/L	-	-	-	-	13	0.012	0.030	0.050	16	0.010	0.030	0.030	< 0.0014 (aquatic)
Electrical Conductivity	µS/cm	19	169	458	644	33	195	512	1140	27	119	251	389	< 720 (baseflow) < 250 (high flow)
Fluoride (total)	mg/L	19	0.1	0.19	0.22	33	0.1	0.2	0.32	26	0.10	0.14	0.20	< 2 (irrigation)
Iron (dissolved)	mg/L	5	0.4	1.0	7.0	30	0.01	0.04	0.234	17	0.020	0.060	0.168	< 0.18 (aquatic)
Manganese (dissolved)	mg/L	-	-	-	-	15	0.008	0.01	0.02	13	0.001	0.01	0.01	< 1.9 (aquatic)
Nitrate (total)	mg/L	9	0.4	1.5	3.6	30	0.98	1.96	3.48	20	0.5	1.1	3.0	< 1.1 (aquatic)
pH	-	19	7.4	7.8	8	33	7.2	7.7	8	26	7.226	7.6	8	6.5-8.5 (aquatic)
Phosphorus (total)	mg/L	-	-	-	-	10	0.041	0.203	0.344	12	0.043	0.089	0.565	< 50 (aquatic)
Sodium (total)	mg/L	19	18	33	58	33	21	67	188	26	12	22	40	< 30 (drinking)
Sulphate (total)	mg/L	13	2.7	4.3	9.8	33	4.7	10	75.4	25	7	10	15.82	< 25 (aquatic)
Total Dissolved Solids	mg/L	19	122	255	353	33	114	280	622	26	81.2	155	219	< 2,000 (stock)
Total Suspended Solids	mg/L	15	10	230	2002	33	14	74	2752	26	10.8	108	900	< 55 (aquatic)
Turbidity	NTU	4	66	100	100	32	16	100	147	19	11.6	50	614.2	< 50 (aquatic)
Zinc (dissolved)	mg/L	-	-	-	-	12	0.01	0.015	0.02	14	0.01	0.01	0.036	< 0.008 (aquatic)

NOTE: values that were recorded as below the limit of reporting have been assumed to be equal to the limit of reporting for the purpose of this statistical analysis.

Table 2.7 – Regional Isaac River water quality summary – Red Hill Mining Lease gauges

Parameter	Unit	Red Hill Mining Lease – Upper Isaac River				Red Hill Mining Lease – Lower Isaac River				Default Guideline Value
		No. of samples	20th %ile value	Median value	80th %ile value	No. of samples	20th %ile value	Median value	80th %ile value	(refer Table 3.1)
Aluminium (total)	mg/L	43	3.5	9.3	16.1	51	3.6	8.5	16	< 5 (stock)
Aluminium (dissolved)	mg/L	36	0.16	0.415	3.6	41	0.12	0.42	3.2	< 0.055 (aquatic)
Ammonia (total)	mg/L	42	0.005	0.02	0.038	51	0.005	0.01	0.03	< 0.02 (aquatic)
Arsenic (total)	mg/L	43	0.001	0.0025	0.0025	51	0.001	0.0025	0.0025	< 2.0 (irrigation) < 0.5 (stock)
Arsenic (dissolved)	mg/L	36	0.0005	0.0005	0.0005	41	0.0005	0.0005	0.0005	< 0.013 (aquatic)
Beryllium (total)	mg/L	1	0.0025	0.0025	0.0025	1	0.0025	0.0025	0.0025	< 0.5 (irrigation)
Boron (total)	mg/L	43	0.03	0.05	0.07	51	0.04	0.05	0.07	< 5 (stock)
Boron (dissolved)	mg/L	43	0.03	0.04	0.06	51	0.025	0.04	0.06	< 0.94 (aquatic)
Cadmium (total)	mg/L	43	0.00025	0.00025	0.00025	51	0.00025	0.00025	0.00025	< 0.01 (stock)
Cadmium (dissolved)	mg/L	36	0.00005	0.00005	0.0001	41	0.00005	0.00005	0.00005	< 0.0002 (aquatic)
Cobalt (total)	mg/L	43	0.003	0.006	0.012	51	0.004	0.007	0.012	< 0.1 (irrigation)
Cobalt (dissolved)	mg/L	36	0.0005	0.0005	0.0005	41	0.0005	0.0005	0.0005	< 0.0014 (aquatic)
Chromium (total)	mg/L	43	0.009	0.016	0.028	51	0.01	0.016	0.034	< 1 (stock)
Chromium (dissolved)	mg/L	43	0.0005	0.0005	0.001	51	0.0005	0.0005	0.002	< 0.001 (aquatic)
Copper (total)	mg/L	36	0.007	0.011	0.016	41	0.007	0.011	0.018	<1 (stock)
Copper (dissolved)	mg/L	43	0.002	0.002	0.0036	51	0.002	0.003	0.005	< 0.0014 (aquatic)
Electrical Conductivity	µS/cm	36	140	166	210	41	170	220	330	< 720 (baseflow) < 250 (high flow)
Filterable Reactive Phosphorus	mg/L	7	0.19	0.29	0.4	10	0.33	0.43	0.68	< 0.02 (aquatic)
Fluoride (total)	mg/L	43	0.05	0.1	0.1	51	0.05	0.1	0.1	< 2 (irrigation)
Iron (total)	mg/L	43	6	12	18.6	51	6.5	11	21	< 10 (irrigation)
Iron (dissolved)	mg/L	43	0.09	0.26	0.85	51	0.09	0.24	0.67	< 0.18 (aquatic)
Lead (total)	mg/L	43	0.0025	0.006	0.008	51	0.0025	0.005	0.01	< 0.1 (stock)
Lead (dissolved)	mg/L	43	0.0005	0.0005	0.0005	51	0.0005	0.0005	0.0005	< 0.0034 (aquatic)
Manganese (total)	mg/L	42	0.1672	0.2625	0.4476	50	0.171	0.251	0.481	< 10 (irrigation)
Manganese (dissolved)	mg/L	43	0.0005	0.0025	0.0056	51	0.0005	0.002	0.003	1.9 (aquatic)
Mercury (total)	mg/L	43	0.00005	0.00005	0.00005	51	0.00005	0.00005	0.00005	< 0.002 (irrigation)
Mercury (dissolved)	mg/L	43	0.00005	0.00005	0.00005	51	0.00005	0.00005	0.00005	< 0.0002 (irrigation)
Molybdenum (total)	mg/L	43	0.0025	0.0025	0.0025	51	0.0025	0.0025	0.0025	< 0.05 (irrigation)

Parameter	Unit	Red Hill Mining Lease – Upper Isaac River				Red Hill Mining Lease – Lower Isaac River				Default Guideline Value
		No. of samples	20th %ile value	Median value	80th %ile value	No. of samples	20th %ile value	Median value	80th %ile value	(refer Table 3.1)
Molybdenum (dissolved)	mg/L	43	0.0005	0.0005	0.0025	51	0.0005	0.001	0.0025	< 0.034 (aquatic)
Nickel (total)	mg/L	43	0.01	0.016	0.029	51	0.011	0.019	0.033	< 1 (stock)
Nickel (dissolved)	mg/L	43	0.002	0.002	0.003	51	0.002	0.002	0.004	< 0.011 (aquatic)
Nitrate (total)	mg/L	43	0.005	0.02	0.04	51	0.02	0.05	0.14	1.1 (aquatic)
pH	-	43	7.6	7.8	8.1	51	7.4	7.8	8	6.5-8.5 (aquatic)
Selenium (total)	mg/L	43	0.001	0.0025	0.0025	51	0.001	0.0025	0.006	< 0.02 (stock)
Selenium (dissolved)	mg/L	43	0.0005	0.0025	0.005	51	0.002	0.0025	0.0025	< 0.005 (aquatic)
Silver (dissolved)	mg/L	35	0.00005	0.00005	0.0025	40	0.00005	0.00005	0.0025	< 0.00005 (aquatic)
Sulphate (total)	mg/L	43	1	2	5.6	51	2	5	19	< 25 (aquatic)
Total Dissolved Solids	mg/L	43	104	200	276	51	140	254	358	< 2,000 (stock)
Total Suspended Solids	mg/L	43	226	343	514	51	251	380	650	< 55 (aquatic)
Turbidity	NTU	43	218	450	882	51	290	597	1270	< 50 (aquatic)
Uranium (total)	mg/L	36	0.00025	0.0005	0.0009	41	0.00025	0.0005	0.0011	< 0.1 (irrigation)
Uranium (dissolved)	mg/L	36	0.00005	0.0002	0.0002	41	0.00005	0.0002	0.0002	< 0.001 (aquatic)
Vanadium (total)	mg/L	36	0.019	0.0285	0.05	41	0.02	0.029	0.05	< 0.5 (irrigation)
Vanadium (dissolved)	mg/L	36	0.0025	0.0025	0.005	41	0.0025	0.0025	0.0025	< 0.01 (aquatic)
Zinc (total)	mg/L	43	0.0162	0.024	0.037	51	0.017	0.03	0.041	< 5 (irrigation)
Zinc (dissolved)	mg/L	43	0.0025	0.0025	0.005	51	0.0025	0.0025	0.005	< 0.008 (aquatic)

NOTE: values that were recorded as below the limit of reporting have been assumed to be equal to the limit of reporting for the purpose of this statistical analysis.

Table 2.7 shows that some readings at the Red Hill Mining Lease monitoring locations are at or above the regional DGVs, including the following:

- Total aluminium at both sites (median and 80th percentile);
- Ammonia at both sites (80th percentile);
- Dissolved aluminium at both sites (median and 20th/80th percentile);
- Dissolved chromium at Lower Isaac River (80th percentile);
- Dissolved copper at Upper Isaac River (80th percentile) and Lower Isaac River (median and 80th percentile);
- Filterable reactive phosphorus at both sites (median and 20th/80th percentile);
- Total iron at both sites (median and 80th percentile);
- Dissolved iron at Lower Isaac River (80th percentile);
- Dissolved silver at Upper Isaac River (80th percentile);
- Total suspended solids at both sites (median and 20th/80th percentile values); and
- Turbidity at both sites (median and 20th/80th percentile values).

The review of the regional water quality data indicates that there are some water quality indicators that are consistently above the DGVs, specifically aluminium (dissolved), copper (total and dissolved), filterable reactive phosphorus, zinc (dissolved), iron (total and dissolved), TSS and turbidity.

This indicates that the current DGV's may not necessarily reflect the typical background water quality within the Upper Isaac River.

DRDMW has collected daily EC data at the Isaac River at the Deverill and Yatton gauges. EC, which is a measure of the salt concentration, has been used to define the potential water quality impacts of the Project. The Deverill gauge is located near the downstream boundary of the Project and would be representative of water quality that drains past the site. The Yatton gauge is located downstream of the Connors River confluence but includes mining releases from all mines within the Isaac River catchment.

Figure 2.12 presents a time history of recorded instantaneous EC and stream flow for the Isaac River at Deverill gauging station. Figure 2.13 details the relationship between instantaneous flow and EC at the Isaac River at Deverill gauging station.

The data collected by DRDMW at the Deverill gauging station spans the period from 2011 to 2022 and indicates:

- The EC for high flows greater than 200 m^3/s are below the high flow WQO EC of 250 µS/cm for 97% of readings.
- The EC of instantaneous flows below 100 m^3/s vary significantly from 9 µS/cm to 1,870 µS/cm with many recorded values exceeding the low flow WQO EC of 720 µS/cm (5% of readings).
- The mean daily EC has exceeded the low flow WQO on a total of 22 days over this period (4% of readings) and all of these days experienced some flow (not stagnant flow).
- The stream flows are highly ephemeral with baseflows ceasing within a few days or weeks of a runoff event, or at least flowing below the top of the sandy bed.

Figure 2.14 presents a time history of recorded instantaneous EC and stream flow for the Isaac River at Yatton gauging station. Figure 2.15 details the relationship between instantaneous flow and EC at the Isaac River at Yatton gauging station recorded from 1995 to 2011 as well as from 2011 to 2022. The latter data period has been shown to provide a direct comparison with the period of record common with the Isaac River at Deverill gauge.

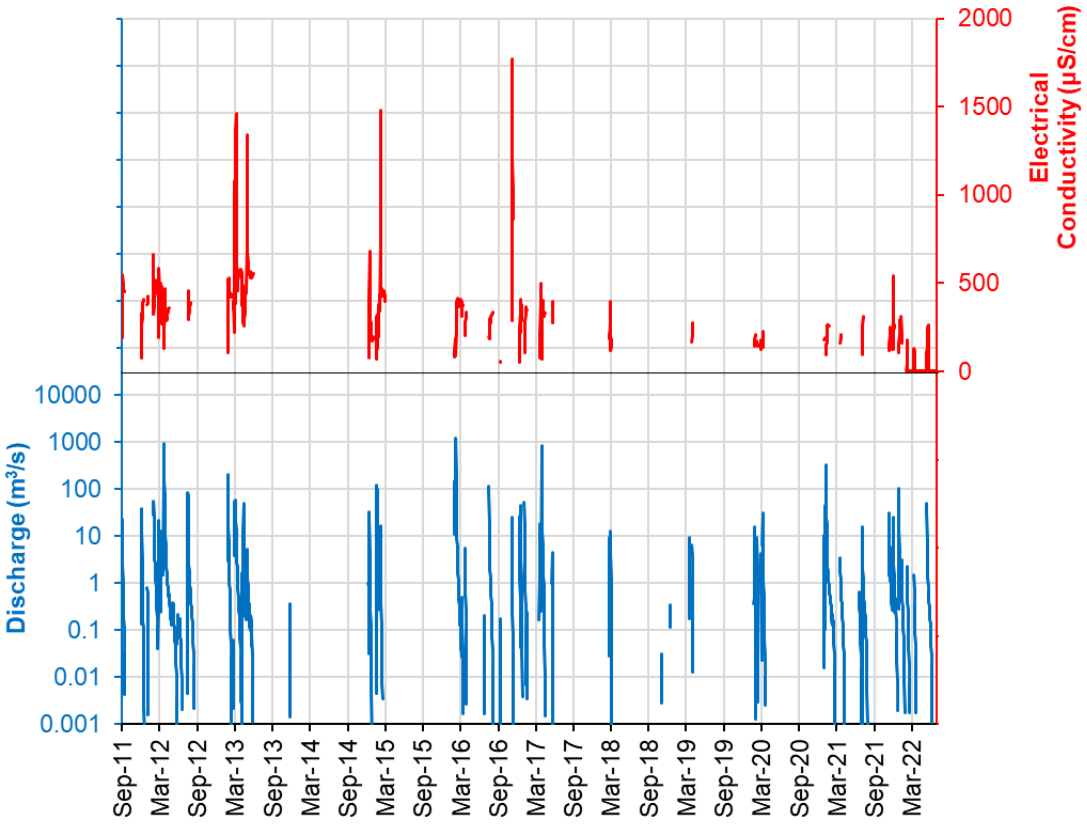


Figure 2.12 – Electrical Conductivity and flow (Isaac River at Deverill gauge)

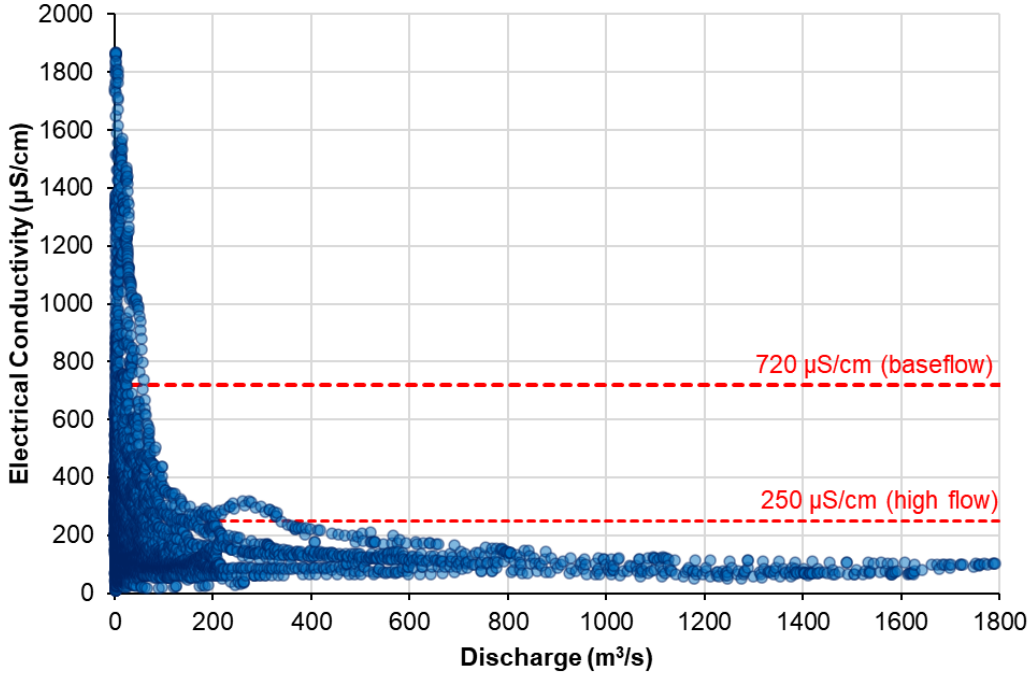


Figure 2.13 – Flow vs Electrical Conductivity (Isaac River at Deverill gauge)

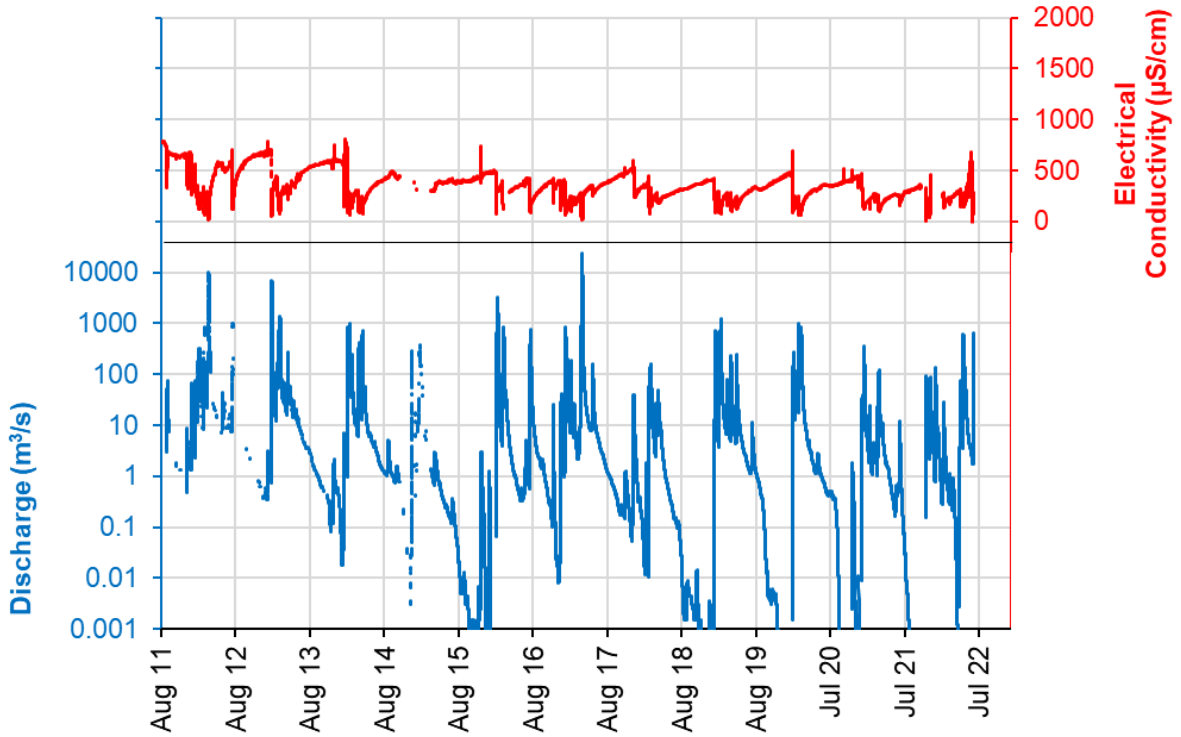


Figure 2.14 – Electrical Conductivity and flow (Isaac River at Yatton gauge)

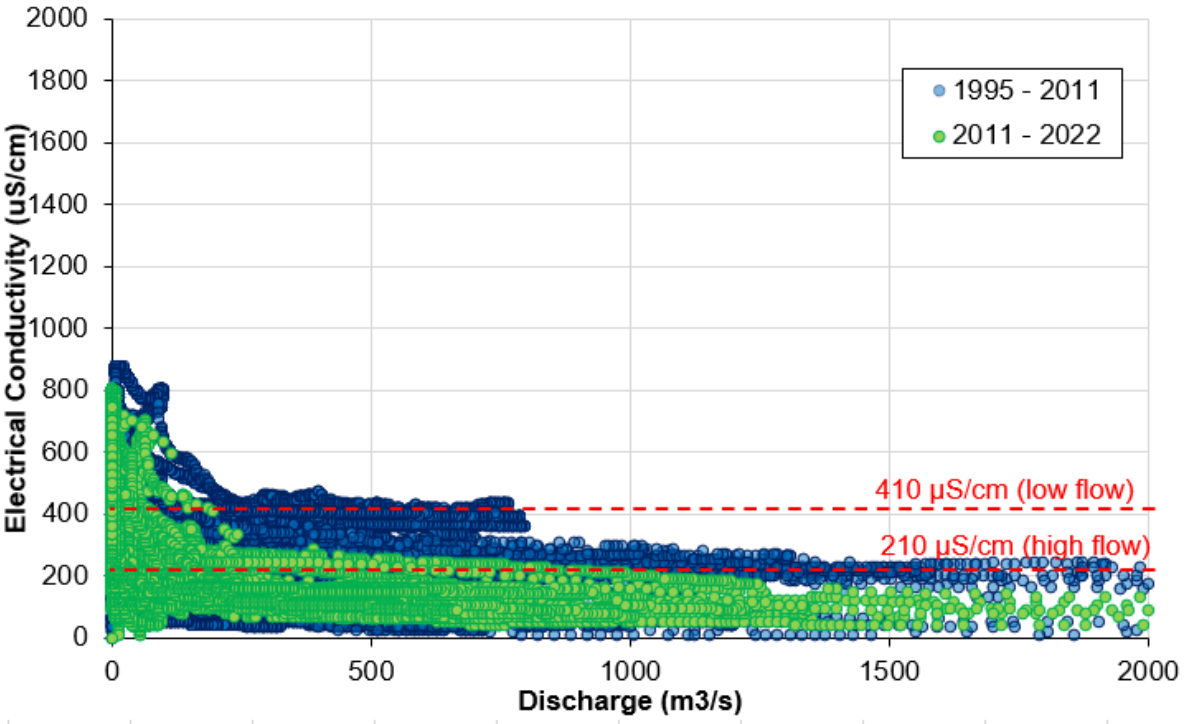


Figure 2.15 – Flow vs Electrical Conductivity (Isaac River at Yatton gauge)

2.8.2 Local water quality

Water quality sampling data for the neighbouring Olive Downs Project has been provided by Pembroke Olive Downs Pty Ltd (Pembroke). Water quality monitoring has been undertaken at various location in the Isaac River and surrounding waterways (including Ripstone Creek) between July 2017 and March 2019.

The water quality sampling results are provided in Tables A1 to A7 in Appendix A. Like the Regional Isaac River water quality data, the Olive Downs Project water quality samples show that a number of the baseline water quality samples do not meet the DGVs for the region. These include (but not limited to) the following:

- pH;
- TSS;
- Turbidity;
- Dissolved oxygen;
- Aluminium (total and dissolved); and
- Iron (total and dissolved).

These background exceedances of the regional DGVs are also generally reflected in the other sampling locations in Ripstone Creek and the unnamed tributaries of the Isaac River. There were multiple exceedances at these locations for the following:

- Copper (dissolved);
- Zinc (dissolved);
- Vanadium (dissolved);
- Reactive phosphorus; and
- TSS.

For this assessment, the following monitoring points for the reach of the Isaac River and Ripstone adjacent to the Project have been analysed (refer to Figure 2.11 for locations):

- Isaac River
  - SW1 (Pembroke) – 10 samples
  - SW3 (Pembroke) - 18 samples
- Ripstone Creek
  - SW4 (Pembroke) – 2 samples
  - SW5 (Pembroke) – 1 sample
  - SW6 (Pembroke) – 2 samples

This water quality sample dataset represents the water quality in a 17 km reach of the Isaac River over a two year period at these two locations. A statistical analysis and comparison with the regional DGVs are provided in Table 2.8 and Table 2.9.

Table 2.8 shows that the DGVs for dissolved aluminium, selenium (dissolved) and turbidity are below the measured 80th percentile values, below the median percentile values for iron and below the 20th percentile values for ammonia in the vicinity of the Project (highlighted cells).

Table 2.9 shows that the DGVs for total aluminium, EC, total iron, selenium (dissolved) and total vanadium are below the measured 80th percentile values, below the median percentile values for total ammonia, dissolved iron, sulphate and total zinc and below the 20th percentile values for dissolved aluminium, total and dissolved cadmium and turbidity in the vicinity of the Project.

This indicates that there may be justification to apply site specific WQOs for the above parameters.

Table 2.8 – Isaac River water quality summary – Olive Downs

Parameter	Unit	Composite Isaac River dataset				Default Guideline Value
		No. of samples	20th %ile value	Median value	80th %ile value	(refer Table 3.1)
Aluminium (total)	mg/L	26	0.12	0.275	1.48	< 5 (stock)
Aluminium (dissolved)	mg/L	26	0.02	0.05	0.14	< 0.055 (aquatic)
Ammonia (total)	mg/L	28	0.04	0.06	0.146	< 0.02 (aquatic)
Arsenic (total)	mg/L	27	0.001	0.002	0.002	< 2.0 (irrigation) < 0.5 (stock)
Arsenic (dissolved)	mg/L	28	0.001	0.001	0.001	< 0.013 (aquatic)
Beryllium (total)	mg/L	-	-	-	-	< 0.5 (irrigation)
Boron (total)	mg/L	26	0.05	0.05	0.07	< 5 (stock)
Boron (dissolved)	mg/L	26	0.05	0.05	0.06	< 0.94 (aquatic)
Cadmium (total)	mg/L	28	0.0001	0.0001	0.0001	< 0.01 (stock)
Cadmium (dissolved)	mg/L	28	0.0001	0.0001	0.0001	< 0.0002 (aquatic)
Cobalt (total)	mg/L	26	0.001	0.001	0.002	< 0.1 (irrigation)
Cobalt (dissolved)	mg/L	26	0.001	0.001	0.001	< 0.0014 (aquatic)
Chromium (total)	mg/L	28	0.001	0.001	0.0026	< 1 (stock)
Chromium (dissolved)	mg/L	28	0.001	0.001	0.001	< 0.001 (aquatic)
Copper (total)	mg/L	28	0.001	0.001	0.002	<1 (stock)
Copper (dissolved)	mg/L	28	0.001	0.001	0.001	< 0.00014 (aquatic)
Electrical Conductivity	µS/cm	27	283.8	330	423.6	< 720 (baseflow) < 250 (high flow)
Filterable Reactive Phosphorus	mg/L	25	0.01	0.01	0.01	< 0.02 (aquatic)
Fluoride (total)	mg/L	28	0.1	0.2	0.2	< 2 (irrigation)
Iron (total)	mg/L	26	0.44	1.195	2.71	< 10 (irrigation)
Iron (dissolved)	mg/L	26	0.09	0.2	0.47	< 0.18 (aquatic)
Lead (total)	mg/L	28	0.001	0.001	0.001	< 0.1 (stock)
Lead (dissolved)	mg/L	28	0.001	0.001	0.001	< 0.0034 (aquatic)
Manganese (total)	mg/L	26	0.227	0.438	0.962	< 10 (irrigation)
Manganese (dissolved)	mg/L	26	0.07	0.332	0.9	1.9 (aquatic)
Mercury (total)	mg/L	28	0.0001	0.0001	0.0001	< 0.002 (irrigation)
Mercury (dissolved)	mg/L	28	0.0001	0.0001	0.0001	< 0.0002 (irrigation)
Molybdenum (total)	mg/L	26	0.001	0.001	0.001	< 0.05 (irrigation)
Molybdenum (dissolved)	mg/L	26	0.001	0.001	0.001	< 0.034 (aquatic)
Nickel (total)	mg/L	28	0.001	0.002	0.0036	< 1 (stock)

Parameter	Unit	Composite Isaac River dataset				Default Guideline Value
		No. of samples	20th %ile value	Median value	80th %ile value	(refer Table 3.1)
Nickel (dissolved)	mg/L	28	0.001	0.001	0.002	< 0.011 (aquatic)
pH	-	27	7.088	7.48	8.234	6.5-8.5 (aquatic)
Phosphorus as P (total)	mg/L	28	0.02	0.035	0.096	< 50 (aquatic)
Selenium (total)	mg/L	26	0.01	0.01	0.01	< 0.02 (stock)
Selenium (dissolved)	mg/L	26	<0.01	<0.01	0.01	< 0.005 (aquatic)
Sulfate as SO4 - Turbidimetric	mg/L	28	3	5	7.2	< 25 (aquatic)
Total Dissolved Solids	mg/L	-	-	-	-	< 2,000 (stock)
Total Suspended Solids	mg/L	28	6.8	13	30	< 55 (aquatic)
Turbidity	NTU	26	8.3	29.05	116	< 50 (aquatic)
Uranium (dissolved)	mg/L	25	0.001	0.001	0.001	< 0.1 (irrigation)
Uranium (total)	mg/L	25	0.001	0.001	0.001	< 0.001 (aquatic)
Vanadium (dissolved)	mg/L	26	0.01	0.01	0.01	< 0.5 (irrigation)
Vanadium (total)	mg/L	26	0.01	0.01	0.01	< 0.01 (aquatic)
Zinc (dissolved)	mg/L	28	0.005	0.005	0.005	< 5 (irrigation)
Zinc (total)	mg/L	28	0.005	0.005	0.013	< 0.008 (aquatic)

Table 2.9 – Ripstone Creek water quality summary – Olive Downs

Parameter	Unit	Composite Ripstone Creek dataset				Default Guideline Value
		No. of samples	20th %ile value	Median value	80th %ile value	(refer Table 3.1)
Aluminium (total)	mg/L	5	0.622	1.15	5.804	< 5 (stock)
Aluminium (dissolved)	mg/L	5	0.074	0.28	0.726	< 0.055 (aquatic)
Ammonia (total)	mg/L	5	0.01	0.06	0.152	< 0.02 (aquatic)
Arsenic (total)	mg/L	5	0.001	0.002	0.0048	< 2.0 (irrigation) < 0.5 (stock)
Arsenic (dissolved)	mg/L	5	0.001	0.003	0.0032	< 0.013 (aquatic)
Beryllium (total)	mg/L	-	-	-	-	< 0.5 (irrigation)
Boron (total)	mg/L	5	0.001	0.003	0.0032	< 5 (stock)
Boron (dissolved)	mg/L	-	-	-	-	< 0.94 (aquatic)
Cadmium (total)	mg/L	5	0.088	0.09	0.102	< 0.01 (stock)
Cadmium (dissolved)	mg/L	5	0.07	0.1	0.102	< 0.0002 (aquatic)
Cobalt (total)	mg/L	5	0.0001	0.0001	0.0001	< 0.1 (irrigation)
Cobalt (dissolved)	mg/L	5	0.0001	0.0001	0.0001	< 0.0014 (aquatic)
Chromium (total)	mg/L	5	0.001	0.001	0.0044	< 1 (stock)

Parameter	Unit	Composite Ripstone Creek dataset				Default Guideline Value
		No. of samples	20th %ile value	Median value	80th %ile value	(refer Table 3.1)
Chromium (dissolved)	mg/L	5	0.001	0.001	0.0012	< 0.001 (aquatic)
Copper (total)	mg/L	5	0.001	0.001	0.0126	<1 (stock)
Copper (dissolved)	mg/L	5	0.001	0.001	0.001	< 0.00014 (aquatic)
Electrical Conductivity	µS/cm	4	333.2	604.5	960.6	< 720 (baseflow)
						< 250 (high flow)
Filterable Reactive Phosphorus	mg/L	4	0.01	0.01	0.018	< 0.02 (aquatic)
Fluoride (total)	mg/L	4	0.2	0.25	0.34	< 2 (irrigation)
Iron (total)	mg/L	4	0.704	1.68	11.432	< 10 (irrigation)
Iron (dissolved)	mg/L	4	0.05	0.235	0.724	< 0.18 (aquatic)
Lead (total)	mg/L	4	0.001	0.001	0.0078	< 0.1 (stock)
Lead (dissolved)	mg/L	4	0.001	0.001	0.001	< 0.0034 (aquatic)
Manganese (total)	mg/L	-	-	-	-	< 10 (irrigation)
Manganese (dissolved)	mg/L	-	-	-	-	1.9 (aquatic)
Mercury (total)	mg/L	-	-	-	-	< 0.002 (irrigation)
Mercury (dissolved)	mg/L	-	-	-	-	< 0.0002 (irrigation)
Molybdenum (total)	mg/L	4	0.001	0.0015	0.0024	< 0.05 (irrigation)
Molybdenum (dissolved)	mg/L	4	0.001	0.0015	0.0024	< 0.034 (aquatic)
Nickel (total)	mg/L	4	0.0032	0.0045	0.0122	< 1 (stock)
Nickel (dissolved)	mg/L	4	0.0026	0.0035	0.0044	< 0.011 (aquatic)
pH	-	4	7.94	8.215	8.35	6.5-8.5 (aquatic)
Phosphorus as P (total)	mg/L	4	0.05	0.085	0.444	< 50 (aquatic)
Selenium (total)	mg/L	4	0.01	0.01	0.01	< 0.02 (stock)
Selenium (dissolved)	mg/L	4	<0.01	<0.01	0.01	< 0.005 (aquatic)
Sulfate as SO4 - Turbidimetric	mg/L	4	16.8	41.5	96.6	< 25 (aquatic)
Total Dissolved Solids	mg/L	-	-	-	-	< 2,000 (stock)
Total Suspended Solids	mg/L	4	15.8	25.5	48.8	< 55 (aquatic)
Turbidity	NTU	4	54.88	91.8	386.84	< 50 (aquatic)
Uranium (dissolved)	mg/L	4	0.001	0.001	0.001	< 0.1 (irrigation)
Uranium (total)	mg/L	4	0.001	0.001	0.001	< 0.001 (aquatic)
Vanadium (dissolved)	mg/L	4	0.01	0.01	0.01	< 0.5 (irrigation)
Vanadium (total)	mg/L	4	0.01	0.01	0.022	< 0.01 (aquatic)
Zinc (dissolved)	mg/L	4	0.005	0.005	0.005	< 5 (irrigation)
Zinc (total)	mg/L	4	0.005	0.0135	0.0344	< 0.008 (aquatic)

3 Surface water management system

3.1 OVERVIEW

EDCM operates under the EDCM Water Management Plan (WMP) (South32, 2021). The WMP addresses the management of water associated with the construction, operation and closure of the Project in accordance with the project's environmental authority (EA) EPML00586713 but is primarily focussed on the current care and maintenance phase. It defines the expected types and quality of water on site based on the potential sources of contaminants, and identifies infrastructure proposed to manage the different types of water based on risk.

The proposed water management infrastructure has been updated as part of an optimisation study undertaken by GHD (2021) and further refined as part of this study. The WMP will need to be updated to account for the revised infrastructure and be updated for the operational phase.

Outlined below is a description of the proposed water management system and optimised water management infrastructure.

3.2 WATER MANAGEMENT TYPES

The WMP outlines management strategies for the following types of water:

- mine affected water;
- stormwater;
- raw water;
- potable water; and
- wastewater from sewage treatment plant (STP).

3.2.1 Mine affected water

'Mine affected water' (MAW) is defined as follows:

- Pit water, tailings dam water, processing plant water;
- Water contaminated by a mining activity which would have been an environmentally relevant activity under Schedule 2 of the EPR 2008 if it had not formed part of the mining activity;
- Rainfall runoff that 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 sediment and erosion control structures that have been installed in accordance with the standard and requirement of an Erosion and Sediment Control Plan (ESCP) to manage runoff containing sediment only, provided that this water has not been mixed with pit water, tailings dam water, processing plant water or workshop water;
- Groundwater that has been in contact with any area disturbed by mining activities which have not yet been rehabilitated;
- Groundwater from the mine's dewatering activities;
- A mix of mine affected water (under any of the above points) and other water.

3.2.2 Stormwater

Stormwater is rainwater run-off from the site. EDCM classifies stormwater in two categories, *clean water* and *dirty water:*

- Clean water is diverted around the mine site and can be discharged to the environment. Clean water is not used as a water source for mining activities.
- Dirty water is runoff from disturbed areas on site. Dirty water is managed through an ESCP and is captured by the surface water infrastructure and re-used on site where possible.

For the purposes of this assessment, dirty water managed under an ESCP is called ESC water. ESC water is unlikely to contain elevated levels of carbonaceous material, salinity or other contaminants besides sediment.

3.2.3 Raw water/ potable water

Raw water is imported water from off site or treated water for use in the CHPP. Raw water is treated on site to be potable or potable water is directly imported from off site.

The Project will require a reverse osmosis (RO) plant to manage the large volumes of water predicted to be dewatered from the underground mining operations. The permeate water, which is the treated water produced by the RO will be used as a raw water source on site.

3.3 CONTAMINANT SOURCES

3.3.1 Mine infrastructure area

There is potential for spills and contamination by metals and hydrocarbons from mine workshop, waste disposal and fuel storage areas to impact on surface water. Run-off from mine infrastructure areas may contain elevated levels of suspended sediment and possibly hydrocarbons or other chemicals.

Runoff from the mine infrastructure area would be considered mine affected water.

3.3.2 Mine dewatering

Coal seam groundwater is brackish and slightly alkaline with pH ranging from 7.8 to 8.4 and salinity, represented as electrically conductivity (EC), ranging between 6,000 µS/cm to 12,000 µS/cm and would be considered mine affected water. Underground coal seam water may also contain elevated levels of suspended sediment.

Coal seam water will be pumped to the surface to dewater the mining area and is considered mine affected water.

3.3.3 Coal rejects material

EDCM engaged RGS Environmental Consultants Pty Ltd to conduct a geochemical and physical assessment of drift spoil, coal and coal reject material generated by the Project (RGS, 2022). The geochemical and physical assessment found the following:

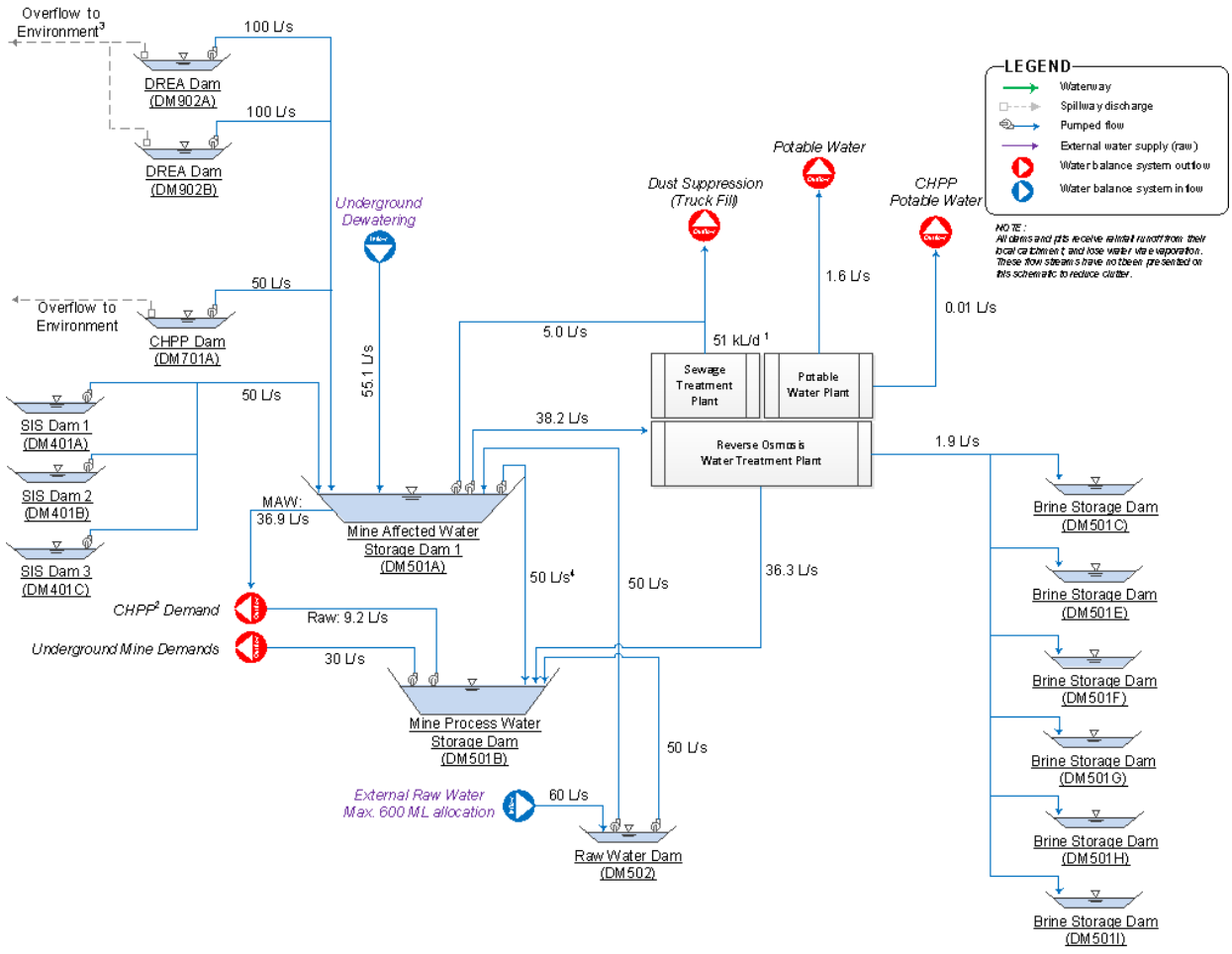
- The leachate from the bulk coal reject material is predicted to have a pH ranging between pH 6.1 and pH 10. The median recorded pH level was pH 8.1, which indicates that the alkalinity/acidity would fall between pH 6.5 and pH 8.5.
- The electroconductivity (EC) of 32 samples of the coal reject material ranged from 18 to 1,010 µS/cm. The median electroconductivity was 163 µS/cm, indicating that the coal reject material would initially have low salinity values.
- The predicted median salinity of the coal reject material samples would be of sufficient quality to release into the environment without having a significant impact (<250 µS/cm during high flow and 720 µS/cm during baseflow conditions).

Based on the geochemical and physical assessment, the surface water runoff from the Dry Rejects Emplacement Areas (DREAs) will not meet the MAW conditions described above. Consequently, the Project will manage DREA runoff under an ESCP as ESC water, rather than as part of the mine WMS.

3.4 KEY SURFACE WATER INFRASTRUCTURE

Figure 3.1 shows the concept surface water management system (WMS). The surface water management system comprises:

- mine water management dams;
- ESC water management dams; and
- Raw water management dams.



Notes:
** All flow rates shown are maximal pump rates only*
1/ Sewage effluent supplements dust suppression supply when total site water demand exceeds total dewatering flows. When total dewatering flows exceeds total site water demand, this water is irrigated.
2/ If MAW component of CHPP demand cannot be met by DM501A, then DM501B supplies make-up water.
3/ Assumes DREA catchment dams are not classified as MAW and are allowed to spill into the environment.
4/ DM501A only pumps the required amount of water to increase the salinity in DM501B to 1200 mg/L
5/ Any site demands unable to be supplied by on-site water is supplied by raw water from DM502.

Figure 3.1 – EDCM conceptual water management schematic

These dams are managed based on their use on site and their potential contaminant risk to the downstream environment. The key components of the Project's proposed water management infrastructure include:

- Mine affected dams;
  - Surface to in-seam (SIS) Dewatering Dam (DM401A-C);

- Mine Water Dam (DM501A);
- Brine Storage Dam (DM501C, E-I);
- Drift Excavation Sediment Dam Cell 1 (DM901A) (To be decommissioned);
- Drift Excavation Sediment Dam Cell 2 (DM901B) (To be decommissioned);
- ROM & CHPP Sediment Dam (DM701A);

- Raw Water Dams;
  - Raw Water Dam (DM502);
  - Mine Process Water Storage Dam (DM501B);
- ESC dams
  - DREA Stage 1 Sediment Dam (DM902A);
  - DREA Stage 2 Sediment Dam (DM902B);
- Underground Operations Area;
- Water Treatment Facility.

The locations of various storages (except for dams constructed post DREA stage 3) are shown in Figure 1.2. Table 3.1 shows the adopted sizes and contributing catchment area of the surface water storages. A description of each storage structure and their interaction is provided below.

Table 3.1 – Adopted storage details

Dam Name	Dam ID	TSV (ML)
Raw Water Dam	DM502	20.00
SIS Dewatering Dam 1	DM401A	13.00
Drift Excavation Sediment Dam Cell 1	DM901A	16.62
Drift Excavation Sediment Dam Cell 2	DM901B	8.73
Mine Water Dam	DM501A	260.0
Mine Process Water Storage Dam	DM501B	172.0
Brine Storage Dam Cell 3	DM501C	110.0
CHPP MIA Dam	DM701A	350.0
DREA Stage 1 Sediment Dam	DM902A	100.0
DREA Catchment Dam 2	DM902B	100.0
SIS Dewatering Dam 2	DM401B	36.0
SIS Dewatering Dam 3	DM401C	13.5
Brine Storage Dam Cell 4	DM501E	250.0
Brine Storage Dam Cell 5	DM501F	110.0
Brine Storage Dam Cell 6	DM501G	110.0
Brine Storage Dam Cell 7	DM501H	110.0
Brine Storage Dam Cell 8	DM501I	110.0
Total		**1660.9**

3.5 MINE WATER DAMS

The ROM and CHPP Sediment Dam is the only mine water dam on site that has a contributing catchment. All of the other mine water dams are of turkeys nest type of construction that have no contributing catchment area other than the surface area of the dam itself. They receive pumped inflows only and as such, can only spill due to a failure of the pumping system or via a controlled release. A description of the mine water dams is given below.

3.5.1 Drift Excavation Sediment Dam Cell 1 (DM901A)

The Drift Excavation Sediment Dam Cell 1 is an existing dam that captures runoff from the dump created from material removed during the construction of the drifts at the Project site.

The Drift Excavation Sediment Dam Cell 1 will be decommissioned after the Early Construction phase.

3.5.2 Drift Excavation Sediment Dam Cell 2 (DM901b)

The Drift Excavation Sediment Dam Cell 2 is an existing dam which receives pumped transfers from the existing workshop sump and drift dewatering flows.

When initial underground development commences, dewatering flows from the underground operation area (consisting of underground process water returns, groundwater and underground in seam UIS) drainage water will be pumped into the Drift Excavation Sediment Dam Cell 2. Mine Affected Water (MAW) from the Drift Excavation Sediment Dam Cell 2 will be used to supply the construction water demand.

The Drift Excavation Sediment Dam Cell 2 will be decommissioned after the Early Construction phase.

3.5.3 Mine Water Dam (DM501A)

The Mine Water Dam is the primary mine water storage within the mine water management system. It will receive pumped transfer from the following storages:

- SIS Dam 1;
- SIS Dam 2;
- SIS Dam 3;
- DREA Stage 1 Sediment Dam;
- DREA Stage 2 Sediment Dam;
- ROM & CHPP Sediment Dam; and
- Raw Water Dam.

The Mine Water Dam is the source of feed water for the proposed water treatment facility.

The Mine Water Dam is a Turkey's Nest dam and will have a storage capacity of 260 ML including a freeboard of 20 ML. (i.e. a maximum operating volume of 240 ML) to contain direct rainfall.

When the volume of water stored in the Mine Water Dam exceeds 240 ML, pumped inflows from other storages will cease. As storage volume becomes available in the Mine Water Dam, the priority of pumping from other storages and disposal of brine is as follows:

1. SIS Dam 1, 2, 3;
2. CHPP Sediment Dam
3. Mine Water Dam 2;
4. DREA Stage 1 Sediment Dam;
5. DREA Stage 2 Sediment Dam; and

6. Raw Water Dam.

Salinity in Mine Process Water Storage Dam will be maintained below a salinity of 5,400 mg/L total dissolved solids (TDS), which is the upper limit of water suitable for use in the RO plant.

3.5.4 SIS Dam 1 (DM401A)

SIS Dam 1 is an existing dam that has been used to manage SIS gas drainage water from previous SIS program at the site. No SIS water is currently produced at the site. When SIS gas drainage recommences at the site, SIS water and GOAF dewatering will be pumped into SIS Dam 1 before being pumped to Mine Water Dam.

Pumping out of SIS Dam 1 commences when the volume of water stored in the dam exceeds 50% capacity and stops when the volume of water stored in the dam has been reduced to below 25% capacity.

3.5.5 SIS Dam 2 (DM401B)

SIS Dam 2 will collect SIS gas drainage water and GOAF dewatering from the start of year 3 of mine life. Water stored in SIS Dam 2 will be pumped to Mine Water Dam.

Pumping out of SIS Dam 2 commences when the volume of water stored in the dam exceeds 50% capacity and stops when the volume of water stored in the dam has been reduced to below 25% capacity.

3.5.6 SIS Dam 3 (DM401C)

SIS Dam 3 will collect SIS gas drainage water and GOAF dewatering from the start of year 7 of mine life. Water stored in SIS Dam 3 will be pumped to Mine Water Dam.

Pumping out of SIS Dam 3 commences when the volume of water stored in the dam exceeds 50% capacity and stops when the volume of water stored in the dam has been reduced to below 25% capacity.

Any overflow from SIS Dam 1 will drain to Feature 1 before entering the Isaac River.

3.5.7 ROM & CHPP Sediment Dam (DM701A)

The ROM & CHPP Sediment Dam captures runoff from the CHPP, associated industrial areas, ROM and product coal stockpiles, train loadout facility and rail loop. The CHPP Sediment Dam has a total catchment area of 58.5 ha, of which 39.7 ha is industrial or hardstand area. Water and salt balance modelling undertaken in this report predicts that water capture in the CHPP Sediment Dam will typically have a salinity of between 1,000 mg/L (1,700 uS/cm EC) and 2,500 mg/L TDS (4,230 uS/cm EC).

Water captured in the CHPP Sediment Dam will be pumped out to the Mine Water Dam before supplying the site mine water demands.

The CHPP Sediment Dam has a storage capacity of 350 ML. When the volume of water stored in the CHPP Sediment Dam exceeds 20 ML, and there is storage volume available in the Mine Water Dam (below 240 ML), the CHPP Sediment Dam is pumped out until the volume of water stored in the dam is reduced to 5 ML. The adopted average pump rate for the CHPP Sediment Dam is 50 L/s.

3.5.8 Brine Storage Dams (DM501C, DM501E-DM501I)

The Brine Storage Dams receive inflows of brine from the RO plant. The Brine Storage Dams will be a multiple-cell dam and contain water with very high salinity concentrations. The Brine Storage dams will be managed with a freeboard sufficient for it not to overflow.

3.6 ESC DAMS

3.6.1 DREA Stage 1 Sediment Dam (DM902A)

The DREA Stage 1 Sediment Dam will capture runoff from stage 1 of the DREA.

The DREA Stage 1 Sediment Dam will be pumped out to the Mine Water Dam when there is available capacity in that dam. Pumping out of the DREA Stage 1 Sediment Dam commences when the volume of water stored in the dam exceeds 5 ML and the receiving dam volume is less than 240 ML, and stops when the volume of water stored in the dam has been reduced to 5 ML or the receiving dam is greater than 240 ML.

Overflows from the DREA Stage 1 Sediment Dam would spill into Feature 1 before discharging into the Isaac River.

3.6.2 DREA Stage 2 Sediment Dam (DM902B)

The DREA Stage 2 Sediment Dam will capture runoff from both stage 2 and stage 3 of the DREA. It may be that several dams are required to capture runoff from both stages but for the purposes of the assessment, only one dam is proposed at present.

The DREA Stage 2 Sediment Dam will be constructed and ready to use by the start of year 7 of mine life. From year 7 of the mine life onwards, the DREA Stage 2 Dam will be pumped out to the Mine Water Dam when there is available storage capacity in that dam.

Pumping out of the DREA Stage 2 Sediment Dam commences when the volume of water stored in the dam exceeds 5 ML and the receiving dam volume is less than 240 ML, and stops when the volume of water stored in the dam has been reduced to 5 ML or the receiving dam is greater than 240 ML.

Any overflows from the DREA Stage 2 Sediment Dam would spill into Feature 1 before connecting to the Isaac River.

3.7 RAW WATER DAMS

3.7.1 Raw Water Dam (DM502)

The Raw Water Dam is a Turkey's Nest dam and is a buffer storage for raw water sourced from an external raw water allocation (Sunwater). It will be the primary water source for supplying the CHPP and Underground Process demands for the Project when mine affected and ESC water is not available. Raw water will be pumped into the dam when the volume drops below 15 ML.

3.7.2 Mine Process Water Storage Dam (DM501B)

The Mine Process Water Storage Dam is intended to operate as a raw water storage to supply the CHPP and underground process water demands. Mine Process Water Storage Dam receives pumped treated water (permeate) from the water treatment facility and top up flows from the Raw Water Dam (DM502) when necessary. Spills from the Mine Process Water Storage Dam drains into the Mine Water Dam.

Salinity in Mine Process Water Storage Dam will be maintained below 1,200 mg/L TDS (2,000 uS/cm EC), which is the upper limit of water suitable for use in the CHPP and underground process raw water streams. If the salinity is below 1,200 mg/L, the required amount of water from the Mine Affected Water Dam to raise the salinity to 1,200 mg/L is pumped into the Mine Process Water Storage Dam. Of the 1,200 mg/L TDS, the chloride concentration shall not exceed 200 mg/L when the volume of water in Mine Process Water Storage Dam is less than 5 ML, water from the Raw Water Dam is pumped into the dam.

3.8 RAW WATER

3.8.1 Reverse osmosis plant

The Project will require a reverse osmosis (RO) plant to manage the large volumes of water predicted to be dewatered from the underground mining operations. The underground water would be classified as mine affected water. Table 3.2 shows the treatment capacity of the RO plant across the life of mine. The feed water used for the RO plant is supplied by the Mine Water Dam. The RO plant has been designed to treat feed with salinity levels between 2,580 mg/L and 5,600 mg/L.

The split between product (permeate) and waste (brine) from the RO plant is assumed to be 95% and be consistent across all salinities of the feed water.

Permeate produced by the RO plant will have a salinity of 200 mg/L TDS (300 uS/cm EC). All permeate will be pumped into the Mine Process Water Storage Dam. The salinity of the brine produced by the water treatment plant facility is expected to be around 33,000 mg/L TDS (49,250 uS/cm EC).

The brine is then disposed in the Brine Storage Dam, where the dam will be used to store and evaporate the brine.

Table 3.2 – RO plant treatment capacity to produce permeate

Date	Treatment capacity (ML/year)
1/7/2023 – 1/12/2023	0
1/12/2023 – 1/7/2025	1
1/7/2025 – 1/12/2037	3.3
1/12/2037 – 1/1/2068	3.1

3.8.2 External water

The Project would utilise external raw water to supplement mine water demands when required. EDCM currently have a Sunwater licence of 600 ML/yr. External raw water would be stored in raw water dam (RWD) until it is used on-site.

3.8.3 Potable water

The Project will require approximately 47.5 ML/year of raw water to be treated to meet potable water demands. In addition, there will be a potable water demand of 0.2 m^3/hr for the CHPP area.

During the early works, potable water demand is sourced from other sources until the water treatment plant is constructed.

3.9 WASTEWATER

Site wastewater would be treated in a packaged sewage treatment plant, located in the MIA. The plant would be designed to meet a Class C effluent quality for irrigation. The biosolids produced would be stored on-site and collected by a licensed contractor for disposal off-site at a licensed facility.

The sewage treatment plant would be designed and installed in accordance with the Queensland Government guidelines and relevant Australian Standards.

The estimated effluent recovery from the sewerage treatment plant is 88.4 kL/day based on the following assumptions:

- Mine work force of up to 520 people and approximately 130 people per shift.
- Sewage generation design criteria of 170 L/person/day
- Treated sewage volume of 88.4 kL/day.

It is assumed that the total volume of sewage treated at the plant will be recovered as effluent (100% recovery).

3.10 RELEASE OF WATER TO THE ENVIRONMENT

The existing EA authorises the release of water from three dams:

- RP1 is the DREA Stage 1 sediment dam (DM902A).
- RP2 is the Mine Water Dam (DM501A); and
- RP3 is the Drift Excavation Sediment Dam Cell 1 (DM901A), which will be decommissioned during the construction works.

The DREA Stage 1 sediment dam (RP1) will be an ESC dam managed under the ESC and therefore not require a controlled release point. The mine water dam will be operated to prevent uncontrolled spills and water balance modelling suggests that controlled releases will not be required.

4 Water balance model configuration

4.1 OVERVIEW

The computer-based simulation model GOLDSIM (GOLDSIM Technology Group, 2015) was used to assess the surface water balance under varying rainfall and catchment conditions throughout the life of the Project. The GOLDSIM model dynamically simulates the operation of the surface water management system and keeps complete account of all site water volumes and representative water quality on a daily time step.

The model has been configured to simulate the operations of all major components of the surface water management system, The simulated inflows and outflows included in the model are given in Table 4.1.

Table 4.1 – Simulated inflows and outflows to mine water management system

Inflow	Outflow
Direct rainfall on water surface of storages	Evaporation from water surface of storages
Catchment runoff	CHPP demand
Groundwater	Surface dust suppression demand
Coal seam water (SIS and UIS)	Underground water losses
Raw water supply	Spills from storages to receiving environment

4.2 SIMULATION METHODOLOGY

The water balance model was configured to represent the changing characteristics of the surface water management system over the mine life. This included:

- Staging of dam storages and contributing catchment areas;
- Varying underground process water demand;
- Varying groundwater and coal seam inflows; and
- Varying CHPP water demand.

The model was configured to represent the inflows to and outflows from the surface water management system shown in Table 4.1, as well as transfers of water between mine site storages and the proposed treatment facility. Details of the model configuration and input data are provided in the following sections.

The model was configured to provide salient information on the following key points of the surface water management system throughout the life of the Project:

- The volume of water likely to accumulate in the dams at the Project site;
- The ability of the mine water management system to supply process water demands;
- The probability and volume of uncontrolled spills and controlled releases (if used) from dams at the Project site;
- The volume of salt and resulting salinity in the dams at the Project site; and
- The volume of external raw water required to supplement the mine water demand.

The model was run as a dynamic forecast simulation over the 46-years of coal extraction proposed for this life-of-mine (LOM) scenario to capture the variations in mine configurations described above.

To assess the effects of varying climatic conditions, the model was run for 130 realisations (with each realisation corresponding to the 46-year LOM period), using 130 years of historical climatic data. A different 46-year rainfall input sequence was applied to each realisation, shifted 1 year for each realisation. A statistical analysis was then performed on the results, which was presented as percentiles versus time.

4.3 MINE STAGES

The following mine water dams will be commissioned during specific years of the mine operations:

- DM501E – Active in year 11 of operations;
- DM501F – Active in year 24 of operations;
- DM501G – Active in year 30 of operations;
- DM501H – Active in year 37 of operations; and
- DM501I – Active in year 43 of operations.

There are three major DREA stockpile landform across the mining life, where the extent of the stockpile landform coincides with the mine progression. In this assessment, the staging of the DREA stockpile will be referred to as DREA Stages. The DREA stages are:

- DREA Stage 1 (DS1): Commences from years 2023 to 2028;
- DREA Stage 2 (DS2): Commences from years 2028 to 2048; and
- DREA Stage 3 (DS3): Commences from years 2048 to LOM.

The DREA Stage 2 sediment dam (DM902B) (amongst others) will be constructed prior to the commencement of the DREA Stage 2;

For the water balance, DREA development will be simplified and modelled as 2 stages as shown in Table 4.2.

Table 4.2 – Representative mine stages

Stage	Model Period	Representative Year	Duration
Early works	1/7/2022 – 1/7/2023	2023	12 months
Operational	1/7/2023 – 1/1/2068	2024	44.5 years

4.4 LIMITATIONS OF THE WATER BALANCE MODEL

The water balance model developed for the Project is assumed to be representative of the proposed water management system. However, as the Project is not yet operating, there are several limitations of this model which must be understood when analysing the results:

1. There is no site-specific data available to calibrate the rainfall runoff behaviour for the mine site catchments. The Australian Water balance Model (AWBM) parameters adopted for the model appear reasonable based on past experience and calibration to available stream flow data (calibrated model of Phillips Creek at Tayglen (WRM, 2010). However, mine site catchment runoff behaviour can vary from site to site.
2. There is no site-specific data available to inform the likely salinity of runoff from mine site catchments. The runoff salinities adopted for the model appear reasonable based on past experience. However, the salinity of mine site catchment runoff can vary from site to site.
3. The groundwater inflows adopted in the water balance model are based on results of groundwater modelling (EDCM, 2022). As such, there is some uncertainty associated with the volume of groundwater that may actually flow into the underground. If groundwater inflows to the underground exceed the AGE (2022) predictions, there will be impacts on

the ability of the water management system to limit releases of water from the mine site. Conversely, if groundwater inflows are lower than the AGE (2022) predictions, more raw water may be required to supply site water demands.

4. Water extraction associated with SIS and UIS gas drainage may influence the groundwater reservoir capacity, and hence the AGE (2022) groundwater inflow predictions.
5. The salinity of groundwater inflows has been estimated from the SIS gas drainage project that was operated at the site over the last few years. It is possible that groundwater inflows to the underground workings could be more or less saline than current data indicates.
6. Losses of groundwater and underground process water in the underground mine workings are currently based on assumptions around vent losses and moisture losses to ROM coal. The values for these assumptions have been provided in EDCM (2022). Actual loss rates in the underground workings remain difficult to quantify, even during mine operations.

4.5 CLIMATE DATA

For the purposes of this assessment, a synthetic rainfall and evaporation dataset was obtained from the Queensland Climate Change Centre of Excellence Data Drill service for a location near the Project (Jeffrey et al, 2001) described in Section 2.3.6. The key advantage of adopting the Data Drill dataset is that it has been adjusted to remove accumulated totals over multiple days and to fill periods of missing data using rainfall from nearby stations. The dataset extends from 1889 and includes open water evaporation estimates using Morton's Method (Morton, 1983) and potential evapo-transpiration estimates using the FAO Penman-Monteith formula (Allen et al, 1998).

4.6 OPERATING RULES AND MODEL SCHEMATIC

Table 4.3 shows the operating rules and pump flow rates adopted in the water balance model. A schematised plan of the site water management system configuration is shown in Figure 3.1.

4.7 WATER DEMANDS AND LOSSES

Figure 4.1 shows the predicted total water demand at the site over the life of the Project, including CHPP usage, underground use, dust suppression and potable demands. The maximum water demand at the Project site, 2,731 ML/yr, is predicted to occur in year 9 of mine life. The average annual water demand at the Project site is 2,181 ML/yr.

Water demands at the Project in years one to two range from 400 ML/yr to 850 ML/yr and are significantly less than demands over the remainder of the mine life, as there is no CHPP or longwall mining unit water demand in years one to two.

Water demands in years 3 to 45 range from 1,750 ML/year to 2,730 ML/year. A summary of the adopted water demands and losses for the Project is provided below.

4.7.1 CHPP water demand

Figure 4.2 shows the adopted CHPP total, raw and mine water demands used in the water balance modelling. Information on the predicted total CHPP demand was provided by EDCM (2022).

The CHPP will utilise two feeds of water:

- Raw water, which has a salinity upper limit of 1,200 mg/L TDS; and
- Mine water, which has a salinity upper limit of 8,400 mg/L TDS.

Sedgman (2022) indicates that raw water demand comprises about 80% of the total CHPP demand, with mine water making up the remaining 20%. CHPP raw water demand will be sourced from the Mine Process Water Storage Dam and the CHPP mine water demand will be sourced from the Mine Water Dam.

Table 4.3 – Water balance operating rules

Transfer from	Transfer into	Flow rate	Operating rules
Early works			
Sunwater offtake	DM502	60 L/s	• Pump on when DM502 volume drops below 15 ML. • Pump off when DM502 volume exceeds 15 ML.
Underground mine	DM901B	9.8 L/s (max)	• Continuous supply.
DM901B	Construction water demand (MAW)	4.2 L/s	• Continuous supply.
DM502	UG construction water demand	2.8 L/s	• Continuous supply.
DM901A	DM701A	-	
DM901B	DM701A	-	• DM701A acts as an overflow dam for DM901A during the early works phase
External potable water	Potable water demand	1.6 L/s	• DM701A acts as an overflow dam for DM901B during the early works phase
Operation phase			
Sunwater offtake	DM502	60 L/s	• Pump on when DM502 volume drops below 15 ML. • Pump off when DM502 volume exceeds 15 ML.
DM401	DM501A	50 L/s	• Pump on when DM401 volume exceeds 50% total capacity of DM401A, DM401B and DM401C. • Pump off when DM401 volume is below 25% total capacity of DM401A, DM401B and DM401C.
DM502	DM501B	50 L/s	• Pump on when DM501B drops below 30 ML and total site water demand exceeds total dewatering flows. • Pump off when DM501B exceeds 30 ML and total site water demand exceeds total dewatering flows. • Pump on when DM501B drops below 17 ML and total dewatering flows exceeds total site water demand. • Pump off when DM501B exceeds 17 ML and total dewatering flows exceeds total site water demand

Transfer from	Transfer into	Flow rate	Operating rules
DM502	DM501A	50 L/s (max)	• Pump on when DM501A volume drops below 240 ML and DM501A salinity exceeds 5400 mg/L. • Pump off when DM501A is above 240 ML or DM501A salinity is below 5400 mg/L. • Note: DM502 will only pump the required amount to decrease the salinity to 5400 mg/L. If the amount exceeds 50 L/s, it will only pump 50 L/s.
DM502	DM501A	50 L/s	• Pump on when DM501A volume is below 15 ML. • Pump off when DM501A volume exceeds 25 ML.
DM701A	DM501A	50 L/s	• Pump on when DM701A volume exceeds 20 ML, and combined DM501A volume is less than 240 ML and total site water demand exceeds total dewatering flows • Pump off when DM701A is below 5 ML, or combined DM501A exceeds 240 ML and total site water demand exceeds total dewatering flows. • Pump on when CHPP sediment dam volume exceeds 65 ML and total dewatering flows exceeds total site water demand. • Pump off when CHPP sediment is below 65 ML and total dewatering flows exceeds total site water demand.
DM501A	DM501B	50 L/s (max)	• Pump on when DM501B salinity is less than 1200 mg/L and DM501B volume is below 30 ML and DM501A volume is above 20 ML. • Pump off when DM501B salinity exceeds 1200 mg/L or DM501B volume exceeds 30 ML or DM501A volume is below 20 ML. • Note: DM501A will only pump the required amount to increase the salinity to 1200 mg/L. If the amount exceeds 50 L/s, it will only pump 50 L/s.
DM501A	RO Plant (potable water demand)	1.69 L/s	• Continuous supply.
DM501A	RO Plant (process water demand)	38.2 L/s	• Pump on when DM501B volume is below 170 ML and DM501A is above 100 ML and DM501A salinity is between 2580 mg/L and 5600 mg/L. • Pump off when DM501B volume exceeds 170 ML or DM501A is below 100ML or DM501A salinity outside the salinity limit of the RO plant.
DM501A	CHPP MAW Demand	36.9 L/s	•
DM501A	Dust suppression	5.0 L/s	• Pump on when daily rainfall is below 5 mm. • Pump off when daily rainfall exceeds 5 mm.

Transfer from	Transfer into	Flow rate	Operating rules
DM501A	Construction Water Demand	3.9 L/s	• Pump on when date exceeds 1/7/2021. • Pump off when date is less than 1/7/2021 or date exceeds 1/7/2024.
DM501B	Underground Process Demand	30 L/s	• Continuous supply.
DM501B	CHPP water Demand (Raw)	9.2 L/s	• Pump off when salinity exceeds 1200 mg/L TDS.
DM501B	CHPP MAW Demand	36.9 L/s (varies)	• Pump on when CHPP MAW supply is below the CHPP MAW Demand. • Pump off when CHPP MAW supply is equal to the CHPP MAW Demand.
DM902A	DM501A	100 L/s	• Pump on when DM902A volume exceeds 5 ML and DM501A volume is below 240 ML. • Pump off when DM902A volume is below 5 ML or DM501A volume exceeds 240 ML.
DM902B	DM501A	100 L/s	• Pump on when DM902B volume exceeds 5 ML and DM501A volume is below 240 ML. • Pump off when DM902B volume is below 5 ML or DM501A volume exceeds 240 ML.
Sewerage Treatment Plant	Dust suppression	0.65 L/s	• Pump on when total site water demand exceeds total dewatering flows. • Pump off when total dewatering flows exceeds total site water demand.
RO Plant (permeate)	DM501B	38.2 L/s	
RO Plant (permeate)	Potable water	1.6 L/s	
RO Plant (permeate)	CHPP Potable water demand	0.01 L/s	
RO Plant (brine)	DM501C	2.1 L/s	
RO Plant (brine)	DM501E	2.1 L/s	
RO Plant (brine)	DM501F	2.1 L/s	
RO Plant (brine)	DM501G	2.1 L/s	
RO Plant (brine)	DM501H	2.1 L/s	
RO Plant (brine)	DM501I	2.1 L/s	

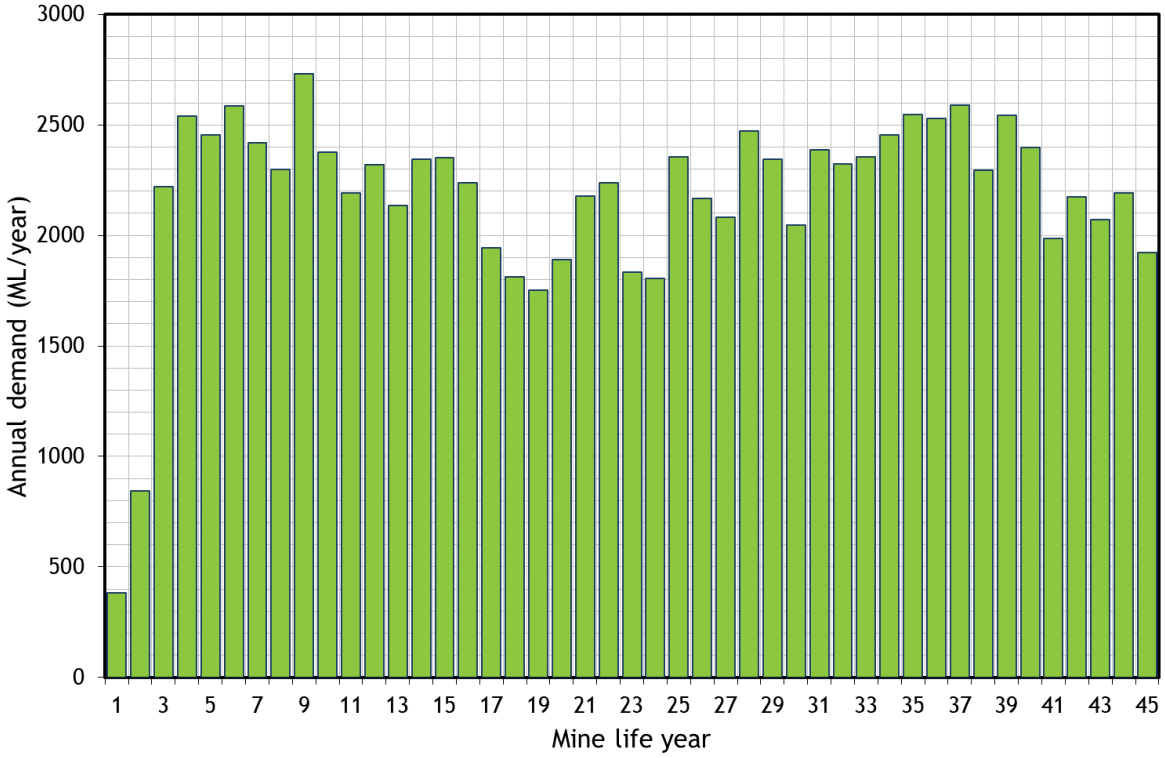


Figure 4.1 – Predicted annual water demands

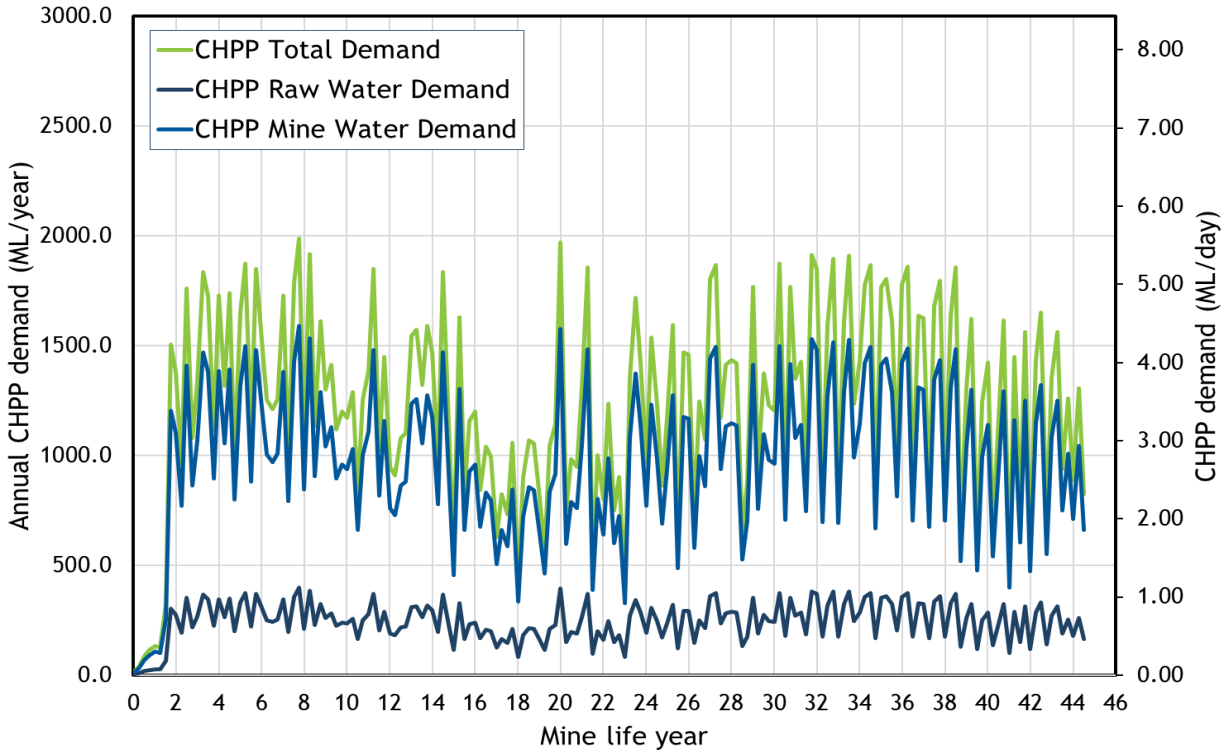


Figure 4.2 – Predicted CHPP water demands

4.7.2 Underground demands

The underground mine requires raw water for use in underground mining processes. This demand will be supplied with raw water sourced from Mine Process Water Storage Dam. The predicted daily underground process use over the life of mine is shown in Figure 4.3. Note that a portion of the underground equipment demand will be recycled through the mine water management system via the underground dewatering pumps.

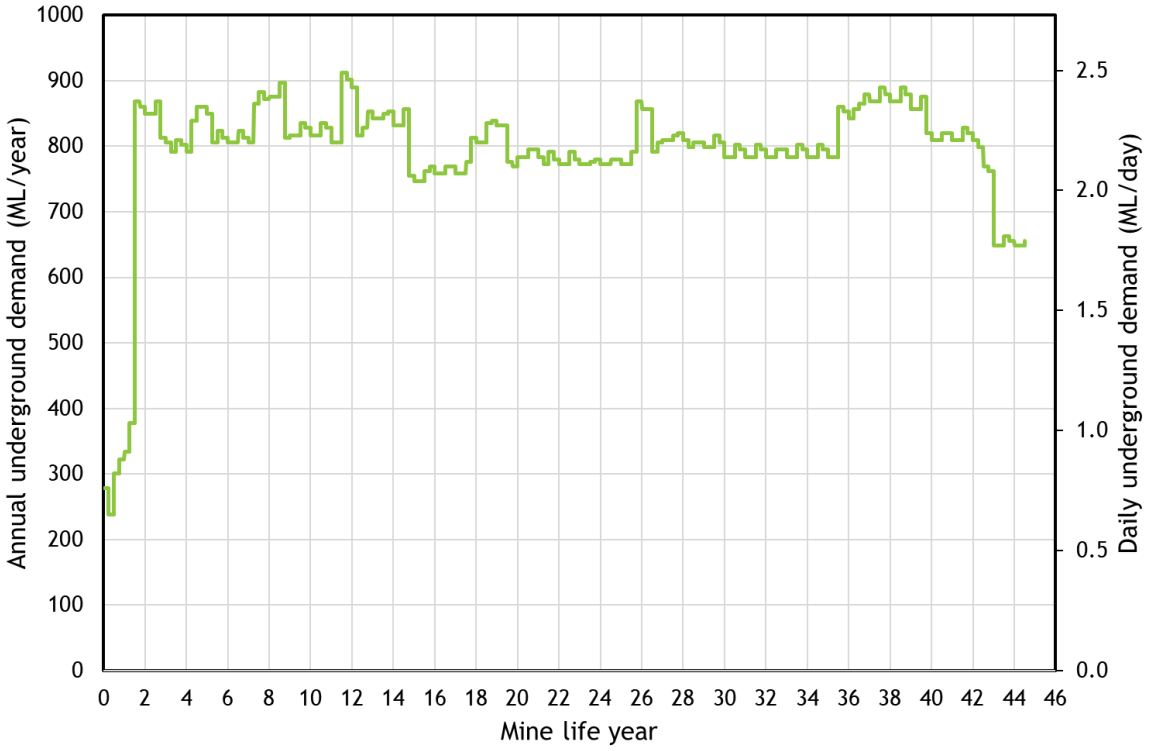


Figure 4.3 – Predicted underground water demands

4.7.3 Moisture losses in underground workings

Water is lost from the underground workings through two main mechanisms:

- Wetting up of ROM coal during mining; and
- Evaporation and vent moisture losses.

No site-specific data is available to accurately quantify the above losses in the Eagle Downs Coal Mine underground workings. The following assumptions have been adopted for water balance modelling for each loss:

- The moisture fraction of the coal will be increased by 50% by mass during mining. The ROM production schedule shown in Figure 4.4 is used in the water balance model to estimate the amount of water lost from the underground due to wetting of the ROM coal. It is assumed that only underground process water will contribute to the wetting of the ROM coal.
- A time series of predicted vent losses has been provided in EDCM (2022) for use in the water balance model. Figure 4.5 shows the vent loss time series. It is assumed that only underground process water will be lost to ventilation.

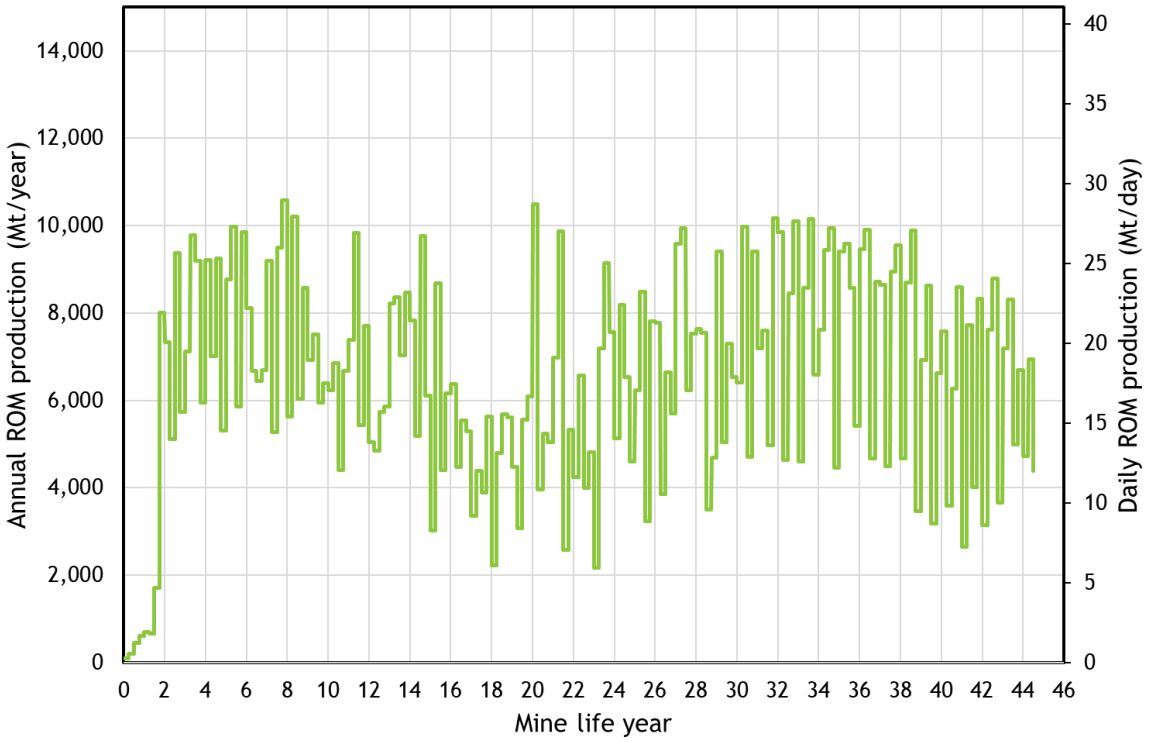


Figure 4.4 – Proposed ROM schedule

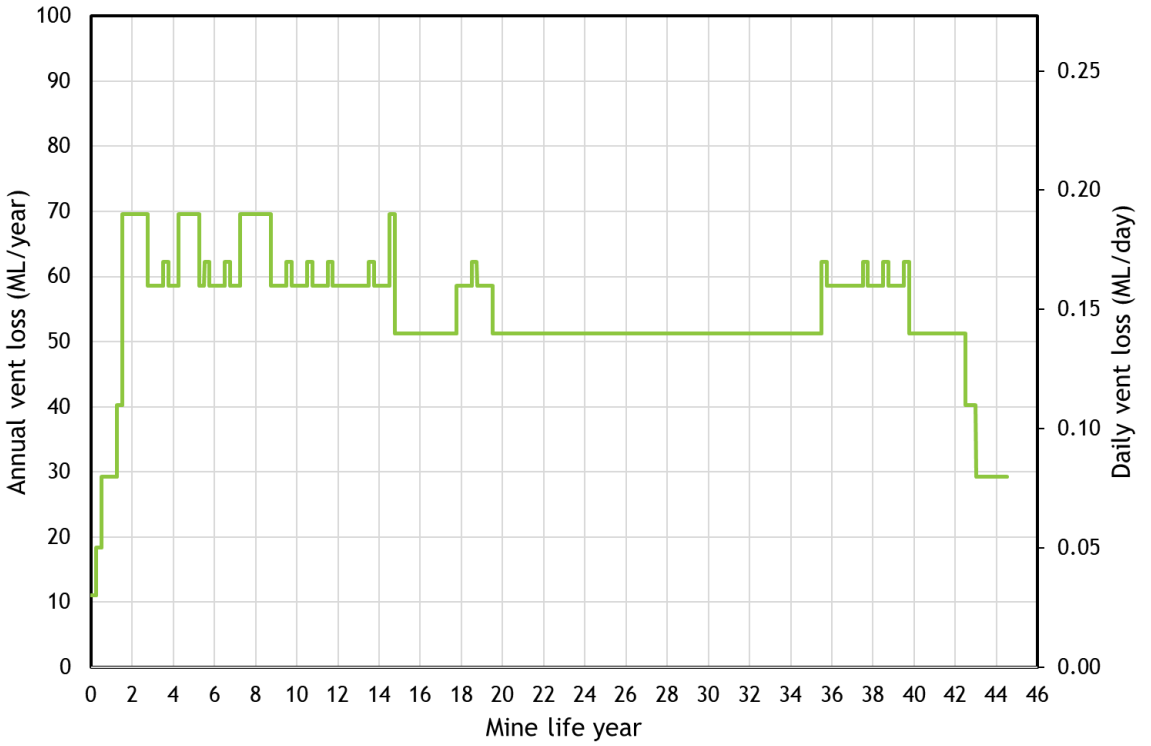


Figure 4.5 – Predicted vent losses from underground

4.7.4 Dust suppression

In the absence of any detailed estimates of surface dust suppression requirements, a constant demand of 0.31 ML/d has been adopted over the life of the mine.

4.7.5 Potable water

The Project will require approximately 0.13 ML/yr of raw water to be treated to meet potable water demands. The raw water for potable treatment will be sourced from the Raw Water Dam.

4.7.6 Construction water demand

The Project will require potable water, raw water and mine water for the initial construction phase of the Project. The construction water demand consists of water required for earthwork activities, construction of the drift and ventilation shaft, concrete production, and potable water requirements for construction. The period of the early works phase is contained within the first year, with several demands lasting until year 3 of the mining life. Figure 4.6 shows the construction demand schedule adopted for the early works phase.

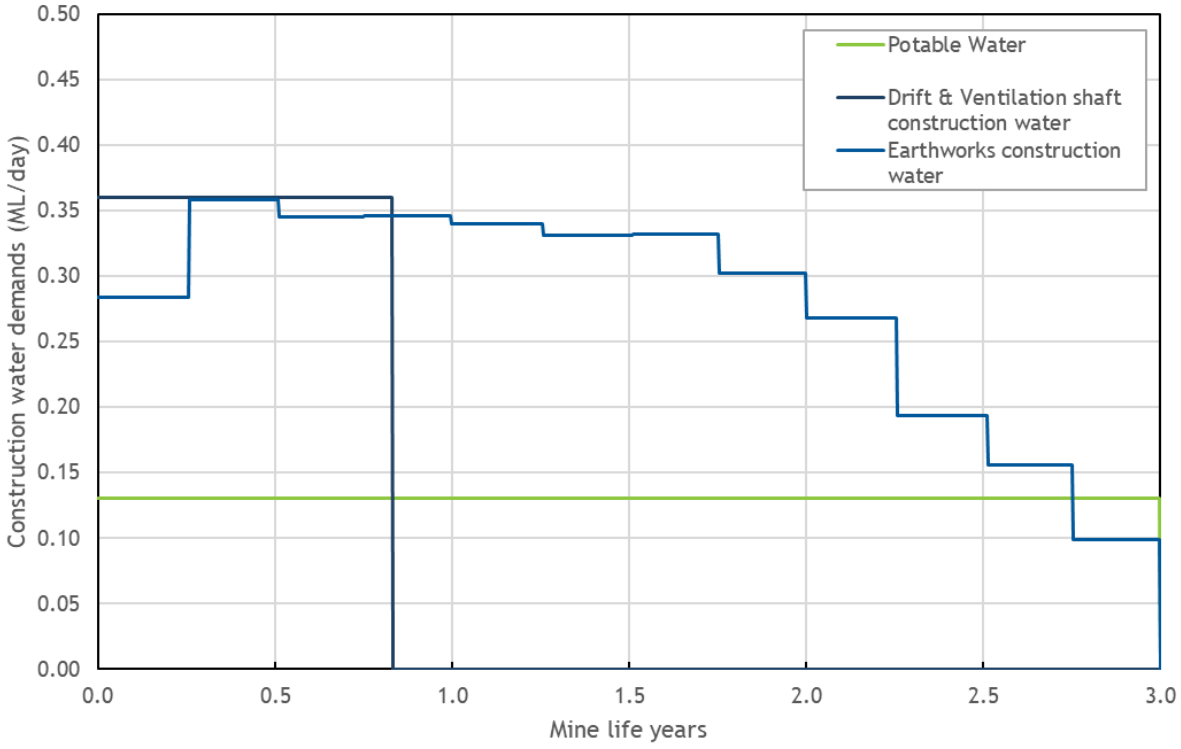


Figure 4.6 – Predicted construction water demands

4.8 WATER SOURCES

4.8.1 Underground dewatering

Mine water will be generated in the underground mine due to the ingress of groundwater, UIS drainage and the recycling of excess underground process water. AGE (2022) provides estimates of predicted groundwater and Palgas (2016) provides estimates of UIS inflows to the underground mine. The predicted groundwater and UIS inflows are shown in Figure 4.7. A portion of the UIS and groundwater inflow to the underground will be removed via the GOAF dewatering system, which is pumped out to the SIS dams (refer to Section 4.8.2).

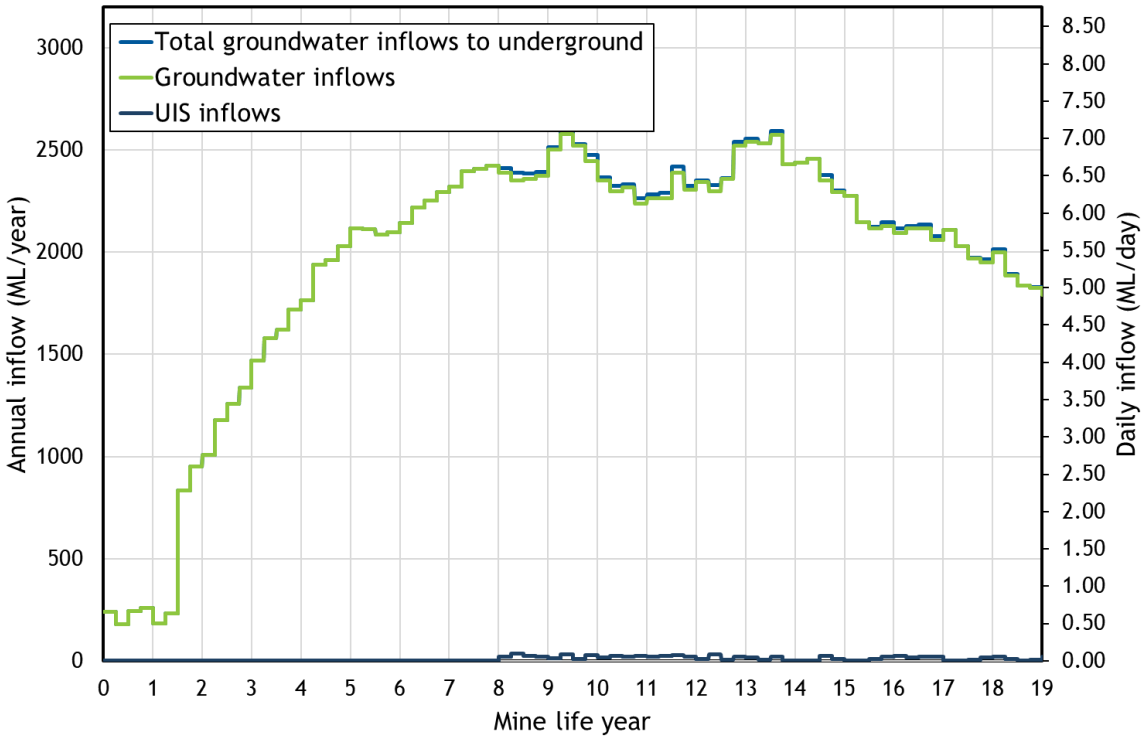


Figure 4.7 – Predicted groundwater and UIS inflows to underground workings

Due to the losses identified in Section 4.7.3, and the removal of some water via the GOAF dewatering system, not all groundwater and process water will be dewatered from the underground workings. Figure 4.8 shows the predicted total inflows to the underground workings (groundwater and UIS inflows and underground process demands), and the predicted daily underground dewatering flows.

4.8.2 SIS and GOAF dewatering

SIS gas drainage water and GOAF dewatering will be pumped out into the SIS Dams. PalGas (2016) provides estimates of SIS gas drainage flows and EDCM (2022) provided estimates of GOAF dewater volumes. Figure 4.9 shows the predicted SIS gas drainage and GOAF dewatering flows, and the total inflow to the SIS Dams.

4.8.3 Raw water

Raw water will be required to supply the potable demands for the mine, and also to make up any shortfall in CHPP and underground process water demands. Raw water will be sourced from the nearby Sunwater pipeline.

4.8.4 Catchment runoff and direct rainfall

All dams at the mine site receive direct rainfall, local catchment runoff (unless Turkey's Nest) and lose water through evaporation. The water management system has been designed to maximise the harvesting of catchment runoff and direct rainfall for use in supply site demands.

4.8.5 Shaft sinking

There will be 38 ML inflow to the mine water management system (likely discharged directly into DM901b) in year 1 of mine life due to the blind bore ventilation shaft sinking works (EDCM, 2022).

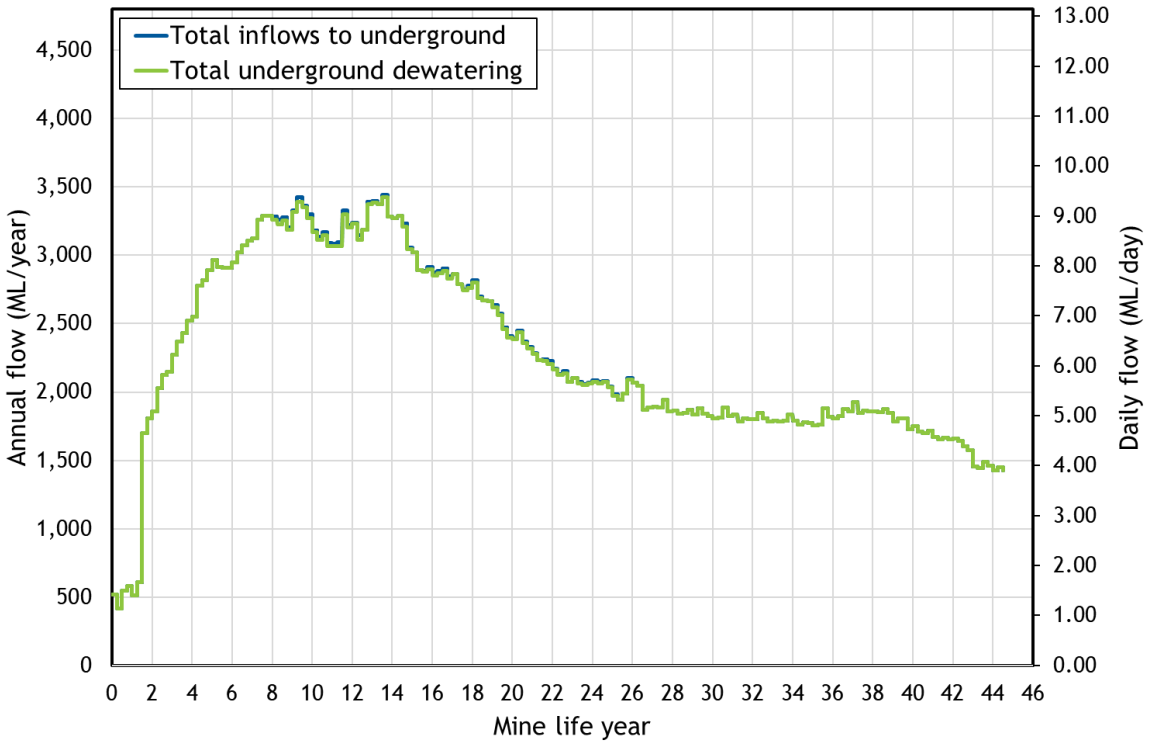


Figure 4.8 – Predicted underground inflows and underground dewatering

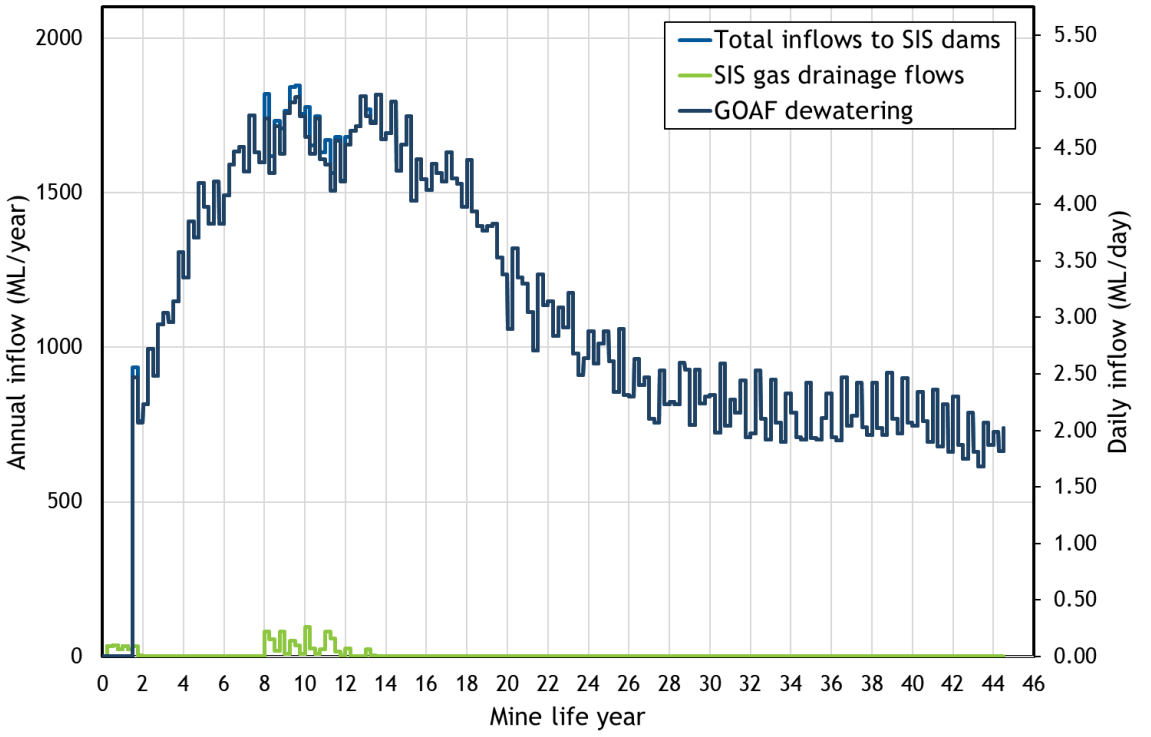


Figure 4.9 – Predicted SIS gas drainage and GOAF dewatering

4.9 COMPARISON OF WATER SOURCES AND DEMANDS

Figure 4.10 shows an annual comparison between the total site water demands and the site water sources (including groundwater, recycled underground process water, SIS and UIS total inflow volumes). This shows that the mine has a water deficit and will need to rely on captured surface runoff and imported water from Sunwater to adequately supply site water demands. It should also be noted that groundwater inflows will be of poor quality and cannot be utilised to supply site water demands without treatment.

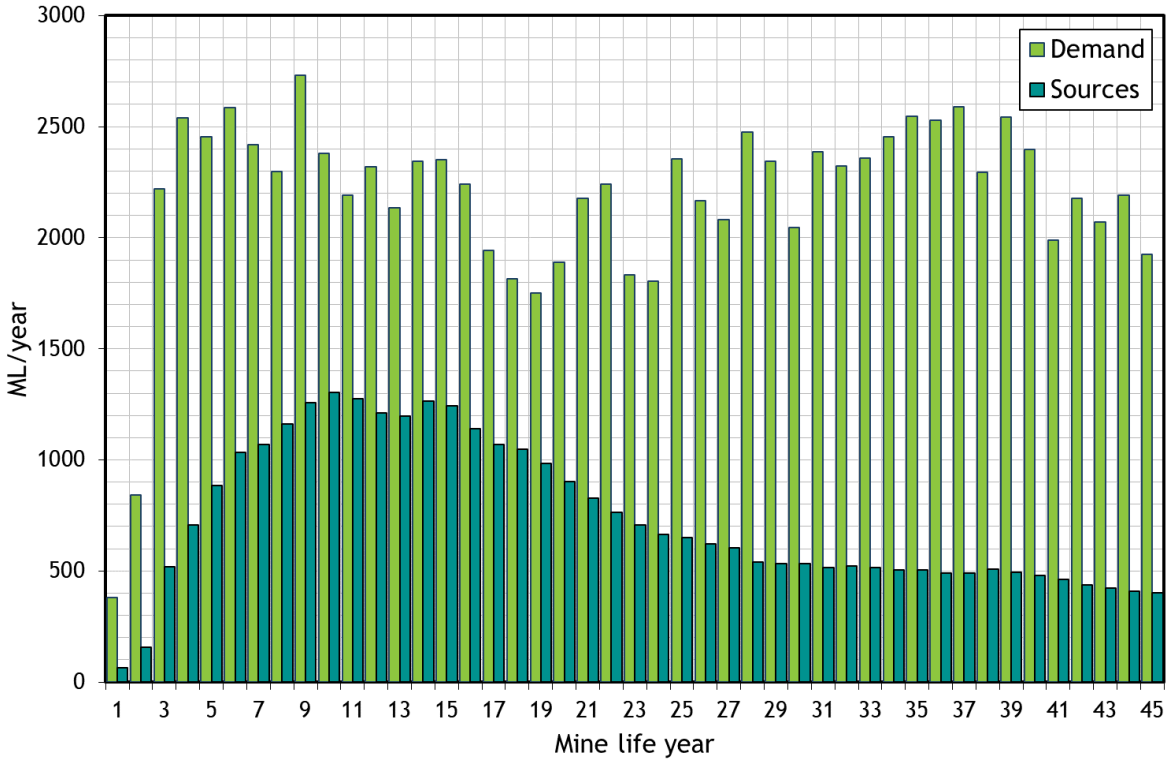


Figure 4.10 – Predicted annual water demand and underground water sources

4.10 MODELLING OF CATCHMENT RUNOFF

4.10.1 AWBM parameters for different catchment types

The AWBM model was used to represent the runoff characteristics of mine site catchments. AWBM uses a group of connected conceptual storages (3 surface storages and 1 groundwater storage) to represent catchment runoff. Water in the conceptual storages is replenished by rainfall and reduced by evapo-transpiration. Simulated surface runoff occurs when these storages fill and overflow. The model parameters define the depth and relative area of each of the storages, as well as the rate of water flux between storages.

To adequately simulate the mine site water balance, it is necessary to define the runoff characteristics of the various catchment surface types. Mine site catchments were classified as either:

- Natural catchment, representing areas undisturbed by mining;
- Industrial/hardstand, representing areas disturbed by mining, such as haul roads and plant area; or
- Stockpile, representing the DREA.

The adopted AWBM parameters for the three catchment types on the mine site are shown in Table 4.4.

Table 4.4 – Adopted AWBM catchment rainfall-runoff parameters

Parameter		Natural	Industrial/ Hardstand	Stockpile
Partial area of surface storages	A1	0.07	0.134	0.134
	A2	0.01	0.433	0.433
Surface storage depths (mm)	C1	20	1.8	10.8
	C2	1	19	110.5
	C3	168.3	54	221
	CAVG	156.3	31.85	145
Base flow recession constant	KBASE	0	0	0
Surface flow recession constant	KSURF	0.33	0	0
Base flow index	BFI	0	0	0
Long term runoff	RC	0.06	0.29	0.09

Natural catchment runoff was based on a calibrated AWBM model of Phillips Creek at Tayglen (WRM, 2010), a nearby creek system with a catchment undisturbed by mining.

Industrial/hardstand catchments are characterised by compacted or hard surfaces which inhibit water infiltration, resulting in much higher rates of surface runoff. The simulated volumetric runoff for industrial catchments was 28%, about 4 times higher than natural catchments in the vicinity (Phillips Creek at Tayglen (WRM, 2010)).

The adopted model parameters for stockpile catchments assume lower opportunities for evapo-transpiration than natural catchments due to the absence of vegetation, resulting in higher surface runoff rates. The simulated volumetric runoff coefficient for stockpile catchments was 9%, about 1.5 times higher than natural catchments.

4.10.2 Catchment areas

The breakdown of catchment types and areas draining to each of the water storages is shown in Table 4.5. Dam surface areas that are not inundated are assigned stockpile or industrial runoff characteristics in the water balance model, dependant on whether the dam will be lined or not.

4.11 SALINITY PARAMETERS

The Project GOLDSIM model has been configured to use salinity as an indicator of water quality. This has been achieved by assigning representative total dissolved solids (TDS) levels to runoff from catchments and other sources of water.

- The adopted DREA catchment runoff salinity was based on the geochemical characterisation of the combined reject material, and drift and shaft spoil (RGS, 2022).
- Available groundwater quality monitoring results were used to determine the salinity of groundwater inflows to the Project.
- Raw coal moisture is assumed to have the same TDS concentration as groundwater.

Table 4.5 – Dam catchment areas

Dam ID	Contributing catchment by land use type (ha)					
	Natural	Stockpile - Coal	Stockpile - DREA	Industrial/ Hardstand	Dam Surface	Total
DM502	-	-	-	-	0.83	0.83
DM401A	-	-	-	-	0.64	0.64
DM901A	8.99	7.52	-	-	0.90	17.4
DM901B	-	-	-	-	0.54	0.54
DM501A	-	-	-	-	6.50	6.50
DM501B	-	-	-	-	4.20	4.20
DM501C	-	-	-	-	4.70	4.70
DM701A	8.70	9.72	-	39.7	3.60	58.5
DM902A	-	-	DS1:98.5[1]	-	2.63	98.5
DM902B[2]	-	-	DS2:160.5	-	2.77	163.3
			DS3:288.5		2.77	291.3
DM401B	-	-	-	-	1.09	1.09
DM401C	-	-	-	-	0.5	0.5
DM501E	-	-	-	-	5.74	5.74
DM501F	-	-	-	-	4.70	4.70
DM501G	-	-	-	-	4.70	4.70
DM501H	-	-	-	-	4.70	4.70
DM501I	-	-	-	-	4.70	4.70

[1] DS1 - DREA stockpile area for the first 5 years of operation, DS2 - DREA stockpile area for years 5-20 of operation and DS3 -DREA stockpile area for years 20-43.5 of operation.

[2] DM902 Stage 2 and Stage 3 denotes the combined DREA stockpile area to DM902B.

The adopted TDS concentrations applied to the model are given in Table 4.6. Equivalent EC values, based on a conversion factor of 0.59 (calculated from available water equality samples in existing dams), are also provided.

Table 4.6 – Adopted salinity concentrations

Water source	TDS (mg/L)	EC (uS/cm)
Groundwater, UIS and SIS drainage	7,600	12,881
Imported Sunwater	200	339
Coal stockpile catchment	2,500	4,237
Hardstand / industrial catchments	1,500	2,542
DREA catchment	354	600
Natural	200	339

5 Water management system assessment

5.1 OVERVIEW

Assessment of the Project's mine water management system has been undertaken using the water balance model, against the following key performance indicators:

- The volume of water likely to accumulate in the dams at the Project site;
- The probability and volume of uncontrolled spills from dams at the Project site;
- The volume of salt and resulting salinity in the dams at the Project site; and
- The volume of external raw water required to supplement the mine water demand.

A schematic layout of the water balance model is presented in Figure 3.1. Operational guidelines and controls applied to the model are described in Section 4.6.

5.2 INTERPRETATION OF RESULTS

The modelling methodology of a forecast simulation is provided in Section 4.2. In interpreting the results of the water balance assessment, it should be noted that the results provide a statistical analysis of the water management system's performance over the 46 years of coal extraction, based on 130 realisations with different climatic sequences. The 50th percentile probability represents the median results, 5th percentile represents 5% exceedance (i.e. wet conditions) and the 95th percentile results represent 95% exceedance (i.e. dry conditions). There is an 80% chance that the result will fall between the 10th and 90th percentiles and a 98% chance that the result will fall between the 1st and 99th percentiles. Importantly, note that a percentile trace shows the percentile chance of a particular value on each day, and does not represent continuous results from a single model realisation (i.e. the 50th percentile trace does not represent the model time series for median climatic conditions).

A single realisation can also be selected from the 130 modelled realisations, in order to show the water management system's actual performance (not a statistical representation) for a particular climate sequence.

5.3 MINE AND RAW WATER BALANCE MODEL RESULTS

5.3.1 Mine water and Raw water inventory

Figure 5.1 to Figure 5.4 show the predicted daily volumes of mine water stored in the SIS Dam 1, SIS Dam 2, SIS Dam 3, Mine Water Dam 1, the Brine Storage Dams and ROM & CHPP Sediment Dam. Figure 5.5 show the predicted daily volumes of raw water stored in the Mine Process Water Storage Dam. The following percentile traces are displayed for each dam:

- 99th percentile (very wet);
- 90th percentile (wet);
- 50th percentile (median);
- 10th percentile (dry); and
- 1st percentile (very dry).

No spills are predicted from any of the mine water dams over the life of the Project, indicating there is a very low risk of releasing mine affected water from the storages at the Project site.

Raw water is continually topped up by external water so remains at a relatively constant level.

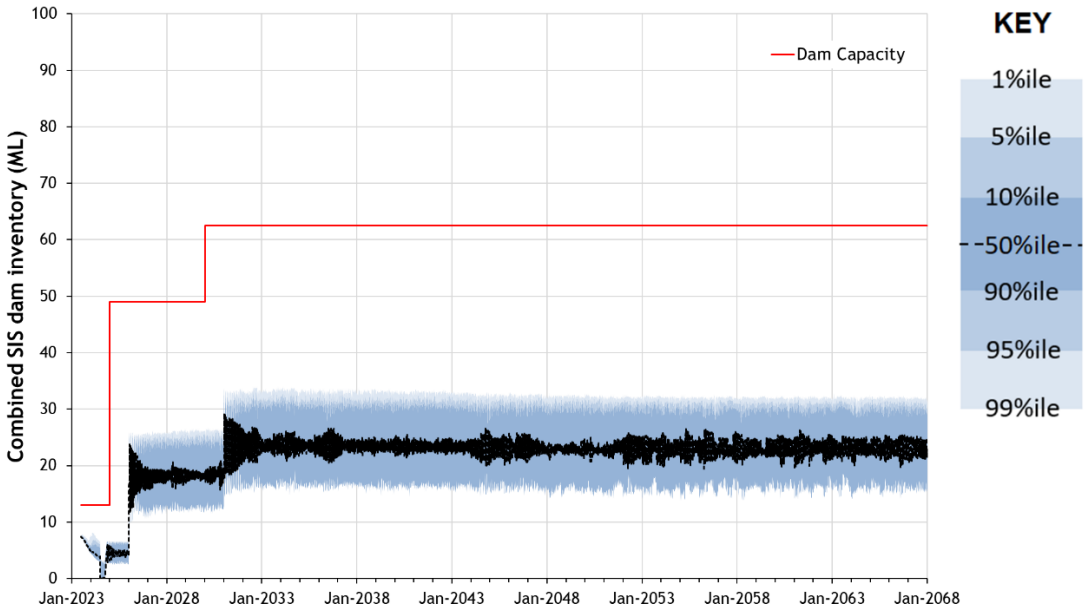


Figure 5.1 – Forecast SIS dams (combined DM401) storage inventory

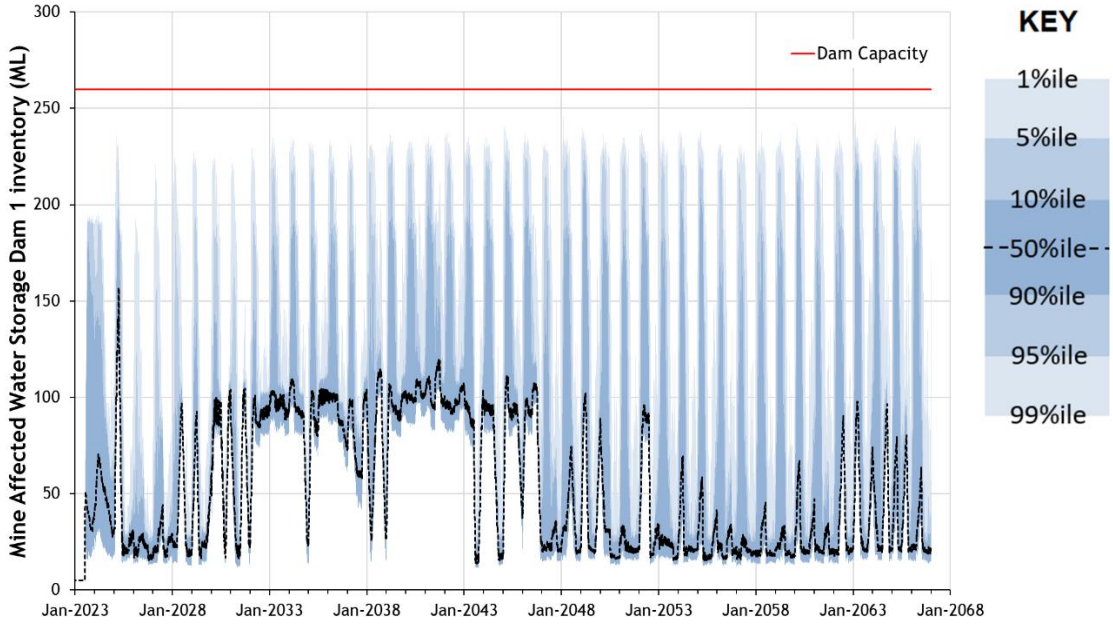


Figure 5.2 – Forecast Mine Water Dam 1 (DM501A) storage inventory

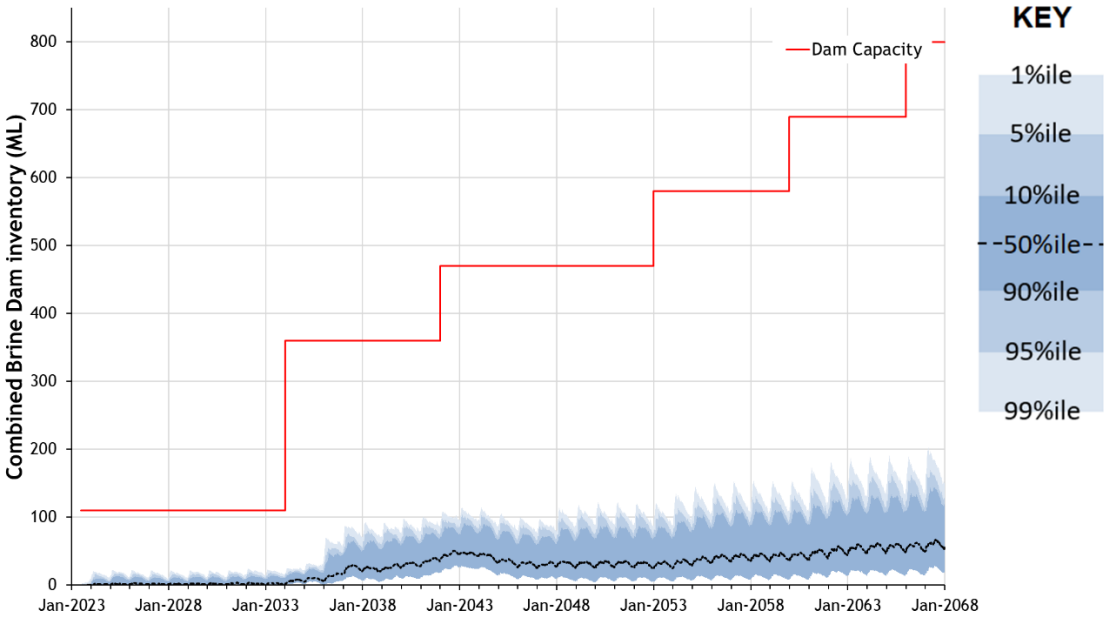


Figure 5.3 – Forecast Brine Dams (DM501C) storage inventory

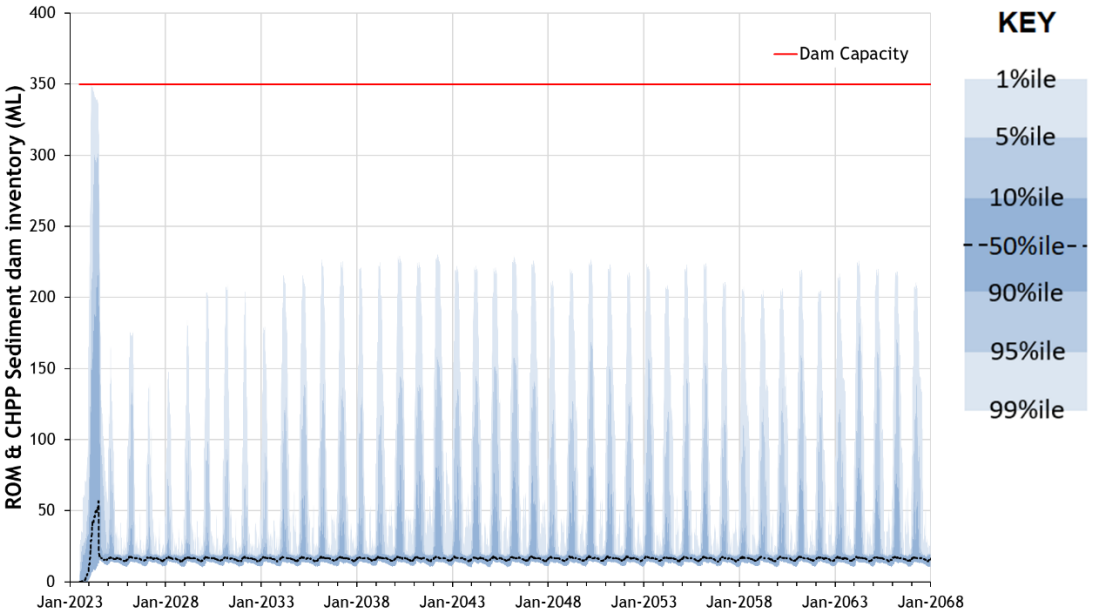


Figure 5.4 – Forecast ROM & CHPP sediment dam (DM701) storage inventory

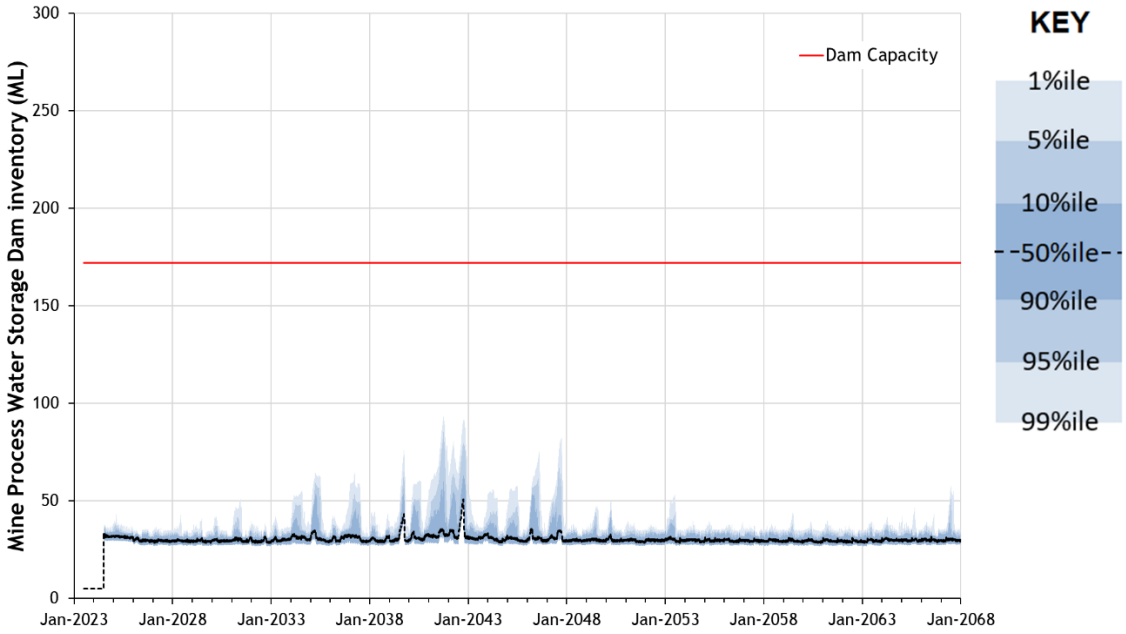


Figure 5.5 – Forecast Mine Process Water Storage Dam (DM501B) storage inventory

5.3.2 Controlled and uncontrolled mine water releases

Controlled releases are not proposed and are not required from the RP2 Mine Water Dam (DM501A).

The water balance model results show that there would not be any uncontrolled spillway discharges into the receiving environment from any of the mine water dams for any climatic conditions assessed over the life of the Project. All of the mine water dams are of turkeys nest type of construction in that they have no contributing catchment area other than the surface area of the dam itself except for the ROM and CHPP Sediment Dam (DM701A).

The ROM and CHPP Sediment Dam catchment, which captures surface water runoff from the ROM and CHPP could potentially overflow if an event larger than the 99th percentile rainfall event occurred. The likelihood of spills will reduce when the Mine Water Dam is built. In the event where DM701A spills into the environment, the water quality would generally be range between 2,000 mg/L and 2,500 mg/L.

5.3.3 Predicted dam salinity

Figure 5.6 to Figure 5.9 show the predicted median salinity in each of the mine water storages at the Project site. Median salinity has been selected for display as traces for the full range of percentiles are skewed by the periods of low water levels (less than 2 ML) in the dams, which cause the model to calculate very high salinities (as salt is conserved in the model). The following is of note:

- Water stored in Mine Process Water Storage Dam will be suitable for use as CHPP and underground raw water supply;
- Water stored in the Mine Water Dam will be suitable for use as CHPP mine water supply. There are some periods where the water is outside the RO Feed limit capacity;

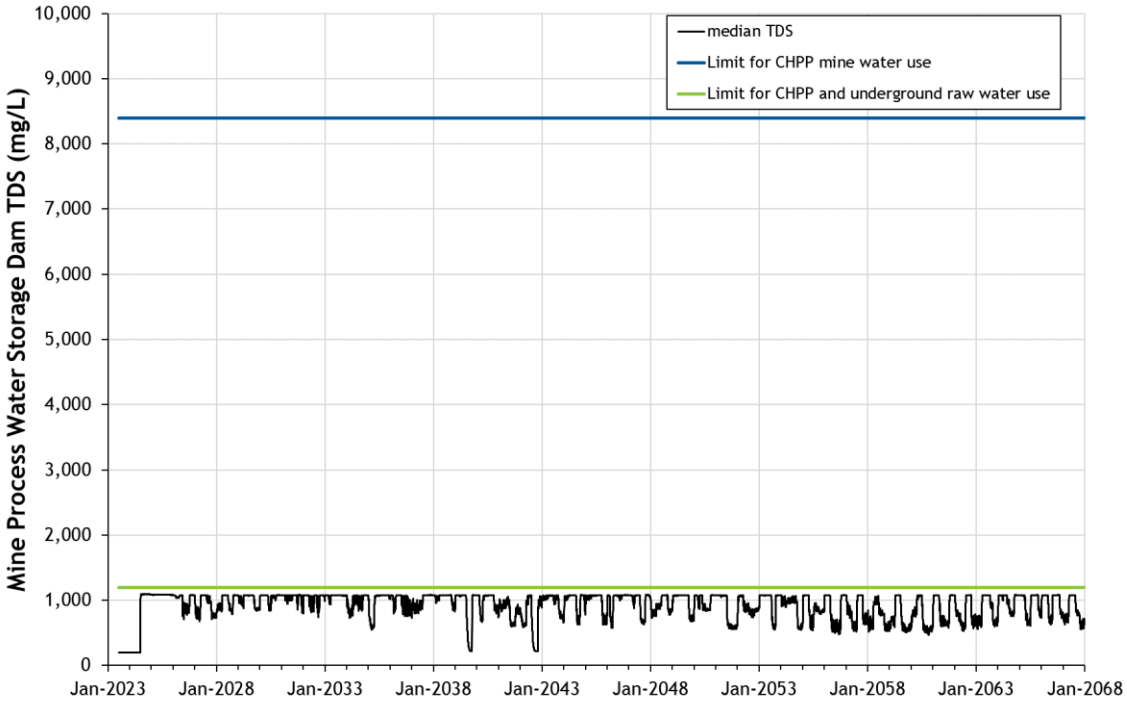


Figure 5.6 – Predicted Mine Process Water Storage Dam (DM501B) salinity

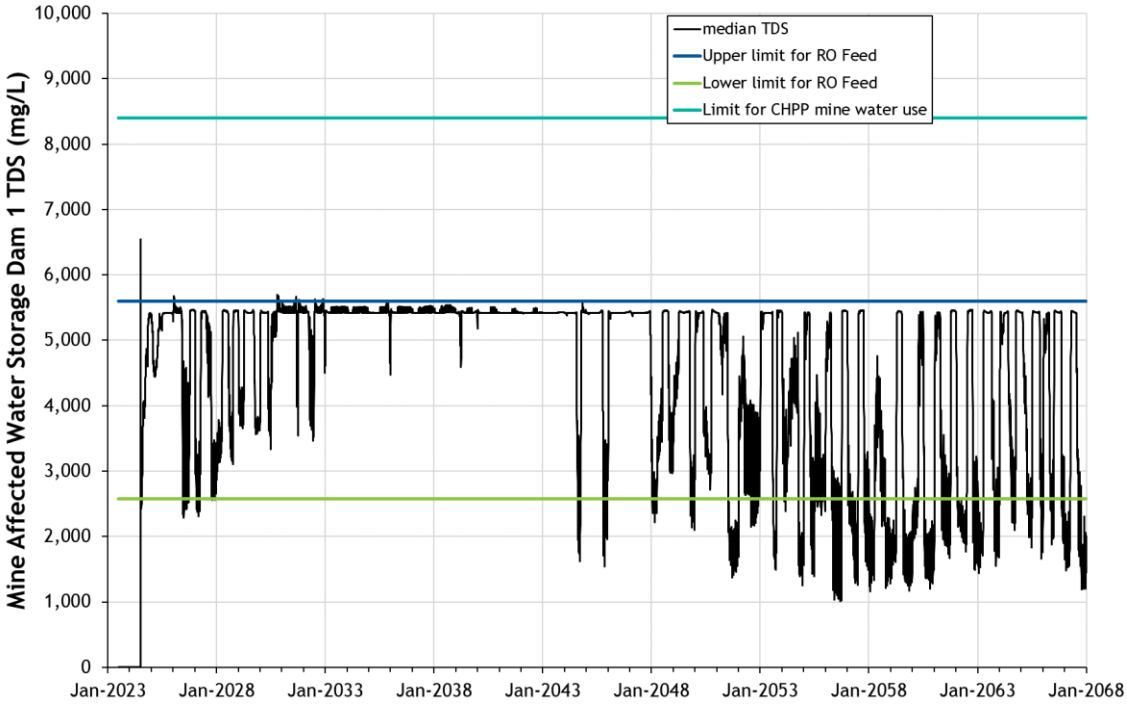


Figure 5.7 – Predicted Mine Water Dam (DM501A) salinity

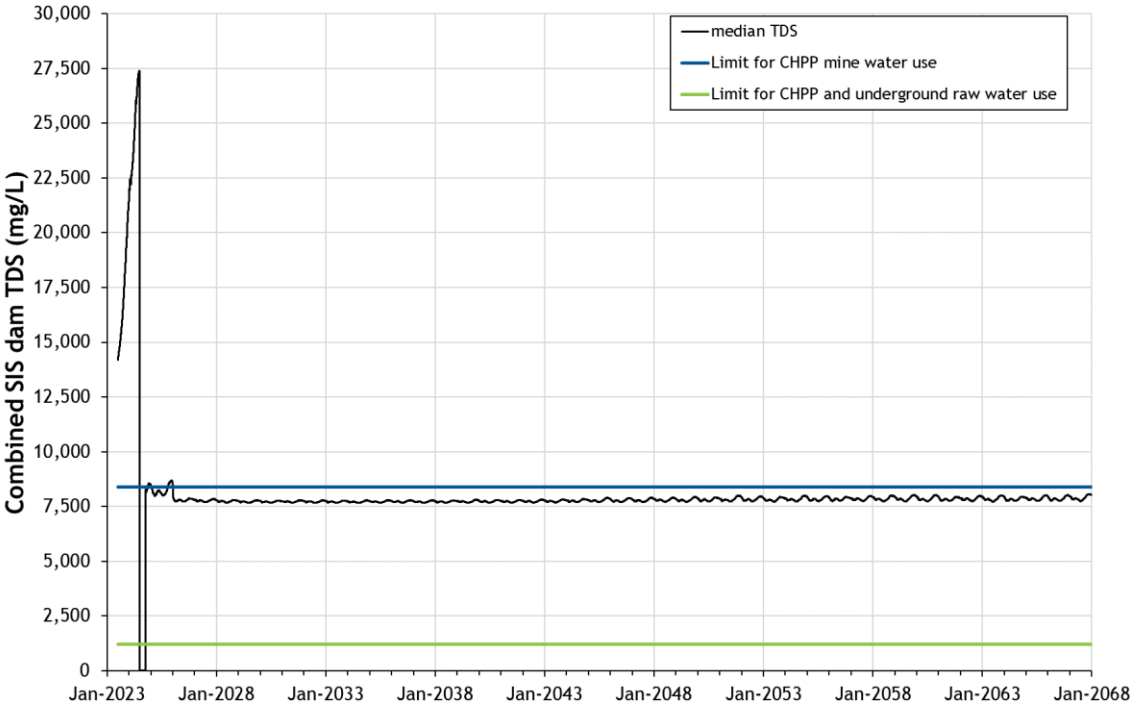


Figure 5.8 – Predicted SIS Dam (DM401A, DM401B, DM401C) salinity

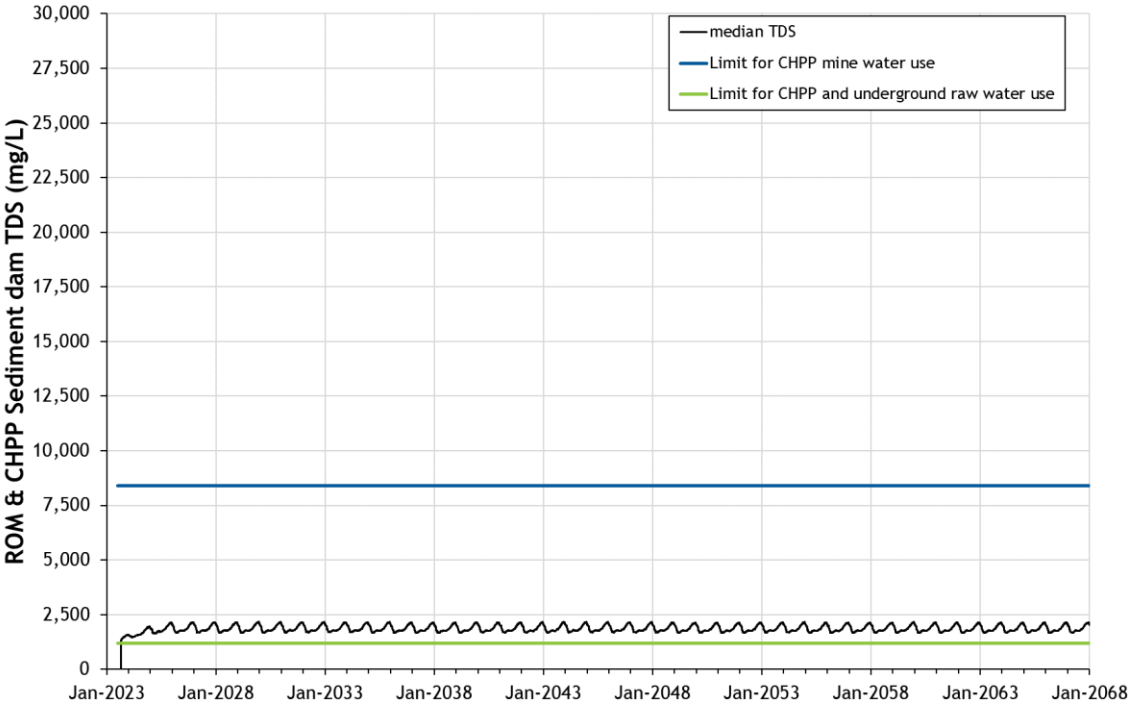


Figure 5.9 – Predicted ROM & CHPP Sediment Dam (DM701) salinity

- The spike in salinity in the SIS dams over the first years of mine life is due to the evaporation of water from the existing dam before Project SIS water is deposited in the dam. The water stored in the SIS dam is generally able to be used for mine affected water demands;
- Water stored in the CHPP and ROM sediment dams are generally suitable for use for mine affected water demands; and
- Opportunity may exist to refine the water management system to re-use more saline water and increase salinity in DM501b, potentially reducing use of imported water.

5.3.4 Raw water import requirements

5.4 ESC DAM WATER BALANCE MODEL RESULTS

Sediment dams form part of the surface water management system with captured water pumped to the mine water management dams. However, the large size of the DREA catchment area and that surface runoff water quality is expected to be better than or equal to the regional water quality, the DREA sediment dams will be designed to passively overflow when rainfall exceeds the design standard.

The potential for overflows from the sediment dams has been assessed using forecast assessment simulation. The annual risk of sediment dam overflows are:

- DREA Sediment Dam 1 (DM902A): 0% to 4% annual spill risk.
- DREA Sediment Dam 2 (DM902B): 0% to 19% annual spill risk.

Figure 5.10 shows a probability exceedance plot of the predicted salinity concentrations for DREA sediment dam overflows (combined). The results show that:

For DM902A:

- DM902A is not predicted to spill into the receiving environment for the 5%ile (wet) climatic conditions or drier.
- During very wet climatic conditions (1%ile), the predicted overflow salinity concentrations for the DREA Sediment would range between 649 µS/cm to 657 µS/cm (TDS 346 mg/L to 350 mg/L).
- During extremely wet climatic conditions (maximum), the predicted overflow salinity concentrations would range between 649 µS/cm to 663 µS/cm (TDS 346 mg/L and 353 mg/L).

Table 5.1 summarises the predicted annual raw water import requirements for the Project to satisfy all demands. Predicted import demands are given for a range of percentile traces, with variability typically related to climatic conditions and the deficit between water demands and sources at the Project site. The following is of note:

- Maximum predicted water import (2,094 ML) will be required in Year 38 of mine life; and
- Predicted water imports for Years 1 to 3 are significantly lower than the rest of the mine life.
- EDCM has an annual Sunwater import allocation of 600 ML/year and the mine site would need to source raw water from alternative sources.

5.5 ESC DAM WATER BALANCE MODEL RESULTS

Sediment dams form part of the surface water management system with captured water pumped to the mine water management dams. However, the large size of the DREA catchment area and that surface runoff water quality is expected to be better than or equal to the regional water quality, the DREA sediment dams will be designed to passively overflow when rainfall exceeds the design standard.

The potential for overflows from the sediment dams has been assessed using forecast assessment simulation. The annual risk of sediment dam overflows are:

- DREA Sediment Dam 1 (DM902A): 0% to 4% annual spill risk.
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Figure 5.10 shows a probability exceedance plot of the predicted salinity concentrations for DREA sediment dam overflows (combined). The results show that:

For DM902A:

- DM902A is not predicted to spill into the receiving environment for the 5%ile (wet) climatic conditions or drier.
- During very wet climatic conditions (1%ile), the predicted overflow salinity concentrations for the DREA Sediment would range between 649 µS/cm to 657 µS/cm (TDS 346 mg/L to 350 mg/L).
- During extremely wet climatic conditions (maximum), the predicted overflow salinity concentrations would range between 649 µS/cm to 663 µS/cm (TDS 346 mg/L and 353 mg/L).

Table 5.1 – Simulated raw water inflows to mine water management system

Year	Annual raw water import (ML)				
	Min	10th percentile	Median	90th percentile	Max
1	208	212	214	217	218
2	406	427	488	533	552
3	298	426	560	616	654
4	1,046	1,224	1,391	1,455	1,495
5	1,331	1,529	1,732	1,803	1,845
6	1,157	1,355	1,597	1,665	1,700
7	1,109	1,369	1,623	1,696	1,746
8	991	1,215	1,474	1,546	1,581
9	780	1,024	1,285	1,360	1,404
10	1,049	1,293	1,564	1,636	1,679
11	795	1,034	1,295	1,370	1,412
12	537	737	1,037	1,121	1,164
13	640	853	1,142	1,225	1,276
14	560	787	1,090	1,180	1,218
15	669	884	1,181	1,271	1,321
16	749	963	1,269	1,347	1,402
17	495	786	1,117	1,198	1,249
18	413	633	976	1,070	1,115
19	220	421	760	854	917
20	206	379	715	806	860
21	342	575	919	1,017	1,061
22	723	911	1,283	1,386	1,434
23	743	946	1,317	1,412	1,476
24	449	628	990	1,087	1,132
25	394	585	950	1,046	1,109
26	944	1,222	1,601	1,696	1,754
27	791	991	1,381	1,494	1,556
28	803	948	1,354	1,450	1,505
29	1,150	1,319	1,721	1,814	1,889
30	1,056	1,248	1,645	1,733	1,806
31	769	960	1,304	1,403	1,450
32	1,072	1,291	1,681	1,783	1,857
33	1,069	1,220	1,624	1,732	1,793
34	1,104	1,286	1,678	1,784	1,841
35	1,120	1,326	1,761	1,867	1,929
36	1,197	1,465	1,893	2,003	2,072
37	1,192	1,413	1,872	1,987	2,049
38	1,283	1,457	1,909	2,030	2,094
39	1,012	1,186	1,575	1,692	1,751
40	1,178	1,368	1,819	1,933	2,012
41	1,012	1,238	1,688	1,802	1,879
42	744	890	1,288	1,408	1,469
43	825	992	1,423	1,539	1,617
44	779	938	1,363	1,480	1,542
45	933	1,128	1,570	1,685	1,773
46	725	859	1,284	1,414	1,470

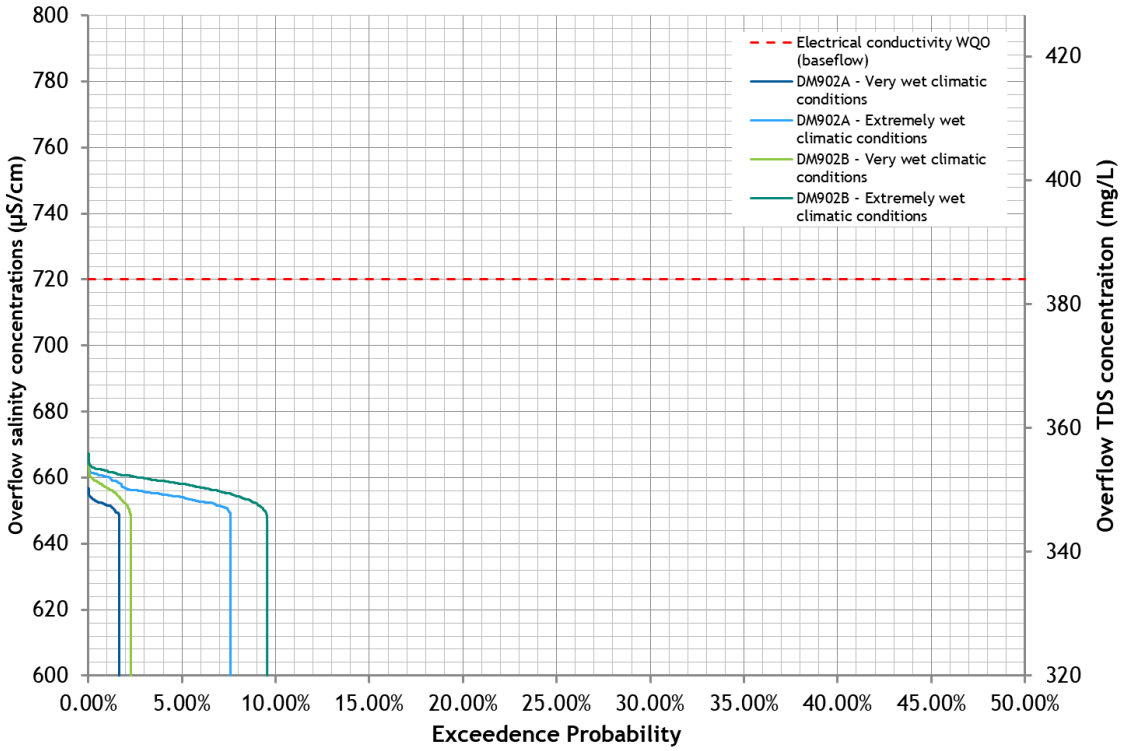


Figure 5.10 – Predicted salinity of DREA sediment dam overflow

- For DM902B:
  - DM902B is not predicted to spill into the receiving environment for the 5%ile (wet) climatic conditions or drier.
  - During very wet climatic conditions (1%ile), the predicted overflow salinity concentrations would range between 649 µS/cm to 663 µS/cm (TDS 346 mg/L to 354 mg/L).
  - During extremely wet climatic conditions (maximum), the predicted overflow salinity concentrations would range between 647 µS/cm to 667 µS/cm (TDS 345 mg/L to 356 mg/L).
- Based on the above results, the DREA sediment dams would spill into the environment during very wet or extremely wet climatic conditions (1%ile or less) and would discharge with salinity concentrations below the low flow WQO's.
- On this basis, the salinity concentrations would be acceptable to release into the environment without a regulated release point on the DREA sediment dam.

5.6 ADAPTIVE MANAGEMENT OF MINE WATER BALANCE

The model results presented above represent the application of the adopted mine water management system rules over the mine life, regardless of climatic conditions. In reality, there are numerous options for adaptive management of the mine water management system to accommodate climatic conditions. For example, when excess water is available on site, it may be possible to increase the application of water for dust suppression. These alternative management approaches would reduce the risks to the Project associated with climatic variability.

6 Mine subsidence impact assessment

6.1 OVERVIEW

The Eagle Downs Project proposes to target three seams (HCU, HCL and DY) by longwall mining. Longwall mining typically results in subsidence which leads to progressive development of shallow, trough-like depressions on the surface above each extracted longwall panel. The trough-like depressions have gentle grades and develop relative to the natural surface.

The depressions on the surface develop as the roof strata above the coal seam progressively collapse to fill the void created by the extraction of coal in the area behind the longwall. As the roof collapses into the mined area (referred to as the 'goaf'), the fracturing and settlement of rocks progresses upwards through the overlying strata and results in sagging and bending of the near surface layers.

Surface subsidence develops progressively on the surface in a wave across the active longwall panel that travels at the same rate as the longwall. The majority of subsidence at a point on the surface occurs within three months of undermining and all subsidence is generally complete within 12 months.

Table E1 of the existing EA approved a maximum ponding disturbance area of 77.5 ha. However, this will change as a result of the revised mine plan. This section provides results of an assessment of water ponding in the depressions in comparison to the existing approval and addresses the potential surface water issues associated with the ponding.

There are no watercourses that would be impacted by surface subsidence. However, surface subsidence has the potential to cause localised ponding that may impact on vegetation. The water quality accumulating in the ponded areas may also degrade through evapo-concentration, which may be of concern to users of the ponded water and for downstream overflows.

6.2 PONDING SURFACE AREAS

6.2.1 Methodology

EDCM provided ground level data for the Project site as 1 m ascii tiles derived from LiDAR. The LiDAR data was stitched together to create a digital elevation model (DEM) of existing conditions. The predicted landform surface for each seam was then determined by subtracting the predicted subsidence ground level impacts for HCU only, HCU and HCL, and fully subsided conditions (i.e., all three seams) from the existing conditions DEM.

The predicted ponding surface areas for the existing conditions DEM and the three subsided conditions DEM's were then determined by interrogating the DEM to define the overflow level of each depression and contouring the depression at that level. The ponding areas were then confirmed through flood modelling described in Section 7.

6.2.2 Surface ponding areas

Figure 6.1 to Figure 6.3 shows the predicted locations and ponding extents for each seam progression. Table 6.1 shows the predicted total ponded areas for existing conditions and for each seam progression. The increase in ponded areas compared to existing conditions is also shown.

The existing ponding within the mining lease is estimated to be 14.4 ha. The mining lease covers an area of about 4,558 ha. All seams would increase the area of ponding above the approved area of 77.5 ha.

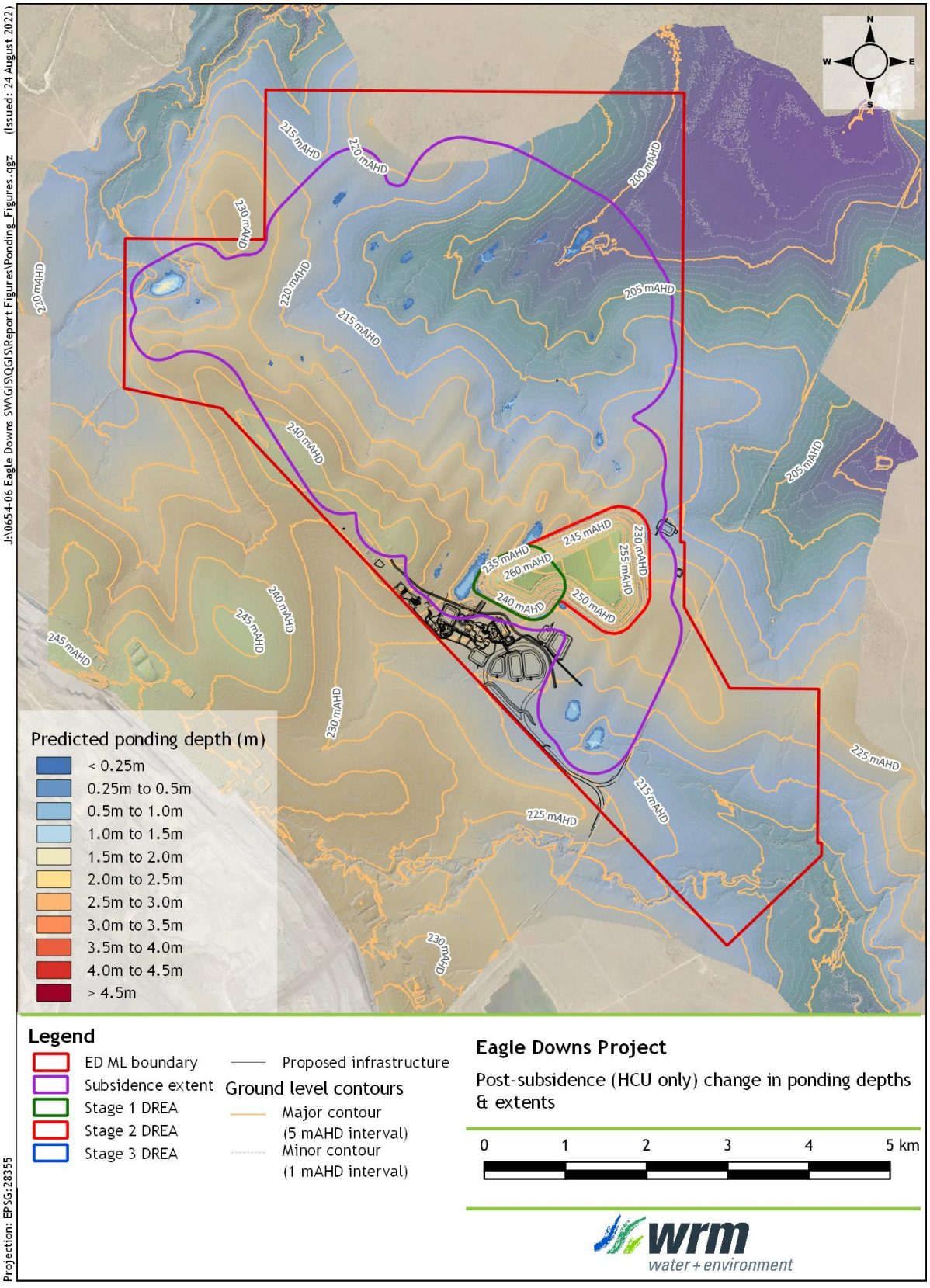


Figure 6.1 – Post-subsidence (HCU only) change in ponding depths & extents

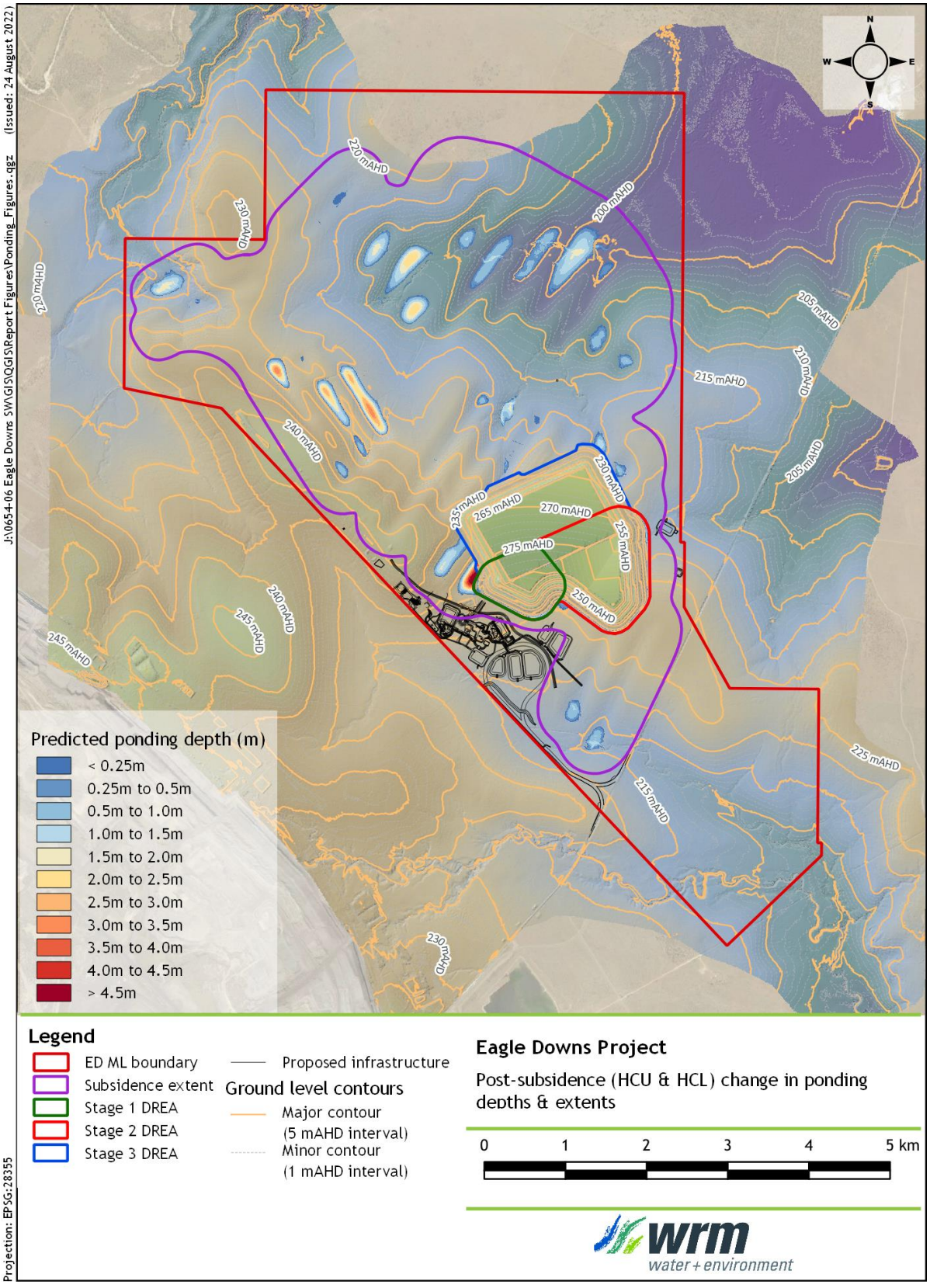


Figure 6.2 – Post-subsidence (HCU & HCL) change in ponding depths & extents

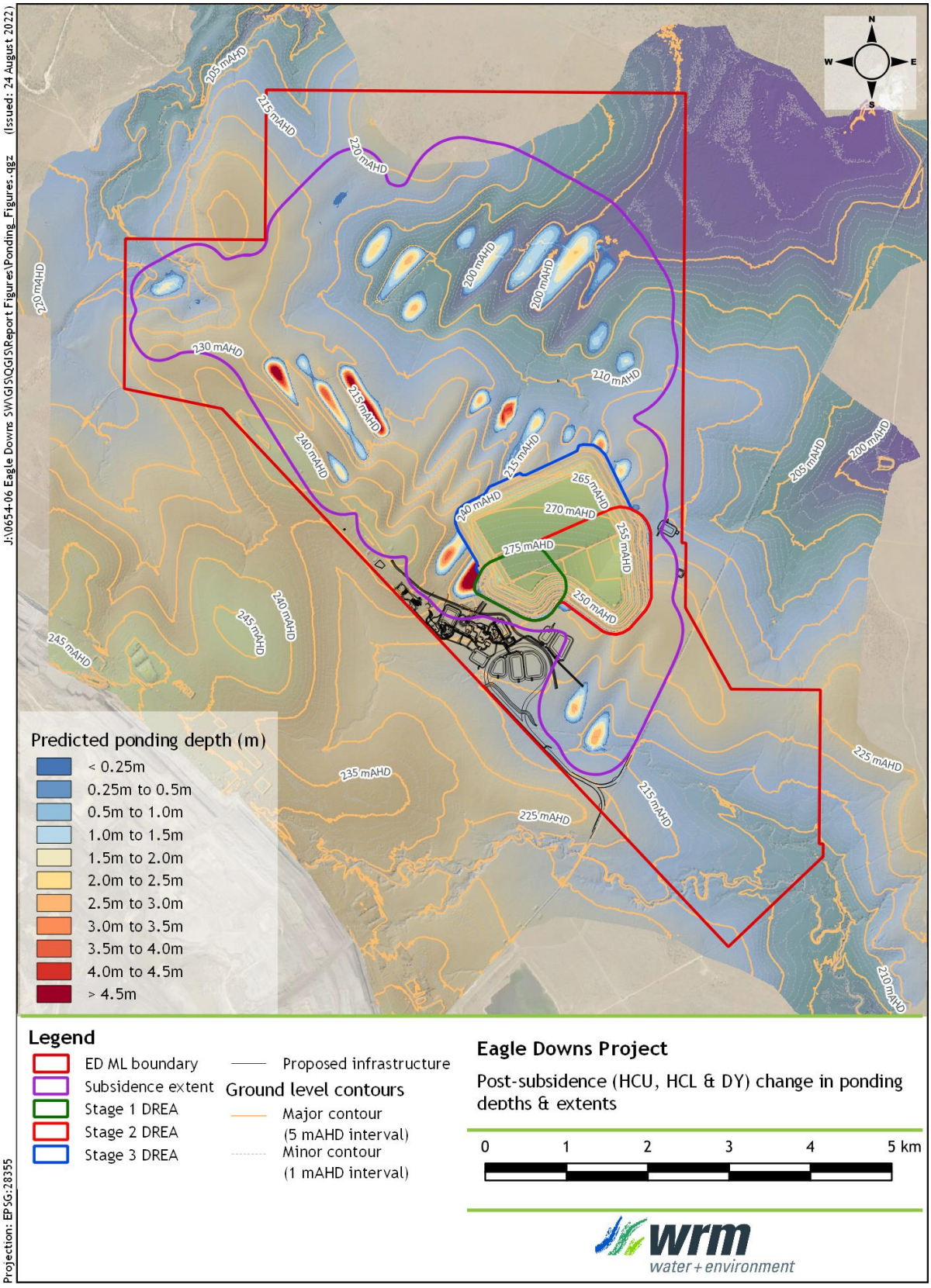


Figure 6.3 – Fully subsided (HCU, HCL & DY) change in ponding depths & extents

Table 6.1 – Existing and predicted ponding areas per seam progression

Scenario	Ponding area (ha)	Increase above existing (ha)
Existing (pre-development)	14.4	-
HCU only	58.0	43.6
HCU + HCL	188.5	174.1
Fully subsided (HCU + HCL + DY)	296.8	282.4

6.3 SURFACE PONDING MITIGATION MEASURES

Concept mitigation measures have been developed to reduce the area of ponding within the subsidence area to the approved area of 77.5 ha or less.

Ponding mitigation measures that have been considered include:

- The construction of drainage channels between the ponded areas; and
- The filling of ponded areas where drainage may not be possible or practical.

The approach adopted in determining the appropriate ponding mitigation measure was based on the following:

- Predicted ponding impacts up to 3.0 m in depth to be drained, with drainage to be confined within the subsidence disturbance footprint;
- Drainage design to achieve long term stability using 1:6 batter slopes and invert grades based on pre-development topography (0.5% to 0.01% slopes); and
- Filling to be used to offset ponding impacts as required in the event that drainage is unable to satisfy the required ponded disturbance area limit.

Predicted ponded areas adjacent to the DREA stockpile are proposed to be filled, to improve the geotechnical stability of the stockpile.

6.4 MITIGATED CONDITIONS PONDED SURFACE AREAS

Figure 6.4 to Figure 6.6 shows the locations of the proposed ponding mitigation measures and the predicted changes in ponding for each seam progression. No measures are proposed for the HCU seam only because the ponded area would be less than approved.

The majority of the mitigation measures would be required following the mining of the HCL seam via a network of drains. The residual ponding area following the mining of the HCL seam and the construction of the drains is predicted to be 23.4 ha.

Under proposed final landform conditions, there would be a residual ponding disturbance area of 76.4 ha, which is less than the currently approved ponding disturbance area of 77.5 ha. A total of 206 ha of ponded area would be reduced, with 180.6 ha mitigated by drainage works and 25.4 ha mitigated by filling.

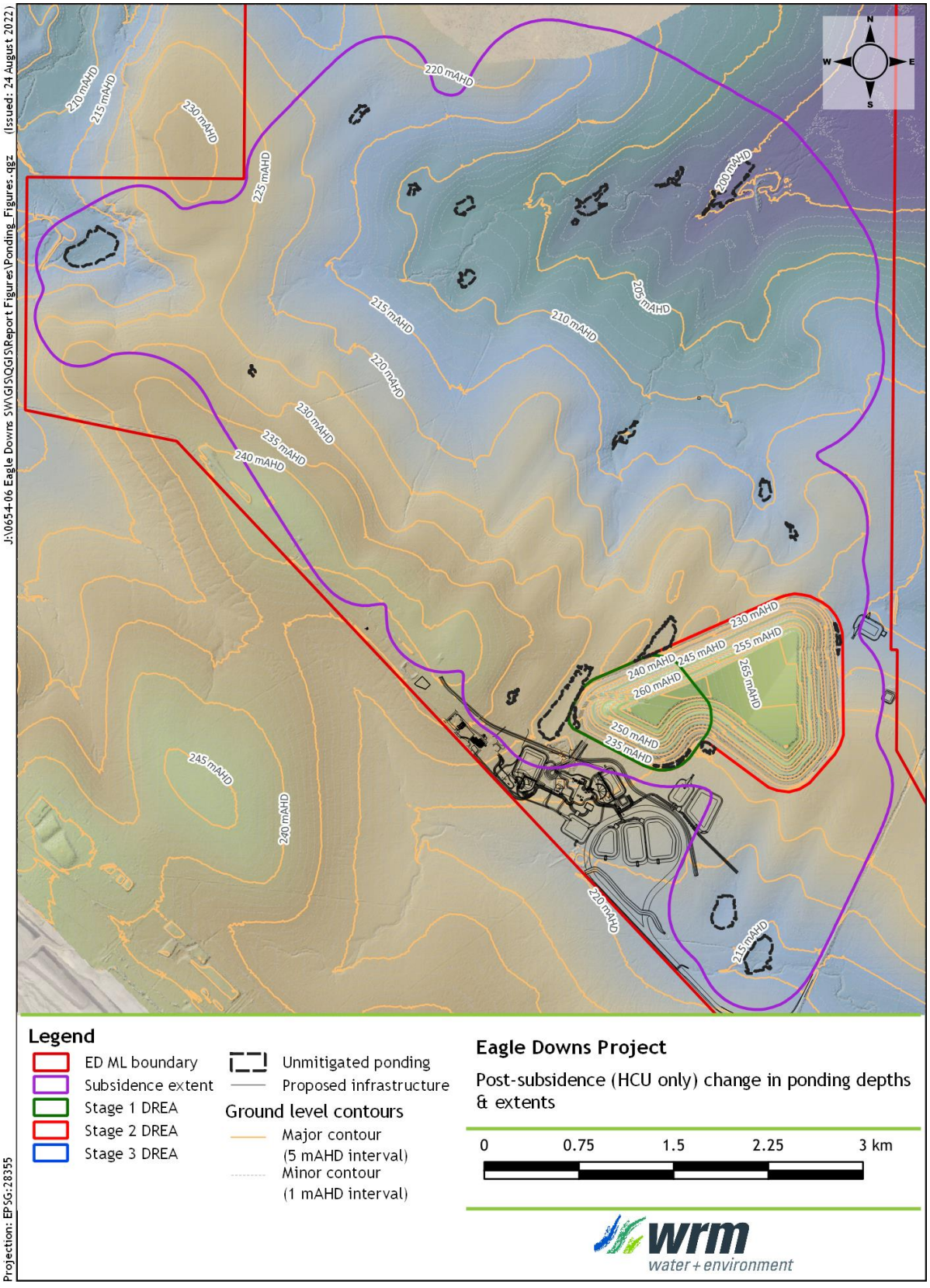


Figure 6.4 – Mitigated post-subsidence (HCU only) change in ponding depths & extents

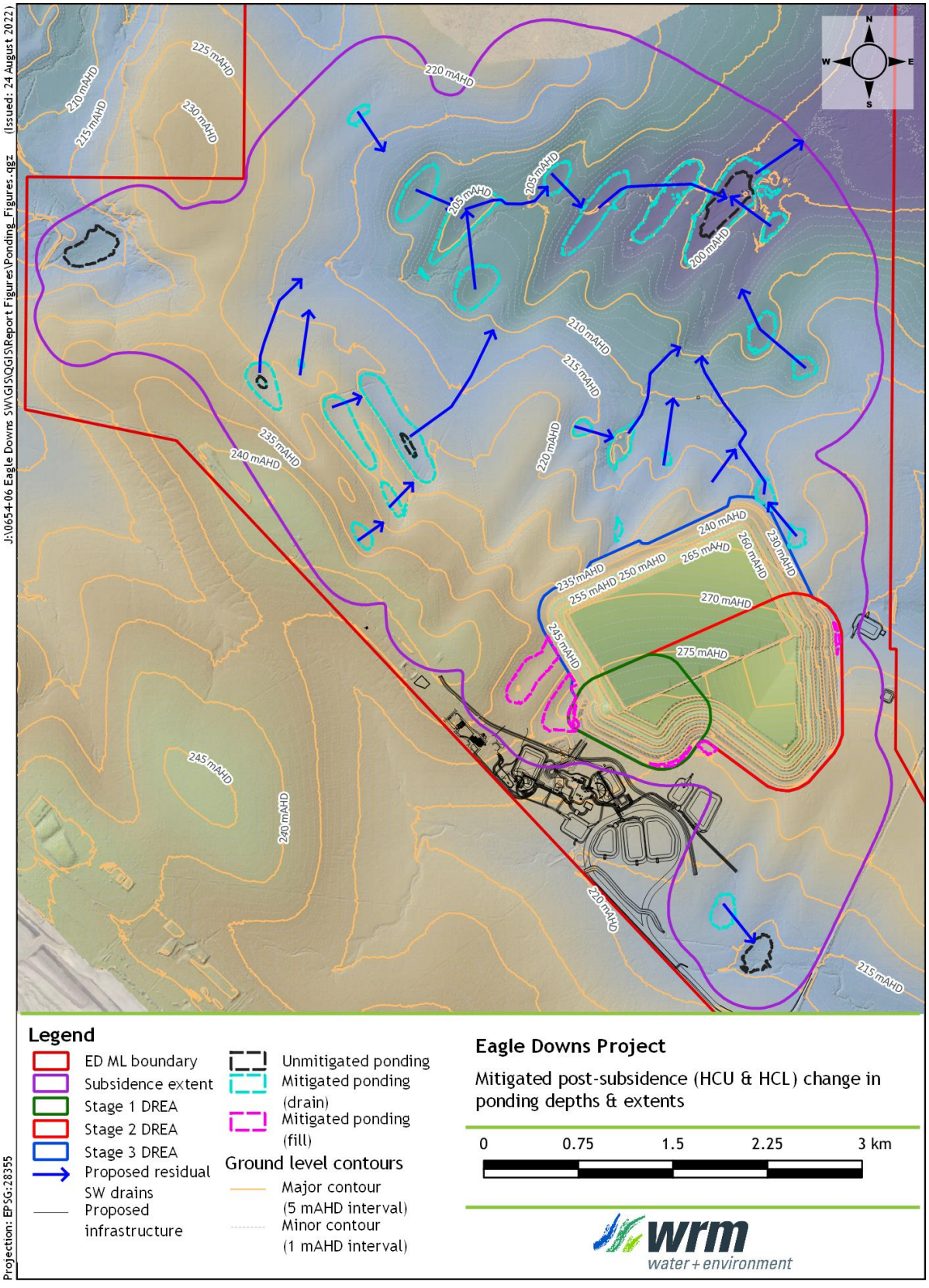


Figure 6.5 – Mitigated post-subsidence (HCU & HCL) change in ponding depths & extents

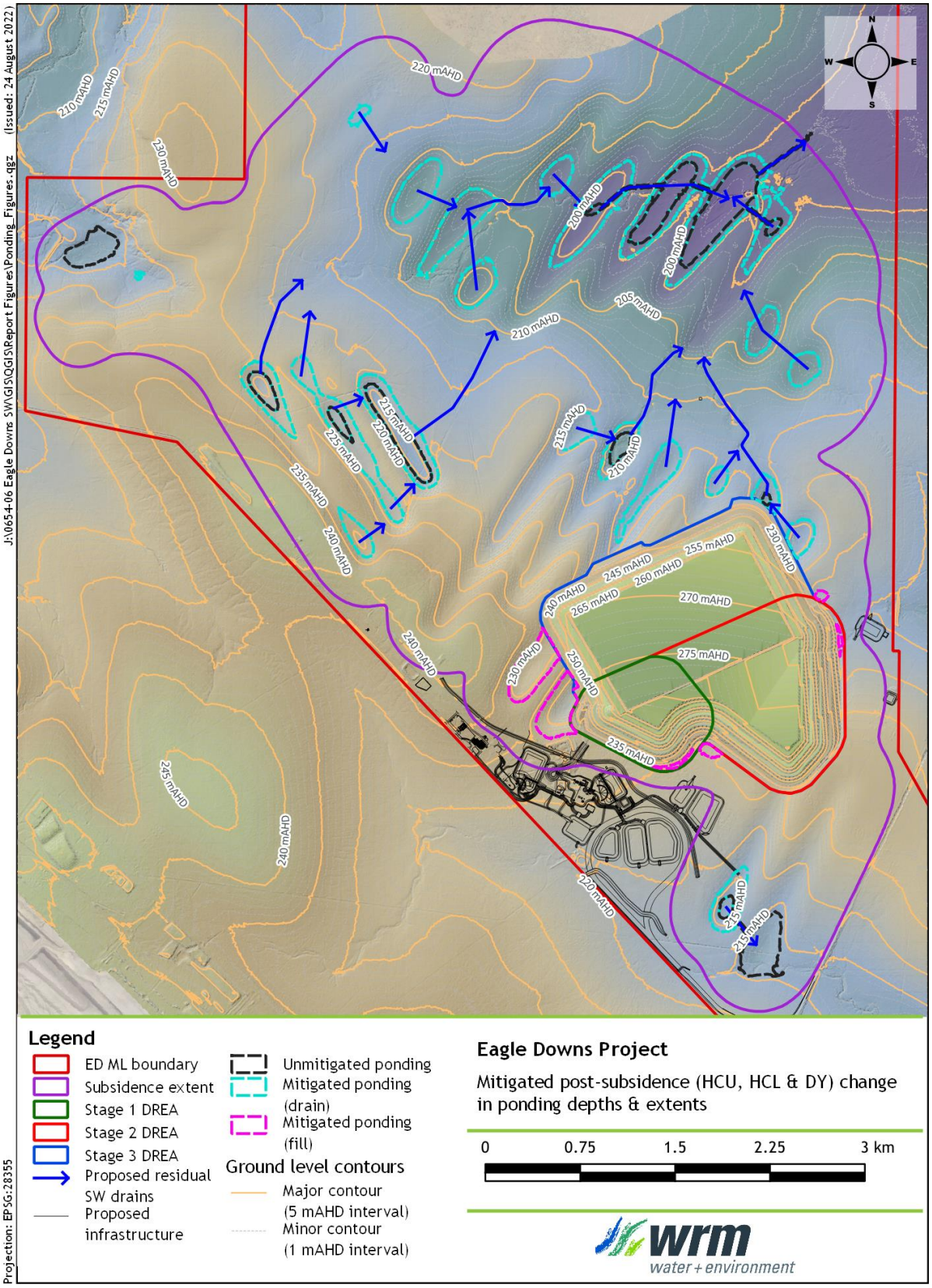


Figure 6.6 – Mitigated post-subsidence (HCU, HCL & DY) change in ponding depths & extents

6.5 PONDING IMPACT ASSESSMENT

6.5.1 Methodology

The computer-based simulation model GOLDSIM (GOLDSIM Technology Group, 2015) was used to assess water quantity and water quality of the subsidence ponds in the final landform after the mitigation measures have been implemented. The existing GOLDSIM model detailed in Section 4 was used as a basis for the assessment. The GOLDSIM model dynamically simulates the rainfall runoff and overflows of the subsidence system and keeps a complete account of pond volumes and representative water quality on a daily timestep.

The model has been configured to simulate the ponding volumes and the spilling between each residual ponding area. The simulated inflows and outflows in this water quality assessment are given in Table 6.2.

Table 6.2 – Simulated inflows and outflows to residual pond system

Inflow	Outflow
Direct rainfall on water surface of storages	Evaporation from water surface of storages
Catchment runoff	Spills from storages to receiving environment
	Soil infiltration

6.5.2 Pond volume and catchment areas

Figure 6.7 shows the locations of the residual ponds and catchment areas for the proposed final landform scenario. Table 6.3 shows the adopted catchment areas and maximum ponding volumes for each residual pond subsidence area.

Table 6.3 – Final landform residual pond characteristics

ID	Maximum volume	Catchment area (ha)		
	(ML)	Natural	Stockpile	Total
Pond 1	82.3	160	-	160
Pond 2	54.5	98	-	98
Pond 3	7.7	28	-	28
Pond 4	165.4	106	-	106
Pond 5	21.8	190	-	190
Pond 6	1.4	35	51	86
Pond 7	216.4	1,453	147	1,600
Pond 8	172.1	1,413	103	1,517
Total	**721.6**	**3,483**	**301**	**3,785**

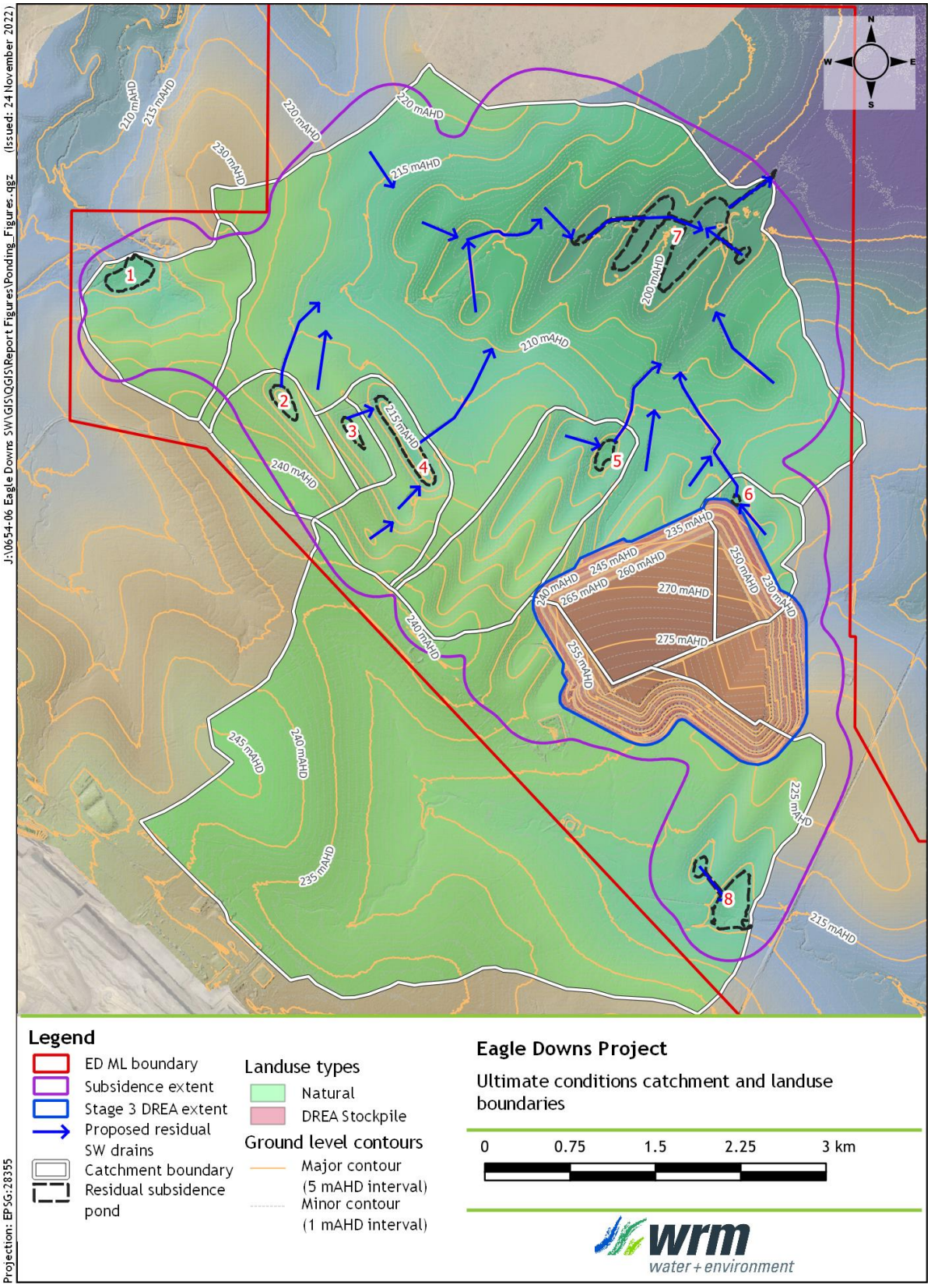


Figure 6.7 – Final landform conditions residual subsidence ponds catchment and landuses

6.5.3 Modelling assumptions

The following assumptions were made for the assessment of water within the ponds:

- The model was run as a static model (assuming the ground levels don't change) using the 132 years of historical rainfall and evaporation data was obtained from SILO.
- The AWBM runoff parameters given in Section 4.10.1 were adopted for the natural and the stockpile (DREA) landuse types;
- Salinity concentrations for each landuse type given in Section 4.11 were adopted;
- Soil infiltration from the surface of the depressions was assumed to be 20 mm/d, which is the lower rate of infiltration rates for clay (Brouwer et al, 1985). The Eagle Downs Closure Plan (EDCM, 2020) identified the following soils across the ponding areas:
  - sandy alluvial rudosols on residual pond 1;
  - thin fine sandy to silt loamy surface soils in association with brown cracking clay chromosol soils for residual pond 2, 3 and 4; and
  - Brownish, black cracking clay vertosols for residual pond 5, 7 and 8.

6.5.4 Pond water quality

Table 6.4 shows the range of predicted salinity concentrations in each depression for the proposed final landform conditions. These results have been reported for stored volumes above 0.001 ML in each depression (as a concentration cannot be reported with zero volume). Table 6.5 shows the range of predicted storage volumes.

It was assumed that the residual ponded areas could potentially be used as intermittent cattle watering holes. The recommended tolerance levels without any adverse effects on cattle condition is 4,000 mg/L for beef cattle (ANZECC and ARMCANZ, 2000). The upper limit of tolerance levels without any adverse effects on cattle livestock are 5,000 mg/L for beef cattle. Salinities within this range will cause animals to have an initial reluctance to drink, but livestock should adapt without loss of production (ANZECC and ARMCANZ, 2000).

The results show the following with the predicted water quality and quantity associated with the final landform residual subsidence ponds:

- Residual Pond 1:
  - would contain water approximately 50% of all days.
  - salinity concentrations would range from 128 mg/L to 2,225 mg/L.
  - The predicted median salinity would be approximately 282 mg/L.
- Residual Pond 2:
  - would contain water approximately 50% of all days.
  - salinity concentrations would range from 117 mg/L to 2,480 mg/L.
  - The predicted median salinity would be approximately 242 mg/L.
- Residual Pond 3:
  - would contain water approximately 50% of all days.
  - salinity concentrations would range from 102 mg/L to 2,089 mg/L.
  - the predicted median salinity would be approximately 231 mg/L.
- Residual Pond 4:
  - would contain water approximately 50% of all days.
  - salinity concentrations would range from 136 mg/L to 1,862 mg/L.
  - the predicted median salinity would be approximately 277 mg/L.

Table 6.4 – Predicted salinity concentrations (mg/L) within final landform conditions residual subsidence ponds.

Pond ID	Total Dissolved Solids (Salinity) (mg/L)								
	Max	99%	95%	90%	50%	10%	5%	1%	Min
1	2,225	1,023	683	545	282	204	199	186	128
2	2,480	1,114	664	496	242	199	194	182	117
3	2,089	924	546	422	231	191	181	159	102
4	1,862	920	626	508	277	206	200	188	136
5	2,459	1,002	592	462	248	200	196	187	118
6	3,086	1,691	923	684	355	275	225	197	107
7	2,606	1,180	578	462	312	242	233	213	172
8	3,748	1,596	869	616	271	223	218	206	151

Table 6.5 – Predicted dam volumes (ML) within final landform conditions residual subsidence ponds.

Pond ID	Total Volume (ML)								
	Max	99%	95%	90%	50%	10%	5%	1%	Min
1	82	60	6.9	2.5	0.04	-	-	-	-
2	54	44	8.9	3.2	0.02	-	-	-	-
3	7.7	4.7	0.6	0.2	0.02	-	-	-	-
4	165	95	6.6	2.3	0.01	-	-	-	-
5	22	19	8.0	4.1	0.03	-	-	-	-
6	1.4	1.4	1.3	0.9	-	-	-	-	-
7	216	194	82	50	5.0	0.4	0.03	-	-
8	172	168	107	73	0.01	-	-	-	-

- Residual Pond 5:
  - would contain water approximately 50% of all days.
  - salinity concentrations would range from 118 mg/L to 2,459 mg/L.
  - the predicted median salinity would be approximately 248 mg/L.
- Residual Pond 6:
  - would contain water approximately 10% of all days.
  - salinity concentrations would range from 107 mg/L to 3,086 mg/L.
  - the predicted median salinity would be approximately 355 mg/L.
- Residual Pond 7:
  - would contain water approximately 95% of all days.
  - salinity concentrations would range from 172 mg/L to 2,606 mg/L.
  - the predicted median salinity would be approximately 312 mg/L.

- Residual Pond 8:
  - would contain water approximately 50% of all days.
  - salinity concentrations would range from 151 mg/L to 3,748 mg/L.
  - the predicted median salinity would be approximately 271 mg/L.
- Final landform depressions would generally contain less than 1 ML of water 50% of the time. This indicates that there would be very little water retained the residual ponds as most water is lost through evaporation and soil infiltration.
- Pond water quality can fall below the natural background concentrations of 200 mg/l when direct rainfall falling on the ponds is the dominant inflow.
- Based on the above salinity concentrations, cattle would have no hesitancy in drinking the residual ponded water.

6.5.5 Pond overflow water quality

Table 6.6 shows the predicted salinities of water that would overflow the ponds and drain to the downstream environment. The results show that overflow salinity concentrations would generally reflect background water quality and would be lower than the Isaac River salinity WQO's.

Table 6.6 – Predicted final landform overflow salinity concentration into receiving environments

Pond ID	Receiving waterway	Total Dissolved Solids (Salinity) (mg/L)								
		Max	99%	95%	90%	50%	10%	5%	1%	Min
1	J B Gully (Cherwell Creek)	199	199	198	197	194	190	189	186	183
7	Feature 1 (Isaac River)	253	238	228	221	212	206	204	199	191
8	Feature 3 (Ripplestone Creek)	234	232	227	221	208	204	204	202	197

The results show that:

- Residual Pond 1 (J B Gully):
  - Would overflow into the receiving environment approximately 0.3% of the time.
  - The salinity concentration of overflows ranges from 183 mg/L to 199 mg/L (EC 344 µS/cm to 374 µS/cm), which are under the WQOs for the receiving environment.
- Residual Pond 7 (Feature 1):
  - would overflow into the receiving environment approximately 0.6% of the time.
  - The salinity concentration of overflows range from 191 mg/L to 253 mg/L (EC 358 µS/cm to 475 µS/cm), which are under the WQOs for the receiving environment.
- Residual Pond 8 (Feature 3):
  - Would overflow into the receiving environment approximately 0.7% of the time.
  - The salinity concentration of overflows ranges from 197 mg/L to 234 mg/L (EC 370 µS/cm to 439 µS/cm), which are under the WQOs for the receiving environment.

6.6 STREAM FLOW IMPACTS

The GOLDSIM water balance model outlined in Section 6.5 was used to determine the stream flow volumes that would drain from the Project boundary to each of the receiving waterways. These volumes were compared to the predicted existing conditions flows at the same location. The receiving environment consists of the following areas:

- J B Gully, which drains to Cherwell Creek;
- Feature 1, which drains to the Isaac River; and
- Feature 3 and Ripplestone Creek, which drains to Ripstone Creek.

Figure 6.8 to Figure 6.10 show ranked plots of the existing conditions and final landform conditions daily flows that drain to the three downstream waterways. The results show that:

- For J B Gully:
  - The mean annual stream flow volume at the lease boundary would change from 367 ML/yr to 346 ML/yr, a 6% change.
  - The frequency of daily flows do not change significantly due to the upstream catchment, which is not impacted by the project.
  - The frequency of flows of at least 100 ML/d would change from 0.25% to 0.24% of days, which is not significant. A flow of 100 ML/d would equate to a peak discharge of 1.1 m^3/s, which is considered a low flow.
- For Feature 1:
  - The mean annual stream flow volume at the lease boundary would change from 729 ML/yr to 486 ML/yr, 33% change.
  - The frequency of flows of at least 100 ML/d would change from 0.37% to 0.3% of days due to mine subsidence.
  - The frequency of very low flows would reduce significantly due to the project. However, given that Feature 1 at the project lease boundary flows along a broad flowpath with no channel, the change in flows would be imperceptible.
  - Feature 1 drains into the Winchester South MLA who propose to divert the waterway to allow for mining. Should Winchester South be approved, the reduced flows will be of benefit to Winchester South.
- For Feature 3 and Ripplestone Creek:
  - The mean annual stream flow volume at the lease boundary would change from 939 ML/yr to 789 ML/yr, a 16% change.
  - The frequency of flows of at least 100 ML/d would change from 0.45% to 0.39% of days due to mine subsidence.
  - These impacts would reduce about 2 km downstream of the lease boundary when Ripplestone Creek converges with Ripstone Creek. Ripstone Creek has a catchment area of 45 km^2 to the Ripplestone Creek confluence, which would double catchment runoff.

Overall, the impacts on the local waterways of JB Gully and Ripplestone Creek are not significant. The impact on Feature 1 is more significant. However, Feature 1 is not a watercourse and has no defined bed and banks where flow would drain. Feature 3 drains to the Isaac River. The overall reduction in flows to the Isaac River would be negligible given it has a catchment area of about 4,100 $km^2$to Feature 1.

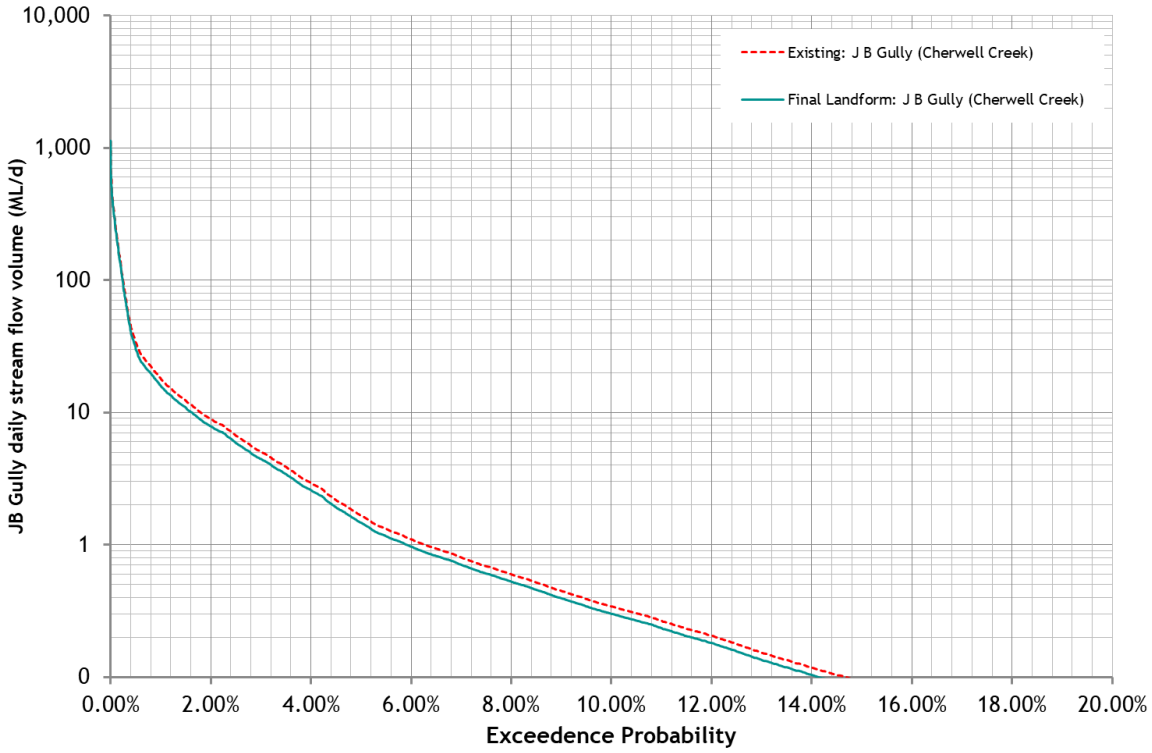


Figure 6.8 – JB Gully daily flow exceedance curve at the Lease boundary, Existing and final landform conditions

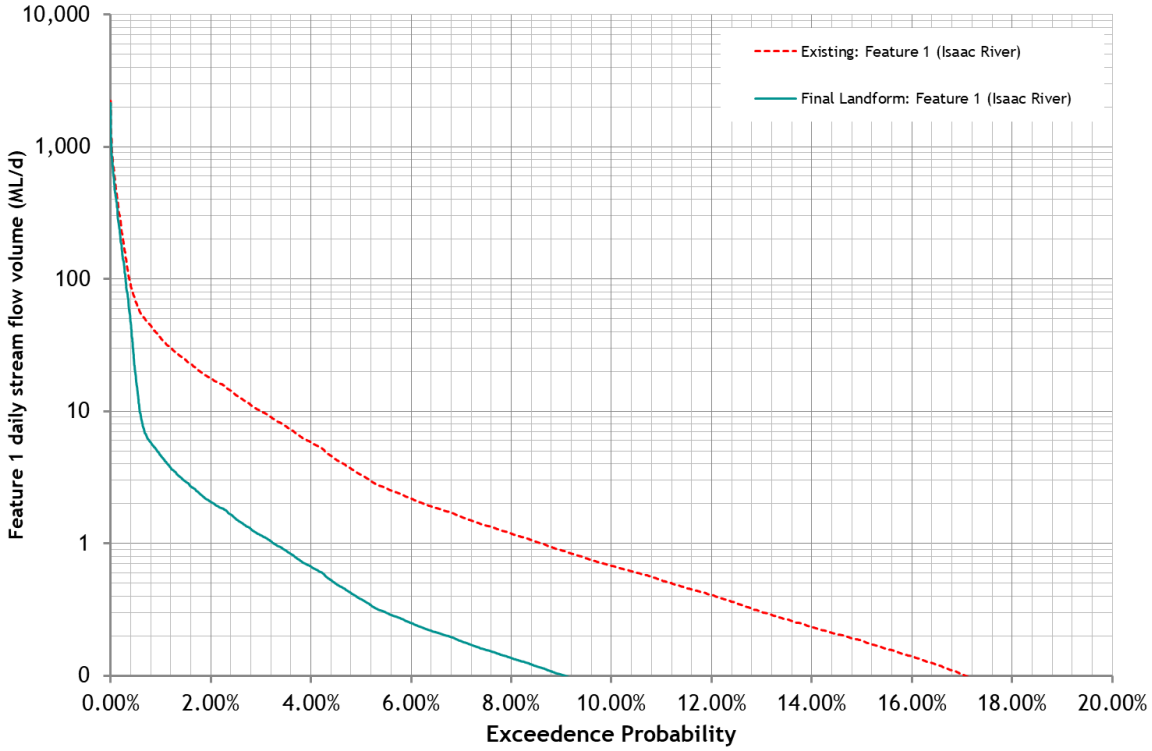


Figure 6.9 – Feature 1 daily flow exceedance curve at the Lease boundary, Existing and final landform conditions

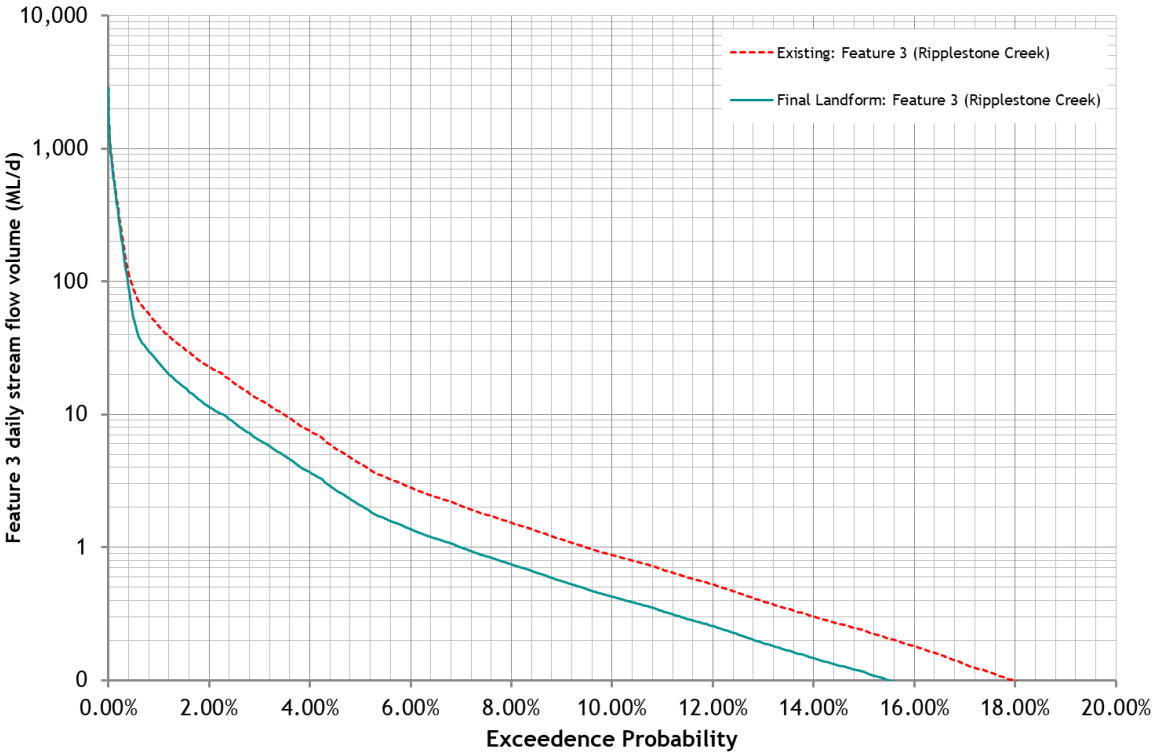


Figure 6.10 – Feature 3 and Ripplestone Creek flow exceedance curve at the Lease boundary, Existing and final landform conditions

7 Flood impact assessment

7.1 OVERVIEW

A flood impact assessment has been conducted for the Project to address the requirements of the PRCP and to define the potential impacts of the Project on the receiving environment throughout and post-mining life. This section covers the following:

- Details on the hydraulic model configuration for each of the modelled scenarios;
- Detailed flood modelling for the modelled scenarios; and
- An assessment of potential impact to peak flows, velocities and volumes for each of the scenarios.

7.2 METHODOLOGY

A TUFLOW two-dimensional hydrodynamic model was used to estimate the flood characteristics (depths, levels and velocities) within the Project boundary. TUFLOW represents hydraulic conditions on a fixed grid by solving the full two-dimensional depth averaged momentum and continuity equations for free surface flow. All hydraulic modelling has been undertaken using the TUFLOW Build 2020-10-AC HPC-GPU solver.

The rain-on-grid (ROG) modelling approach was adopted, which applies rainfall inputs directly to each model grid cell over the modelled area. The model was configured with a grid cell size of 10 m which provides an accurate representation of the catchment topography suitable for generating the design outputs for this assessment.

Information on historical flood events is not available for model calibration and therefore estimated design discharges were validated against the Regional Flood Frequency Estimation (RFFE) model and Rational Method estimates.

Flood modelling was undertaken for the following conditions:

- Existing conditions, which includes the existing mine infrastructure;
- Mine infrastructure conditions (in the Feature 3 catchment);
- Proposed fully subsided conditions (no mitigation); and
- Proposed final landform conditions.

7.3 MODEL CONFIGURATION

7.3.1 Existing conditions

Figure 7.1 shows the existing conditions hydraulic model extent. The model covers an area of 107.2 km^2 which includes the Project area and downstream waterway catchments.

The TUFLOW model uses 1m topographic aerial survey data (LiDAR) supplied by EDMC for mining lease 70389. Areas outside the extent of the ED ML boundary were supplemented using 2 m resolution LiDAR from 2012, provided by Whitehaven. Figure 7.2 shows the topographic data used in the hydraulic model.

The normal depth slopes adopted for the model outflow were:

- 5.6% for the northern catchment boundary;
- 1.8% for the north-eastern catchment boundary;
- 4.2% for the eastern catchment boundary; and
- 4.3% for the south-eastern catchment boundary.

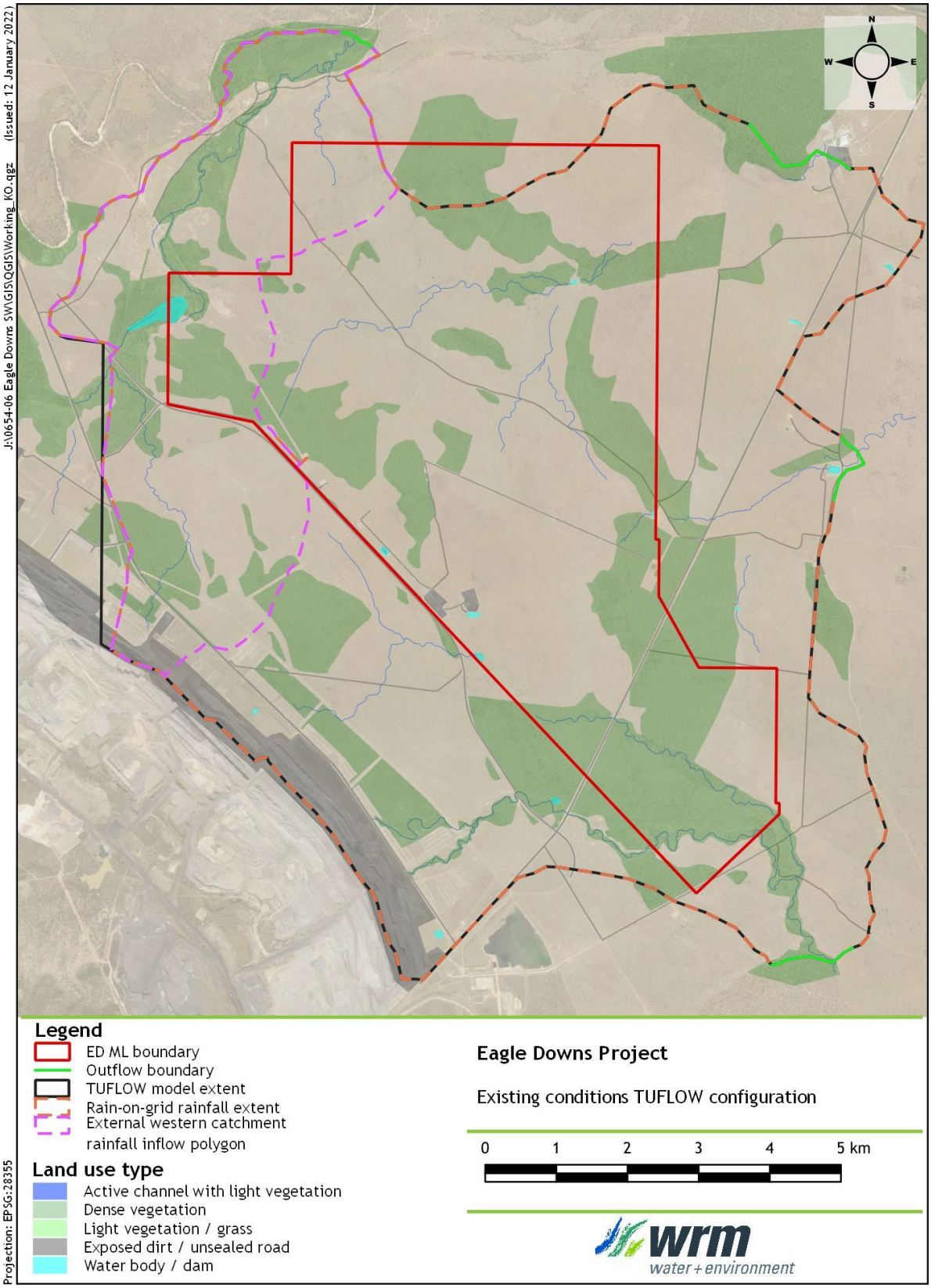


Figure 7.1 – Existing conditions TUFLOW model configuration

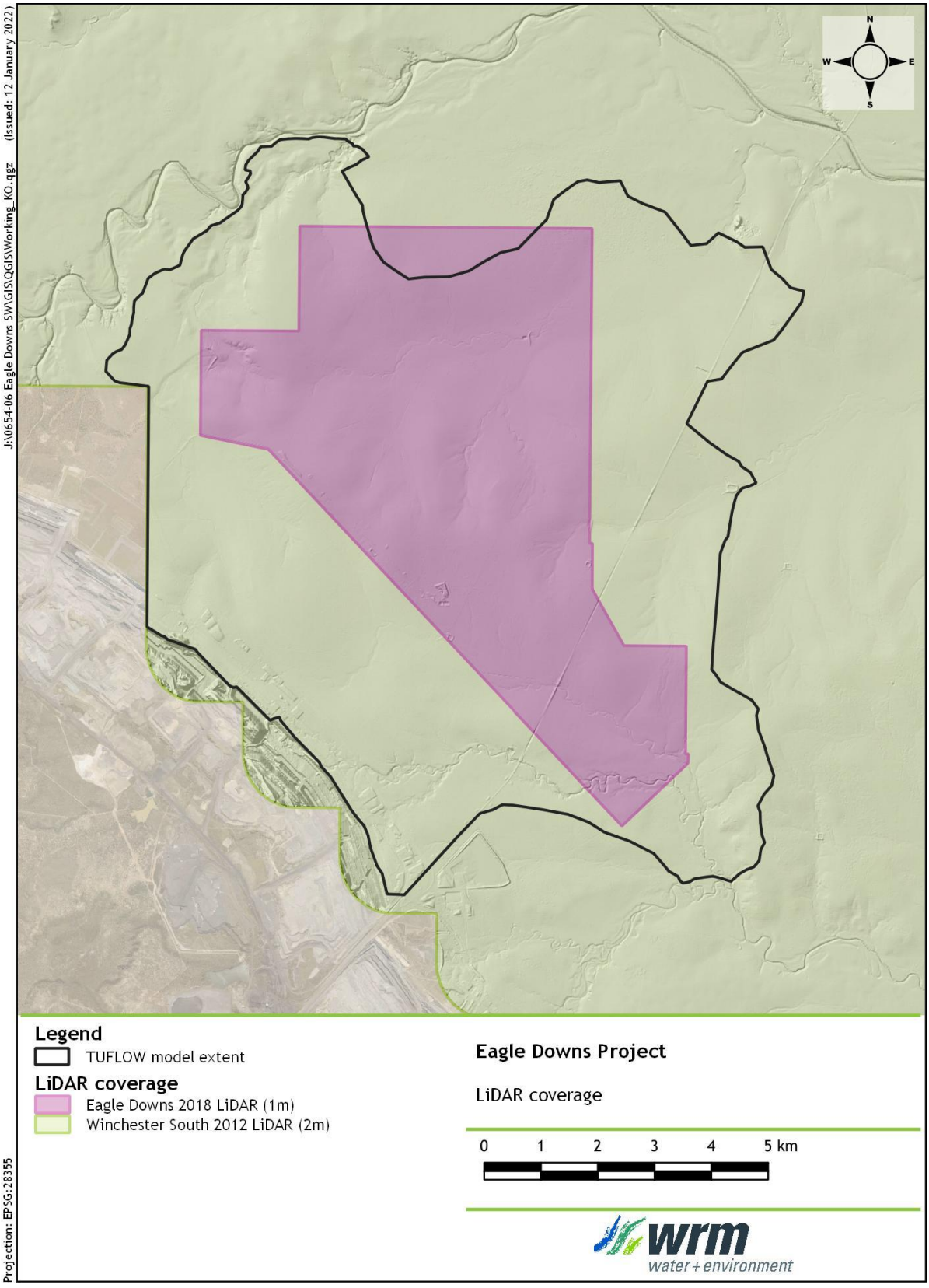


Figure 7.2 – LiDAR coverage extent

The model outflow boundaries are approximately:

- 4.7 km for the northern catchment;
- 2.0 km for the northern-eastern catchment;
- 3.0 km for the eastern catchment; and
- 2.1 km for the south-eastern catchment.

The model outflow boundaries were selected to ensure that there is enough distance to determine the impacts of subsidence areas and the downstream catchments.

7.3.2 Mine infrastructure conditions

Figure 7.3 shows the proposed mine infrastructure. The key differences between the existing and proposed mine infrastructure conditions are:

- On-site drains to redirect runoff around the mine infrastructure into Feature 3;
- Removal of existing dams DM901A and DM901B; and
- New proposed rail spur which connects with the existing Goonyella rail line.

The proposed conditions design model uses the same existing conditions hydraulic configuration.

7.3.3 Proposed fully subsided conditions

Figure 7.4 shows the proposed fully subsided (all seams fully mined) conditions with all proposed infrastructure removed. The key difference between the existing and proposed conditions is the addition of surface subsidence.

The proposed subsided conditions design model uses the same existing conditions hydraulic configuration.

7.3.4 Proposed final landform conditions

Figure 7.5 shows the proposed final landform conditions. The key difference between the fully subsided and proposed final landform conditions are:

- Addition of drains to reduce the amount of residual ponding caused by the subsided topography; and
- Filling of several subsided areas where drains could not be used to reduce the residual ponding extent.

The proposed subsided conditions design model uses the same existing conditions hydraulic configuration.

7.3.5 Hydraulic model roughness

The hydraulic model uses Manning's 'n' values to represent hydraulic resistance (notionally channel or floodplain roughness). Discrete regions of continuous vegetation types and land uses were mapped, and appropriate roughness values assigned to each region. Vegetation and land use mapping was based on the aerial imagery and topographic data. Figure 7.1 shows the locations of various land use areas adopted in the model.

The adopted Manning's 'n' values were assigned based on various land use types and refined during model validation. Table 7.1 shows the adopted Manning's 'n' values used for the various land use areas in the hydraulic model.

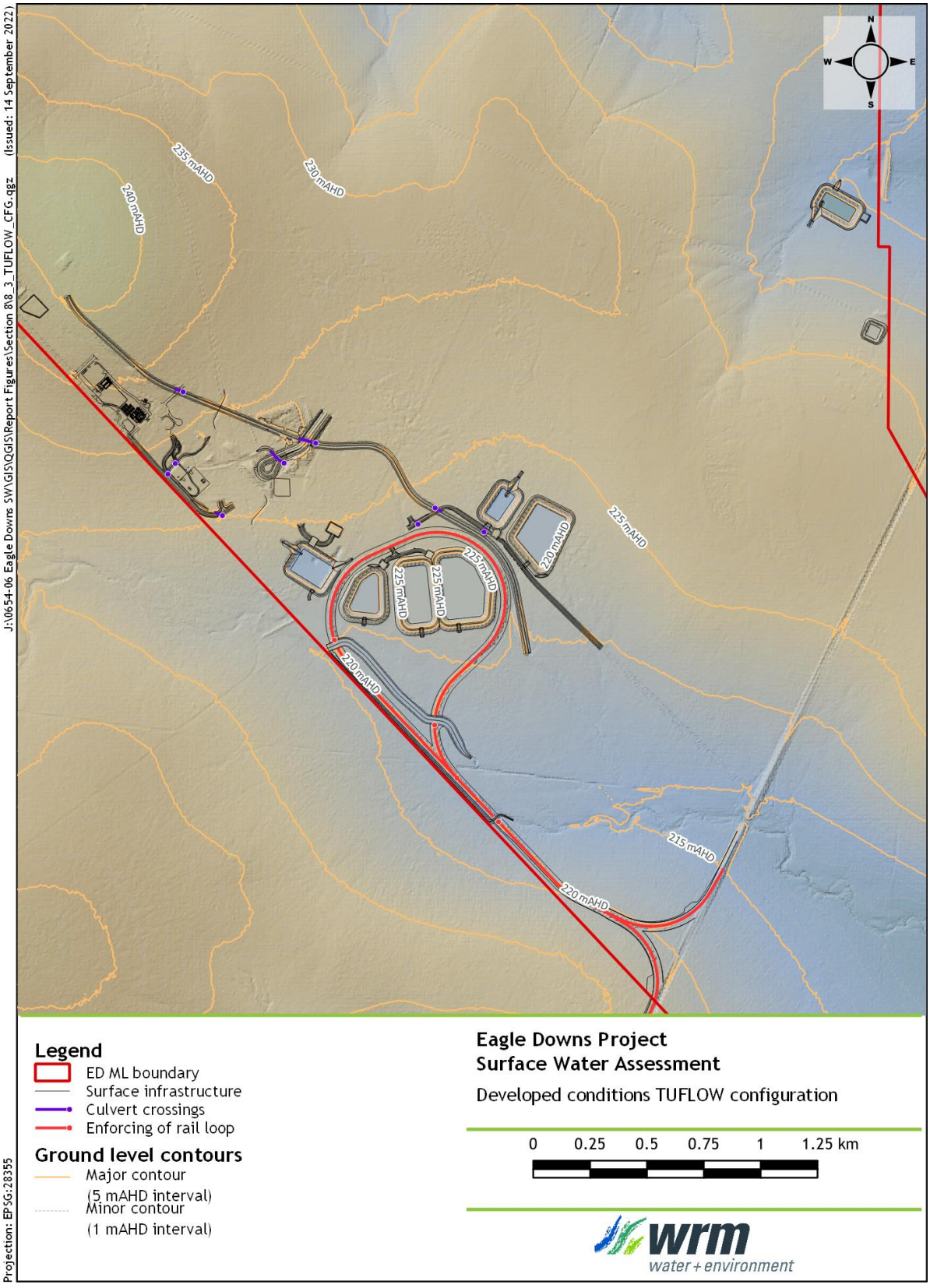


Figure 7.3 – Mine infrastructure conditions topography

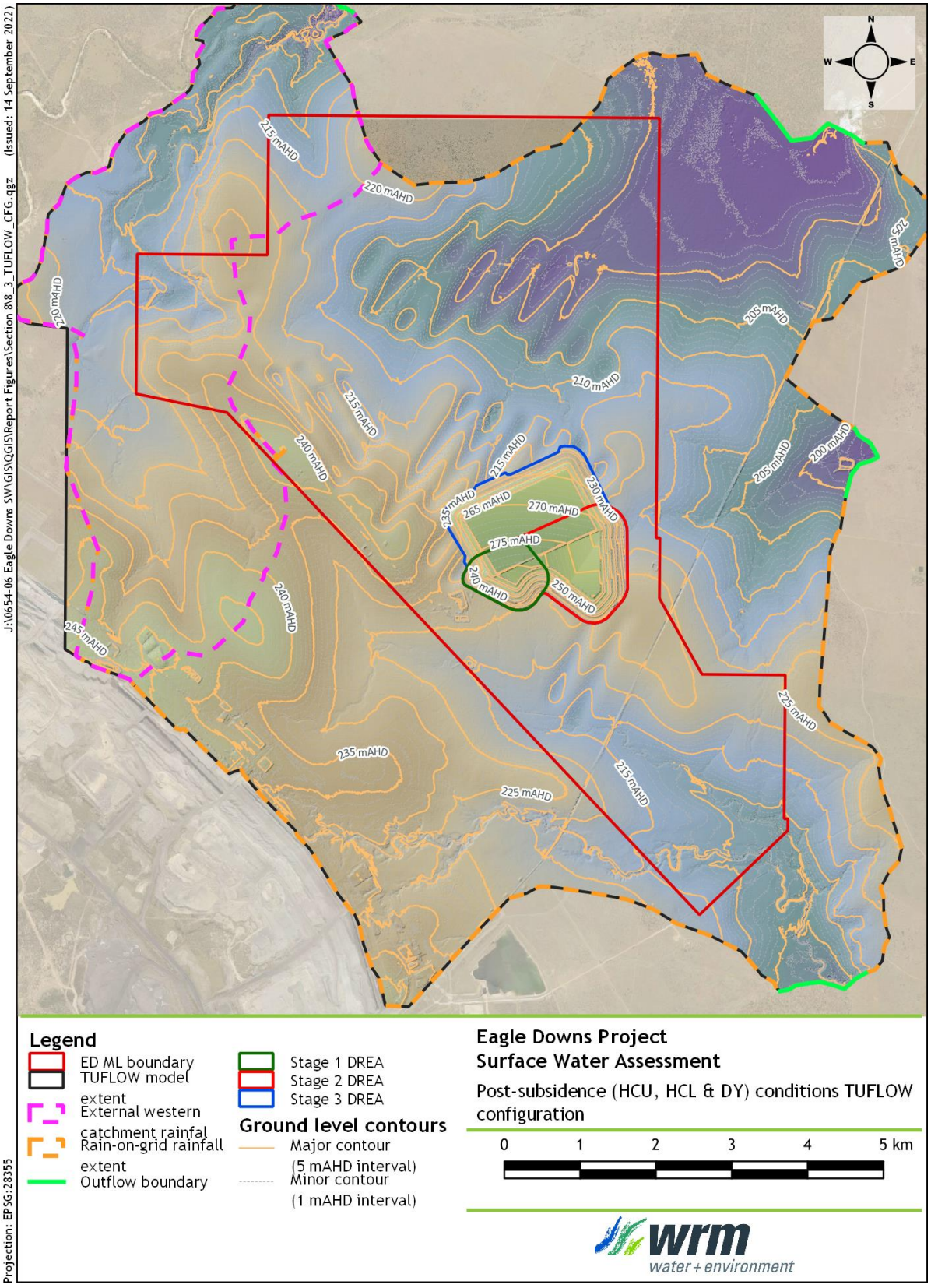


Figure 7.4 – Proposed fully subsided (HCU, HCL & DY) conditions topography

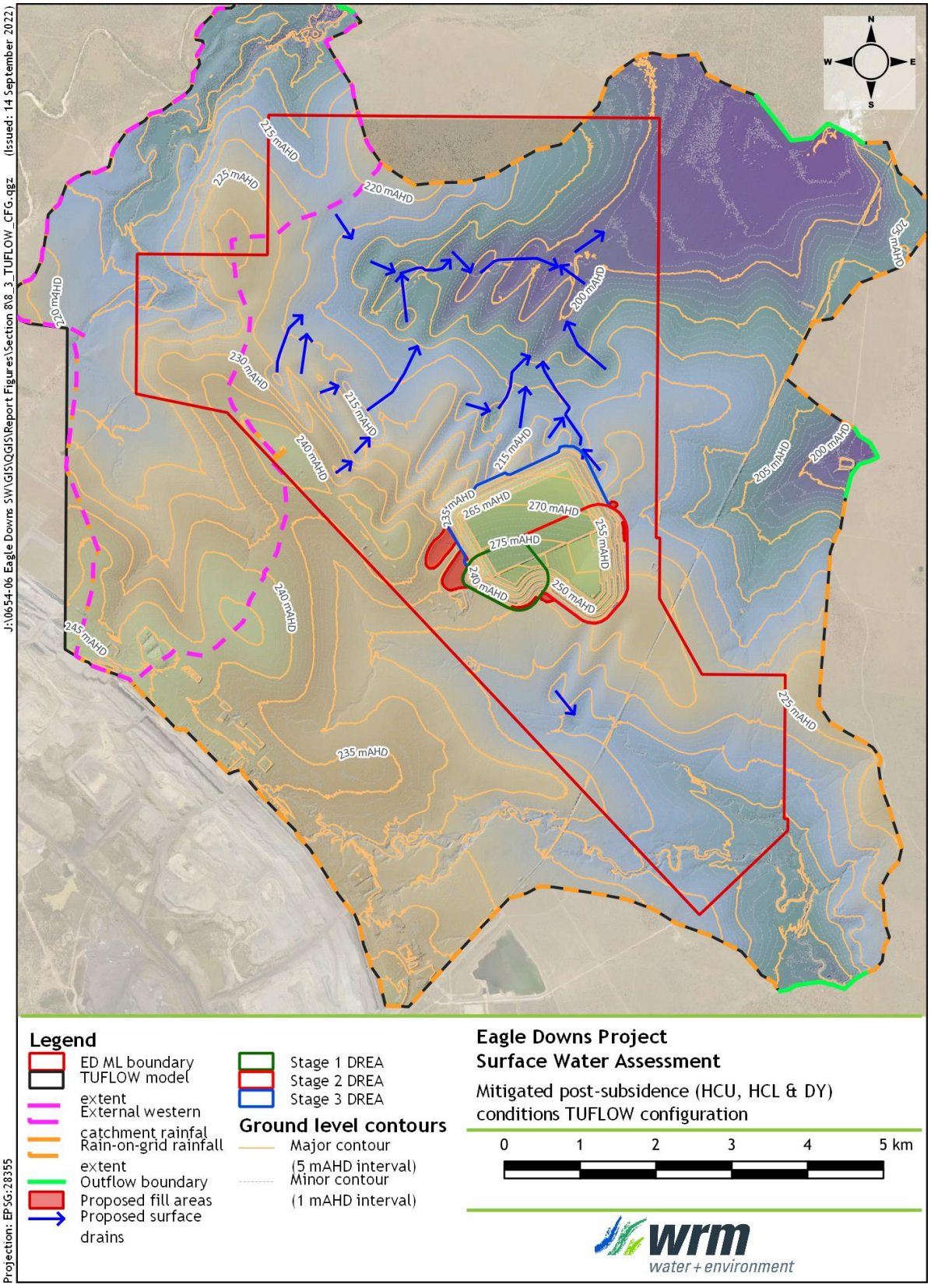


Figure 7.5 – Proposed final landform conditions

Table 7.1 – Adopted Manning's roughness parameters

Land use type	Manning's roughness
Active channel with light vegetation	0.035
Dense vegetation	0.100
Light vegetation / grass	0.040
Exposed dirt / unsealed road	0.025
Water body / dam	0.015

7.3.6 Design rainfall depths

The design rainfall depths were obtained from BOM (2016) at the centroid of the TUFLOW model extent. The design rainfall depths were extracted for the 62%, 39%, 10%, 2%, 1%, and 0.1% annual exceedance probability (AEP) events for durations up to 18 hours. The rainfall depths for the Probable Maximum Precipitation (PMP) event were estimated using the Generalised Short Duration Method (GSDM) (BOM, 2003).

Table 7.2 – Design rainfall depths

Storm Duration (hours)	Rainfall Depths (mm)						
	63%	39%	10%	2%	1%	0.10%	PMP
0.25	-	-	-	-	-	-	150
0.5	-	-	-	-	-	-	220
0.75	-	-	-	-	-	-	270
1	33.5	38	59.7	77.3	84.3	134	330
1.5	37.7	42.8	67.9	88.4	96.7	154	380
2	40.6	46.1	73.6	96.5	106	168	430
3	44.5	50.6	81.7	108	120	190	490
4	-	-	-	-	-	-	550
4.5	48.4	55.2	90.2	121	135	214	-
5	-	-	-	-	-	-	590
6	51.4	58.6	96.6	132	147	234	630
9	55.9	63.9	107	148	167	266	-
12	59.6	68.1	115	162	184	292	-
18	65.5	75	128	184	211	335	-

7.3.7 Areal reduction factor

No Areal reduction factor was applied to the design rainfall depths.

7.3.8 Rainfall temporal patterns

The ten North East Coast region temporal patterns for each design AEP and storm duration were adopted for design events up to 1% AEP. For the 0.1% AEP event and Probable Maximum Flood (PMF), the GSDM (BOM, 2003) temporal patterns were adopted in accordance with AR&R 2019.

7.3.9 Rainfall losses

Table 7.3 shows the adopted initial and continuing losses for a range of design flood events. The adopted initial rainfall losses were determined by validating design discharges against Rational Method estimates.

Table 7.3 – Adopted initial and continuing losses

Design AEP	Initial Loss (mm)	Continuing Loss (mm/hr)
63% & 50%	20	1.7
10%	15	1.7
2% & 1%	10	1.7
0.1% & PMF	0	1.7

The following is of note:

- A 20 mm initial loss was adopted for the 63% and 50% AEP design flood events;
- A 15 mm initial loss was adopted for the 10% AEP design flood event;
- A 10 mm initial loss was adopted for the 2% and 1% AEP design flood events;
- A zero initial loss was adopted for the 0.1% AEP and PMF design flood events; and
- A consistent 1.7 mm/hr continuing loss was adopted for all design flood events.

7.3.10 Model validation

The peak discharges estimated from the TUFLOW model were validated against Rational Method estimates and the Regional Flood Frequency Estimation (RFFE) peak discharges for the 63%, 50%, 10%, 2%, 1% AEP design events at the centre of the sub-catchment extent (As shown in Figure 7.6). The adopted Manning's 'n' roughness values for various land use types and rainfall losses were refined during model validation to obtain design discharges generally consistent with the Rational Method. The RFFE estimated peak discharges are considerably lower than the discharges reported by the TUFLOW model and the Rational Method calculations. The Rational Method calculations are shown in Appendix B.

Table 7.4 shows the TUFLOW model estimated peak discharges estimated by the Rational Method and RFFE. The TUFLOW estimated peak discharges for the 10%, 2% and 1% AEP are conservatively high when compared to the Rational Method but match well to the 39% AEP. The estimated peak discharge for the 63% AEP is underestimated, however all predicted peak discharges are within 25% of the Rational Method.

Table 7.4 – Model validation results

Design AEP	Peak discharge (m^3/s)				Difference	
	Rational Method	RFFE	RFFE - Upper Confidence Limit (95%)	TUFLOW	TUFLOW vs. Rational Method	TUFLOW vs. RFFE
63%	27.2	-	-	20.4	-25%	-
39%	33.0	3.97	8.82	32.9	0%	273%
10%	62.6	8.74	20.3	69.4	11%	242%
2%	94.7	14.4	40.3	103.5	9%	157%
1%	108.3	17.3	52.9	116.7	8%	127%

The TUFLOW estimated peak discharges are over-estimating the peak discharges for all design events when compared to the RFFE estimates. It is concluded that the predicted peak discharges from RFFE is not an accurate representation on the catchment characteristics of the mine site.

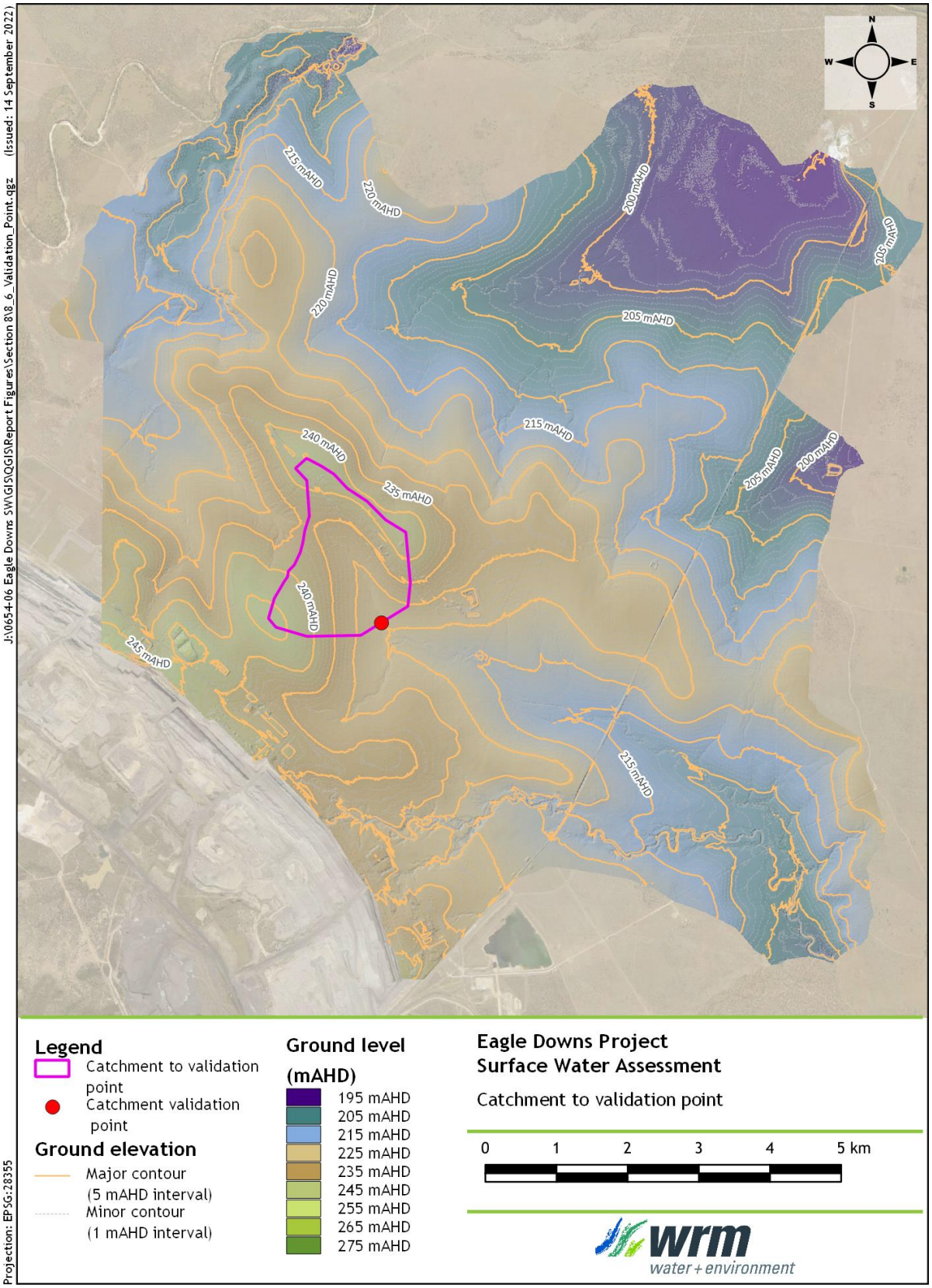


Figure 7.6 – Catchment to validation point

Overall, the validation shows that the TUFLOW model predicts reasonable estimates for the design discharges compared to the Rational Method estimates. On this basis, the model is suitable to assess the flood characteristics for the study area.

7.4 ESTIMATION OF DESIGN FLOOD LEVELS AND EXTENT

7.4.1 Selection of critical storm duration and temporal pattern

Design event hydraulic modelling was undertaken in accordance with AR&R 2019 for the 63%, 50%, 10%, 2%, 1%, 0.1% and PMF design events. The model was run for all 10 ensemble temporal patterns for each storm duration for the selected design events. The median water levels of the 10 ensemble temporal patterns were extracted for the entire model extent for each design event and storm duration.

A "max-max" selection of the median grids for each storm duration was used to ensure the representative temporal pattern and critical storm duration results were identified and selected for each design event. The model was simulated only for duration up to and including 9 hours. The hydraulic model results indicate that this range of durations was sufficient to capture the critical storm durations at all areas within the hydraulic model extent.

Table 7.5 shows the 'representative design storms' selected using the procedure outline above.

Table 7.5 – Representative design storm temporal pattern selected.

Storm duration	Representative design event temporal pattern				
(minutes)	63%	50%	10%	2%	1%
30	-	-	-	-	-
45	-	-	TP06	TP03	TP03
60	-	-	TP09	TP05	TP05
90	-	-	TP06	TP03	TP03
120	TP05	TP08	TP09	TP08	TP08
180	-	TP03	TP04	TP09	TP09
270	TP06	TP05	-	TP09	TP09
360	-	-	TP05	-	-
540	-	-	-	-	-

7.4.2 Existing conditions flood levels and extent

Figure C.1 to Figure C.7 in Appendix C shows the design flood depths, extents for the selected design events for each modelled scenario. Rain-on-grid modelling uses a process whereby rainfall is applied to every model cell. Mapping of these results would show the entire model area to be flooded. For this reason, areas where the flow depth is less than 0.1 m (100 mm) were removed from the mapping.

7.4.3 Mine infrastructure conditions

Figure D.1 to Figure D7 in Appendix D shows the predicted flood depths and extents adjacent to the proposed mine infrastructure area. Figure E.1 to Figure E.7 in Appendix E show the impacts of the proposed mine infrastructure in comparison to existing conditions. The following is of note:

- For the 1 year and 2 year ARI event:
  - There would be no impact on the neighbouring property.

- For the 10% AEP event:
  - There would be increases in flood levels of up to 0.30 m on the western side of the ML boundary due to the proposed rail.
  - There would also be a decrease in flood levels greater than 0.1 m directly upstream of the rail embankment due to the removal of the existing dams and returning the topography to existing conditions.
  - There would be no flood level increases downstream the mine infrastructure area.
- For the 2% AEP event:
  - There would be increases in flood levels up to 0.4 m on the western side of the ML boundary.
  - There would be no flood level increases downstream the mine infrastructure area.
- For the 1% AEP event:
  - There would be increases in flood levels up to 0.5 m on the western side of the ML boundary.
  - There would be no flood level increases downstream the mine infrastructure area.
- For the 0.1% AEP event:
  - There would be increases in flood levels up to 1.0 m on the western side of the ML boundary.
  - There would be reductions in flood levels up to 0.1 m downstream of the Goonyella Rail rail embankment.
- For the PMF event:
  - There would be increases in flood levels greater than 1.0 m on the western side of the ML boundary.
  - There would be reductions in flood levels greater than 0.10 m downstream of the Goonyella Rail rail embankment.

The proposed rail spur embankment would increase the ponding to the west. Options to mitigate this impact will be investigated during detailed design. It may be possible to mitigate this ponded area by moving the bridge structure towards the low spot at the boundary and increase the size of the bridge crossing in the railway.

7.4.4 Subsided conditions

Figure F.1 to Figure F7 in Appendix F shows the predicted flood depths and extents across the underground mining area. Figure G.1 to Figure G.7 in Appendix G shows the predicted flood level impacts of the subsided conditions model results in comparison to existing conditions.

For all modelled events there would be a general reduction in flood levels across the mine subsidence area and the downstream reaches. The greatest reduction occurs within Reach 1, which drains across the downstream Winchester South Mining Lease application area. If Winchester South is approved, Reach 3 will be significantly disturbed by mining. The impacts on Reach 2 and Reach 3 are only minor.

7.4.5 Final landform conditions

Figure H.1 to Figure H7 in Appendix H shows the predicted flood depths and extents across the underground mining area. Figure I.1 to Figure I.7 in Appendix I shows the predicted flood level impacts of the final landform conditions in comparison to existing conditions. In comparison to the subsided conditions, the proposed drains would appear to moderately increase the downstream peak flows particularly in Reach 1 where the majority of the ponding occurs.

7.5 DOWNSTREAM PEAK FLOW IMPACT ASSESSMENT

Table 7.6 show comparisons of existing and proposed final landform peak discharges at the Project boundary for Reach 1 and Reach 3. The impacts on Reach 2 are minimal and have not been shown.

The results have been provided for a range of design storm events for a single temporal pattern (temporal pattern 9). This assessment assumes the ponding areas are empty at the start of the event and as such, this is the "worst case" scenario for flow impacts.

Table 7.6 – Comparison of predicted peak discharges at key locations

Storm event (% AEP)	Peak design discharges (m^3/s)					
	Reach 1			Reach 3		
	Existing	Final landform	% Difference	Existing	Final landform	% Difference
63%	57.6	5.3	-91%	36.8	21.9	-41%
50%	88.5	11.0	-88%	59.1	41.1	-30%
10%	180.8	51.7	-71%	104.5	76.1	-27%
2%	273.0	96.3	-65%	163.9	135.0	-18%
1%	309.6	114.1	-63%	184.7	157.6	-15%
0.1%	607.4	240.2	-60%	328.1	264.6	-19%

Appendix J shows the predicted hydrographs for existing conditions (without any subsidence) and final landform conditions. The results show a significant reduction in peak flows at the downstream boundary, particularly for the more frequent events. The flood peak is also significantly delayed due to the volume that the subsidence captures before releasing to the environment.

Reach 1, which is not a watercourse, drains in an ill-defined manner across the Winchester South MLA to the Isaac River. The reduction in peak flow is significant (when the ponding areas are assumed to be empty) and is a residual impact of the Project. However, the reduction in flow will be significantly beneficial for the Winchester South Project if it proceeds.

Reach 3, which also is not a watercourse, drains into the Ripplestone/Ripstone Creek catchment. The proposed mining area occupies about 1,306 ha, or approximately 4.3% of the total Ripstone Creek catchment. Future mining at Peak Downs Mine will also consume much of the Reach 3 catchment upstream of the Project.

The impacts on Isaac River catchment flows are not expected to be significant. The total disturbance footprint for the Project is 30.6 km^2 compared to around 4,100 km^2 to the Project area. There are also no baseflows in the Isaac River (see Figure 2.10) that would be impacted and these catchments do not flow with baseflow.

8 Summary of findings

8.1 WATER MANAGEMENT SYSTEM ASSESSMENT

The proposed water management infrastructure has been updated as part of an optimisation study undertaken by GHD (2021) and further refined as part of this study. A water balance model was developed of the proposed water management system to assess its performance against the following key indicators:

- The volume of water likely to accumulate in the dams at the Project site;
- The probability and volume of uncontrolled spills from dams at the Project site;
- The volume of salt and resulting salinity in the dams at the Project site; and
- The volume of external raw water required to supplement the mine water demand.

The results of the water balance model for the mine water management system are as follows:

- No spills are predicted from any of the mine water dams over the life of the Project, indicating there is a very low risk of releasing mine affected water from the storages at the Project site.
- Controlled releases are not proposed and are not required from the RP2 Mine Water Dam (DM501A).
- There would not be any uncontrolled spillway discharges into the receiving environment from any of the mine water dams for any climatic conditions assessed over the life of the Project.
- The ROM and CHPP Sediment Dam catchment, which captures surface water runoff from the ROM and CHPP could potentially overflow if an event larger than the 99th percentile rainfall event occurred. The likelihood of spills will reduce when the Mine Water Dam is built. In the event where DM701A spills into the environment, the water quality would generally be range between 2,000 mg/L and 2,500 mg/L.
- Water stored in Mine Process Water Storage Dam will be of suitable quality for use as CHPP and underground raw water supply;
- Maximum predicted water import (2,094 ML) will be required in Year 38 of mine life with predicted water imports for Years 1 to 3 significantly lower than the rest of the mine life. EDCM has an annual Sunwater import allocation of 600 ML/year and the mine site would need to source raw water from alternative sources.

The results of the water balance model for the ESC water management system are as follows:

- The DREA dams DM902A are not predicted to spill into the receiving environment for the 5%ile (wet) climatic conditions or drier as water is pumped to the mine water system.
- During very wet climatic conditions (1%ile), the predicted overflow salinity concentrations for the DREA Sediment would range between 649 µS/cm to 657 µS/cm (TDS 346 mg/L to 350 mg/L).
- During extremely wet climatic conditions (maximum), the predicted overflow salinity concentrations would range between 649 µS/cm to 663 µS/cm (TDS 346 mg/L and 353 mg/L).

Overall, the mine water management system can be operated to protect the environmental values of the downstream receiving waters.

8.2 MINE SUBSIDENCE IMPACT ASSESSMENT

The Eagle Downs Project proposes to target three seams (HCU, HCL and DY) by longwall mining. Longwall mining typically results in subsidence which leads to progressive development of shallow, trough-like depressions on the surface above each extracted longwall panel. ECDM currently have approval for a maximum ponding disturbance area of 77.5 ha. However, the revised mine plan will result in a total ponding area of 282.4 ha.

Concept mitigation measures have been developed to reduce the area of ponding within the subsidence area to the approved area of 77.5 ha or less. Ponding mitigation measures that have been considered include:

- The construction of drainage channels between the ponded areas; and
- The filling of ponded areas where drainage may not be possible or practical.

No mitigation measures are proposed following the mining of the HCU seam because the ponded area would be less than approved. The mitigation measures would generally be required following the mining of the HCL seam. The residual ponding area following the mining of the HCL seam and the construction of the mitigation drains is predicted to be 23.4 ha. Under proposed final landform conditions, there would be a residual ponding disturbance area of 76.4 ha, which is less than the currently approved ponding disturbance area of 77.5 ha. A total of 206 ha of ponded area would be reduced, with 180.6 ha mitigated by drainage works and 25.4 ha mitigated by filling.

There are no watercourses that would be impacted by surface subsidence. However, surface subsidence has the potential to cause localised ponding that may impact on vegetation. The water quality accumulating in the ponded areas may also degrade through evapo-concentration, which may be of concern to users of the ponded water and for downstream overflows. The water balance model developed for the water management system assessment was extended to determine the ponded water quality and impact on downstream flows. The model found the following:

- Final landform depressions would generally contain less than 1 ML of water 50% of the time. This indicates that there would be very little water retained the residual ponds as most water is lost through evaporation and soil infiltration.
- The predicted salinity concentrations of the ponded water would be below the threshold that would impact on cattle drinking. Cattle would have no hesitancy in drinking the ponded water.
- The predicted salinity concentrations of the overflows to the receiving water would generally be similar to background concentrations and therefore meet downstream water quality objectives.
- The reduction in flow to the local waterways of JB Gully and Ripplestone Creek are not significant as there is considerable upstream and downstream catchment to mitigate the impact. The impact on Feature 1 is more significant with mean annual stream flow volume at the lease boundary predicted to change from 729 ML/yr to 486 ML/yr, a 33% change. However, Feature 1 is not a watercourse and has no defined bed and banks where flow would drain. It will also be significantly disturbed by Winchester South, if approved.
- Feature 3 drains to the Isaac River. The overall reduction in flows to the Isaac River would be negligible given it has a catchment area of about 4,100 km^{2}to Feature 1.

8.3 FLOOD IMPACT ASSESSMENT

A TUFLOW two-dimensional hydrodynamic model was used to estimate the flood characteristics (depths, levels and velocities) within the Project boundary. Flood modelling was undertaken for the following conditions:

- Existing conditions, which includes the existing mine infrastructure;

- Mine infrastructure conditions (in the Feature 3 catchment);
- Proposed fully subsided conditions (no mitigation); and
- Proposed final landform conditions.

Drains are proposed divert clean catchment runoff around the mine infrastructure area. The result of the mine infrastructure modelling show that there would be a flood level increase immediately upstream of the proposed rail spur, which may be mitigated by upgrading the proposed rail infrastructure. The ponding caused by the upstream ponding, would marginally reduce downstream flood levels.

The proposed fully subsided conditions without the proposed mitigation measures would generally reduce flood levels across the mine subsidence area and the downstream reaches. The greatest reduction occurs within Reach 1, which drains across the downstream Winchester South Mining Lease application area. If Winchester South is approved, Reach 3 will be significantly disturbed by mining. The impacts on Reach 2 and Reach 3 are only minor.

For the final landform conditions with the mitigation measures in place, the proposed drains would appear to moderately increase the downstream peak flows particularly in Reach 1 where the majority of the ponding occurs.

9 References

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Appendix A - Olive Downs Project baseline water quality samples

Table A.1: Local water quality sampling data – Olive Downs Project (SW1)

Parameter	Unit	SW1										Default Guideline Value (refer Table 3.1)
		15/8/17	14/9/17	12/10/17	16/11/17	14/12/17	25/1/18	13/11/18	21/12/18	14/2/19	26/3/19	
pH	-	8.29	8.21	8.32	8.36	8.24	7.87	7.4	7.48	8.85	7.43	6.5-8.5 (aquatic)
Electrical Conductivity	µS/cm	389	398	467	475	464	449	281	430	475	177	< 720 (baseflow) < 250 (high flow)
Total Suspended Solids	mg/L	11	11	16	13	12	66	107	30	36	8	< 55 (aquatic)
Turbidity	NTU	7.4	8.3	15.2	62.3	30	123	806	138	116	31.3	< 50 (aquatic)
Dissolved Oxygen	% sat.	59.3	52.4	56.5	60.8	42	44.5	55.7	-	37	48.8	85-110% (aquatic)
Total Hardness	mg/L	98	109	132	160	186	-	70	118	141	46	150 (drinking)
Sulphate as SO4	mg/L	6	4	8	3	3	4	15	6	11	6	25 (aquatic)
Sodium (dissolved)	mg/L	33	38	57	53	41	37	23	21	32	15	< 30 (drinking)
Aluminium (dissolved)	mg/L	0.02	0.08	0.11	0.15	0.05	0.05	0.14	0.83	0.03	-	< 0.055 (aquatic)
Arsenic (dissolved)	mg/L	<0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.002	0.001	0.001	< 0.013 (aquatic)
Cadmium (dissolved)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.0001	0.0001	0.0001	< 0.0002 (aquatic)
Chromium (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	0.001	< 0.001 (aquatic)
Cobalt (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	-	< 0.0014 (aquatic)
Copper (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.001	0.002	0.001	< 0.0014 (aquatic)
Lead (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	0.001	< 0.0034 (aquatic)
Molybdenum (dissolved)	mg/L	0.001	0.001	<0.001	<0.001	0.001	0.001	0.001	0.001	0.001	-	< 0.034 (aquatic)
Nickel (dissolved)	mg/L	<0.001	<0.001	0.001	0.002	0.002	0.001	0.002	0.004	0.002	0.001	< 0.011 (aquatic)
Selenium (dissolved)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.01	-	< 0.005 (aquatic)
Silver (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	-	< 0.00005 (aquatic)
Uranium (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	-	< 0.001 (aquatic)
Vanadium (dissolved)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.01	-	< 0.01 (aquatic)
Zinc (dissolved)	mg/L	<0.005	<0.005	<0.005	<0.005	0.01	<0.005	0.005	0.005	0.005	0.005	< 0.008 (aquatic)
Boron (dissolved)	mg/L	<0.05	<0.05	<0.05	0.06	0.06	<0.05	0.05	0.08	0.05	-	< 0.94 (aquatic)
Iron (dissolved)	mg/L	0.08	0.14	0.09	0.18	0.12	0.07	0.21	0.8	0.05	-	< 0.18 (aquatic)
Aluminium (total)	mg/L	0.28	0.3	0.27	0.21	0.36	1.1	12	3.3	1.48	-	< 5 (stock)
Arsenic (total)	mg/L	<0.001	0.001	0.001	0.002	0.001	0.002	0.003	0.003	0.002	0.001	< 2.0 (irrigation) < 0.5 (stock)
Cadmium (total)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.0005	0.0001	0.0001	< 0.01 (stock)
Chromium (total)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.015	0.004	0.002	0.003	< 1 (stock)
Cobalt (total)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.007	0.002	0.001	-	< 0.1 (irrigation)
Copper (total)	mg/L	<0.001	<0.001	0.001	<0.001	<0.001	0.002	0.01	0.004	0.002	0.002	<1 (stock)
Lead (total)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.014	0.004	0.001	0.001	< 0.1 (stock)
Molybdenum (total)	mg/L	<0.001	0.001	0.001	0.001	<0.001	0.002	0.001	0.001	0.001	-	< 0.05 (irrigation)
Nickel (total)	mg/L	<0.001	0.001	0.002	0.002	0.002	0.003	0.018	0.007	0.003	0.003	< 1 (stock)
Selenium (total)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.01	-	< 0.02 (stock)
Uranium (total)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	-	< 0.1 (irrigation)
Vanadium (total)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.01	0.01	-	< 0.5 (irrigation)
Zinc (total)	mg/L	<0.005	<0.005	0.025	<0.005	<0.005	<0.005	0.032	0.007	0.005	0.006	< 5 (irrigation)
Boron (total)	mg/L	<0.05	0.05	0.05	0.06	0.05	0.07	0.07	0.12	0.11	-	< 5 (stock)
Iron (total)	mg/L	0.28	0.42	0.4	0.44	0.81	2.71	20.7	5.61	2.13	-	< 10 (irrigation)

Parameter	Unit	SW1										Default Guideline Value (refer Table 3.1)
		15/8/17	14/9/17	12/10/17	16/11/17	14/12/17	25/1/18	13/11/18	21/12/18	14/2/19	26/3/19	
Fluoride (total)	mg/L	0.2	0.2	0.2	0.2	<0.1	0.2	0.2	0.2	0.2	0.2	< 2 (irrigation)
Ammonia (total)	mg/L	0.04	0.1	0.05	0.03	0.12	0.21	0.12	0.1	0.05	0.14	< 0.02 (aquatic)
Nitrate as N	mg/L	<0.01	<0.01	<0.01	<0.01	0.02	0.02	0.05	0.01	0.01	0.05	< 1.1 (aquatic)
Phosphorus as P (total)	mg/L	0.02	0.02	0.03	0.04	0.02	0.1	0.45	0.11	0.09	0.03	< 50 (aquatic)
Reactive Phosphorus as P	mg/L	<0.01	<0.01	<0.01	-	<0.01	<0.01	0.01	0.01	0.01	0.01	< 0.02 (aquatic)

Table A.2: Local water quality sampling data – Olive Downs Project (SW2)

Parameter	Unit	SW2												Default Guideline Value (refer Table 3.1)
		19/7/17	15/8/17	14/9/17	12/10/17	15/2/18	14/3/18	13/4/18	23/5/18	13/11/18	17/12/18	14/2/19	26/3/19	
pH	-	8.32	8.24	8.07	7.74	6.37	7.07	6.67	7.43	6.51	-	7.94	6.72	6.5-8.5 (aquatic)
Electrical Conductivity	µS/cm	399	479	493	516	124	203	319	261	171	-	269	312	< 720 (baseflow) < 250 (high flow)
Total Suspended Solids	mg/L	24	28	58	51	14	24	17	25	34	842	13	62	< 55 (aquatic)
Turbidity	NTU	55.3	56.2	132	82	30.2	109	51.7		99.1	-	30.7	80.7	< 50 (aquatic)
Dissolved Oxygen	% sat.	73.1	39.8	33.1	94.9	24.8	3.1	16.1	4	71.4	-	55.2	8.6	85-110% (aquatic)
Total Hardness	mg/L	130	137	162	190	32	74	106	124	65	21	83	82	150 (drinking)
Sulphate as SO4	mg/L	2	1	1	<1	<1	<1	<1	<1	1	1	1	1	25 (aquatic)
Sodium (dissolved)	mg/L	30	33	38	50	4	15	17	28	7	12	20	13	< 30 (drinking)
Aluminium (dissolved)	mg/L	0.04	0.07	0.07	0.13	0.61	0.36	0.05	0.05	1.83	0.4	0.3	-	< 0.055 (aquatic)
Arsenic (dissolved)	mg/L	<0.001	<0.001	<0.001	0.002	0.001	0.001	0.001	<0.001	0.002	0.001	0.002	0.004	< 0.013 (aquatic)
Cadmium (dissolved)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.0001	0.0001	0.0001	< 0.0002 (aquatic)
Chromium (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	0.001	< 0.001 (aquatic)
Cobalt (dissolved)	mg/L	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	-	< 0.0014 (aquatic)
Copper (dissolved)	mg/L	0.002	0.002	0.002	0.002	0.002	0.001	<0.001	0.002	0.003	0.002	0.001	0.002	< 0.0014 (aquatic)
Lead (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	0.001	< 0.0034 (aquatic)
Molybdenum (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	-	< 0.034 (aquatic)
Nickel (dissolved)	mg/L	<0.001	0.001	<0.001	0.002	0.003	0.002	0.002	0.002	0.004	0.001	0.003	0.006	< 0.011 (aquatic)
Selenium (dissolved)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.01	-	< 0.005 (aquatic)
Silver (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	0.001	0.001	0.001	-	< 0.00005 (aquatic)
Uranium (dissolved)	mg/L	<0.001	<0.001	0.002	0.002	-	<0.001	<0.001	<0.001	0.001	0.001	0.001	-	< 0.001 (aquatic)
Vanadium (dissolved)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.01	-	< 0.01 (aquatic)
Zinc (dissolved)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.017	0.005	0.005	0.005	< 0.008 (aquatic)
Boron (dissolved)	mg/L	<0.05	0.05	0.05	0.08	<0.05	<0.05	0.06	0.1	0.06	0.05	0.05	-	< 0.94 (aquatic)
Iron (dissolved)	mg/L	<0.05	<0.05	<0.05	0.16	0.52	0.3	0.06	0.09	1.19	0.28	1.05	-	< 0.18 (aquatic)
Aluminium (total)	mg/L	0.8	0.74	1.3	1.01	1.11	3.76	0.58	0.58	4.18	15.9	1.31	-	< 5 (stock)
Arsenic (total)	mg/L	<0.001	<0.001	0.001	0.002	0.002	0.002	0.002	0.001	0.003	0.002	0.003	0.007	< 2.0 (irrigation) < 0.5 (stock)
Cadmium (total)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.0001	0.0001	0.0001	< 0.01 (stock)
Chromium (total)	mg/L	<0.001	<0.001	0.001	0.001	0.001	0.003	<0.001	<0.001	0.002	0.011	0.001	0.003	< 1 (stock)
Cobalt (total)	mg/L	<0.001	<0.001	0.002	0.002	<0.001	0.002	<0.001	<0.001	0.002	0.009	0.001	-	< 0.1 (irrigation)

Parameter	Unit	SW2												Default Guideline Value (refer Table 3.1)
		19/7/17	15/8/17	14/9/17	12/10/17	15/2/18	14/3/18	13/4/18	23/5/18	13/11/18	17/12/18	14/2/19	26/3/19	
Copper (total)	mg/L	<0.001	0.003	0.004	0.003	0.004	0.004	0.001	0.001	0.005	0.018	0.002	0.005	<1 (stock)
Lead (total)	mg/L	<0.001	<0.001	0.001	<0.001	<0.001	0.002	<0.001	<0.001	0.001	0.008	0.001	0.003	< 0.1 (stock)
Molybdenum (total)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	-	< 0.05 (irrigation)
Nickel (total)	mg/L	0.002	<0.001	0.003	0.004	0.004	0.005	0.002	0.002	0.006	0.016	0.003	0.009	< 1 (stock)
Selenium (total)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.01	-	< 0.02 (stock)
Uranium (total)	mg/L	<0.001	<0.001	0.002	0.002	-	<0.001	<0.001	<0.001	0.001	0.001	0.001	-	< 0.1 (irrigation)
Vanadium (total)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.03	0.01	-	< 0.5 (irrigation)
Zinc (total)	mg/L	<0.005	0.011	0.006	<0.005	<0.005	0.012	<0.005	<0.005	0.01	0.041	0.007	0.009	< 5 (irrigation)
Boron (total)	mg/L	0.06	<0.05	0.07	0.08	<0.05	<0.05	0.06	0.06	0.05	0.05	0.07	-	< 5 (stock)
Iron (total)	mg/L	0.73	0.65	1.54	1.55	1.2	3.95	1.12	1.12	4.31	14.9	2.56	-	< 10 (irrigation)
Fluoride (total)	mg/L	0.2	0.2	0.3	0.3	<0.1	0.2	0.2	0.3	0.2	0.2	0.3	0.2	< 2 (irrigation)
Ammonia (total)	mg/L	<0.01	<0.01	0.04	0.04	0.16	0.08	0.12	0.05	0.05	0.05	0.12	0.02	< 0.02 (aquatic)
Nitrate as N	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	<0.01	<0.01	0.01	0.2	0.01	0.01	< 1.1 (aquatic)
Phosphorus as P (total)	mg/L	0.05	0.04	0.09	0.14	0.25	0.09	0.04	0.05	0.18	0.47	0.14	0.28	< 50 (aquatic)
Reactive Phosphorus as P	mg/L	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	0.01	0.03	0.01	0.03	< 0.02 (aquatic)

Table A.3: Local water quality sampling data – Olive Downs Project (SW3)

Parameter	Unit	SW3									Default Guideline Value (refer Table 3.1)
		15/8/17	14/9/17	12/10/17	16/11/17	14/12/17	25/1/18	15/2/18	14/3/18	13/4/19	
pH	-	8.04	7.17	7.51	7.67	8.18	8.08	6.4	7.44	7.0	6.5-8.5 (aquatic)
Electrical Conductivity	µS/cm	330	311	317	313	322	358	218	225	297	< 720 (baseflow) < 250 (high flow)
Total Suspended Solids	mg/L	11	10	<5	<5	<5	6	38	<5	<5	< 55 (aquatic)
Turbidity	NTU	7.7	1.7	0.5	35.7	4.4	12.4	498	10.4	15.2	< 50 (aquatic)
Dissolved Oxygen	% sat.	41.5	30.7	23.8	33.6	42.2	57.2	27.1	29.8	17.3	85-110% (aquatic)
Total Hardness	mg/L	65	72	79	86	105		48	57	82	150 (drinking)
Sulphate as SO4	mg/L	8	6	5	4	5	5	9	6	5	25 (aquatic)
Sodium (dissolved)	mg/L	34	32	39	38	36	39	19	23	30	< 30 (drinking)
Aluminium (dissolved)	mg/L	0.09	0.07	0.05	0.05	0.02	0.02	0.52	0.12	0.04	< 0.055 (aquatic)
Arsenic (dissolved)	mg/L	<0.001	<0.001	0.001	0.001	0.001	0.001	<0.001	<0.001	0.001	< 0.013 (aquatic)
Cadmium (dissolved)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	< 0.0002 (aquatic)
Chromium (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	< 0.001 (aquatic)
Cobalt (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	< 0.0014 (aquatic)
Copper (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	< 0.0014 (aquatic)
Lead (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	< 0.0034 (aquatic)
Molybdenum (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	< 0.034 (aquatic)
Nickel (dissolved)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.002	0.001	0.002	< 0.011 (aquatic)
Selenium (dissolved)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	< 0.005 (aquatic)
Silver (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	< 0.00005 (aquatic)
Uranium (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	< 0.001 (aquatic)

Parameter	Unit	SW3									Default Guideline Value (refer Table 3.1)
		15/8/17	14/9/17	12/10/17	16/11/17	14/12/17	25/1/18	15/2/18	14/3/18	13/4/19	
Vanadium (dissolved)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	< 0.01 (aquatic)
Zinc (dissolved)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	< 0.008 (aquatic)
Boron (dissolved)	mg/L	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	0.06	< 0.94 (aquatic)
Iron (dissolved)	mg/L	0.06	0.09	0.39	0.63	0.61	0.47	0.31	0.09	0.15	< 0.18 (aquatic)
Aluminium (total)	mg/L	0.11	0.27	0.15	0.12	0.04	0.07	10.5	0.39	0.22	< 5 (stock)
Arsenic (total)	mg/L	<0.001	<0.001	0.002	0.002	<0.001	0.002	0.004	<0.001	0.001	< 2.0 (irrigation) < 0.5 (stock)
Cadmium (total)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	< 0.01 (stock)
Chromium (total)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.011	0.001	<0.001	< 1 (stock)
Cobalt (total)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	<0.001	0.001	< 0.1 (irrigation)
Copper (total)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.011	<0.001	<0.001	<1 (stock)
Lead (total)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.009	<0.001	<0.001	< 0.1 (stock)
Molybdenum (total)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	< 0.05 (irrigation)
Nickel (total)	mg/L	<0.001	0.002	0.001	0.001	<0.001	0.002	0.015	0.002	0.002	< 1 (stock)
Selenium (total)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	< 0.02 (stock)
Uranium (total)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	< 0.1 (irrigation)
Vanadium (total)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	< 0.5 (irrigation)
Zinc (total)	mg/L	<0.005	<0.005	0.017	<0.005	<0.005	0.008	0.026	<0.005	<0.005	< 5 (irrigation)
Boron (total)	mg/L	<0.05	0.05	<0.05	<0.05	<0.05	0.05	<0.05	<0.05	0.05	< 5 (stock)
Iron (total)	mg/L	0.15	0.35	0.65	0.91	0.8	1.41	12.6	0.44	0.57	< 10 (irrigation)
Fluoride (total)	mg/L	0.2	0.1	0.2	0.1	<0.1	0.1	0.2	0.1	0.2	< 2 (irrigation)
Ammonia (total)	mg/L	0.04	0.03	0.05	0.04	0.2	<0.01	0.17	0.06	0.06	< 0.02 (aquatic)
Nitrate as N	mg/L	<0.01	<0.01	<0.01	0.25	<0.01	<0.01	0.02	0.03	<0.01	< 1.1 (aquatic)
Phosphorus as P (total)	mg/L	0.01	0.02	0.02	0.03	0.02	0.04	0.28	0.07	0.03	< 50 (aquatic)
Reactive Phosphorus as P	mg/L	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	< 0.02 (aquatic)

Table A.4: Local water quality sampling data – Olive Downs Project (SW3) cont'

Parameter	Unit	SW3									Default Guideline Value (refer Table 3.1)
		23/5/18	28/6/18	24/7/18	21/8/18	11/9/18	13/11/18	17/12/18	14/2/19	26/3/19	
pH	-	7.45	6.92	7.12	7.47	7.08	6.68	-	8.52	7.02	6.5-8.5 (aquatic)
Electrical Conductivity	µS/cm	295	334	360	343	371	251	-	301	214	< 720 (baseflow) < 250 (high flow)
Total Suspended Solids	mg/L	13	14	19	12	19	30	832	26	24	< 55 (aquatic)
Turbidity	NTU	-	10.1	31.2	32.2	28.1	187	-	42	15.3	< 50 (aquatic)
Dissolved Oxygen	% sat.	5.1	62.9	45.2	53.8	78.5	35.6	-	65	24.3	85-110% (aquatic)
Total Hardness	mg/L	96	84	94	103	64	75	21	87	68	150 (drinking)
Sulphate as SO4	mg/L	5	3	3	4	3	9	2	2	3	25 (aquatic)
Sodium (dissolved)	mg/L	34	36	30	27	24	18	12	22	13	< 30 (drinking)
Aluminium (dissolved)	mg/L	0.04	0.01	0.01	0.01	0.03	1.77	0.2	0.06	-	< 0.055 (aquatic)
Arsenic (dissolved)	mg/L	<0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.002	0.001	< 0.013 (aquatic)
Cadmium (dissolved)	mg/L	<0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	< 0.0002 (aquatic)

Parameter	Unit	SW3									Default Guideline Value (refer Table 3.1)
		23/5/18	28/6/18	24/7/18	21/8/18	11/9/18	13/11/18	17/12/18	14/2/19	26/3/19	
Chromium (dissolved)	mg/L	<0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	< 0.001 (aquatic)
Cobalt (dissolved)	mg/L	<0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	-	< 0.0014 (aquatic)
Copper (dissolved)	mg/L	<0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.001	0.001	< 0.0014 (aquatic)
Lead (dissolved)	mg/L	<0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	< 0.0034 (aquatic)
Molybdenum (dissolved)	mg/L	<0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	-	< 0.034 (aquatic)
Nickel (dissolved)	mg/L	0.001	0.001	0.001	0.001	0.001	0.003	0.001	0.001	0.002	< 0.011 (aquatic)
Selenium (dissolved)	mg/L	<0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-	< 0.005 (aquatic)
Silver (dissolved)	mg/L	<0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	-	< 0.00005 (aquatic)
Uranium (dissolved)	mg/L	<0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	-	< 0.001 (aquatic)
Vanadium (dissolved)	mg/L	<0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-	< 0.01 (aquatic)
Zinc (dissolved)	mg/L	<0.005	0.005	0.005	0.005	0.005	0.016	0.005	0.005	0.005	< 0.008 (aquatic)
Boron (dissolved)	mg/L	0.07	0.09	0.05	0.05	0.05	0.06	0.05	0.05	-	< 0.94 (aquatic)
Iron (dissolved)	mg/L	0.33	0.37	0.33	0.2	0.49	0.77	0.16	0.2	-	< 0.18 (aquatic)
Aluminium (total)	mg/L	0.26	0.08	0.06	0.15	0.38	5.67	18.1	0.66	-	< 5 (stock)
Arsenic (total)	mg/L	0.001	0	0.002	0.001	0.002	0.004	0.002	0.002	0.003	< 2.0 (irrigation) < 0.5 (stock)
Cadmium (total)	mg/L	<0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	< 0.01 (stock)
Chromium (total)	mg/L	<0.001	0.001	0.001	0.001	0.001	0.006	0.014	0.001	0.001	< 1 (stock)
Cobalt (total)	mg/L	<0.001	0	0.001	0.001	0.001	0.004	0.01	0.001	-	< 0.1 (irrigation)
Copper (total)	mg/L	<0.001	0	0.001	0.001	0.001	0.004	0.017	0.001	0.001	<1 (stock)
Lead (total)	mg/L	<0.001	0.001	0.001	0.001	0.001	0.004	0.008	0.001	0.001	< 0.1 (stock)
Molybdenum (total)	mg/L	<0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	-	< 0.05 (irrigation)
Nickel (total)	mg/L	0.002	0	0.001	0.001	0.001	0.008	0.017	0.002	0.004	< 1 (stock)
Selenium (total)	mg/L	<0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-	< 0.02 (stock)
Uranium (total)	mg/L	<0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	-	< 0.1 (irrigation)
Vanadium (total)	mg/L	<0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.01	-	< 0.5 (irrigation)
Zinc (total)	mg/L	<0.005	0.005	0.013	0.005	0.005	0.013	0.036	0.005	0.005	< 5 (irrigation)
Boron (total)	mg/L	0.05	0.07	0.05	0.05	0.06	0.05	0.05	0.07	-	< 5 (stock)
Iron (total)	mg/L	1.28	1.73	2.31	1.11	1.4	7.39	16.6	1.62	-	< 10 (irrigation)
Fluoride (total)	mg/L	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.3	0.2	< 2 (irrigation)
Ammonia (total)	mg/L	0.15	0.04	0.41	0.43	0.12	0.03	0.05	0.05	0.06	< 0.02 (aquatic)
Nitrate as N	mg/L	<0.01	0.01	0.03	0.01	0.01	0.03	0.2	0.01	0.01	< 1.1 (aquatic)
Phosphorus as P (total)	mg/L	0.02	0.07	0.04	0.09	0.03	0.16	0.44	0.06	0.02	< 50 (aquatic)
Reactive Phosphorus as P	mg/L	<0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	< 0.02 (aquatic)

Table A.5: Local water quality sampling data – Olive Downs Project (SW4/SW5/SW6/SW8)

Parameter	Unit	SW4		SW5	SW6		SW8				Default Guideline Value (refer Table 3.1)
		20/7/17	13/11/18	13/11/18	20/7/17	21/12/18	20/7/17	13/11/18	21/12/18	14/2/19	
pH	-	8.38	7.7	8.1	8.33	-	8.47	7.8	6.95	7.69	6.5-8.5 (aquatic)
Electrical Conductivity	µS/cm	781	428	191	1,230	-	2,020	1,120	958	477	< 720 (baseflow) < 250 (high flow)

Parameter	Unit	SW4		SW5	SW6		SW8				Default Guideline Value (refer Table 3.1)
		20/7/17	13/11/18	13/11/18	20/7/17	21/12/18	20/7/17	13/11/18	21/12/18	14/2/19	
Total Suspended Solids	mg/L	5	23	80	28	-	<5	12	527	50	< 55 (aquatic)
Turbidity	NTU	4.9	88.2	824	95.4	-	14.5	26.8	2,240	252	< 50 (aquatic)
Dissolved Oxygen	% sat.	78	54.1	59.5	62.2	-	59.5	93.7	-	30.1	85-110% (aquatic)
Total Hardness	mg/L	147	105	43	149	-	300	164	133	67	150 (drinking)
Sulphate as SO4	mg/L	57	26	3	156	-	410	158	144	47	25 (aquatic)
Sodium (dissolved)	mg/L	105	42	18	197	-	300	154	136	66	< 30 (drinking)
Aluminium (dissolved)	mg/L	0.05	1.23	0.6	0.08	0.28	0.11	0.67	0.45	0.37	< 0.055 (aquatic)
Arsenic (dissolved)	mg/L	<0.001	0.004	0.003	<0.001	0.003	<0.001	0.002	0.001	0.001	< 0.013 (aquatic)
Cadmium (dissolved)	mg/L	<0.0001	0.0001	0.0001	<0.0001	0.0001	<0.0001	0.0001	0.0001	0.0001	< 0.0002 (aquatic)
Chromium (dissolved)	mg/L	<0.001	0.001	0.001	<0.001	0.001	<0.001	0.001	0.001	0.001	< 0.001 (aquatic)
Cobalt (dissolved)	mg/L	<0.001	0.002	0.001	<0.001	0.001	<0.001	0.001	0.001	0.001	< 0.0014 (aquatic)
Copper (dissolved)	mg/L	0.002	0.002	0.003	0.002	0.001	0.002	0.002	0.012	0.002	< 0.0014 (aquatic)
Lead (dissolved)	mg/L	<0.001	0.001	0.001	<0.001	-	<0.001	0.001	0.001	0.001	< 0.0034 (aquatic)
Molybdenum (dissolved)	mg/L	0.002	0.001	0.001	0.003	-	0.002	0.001	0.001	0.001	< 0.034 (aquatic)
Nickel (dissolved)	mg/L	0.002	0.005	0.004	0.003	-	0.002	0.004	0.004	0.002	< 0.011 (aquatic)
Selenium (dissolved)	mg/L	<0.01	0.01	0.01	<0.01	-	<0.01	0.01	0.01	0.01	< 0.005 (aquatic)
Silver (dissolved)	mg/L	<0.001	0.001	0.001	<0.001	-	<0.001	0.001	0.001	0.001	< 0.00005 (aquatic)
Uranium (dissolved)	mg/L	<0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	< 0.001 (aquatic)
Vanadium (dissolved)	mg/L	<0.01	0.01	0.01	<0.01	-	<0.01	0.01	0.01	0.01	< 0.01 (aquatic)
Zinc (dissolved)	mg/L	<0.005	0.005	0.005	<0.005	-	<0.005	0.012	0.007	0.005	< 0.008 (aquatic)
Boron (dissolved)	mg/L	0.1	0.1	0.07	0.11	0.07	0.08	0.1	0.09	0.05	< 0.94 (aquatic)
Iron (dissolved)	mg/L	<0.05	1.18	0.42	<0.05	-	0.07	0.69	0.31	0.28	< 0.18 (aquatic)
Aluminium (total)	mg/L	0.11	1.23	24.1	1.15	0.75	0.43	2.67	14.7	8.53	< 5 (stock)
Arsenic (total)	mg/L	<0.001	0.002	0.008	<0.001	0.004	<0.001	0.005	0.004	0.003	< 2.0 (irrigation) < 0.5 (stock)
Cadmium (total)	mg/L	<0.0001	0.0001	0.0001	<0.0001	0.0001	<0.0001	0.0001	0.0001	0.0001	< 0.01 (stock)
Chromium (total)	mg/L	0.011	0.001	0.019	<0.001	0.001	<0.001	0.002	0.021	0.011	< 1 (stock)
Cobalt (total)	mg/L	<0.001	0.002	0.014	0.001	0.001	<0.001	0.003	0.011	0.004	< 0.1 (irrigation)
Copper (total)	mg/L	<0.001	0.002	0.019	0.003	0.001	0.002	0.004	0.014	0.007	<1 (stock)
Lead (total)	mg/L	<0.001	0.001	0.018	<0.001	-	<0.001	0.002	0.01	0.006	< 0.1 (stock)
Molybdenum (total)	mg/L	0.002	0.001	0.001	0.003	-	0.002	0.001	0.001	0.001	< 0.05 (irrigation)
Nickel (total)	mg/L	0.002	0.005	0.023	0.004	-	0.003	0.006	0.022	0.011	< 1 (stock)
Selenium (total)	mg/L	<0.01	0.01	0.01	<0.01	-	<0.01	0.01	0.01	0.01	< 0.02 (stock)
Uranium (total)	mg/L	<0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	< 0.1 (irrigation)
Vanadium (total)	mg/L	<0.01	0.01	0.04	<0.01	-	<0.01	0.01	0.03	0.02	< 0.5 (irrigation)
Zinc (total)	mg/L	<0.005	0.022	0.053	<0.005	-	<0.005	0.006	0.033	0.027	< 5 (irrigation)
Boron (total)	mg/L	0.09	0.09	0.08	0.11	0.1	0.08	0.09	0.13	0.08	< 5 (stock)
Iron (total)	mg/L	0.2	2.32	25.1	1.04	-	0.31	3.94	20.1	9.64	< 10 (irrigation)
Fluoride (total)	mg/L	0.3	0.2	0.2	0.4	-	0.3	0.2	0.3	0.2	< 2 (irrigation)
Ammonia (total)	mg/L	<0.01	0.06	0.48	<0.01	0.07	0.02	0.02	0.11	0.06	< 0.02 (aquatic)
Nitrate as N	mg/L	<0.01	0.01	0.02	<0.01	-	<0.01	0.01	0.01	0.01	< 1.1 (aquatic)
Phosphorus as P (total)	mg/L	0.02	0.1	0.96	0.07	-	0.05	0.07	0.43	0.31	< 50 (aquatic)
Reactive Phosphorus as P	mg/L	<0.01	0.01	0.03	<0.01	-	<0.01	0.01	0.01	0.01	< 0.02 (aquatic)

Table A.6: Local water quality sampling data – Olive Downs Project (SW11/SW12)

		SW11									SW12			Default Guideline Value
Parameter	Unit	13/9/17	12/10/17	16/11/17	14/12/17	14/3/18	13/11/18	17/12/18	14/2/19	26/3/19	13/9/17	12/10/17	16/11/17	(refer Table 3.1)
pH	-	8.32	7.21	7.22	7.26	7.1	8.17	-	7.55	7.85	7.73	7.44	7.73	6.5-8.5 (aquatic)
Electrical Conductivity	µS/cm	595	590	515	515	262	439	-	456	182	612	631	571	< 720 (baseflow) < 250 (high flow)
Total Suspended Solids	mg/L	16	<5	17	15	16	56	49	72	88	11	<5	16	< 55 (aquatic)
Turbidity	NTU	26.4	8.8	84.3	35.2	101	477	-	304	491	12.5	1.7	77.6	< 50 (aquatic)
Dissolved Oxygen	% sat.	57.9	25.5	29.5	7	34.6	97.3	-	27.5	64.4	44.8	79.3	22.8	85-110% (aquatic)
Total Hardness	mg/L	110	142	125	146	61	74	102	76	45	119	166	132	150 (drinking)
Sulphate as SO4	mg/L	47	39	36	27	13	42	28	43	12	36	14	15	25 (aquatic)
Sodium (dissolved)	mg/L	78	83	65	63	23	49	52	52	18	64	85	67	< 30 (drinking)
Aluminium (dissolved)	mg/L	0.28	0.2	0.14	0.16	0.27	0.1	0.01	0.1	-	0.12	0.11	0.11	< 0.055 (aquatic)
Arsenic (dissolved)	mg/L	<0.001	0.001	0.002	0.002	<0.001	0.001	0.001	0.001	0.001	<0.001	0.003	0.001	< 0.013 (aquatic)
Cadmium (dissolved)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.0001	0.0001	0.0001	<0.0001	<0.0001	<0.0001	< 0.0002 (aquatic)
Chromium (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	0.001	<0.001	<0.001	<0.001	< 0.001 (aquatic)
Cobalt (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	-	<0.001	0.001	<0.001	< 0.0014 (aquatic)
Copper (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	0.002	0.002	0.001	0.002	0.002	<0.001	<0.001	<0.001	< 0.0014 (aquatic)
Lead (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	0.001	<0.001	<0.001	<0.001	< 0.0034 (aquatic)
Molybdenum (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	-	<0.001	<0.001	<0.001	< 0.034 (aquatic)
Nickel (dissolved)	mg/L	<0.001	0.002	0.002	0.003	0.001	0.003	0.002	0.002	0.002	0.002	0.002	0.002	< 0.011 (aquatic)
Selenium (dissolved)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.01	-	<0.01	<0.01	<0.01	< 0.005 (aquatic)
Silver (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	-	<0.001	<0.001	<0.001	< 0.00005 (aquatic)
Uranium (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	-	<0.001	<0.001	<0.001	< 0.001 (aquatic)
Vanadium (dissolved)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.01	-	<0.01	<0.01	<0.01	< 0.01 (aquatic)
Zinc (dissolved)	mg/L	<0.005	<0.005	<0.005	0.006	<0.005	0.005	0.005	0.005	0.005	<0.005	<0.005	<0.005	< 0.008 (aquatic)
Boron (dissolved)	mg/L	0.05	<0.05	0.05	0.07	<0.05	0.06	0.07	0.05	-	0.05	0.06	<0.05	< 0.94 (aquatic)
Iron (dissolved)	mg/L	0.15	0.34	0.19	0.38	0.17	0.16	0.06	0.11	-	0.1	0.87	0.18	< 0.18 (aquatic)
Aluminium (total)	mg/L	0.84	0.43	0.59	0.62	2.7	9.02	3.14	7.95	-	0.55	0.21	0.63	< 5 (stock)
Arsenic (total)	mg/L	<0.001	0.002	0.002	0.003	0.001	0.003	0.003	0.003	0.003	<0.001	0.003	0.002	< 2.0 (irrigation) < 0.5 (stock)
Cadmium (total)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.0001	0.0001	0.0001	<0.0001	<0.0001	<0.0001	< 0.01 (stock)
Chromium (total)	mg/L	0.001	<0.001	<0.001	0.001	0.005	0.012	0.004	0.009	0.021	<0.001	<0.001	0.001	< 1 (stock)
Cobalt (total)	mg/L	<0.001	<0.001	0.001	0.001	0.001	0.005	0.002	0.004	-	<0.001	0.001	0.001	< 0.1 (irrigation)
Copper (total)	mg/L	0.002	0.001	0.008	<0.001	0.004	0.008	0.003	0.008	0.012	0.002	<0.001	0.002	<1 (stock)
Lead (total)	mg/L	<0.001	<0.001	<0.001	<0.001	0.002	0.007	0.002	0.005	0.006	<0.001	<0.001	<0.001	< 0.1 (stock)
Molybdenum (total)	mg/L	<0.001	0.001	0.001	<0.001	<0.001	0.001	0.001	0.001	-	<0.001	<0.001	<0.001	< 0.05 (irrigation)
Nickel (total)	mg/L	0.003	0.002	0.003	0.002	0.005	0.015	0.007	0.011	0.018	0.002	0.002	0.003	< 1 (stock)
Selenium (total)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.01	-	<0.01	<0.01	<0.01	< 0.02 (stock)
Uranium (total)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	-	<0.001	<0.001	<0.001	< 0.1 (irrigation)
Vanadium (total)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.01	0.01	-	<0.01	<0.01	<0.01	< 0.5 (irrigation)
Zinc (total)	mg/L	<0.005	<0.005	0.012	0.009	0.013	0.02	0.009	0.024	0.025	<0.005	<0.005	<0.005	< 5 (irrigation)
Boron (total)	mg/L	0.06	<0.05	0.06	<0.05	<0.05	0.06	0.07	0.08	-	0.07	0.07	<0.05	< 5 (stock)
Iron (total)	mg/L	0.94	0.85	0.92	1.5	3.2	11.1	4.62	9.34	-	0.67	1.29	1.41	< 10 (irrigation)
Fluoride (total)	mg/L	0.2	0.2	0.2	<0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	< 2 (irrigation)

Parameter	Unit	SW11									SW12			Default Guideline Value (refer Table 3.1)
		13/9/17	12/10/17	16/11/17	14/12/17	14/3/18	13/11/18	17/12/18	14/2/19	26/3/19	13/9/17	12/10/17	16/11/17	
Ammonia (total)	mg/L	0.05	0.14	0.03	0.1	0.1	0.12	0.03	0.05	0.04	0.04	0.07	0.03	< 0.02 (aquatic)
Nitrate as N	mg/L	<0.01	<0.01	0.13	<0.01	0.19	0.08	0.01	0.01	0.27	<0.01	<0.01	0.18	< 1.1 (aquatic)
Phosphorus as P (total)	mg/L	0.03	0.03	0.04	0.03	0.12	0.27	0.12	0.25	0.3	0.04	0.11	0.07	< 50 (aquatic)
Reactive Phosphorus as P	mg/L	<0.01	<0.01	-	<0.01	<0.01	0.01	0.01	0.01	0.02	<0.01	0.02	-	< 0.02 (aquatic)

Table A.7: Local water quality sampling data – Olive Downs Project (SW12)

Parameter	Unit	SW11									SW12			Default Guideline Value (refer Table 3.1)
		13/9/17	12/10/17	16/11/17	14/12/17	14/3/18	13/11/18	17/12/18	14/2/19	26/3/19	13/9/17	12/10/17	16/11/17	
pH	-	8.32	7.21	7.22	7.26	7.1	8.17	-	7.55	7.85	7.73	7.44	7.73	6.5-8.5 (aquatic)
Electrical Conductivity	µS/cm	595	590	515	515	262	439	-	456	182	612	631	571	< 720 (baseflow) < 250 (high flow)
Total Suspended Solids	mg/L	16	<5	17	15	16	56	49	72	88	11	<5	16	< 55 (aquatic)
Turbidity	NTU	26.4	8.8	84.3	35.2	101	477	-	304	491	12.5	1.7	77.6	< 50 (aquatic)
Dissolved Oxygen	% sat.	57.9	25.5	29.5	7	34.6	97.3	-	27.5	64.4	44.8	79.3	22.8	85-110% (aquatic)
Total Hardness	mg/L	110	142	125	146	61	74	102	76	45	119	166	132	150 (drinking)
Sulphate as SO4	mg/L	47	39	36	27	13	42	28	43	12	36	14	15	25 (aquatic)
Sodium (dissolved)	mg/L	78	83	65	63	23	49	52	52	18	64	85	67	< 30 (drinking)
Aluminium (dissolved)	mg/L	0.28	0.2	0.14	0.16	0.27	0.1	0.01	0.1	-	0.12	0.11	0.11	< 0.055 (aquatic)
Arsenic (dissolved)	mg/L	<0.001	0.001	0.002	0.002	<0.001	0.001	0.001	0.001	0.001	<0.001	0.003	0.001	< 0.013 (aquatic)
Cadmium (dissolved)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.0001	0.0001	0.0001	<0.0001	<0.0001	<0.0001	< 0.0002 (aquatic)
Chromium (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	0.001	<0.001	<0.001	<0.001	< 0.001 (aquatic)
Cobalt (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	-	<0.001	0.001	<0.001	< 0.0014 (aquatic)
Copper (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	0.002	0.002	0.001	0.002	0.002	<0.001	<0.001	<0.001	< 0.0014 (aquatic)
Lead (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	0.001	<0.001	<0.001	<0.001	< 0.0034 (aquatic)
Molybdenum (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	-	<0.001	<0.001	<0.001	< 0.034 (aquatic)
Nickel (dissolved)	mg/L	<0.001	0.002	0.002	0.003	0.001	0.003	0.002	0.002	0.002	0.002	0.002	0.002	< 0.011 (aquatic)
Selenium (dissolved)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.01	-	<0.01	<0.01	<0.01	< 0.005 (aquatic)
Silver (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	-	<0.001	<0.001	<0.001	< 0.00005 (aquatic)
Uranium (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	-	<0.001	<0.001	<0.001	< 0.001 (aquatic)
Vanadium (dissolved)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.01	-	<0.01	<0.01	<0.01	< 0.01 (aquatic)
Zinc (dissolved)	mg/L	<0.005	<0.005	<0.005	0.006	<0.005	0.005	0.005	0.005	0.005	<0.005	<0.005	<0.005	< 0.008 (aquatic)
Boron (dissolved)	mg/L	0.05	<0.05	0.05	0.07	<0.05	0.06	0.07	0.05	-	0.05	0.06	<0.05	< 0.94 (aquatic)
Iron (dissolved)	mg/L	0.15	0.34	0.19	0.38	0.17	0.16	0.06	0.11	-	0.1	0.87	0.18	< 0.18 (aquatic)
Aluminium (total)	mg/L	0.84	0.43	0.59	0.62	2.7	9.02	3.14	7.95	-	0.55	0.21	0.63	< 5 (stock)
Arsenic (total)	mg/L	<0.001	0.002	0.002	0.003	0.001	0.003	0.003	0.003	0.003	<0.001	0.003	0.002	< 2.0 (irrigation) < 0.5 (stock)
Cadmium (total)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.0001	0.0001	0.0001	<0.0001	<0.0001	<0.0001	< 0.01 (stock)
Chromium (total)	mg/L	0.001	<0.001	<0.001	0.001	0.005	0.012	0.004	0.009	0.021	<0.001	<0.001	0.001	< 1 (stock)
Cobalt (total)	mg/L	<0.001	<0.001	0.001	0.001	0.001	0.005	0.002	0.004	-	<0.001	0.001	0.001	< 0.1 (irrigation)
Copper (total)	mg/L	0.002	0.001	0.008	<0.001	0.004	0.008	0.003	0.008	0.012	0.002	<0.001	0.002	<1 (stock)

Parameter	Unit	SW11									SW12			Default Guideline Value (refer Table 3.1)
		13/9/17	12/10/17	16/11/17	14/12/17	14/3/18	13/11/18	17/12/18	14/2/19	26/3/19	13/9/17	12/10/17	16/11/17	
Lead (total)	mg/L	<0.001	<0.001	<0.001	<0.001	0.002	0.007	0.002	0.005	0.006	<0.001	<0.001	<0.001	< 0.1 (stock)
Molybdenum (total)	mg/L	<0.001	0.001	0.001	<0.001	<0.001	0.001	0.001	0.001	-	<0.001	<0.001	<0.001	< 0.05 (irrigation)
Nickel (total)	mg/L	0.003	0.002	0.003	0.002	0.005	0.015	0.007	0.011	0.018	0.002	0.002	0.003	< 1 (stock)
Selenium (total)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.01	-	<0.01	<0.01	<0.01	< 0.02 (stock)
Uranium (total)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	-	<0.001	<0.001	<0.001	< 0.1 (irrigation)
Vanadium (total)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.01	0.01	-	<0.01	<0.01	<0.01	< 0.5 (irrigation)
Zinc (total)	mg/L	<0.005	<0.005	0.012	0.009	0.013	0.02	0.009	0.024	0.025	<0.005	<0.005	<0.005	< 5 (irrigation)
Boron (total)	mg/L	0.06	<0.05	0.06	<0.05	<0.05	0.06	0.07	0.08	-	0.07	0.07	<0.05	< 5 (stock)
Iron (total)	mg/L	0.94	0.85	0.92	1.5	3.2	11.1	4.62	9.34	-	0.67	1.29	1.41	< 10 (irrigation)
Fluoride (total)	mg/L	0.2	0.2	0.2	<0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	< 2 (irrigation)
Ammonia (total)	mg/L	0.05	0.14	0.03	0.1	0.1	0.12	0.03	0.05	0.04	0.04	0.07	0.03	< 0.02 (aquatic)
Nitrate as N	mg/L	<0.01	<0.01	0.13	<0.01	0.19	0.08	0.01	0.01	0.27	<0.01	<0.01	0.18	< 1.1 (aquatic)
Phosphorus as P (total)	mg/L	0.03	0.03	0.04	0.03	0.12	0.27	0.12	0.25	0.3	0.04	0.11	0.07	< 50 (aquatic)
Reactive Phosphorus as P	mg/L	<0.01	<0.01	-	<0.01	<0.01	0.01	0.01	0.01	0.02	<0.01	0.02	-	< 0.02 (aquatic)

Appendix B - Rational Method

Table B.1: Rational method calculation of validation catchment

Catchment:	Validation catchment

Catchment area and coefficient of runoff	
Catchment Area (ha)	311.25
C_{10}	0.44

Channel Characteristics	
Channel length (m)	1900
Channel slope (m/m)	0.005
Manning's 'n'	0.045
Channel bottom width (m)	5.00
Channel side slope (m/m)	0.250

Design Discharges						
ARI (years)	AEP (%)	Frequency Factor F_y	C_y	t_c[a] (mins)	Rainfall Intensity (mm/h)	Peak Discharge (m^3/s)
1	63	0.80	0.35	57.02	34.6	10.55
1.44	50	0.85	0.37	56.27	39.5	12.79
10	10	1.00	0.44	53.90	63.9	24.29
50	2	1.15	0.51	52.46	84.0	36.73
100	1	1.20	0.53	52.00	92.0	42.01

a - Time of Concentration (t_c) is calculated using Modified Friend's equation

Appendix C - Existing conditions design flood mapping

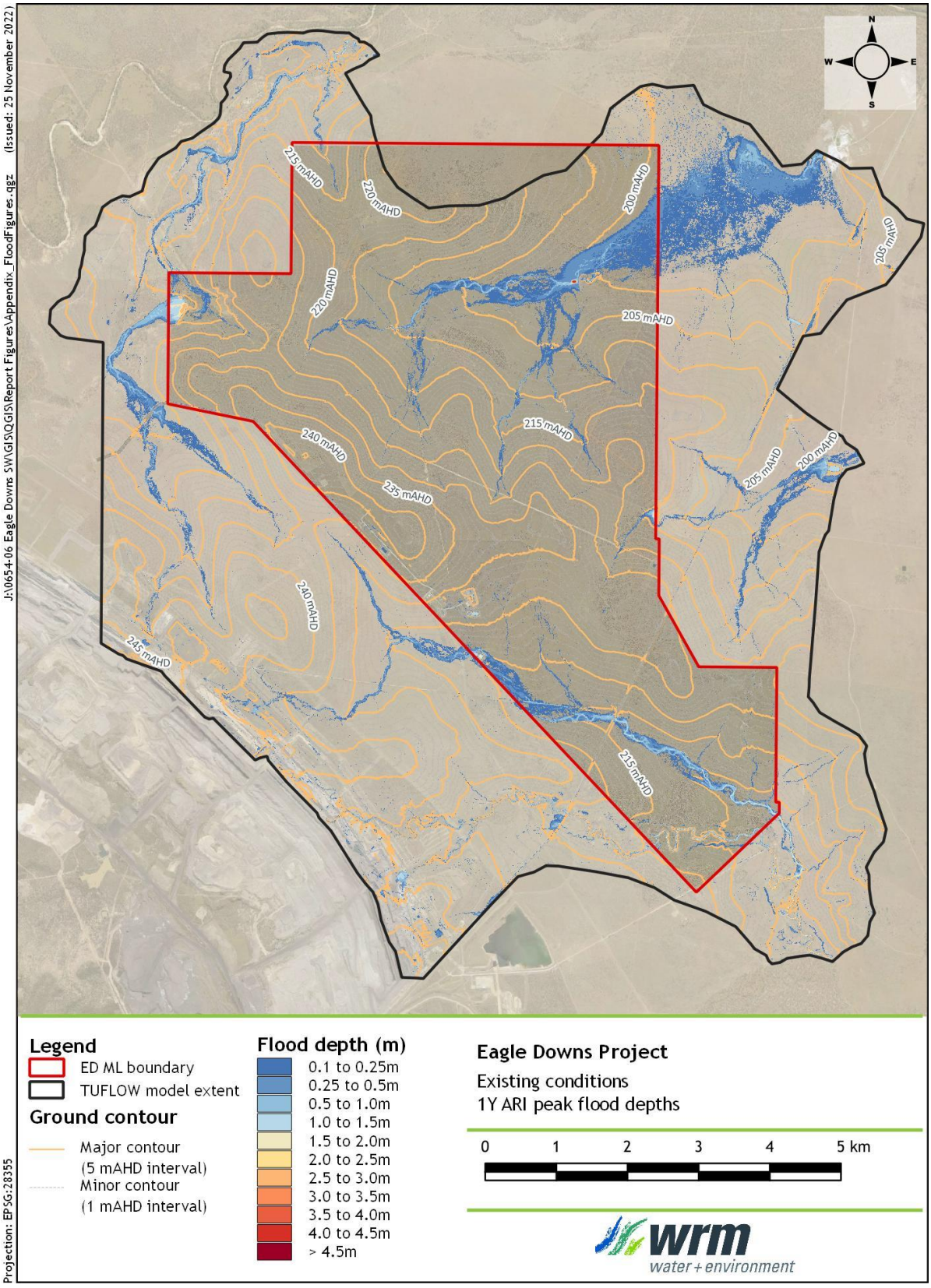


Figure C.1: Existing conditions 63% AEP flood depths

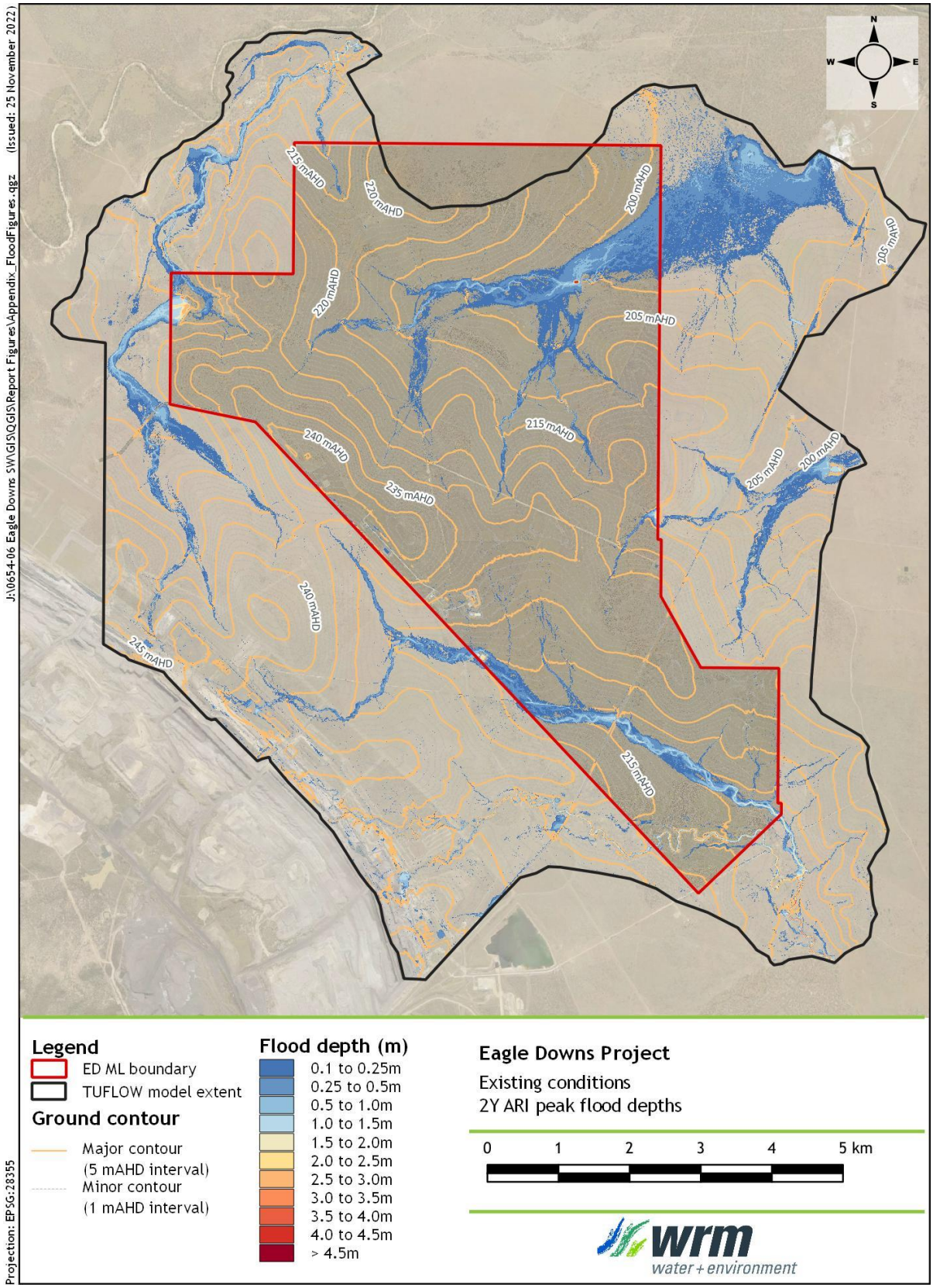


Figure C.2: Existing conditions 50% AEP flood depths

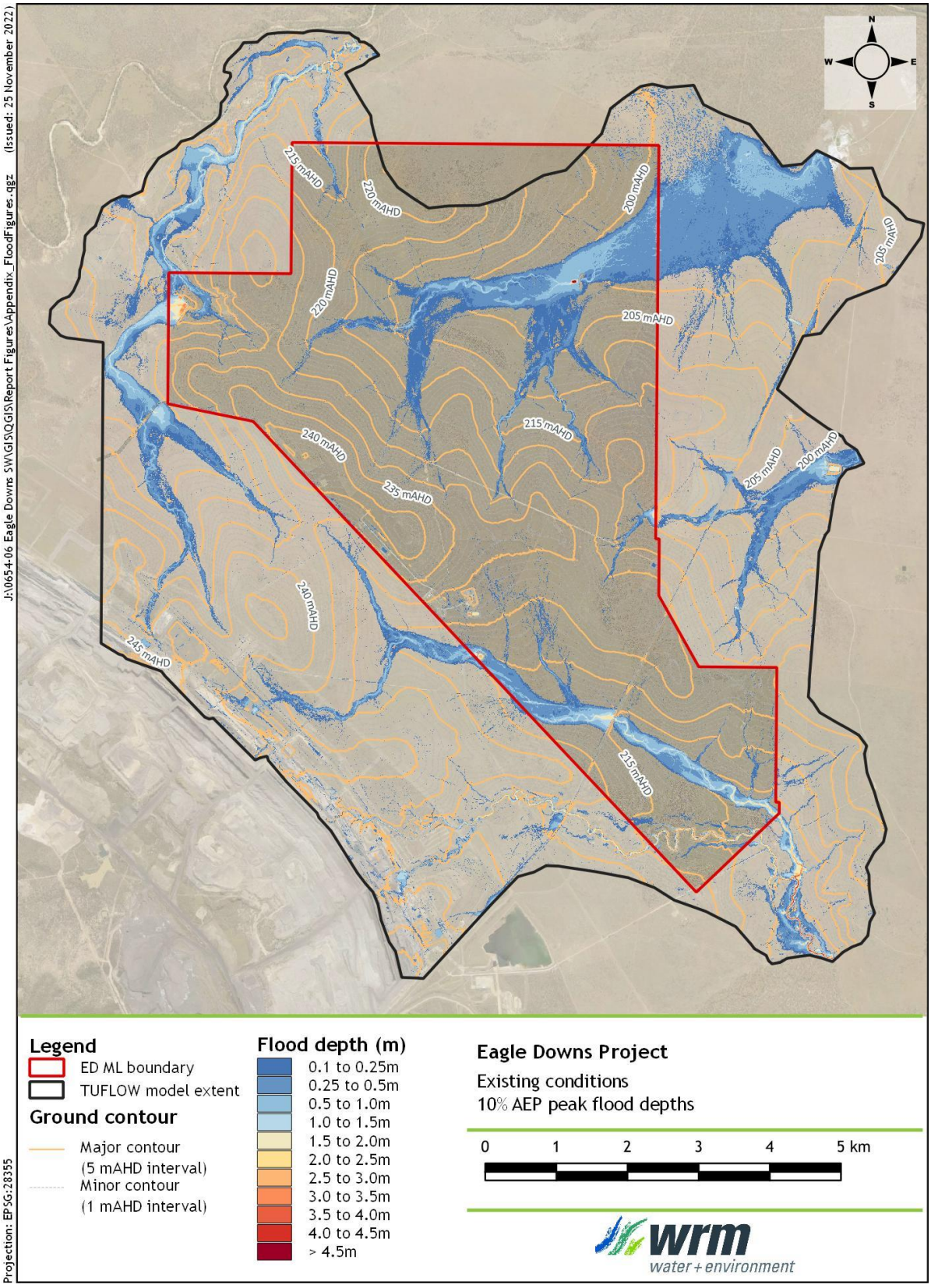


Figure C.3: Existing conditions 10% AEP flood depths

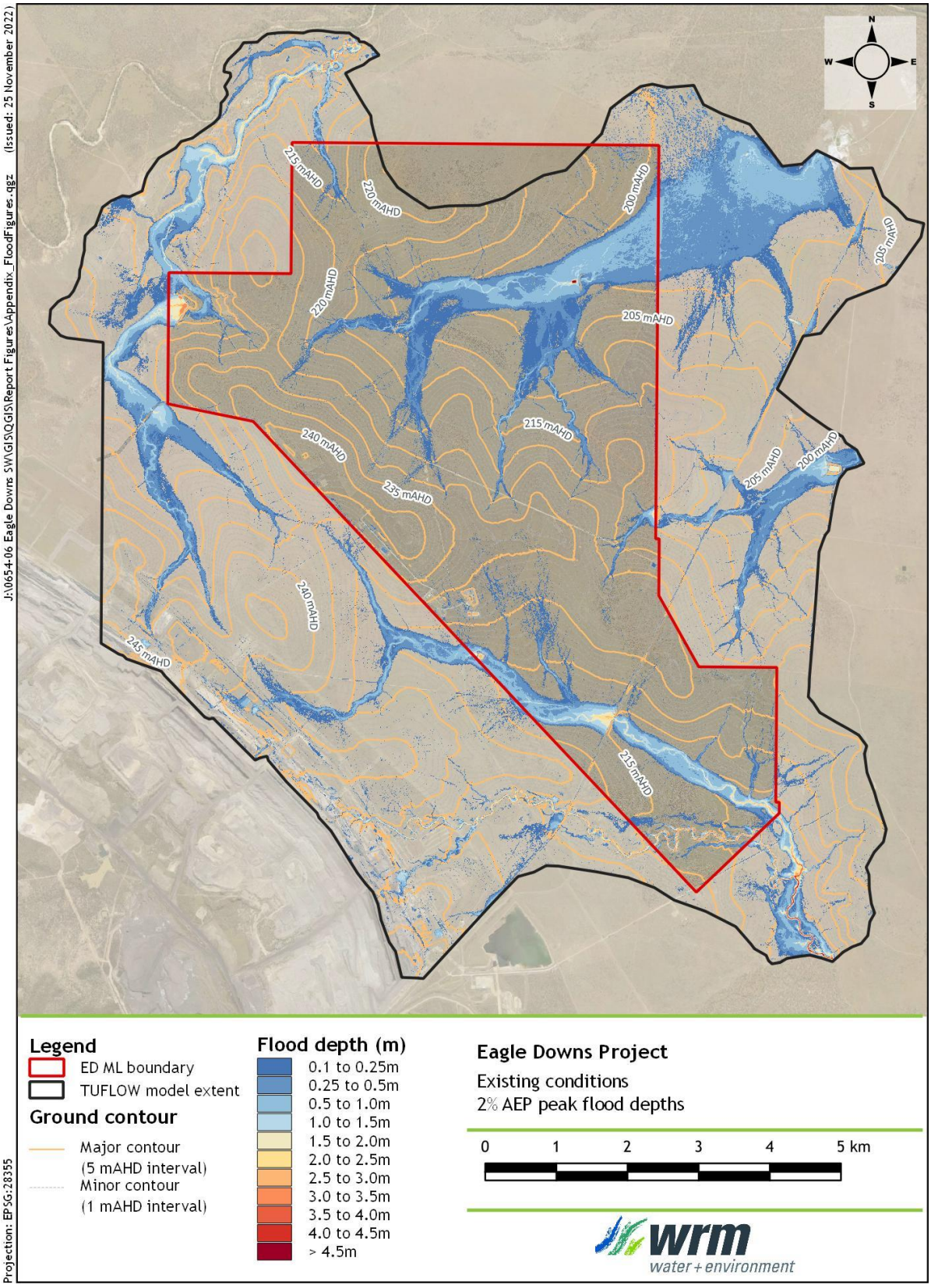


Figure C.4: Existing conditions 2% AEP flood depths

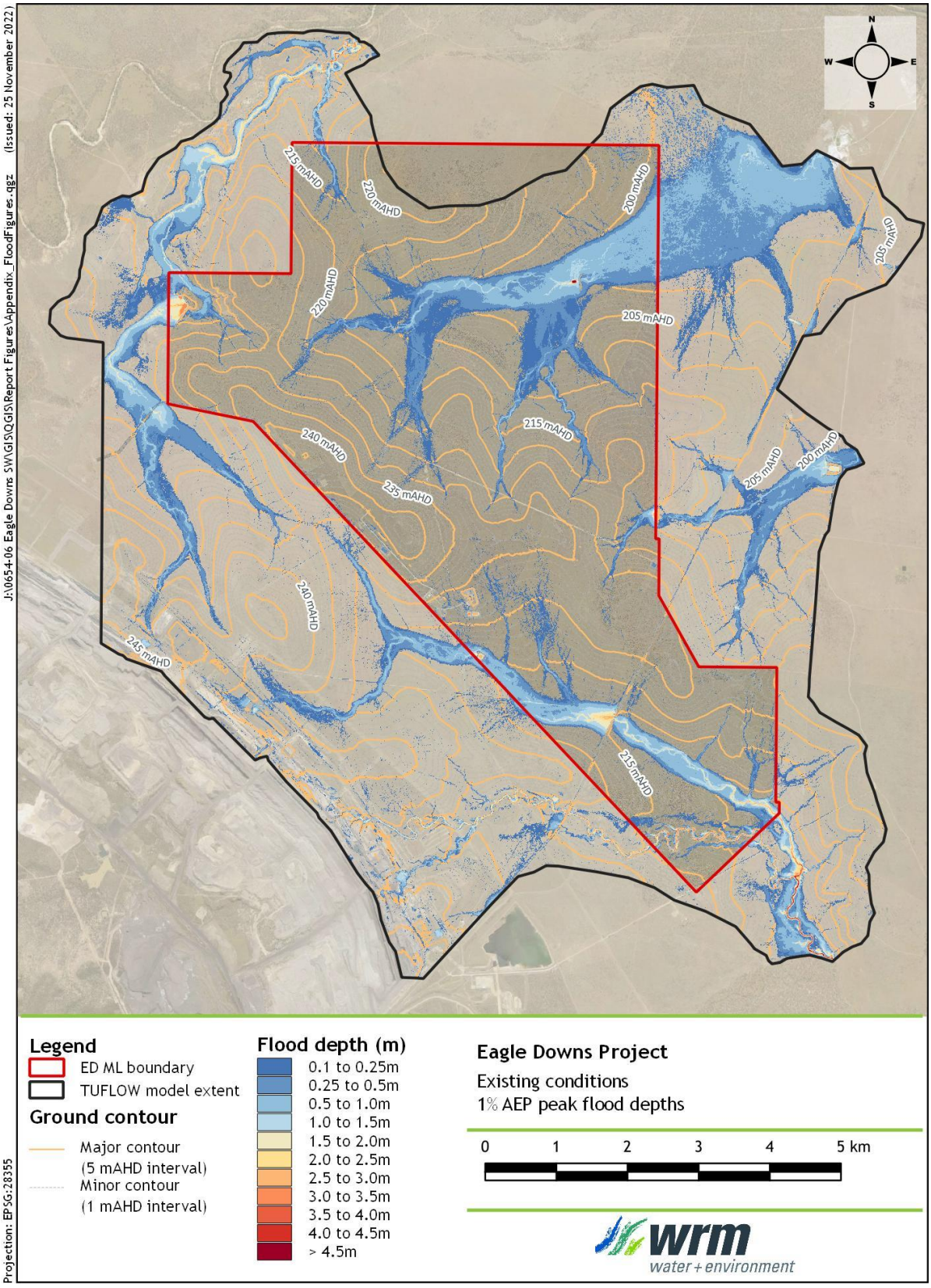


Figure C.5: Existing conditions 1% AEP flood depths

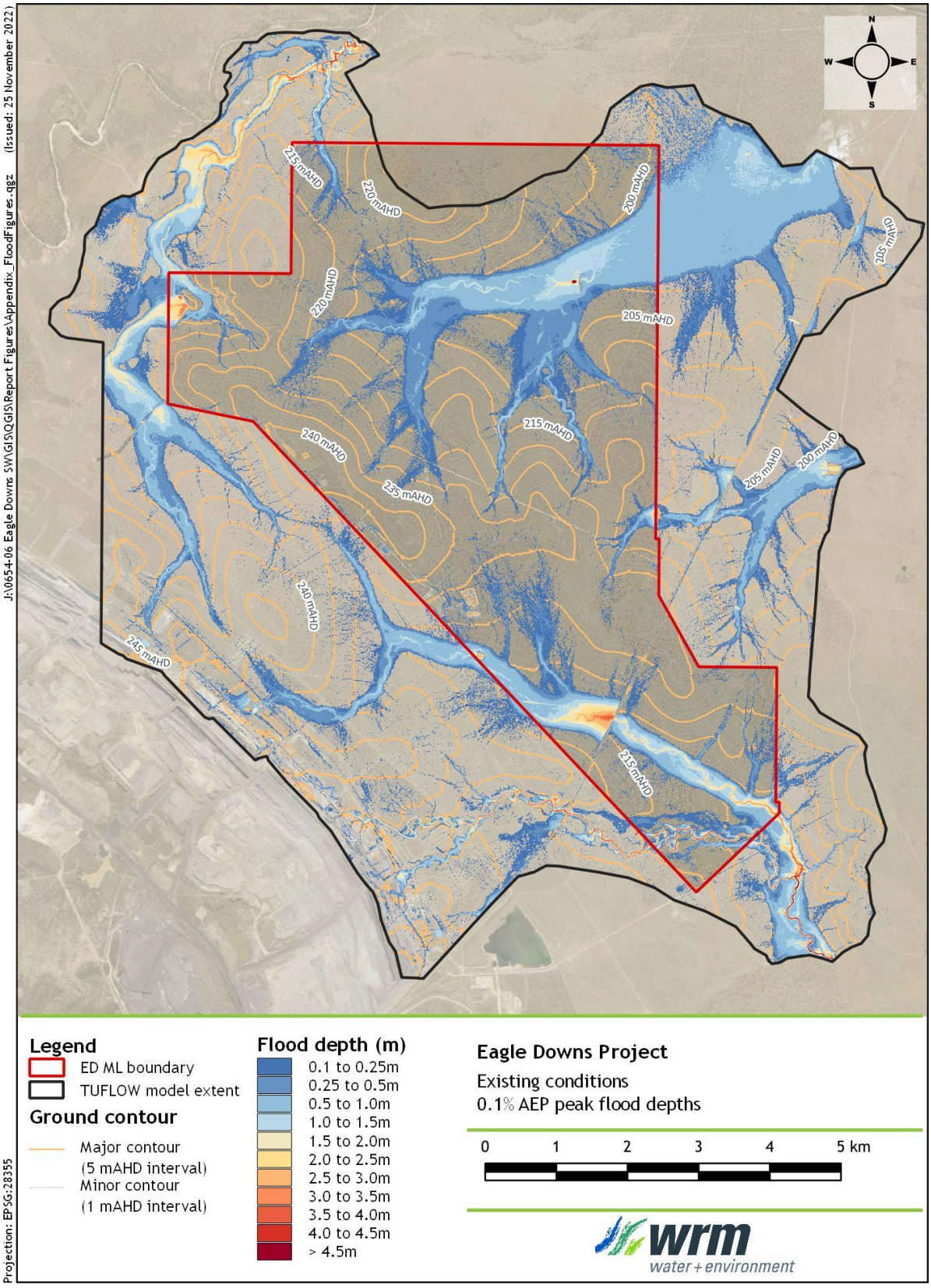


Figure C.6: Existing conditions 0.1% AEP flood depths

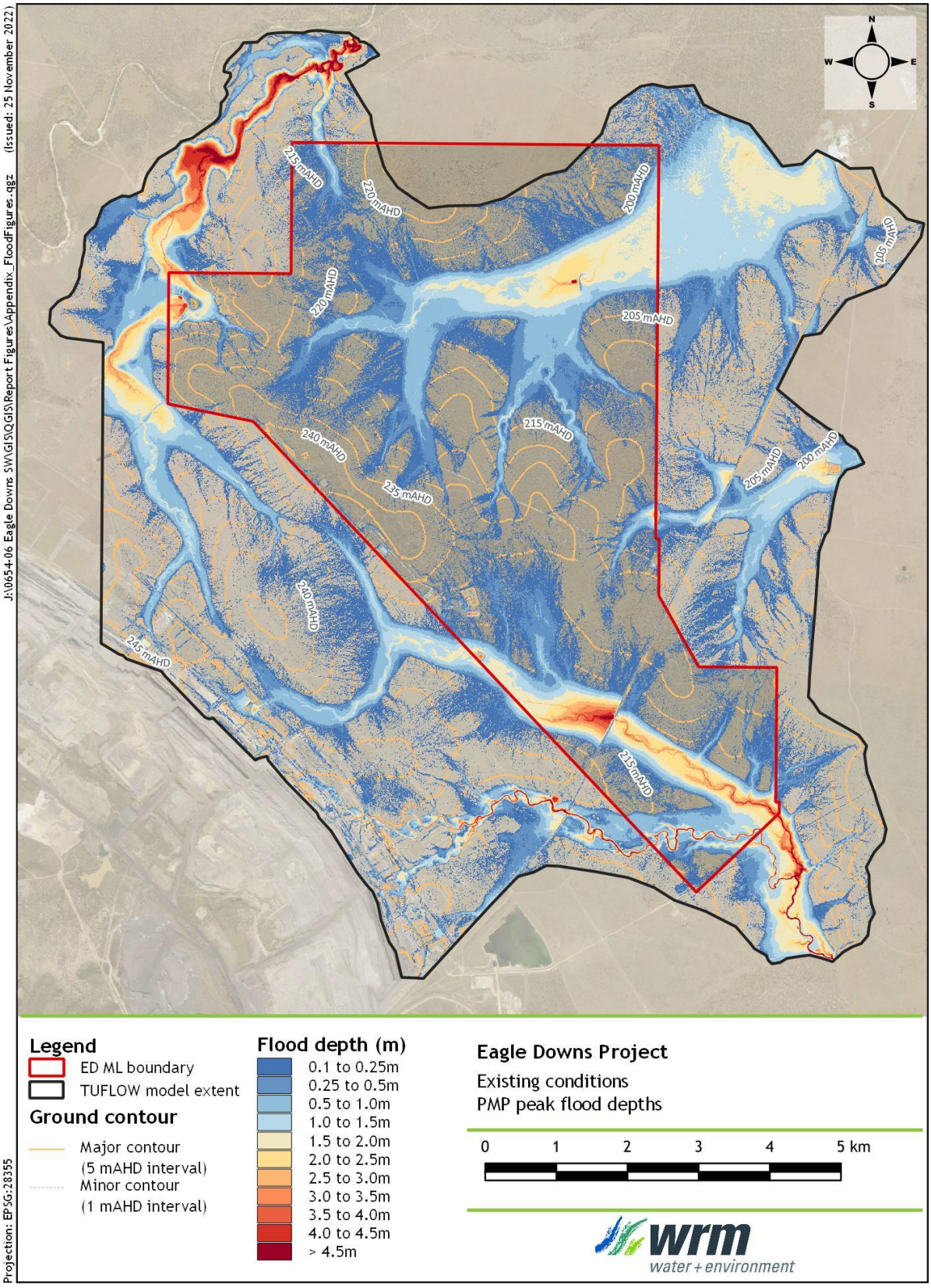


Figure C.7: Existing conditions PMF flood depths

Appendix D - Mine Infrastructure conditions flood maps

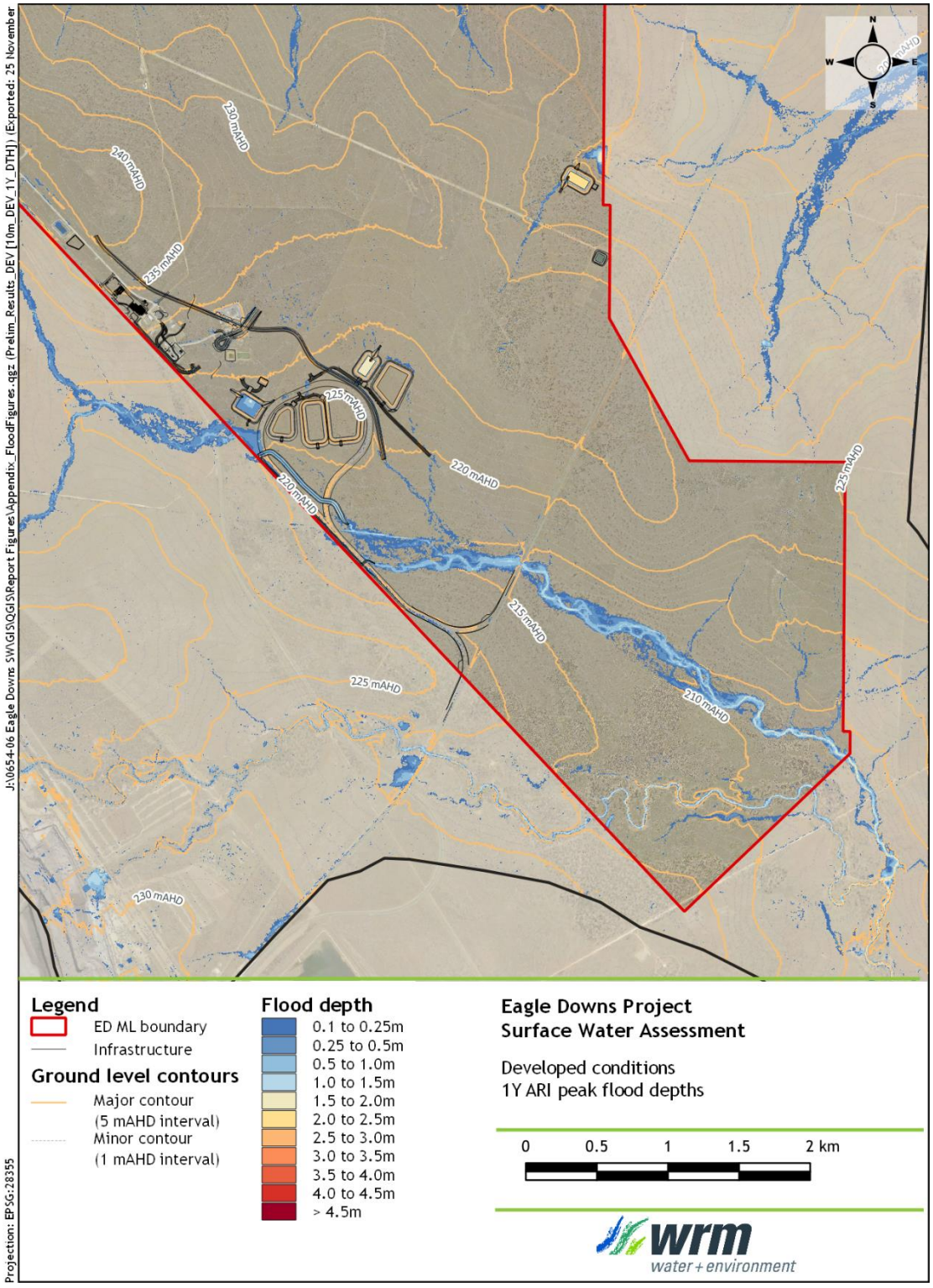


Figure D.1: Mine infrastructure conditions 63% AEP flood depths

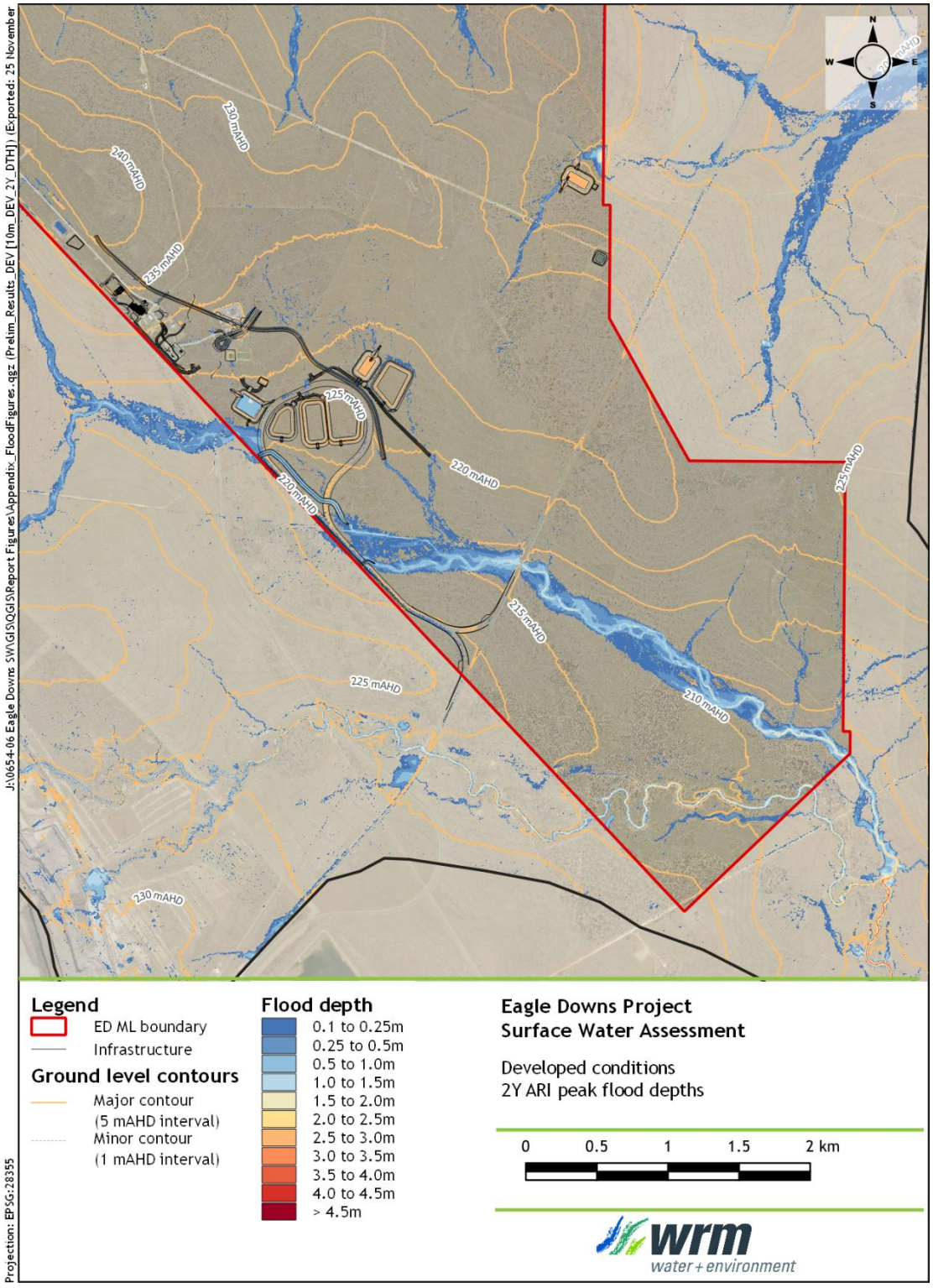


Figure D.2: Mine infrastructure conditions 50% AEP flood depths

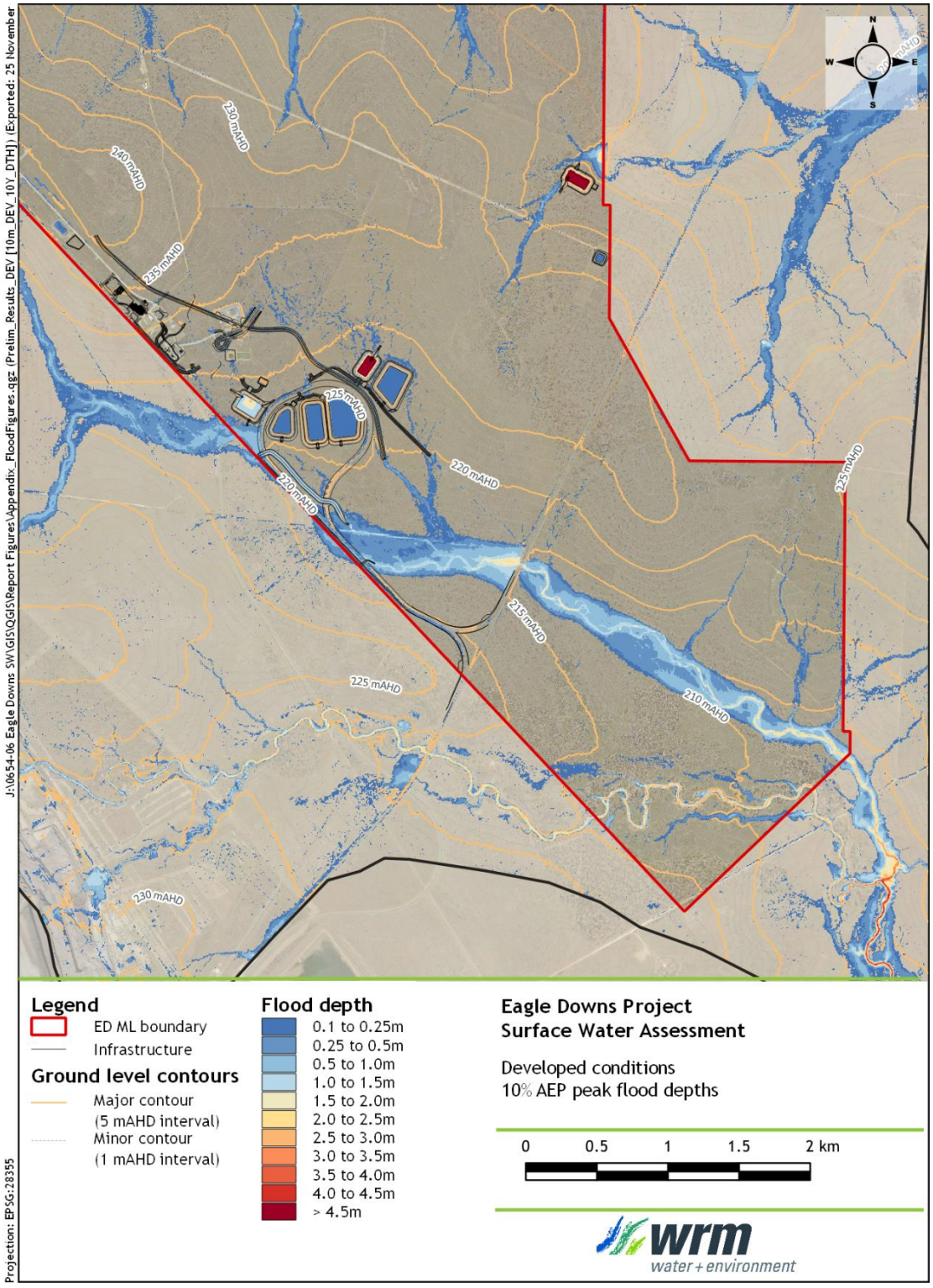


Figure D.3: Mine infrastructure conditions 10% AEP flood depths

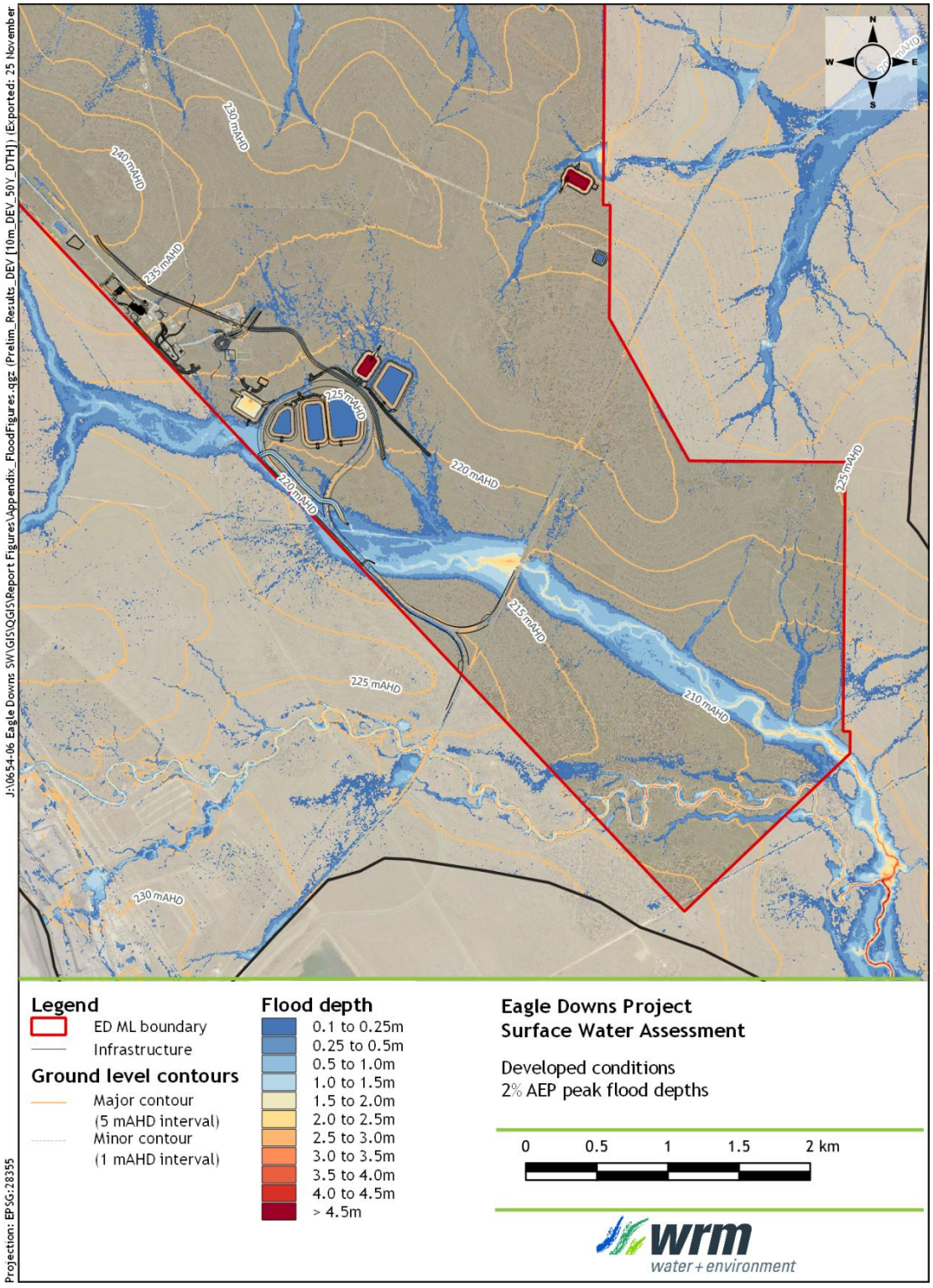


Figure D.4: Mine infrastructure conditions 2% AEP flood depths

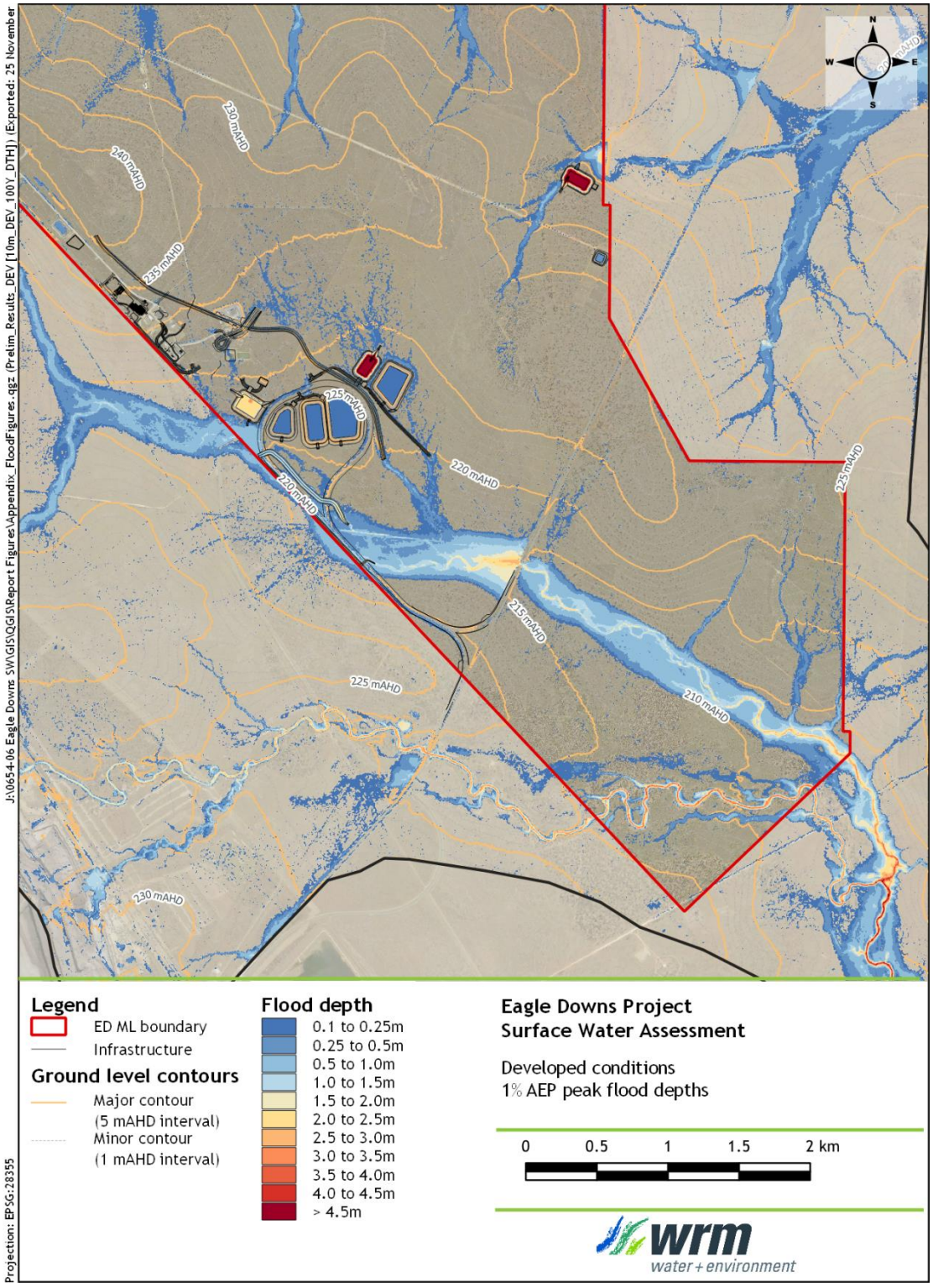


Figure D.5: Mine infrastructure conditions 1% AEP flood depths

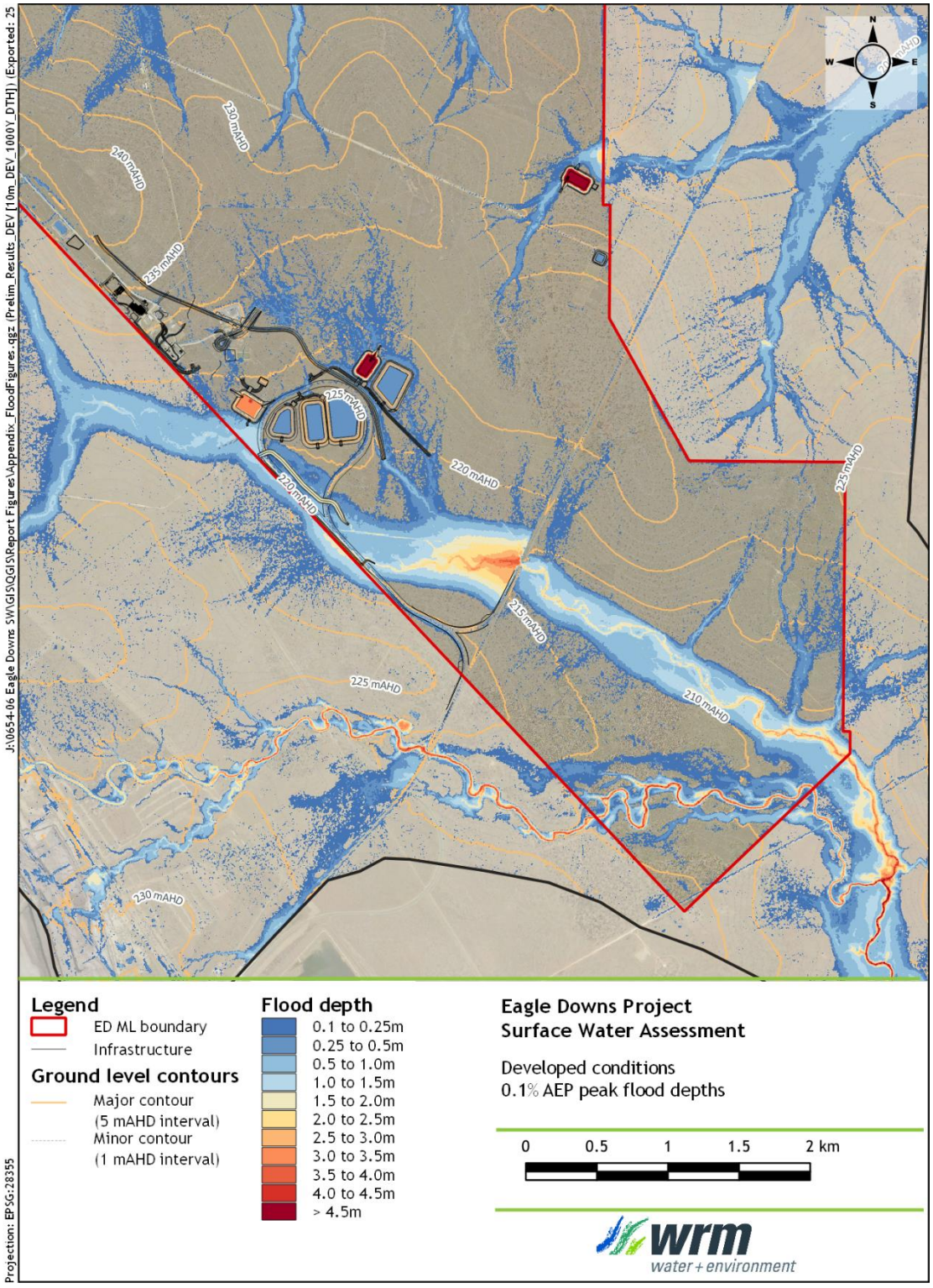


Figure D.6: Mine infrastructure conditions 0.1% AEP flood depths

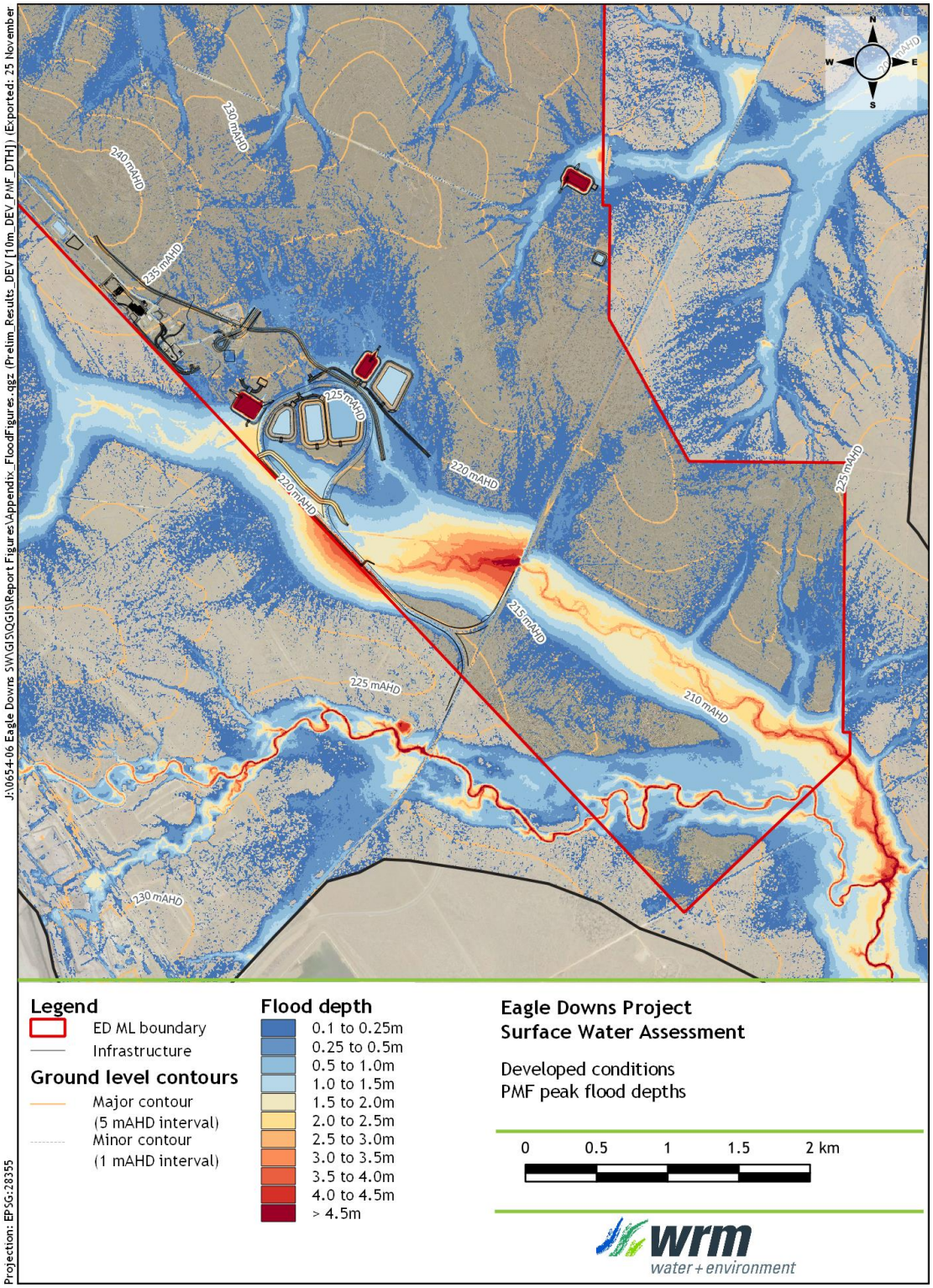


Figure D.7: Mine infrastructure conditions PMF flood depths

Appendix E - Mine infrastructure flood impacts

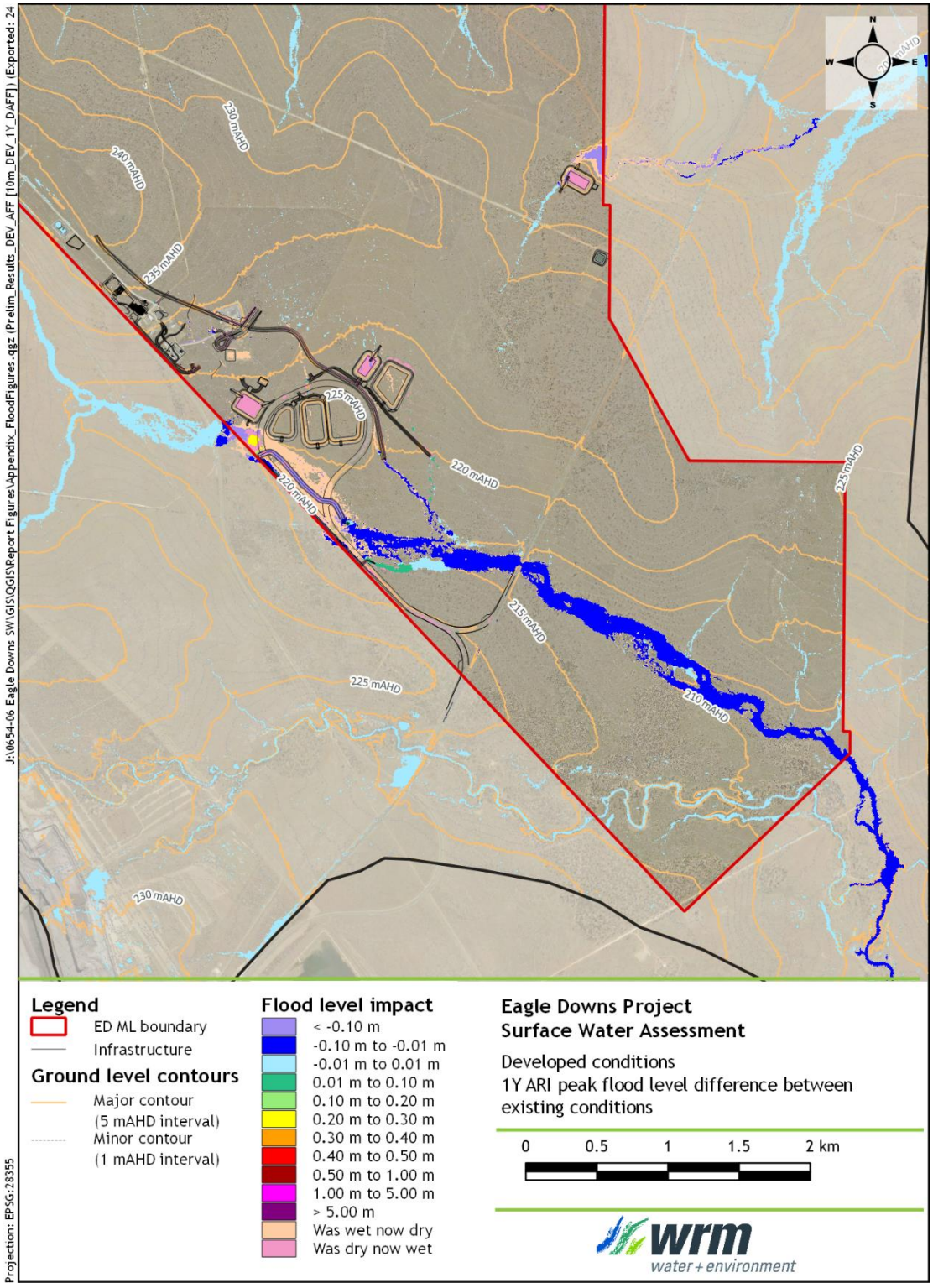


Figure E.1: Impact on 63% AEP depth and flood levels in Feature 3, Mine infrastructure minus Existing conditions

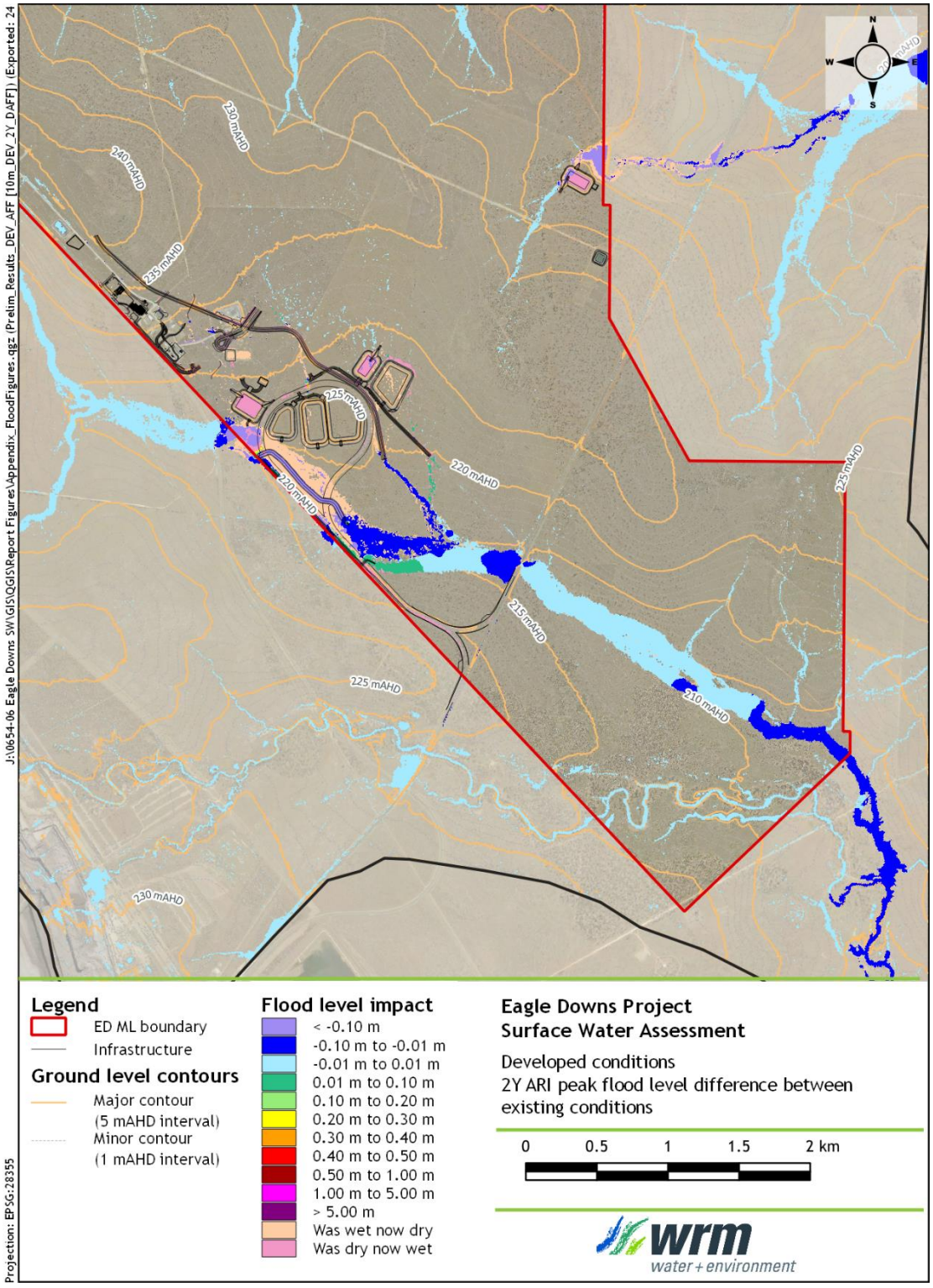


Figure E.2: Impact on 50% AEP depth and flood levels in Feature 3, Mine infrastructure minus Existing conditions

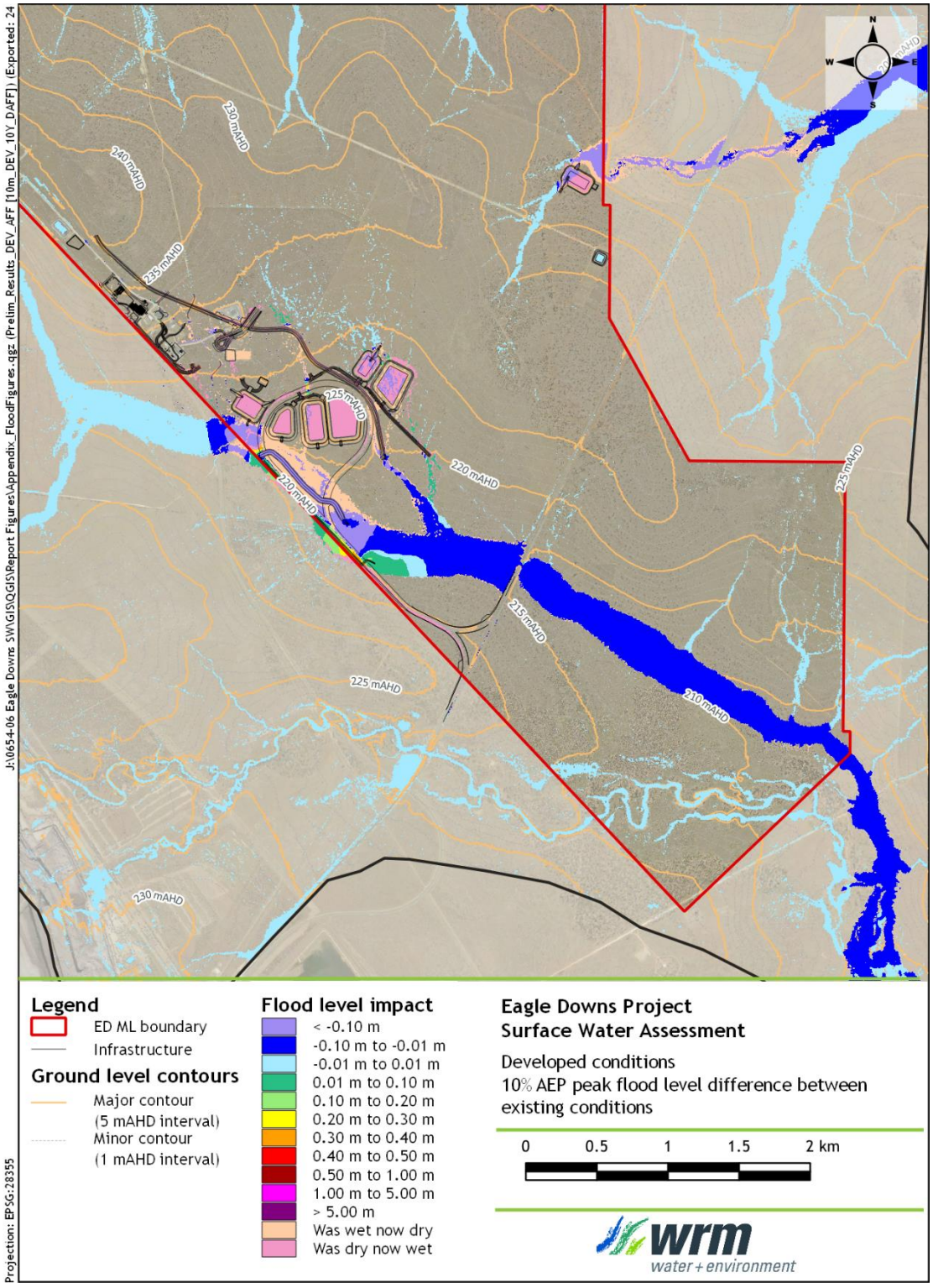


Figure E.3: Impact on 10% AEP depth and flood levels in Feature 3, Mine infrastructure minus Existing conditions

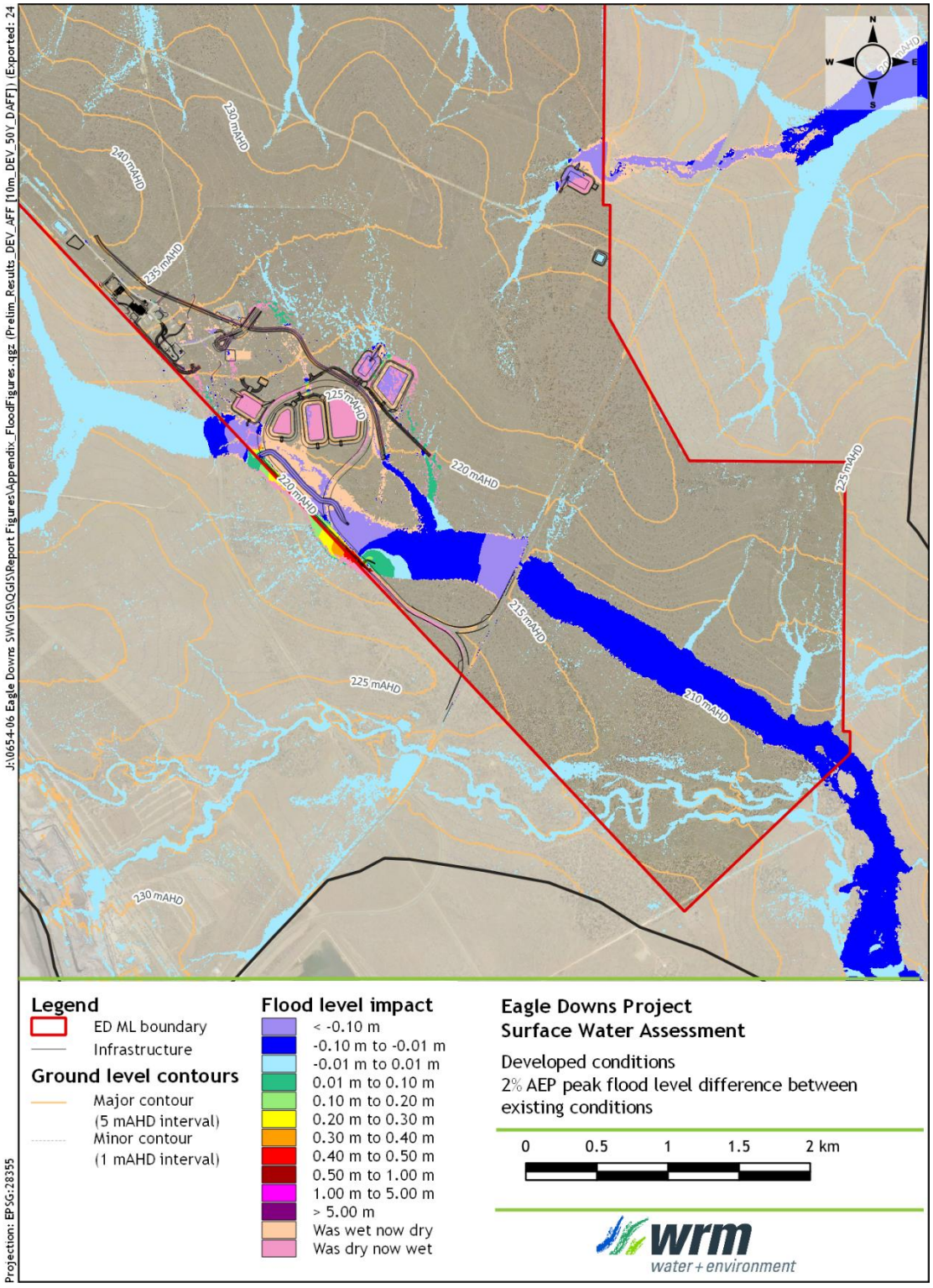


Figure E.4: Impact on 2% AEP depth and flood levels in Feature 3, Mine infrastructure minus Existing conditions

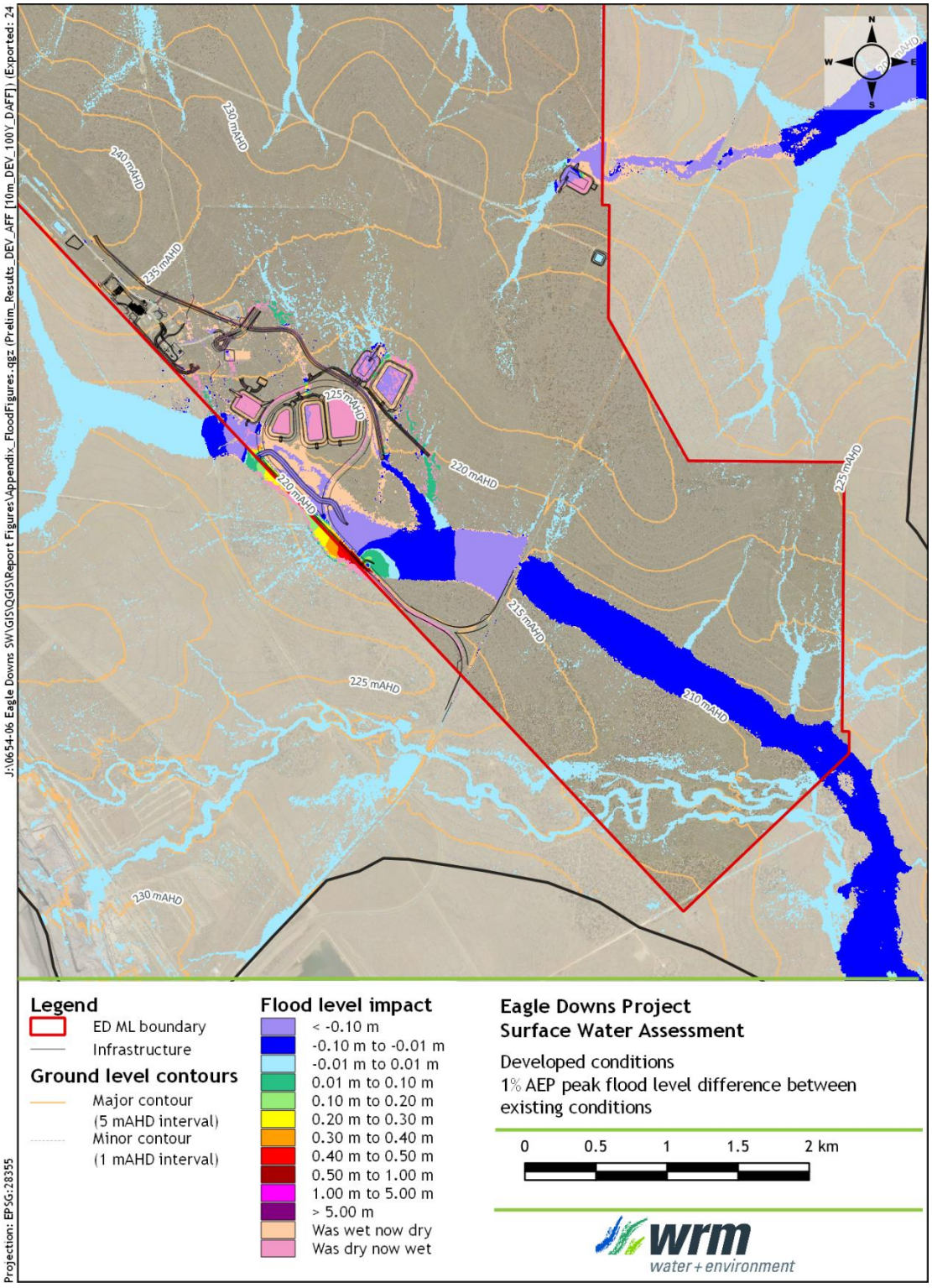


Figure E.5: Impact on 1% AEP depth and flood levels in Feature 3, Mine infrastructure minus Existing conditions

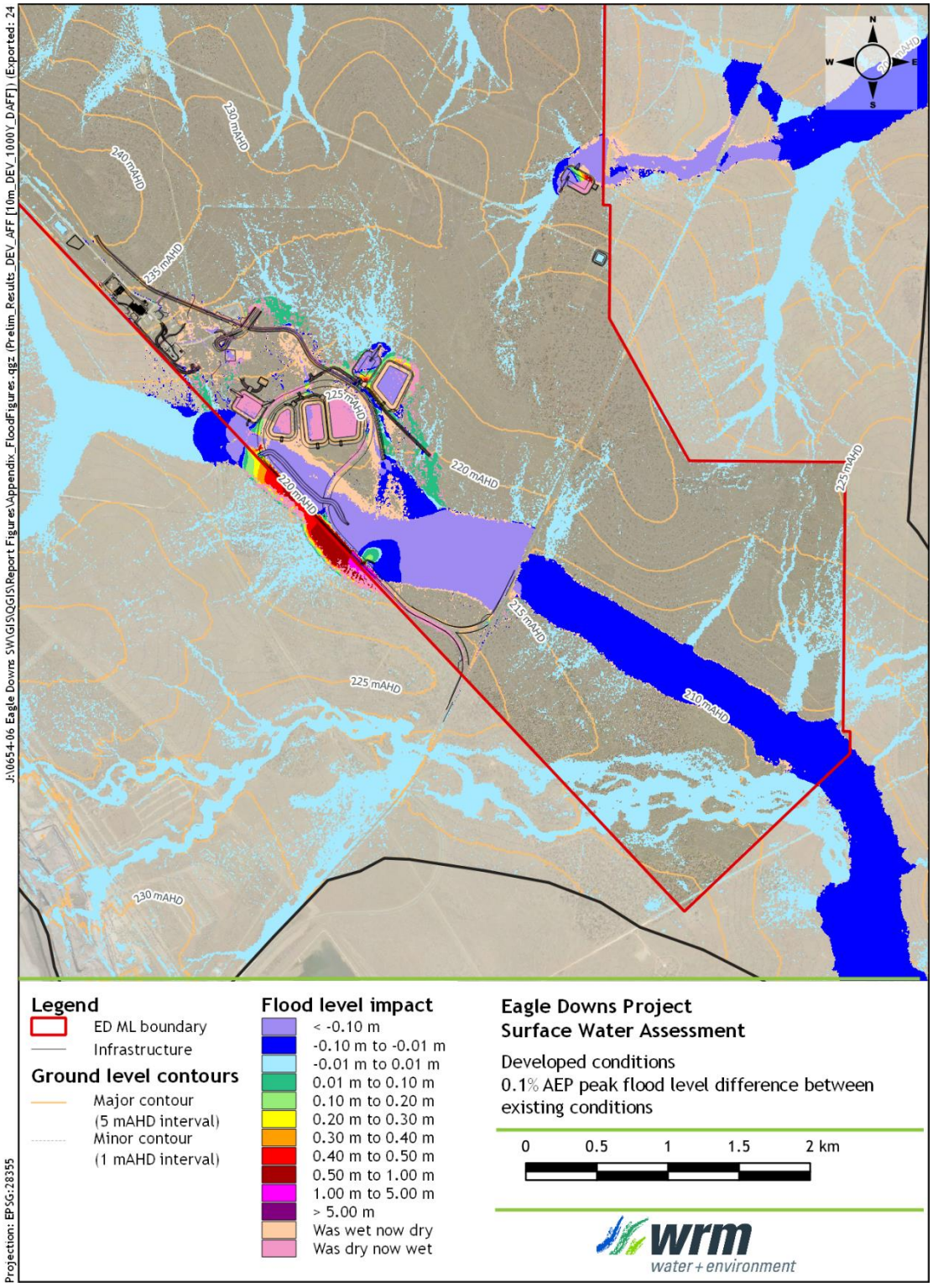


Figure E.6: Impact on 0.1% AEP depth and flood levels in Feature 3, Mine infrastructure minus Existing conditions

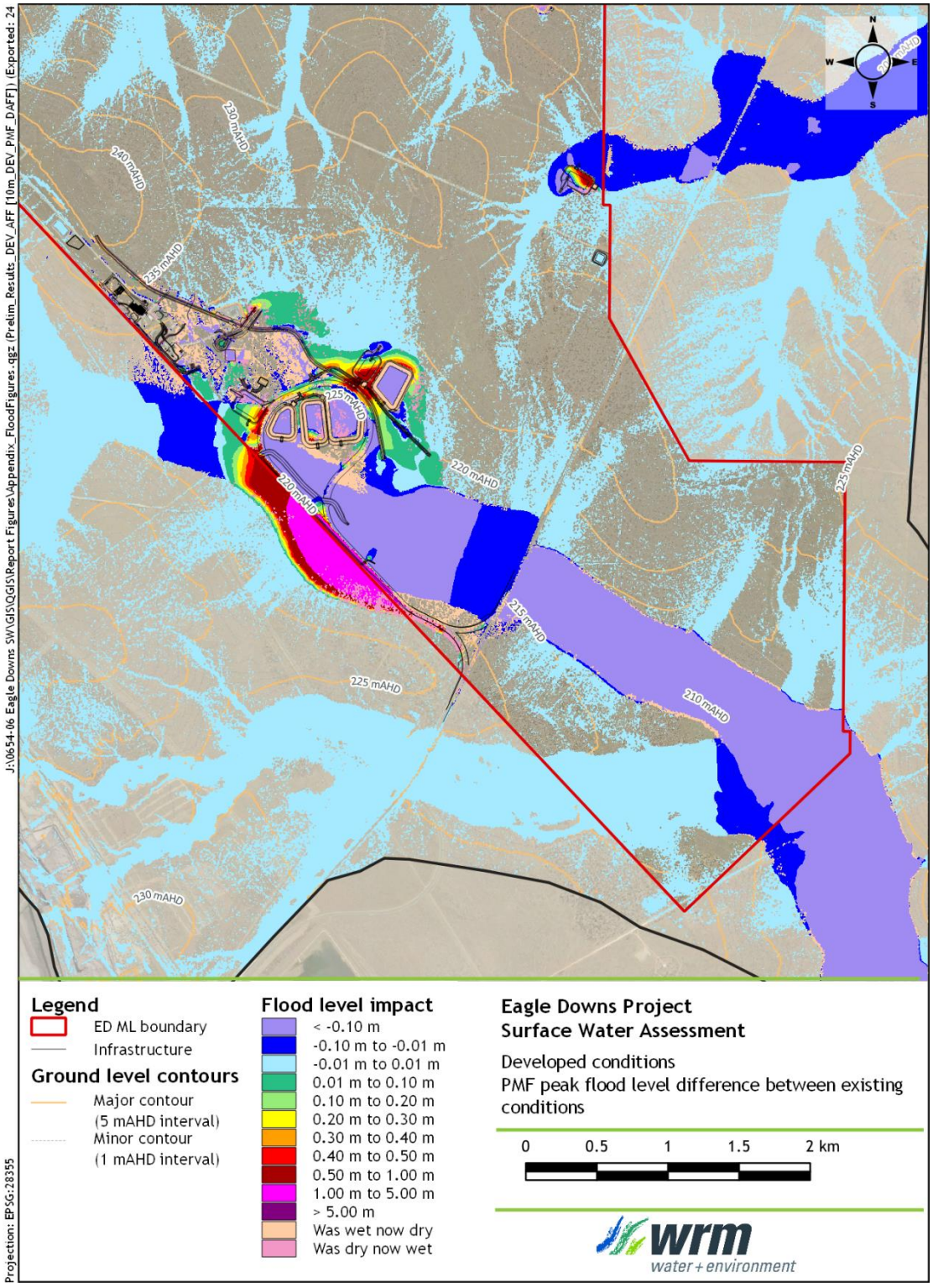


Figure E.7: Impact on PMF depth and flood levels in Feature 3, Mine infrastructure minus Existing conditions

Appendix F - Subsided conditions flood maps

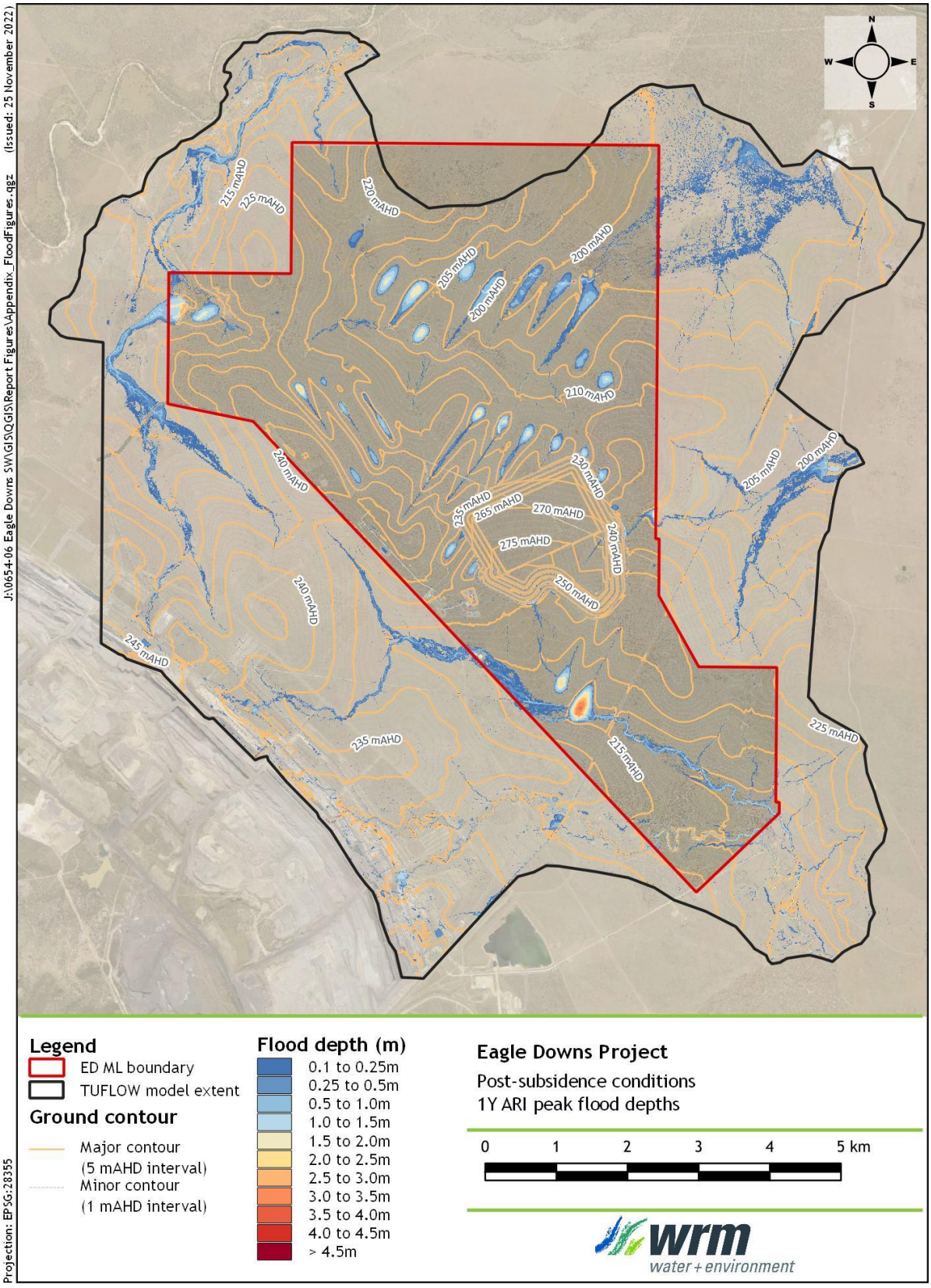


Figure F.1: Subsided conditions 63% AEP flood depths

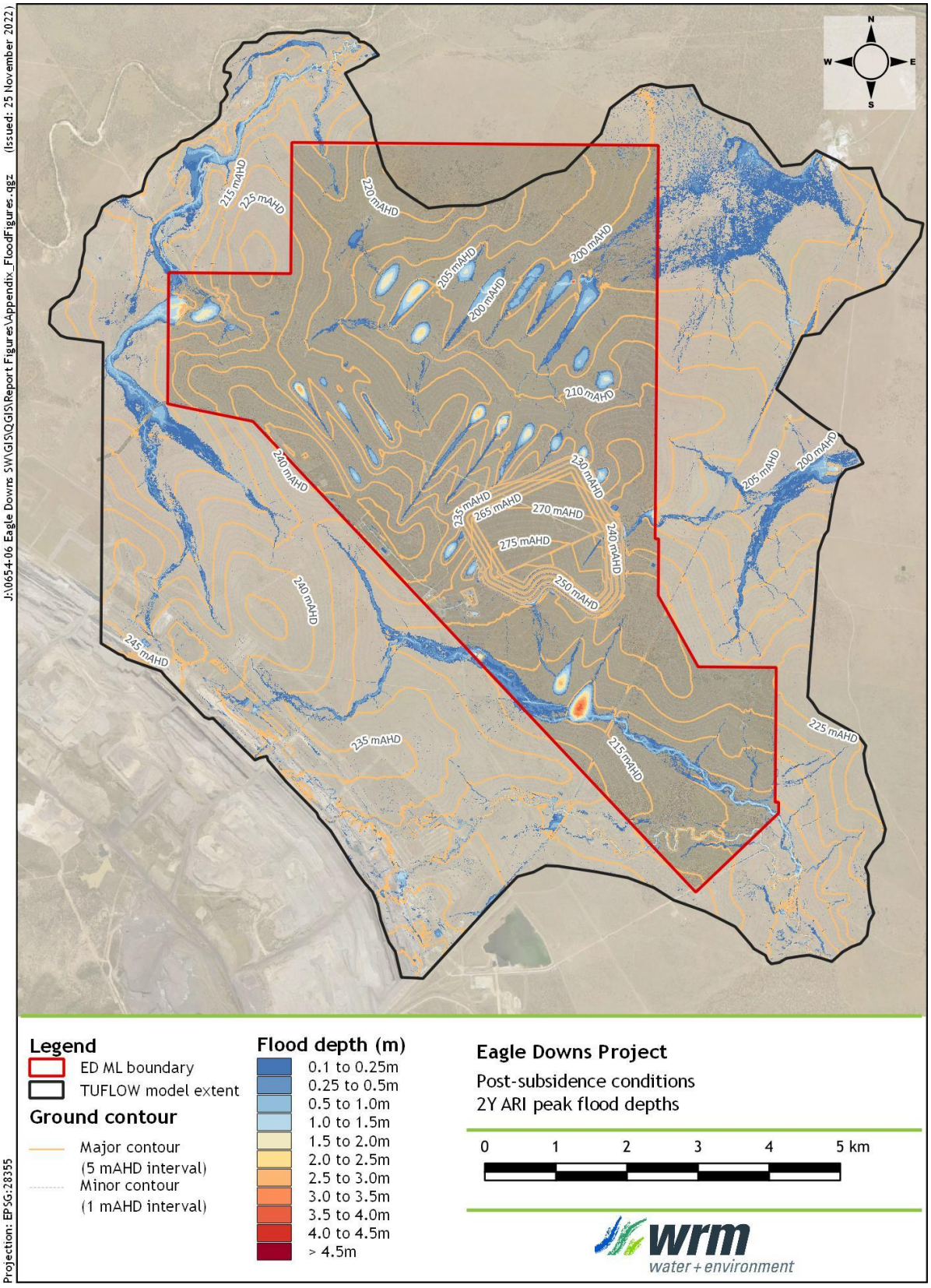


Figure F.2: Subsided conditions 50% AEP flood depths

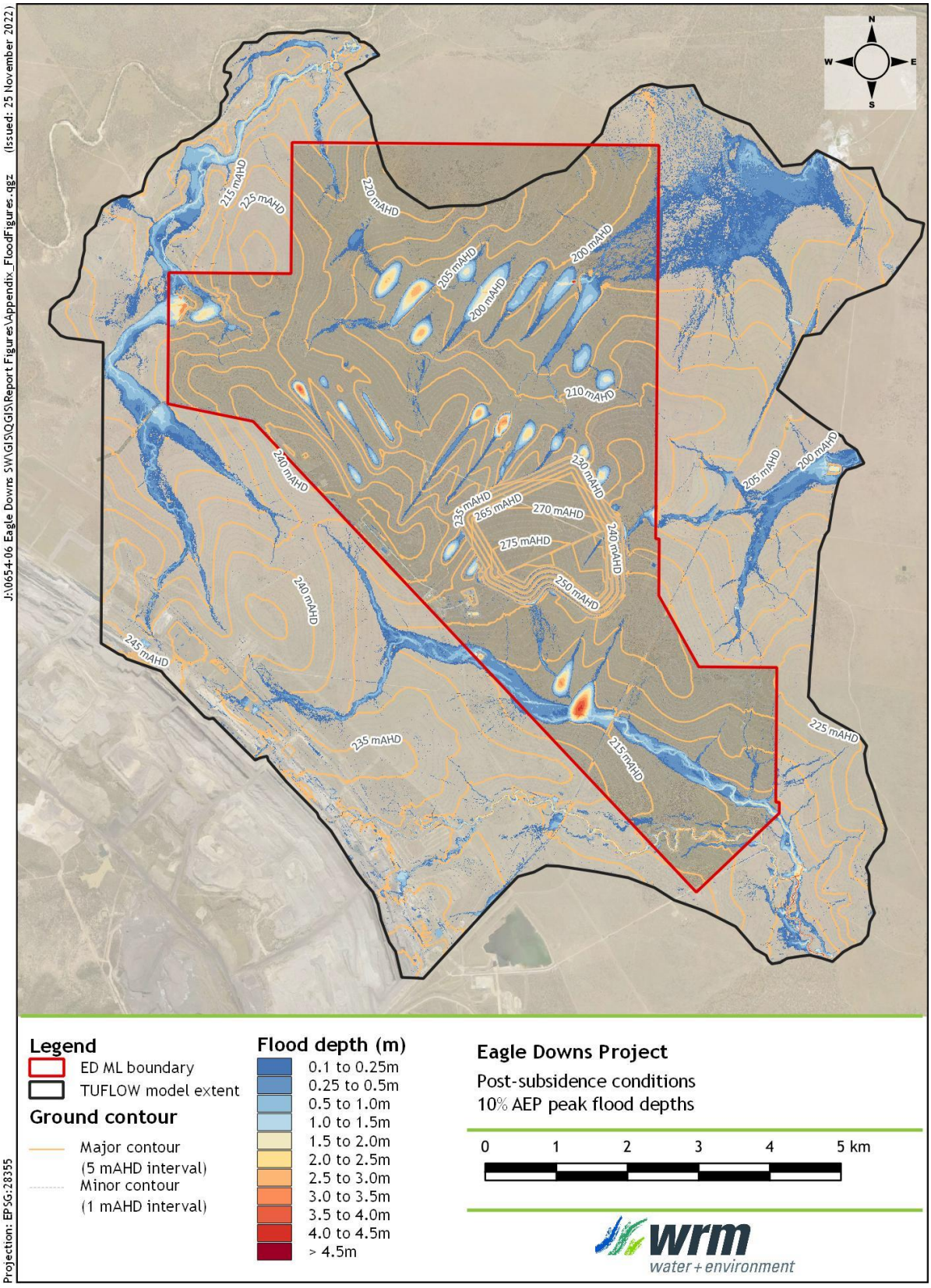


Figure F.3: Subsided conditions 10% AEP flood depths

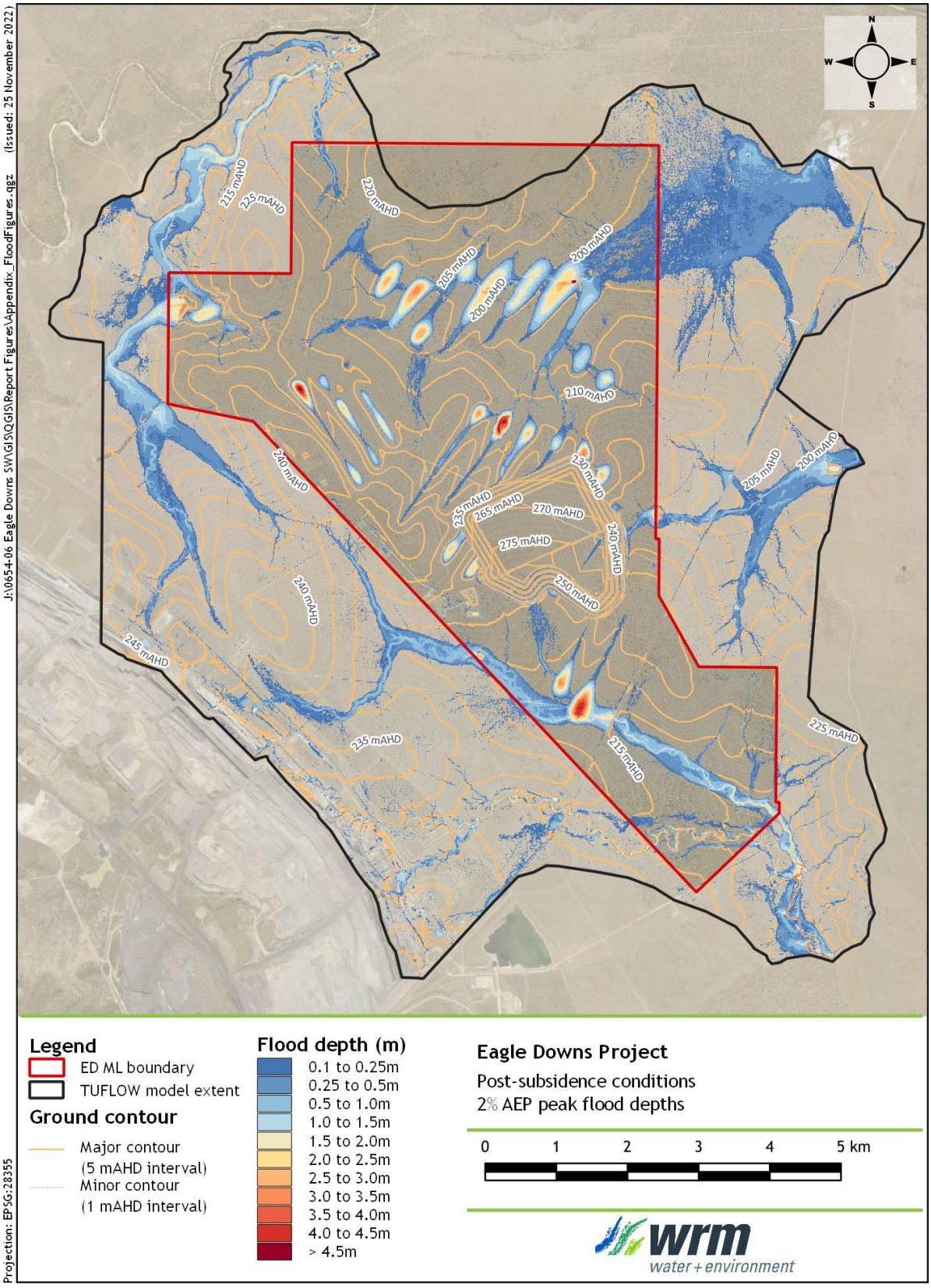


Figure F.4: Subsided conditions 2% AEP flood depths

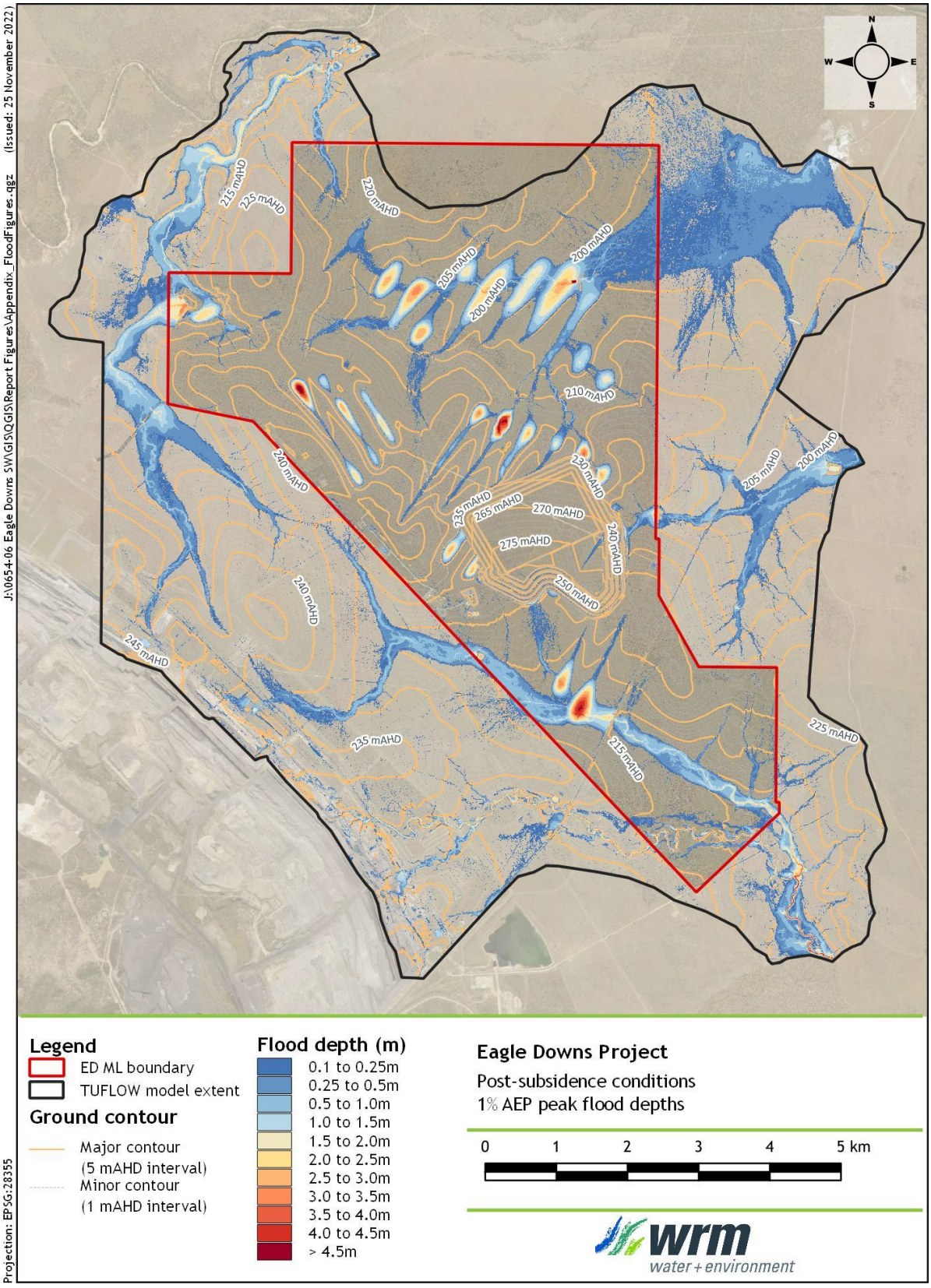


Figure F.5: Subsided conditions 1% AEP flood depths

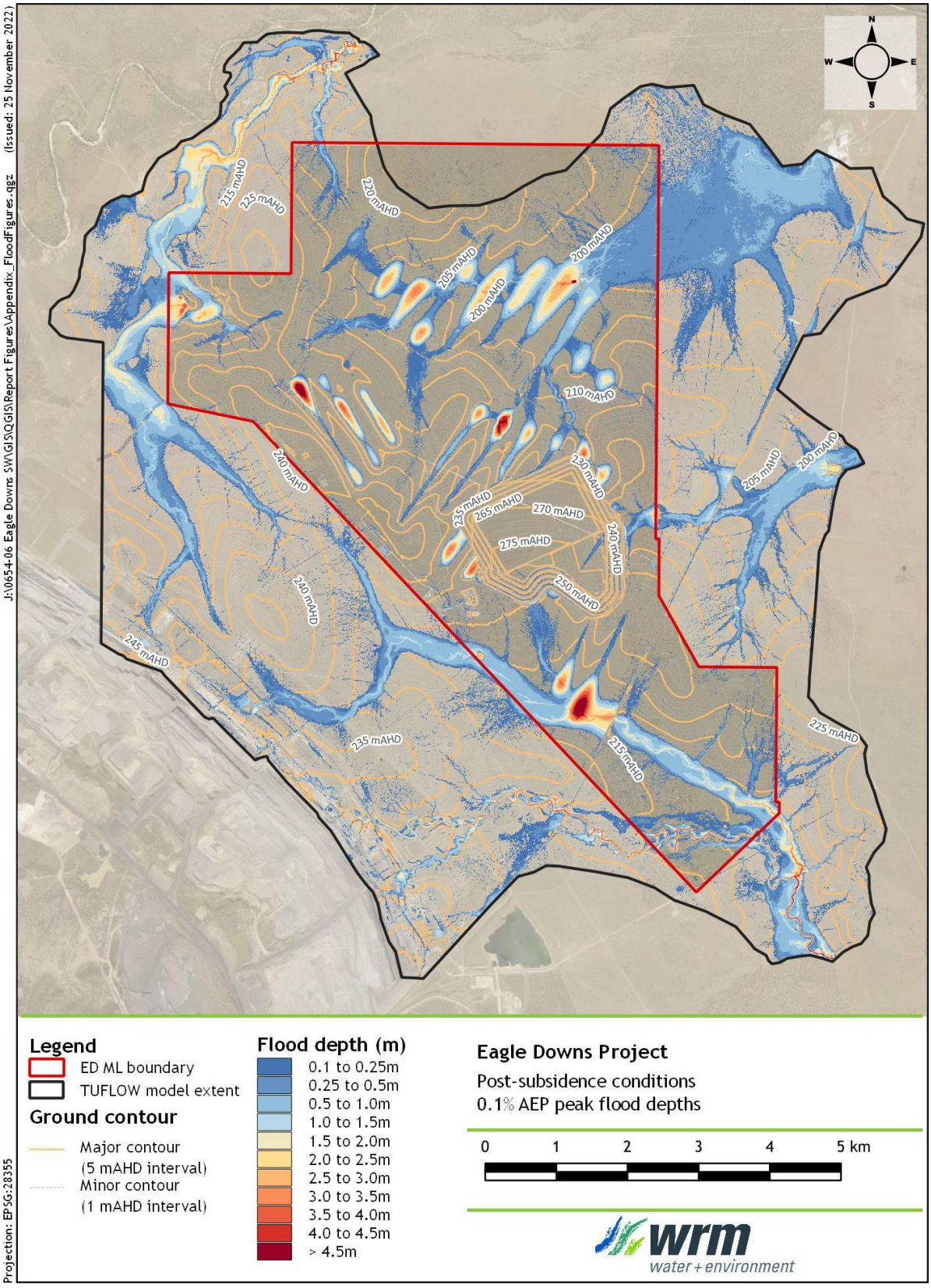


Figure F.6: Subsided conditions 0.1% AEP flood depths

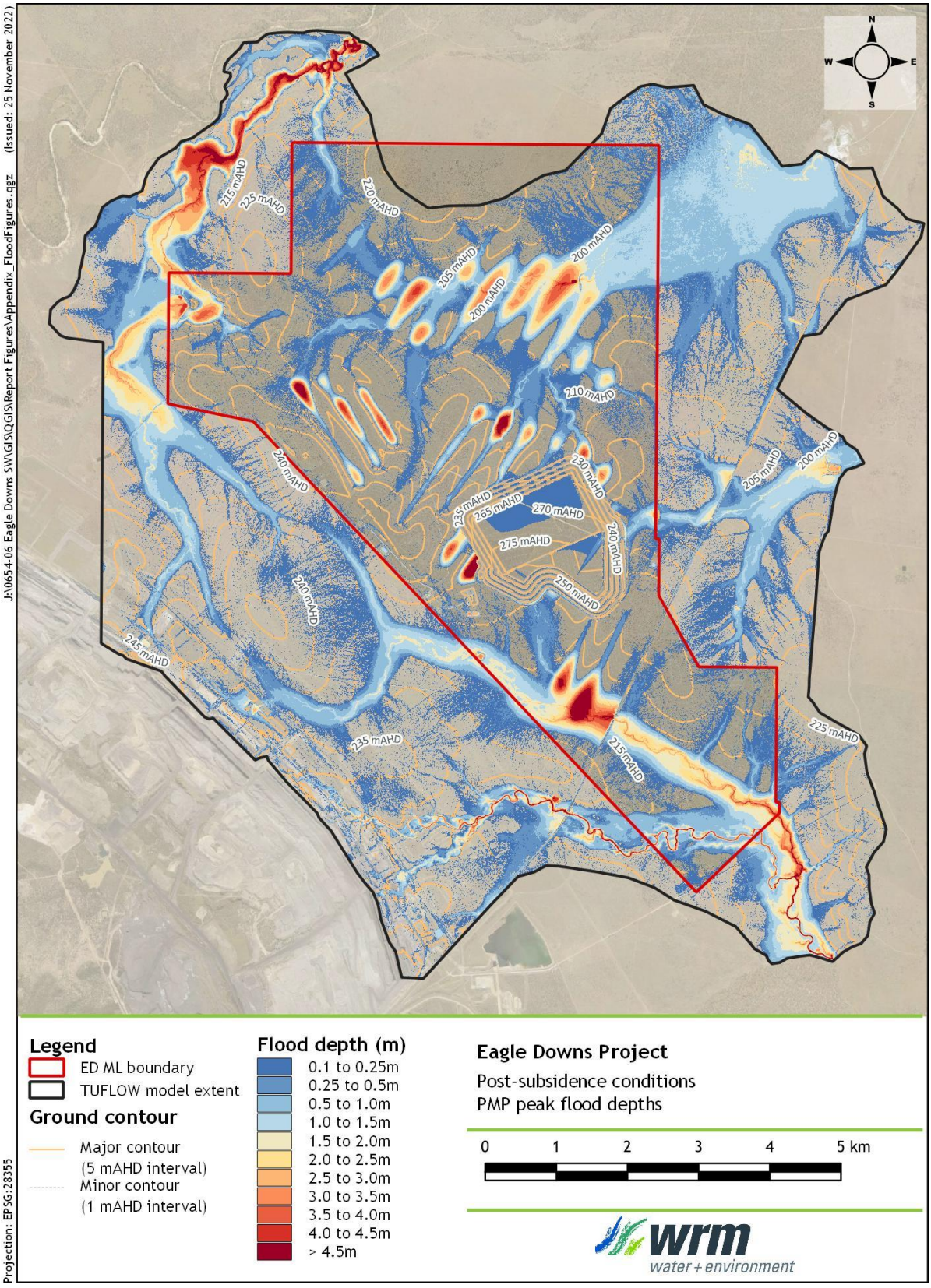


Figure F.7: Subsided conditions PMF flood depths

Appendix G - Subsided conditions flood impacts

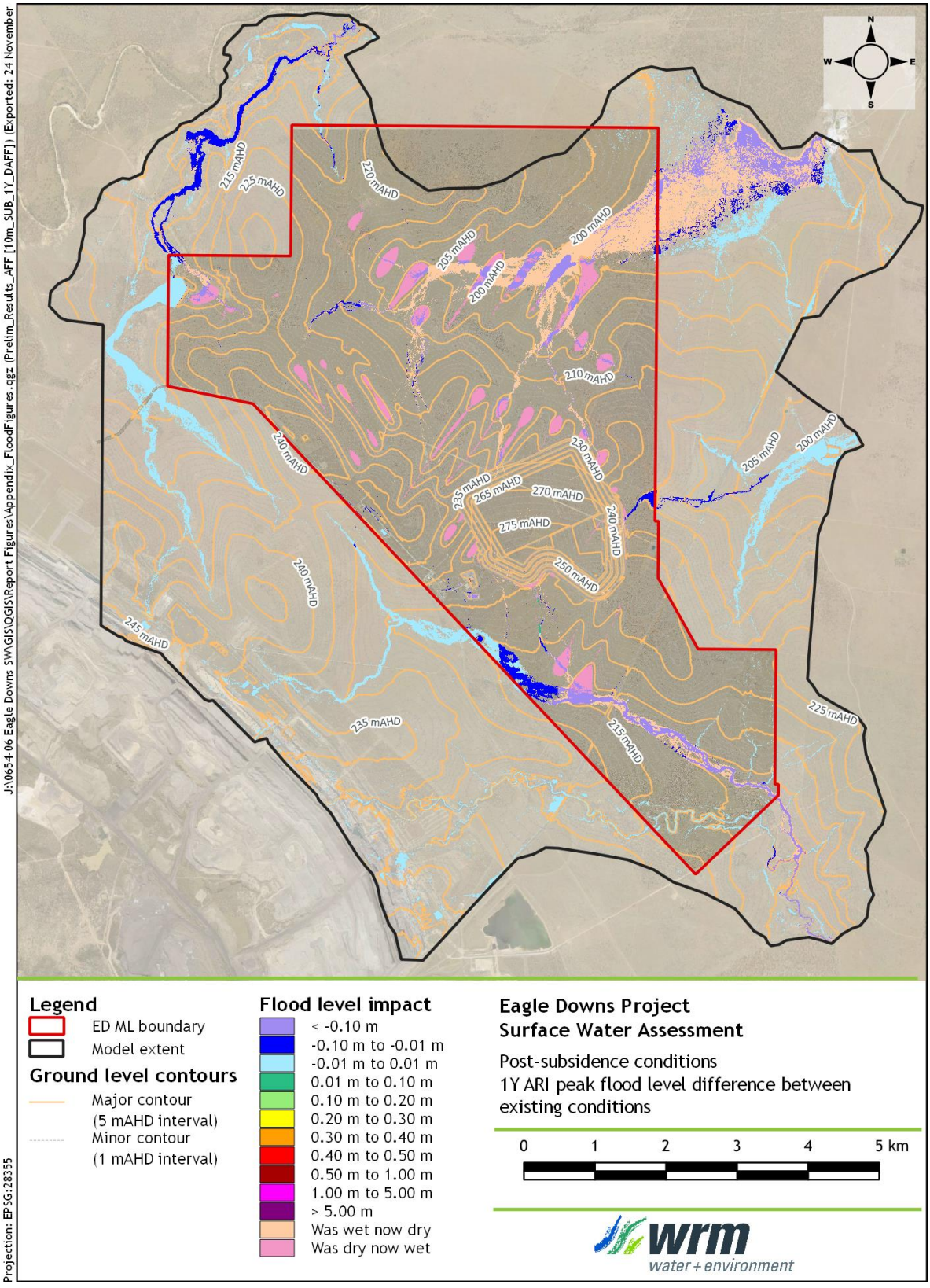


Figure G.1: Impact on 63% AEP flood levels, Subsided (HCU, HCL & DY) minus Existing conditions

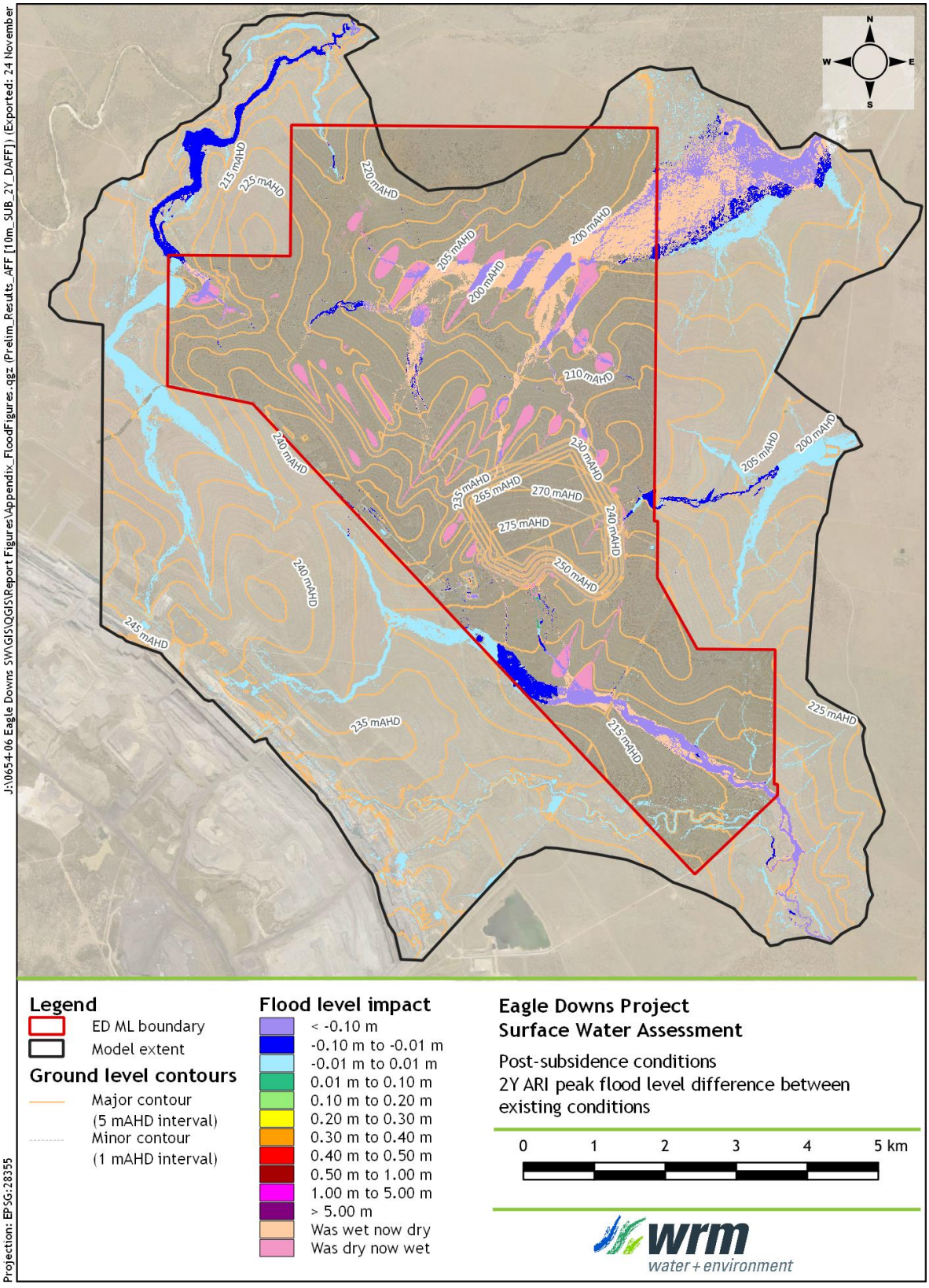


Figure G.2: Impact on 50% AEP flood levels, Subsided (HCU, HCL & DY) minus Existing conditions

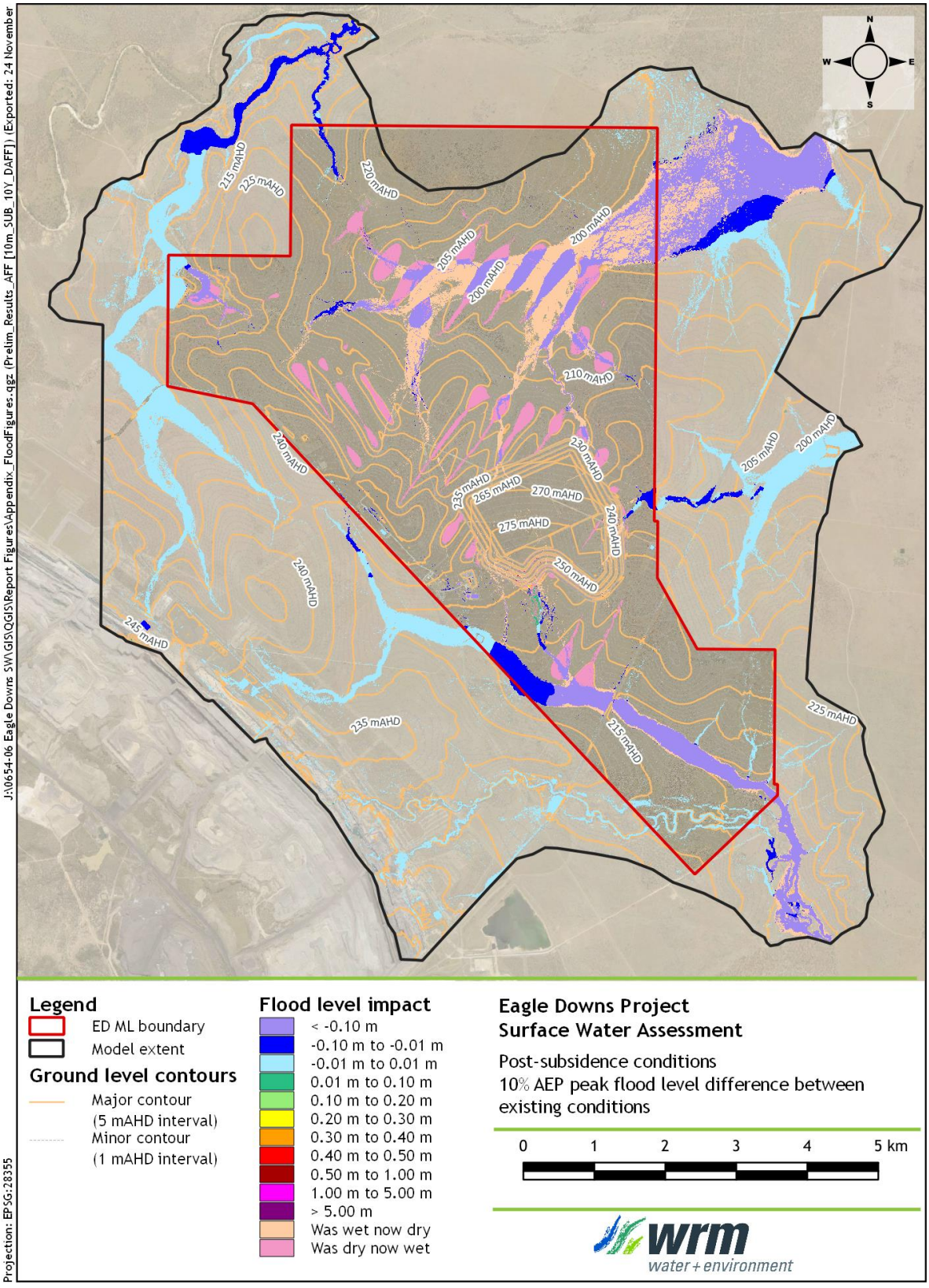


Figure G.3: Impact on 10% AEP flood levels, Subsided (HCU, HCL & DY) minus Existing conditions

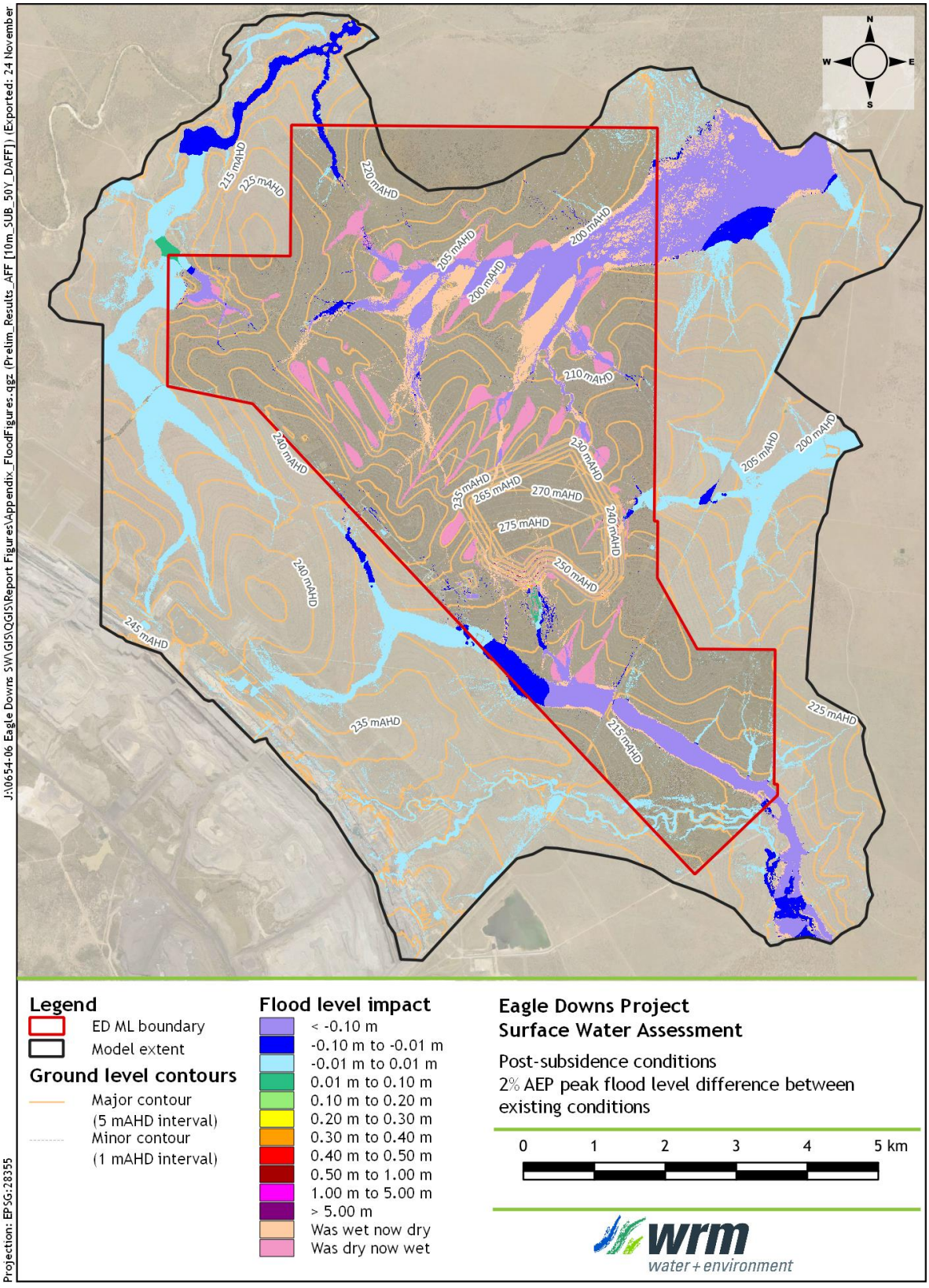


Figure G.4: Impact on 2% AEP flood levels, Subsided (HCU, HCL & DY) minus Existing conditions

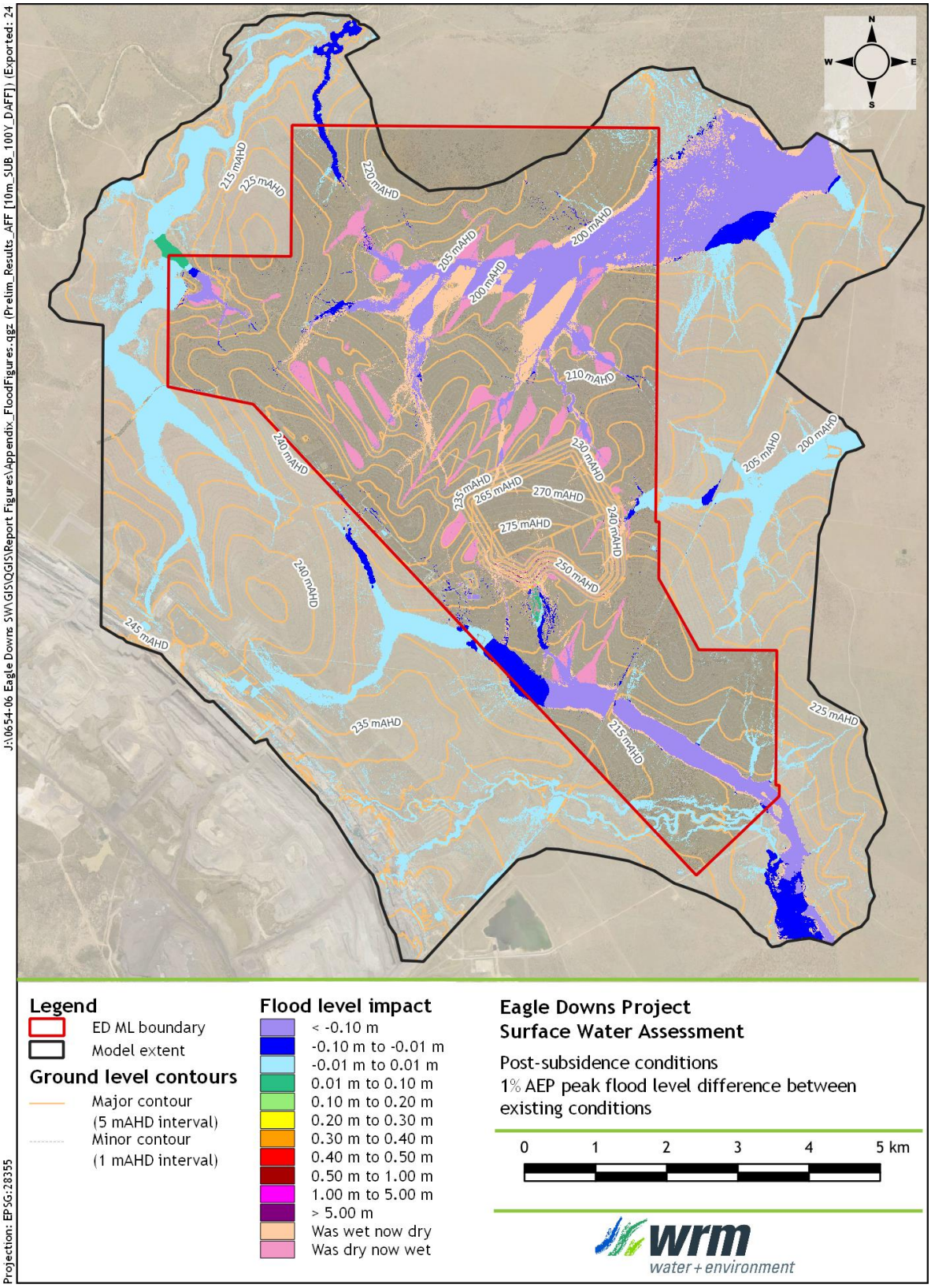


Figure G.5: Impact on 1% flood levels, Subsided (HCU, HCL & DY) minus Existing conditions

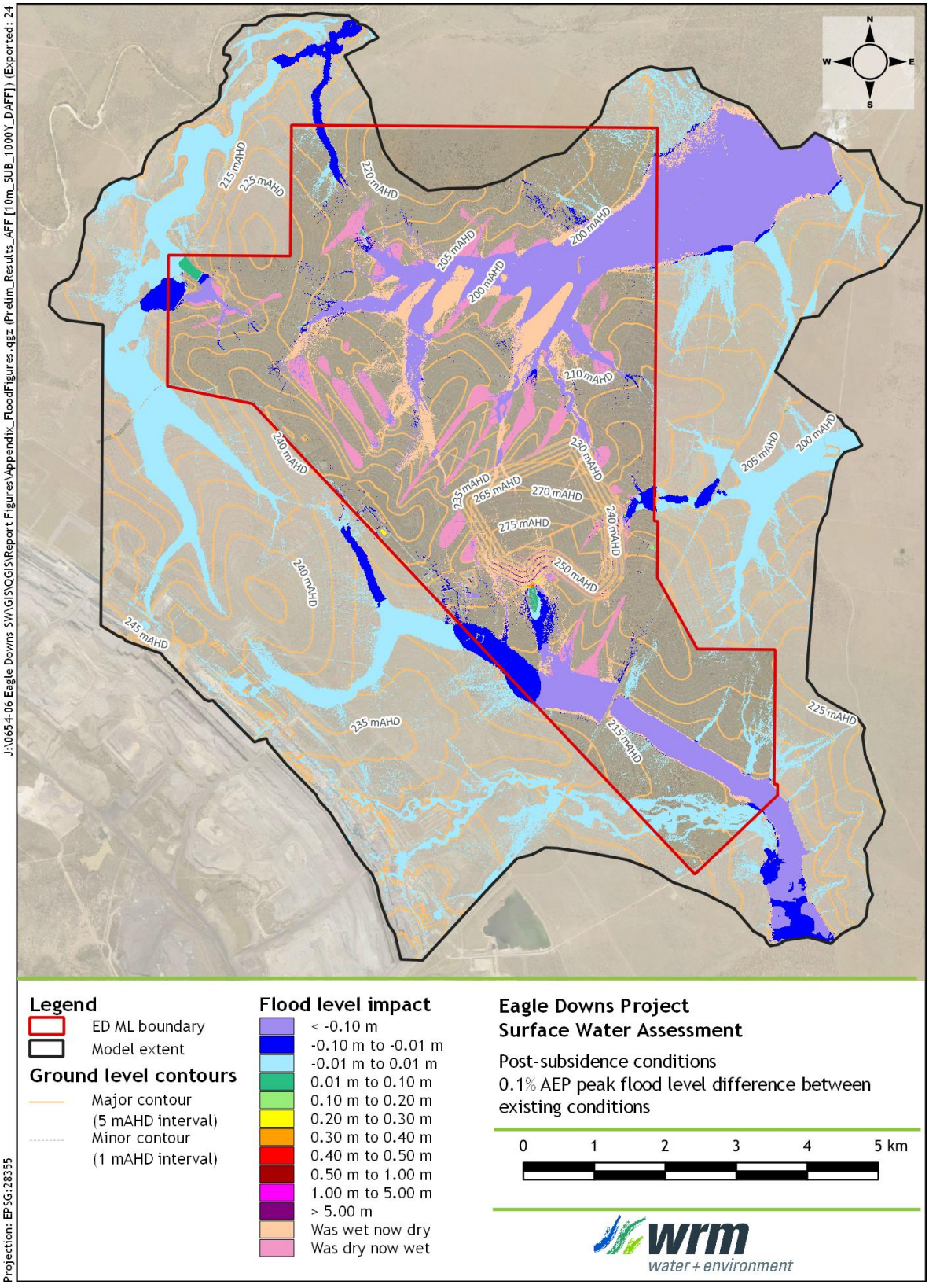


Figure G.6: Impact on 0.1% AEP flood levels, Subsided (HCU, HCL & DY) minus Existing conditions

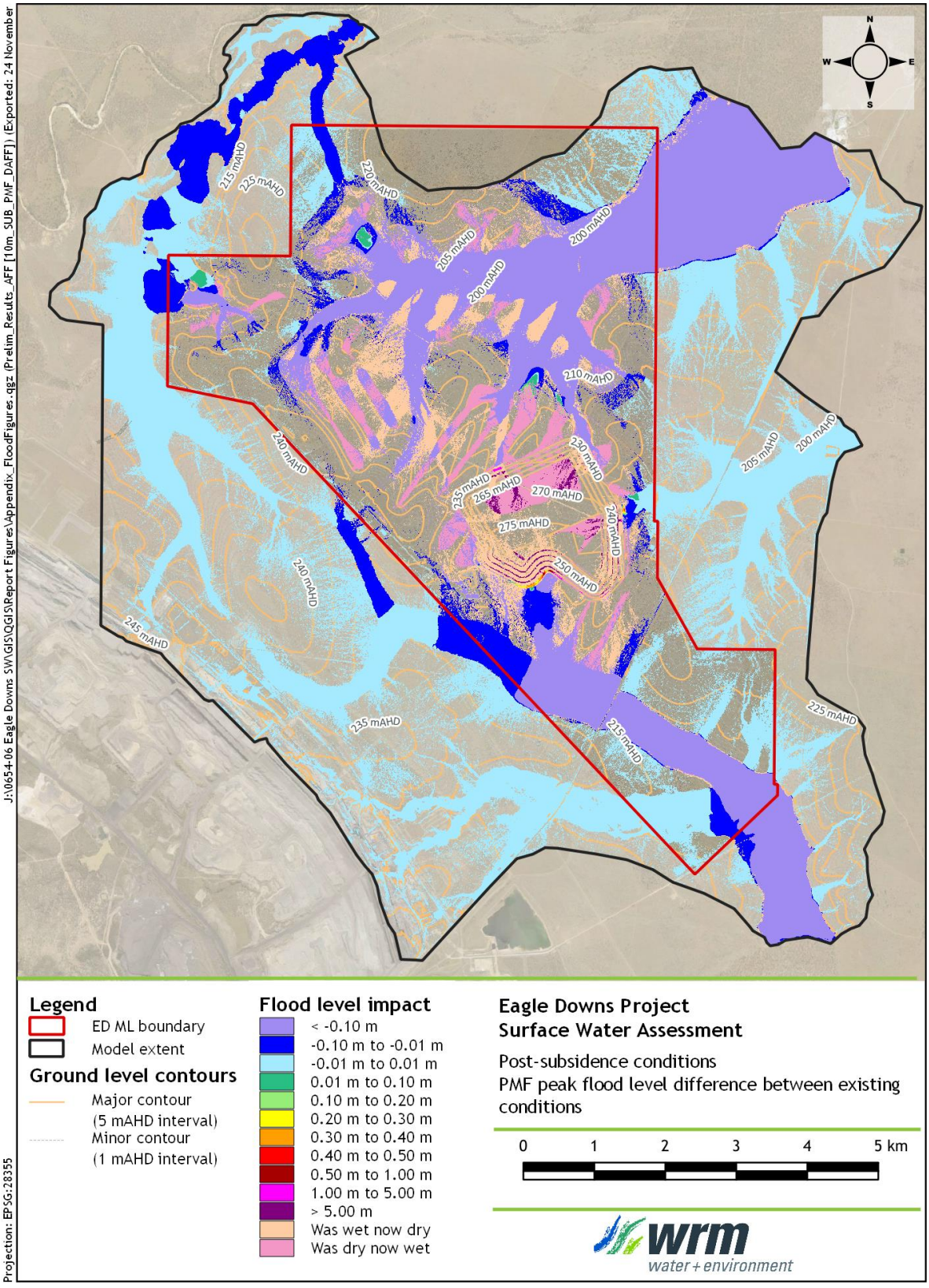


Figure G.7: Impact on PMF flood levels, Subsided (HCU, HCL & DY) minus Existing conditions

Appendix H - Final landform conditions flood maps

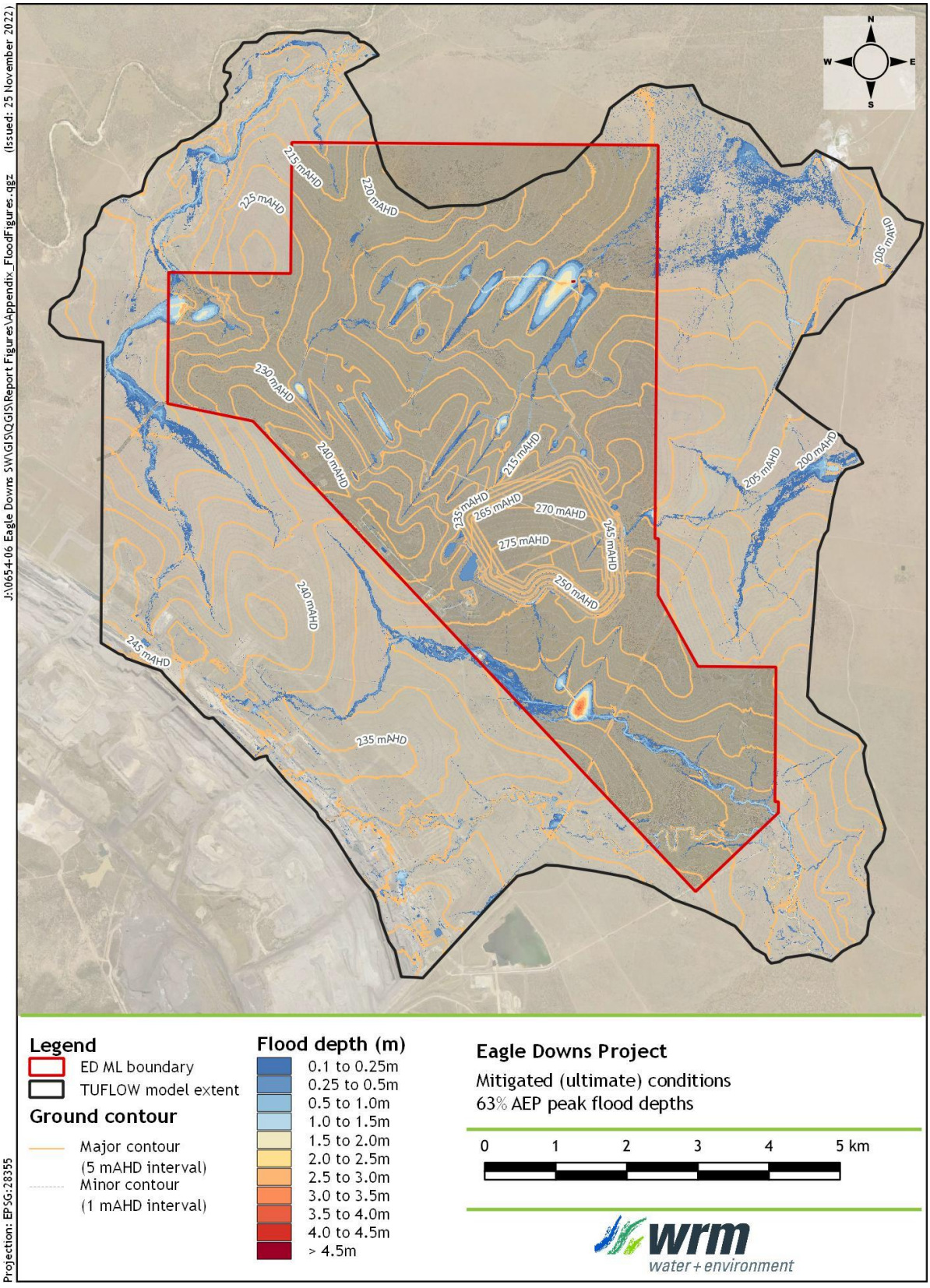


Figure H.1: Final landform conditions 63% AEP flood depths

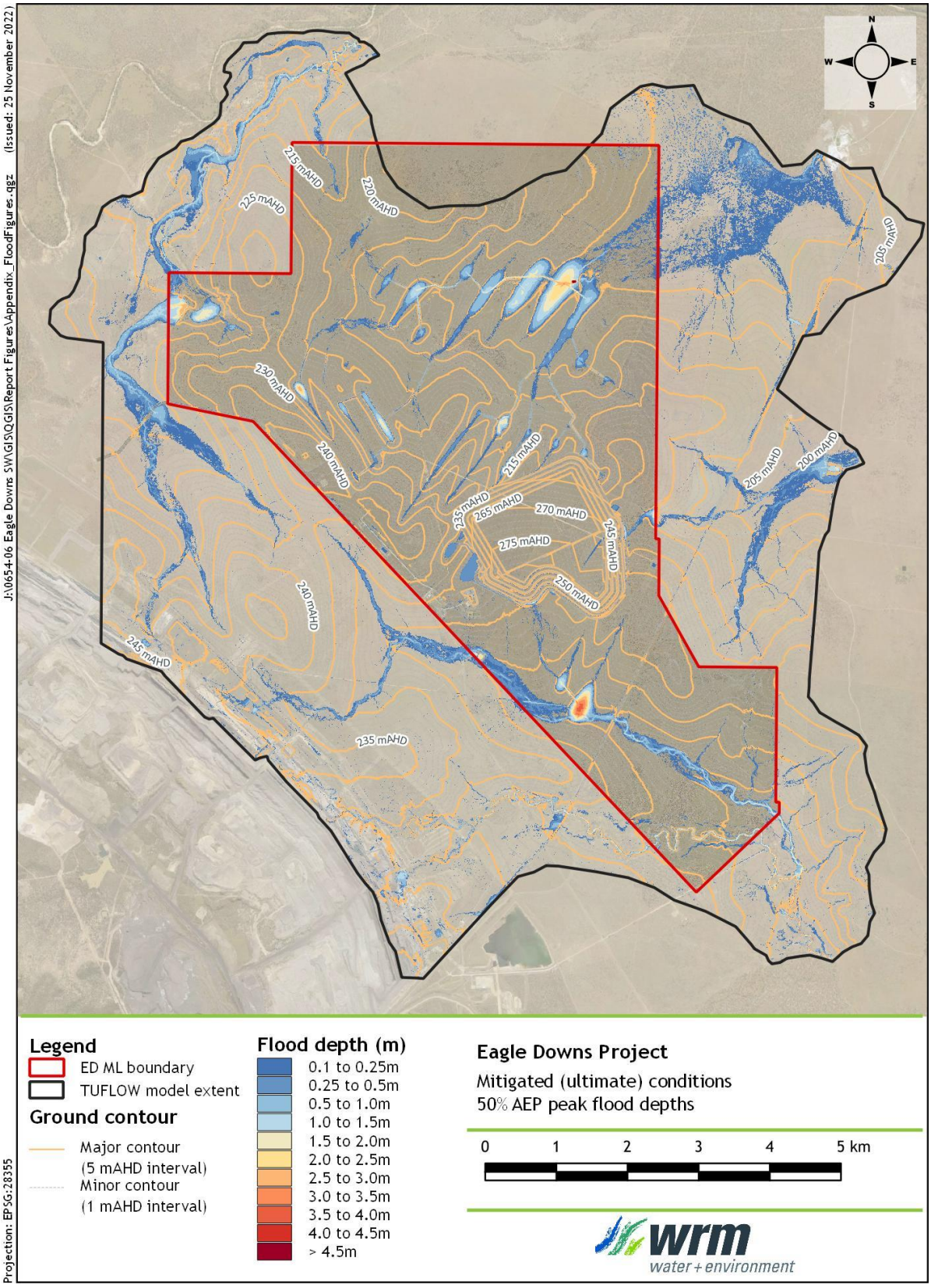


Figure H.2: Final landform conditions 50% AEP flood depths

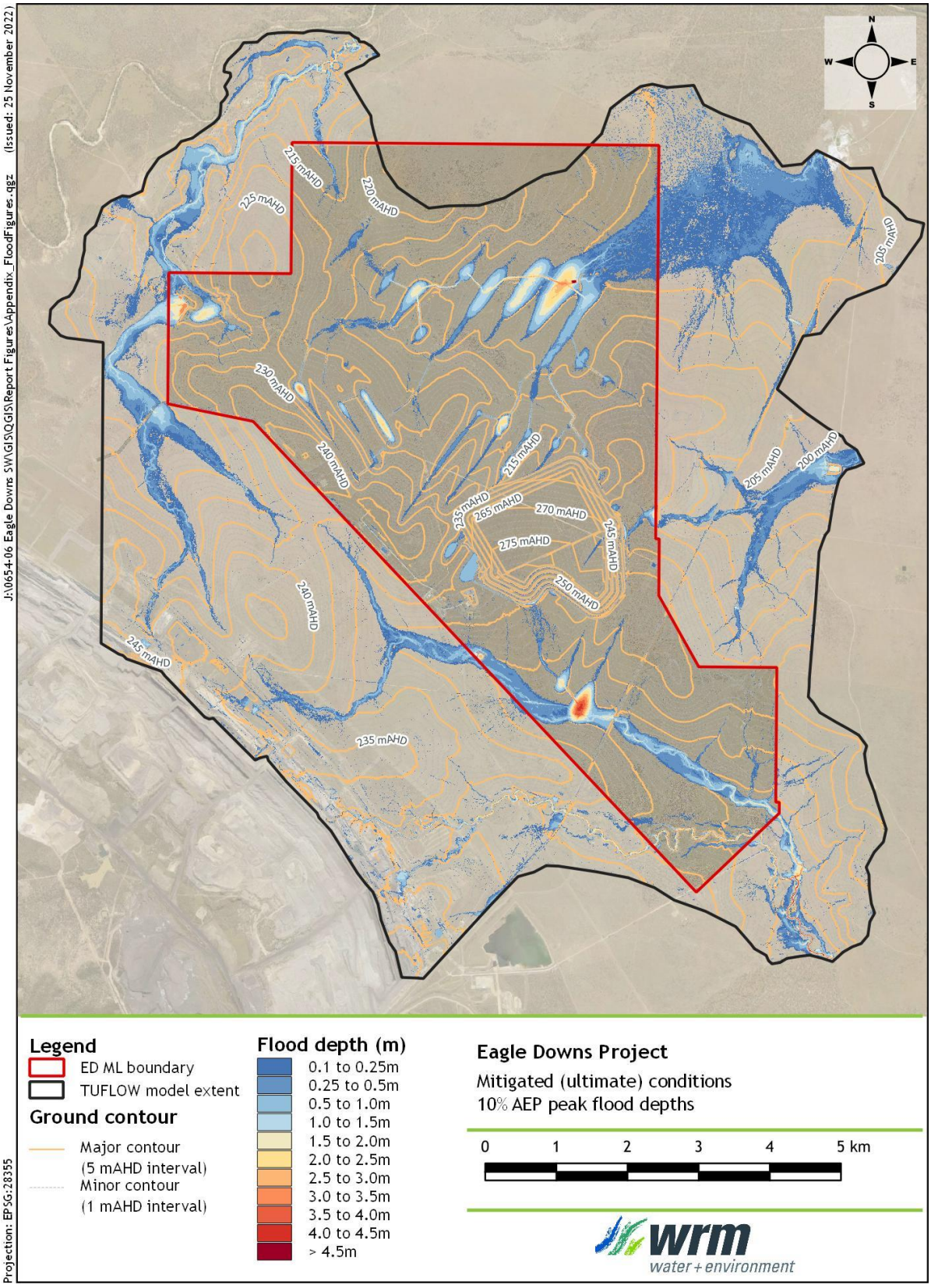


Figure H.3: Final landform conditions 10% AEP flood depths

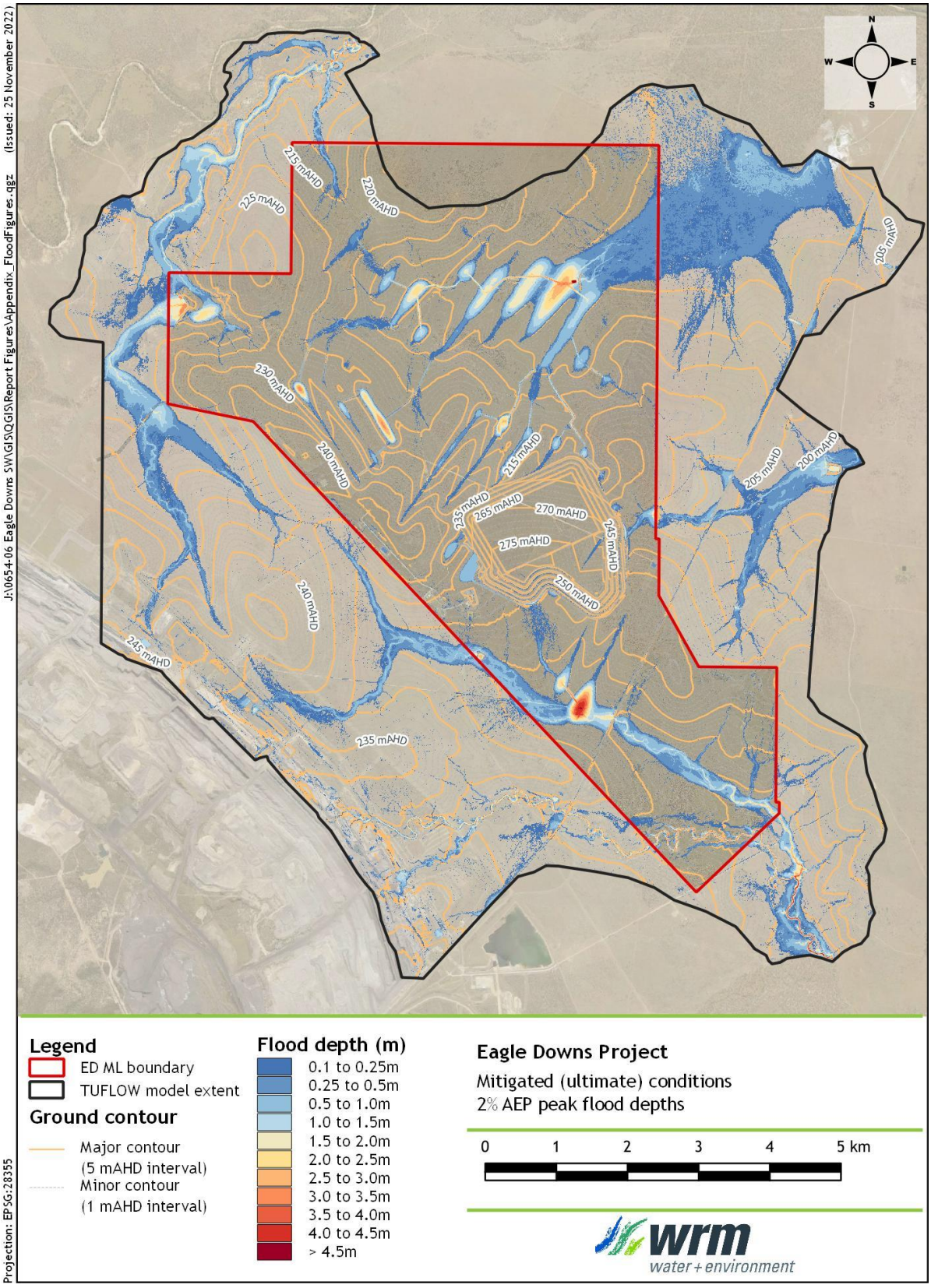


Figure H.4: Final landform conditions 2% AEP flood depths

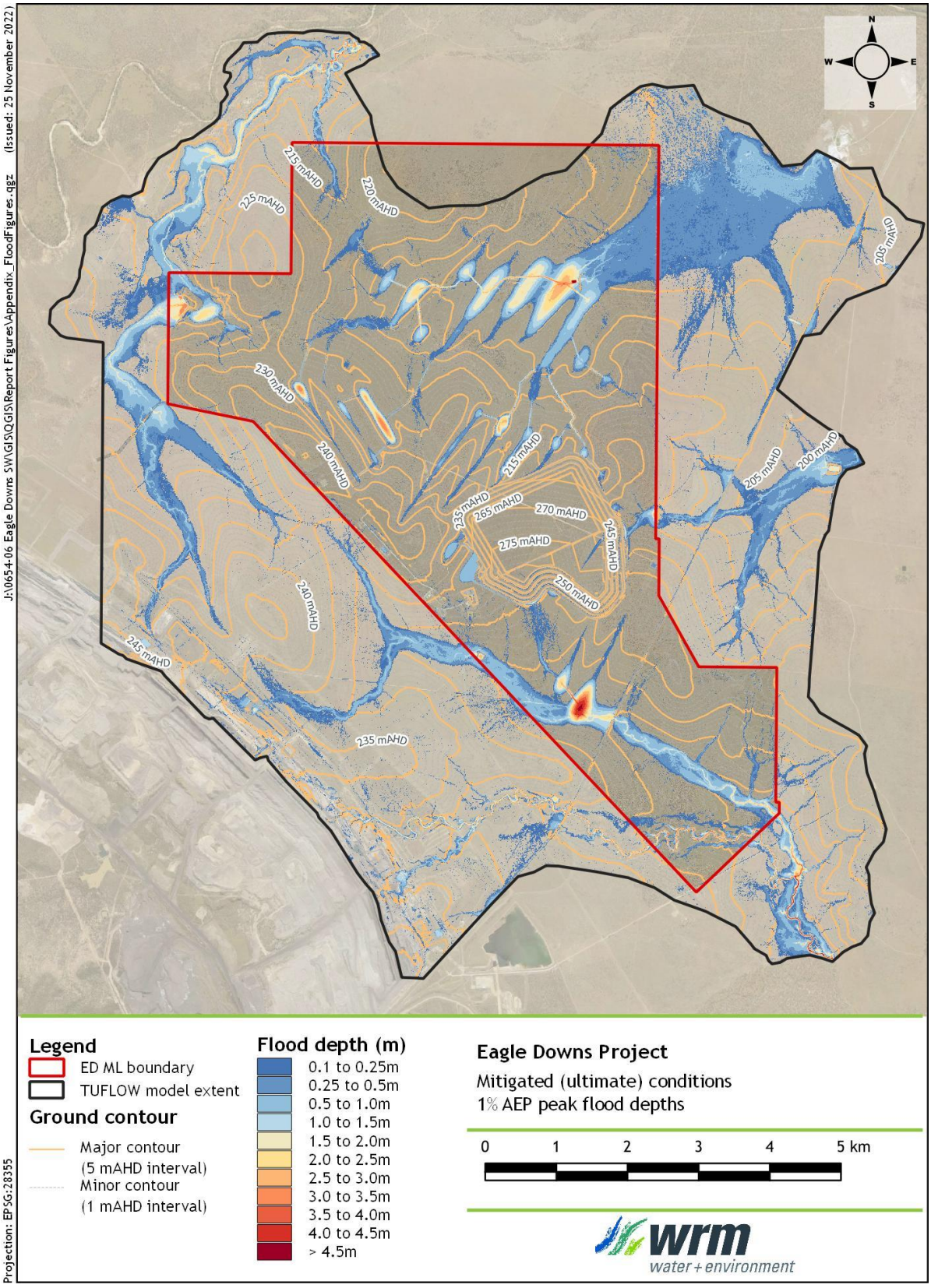


Figure H.5: Final landform conditions 1% AEP flood depths

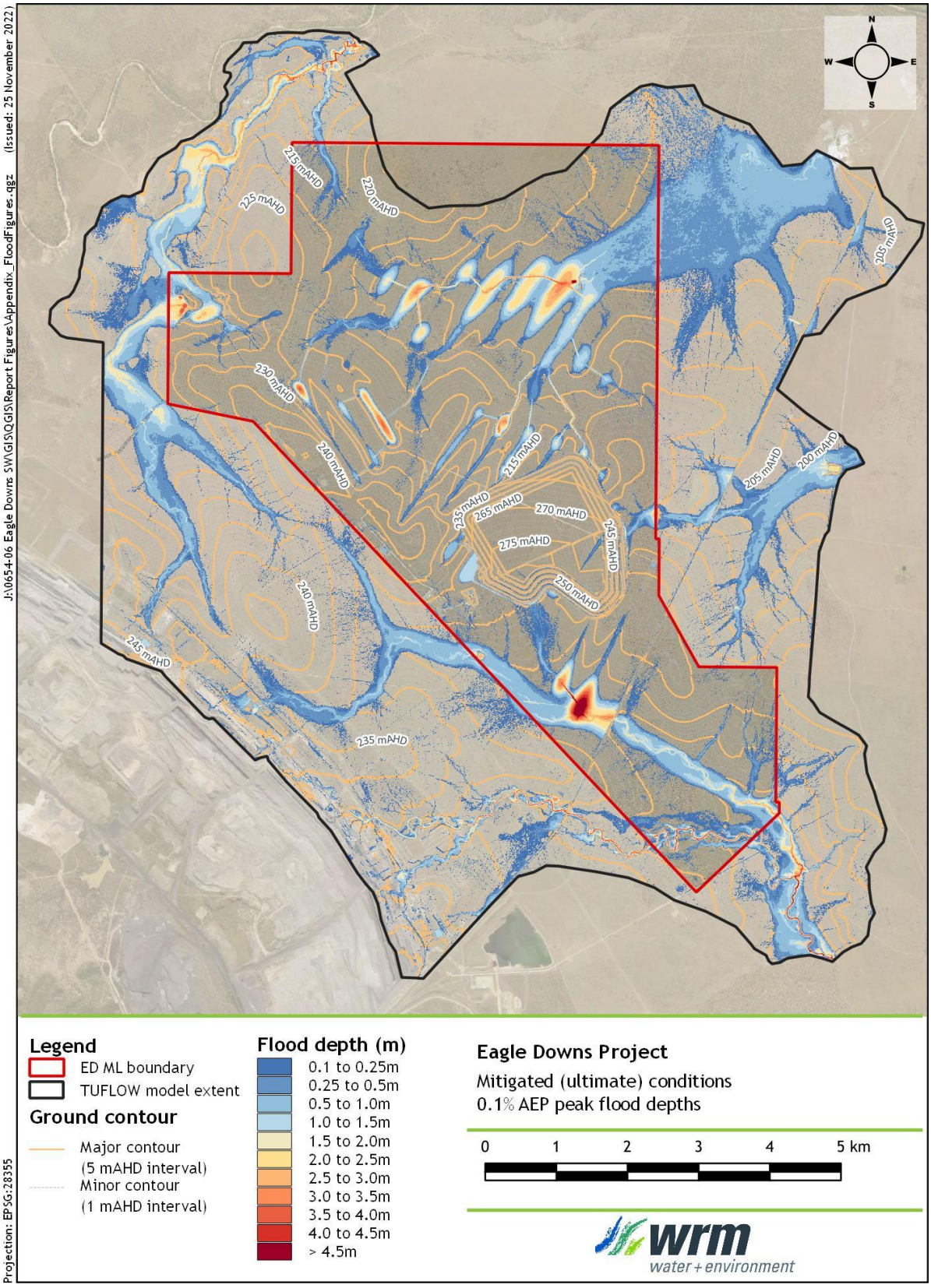


Figure H.6: Final landform conditions 0.1% AEP flood depths

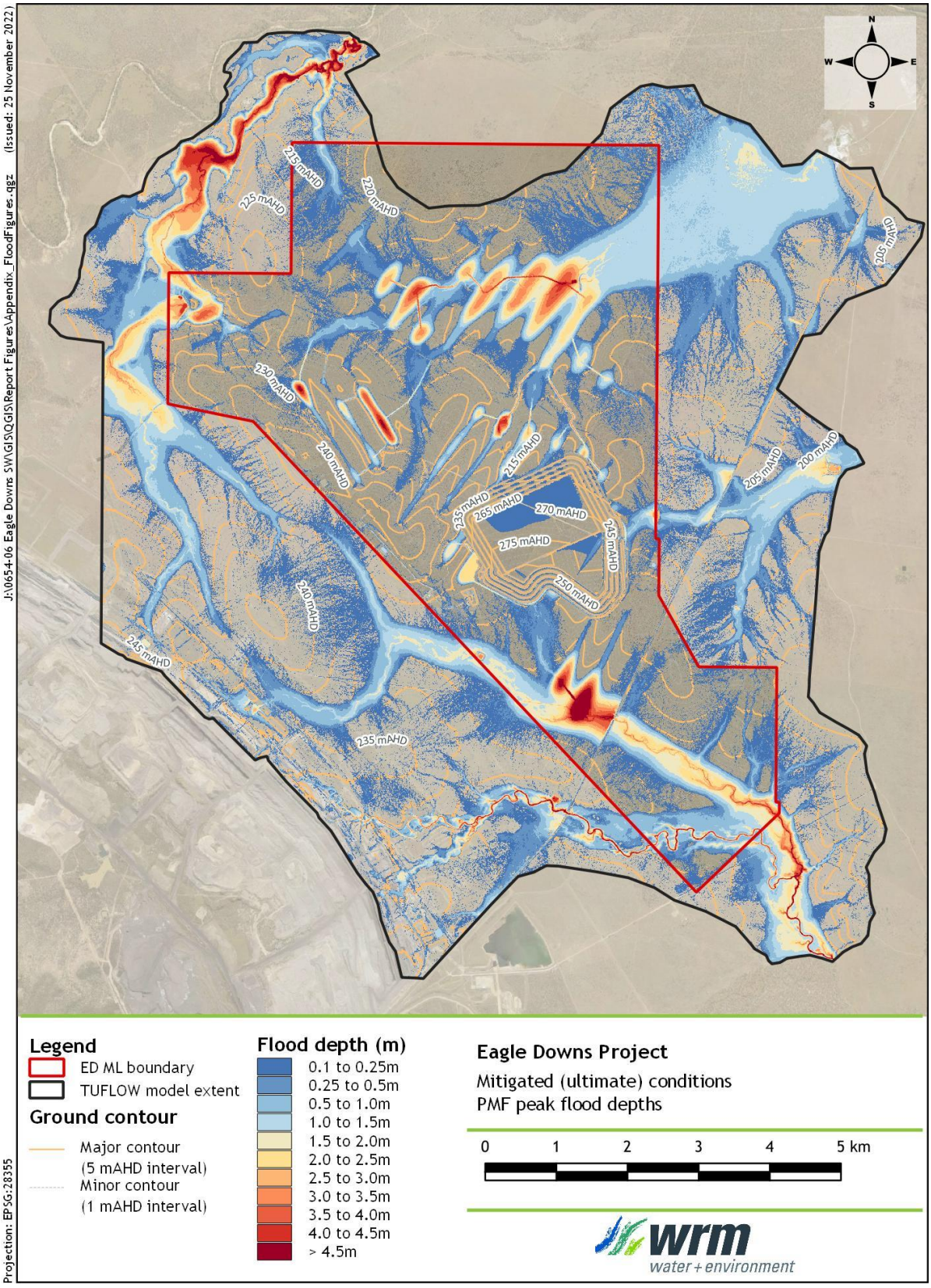


Figure H.7: Final landform conditions PMF flood depths

Appendix I - Final landform conditions flood impacts

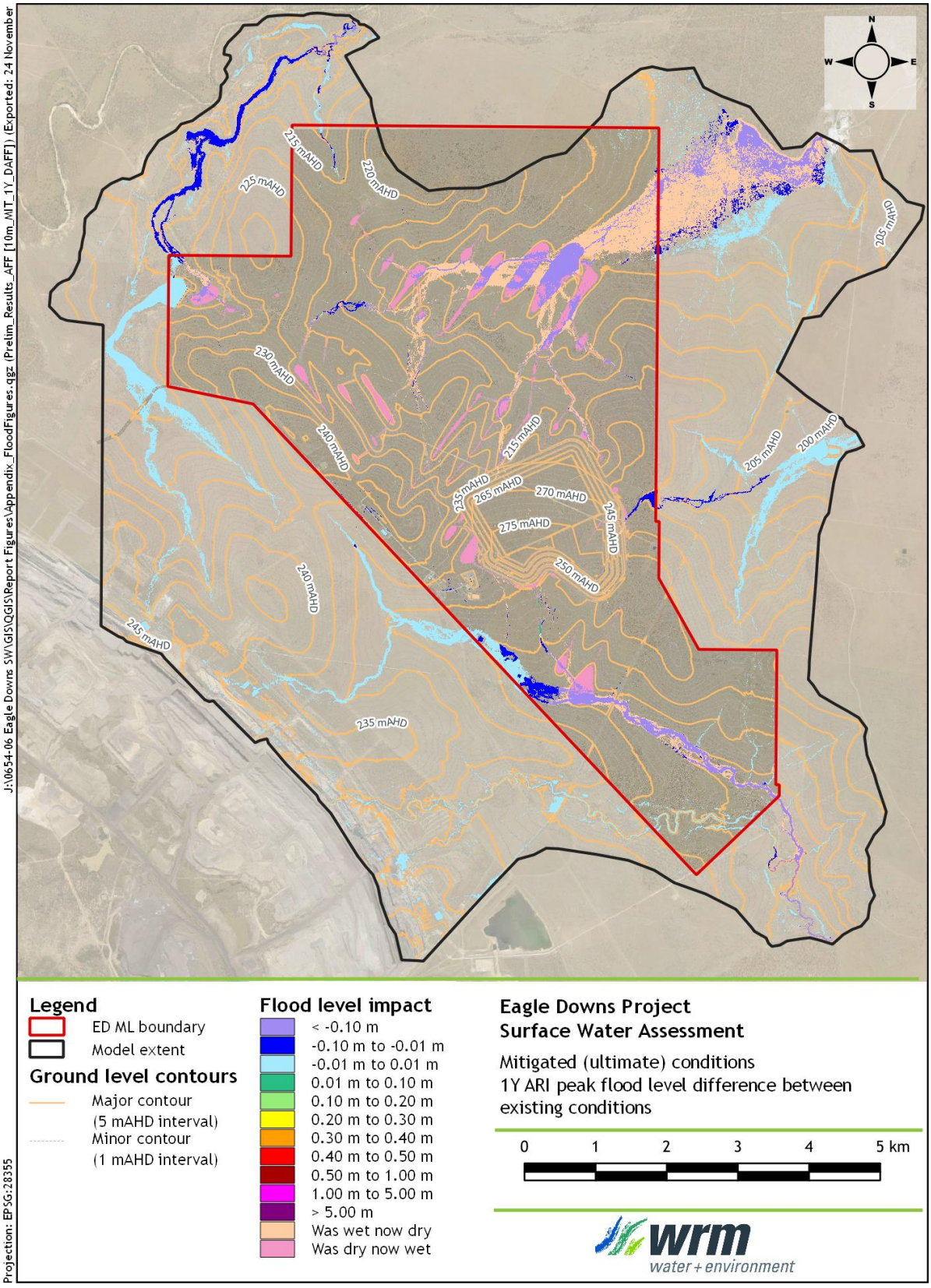


Figure I.1: Impact on 63% AEP flood levels, Final landform minus Existing conditions

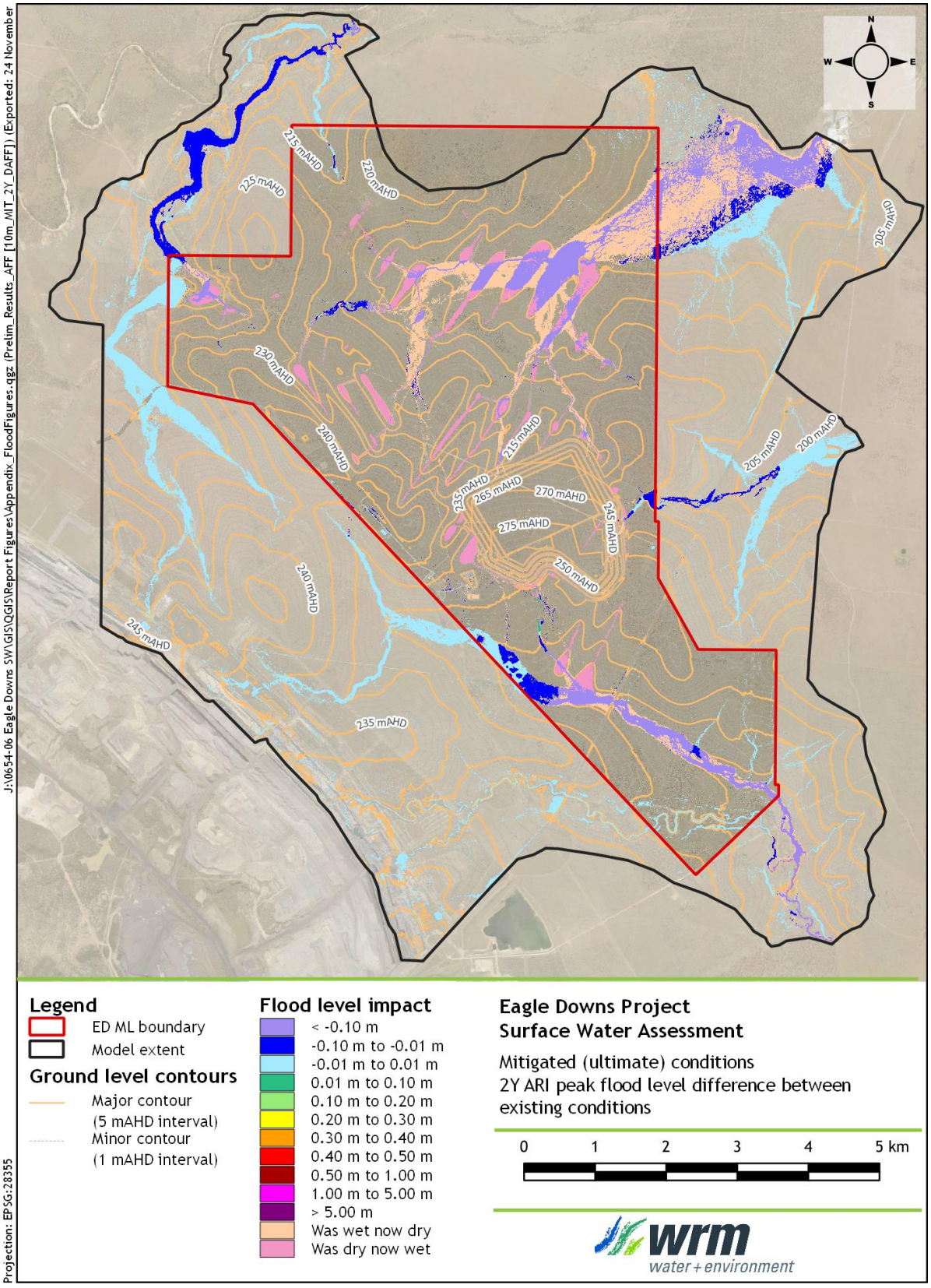


Figure I.2: Impact on 50% AEP flood levels, Final landform minus Existing conditions

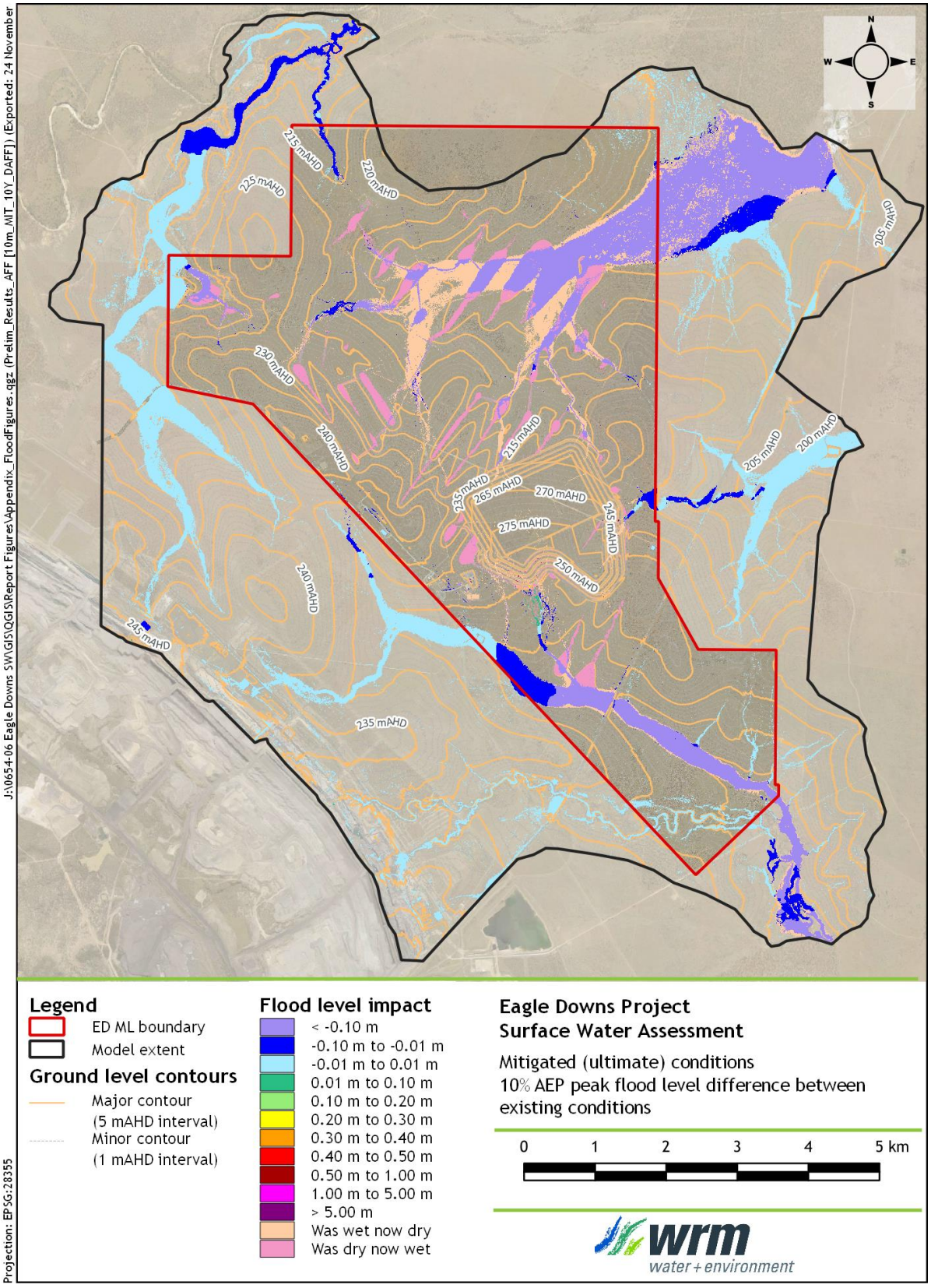


Figure I.3: Impact on 10% AEP flood levels, Final landform minus Existing conditions

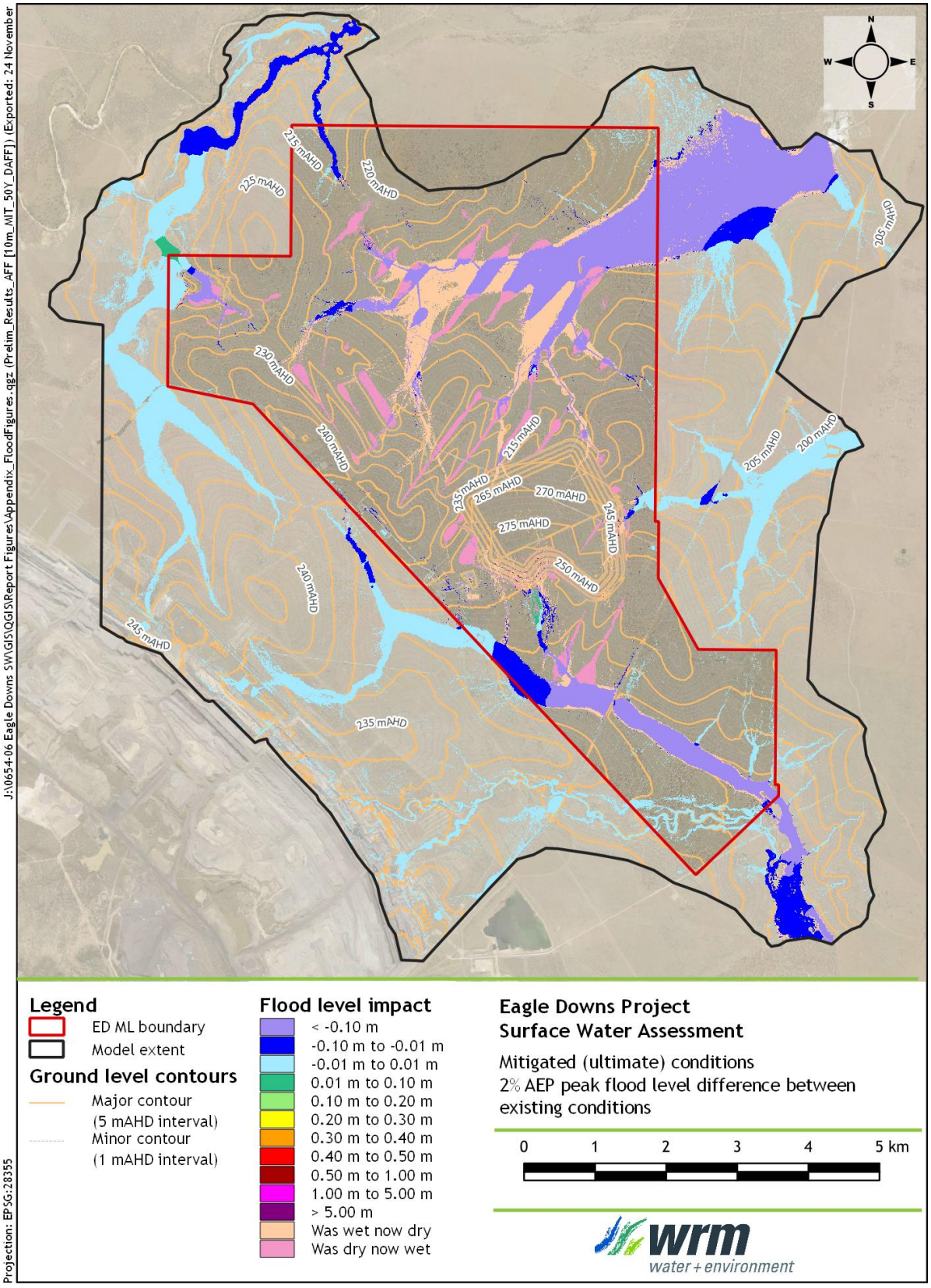


Figure I.4: Impact on 2% AEP flood levels, Final landform minus Existing conditions

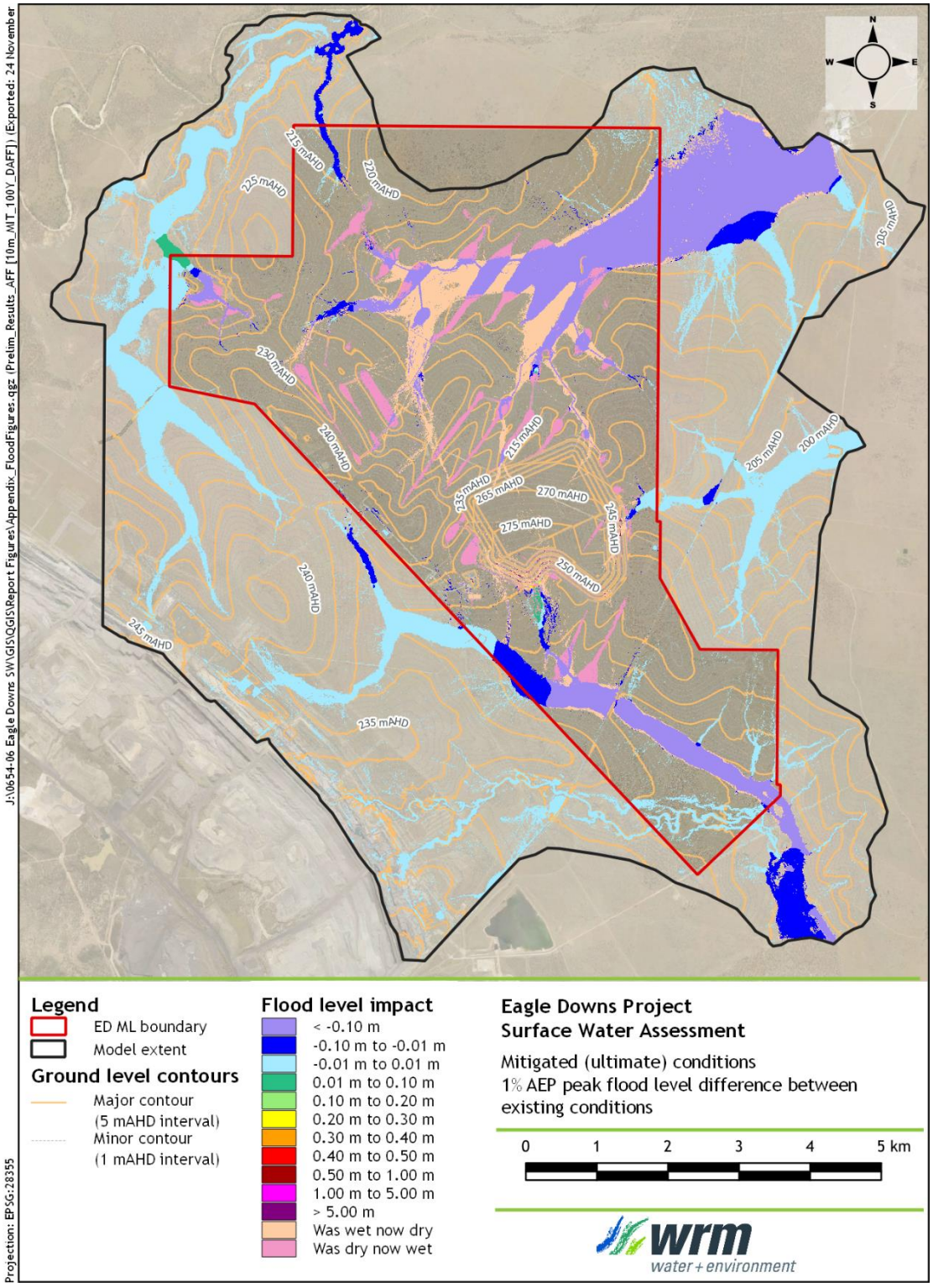


Figure I.5: Impact on 1% AEP flood levels, Final landform minus Existing conditions

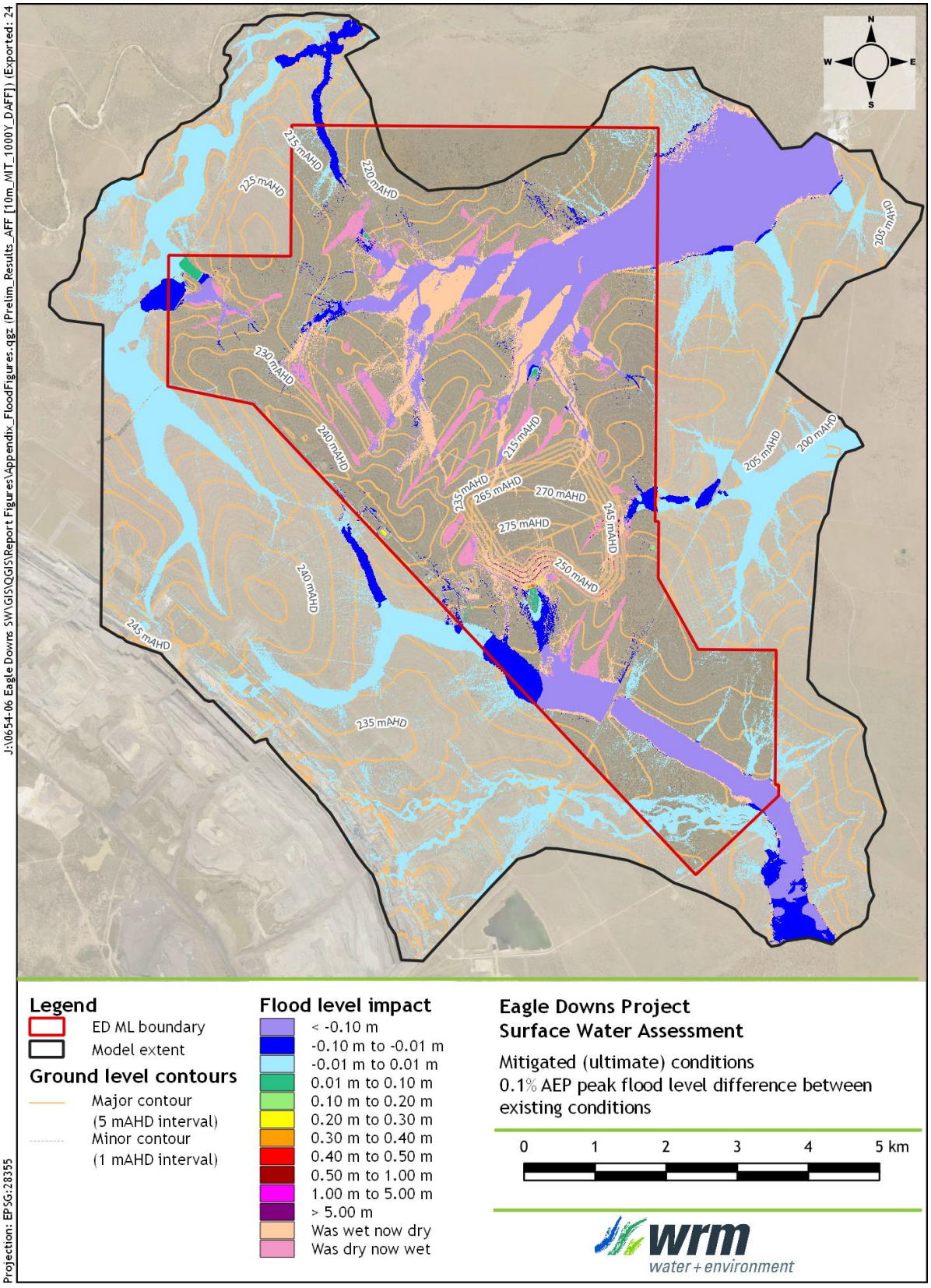


Figure I.6: Impact on 0.1% AEP flood levels, Final landform minus Existing conditions

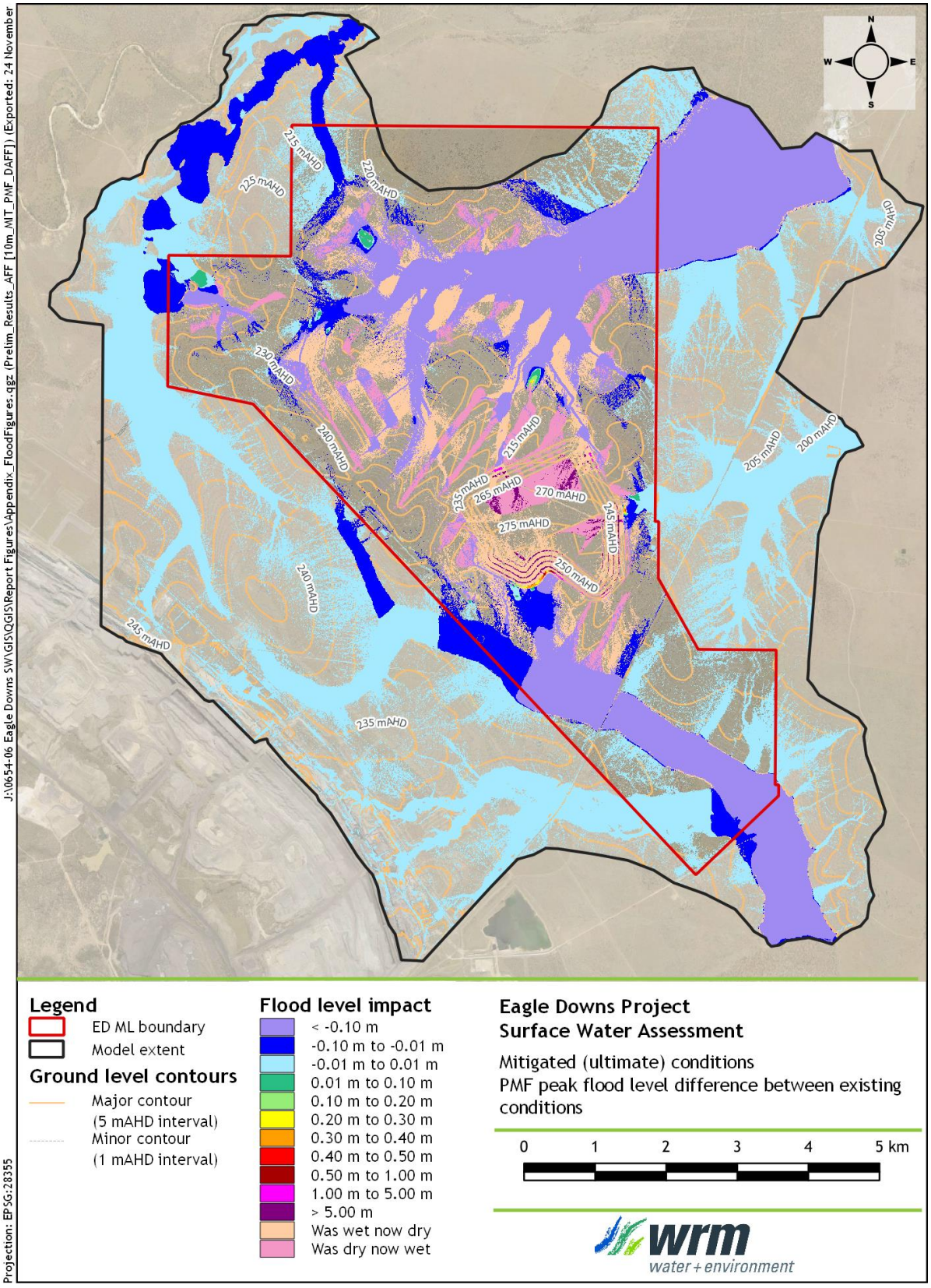


Figure I.7: Impact on PMF flood levels, Final landform minus Existing conditions

Appendix J - Flow impact hydrographs

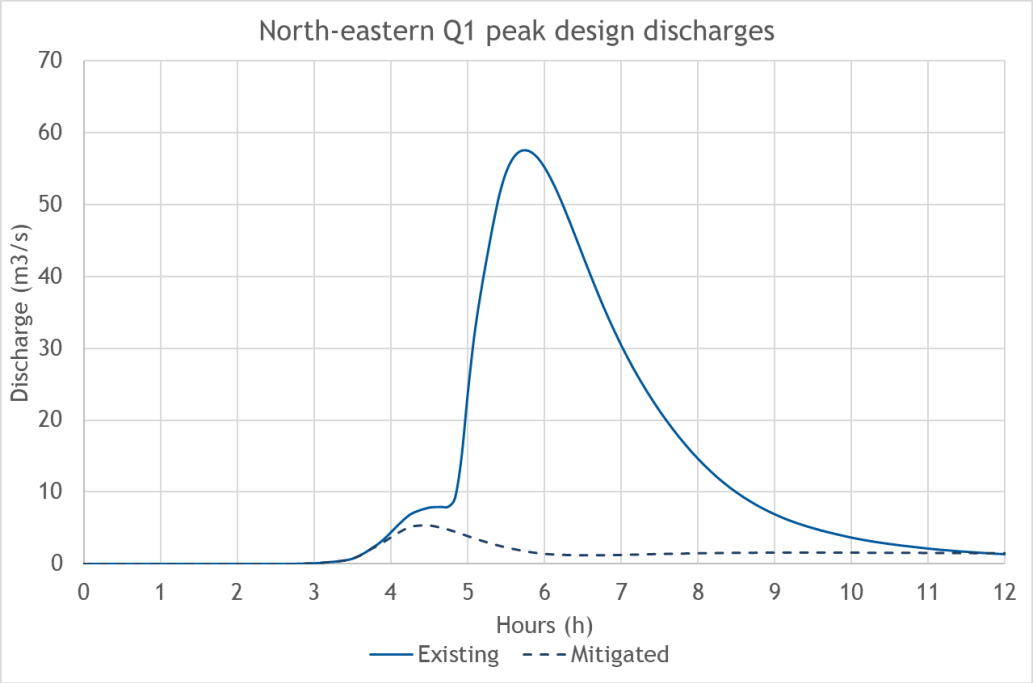


Figure J.1: North-eastern (Feature 1) 63% AEP peak design discharges comparison

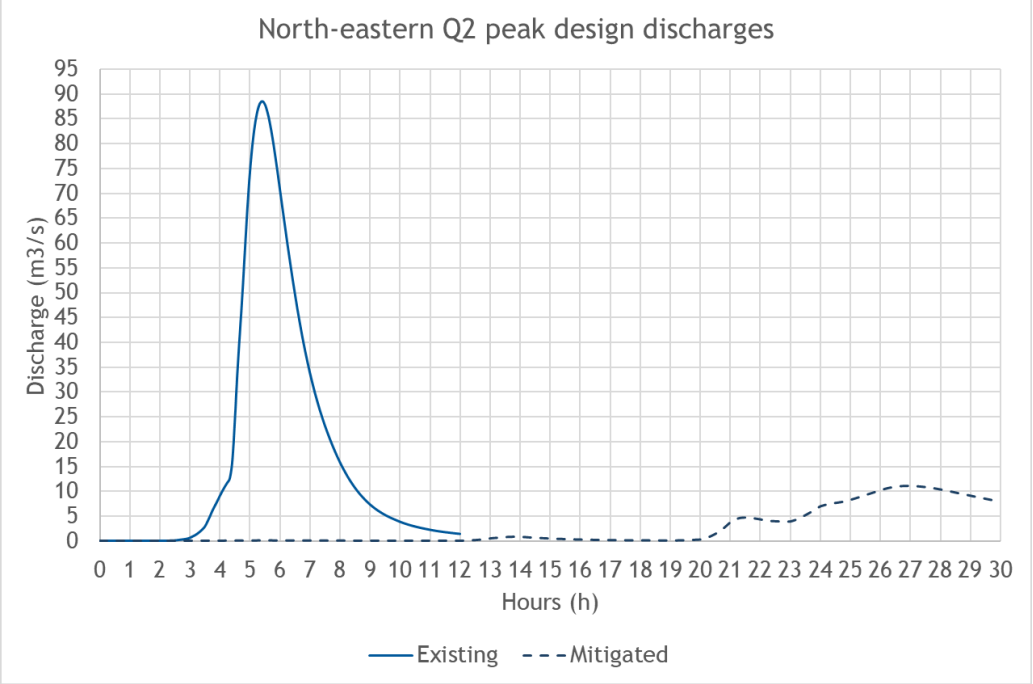


Figure J.2: North-eastern (Feature 1) 50% AEP peak design discharges comparison

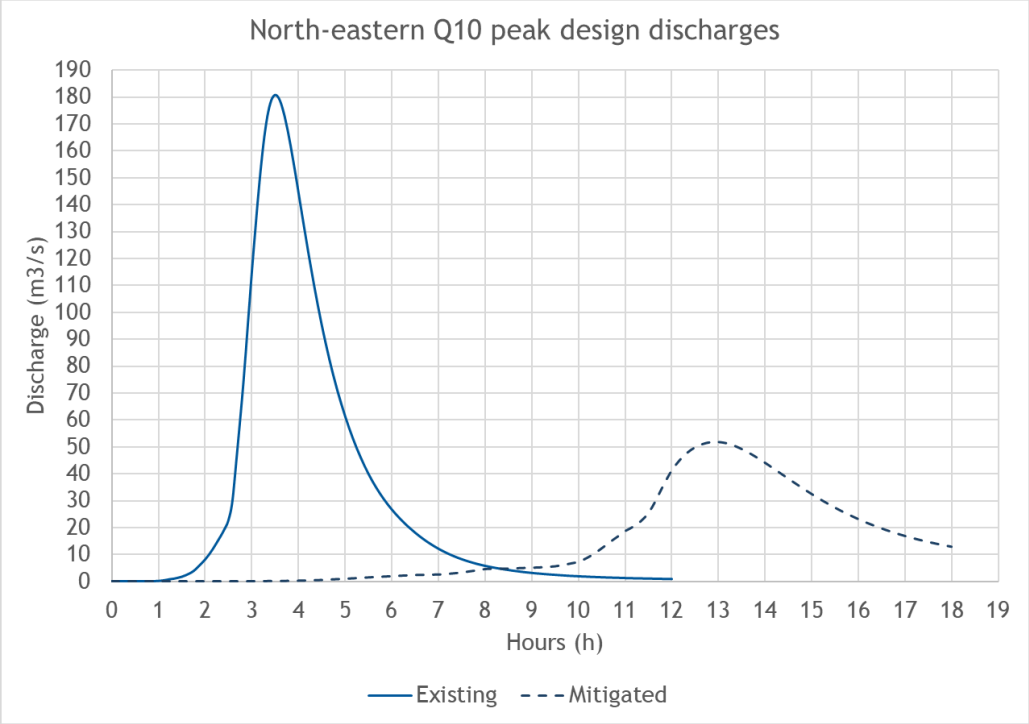


Figure J.3: North-eastern (Feature 1) 10% AEP peak design discharges comparison

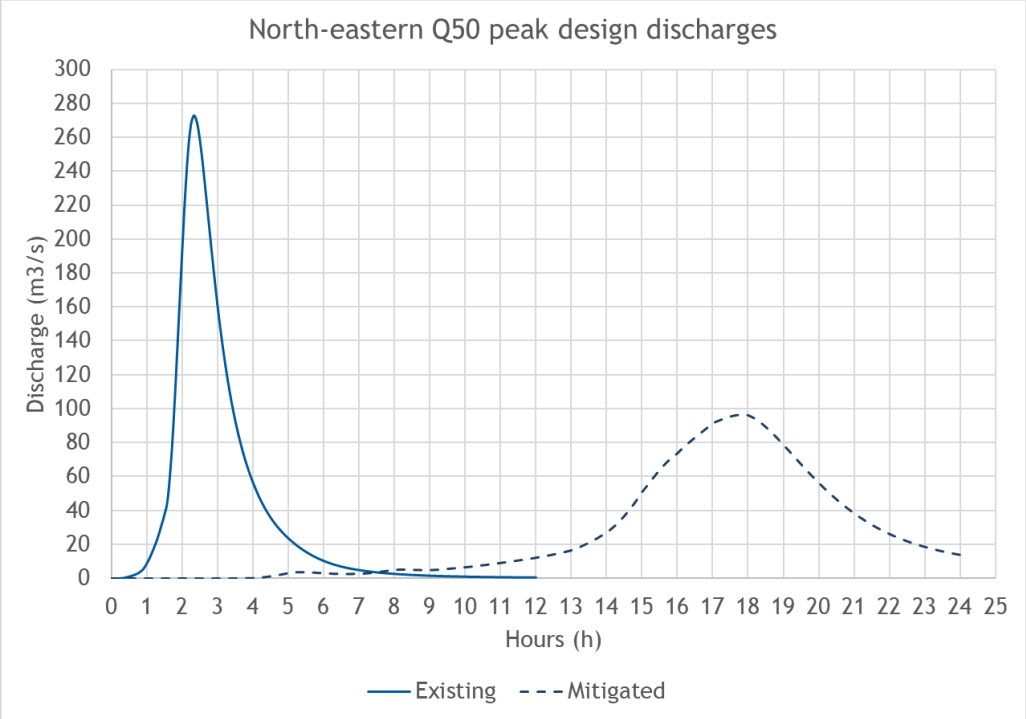


Figure J.4: North-eastern (Feature 1) 2% AEP peak design discharges comparison

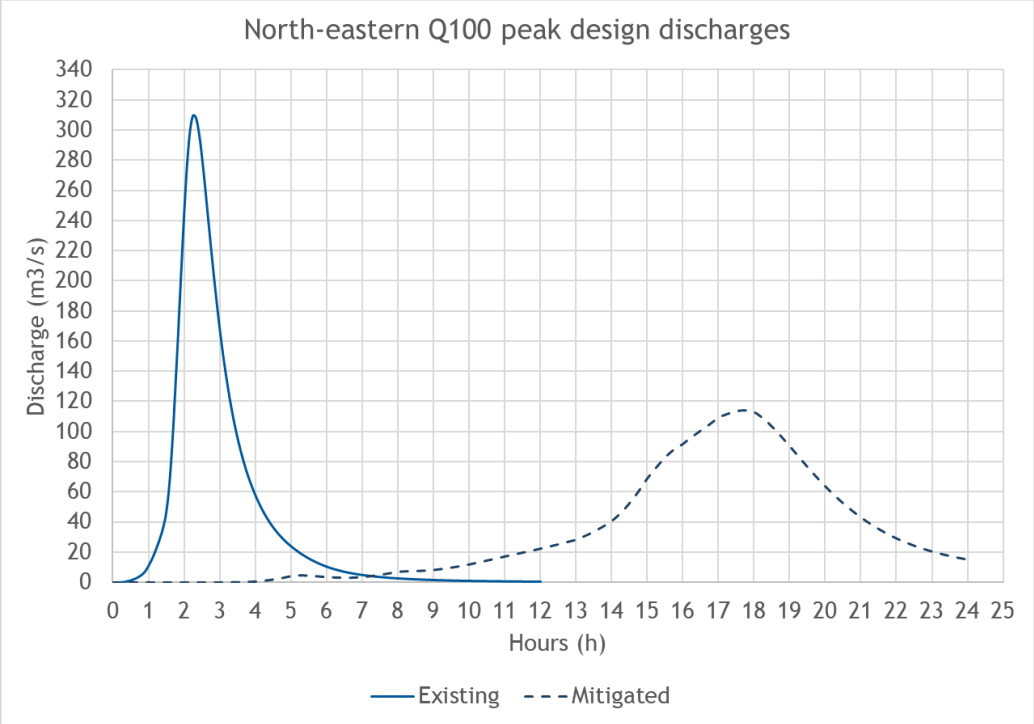


Figure J.5: North-eastern (Feature 1) 1% AEP peak design discharges comparison

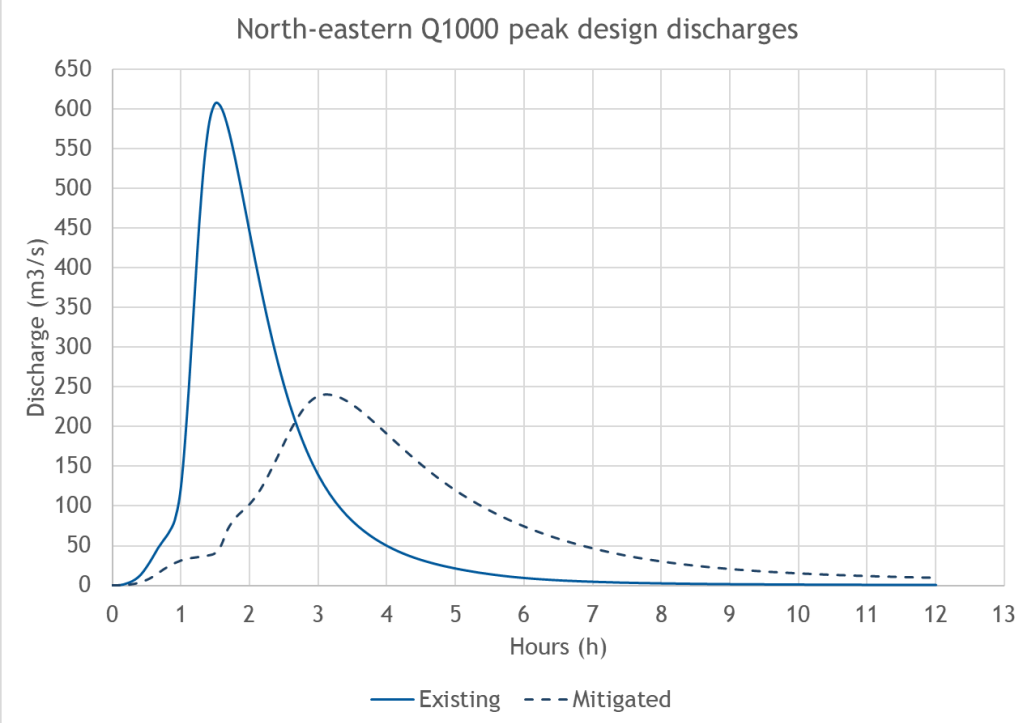


Figure J.6: North-eastern (Feature 1) 0.1% AEP peak design discharges comparison

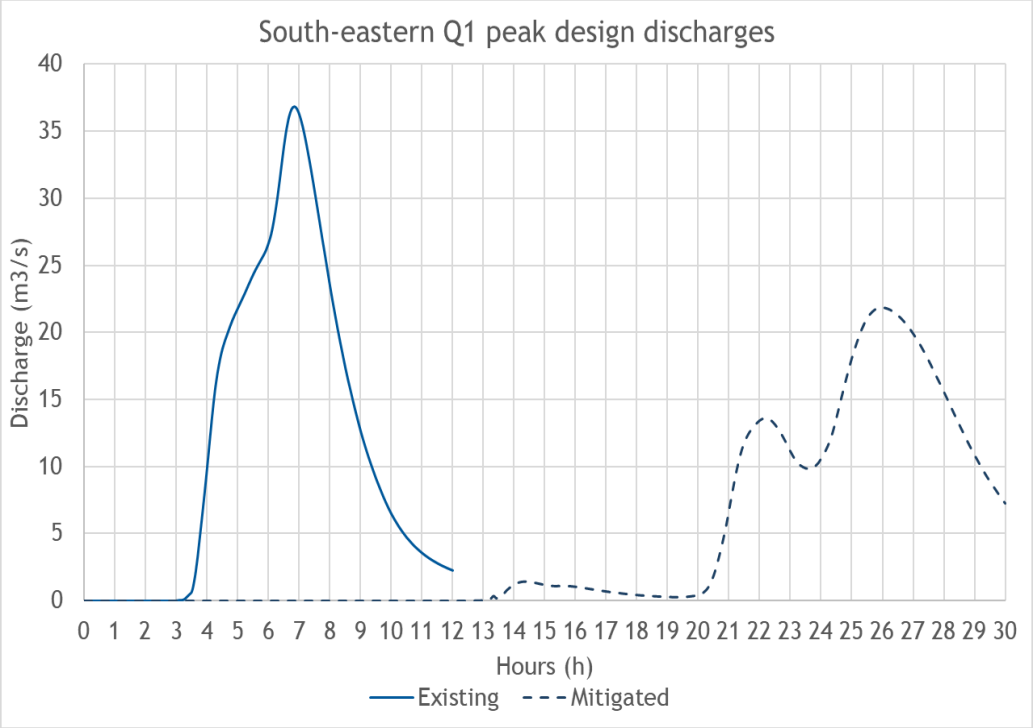


Figure J.7: South-eastern (Ripplestone Creek) 63% AEP peak design discharges comparison

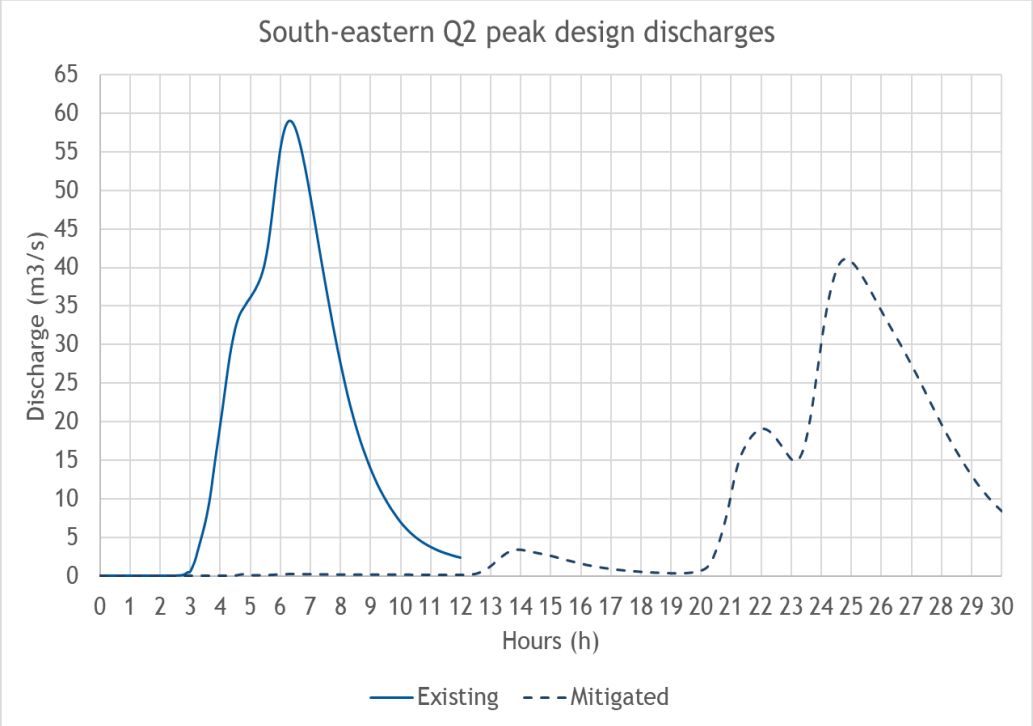


Figure J.8: South-eastern (Ripplestone Creek) 50% AEP peak design discharges comparison

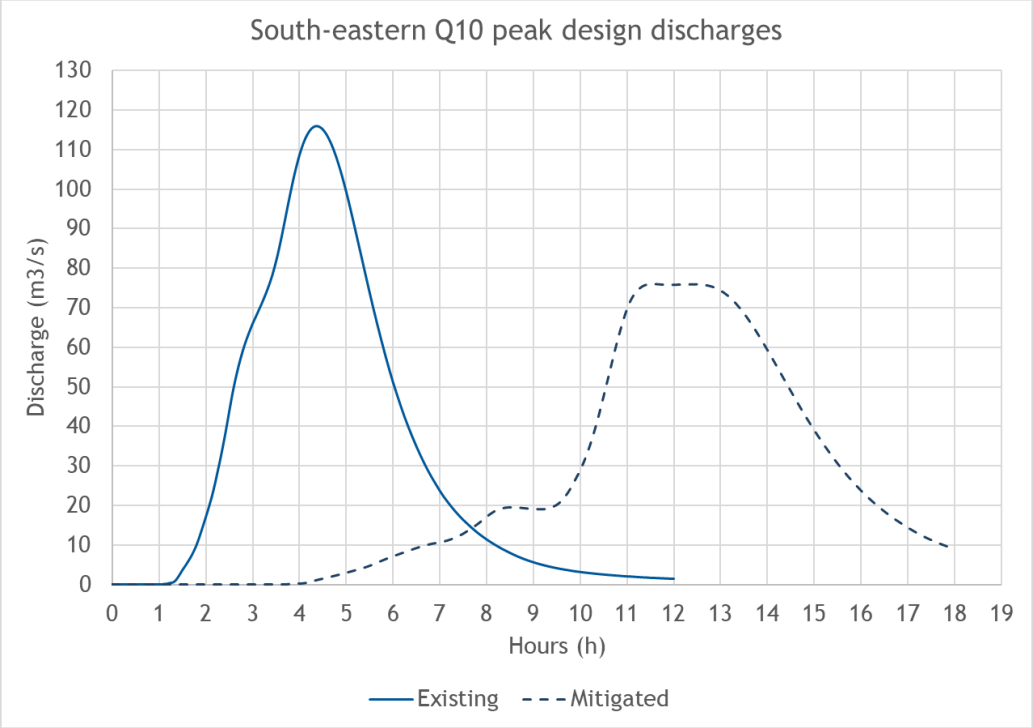


Figure J.9: South-eastern (Ripplestone Creek) 10% AEP peak design discharges comparison

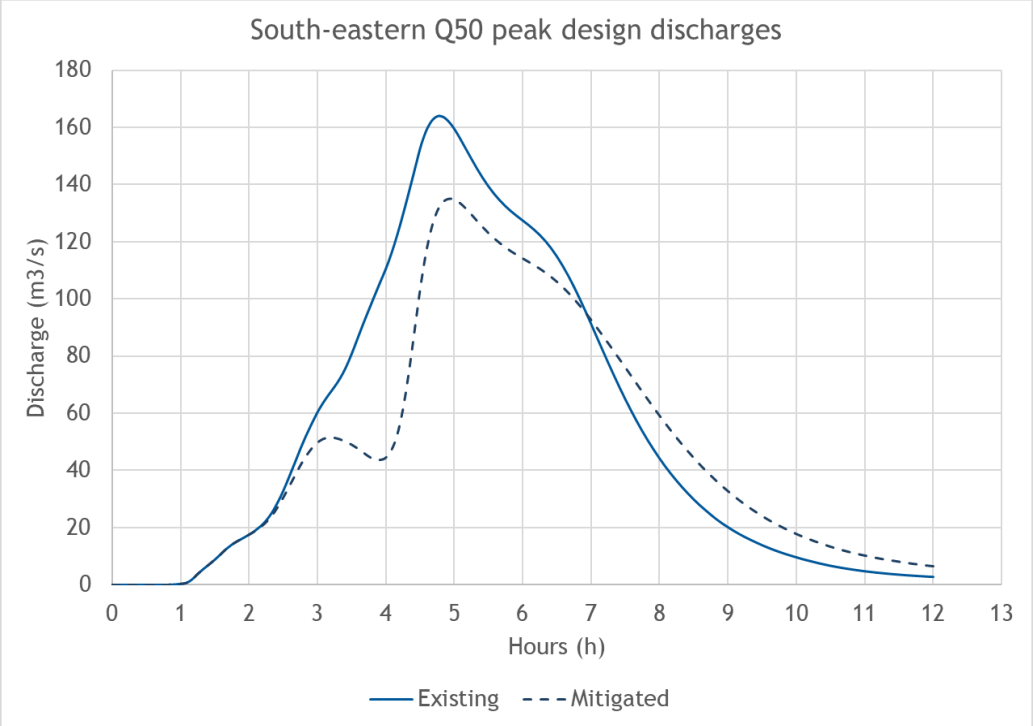


Figure J.10: South-eastern (Ripplestone Creek) 2% AEP peak design discharges comparison

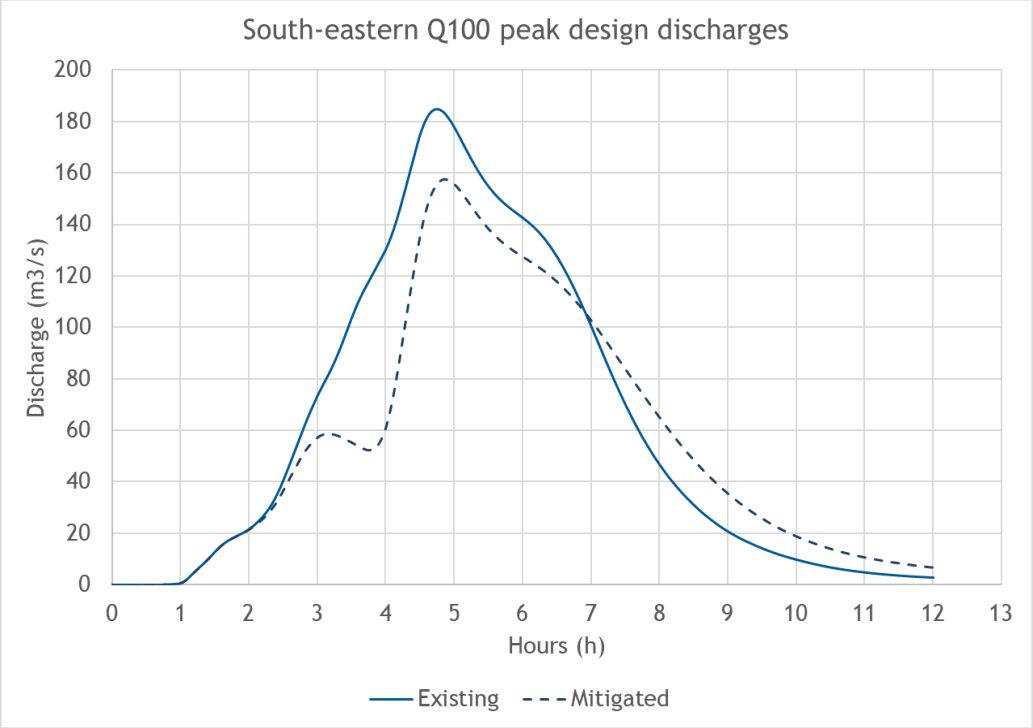


Figure J.11: South-eastern (Ripplestone Creek) 1% AEP peak design discharges comparison

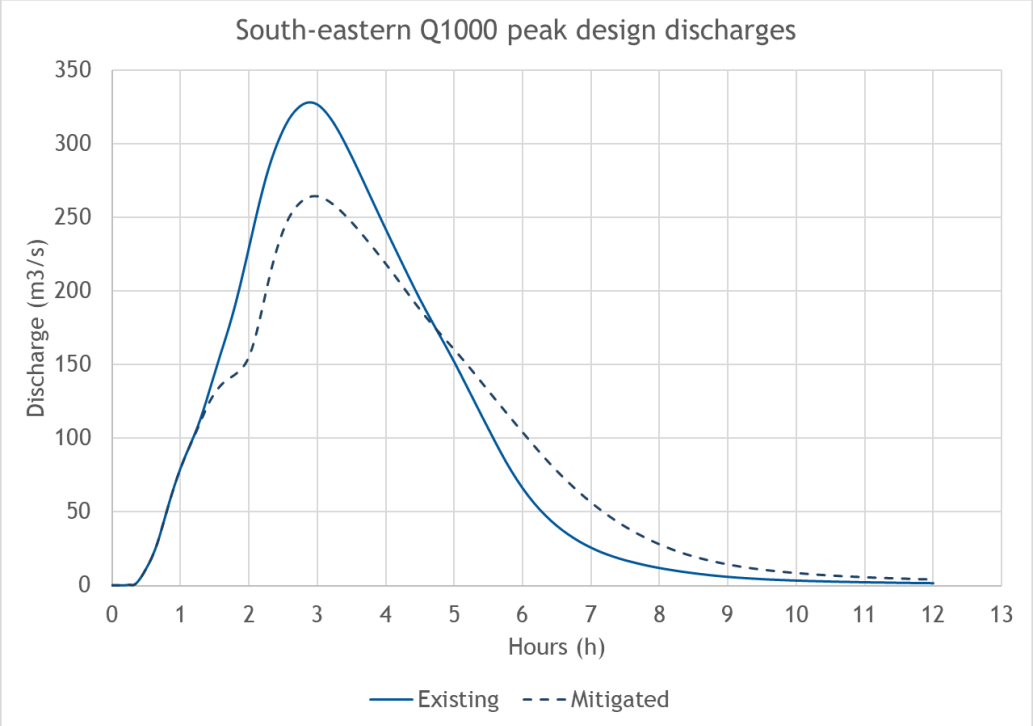


Figure J.12: South-eastern (Ripplestone Creek) 0.1% AEP peak design discharges comparison

Appendix H. Geochemistry and Waste Characterisation Assessment

TECHNICAL REPORT

Geochemical and Physical Assessment of Drift Spoil, Coal and Coal Reject Materials

Eagle Downs Project

Prepared for: Eagle Downs Metallurgical Coal

MINE WASTE AND
WATER MANAGEMENT

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TECHNICAL REPORT

Geochemical and Physical Assessment of Drift Spoil, Coal and Coal Reject Materials

Eagle Downs Project

Prepared for: **Eagle Downs Metallurgical Coal**

Limitations and disclaimer:

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Glossary of terms and acronyms

Acidity	A measure of hydrogen ion (H+) concentration and certain dissolved metals in a solution when titrated to a set pH value; generally expressed as mg/L $CaCO_3$ equivalent..
ABA	Acid Base Account. Evaluation of the balance between acid generation and acid neutralisation processes. Determines the maximum potential acidity (MPA) and the inherent acid neutralising capacity (ANC), as defined below.
ALS	Australian Laboratory Services.
AMD	Acid and metalliferous drainage from mine waste materials characterised by low pH, elevated metal concentrations, high sulfate concentrations and high salinity.
ANC	Acid Neutralising Capacity expressed as kg H_2SO_4 per tonne of sample. A measure of a sample's maximum potential ability to neutralise acid.
ANC:MPA	The ratio of the acid neutralising capacity to the maximum potential acidity of a sample. Used to assess the risk of a sample generating acid conditions.
AS	Australian Standards
Dispersive	Dispersive soil and rock materials are structurally unstable and disperse into basic particles such as sand, silt and clay in water. When a dispersive soil is wet, the basic structure has a tendency to collapse, whereas when it is dry it is prone to surface sealing and crusting.
EC	Electrical Conductivity, expressed as µS/cm.
eCEC	Effective cation exchange capacity provides a measure of the mass of exchangeable cations (Ca, Mg, Na and K) in a sample.
Eh	Redox potential. A measure of the tendency of a chemical species to acquire or lose electrons to an electrode. Used to measure oxidising (+ve) or reducing (-ve) conditions in a saturated column.
EIS	Environmental Impact Statement.
ESP	Exchangeable sodium percentage provides a measure of the sodicity of a material and propensity to erode.
EA	Emmerson Aggregate
FIMS	Flow Injection Mercury System.
GAI	Geochemical Abundance Index
ICP-MS	Inductively Coupled Plasma Mass Spectrometry
ICP-AES	Inductively Coupled Plasma Atomic Emission Spectrometry.
INAP	International Network on Acid Prevention
Interburden	The material found in between ore layers, and considered to be of low economic value (ie. a type of waste material).
KLC	Kinetic Leach Column. Leaching setup that generates time-dependent data on the kinetics and rate of acid generation and acid neutralising reactions under laboratory controlled (or onsite conditions)
LoR	Limit of Reporting. Laboratory detection limit for the reporting of results for a particular geochemical test.
MPA	Maximum Potential Acidity. Calculated by multiplying the total sulfur or sulfide-sulfur (Scr) content of a sample by 30.6 (stoichiometric factor) and expressed as kg H_2SO_4 per tonne.

NAF	Non-Acid Forming. Geochemical classification criterion for a sample that will not generate acid conditions.
NAF_{BARREN}	Non-Acid Forming and barren of sulfur (i.e. less than or equal to 0.1% sulfur).
NAPP	Net Acid Producing Potential, expressed as kg H_2SO_4 per tonne. Calculated by subtracting the ANC from the MPA.
Overburden	The waste rock material found overlying the first target coal seam within the stratigraphic profile.
PAF	Potentially Acid Forming. Geochemical classification criterion for a sample that has the potential to generate acid conditions.
PC Titrator	Potentiometric Compact Titrator. PC Titrators are specially designed for routine applications and simple operation, allowing basic titration analysis from a single device.
pH	A measure of hydrogen ion (H^+) concentration.
PSD	Particle size distribution.
S	Sulfur.
Slaking	Disintegration of unconfined soil or rock after exposure to air and subsequent immersion in water.
Sodic	Sodic soil and rock materials are characterized by a disproportionately high concentration of sodium (Na) in their cation exchange complex and are innately unstable, exhibiting poor physical and chemical properties, which impede water infiltration, water availability, and ultimately plant growth.
SO_4^{2-}	Sulfate.
Static test	Procedure for characterising the geochemical nature of a sample at a single point in time. Static tests may include measurements of mineral and chemical composition of a sample and the Acid Base Account.
TSS	Total suspended solids is a measurement of the suspended solids concentration in a water sample.
TS	Total sulfur content of a sample generally measured using a 'LECO' analyser expressed as total sulfur%.
w:v	Weight to volume ratio.

1 Introduction

RGS Environmental Consultants Pty Ltd (RGS) was commissioned by Eagle Downs Metallurgical Coal Pty Ltd to complete a geochemical and physical characterisation of drift spoil, coal and coal reject materials as part of baseline studies and the approvals process for the Eagle Downs Metallurgical Coal project (the Project). The Project is a proposed underground coal mine in the Bowen Basin, Central Queensland.

The Project lies immediately down dip from BMA's Peak Downs mine and directly north of the Eagle Downs South project. Other projects in the region include Whitehaven's Winchester South project, Pembroke's Olive Downs mine and Jellinbah's Lake Vermont mine, which lie on the eastern boundary of the Project. The Project is well serviced with supporting infrastructure with regional power lines and a water supply pipeline crossing the tenement.

The Project involves the construction, development and operation of an underground longwall metallurgical coal mine. Eagle Downs Coal Management (EDCM) is delivering the project under the Eagle Downs Coal Joint Venture, a joint venture between Aquila Resources and South32.

The Eagle Downs site is located approximately 20 km south of the mining town of Moranbah, in central Queensland (refer to **Figure 1-1**).

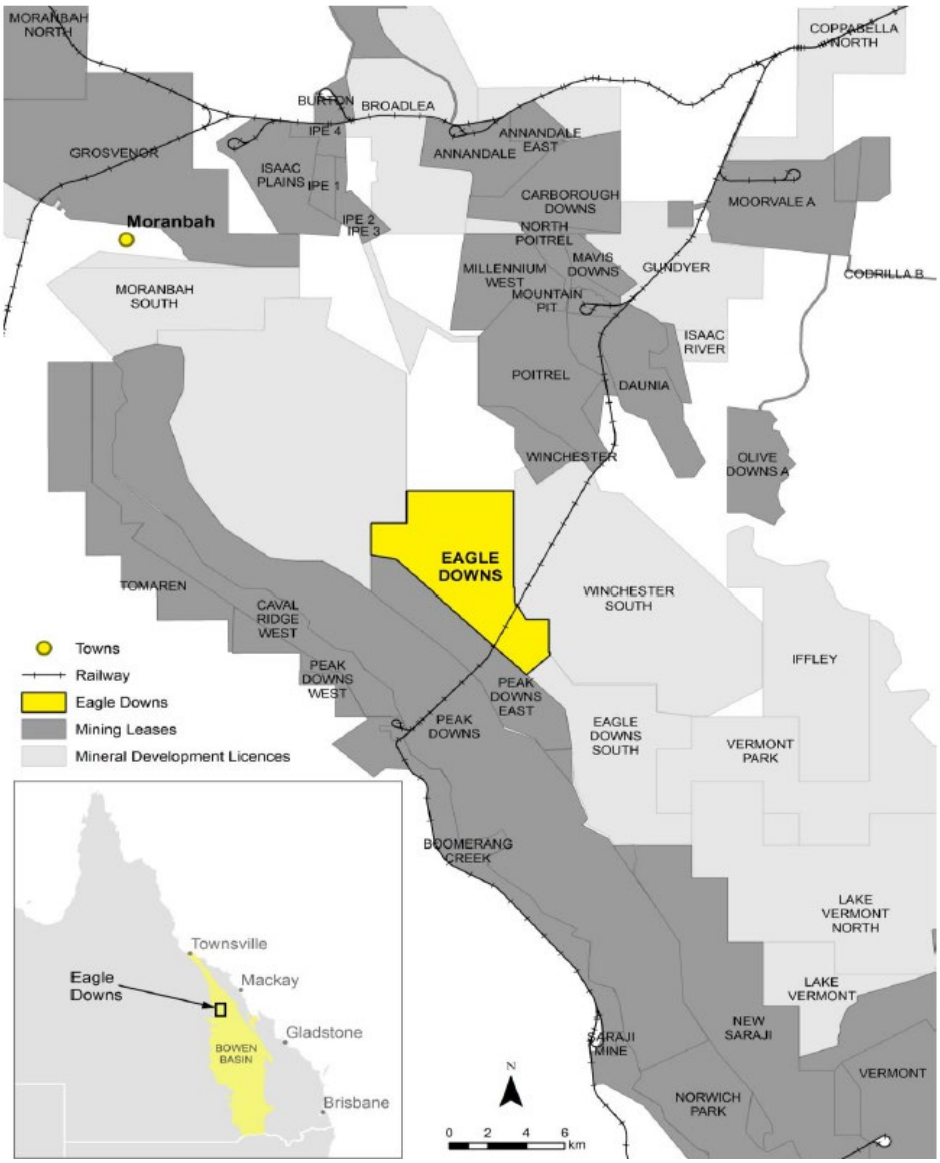


Figure 1-1: Eagle Downs site location

A Concept Study showed that the Moranbah Coal Measures are present throughout the mining lease area. An Initial Development Plan was submitted in 2007 and approved in 2011. The mining lease (ML70389) and Petroleum Lease (PL485) were also granted for the project in 2011 and 2014 respectively. The Mining Lease (ML70389) covers an area of approximately 4,550 ha and the associated Petroleum Lease (PL485), which is wholly within the mining lease, covers an area approximately 3,700 ha.

The mine has approval to extract up to 11 million tonnes per annum (Mtpa) of Run-of-Mine (ROM) coal. This would correspond to approximately 7 Mtpa of product coal. The anticipated life of the mine is 47 years.

The mine is currently under care and maintenance and construction completed to date is limited to the mine access road, partial excavation of the drift, some limited associated surface facilities, and coal seam gas drainage activities.

The Feasibility Study completed in 2020 has resulted in further optimisation of the surface infrastructure and underground mine design. Eagle Downs plans to produce coking coal from the Harrow Creek Upper (HCU), Harrow Creek Lower (HCL) and Dysart (DY) seams over a 47-year mine life, with 292 million tonnes in Proven and Probable reserves. Care and maintenance will continue for the Mining Lease while the Joint Venture Partners are reviewing the Feasibility Study outcomes and developing an investment strategy for the Project.

Currently, a key focus for EDCM is to proceed with the approvals required to allow the revised project to move to construction and operation.

In addition, EDCM is required to prepare a Progressive Rehabilitation and Closure Plan (PRCP) by 2 October 2023. The PRCP is required to meet the requirements in sections 126C and 126D of the *Environmental Protection Act 1994* (EP Act), pursuant to section 754 of the EP Act.

EDCM has appointed an environmental approvals consultant (RPM) for preparing the necessary documentation for the environmental approvals amendment application under the EP Act, and potential referral under the Commonwealth *Environment Protection and Biodiversity Act 1999* (EPBC Act) and the PRCP. EDCM is managing the delivery of the technical studies for this work.

1.1 Environmental Approvals

An Environmental Impact Statement (EIS) was completed for the mine in 2009. The mine was approved and an environmental authority (EA) EPML00586713 was granted in 2011. The EA has been amended several times since 2011 and the mine is currently operating under the EA which took effect on 16 December 2020. An approval under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (EPBC 2008/3945) was also obtained in 2011 for impacts on listed threatened species and communities within the project footprint. A surface water impact assessment was completed as part of the EIS.

The update to the mine plan during the feasibility study resulted in a revised surface infrastructure layout and underground mine plan. Some of these changes do not currently comply under the existing environmental approvals.

In 2020, an Environmental Approvals Strategy was prepared that maps the approvals pathway to allow for construction and operation of the mine plan proposed in the feasibility study.

The strategy consists of a four-staged approach, as at the time of preparing the approvals strategy, EDCM was planning to commence construction in 2021. The staged approach aimed to ensure that approvals were obtained for each phase of the project with minimum delay:

- Stage 1: Approval to commence early works construction
- Stage 2: Approval to commence construction for relocated surface infrastructure
- Stage 3: Approvals to allow revised underground mine layout and clearing for associated gas drainage to proceed
- Stage 4: Approvals of extension of longwall mining beyond the currently approved mining area.

The strategy commenced to be implemented in 2020, with preparation and submission of an application to amend the EA to allow the construction and operation of turkey's nest dam which was required to commence early works. At that time, re-commencement of construction was planned for early 2021.

The approval for Stage 1 was obtained in 2020 and the amended EA took effect 16 December 2020.

In line with the commitment to progress in a staged approach, works on the Stage 2 approval (revised surface infrastructure) commenced in early 2021. **Figure 2-1** shows the revised surface layout and proposed underground mine plan.

The proposed scope of the Stage 3 amendment application and potential EPBC Act referral is to gain approval for the updated underground mine layout and gas drainage infrastructure.

A revised underground mine plan for the mine has been approved by the Joint Venture participants in June 2021. EDCM engaged RPM as the approval's consultant for the works and work on the approvals has commenced.

On 16 June 2021, EDCM attended a pre-lodgement meeting with DES to discuss suitable timeframes for transitioning to a PRCP. EDCM proposed to DES that the PRCP will be based on the revised Life of Mine plan and not the plan approved in the EIS. It is expected that the PRCP will be aligned to the Stage 3 approvals submission for the EA. EDCM agreed to a submission date of a PRCP by 2 October 2023

A geochemical and physical assessment is required to support both the environmental approval amendment application under the EP Act and the PRCP. EDCM has commissioned RGS to complete the required geochemical and physical assessment for the Project. The RGS scope of works is provided in **Section 4** of this technical report.

2 Geology

The Eagle Downs project is located in the northern part of the Permo-Triassic Bowen Basin, containing principally fluvial and some marine sediments. The Moranbah Coal Measures are overlain by the Fort Cooper Coal Measures, Rangal Coal Measures (RCM) and the Late Permian to Early Triassic Rewan Group.

The Harrow Coal Upper (HCU), Harrow Coal Lower (HCL) and Dysart (DY) seams of the Moranbah Coal Measures from the principal economic coal resources of the Eagle Downs Project. The four coal seams in the project area are classified as medium to low density bituminous coal.

HCU Seam

The HCU seam averages 7.2 m thick in the project area and its depth varies from 240 m to 500 m below surface. The HCU seam is intruded in the northern half of the MDL area. The total sulfur content of the seam averages around 0.50 percent total sulfur (%S). There are five consistent plies in the HCU seam, defined by stone bands and coal brightness. The top ply (HCU_1) being higher in ash and poorer in yield. Plies HCU_2 and HCU_3 have the lowest ash; HCU_3 containing the brightest coal. HCU_4 is a thin stone band at the base of Ply 3. The moderately bright basal Ply 5 contains thin stone bands leading to slightly higher raw ash.

HCL Seam

The HCL seam averages 5.2 m thick in the project area and its depth varies from 280 m to 600 m below surface. Mid-burden between the HCU and HCL seam averages 33 m (range 27-40 m). The sulfur content of the seam averages around 0.41 %S. The seam is quite banded and there are up to 5 plys in the seam. Ply 4 is a stone ply near the base of the seam Selective mining of sub-plys may improve the ash level of the coal from this seam. The HCL seam whole seam raw ash averages 39 %, principally due to the high inherent ash and thick stone bands in Ply 4. Selective mining of Plies 1-3 will achieve better ash levels at the expense of lower coal volumes

DY Seam

The Dysart seam is present as a series of separate plies or seams, viz Dysart Upper (DU1, DU2) seams, Dysart seam (DY) and the Dysart Lower seams (DL). These vary across the area in both thickness and depth between seams. The DU1 and DU2 are typically 1.5 m and 1.0 m thick. The DU1 is 2 m to 4 m above the DY and the DU2 is 20 m to 30 m above the DU1. The sulfur content of the seam averages around 0.47 %S.

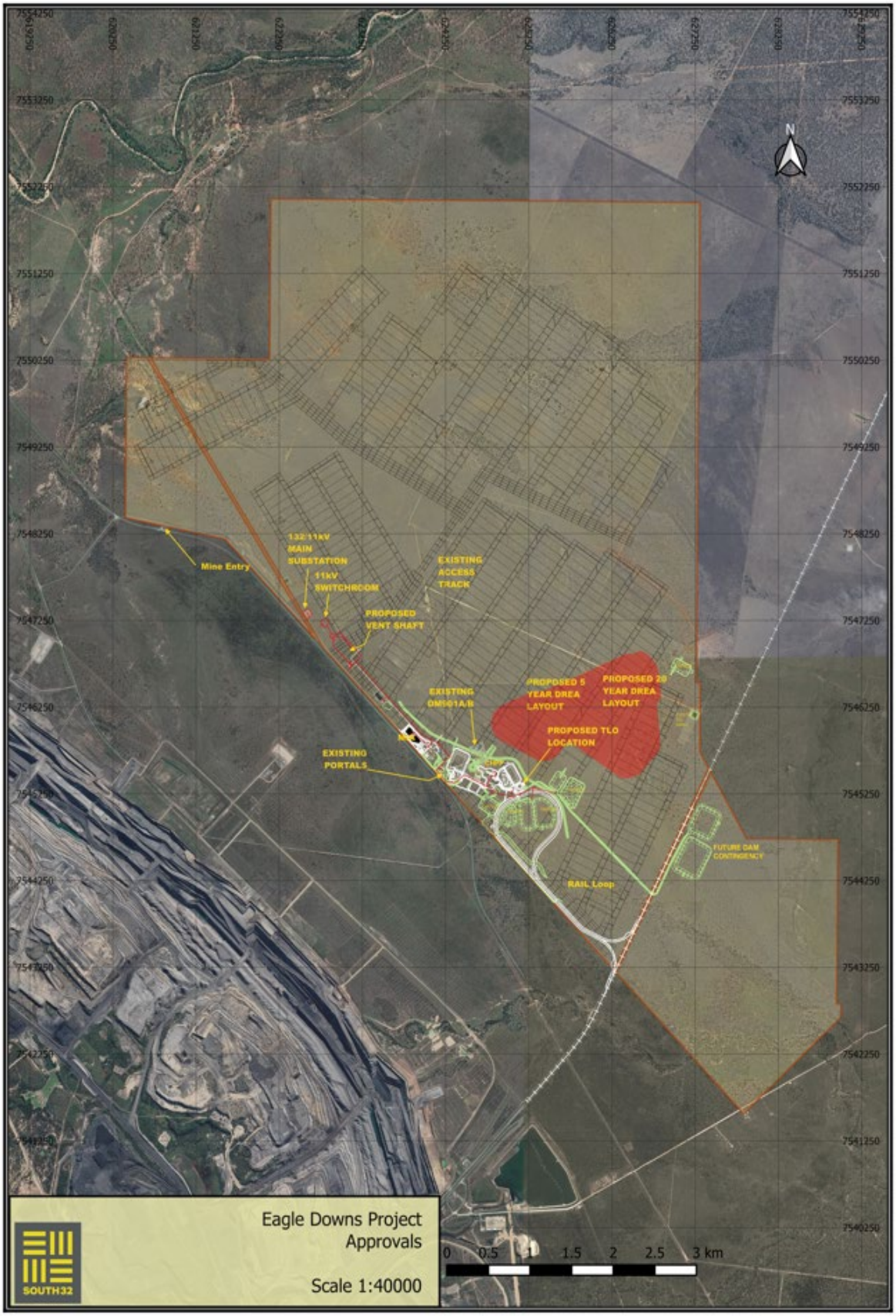


Figure 2-1: Proposed mine plan

3 Previous Reports

3.1.1 Peak Downs East Project (RGS, 2008)

RGS completed a geochemistry study of potential drift spoil and coal reject material at the Eagle Downs (Peak Downs East) project, located south of the Eagle Downs project in 2008 (RGS, 2008) for Hansen Bailey, as part of the EIS studies for the proposed underground Eagle Downs mine at that time.

The RGS 2008 study found both the potential drift spoil and coal reject materials likely to be generated at the Eagle Downs project to be relatively benign and likely to generate mildly alkaline surface run-off and seepage with relatively low salinity. Samples of both the potential drift spoil and coal reject materials had low total sulfur content and excess Acid Neutralising Capacity (ANC) and were classified as Non-Acid Forming (NAF). Given the low total sulfur content, excess ANC and expected mildly alkaline pH of the materials, it was considered that acid generation would be unlikely.

Water extract tests for the potential drift spoil and coal reject materials also indicated that the concentration of soluble metals and salts would remain within applied water quality guideline criteria. However, both materials were considered to be moderately to strongly sodic and expected to present engineering challenges if used for rehabilitation purposes.

3.1.2 Eagle Downs South Coal Project - MDL 519 (RGS, 2019)

In 2019, a geochemistry study of potential drift spoil and coal reject material from two drill holes in the southern part of the Eagle Downs South area was completed for Aquila (RGS, 2019).

The study found that potential drift spoil materials were classified as NAF, had excess ANC and negligible sulfur. Potential coal rejects (roof, floor, parting and coal) were also classified as NAF, although some samples had sulfur concentrations greater than background levels. These samples represent materials with a low risk of acid generation and a high factor of safety with respect to potential Acid and Metalliferous Drainage (AMD).

Water extract tests for the potential drift spoil and coal reject materials confirmed that soluble metals/metalloids were sparingly soluble and concentrations of these and soluble salts were expected to remain within the applied water quality guideline criteria. In addition, static and kinetic geochemical test results also indicated that surface runoff and seepage from drift spoil and low sulfur coal reject materials was likely to be moderately alkaline and have a low salinity value.

From a soil chemistry viewpoint, the study concluded that materials represented by the potential drift spoil and coal reject samples were likely to be alkaline. Most materials were predicted to be sodic and have some risk of being susceptible to dispersion and erosion, although it was suggested that these material characteristics could be improved by the addition of gypsum.

3.1.3 Eagle Downs South Coal Project - MDL 519 (RGS, 2021)

In 2021, a geochemical and physical assessment of representative samples of potential drift spoil, coal and coal reject material was completed for the inclusion in the Eagle Downs South Project baseline studies and approvals process (RGS, 2021).

The study found the overburden and interburden (spoil) samples were classified as NAF, had excess ANC and were essentially devoid of sulfur with very low risk of acid generation and a high factor of safety with respect to potential for AMD. The coal and coal reject materials typically had low to average sulfide sulfur content and excess ANC and were generally classified as NAF.

Water extract tests on the mine materials confirmed that most metals/metalloids are sparingly soluble at the moderately alkaline pH of initial contact water. Dissolved metal/metalloid concentrations in surface runoff and leachate from bulk materials were expected to be relatively low and unlikely to pose a significant risk to the quality of surface and groundwater resources at relevant storage facilities.

The study concluded that overburden and interburden (spoil) materials would be amenable to revegetation as part of rehabilitation activities, although gypsum, fertiliser and organic matter addition, topsoil addition, and contour ripping of a nominal rock mulch material may need to be considered for sodic materials on the steeper slopes of final landforms to limit the potential for dispersion and erosion and to provide a reasonable growth medium for revegetation and rehabilitation.

4 Scope of Works

RGS completed a static and kinetic geochemical testing program, the objective of which was to provide an improved understanding of the geochemical characteristics of mine materials (drift spoil, coal and coal reject) and any potential issues relating to AMD. Physical characterisation of selected drill core samples representing drift spoil materials was also completed to allow the stability of the materials used in the final landforms to be better understood and therefore provide a higher level of confidence that proposed surface structures are safe, stable and sustainable in the longer term, as required by PRCP guidelines

The geochemical and physical test program was completed to align with the requirements of applicable industry standards including Australian (AMIRA, 2002; COA, 2016) and international (INAP, 2022) technical guidelines used in the mining industry.

4.1 Purpose

The purpose of the work program is to:

- **comply** with mandatory requirements associated with coal mining projects in Queensland;
- **characterise** the geochemical and physical properties of drift spoil materials;
- **characterise** the geochemical properties of the coal and coal reject materials; and
- **classify** the relevant materials based on their geochemical and physical properties.

The outcome of the work can be used to:

- **define** potential impacts associated with material management;
- **provide** recommendations to reduce potential environmental impacts, if required;
- **validate** proposed mine waste rehabilitation strategies;
- **document** life of mine material management plans; and
- **provide input** into the PRCP

4.2 Tasks

The work program includes the following completed tasks below.

- **Task 1:** Provide advice and develop an appropriate sampling and geochemical/physical testing program for representative samples of drift spoil, coal, and coal reject materials from the Project
- **Task 2:** Coordinate static geochemical and physical testing programs at RGS and commercial laboratories.
- **Task 3:** Tabulate and interpret geochemical and physical test data
- **Task 4:** Reporting

4.3 Deliverable

The deliverable for the overall scope of work is this technical report which addresses Tasks 1 to 4.

5 Geochemical Sampling and Testing Methodology

This section provides a summary of the methodology used for the sampling and geochemical and physical characterisation of representative samples of mine materials likely to be generated at the site.

5.1 Investigation strategy

RGS worked closely with EDMC personnel to develop a strategy to collect and geochemically characterise representative samples of drift spoil, coal and coal reject materials. The drift spoil samples comprise overburden, interburden, roof, floor and coal samples from selected drill holes, which were sent to RGS to coordinate a series of geochemical and physical tests RGS and commercial laboratories. The coal reject samples were prepared by ALS Richlands coal quality laboratory from drill core representing working sections of target coal seams.

The sampling strategy and subsequent geochemical characterisation study for the materials from the Project were guided by Australian (DME, 1995; DEHP, 2013; COA, 2016) and international (INAP, 2022) technical guidelines for the geochemical assessment of mine materials.

5.2 Sampling program

A total of 57 samples comprising raw float-sink samples and drift spoil samples from Eagle Downs Project were collected and are listed in **Table 5-1**.

32 raw float-sink samples (22 coarse reject and 10 fine reject samples) were from the coal quality laboratory amassed from nine drill holes providing lateral coverage of the underground mining area to best represent the coal reject materials (mixed coarse reject and fine reject) likely to be produced at the mine and report to the coal reject surface storage area.

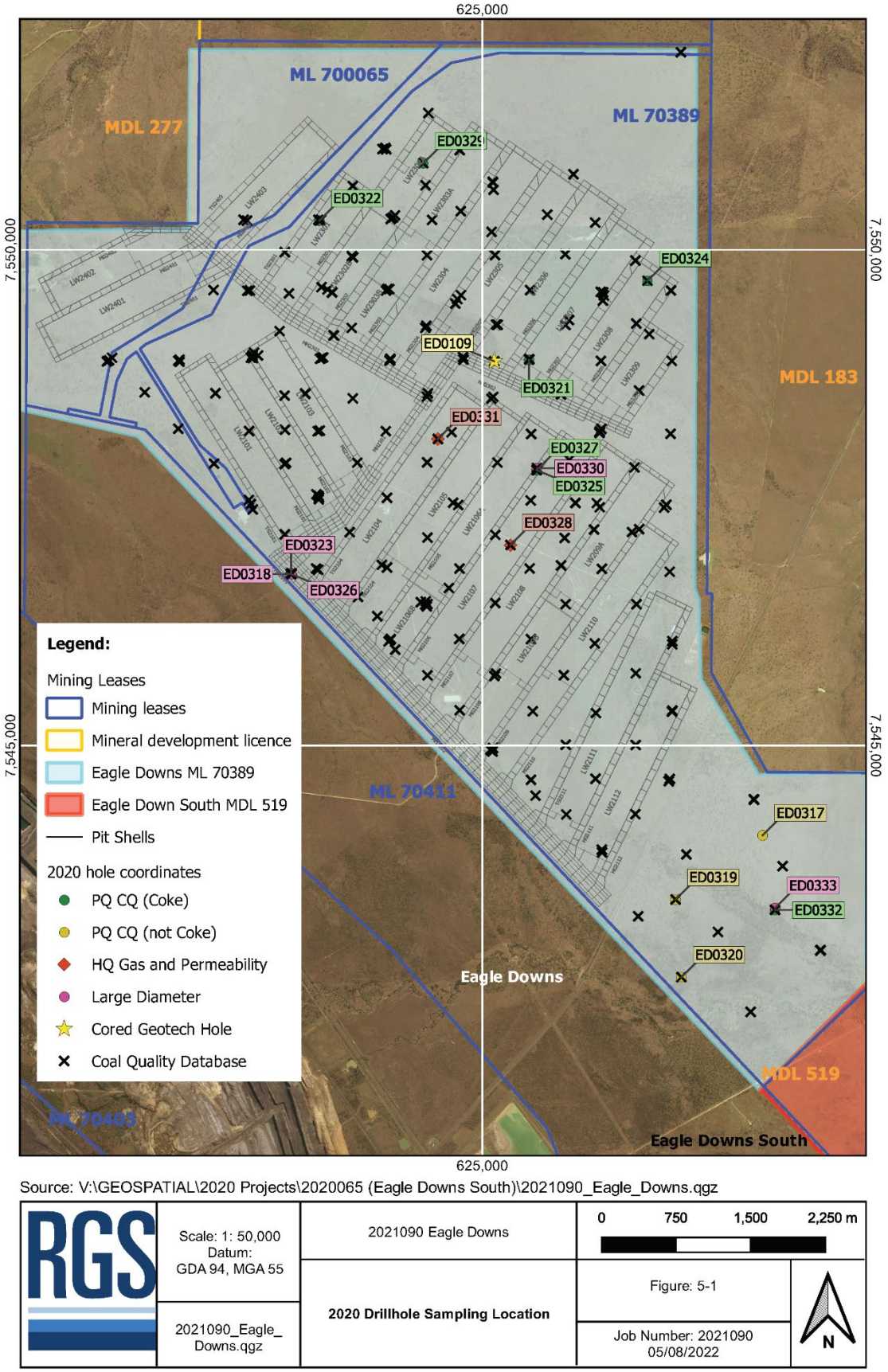
25 drift spoil and coal samples consisting of overburden, interburden, roof, floor and coal samples were obtained from an existing geotechnical drill hole.

The location of the 10 drill holes sampled at the Project is provided in **Figure 5-1**. The coal reject samples were generated from processing working sections of the HCU and HCL seams. The drift spoil samples from the geotechnical drill hole consists of overburden and interburden from sandstone, siltstone and mudstone lithologies, with carbonaceous and coal inclusions in sandstone, siltstone and mudstone generated for roof, floor and also uneconomic coal samples encountered in the drill hole from non-target seams.

The drift spoil, coal and coal reject samples were crushed and sub-sampled, and the sub-samples then pulverised to pass 75 µm sieve size, for static Acid Base Account geochemical testing. This standard laboratory procedure provides a homogenous sample, but also generates a large sample surface area in contact with the resultant assay solution, thereby providing greater potential for dissolution and reaction, and represents an assumed initial 'worst case' pore water scenario for these materials.

Table 5-1: Sample materials used for geochemical testing

Sample Description	Drill Hole ID	Min. Depth (m)	Max. Depth (m)	Number of Samples
Coarse Reject	ED0318, ED0321, ED0322, ED0324, ED0326, ED0329, ED0330,	-	-	22
Fine Reject	ED0322, ED0326, ED0329, ED0330, ED0332, ED0333	-	-	10
Overburden	ED0109	101.5	230.9	6
Interburden		254.5	406.8	9
Roof/Floor		281.5	414.8	6
Coal		173.9	375.0	4
Total				**57**



Source: V:\GEOSPATIAL\2020 Projects\2020065 (Eagle Downs South)\2021090_Eagle_Downs.qgz

RGS	Scale: 1: 50,000 Datum: GDA 94, MGA 55	2021090 Eagle Downs	0 750 1,500 2,250 m
	2021090_Eagle_ Downs.qgz	**2020 Drillhole Sampling Location**	Figure: 5-1 Job Number: 2021090 05/08/2022 N

Figure 5-1: Drill holes selected for geochemical sampling

5.3 Geochemical Test Program

5.3.1 Static geochemical tests

A series of static geochemical tests were completed by Australia Laboratory Services (ALS Stafford) on the 32 coal reject samples and 25 drift spoil and coal samples. The geochemical test program was designed to assess the degree of risk from the presence and potential oxidation of sulfides, acid generation and the presence/leaching of soluble metals/metalloids and salts.

A summary of the parameters involved in geochemical assessment of mining waste materials is provided in **Attachment A**.

The Acid Base Account was used to determine the acid-neutralising and acid-generating characteristics of the 57 drift spoil, coal and coal reject sample materials. The ABA program included static geochemical tests for the following parameters:

- pH (1:5 sample:water (w:v)) [AMIRA, 2002];
- Electrical Conductivity (EC) (1:5 sample:water (w:v)) [electrometric];
- Total sulfur [High temperature combustion method];
- Sulfide sulfur (Chromium Reducible Sulfur (Scr)) [Australian Standard AS 4969.7, 2008 method]; and
- Acid Neutralising Capacity (ANC) [Sobek method].

From the total sulfur and ANC results, Maximum Potential Acidity (MPA) and Net Acid Producing Potential (NAPP) values were calculated. The sample MPA was calculated using the total sulfur or sulfide (Scr) data. The Scr test provides a more accurate representation of the MPA that could be generated from a sample material, as acid generation primarily forms from the reactive sulfide content measured by this method. NAPP values were calculated using the MPA value balanced against the ANC.

Based on the results of the Acid Base Account tests received and interpreted by RGS, four composite samples of coal reject materials (two coarse reject and two fine reject) were prepared from the original 32 individual samples. In addition, four composite samples were prepared from the 25 individual drift spoil and coal materials (two overburden and interburden composites, and two roof, floor and coal composites) and subjected to multi-element analysis. The eight composites (Composites A – H) were selected based on material type, location and static geochemical characteristics.

The selected samples were be tested for:

- Total metals/metalloids: (Al, As, B, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Sb, Se, Th, U, V, Zn) [HCl and HNO_3 acid digest followed by FIMS and/or ICP-AES/MS];
- Total cations (Ca, Mg, Na and K) [HCl and HNO_3 acid digest followed by ICP-AES/MS];
- Soluble metals/metalloids (Al, As, B, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Sb, Se, Th, U, V, Zn) [ICP-AES/MS and FIMS (1:5 w:v water extracts)];
- Major cations (Ca, Mg, Na and K) [ICP-AES/MS (1:5 w:v water extracts)];
- Major anions (Cl, F and SO_4) [ICP-AES/MS and PC Titrator (1:5 w:v water extracts)]; and
- Titratable alkalinity and acidity [automatic titrator measured as $CaCO_3$]

Four composite samples of overburden and interburden samples (Composites E1, E2, F1 and F2) were then prepared and tested for exchangeable cations (Ca, Mg, Na and K) using [ICP-AES], and results were used to calculate the effective cation exchange capacity (eCEC) and exchangeable sodium percentage (ESP) of the sample materials. The composition of the composite samples selected for multi-element analysis, eCEC and ESP are provided in **Table B1** (**Attachment B**).

The raw laboratory test results for the static Acid Base Account, multi-element and exchangeable cation geochemical test program are provided in **Attachment E**.

5.3.2 Kinetic geochemical tests

Two composite coal reject samples (one coarse reject and one fine reject) and two composite drift spoil and coal samples (one overburden and interburden composite, and one roof, floor and coal composite) were prepared from the crushed portions of the original 57 individual samples and were subjected to Kinetic Leach Column (KLC) testing over a period of 24 weeks (from March to September 2022). The identity of the individual samples used to make up the four composite KLC samples (KLC 1, KLC 2, KLC 3 and KLC 4) is provided in **Table B1** (**Attachment B**).

The KLC test results can be used to predict the ongoing geochemical characteristics and likely quality of any leachate from the mine materials and assist with refining the planned methods for managing these materials in the field. Leachate collected from the KLC test program is analysed for:

- pH and EC;
- Acidity and alkalinity [PC Titrator];
- Dissolved metals/metalloids (Al, As, B, Cd, Cr, Co, Cu, Fe, Pb, Mn, Mo, Ni, Sb, Se, Th, U, V, Zn) [ICP-AES/MS];
    - Dissolved major cations (Ca, Mg, Na and K) [ICP-AES/MS]; and
    - Dissolved major anions (Cl, F, SO_4, alkalinity) [ICP-AES/MS].

The ALS test results for the kinetic geochemical test program are provided in **Attachment E**. Summary KLC results tables and trends are provided in **Attachment C** and discussed in **Section 6.5**.

5.4 Soil Class Characterisation

5.4.1 Cation Exchange Capacity (eCEC)

Cation Exchange Capacity (CEC) measures the capacity of a soil to hold and exchange cations, which provides a buffering effect to changes in pH and available nutrient levels (Hazelton and Murphy, 2007). Cation Exchange Capacity (CEC). The main ions associated with CEC in soils are the exchangeable cations calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^{+}) and potassium (K^{+}) (Rayment and Higginson, 1992), and are generally referred to as the base cations.

5.4.2 Exchangeable Sodium Percentage (ESP) and sodicity

Sodicity occurs when exchangeable sodium on the cation-exchange complex leads to clay dispersion in the soil (Hazelton and Murphy, 2007). The exchangeable sodium percentage (ESP) measures the proportion of cation exchange sites occupied by sodium. ESP is used in the classification of saline and alkali soils or to determine if a sodium hazard exists. Generally, samples with ESP values less than 6 % are considered non-sodic, greater than 6 % are considered moderately sodic, and greater than 14 % are considered strongly sodic and may be susceptible to dispersion and erosion (Isbell, 2002; Northcote and Skene, 1972). Sodicity is of interest as it can result in surface crusting and low infiltration and hydraulic conductivity within affected soils.

5.4.3 Soil classification plots

The ESP values (calculated from exchangeable cation results) and EC values were plotted on a soil class characterisation plot (shown in **Section 6.5**), with equations derived from a Sodium Absorption Ratio (SAR) and total cation concentration (TCC) soil class characterisation plot provided using the assumptions noted in **Table 6-5.** The relationship between the TCC (mmol (+)/L) and EC (dS/cm or µS/cm) is assumed linear for solutions with EC < 10 dS/m, i.e. TCC (mmol (+)/L) ~ 10 EC (dS/m) (Marchuk, 2013).

5.5 Physical Tests

The physical testing of mine materials helps to determine their engineering properties from a geotechnical and rehabilitation perspective. In many instances, an analysis of the physical properties of rocks can be used to interpret changes in geochemical behaviour over time, e.g. changes in permeability due to weathering. A summary of the physical test results is provided in **Section 6.6** and full test results are presented in **Attachment F** and **G.**

5.5.1 Particle Size Distribution (PSD)

The objective of the PSD analysis was to group an assembly of sample particles of various shapes and sizes into separate ranges of sizes and so determine the relative proportion by weight of each size range. The method employed sieving and sedimentation of a material/water/dispersant suspension to separate the particles. The sedimentation technique was based on an application of Stokes' law to a soil/water suspension and periodic measurement of the density of the suspension (Gee et al., 2002).

A total of 57 individual samples were mixed and used in KLC 1, KLC 2, KLC 3 and KLC 4 composites for the water quality KLC study described in **Section 6.8** and these composite samples underwent PSD testing. The PSD graph for each composite sample is a combination of dry sieving for coarse particles (0.075 to 150 mm) and hydrometer results for fine particles (0.0014 to 2.36 mm).

5.5.2 Soil texture classification

The geochemical and physical properties of a mine material (intended for use as a soil) are related to texture. Particle size and distribution will affect a material' capacity for holding water and nutrients. For example, fine textured soils generally have a higher capacity for water retention, whereas sandy soils contain large pore spaces that allow leaching.

Twelve major soil texture classifications commonly used are sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. These soil textures are classified by the fractions of sand, silt, and clay present in a soil sample. Loam is used to describe a texture that is roughly 40-40-20% sand-silt-clay and is generally desirable as it contains the advantageous drainage properties of each particle size.

Determining soil texture is often aided with the use of a soil texture triangle. One side of the triangle represents sand, the second side represents clay, and the third side represents silt. If the percentages of sand, clay, and silt in the soil sample are known, then the triangle can be used to determine the soil texture classification. The soil texture triangles for the four composites of crushed samples representing coarse rejects, fine rejects, overburden and interburden, and roof, floor and coal materials are presented in **Section 6.6.2**

5.5.3 Emerson Aggregate class test

The objective of the Emerson Aggregate test is to classify the behaviour of immersed soil aggregates, on their coherence in water. Testing is generally done only on soils with suitable aggregates. This test is usually performed on mudstones and siltstones, as sands and gravels may be too coarse and unsuitable (Craze et al., 2003, Emerson, 1967).

The four composite samples representing overburden and interburden (Composites E1, E2, F1 and F2) described in **Section 5.3.1** were subjected to Emerson Aggregate testing.

5.5.4 Point load strength

Point load testing is an index which measures the strength characteristics of intact rocks. After determining sample dimensions, the sample is loaded with uniformly increasing force so that a break generally occurs between 10 and 60 seconds. The strength index (I_s) is usually carried out on core samples of 50 mm diameter for which no correction is required ($I_{s(50)}$). However, if the sample has different dimensions, it is termed an 'irregular lump' and must be corrected. The application of such a correction factor introduces possible inaccuracy (Broch and Franklin, 1972).

Diametral load direction tests are a better estimate of uniaxial compressive strength indexing as there is less shape effects influence (Forster, 1989). Axial load direction tests are used to measure strength anisotropy. The strength anisotropy index ($I_{a(50)}$) refers to the ratio of median strengths in the strongest and weakest direction (Broch and Franklin, 1972).

Three drill core samples representing overburden (Sample 35) and interburden (Sample 41 and 46) were tested at Trilab laboratory and measured directly for load strength in axial and diametral load direction, (I_s), and then standardised ($I_{s(50)}$) by calculation.

5.5.5 Sodium soundness test

Three drill core samples representing overburden, interburden and roof materials (Samples 37, 44 and 48, respectively) were subjected to sodium soundness testing at the RGS in-house laboratory. This test determines the resistance of aggregate particles to disintegration or drying, after soaking in a saturated salt solution (12.14 g/L (NaCl, Na_2CO_3, $NaSO_4$)).

Each sample was first submerged in a solution of 24 g of sodium sulfate, 24 g of sodium carbonate, and 24 g of sodium chloride in 6,000 mL of deionised water (EC = 16.49 mS) for three weeks. The sample was then removed from the solution and left to dry for three weeks, and the cycle repeated three times (or until disintegration occurs). This process causes salt crystals to form in the aggregate pores, simulating accelerated weathering. Sodium soundness is a long-term weathering test that may require several months or longer to reach completion.

After completion of the test cycles and a final washing, each size fraction was again sieved and weighed to determine the percentage of mass lost by degradation during the process. A qualitative examination of the coarse aggregate classifies the degree of damage sustained by the particles. Test results are considered a preliminary estimate of aggregate suitability and are not used for outright rejection of the source.

5.5.6 Semi-Quantitative X-Ray diffraction

Semi-quantitative X-Ray Diffraction (XRD) tests were performed by Levay and Co. Laboratory in South Australia on two drill core spoil samples representing overburden (Composite E) and interburden (Composite F) with a Panalytical Aeris Powder Diffractometer, and linear Pixcel detector. Operating conditions were 40kV/15mA, Fe Kß filter, step scan 0.01/29 secs˚2Θ at, 1/2˚ divergence and a 1.0˚ ant-scatter slit. Scan range was 5° to 90° 2Θ. Phases were identified by computer search-match of the COD 2021 Database. Quantitative results were determined with full pattern Rietveld refinement software. Results from sedimented mounts were treated as per the USGS Clay Identification Flowsheet to ascertain the presence of smectite clay i.e., intercalation with glycol.

5.6 Coal quality database assay

Eagle Downs coal quality database assay data was provided by EDMC for three target coal seams from Harrow Coal Upper (HCU), Harrow Coal Lower (HCL) and Dysart (DY) seams of the Moranbah Coal Measures from the principal economic coal resources of the Eagle Downs Project. The coal quality database consists of assay from drill holes shown in **Figure 5-1**. Statistical analysis, histogram distribution and boxplots for the total sulfur results from the coal quality database, based on the three target coal seams were plotted and are provided in **Attachment D**.

6 Geochemistry of Drift Spoil, Coal and Coal Reject Materials

6.1 Acid Base Account test results

The Acid Base Account test results for the 57 samples of mine materials sorted by material type (i.e., coarse reject, fine reject, overburden, interburden, roof/floor and coal) are provided in **Table B2 (Attachment B)**. The methodology used in this section, including a description of the test methods, is explained in **Section 5.3** and a glossary of terms and acronyms used is listed on **Page V-VI**.

- **pH**: The pH of the samples tested ranges from 3.7-10.0 (i.e., in the acidic to moderately alkaline range) and has a median value of 9.3 (**Figure 6-1**). Most of the samples have a pH value greater than the deionised water used in the tests (pH 5.2), suggesting that at least initially, addition of some alkalinity to water in contact with most of these materials is likely. The pH of drift spoil samples (overburden, interburden, roof/floor and coal) typically has a small range of pH between 9.3 and 10. The main exception is a single roof sample from the PU seam (Sample 50) that has an acidic pH of 3.7.

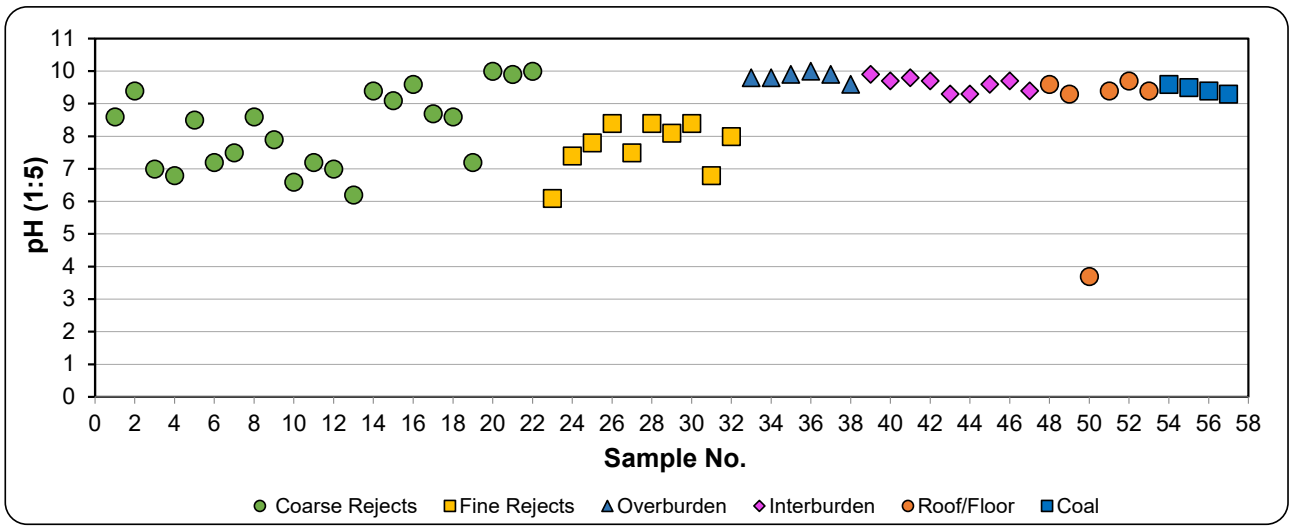


Figure 6-1: pH values for mine materials

- The EC value of the samples ranges from 18 to 1,960 µS/cm and is generally low (median 270 µS/cm) (**Figure 6-2**). The two samples with an EC value greater than 1,000 µS/cm are a coarse reject sample (Sample 10) and a roof sample from the PU seam (Sample 50). Hence, at least initially, most drift spoil, coal and coal rejects materials are likely to have a relatively low salinity value.

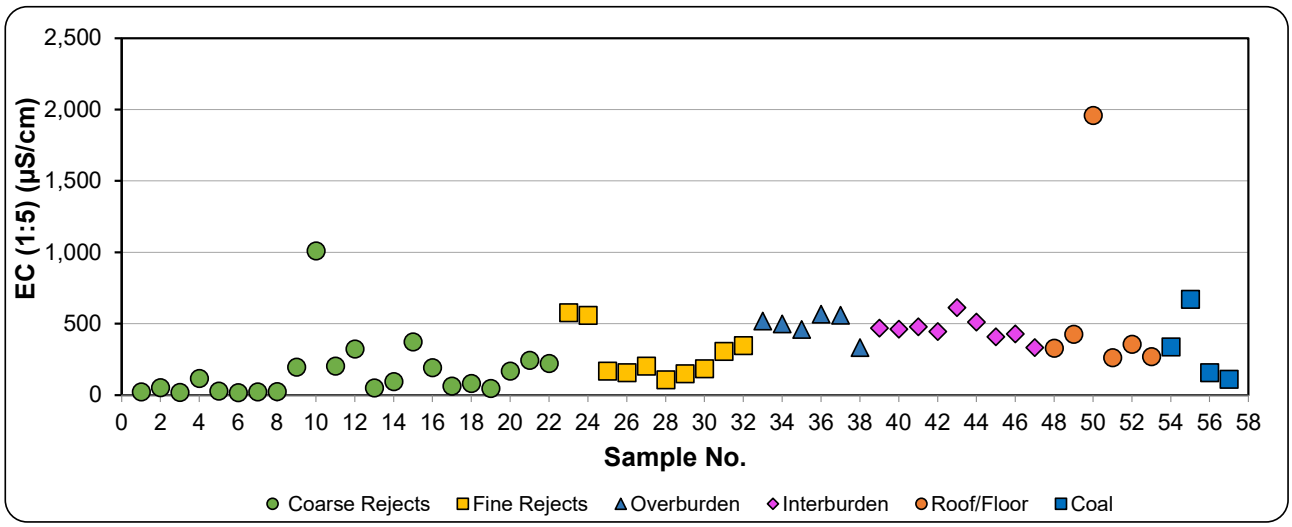


Figure 6-2: EC values for mine materials

To provide additional context, the pH (1:5) and EC (1:5) results are classified against pH and salinity criteria for mining waste materials, as defined by the Queensland DME (1995) technical guidelines for the environmental management of exploration and mining in Queensland (**Table 6-1**).

Based on the median pH and EC values, most samples tested are generally regarded as having 'Very High' soil pH and 'Low' salinity values.

Table 6-1: pH and Salinity Criteria for Assessment of Mine Materials

	Very Low	Low	Medium	High	Very High
pH (1:5)	**< 4.5**	**4.5 – 5.5**	**5.5 – 7.0**	**7.0 – 9.0**	**> 9.0** (Median 9.3)
EC (1:5) (µS/cm)	**< 150**	**150 – 450** (median = 270)	**450 – 900**	**900 – 2,000**	**> 2,000**

Note: Adapted from DME (1995). Highlighted cells show the category corresponding to the median pH and EC values (orange shading) for the Eagle Downs samples.

The pH and EC tests described above were completed on pulverised samples (≤ 75 µm) with a large surface area in contact with the leaching solution, thereby providing greater potential for dissolution and reaction, and represent an assumed 'worst case' scenario.

It is also expected that the salinity of leachate from low sulfur mining waste materials will diminish with time as salts are flushed from the sample matrix and a state of equilibrium develops. At that point, the salinity of seepage/runoff should stabilise at a lower asymptotic concentration relative to the weathering/erosion of the materials. The salinity of leachate from any higher sulfur mine materials may potentially increase, or remain at a similar value, if these materials are allowed to oxidise over time.

- **Total Sulfur**: The total sulfur content of the 57 samples ranges from 0.01 to 1.83 %S (**Figure 6-3)** and has a slightly elevated median value of 0.22 %S compared to median crustal abundance (0.1 %S) in unmineralised soils (INAP, 2022; Bowen, 1979).

  The median values of the overburden (0.04 %S), interburden (0.08 % S) and roof/floor (0.03 % S) samples are all low. The median value for coarse rejects (0.38 % S), fine rejects (0.29 % S) and coal (0.28 % S) are slightly elevated compared to median crustal abundance in unmineralised soils and typically show greater variation in sulfur content than the overburden, interburden and roof/floor material. Materials with a total sulfur content less than or equal to 0.1 % are essentially barren of sulfur, generally represent background concentrations, and have negligible capacity to generate acidity[1].

  The EDCM coal quality database contains total sulfur data on coal plys associated with the three target coal seams [Harrow Coal Upper (HCU), Harrow Coal Lower (HCL) and Dysart (DY)] at the Project and an interpretation of these data is summarised in **Attachment D**. In addition total sulfur isopachs have been prepared for the three target seams across the Project area that is planned to be mined using longwall mining methods and these are also provided and discussed in **Attachment D**.

- **Sulfide Sulfur:** The sulfide sulfur content of 39 selected samples with total sulfur content greater than 0.1 %S was also tested (as measured in the Scr test). The median sulfide sulfur values measured for the material types tested is coarse reject (0.03 %S), fine reject (0.09 %S), interburden (0.07 %S), roof (0.9 %S) and coal (0.06 %S) materials. **Figure 6-4** shows a plot of total sulfur versus sulfide sulfur for the mine materials. The results indicate that much of the total sulfur is likely to be present as organic sulfur which has negligible capacity to generate acidity. Some of the coal reject and coal samples have a reasonable proportion of their total sulfur (> 50 %) present as sulfide sulfur (e.g., pyrite or marcasite) and may have some capacity to generate acidity, although this would only occur in materials with low buffering capacity (ANC) .

[1] The median crustal abundance of sulfur (0.07 %S) has been rounded up to 0.1 % (INAP, 2022; Bowen, 1979).

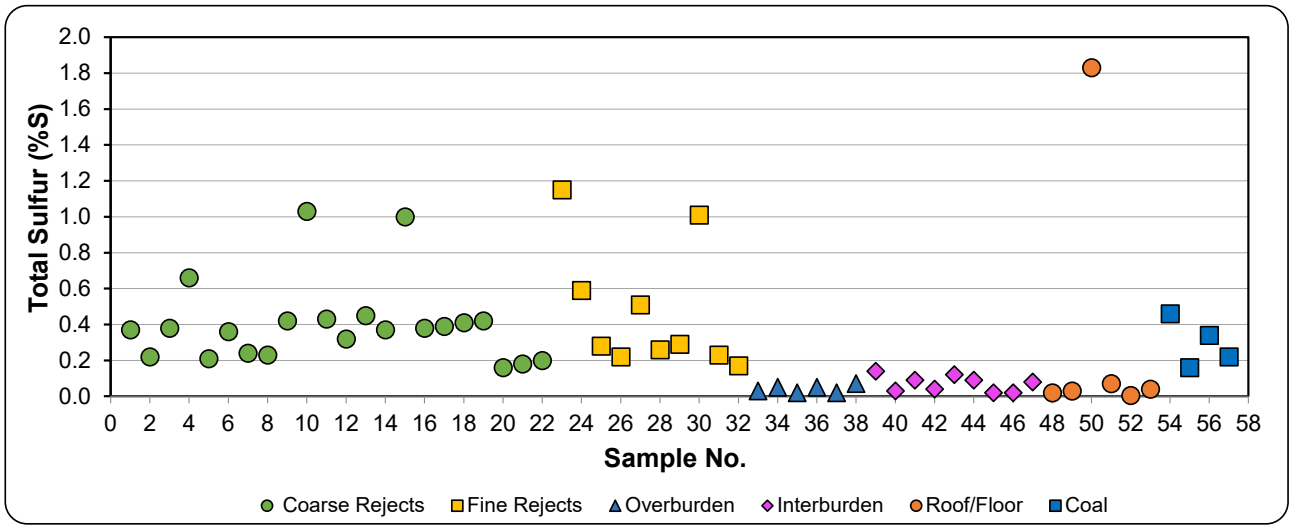


Figure 6-3: Total sulfur concentrations for mine materials

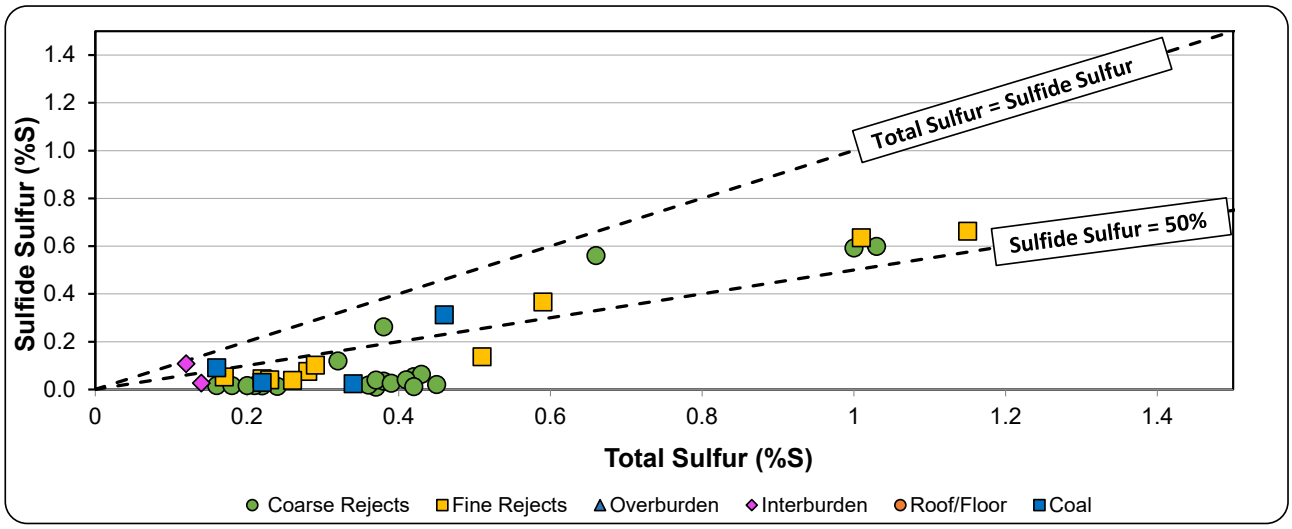


Figure 6-4: Total sulfur vs sulfide sulfur concentrations for mine materials

- **MPA**: Based on the sulfide sulfur content, the MPA that could be generated by the 57 samples of mine materials ranges from 0.2 to 26.6 kg H_2SO_4/t with a low median value of 1.3 kg H_2SO_4/t.
- **ANC**: The ANC value for the samples ranges from less than the laboratory Limit of Reporting (LoR) (0.5 kg H_2SO_4/t) to 503 kg H_2SO_4/t and has a moderate median value of 20.4 kg H_2SO_4/t. The highest ANC values are typically recorded for interburden samples followed by some of the overburden and fine reject samples and overall the median ANC value for mine materials is more than an order of magnitude greater than the median MPA value.
- **NAPP**: The NAPP is the balance between the capacity of a sample to generate acidity (MPA) minus its capacity to neutralise acidity (ANC). The calculated NAPP value for the 57 samples ranges from -502.1 to +26.3 kg H_2SO_4/t and has a negative median value of -1.7 kg H_2SO_4/t (**Figure 6-5**). Only two samples [a coarse reject sample from processing the HCU seam (Sample 4) and a roof sample from the PU seam (Sample 50)] have a positive NAPP value greater than +5 kg H_2SO_4/t and the remainder of the NAPP values for the samples tested are negative or close to zero.

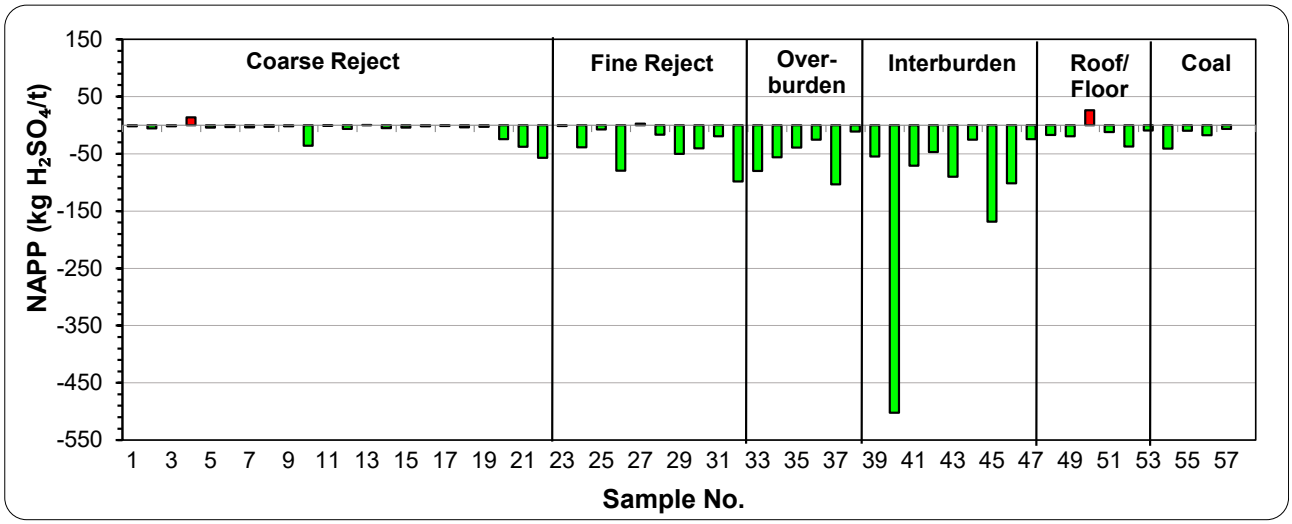


Figure 6-5: NAPP values for mine materials

- **ANC:MPA Ratio:** A plot of ANC vs MPA for the 57 samples of mine materials is presented in **Figure 6-6**. ANC:MPA ratio lines are shown to illustrate the factor of safety associated with the samples. Generally, those samples with an ANC:MPA ratio greater than 2 (and/or with a sulfur content ≤ 0.1 %S) are considered to have a low risk of acid generation and a high factor of safety in terms of potential for AMD.

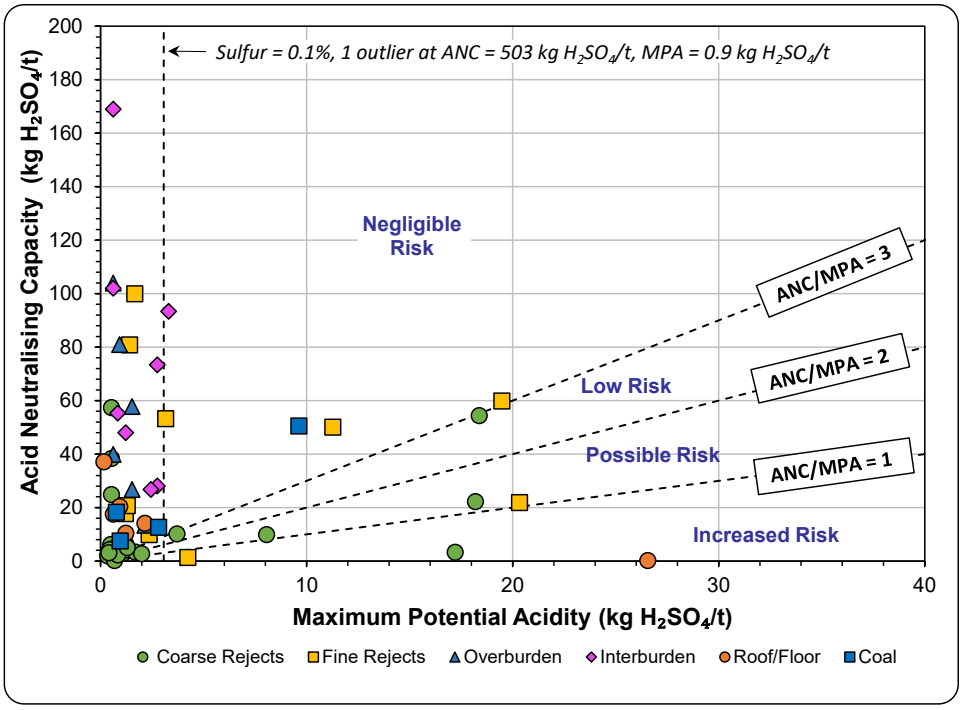


Figure 6-6: ANC v MPA for mine materials

The results in **Figure 6-6** indicate that most (51) of the 57 drift spoil, coal and coal reject samples (89.5 %) plot in the negligible/low risk domains and represent materials with a very low risk of acid generation and a high factor of safety with respect to potential acid generation. While three samples plot in the possible risk domain and three samples plot in the increased risk domain, only two samples [a coarse reject (Sample 4) and a PU seam roof sample (Sample 50) has sufficient sulfide content and insufficient inherent ANC to potentially generate any appreciable net acidity.

The Acid Base Account test data has been used to classify the acid forming nature of the mine materials represented by the 57 samples. These classification criteria generally reflect Australian (COA, 2016) and international (INAP, 2022) guideline criteria for classification of mine materials.

Table 6-2 provides a summary of the criteria used by RGS to classify the acid forming nature of the samples and a breakdown of the number of samples in each classification category by material type.

Table 6-2: Geochemical classification criteria for mine materials

Geochemical Classification	Total Sulfur[1] (%)	NAPP (kg H_2SO_4/t)	ANC:MPA Ratio	Coal Reject Samples		Drill Hole ED0109			
				Coarse Reject (n = 22)	Fine Reject (n = 10)	Over-burden (n = 6)	Inter-burden (n = 9)	Roof/ Floor (n = 6)	Coal (n = 4)
Non-Acid Forming (Barren)[2]	≤ 0.1	-	-	17	6	6	8	5	3
Non-Acid Forming (NAF)	> 0.1	< -5	-	2	2	0	1	0	1
Uncertain[3]	> 0.1	> -5 & ≤ 5	≤ 2	2	2	0	0	0	0
Potentially Acid Forming (PAF) – Low Capacity	> 0.1	> 5 & ≤ 10	< 2	0	0	0	0	0	0
Potentially Acid Forming (PAF)	> 0.1	> 10	< 2	1	0	0	0	1	0

Notes:

1. If total sulfur is less than or equal to 0.1 %, the NAPP and ANC:MPA ratio are not required for material classification as the sample is essentially barren of oxidisable sulfur.
2. A sample classified as NAF can be further described as 'barren' if the total sulfur and/or sulfide sulfur content is less than or equal to 0.1 per cent, as the sample typically has negligible acid generating capacity.
3. Samples that fall outside the stated classification categories based on the criteria provided are classified as Uncertain.

The data presented in **Table 6-2** illustrates that most (51) of the 57 coal reject samples have low sulfur content, excess ANC and are classified as Non-Acid Forming (NAF) and over two-thirds of these samples (45 samples) have a sufficiently low concentration of sulfur to be considered barren of sulfides and have a high factor of safety with respect to potential to generate acidic drainage. While four coal reject samples are classified as uncertain, any potential capacity for acid generation is very low. One coarse reject sample (Sample 4) and one sample of PU roof material (Sample 50) have elevated sulfur, low ANC and are classified as Potentially Acid Forming (PAF).

Overall, as a bulk mixed material, it is expected that the drift spoil, coal and coal reject will have excess buffering capacity and any potential for acid generation is likely to be very low. Notwithstanding, some of the drift spoil materials sourced from the roof of the PU seam and some of the coal reject materials may be a potential source of Neutral Mine Drainage (NMD) and these materials should be well managed at the project. For example any identified PAF materials should be stored within the central core of drift spoil landform(s) and should not report to the surface of final landforms.

6.2 Multi-elements in solids

Multi-element analysis has been completed on eight composite samples of mine materials (two coarse reject, two fine reject, and one each for overburden, interburden, roof/floor and coal samples) made up from the 57 individual samples of mine materials described in **Section 5.3**. The selection of samples was based on materials type and geochemistry. The individual samples used to prepare each composite sample are identified in **Table B1** (**Attachment B**).

The eight composite samples of mine materials have been tested to identify any elements (metals/metalloids) present in whole rock at concentrations that may be of environmental concern with respect to materials handling, storage, and/or water quality. To provide relevant context, RGS has compared the metal/metalloid concentration in whole rock samples with National Environmental Protection Council (NEPC) Health-based Investigation Levels (HIL(C)) for soils in public open spaces (NEPC, 2013).

The results from multi-element testing (total metals/metalloids) of the eight composite samples of mine materials are presented in **Table B2** (**Attachment B**). The results demonstrate that the concentrations of major, minor and trace elements in all samples are typically several orders of magnitude less than the applied NEPC guideline limits.

6.3 Assessment of element enrichment in solids

To provide additional context and in line with mining industry guidelines, the multi-element results described in **Section 5.3.1** were also compared to the typical background concentrations (median crustal abundance) of those elements (metal/metalloids) in unmineralised soils (COA, 2016; INAP, 2022).

The extent of enrichment is reported as the Geochemical Abundance Index (GAI), which relates the actual concentration in a sample with the median crustal abundance on a $\log_{10}$ scale. The GAI is expressed in integer increments from 0 to 6, where a GAI value of 0 indicates that the element is present at a concentration less than, or similar to, the median crustal abundance; and a GAI value of 6 indicates approximately a 100-fold enrichment above median crustal abundance (**Table 6-3**).

Table 6-3: Geochemical Abundance Index (GAI) values and Enrichment Factors

GAI	Enrichment Factor	GAI	Enrichment Factor
0	Less than 3-fold enrichment	4	24- to 48-fold enrichment
1	3- to 6-fold enrichment	5	48- to 96-fold enrichment
2	6- to 12-fold enrichment	6	Greater than 96-fold enrichment
3	12- to 24-fold enrichment		

As a general rule, a GAI of 3 or greater signifies enrichment that may warrant further examination. This is particularly the case with some environmentally important ‘trace’ elements, such as As, Cr, Cd, Cu, Pb, Se and Zn, more so than with major rock-forming elements, such as Al, Ca, Fe, Mg and Na.

Elements identified as enriched using the GAI may not necessarily be a concern for revegetation, drainage water quality or public health and the following points should also be noted:

- The median crustal abundance varies between different literature sources, therefore affecting the calculated GAI values.
- If a sample is enriched relative to the median crustal abundance, there is no direct correlation that the sample will also leach metals/metalloids at elevated concentrations. The mobility of metals/metalloids is dependent on mineralogy, adsorption/desorption and the environment in which it occurs.
- Whilst some element concentrations can be elevated relative to the median crustal abundance, the nature of a deposit means the background levels of some elements are generally expected to be elevated.

Similarly, because an element is not enriched does not mean it will never be a concern, because under some conditions (e.g., low pH) the solubility of common environmentally important elements such as Al, Cu, Cd, Fe and Zn can increase significantly.

Table B2 (Attachment B) provides total metal/metalloid concentrations for the eight composite samples of mine materials. The relative enrichment of metals/metalloids in these samples compared to median crustal abundance (the GAI) is presented in **Table B3 (Attachment B)**.

The results demonstrate that all major, minor and trace elements are not significantly enriched, have a GAI value less than 3, and do not warrant further examination.

The potential initial solubility and mobility of these elements in water extracts is presented in **Section 6.4**.

6.4 Multi-elements in solution

The potential initial solubility and mobility of the elements contained in the eight composite samples of mine materials was investigated further through water extract tests as described in **Section 5.3.1.** Using sample pulps (ground to passing 75 µm) provides a very high surface area to solution ratio, which encourages mineral reaction and dissolution of the solid phase. As such, the results of screening tests on water extract solutions are assumed to represent an assumed 'worst case' scenario for initial pore water that could interact with surface runoff and seepage from mine materials in the field.

RGS has compared the multi-element test results for water extracts from the eight composite samples of mine materials with ANZG (2018) water quality guideline values. These guidelines are provided for context only and are not intended to be interpreted as "maximum permissible levels" for site water storage or discharge. It should also be recognised that direct comparison of geochemical data with guideline values can be misleading. For the purposes of this study, guideline values are only provided for broad context and should not be interpreted as arbitrary 'maximum' values or 'trigger' values. Whilst arbitrary comparison against guideline concentrations can be useful in some situations and help to provide relevant context, such comparisons cannot be directly extrapolated to the field situation at the Project. Direct comparison against water quality guideline concentrations generally requires some form of numerical modelling of site conditions and input from a variety of disciplines including surface water hydrology and hydrogeology.

The results from multi-element testing of water extracts (1:5 solid:water) from the eight composite samples of mine materials are presented in **Table B4** (**Attachment B**).

The pH of the water extracts ranges from neutral (pH 7.6) to moderately alkaline (pH 9.9) with a median pH value of 9.2. Some composite samples have pH values slightly above the recommended range for 95 % species protection in freshwater aquatic ecosystems (pH 6 to 9). Based on these results, is expected that as a bulk material, the drift spoil, coal reject and coal materials will generate an initial pH value towards the upper end (or slightly greater than) the ideal pH range for freshwater ecosystems (6 to 9) and will contain excess alkalinity.

The EC value for the water extracts from the composite samples of mine materials is generally low relative to applied guideline values (median value of 443 µS/cm), and as a bulk materials, EC values in initial contact water are expected to be less than 500 µS/cm.

Most of the composite samples of mine materials have elevated alkalinity values, comparatively lower acidity values, resulting in a positive net alkalinity value. The excess alkalinity is mainly present as bicarbonate with smaller concentrations of carbonate being recorded.

The concentration of soluble major ions in most of the water extracts from the eight composite samples are relatively low and variable but are generally dominated by calcium, sodium, chloride and sulfate. The calcium and sulfate and fluoride concentrations in leachate are less than the applied livestock drinking water guideline values of 1,000 mg/L, 1,000 mg/L and 2 mg/L for these ions, respectively.

Dissolved trace metal and metalloid concentrations in the eight composite samples of mine materials are generally low with most of the results below the relevant laboratory LoR. Some water extract samples have dissolved concentrations of aluminium (5 samples), arsenic (3 samples), chromium (1 sample) and selenium (2 samples) marginally greater than the applied the freshwater aquatic ecosystems guideline trigger values (95 % species protection). However, all dissolved trace metal/ metalloid concentrations, apart from selenium in the water extract from one composite coarse reject sample (Composite A), are well within the applied livestock drinking water guideline values. While the slightly elevated concentration of dissolved aluminium in five of the water extracts may be at least partly due to a breakthrough of fine colloidal particles through the 0.45 mm filter used in the in the water extract laboratory preparation stage, an increased solubility effect is also likely as the pH in the relevant water extract samples is generally greater than pH 9.0.

Slightly elevated concentrations of some metals/metalloids in water extracts from composite samples of mine materials, compared to receiving environment water quality guidelines, is relatively common and cannot be directly extrapolated with what may occur in the field. It should also be noted that during sample collection and laboratory preparation, the physical agitation and mixing of the samples can affect the physical stability of minerals and increase their solubility in a "first flush" leaching event, such as a static water extract test, generally do not reflect the field situation at the Project where coal rejects of varying sizes will be dumped/stockpiled and rainfall/hydrological interaction with these materials is highly variable.

6.5 Water quality kinetic tests

KLC testing was completed on four composite samples of mine materials using the methodology described in **Section 5.3.2** and **Attachment A.** The composition of the four composite samples used in the KLC tests is provided in **Table B1** (**Attachment B**) and summarised in **Table 6-4**. The KLC tests were operated for a period of 24 weeks from March to September 2022 under a monthly watering and leaching regime. The KLC tests were operated following mining industry guidelines for such tests (AMIRA, 2002; COA, 2016).

The KLC results for the four composite samples are available for the 24 week test period with the final leachate pH and EC results shown in **Table 6-4.** The detailed KLC results and data trends over the test period are provided in **Attachment C**.

Table 6-4: Initial KLC test results for composite waste rock and ore samples

Sample Description	Classification	KLC Number	pH	EC (µS/cm)
Coarse Rejects	Non-Acid Forming	KLC 1	8.23	163
Fine Rejects	Non-Acid Forming	KLC 2	7.69	277
Overburden & Interburden	Non-Acid Forming (Barren)	KLC 3	9.69	472
Roof, Floor and Coal	Non-Acid Forming	KLC 4	8.89	488

The leachate results from the KLC test program are presented alongside Australian water quality guideline values for livestock drinking water quality (ANZG, 2018). These guidelines are provided for context only and are not intended to be interpreted as "maximum permissible levels" for site water storage or discharge. It should be noted that the KLC samples were crushed to pass a 10 mm sieve size, where required, and therefore have a high surface area for potential geochemical reaction. The ratio of sample to water in the KLC tests was approximately 2:1 (w/v) (i.e., concentrated), whereas the ratio of sample to water used in the water extract tests (**Section 6.4**) where results were arbitrarily compared against water quality guideline values to provide some context is an order of magnitude more dilute at 1:5 (w/v). Whilst arbitrary comparisons against guideline concentrations can be helpful in some situations to provide context, such comparisons cannot be directly extrapolated to the field situation at the Project.

The KLC leach test results obtained for the four KLC test materials are presented in **Attachment C**. Tables **KLC 1, KLC 2, KLC 3** and **KLC 4** provide the KLC test data for seven leach events (over 24 weeks), for the four composite samples classified as NAF/NAF(Barren) from static test results described in **Section 6.1**.

The KLC test results indicate that:

- Leachate from the KLC test representing overburden and interburden materials (KLC3) has a pH value in the range 9.44 to 8.97 over the test period. Whilst some pH fluctuations are noted within this range, the pH values are typically quite stable. These results indicate that pH values in pore water within bulk overburden and interburden materials, if exposed to weathering conditions are likely to remain within narrow and slightly alkaline pH range.
- Leachate from the KLC tests representing coarse rejects (KLC1), fine rejects (KLC2) and roof/floor/coal (KLC4) materials has a pH value in the range 5.46 to 8.02 over the test period. Whilst some pH fluctuations are noted within this range, the pH values are typically quite stable. These results suggest that pH values in pore water within these bulk mine materials, if exposed to weathering conditions, are likely to remain in the pH neutral range.

- Leachate from the coal rejects and interburden/overburden materials has an EC value in the range 103 to 576 µS/cm and remains relatively steady over the test period. Leachate from the roof/floor/coal materials has a higher EC value in the range of 909 to 1,780 µS/cm but shows a decreasing trend. These results indicate that the salinity of pore water that may interact with surface runoff and seepage at storage facilities is likely to be fresh to slightly brackish.
- The acidity in leachate from the four KLC tests over the test period is low (<1 to 22 mg/L, as $CaCO_3$). The alkalinity value is low in coal rejects and roof/floor/coal materials and is typically in the range of 4 to 48 mg/L, as $CaCO_3$ throughout the test period. Overburden and interburden material shows a higher higher alkalinity value in the range of 63 to 154 mg/L, as $CaCO_3$. Most net alkalinity values are positive (i.e., the alkalinity is greater than the acidity) in collected leachate throughout the test period. Minor exceptions include the initial leachates collected from coarse reject (KLC1) and the final leachate collected from roof/floor/coal (KLC4).
- The concentrations of major ions in leachate from the four KLC tests is relatively low and dominated by calcium, sodium, chloride and sulfate (and bicarbonate). Over the test period, the concentrations of major ions remains relatively consistent.
- The concentration of sulfate in leachate is relatively consistent throughout the test period and remains within the range of 23 to 215 mg/L for coal rejects, overburden and interburden material. The sulfate concentration in roof/floor/coal material is higher and in the range of 453 to 881 mg/L but generally shoes a decreasing trend.
- The sulfate concentration in all KLC leachate is less than the applied livestock water quality guideline criterion for this anion (1,000 mg/L) over the test period.
- The samples used in the KLC tests retain at least 88.3 % of their inherent total sulfur content after 24 weeks of exposure to idealised oxidising (wetting and drying) conditions, which indicates a slow rate of any sulfide oxidation for these materials.
- The KLC test samples retain at least 99.3 % of their inherent ANC value after 24 weeks of exposure to oxidising conditions, which reflects the slow release of alkalinity from these materials.
- The concentration of dissolved trace metals/metalloids in leachate from the KLC test samples is low and typically below the laboratory limit of reporting (LoR). This suggests that most trace metals/metalloids are sparingly soluble at the neutral to slightly alkaline pH of the KLC leachate collected from the sample materials. In addition, the measured dissolved metal/metalloid concentrations are mostly below the livestock applied water quality guideline values (ANZG, 2018). An exception is dissolved selenium, which can have a slightly elevated concentration compared to the applied livestock drinking water guideline in some of the leachate samples collected from coarse rejects (KLC1), interburden/overburden (KLC3) and roof/floor coal (KLC4). In addition the dissolved molybdenum concentration can be slightly elevated compared to the applied livestock drinking water guideline in a few of the leachate samples collected from interburden/overburden (KLC3).
- The sulfate generation rate results obtained for the four KLC samples have been used to determine the rate of sulfide oxidation in these materials. Most sulfate salts generated from sulfide reaction involving materials with a relatively low sulfide sulfur concentration are highly soluble, and therefore will be collected in column leachate. The dissolved sulfate (and calcium) concentrations in the KLC leachate are typically much less than the solubility limit of gypsum ($CaSO_4$), for example, which indicates that sulfate generation is not controlled by gypsum dissolution in the KLC test materials. Therefore, the sulfate concentrations and oxidation rate calculations provide reasonable estimates of these parameters and the results align well with existing static and dynamic geochemical data derived from a wide range of mine waste materials (AMIRA, 1995). The sulfate generation rate and associated sulfide oxidation rate for the three KLC tests are shown in **Table 6-5.**

Table 6-5: Sulfate Generation and Sulfide Oxidation Rates for KLC Tests on Mining Waste

KLC Sample Number	Sample Description	Sulfate Generation Rate (mg/kg/week)	Oxidation Rate (kg $O_2/m^3/s$)
KLC 1	Coarse Reject	12.7	5.5×10^{-9}
KLC 2	Fine Reject	8.9	3.9×10^{-9}
KLC 3	Interburden/Overburden	5.0	2.2×10^{-9}
KLC 4	Roof/Floor/Coal	39.7	1.7×10^{-8}

The sulfate generation rate from the KLC samples ranges from 5.0 to 39.7 mg/kg/week indicating that the rate of sulfide oxidation is moderate to low in most mine materials. The equivalent oxidation rate ranges from 2.2×10^{-9} to 1.7×10^{-8} kg $O_2/m^3/s$. Mine materials with an oxidation rate in the low range (i.e., less than 5×10^{-8} kg $O_2/m^3/s$) and a moderate ANC level have an increased factor of safety and are likely to generate leachate that is pH neutral or alkaline and/or has a low level of acidity (AMIRA, 1995; Bennett *et al*., 2000). Hence, all of the KLC composite samples tested fall into this category. Overall, the KLC results reflect the range of material characteristics predicted from the static geochemical test results presented in **Section 6.1**.

Potential implications of these results with respect to the management of drift spoil (overburden and interburden), coal and coal reject materials at the Project are discussed further in **Section 7**.

6.6 Cation Exchange Capacity and Exchangeable Sodium Percentage

The effective Cation Exchange Capacity (eCEC) and Exchangeable Sodium Percentage (ESP) results for four composite overburden and interburden samples (made up from of the 15 overburden and interburden samples described in **Section 5.3.1**) are presented in **Table B2** (**Attachment B**). The four samples were selected for testing as they represent sandstone, siltstone and mudstone overburden and interburden drift spoil material that could report to surface and potentially be used as part of site earthworks and rehabilitation activities.

The results indicate that the eCEC of the samples ranges from 5.3 to 12.2 meq/100g and is considered low (with a median value of 6.7 meq/100g), based on the classification criteria shown in **Table 6-6**. For mining materials with a low eCEC value, some fertiliser and organic matter addition may be advantageous to provide a reasonable growth medium for vegetation roots.

The ESP results for the samples range from 43.3 to 63.6 % and are considered elevated (with a median value of 56.6 %), indicating that materials represented by these samples are likely to be sodic and if used on steeper slopes of final landforms may be susceptible to dispersion and erosion.

Table 6-6: Ratings for eCEC and ESP

eCEC Rating	CEC (meq/100g)	ESP Rating[1]	Percentage (%)
Very low	<6	**Non-sodic**	< 6
Low	6 – 12	**Moderate**	6 – 14
Moderate	12 – 25	**Strong**	> 14
High	25 – 40		
Very high	>40		

Notes: 1. ESP ratings are based on Isbell (2002) and Northcote and Skene (1972).

6.7 Soil classification plots

The EC and ESP values for the four composite samples described in **Section 6.6** can be plotted on a graph (**Figure 6-7**) to predict the soil dispersion and assign a soil classification (Rengasamy, 1984; Marchuk, 2013).

Table 6-7 further describes the soil dispersion classification criteria and equation, based on relationships derived by Rengasamy et al. (1984) that characterized the surface soils which may disperse of flocculate under different electrolytic environments. The figure shows that three of the composite samples are Class 1, and one interburden sample in Class 2B and are likely to represent overburden and interburden materials that are sodic and may be prone to dispersion.

Overall, the results of the eCEC and ESP tests and in the soil classification plots, indicate that fertiliser and organic matter addition may need to be considered for surface materials on final landforms to provide a reasonable growth medium for revegetation and rehabilitation purposes.

In addition, the elevated ESP values are strongly influenced by the low calcium and magnesium concentrations in these samples rather than elevated sodium. The materials represented by the samples are likely to have elevated sodicity levels and may be susceptible to dispersion and erosion, although these characteristics may be improved to some extent by the addition of gypsum.

It is recommended that rehabilitation field trials be completed for drift spoil materials, if earmarked for use as part of site earthworks and rehabilitation activities, when bulk materials become available.

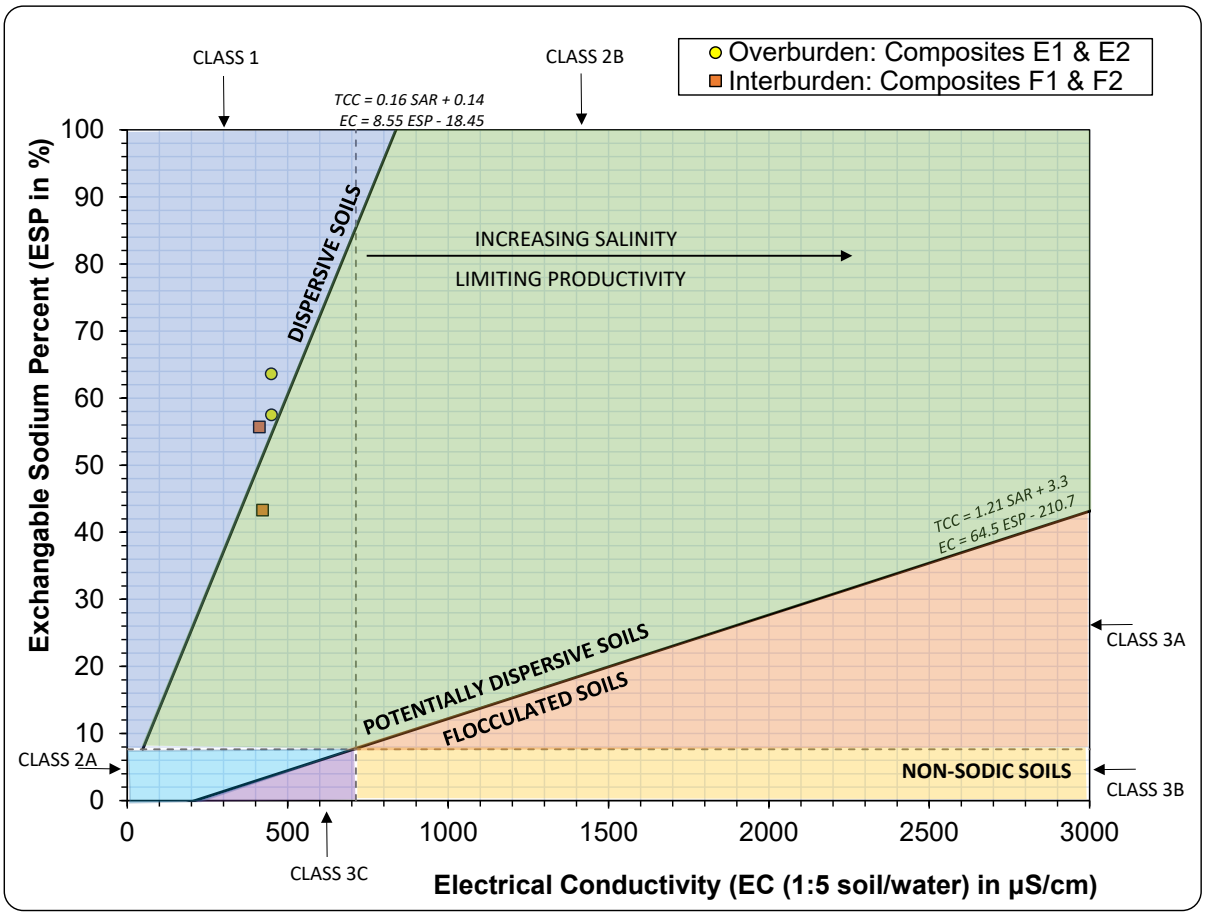


Figure 6-7: Soil classification for overburden and interburden

Table 6-7: Description of soil dispersion classification (Rengasamy et al, 1984)

Equation*	Horizon	Soil classes
Class 1: Dispersive Soil		
TCC < 0.16 SAR + 0.14	-	*Dispersive soils that disperse spontaneously in water. These are unstable, sodic soils that can have management and erosion problems*
Class 2: Potentially Dispersive Soils		
Potentially dispersive soils that disperse after the application of mechanical work either by raindrop impact, irrigation, or tillage. This was simulated by one hour of end to end shaking in the laboratory.		
TCC < 1.21 SAR + 3.3	SAR < 3	**Class 2A:** Soils that have few structural problems if managed using minimum tillage techniques or if maintained under continuous pasture growth
TCC < 1.21 SAR + 3.3	SAR > 3	**Class 2B:** Unlike Class 2a soils, these soils become spontaneously dispersive (Class 1) when leached without the addition of calcium compounds, and if there is no generation of electrolytes in the soil due to mineral weathering
TCC < 1.21 SAR + 3.3	SAR > 3	**Class 2C:** *(not shown)* Subsoil (B-horizon) that require higher electrolyte levels (3.19 SAR -1.7) m.e. L^{-1} to prevent dispersion. Potential severe surface structure problems than corresponding areas where the topsoil is retained.
Class 3: Flocculated Soils		
Flocculated soils that remain flocculated even when subjected to mechanical stress. Typical flocculation value of 7 m.e. L^{-1} or more (saturation extract EC of approximately 4 dS m^{-1})		
TCC > 1.21 SAR + 3.3	SAR >3	**Class 3A:** Leaching with low electrolyte water may change saline-sodic soil to Class 2b, or in extreme leaching to Class 1. Soils may then disperse and cause severe crusting
TCC > 1.21 SAR + 3.3	SAR<3, TCC>7	**Class 3B:** These soils are saline but dominated by non-sodium salts. These soils have no physical problems and the amount of leaching required depends on the salt tolerance of crops to be grown.
TCC > 1.21 SAR + 3.3	SAR<3, TCC<7	**Class 3C:** No dispersion and salinity problems occur where total cation concentration (TCC) is greater than 20

Assumptions: ESP and EC are linearly correlated to SAR and TCC, based on Original Plot by Rengasamy et al (1984) and Modified Plot by Marchuk (2013) and adhere to conditions listed in Hazelton et al (2007) below:

(1) The correlation between ESP and Sodium Absorption Ratio (SAR) depends on whether SAR is calculated from cation concentrations determined from saturated paste extracts or from 1: 5 soil/water suspensions. Cation concentrations based on paste extracts measurements has the approximate correlation of ESP ~ SAR, and a soil is sodic if SAR (1:5) > 5-6. Cation concentration based on 1:5 soil/water suspensions uses ESP ~ 2 x SAR approximate correlation, which means soil is sodic if SAR (1:5) > 2.5-3. ESP is based on 1:5 soil/water suspension.

(2) The relationship between Total Cation Concentration (TCC) (mmol/L) and Electrical Conductivity (EC) (dS/cm) is linear for solutions with EC < 10 dS/cm and can be expressed as TCC ~ 10 x EC. The EC for samples handled by RGS is below 10 dS/cm (100000 µS/cm). EC is based on 1:5 soil/water suspension.

6.8 Physical testing

Physical test results for the three drill core samples described in **Section 5.5.5** and the four composite KLC samples described in **Section 6.5** are presented in and summarised below. Results are shown by material type to facilitate interpretation.

6.8.1 Particle size distribution

A total of 57 samples that were mixed to generate samples KLC 1, KLC 2, KLC 3 and KLC 4 and these composite samples underwent PSD testing. The results for the four composites samples are shown **Figure 6-8** and the distribution of particle size across soil textural classes are shown in **Figure 6-9**.

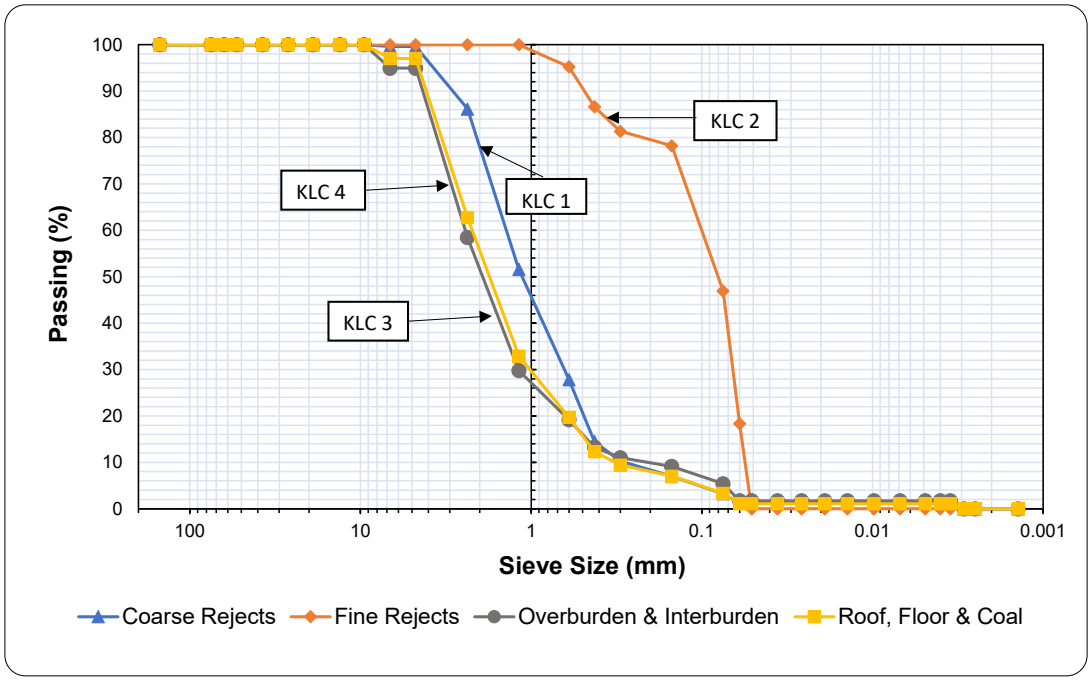


Figure 6-8: Particle size distribution of selected composites

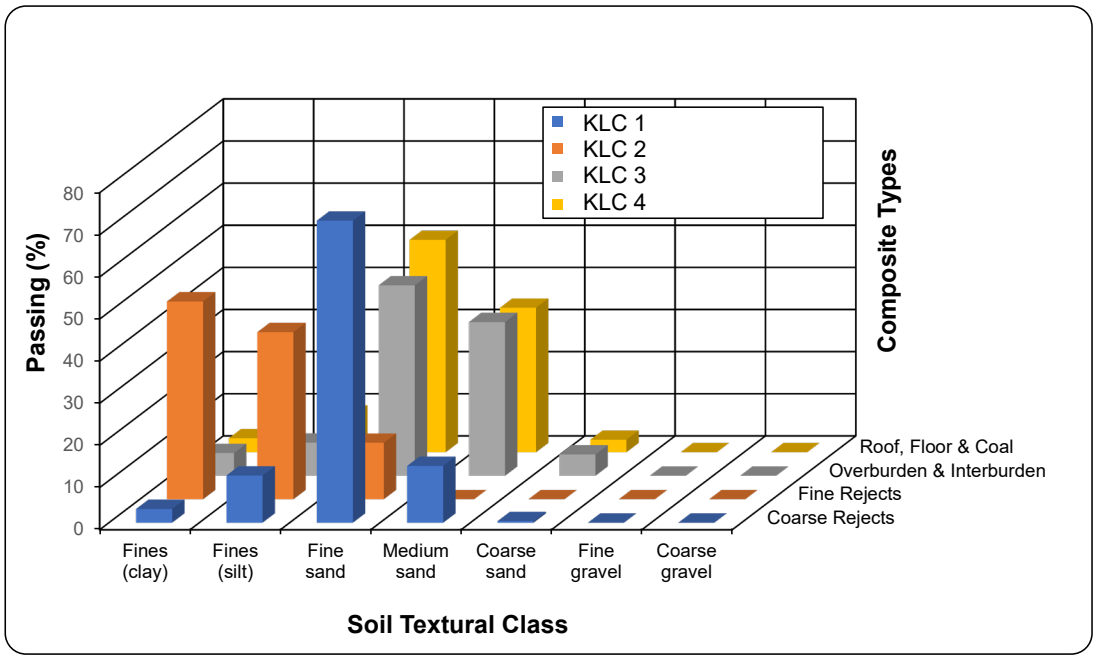


Figure 6-9: Distribution of particle sizes across soil textural classes in selected composites

The PSD graph (**Figure 6-8**) indicates that KLC 2 (fine rejects) has a finer particle size ($\Phi_{50\%}$ = 0.10 mm) compared to KLC 1, 2 and 3 ($\Phi_{50\%}$ between 1.15mm - 1.88 mm).

The soil textural class distribution in **Figure 6-9** for the four composite KLC samples are mostly sandy (>98%), categorised into medium sand, course sand, and fine sand (0.15 to 4.75 mm) with surface areas between 2.1 to 4.0 m^2/kg. KLC 2 (fine rejects) is the only exception with 9 % found in fine silt (0.15 to 4.75 mm) category with higher exposed particle surface areas of 18.3 m^2/kg. It should be noted that the KLC samples were crushed to pass a 10 mm sieve size and therefore have a relatively high surface area for potential geochemical reaction compared to that expected under drift spoil storage and potential reuse scenarios.

6.8.2 Soil texture classification

The premise for the soil texture classification is described in **Section 5.5.2**. Using the PSD results and proportions (0 – 100 %) of clay, silt, and sand, the four composite KLC samples representing the various mine materials have been plotted on a soil texture classification triangle (**Figure 6-10**). The results indicate soil texture are high in sand particles found in all composite samples.

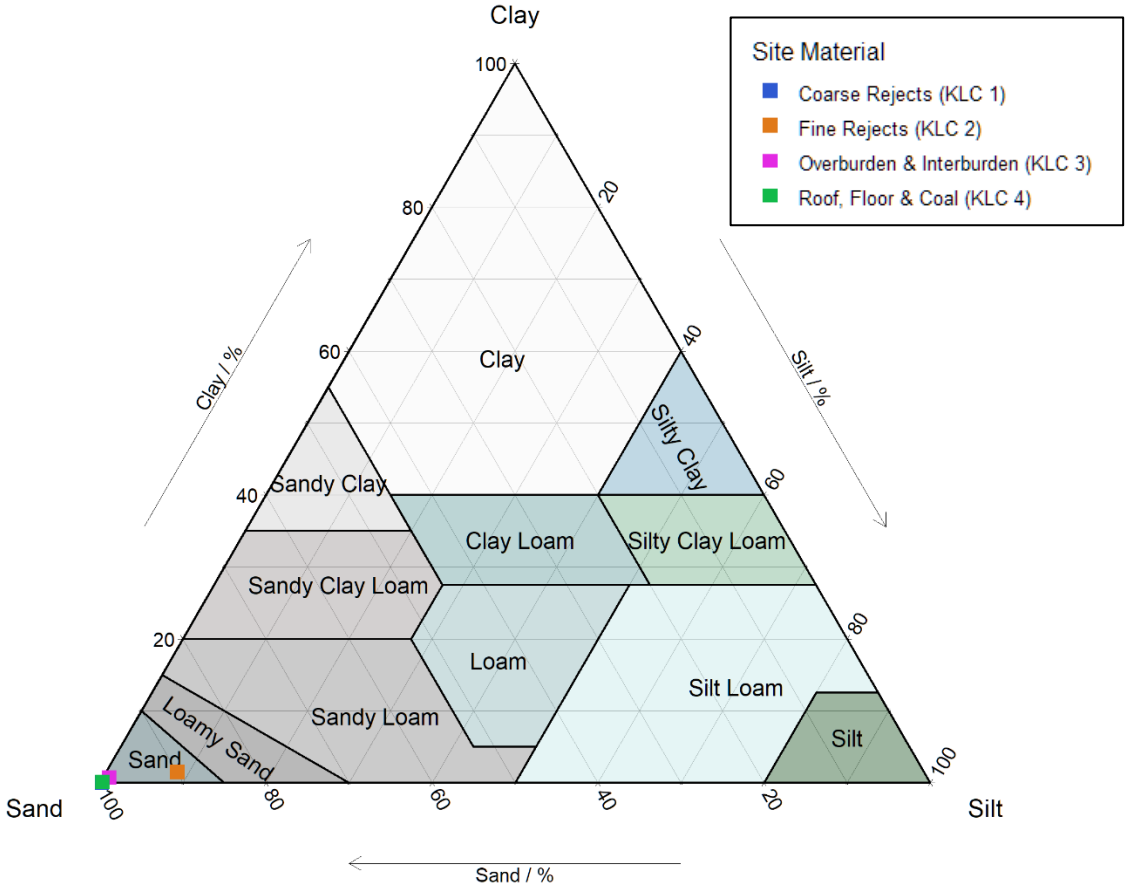


Figure 6-10: Soil texture classification triangle for Eagle Downs Project

6.8.3 Emerson Aggregate class

The four composite overburden and interburden samples (Composite E1 & E2, and Composite F1 & F2, respectively), described in **Section 5.5.3** were also subjected to the Emerson Aggregate test. It is important to note that the sands and gravel are usually found unsuitable for this test. Composites were described as Clay Loam Sandy/Sandy Clay Loam in gray and black. Composites E1, F1 and F2 are classed as Emerson Class 7-8 which represent materials with no slaking with potential swelling occurrence (**Table 6-8**).

Composite E2 is classed as Emerson Class 2 as samples may be sodic and dispersive (Hazelton and Murphy, 2007). Generally, materials represented by these samples should generally not be used on steeper slopes in final rehabilitated landforms. An ameliorant, such gypsum ($CaSO_4 \cdot 2H_2O$) and additives such as fertilizer and organic matter may also provide some benefit to these materials, if used in rehabilitation activities.

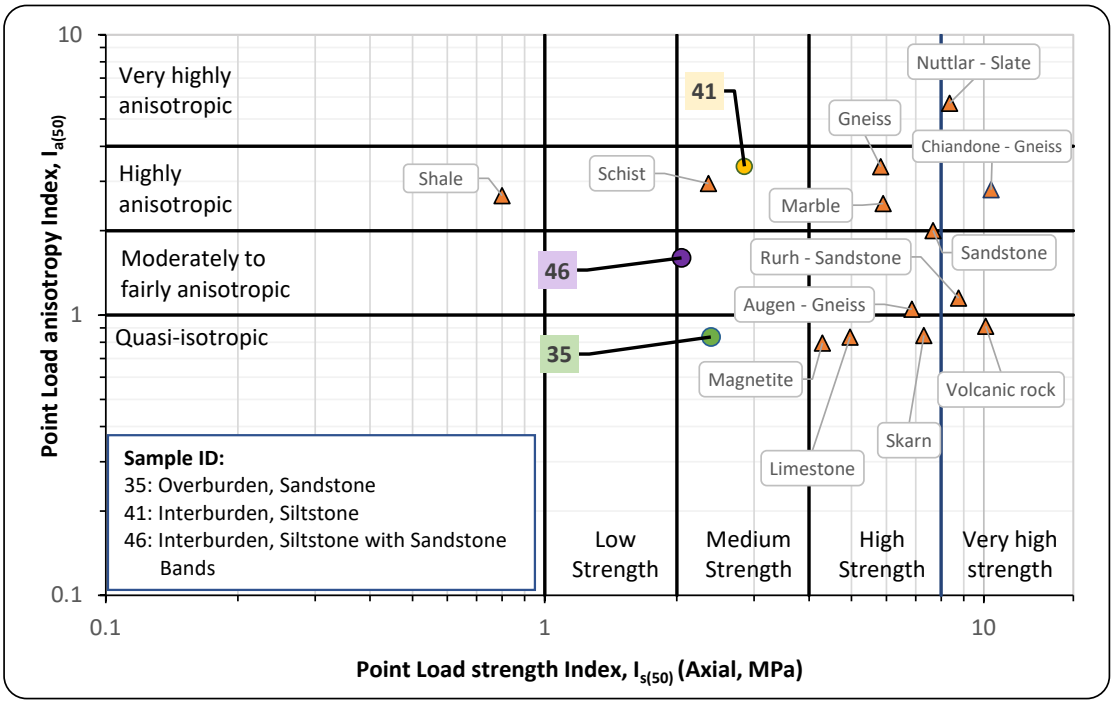
Table 6-8: Emerson Aggregate Class description

Class	Emerson Aggregate Class description
1	Slaking, Complete dispersion
2	Slaking, Some dispersion
3	Dispersion after remould at water content equivalent to Field Capacity
4	Slaking, with No Dispersion and Carbonate or Gypsum present
5	Dispersion (DP >= 6) after 1:5 soil-to-water suspension
6	Complete flocculation (DP< 6) after 1:5 soil-to-water suspension
7	Either Slaking and No dispersion, or No Slaking with Swelling
8	No Slaking with No Swelling

6.8.4 Point load strength

The diametral and axial point load strength of the three drill core samples representing interburden described in **Section 5.5.4** were analysed by Trilab laboratory. The load strengths (I_s) of the materials range from 0.77 to 2.85 MN/m^2 (or MPa). When a correction factor is applied to standardise the samples to have a 50 mm diameter, the corrected load strengths ($I_{s(50)}$) range from 0.84 to 2.86 MN/m^2 (median 2.22 MN/m^2).

Results are plotted against point load strength literature ranges in **Figure 6-11** (Broch and Franklin, 1972). The strength anisotropy index ($I_{a(50)}$) calculated is the ratio of axial to diametral point load strength index.



Notes: Graph of point load axial strength index ($I_{S(50)}$) against anisotropy index ($I_{a(50)}$) is based on study by Saroglou and Tsiambaos (2006) from a large range of literature data for slates, schists, gneisses, siltshales and mudshales with anisotropic characteristics of rock becoming less significant as degree of weather increases. The dataset references for literature rock types are:
1) Schist, Gneiss and Marble references Saroglou and Tsiambaos (2006)
2) Sandstone average by Khanlari, G., Rafiei, B. and Abdi, Y. (2014)
3) Limestone, Skarn, Volcanic rock and Magnetite by Hansson, S. (2015).
4) Pilbara-based Highly Weathered Shale by Gao, X. (2020)
5) Switzerland-based Augen and Chiadone Gneiss and Germany-based Nuttlar Slate and Ruhr Sandstone by Greminger (1982)

Figure 6-11: Variation of degree of anisotropy, I_{a50}, with axial point load strength, $I_{s(50)}$ (MPa)

Point load strength values for the three overburden and interburden samples are listed in **Table 6-9** and the complete data set is presented in Trilab Laboratory Data (Certificates of Analysis) **(Attachment F).**

Table 6-9: Point load test results

Sample No.	Stratigraphy	Lithology	Depth (m)	I_s (MPa)	$I_{s(50)}$ (MPa)	$I_{a(50)}$ (MPa)	Load Direction
35-D	Overburden	Sandstone	137.10-137.37	2.70	2.86	0.84	Diametral
35-A			137.10-137.37	2.49	2.39		Axial
41-D	Interburden	Siltstone	306.18-306.41	0.77	0.84	3.39	Diametral
41-A			306.18-306.41	2.85	2.85		Axial
46-D	Interburden	Siltstone with sandstone bands	404.56-404.91	1.19	1.28	1.60	Diametral
46-A			404.56-404.91	2.21	2.05		Axial

Figure 6-11 indicates the measurement of Sample 35 (overburden consisting of sandstone lithology) have point load strengths that are quasi-isotropic and at medium strength. Sample 35 has point load strengths equivalent to sandstone with strength designation falling between high strength for point load strength ($I_{s(50)}$) and strong for uniaxial compressive strength (UCS), with a very small range between the axial and diametral load direction strength. In contrast, samples 41 consisting of siltstone lithology show moderately to fairly anisotropic with medium strength, and sample 46 consisting of siltstone with some sandstone bands show highly anisotropic behaviour with medium strength.

Figure 6-12 shows the samples also have point load strength equivalent to mudstone/sandstone with strength designation falling between medium to high strength for point load strength ($I_{s(50)}$) and moderately strong to strong for Uniaxial Compression Strength (UCS), with the weakest and strongest load direction strength ($I_{s(50)}$) of 0.84 MPa and 2.85 MPa. Rocks with a high load strength may be resistant to weathering and suitable as rock armouring to reduce erosion on sloping surfaces.

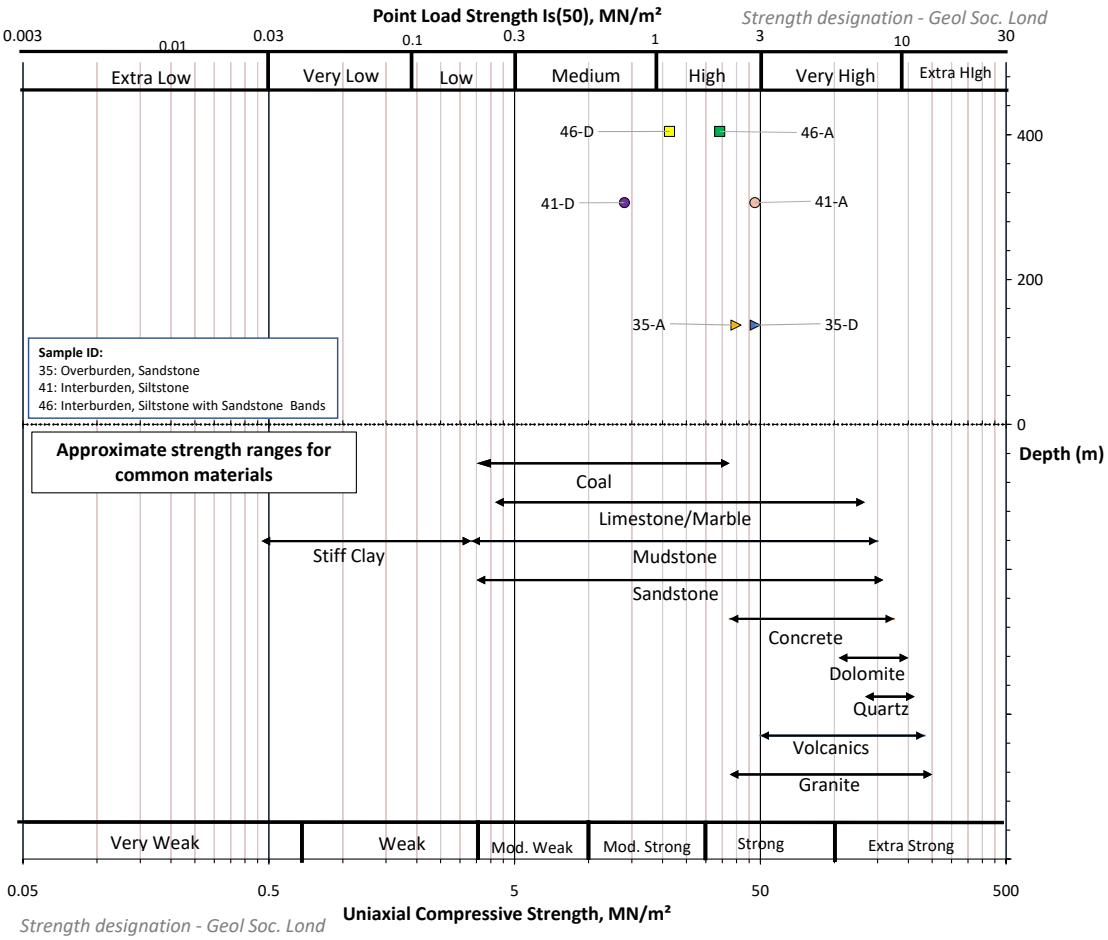


Figure 6-12: Point load strengths of overburden and interburden drill core samples

6.8.5 Sodium soundness test

Drill hole core samples representing overburden sandstone (Sample 37), interburden siltstone with fine grained sandstone (Sample 44) and roof siltstone (Sample 48) were subjected to sodium soundness testing at the RGS in-house laboratory. The rock samples were subjected to 5 complete cycles over a period of 4 months. The resistance to disintegration for three drill hole samples using the sodium sulfate soundness testing method is shown in **Figure 6-13** to **Figure** 6-15.

No significant degradation was observed for the overburden sandstone (Sample 37) material over the test period (<5 % change). The sodium sulfate soundness testing of sandstone in cyclic saturation show structural integrity through the soaking cycles. Sandstone overburden is reasonably competent and will not weather quickly. Aggregates that are durable (resistance to weathering) are less likely to degrade in field conditions when placed in stockpiles or in final landforms.

However, interburden siltstone with fine grained sandstone (Sample 44) and roof siltstone (Sample 48) show significant degradation from the 2nd cycle onwards (~70 % change). High absorptive and porous aggregate with siltstone waste rock composition is less competent and will weather faster in field conditions.

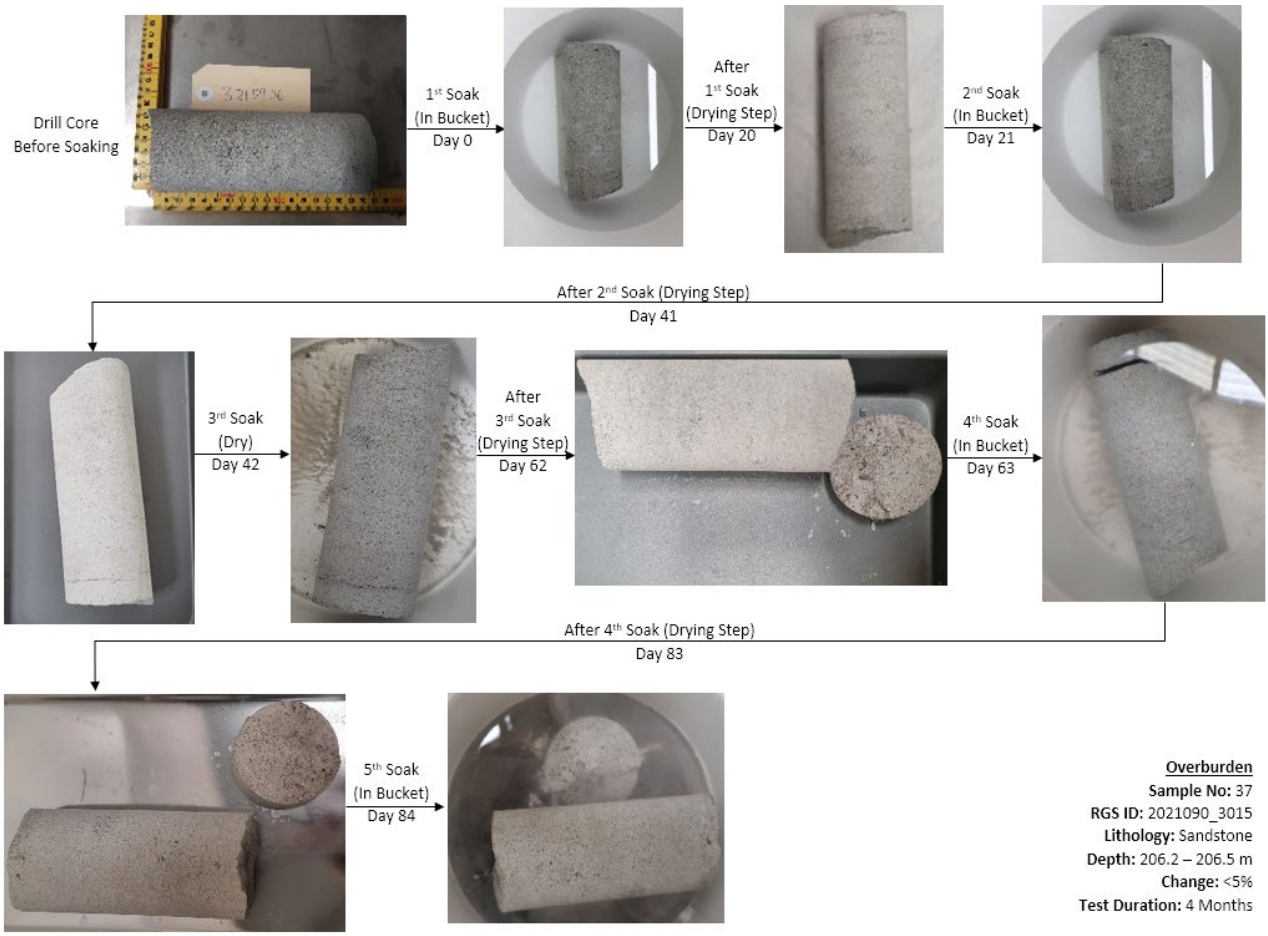


Figure 6-13: Sodium Soundness Test: Sample 37 (Overburden)

Hence, sandstone materials represented by Sample 37 are more likely to be suitable as rock armouring to reduce erosion on sloping surfaces of final landforms, if required.

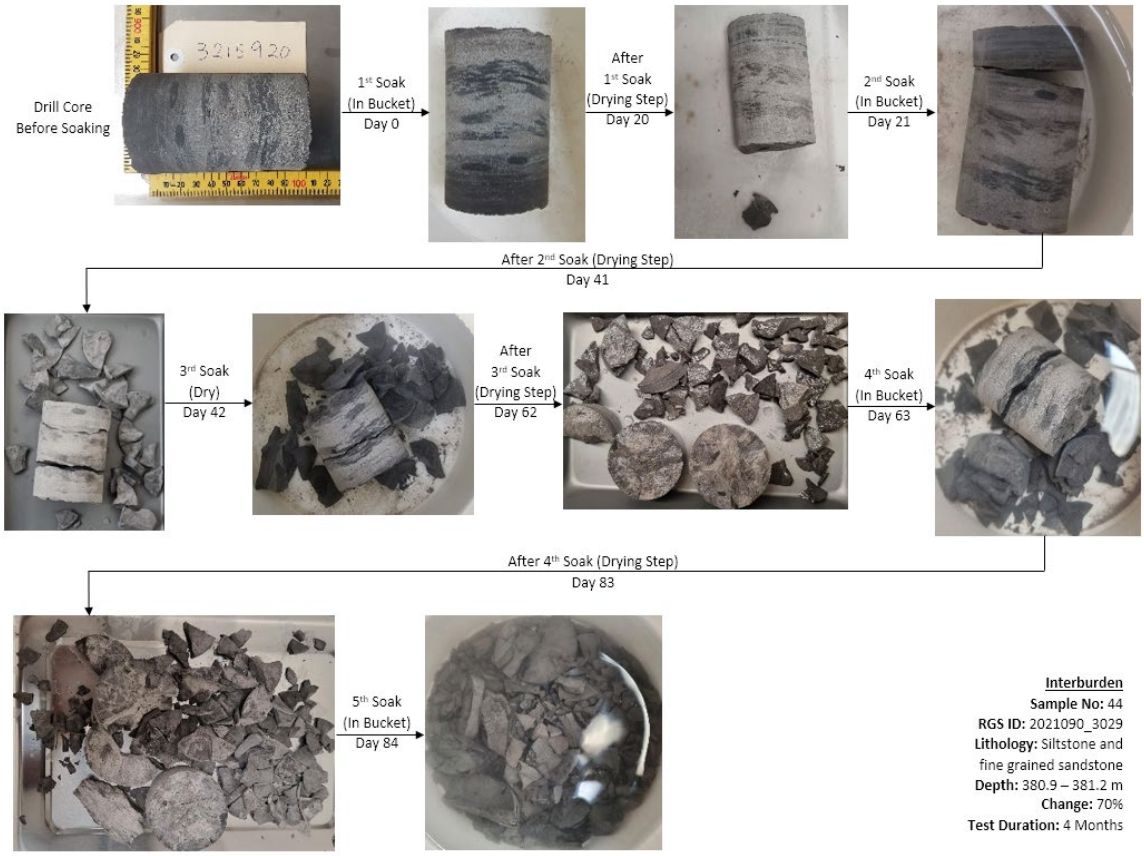


Figure 6-14: Sodium Soundness Test: Sample 44 (Interburden)

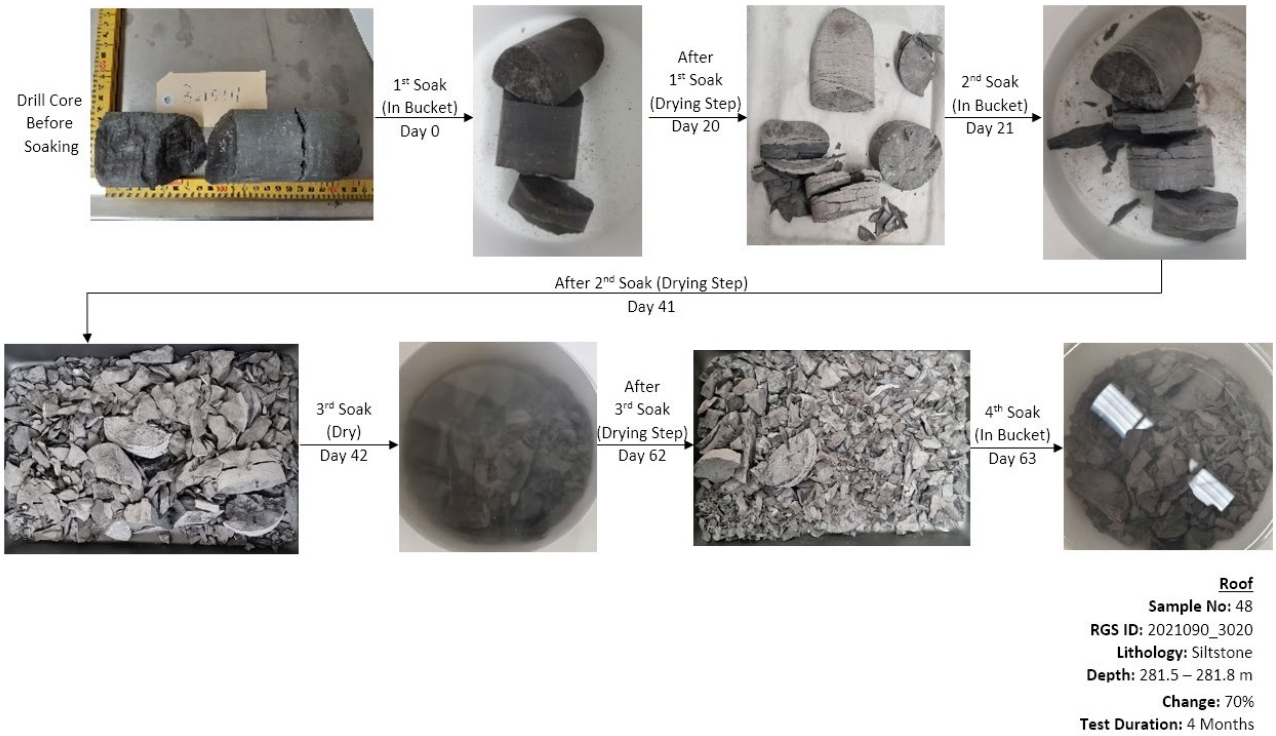


Figure 6-15: Sodium Soundness Test: Sample 48 (Roof)

6.8.6 Semi-Quantitative X-Ray Diffraction (XRD)

The two overburden and interburden samples described in **Section 5.5.6** were analysed by semi-quantitative XRD. The detailed test results are presented in **Attachment G** and indicate that their composition is dominated by silicate (including phyllosilicate and tectosilicate) minerals, in the order of quartz > illite > albite> kaolinite. Carbonate minerals are present at smaller amounts (<5 %), in the order of ankerite ~ calcite >> siderite, though carbonaceous coal consists of close to 20 % of both overburden and interburden mineralogy. The mineral Anatase is also present in very low amounts (<1%). Sulfide mineral is present in the form of pyrite and anhydrite although in very low concentration (<0.5 %), below the semiquantitative detection limit (**Table 6-10**).

Table 6-10: Semi-Quantitiative XRD Mineral Percentage in Eagle Downs

Sample I.D.		Composite E	Composite F
Lithology		Overburden	Interburden
Mineral Phase	**Classification**	**Mineral Percentage (%)**	
Quartz	Silicate	24.1	28.1
Albite	Plagioclase (Tectosilicate)	19.1	8.2
Illite*	Mica (Phyllosilicate)	29	26.2
Kaolinite	Clay (Phyllosilicate)	3.1	9.9
Amorphous-coal	Carbonaceous	18.1	17.3
Calcite	Calcium Carbonate	1.5	3.1
Ankerite	Complex Carbonate	1.6	4.6
Siderite	Iron Carbonate	0.1	ND[2]
Clinochlore	Magnesium-rich Chlorite	2.1	1.6
Anatase	Titanium Oxide	0.7	0.5
Anhydrite	Calcium Sulfate	0.1	0.1
Pyrite	Iron Sulfide	0.5	0.4

Notes: Semiquantitative Detection limit ~0.4 wt.%, N.D: Non-Detectable. * Illite and Mixed Layer Illite (I-S) are combined.

7 Discussion

7.1 AMD potential and management

The results of the ABA tests presented in **Section 6** indicate that the AMD potential of the material represented by the samples is closely linked to lithology within the stratigraphic profile and material type. The overburden and interburden materials that will report as drift spoil are generally classified as NAF, with excess ANC and are mostly devoid of sulfur. These samples represent materials with a very low risk of acid generation and a high factor of safety with respect to potential AMD. The only exception is a PAF roof sample from the uneconomic PU seam that may be intersected by the drift development. Material represented by this sample should report to the central core of the drift spoil landform(s) and not to the surface of final landforms to eliminate the risk of NMD.

Coal, potential coal reject (roof, floor), and coal reject materials (coarse and fine) are also generally classified as NAF, although some samples have sulfur concentrations elevated above background concentrations. While one coal reject sample derived from processing the HCU seam was classified as PAF, it is expected that there will be sufficient inherent ANC in bulk materials for coal rejects to be classified as NAF. If left exposed to oxidising conditions, roof/floor/coal and coal reject materials with elevated sulfur content may have the potential to generate leachate containing higher concentrations of sulfate (NMD). It is therefore recommended that coal reject and any other materials identified as PAF also report to the central core of any spoil storage area away from the outside surface of the final rehabilitated landform(s).

As coal materials will only remain stockpiled at the run-of-mine (ROM) area for a short period of time, management of this material should involve regular collection and monitoring of any surface runoff and seepage from this area. The potential for any connectivity between any surface runoff or seepage from the coal stockpiles at the ROM and any groundwater resources should also be evaluated.

If the management recommendations for mine materials in this section are implemented, it is expected that the risk any adverse environmental outcomes will be very low. This mine material management strategy described in this section has successfully been employed at several coal mines within the Bowen Basin.

7.2 Multi-element composition and water quality

7.2.1 Multi-element composition and enrichment

The multi-element concentration of the metals/metalloids present in the mining materials are presented in **Section 6.4**. The results indicate that the sample materials typically have low total metal and metalloid concentrations in solids, mostly below the laboratory limit of reporting (LoR) and all well below the applied NEPC (HIL(C)) guideline for soils.

Comparison with median crustal abundance values in unmineralised soils indicates that the mine materials are not significantly enriched with metals/metalloids.

7.2.2 Water quality

The static and kinetic geochemical test results indicate that pore water that has the potential to interact with surface runoff and seepage from mine materials is likely to be pH neutral to moderately alkaline and have a relatively low salinity value. Multi-element testing of water extracts and KLC test leachates indicate that pore water quality is likely to remain withing livestock drinking water guideline values (ANZG, 2018).

While minor exceptions may include dissolved selenium and molybdenum, as a precautionary measure, it is recommended that these metalloids be included in the suite of parameters measured in the site water quality monitoring program as part of the Water Management Plan.

Overall, is expected that the potential risk of any significant impact on the quality of surface and groundwater water from water in contact with material represented by the test samples at the Project will be low. Notwithstanding, higher sulfur materials, if left exposed to oxidising conditions, may have the potential to generate brackish leachate containing elevated concentrations of sulfate. Hence, coal reject and any other materials identified as PAF should report to the central core of any spoil storage area away from the outside surface of the final rehabilitated landform(s).

As discussed in **Section 7.1**, coal materials will only remain stockpiled at the ROM area for a short period of time, and the management of this material should involve regular collection and monitoring of surface runoff and seepage from this area. The potential for any connectivity between any surface runoff or seepage from the coal stockpiles at the ROM and any groundwater resources should also be evaluated.

7.3 Physical characteristics and rehabilitation

Dispersive materials can impact surface water environments through increasing the sediment load present in surface waters, increasing the turbidity of surface waters. Overall, the results of the physical characterisation tests described in this report indicate that most of the overburden and interburden materials are expected to be sodic and under some circumstances (e.g., if siltstone dominant overburden were to be used on steeper slopes in final landforms) may be susceptible to dispersion and erosion.

The cation exchange results on overburden and interburden samples indicate that material represented by these samples may be sodic and potentially prone to dispersion. The physical test results on drill core demonstrate that sandstone overburden will take some time to weather and break down under field conditions, whereas siltstone and siltstone overburden are more susceptible to dispersion and erosion with up to 70 % change observed in the sodium soundness test. Providing that the overburden and interburden materials represented by the samples tested are utilised in rehabilitation activities, before significant weathering takes place, and are not used on steeper slopes of final landforms using the strategies described above, it is expected that the rehabilitation field trials can be used to demonstrate the most appropriate rehabilitation methodology for the specific site materials and conditions.

The characteristics of any dispersive materials can generally be improved by the addition of gypsum to the material or use of a vegetated topsoil/subsoil cover and/or ripping on the contour a nominal rock mulch on the outer surface of the final landform. In addition, fertiliser and organic matter addition may improve the fertility of overburden and interburden (drift spoil) materials used in rehabilitation activities to provide a reasonable growth medium for revegetation and rehabilitation purposes. Rehabilitation field trials are recommended when the mine is operational and bulk materials are available. A wealth of existing information is available on successful rehabilitation techniques used for final landforms at nearby coal mines in the region and this should be used to guide the focus of the recommended rehabilitation trials at the Project.

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8 Conclusions and recommendations

8.1 Conclusions

RGS has completed a geochemical and physical assessment of the mine materials likely to be generated at the Project. The main findings of the geochemical assessment are:

- The overburden and interburden (drift spoil) materials are typically classified as NAF Barren, have excess ANC and are essentially devoid of sulfide sulfur. These samples have a very low risk of acid generation and a high factor of safety with respect to potential for AMD.
- The roof, floor, coal and coal reject samples can have slightly higher sulfide sulfur content and generally have excess ANC and are mostly classified as NAF. As a bulk material, these sample types have a relatively low risk of acid generation and a high factor of safety with respect to potential for AMD. Some samples have an elevated sulfur content compared to background concentrations (and may be a source of sulfate and NMD in pore water and potentially contact water).
- Initial and ongoing surface runoff and seepage from mine materials is expected to be pH neutral to moderately alkaline for and have a low to moderate level of salinity. The salinity of leachate from materials with elevated sulfide content could increase over time if left unmanaged and exposed to oxidising conditions and could be a source of dissolved sulfate and NMD.
- Comparison with NEPC guideline values and median crustal abundance values indicates that the mine materials are not significantly enriched with metals/metalloids.
- Most metals/metalloids are sparingly soluble at the pH neutral to moderately alkaline pH of the leachate from mining materials.
- Overall, is expected that the potential risk of any significant impact on the quality of surface water and groundwater from water in contact with material represented by the samples tested at the Project will be low.
- Overburden and interburden (spoil) materials should be amenable to revegetation as part of rehabilitation activities, although for sodic materials addition of gypsum, fertiliser and organic matter and topsoil may need to be considered on steeper slopes of final landforms to limit the potential for dispersion and erosion and to provide a reasonable growth medium for revegetation and rehabilitation. Some consideration should also be given to the merits of contour ripping and rock mulching on steeper slopes.

8.2 Recommendations

As a result of the geochemical (and physical) assessment work completed on mine materials at the project, several recommendations are provided to minimise the risk of any significant environmental harm to the immediate and downstream environment.

- Operational sampling and geochemical testing of representative samples of mine material should be completed as required when the mine is operational to verify the findings of this report.
- Roof, floor, coal and coal reject materials should not report to the outside surface of any final rehabilitated landforms.
- The most appropriate methodology for beneficial re-use of overburden and interburden (spoil) materials at the site as part of infrastructure development and site rehabilitation activities should be investigated when the mine is operational and bulk materials become available as part of field trials.
- Surface water and seepage from areas used for stockpiling and/or storage and rehabilitation of mine materials should be monitored to ensure that key water quality parameters remain within appropriate criteria. Water quality monitoring parameters should include pH, EC, total suspended solids (TSS) on a quarterly basis and the suite of water quality analyses described in **Table B4** (**Attachment B)** of this report opportunistically and at least on an annual basis.

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10 Attachments

Attachment A: Geochemical Assessment Methodology for Mine Materials

Acid Generation and Prediction

Acid generation is caused by the exposure of sulfide minerals, most commonly pyrite (FeS_2), to atmospheric oxygen and water. Sulfur assay results are used to calculate the maximum amount of acid that could be generated by a material based on either direct measurement of the pyritic sulfur content, or assuming that all sulfur not present as sulfate occurs as pyrite. Pyrite reacts under oxidising conditions to generate acid according to the following overall reaction:

$$FeS_2 + 15/4\ O_2 + 7/2\ H_2O \text{ ---> } Fe(OH)_3 + 2\ H_2SO_4$$

According to this reaction, the maximum potential acidity (MPA) of a sample containing 1 %S as pyrite would be 30.6 kg H_2SO_4/t. The chemical components of the acid generation process consist of the above sulfide oxidation reaction and acid neutralization, which is mainly provided by inherent carbonates and to a lesser extent silicate materials. The amount and rate of acid generation is determined by the interaction and overall balance of the acid generation and neutralisation components.

Net Acid Producing Potential (NAPP)

The net acid producing potential (NAPP) is used as an indicator of materials that may be of concern with respect to acid generation. The NAPP calculation represents the balance between the maximum potential acidity (MPA) of a sample, which is derived from the sulfide sulfur content, and the acid neutralising capacity (ANC) of the material, which is determined experimentally. By convention, the NAPP result is expressed in units of kg H_2SO_4/t sample. If the capacity of the solids to neutralise acid (ANC) exceeds their capacity to generate acid (MPA), then the NAPP of the material is negative. Conversely, if the MPA exceeds the ANC, the NAPP of the material is positive. A NAPP assessment involves a series of analytical tests that include:

Determination of pH and EC

pH and EC measured on 1:5 w/w or saturated paste water extract. This gives an indication of the inherent acidity and salinity of the mining waste material when initially exposed in an emplacement area.

Total sulfur content and Maximum Potential Acidity (MPA)

Total sulfur content is determined by the Leco high temperature combustion method. The total sulfur content is then used to calculate the MPA which assumes that the entire sulfur content is present as reactive pyrite. Direct determination of the pyritic sulfur content can provide a more accurate estimate of the MPA.

Acid neutralising capacity (ANC)

The ANC is determined by addition of acid to a known weight of sample, then titration with NaOH to determine the amount of residual acid. The ANC measures the capacity of a sample to react with and neutralise acid. The ANC can be further evaluated by slow acid titration to a set end-point in the Acid Buffering Characteristic Curve (ABCC) test, calculation of the amount of acid consumed, and evaluation of the resultant titration curve.

Assessment of Element Enrichment and Solubility

In mineralised areas it is common to find a suite of enriched elements from natural geological processes. Multi-element scans are carried out to identify any elements that are present in a material (or readily leachable from a material) at concentrations that may be of environmental concern with respect to surface water quality, revegetation and public health. The samples are generally analysed for the following elements:

Major elements	Al, Ca, Fe, K, Mg, Na and S.
Minor elements	As, B, Cd, Co, Cr, Cu, F, Hg, Mn, Mo, Ni, Pb, Sb, Se and Zn.

The concentration of these elements in samples can be directly compared with the median concentration in un-mineralised soils to determine the Geochemical Abundance Index (GAI) and level of significance. Water extracts are used to determine the immediate element solubilities under the existing sample pH conditions of the sample. The following tests are normally carried out:

Multi-element composition of solids.

Multi-element composition of solid samples determined using a combination of ICP-mass spectroscopy (ICP-MS), ICP-optical emission spectroscopy (OES), and atomic absorption spectrometry (AAS).

Multi-element composition of water extracts (1:5 sample:deionised water).

Multi-element composition of 1:5 (solid:water) water extracts from solid samples determined using a combination of ICP-mass spectroscopy (ICP-MS), ICP-optical emission spectroscopy (OES), and atomic absorption spectrometry (AAS).

Under some conditions (eg. low pH) the solubility and mobility of common environmentally important elements can increase significantly. If element mobility under initial pH conditions is deemed likely and/or subsequent low pH conditions may occur, kinetic leach column test work may be completed on representative samples.

Kinetic Leach Column Tests

Kinetic leach column (KLC) tests can be used to provide information on the reaction kinetics of mine waste materials. The major objectives of kinetics tests are to:

- Provide time-dependent data on the kinetics and rate of acid generation and acid neutralising reactions under laboratory controlled (or onsite conditions);
- Investigate metal release and drainage/seepage quality; and
- Assess treatment options such as addition of alkaline materials.

The KLC tests simulate the weathering process that leads to acid and base generation and reaction under laboratory controlled or site conditions. The kinetic tests allow an assessment of the acid forming characteristics and indicate the rate of acid generation, over what period it will occur, and what management controls may be required.

In KLC tests, water is added to a sample and the mixture allowed to leach products and by-products of acid producing and consuming reactions. Samples of leachate are then collected and analysed. Intermittent water application is applied to simulate rainfall and heat lamps are used to simulate sunshine. These tests provide real-time information and may have to continue for months or years. Monitoring includes trends in pH, sulfate, acidity or alkalinity, and metals, for example. The pH of the collected leachate simulates the acid drainage process, acidity or alkalinity levels indicate the rate of acid production and acid neutralisation, and sulfate production can be related to the rate of sulfide oxidation. Metal concentration data provides an assessment of metal solubility and leaching behaviour.

Figure A1 shows the kinetic leach column set up typically used by RGS/ECC adapted from *AMIRA, 2002*. The columns can be placed under heat lamps to allow the sample to dry between water additions to ensure adequate oxygen ingress into the sample material.

Approximately 2 kg of sample is accurately weighed and used in the leach columns and depending on the physical nature of the material and particle size can be used on an as-received basis (i.e., no crushing as with process residues) or crushed to nominal 5-10 mm particle size (as with waste rock). The sample in the column is initially leached with deionised water at a rate of about 400 ml/kg of sample and the initial leachate from the columns collected and analysed. Subsequent column leaching is carried out at a rate of about 400 ml/kg per month and again collected and analysed. The leaching rate can be varied to better simulate expected site conditions or satisfy test program data requirements. The column must be exposed to drying conditions in between watering events. The residual water content and air void content in the column can be determined by comparing the wet and dry column weights. A heat lamp can be used above the sample during daylight hours to maintain the leach column surface temperature at about 30^{o}C.

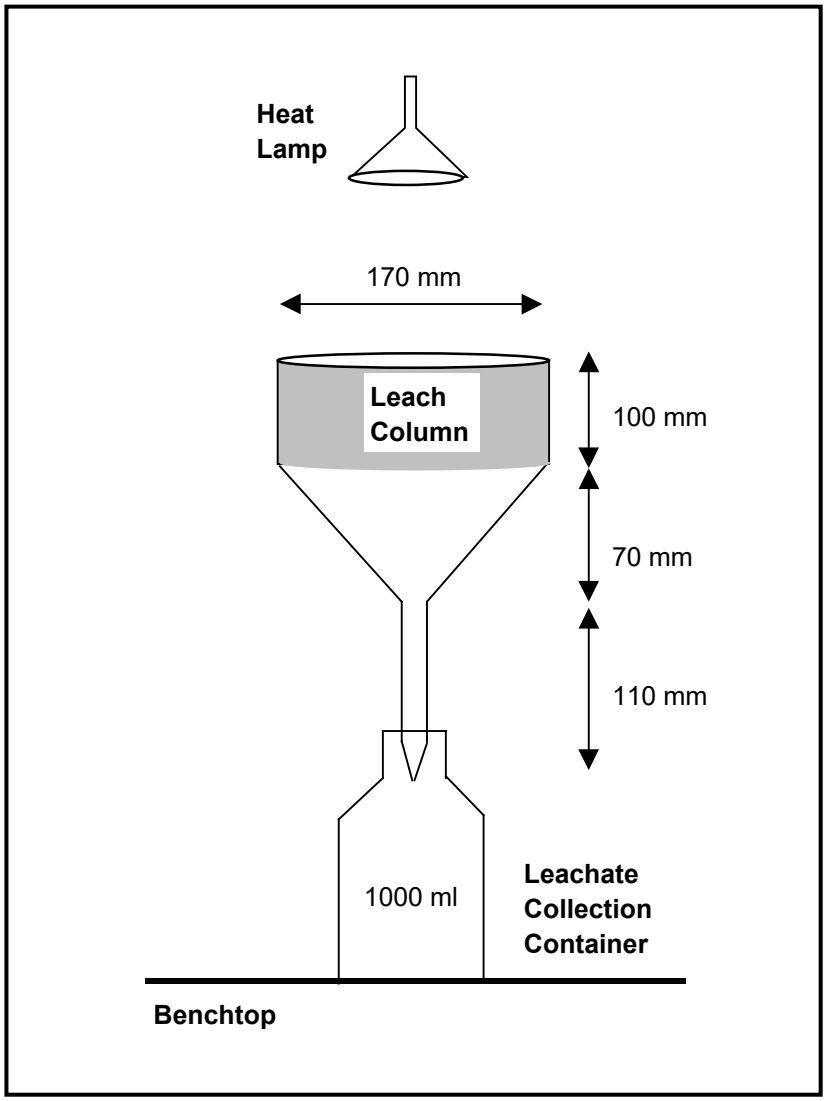


Figure A1: Kinetic leach column setup

Attachment B: Static Geochemical Test Result Summary Tables

Attachment C: KLC Test Result Summary Tables and Trends

Attachment D: EDCM Coal Quality Database - Interpretation of Total Sulfur Data

EDCM has provided RGS with the coal quality database for three target coal seams from Harrow Coal Upper (HCU), Harrow Coal Lower (HCL) and Dysart (DY) seams of the Project. **Figure D1** shows the distribution of total sulfur in the database sorted by depth and target coal seam.

Most of the coal samples contain less than 1 %S total sulfur with a median value of 0.52 %S (HCU), 0.42 %S (HCL) and 0.44 %S (DY), respectively. The number of samples which were analysed through statistical means are 672, 1,141 and 701 samples for HCU, HCL and DY respectively.

The distribution of the HCU, HCL and DY total sulfur values are presented in the form of histograms and "box and whisker" plots in **Figure D2**. The histograms for HCU, HCL and DY show a positively skewed unimodal histogram, with most of the samples total sulfur distributed between 0.4 to 0.6 %S. The "box and whisker" plot indicates similar mean and median ranges with little spread and uniformity in all three target coal seams distribution.

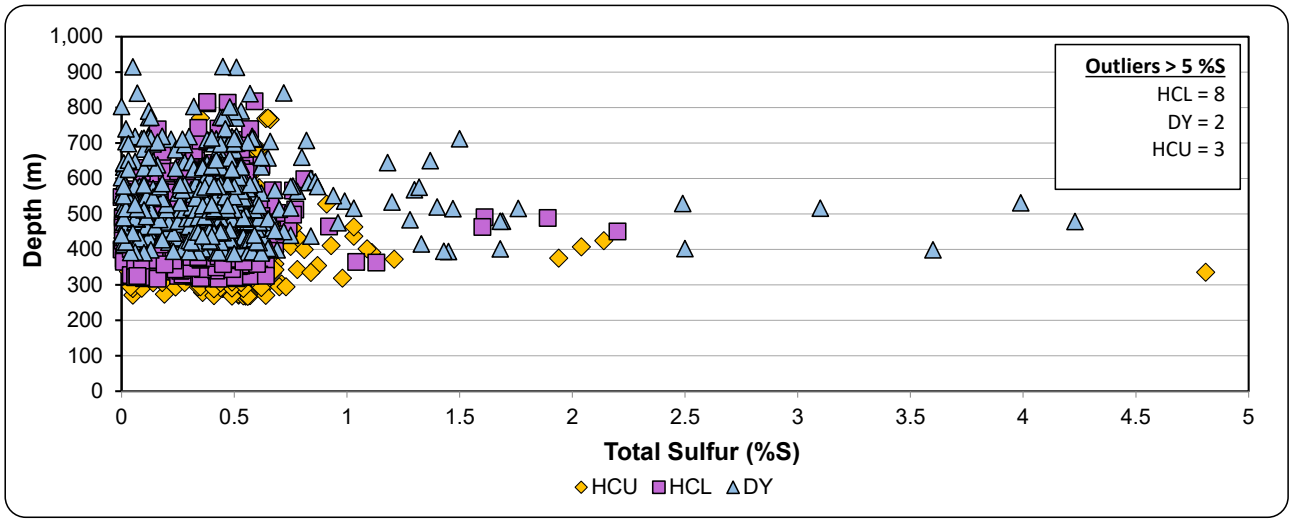


Figure D1: Total sulfur distribution by depth and target coal seams from coal quality database.

Total sulfur isopachs have also been plotted for the three target seams at the Project and are provided in **Figures D3** to **D5**. The total sulfur isopachs indicate that the total sulfur content of the coal seam materials is reasonably uniform across the planned longwall mining area apart for two areas

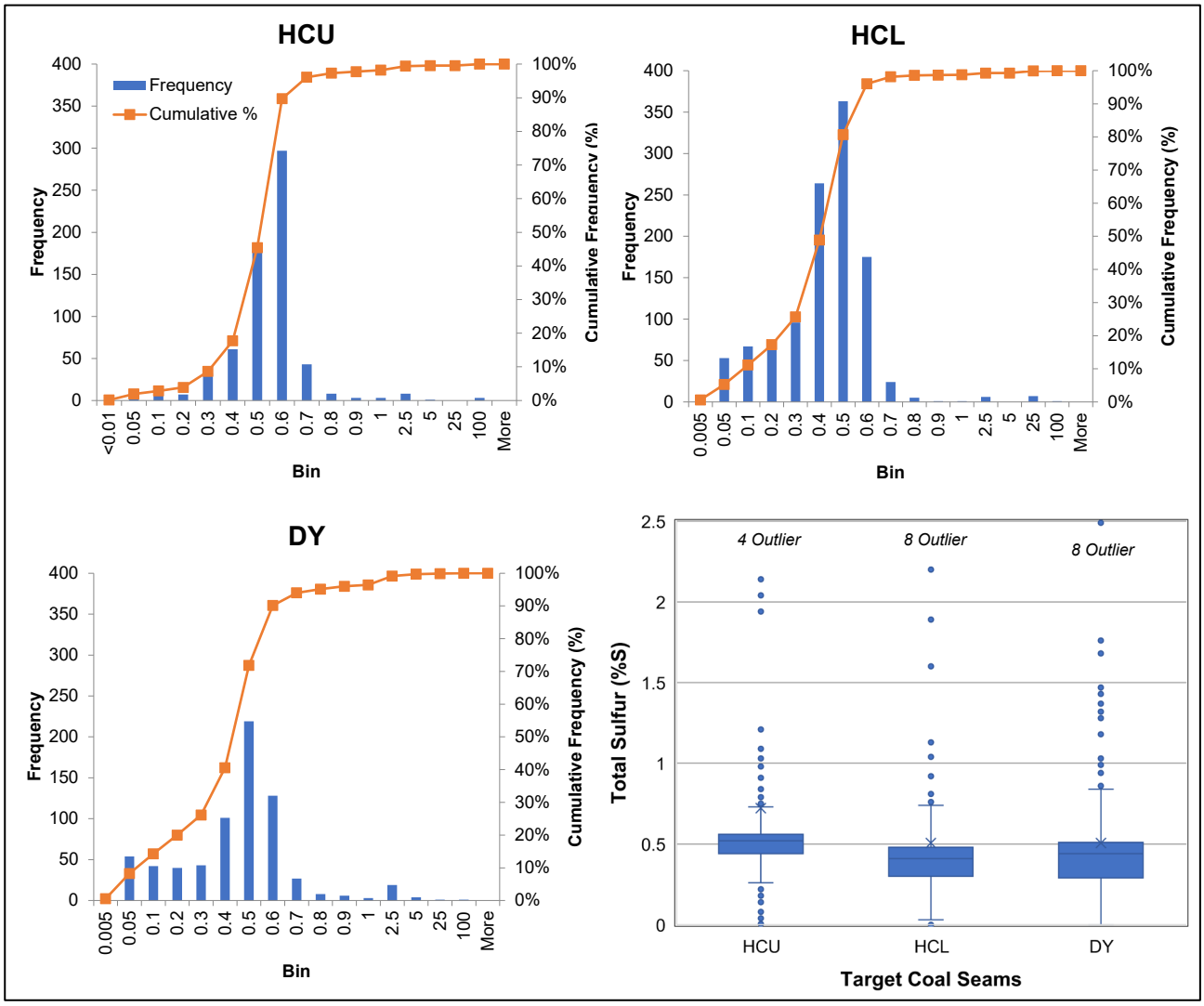


Figure D2: Histograms and boxplot for HCU, HCL and DY target coal seams

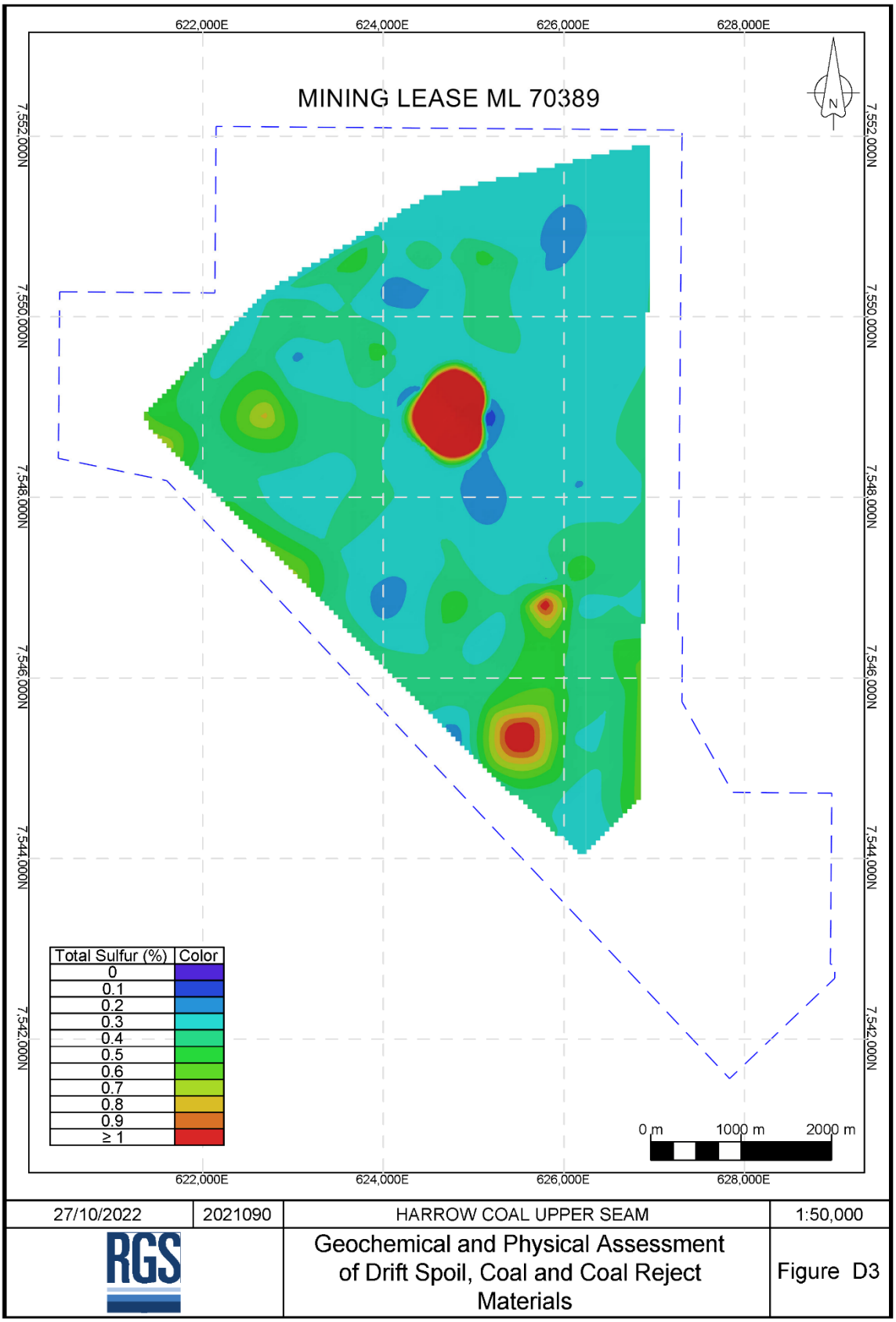


Figure D3: Total sulfur isopach for the HCU seam

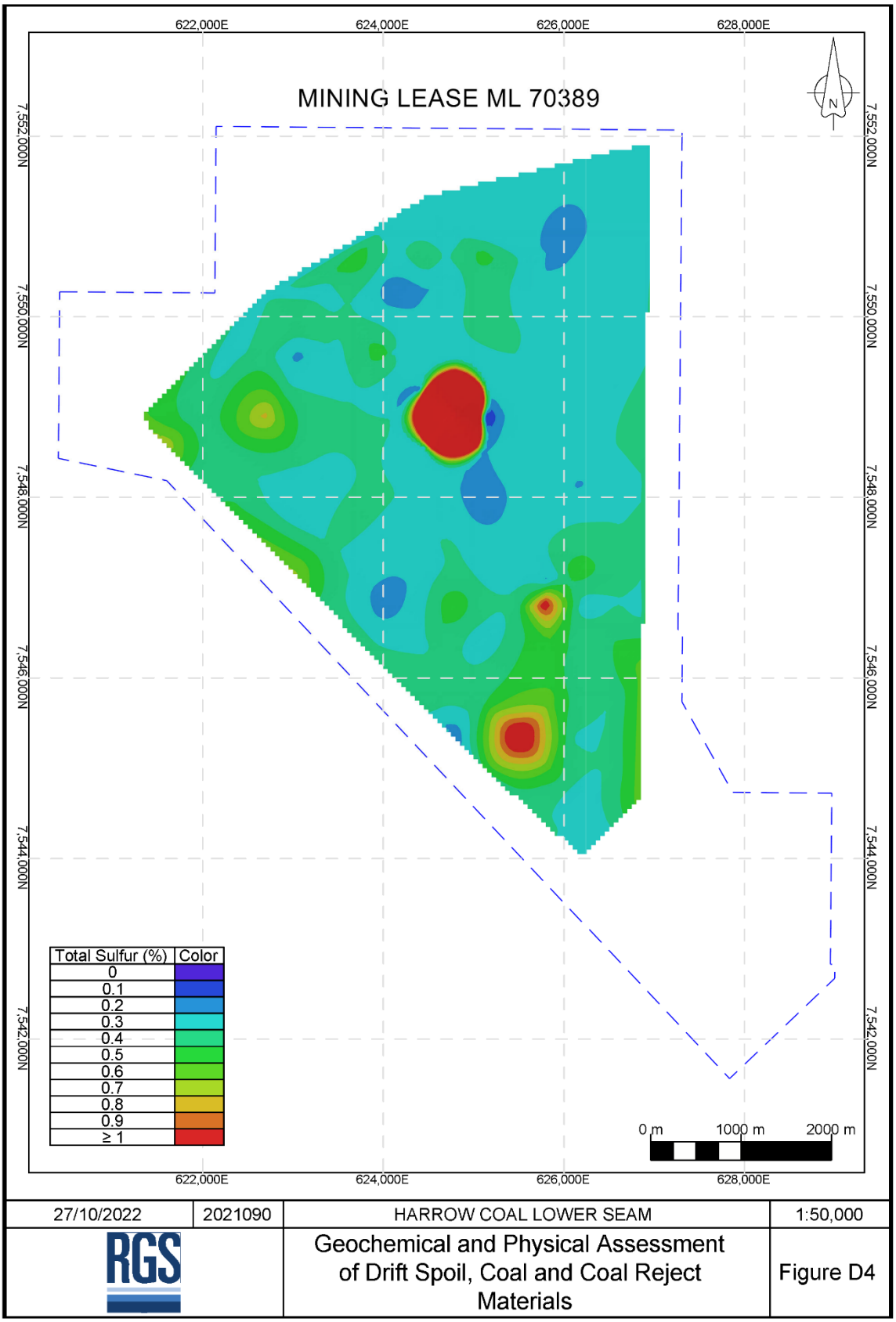


Figure D4: Total sulfur isopach for the HCL seam

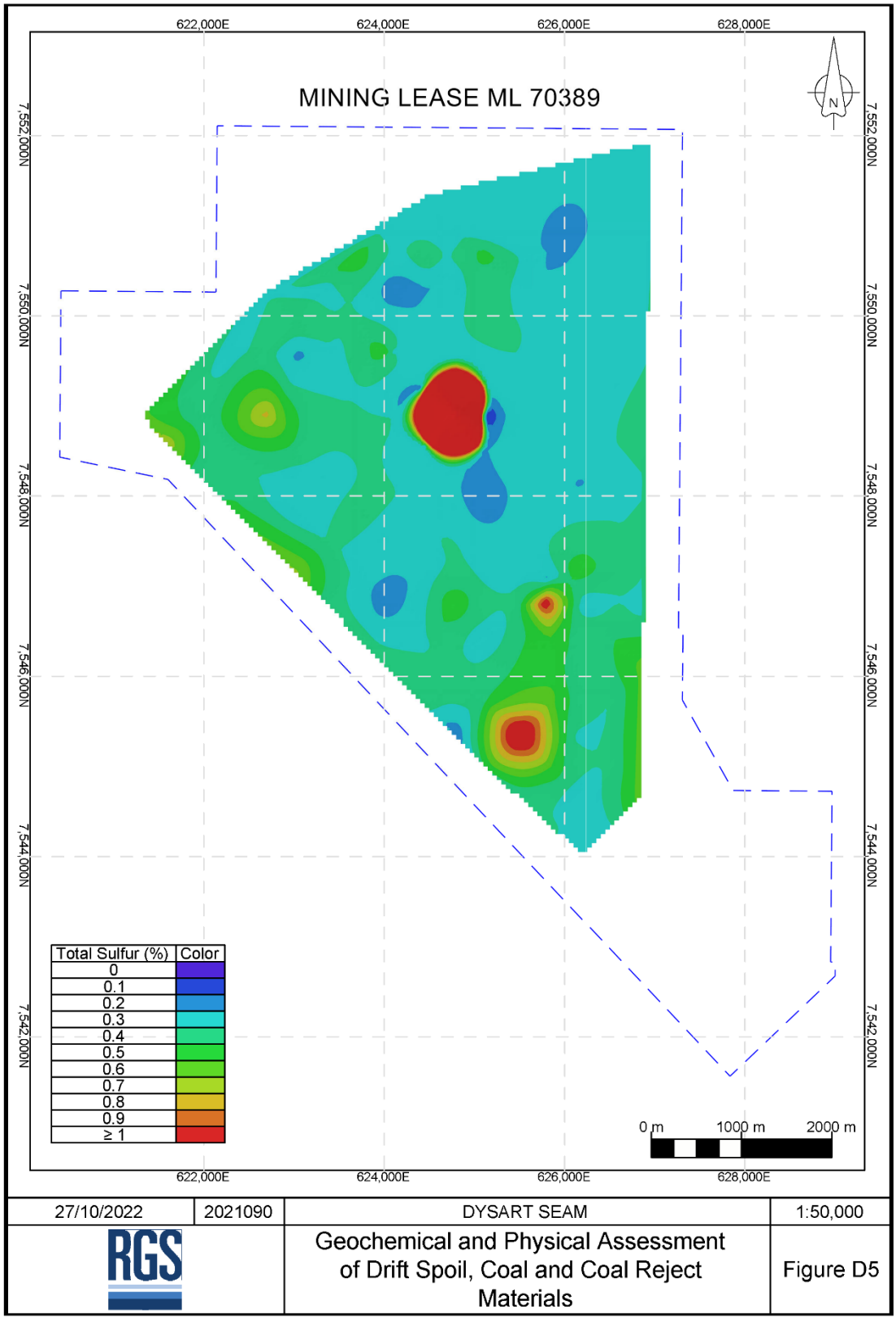


Figure D5: Total sulfur isopach for the DY seam

Attachment E: Analytical Laboratory Services (ALS) Laboratory Results

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2200716**	Page	: 1 of 10
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: PRITII TAM	Contact	: Customer Services EB
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4107	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2021090 Eagle Downs	Date Samples Received	: 12-Jan-2022 14:52
Order number	: ----	Date Analysis Commenced	: 13-Jan-2022
C-O-C number	: ----	Issue Date	: 31-Jan-2022 16:59
Sampler	: PRIYA RAJENDRAN		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 33		
No. of samples analysed	: 33		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ASS: EA013 (ANC) Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong; 5- Lime.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_1001 IP20000829_R022	2021090_1002 IP20000829_R023	2021090_1003 IP20000829_R019	2021090_1004 IP20000829_R020	2021090_1005 IP20000829_R018
			Sampling date / time	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00
Compound	CAS Number	LOR	Unit	EB2200716-001	EB2200716-002	EB2200716-003	EB2200716-004	EB2200716-005
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	7.9	6.6	7.2	7.0	6.2
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	9.4	-22.9	10.4	-0.4	13.8
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	196	1010	203	324	51
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	3.4	54.4	2.8	10.2	<0.5
ANC as CaCO3	----	0.1	% CaCO3	0.3	5.6	0.3	1.0	<0.1
Fizz Rating	----	0	Fizz Unit	0	2	0	1	0
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	1.9	2.5	2.1	3.5	2.0
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.42	1.03	0.43	0.32	0.45

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_1006 IP20001439_R021	2021090_1007 IP20001439_R022	2021090_1008 IP20000831_R027	2021090_1009 IP20000831_R026	2021090_1010 IP20001212_R089
			Sampling date / time	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00
Compound	CAS Number	LOR	Unit	EB2200716-006	EB2200716-007	EB2200716-008	EB2200716-009	EB2200716-010
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.6	9.4	7.0	6.8	8.5
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	9.3	0.5	8.6	16.9	1.8
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	24	52	20	117	29
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	2.0	6.2	3.0	3.3	4.6
ANC as CaCO3	----	0.1	% CaCO3	0.2	0.6	0.3	0.3	0.5
Fizz Rating	----	0	Fizz Unit	0	0	0	0	0
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	1.5	1.9	1.5	2.4	2.4
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.37	0.22	0.38	0.66	0.21

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_1011 IP20001212_R088	2021090_1012 IP20001214_R014	2021090_1013 IP20001214_R015	2021090_1014 IP20001214_R026	2021090_1015 IP20001214_R024
			Sampling date / time	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00
Compound	CAS Number	LOR	Unit	EB2200716-011	EB2200716-012	EB2200716-013	EB2200716-014	EB2200716-015
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	7.2	9.4	9.1	9.6	8.7
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	7.2	5.0	8.3	1.7	9.5
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	18	96	373	192	63
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	3.8	6.3	22.3	9.9	2.4
ANC as CaCO3	----	0.1	% CaCO3	0.4	0.6	2.3	1.0	0.2
Fizz Rating	----	0	Fizz Unit	0	0	1	1	0
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	1.8	1.8	2.0	2.5	1.9
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.36	0.37	1.00	0.38	0.39

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_1016 IP20001214_R020	2021090_1017 IP20001214_R023	2021090_1018 IP20001217_R035	2021090_1019 IP20001217_R016	2021090_1020 IP20001218_R013
			Sampling date / time	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00
Compound	CAS Number	LOR	Unit	EB2200716-016	EB2200716-017	EB2200716-018	EB2200716-019	EB2200716-020
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.6	7.2	7.5	8.6	10.0
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	7.4	9.6	3.0	2.8	-20.0
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	82	47	23	25	169
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	5.1	3.2	4.3	4.2	24.9
ANC as CaCO3	----	0.1	% CaCO3	0.5	0.3	0.4	0.4	2.5
Fizz Rating	----	0	Fizz Unit	0	0	0	0	1
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	1.1	1.6	2.1	2.5	2.9
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.41	0.42	0.24	0.23	0.16

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_1021 IP20001218_R020	2021090_1022 IP20001218_R017	2021090_1023 IP20000829_R029	2021090_3001 IP20000831_R023	2021090_3002 IP20001214_R021
			Sampling date / time	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00
Compound	CAS Number	LOR	Unit	EB2200716-021	EB2200716-022	EB2200716-023	EB2200716-024	EB2200716-025
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.9	10.0	7.5	6.1	7.4
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-32.9	-51.3	14.2	13.3	-32.0
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	244	222	204	578	559
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	38.4	57.4	1.4	21.9	50.1
ANC as CaCO3	----	0.1	% CaCO3	3.9	5.8	0.1	2.2	5.1
Fizz Rating	----	0	Fizz Unit	1	2	0	1	2
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	2.3	2.4	1.4	1.9	1.8
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.18	0.20	0.51	1.15	0.59

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_3003 IP20001217_R029	2021090_3004 IP20001218_M026	2021090_3005 IP20001222_R054	2021090_3006 IP20001222_R077	2021090_3007 IP20001222_R031
			Sampling date / time	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00
Compound	CAS Number	LOR	Unit	EB2200716-026	EB2200716-027	EB2200716-028	EB2200716-029	EB2200716-030
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	7.8	8.4	8.4	8.1	8.4
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-1.3	-74.2	-9.8	-44.4	-29.0
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	169	157	108	151	185
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	9.9	80.9	17.8	53.3	59.9
ANC as CaCO3	----	0.1	% CaCO3	1.0	8.2	1.8	5.4	6.1
Fizz Rating	----	0	Fizz Unit	0	2	1	2	2
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	1.1	1.0	1.2	1.1	1.1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.28	0.22	0.26	0.29	1.01

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_3008 IP20000807_R057	2021090_3009 IP20000807_R032	----	----	----
			Sampling date / time	12-Jan-2022 00:00	12-Jan-2022 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2200716-031	EB2200716-032	--------	--------	--------
				Result	Result	----	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	6.8	8.0	----	----	----
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-13.8	-94.8	----	----	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	307	347	----	----	----
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	20.8	100	----	----	----
ANC as CaCO3	----	0.1	% CaCO3	2.1	10.2	----	----	----
Fizz Rating	----	0	Fizz Unit	1	2	----	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	1.4	1.4	----	----	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.23	0.17	----	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **SOIL**)			Sample ID	**pH and EC DI Water**	**----**	**----**	**----**	**----**
			Sampling date / time	12-Jan-2022 00:00	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB2200716-033**	**--------**	**--------**	**--------**	**--------**
				Result	----	----	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**5.6**	**----**	**----**	**----**	**----**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	<1	**----**	**----**	**----**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2203315**	Page	: 1 of 9
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: PRITII TAM	Contact	: Customer Services EB
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4107	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2021090 Eagle Downs	Date Samples Received	: 08-Feb-2022 09:23
Order number	: ----	Date Analysis Commenced	: 16-Feb-2022
C-O-C number	: ----	Issue Date	: 17-Feb-2022 11:57
Sampler	: PRIYA RAJENDRAN		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 32		
No. of samples analysed	: 32		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_1001 ED0318	2021090_1002 ED0318	2021090_1003 ED0318	2021090_1004 ED0318	2021090_1005 ED0318
			Sampling date / time	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00
Compound	CAS Number	LOR	Unit	EB2203315-001	EB2203315-002	EB2203315-003	EB2203315-004	EB2203315-005
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.055**	**0.600**	**0.065**	**0.121**	**0.022**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_1006 ED0321	2021090_1007 ED0321	2021090_1008 ED0322	2021090_1009 ED0322	2021090_1010 ED0324
			Sampling date / time	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00
Compound	CAS Number	LOR	Unit	EB2203315-006	EB2203315-007	EB2203315-008	EB2203315-009	EB2203315-010
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.011**	**0.016**	**0.036**	**0.562**	**0.018**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_1011 ED0324	2021090_1012 ED0326	2021090_1013 ED0326	2021090_1014 ED0326	2021090_1015 ED0326
			Sampling date / time	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00
Compound	CAS Number	LOR	Unit	EB2203315-011	EB2203315-012	EB2203315-013	EB2203315-014	EB2203315-015
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.020**	**0.040**	**0.594**	**0.263**	**0.027**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_1016 ED0326	2021090_1017 ED0326	2021090_1018 ED0329	2021090_1019 ED0329	2021090_1020 ED0330
			Sampling date / time	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00
Compound	CAS Number	LOR	Unit	EB2203315-016	EB2203315-017	EB2203315-018	EB2203315-019	EB2203315-020
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.042**	**0.013**	**0.014**	**0.043**	**0.017**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_1021 ED0330	2021090_1022 ED0330	2021090_1023 ED0332_ED0333	2021090_3001 ED0322	2021090_3002 ED0326
			Sampling date / time	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00
Compound	CAS Number	LOR	Unit	EB2203315-021	EB2203315-022	EB2203315-023	EB2203315-024	EB2203315-025
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.017**	**0.017**	**0.138**	**0.664**	**0.368**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_3003 ED0329	2021090_3004 ED0330	2021090_3005 ED0332_ED0333	2021090_3006 ED0332_ED0333	2021090_3007 ED0332_ED0333
			Sampling date / time	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00	12-Jan-2022 00:00
Compound	CAS Number	LOR	Unit	EB2203315-026	EB2203315-027	EB2203315-028	EB2203315-029	EB2203315-030
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.077**	**0.046**	**0.039**	**0.103**	**0.636**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_3008 ED0333R	2021090_3009 ED0333R	----	----	----
			Sampling date / time	12-Jan-2022 00:00	12-Jan-2022 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2203315-031	EB2203315-032	--------	--------	--------
				Result	Result	----	----	----
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.042**	**0.054**	**----**	**----**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2205062**	Page	: 1 of 8
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: PRITII TAM	Contact	: Customer Services EB
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4107	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2021090 Eagle Downs	Date Samples Received	: 22-Feb-2022 16:21
Order number	: ----	Date Analysis Commenced	: 10-Mar-2022
C-O-C number	: ----	Issue Date	: 11-Mar-2022 16:09
Sampler	: PRIYA RAJENDRAN		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 26		
No. of samples analysed	: 26		

Accreditation No. 825
Accredited for compliance with
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This Certificate of Analysis contains the following information:

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- Analytical Results

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Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD

General Comments

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Where moisture determination has been performed, results are reported on a dry weight basis.

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LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Particular samples have been crushed prior to preparation and analysis as per client request on the Chain of Custody. Please refer to SRN for further details.
- ASS: EA013 (ANC) Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong; 5- Lime.

Analytical Results

Sub-Matrix: **ROCK** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Sample ID	2021090_3010 3215901	2021090_3011 3215902	2021090_3012 3215903	2021090_3013 3215904	2021090_3014 3215905
				Sampling date / time	22-Feb-2022 00:00	22-Feb-2022 00:00	22-Feb-2022 00:00	22-Feb-2022 00:00	22-Feb-2022 00:00
					EB2205062-001	EB2205062-002	EB2205062-003	EB2205062-004	EB2205062-005
					Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		**9.8**	**9.8**	**9.9**	**9.6**	**10.0**
EA009: Net Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		**-80.1**	**-56.3**	**-39.3**	**-36.5**	**-25.3**
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		**519**	**498**	**459**	**339**	**566**
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		**81.0**	**57.8**	**39.9**	**50.6**	**26.8**
ANC as CaCO3	----	0.1	% CaCO3		**8.3**	**5.9**	**4.1**	**5.2**	**2.7**
Fizz Rating	----	0	Fizz Unit		**2**	**2**	**2**	**2**	**1**
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		**0.03**	**0.05**	**0.02**	**0.46**	**0.05**

Analytical Results

Sub-Matrix: **ROCK** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Sample ID	2021090_3015 3215906	2021090_3016 3215907	2021090_3017 3215908	2021090_3018 3215909	2021090_3019 3215910
				Sampling date / time	22-Feb-2022 00:00	22-Feb-2022 00:00	22-Feb-2022 00:00	22-Feb-2022 00:00	22-Feb-2022 00:00
					EB2205062-006	EB2205062-007	EB2205062-008	EB2205062-009	EB2205062-010
					Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		**9.9**	**9.6**	**9.5**	**9.9**	**9.7**
EA009: Net Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		**-103**	**-11.2**	**-7.8**	**-51.0**	**-502**
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		**559**	**333**	**672**	**469**	**461**
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		**104**	**13.4**	**12.7**	**55.3**	**503**
ANC as CaCO3	----	0.1	% CaCO3		**10.6**	**1.4**	**1.3**	**5.6**	**51.3**
Fizz Rating	----	0	Fizz Unit		**2**	**1**	**1**	**2**	**5**
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		**0.02**	**0.07**	**0.16**	**0.14**	**0.03**

Analytical Results

Sub-Matrix: **ROCK** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Sample ID	2021090_3020 3215911	2021090_3021 3215912	2021090_3022 3215913	2021090_3023 3215914	2021090_3024 3215915
				Sampling date / time	22-Feb-2022 00:00	22-Feb-2022 00:00	22-Feb-2022 00:00	22-Feb-2022 00:00	22-Feb-2022 00:00
					EB2205062-011	EB2205062-012	EB2205062-013	EB2205062-014	EB2205062-015
					Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		**9.6**	**9.4**	**9.8**	**9.7**	**9.3**
EA009: Net Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		**-17.0**	**-7.9**	**-70.6**	**-46.8**	**-89.7**
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		**329**	**158**	**478**	**445**	**613**
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		**17.6**	**18.3**	**73.4**	**48.0**	**93.4**
ANC as CaCO3	----	0.1	% CaCO3		**1.8**	**1.9**	**7.5**	**4.9**	**9.5**
Fizz Rating	----	0	Fizz Unit		**1**	**1**	**2**	**2**	**2**
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		**0.02**	**0.34**	**0.09**	**0.04**	**0.12**

Analytical Results

Sub-Matrix: **ROCK** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Sample ID	2021090_3025 3215916	2021090_3026 3215917	2021090_3027 3215918	2021090_3028 3215919	2021090_3029 3215920
				Sampling date / time	22-Feb-2022 00:00	22-Feb-2022 00:00	22-Feb-2022 00:00	22-Feb-2022 00:00	22-Feb-2022 00:00
					EB2205062-016	EB2205062-017	EB2205062-018	EB2205062-019	EB2205062-020
					Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		**9.3**	**3.7**	**9.3**	**9.7**	**9.3**
EA009: Net Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		**-19.5**	**56.0**	**-0.9**	**-37.2**	**-25.3**
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		**426**	**1960**	**112**	**356**	**512**
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		**20.4**	<0.5	**7.6**	**37.2**	**28.1**
ANC as CaCO3	----	0.1	% CaCO3		**2.1**	<0.1	**0.8**	**3.8**	**2.9**
Fizz Rating	----	0	Fizz Unit		**1**	**0**	**0**	**1**	**1**
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		**0.03**	**1.83**	**0.22**	<0.01	**0.09**

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021090_3030 3215921	2021090_3031 3215922	2021090_3032 3215923	2021090_3033 3215924	2021090_3034 3215925
			Sampling date / time	22-Feb-2022 00:00	22-Feb-2022 00:00	22-Feb-2022 00:00	22-Feb-2022 00:00	22-Feb-2022 00:00
Compound	CAS Number	LOR	Unit	EB2205062-021	EB2205062-022	EB2205062-023	EB2205062-024	EB2205062-025
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**9.6**	**9.7**	**9.4**	**9.4**	**9.4**
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-168**	**-101**	**-24.4**	**-12.0**	**-9.3**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**409**	**428**	**332**	**262**	**270**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**169**	**102**	**26.8**	**14.2**	**10.5**
ANC as CaCO3	----	0.1	% CaCO3	**17.2**	**10.4**	**2.7**	**1.4**	**1.1**
Fizz Rating	----	0	Fizz Unit	**3**	**2**	**1**	**1**	**1**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.02**	**0.02**	**0.08**	**0.07**	**0.04**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **SOIL**)			Sample ID	**pH and EC DI water**	**----**	**----**	**----**	**----**
			Sampling date / time	22-Feb-2022 00:00	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB2205062-026**	**--------**	**--------**	**--------**	**--------**
				Result	----	----	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**5.2**	**----**	**----**	**----**	**----**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	<1	**----**	**----**	**----**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2207643**	Page	: 1 of 3
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: PRITII TAM	Contact	: Customer Services EB
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4107	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2021090 Eagle Downs	Date Samples Received	: 18-Mar-2022 16:00
Order number	: ----	Date Analysis Commenced	: 21-Mar-2022
C-O-C number	: ----	Issue Date	: 31-Mar-2022 15:56
Sampler	: PRIYA RAJENDRAN		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 4		
No. of samples analysed	: 4		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ALS is not NATA accredited for the analysis of Exchangeable Aluminium and Exchange Acidity in soils when performed under ALS Method ED005.
- ALS is not NATA accredited for the analysis of Exchangeable Cations on Alkaline Soils when performed under ALS Method ED006.
- ED006 (Exchangeable Cations on Alkaline Soils): Unable to calculate Magnesium/Potassium Ratio result as required Exchangeable Potassium results are less than the limit of reporting.
- ED006 (Exchangeable Cations on Alkaline Soils): Composite F1 (EB2207643-003) shows poor duplicate results due to sample heterogeneity. This has been confirmed by visual inspection.
- EA058 Emerson: V. = Very, D. = Dark, L. = Light, VD. = Very Dark
- ED007 and ED008: When Exchangeable Al is reported from these methods, it should be noted that Rayment & Lyons (2011) suggests Exchange Acidity by 1M KCl - Method 15G1 (ED005) is a more suitable method for the determination of exchange acidity (H+ + Al3+).

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	Composite E1 2021090_C005_1	Composite E2 2021090_C005_2	Composite F1 2021090_C006_1	Composite F2 2021090_C006_2	----
			Sampling date / time	18-Mar-2022 00:00	18-Mar-2022 00:00	18-Mar-2022 00:00	18-Mar-2022 00:00	----
Compound	CAS Number	LOR	Unit	EB2207643-001	EB2207643-002	EB2207643-003	EB2207643-004	--------
				Result	Result	Result	Result	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	10.1	10.1	10.1	10.0	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	449	448	411	421	----
EA058: Emerson Aggregate Test								
Color (Munsell)	----	-	-	Gray (N 5/)	Very Dark Gray (N 3/)	Black (N 2.5/)	Very Dark Gray (N 3/)	----
Texture	----	-	-	Clay Loam Sandy	Clay Loam Sandy	Sandy Clay Loam	Clay Loam Sandy	----
Emerson Class Number	EC/TC	-	-	7	2	8	7	----
ED006: Exchangeable Cations on Alkaline Soils								
ø Exchangeable Calcium	----	0.2	meq/100g	2.3	3.5	2.0	2.3	----
ø Exchangeable Magnesium	----	0.2	meq/100g	0.5	0.6	0.5	0.5	----
ø Exchangeable Potassium	----	0.2	meq/100g	0.3	0.4	<0.2	<0.2	----
ø Exchangeable Sodium	----	0.2	meq/100g	4.2	7.8	3.3	2.3	----
ø Cation Exchange Capacity	----	0.2	meq/100g	7.4	12.2	5.9	5.3	----
ø Exchangeable Sodium Percent	----	0.2	%	57.5	63.6	55.7	43.3	----
ø Calcium/Magnesium Ratio	----	0.2	-	4.6	5.8	4.1	4.4	----
ø Magnesium/Potassium Ratio	----	0.2	-	1.8	1.5	----	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2207645**	Page	: 1 of 4
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: PRITII TAM	Contact	: Customer Services EB
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4107	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2021090 Eagle Downs	Date Samples Received	: 18-Mar-2022 16:00
Order number	: ----	Date Analysis Commenced	: 29-Mar-2022
C-O-C number	: ----	Issue Date	: 30-Mar-2022 11:07
Sampler	: PRIYA RAJENDRAN		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 7		
No. of samples analysed	: 7		

Accreditation No. 825
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ISO/IEC 17025 - Testing

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Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD

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^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_3013 3215904	2021090_3017 3215909	2021090_3018 3215907	2021090_3021 3215912	2021090_3024 3215915
			Sampling date / time	18-Mar-2022 00:00	18-Mar-2022 00:00	18-Mar-2022 00:00	18-Mar-2022 00:00	18-Mar-2022 00:00
Compound	CAS Number	LOR	Unit	EB2207645-001	EB2207645-002	EB2207645-003	EB2207645-004	EB2207645-005
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.314**	**0.092**	**0.027**	**0.025**	**0.108**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_3026 3215917	2021090_3027 3215918	----	----	----
			Sampling date / time	18-Mar-2022 00:00	18-Mar-2022 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2207645-006	EB2207645-007	--------	--------	--------
				Result	Result	----	----	----
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.867**	**0.031**	**----**	**----**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2207646**	Page	: 1 of 9
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: PRITII TAM	Contact	: Customer Services EB
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4107	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2021090 Eagle Downs	Date Samples Received	: 21-Mar-2022 13:41
Order number	: ----	Date Analysis Commenced	: 23-Mar-2022
C-O-C number	: ----	Issue Date	: 30-Mar-2022 17:03
Sampler	: PRIYA RAJENDRAN		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 9		
No. of samples analysed	: 9		

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Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

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^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ED037 (Alkalinity): NATA accreditation does not cover the performance of this service.
- ED038 (Acidity): NATA accreditation does not cover the performance of this service.
- EK040S (Soluble Fluoride) - Particular samples required dilution prior to analysis due to matrix interferences. LOR values have been adjusted accordingly.
- EG005T (Total Metals by ICP-AES): EB2207648-002 shows poor duplicate results due to sample heterogeneity. This has been confirmed by visual inspection.

Analytical Results

Sub-Matrix: SOIL
(Matrix: SOIL)

Compound	CAS Number	LOR	Unit	Sample ID	2021090_C001 Composite A	2021090_C002 Composite B	2021090_C003 Composite C	2021090_C004 Composite D	2021090_C005 Composite E
				Sampling date / time	18-Mar-2022 00:00	18-Mar-2022 00:00	18-Mar-2022 00:00	18-Mar-2022 00:00	18-Mar-2022 00:00
					EB2207646-001	EB2207646-002	EB2207646-003	EB2207646-004	EB2207646-005
					Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		9.4	9.0	7.6	8.0	9.8
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		118	343	664	332	496
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%		1.2	1.0	1.3	1.3	1.2
ED037: Alkalinity									
ø Total Alkalinity as CaCO3	----	1	mg/kg		1110	8600	7360	15400	12900
ø Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/kg		936	8520	7360	15400	12000
ø Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/kg		178	89	<5	<5	892
ED038A: Acidity									
Acidity	----	1	mg/kg		<5	<5	742	330	<5
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg		70	360	1360	480	230
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	10	mg/kg		10	50	40	30	30
ED093S: Soluble Major Cations									
Calcium	7440-70-2	10	mg/kg		<10	10	520	250	<10
Magnesium	7439-95-4	10	mg/kg		<10	<10	40	40	<10
Sodium	7440-23-5	10	mg/kg		160	390	80	80	480
Potassium	7440-09-7	10	mg/kg		<10	<10	20	20	20
ED093T: Total Major Cations									
Calcium	7440-70-2	50	mg/kg		1590	11400	9190	19000	16400
Magnesium	7439-95-4	50	mg/kg		890	1300	2610	3540	4910
Sodium	7440-23-5	50	mg/kg		940	790	190	190	1870
Potassium	7440-09-7	50	mg/kg		500	620	540	720	1560
EG005(ED093)S : Soluble Metals by ICPAES									
Boron	7440-42-8	1	mg/kg		<1	<1	<1	<1	<1
Iron	7439-89-6	1	mg/kg		<1	<1	<1	<1	<1
EG005(ED093)T: Total Metals by ICP-AES									
Aluminium	7429-90-5	50	mg/kg		3240	4290	13300	7240	11800
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Iron	7439-89-6	50	mg/kg		6810	9280	27800	25000	28600
EG020S: Soluble Metals by ICPMS									

Analytical Results

Sub-Matrix: **SOIL**
(Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Sample ID	2021090_C001 Composite A	2021090_C002 Composite B	2021090_C003 Composite C	2021090_C004 Composite D	2021090_C005 Composite E
				Sampling date / time	18-Mar-2022 00:00	18-Mar-2022 00:00	18-Mar-2022 00:00	18-Mar-2022 00:00	18-Mar-2022 00:00
					EB2207646-001	EB2207646-002	EB2207646-003	EB2207646-004	EB2207646-005
					Result	Result	Result	Result	Result
EG020S: Soluble Metals by ICPMS - Continued									
Arsenic	7440-38-2	0.01	mg/kg		**0.06**	**0.01**	<0.01	<0.01	**0.42**
Selenium	7782-49-2	0.1	mg/kg		**0.3**	**0.1**	<0.1	<0.1	<0.1
Cadmium	7440-43-9	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt	7440-48-4	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Chromium	7440-47-3	0.01	mg/kg		<0.01	**0.01**	<0.01	<0.01	<0.01
Copper	7440-50-8	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Manganese	7439-96-5	0.01	mg/kg		<0.01	<0.01	**1.02**	**0.13**	<0.01
Molybdenum	7439-98-7	0.01	mg/kg		**0.16**	**0.10**	**0.03**	**0.09**	**0.25**
Nickel	7440-02-0	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Lead	7439-92-1	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Antimony	7440-36-0	0.01	mg/kg		**0.02**	**0.01**	<0.01	**0.01**	**0.03**
Uranium	7440-61-1	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
Vanadium	7440-62-2	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Aluminium	7429-90-5	0.1	mg/kg		**0.4**	**0.2**	**0.1**	**0.3**	**0.6**
Thorium	7440-29-1	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
EG020T: Total Metals by ICP-MS									
Arsenic	7440-38-2	0.1	mg/kg		**1.9**	**2.7**	**2.7**	**4.9**	**6.7**
Selenium	7782-49-2	1	mg/kg		**2**	**2**	**1**	**2**	<1
Cadmium	7440-43-9	0.1	mg/kg		**0.1**	**0.1**	**0.2**	**0.2**	<0.1
Cobalt	7440-48-4	0.1	mg/kg		**2.4**	**0.7**	**1.8**	**1.6**	**11.3**
Chromium	7440-47-3	0.1	mg/kg		**1.1**	**0.8**	**4.8**	**4.4**	**10.0**
Copper	7440-50-8	0.1	mg/kg		**27.4**	**21.5**	**33.5**	**40.3**	**32.6**
Thorium	7440-29-1	0.1	mg/kg		**2.0**	**2.1**	**2.2**	**2.4**	**2.7**
Manganese	7439-96-5	0.1	mg/kg		**109**	**182**	**233**	**575**	**539**
Molybdenum	7439-98-7	0.1	mg/kg		**1.1**	**0.5**	**1.2**	**1.5**	**0.5**
Nickel	7440-02-0	0.1	mg/kg		**3.6**	**1.8**	**4.6**	**4.0**	**17.5**
Lead	7439-92-1	0.1	mg/kg		**14.3**	**11.4**	**18.1**	**14.2**	**12.4**
Antimony	7440-36-0	0.1	mg/kg		**0.2**	<0.1	<0.1	**0.1**	**0.1**
Uranium	7440-61-1	0.1	mg/kg		**0.2**	**0.3**	**0.4**	**0.4**	**0.2**
Zinc	7440-66-6	0.5	mg/kg		**38.8**	**25.4**	**150**	**108**	**74.5**
Vanadium	7440-62-2	1	mg/kg		**6**	**5**	**14**	**7**	**30**
EK040S: Fluoride Soluble									
Fluoride	16984-48-8	1	mg/kg		**5**	**2**	**1**	**8**	**3**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	2021090_C001 Composite A	2021090_C002 Composite B	2021090_C003 Composite C	2021090_C004 Composite D	2021090_C005 Composite E
				Sampling date / time	18-Mar-2022 00:00	18-Mar-2022 00:00	18-Mar-2022 00:00	18-Mar-2022 00:00	18-Mar-2022 00:00
Compound	CAS Number	LOR	Unit		EB2207646-001	EB2207646-002	EB2207646-003	EB2207646-004	EB2207646-005
					Result	Result	Result	Result	Result
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	**0.2**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_C006 Composite F	2021090_C007 Composite G	2021090_C008 Composite H	----	----
			Sampling date / time	18-Mar-2022 00:00	18-Mar-2022 00:00	18-Mar-2022 00:00	----	----
Compound	CAS Number	LOR	Unit	EB2207646-006	EB2207646-007	EB2207646-008	--------	--------
				Result	Result	Result	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.9	7.9	9.8	----	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	470	674	415	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	1.4	1.6	1.0	----	----
ED037: Alkalinity								
ø Total Alkalinity as CaCO3	----	1	mg/kg	17400	6420	1830	----	----
ø Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/kg	16500	6420	916	----	----
ø Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/kg	916	<5	916	----	----
ED038A: Acidity								
Acidity	----	1	mg/kg	<5	82	<5	----	----
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	310	1100	330	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	40	30	20	----	----
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	<10	30	<10	----	----
Magnesium	7439-95-4	10	mg/kg	<10	10	<10	----	----
Sodium	7440-23-5	10	mg/kg	450	650	440	----	----
Potassium	7440-09-7	10	mg/kg	20	50	10	----	----
ED093T: Total Major Cations								
Calcium	7440-70-2	50	mg/kg	41600	4400	14500	----	----
Magnesium	7439-95-4	50	mg/kg	10900	5520	2790	----	----
Sodium	7440-23-5	50	mg/kg	1520	1540	1390	----	----
Potassium	7440-09-7	50	mg/kg	1310	1420	1050	----	----
EG005(ED093)S : Soluble Metals by ICPAES								
Boron	7440-42-8	1	mg/kg	<1	<1	<1	----	----
Iron	7439-89-6	1	mg/kg	<1	<1	<1	----	----
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	9470	11400	4970	----	----
Boron	7440-42-8	50	mg/kg	<50	<50	<50	----	----
Iron	7439-89-6	50	mg/kg	28500	32700	16100	----	----
EG020S: Soluble Metals by ICPMS								

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_C006 Composite F	2021090_C007 Composite G	2021090_C008 Composite H	----	----
			Sampling date / time	18-Mar-2022 00:00	18-Mar-2022 00:00	18-Mar-2022 00:00	----	----
Compound	CAS Number	LOR	Unit	EB2207646-006	EB2207646-007	EB2207646-008	--------	--------
				Result	Result	Result	----	----
EG020S: Soluble Metals by ICPMS - Continued								
Arsenic	7440-38-2	0.01	mg/kg	**0.44**	<0.01	**0.37**	----	----
Selenium	7782-49-2	0.1	mg/kg	<0.1	<0.1	<0.1	----	----
Cadmium	7440-43-9	0.01	mg/kg	<0.01	<0.01	<0.01	----	----
Cobalt	7440-48-4	0.01	mg/kg	<0.01	<0.01	<0.01	----	----
Chromium	7440-47-3	0.01	mg/kg	<0.01	<0.01	<0.01	----	----
Copper	7440-50-8	0.01	mg/kg	<0.01	<0.01	<0.01	----	----
Manganese	7439-96-5	0.01	mg/kg	<0.01	**0.22**	<0.01	----	----
Molybdenum	7439-98-7	0.01	mg/kg	**0.24**	**0.05**	**0.17**	----	----
Nickel	7440-02-0	0.01	mg/kg	<0.01	**0.01**	<0.01	----	----
Lead	7439-92-1	0.01	mg/kg	<0.01	<0.01	<0.01	----	----
Antimony	7440-36-0	0.01	mg/kg	**0.03**	**0.02**	**0.03**	----	----
Uranium	7440-61-1	0.01	mg/kg	<0.01	<0.01	<0.01	----	----
Zinc	7440-66-6	0.05	mg/kg	<0.05	<0.05	<0.05	----	----
Vanadium	7440-62-2	0.1	mg/kg	<0.1	<0.1	<0.1	----	----
Aluminium	7429-90-5	0.1	mg/kg	**0.5**	<0.1	**0.7**	----	----
Thorium	7440-29-1	0.01	mg/kg	<0.01	<0.01	<0.01	----	----
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.1	mg/kg	**7.4**	**7.6**	**17.0**	----	----
Selenium	7782-49-2	1	mg/kg	<1	<1	<1	----	----
Cadmium	7440-43-9	0.1	mg/kg	<0.1	**0.1**	<0.1	----	----
Cobalt	7440-48-4	0.1	mg/kg	**15.4**	**10.3**	**4.8**	----	----
Chromium	7440-47-3	0.1	mg/kg	**13.5**	**13.3**	**1.5**	----	----
Copper	7440-50-8	0.1	mg/kg	**22.6**	**34.2**	**22.4**	----	----
Thorium	7440-29-1	0.1	mg/kg	**2.4**	**2.2**	**1.7**	----	----
Manganese	7439-96-5	0.1	mg/kg	**832**	**360**	**299**	----	----
Molybdenum	7439-98-7	0.1	mg/kg	**0.9**	**0.8**	**0.9**	----	----
Nickel	7440-02-0	0.1	mg/kg	**29.3**	**37.7**	**5.3**	----	----
Lead	7439-92-1	0.1	mg/kg	**12.4**	**19.6**	**10.9**	----	----
Antimony	7440-36-0	0.1	mg/kg	**0.1**	**0.1**	**0.1**	----	----
Uranium	7440-61-1	0.1	mg/kg	**0.2**	**0.2**	**0.1**	----	----
Zinc	7440-66-6	0.5	mg/kg	**57.8**	**70.4**	**26.0**	----	----
Vanadium	7440-62-2	1	mg/kg	**27**	**26**	**7**	----	----
EK040S: Fluoride Soluble								
Fluoride	16984-48-8	1	mg/kg	<2	<2	<2	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_C006 Composite F	2021090_C007 Composite G	2021090_C008 Composite H	----	----
			Sampling date / time	18-Mar-2022 00:00	18-Mar-2022 00:00	18-Mar-2022 00:00	----	----
Compound	CAS Number	LOR	Unit	EB2207646-006	EB2207646-007	EB2207646-008	--------	--------
				Result	Result	Result	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.1	mg/kg	<0.1	<0.1	**0.1**	**----**	**----**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **SOIL**)			Sample ID	**DI Water for 1:5 leachate**	**----**	**----**	**----**	**----**
			Sampling date / time	19-Mar-2022 00:00	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB2207646-009**	**--------**	**--------**	**--------**	**--------**
				Result	----	----	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**5.4**	**----**	**----**	**----**	**----**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	<1	**----**	**----**	**----**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2217841**	Page	: 1 of 4
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: PRITII TAM	Contact	: Customer Services EB
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4107	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2021090 Eagle Downs	Date Samples Received	: 20-Jun-2022 09:00
Order number	: ----	Date Analysis Commenced	: 25-Jun-2022
C-O-C number	: ----	Issue Date	: 01-Jul-2022 09:12
Sampler	: PRIYA RAJENDRAN		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 8		
No. of samples analysed	: 8		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EG035T (Total Mercury): Sample 2021090_C008(EB2217841-008) shows poor matrix spike recovery due to sample heterogeneity. Confirmed by re-extraction and re-analysis.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_C001 Composite A	2021090_C002 Composite B	2021090_C003 Composite C	2021090_C004 Composite D	2021090_C005 Composite E
			Sampling date / time	18-Mar-2022 00:00	18-Mar-2022 00:00	18-Mar-2022 00:00	18-Mar-2022 00:00	18-Mar-2022 00:00
Compound	CAS Number	LOR	Unit	EB2217841-001	EB2217841-002	EB2217841-003	EB2217841-004	EB2217841-005
				Result	Result	Result	Result	Result
EG035S: Soluble Mercury by FIMS								
Mercury	7439-97-6	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_C006 Composite F	2021090_C007 Composite G	2021090_C008 Composite H	----	----
			Sampling date / time	18-Mar-2022 00:00	18-Mar-2022 00:00	18-Mar-2022 00:00	----	----
Compound	CAS Number	LOR	Unit	EB2217841-006	EB2217841-007	EB2217841-008	--------	--------
				Result	Result	Result	----	----
EG035S: Soluble Mercury by FIMS								
Mercury	7439-97-6	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	**----**	**----**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	**----**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2207870**	Page	: 1 of 4
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: ALAN ROBERTSON	Contact	: Customer Services EB
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4107	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2021090 Eagle Downs	Date Samples Received	: 22-Mar-2022 17:24
Order number	: ----	Date Analysis Commenced	: 26-Mar-2022
C-O-C number	: ----	Issue Date	: 30-Mar-2022 16:13
Sampler	: ASITHA JAJASINGHE		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 4		
No. of samples analysed	: 4		

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Accreditation No. 825
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ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	WKLC1	WKLC2	WKLC3	WKLC4	----
			Sampling date / time	22-Mar-2022 00:00	22-Mar-2022 00:00	22-Mar-2022 00:00	22-Mar-2022 00:00	----
Compound	CAS Number	LOR	Unit	EB2207870-001	EB2207870-002	EB2207870-003	EB2207870-004	--------
				Result	Result	Result	Result	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**5.46**	**7.13**	**9.41**	**7.31**	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**153**	**108**	**585**	**1420**	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	**54**	<1	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**4**	**27**	**100**	**42**	----
Total Alkalinity as CaCO3	----	1	mg/L	**4**	**27**	**154**	**42**	----
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	**22**	**3**	**1**	**4**	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**53**	**23**	**85**	**620**	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**3**	**1**	**31**	**21**	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**3**	**11**	**2**	**17**	----
Magnesium	7439-95-4	1	mg/L	<1	**2**	<1	**10**	----
Sodium	7440-23-5	1	mg/L	**15**	**4**	**124**	**263**	----
Potassium	7440-09-7	1	mg/L	<1	<1	**2**	**3**	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.08**	**0.32**	**1.39**	**0.02**	----
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	**0.002**	<0.001	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	**0.045**	**0.001**	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	**0.0006**	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	**0.001**	<0.001	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	**0.037**	----
Copper	7440-50-8	0.001	mg/L	**0.002**	<0.001	**0.004**	**0.003**	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Manganese	7439-96-5	0.001	mg/L	**0.010**	**0.012**	**0.002**	**0.382**	----
Molybdenum	7439-98-7	0.001	mg/L	**0.002**	**0.004**	**0.084**	**0.025**	----
Nickel	7440-02-0	0.001	mg/L	**0.002**	<0.001	<0.001	**0.079**	----
Selenium	7782-49-2	0.01	mg/L	**0.01**	<0.01	**0.02**	**0.03**	----
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	WKLC1	WKLC2	WKLC3	WKLC4	----
			Sampling date / time	22-Mar-2022 00:00	22-Mar-2022 00:00	22-Mar-2022 00:00	22-Mar-2022 00:00	----
Compound	CAS Number	LOR	Unit	EB2207870-001	EB2207870-002	EB2207870-003	EB2207870-004	--------
				Result	Result	Result	Result	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	**0.01**	<0.01	**----**
Zinc	7440-66-6	0.005	mg/L	**0.011**	<0.005	<0.005	**0.051**	**----**
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	**0.09**	**0.06**	**----**
Iron	7439-89-6	0.05	mg/L	**11.4**	<0.05	**0.09**	<0.05	**----**
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	<0.1	**0.6**	**0.7**	**0.2**	**----**
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	**1.27**	**1.05**	**5.72**	**14.3**	**----**
ø Total Cations	----	0.01	meq/L	**1.21**	**----**	**----**	**----**	**----**
ø Total Cations	----	0.01	meq/L	**----**	**0.89**	**5.54**	**13.2**	**----**
ø Ionic Balance	----	0.01	%	**----**	**----**	**1.57**	**4.18**	**----**

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CERTIFICATE OF ANALYSIS

Work Order	: **EB2212637**	Page	: 1 of 4
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: PRITII TAM	Contact	: Customer Services EB
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4107	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2021090 Eagle Downs	Date Samples Received	: 06-May-2022 15:00
Order number	: ----	Date Analysis Commenced	: 09-May-2022
C-O-C number	: ----	Issue Date	: 16-May-2022 10:13
Sampler	: PRIYA RAJENDRAN		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 4		
No. of samples analysed	: 4		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

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This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	WKLC1	WKLC2	WKLC3	WKLC4	----
			Sampling date / time	19-Apr-2022 00:00	19-Apr-2022 00:00	19-Apr-2022 00:00	19-Apr-2022 00:00	----
Compound	CAS Number	LOR	Unit	EB2212637-001	EB2212637-002	EB2212637-003	EB2212637-004	--------
				Result	Result	Result	Result	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**6.32**	**7.08**	**9.20**	**6.54**	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**162**	**368**	**412**	**1780**	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	**26**	<1	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**5**	**34**	**90**	**10**	----
Total Alkalinity as CaCO3	----	1	mg/L	**5**	**34**	**115**	**10**	----
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	**6**	**4**	<1	**3**	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**56**	**134**	**68**	**881**	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**3**	**5**	**16**	**16**	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**2**	**50**	**1**	**23**	----
Magnesium	7439-95-4	1	mg/L	<1	**7**	<1	**6**	----
Sodium	7440-23-5	1	mg/L	**32**	**12**	**95**	**407**	----
Potassium	7440-09-7	1	mg/L	<1	**2**	**4**	**4**	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.10**	**0.09**	**4.54**	**0.02**	----
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	**0.003**	**0.001**	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	**0.024**	**0.002**	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	**0.0002**	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	**0.003**	<0.001	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	**0.006**	----
Copper	7440-50-8	0.001	mg/L	<0.001	**0.002**	**0.004**	**0.002**	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Manganese	7439-96-5	0.001	mg/L	**0.003**	**0.026**	**0.003**	**0.124**	----
Molybdenum	7439-98-7	0.001	mg/L	**0.006**	**0.029**	**0.104**	**0.013**	----
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	**0.013**	----
Selenium	7782-49-2	0.01	mg/L	**0.02**	<0.01	**0.02**	**0.05**	----
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	WKLC1	WKLC2	WKLC3	WKLC4	----
			Sampling date / time	19-Apr-2022 00:00	19-Apr-2022 00:00	19-Apr-2022 00:00	19-Apr-2022 00:00	----
Compound	CAS Number	LOR	Unit	EB2212637-001	EB2212637-002	EB2212637-003	EB2212637-004	--------
				Result	Result	Result	Result	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	**0.01**	<0.01	**----**
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	**0.013**	**----**
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	**0.07**	<0.05	**----**
Iron	7439-89-6	0.05	mg/L	**0.11**	<0.05	**0.30**	<0.05	**----**
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	<0.1	**1.0**	**0.6**	**0.2**	**----**
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	**1.35**	**3.61**	**4.16**	**19.0**	**----**
ø Total Cations	----	0.01	meq/L	**1.49**	**3.64**	**4.28**	**19.4**	**----**
ø Ionic Balance	----	0.01	%	**----**	**0.47**	**1.42**	**1.18**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2213933**	Page	: 1 of 4
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: PRITII TAM	Contact	: Customer Services EB
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4107	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2021090 Eagle Downs	Date Samples Received	: 17-May-2022 15:42
Order number	: ----	Date Analysis Commenced	: 20-May-2022
C-O-C number	: ----	Issue Date	: 27-May-2022 17:53
Sampler	: PRIYA RAJENDRAN		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 4		
No. of samples analysed	: 4		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

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This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	WKLC1 L3	WKLC2 L3	WKLC3 L3	WKLC4 L3	----
			Sampling date / time	17-May-2022 00:00	17-May-2022 00:00	17-May-2022 00:00	17-May-2022 00:00	----
Compound	CAS Number	LOR	Unit	EB2213933-001	EB2213933-002	EB2213933-003	EB2213933-004	--------
				Result	Result	Result	Result	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	7.17	7.57	9.44	7.74	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	302	332	506	1660	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	43	<1	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	10	23	81	48	----
Total Alkalinity as CaCO3	----	1	mg/L	10	23	124	48	----
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	1	1	<1	2	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	97	112	79	716	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	8	6	20	10	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	2	43	<1	14	----
Magnesium	7439-95-4	1	mg/L	<1	6	<1	4	----
Sodium	7440-23-5	1	mg/L	58	10	111	337	----
Potassium	7440-09-7	1	mg/L	1	2	1	3	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.07	0.08	0.31	0.06	----
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.001	<0.001	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.025	0.002	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	0.001	----
Copper	7440-50-8	0.001	mg/L	<0.001	0.001	0.003	<0.001	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Manganese	7439-96-5	0.001	mg/L	<0.001	0.021	0.001	0.068	----
Molybdenum	7439-98-7	0.001	mg/L	0.018	0.020	0.158	0.025	----
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	0.003	----
Selenium	7782-49-2	0.01	mg/L	0.07	<0.01	0.03	0.05	----
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	WKLC1 L3	WKLC2 L3	WKLC3 L3	WKLC4 L3	----
				Sampling date / time	17-May-2022 00:00	17-May-2022 00:00	17-May-2022 00:00	17-May-2022 00:00	----
Compound	CAS Number	LOR	Unit		EB2213933-001	EB2213933-002	EB2213933-003	EB2213933-004	--------
					Result	Result	Result	Result	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	**----**
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	**0.006**	<0.005	**----**
Boron	7440-42-8	0.05	mg/L		<0.05	<0.05	**0.06**	<0.05	**----**
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	**0.11**	<0.05	**----**
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.1**	**1.0**	**0.7**	**0.4**	**----**
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**2.44**	**2.96**	**4.69**	**16.1**	**----**
ø Total Cations	----	0.01	meq/L		**2.65**	**3.12**	**4.85**	**15.8**	**----**
ø Ionic Balance	----	0.01	%		**----**	**----**	**1.75**	**1.21**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2217146**	Page	: 1 of 4
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: PRITII TAM	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4107	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2021090 Eagle Downs	Date Samples Received	: 14-Jun-2022 16:12
Order number	: ----	Date Analysis Commenced	: 20-Jun-2022
C-O-C number	: ----	Issue Date	: 23-Jun-2022 14:38
Sampler	: VERONICA CANALES		
Site	:		
Quote number	: BN/1234/19		
No. of samples received	: 4		
No. of samples analysed	: 4		

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Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

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Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Ionic Balance out of acceptable limits for some samples due to analytes not quantified in this report.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	WKLC1	WKLC2	WKLC3	WKLC4	----
			Sampling date / time	14-Jun-2022 00:00	14-Jun-2022 00:00	14-Jun-2022 00:00	14-Jun-2022 00:00	----
Compound	CAS Number	LOR	Unit	EB2217146-001	EB2217146-002	EB2217146-003	EB2217146-004	--------
				Result	Result	Result	Result	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**6.63**	**6.96**	**8.97**	**6.83**	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**354**	**368**	**222**	**1090**	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	**17**	<1	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**9**	**28**	**46**	**12**	----
Total Alkalinity as CaCO3	----	1	mg/L	**9**	**28**	**63**	**12**	----
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	**2**	**2**	<1	**2**	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**120**	**126**	**36**	**453**	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**8**	**8**	**22**	**30**	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**3**	**44**	<1	**10**	----
Magnesium	7439-95-4	1	mg/L	<1	**6**	<1	**3**	----
Sodium	7440-23-5	1	mg/L	**64**	**13**	**45**	**200**	----
Potassium	7440-09-7	1	mg/L	<1	**2**	<1	**2**	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.09**	**0.08**	**0.91**	**0.14**	----
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	**0.001**	<0.001	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	**0.009**	**0.001**	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Barium	7440-39-3	0.001	mg/L	**0.065**	**0.088**	**0.036**	**0.078**	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	**0.002**	----
Copper	7440-50-8	0.001	mg/L	<0.001	**0.002**	**0.003**	**0.002**	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Manganese	7439-96-5	0.001	mg/L	**0.003**	**0.025**	**0.002**	**0.068**	----
Molybdenum	7439-98-7	0.001	mg/L	**0.017**	**0.026**	**0.050**	**0.008**	----
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	**0.005**	----
Selenium	7782-49-2	0.01	mg/L	**0.07**	**0.01**	**0.01**	**0.02**	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	WKLC1	WKLC2	WKLC3	WKLC4	----
			Sampling date / time	14-Jun-2022 00:00	14-Jun-2022 00:00	14-Jun-2022 00:00	14-Jun-2022 00:00	----
Compound	CAS Number	LOR	Unit	EB2217146-001	EB2217146-002	EB2217146-003	EB2217146-004	--------
				Result	Result	Result	Result	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	----
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	----
Iron	7439-89-6	0.05	mg/L	**0.12**	<0.05	**0.12**	<0.05	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.1**	**0.8**	**0.3**	**0.2**	----
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	**2.90**	**3.41**	**2.63**	**10.5**	----
ø Total Cations	----	0.01	meq/L	**2.93**	**3.31**	**1.96**	**9.50**	----
ø Ionic Balance	----	0.01	%	**----**	**1.52**	**----**	**5.10**	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2220270**	Page	: 1 of 4
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: ALAN ROBERTSON	Contact	: Customer Services EB
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4108	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2021090 Eagle Downs	Date Samples Received	: 12-Jul-2022 16:50
Order number	: ----	Date Analysis Commenced	: 14-Jul-2022
C-O-C number	: ----	Issue Date	: 20-Jul-2022 09:37
Sampler	: ASITHA JAJASINGHE		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 4		
No. of samples analysed	: 4		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	WKLC1	WKLC2	WKLC3	WKLC4	----
			Sampling date / time	12-Jul-2022 00:00	12-Jul-2022 00:00	12-Jul-2022 00:00	12-Jul-2022 00:00	----
Compound	CAS Number	LOR	Unit	EB2220270-001	EB2220270-002	EB2220270-003	EB2220270-004	--------
				Result	Result	Result	Result	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.21**	**7.16**	**9.17**	**7.17**	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**578**	**150**	**260**	**1060**	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	**14**	<1	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**11**	**8**	**54**	**9**	----
Total Alkalinity as CaCO3	----	1	mg/L	**11**	**8**	**68**	**9**	----
ED038A: Acidity								
Acidity as CaCO3	----	1	mg/L	**3**	**2**	<1	**2**	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**215**	**42**	**38**	**467**	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**10**	**4**	**4**	**3**	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**3**	**16**	<1	**12**	----
Magnesium	7439-95-4	1	mg/L	<1	**3**	<1	**4**	----
Sodium	7440-23-5	1	mg/L	**110**	**5**	**56**	**199**	----
Potassium	7440-09-7	1	mg/L	<1	<1	<1	**2**	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.12**	**0.05**	**0.16**	**0.04**	----
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	**0.001**	<0.001	----
Arsenic	7440-38-2	0.001	mg/L	**0.001**	<0.001	**0.012**	**0.002**	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	**0.003**	----
Copper	7440-50-8	0.001	mg/L	**0.001**	<0.001	**0.003**	**0.001**	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Manganese	7439-96-5	0.001	mg/L	**0.003**	**0.012**	**0.001**	**0.092**	----
Molybdenum	7439-98-7	0.001	mg/L	**0.040**	**0.013**	**0.061**	**0.008**	----
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	**0.008**	----
Selenium	7782-49-2	0.01	mg/L	**0.14**	<0.01	**0.01**	**0.02**	----
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	WKLC1	WKLC2	WKLC3	WKLC4	----
			Sampling date / time	12-Jul-2022 00:00	12-Jul-2022 00:00	12-Jul-2022 00:00	12-Jul-2022 00:00	----
Compound	CAS Number	LOR	Unit	EB2220270-001	EB2220270-002	EB2220270-003	EB2220270-004	--------
				Result	Result	Result	Result	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	**0.009**	----
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	----
Iron	7439-89-6	0.05	mg/L	**0.14**	<0.05	**0.05**	<0.05	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.2**	**0.3**	**0.4**	**0.2**	----
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	**4.98**	**1.15**	**2.26**	**9.99**	----
ø Total Cations	----	0.01	meq/L	**4.93**	**1.26**	**2.44**	**9.64**	----
ø Ionic Balance	----	0.01	%	**0.44**	**----**	**----**	**1.80**	----

Attachment F: Trilab Laboratory Results

Trilab
Soil Rock Calibration

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346A Bilsen Road,
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Perth
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Ph: +61 8 9258 8323

POINT LOAD TEST REPORT

Test Method: AS 4133.4.1

Client	RGS Environmental Pty Ltd	**Report No.**	22030314-PL
		Workorder No.	0009607
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	15/04/2022
		Report Date	24/03/2022
Project	2021090 - Eagle Downs		

Sample No.	22030314	22030315	22030316				
Client ID	3 - 2021090_3012 - 3215903 - ED0109 - Overburden	13 - 2021090_3022 - 3215913 - ED0109 - Interburden	22 - 2021090_3031 - 3215922 - ED0109 - Interburden				
Depth (m)	137.10-137.37	306.18-306.41	404.56-404.91				
I_S (MPa)	2.49	2.85	2.21				
$I_{S(50)}$ (MPa)	2.39	2.85	2.05				
Load Direction	Axial	Axial	Axial				

Sample No.							
Client ID							
Depth (m)							
I_S (MPa)							
$I_{S(50)}$ (MPa)							
Load Direction							

NOTES/REMARKS: Tested as received + Irregular Lump

Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in this document are traceable to the International System of Units (SI). References are traceable to National Measurement Institutes or laboratories accredited to ISO/IEC 17025 by a signatory to the ILAC MRA.
Tested at Trilab Brisbane Laboratory

Authorised Signatory
C. Purvis

NATA ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
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POINT LOAD TEST REPORT

Test Method: AS 4133.4.1

Client	RGS Environmental Pty Ltd	**Report No.**	22030314-PL
		Workorder No.	0009607
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	15/03/2022
		Report Date	24/03/2022
Project	2021090 - Eagle Downs		

Sample No.	22030314	22030315	22030316				
Client ID	3 - 2021090_3012 - 3215903 - ED0109 - Overburden	13 - 2021090_3022 - 3215913 - ED0109 - Interburden	22 - 2021090_3031 - 3215922 - ED0109 - Interburden				
Depth (m)	137.10-137.37	306.18-306.41	404.56-404.91				
I_S (MPa)	2.70	0.77	1.19				
$I_{S(50)}$ (MPa)	2.86	0.84	1.28				
Load Direction	Diametral	Diametral	Diametral				

Sample No.							
Client ID							
Depth (m)							
I_S (MPa)							
$I_{S(50)}$ (MPa)							
Load Direction							

NOTES/REMARKS: Tested as received + Irregular Lump

Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in this document are traceable to the International System of Units (SI). References are traceable to National Measurement Institutes or laboratories accredited to ISO/IEC 17025 by a signatory to the ILAC MRA.
Tested at Trilab Brisbane Laboratory

Authorised Signatory
C. Purvis

NATA ACCREDITED FOR TECHNICAL COMPETENCE

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Attachment G: Levay XRD Results

LEVAY & CO. ENVIRONMENTAL SERVICES

Water Quality, Water Treatment and Environmental Pollution Research Laboratories

Job No.
L&C-22-086

REPORT

QXRD Analysis of Two Samples

RGS Job No. 2021090
Purchase Order No. 2022014

Prepared for:

Dr. Alan M. Robertson,
Director – Principal Geochemist,
RGS Environmental Consultants Pty. Ltd.,
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Prepared by:

George Levay,
Levay & Co. Environmental Services,
Unit 8, 62 – 64 West Avenue,
Edinburgh. SA. 5111.

Date: 7th April, 2022

Introduction

Levay & Co. Environmental Services received two samples (RGS Job No. 2021090 Eagle Downs) from RGS Environmental on the 24th March, 2022 to determine their mineralogical content by (semi-) quantitative x-ray diffraction (QXRD) analysis. The sample details are provided in the table below.

Table 1. List of samples received for QXRD analysis

RGS Sample ID.	Levay & Co. ID.	Sample Description
2021090_C005	22-086-01	Composite E (Overburden Waste Rock)
2021090_C006	22-086-02	Composite F (Interburden Waste Rock)

(Semi) - Quantitative X-Ray Diffraction (QXRD)

X-ray diffraction traces were obtained from the sample with a Panalytical Aeris Research Powder Diffractometer. Operating conditions were 40kV/15mA, Fe Kß filter, step scan 0.01/29 secs˚2Θ at, 1/2˚ divergence and a 1.0˚ ant-scatter slit. Scan range was 5° to 90° 2Θ. Phases were identified by computer search/match of the COD 2021 Database. Quantitative results determined with full pattern Rietveld refinement software.

Results from sedimented mounts were treated as per the USGS Clay Identification Flowsheet to ascertain the presence of smectite clay i.e., intercalation with glycol.

Results

The results from QXRD analysis of these samples are shown in Table 2 below. Mineralisation includes silicate (quartz and albite), clay (illite, kaolinite and chlorite) and coal-amorphous, as the dominant phases. These samples also contain small amount of carbonate (calcite and ankerite).

The proportion of amorphous phase(s) has been estimated by modelling the broadened background using an experimentally derived structure for black coal and should be considered approximate.

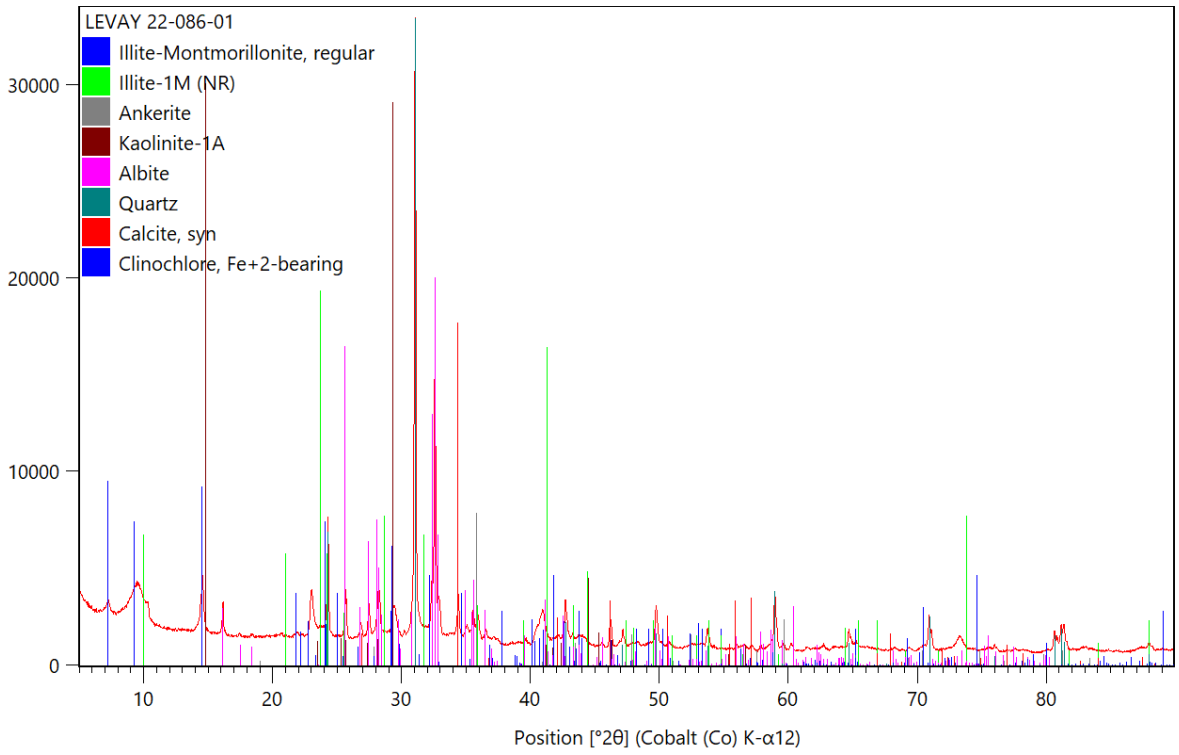
Table 2: QXRD results

Phase	2021090_C005 Weight %[1]	2021090_C006 Weight %[1]
Quartz	24.1	28.1
Albite	19.1	8.2
Mixed layer illite (I-S)	14.9	14.3
Illite	14.1	11.9
Kaolinite	3.1	9.9
Chlorite (clinochlore)	2.1	1.6
Calcite	1.5	3.1
Pyrite	0.5	0.4
Anatase	0.7	0.5
Anhydrite	0.1	0.1
Ankerite	1.6	4.6
Siderite	0.1	ND[2]
Amorphous-coal	18.1	17.3

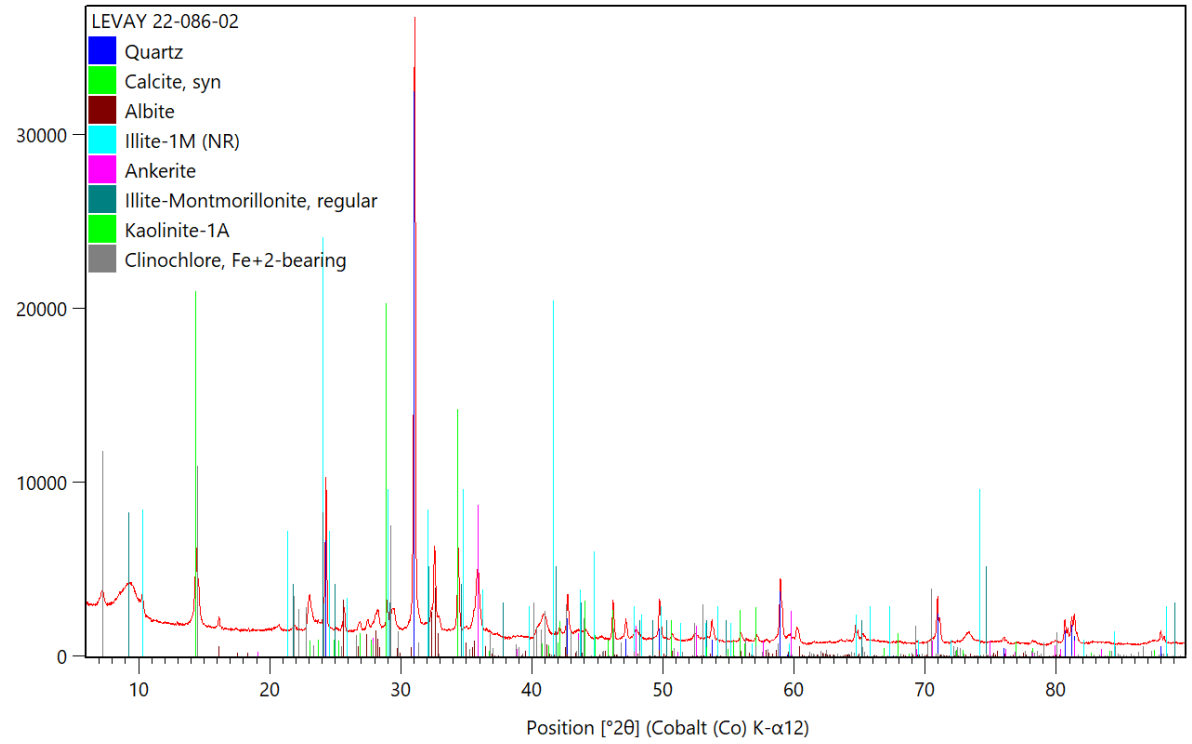
1 Semiquantitative Detection limit ~0.4 wt.%
2 ND = Non Detectable

Results Graphical – Phase ID

22-086-01: 2021090_C005 Composite E

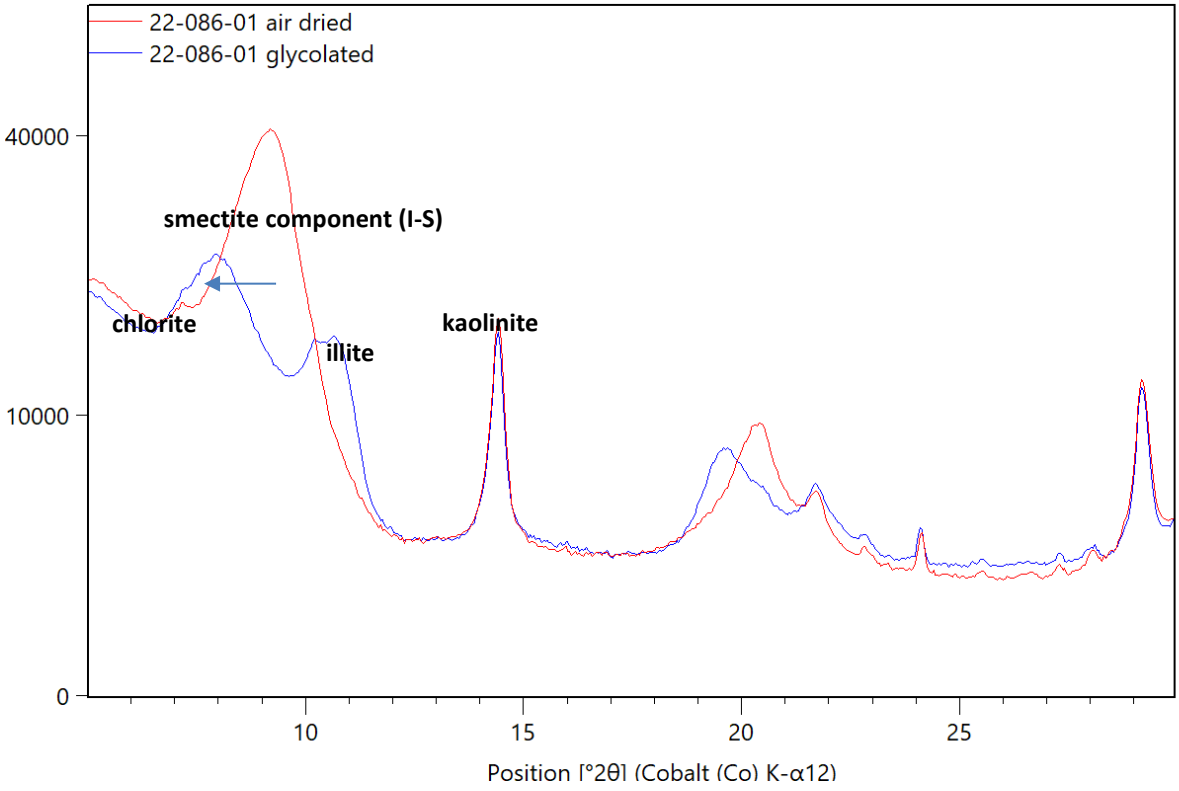


22-086-02: 2021090_C006 Composite F



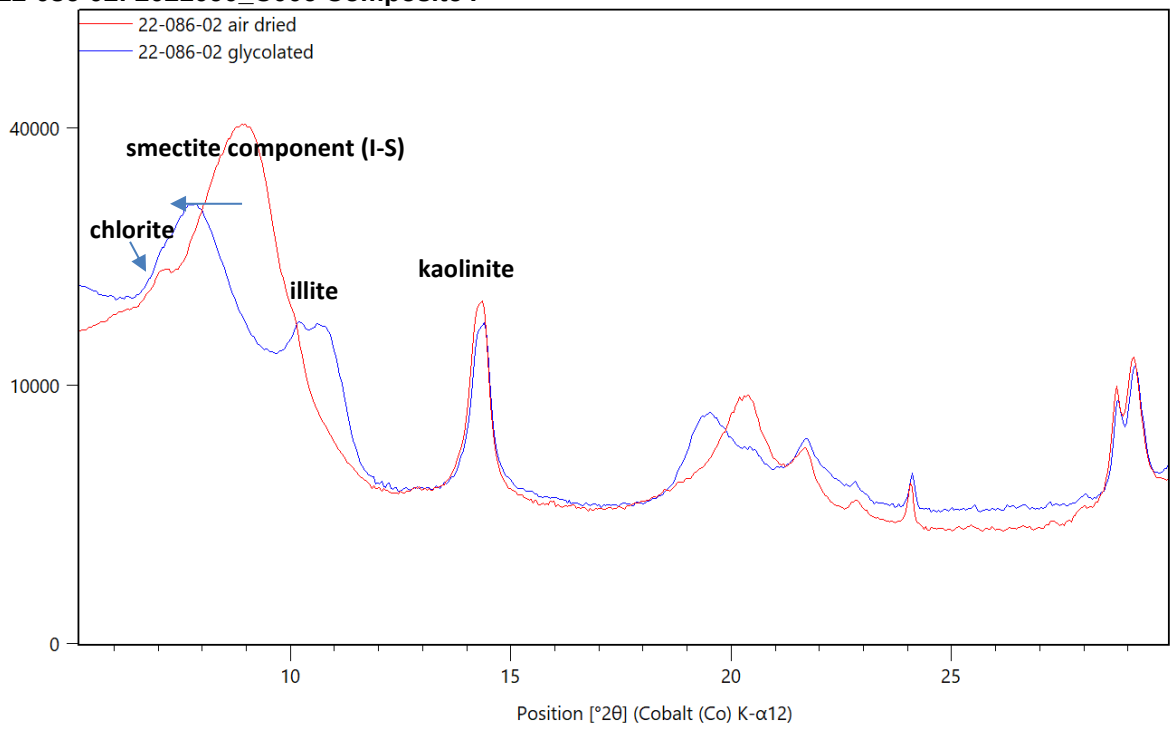
Sedimented and Glycol Treated Samples Results

22-086-01: 2021090_C005 Composite E



Peak shift on glycol intercalation demonstrates interlayer illite-smectite (I-S) presence

22-086-02: 2021090_C006 Composite F



Peak shift on glycol intercalation demonstrates interlayer illite-smectite (I-S) presence



MINE WASTE AND
WATER MANAGEMENT

Appendix I. Final Landform Design

REPORT

SOUTH32 LIMITED
ABN: 84 093 732 597

EAGLE DOWNS DRY REJECTS EMPLACEMENT AREA
Final Landform Design Report

119224.02R01 Rev B
APRIL 2023

TAILINGS.WATER.WASTE.

Document Control

Project Name:	Eagle Downs Coal Management – South32
Document Title:	Dry Rejects Emplacement Area Final Landform Design Report
File Location:	N:\Synergy\Projects\119\119224 Eagle Downs Coal Management - South32\02 DREA Final Landform Design\Documents\R01\Text\119224.02R01 Rev B.docx
Document Number:	119224.02R01 Rev B

Revision History

Revision	Issue	Issue Date	Prepared by	Reviewed by
A	Draft Issue	11/01/2023	HAA	AW
B	Revised Draft	13/04/2023	HAA/LPa/JP	AW/GS

Issue Register

Distribution List	Date
South32 Ltd	11/01/2023
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EXECUTIVE SUMMARY

The Eagle Downs Metallurgical Coal Project involves construction, development and operation of an underground longwall metallurgical coal mine in Queensland's Bowen Basin. Large quantities of rejects will be produced as part of the mining activities and stored in the Dry Rejects Emplacement Area (DREA) which requires rehabilitation to meet the requirements of the Environmental Authority (EA) and Progressive Rehabilitation and Closure Plan (PRCP) requirements. The DREA is required to be rehabilitated to form a final landform that is geotechnically and erosionally stable.

This report describes the final landform design and associated geotechnical and erosional stability assessment completed for the DREA. Details of the design and the DREA completed have been included to provide the required background to the structure and development to achieve the required final landform that is geotechnically and erosionally stable.

The intent of this report is to present the design information and staging of the DREA to the end of the Life of Mine and the completion of progressive rehabilitation of the structure to form the final landform. The development of the DREA will be completed in three stages, Stage 1: 0 – 5 Years, with Stage 2: 5 – 20 Years to the southeast of Stage 1 and Stage 3: 20 – 50 Years constructed to the north of Stages 1 and 2. By following the staged development, quality control and efficient use of the materials can be implemented throughout the life of the development. The final landform will be progressively rehabilitated to form the final landform with a low profile to enhance the visual amenity of the site.

The design adopted a risk-based approach that ensure that the design adhered to compliance requirements and best practice guidelines. All identified risks were addressed through designed control measures to manage the identified risks.

Analysis of the DREA completed included:

- Geotechnical Stability under the following loading conditions:
  - Long Term;
  - Short Term; and
  - Seismic; and
- Erosional Stability:
  - Landform Evolution Modelling.

The final landform design review and refined the existing detailed design of Stage 1: 0 – 5 Years and Stage 2: 5 – 20 Years Design and completed Stage 3: 20 – 50 Years from concept to detailed design. The design includes the design of stormwater management structures to manage surface water runoff from the DREA. The final landform was completed to be water shedding.

Material properties assumed for in the geotechnical and erosional stability modelling are to be confirmed once the materials become available and where required, the stability assessments are to be completed with the updated parameters.

The rehabilitation areas have been identified and rehabilitation milestones assigned to ensure the completion of the progressive rehabilitation to meet regulatory requirements.

The completion of the final landform forms part of the steps required in the development of the PRCP schedule for the site.

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APPENDIX A: STABILITY ASSESSMENT
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1 INTRODUCTION

1.1 Background

The Eagle Downs Metallurgical Coal (EDCM) Project involves the construction and operation of an underground longwall metallurgical coal mine in Queensland's Bowen Basin. The EDCM project team is delivering the project on behalf of the Eagle Downs Coal Joint Venture, formed between Aquila Resources and South32 Limited (South32).

A feasibility study in relation to the EDCM project was completed in 2011, which showed that the Moranbah Coal Measures are present throughout the mining lease that overlies the project site. Drift construction commenced in late 2013, however, ceased in 2014, with construction at 44% complete. In 2015/16, trade-off studies commenced with a view to optimising the project, including the mine, the coal handling and processing plant (CHPP) and the surface infrastructure.

The first stage of a feasibility study to recommence mine construction and operation was undertaken in 2019, based on a single "go-forward scope" and basis for design. The second stage of the feasibility study commenced thereafter and was completed by December 2020. The purpose of this study was to inform the final investment decision (FID), after which the project was placed on hold.

As part of the 2019 feasibility study, ATC Williams Pty Ltd (ATCW) was engaged by EDCM to complete the Dry Rejects Emplacement Area (DREA) feasibility-level design with the report presented in ATCW (2020) **[1].** This study addressed the final landform design for the DREA, operational methodologies and general rehabilitation requirements. The DREA feasibility design was based on a Life of Mine (LoM) rejects emplacement capacity of 100 Mm^3 in relation to the following staging:

- Stage 1 : 0 – 5 Years;
- Stage 2 : 5 – 20 Years; and
- Stage 3 : 20 – 50 Years.

It was intended that development stages would be integrated, with Stage 1 formed within the south eastern corner of the allocated DREA footprint, Stage 2 to the east and southeast of Stage 1 and Stage 3 to the north of Stages 1 and 2. The premise of this staged development approach was to achieve enhancements in construction, quality control and quality assurance on emplacement construction and operation and efficient use of available materials.

The ATCW (2020) DREA study implemented a risk-based approach to achieve compliance with statutory and development approvals requirements and best practice guidelines. The design aligned with the Environmental Authority (EA) for the EDCM project (DES (2021) **[2]**), and the Environmental Impact Statement (EIS) (BCC & Aquila (2008) [3]) for the development that were current at the time. The design presented the storage construction methodology for Stage 1 (0 – 5 Years), the principles for which would be replicated for Stage 2 (5 – 20 Years) and Stage 3 (20 – 50 Years). The report also provided for the closure and rehabilitation of the DREA. However, with limited project data available at that time, it was recognised that the refinement of the design, construction, operational and rehabilitation elements of the DREA would be required to ensure compliance with the overall design intent.

1.2 DREA Final Landform Design

It is a legal obligation for any land disturbed by mining activities in Queensland to be rehabilitated. The Queensland Government delivered a reform package which included the Mineral and Energy Resources (Financial Provisioning) Act 2018 to improve the rehabilitation and financial assurance outcomes in the resources sector.

A key element of the current regulatory position is that land disturbed by mining activities is to be progressively rehabilitated, as a means of minimising the risks of environmental impact and reduce the cumulative areas of disturbed land throughout the LoM. Progressive rehabilitation of mine disturbed land is a critical element of the Mined Land Rehabilitation Policy, supporting the Financial Provisioning Act. The commitment for progressive rehabilitation is captured within a site-specific Progressive Rehabilitation and Closure Plan (PRCP), which is a mandatory requirement to scope and schedule

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actions that achieve appropriate rehabilitation outcomes. Land disturbed by mining activities is considered rehabilitated when it can be demonstrated that the land is:

- Safe;
- Stable;
- Does not cause environmental harm; and
- Is able to sustain the defined post-mining land use (PMLU).

The PRCP process is a critical backdrop to DREA development as part of the EDCM project. The DREA will be formed as a mining-related landform, and therefore the PRCP creates the framework around DREA landform design, construction, operation and rehabilitation to achieve the above objectives.

PRCP preparation is being completed by EDCM. As input to the PRCP, ATCW has been commissioned by EDCM to complete a final landform design for the DREA, the key criteria for which is to create a landform that is geotechnically and erosionally stable. Implementation of the DREA development will thereafter be subject to the following documentation:

- Technical Specification for construction of the DREA, ATCW(2020) [4]; and
- Operational Management Plan (OMP) for operation of the DREA, ATCW (2020) [5].

1.3 Document Purpose and Scope

The purpose of this document, referred to as the DREA Final Landform Design Report, is to present a final landform design for the DREA. The key elements of this design include:

- Staged development outline for the DREA;
- Geometry of the final DREA landform; and
- Details of a final closure and rehabilitation capping layer.

The scope of work addressed in the document, formed to satisfy the requirements of the PRCP as described in **SECTION 1.2**, is as follows:

- 3D Design of the final DREA landform based on rejects capacity demand for the life-of-mine (LoM), based on the staging approach adopted;
- Model predictions of long-term stability of the final landform (considering both geotechnical and erosion/soil loss stability);
- Method of construction of the emplacement in terms of rejects placement and compaction, including Quality Assurance/ Quality Control (QA/ QC) requirements;
- Integration of surface water drainage from the DREA into the surrounding landscape;
- Details of a suitable capping arrangement for completed DREA surfaces, including re-shaping works to facilitate capping placement;
- Trial methodology to verify the predicted success of the rehabilitated final landform (rejects and capping layer) design.

Any relevant limitations identified and assumptions made in relation to final landform design are also highlighted, with recommended actions to address these aspects.

1.4 Guiding Principles for DREA Development

1.4.1 Regulatory Context

An Environmental Authority (EA), No. EPML00586713 issued by the Department of Environment and Science (DES) for the EDCM project was secured in December 2019 for mine construction and operation. An updated EA, with effective date of 3 December 2021, DES (2021) [**2],** includes specific requirements for DREA development, principally:

- to assess geotechnical and erosivity issues; and

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- to prepare an assessment report by a Registered Professional Engineer of Queensland (RPEQ).

EA conditions relevant to the DREA are reproduced in **TABLE 1**.

TABLE 1: EA CONDITIONS RELATED TO DREA

<table>
<tr><th>Condition Number</th><th>Condition</th></tr>
<tr><td colspan="2">Rehabilitation Landform Criteria</td></tr>
<tr><td>E4</td><td>The environmental authority holder must develop a Rehabilitation Management Plan prior to commencement of longwall mining activities and submit to the administering authority for review and comment.</td></tr>
<tr><td>E5</td><td>The Rehabilitation Management Plan must be implemented and include:
a) map existing areas of rehabilitation;
b) develop design objectives for rehabilitation of disturbed areas and post-mining land uses across the mine;
c) specify spoil characteristics, soil analysis, soil separation for use on rehabilitation;
d) detail rehabilitation methods applied to areas;
e) contain landform design criteria including end of mine design;
f) detail how landform designs will be consistent with the surrounding topography;
g) identify success criteria for areas and itemise revegetation criteria;
h) explain planned native vegetation rehabilitation areas and corridors;
i) identify at least a minimum of three (3) reference and three (3) rehabilitation sites to be used to develop rehabilitation success criteria;
j) describe rehabilitation indicators and the monitoring program to be used;
k) develop a contingency plan for rehabilitation maintenance or redesign;
l) describe end of mine landform design plan and post-mining land uses across the mine; and
m) include a cost benefit analysis/triple bottom line assessment (or an alternative assessment method) of the proposed final landform design criteria and alternatives.</td></tr>
<tr><td>E6</td><td>In carrying out the mining activity authorised by this environmental authority, the environmental authority holder must comply with the maximum disturbance area (ha) in Table E1 (Final land use and rehabilitation approval schedule).
Excerpt from Table E1 related to DREA as follows providing Interim Completion Criteria:
<table>
<tr><th>Details</th><th>Disturbance Area
(DREA including Topsoil and Capping Material Stockpiles)</th></tr>
<tr><td>Maximum disturbance area (ha)</td><td>621.4 ha
(The maximum DREA footprint is 385 ha)</td></tr>
<tr><td>Pre-mine land use</td><td>Grazing</td></tr>
<tr><td>Post-mine land use</td><td>Native Ecosystem for DREA and grazing for topsoil and capping material stockpiles</td></tr>
<tr><td>Post-mine land capability classification</td><td>Class C and Class D Agricultural Land</td></tr>
<tr><td>Projective cover range (%)</td><td>70%</td></tr>
</table></td></tr>
</table>

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Condition Number	Condition
E7	In carrying out the mining activity authorised by this environmental authority, the environmental authority holder must comply with the disturbance area in Figure 2 (Maximum disturbance area). *Refer Condition E9*
E8	Interim Completion Criteria Land disturbed by mining must be rehabilitated in accordance with Table E1 (Final land use and rehabilitation approval schedule). *Refer Condition E6*
Final Completion Criteria	
E9	Completion criteria must be developed and amended in Attachment 1: Rehabilitation requirements prior to the commencement of longwall mining. *(Note that this relates generally to the Figure 2 attachment in the EA showing Maximum Disturbance Areas)*
E10	Progressive rehabilitation must commence when areas become available within the operational land
E11	Development of acceptance criteria in accordance with condition E5 is to consider the reestablishment of representative regional ecosystems (reference sites or another suitable alternative approved by the administering authority) and functioning habitat of areas of equal to or greater than areas to be cleared and specific revegetation performance descriptors (e.g. rehabilitated areas are to display characteristics of the existing (pre-mining) regional ecosystems).
E12	Areas which are to be rehabilitated to native ecosystem must achieve a self-sustaining native ecosystem with species composition and distribution similar to an analogue/ reference site or another suitable alternative approved by the administering authority.
E13	Where reasonable and practicable, areas of the site where grazing is nominated as the post-mine land use must include native grass species endemic to the area.
Dry Rejects Emplacement Area (DREA)	
F10	Waste from the Coal Handling and Preparation Plant shall be disposed of: a) In accordance with conditions G1 to G8 (Dams) of this environmental authority if the shear strength of the waste is less than 1000 Pascals when deposited; or b) In accordance with conditions F11 to F16 if the shear strength of the waste is equal or more than 1000 Pascals when deposited. *(Note that the premise of DREA design is that the "waste" will exceed the shear strength criteria, therefore Conditions G1 to G8 do not apply)*
F11	DREA – certification and operation The authorised DREA used for the disposal of waste is located within the control points defined in Table F1 (Location of DREA). *(Note that this area is shown on drawings attached to this report)*
F12	DREA shall be designed to prevent environmental harm arising from contaminants being generated in the facility, leachate and runoff from the facility or other sources.
F13	The authorised DREA must be constructed and maintained in accordance with certified plans submitted to the administering authority.
F14	Design plans for the authorised DREA must include performance indicators, such that: a) during operations of the DREA will be operated with minimal or no potential for adverse environmental harm resulting from collapse of any component of facility; b) the potential for leachate generation will be minimal or non-existent;

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Condition Number	Condition
	c) adequate drainage structures, erosion protection and storage are provided to manage seasonal and rare rainfall events with minimal or no environmental harm; and d) decommissioning and rehabilitation strategies for the DREA that demonstrate consistency with the conditions of this environmental authority.
F15	Construction of any DREA detailed in Table F1 (Location of DREA) must not commence unless: a) the environmental authority holder has submitted to the administering authority two copies of a design plan; b) certification from a suitably qualified and experienced person that the design of the DREA will deliver the performance stated in that design plan and that it will be compliant in all other respects with this environmental authority; c) at least twenty (20) business days has passed since the receipt of those documents by the administering authority; d) The administering authority notifies the environmental authority holder that a design plan and certification has been submitted for that disposal facility.
Operational plan – DREA	
F16	An operational plan must be developed and maintained for the DREA. The operational plan must include but not be limited to: a) description of landform development stages of the DREA; b) placement technique for spoil and waste material from the coal handling and processing plant on the mine site; c) management of any containment structures within the DREA designed to contain materials from the coal handling and processing plant on the mine site; d) demonstration of how operations of the DREA are consistent with the accepted design plan for the facility; and e) decommissioning and rehabilitation strategies for the DREA that demonstrate consistency with conditions of this environmental authority.

1.4.2 EIS Commitments

Specific commitments of the EIS (BCC & Aquila (2008) [3]) in relation to the DREA (refer **SECTION 1.1**) are summarised as follows:

- DREA Capacity : ~ 110 million cubic metres (Mm3)
- External Surfaces (post-construction)
  - Batter Slopes : 13% (maximum)
  - Maximum slope lengths : 100 m (maximum)
  - Top Surface/Plateau Grade/Slope : 2% (maximum)
- Maximum height (post- subsidence) : 40 m (maximum)
- Soil cover thickness : 1 m (minimum)
- Topsoil thickness : 0.25 m (minimum)

Note that these commitments are not directly reflected by EA commitments (refer **SECTION 1.4.1)**, however, provide basic criteria for DREA landform design.

1.4.3 DREA Design Objectives

As outlined in **SECTION 1.2**, the overall objective for DREA final landform development is to achieve the following outcomes:

- Safe;
- Stable;

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- Does not cause environmental harm; and
- Is able to sustain the defined post-mining land use.

Based on EA conditions relevant to the DREA as listed in **SECTION 1.4.1**, further definition around the above outcomes is described below as a basis for DREA design objectives:

- Be rehabilitated to a safe and stable landform:
  - *DREA has been located, or set back, from open cut pits and other mine infrastructure to avoid impact on rehabilitation outcomes;*
  - *DREA to adopt a landform that is geotechnically stable;*
  - *DREA to incorporate batter slopes that are sufficiently shallow slopes that are able to be revegetated this enhancing erosion protection;*
- Not cause environmental harm:
  - *Characterisation of reject materials to assess potential generation of mobile contaminants or processes;*
  - *DREA containment systems are to be incorporated as required to prevent release of contaminants to receiving environments*
- Sustain post-mining land uses:
  - *The DREA is to be rehabilitated to achieve a PMLU comprising Native Ecosystem for DREA and grazing for topsoil and capping material stockpiles (refer Condition E6 of EA)*

1.5 Report Structure

The structure of this DREA final landform design report, addressing the scope and context outlined in **SECTIONS 1.3** and **1.4** is as follows:

Section 2.0 provides a description of the project, specifically DREA development approach and a general characterisation of rejects as a basis for consideration of DREA design.

Section 3.0 describes the geo-environmental setting of the EDCM project area, including climatic, geological and geotechnical conditions.

Section 4.0 presents a risk assessment to support the DREA design

Section 5.0 addresses the DREA design, outlining key design considerations and criteria, and presenting design outputs, including landform and geotechnical stability modelling.

Section 6.0 presents water management aspects.

Section 7.0 describes the DREA construction approach.

Section 8.0 presents the staged rehabilitation approach for the DREA, including post construction landform preparation, and basis for capping layer design.

Section 9.0 presents the instrumentation and monitoring requirements for the DREA.

Section 10.0 presents the progressive rehabilitation schedule for the DREA.

Section 11.0 presents the conclusion of the progressive rehabilitation and closure plan aspects.

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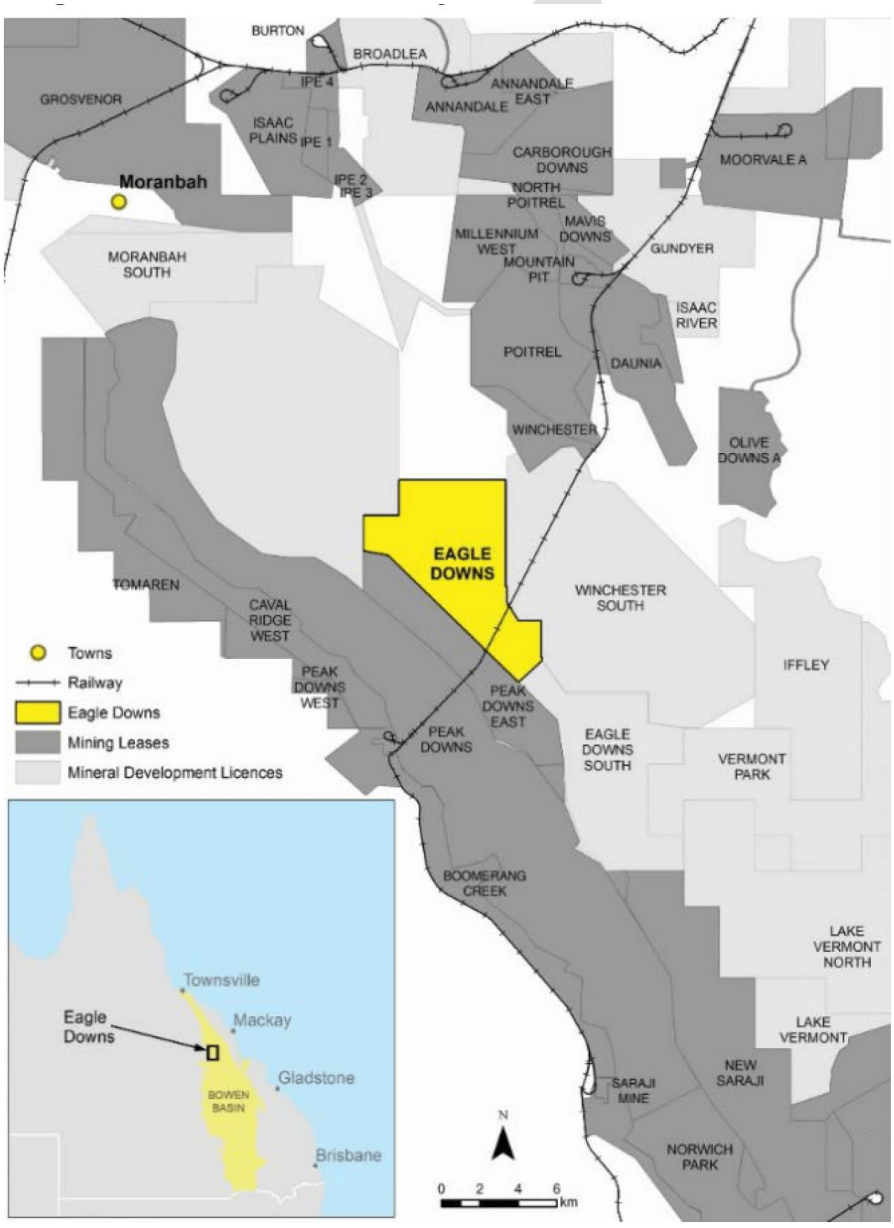
2 PROJECT DESCRIPTION

2.1 Project Location and Layout

The EDCM Project is located on the western edge of the northern Bowen Basin resource area in Central Queensland amongst major coking coal mines, the nearest being the BHP Billiton Mitsubishi Alliance (BMA) Peak Downs Open-Cut Mine. Moranbah is the nearest population centre to the project site, located approximately 25 km to the south-east. The Eagle Downs lease area, formed by Mine Lease (ML) 70389 and Petroleum Lease (PL) 485 is shown in **DIAGRAM 1**. The lease area covers approximately 4,563 ha.

The site is accessed off Winchester Road from the south-west. Queensland Rail's Norwich Park branch railway passes through the southern end of the lease area.

DIAGRAM 1: EAGLE DOWNS SITE LOCATION



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2.2 Project Development

2.2.1 Overview

The current plan for the EDCM project is that coal mining operations will commence in the HCU seam, proceeding to the HCL seam and then the DY seam. In this configuration, the full production rate will be up to 8 million tonnes (Mt) run of mine (ROM) per annum.

The proposed general arrangement of the site to support this operation comprises the following principal features:

- Underground Longwall Mine;
- CHPP;
- Haul Roads;
- Site Water Management Structures;
- Offices; and
- DREA.

2.2.2 Dry Reject Stream Production

The CHPP will produce 2 reject streams, coarse reject (comprising coarse and mid-size material, greater than 0.25 mm size) and fine reject (less than 0.25 mm size). Under anticipated operating conditions, the expected coarse to fine reject split will likely be around 10:1.

Coarse and fine reject will be co-mingled to produce a "dry reject" stream that will report to and be contained within the DREA. Fine rejects will exit the CHPP as a low-density solids concentration slurry that will be thickened and then further dewatered through belt-press filters to produce a dry fine product (with water content of around 40%). The dry fine reject will be mixed with coarse rejects to form the "dry rejects" prior to transportation to the DREA for emplacement.

EDCM has reported production characteristics of dry reject production for the LoM as follows:

- Nominal daily production rate : Up to 10,000 tonnes per day (tpd)
- Nominal emplaced dry density : 1.1 t/m^3
- Dry reject moisture content : Approximately 20 – 25 %
- Bulk density : Between 1.3 and 1.4t/m^3
- Equivalent DREA capacity demand : 7,200 m^3 per day

Critical factors for dry reject production related to DREA emplacement are as follows:

- Subject to Condition F10(a) of the EA, the residual shear strength of dry rejects (fine only, coarse only or combined fine and coarse) must be greater than 1kPa for placement within the DREA (otherwise disposal within a regulated dam would be required).
- The moisture content for the dry reject must be such that:
    - the reject is transportable by haul truck; and
    - on loading out to the DREA, the reject is able to be spread and compacted and be generally trafficable to enable an ongoing operation.

2.3 Total DREA Capacity

Based on production characteristics outlined in **SECTION 2.2.2**, the total capacity demand for the DREA, adopted for the purpose of final landform design, is as outlined below:

- Nominal Life of Mine : 50 years
- Nominal DREA capacity demand : 7,200m^3 per day

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- Nominal total capacity demand : 110 Mm^3 (based on density of 1.1 t/m^3)

Basic production details forming the basis for this capacity demand is provided in **TABLE 2**.

TABLE 2: KEY INPUTS FOR DREA CAPACITY DEMAND ASSESSMENT

Inputs	Range of Quantities	Units
Plant rejects output (t) – HCU Seam	198 – 550	t/hr
Plant rejects output (t) – HCL Seam	517 – 715	t/hr
Plant reject output (t) – DY Seam	505	t/hr
Density	1.1 – 1.4*	t/m^3
Assumed hourly operations	24	hr/day, 7 days/week
Production days/ year	364	days/year
CHPP projected operating time	7000 – 7400	hours/year

NOTE:

*If a higher density than 1.1 t/m^3 is achieved, a reduction in dry reject demand capacity for dry rejects would result accordingly.

2.4 Basic DREA Development Approach

2.4.1 Operating Phase

The DREA will be developed during its operating life as a benched emplacement based on the following general configuration:

- Capacity : 110 Mm^3 (refer **SECTION 2.3**)
- Maximum bench height : 10 m
- Minimum inter-bench slope (post closure): 30 °

Ramps and chutes will also be formed for access and surface water management purposes.

It is proposed that the DREA will be developed in three stages, with nominal timeframes as follows:

- Stage 1 : 0 – 5 Years
- Stage 2 : 5 – 20 Years
- Stage 3 : 20 – 50 Years

The basis for landform design for each of the development stages is provided in **TABLE 3**, which provides an indication of the scale of the DREA.

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TABLE 3: BASIS OF DESIGN FOR DREA LANDFORM DEVELOPMENT

Aspect	Stage 1	Stage 2	Stage 3
DREA Height (Total)	45m	45m	45m
DREA Footprint Area	70.3ha	149.0 ha	167.4 ha
Stage DREA Capacity	11.8 Mm^3	36.0 Mm^3	63.5 Mm^3

Further details regarding the design of the DREA landform subject to this staging approach are provided in **SECTION 5**.

2.4.2 Rehabilitation Phase

The rehabilitation phase of the DREA will also be staged, with rehabilitation works undertaken when sufficient areas become available. Notionally, rehabilitation will be completed following completion of each of the major stages outlined in **SECTION 2.4.1**.

Rehabilitation works will involve the following basic tasks:

- Reprofiling of external batters from the benched configuration developed during the operational phase to a linear profile from crest to toe.
- Reprofiling of the upper surface (plateau) of the DREA landform to facilitate stormwater drainage to external batters.
- Development of drainage pathways across the landform to convey stormwater to beyond the DREA footprint; and
- Placement of a suitable capping layer across all reprofiled DREA surfaces, being applied to support revegetation and to protect against soil loss/erosion under expected stormwater conditions.

2.5 Rejects Characteristics

2.5.1 Physical Characteristics

Physical characteristics of rejects from the EDCM project, limited to moisture content and particle size distribution, were reported in Golder (2011) **[6].** Reference was also made in Golder (2011) **[6]** to the physical characterisation testing carried out on rejects samples taken from a nearby coking coal operation (located within a distance of 30 km from the EDCM project). A summary of the laboratory testing completed on combined rejects passing 3.35 mm after 500 kPa Direct Shear Testing as reported in Golder (2011) **[6]** is presented in **TABLE 4**.

TABLE 4: SUMMARY OF REJECTS GEOTECHNICAL TESTING (GOLDER, 2011)

Test	Result
Initial Dry Density (t/m^3)	0.96 – 1.0
Initial Moisture Content (%)	42.2 – 43.3
Initial % Solids (%)	69.8 – 70.2
End of Overnight Consolidation Dry Density (t/m^3)	1.00 – 1.29
Final Dry Density (t/m^3)	1.07 – 1.32

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Test	Result
Final Moisture Content (%)	21.0 – 25.9
Final % Solids (%)	79.4 – 82.6

The general comment made in Golder (2011) **[6]** in relation to the materials tested was that the fines content and moisture condition of the reference samples differed from the anticipated EDCM rejects materials.

Golder (2011) **[6]** also reported that reject from bench scale process testing on core samples from the Eagle Downs coal seams was obtained, with classification testing undertaken on the fine fraction obtained from these samples. A summary of the observations from this testing, as well as a comparison with the reference sample testing is provided below:

- The fine reject plots as a medium plasticity CLAY, grading to a low Liquid Limit SILT; and
- Fines fraction (less than 75um size) falls generally between 60 and 70 % (by weight).

These characteristics correlate generally with expected properties for fine reject within the Bowen Basin.

2.5.2 Shear Strength Testing

Golder (2011) **[6]** also assessed shear strength conditions that could be applied to EDCM dry rejects, with a combined sample from the reference project (described in **SECTION 2.5.1**) being subject to direct shear testing. The primary difference between the tested reference sample and the expected EDCM rejects was that the tested sample contained around 40 % fine reject, compared to around 10% for EDCM.

Friction angles from the direct shear testing on the reference samples indicated friction angles between 35.5 and 41.5 %, with cohesion taken as 0 kPa. A unit weight of 14.7 kN/m^3 was also adopted.

Despite the marked difference in fine reject content between the reference and EDCM materials, these shear strength parameters could be conservatively applied for the EDCM project. Further discussion related to geotechnical stability of the DREA is provided in **SECTION 5.5** to **SECTION 5.6**.

Notwithstanding, with reference to the Condition F10(a) of the EA (refer **SECTION 1.4.1)**, this testing confirms that the proposed EDCM dry reject will be suitable for emplacement within the DREA.

2.5.3 Geochemistry of Rejects

RGS (2022) **[7]** completed a geochemical assessment of EDCM reject materials. This assessment concluded that the rejects expected to report to the DREA possess an elevated sulfide sulphur content and generally an excess acid neutralizing capacity (ANC). The material can therefore be classified generally as Non-Acid Forming (NAF). As such, the rejects are considered to pose a relatively low risk of acid generation and a high factor of safety against the potential for acid mine drainage.

Based on these characteristics, initial and ongoing surface runoff and seepage (of interstitial water) from the DREA is expected to be pH neutral to moderately alkaline and have a low to moderate level of salinity.

In addition, RGS (2022) **[7]** classified rejects as not significantly enriched with metals/ metalloids.

In summary, it is expected that the potential risk of any significant/material impact on the quality of receiving surface water and groundwater environments from DREA releases will be low. This condition influences the approach to DREA design to the extent that no specific containment requirements exist for either seepage (leachate) or surface water runoff from the DREA.

2.5.4 Potential for Spontaneous Combustion

Potential for spontaneous combustion within the DREA is expected to be minimal as:

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- The rejects are estimated to have low carbon content; and
- The rejects will be compacted during placement and construction, thus reducing void space and exposure to the atmosphere.

In addition to the above, the rejects are estimated to have a relatively low moisture content/field capacity due to the grading of the material, which will limit the potential for spontaneous combustion.

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3 GEO-ENVIRONMENTAL SETTING

3.1 Topography and Surface Water Hydrology

3.1.1 Regional

The EDCM Project is located adjacent to the Isaac River, within the Isaac Connors catchment, a sub-catchment of the broader Fitzroy Basin. Queensland Reconstruction Authority flood mapping **[8]** indicates that the majority of the EDCM leases are within the Floodplain Extent (QFAQ) Level 1 (Rapid Hazard Assessment).

The topography of the area containing the project site is typical of a floodplain, being relatively flat with a minor north easterly drainage gradient, falling in elevation from 244 m AHD in the southwest to 198 m AHD in the northeast.

The Isaac River is the principle regional drainage feature, located approximately 3.5 km from the eastern boundary of the EDCM leases. The Isaac River system flows from northwest to southeast.

The nearest major tributary of Isaac River proximal to the project area is Ripplestone Creek, flowing from northwest to southeast, with the upstream tributaries traversing the southern corner of the project site. Cherwell Creek is located approximately 1 km to the north of the project area.

3.1.2 Local

The topography of the project site is described as generally flat to undulating and is traversed by a number of minor ephemeral drainage lines. Local relief ranges from approximately RL 235 m AHD in the west to RL 200 m in the east.

Most of the site was cleared in the past for grazing, although there are small areas of remnant vegetation on the site.

3.1.3 Flooding Hazard

The Isaac River is an ephemeral watercourse. It is understood from the EIS, BCC & Aquila (2008) **[3]** that the floodplain, as defined by the 100 year ARI flood level would not extend to the location of the DREA. It is therefore unlikely that the Isaac River floodwater would enter the location of the DREA. The EIS therefore concluded that there is no credible risk of flooding for the project, as the project is not located within the floodplain of a significant watercourse.

Under these conditions, there is no preparatory work to be undertaken to prevent flood inundation of the DREA site area.

3.1.4 Local Surface Water Users

The project area is surrounded by grazing land. BCC & Aquila (2008) **[3]** reported that there is only one private residence within 5 km of the site boundary which is located approximately 6 km from the closest proposed mine surface facilities. The closest township to the project area is Moranbah, which is located approximately 20 km to the north-west.

The Peak Downs open cut mine is located approximately 2.5 km to the west of the project site and Poitrel Mine is located 1.5 km to the north-east.

There is no record of active surface water extractions or beneficial uses of water contained within creeks and drainages proximal to the project site, although extraction from Isaac River may occur downstream of the area. Notwithstanding, consideration of potential releases from the DREA reaching regional receiving surface water environments will be necessary, although the current understanding is that the DREA water is not classified as mine affected water (refer **SECTION 2.5.3**).

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3.2 Climate

3.2.1 Overview

Long-term meteorological data for the region is available from a range of Bureau of Meteorology (BoM) Stations. The Moranbah Water Treatment Plant Weather Station (Station No. 034038) located approximately 25 km North-East of EDCM site provides the most extensive rainfall data set in the vicinity , with the location of this station to the site shown in **DIAGRAM 2**. A summary of meteorological data, in terms of rainfall, evaporation and ambient temperature, obtained from Moranbah Water Treatment Plant is provided in **TABLE 5.**

TABLE 5: SUMMARY OF SITE WEATHER INFORMATION

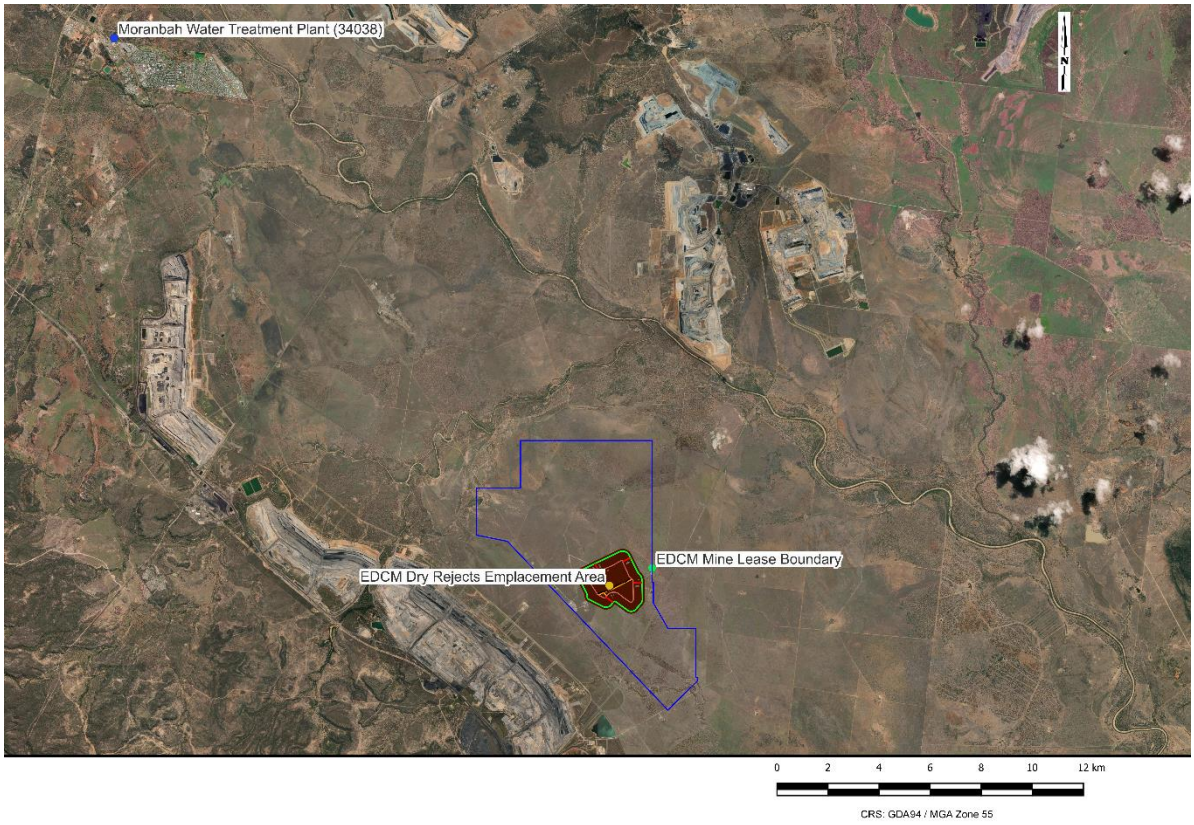
Month	Average Monthly Rainfall (mm)	Average Monthly Evaporation (mm)	Average Monthly Maximum Temperature (° C)	Average Monthly Minimum Temperature (° C)
January	106	229.2	33.8	21.5
February	96	187.4	32.7	21.2
March	64	187.8	31.7	19.8
April	30	152.8	29.4	16.7
May	26	120.5	26.3	13.0
June	28	95.4	23.6	9.8
July	21	105.5	23.5	8.6
August	19	137.7	25.6	9.5
September	15	178.4	28.8	12.9
October	30	227.2	33.3	16.3
November	50	234.6	34.2	20.5
December	84	248.5	33.8	21.5

Average monthly rainfall and evaporation data from **TABLE 5** is plotted in **DIAGRAM 3.**

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DIAGRAM 2: EDCM PROJECT SITE AND WEATHER STATION LOCATION



3.2.2 Rainfall and Evaporation

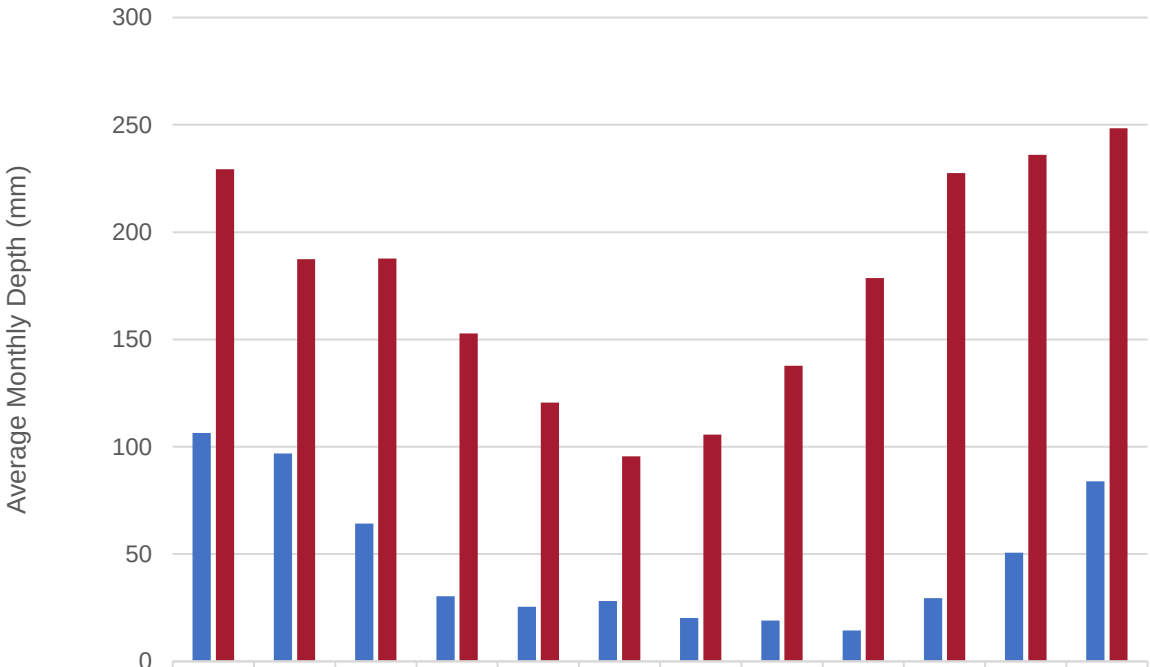
From **SECTION 3.2.1**, annual mean rainfall for the EDCM lease area can be taken as 614 mm. From the available record, the highest recorded daily rainfall was 165 mm occurring in March 1988 and the highest monthly total recorded rainfall was 530 mm recorded in February 1898. The highest annual rainfall was 1,318 mm recorded in 1890.

Average monthly evaporation is greater than average monthly precipitation throughout the year. This is shown in **DIAGRAM 3,** indicating that mean annual evaporation of 2,107 mm exceeds mean yearly rainfall by approximately 1,538 mm.

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DIAGRAM 3: AVERAGE MONTHLY RAINFALL AND EVAPORATION FOR EDCM SITE (MORANBAH WATER TREATMENT PLANT, STATION NO. 34038)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall	106	97	64	30	25	28	20	19	14	29	51	84
Evaporation	229	187	188	153	121	95	106	138	179	228	236	248

3.2.3 Temperature

From **SECTION 3.2.1**, mean monthly maximum temperature ranges from 24°C to 34°C, with minimum average temperatures varying from around 10°C during winter months to 22°C during summer.

3.2.4 Potential Climate Change Effects

According to the United Nations Climate Action Fast Facts **[9],** climate change is the natural process where temperature, rainfall, wind and other elements vary over decades or more. In this context, potential climate change effects on the EDCM development includes:

- More intense storms as well as unpredictable rainfall patterns.
- Higher ambient temperatures.

With respect to DREA construction and operation, changes in rainfall conditions may impact on the ability to achieve optimum placement and compaction efficiencies, potentially compromising overall DREA stability, while if spontaneous combustion evolves as an issue (although not expected as outlined in **SECTION 2.5.4**), increased ambient temperatures may increase the propensity for this to occur.

The uncertainty associated with climate variability and climate change is clearly defined, and covered extensively by International (e.g. IPCC Representative Concentration Pathways), Commonwealth and State institutions (Queensland Future Climate Dashboard). It is generally considered that the overall EDCM development requires consideration of climate change effects, although the standards of design for the DREA based on background site conditions, rejects characteristics and operating protocols would allow these effects to be effectively addressed.

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3.3 Geological Setting

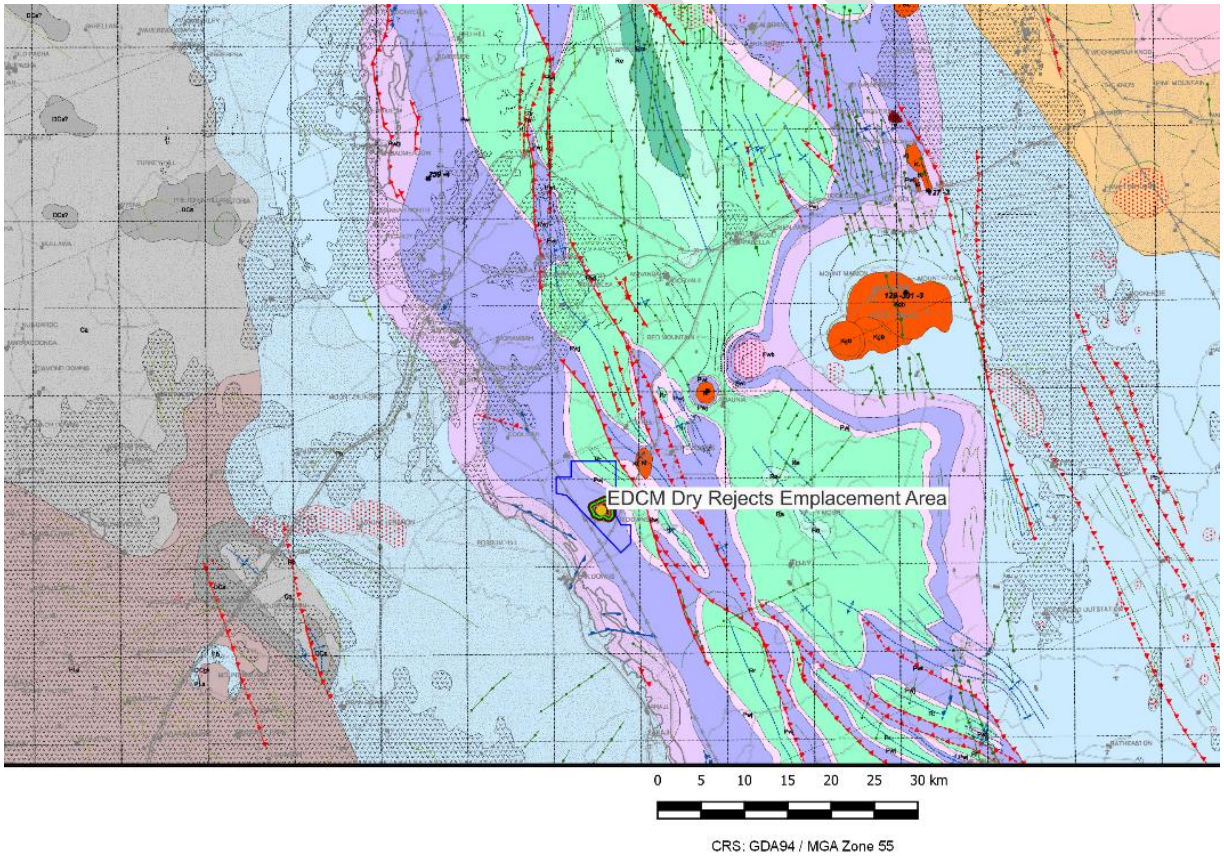
3.3.1 Regional Geology (covering the EDCM Project Area)

The Bowen Basin is located in eastern Australia and is part of an extensive Permian-Triassic basin complex, which is divided into a number of tectonic units comprising north north-west to south south-east trending platforms or shelves, separated by sedimentary troughs. These are overlain by a thin covering of unconsolidated Quaternary alluvium and colluvium.

As reported in AECOM (2011) **[10]** basement sequences of the Bowen Basin mainly comprises volcanothic sediments, Devonian-Carboniferous meta-sediments, and igneous rocks of the Tasman Fold belt

DIAGRAM 4 indicates that Project is located within the northern Bowen Basin with the mine product categorized as Group III coals of Late Permian age which were deposited on the Collinsville Shelf, under conditions which varied from a marine-influenced deltaic environment in the German Creek Formation, to dominantly fluvial flood plain environments in the Moranbah Coal Measures.

DIAGRAM 4: NOTHERN BOWEN BASIN GEOLOGY (REF. CSIRO & DNRM (2003) [11])



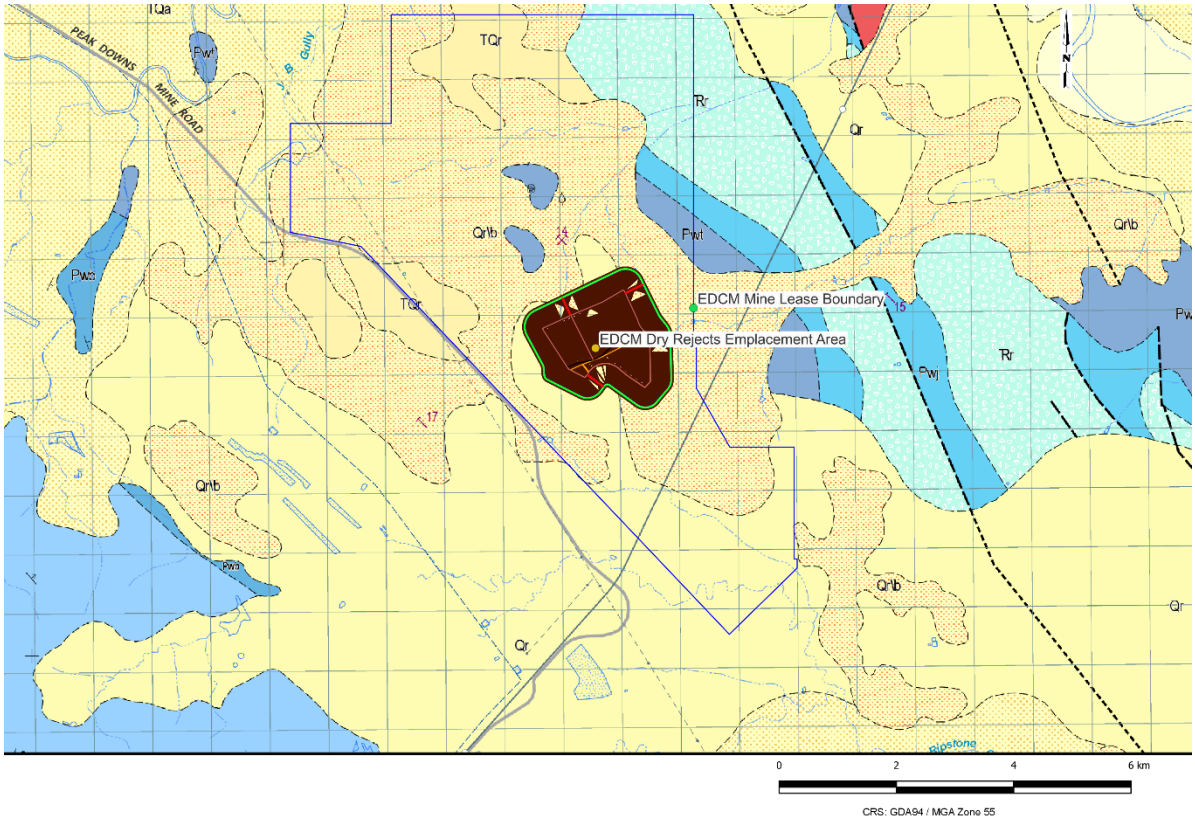
3.3.2 Geology within the DREA Site Area

CSIRO & DNRM (2003) **[11]** indicate that the solid geology of the area in which the DREA will be located consists of Fort Cooper Coal Measures. Fort Cooper Coal Measures is formed by lithic sandstone, conglomerate, mudstone, carbonaceous shale, coal, tuff and tuffaceous (cherty) mudstone. There are no indications of faults within the DREA limits.

The “Grosvenor Downs 1:100 000 Scale Geological Map Sheet 8553” indicates that the upper geology within the DREA site, as presented in **DIAGRAM 5,** comprises two Quaternary Aged units formed from colluvial (Qr) and residual (Qr\b) deposits. The Qr unit consisting of clay, silt, sand, gravel and soil; colluvial while the Qr\b-unit consists of black soil, silt and mud; basalt-derived residual and colluvial deposits.

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DIAGRAM 5: EDCM PROJECT SITE REGIONAL GEOLOGY (REF. GEOLOGICAL MAP SHEET 8553)



3.4 DREA Geotechnical Conditions

3.4.1 General Subsurface Conditions

Site investigations reported in Golder (2011) **[6]** and AECOM (2011) **[10]** provide an overview of general subsurface conditions within the DREA site. These conditions are consistent with geological mapping reported in **SECTION 3.3**, indicating the presence of colluvium and residual soils consisting mainly of medium to high plasticity, firm to hard Silty CLAY with traces of sand and gravel. These units are underlain by extremely to distinctly weathered rocks mainly sandstone and siltstone of low to medium strength.

Representative near surface conditions, to a depth of up to 20 m below ground level, as reported in Golder (2011) **[6]**, are summarised in **TABLE 6**.

TABLE 6: GOLDER 2011 GEOTECHNICAL INVESTIGATION OUTCOME

Material	Approximate Thickness (m)	Comments
Silty CLAY, medium to high plasticity, brown to dark brown	0.6 – 3.2 Average ~1.45	Often containing trace amounts of fine to coarse sand and gravels, and varying contents of organics.
SILTSTONE/ SANDSTONE	>20	Strengths ranging from extremely low to medium, extremely to distinctly weathered. Blocky/ slaty structure. Some localised iron cemented medium to high strength zones.

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AECOM (2011) **[10]** provides a more detailed lithological description of each soil unit as outlined below:

- Soils (up to 3m depth):
    - Topsoil — Silty CLAY with roots, medium to high plasticity, generally firm, dark brown-black
    - Colluvium — Silty CLAY with occasional sand and gravel, high plasticity, generally firm to very stiff, dark brown-black
    - Residual Soil — Silty Sandy CLAY, medium to high plasticity, generally firm to hard, pale brown-brown (Mudstone origin)
- Basement (3m to greater than 20m):

  Saprolites and weathered rock (mudstone, sandstone, claystone, siltstone and shale).

3.4.2 DREA Foundation Conditions

Subsurface lithologies described in **SECTION 3.4.1** indicate that beneath topsoil layers across the site, no specific issues exist with respect to the DREA foundation. It may be necessary for local sub-excavation to remove poor quality subgrade soils, however the extent of such works is expected to be limited.

Note that foundation preparation are addressed in the Technical Specification for DREA construction, ATCW (2020) **[4]**.

3.4.3 Subsidence Potential and Management

Subsidence in the context of the DREA is defined as the movement of the surface strata in response to the loss of underground support and is expected to occur within the DREA footprint as a result of longwall mining.

Surface subsidence within the longwall footprint will develop over the LoM, although detailed prediction of the magnitude of this subsidence has not yet been undertaken. Notwithstanding, EDCM has indicated that potential maximum vertical displacements at ground level within the DREA will be of the order of 11m as reported in Primed Global (2020) **[12]**.

Potential impacts from subsidence occurring within the DREA footprint will depend on timing of mining and DREA development. Such impacts may include:

- Pre-DREA development – where longwall mining occurs prior to overlying DREA development, the potential is that subsidence will be well advanced, which could be compensated for in DREA preparation works.
- Post-DREA development – where longwall mining occurs after overlying DREA development, the DREA landform will be impacted in terms of vertical displacement, tilting or slumping. The potential impacts of subsidence effects would be:
    - Vertical settlement of formed DREA surfaces;
    - Slumping of DREA batters and re-orientation of batter slopes (either steepening or flattening)
    - Re-orientation of adjacent surface water drainage patterns, with the possibility that localised ponding areas adjacent to or against the DREA landform will develop. This would result in disconnection from local drainages.

Either of these conditions would prompt adjustment of the DREA landform, primarily in terms of reprofiling of pre-existing DREA surfaces. The extent of such adjustments cannot be predicted at this stage, although is expected to comprise:

- Additional rejects filling across the DREA to reform the final landform design;

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- Re-alignment of DREA surfaces to maintain stability; and
- Local excavation and reprofiling around the DREA to reform surface water drainage pathways.

It can be expected that rehabilitation works, including post-development batter reprofiling and capping layer placement, would only occur post-subsidence. This approach would be applied as a basic DREA development principle.

3.4.4 Soil and Capping Material Assessment

It is expected from EDCM advice that there will be a deficit in topsoil in terms of rehabilitation across the project area, including the DREA. As such, it has been identified that manufacture of soil substitutes (mulches and composting) would be required. Background to topsoil management is provided in South32 (2021) **[13]**, Topsoil Management Plan. Further advice regarding topsoil availability and management is provided in RGS (2022) **[14]** indicating that:

- Topsoil can generally be classified as Non-Acid Forming (NAF);
- Available soils have moderate cation exchange capacity, are non-sodic and contain sufficient exchangeable cations and nutrients for plant growth;
- Physically, soils are rich in clay with lesser proportions of silt and sand, and therefore have good moisture and stability characteristics; and
- Soils are expected to be suitable for use in rehabilitation capping works.

It has been concluded that available topsoil stockpiles on site are suitable as soil capping.

3.5 Hydrogeology

3.5.1 Overview

The current concept for hydrogeological setting of the Bowen Basin comprises the following broadly-based aquifer systems (in order of depth below ground surface):

- Quaternary alluvium;
- Tertiary sediment;
- Tertiary basalt;
- Triassic formations; and
- Permian formations.

Previous investigations related to development of the EDCM project indicate that two of the above aquifer systems exist within the EDCM lease area, as follows:

- Deeper aquifers associated with Permian formations; and
- A shallow aquifer associated with upper weathered/ fractured rocks.

It is indicated that regional alluvial aquifers associated with sand and gravel deposits exist along the Cherwell Creek (located approximately 1 km north of the Mine Lease boundary) and the near-reaches of the Isaac River, however, no alluvial aquifers are known to exist within the site.

3.5.2 Site Groundwater Conditions

AGE (2019) **[15]** has characterised groundwater conditions within the EDCM site as follows:

- Shallow Weathered/ Fractured Rock Aquifers

  Weathered sequences of the Fort Cooper Coal formation exist across the site at thicknesses of around 22 m. It is likely that groundwater is hosted within these sequences as a result of secondary porosity (primarily fractures and fissures). Recharge to this aquifer is likely to result from surface infiltration, therefore can be assumed exists as an unconfined system. It is also inferred that due to the nature of these rocks, permeability would be low.

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It can be expected that under dry season conditions, discharge from the shallow fractured rock aquifer to alluvium within the near-reaches of the Isaac River may occur. It may also be expected that under Isaac River flood conditions, recharge to the upper aquifer would occur. Under normal climatic conditions, groundwater flow in the shallow aquifer would occur generally from west to east towards the Isaac River.

- Deeper Permian Aquifers

  Coal seams contained within Permian sequences typically exist as groundwater aquifers, which is consistent across the Bowen Basin. Groundwater occurrence and movement in the coal seams is associated with secondary porosity (cleats, fissures and the open fractures), with permeability generally higher than the overburden and interburden rocks. In the EDCM project area, coal seams are deep and confined, with aquitards formed by the overburden and interburden sequences.

Measured groundwater levels reported in AGE (2019) **[15]** suggest that the shallow fractured rock aquifer within the site area exists at a depth of some 10 to 20 m below ground level. The measured elevation of groundwater within the Permian coal seams appears to be some 20 m lower than the upper aquifer. This indicates that the shallow weathered sequences and coal seams are not hydraulically connected.

AGE (2019) **[15]** also reports that groundwater within the upper aquifer is fresh to saline, with electrical conductivity (EC) up to 25,000 µS/cm. pH is circa-neutral ranging from pH 6 to 9. Very low levels of metalloids in solution are also reported.

3.5.3 Groundwater Users

There is no record of active groundwater users from either the upper fractured rock or lower Permian coal seams aquifers within or proximal to the project site. Such use would be precluded due to low permeability/yields, and potentially high salinity. It is possible that the Isaac River alluvium is accessed as a groundwater supply, although recognizing that connection between the site and this system is limited. Notwithstanding, consideration of potential releases from the DREA via groundwater will be necessary.

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4 DREA DESIGN RISK ASSESSMENT

4.1 Potential Risk factors

The review of the geo-environmental setting of the EDCM project area, reconciled against the characteristics of the dry rejects to be emplaced within the DREA has identified the risk factors as listed in **TABLE 7**.

TABLE 7: POTENTIAL RISK FACTORS

Aspect	Potential Risk Factor
Physical Characteristics of Dry Rejects	Due to the proposed coarse: fine split expected from the EDCM project (of approximately 85%:15% by weight), co-mingling is expected to form a material that is transportable (by haul vehicle), and able to be placed, spread and compacted using conventional earthmoving plant. Geotechnical testing indicates that shear strength for the comingled dry reject will exceed EA requirements and would be of a magnitude that would support stable DREA batter construction. Risk factors relate to the following: (i) Any change to the coarse: fine split, with any significant increase in fines likely to increase moisture content, achievable density, handling characteristics and shear strength. Worst case scenario would be the need to contain rejects within regulated structures, as per EA requirements. (ii) Strength conditions for dry reject is lower than anticipated, with potential for reduced stability of external DREA batters.
Geochemical Characteristics of Dry Reject	Dry rejects have been characterised as posing a relatively low risk of acid generation with a high factor of safety against the potential for acid mine drainage. The material has been classified generally as Non-Acid Forming (NAF) and not significantly enriched with metals/ metalloids. The dry reject material is also considered to possess a very low propensity for spontaneous combustion. Risk factors relate to the potential variability of reject materials in terms of geochemistry are the potential for: (i) Generation and release of leachate with elevated salinity (ii) Generation and release of leachate with elevated acidity, with or without metals/metalloids in solution (iii) Generation of areas of heating within the emplacement through spontaneous combustion effects, impacting on structural integrity of the placed reject or release of contaminants from burning reject in leachate.
Stormwater Drainage (Surface Water Management)	The EDCM project area is subject to variable rainfall conditions, with the highest proportion of annual rainfall occurring between October and April. Storm rain is expected to be experienced throughout any year, during which rainfall of highest intensity is likely to occur. Rainfall across the DREA, either during or post-construction, would generate surface runoff or would infiltrate into the DREA landform. Risk factors related to such events include: (i) Erosion of exposed DREA surfaces from concentrated stormwater runoff (ii) Infiltration of precipitation into the DREA, accumulating in zones of saturation, which could compromise batter stability

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Aspect	Potential Risk Factor
	(iii) Infiltration into the DREA as recharge to leachate that may release from the landform and report to receiving environments. Climatic change effects should be considered in assessing the potential magnitude of these risks.
Flooding	The evidence is that the EDCM project is located broadly on the Isaac River floodplain but not necessarily flood prone. Given there will be uncertainty in terms of potential flooding given the current level of assessment, risk factors relate to: (i) Inundation of the DREA impacting on foundation preparation or development works (ii) Inundation of completed sections of DREA causing saturation of the rejects emplacement, with the potential to compromise batter stability or generate impacted leachate.
Foundation Conditions	Subsurface conditions within the DREA comprise a shallow topsoil layer overlying competent Silty CLAY soils, either colluvium or residually formed, to a depth of around 3m. Weathered basement occurs beneath these soils to depths in excess of 20m. Given these conditions, risk factors related to the DREA foundation include: (i) the presence of local low strength soils across the development footprint; and (ii) the need for a low permeability basal liner subject to the risk of leachate generation and release. The extent of these risks is the need for additional effort in foundation preparation. Under worst case conditions, low strength foundation sequences, if left untreated, could contribute to DREA batter stability.
Subsidence	Surface subsidence within the longwall footprint will develop over the LoM, with potential maximum vertical displacements at ground level within the DREA being of the order of 11 m. Risk factors related to subsidence include the following: (i) Under pre-DREA conditions, the need for additional foundation preparation works to address undulations and displacement areas formed by subsidence to enable effective DREA development. (ii) Under post-DREA conditions, the potential for large scale vertical displacement, tilting or slumping of the landform, with the need for additional rejects filling to reform the final landform, re-alignment of DREA surfaces to maintain stability, or local excavation and reprofiling to reform surface water drainage pathways. Under either condition, the overall risk is that rehabilitation works will need to be delayed until subsidence in different areas of the DREA has reached completion.
Topsoil Availability	The overall position is that there are available topsoil stocks within the site that are suitable for use in capping of the completed DREA. The principal risk factor is the lack of topsoil availability to complete the capping works, with the need to manufacture soil substitutes (mulches and composting) identified.
Groundwater	Two aquifer systems exist within the EDCM lease area, as follows: • Deeper aquifers associated with Permian formations; and

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Aspect	Potential Risk Factor
	• A shallow aquifer associated with upper weathered/ fractured rocks. The uppermost (shallow) aquifer hosted within weathered/fractured rocks is deemed more exposed to the DREA than the deeper aquifer, given that it is unconfined and subject to recharge either directly by surface water infiltration or during Isaac River flood events. This aquifer is nonetheless of low permeability and generally located at depth (more than 10m below existing ground level). Risk factors are that groundwater becomes exposed to impacted leachate from the DREA and becomes a mechanism for contaminant migration to nearby groundwater dependent ecosystems or surface water systems such as Isaac River. Under either conditions, infiltration from the DREA to the groundwater system through upper level low permeability surface soils would need to occur.

4.2 Sensitive Receptors and Potential Exposure Pathways

The potential consequence aspects of risk factors as listed in **SECTION 4.1** relate specifically to release of contaminants via leachate generated within the DREA. Mechanisms for leachate release based on these risk factors include:

- Batter failure, with gross exposure of dry rejects
- Subsidence causing deformation of the DREA and exposure of rejects
- Drainage from DREA surfaces (due to leachate accumulation within the DREA)
- Infiltration through the DREA foundation, as recharge to groundwater.

The generation of leachate would relate to surface water infiltration or flood inundation.

Given the geo-environmental setting of the site (refer **SECTION 3**), the principal sensitive receptor (i.e. the receiving environment possessing values that may be compromised on contact with DREA leachate) would be the Isaac River. Connection to the Isaac River would be either through internal/intermediate drainages through the site and near region, or via groundwater.

4.3 Risk Assessment

A Safety in Design (SiD) Risk Assessment was conducted to support the design of the DREA. Critical elements of the SiD process, relating to risk factors listed in **SECTION 4.1** have been further assessed as a means of identifying key DREA design issues, and highlighting risk mitigation measures that should be considered in design.

The issues, impacts and controls associated with the DREA are summarised in **TABLE 8** in the form of a (qualitative) risk assessment. This assessment includes control (mitigation) strategies based on the following waste management hierarchy (in preference order):

- Prevention of impact;
- Minimisation of impact through active or passive treatment;
- Interception and control of the impact; and
- Monitoring and management of the impact.

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TABLE 8: QUALITIATIVE (SAFETY IN DESIGN) RISK ASSESSMENT

Issue	Hazard	Sensitive Receptor	Likelihood/ Potential Risk	Control Measure
Batter Stability (Failure)	Release of interstitial water, as leachate contained in DREA (Note that worker safety is also a critical hazard, but not considered as part of this assessment)	Surface Water (Isaac River)	Unlikely for batter instability (due to inherent strength of dry reject and shallow batter slopes), therefore unlikely for leachate release to receiving environment	Effective geotechnical characterisation of reject material Adopt industry standards (safety factors) for batter stability Appropriate construction methods, including QA/QC provisions Repair of landform subject to subsidence impacts Reduce risk of leachate generation (refer issues below)
Leachate Generation and Release via External DREA Surfaces	Contaminant migration to receiving environment	Surface Water (Isaac River)	Possible (Pre-capping, given grading of reject providing opportunity for surface infiltration as leachate recharge and release) Unlikely to Possible (DREA stage completion and post-capping, with likelihood related to potential failure of rehabilitation capping layer)	Effective geochemical characterisation of reject material regarding potential contaminant migration Appropriate construction methods, including QA/QC provisions (reducing permeability of emplaced reject) Effective shaping of landform during operation and post-completion Prompt repair of landform subject to subsidence impacts, including surface water drainage pathways Where deemed necessary, construct flood levee to protect DREA. Erosional stability assessment for design of capping layer to reduce erosion potential.
Leachate Generation and Release through DREA Foundation	Contaminant migration to receiving environment	Surface Water (Isaac River) via groundwater	Very Unlikely (Due to low permeability of foundation sequences and upper aquifer, as well as likely low hydraulic head and considerable	As Above Where deemed necessary, specific foundation preparation works including moisture conditioning and compaction.

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Issue	Hazard	Sensitive Receptor	Likelihood/ Potential Risk	Control Measure
			groundwater depth)	
Lack of Topsoil/ Capping Material for Rehabilitation	Inability to achieve rehabilitation outcomes (linked to leachate generation and release risks)	Surface Water (Isaac River)	Possible	As Above Manufacture of soil substitutes (mulches and composting)

In summary, the risk assessment indicates that the potential for leachate generation and release is the greatest risk in relation to the DREA, with a range of mitigation measures to be considered to address these issues. Key mitigation measures include:

- Rejects characterisation (geotechnically and geochemically)
- Geotechnical and erosional stability assessments, identifying key aspects to maintain long term integrity of DREA batters and rehabilitated capping layers
- Appropriate construction methods, including QA/QC provisions (reducing permeability of emplaced reject)
- Effective shaping of landform during operation and post-completion, particularly in response to subsidence
- Re-alignment of surface water drainage pathways subject to subsidence (as a means of preventing inundation of the DREA through local ponding)

Other measures, where deemed necessary include:

- Specific foundation preparation works including moisture conditioning and compaction to reduce foundation permeability (thus reducing potential for infiltration to groundwater)
- Construction of flood levees to protect from potential Isaac River flooding
- Manufacture of soil substitutes (mulches and composting) for use in capping works subject to available topsoil stocks.

Note that these “other measures” are highlighted as provisional and not addressed at the current level of DREA design.

4.4 DREA Design and Management Principles

Based on the risk assessment presented in **SECTION 4.3** and particularly the highlighted control measures, principles to be adopted for DREA development are described as follows.

4.4.1 Dry Rejects Characterisation

Characterisation of mine waste materials is critical for DREA construction and operational planning purposes, in terms of controls applied in materials handling processes, and encapsulation requirements.

Materials characterisation would form part of the short to medium term mine planning process. Specific requirements for materials characterisation are addressed in **SECTION 8.4.2**.

Principle 1 – Dry Rejects Characterisation

The basic principle to be adopted is to ensure that dry rejects are effectively characterised to ensure that special handling or burial/ isolation protocols are not required.

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4.4.2 DREA Construction

The construction of the DREA in readiness to receive dry reject will comprise conventional engineering practices for clearing, topsoil stripping and subgrade preparation. Under advised expected conditions within the DREA footprint and redefinition of the contaminant from the DREA, no specific foundation preparation works, such as tyning, moisture conditioning and compaction to reduce foundation permeabilities, are deemed necessary. However, the technical specification required the following foundation preparation to be completed following topsoil stripping and the necessary foundation excavations:

- Ripping to a nominal depth of 0.5 m into the in situ clay;
- Tyning, moisture conditioning and compacting the clay materials to no less than 95% Standard Dry Density (AS1289.5.5.1) and ±2% Optimum Moisture Content (OMC);
- Compaction of the prepared clay base with at least 4 passes of a pad foot roller (>10 t mass); and
- Finishing of the compacted surface prior to dry rejects placement with passes of smooth drum vibrating roller (>10 t mass).

Construction works and control testing would be undertaken in accordance with the Technical Specification for DREA construction, ATCW (2020) **[4]** or as otherwise advised by the South32's Representative**.**

Principle 2 – DREA Construction

The basic principle is to adopt the DREA construction requirements as outlined in the Technical Specification for DREA construction, ATCW (2020) **[4]** *or as otherwise advised to meet development, design, construction and approval requirements. Only where further investigation or observations indicate that foundation sequences require further work to achieve a competent, low permeability surface, and/or where reject characterisation indicates "problematic" material conditions would adjustments to this specification be made.*

4.4.3 Material Movement

As outlined in **SECTION 2.2.2**, coarse and fine reject will be co-mingled to produce a "dry reject" stream that will report to and be contained within the DREA. Fine rejects will exit the CHPP as a low-density solids concentration slurry that will be thickened and then further dewatered through belt-press filters to produce a dry fine product (with water content of around 40%). The dry fine reject will be mixed with coarse rejects to form the "dry rejects" prior to transportation to the DREA for emplacement.

It is expected that all dry reject will be transported to the DREA using haul trucks.

Principle 3 – Movement of Dry Reject

The basic principle to be adopted for movement of dry rejects is that appropriate methods will be used such that all material arrives at the appropriate location to enable staged development of the DREA, with consideration also to reduce the risk of exposure to any receiving environments (refer Principle 2).

4.4.4 Material Placement

All dry reject will report to the DREA. (The only exception will be fine reject slurry during belt filter downtimes, during which the slurry will report to temporary storage ponds.)

Principle 4 – Placement

Placement of dry reject will be undertaken in accordance with the Operational Management Plan (OMP) for operation of the DREA, ATCW (2020) **[5]***.*

Principle 5 – Development Landform

The Operational Management Plan (OMP), ATCW (2020) **[5]***, describes the landform to be developed pre-rehabilitation, which will comprise benched outer batters. Only subject to completion of subsidence will outer batter reprofiling and rehabilitation be commenced (refer Principle 8).*

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Principle 6 – Off-site Movement

No bulk quantities of dry reject, regardless of physical or geochemical characteristics, can be taken off-site for any reason without appropriate permitting.

4.4.5 Water Management

The most likely pathway connecting the DREA to sensitive receptors is through water, with surface water (Isaac River) being the potentially exposed receiving environment. Water management is therefore critical to the operation to mitigate the risk of impact.

The critical pathway that may develop is direct rainfall across the DREA, creating a recharge source to leachate. Exposure pathways to the receiving environment would include:

- Leachate release from outer DREA surfaces (either directly or through exposure resulting from geotechnical or erosional stability issues)
- Discharge to groundwater through DREA foundation.

The key water management issues are therefore to (1) maximise separation of water inputs and the DREA and (2) ensure prompt recovery of any standing water within or adjacent to emplacements.

Principle 7 – Water Management

- *Ensure that bunding on the perimeter of the DREA to divert/manage stormwater runoff is in place as part of development works. This includes access ramps and drainage structures.*
- *During DREA development and prior to rehabilitation, provide an effective stormwater management system across all surfaces of the DREA, using haul roads, external benches and engineered batter drainage structures at appropriate locations to convey stormwater to beyond DREA footprint. This system is to report to appropriate outlet structures for controlled release to the environment.*
- *Ensure that any ponded/surface water occurring within or adjacent to the DREA is promptly removed to minimise exposure to dry rejects material. This practice is of significance subject to the occurrence of subsidence to ensure that surface water drainage pathways are maintained, and local ponding is minimised.*
- *As part of staged DREA rehabilitation, provide a drainage system comprising graded slopes and formed drainage pathways to convey stormwater from rehabilitated surfaces (Refer Principle 8).*

Note that the need for flood protection levees should also be considered and introduced as part of DREA development as required.

4.4.6 DREA Rehabilitation

Rehabilitation of the DREA will be completed in accordance with EDCM's Closure Plan, South32 (2020) **[16]** prepared in accordance with requirements of the PRCP (refer **SECTION 1.2**). The premise for this plan will be to reprofile all DREA surfaces (batters and plateaus) to achieve the final landform design, and to apply capping layers as required to achieve long term erosionally stable surfaces.

Principle 8 – Rehabilitation

The basic principle applying to DREA rehabilitation in the context of the final landform design is to reprofile final surfaces (batters and plateau) to achieve the final landform design and to apply final capping layers. Rehabilitation is also required to accommodate stormwater management (refer Principle 7), to the extent that all rehabilitated DREA surfaces are to be free-draining, therefore implying that no medium to long term ponding on any surface will be acceptable.

4.4.7 Other Operating Controls

Principle 9 – Dust Suppression

Use dust suppression techniques to reduce the risk of dust generation. Techniques such as managed/ scheduled placement of new mine waste material over previously placed material and

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watering of dried surfaces should be applied. Watering of haul roads associated with general mining activities as well as mine waste placement should also be maintained to reduce dust propagation.

(Note that dust propagation from the DREA has not been addressed as a risk, subject to applying this principle).

Principle 10 – Monitoring

A monitoring program must be maintained to confirm that the DREA are not impacting on receiving environments. Monitoring program requirements are outlined in ***SECTION 9****.*

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5 DREA DESIGN

5.1 DREA Landform Design Objectives

As outlined in **SECTION 1.2**, the design objectives for the DREA final landform are as follows:

- Be rehabilitated to a safe and stable landform:
  - *DREA has been located, or set back, from open cut pits and other mine infrastructure to avoid impact on rehabilitation outcomes;*
  - *DREA to adopt a landform that is geotechnically stable;*
  - *DREA to incorporate batter slopes that are sufficiently shallow slopes that are able to be revegetated this enhancing erosion protection;*
- Not cause environmental harm:
  - *Characterisation of reject materials to assess potential generation of mobile contaminants or processes;*
  - *DREA containment systems are to be incorporated as required to prevent release of contaminants to receiving environments*
- Sustain post-mining land uses:
  - *The DREA is to be rehabilitated to achieve a PMLU comprising Native Ecosystem for DREA and grazing for topsoil and capping material stockpiles (refer Condition E6 of EA)*

5.2 Design Considerations

Based on the design and management principles outlined in **SECTION 4.4**, being based on the design risk assessment (**SECTION 4.3**), the following sections list critical design elements for the DREA.

5.2.1 Principal Safety in Design Elements

Principles 1 to 6

Key Safety in Design (SiD) elements related specifically to safety around the DREA during construction, operation and closure phases include:

- Haulage roads to access DREA during operation to be appropriately located to provide easy/ convenient access to rejects placement areas and landform benches, but to reduce overall footprint. A maximum longitudinal grade of 2.3 % to be adopted for access/ haul roads.
- Haulage roads are constructed to shed stormwater to reduce ponding potential and to ensure controlled release to stormwater drainage system. Minimum crossfall of 1 % to be adopted for haul roads.
- Reject materials are to be compacted following placement and spreading to enhance DREA stability and to reduce potential for dust and erosion from exposed rejects surfaces.
- During the operational phase, benched external batters to have a maximum bench height of 10 m, with bench width of 26 m. The starter embankment has the maximum batter slope of 1V:1.7H. The maximum intermediate batter slope of 1V:5H are to be formed.
- As part of the rehabilitation phase, reprofile external batters to form minimum long-term permanent slopes of approximately 1V:9H and maximum permanent slopes of approximately 1V:8H.
- There will be a need for progressive rehabilitation works to commence following Year 1 of the operation to further assess/ground-truth closure options, including seeding, mulching, soil cover composition and profiling of embankments for surface water management and long-term stability.

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5.2.2 Stormwater and Seepage Management

Principles 1, 4, 5, 7 and 10

A key principle for DREA development is to ensure positive drainage of stormwater from the DREA to beyond the DREA footprint. Effective surface drainage practices will enable release of stormwater runoff to the environment without treatment. Nonetheless, infiltration of stormwater into the DREA can be expected, and seepage expression or release of this infiltration (as leachate) to external batters will result. Based on the current understanding of rejects geochemistry (refer **SECTION 2.5.3**), it is expected that the quality of leachate from the DREA will not exceed appropriate water quality guidelines, therefore will be allowed to discharge to the stormwater management system (releasing to the receiving environment).

Management measures for stormwater and seepage will include:

- The initial rejects layer (0 to 4m depth) is critical in managing seepage potential during the early phases of rejects placement, and also in managing seepage water during later stages of placement. These management measures include:
    - DREA footprint preparation will stage develop in monthly timesteps, during which time, surface profiling will be established to direct stormwater runoff to appropriate outlet locations.
    - Topsoil cover will be removed (expected 0 to 0.3m thickness) and stockpiled for later use in rehabilitation;
    - In situ clay layer (nominal 0.5 m thickness) will be ripped and compacted;
    - Rejects will be placed to form 1 m lifts in 0.3m compacted lifts, to minimise permeability across the footprint, with the surface of the lift graded to promote lateral drainage;
- Rejects at all levels will be compacted to meet construction standards to reduce permeability and close out any interstitial pathways within the rejects mass, thus reducing potential for downwards movement and possible accumulation of moisture.
- Operational practices will maintain surface grades to shed stormwater away from the surface of rejects placement areas to minimise the potential for infiltration. Stormwater runoff will be directed to localised sumps and released into stormwater drainage system.
- Operational stormwater management will utilise haul roads, external benches and formed drainage chutes to convey stormwater runoff to beyond the DREA footprint. The design criteria for engineered components of the stormwater management system will be:
    - 5 % Annual Exceedance Probabilities (AEP) (1-in-20 year);
    - 1 % AEP (1-in-100 year); and
    - 0.1 % AEP (1-in-1000 year).
- Sediment pond structures have been provided on the perimeter of the DREA as part of the site-wide water management system as presented in ATCW (2020) **[1]**. The general intention will be to utilise these structures to facilitate energy dissipation of stormwater flows from engineered structures and then release to the environment.
- Engineered batter chutes will be located on the south-east of the Stage 1 footprint and north-east of the Stage 2 footprint with discharge directed to sediment dams. Two chutes will be located on the Stage 3 footprint, with the possibility that chutes will be relocated in response to subsidence as the changes in the adjacent drainage topography occurs.

5.2.3 Impact of Subsidence

Principles 2, 4, 5, 7 and 10

Progressive longwall mining within the DREA footprint will result in irregular subsidence patterns that will cause displacement in the DREA foundation and, as such, the emplacement. Management measures subject to subsidence will include:

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- Compaction of placed rejects is to be undertaken to reduce infiltration and minimise structural impact on foundation.
- Progressive reprofiling of DREA surfaces is required to maintain grade and drainage patterns. This will include in-filling and reshaping of the landform (including external benches) to achieve capacity, maintain stability and restore stormwater drainage patterns.
- Post-operational (pre-rehabilitation) reprofiling of DREA surface is performed by grading of completed surfaces and in-filling of subsidence areas. Rehabilitation works would typically not proceed until subsidence movements have substantially ceased.
- As a result of subsidence, there is no consideration for use of subsurface drains due to subgrade displacement. Any accumulation of moisture will therefore drain from the toe or lower batters of the DREA into the stormwater drainage system (refer **SECTION 0**).

5.2.4 Installation of Bores through DREA into Longwall

Principles 4 and 7

Installation of air intake vents and degassing bores for methane removal in the longwall may require intersection with the DREA. Particular measures will be required to manage any impacts from bore installation.

- Compaction of placed rejects material to limit entrainment of oxygen and increased potential for spontaneous combustion. Nonetheless, as indicated in **SECTION 2.5.4**, rejects material is expected to have a low carbon content which minimises the potential for spontaneous combustion;
- Drilling through the DREA will apply proper grouting processes, in-case drilling and pressure testing to ensure sealing of sub-surface annulus in rejects material and footprint zone;
- Impacted bores resulting from subsidence will be redrilled at the location of the initial vent or bore. Abandoned bores will be properly grouted and backfilled; and
- Drilling pads on the DREA will be located on flat areas that does not affect drainage and carefully prepared to avoid any potential infiltration.

5.2.5 Closure and Rehabilitation

Principles 8 and 10

Rehabilitation will be undertaken in stages, across completed DREA surface (refer **SECTION 2.4.2**). Design aspects of the rehabilitation phase will include:

- Rehabilitation works will be staged. The critical indicators for commencement of rehabilitation in a particular area will be:
    - Completion of the design landform at that location.
    - Substantial completion of subsidence and associated displacement in that area; and
    - Completion of subsidence correction, in the form of reprofiling, in-filling and/or reshaping.
- All rehabilitated DREA surfaces are to be free-draining, therefore implying that no medium to long term ponding on any surface will be acceptable.
- Batter slopes are to be re-profiled to achieve the final landform batter slopes, with a minimum reprofiled slope of approximately 1V:9H to be formed.
- It is expected that progressive closure can commence from Year 2 in the construction program commencing with the first lift of Stage 1.
- It is anticipated that the south-west and eastern flanks of Stage 1 will act as a long-term testing area to ground truth capping layer configuration (as well as revegetation success). This will confirm the approach for later stages of rehabilitation.

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- It is expected that there will be a deficit in topsoil in the area and manufacture of soil substitutes (mulches, composting and profiling) would be required.

5.2.6 Other General Aspects

Principles 4 and 10

- The risk of groundwater connection with the DREA would be limited given:
  - Coal extraction would minimise phreatic pressure from coal seams;
  - Upper weathered zone aquifer is at least 10m below surface;
  - Footprint development approach (refer **Section 5.2.2**).
- Dust control will be provided during active periods of DREA development through water truck sprayers and compaction of reject materials, particularly on haulage roads. Also, haul truck movements would be limited to the DREA and CHPP, with a small pad used as the go-line and for maintenance activities

5.3 DREA Design – Operational Phase

5.3.1 3D Design

The geometry of the DREA presented in ATCW (2020) [1] was further developed to achieve the final landform design. The 3D Model based design was developed using 12d design software for the following DREA stages:

- Stage 1 : 0 – 5 Years
- Stage 2 : 5 – 20 Years
- Stage 3 : 20 – 50 Years

The basis for the 3D design covering the operational phase development (i.e., pre-rehabilitation) was as follows:

Geometry and Capacity (refer **SECTION 2.4.1**)

- Total Capacity : 110 Mm^3
- Stage Capacities
  - Stage 1 : 11.8 Mm^3
  - Stage 2 : 36.0 Mm^3
  - Stage 3 : 63.5 Mm^3
- Footprint Area
  - Stage 1 : 70.3 ha
  - Stage 2 : 149 ha
  - Stage 3 : 167 ha
- Total Landform Height : 45 m
- Maximum bench height : 10 m
- Minimum inter-bench slope : 30 °
- Terrace Slopes : 1%

Access Ramps and Haul Roads (refer **SECTION 5.2.1**)

- Haul roads to be provided to each development stage, located to minimize total DREA footprint
- Maximum longitudinal grade for haul roads of 2.3%.

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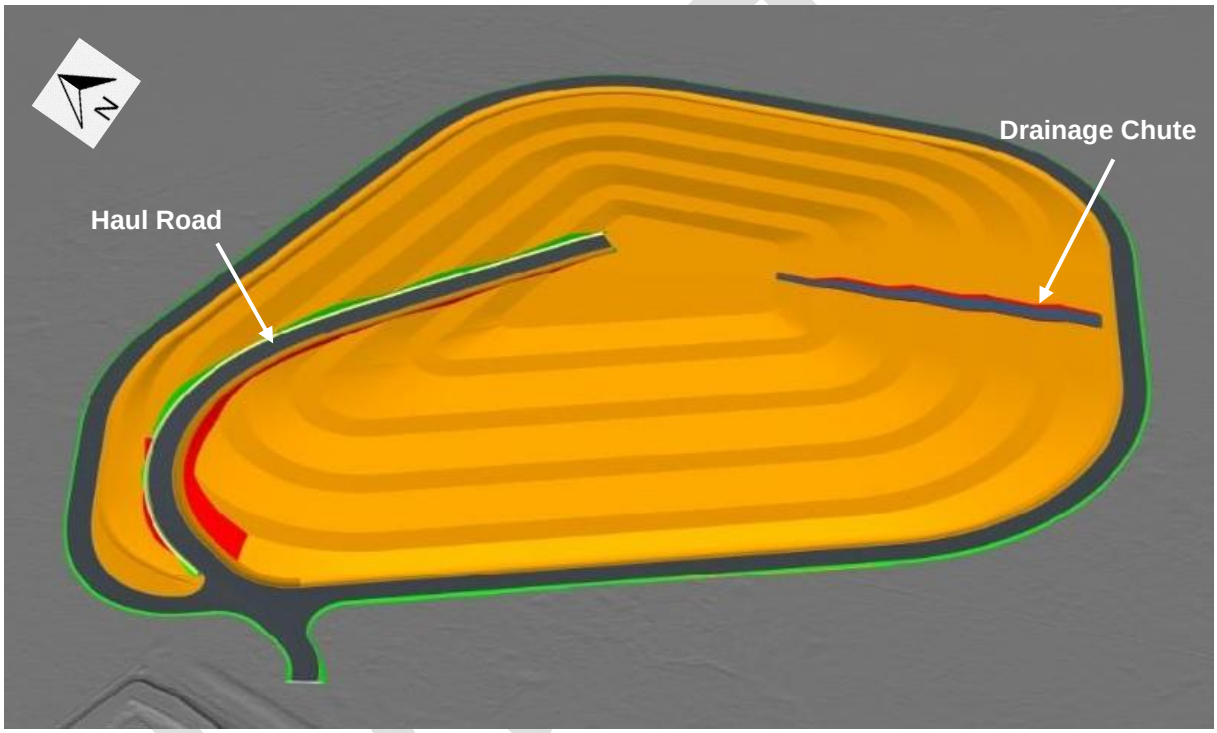
Stormwater Drainage Structures/Chutes (refer **SECTION 0**)

- Chute Locations
  - Stage 1 — South east corner
  - Stage 2 — North east corner
  - Stage 3 — North east corner
    Central north batter
- Design Criteria — 5%, 1% and 0.1% AEP

Design Output

3D design output for staged DREA development based on the above criteria is presented in 3D diagrammatic form in **DIAGRAM 6** to **DIAGRAM 9**.

DIAGRAM 6: STAGE 1 (0 – 5 YEARS) DREA 3D DESIGN



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DIAGRAM 7: STAGE 2 (0 – 20 YEARS) DREA 3D DESIGN

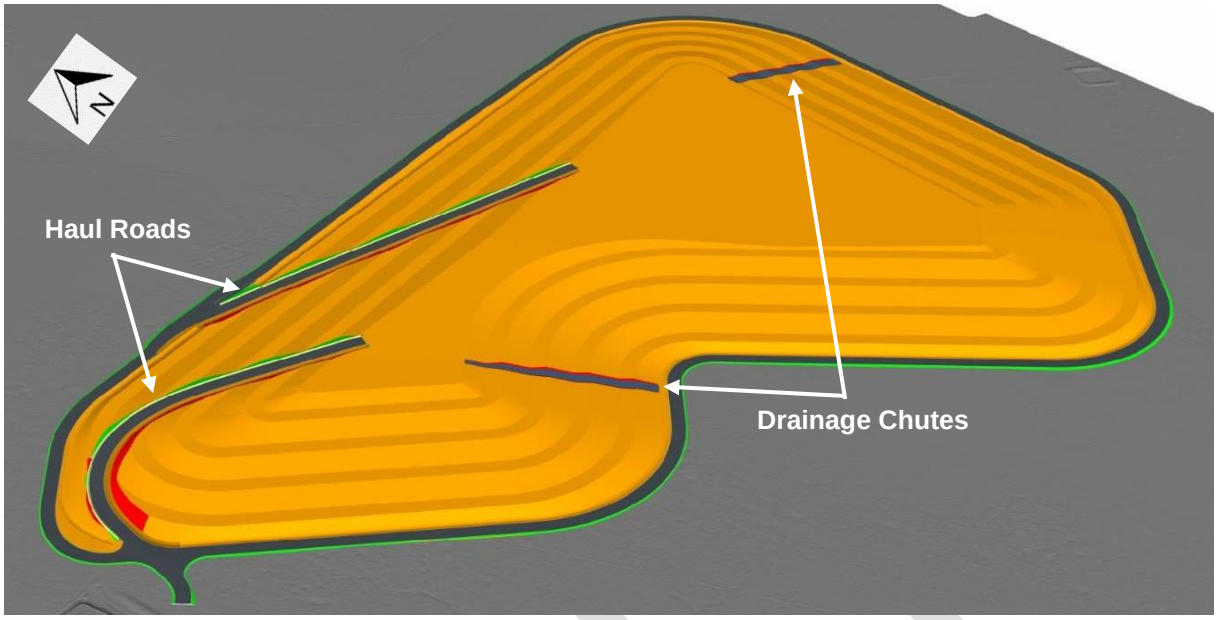
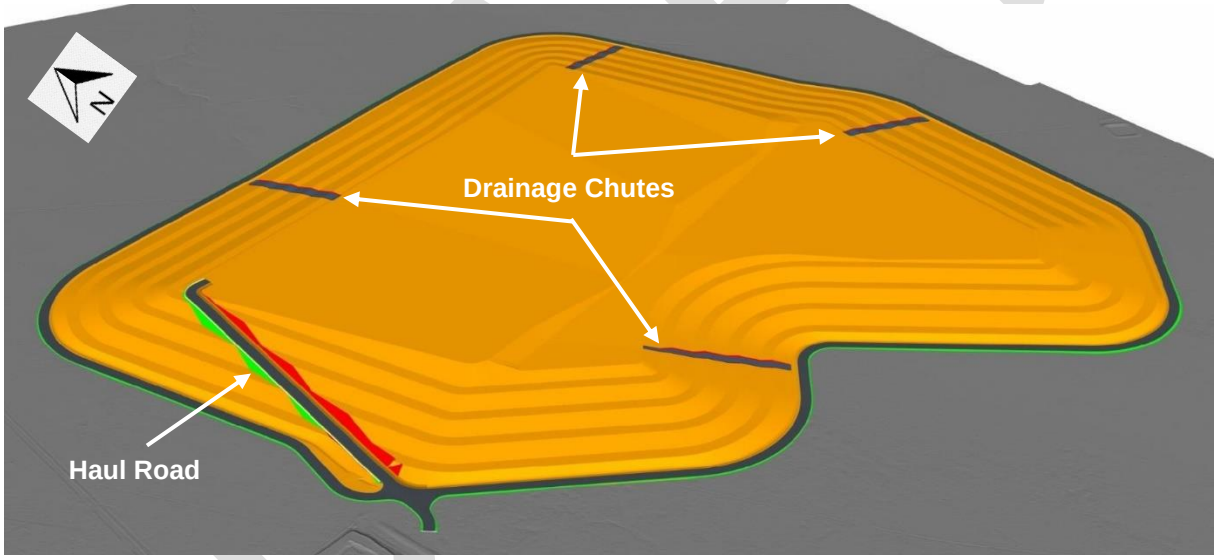


DIAGRAM 8: STAGE 3 (0 – 50 YEARS) DREA 3D DESIGN



5.4 DREA Design – Rehabilitation Phase

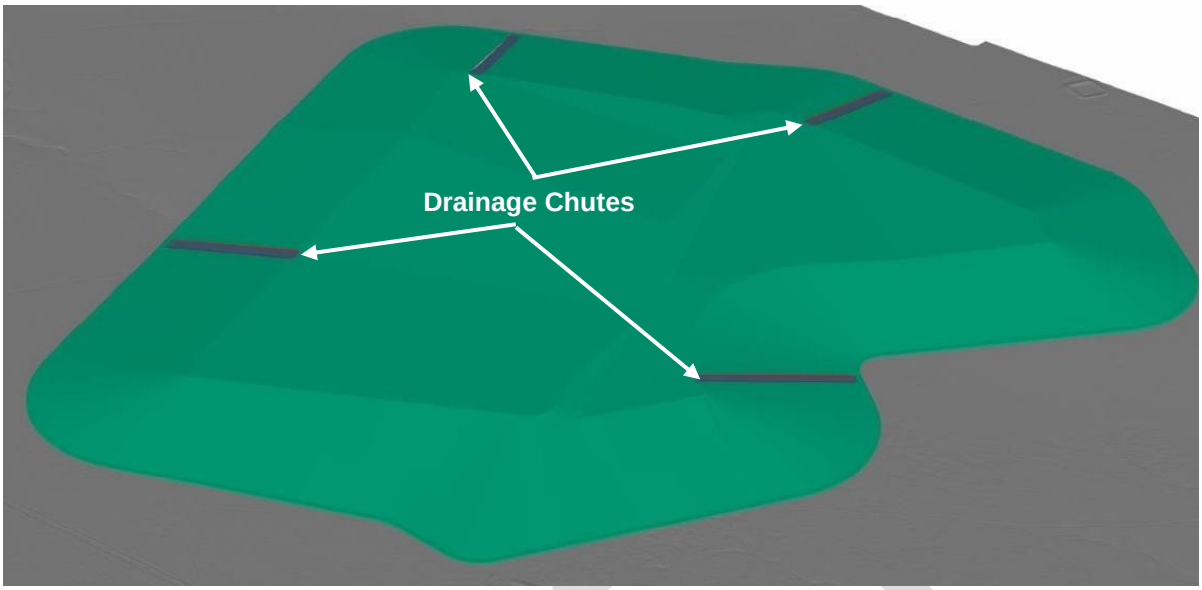
The rehabilitation phase of DREA development will involve landform reprofiling under Principle 8 in **SECTION 4.4.6** and with regard to design considerations presented in **SECTION 5.2.5**.

The principal criteria for the final landform subject to rehabilitation is for a minimum batter slope of 1V:9H.

The 3D design for the rehabilitated DREA for Closure is shown on **DIAGRAM 9**.

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DIAGRAM 9: FINAL LANDFORM 3D DESIGN



Long term, proposed permanent drainage pathways are also indicated on **PLATE 10**. It is however recommended that further drainage pathways be created through reprofiling based on post-subsidence surface deformations to ensure that drainage of the structure is maintained.

5.5 Geotechnical Stability of DREA External Batters (Operational Phase)

5.5.1 General

Slope stability modelling in relation to the proposed DREA final landform design slope has been completed using SLOPE/W computer package, which uses limit equilibrium theory to solve for the factor of safety of the slope. The model calculates a factor of safety for a two-dimensional section, satisfying both moment and force equilibrium. The limit equilibrium method by Morgenstern-Price method of analysis has been adopted using a circular failure surface.

A summary of the failure surface definitions used in the analysis is as follows:

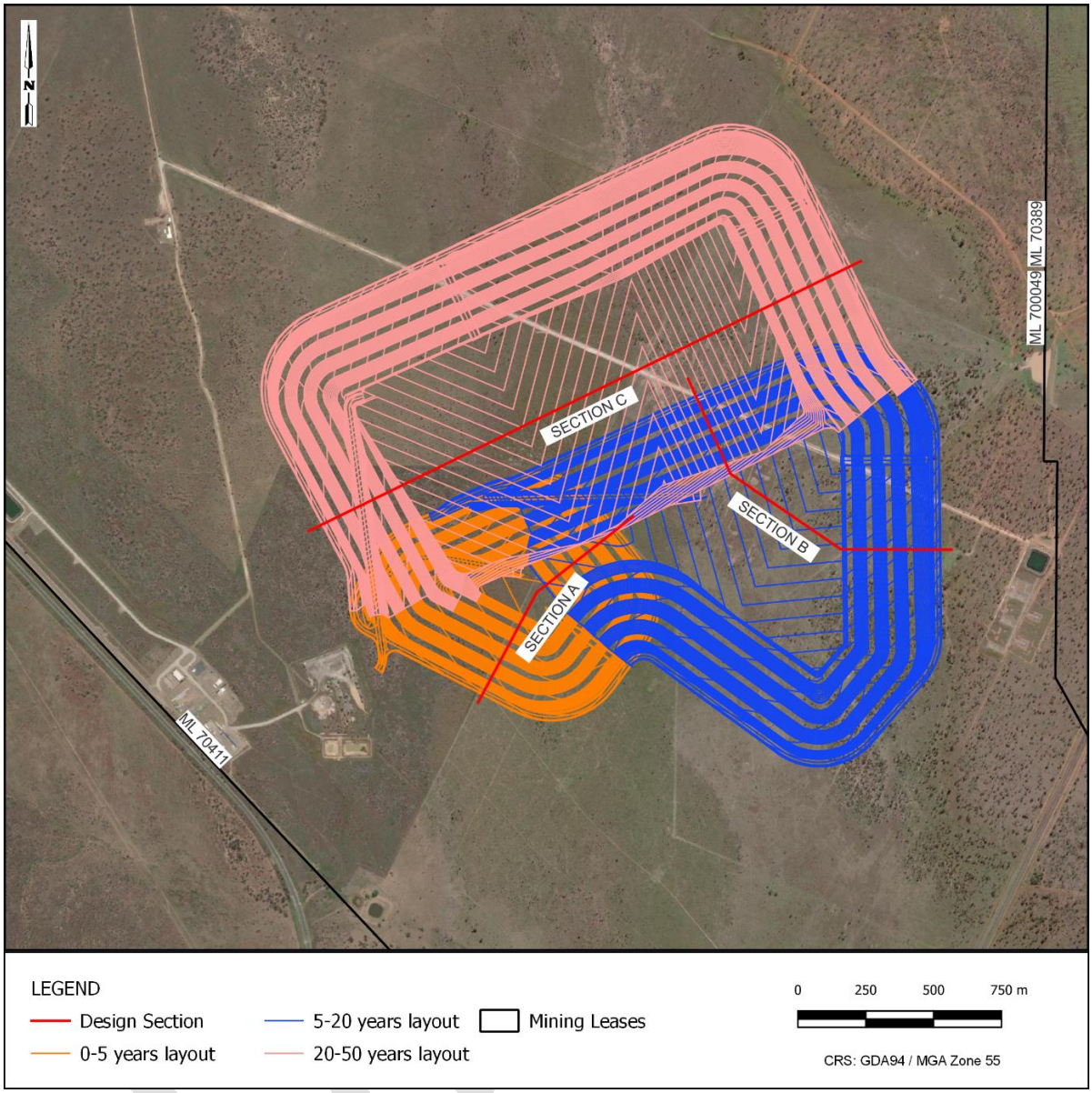
- Slip surfaces were defined using the entry and exit method. This method has been set to evaluate the impact of failures initiating along the slope or crest of the DREA and extending as deep as into the bedrock surface. This is considered consistent with ANCOLD recommendations for tailings dams to select critical failure surfaces that would cause significant damage if a failure occurred (ANCOLD, 2019) **[17].**
- Both left-hand side (LHS) and right-hand side slopes (RHS) failures, where applicable, were considered in the stability analysis.
- The optimised critical slip surface location was used for the analysis. This is considered consistent with ANCOLD Guidelines for tailings dams, which note that non-circular failure surfaces may need to be considered in the majority of applications (ANCOLD, 2019) **[17]**.
- The pore water pressures utilised in the analyses were based upon the results of the seepage analysis described in **SECTION 5.5.5**.

5.5.2 Evaluated Scenarios

A total of three cross-sections were selected as being representative of the DREA final landform for the slope stability assessment (i.e., Cross-Sections A to C, **DIAGRAM 10**).

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DIAGRAM 10: LOCATION OF DESIGN CROSS-SECTIONS



For assessment of the critical condition for the final landform using SLOPE/W, three design cases (short term stability, long-term stability and post seismic) were analysed in accordance with ANCOLD (2019) **[17]** guidelines for tailings dams. These cases are described in

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TABLE 9: SUMMARY OF GEOTECHNICAL STABILITY MODELLING

Design Case	Description	Input Parameters
Short-Term Condition (End-of-construction)	Considers final landform stability immediately following completion of construction. Incorporates predicted pore water pressures developed within the DREA one year before the stage construction conclusion.	Effective (c', Φ') and undrained strength (S_u) parameters with the predicted phreatic surface from one year before the DREA stage construction conclusion.
Long-Term Condition	Considers final landform stability incorporating the predicted pore water pressures developed at the end of the lifespan of each DREA stage.	Effective (c', Φ') and undrained strength (S_u) parameters with the predicted phreatic surface from the end of the lifespan of each DREA stage.
Post-seismic Condition	Considers final landform stability subject to strength reduction for materials in a non-liquefiable condition	Effective (c', Φ') and undrained strength (S_u) parameters with a 20% strength reduction. Assumed piezometric profile prior to earthquake, as for Long term condition.

Details of above design cases are described below.

Short-Term Condition (End of Construction)

The short-term condition represents the case where a phreatic surface predicted to be developed within the DREA one year before the conclusion of each stage's final lifespan is adopted. Effective and undrained strength parameters have been considered due to the likelihood that evaluated materials present a contractive behaviour.

Long-Term Condition

The long-term condition represents the case where a phreatic surface predicted to be developed within the DREA at the analysed stage final lifespan is adopted. Effective and undrained strength parameters have been considered due to the likelihood that evaluated materials present a contractive behaviour.

Post-Seismic Condition

This condition is based on the Long-Term Condition, however, with post-seismic strength considered. The rejects material has been assessed as non-liquefiable. Based on ANCOLD (2019) [17] guidelines, cyclically reduced undrained/ drained shear strengths have been applied. A 20% strength reduction has been conservatively allowed for the post-seismic analysis.

5.5.3 Batter Stability Criteria

The stability design criteria include minimum Factor of Safety (FoS) requirements recommended by ANCOLD (2019) **[17]** for tailings dams, used as targets in the stability analysis, are presented in **TABLE 10**.

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TABLE 10: ANCOLD RECOMMENDED MINIMUM SLOPE STABILITY FACTORS OF SAFETY

Loading Condition	Minimum FoS	Shear Strength Criteria
Short-Term (End of Construction)	1.5	Effective and Consolidated Undrained Strengths
Short-Term (No potential loss of containment – Local failure)	1.3	Effective and Consolidated Undrained Strengths
Long-Term	1.5	Effective and Consolidated Undrained Strengths
Post-Seismic	1.0 to 1.2	Post-Seismic Shear Strength*

* Cyclically reduced undrained/drained shear strength and/or liquefied residual shear strength for potentially liquefiable materials.

5.5.4 Adopted Parameters for Stability Analysis

The parameters adopted for the design completed and presented in ATCW (2020) **[1]** has been maintained for the final landform design analysis. Material properties for the embankment and in-situ materials were selected based on field data and observations, engineering judgement and experience with similar materials. A summary of the properties used in the static and post-seismic stability analyses are presented in **TABLE 11** and **TABLE 12,** respectively.

TABLE 11: MATERIAL STRENGTH PARAMETERS FOR STATIC STABILITY ANALYSIS

Material	Unit Weight, γ (kN/m³)	Effective Strength Parameters		Undrained Shear Strength (S_u)	Hoek Brown Failure Criterion			
		Cohesion, c' (kPa)	Friction Angle, φ' (°)		Intact UCS (kPa)	GSI	Intact Rock Constant (mi)	Disturbance Factor
Engineered Materials								
Compacted Clay	20	1	28	0.35σ'v + 40 kPa	-	-	-	-
Rejects	18	1	30	-	-	-	-	-
Capping Layer	20	1	30	-	-	-	-	-
In-situ Materials								
Surface Soils	21	1	21	0.24σ'v + 45 kPa	-	-	-	-
Weathered Sandstone/ Mudstone (Bedrock)	20	-	-	-	50,000	30	10	0.6
Fresh Sandstone/ Mudstone (Bedrock)	20	-	-	-	175,000	30	10	0.1

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TABLE 12: MATERIAL STRENGTH PARAMETERS FOR POST-SEISMIC STABILITY ANALYSIS

Material	Post-Seismic			
	Unit Weight, γ (kN/m3)	Effective Cohesion, c' (kPa)	Effective Friction Angle, φ' (°)	Undrained Shear Strength (S_u)
Engineered Materials				
Compacted Clay	20	-	-	0.28σ'v + 32 kPa
Rejects	18	1	24.8	-
In-situ Materials				
Surface Soils	21	-	-	0.19σ'v + 36 kPa

5.5.5 Piezometric Conditions

Seepage analyses were performed to estimate the phreatic surfaces at selected locations under various design stages using the software SEEP/W, developed by GeoSlope International. The seepage analysis results were then used as input to provide pore pressures for use in the slope stability analyses performed for the DREA design.

Transient analysis method were adopted over the LoM period. A five-year rainfall data interval was selected to evaluate potential interaction with surface water and groundwater environments and predict the phreatic surface development within the DREA landform. Rainfall infiltration was based on a conservative estimate of 30% based on the daily rainfall data from 2010 to 2015 sourced from the SILO Data Drill Program.

The results of the predicted piezometric conditions are shown in the figures provided in **APPENDIX A**. **TABLE 13** outlines the cross-sections analysed with the corresponding scenario and figure number.

TABLE 13: SEEPAGE ANALYSES SUMMARY

Section	Scenario	Figure No. (Appendix A)
Section A	**0-5 Years**	
	Short-Term (End of Construction)	A-1
	Long Term	A-6
	5-20 Years	
	Short-Term (End of Construction)	A-17
	Long Term	A-20
	20-50 Years	
	Short-Term (End of Construction)	A-26
	Long Term	A-29
Section B	**5-20 Years**	
	Short-Term (End of Construction)	A-35
	Long Term	A-40
	20-50 Years	
	Short-Term (End of Construction)	A-51
	Long Term	A-54
Section C	**20-50 Years**	

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Section	Scenario	Figure No. (Appendix A)
	Short-Term (End of Construction)	A-60
	Long Term	A-65

5.5.6 Results of Batter Stability Analyses

Results of the slope stability analyses are presented in **APPENDIX A**. The calculated minimum factors of safety for the proposed section of the DREA final landform configuration are summarised in **TABLE 14**.

TABLE 14: SLOPE STABILITY ANALYSES RESULTS

Cross-section	Design Case		Analysed Slope	Minimum FoS	Calculated FoS	Figure No.
A	**Stage 1 – 0-5 Years**					
	Short Term (End of Construction)	Undrained	LHS	1.50	3.30	A-2
		Undrained - Local		1.30	1.74	A-3
		Undrained	RHS	1.50	3.88	A-4
		Undrained - Local		1.30	1.95	A-5
	Long-Term	Drained	LHS	1.50	3.73	A-7
		Drained - Local		1.30	1.79	A-8
		Undrained		1.50	3.30	A-9
		Undrained - Local		1.30	1.74	A-10
		Post-Earthquake		1.0 - 1.2	2.64	A-11
		Drained	RHS	1.50	4.30	A-12
		Drained - Local		1.30	1.92	A-13
		Undrained		1.50	3.88	A-14
		Undrained - Local		1.30	1.95	A-15
		Post-Earthquake		1.0 - 1.2	3.11	A-16
	Stage 2 – 5-20 Years					
		Undrained	LHS	1.50	2.41	A-18

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Cross-section	Design Case		Analysed Slope	Minimum FoS	Calculated FoS	Figure No.
	Short Term (End of Construction)	Undrained - Local		1.30	1.40	A-19
	Long-Term	Drained	LHS	1.50	3.73	A-21
		Drained - Local		1.30	1.79	A-22
		Undrained		1.50	3.30	A-23
		Undrained - Local		1.30	1.74	A-24
		Post-Earthquake		1.0 - 1.2	2.64	A-25
	Stage 3 – 20-50 Years					
	Short Term (End of Construction)	Undrained	LHS	1.50	1.99	A-27
		Undrained - Local		1.30	1.38	A-28
	Long-Term	Drained	LHS	1.50	3.73	A-30
		Drained - Local		1.30	1.79	A-31
		Undrained		1.50	3.30	A-32
		Undrained - Local		1.30	1.74	A-33
		Post-Earthquake		1.0 - 1.2	2.64	A-34
B	**Stage 2 – 5-20 Years**					
	Short Term (End of Construction)	Undrained	LHS	1.50	2.64	A-36
		Undrained - Local		1.30	2.29	A-37
		Undrained	RHS	1.50	2.24	A-38
		Undrained - Local		1.30	2.16	A-39
	Long-Term	Drained	LHS	1.50	4.29	A-41
		Drained - Local		1.30	3.53	A-42
		Undrained		1.50	3.69	A-43
		Undrained - Local		1.30	3.55	A-44

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Cross-section	Design Case		Analysed Slope	Minimum FoS	Calculated FoS	Figure No.
		Post-Earthquake		1.0 - 1.2	2.95	A-45
		Drained	RHS	1.50	3.95	A-46
		Drained - Local		1.30	3.27	A-47
		Undrained		1.50	3.50	A-48
		Undrained - Local		1.30	3.24	A-49
		Post-Earthquake		1.0 - 1.2	2.80	A-50
	Stage 3 – 20-50 Years					
	Short Term (End of Construction)	Undrained	RHS	1.50	1.98	A-52
		Undrained - Local		1.30	2.14	A-53
	Long-Term	Drained	RHS	1.50	3.67	A-55
		Drained - Local		1.30	3.04	A-56
		Undrained		1.50	3.33	A-57
		Undrained - Local		1.30	3.14	A-58
		Post-Earthquake		1.0 - 1.2	2.61	A-59
C	**Stage 3 – 20-50 Years**					
	Short Term (End of Construction)	Undrained	LHS	1.50	2.05	A-61
		Undrained - Local		1.30	2.53	A-62
		Undrained	RHS	1.50	2.43	A-63
		Undrained - Local		1.30	1.57	A-64
	Long-Term	Drained	LHS	1.50	3.62	A-66
		Drained - Local		1.30	3.24	A-67
		Undrained		1.50	3.04	A-68
		Undrained - Local		1.30	3.51	A-69
		Post-Earthquake		1.0 - 1.2	2.43	A-70

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Cross-section	Design Case		Analysed Slope	Minimum FoS	Calculated FoS	Figure No.
		Drained	RHS	1.50	4.18	A-71
		Drained - Local		1.30	2.07	A-72
		Undrained		1.50	3.71	A-73
		Undrained - Local		1.30	2.10	A-74
		Post-Earthquake		1.0 - 1.2	2.97	A-75

5.5.7 Conclusion from Operational Phase Stability Analyses

The results in **TABLE 14** demonstrate that all the calculated factors of safety comply with the minimum requirements, as indicated in **SECTION 5.5.3**. Therefore, the proposed DREA configuration meets best practice requirements under both short, long-term and earthquake conditions.

5.6 Geotechnical Stability of DREA External Batters (Rehabilitation Phase)

Reprofiling of external DREA batters as part of rehabilitation to minimum 1V:9H slopes and maximum of 1V:8H slopes would further improve geotechnical. It is therefore accepted that rehabilitation of the DREA would improve the overall slope stability of the landform.

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6 WATER MANAGEMENT ASPECTS

6.1 Context

The basis for DREA water management is addressed as follows:

- Principle 7 in **SECTION 4.4.5**, with key aspects as follows:
    - Effective stormwater management system across the surfaces of the DREA through all stages of development to convey stormwater to beyond the DREA footprint.
    - Active management of DREA surfaces to reduce ponding.
    - Reprofiling of subsided areas beyond the DREA footprint to ensure that surface water drainage pathways are maintained.
- Stormwater and seepage management design considerations in **SECTION 0**, with key aspects as follows:
    - The premise for overall water management is that the quality of both surface water runoff and seepage (leachate) expression from the DREA will be such that direct release to the receiving environment is possible.
    - Fundamental water management measures will include controls at drainage chute locations (operational phase) or drainage pathway locations (rehabilitation phase) for release to the environment. Sediment ponds proposed at locations on the perimeter of the DREA will be used for this purpose.
    - Operational practices relate to rejects placement and compaction to reduce permeability and inhibit moisture infiltration into the DREA.
    - Haul roads and benches formed across external batters will be used for stormwater management purposes, until reprofiling as part of rehabilitation is undertaken.

6.2 Stormwater Management Design

6.2.1 Context

Preliminary hydraulic design was undertaken in 2020 **[1]** for the sizing of the proposed chutes and cross drainage structures. The 0.1% AEP event was adopted as the design standard for the chutes, bench drains and bunds to ensure the proposed geometry has sufficient capacity to convey runoff, where the 5% AEP design event was adopted for the hydraulic design and capacity check of the proposed cross drainage culverts.

This design and assessment assumes the final landform will be free draining to the downstream receiving environment. During the phase of active subsidence, regrading of the surface profile will be required to allowing free draining to the receiving environment, to prevent ponding of runoff on the surface of the landform, within the bench drains and chutes. Further, at the interface of the subsidence zone and the existing topography, small drains will be required to prevent of surface water runoff on the subsidence zone. These drains will be constructed at the discretion of site management based upon the final landform during, and after subsidence.

6.2.2 Capacity Check for Drainage Structures

The key stormwater design aspect for the DREA is related to sizing and configuration for drainage structures both under operational and rehabilitation phase conditions. Design analyses have been undertaken to estimate peak flows for drainage structures based on a design event of 5 % AEP, 1 % AEP and 0.1 % AEP (refer **SECTION 0**). It is noted that this design analysis has been applied to a single conservative condition, being applied to all structures.

The Australian Rainfall and Runoff (ARR) online datahub was accessed to source design rainfall data for the site via the XP-STORM 'Storm Generator' function for the location of the site Babister, M., Trim, A., Testoni, I. & Retallick, M., (2016) **[18]**, accessed 12th February 2020). The XP-STORM hydrology model (version 2019.1.13) was used to assess the peak catchment discharge rate and critical storm

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duration using a simple 1d node analysis. Assessment was also made of the appropriate temporal pattern (representative of the median peak discharge) to be used in subsequent TUFLOW hydraulic modelling. The results of the assessment are provided in ATCW (2020) **[1]**.

In summary, drainage structures as detailed in ATCW (2020) **[1]**.are designed to accommodate a peak flow of 22.2 m^3/s.

6.2.3 Design of Drainage Structures

The design capacity of 22.2 m^3s was adopted for the geometric design of the chutes to manage peak stormwater flows from the rehabilitated DREA landform. The locations of these chutes are shown on **DIAGRAM 6** to **DIAGRAM 8** for Stages 1 to 3**.** The typical long section through drainage chutes for operational and rehabilitation phases are shown on **DIAGRAM 11** and **DIAGRAM 12** respectively. A proposed nominal drain cross section is shown on **DIAGRAM 13**.

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DIAGRAM 11: TYPICAL SECTION THROUGH DRAINAGE CHUTE – OPERATIONAL PHASE

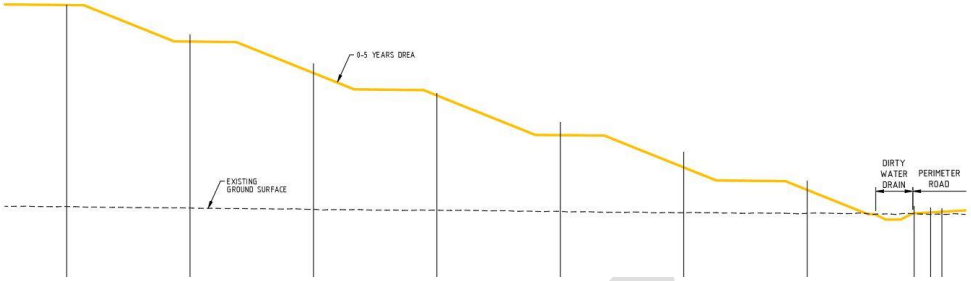


DIAGRAM 12: TYPICAL SECTION THROUGH DRAINAGE CHUTE – REHABILITATION PHASE

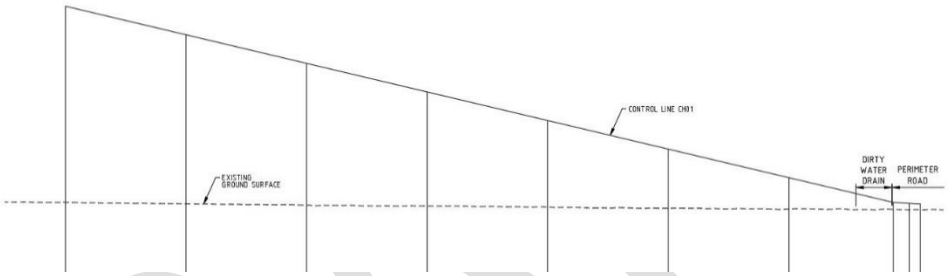
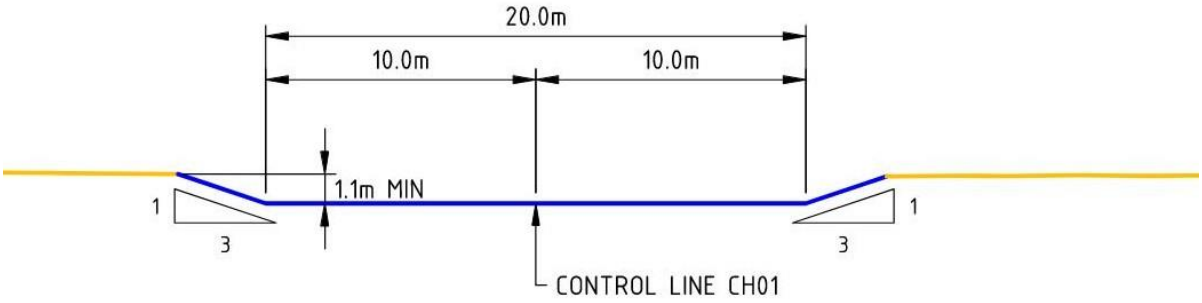


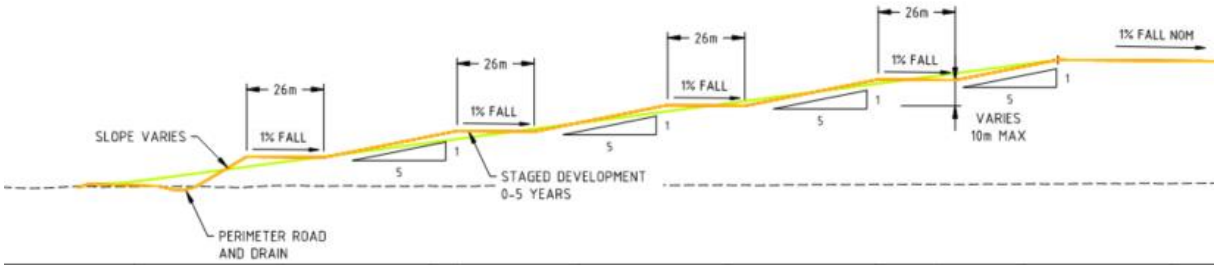
DIAGRAM 13: PROPOSED DRAINAGE CHUTE CROSS SECTION (OPERATIONAL PHASE)



(Note: Refer **DIAGRAM 6** to **DIAGRAM 8** for the proposed drainage chute locations for the operational phase of the DREA)

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DIAGRAM 14: TYPICAL SECTION THROUGH DRAINAGE PATHWAY – OPERATIONAL AND REHABILITATION PHASE



(Note: refer **DIAGRAM 9** for proposed drainage pathway locations for the final landform)

Where required, the design of drainage chutes/pathways may be subject further design once the landform development has progressed and the certainty around water management aspects as listed in **SECTION 6.2.1** have been confirmed.

6.2.4 Subsidence Management

Potential impacts of subsidence from underground longwall mining is addressed in **SECTION 5.2.3** as a key management measure that has the potential to impact on the serviceability of stormwater management systems. Subsidence management is particularly critical to stormwater management due to displacements likely to reflect in the DREA landform, causing disruption to drainage patterns and related ponding. Subsidence in the DREA will therefore trigger the need for infilling of depressions and general reprofiling of the landform to reinstate the required surface profile and landform design configuration.

6.3 Seepage Management

The position adopted with respect to potential seepage from the DREA, as described in **SECTION 0**, is that infiltration of stormwater into the DREA can be expected, and seepage expression or release of this infiltration (as leachate) to external batters will result. However, based on the current understanding of rejects geochemistry (refer **SECTION 2.5.3**), it is expected that the quality of leachate from the DREA will not exceed appropriate water quality guidelines, therefore will be allowed to discharge to the stormwater management system.

Reference is also made to the feasibility design report for the DREA, ATCW (2020) **[1]**, which includes a seepage analysis, with a view to assessing the potential for migration of leachate contained within the DREA to reach groundwater. This analysis incorporated a clay liner of varying thickness, indicating that under model conditions, the potential for vertical downward migration of leachate would be very low (of the order of 10^{-8} m^3/s per square metre of DREA footprint). This is equivalent to a seepage rate of less than 0.1L/s per ha. This seepage rate is also tempered by the considerable depth between the base of the DREA and the upper groundwater aquifer (greater than 10m depth).

Based on the reclassification of the contamination from the DREA, it is considered that an engineered liner for the DREA is not warranted, although provision has been made in the construction of the DREA for tyning, moisture conditioning and compaction of the in situ, with a target depth of 0.5 m for this treatment.

Beyond these preparation works, specific measures in placement of the initial rejects layer across the prepared foundation will be made, as described in **SECTION 0**, and addressed in the Technical Specification, ATCW (2020) **[4]**.

In summary, the following seepage control measures are available and will be considered for the DREA construction phase:

- General sub-excavation within the DREA footprint to remove topsoil and any weak or loose subgrade soils;

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- 0.5 m thick subgrade treatment (tyning, moisture conditioning and compaction) across the DREA footprint;
- Placement of 1.0 m thickness of dry rejects to be compacted and moisture conditioned in maximum 0.3 m loose thickness layers;
- Ongoing compaction control for dry rejects for the full thickness of the DREA;
- Stormwater diversion and drainage measures;
- Implementation of monitoring including:
    - Standpipes;
    - Piezometers;
    - Settlement monuments;
    - Soil moisture probes; and
    - Temperature probes.

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7 DREA CONSTRUCTION

7.1 Proposed Landform Construction Methods

The methodology for rejects placement is outlined in the Stage 2 Design Report, ATCW (2020) **[1]**, the Operations and Management Plan, ATCW (2020) **[5]** with construction requirements included in the Technical Specification, ATCW (2020) **[4]**.

Construction of the DREA works include:

- Stripping and clearing of topsoil and vegetation from within the footprint;
- Moisture conditioning, ripping (minimum 0.5 m) and compaction of in situ subsurface materials to form a clay liner over the DREA footprint. Construction of the clay liner would be completed in cells to align with rejects placement such that the clay liner is not left exposed for extended periods of time prior to the placement of rejects;
- Compaction of the first 1 m of rejects material over the clay liner;
- Placement of rejects by paddock dumping using haul trucks for transport from the CHPP and compactors for spreading and compaction of the dumped rejects;
- Construction of temporary and permanent drainage structures for management of stormwater; and
- Rehabilitation of external surfaces as the DREA is formed.

DIAGRAM 14 represents the placement planning for Stage 1 covering the Stage 1 (0 to 5 year) footprint as a series of cells. The approximate area for each section in the order of 3.5 ha. This provides an indication of placement approach, with the placement strategy for Stages 2 and 3 of the DREA (Years 5 – 20 and Years 20 – 50, respectively) to be optimised based on the outcome of the Stage 1 operations.

Prior to the commencement of the Stage 1, an area with the Year 1 0-8 months footprint to be nominated for the completion of dry rejects emplacement trials. The trials to focus on:

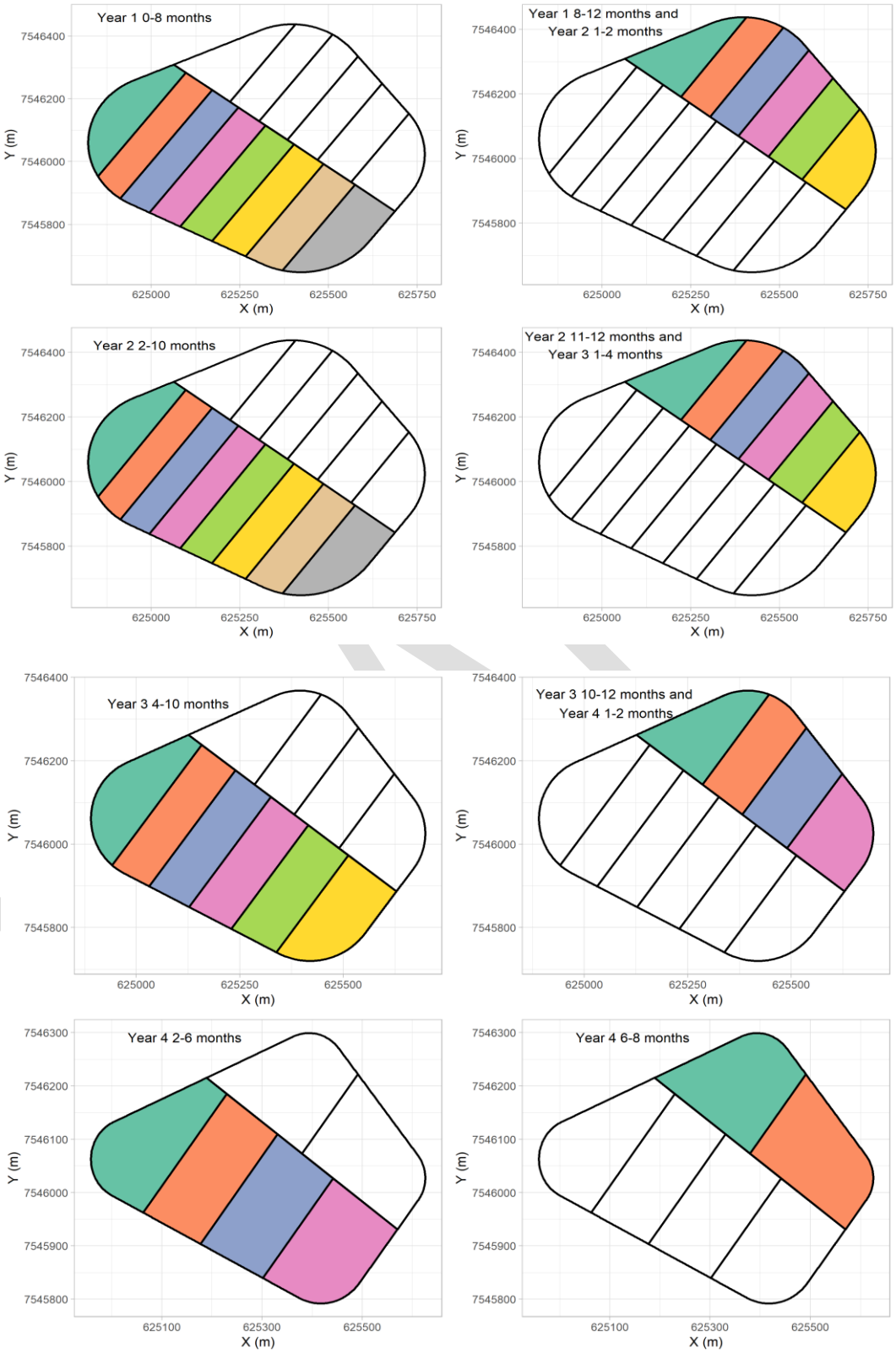
- Placement of rejects by paddock dumping using haul trucks;
- Spreading of rejects and compaction of dumped rejects;
- Confirmation of number of compaction passes of rollers to achieve adequate compaction; and
- Confirmation of the effect of the moisture content of the rejects on achieving adequate compaction.

The methodology shall be completed with the aim to optimise the operation of the DREA.

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DIAGRAM 15: PLACEMENT PLANNING FOR YEAR 1 INTO YEAR 4 FROM COMMISSIONING



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7.2 Reject Placement Trials

With limited information on the rejects materials reporting to the DREA, rejects placement trials would need to be completed to optimize the placement approach and to ensure appropriate performance outcomes. Prior to the commencement of Stage 1, an area within the DREA footprint for Year 1 0-8 months as shown in **DIAGRAM 15** would be nominated for reject compaction trials, which would include foundation preparation works. As outlined in **SECTION 7.1**, such an area would best be in the footprint of Year 1 0-8 months.

7.3 Quality Assurance/ Quality Control (QA/QC)

The development of the DREA stages and the formation of the final landform would be completed under an approved Quality Assurance Plan in accordance to the quality management systems requirements of AS/NZS ISO 9001:2000 and the Technical Specification, ATCW (2020) **[4]**. This Construction Quality Plan would address the following (as a minimum requirement):

- Project organizational chart;
- Details of the qualifications of key personnel;
- Inspection and Test Plans;
- Copy of the NATA registration for the compliance testing laboratory; and
- Project operating procedures.

The DREA would need to be constructed with adequate identification and traceability of the works. The identification and traceability process would include the division of the works into nominated lots aligning with construction staging and landform development profiles. The quality assurance elements of the Construction Quality Plan would include:

- Conformance reporting;
- Non-conformance reporting;
- Compliance inspection and testing by NATA registered laboratory; and
- Project quality records including surveys of the works.

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8 DREA LANDFORM REHABILITATION

8.1 Background

Progressive Rehabilitation and Closure Planning requirements (based on DES (2021) **[19]**) are applicable to the DREA and forms part of the Mined Land Rehabilitation Policy (refer **SECTION 1.2**), with rehabilitation objectives outlined in the EA (summarised in **SECTION 1.4.1**). Of note is that the PMLU as nominated under Condition E6 of EA is as follows:

- Native Ecosystem for DREA; and
- Grazing for topsoil and capping material stockpiles (refer).

A Rehabilitation Management Plan would form the basis for rehabilitation of the DREA. As outlined under Principles 8 and 10 (**SECTIONS 4.4.6** and **4.4.7**), and design considerations presented in **SECTION 5.2.5**, the critical elements of DREA landform rehabilitation would include:

- Rehabilitation works will be staged. The critical indicators for commencement of rehabilitation in a particular area will be:
    - Completion of the design landform at that location.
    - Substantial completion of subsidence and associated displacement in that area; and
    - Completion of subsidence correction, in the form of reprofiling, in-filling and/or reshaping.
- All rehabilitated DREA surfaces are to be free-draining, therefore implying that no medium to long term ponding on any surface will be acceptable.
- Batter slopes are to be re-profiled to achieve the final landform batter slopes, with a final minimum slope of approximately 1V:9H and maximum slope of 1V:8H to be formed.
- Progressive closure can commence from Year 5 in the construction program commencing with available area in Stage 1. the first lift of Stage 1 rehabilitation trials.
- There will is likely to be a deficit in topsoil in the area and development of soil substitutes (mulches, composting and profiling) would be required.

8.2 Rehabilitation Principles

The basic principle applying to the DREA rehabilitation in the concept of the final landform is to reprofile the final surfaces (batters and top/ plateau) to achieve the rehabilitated landform prior to application of the final capping and topsoil layers and vegetation. The rehabilitation principle is presented in **SECTION 4.4.6**.

The rehabilitated DREA is to be free-draining, implying that no medium to long term ponding on the rehabilitated DREA is acceptable. The stormwater management principle of the DREA is presented in **SECTION 4.4.5**.

8.3 Landform Evolution/Erosional Stability Assessment

8.3.1 Overview

A Landform Evolution/ Erosional Stability Assessment has been completed by Landloch Pty Ltd (Landloch), for input to the DREA final landform design. Landloch used SIBERIA specialist software to undertake the stability assessment.

The Landloch report presenting the results of the landform evolution analyses is presented in **APPENDIX B** and summarized in **SECTIONS 8.3.2** to Error! Reference source not found..

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8.3.2 Basis of Assessment

A key design philosophy for the rehabilitated phase of the DREA, reflected by the South32 Rehabilitation Management Plan **[16]**, is to provide an erosion resistant cover using rock and a rock/ soil surface mulching layer to support vegetation. Landform evolution modelling completed by Landloch was therefore based on a configuration comprising a vegetated soil/ rock mix layer over the final landform (top and batters).

Specific details of the soil/ rock mix layer have not been confirmed by EDCM, with model properties adopted for site materials and vegetation groundcover assumed based on available information on geochemical and physical assessment of drift spoil, coal and coal rejects materials presented in RGS (2022) **[7]** and the topsoil quality assessment presented in RGS (2022) **[14]**.

8.3.3 Adopted Performance Targets

Target long-term erosion rate is adopted when erosion models are developed for minesite landforms and when exceeded, the design is considered to be unacceptable.

The adopted performance targets is the long-term erosion rate. Average erosion rate (t/ha/y) of the outer batters for each output year is a measure of the rate of erosion as a means of showing areas that do not meet the target erosion rate. The adopted performance target rate is the rate at which rill erosion risk is significantly reduced. The adopted target erosion rate is <5 t/ha/y.

For the Moranbah region, erosion risk is moderate due to relatively high rainfall erosivity and the low infiltration potential of the cover material. Generally, the adopted erosion rate of 5-10 t/ha/y are associated with surfaces with a low tendency for riling.

Other adopted performance targets are:

- Maximum gully depth (m): this is measured as the depth of material movements as a means of showing gully depth. A gully is defined as an erosion feature greater than 0.3 m. Where gully features are not modelled, the landform is said to have a gully erosion. Typically, a maximum gully depth is not adopted in the erosion modelling. Given that the capping layer involves 0.25 m of topsoil overlying 1 m of subsoil, ideally, erosion by year 300 (end of simulation) should not exceed half the cover depth (1.25 m), therefore a threshold of 0.65 m was adopted as the maximum permissible depth of gully erosion at any given point on the landform; and
- Vegetation cover (%): adopted vegetative cover target is 50%. The landform is considered erosion prone until such a time as sufficient vegetative cover levels above 50% is established to improve the erosional performance.

8.3.4 Landform Evolution Modelling

The Landform Evolution Modelling was completed using the SIBERIA specialist software. The SIBERIA landform evolution model predicts the long-term, 3D development of channels and hillslopes (e.g., landform batters) on the basis of runoff, erosion and deposition. The modelling approach is widely used to assess the evolution of constructed mine waste landform shapes across Australia and overseas.

SIBERIA does not directly apply rainfall or material erodibility parameters. Rather, input parameters are uses a channelization function based on both runoff and erosion. As a result, the model parameters are specific to both the rainfall regime and material being considered and must be derived for each specific material located within each specific location.

Using this approach, SIBERIA solves for two variables:

- Elevation, from which slope geometries are determined; and
- An indicator function that determines where erosion features (channels) exist.

The range of inputs used in the modelling is as follows:

- Sediment transport rate coefficient;
- Discharge (m^3/y);
- Slope (m/m);

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- Coefficient between discharge and area;
- Area (m^2); and
- Exponent of the area in discharge.

8.3.4.1 Closure Strategy

South32 (2020) **[16]** provides detail on the proposed closure strategy for project including the DREA. The conceptual closure design for the DREA involves capping the rejects with 0.25 m of topsoil overlying 1 m of subsoil. Data on the physical and chemical characteristics of the capping materials was not included in the report, South32 (2020) **[16]**.

8.3.4.2 Cover Layer

Landloch (2023) **[20]** reported that the proposed cover layer modelled is assumed to comprise of a sandstone/topsoil mix with a vegetative groundcover percentage of 50%. The erosion modelling assumed that the cover layer will be comprised of a rock armour (sandstone assumed) mixed with topsoil such that a 30% rock cover is produced once the surface is armoured under rain.

The success of the capping layer for the DREA in terms of erosional stability is dependent on:

- Type of rock;
- The mean size of the rock; and
- Physical and chemical properties of the fines.

The assumed cover layer for the DREA was modelled to include:

- Rock armour (sandstone has been assumed) that is:
    - Geochemically benign;
    - Fresh or slightly weathered;
    - Durable;
- Topsoil mixed to produce 30% rock cover once armoured; and
- Minimum vegetative cover of 50% establishment on the overall final landform.

The above properties to be confirmed prior to placement to ensure it meets the minimum requirements as well as availability for the cover layer. It is vital that vegetation is established rapidly following rehabilitation as the cover layer is prone to erosion.

The EA, DES (2021) **[2]** proposes 70% vegetation cover and achieving the 70 % vegetation cover, which is more than the modelled 50% vegetation cover will improve the overall erosional performance of the final landform.

8.3.4.3 Model Outcomes

Statistical results for the SIBERIA simulation conducted for the DREA capping layer model parameters applied to the 3D surface are provided in **TABLE 15**. For the purposes of this assessment, a gully is defined as an erosional feature with a depth greater than 0.3 m.

TABLE 15: MAXIMUM GULLY DEPTH, AVERAGE ANNUAL EROSION AND CUMULATIVE EROSION ON THE DREA BATTER SLOPES

Simulation Year	Maximum Gully Depth (m)	Average Erosion (t/ha/y)	Cumulative Erosion (mm)
50	-	4.9	16
100	0.3	4.0	30

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150	0.4	3.7	42
200	0.5	3.6	54
250	0.6	3.5	66
300	0.7	3.4	77

Erosion is predicted to be at a long-term average of 4.9 t/ha/y by Year 50, decreasing to 3.4 t/ha/y by Year 300. The rates are less than the target 5 t/ha/y (refer **SECTION 8.3.3**). The maximum predicted gully erosion of approximately 0.7 m is not likely to erode through the proposed cover layer thickness of 1.25 m and into the dry rejects.

Based on the landform evolution model outcomes, it was concluded that the proposed capping layer profile as described in **SECTION 8.3.4.1** is generally erosionally stable and will not result in erosion that would penetrate the cover layer and expose the underlying dry rejects within the modelled period of 300 years.

8.4 Potential Rehabilitation Constraints

8.4.1 Design Geometry

The final landform for the DREA influences both the predicted rate of erosion and erosional gully depth. Engineered structures have a set design life and by implication will eventually lose serviceability over time. As such, the hydrology of the landform will change and will therefore impact on the erosional stability.

The stormwater management system proposed for the rehabilitated landform is based on creating four drainage pathways for the final landform. The presence of these four drainage structures, and potential deterioration over time may impact on long term erosional stability, creating uncontrolled concentrated stormwater discharges. Potentially, review of the performance of the drainages to be completed during rehabilitation to ensure the performance is maintained. Where required, rock armouring of the drainage pathways to be completed to limit the deterioration during the lifetime of the structure. A more stable solution will be shotcretting the drainage pathways.

8.4.2 Availability of growth media

In many similar circumstances, suitable mine spoil would be available for reuse as growth media and would be applied on the exposed surface of the final landform. As an underground operation, Eagle Downs will not develop significant volumes of mine spoil and thus an alternate source of growth media will be required. It is anticipated that the local soils and sub-soils will be suitable for this task with expected volumes required in the order of 1.5M BCM allowing for the following minimum thicknesses:

- 0.5 Mm^3 (placed) for batter slopes (100 ha at 500 mm)
- 1.2 Mm^3 (loose) for Terrace slopes (100 ha at 1200 mm)

An assessment of soil nutrition would be required to understand the ability for the borrow material to support vegetation.

With limited information on available cover layer, Landloch (2023) **[20]** assumed and modelled the capping layer to consist of topsoil rock mix (30% rock cover) with parameters requiring confirmation provided in **SECTION 8.3.4.2**. Rock fill would be sourced from produce mine spoils and waste rock dumps and supplementary rock fill sourced from local site materials.

8.4.3 Plant available water

Perhaps the greatest constraint to achievement of the rehabilitation and final closure objectives is the provision of enough plant available water (PAW). Material borrowed locally and placed for reuse as growth media will still be a meta-soil with very little soil structure and with very poor moisture retaining capacity.

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8.5 Rehabilitation of Batter Slopes

As outlined in **SECTION 8.1**, batter slopes of the final DREA landform will be reprofiled to a minimum slope of 1V:9H and a maximum slope of 1V:8H. This relatively flat slope is a standard approach to rehabilitation of landforms of this nature.

A cover of 300 to 500mm of local borrow soil will be placed over the exposed batter slope. Trucks will tip material from the crest above and track-dozers will be used to spread the material to the required thickness. Further 300-500mm thick layers of borrow material will be placed and compacted to achieve the 1m thick capping layer. Following that, dozers will be used to install deep rip lines along contour to aid in moisture retention and seed establishment.

8.6 Establishment of Vegetation

Vegetation communities will be established on both the reprofiled batter slopes via the direct application of a suitable mix of tree and shrub species. Further advice will be required to confirm appropriate plant species for the DREA and the methods for planting and maintenance.

8.7 Progression to Execution Level Plan

To progress this Concept Closure Strategy to an execution level plan, additional assessments and refinements will have to be completed during the early operations phase. These assessments will be concerned with aspects such as the properties of the borrow soil and an understanding of the proposed vegetation.

Much of this work can be modelled, but in many regards, demonstration by field trial is the most conclusive approach.

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9 PROGRESSIVE REHABILITATION SCHEDULE

9.1 Final Landform Design

The final landform design for the DREA is shown in **DIAGRAM 9** and presented on DWG. No. 119224-02-000-006. The final landform design includes the disturbed area footprints for the DREA within the mine lease boundaries and final landform contours.

9.2 Rehabilitation Milestones

State of Queensland (2019) **[21]** requires the following:

1. For an area that has been mined on the tenure, the holder must finish progressive rehabilitation of the area within 1 year after finishing mining activity in that area; and
2. The holder must carry out and finish rehabilitation works to establish a landform –
    a. That is safe, stable and self sustaining; and
    b. With vegetation of a species and density of cover similar to surrounding undisturbed areas or the landform that existed before the mining activity.

In order to complete the rehabilitation of the available areas within 1 year after finishing mining activity in that area, per the requirements of State of Queensland (2019) **[21]**, rehabilitation milestones have been developed including identifying rehabilitation areas. In accordance to DES (2021) **[19]**, a rehabilitation area is defined in the EP Regulation as an area of land in the PMLU to which a rehabilitation milestone for the post-mining use relates. The objective of identifying rehabilitation areas is to facilitate the progressive rehabilitation of the site over the life of mine. The setting of milestones is to ensure areas area rehabilitated within the set milestone to meet the progressive rehabilitation requirements.

The DREA has an assigned post mining land use to be a native ecosystem. The DREA rehabilitation will return the available areas to native ecosystems as required.

The rehabilitation milestones criteria for all available areas is as below:

- All major earthworks completed;
- All rejects emplacement final landform completed to form minimum slopes of 1V:9H and maximum slopes of 1V:8H;
- Placement of capping layers;
- Seeding to achieve minimum 50% vegetation cover; and
- Application of fertilizer where required.

Identified Rehabilitation Milestones (RM) together with time available and expected rehabilitation completion time for the DREA is presented in **TABLE 16**. The milestones are to be used as a general guidance for completing the PRCP schedule.

TABLE 16: REHABILITATION MILESTONES FOR THE DREA

Rehabilitation Milestone	Area (ha)	Cumulative Rehabilitated Area (ha)	Time Available*	Rehabilitation Completion**	Reference Drawing Number
RM1	315.4	315.4	Year 5	Year 6	119224-02-100-001
RM2	95.7	411.1	Year 10	Year 11	119224-02-100-002
RM3	473.6	884.7	Year 15	Year 16	119224-02-100-003
RM4	609.6	1494.3	Year 20	Year 21	119224-02-100-004
RM5	829.8	2324.1	Year 30	Year 31	119224-02-100-005

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RM6	731.1	3055.2	Year 40	Year 41	119224-02-100-006
RM6	1030.2	4085.4	Year 50	Year 51	119224-02-100-007

* End of the year post commencement of rejects emplacement;

** Available plus 1 year in accordance to the requirements of EP Regulation.

9.3 Available Rehabilitation Areas

Construction of the DREA to achieve the available areas for the progressive rehabilitation of the structure shall be completed in accordance to Option 1 Staging Sequence for Stage 2: 5-20 Years and Stage 3: 20-50 Years as presented in ATCW (2023) **[22]**.

State of Queensland (2023) **[23]** defined stipulated land is available for rehabilitation if the land is not being mined, unless:

(a) The land is being used for operating infrastructure or machinery for mining, including, for example, a dam or water storage facility; or
(b) The land is identified in the proposed PRCP schedule or the application for an environmental authority for relevant activities to which the schedule relates as containing a probable or proved ore reserve that is to be mine withing 10 years after the land would otherwise have become available for rehabilitation; or
(c) The land is required for the mining of a probable or proved ore reserve mentioned in (b); or
(d) The land contains permanent infrastructure identified in the proposed PRCP schedule as remaining on land for a post-mining land use.

Sections of the DREA have been identified at different periods to be progressively becoming available for rehabilitation. Available rehabilitation areas are shaded and presented in **DIAGRAM 16**.

DIAGRAM 16: AVAILABLE REHABILITATION AREAS

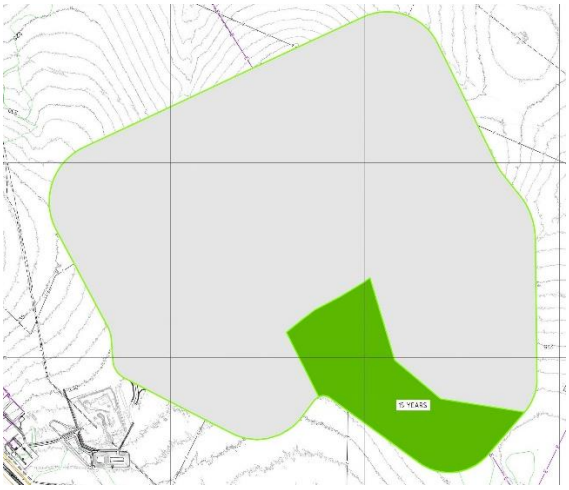


Available Area – End of Year 5

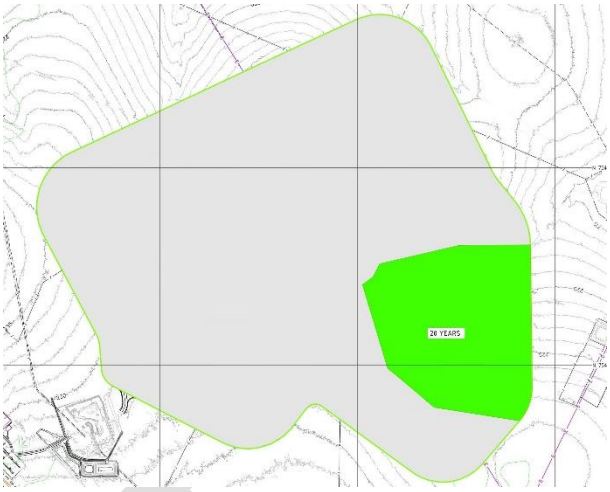
Available Area – End of Year 10

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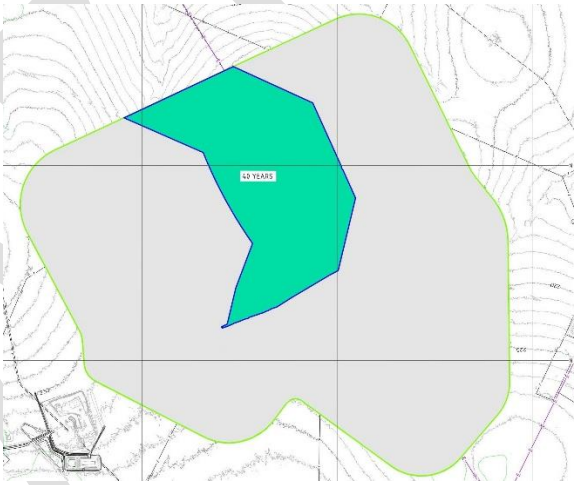
Available Area – End of Year 15



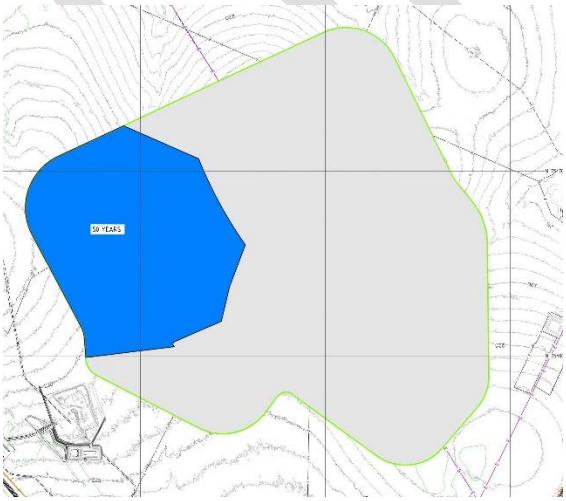
Available Area – End of Year 20



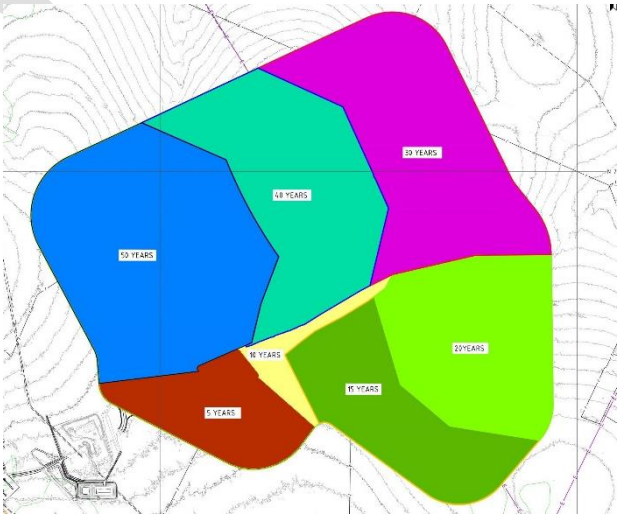
Available Area – End of Year 30



Available Area – End of Year 40



Available Area – End of Year 50



Total Completed Rehabilitated DREA

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10 INSTRUMENTATION AND MONITORING

An Operations Management Plan, ATCW (2020) **[5]** has been prepared for the DREA and includes instructions and forms to cover all necessary monitoring, inspection and surveillance activities. These activities will be compiled into a Trigger Action and Response Plan (TARP) for the DREA during construction and operation and be updated upon completion of the rehabilitation of the facility.

The monitoring requirements for the DREA during operation and upon completion of rehabilitation are presented in **SECTIONS 10.1** to **10.4**.

The current OMP, ATCW (2020) **[5]** to be updated to include the final landform design instrumentation and monitoring requirements.

10.1 Movement Monitoring

Movement monitoring (both vertical and horizontal) of the DREA outer slopes and lifts is recommended as part of the monitoring during the construction and operation of the DREA and upon completion of rehabilitation. Survey monuments destroyed during the rehabilitation of the DREA to be reinstated upon completion of the rehabilitation. In order to monitor surface displacements, mass concrete survey monuments as well as monitoring prisms mounted on poles will be installed at nominated locations of the DREA as required.

10.2 Temperature Monitoring

With the potential for spontaneous combustion, temperature monitoring in the DREA is to be undertaken by EDCM as part of the monitoring. Temperature probes will be installed in the DREA to monitor the temperature of the DREA in order to monitor and predict the potential for spontaneous combustion and associated risks mitigation measures taken in accordance to the prepared TARP.

10.3 Pore Pressure Monitoring

Low or negligible pore pressures are expected to be present in the DREA as it is constructed and to be operated as a dry rejects storage facility. However, with the reliance of the design for low moisture content of the rejects, pore pressure monitoring is required as part of the operation of the DREA, including the monitoring of the pore pressures in the foundation.

Instrumentation required for monitoring of pore pressures will be installed as part of the construction of the DREA including:

- Standpipe Piezometers (groundwater monitoring bores); and
- Vibrating Wire Piezometers (VWP) associated with Cabling and Data Acquisition Systems.

Monitoring of the foundation pore pressures; the groundwater level and the water quality will be carried out by EDCM on regular basis as part of the DREA operation. The information will be made available to use as input into updating the modelling assumptions made during the DREA design and preparation of the TARP for the DREA.

VWPs to be installed with adequate cabling to ensure the extension of the data loggers as the DREA development progresses and upon rehabilitation of the DREA.

10.3.1 Groundwater Monitoring Bores

All piezometers to be installed as part of future geotechnical investigation outside the DREA must be maintained to serve as monitoring bores for the operation of the DREA. Any existing or future monitoring bores located in the DREA will be decommissioned during the construction of the DREA. Where applicable, Standpipes Piezometers to be extended above the DREA landform to allow access for monitoring of the Standpipe Piezometers.

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10.3.2 Vibrating Wire Piezometers

As part of the construction works, VWPs will be installed to monitor foundation sub-surface pore pressures and DREA pore pressures (within the first 10 m of the placed rejects). It is recommended that heavy duty VWPs complete with heavy duty cables be installed in boreholes in the DREA and adjacent foundations. Cables from the VWPs will be connected to data loggers or extended to readout stations to facilitate data collection from the VWPs. VWP cables must be sufficient to extend to the final landform design surface upon completion of rehabilitation.

10.4 Soil Moisture Monitoring

In conjunction with VWPs, soil moisture probes would be installed to monitor moisture conditions within the rejects as the landform is constructed and upon completion of rehabilitation as the moisture content to the rejects is critical to the design, operation and closure of the DREA.

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11 CONCLUSION - PROGRESSIVE REHABILATION AND CLOSURE PLAN ASPECTS

11.1 Summary of Potential Risks

The following are considered potential risks to the DREA staging and final landform related to the release:

- Batter failure, with gross exposure of dry rejects;
- Subsidence causing deformation of the DREA and exposure of rejects;
- Drainage from DREA surfaces (due to leachate accumulation within the DREA) and
- Infiltration through the DREA foundation, as recharge to groundwater.

Other potential risks include:

- Lack of topsoil/ capping material for rehabilitation;
- Failure to achieve minimum strength parameters for DREA development per the EA due to changes in coarse and fine rejects split;
- Presence of localized slow strength foundation soils within the DREA footprint;
- Inundation of completed sections of the DREA causing saturation of the rejects with the potential to compromise stability and leachate generation; and
- Failure to establish minimum required vegetation to address erosional stability requirements.

Design of the DREA considered the above potential risks and completed designs to mitigate the risks to the DREA. Construction and operation must be to specification and per the operational management plan for the structure.

11.2 Overall Landform Development and Rehabilitation Approach

DREA to be completed in stages with the deposition approach provided in **SECTION 7.1** to be replicated for the ongoing development of other remaining stages of the DREA. During the development of the DREA, the batter slopes are at a minimum of 1V:5H, with 26 m wide benches and maximum bench height of 10 m except for the first 10 m of the DREA development which has varying batter slopes.

Once completed areas become available and further development of the DREA will not interfere with the nominated location, progressive rehabilitation of the DREA to commence by reprofiling of the DREA to a minimum slope of 1V:9H per the design slopes, placement of cover layer and establishing of vegetation as required. Completing the reprofiling and capping and revegetation is to provide a final landform that is geotechnical and erosional stable.

11.3 Development/Rehabilitation Milestones

The following are considered the required development/ rehabilitation milestones:

11.3.1 Project approval

This is considered the first milestone for the development/rehabilitation of the DREA. This is considered to have been partly achieved as the size, function, goals and quality of the DREA construction and costing has been estimated.

Ongoing assessment and approval by the Environmental Authority remains a major part of the project approval for the life of mine.

11.3.2 Requirements review

Review of the design, construction and operational methodologies of the DREA to be completed as the construction of Stage 1: 0 – 5 Years is progressed and rehabilitation of available areas is commenced. Outcomes of the reviews to be included in future developments to optimize the progression of the DREA development and rehabilitation. The review to include the review of the in

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situ materials that will serve as the basal liner to the DREA and availability of capping material to meet the erosional stability and closure plan requirements.

11.3.3 Design approval

Progressing the final landform design will be dependent on the approval of the design by EDCM and further by the Environmental Authority in accordance to the regulatory and legislative requirements.

11.3.4 Project execution

This will be achieved at the start of the actual construction of the DREA.

11.3.5 Project phase milestone

The project phase milestones to be developed at the start of the project execution milestone. These are specific solutions to indicate the marked milestones. Some project phase milestones may include:

- Survey of DREA stage location;
- Topsoil stripping;
- Basal liner;
- Reprofiling of batters; and
- Others.

11.3.6 Rehabilitation Milestones

Rehabilitation areas have been identified and rehabilitation milestones set to complete the rehabilitation of the available areas to meet the regulatory requirements. The rehabilitation milestones have been provided as a general guidance. The timing of the milestones must be considered to ensure the rehabilitation of the available areas is satisfactorily and effectively completed to meet the PMLU within the acceptable timeframe. Seeding will require completion in wetter months of the year to maximise the effective establishment of the vegetation cover. It is anticipated that seasonal and extreme events may hinder the completion of the milestones per the assigned timeframes.

11.3.7 Project handover

This marks the practical completion and handover following the overall achievement of all key project milestones. This milestone is achieved following extensive inspection, testing and handover sessions where all stakeholders agree that the work has been completed to schedule and includes final "as constructed" survey and reporting.

11.4 PRCP Schedule Conditions

Two deemed conditions are included in all PRCP schedules in accordance to the EP Act, State of Queensland (2003) [**23**]. In accordance to DES (2021) **[19]**, the first condition is that when carrying out a relevant activity under PRCP schedule, the holder must comply with a requirement stated in the EA relevant to carrying out the activity, which is DES (2021) **[2]** for the DREA. It further stated that the second condition is 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.

In accordance to DES (2021) **[19]**, the development and implementation of the PRCP schedule is an essential element of a PRC plan. The administering authority approves PRCP schedule and applicants are required to comply with the conditions and milestones of the schedule. The PRCP schedule must include:

- Either PMLU or NUMA for all land within the relevant resource tenures, including undisturbed land;
- Identification of when land becomes available for rehabilitation or improvement;
- Rehabilitation or management milestones to achieve PMLU or NUMA outcomes;
- Milestone criteria that demonstrate when each milestone has been completed;

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- Completion dates for each milestone to be achieved; and
- Any conditions considered desirable.

PRCP schedule has not been completed as part of this final landform design, however, the PRCP schedule is recommended to be completed as part of the site specific PRCP.

The first step of the development of the PRCP schedule is the completion of the final site design, which has been completed in this final landform design of the DREA, with the rehabilitation to be replicated across other disturbed areas of the site requiring rehabilitation. This final landform design forms part of the PRCP schedule to be completed.

The design provides the maximum disturbance footprint for the DREA. The purpose of the final landform design of the DREA is to provide what the DREA will look like post surrender per the PRCP.

The steps in developing PRCP Schedule are:

- Step 1: Final site design;
- Step 2: Divide PMLU/NUMA into rehabilitation areas/ improvement areas;
- Step 3: Determine when land becomes available;
- Step 4: Develop relevant milestones;
- Step 5: Develop site-specific milestone criteria;
- Step 6: Propose when the first milestone must commence; and
- Step 7: Propose timing for when each milestone will be completed.

The final landform is completed as part of Step 1 in the development of the PRCP Schedule.

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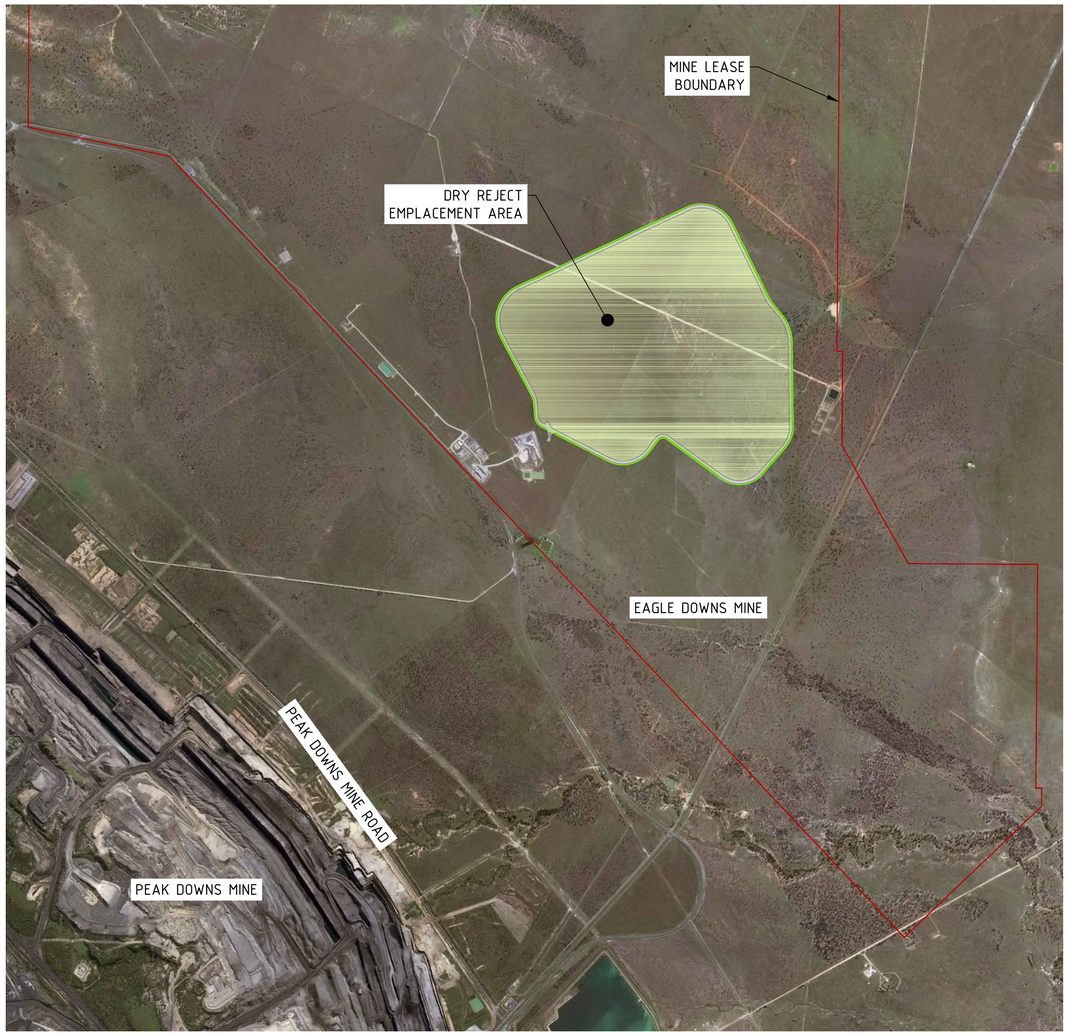
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DRAWINGS

EAGLE DOWNS COAL MANAGEMENT (EDCM) PROJECT - DREA FINAL LANDFORM DESIGN



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DRAWING LIST

DWG NO.	DRAWING TITLE	REVISION
119224-02-000-001	SITE LOCALITY AND DRAWING LIST	A
119224-02-000-002	EXISTING SITE CONDITIONS PLAN	A
119224-02-000-003	STAGED DEVELOPMENT PLAN - 0 - 5 YEARS	A
119224-02-000-004	STAGED DEVELOPMENT PLAN - 5 - 20 YEARS	A
119224-02-000-005	STAGED DEVELOPMENT PLAN - 20 - 50 YEARS	A
119224-02-000-006	FINAL LANDFORM DESIGN - 0 - 50 YEARS	A
119224-02-000-007	SETOUT PLAN	A
119224-02-000-008	FINAL LANDFORM SECTION - 0 - 5 YEARS	A
119224-02-000-009	FINAL LANDFORM SECTION - 5 - 20 YEARS	A
119224-02-000-010	FINAL LANDFORM SECTION - 20 - 50 YEARS	A
119224-02-000-011	FINAL LANDFORM LONG SECTIONS CH01 - STORMWATER	A
119224-02-000-012	FINAL LANDFORM LONG SECTIONS CH02 - STORMWATER	A
119224-02-000-013	FINAL LANDFORM LONG SECTIONS CH03 - STORMWATER	A
119224-02-000-014	FINAL LANDFORM LONG SECTIONS CH04 - STORMWATER	A
119224-02-000-015	FINAL LANDFORM LONG SECTIONS - PERIMETER ROAD	A
119224-02-000-016	FINAL LANDFORM LONG SECTIONS - PERIMETER ROAD	A
119224-02-000-017	FINAL LANDFORM LONG SECTIONS - PERIMETER ROAD	A
119224-02-000-018	FINAL LANDFORM LONG SECTIONS - PERIMETER ROAD	A
119224-02-000-019	FINAL LANDFORM LONG SECTIONS - PERIMETER ROAD	A
119224-02-000-020	FINAL LANDFORM LONG SECTIONS - PERIMETER ROAD	A

ISSUED FOR REPORTING
NOT FOR CONSTRUCTION

REV	DESCRIPTION	BY	DRG CHK	ENG CHK	DATE	APPROVED
A	ISSUED FOR REPORTING	CW	HA	HA	18/01/23	AW

DRAWING REFERENCES | DRAWING REVISIONS

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SOUTH32 Eagle Downs Coal

CONSULTANT JOB NO 119224-02

PRELIMINARY

DRAWN	CW	04/01/23
CHECKED	HA	09/01/23
DESIGNED	BH	02/01/23
LEAD ENG	HA	09/01/23
APPROVED	AW	18/01/23

SCALE N/A OR AS SHOWN
DO NOT SCALE A1

PROJECT EAGLE DOWNS COAL PROJECT - DREA FINAL LANDFORM DESIGN
TITLE DREA FINAL LANDFORM DESIGN
SITE LOCALITY AND DRAWING LIST

DRAWING NO 119224-02-000-001 | SHEET No. 1 OF 20 | REVISION A

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CHECKED	HA	09/01/23
DESIGNED	BH	02/01/23
LEAD ENG	HA	09/01/23
APPROVED	AW	18/01/23

SCALE 1:10,000 OR AS SHOWN
DO NOT SCALE A1

PROJECT
EAGLE DOWNS COAL PROJECT - DREA FINAL LANDFORM DESIGN

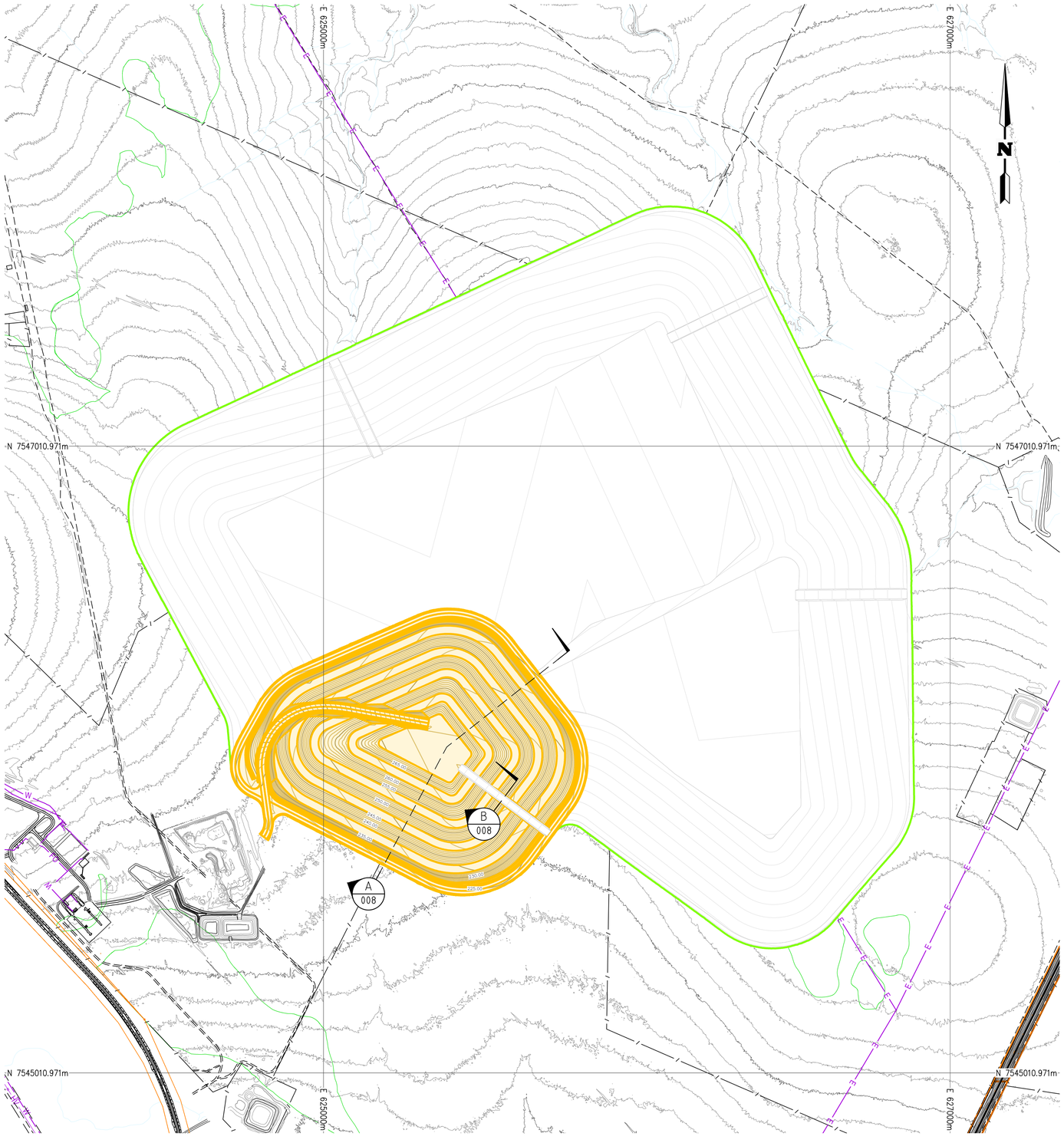
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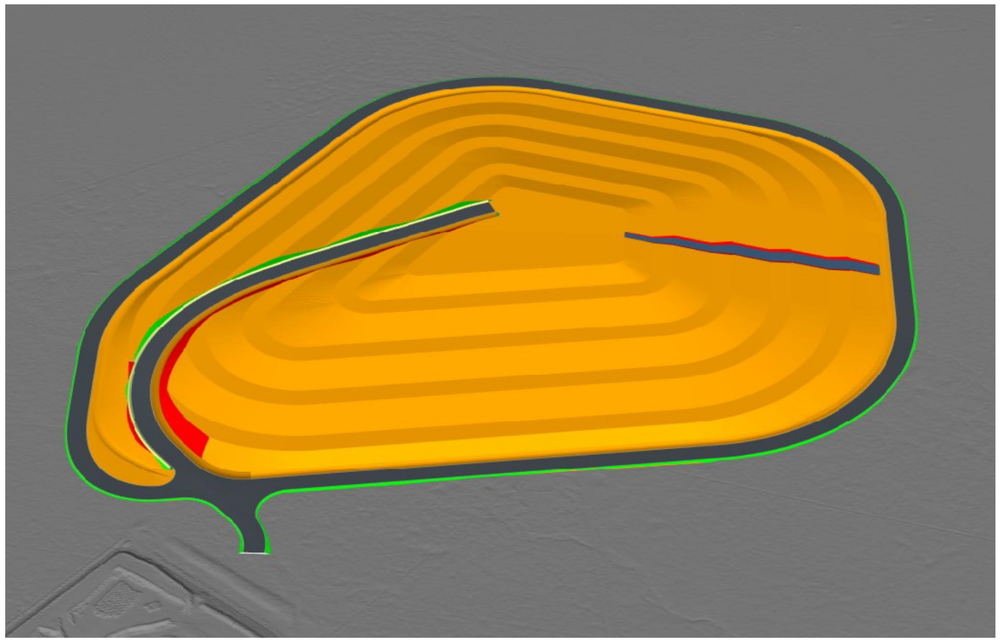
DRAWING NO 119224-02-000-002
SHEET No. 2 OF 20
REVISION A

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Plot Date: 18 January 2023 - 2:56 PM Plotted by: Claire Wilson

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3D STAGED DEVELOPMENT
0 - 5 YEARS

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		A	ISSUED FOR REPORTING	CW	HA	HA	18/01/23	AW

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SOUTH32 Eagle Downs Coal

CONSULTANT JOB NO 119224-02

PRELIMINARY

DRAWN	CW	04/01/23
CHECKED	HA	09/01/23
DESIGNED	BH	02/01/23
LEAD ENG	HA	09/01/23
APPROVED	AW	18/01/23

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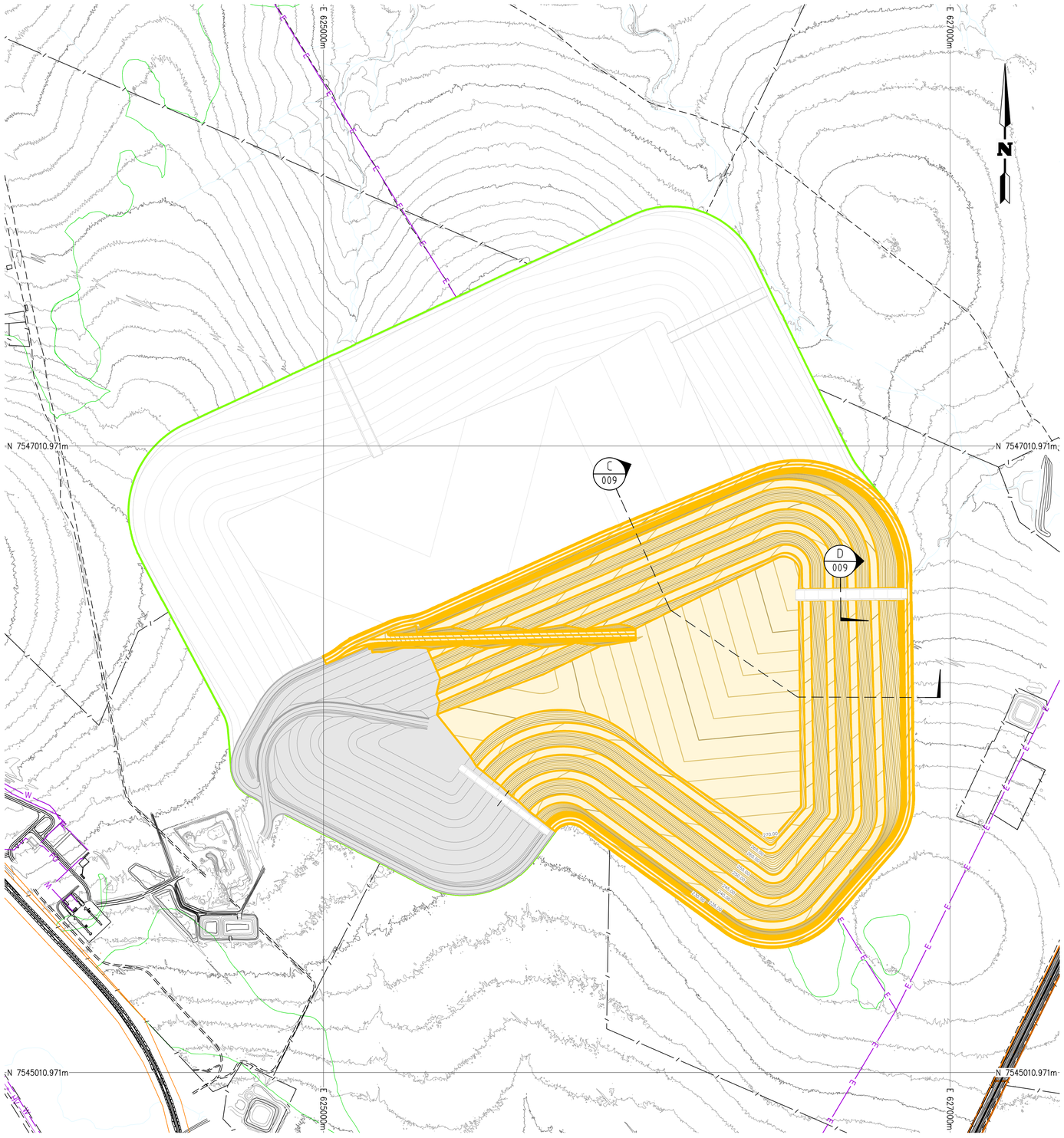
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EAGLE DOWNS COAL PROJECT - DREA FINAL LANDFORM DESIGN

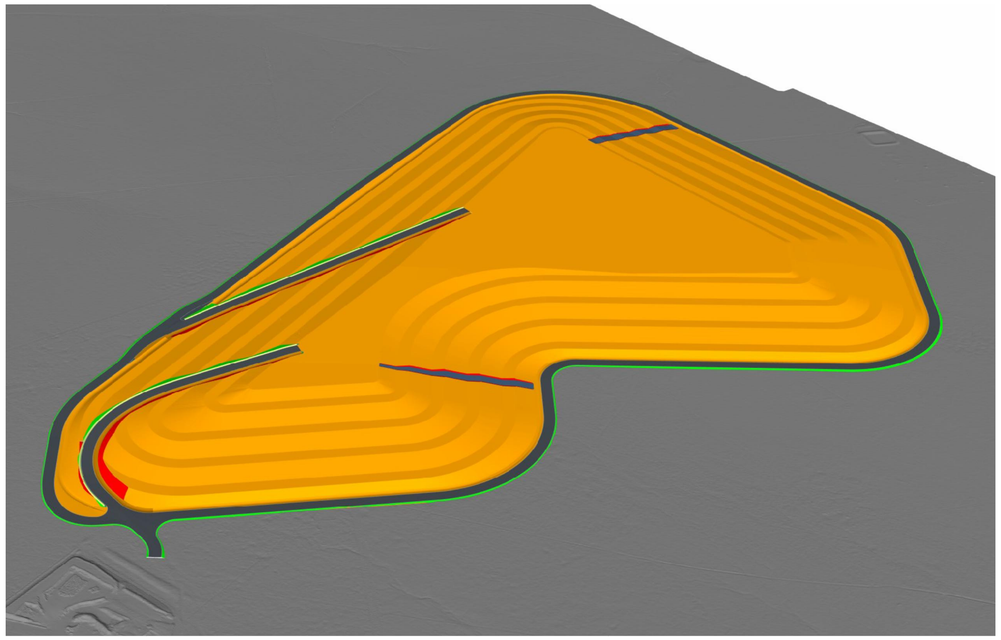
TITLE
DREA FINAL LANDFORM DESIGN
STAGED DEVELOPMENT PLAN
0 - 5 YEARS

DRAWING NO 119224-02-000-003
SHEET No. 3 OF 20
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3D STAGED DEVELOPMENT
0 - 20 YEARS

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WORK IN PROGRESS

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CONSULTANT JOB NO
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SOUTH32 Eagle Downs Coal

PRELIMINARY

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LEAD ENG	HA	09/01/23
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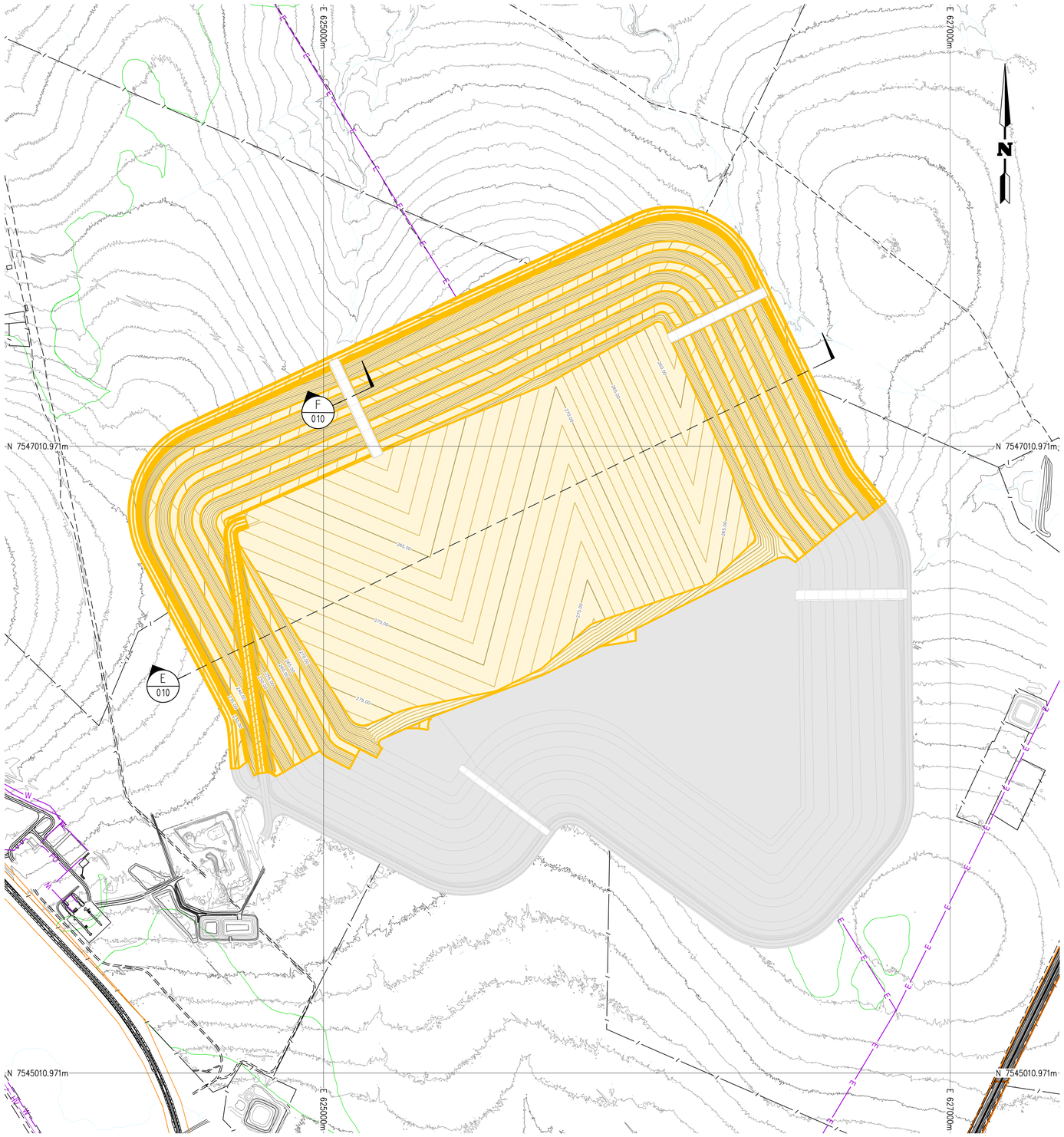
PROJECT
EAGLE DOWNS COAL PROJECT - DREA FINAL LANDFORM DESIGN
TITLE
DREA FINAL LANDFORM DESIGN
STAGED DEVELOPMENT PLAN
5 - 20 YEARS

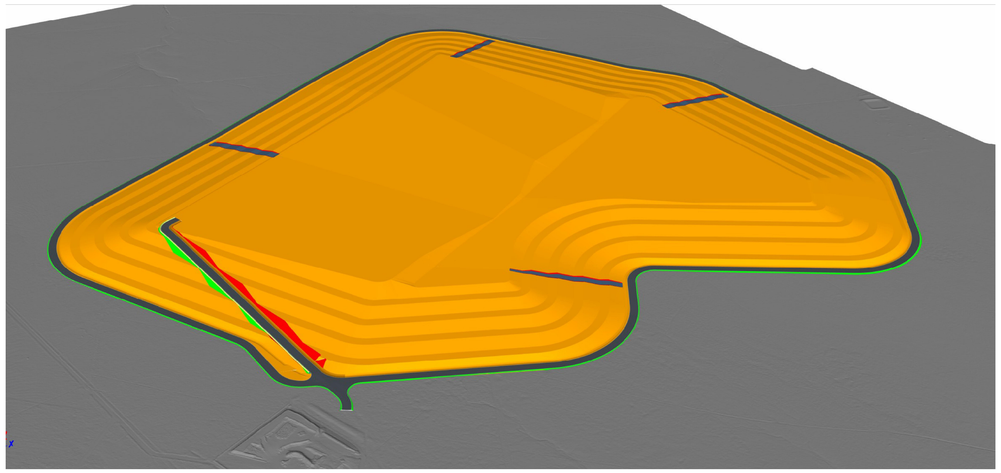
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3D STAGED DEVELOPMENT
0 - 50 YEARS

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SOUTH32 Eagle Downs Coal

CONSULTANT JOB NO 119224-02

PRELIMINARY

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PROJECT
EAGLE DOWNS COAL PROJECT - DREA FINAL LANDFORM DESIGN

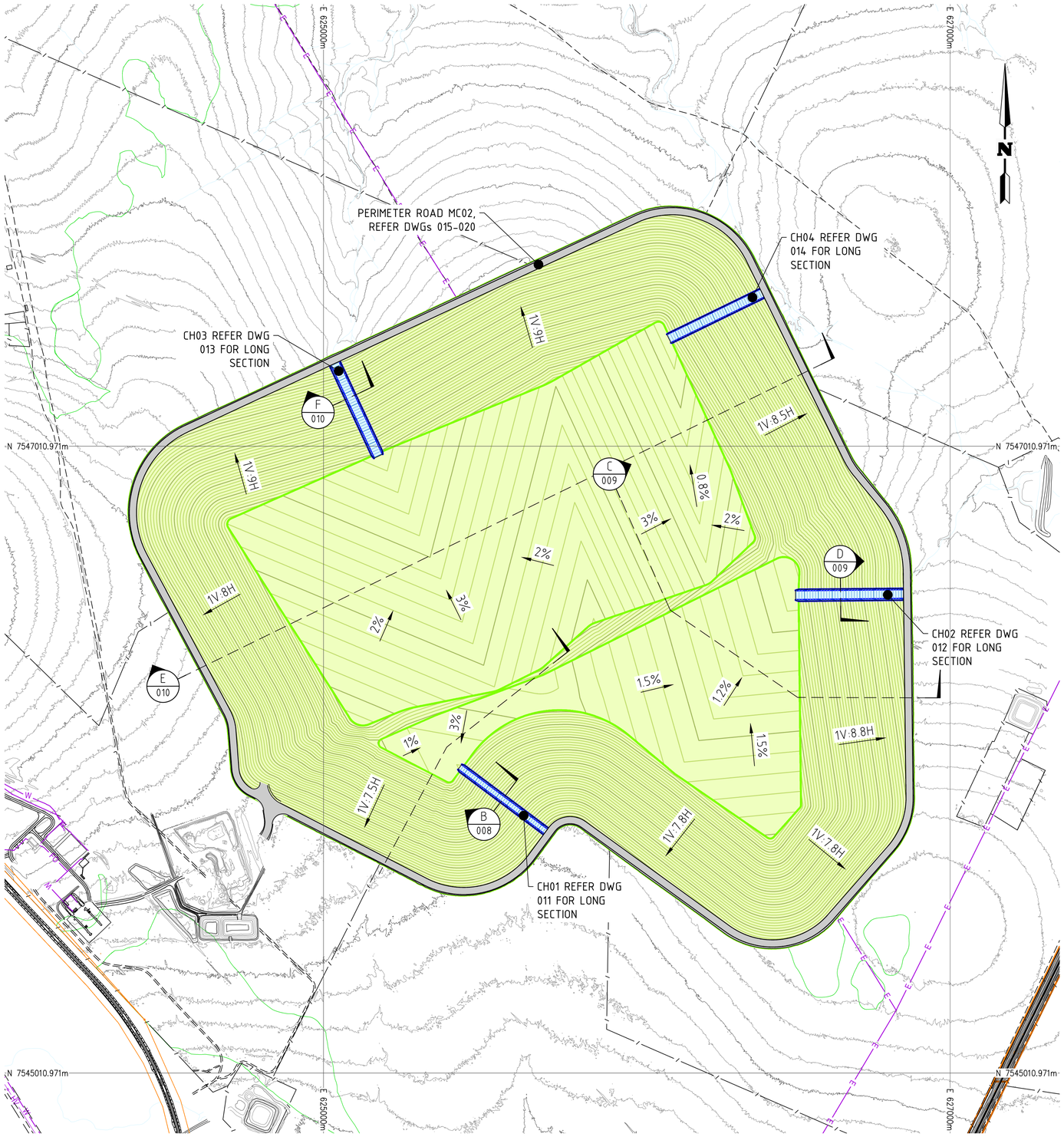
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DREA FINAL LANDFORM DESIGN
STAGED DEVELOPMENT PLAN
20 - 50 YEARS

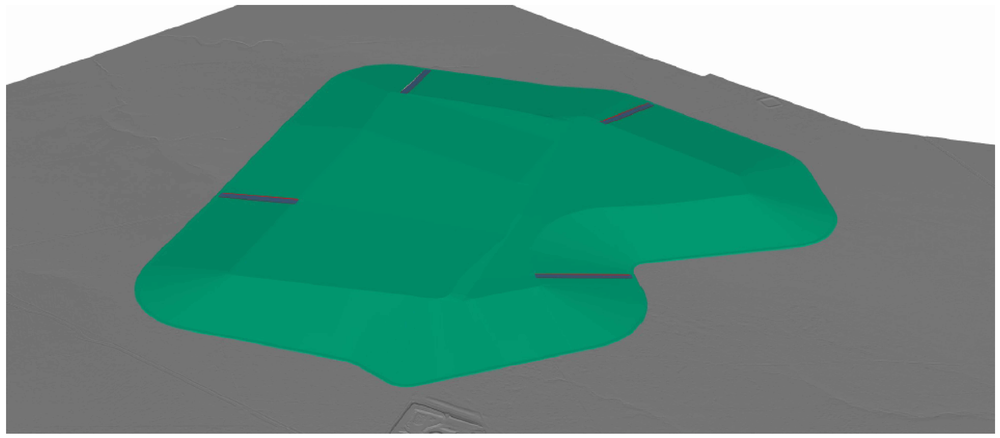
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3D FINAL LANDFORM

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SOUTH32 Eagle Downs Coal

CONSULTANT JOB NO 119224-02

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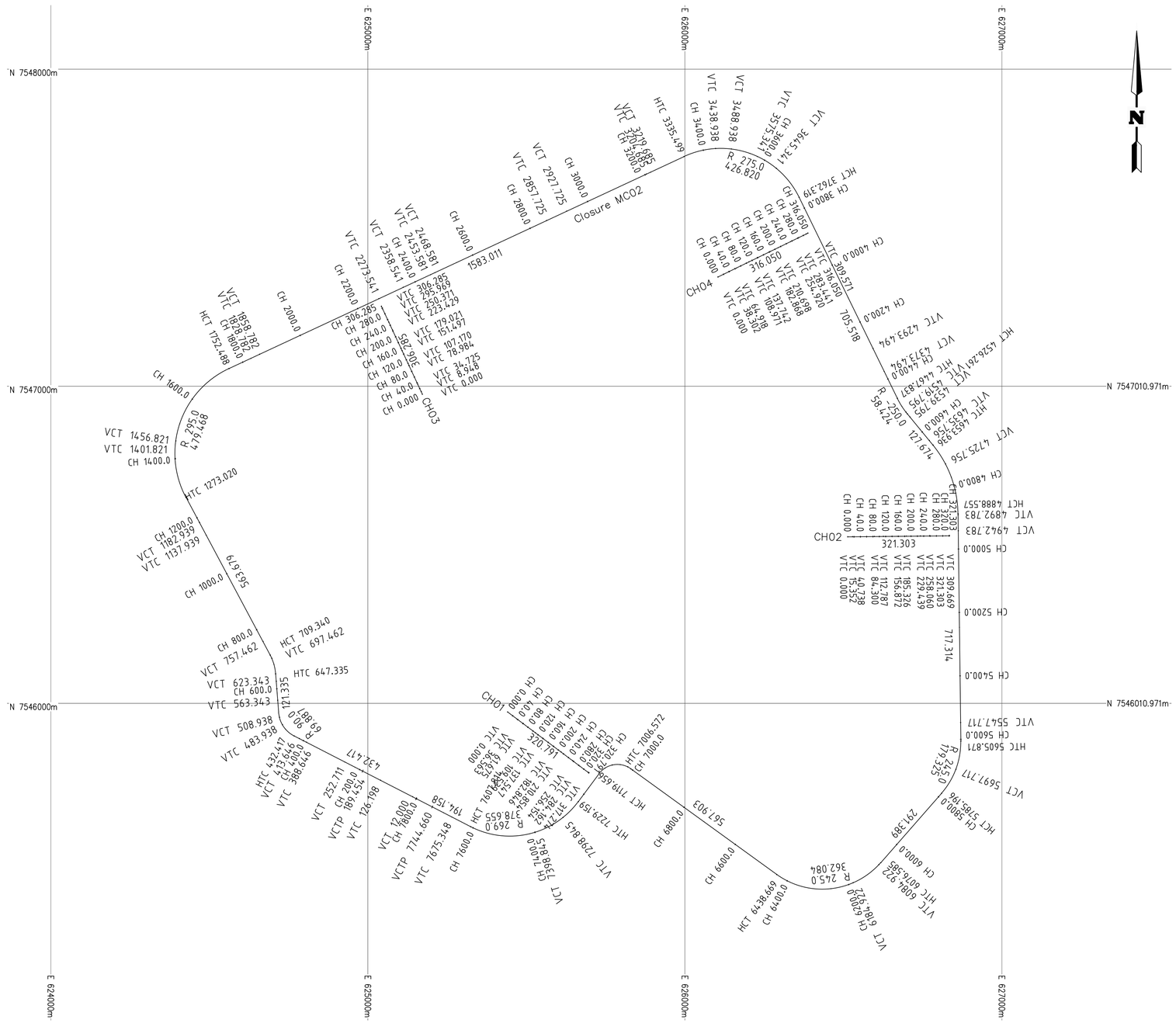
PROJECT EAGLE DOWNS COAL PROJECT - DREA FINAL LANDFORM DESIGN
TITLE DREA FINAL LANDFORM DESIGN
FINAL LANDFORM DESIGN
0 - 50 YEARS

DRAWING NO 119224-02-000-006
SHEET No. 6 OF 20
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Closure MC02 Align->Closure MC02 HORIZONTAL SEGMENTS (CLOSED)								
PT	CHAINAGE	EASTING	NORTHING	HEIGHT	BEARING	DEP.SEG	DEP.RAD	DEP.LEN
S	0.000	625152.032	7545710.391	227.803	297°11'45.18"	HTP		432.417
DIS	297°11'45.18"	LINE		432.417				
TC	432.417	624767.420	7545908.020	230.078	297°11'45.18"	ARC	90.000	69.887
CS	502.304	624723.111	7545959.792	230.613	341°41'14.02"	TRANSITION		23.696
ST	526.000	624718.533	7545982.983	230.738	355°34'52.46"	LINE		121.335
TC	647.335	624709.184	7546103.957	231.635	355°34'52.46"	ARC	-150.000	62.005
CT	709.340	624691.946	7546163.059	232.261	331°53'49.34"	LINE		563.679
TC	1273.020	624426.420	7546660.282	236.079	331°53'49.34"	ARC	295.000	479.468
CT	1752.488	624562.065	7547066.650	232.908	65°01'15.00"	LINE		1583.011
TC	3335.499	625997.004	7547735.138	220.377	65°01'15.00"	ARC	275.000	426.820
CT	3762.319	626360.192	7547606.637	218.231	153°56'53.20"	LINE		705.518
TC	4467.837	626670.045	7546972.802	223.272	153°56'53.20"	ARC	-250.000	58.424
CT	4526.261	626701.576	7546923.775	223.122	140°33'29.90"	LINE		127.674
TC	4653.936	626782.687	7546825.176	220.297	140°33'29.90"	ARC	347.000	234.622
CT	4888.557	626861.683	7546608.978	218.607	179°17'54.48"	LINE		717.314
TC	5605.871	626870.465	7545891.718	228.653	179°17'54.48"	ARC	245.000	179.325
CT	5785.196	626809.726	7545727.226	229.602	221°14'07.56"	LINE		291.389
TC	6076.585	626617.655	7545508.099	230.616	221°14'07.56"	ARC	245.000	362.084
CT	6438.669	626289.709	7545471.163	229.603	305°54'45.20"	LINE		567.903
TC	7006.572	625829.756	7545804.267	227.329	305°54'45.20"	ARC	-72.500	113.084
CT	7119.656	625728.985	7545788.718	226.980	216°32'38.59"	LINE		109.503
TC	7229.159	625663.782	7545700.743	226.217	216°32'38.59"	ARC	269.000	378.655
CT	7607.814	625324.726	7545621.654	226.675	297°11'45.18"	LINE		194.158
E	7801.972	625152.032	7545710.391	227.803	297°11'45.18"			

Closure CH00 Align->Closure SP01 HORIZONTAL SEGMENTS						
PT	CHAINAGE	EASTING	NORTHING	HEIGHT	BEARING	DEP.SEG	DEP.LEN
S	0.000	625435.096	7545987.608	267.902	126°48'46.99"	LINE	7.000
TT	7.000	625440.700	7545983.413	267.072	126°48'46.99"	LINE	347.542
E	354.542	625718.940	7545775.164	226.864	126°48'46.99"		

Closure CH00 Align->Closure SP02 HORIZONTAL SEGMENTS							
PT	CHAINAGE	EASTING	NORTHING	HEIGHT	BEARING	DEP.SEG	DEP.LEN
S	0.000	626506.406	7546535.800	258.254	89°23'52.45"	LINE	7.000
TT	7.000	626513.406	7546535.874	257.462	89°23'52.45"	LINE	349.146
E	356.146	626862.533	7546539.543	219.065	89°23'52.45"		

Closure CH00 Align->Closure SP03 HORIZONTAL SEGMENTS							
PT	CHAINAGE	EASTING	NORTHING	HEIGHT	BEARING	DEP.SEG	DEP.LEN
S	0.000	625175.004	7546979.135	260.231	334°59'39.42"	LINE	7.000
TT	7.000	625172.045	7546985.478	259.449	334°59'39.42"	LINE	331.167
E	338.167	625032.058	7547285.604	223.468	334°59'39.42"		

Closure CH00 Align->Closure SP04 HORIZONTAL SEGMENTS							
PT	CHAINAGE	EASTING	NORTHING	HEIGHT	BEARING	DEP.SEG	DEP.LEN
S	0.000	626102.284	7547354.314	258.250	64°01'18.14"	LINE	2.000
TT	2.000	626104.082	7547355.190	258.020	64°01'18.14"	LINE	340.521
E	342.521	626410.197	7547504.349	219.295	64°01'18.14"		

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DRAWING NO	TITLE
DRAWING REFERENCES	

REV	DESCRIPTION	BY	DRG CHK	ENG CHK	DATE	APPROVED
A	ISSUED FOR REPORTING	CW	HA	HA	18/01/23	AW
DRAWING REVISIONS						

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CONSULTANT JOB NO
119224-02

SOUTH32 Eagle Downs Coal

PRELIMINARY

DRAWN	CW	04/01/23
CHECKED	HA	09/01/23
DESIGNED	BH	02/01/23
LEAD ENG	HA	09/01/23
APPROVED	AW	18/01/23

SCALE 1:7,500 OR AS SHOWN
DO NOT SCALE A1

PROJECT
EAGLE DOWNS COAL PROJECT - DREA FINAL LANDFORM DESIGN

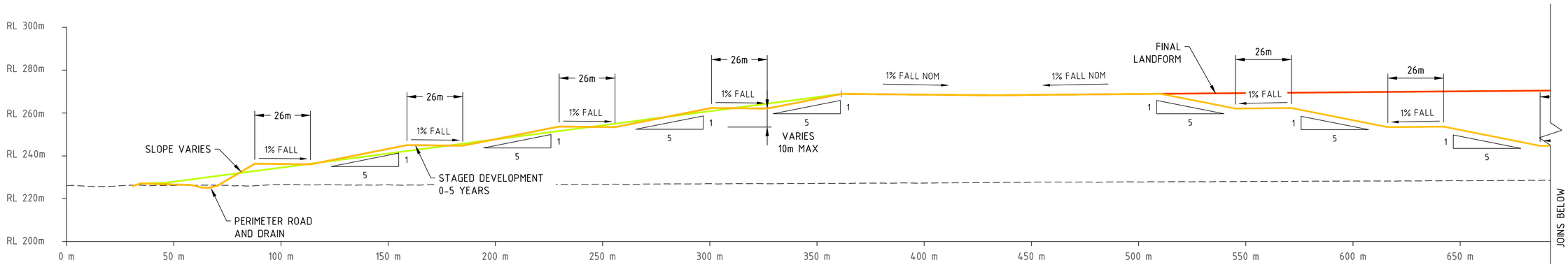
TITLE
DREA FINAL LANDFORM DESIGN
SETOUT PLAN
PERIMETER ROAD AND STORMWATER

DRAWING NO 119224-02-000-007
SHEET No. 7 OF 20
REVISION A

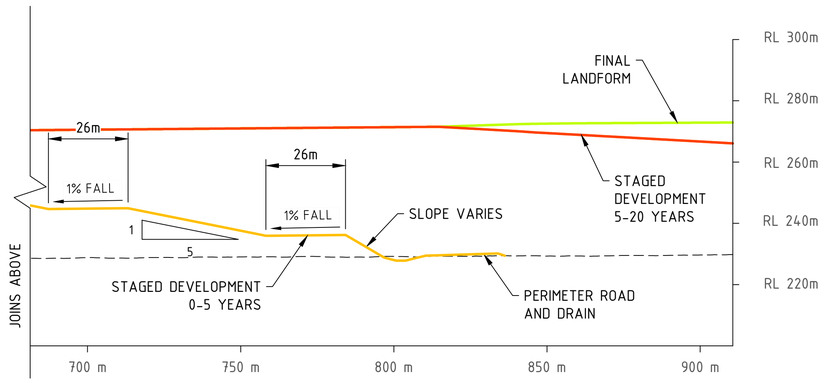
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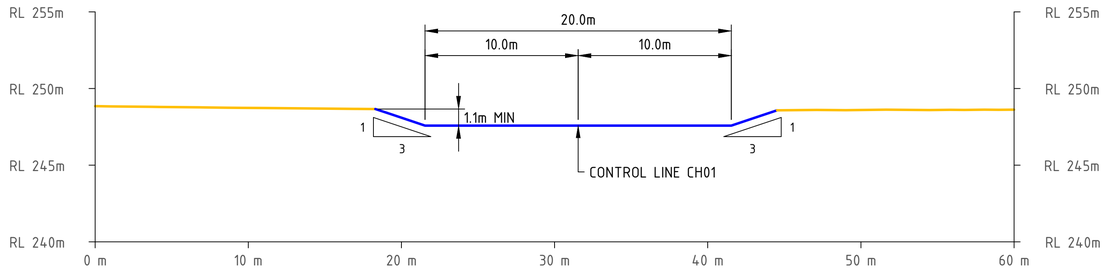
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SECTION A FINAL LANDFORM
SCALE: HORIZ 1:1000 003 0 - 5 YEARS
VERT 1:1000



SECTION A FINAL LANDFORM
SCALE: HORIZ 1:1000 003 0 - 5 YEARS
VERT 1:1000



SECTION B BATTER CHUTE
SCALE: HORIZ 1:200 003 CH01
VERT 1:200

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REV	DESCRIPTION	BY	DRG CHK	ENG CHK	DATE	APPROVED
A	ISSUED FOR REPORTING	CW	HA	HA	18/01/23	AW

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CONSULTANT JOB NO 119224-02

SOUTH32 Eagle Downs Coal

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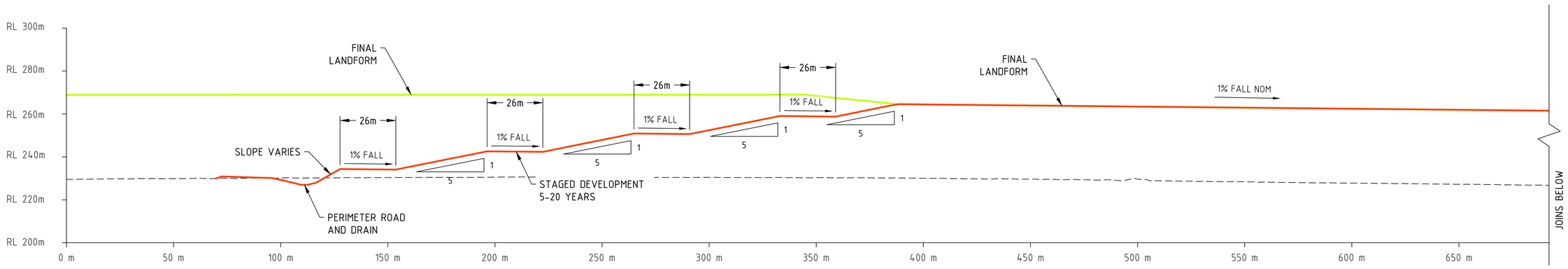
PROJECT EAGLE DOWNS COAL PROJECT - DREA FINAL LANDFORM DESIGN
TITLE DREA FINAL LANDFORM DESIGN
FINAL LANDFORM SECTION
0 - 5 YEARS

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SHEET No. 8 OF 20
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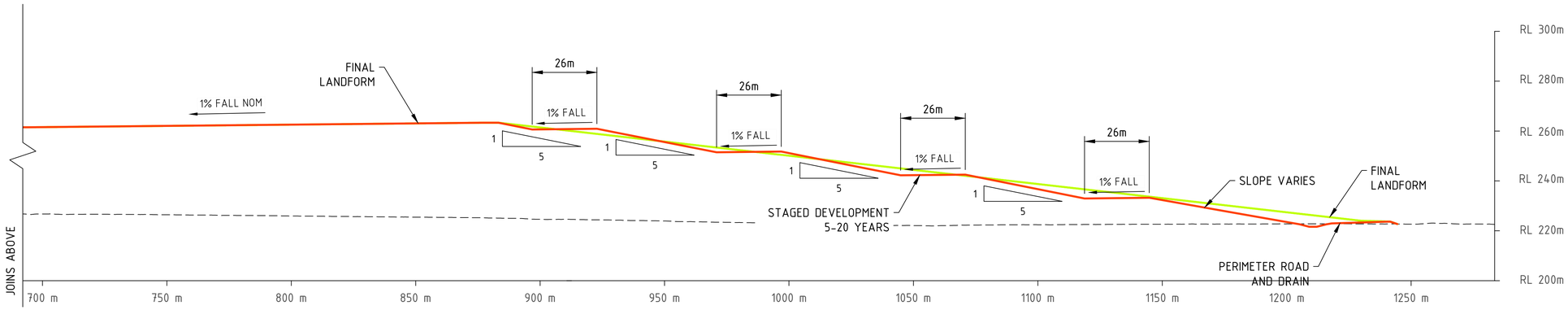
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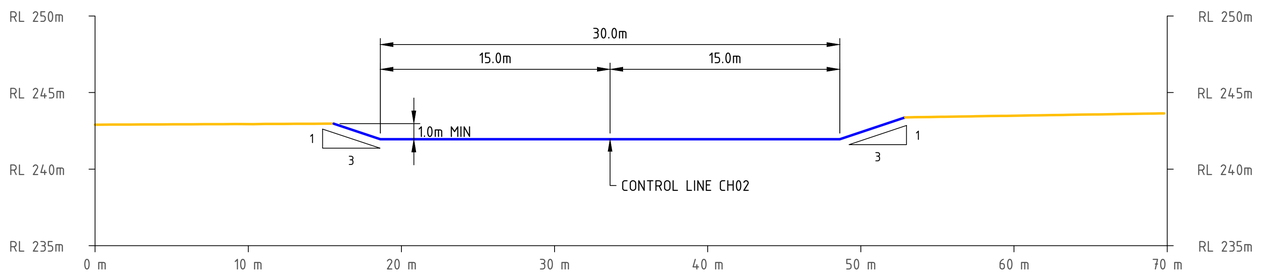
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SECTION C 004 FINAL LANDFORM 5 - 20 YEARS
SCALE: HORIZ 1:1000
VERT 1:1000



SECTION C 004 FINAL LANDFORM 5 - 20 YEARS
SCALE: HORIZ 1:1000
VERT 1:1000



SECTION D 004 BATTER CHUTE CH02
SCALE: HORIZ 1:200
VERT 1:200

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SOUTH32 Eagle Downs Coal

CONSULTANT JOB NO 119224-02

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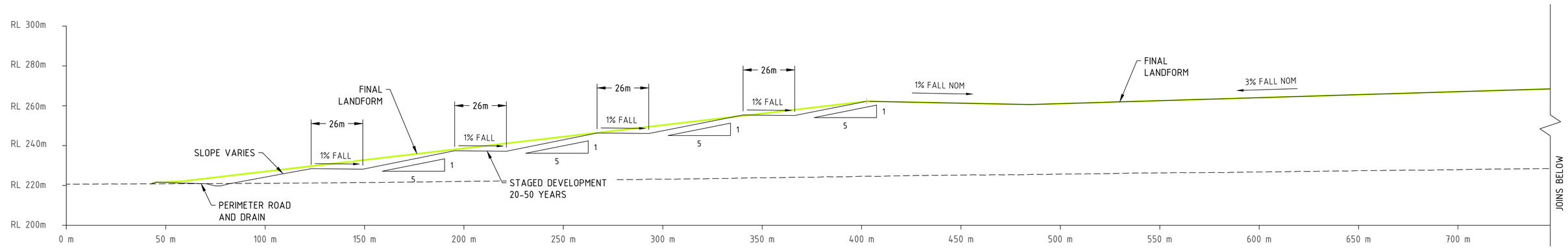
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PROJECT EAGLE DOWNS COAL PROJECT - DREA FINAL LANDFORM DESIGN
TITLE DREA FINAL LANDFORM DESIGN
FINAL LANDFORM SECTION
5 - 20 YEARS

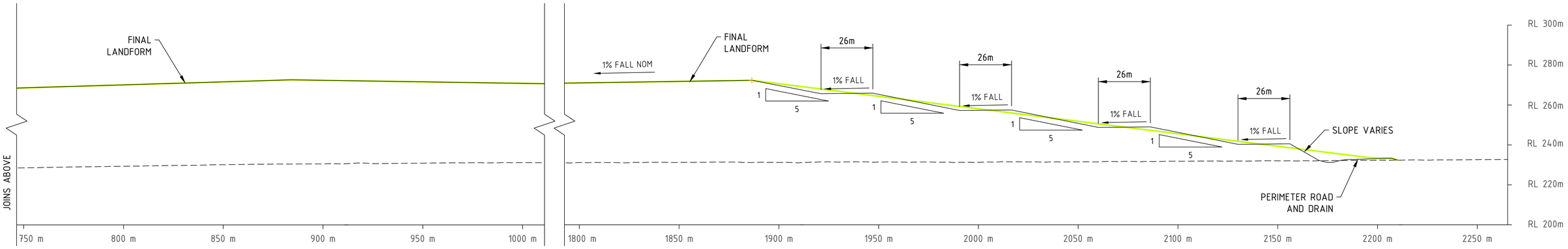
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SHEET No. 9 OF 20
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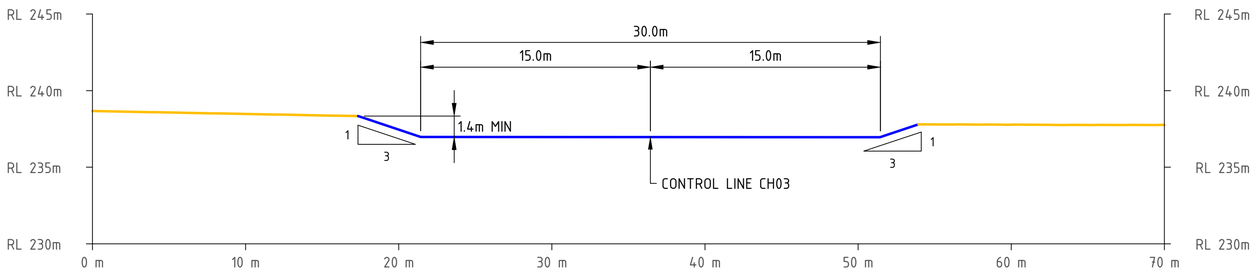
Plot Date: 18 January 2023 - 3:24 PM Plotted by: Claire Wilson
Cad File No: N:\Synergy\Projects\119\119224 Eagle Downs Coal Management - South32\02 DREA Final Landform Design\CADD\CAD\119224-02-000-009.dwg



SECTION E 005 FINAL LANDFORM 20 - 50 YEARS
SCALE: HORIZ 1:1000
VERT 1:1000



SECTION E 005 FINAL LANDFORM 20 - 50 YEARS
SCALE: HORIZ 1:1000
VERT 1:1000



SECTION F 005 BATTER CHUTE CH03
SCALE: HORIZ 1:200
VERT 1:200

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DRAWING NO	TITLE	REV	DESCRIPTION	BY	DRG CHK	ENG CHK	DATE	APPROVED
		A	ISSUED FOR REPORTING	CW	HA	HA	18/01/23	AW

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SOUTH32 Eagle Downs Coal

CONSULTANT JOB NO 119224-02

PRELIMINARY

DRAWN	CW	04/01/23
CHECKED	HA	09/01/23
DESIGNED	BH	02/01/23
LEAD ENG	HA	09/01/23
APPROVED	AW	18/01/23

SCALE 1:1,000 OR AS SHOWN
DO NOT SCALE A1

PROJECT EAGLE DOWNS COAL PROJECT - DREA FINAL LANDFORM DESIGN

TITLE DREA FINAL LANDFORM DESIGN
FINAL LANDFORM SECTION
20 - 50 YEARS

DRAWING NO 119224-02-000-010

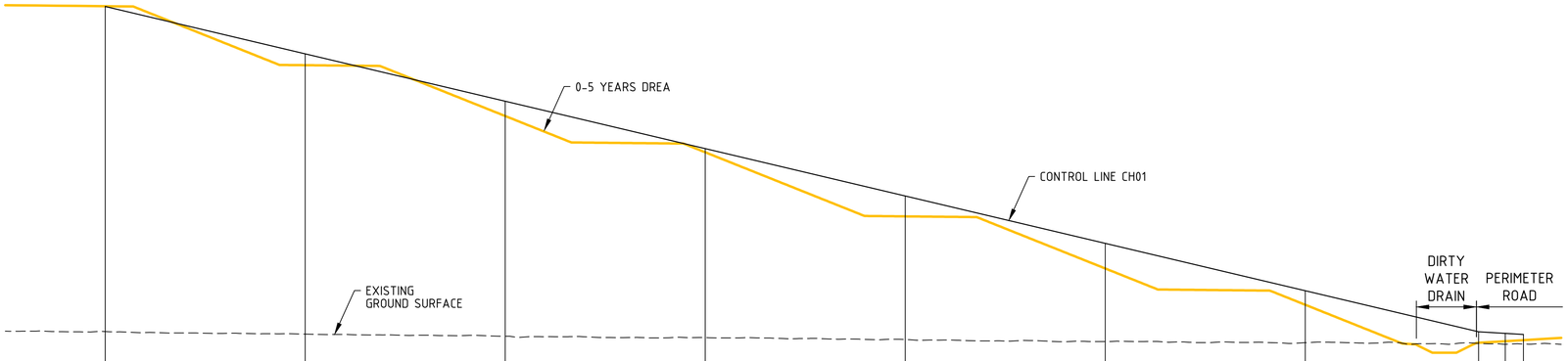
SHEET No. 10 OF 20

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Vertical Curve Length (m)
Vertical Curve Radius (m)

Vertical Geometry Grade (%) -11.855% -3%
Vertical Geometry Length (m) 343.328m 11.213m

DATUM RL 194

HORIZONTAL CURVE LENGTH (m) HORIZONTAL CURVE RADIUS (m)																								
LANDFORM SURFACE LEVELS ALONG CONTROL LINE	261.937		260.554		254.195		249.657		241.637		235.119		230.580		225.820		226.020		226.156					
CUT / FILL DEPTH TO LANDFORM SURFACE	0.035		1.421		1.851		0.462		2.555		3.146		1.757		1.380		0.980		0.708					
DESIGN LEVELS ALONG CONTROL LINE	261.902		261.974		256.047		250.119		244.192		238.264		232.337		227.200		227.000		226.864					
CONTROL LINE CHAINAGE	0		50		100		150		200		250		300		343.328		350		354.542					

10
@1:750 A1

CH01
HORIZONTAL SCALE (A1) 1:750
VERTICAL SCALE (A1) 1:375

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SOUTH32 Eagle Downs Coal

CONSULTANT JOB NO 119224-02

PRELIMINARY

DRAWN	CW	04/01/23
CHECKED	HA	09/01/23
DESIGNED	BH	02/01/23
LEAD ENG	HA	09/01/23
APPROVED	AW	18/01/23

SCALE 1:750 OR AS SHOWN
DO NOT SCALE A1

PROJECT
EAGLE DOWNS COAL PROJECT - DREA FINAL LANDFORM DESIGN

TITLE
DREA FINAL LANDFORM DESIGN
FINAL LANDFORM LONG SECTIONS CH01
STORMWATER
0 - 5 YEARS

DRAWING NO 119224-02-000-011

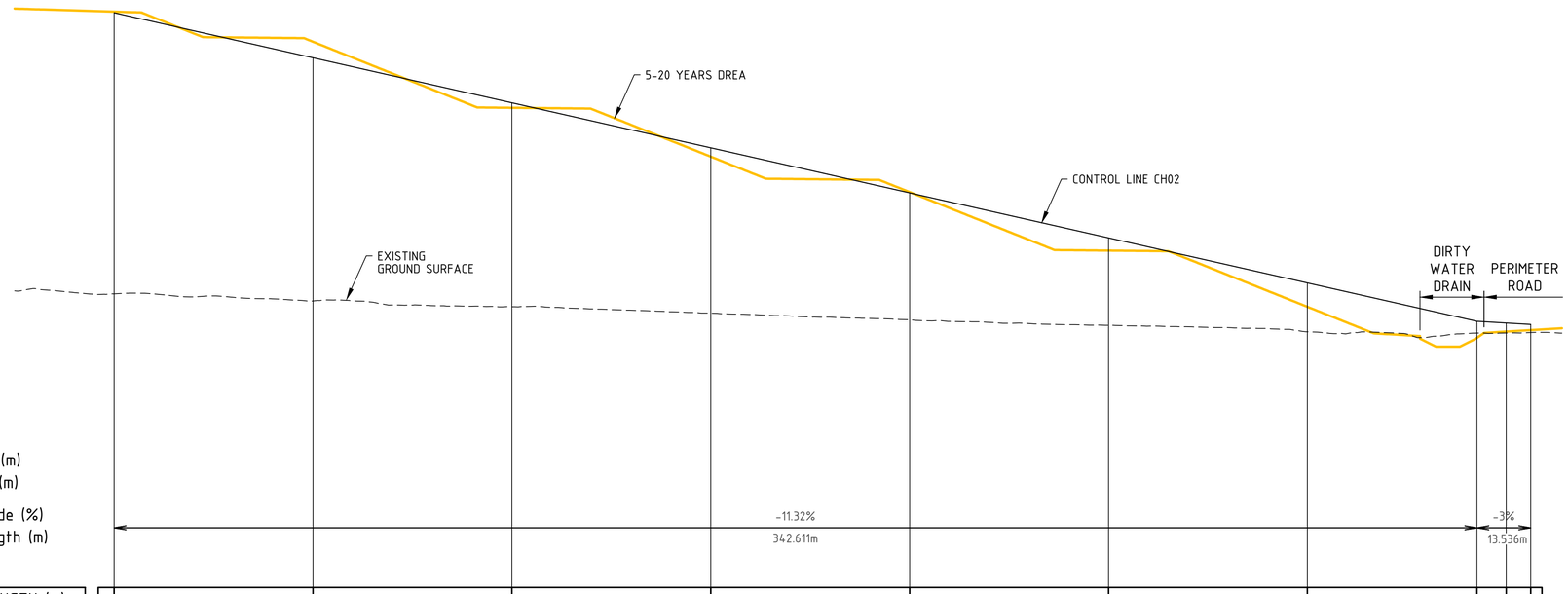
SHEET No. 11 OF 20

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Vertical Curve Length (m)
Vertical Curve Radius (m)

Vertical Geometry Grade (%) ~11.32% ~3%
Vertical Geometry Length (m) 342.611m 13.536m

DATUM RL 186

HORIZONTAL CURVE LENGTH (m) HORIZONTAL CURVE RADIUS (m)													
LANDFORM SURFACE LEVELS ALONG CONTROL LINE	258.389	254.604	246.300	240.159	235.707	228.351	221.288	217.370	218.172	218.357			
CUT / FILL DEPTH TO LANDFORM SURFACE	-0.134	-2.009	0.634	1.116	-0.093	1.603	3.006	2.101	1.077	0.708			
DESIGN LEVELS ALONG CONTROL LINE	258.254	252.596	246.934	241.274	235.614	229.954	224.294	219.471	219.249	219.065			
CONTROL LINE CHAINAGE	0	50	100	150	200	250	300	342.611	350	356.146			

CH02
HORIZONTAL SCALE (A1) 1:750
VERTICAL SCALE (A1) 1:375

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REV	DESCRIPTION	BY	DRG CHK	ENG CHK	DATE	APPROVED
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SOUTH32 Eagle Downs Coal

CONSULTANT JOB NO 119224-02

PRELIMINARY

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DESIGNED	BH	02/01/23
LEAD ENG	HA	09/01/23
APPROVED	AW	18/01/23

SCALE 1:750 OR AS SHOWN
DO NOT SCALE A1

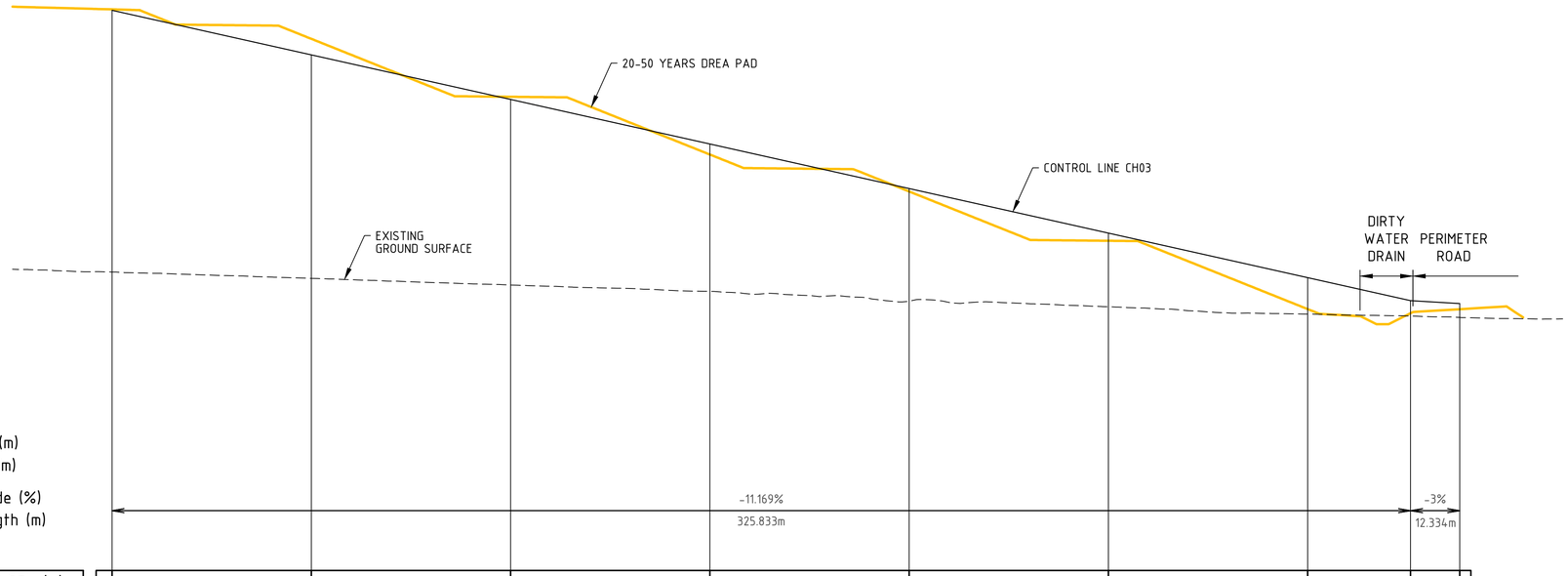
PROJECT
EAGLE DOWNS COAL PROJECT - DREA FINAL LANDFORM DESIGN

TITLE
DREA FINAL LANDFORM DESIGN
FINAL LANDFORM LONG SECTIONS CH02
STORMWATER
5 - 20 YEARS

DRAWING NO 119224-02-000-012
SHEET No. 12 OF 20
REVISION A

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Vertical Curve Length (m)
Vertical Curve Radius (m)

Vertical Geometry Grade (%) ~11.169% ~3%
Vertical Geometry Length (m) 325.833m 12.334m

DATUM RL 190

HORIZONTAL CURVE LENGTH (m) HORIZONTAL CURVE RADIUS (m)								
LANDFORM SURFACE LEVELS ALONG CONTROL LINE	260.352	256.658	249.391	242.154	237.522	231.338	222.775	222.260	222.760
CUT / FILL DEPTH TO LANDFORM SURFACE	0.122	2.012	0.330	1.323	0.371	0.970	3.948	1.578	0.709
DESIGN LEVELS ALONG CONTROL LINE	260.231	254.646	249.062	243.477	237.893	232.308	226.724	223.838	223.468
CONTROL LINE CHAINAGE	0	50	100	150	200	250	300	325.833	338.167

CH03
HORIZONTAL SCALE (A1) 1:750
VERTICAL SCALE (A1) 1:375

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REV	DESCRIPTION	BY	DRG CHK	ENG CHK	DATE	APPROVED
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SOUTH32 Eagle Downs Coal

PRELIMINARY

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CHECKED	HA	09/01/23
DESIGNED	BH	02/01/23
LEAD ENG	HA	09/01/23
APPROVED	AW	18/01/23

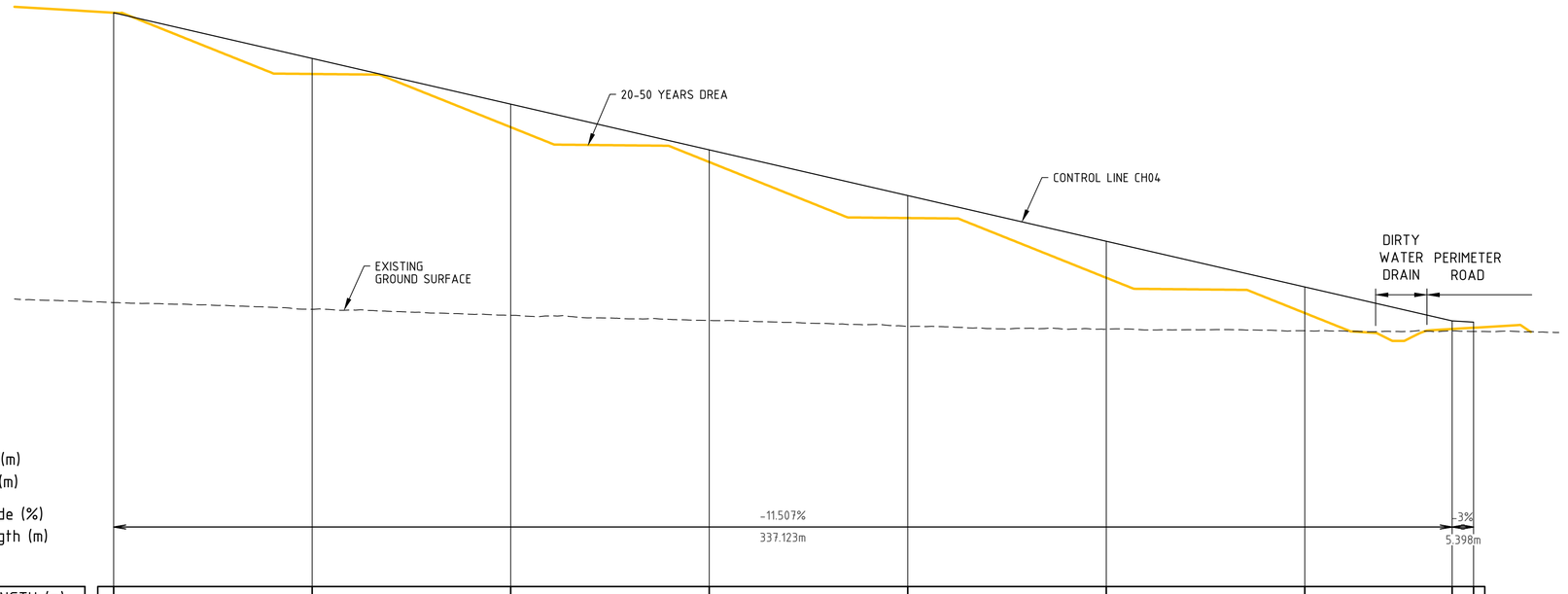
SCALE 1:750 OR AS SHOWN
DO NOT SCALE A1

PROJECT
EAGLE DOWNS COAL PROJECT - DREA FINAL LANDFORM DESIGN
TITLE
DREA FINAL LANDFORM DESIGN
FINAL LANDFORM LONG SECTIONS CH03
STORMWATER
20 - 50 YEARS

DRAWING NO 119224-02-000-013
SHEET No. 13 OF 20
REVISION A

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Vertical Curve Length (m)
Vertical Curve Radius (m)

Vertical Geometry Grade (%) -11.507% -3%
Vertical Geometry Length (m) 337.123m 5.398m

DATUM RL 186

HORIZONTAL CURVE LENGTH (m) / HORIZONTAL CURVE RADIUS (m)												
LANDFORM SURFACE LEVELS ALONG CONTROL LINE	258.248	250.541	243.840	239.450	232.401	224.877	220.439	218.425	218.587			
CUT / FILL DEPTH TO LANDFORM SURFACE	0.002	1.955	2.903	1.539	2.835	4.605	3.290	1.032	0.708			
DESIGN LEVELS ALONG CONTROL LINE	258.250	252.496	246.743	240.989	235.236	229.482	223.729	219.457	219.295			
CONTROL LINE CHAINAGE	0	50	100	150	200	250	300	337.123	342.521			

CH04
HORIZONTAL SCALE (A1) 1:750
VERTICAL SCALE (A1) 1:375

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SOUTH32 Eagle Downs Coal

PRELIMINARY

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DESIGNED	BH	02/01/23
LEAD ENG	HA	09/01/23
APPROVED	AW	18/01/23

SCALE 1:750 OR AS SHOWN
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PROJECT
EAGLE DOWNS COAL PROJECT - DREA FINAL LANDFORM DESIGN

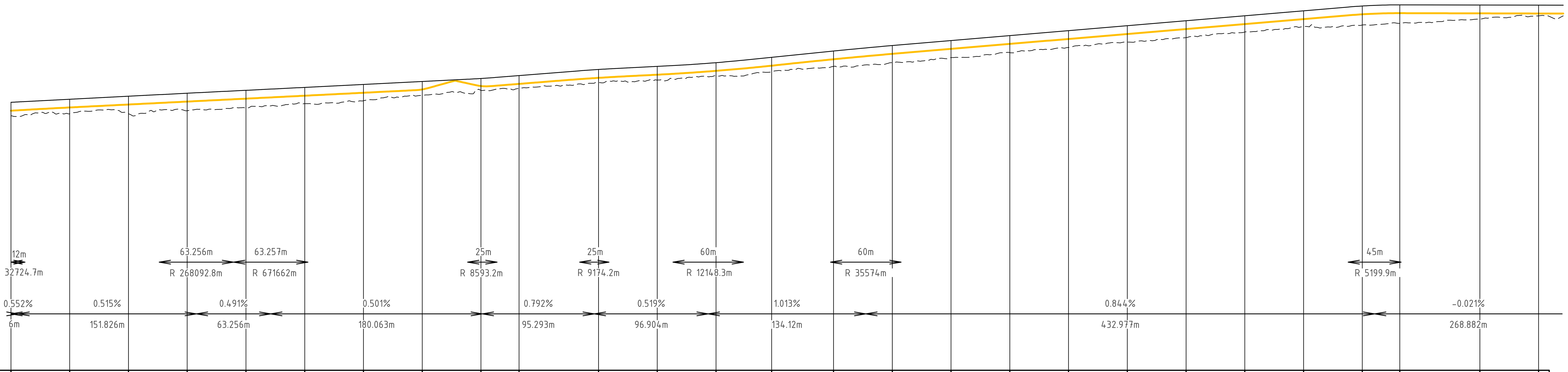
TITLE
DREA FINAL LANDFORM DESIGN
FINAL LANDFORM LONG SECTIONS CH04
STORMWATER
20 - 50 YEARS

DRAWING NO 119224-02-000-014
SHEET No. 14 OF 20
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1 2 3 4 5 6 7 8 9 10 11 12



Vertical Curve Length (m)	Vertical Curve Radius (m)
12m	R 32724.7m
63.256m	R 268092.8m
63.257m	R 671662m
25m	R 8593.2m
25m	R 9174.2m
60m	R 12148.3m
60m	R 35574m
45m	R 5199.9m

Vertical Geometry Grade (%)	Vertical Geometry Length (m)
0.552%	6m
0.515%	151.826m
0.491%	63.256m
0.501%	180.063m
0.792%	95.293m
0.519%	96.904m
1.013%	134.12m
0.844%	432.977m
-0.021%	268.882m

DATUM RL 205

HORIZONTAL CURVE LENGTH (m) / HORIZONTAL CURVE RADIUS (m): 69.887m, R 90m; 62.005m, R -150m; 479.468m, R 295m

CONTROL LINE CHAINAGE	LANDFORM SURFACE LEVELS ALONG CONTROL LINE	CUT / FILL DEPTH TO LANDFORM SURFACE	DESIGN LEVELS ALONG CONTROL LINE
0	227.088	0.715	227.803
50	227.366	0.697	228.063
100	227.616	0.704	228.320
150	227.866	0.711	228.576
200	228.116	0.709	228.825
250	228.366	0.708	229.073
300	228.616	0.708	229.324
350	228.901	0.673	229.574
400	229.190	0.642	229.832
432.417	229.371	0.706	230.078
500	229.886	0.713	230.599
550	230.152	0.710	230.863
600	230.481	0.697	231.178
647.335	230.920	0.715	231.635
700	231.466	0.702	232.168
750	231.928	0.708	232.636
800	232.351	0.708	233.059
850	232.773	0.708	233.481
900	233.196	0.708	233.903
950	233.618	0.708	234.325
1000	234.040	0.708	234.748
1050	234.462	0.708	235.170
1100	234.884	0.708	235.592
1150	235.294	0.706	236.000
1181.846	235.390	0.708	236.098
1250	235.374	0.709	236.083
1300	235.363	0.710	236.073

CLOSURE MC02
HORIZONTAL SCALE (A1) 1:2000
VERTICAL SCALE (A1) 1:200

20
@1:2000 A1

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REV	DESCRIPTION	BY	DRG CHK	ENG CHK	DATE	APPROVED
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SOUTH32 Eagle Downs Coal

PRELIMINARY

DRAWN	CW	04/01/23
CHECKED	HA	09/01/23
DESIGNED	BH	02/01/23
LEAD ENG	HA	09/01/23
APPROVED	AW	18/01/23

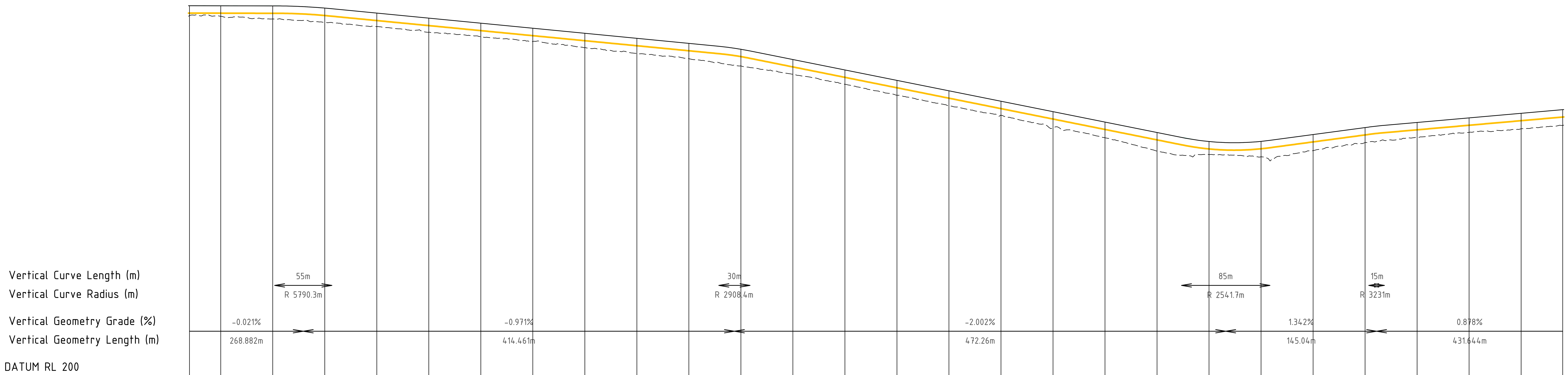
SCALE 1:2,000 OR AS SHOWN
DO NOT SCALE A1

PROJECT
EAGLE DOWNS COAL PROJECT - DREA FINAL LANDFORM DESIGN

TITLE
DREA FINAL LANDFORM DESIGN
FINAL LANDFORM LONG SECTIONS
PERIMETER ROAD
SHEET 1 OF 6

DRAWING NO 119224-02-000-015
SHEET No. 15 OF 20
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CONTROL LINE CHAINAGE	1320	1350	1400	1450	1500	1550	1600	1650	1700	1750	1800	1850	1900	1950
HORIZONTAL CURVE LENGTH (m)					479.468m									
HORIZONTAL CURVE RADIUS (m)					R 295m									
LANDFORM SURFACE LEVELS ALONG CONTROL LINE	235.358	235.351	235.339	235.126	234.643	234.159	233.675	233.191	232.707	232.223	231.739	231.180	230.188	229.187
CUT / FILL DEPTH TO LANDFORM SURFACE	0.711	0.712	0.713	0.715	0.717	0.715	0.714	0.712	0.711	0.709	0.708	0.704	0.708	0.708
DESIGN LEVELS ALONG CONTROL LINE	236.069	236.062	236.052	235.841	235.360	234.874	234.389	233.903	233.418	232.932	232.447	231.884	230.896	229.895

CONTROL LINE CHAINAGE	2000	2050	2100	2150	2200	2250	2300	2350	2400	2450	2500	2550	2600	2640
HORIZONTAL CURVE LENGTH (m)														
HORIZONTAL CURVE RADIUS (m)														
LANDFORM SURFACE LEVELS ALONG CONTROL LINE	228.186	227.184	226.183	225.182	224.181	223.180	222.311	222.325	222.984	223.655	224.146	224.584	225.023	225.374
CUT / FILL DEPTH TO LANDFORM SURFACE	0.708	0.708	0.708	0.708	0.708	0.708	0.713	0.711	0.708	0.708	0.708	0.708	0.708	0.708
DESIGN LEVELS ALONG CONTROL LINE	228.894	227.893	226.891	225.890	224.889	223.888	223.024	223.035	223.692	224.363	224.853	225.292	225.731	226.082

CLOSURE MC02
HORIZONTAL SCALE (A1) 1:2000
VERTICAL SCALE (A1) 1:200

20 @1:2000 A1

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REV	DESCRIPTION	BY	DRG CHK	ENG CHK	DATE	APPROVED
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SOUTH32 Eagle Downs Coal

PRELIMINARY

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DESIGNED	BH	02/01/23
LEAD ENG	HA	09/01/23
APPROVED	AW	18/01/23

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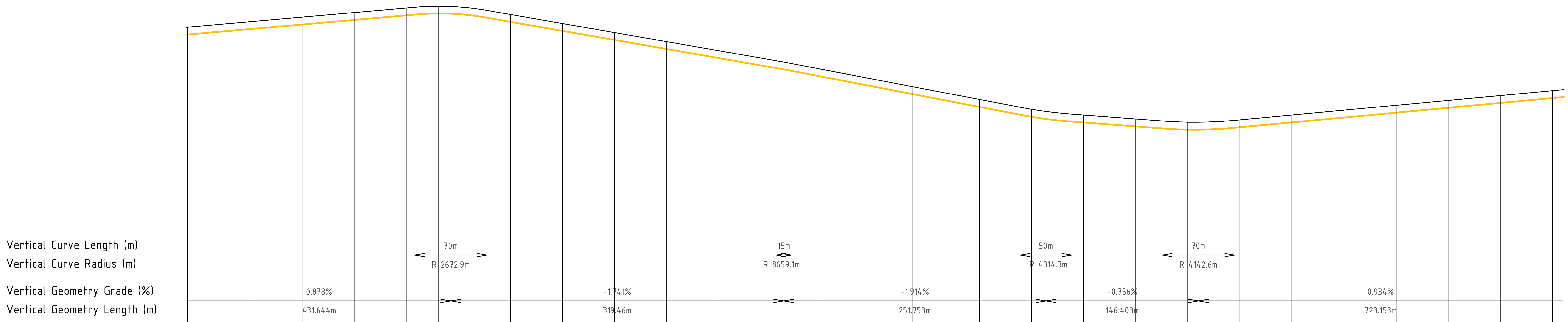
PROJECT
EAGLE DOWNS COAL PROJECT - DREA FINAL LANDFORM DESIGN

TITLE
DREA FINAL LANDFORM DESIGN
FINAL LANDFORM LONG SECTIONS
PERIMETER ROAD
SHEET 2 OF 6

DRAWING NO 119224-02-000-016
SHEET No. 16 OF 20
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DATUM RL 195

HORIZONTAL CURVE LENGTH (m) / HORIZONTAL CURVE RADIUS (m): 426.82m, R 275m (from chainage 3335.499 to 3750)

CONTROL LINE CHAINAGE	2640	2700	2750	2800	2850	2881.184	2950	3000	3050
LANDFORM SURFACE LEVELS ALONG CONTROL LINE	225.374	225.901	226.340	226.778	227.217	227.401	226.594	225.724	224.853
CUT / FILL DEPTH TO LANDFORM SURFACE	0.708	0.708	0.708	0.708	0.708	0.695	0.708	0.708	0.708
DESIGN LEVELS ALONG CONTROL LINE	226.082	226.609	227.047	227.486	227.925	228.096	227.303	226.432	225.561

CONTROL LINE CHAINAGE	3100	3150	3200	3250	3300	3335.499	3400	3450	3500
LANDFORM SURFACE LEVELS ALONG CONTROL LINE	223.983	223.112	222.242	221.307	220.347	219.666	218.429	217.481	216.932
CUT / FILL DEPTH TO LANDFORM SURFACE	0.708	0.708	0.708	0.707	0.709	0.710	0.713	0.718	0.713
DESIGN LEVELS ALONG CONTROL LINE	224.691	223.820	222.950	222.013	221.056	220.377	219.142	218.199	217.645

CONTROL LINE CHAINAGE	3550	3600	3650	3700	3750	3800	3850	3900	3950
LANDFORM SURFACE LEVELS ALONG CONTROL LINE	216.556	216.249	216.474	216.941	217.408	217.876	218.343	218.810	219.277
CUT / FILL DEPTH TO LANDFORM SURFACE	0.712	0.715	0.708	0.708	0.708	0.708	0.708	0.708	0.708
DESIGN LEVELS ALONG CONTROL LINE	217.267	216.963	217.182	217.649	218.116	218.583	219.051	219.518	219.985

CLOSURE MC02
HORIZONTAL SCALE (A1) 1:2000
VERTICAL SCALE (A1) 1:200

20
@1:2000 A1

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REV	DESCRIPTION	BY	DRG CHK	ENG CHK	DATE	APPROVED
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CONSULTANT JOB NO 119224-02

SOUTH32 Eagle Downs Coal

PRELIMINARY

DRAWN	CW	04/01/23
CHECKED	HA	09/01/23
DESIGNED	BH	02/01/23
LEAD ENG	HA	09/01/23
APPROVED	AW	18/01/23

SCALE 1:2,000 OR AS SHOWN
DO NOT SCALE A1

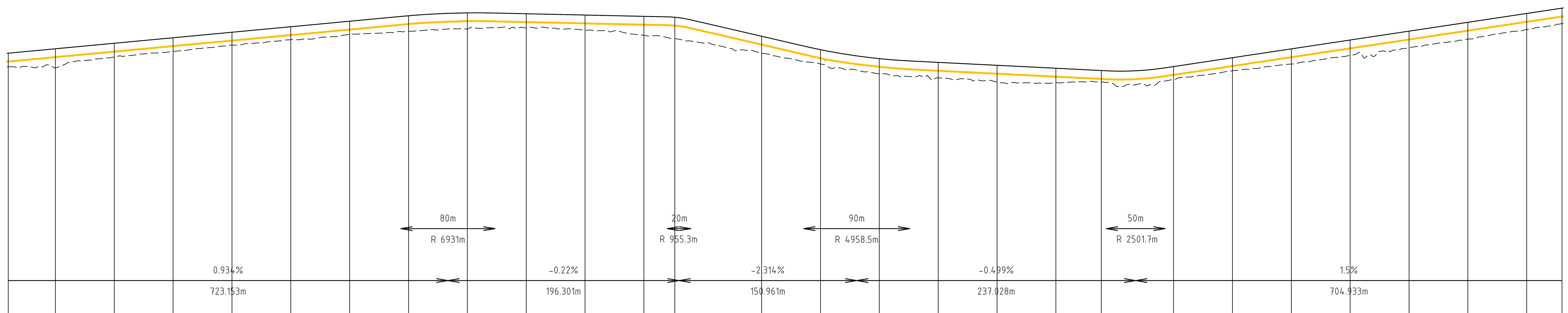
PROJECT
EAGLE DOWNS COAL PROJECT - DREA FINAL LANDFORM DESIGN

TITLE
DREA FINAL LANDFORM DESIGN FINAL LANDFORM LONG SECTIONS PERIMETER ROAD SHEET 3 OF 6

DRAWING NO 119224-02-000-017
SHEET No. 17 OF 20
REVISION A

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Plot Date: 18 January 2023 - 3:07 PM Plotted by: Claire Wilson
Cad File No: N:\Synergy\Projects\119\119224 Eagle Downs Coal Management - South32\02 DREA Final Landform Design\CADD\CAD\119224-02-000-017.dwg



Vertical Curve Length (m)
Vertical Curve Radius (m)

Vertical Geometry Grade (%)
Vertical Geometry Length (m)

DATUM RL 196

CONTROL LINE CHAINAGE	3960	4000	4050	4100	4150	4200	4250	4300	4350	4400	4450	4500	4526.261	4600
HORIZONTAL CURVE LENGTH (m) / HORIZONTAL CURVE RADIUS (m)												58.424m R -250m		
LANDFORM SURFACE LEVELS ALONG CONTROL LINE	219.370	219.744	220.211	220.678	221.146	221.613	222.080	222.547	222.797	222.713	222.604	222.495	222.413	220.803
CUT / FILL DEPTH TO LANDFORM SURFACE	0.708	0.708	0.708	0.708	0.708	0.708	0.708	0.705	0.694	0.708	0.707	0.706	0.709	0.708
DESIGN LEVELS ALONG CONTROL LINE	220.078	220.452	220.919	221.386	221.853	222.320	222.787	223.252	223.491	223.421	223.311	223.201	223.122	221.511

CONTROL LINE CHAINAGE	4650	4700	4750	4800	4850	4888.557	4950	5000	5050	5100	5150	5200	5250	5280
HORIZONTAL CURVE LENGTH (m) / HORIZONTAL CURVE RADIUS (m)				234.622m R 347m										
LANDFORM SURFACE LEVELS ALONG CONTROL LINE	219.647	218.925	218.588	218.338	218.088	217.895	218.237	218.987	219.737	220.487	221.237	221.987	222.737	223.187
CUT / FILL DEPTH TO LANDFORM SURFACE	0.728	0.689	0.710	0.711	0.712	0.712	0.708	0.708	0.708	0.708	0.708	0.708	0.708	0.708
DESIGN LEVELS ALONG CONTROL LINE	220.375	219.614	219.298	219.048	218.799	218.607	218.944	219.695	220.445	221.195	221.945	222.695	223.445	223.895

CLOSURE MC02
HORIZONTAL SCALE (A1) 1:2000
VERTICAL SCALE (A1) 1:200

20
@1:2000 A1

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REV	DESCRIPTION	BY	DRG CHK	ENG CHK	DATE	APPROVED
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CONSULTANT JOB NO 119224-02

SOUTH32 Eagle Downs Coal

PRELIMINARY

DRAWN	CW	04/01/23
CHECKED	HA	09/01/23
DESIGNED	BH	02/01/23
LEAD ENG	HA	09/01/23
APPROVED	AW	18/01/23

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PROJECT
EAGLE DOWNS COAL PROJECT - DREA FINAL LANDFORM DESIGN

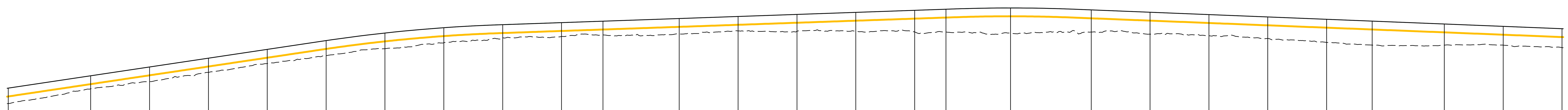
TITLE
DREA FINAL LANDFORM DESIGN
FINAL LANDFORM LONG SECTIONS
PERIMETER ROAD
SHEET 4 OF 6

DRAWING NO 119224-02-000-018
SHEET No. 18 OF 20
REVISION A

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Plot Date: 18 January 2023 - 3:07 PM Plotted by: Claire Wilson

Cad File No: N:\Synergy\Projects\119\119224 Eagle Downs Coal Management - South32\02 DREA Final Landform Design\CADD\CAD\119224-02-000-018.dwg



Vertical Curve Length (m)	Vertical Curve Radius (m)
150m	R 13022.1m
100m	R 13356.8m

Vertical Geometry Grade (%)	Vertical Geometry Length (m)
1.5%	704.933m
0.348%	512.205m
-0.4%	895.85m

DATUM RL 201

HORIZONTAL CURVE LENGTH (m)	HORIZONTAL CURVE RADIUS (m)
179.325m	R 245m
362.084m	R 245m

CONTROL LINE CHAINAGE	LANDFORM SURFACE LEVELS ALONG CONTROL LINE	CUT / FILL DEPTH TO LANDFORM SURFACE	DESIGN LEVELS ALONG CONTROL LINE
5280	223.187	0.708	223.895
5350	224.237	0.708	224.945
5400	224.987	0.708	225.695
5450	225.737	0.708	226.445
5500	226.487	0.708	227.195
5550	227.237	0.708	227.945
5600	227.880	0.710	228.590
5650	228.331	0.712	229.043
5700	228.591	0.714	229.305
5750	228.766	0.713	229.479
5785.196	228.890	0.712	229.602
5850	229.116	0.711	229.827
5900	229.291	0.710	230.001
5950	229.466	0.709	230.176
6000	229.641	0.708	230.350
6050	229.816	0.707	230.524
6076.585	229.909	0.707	230.616
6131.432	230.017	0.709	230.726
6200	229.847	0.712	230.559
6250	229.647	0.711	230.359
6300	229.447	0.711	230.158
6350	229.247	0.711	229.958
6400	229.047	0.711	229.758
6438.669	228.892	0.711	229.603
6500	228.647	0.710	229.357
6550	228.447	0.710	229.157
6600	228.247	0.710	228.957

CLOSURE MC02
HORIZONTAL SCALE (A1) 1:2000
VERTICAL SCALE (A1) 1:200

20 @1:2000 A1

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REV	DESCRIPTION	BY	DRG CHK	ENG CHK	DATE	APPROVED
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CONSULTANT JOB NO 119224-02

SOUTH32 Eagle Downs Coal

PRELIMINARY

DRAWN	CW	04/01/23
CHECKED	HA	09/01/23
DESIGNED	BH	02/01/23
LEAD ENG	HA	09/01/23
APPROVED	AW	18/01/23

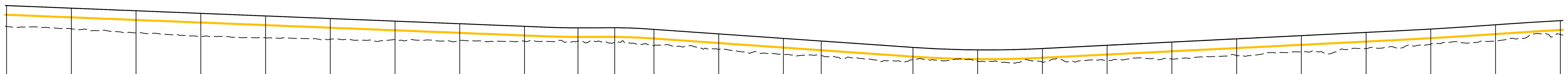
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DO NOT SCALE A1

PROJECT
EAGLE DOWNS COAL PROJECT - DREA FINAL LANDFORM DESIGN

TITLE
DREA FINAL LANDFORM DESIGN
FINAL LANDFORM LONG SECTIONS
PERIMETER ROAD
SHEET 5 OF 6

DRAWING NO 119224-02-000-019
SHEET No. 19 OF 20
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Vertical Curve Length (m)	Vertical Curve Radius (m)
25m	R 5758.3m
25m	R 3423.3m
100m	R 8365.3m
69.312m	R 30415.4m
57.312m	R 32724.7m

Vertical Geometry Grade (%)	Vertical Geometry Length (m)
-0.4%	895.85m
0.034%	50.282m
-0.697%	267.791m
0.499%	361.159m
0.727%	63.312m
0.552%	28.656m

DATUM RL 203

HORIZONTAL CURVE LENGTH (m)	HORIZONTAL CURVE RADIUS (m)
113.084m	R -72.5m
378.655m	R 269m

CONTROL LINE CHAINAGE	LANDFORM SURFACE LEVELS ALONG CONTROL LINE	CUT / FILL DEPTH TO LANDFORM SURFACE	DESIGN LEVELS ALONG CONTROL LINE
6600	228.247	0.710	228.957
6650	228.047	0.710	228.757
6700	227.847	0.709	228.556
6750	227.647	0.709	228.356
6800	227.447	0.709	228.156
6850	227.247	0.709	227.956
6900	227.047	0.708	227.756
6950	226.847	0.708	227.555
7000	226.647	0.708	227.355
7041.331	226.532	0.704	227.236
7069.706	226.535	0.710	227.245
7100	226.411	0.706	227.117
7150	226.062	0.707	226.769
7200	225.712	0.709	226.420
7229.159	225.507	0.710	226.217
7300	225.012	0.712	225.724
7350	224.818	0.714	225.532
7400	224.924	0.714	225.639
7450	225.174	0.714	225.888
7500	225.424	0.713	226.137
7550	225.674	0.712	226.387
7600	225.924	0.712	226.636
7650	226.174	0.711	226.886
7700	226.440	0.705	227.145
7750	226.752	0.723	227.475
7800	227.077	0.716	227.792

CLOSURE MC02
HORIZONTAL SCALE (A1) 1:2000
VERTICAL SCALE (A1) 1:200

20 @1:2000 A1

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CONSULTANT JOB NO 119224-02

SOUTH32 Eagle Downs Coal

PRELIMINARY

DRAWN	CW	04/01/23
CHECKED	HA	09/01/23
DESIGNED	BH	02/01/23
LEAD ENG	HA	09/01/23
APPROVED	AW	18/01/23

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PROJECT
EAGLE DOWNS COAL PROJECT - DREA FINAL LANDFORM DESIGN

TITLE
DREA FINAL LANDFORM DESIGN
FINAL LANDFORM LONG SECTIONS
PERIMETER ROAD
SHEET 6 OF 6

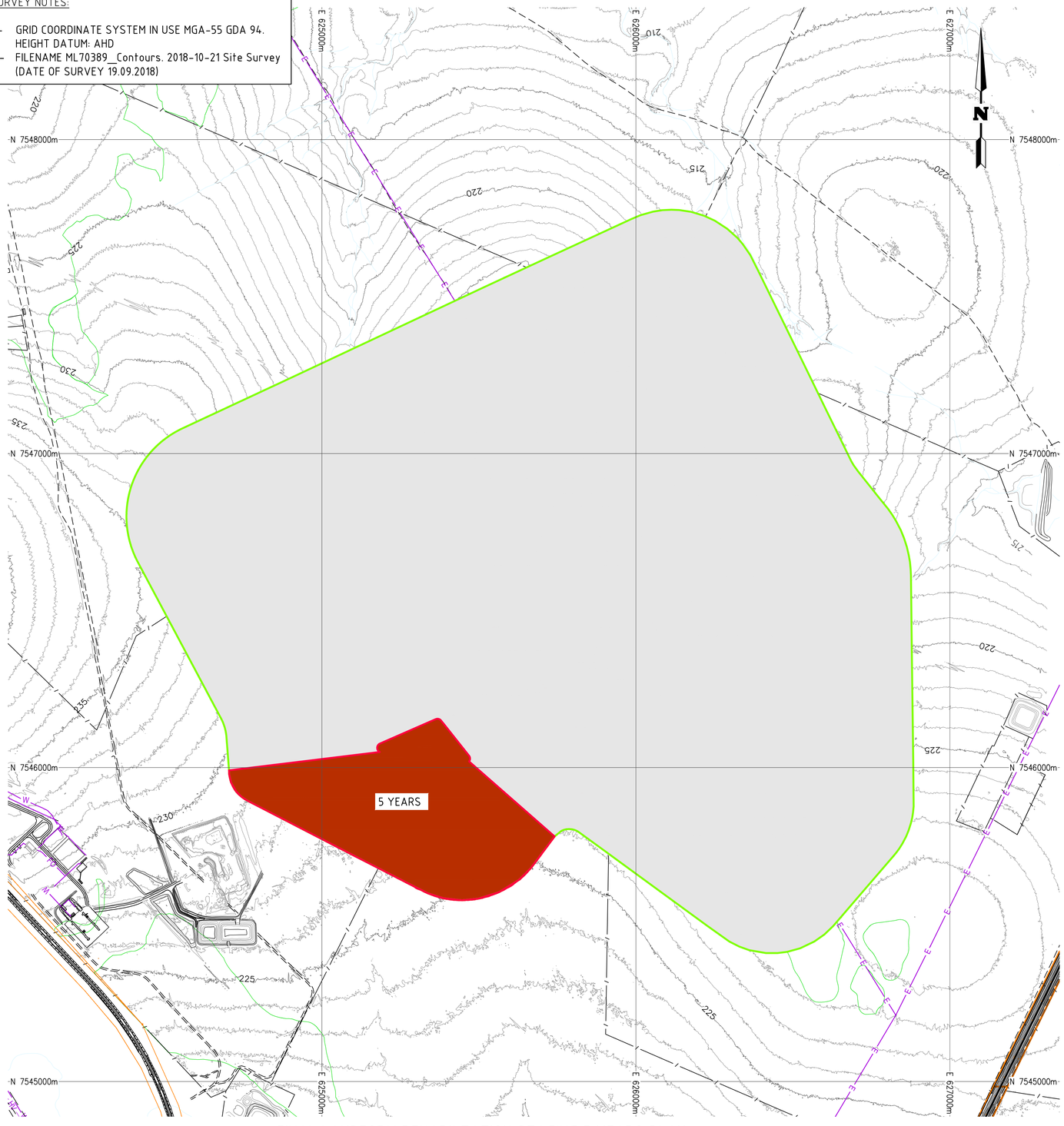
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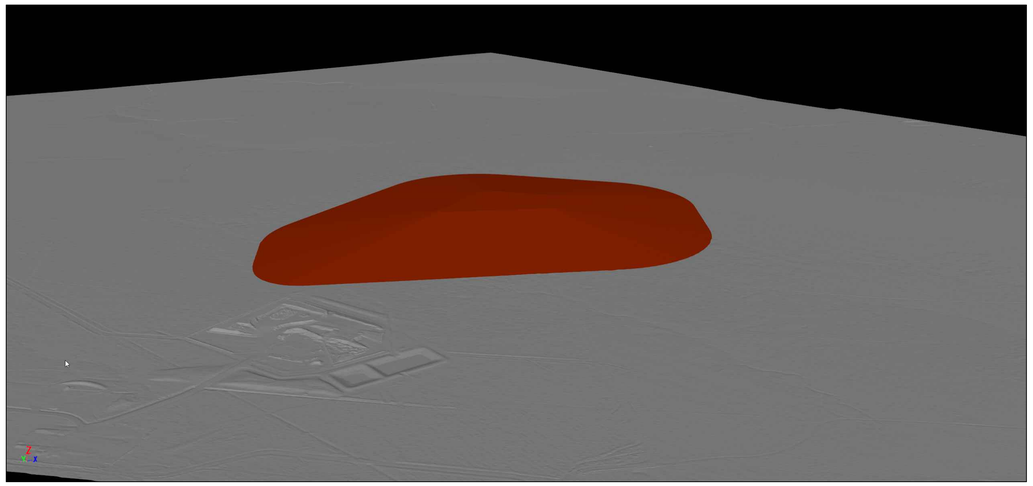
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Cad File No: N:\Synergy\Projects\119\119224 Eagle Downs Coal Management - South32\02 DREA Final Landform Design\CADD\CAD\119224-02-000-020.dwg

SURVEY NOTES:

1.- GRID COORDINATE SYSTEM IN USE MGA-55 GDA 94.
HEIGHT DATUM: AHD
2.- FILENAME ML70389_Contours. 2018-10-21 Site Survey
(DATE OF SURVEY 19.09.2018)



FINAL LANDFORM REHABILTATION STAGING 5 YEARS PLAN
SCALE 1:7,500



3D REHABILITATION STAGED DEVELOPMENT
5 YEARS

150 0 150 300 450 600 750
SCALE OF METRES 1:7500

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SOUTH32 Eagle Downs Coal

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DESIGNED	BH	02/01/23
LEAD ENG	HA	09/01/23
APPROVED	AW	18/01/23

PROJECT
EAGLE DOWNS COAL PROJECT - DREA FINAL LANDFORM DESIGN

TITLE
DREA FINAL LANDFORM DESIGN
FINAL LANDFORM REHABILTATION STAGING
5 YEARS
SHEET 1 OF 8

SCALE 1:7,500 OR AS SHOWN
DO NOT SCALE A1

DRAWING NO 119224-02-100-001

SHEET No. 1 OF 8

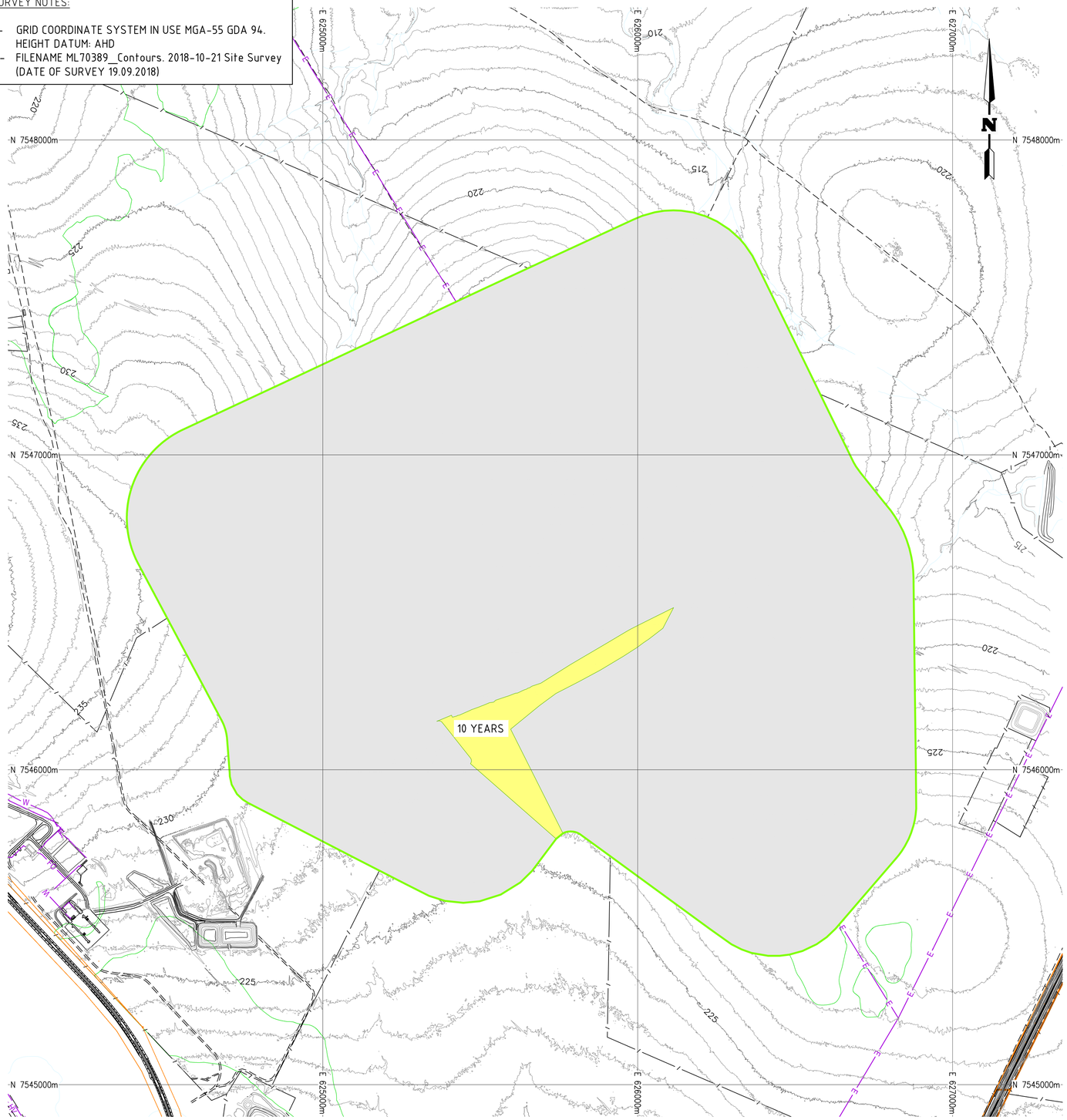
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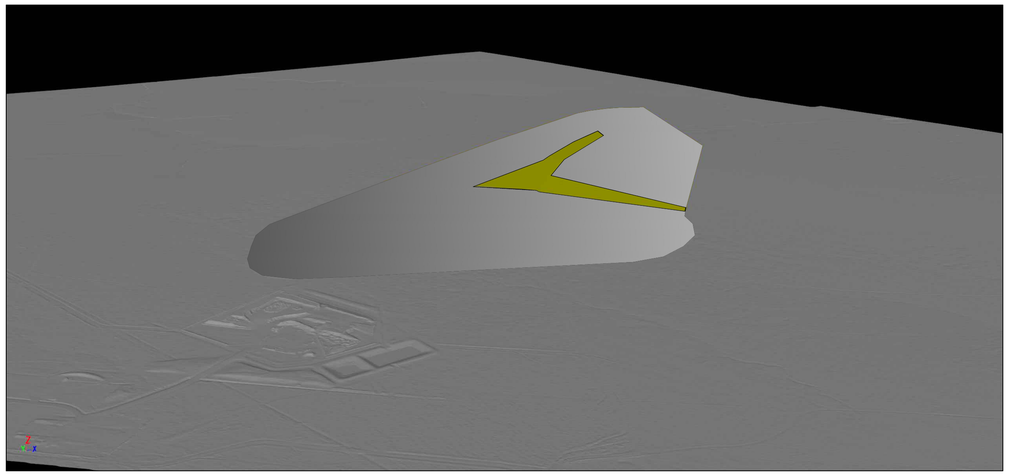
Plot Date: 30 March 2023 - 3:11 PM Plotted by: James Camille
Cad File No: N:\Synergy\Projects\119\119224 Eagle Downs Coal Management - South32\02 DREA Final Landform Design\CADD\CAD\119224-02-100-001.dwg

SURVEY NOTES:

1.- GRID COORDINATE SYSTEM IN USE MGA-55 GDA 94.
HEIGHT DATUM: AHD
2.- FILENAME ML70389_Contours. 2018-10-21 Site Survey
(DATE OF SURVEY 19.09.2018)



FINAL LANDFORM REHABILTATION STAGING 10 YEARS PLAN
SCALE 1:7,500



3D REHABILITATION STAGED DEVELOPMENT
10 YEARS

150 0 150 300 450 600 750
SCALE OF METRES 1:7500

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		A	ISSUED FOR REPORTING	JC	HA	HA	30/03/23	AW

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CONSULTANT JOB NO 119224-02

SOUTH32 Eagle Downs Coal

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DESIGNED	BH	02/01/23
LEAD ENG	HA	09/01/23
APPROVED	AW	18/01/23

SCALE 1:7,500 OR AS SHOWN
DO NOT SCALE A1

PROJECT
EAGLE DOWNS COAL PROJECT - DREA FINAL LANDFORM DESIGN
TITLE
DREA FINAL LANDFORM DESIGN
FINAL LANDFORM REHABILTATION STAGING
10 YEARS
SHEET 2 OF 8

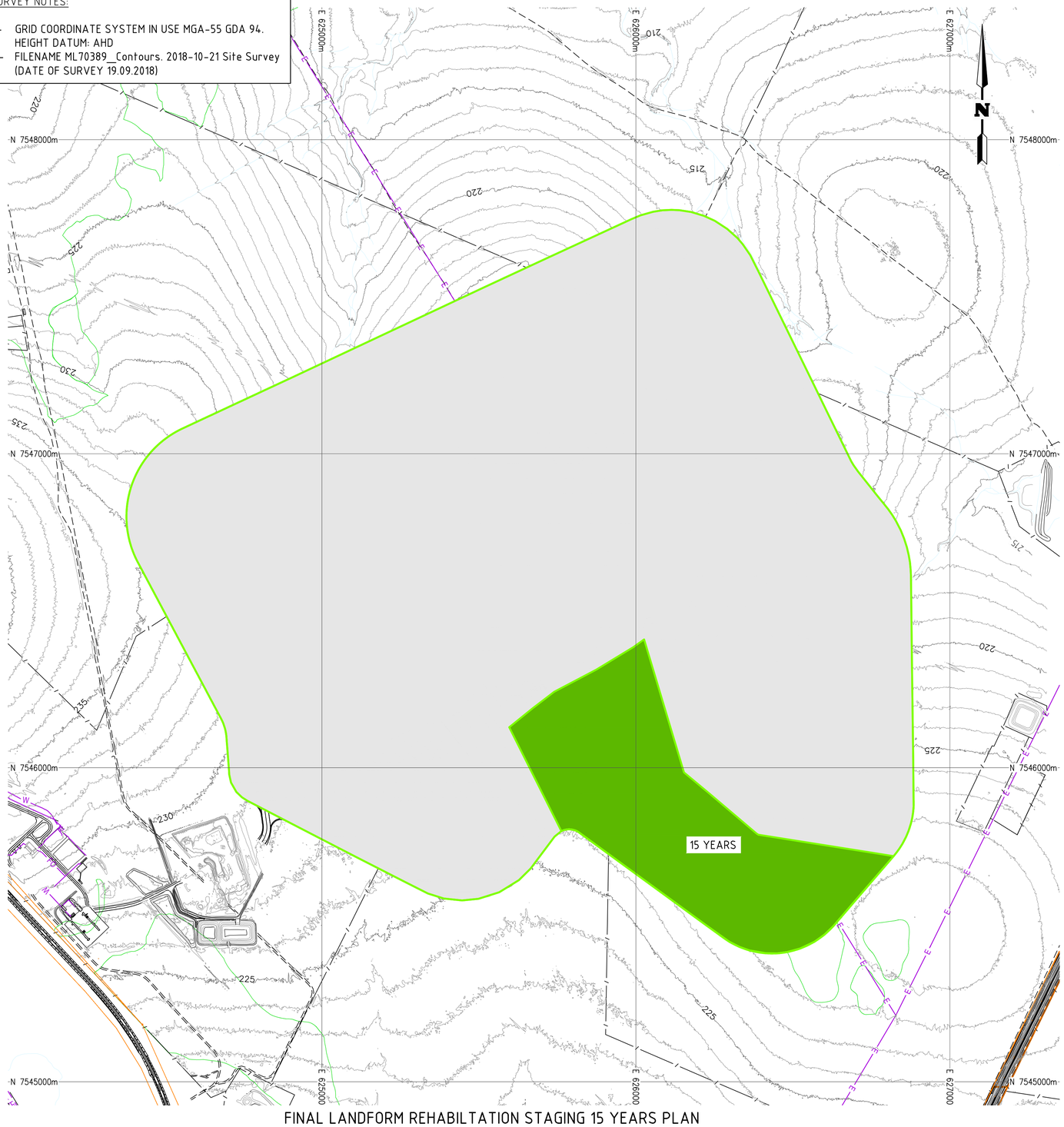
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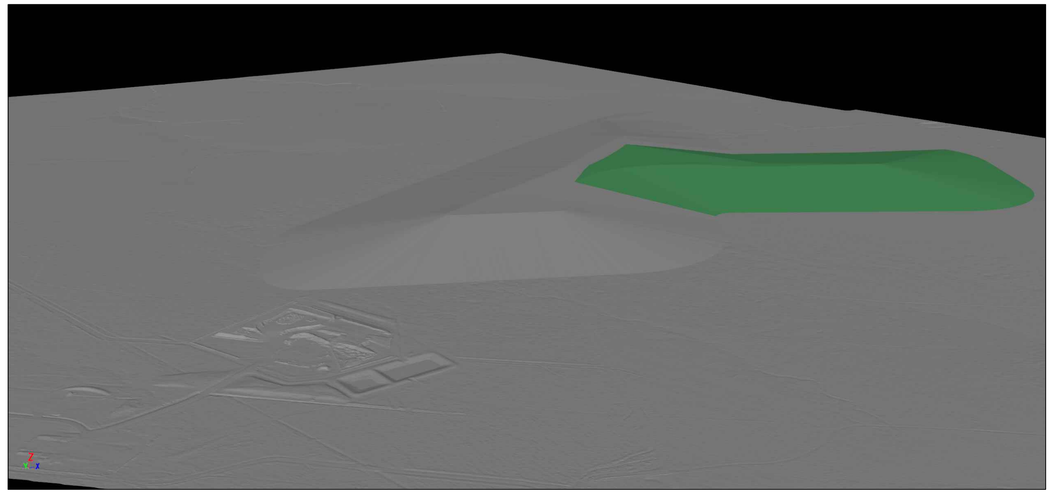
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SURVEY NOTES:

1.- GRID COORDINATE SYSTEM IN USE MGA-55 GDA 94.
HEIGHT DATUM: AHD
2.- FILENAME ML70389_Contours. 2018-10-21 Site Survey
(DATE OF SURVEY 19.09.2018)



FINAL LANDFORM REHABILTATION STAGING 15 YEARS PLAN
SCALE 1:7,500



3D REHABILITATION STAGED DEVELOPMENT
15 YEARS

150 0 150 300 450 600 750
SCALE OF METRES 1:7500

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REV	DESCRIPTION	BY	DRG CHK	ENG CHK	DATE	APPROVED
A	ISSUED FOR REPORTING	JC	HA	HA	30/03/23	AW

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CONSULTANT JOB NO
119224-02

SOUTH32 Eagle Downs Coal

ISSUE FOR REPORT

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CHECKED	HA	09/01/23
DESIGNED	BH	02/01/23
LEAD ENG	HA	09/01/23
APPROVED	AW	18/01/23

SCALE 1:7,500 OR AS SHOWN
DO NOT SCALE A1

PROJECT
EAGLE DOWNS COAL PROJECT - DREA FINAL LANDFORM DESIGN

TITLE
DREA FINAL LANDFORM DESIGN
FINAL LANDFORM REHABILTATION STAGING
15 YEARS
SHEET 3 OF 8

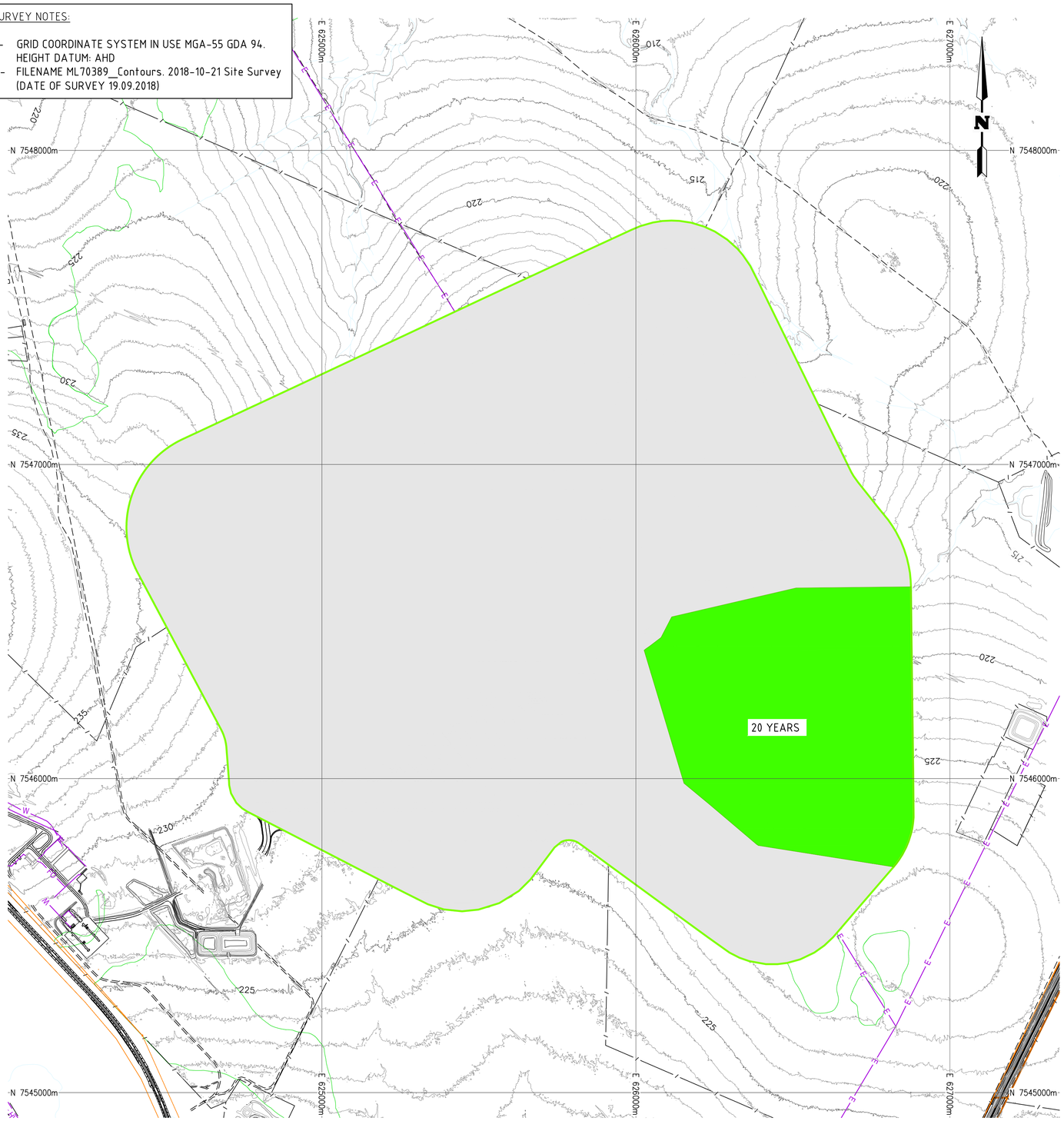
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SHEET No. 3 OF 8
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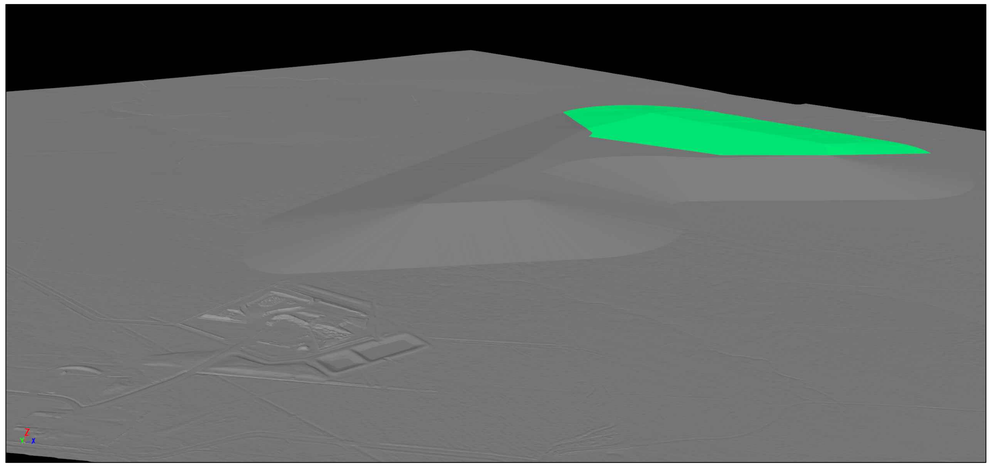
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SURVEY NOTES:

1.- GRID COORDINATE SYSTEM IN USE MGA-55 GDA 94.
HEIGHT DATUM: AHD
2.- FILENAME ML70389_Contours. 2018-10-21 Site Survey
(DATE OF SURVEY 19.09.2018)



FINAL LANDFORM REHABILTATION STAGING 20 YEARS PLAN
SCALE 1:7,500



3D REHABILITATION STAGED DEVELOPMENT
20 YEARS

150 0 150 300 450 600 750
SCALE OF METRES 1:7500

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REV	DESCRIPTION	BY	DRG CHK	ENG CHK	DATE	APPROVED
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SOUTH32 Eagle Downs Coal

CONSULTANT JOB NO 119224-02

ISSUE FOR REPORT

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APPROVED	AW	18/01/23

SCALE 1:7,500 OR AS SHOWN
DO NOT SCALE A1

PROJECT
EAGLE DOWNS COAL PROJECT - DREA FINAL LANDFORM DESIGN

TITLE
DREA FINAL LANDFORM DESIGN
FINAL LANDFORM REHABILTATION STAGING
20 YEARS
SHEET 4 OF 8

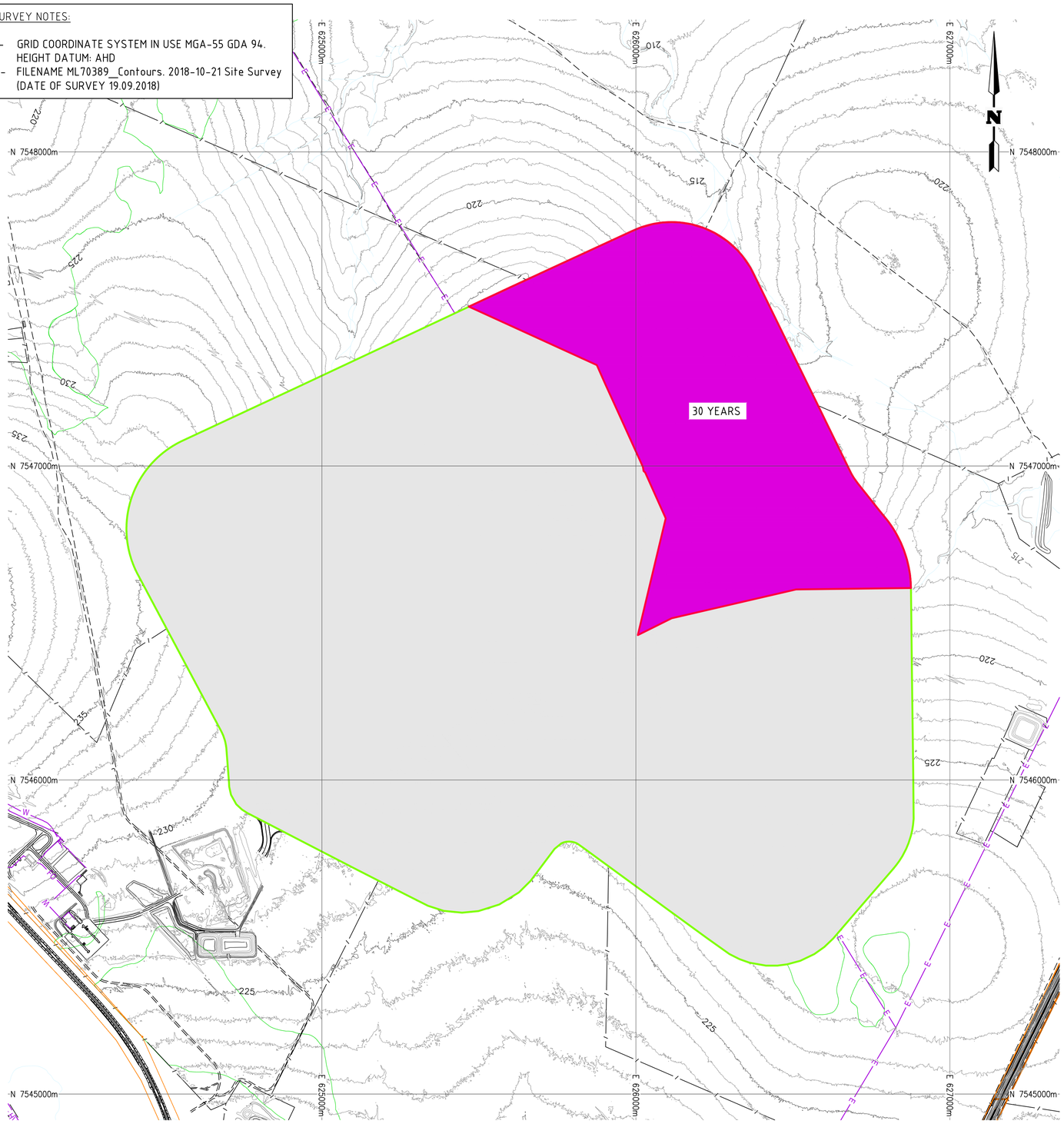
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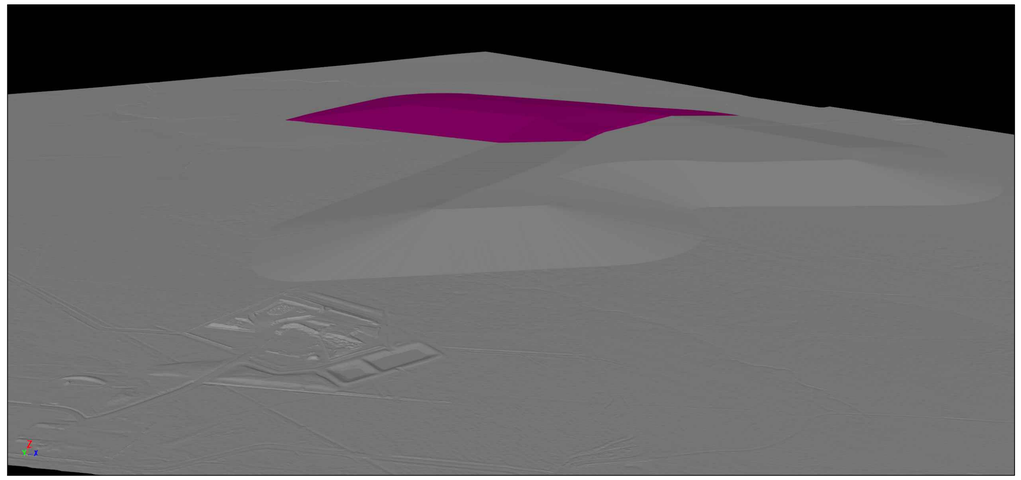
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SURVEY NOTES:

1.- GRID COORDINATE SYSTEM IN USE MGA-55 GDA 94.
HEIGHT DATUM: AHD
2.- FILENAME ML70389_Contours. 2018-10-21 Site Survey
(DATE OF SURVEY 19.09.2018)



FINAL LANDFORM REHABILTATION STAGING 30 YEARS PLAN
SCALE 1:7,500



3D REHABILITATION STAGED DEVELOPMENT
30 YEARS

150 0 150 300 450 600 750
SCALE OF METRES 1:7500

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DRAWING NO	TITLE	REV	DESCRIPTION	BY	DRG CHK	ENG CHK	DATE	APPROVED
		A	ISSUED FOR REPORTING	JC	HA	HA	30/03/23	AW

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SOUTH32 Eagle Downs Coal

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APPROVED	AW	18/01/23

SCALE 1:7,500 OR AS SHOWN
DO NOT SCALE A1

PROJECT EAGLE DOWNS COAL PROJECT - DREA FINAL LANDFORM DESIGN
TITLE DREA FINAL LANDFORM DESIGN
FINAL LANDFORM REHABILTATION STAGING
30 YEARS
SHEET 5 OF 8

DRAWING NO 119224-02-100-005 | SHEET No. 5 OF 8 | REVISION A

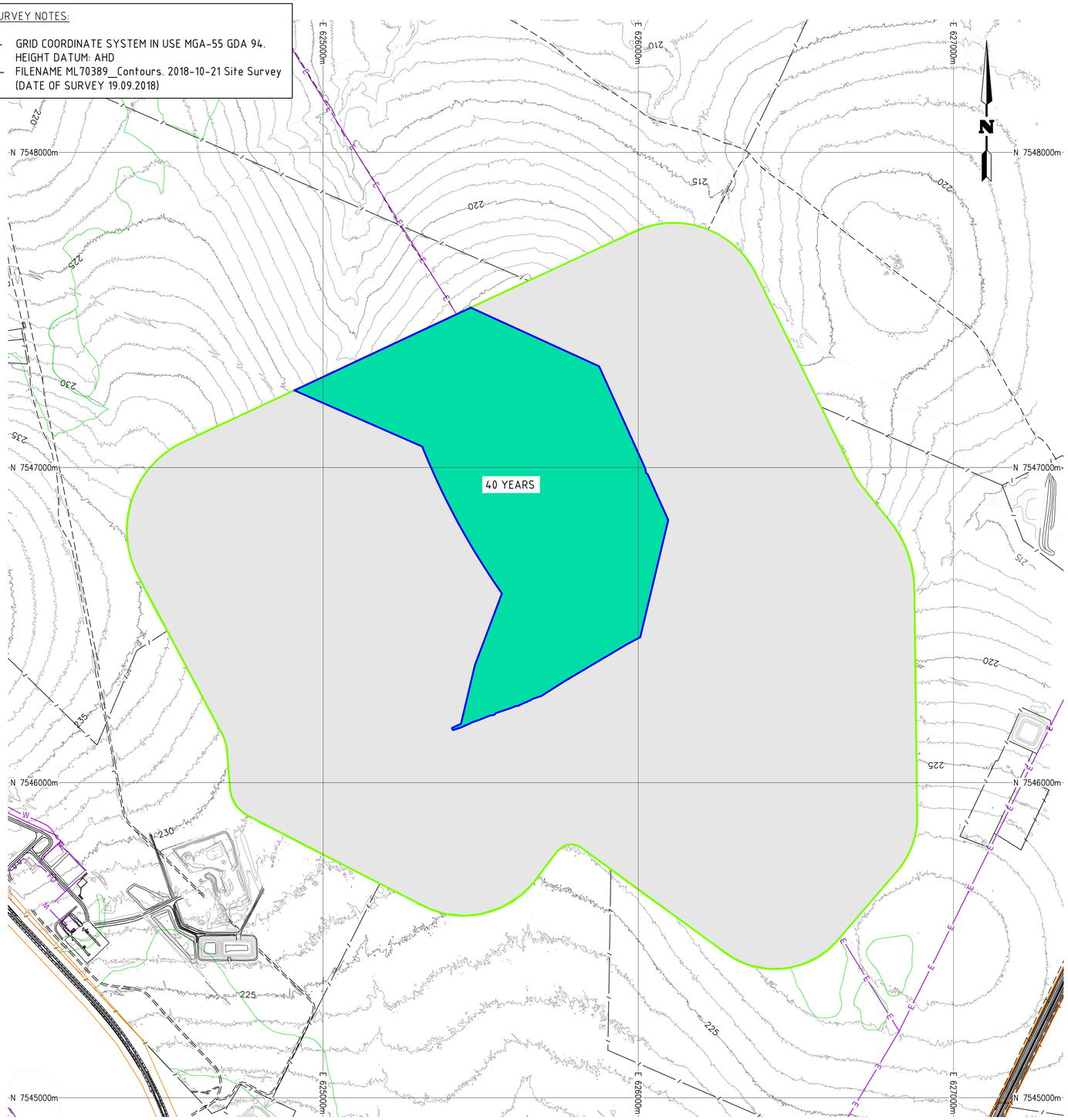
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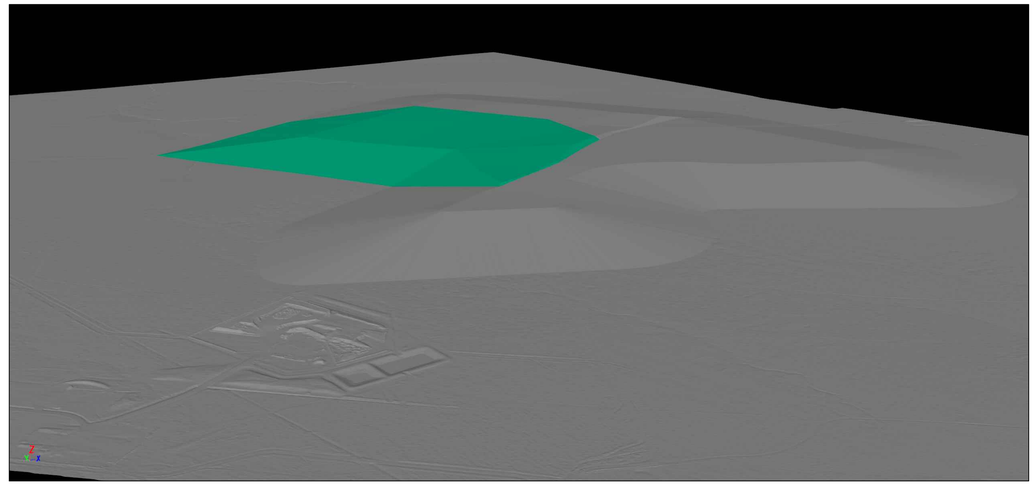
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SURVEY NOTES:

1.- GRID COORDINATE SYSTEM IN USE MGA-55 GDA 94.
HEIGHT DATUM: AHD
2.- FILENAME ML70389_Contours. 2018-10-21 Site Survey
(DATE OF SURVEY 19.09.2018)



FINAL LANDFORM REHABILTATION STAGING 40 YEARS PLAN
SCALE 1:7,500



3D REHABILITATION STAGED DEVELOPMENT
40 YEARS

150 0 150 300 450 600 750
SCALE OF METRES 1:7500

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APPROVED	AW	18/01/23

SCALE 1:7,500 OR AS SHOWN
DO NOT SCALE A1

PROJECT
EAGLE DOWNS COAL PROJECT - DREA FINAL LANDFORM DESIGN

TITLE
DREA FINAL LANDFORM DESIGN
FINAL LANDFORM REHABILTATION STAGING
40 YEARS
SHEET 6 OF 8

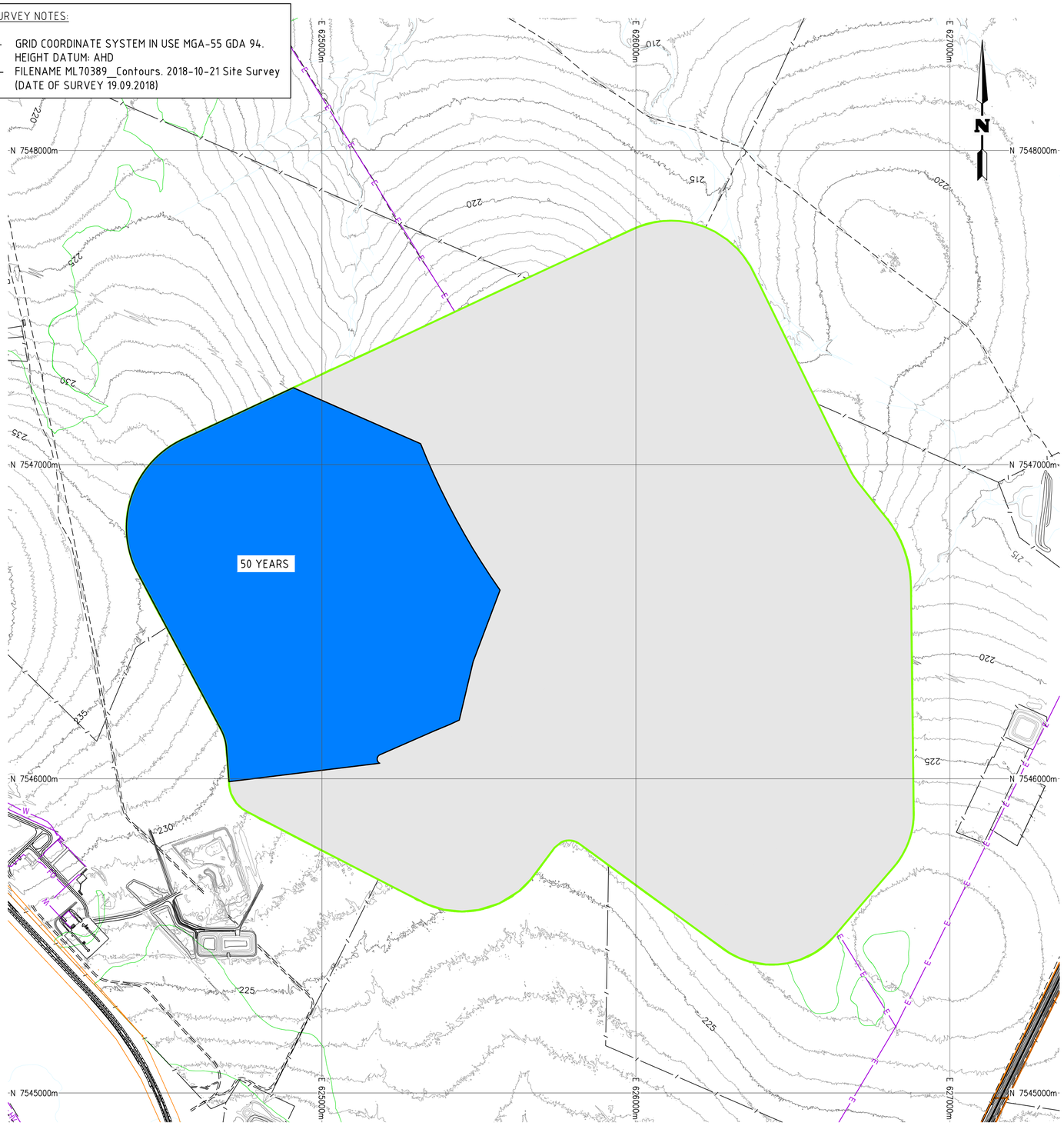
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SHEET No. 6 OF 8
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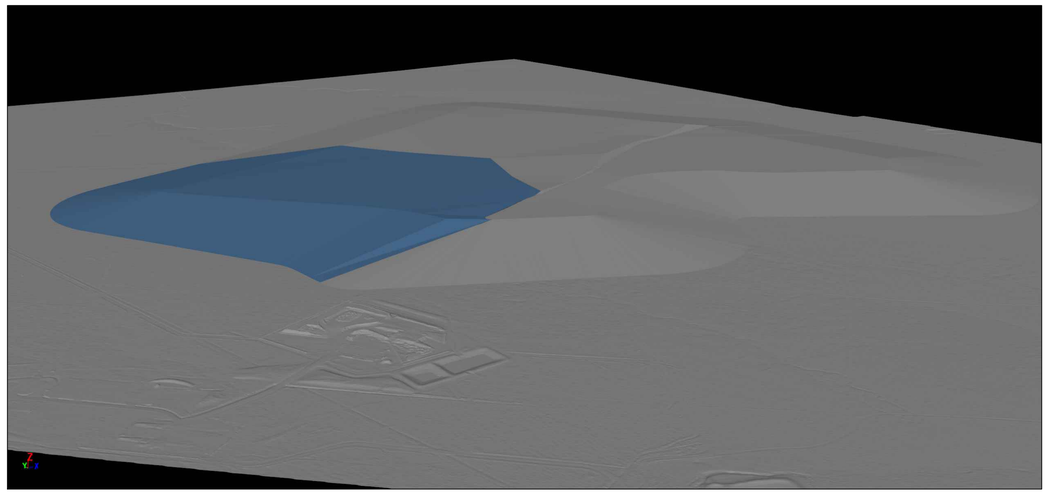
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Cad File No: N:\Synergy\Projects\119\119224 Eagle Downs Coal Management - South32\02 DREA Final Landform Design\CADD\CAD\119224-02-100-006.dwg

SURVEY NOTES:

1.- GRID COORDINATE SYSTEM IN USE MGA-55 GDA 94.
HEIGHT DATUM: AHD
2.- FILENAME ML70389_Contours. 2018-10-21 Site Survey
(DATE OF SURVEY 19.09.2018)



FINAL LANDFORM REHABILTATION STAGING 50 YEARS PLAN
SCALE 1:7,500



3D REHABILITATION STAGED DEVELOPMENT
50 YEARS

150 0 150 300 450 600 750
SCALE OF METRES 1:7500

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APPROVED	AW	18/01/23

SCALE 1:7,500 OR AS SHOWN
DO NOT SCALE A1

PROJECT
EAGLE DOWNS COAL PROJECT - DREA FINAL LANDFORM DESIGN
TITLE
DREA FINAL LANDFORM DESIGN
FINAL LANDFORM REHABILTATION STAGING
50 YEARS
SHEET 7 OF 8

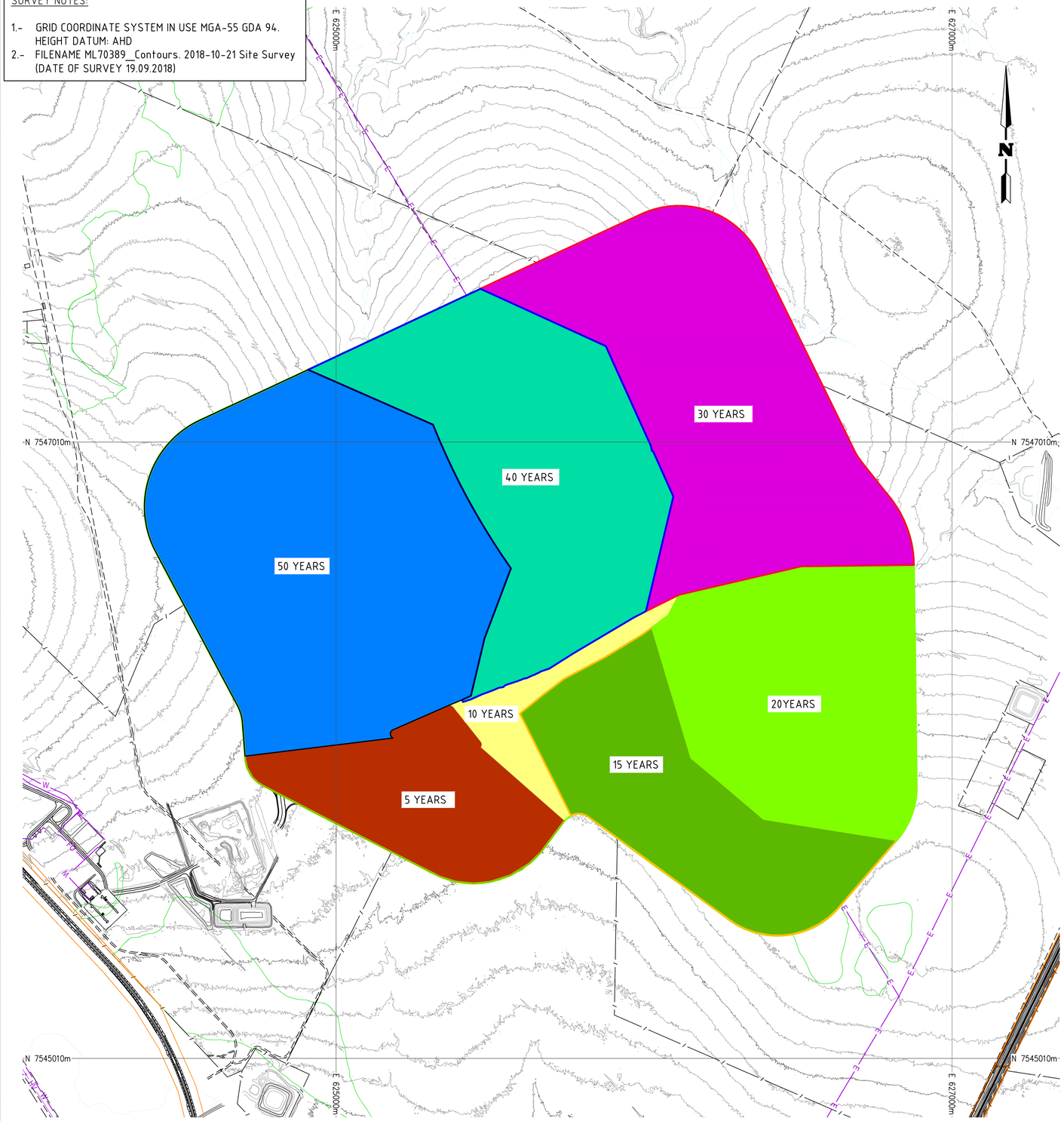
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SHEET No. 7 OF 8
REVISION A

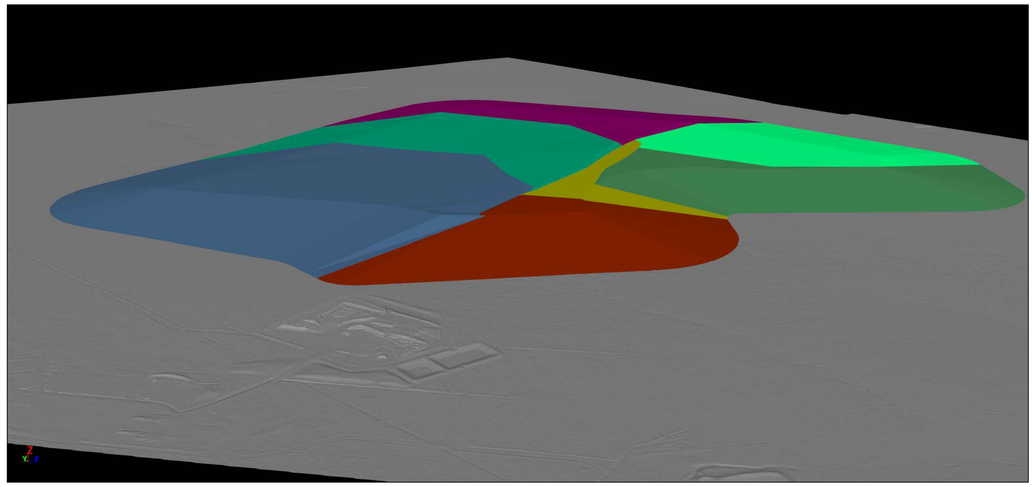
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SURVEY NOTES:

1.- GRID COORDINATE SYSTEM IN USE MGA-55 GDA 94.
HEIGHT DATUM: AHD
2.- FILENAME ML70389_Contours. 2018-10-21 Site Survey
(DATE OF SURVEY 19.09.2018)





3D STAGED DEVELOPMENT
OVERALL YEARS

STAGES	AREA
5 YEARS	315,314.65m^2
10 YEARS	95,720.45m^2
15 YEARS	473,530.45m^2
20 YEARS	609,616.18m^2
30 YEARS	829,813.31m^2
40 YEARS	731,145.98m^2
50 YEARS	1,030,118.10m^2
TOTAL	4,085,259.38m^2

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A	ISSUED FOR REPORTING	JC	HA	HA	30/03/23	AW

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CONSULTANT JOB NO 119224-02

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SCALE 1:7,500 OR AS SHOWN
DO NOT SCALE A1

PROJECT
EAGLE DOWNS COAL PROJECT - DREA FINAL LANDFORM DESIGN

TITLE
DREA FINAL LANDFORM DESIGN
FINAL LANDFORM REHABILTATION STAGING
OVERALL YEARS AND AREAS
SHEET 8 OF 8

DRAWING NO 119224-02-100-008
SHEET No. 8 OF 8
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Plot Date: 30 March 2023 - 3:14 PM Plotted by:James Camille

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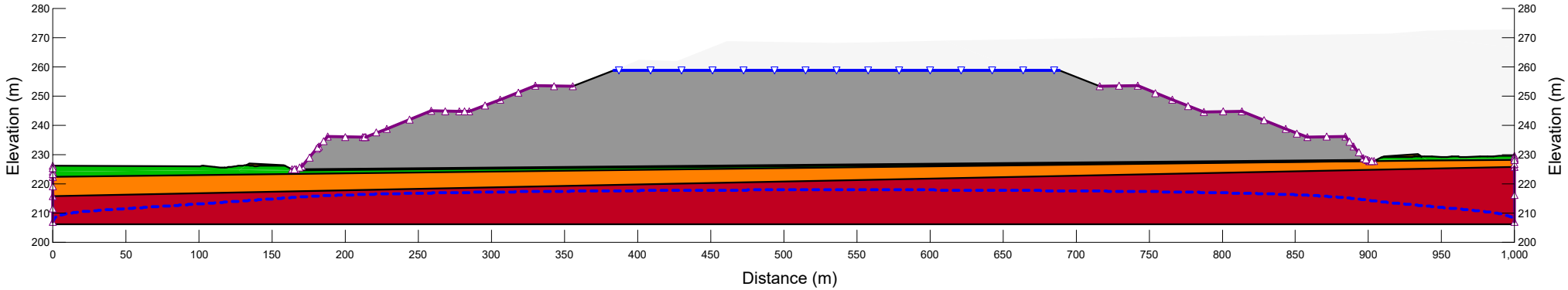
APPENDICES

APPENDIX A – STABILITY ASSESSMENT

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Color	Name	Hydraulic Material Model	Sat Kx (m/sec)	Ky'/Kx' Ratio	Volumetric Water Content
	[Seepage] Compacted Clay	Saturated Only	1e-09	1	0.4
	[Seepage] Fresh Bedrock	Saturated Only	1e-07	1	0.4
	[Seepage] Rejects	Saturated Only	1e-06	1	0.4
	[Seepage] Surface Soil	Saturated Only	1e-06	1	0.4
	[Seepage] Weathered Bedrock	Saturated Only	1e-07	1	0.4

Color	Name	Category	Kind	Parameters
	Drainage	Hydraulic	Water Rate	0 m³/sec
	Rainfall_2010-2015	Hydraulic	Water Flux	Rainfall 2010-2015 - 30% Infiltration



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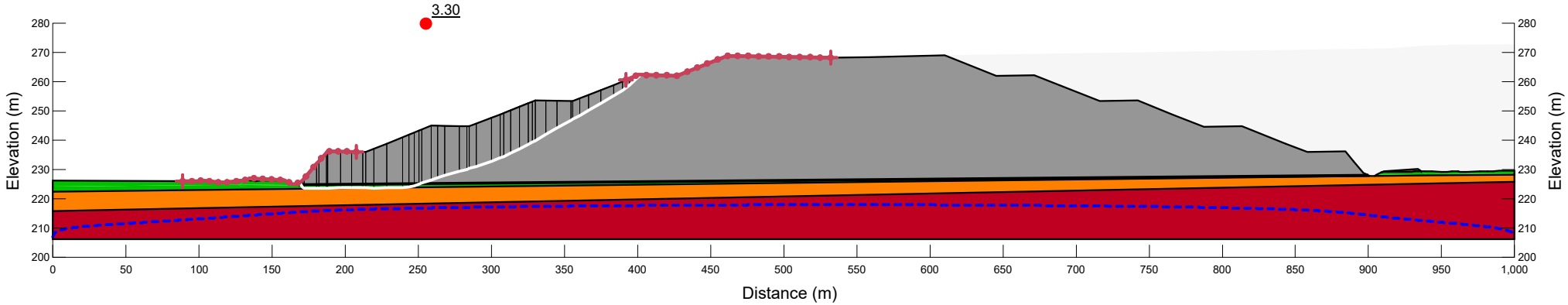
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section A: End of Construction (EoC) - 0-5 years

Date: 12/01/2023 | Job No: 119224.02 | Appendix A-1

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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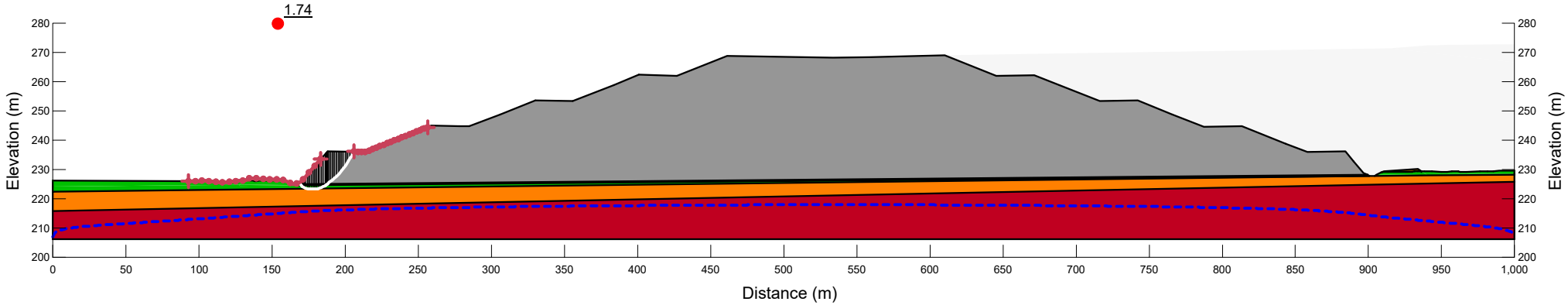
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section A: EoC - LHS Slope - 0-5 years

Date: 12/01/2023 | Job No: 119224.02 | Appendix A-2

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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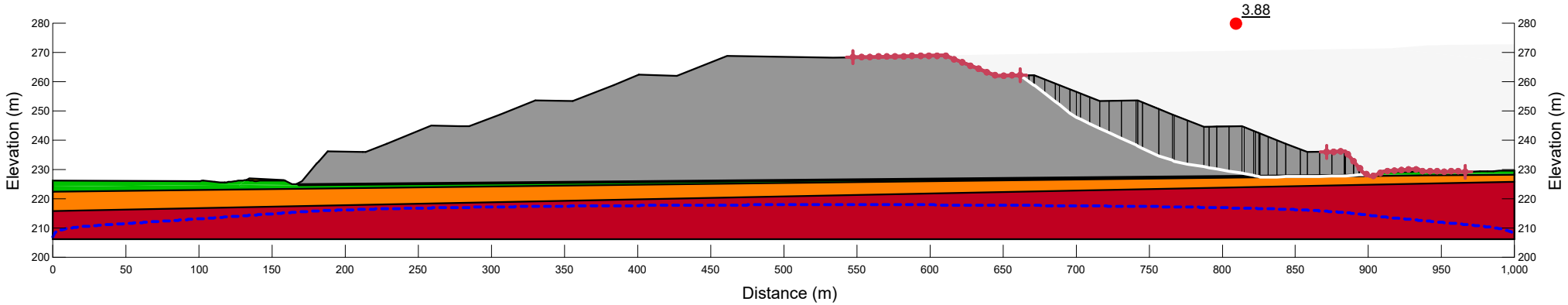
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section A: EoC - LHS Slope - 0-5 years - Local

Date: 13/01/2023 | Job No: 119224.02 | Appendix A-3

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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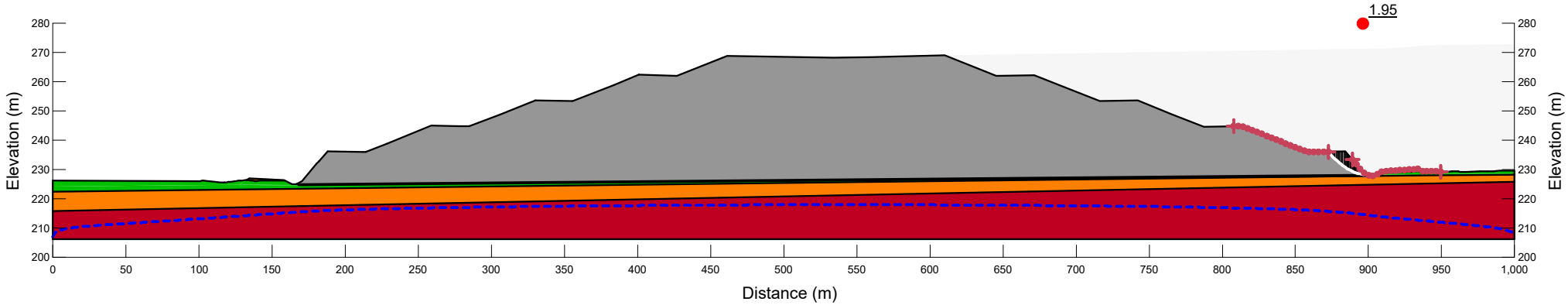
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section A: EoC - RHS Slope - 0-5 years

Date: 12/01/2023 | Job No: 119224.02 | Appendix A-4

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

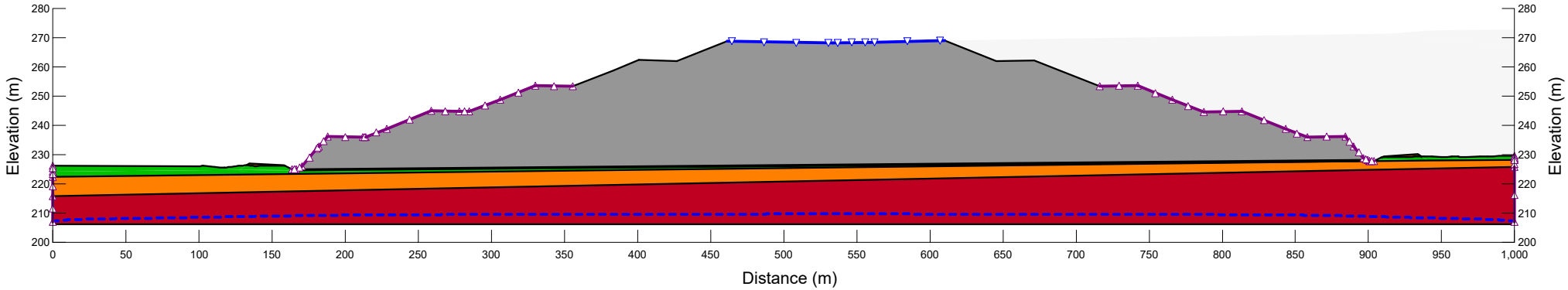
Section A: EoC - RHS Slope - 0-5 years - Local

Date: 13/01/2023 | Job No: 119224.02 | Appendix A-5

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Color	Name	Hydraulic Material Model	Sat Kx (m/sec)	Ky'/Kx' Ratio	Volumetric Water Content
	[Seepage] Compacted Clay	Saturated Only	1e-09	1	0.4
	[Seepage] Fresh Bedrock	Saturated Only	1e-07	1	0.4
	[Seepage] Rejects	Saturated Only	1e-06	1	0.4
	[Seepage] Surface Soil	Saturated Only	1e-06	1	0.4
	[Seepage] Weathered Bedrock	Saturated Only	1e-07	1	0.4

Color	Name	Category	Kind	Parameters
	Drainage	Hydraulic	Water Rate	0 m³/sec
	Rainfall_2010-2015	Hydraulic	Water Flux	Rainfall 2010-2015 - 30% Infiltration



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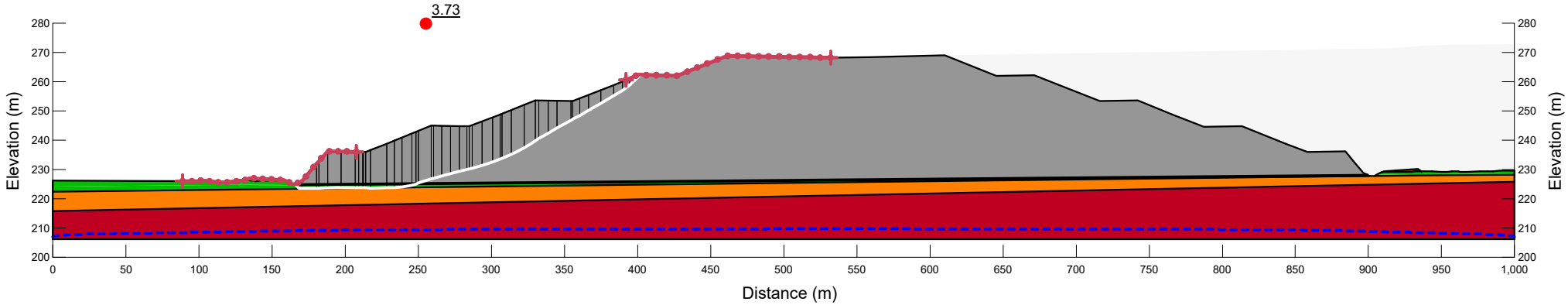
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section A: Long Term - 0-5 years

Date: 12/01/2023 | Job No: 119224.02 | Appendix A-6

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	[Drained] Compacted Clay	Mohr-Coulomb	20						1	28
	[Drained] Fresh Bedrock	Hoek-Brown	20	175,000	10	30	0.1	800		
	[Drained] Rejects	Mohr-Coulomb	18						1	30
	[Drained] Surface Soil	Mohr-Coulomb	21						1	21
	[Drained] Weathered Bedrock	Hoek-Brown	20	50,000	10	30	0.6	800		



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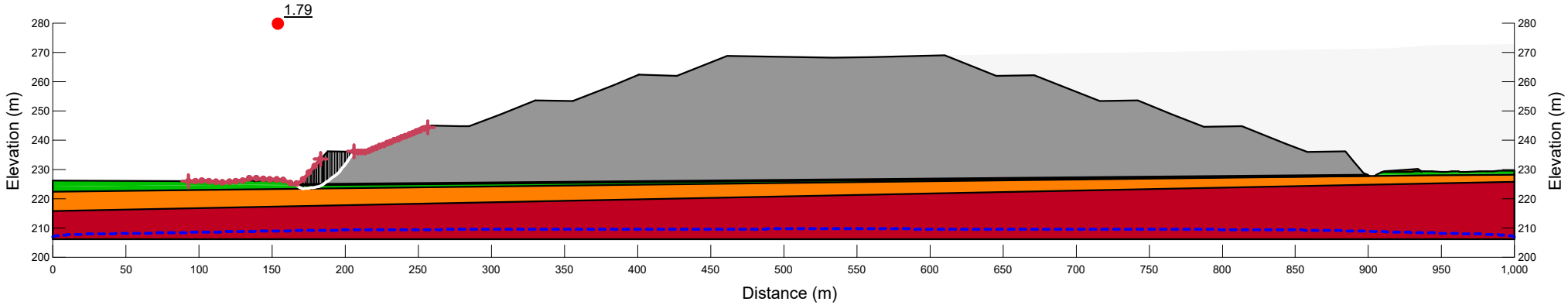
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section A: LHS Slope - Long Term - Drained - 0-5 years

Date: 12/01/2023 | Job No: 119224.02 | Appendix A-7

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	[Drained] Compacted Clay	Mohr-Coulomb	20						1	28
	[Drained] Fresh Bedrock	Hoek-Brown	20	175,000	10	30	0.1	800		
	[Drained] Rejects	Mohr-Coulomb	18						1	30
	[Drained] Surface Soil	Mohr-Coulomb	21						1	21
	[Drained] Weathered Bedrock	Hoek-Brown	20	50,000	10	30	0.6	800		



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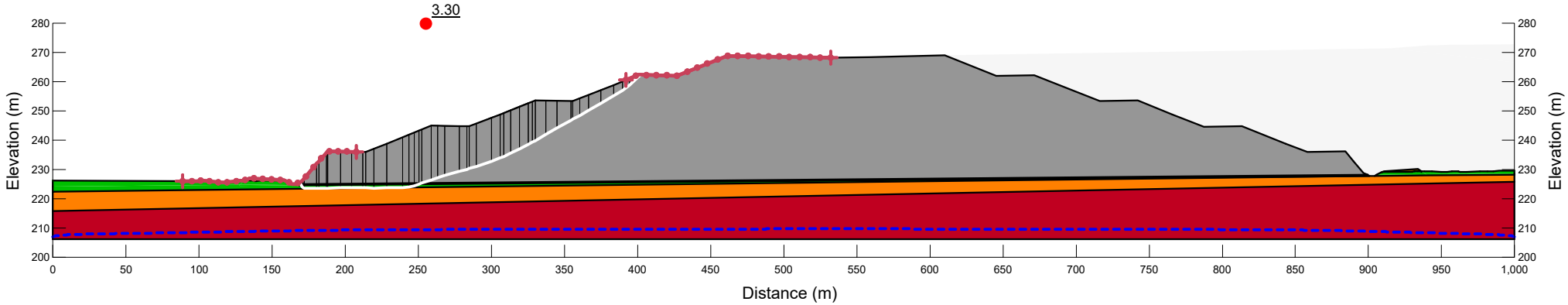
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section A: LHS Slope - Long Term - Drained - 0-5 years - Local

Date: 13/01/2023 | Job No: 119224.02 | Appendix A-8

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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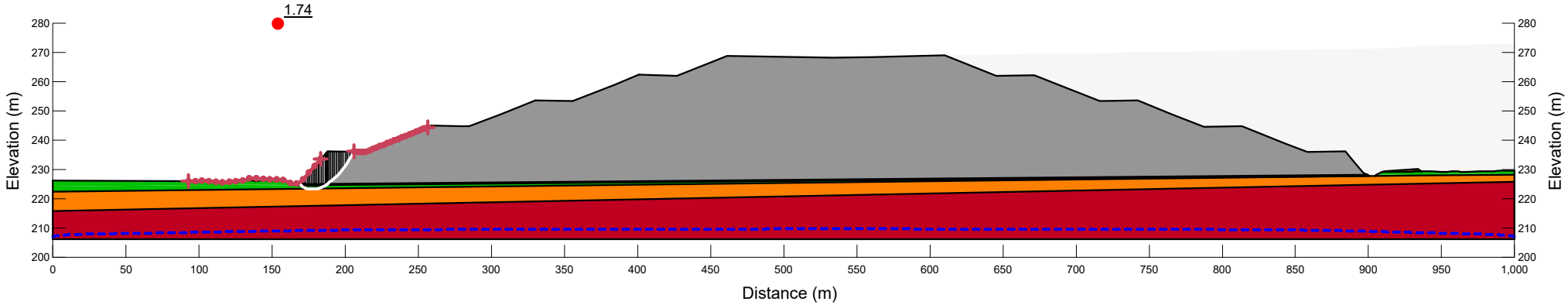
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section A: LHS Slope - Long Term - Undrained - 0-5 years

Date: 12/01/2023 | Job No: 119224.02 | Appendix A-9

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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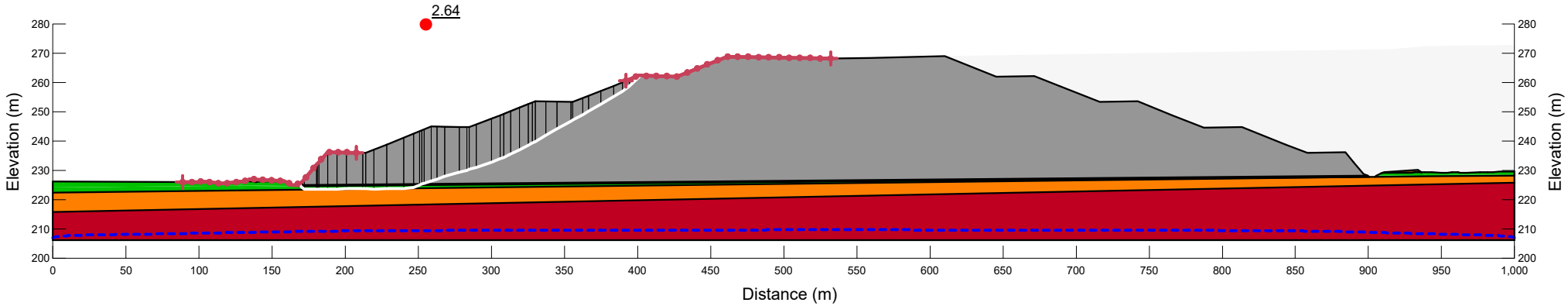
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section A: LHS Slope - Long Term - Undrained - 0-5 years - Local

Date: 13/01/2023 | Job No: 119224.02 | Appendix A-10

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Softened Drained] Rejects (20% Reduction)	Mohr-Coulomb	18			1	24.8					
	[Softened Undrained] Compacted Clay (20% Reduction)	SHANSEP	20	32	0.28							
	[Softened Undrained] Surface Soil (20% Reduction)	SHANSEP	21	36	0.19							



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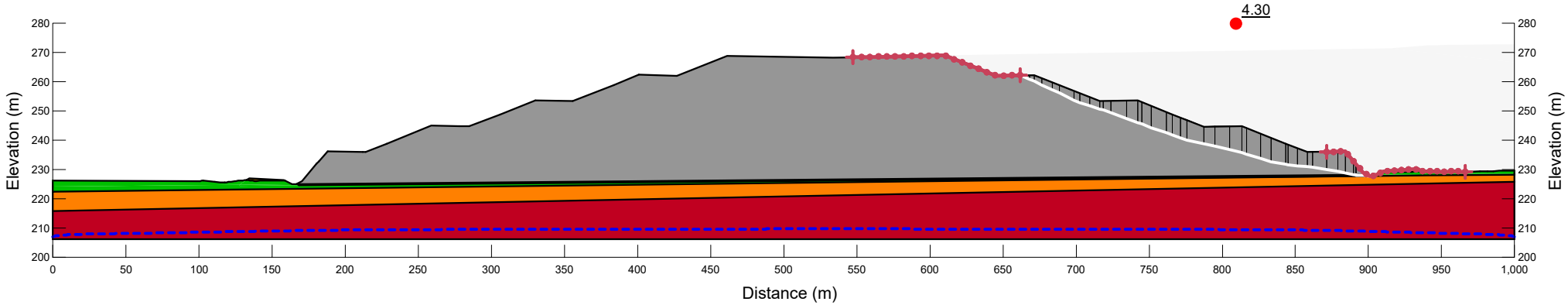
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section A: LHS Slope - Post-Seismic - 0-5 years

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	[Drained] Compacted Clay	Mohr-Coulomb	20						1	28
	[Drained] Fresh Bedrock	Hoek-Brown	20	175,000	10	30	0.1	800		
	[Drained] Rejects	Mohr-Coulomb	18						1	30
	[Drained] Surface Soil	Mohr-Coulomb	21						1	21
	[Drained] Weathered Bedrock	Hoek-Brown	20	50,000	10	30	0.6	800		



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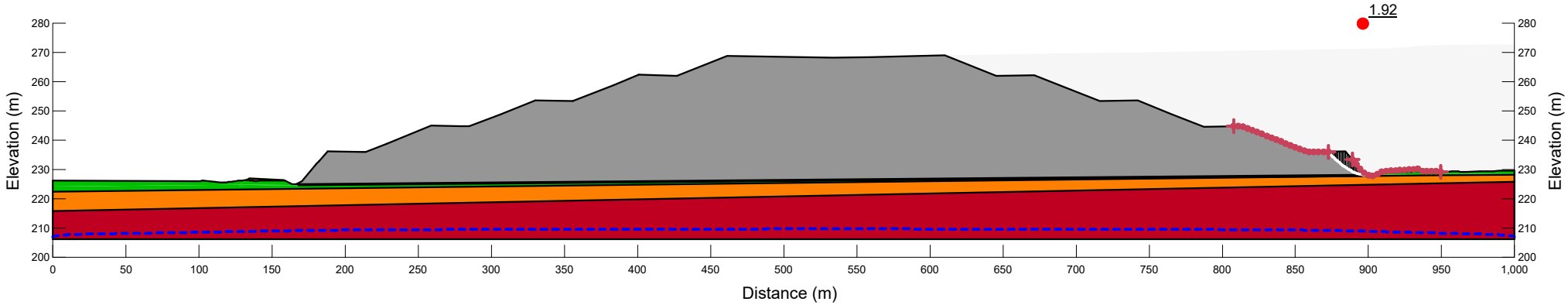
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section A: RHS Slope - Long Term - Drained - 0-5 years

Date: 12/01/2023 | Job No: 119224.02 | Appendix A-12

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	[Drained] Compacted Clay	Mohr-Coulomb	20						1	28
	[Drained] Fresh Bedrock	Hoek-Brown	20	175,000	10	30	0.1	800		
	[Drained] Rejects	Mohr-Coulomb	18						1	30
	[Drained] Surface Soil	Mohr-Coulomb	21						1	21
	[Drained] Weathered Bedrock	Hoek-Brown	20	50,000	10	30	0.6	800		



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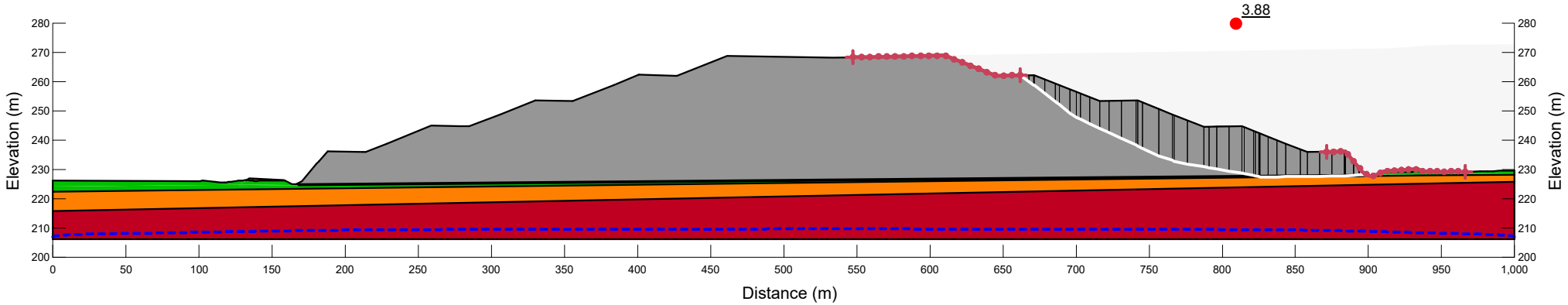
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section A: RHS Slope - Long Term - Drained - 0-5 years - Local

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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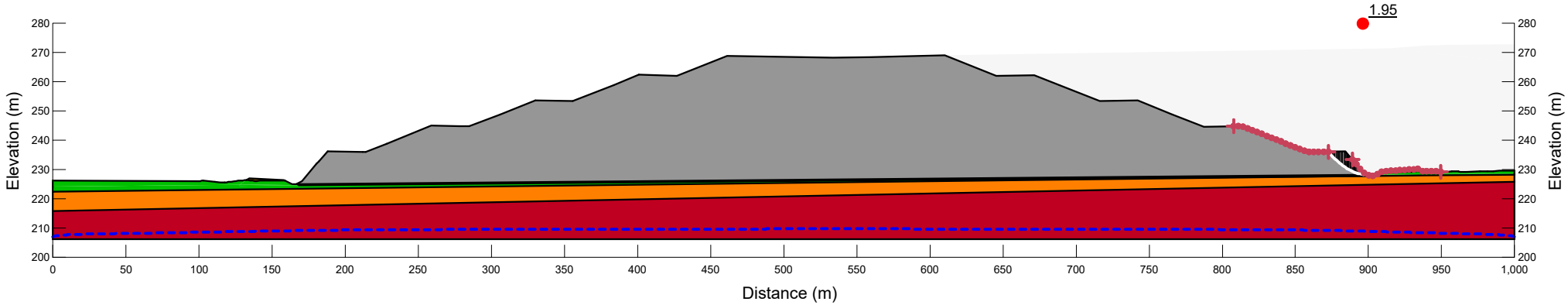
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section A: RHS Slope - Long Term - Undrained - 0-5 years

Date: 12/01/2023 | Job No: 119224.02 | Appendix A-14

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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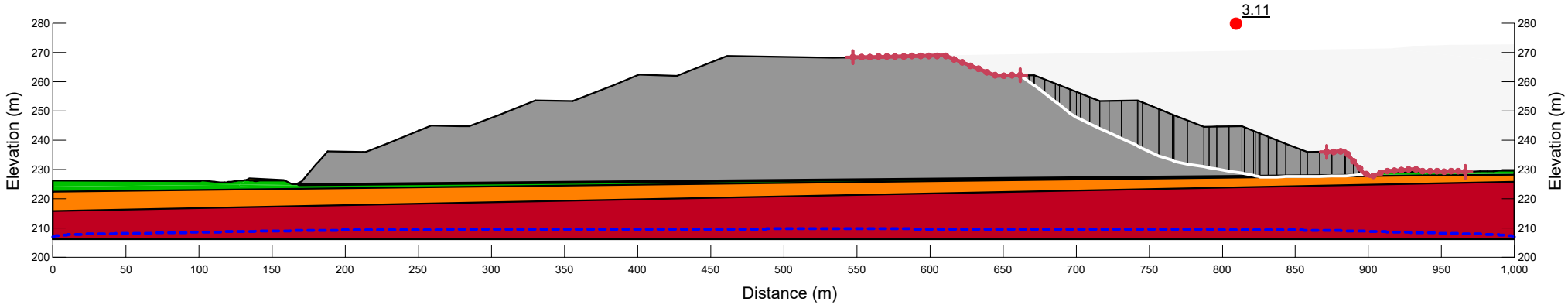
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section A: RHS Slope - Long Term - Undrained - 0-5 years - Local

Date: 13/01/2023 | Job No: 119224.02 | Appendix A-15

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Softened Drained] Rejects (20% Reduction)	Mohr-Coulomb	18			1	24.8					
	[Softened Undrained] Compacted Clay (20% Reduction)	SHANSEP	20	32	0.28							
	[Softened Undrained] Surface Soil (20% Reduction)	SHANSEP	21	36	0.19							



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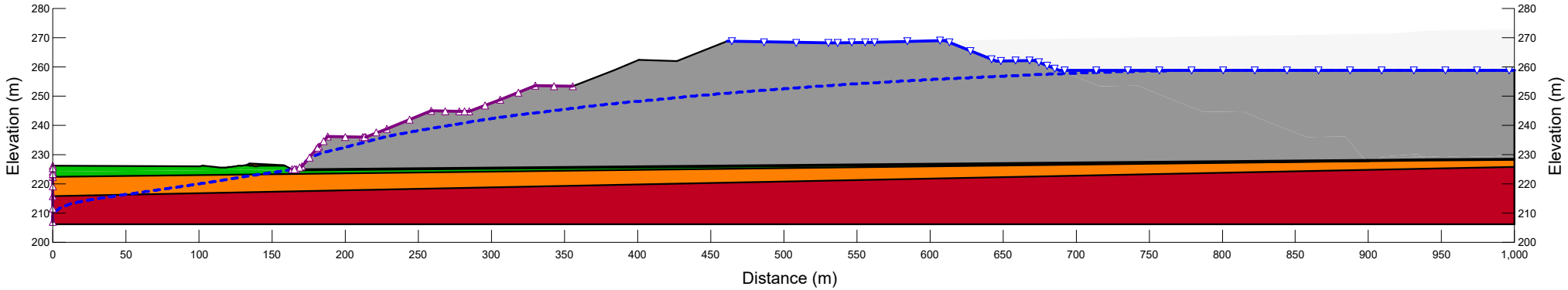
Section A: RHS Slope - Post-Seismic - 0-5 years

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Color	Name	Hydraulic Material Model	Sat Kx (m/sec)	Ky'/Kx' Ratio	Volumetric Water Content
	[Seepage] Compacted Clay	Saturated Only	1e-09	1	0.4
	[Seepage] Fresh Bedrock	Saturated Only	1e-07	1	0.4
	[Seepage] Rejects	Saturated Only	1e-06	1	0.4
	[Seepage] Surface Soil	Saturated Only	1e-06	1	0.4
	[Seepage] Weathered Bedrock	Saturated Only	1e-07	1	0.4

Color	Name	Category	Kind	Parameters
	Drainage	Hydraulic	Water Rate	0 m³/sec
	Rainfall_2010-2015	Hydraulic	Water Flux	Rainfall 2010-2015 - 30% Infiltration



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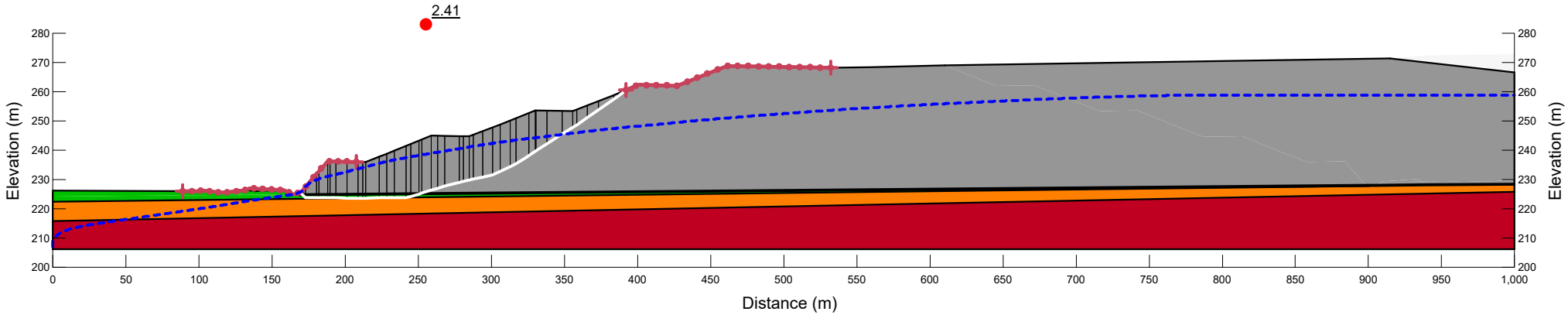
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section A: End of Construction (EoC) - 05-20 years

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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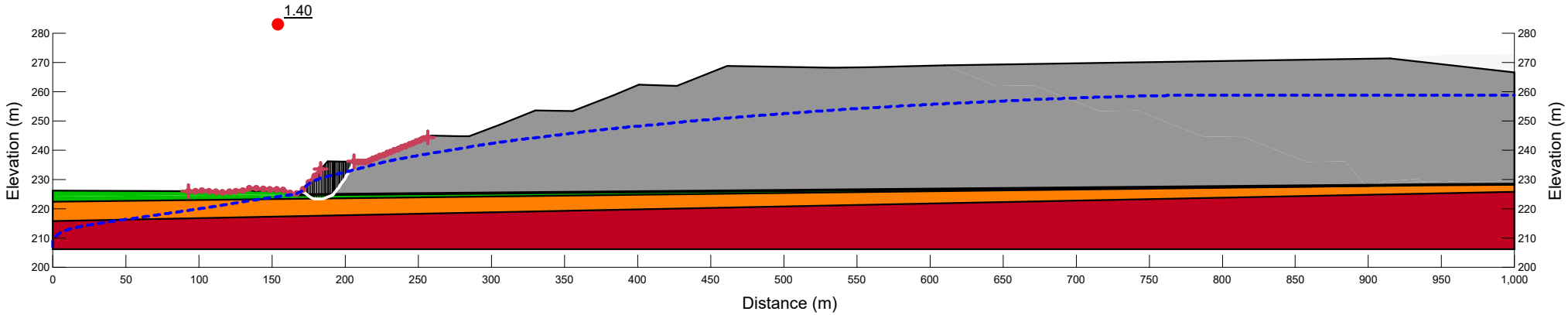
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section A: EoC - 5-20 years

Date: 12/01/2023 | Job No: 119224.02 | Appendix A-18

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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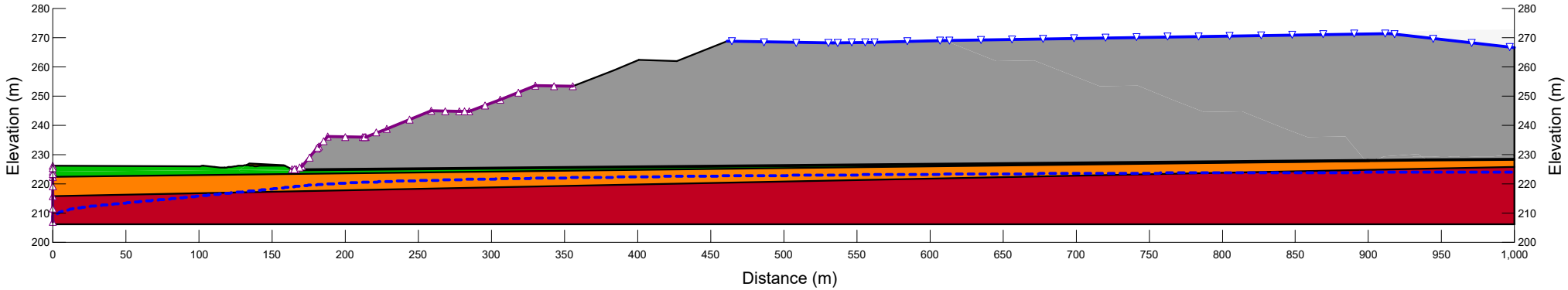
Section A: EoC - 5-20 years - Local

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Color	Name	Hydraulic Material Model	Sat Kx (m/sec)	Ky'/Kx' Ratio	Volumetric Water Content
	[Seepage] Compacted Clay	Saturated Only	1e-09	1	0.4
	[Seepage] Fresh Bedrock	Saturated Only	1e-07	1	0.4
	[Seepage] Rejects	Saturated Only	1e-06	1	0.4
	[Seepage] Surface Soil	Saturated Only	1e-06	1	0.4
	[Seepage] Weathered Bedrock	Saturated Only	1e-07	1	0.4

Color	Name	Category	Kind	Parameters
	Drainage	Hydraulic	Water Rate	0 m³/sec
	Rainfall_2010-2015	Hydraulic	Water Flux	Rainfall 2010-2015 - 30% Infiltration



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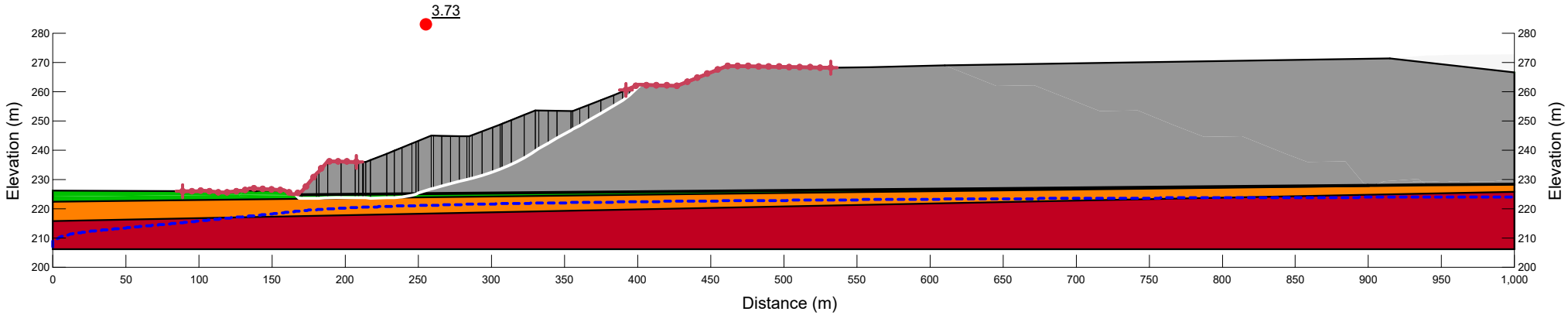
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section A: Long Term - 5-20 years

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	[Drained] Compacted Clay	Mohr-Coulomb	20						1	28
	[Drained] Fresh Bedrock	Hoek-Brown	20	175,000	10	30	0.1	800		
	[Drained] Rejects	Mohr-Coulomb	18						1	30
	[Drained] Surface Soil	Mohr-Coulomb	21						1	21
	[Drained] Weathered Bedrock	Hoek-Brown	20	50,000	10	30	0.6	800		



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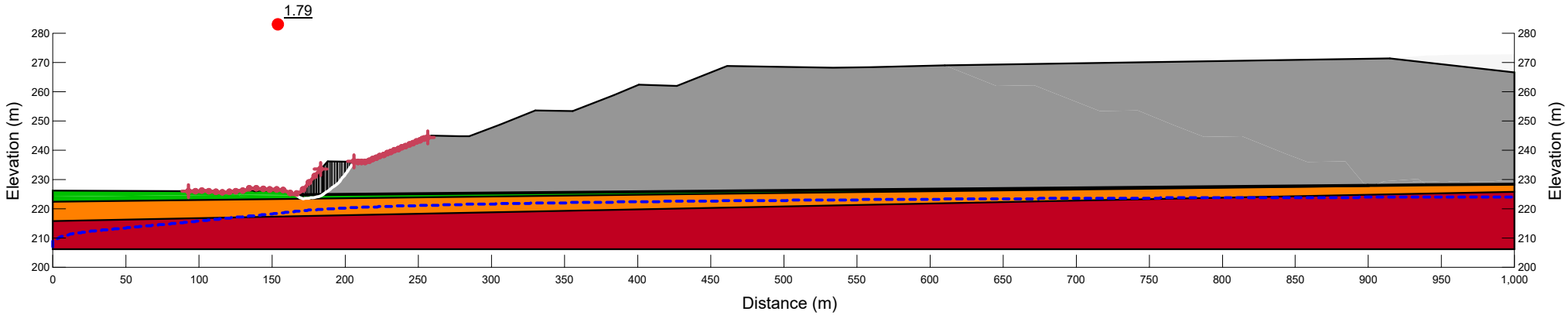
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section A: Long Term - Drained - 5-20 years

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	[Drained] Compacted Clay	Mohr-Coulomb	20						1	28
	[Drained] Fresh Bedrock	Hoek-Brown	20	175,000	10	30	0.1	800		
	[Drained] Rejects	Mohr-Coulomb	18						1	30
	[Drained] Surface Soil	Mohr-Coulomb	21						1	21
	[Drained] Weathered Bedrock	Hoek-Brown	20	50,000	10	30	0.6	800		



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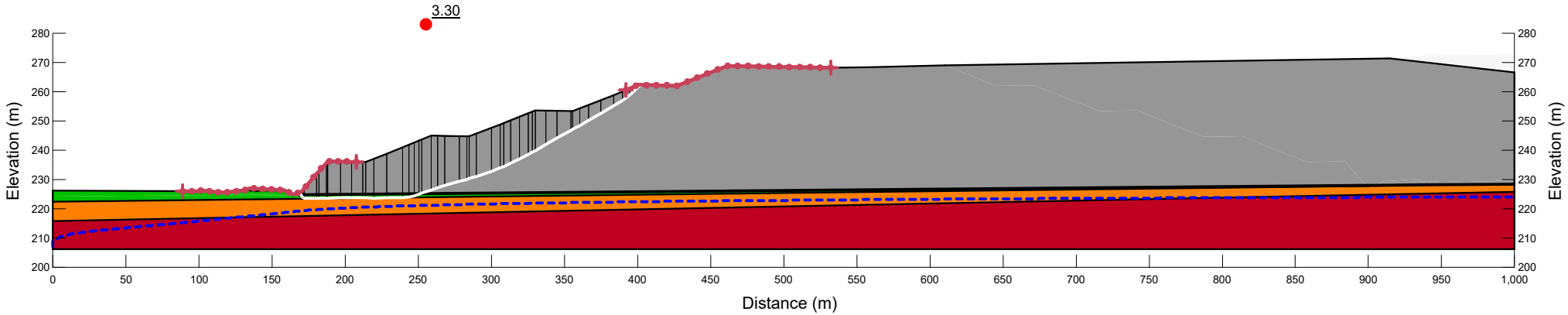
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section A: Long Term - Drained - 5-20 years - Local

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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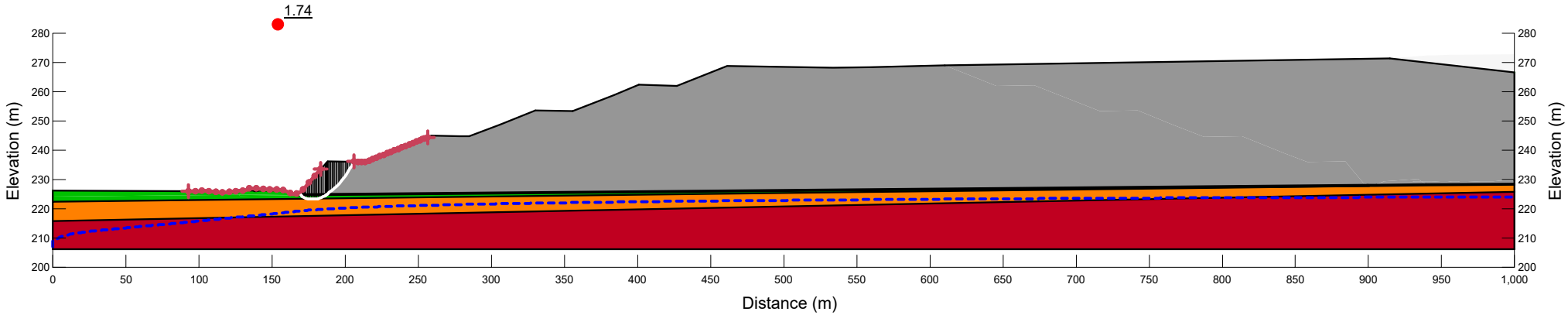
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section A: Long Term - Undrained - 5-20 years

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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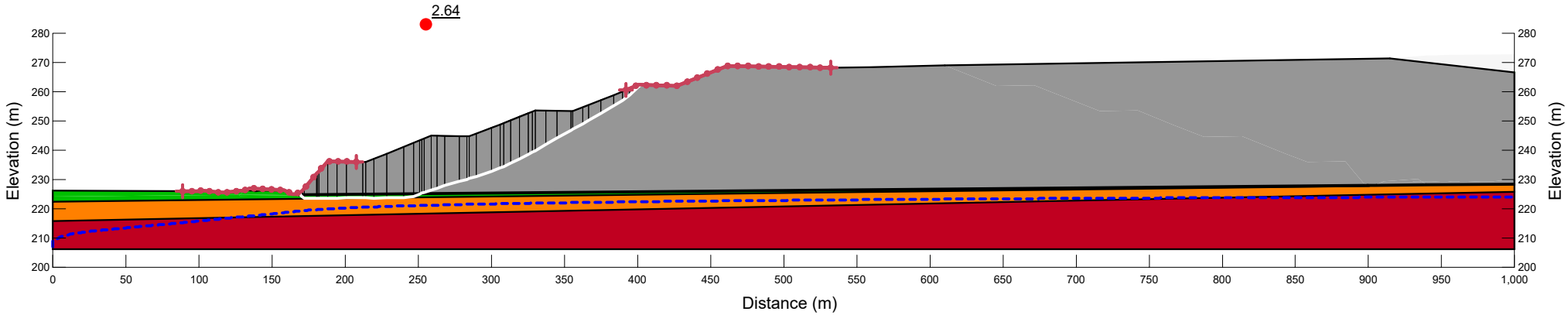
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section A: Long Term - Undrained - 5-20 years - Local

Date: 13/01/2023 | Job No: 119224.02 | Appendix A-24

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Softened Drained] Rejects (20% Reduction)	Mohr-Coulomb	18			1	24.8					
	[Softened Undrained] Compacted Clay (20% Reduction)	SHANSEP	20	32	0.28							
	[Softened Undrained] Surface Soil (20% Reduction)	SHANSEP	21	36	0.19							



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DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

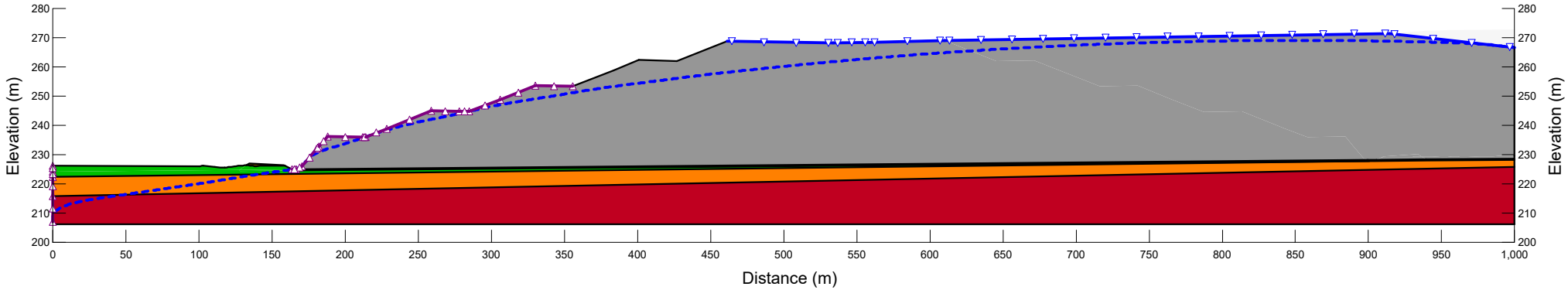
Section A: Post-Seismic - 5-20 years

Date: 12/01/2023 | Job No: 119224.02 | Appendix A-25

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Color	Name	Hydraulic Material Model	Sat Kx (m/sec)	Ky'/Kx' Ratio	Volumetric Water Content
	[Seepage] Compacted Clay	Saturated Only	1e-09	1	0.4
	[Seepage] Fresh Bedrock	Saturated Only	1e-07	1	0.4
	[Seepage] Rejects	Saturated Only	1e-06	1	0.4
	[Seepage] Surface Soil	Saturated Only	1e-06	1	0.4
	[Seepage] Weathered Bedrock	Saturated Only	1e-07	1	0.4

Color	Name	Category	Kind	Parameters
	Drainage	Hydraulic	Water Rate	0 m³/sec
	Rainfall_2010-2015	Hydraulic	Water Flux	Rainfall 2010-2015 - 30% Infiltration



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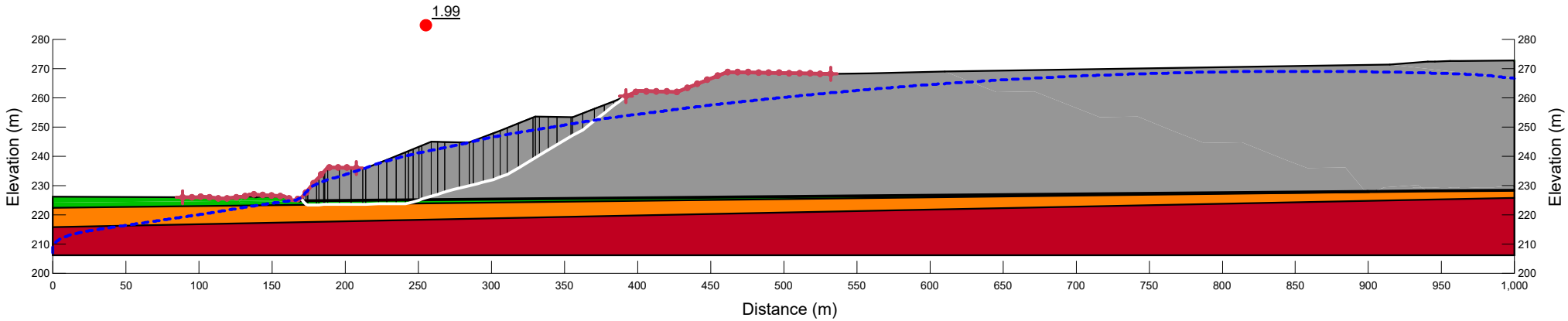
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section A: End of Construction (EoC) - 20-50 years

Date: 12/01/2023 | Job No: 119224.02 | Appendix A-26

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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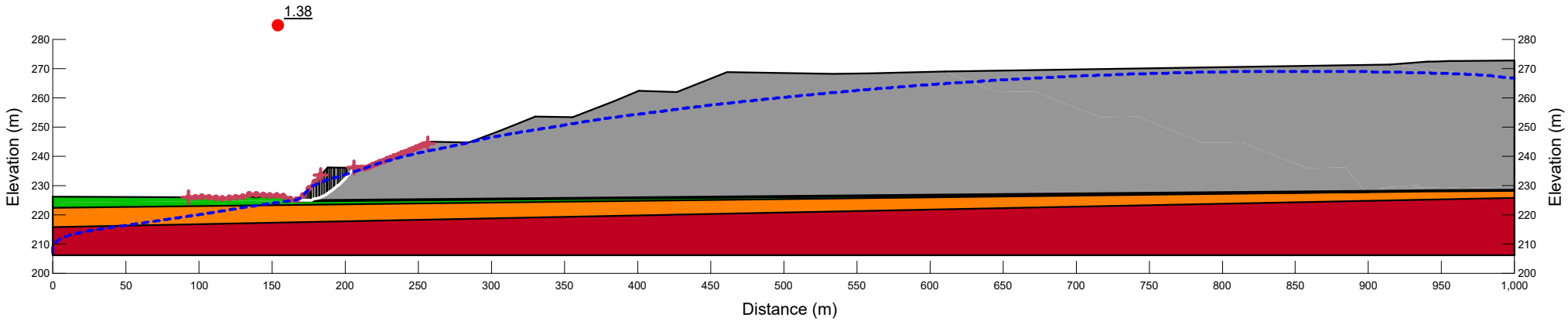
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section A: EoC - 20-50 years

Date: 12/01/2023 | Job No: 119224.02 | Appendix A-27

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

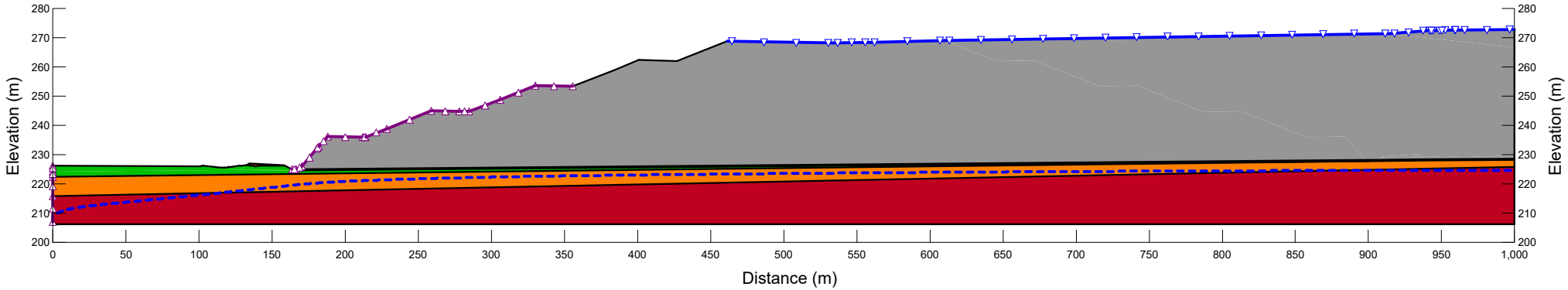
Section A: EoC - 20-50 years - Local

Date: 13/01/2023 | Job No: 119224.02 | Appendix A-28

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Color	Name	Hydraulic Material Model	Sat Kx (m/sec)	Ky'/Kx' Ratio	Volumetric Water Content
	[Seepage] Compacted Clay	Saturated Only	1e-09	1	0.4
	[Seepage] Fresh Bedrock	Saturated Only	1e-07	1	0.4
	[Seepage] Rejects	Saturated Only	1e-06	1	0.4
	[Seepage] Surface Soil	Saturated Only	1e-06	1	0.4
	[Seepage] Weathered Bedrock	Saturated Only	1e-07	1	0.4

Color	Name	Category	Kind	Parameters
	Drainage	Hydraulic	Water Rate	0 m³/sec
	Rainfall_2010-2015	Hydraulic	Water Flux	Rainfall 2010-2015 - 30% Infiltration



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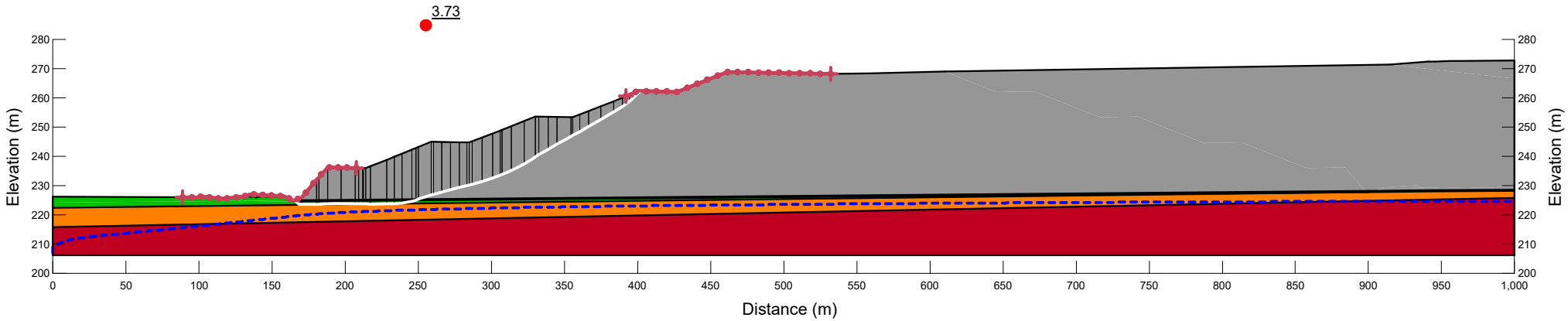
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section A: Long Term - 20-50 years

Date: 12/01/2023 | Job No: 119224.02 | Appendix A-29

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	[Drained] Compacted Clay	Mohr-Coulomb	20						1	28
	[Drained] Fresh Bedrock	Hoek-Brown	20	175,000	10	30	0.1	800		
	[Drained] Rejects	Mohr-Coulomb	18						1	30
	[Drained] Surface Soil	Mohr-Coulomb	21						1	21
	[Drained] Weathered Bedrock	Hoek-Brown	20	50,000	10	30	0.6	800		



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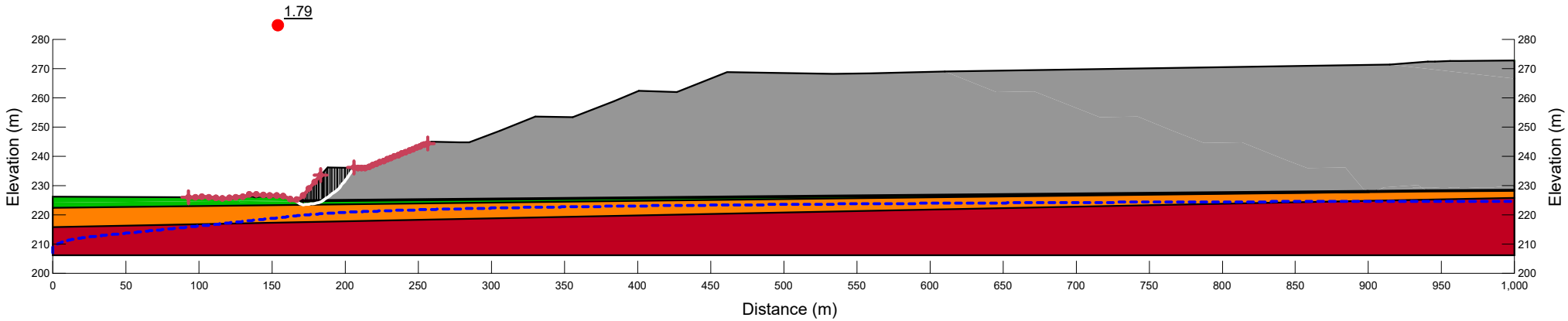
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section A: Long Term - Drained - 20-50 years

Date: 12/01/2023 | Job No: 119224.02 | Appendix A-30

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	[Drained] Compacted Clay	Mohr-Coulomb	20						1	28
	[Drained] Fresh Bedrock	Hoek-Brown	20	175,000	10	30	0.1	800		
	[Drained] Rejects	Mohr-Coulomb	18						1	30
	[Drained] Surface Soil	Mohr-Coulomb	21						1	21
	[Drained] Weathered Bedrock	Hoek-Brown	20	50,000	10	30	0.6	800		



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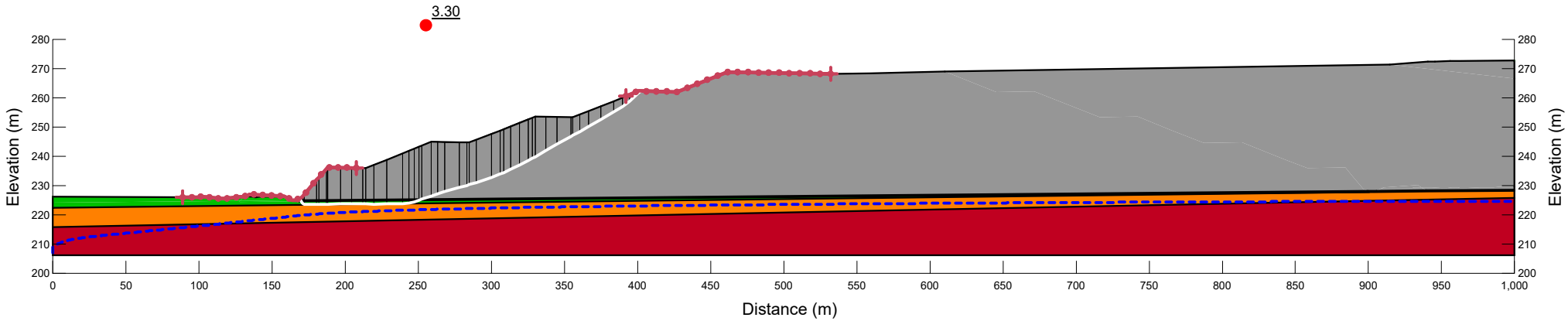
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section A: Long Term - Drained - 20-50 years - Local

Date: 13/01/2023 | Job No: 119224.02 | Appendix A-31

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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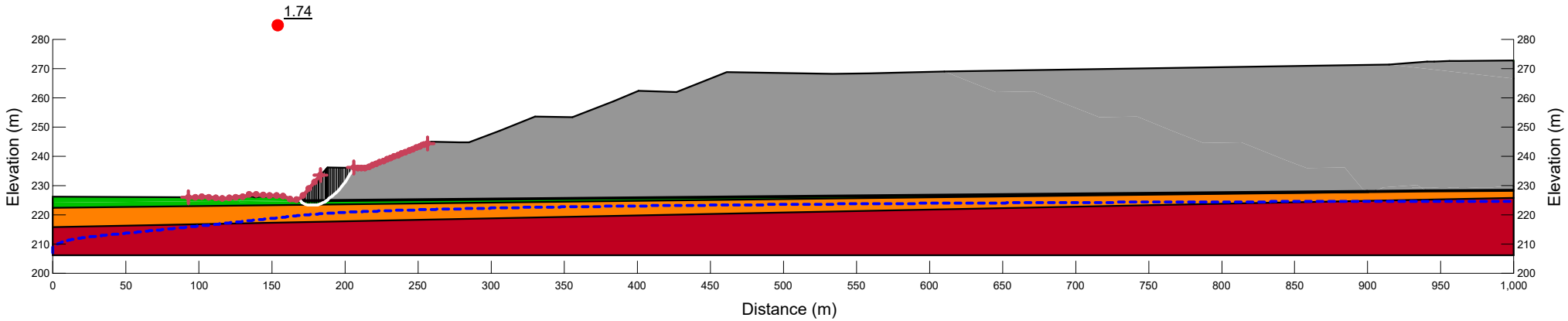
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section A: Long Term - Undrained - 20-50 years

Date: 12/01/2023 | Job No: 119224.02 | Appendix A-32

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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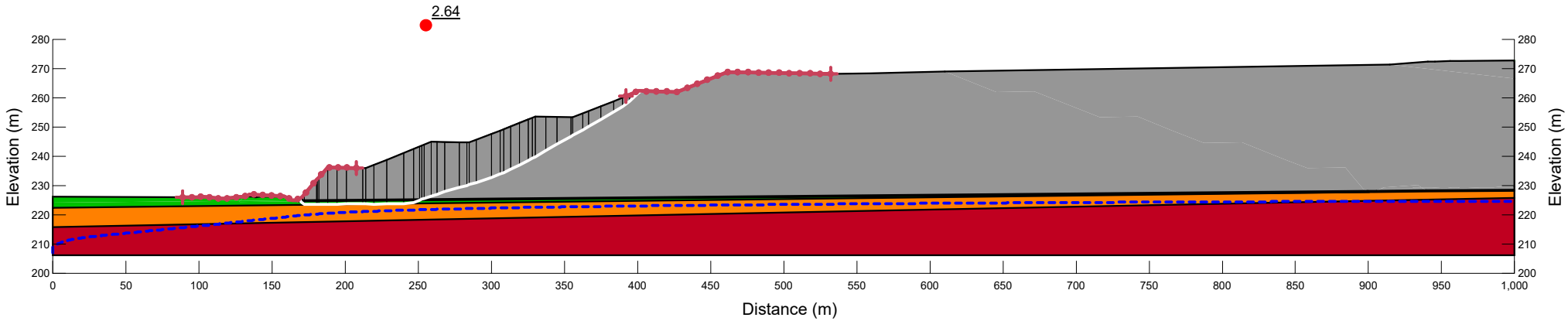
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section A: Long Term - Undrained - 20-50 years - Local

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Softened Drained] Rejects (20% Reduction)	Mohr-Coulomb	18			1	24.8					
	[Softened Undrained] Compacted Clay (20% Reduction)	SHANSEP	20	32	0.28							
	[Softened Undrained] Surface Soil (20% Reduction)	SHANSEP	21	36	0.19							



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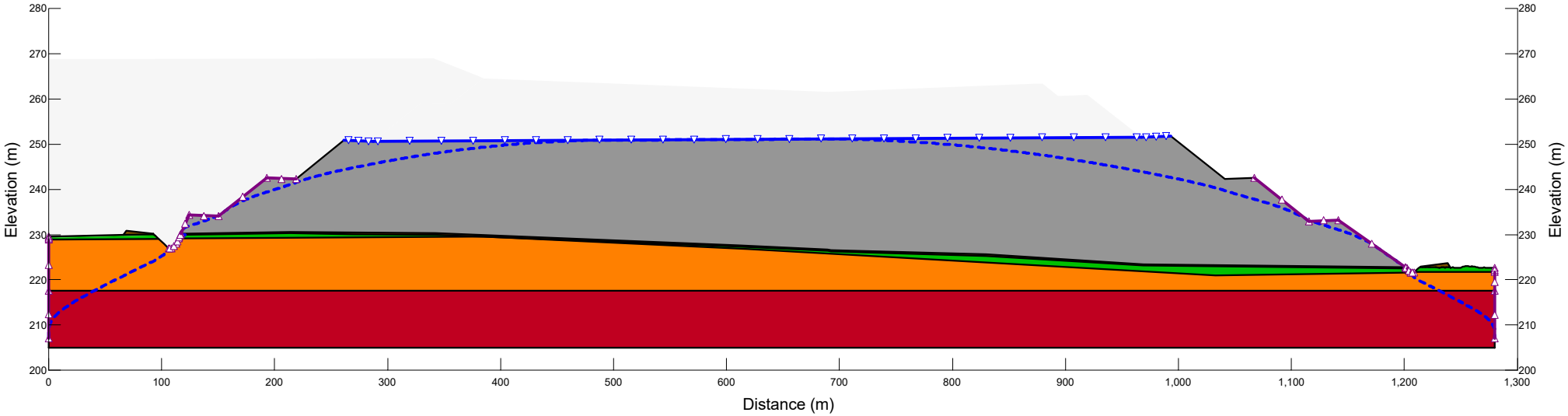
Section A: Post-Seismic - 20-50 years

Date: 12/01/2023 | Job No: 119224.02 | Appendix A-34

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Color	Name	Hydraulic Material Model	Sat Kx (m/sec)	Ky'/Kx' Ratio	Volumetric Water Content
	[Seepage] Compacted Clay	Saturated Only	1e-09	1	0.4
	[Seepage] Fresh Bedrock	Saturated Only	1e-07	1	0.4
	[Seepage] Rejects	Saturated Only	1e-06	1	0.4
	[Seepage] Surface Soil	Saturated Only	1e-06	1	0.4
	[Seepage] Weathered Bedrock	Saturated Only	1e-07	1	0.4

Color	Name	Category	Kind	Parameters
	Drainage	Hydraulic	Water Rate	0 m³/sec
	Rainfall_2010-2015	Hydraulic	Water Flux	Rainfall 2010-2015 - 30% Infiltration



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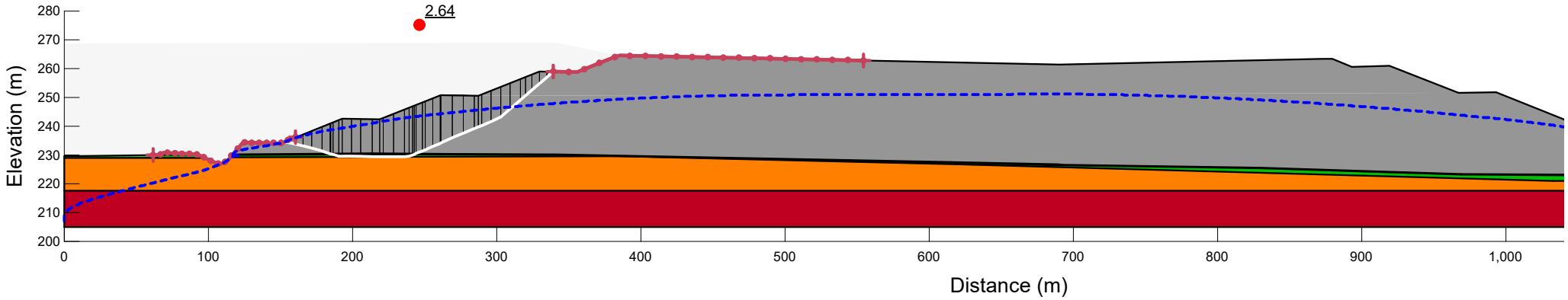
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section B: End of Construction (EoC) - 05-20 years

Date: 12/01/2023 | Job No: 119224.02 | Appendix A-35

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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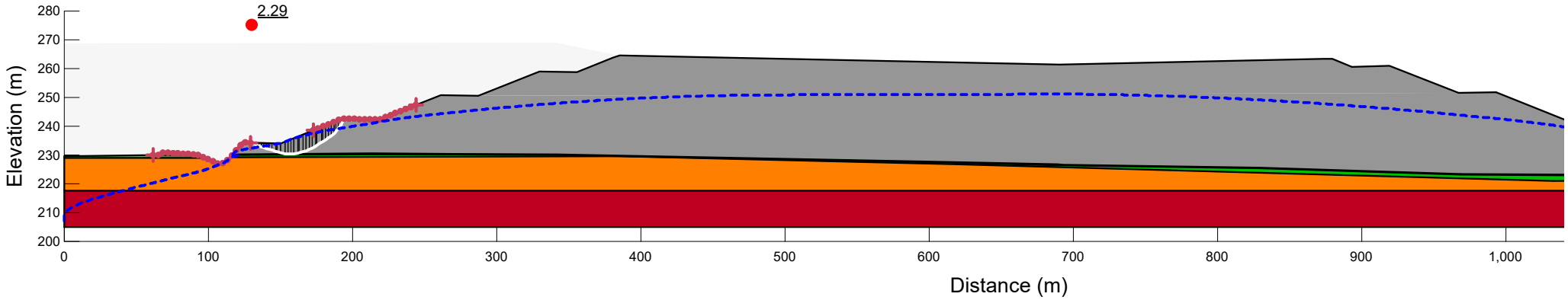
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section B: EoC - LHS Slope - 05-20 years

Date: 12/01/2023 | Job No: 119224.02 | Appendix A-36

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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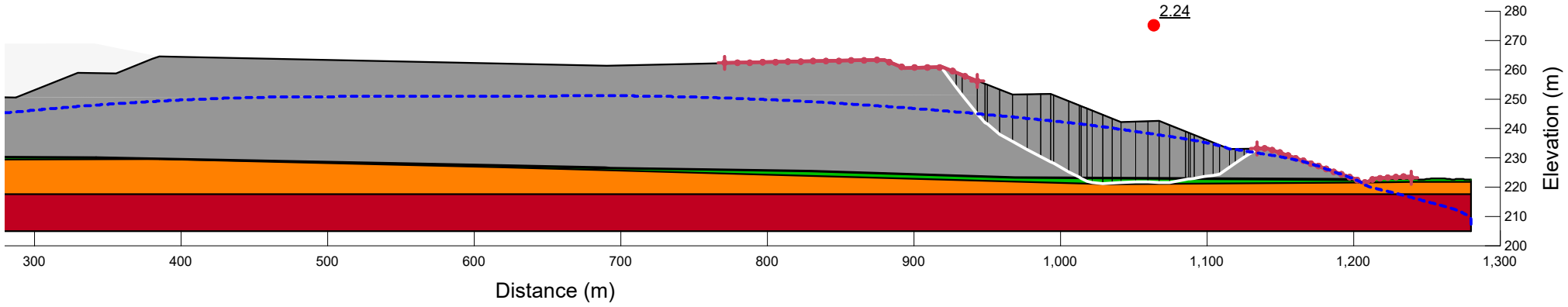
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section B: EoC - LHS Slope - 05-20 years - Local

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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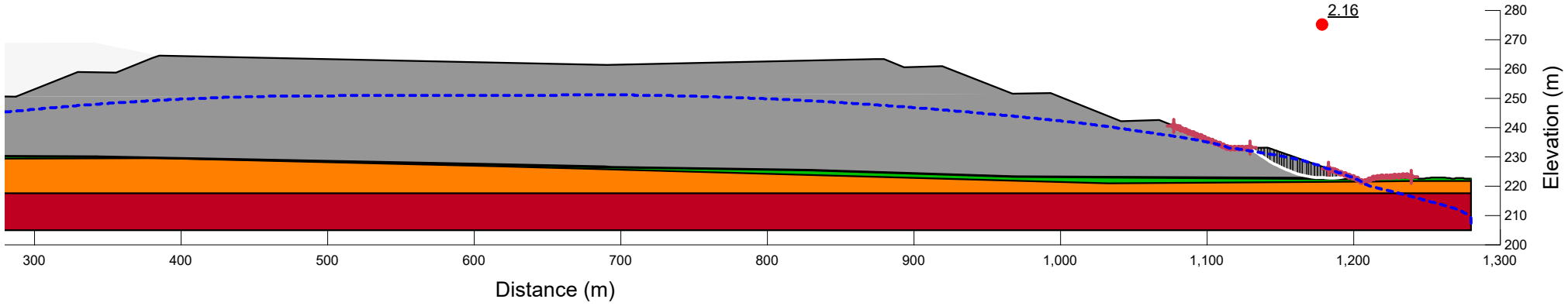
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section B: EoC - RHS Slope - 05-20 years

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

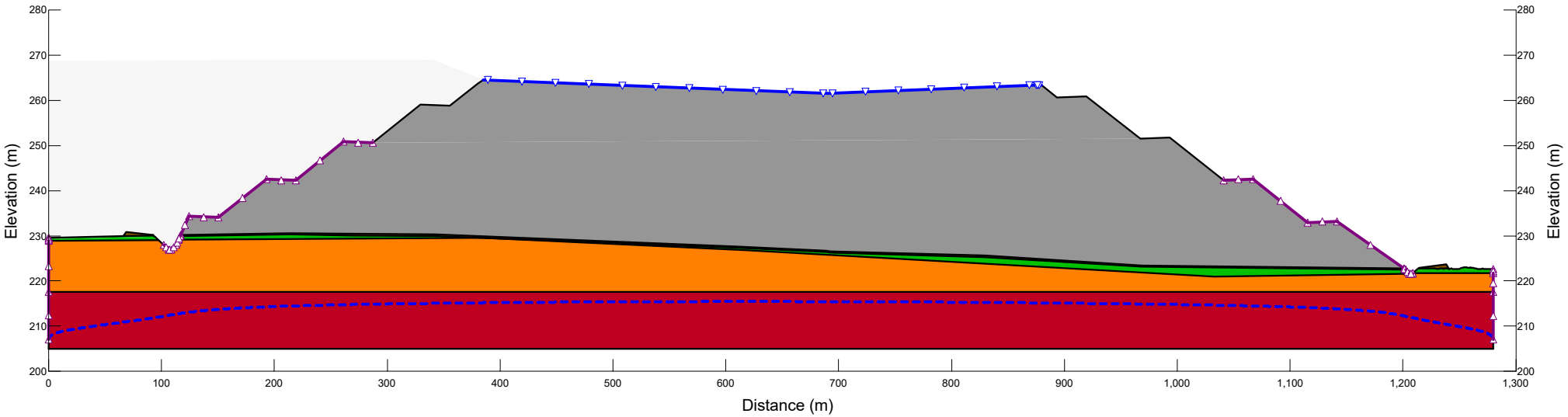
Section B: EoC - RHS Slope - 05-20 years - Local

Date: 13/01/2023 | Job No: 119224.02 | Appendix A-39

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Color	Name	Hydraulic Material Model	Sat Kx (m/sec)	Ky'/Kx' Ratio	Volumetric Water Content
	[Seepage] Compacted Clay	Saturated Only	1e-09	1	0.4
	[Seepage] Fresh Bedrock	Saturated Only	1e-07	1	0.4
	[Seepage] Rejects	Saturated Only	1e-06	1	0.4
	[Seepage] Surface Soil	Saturated Only	1e-06	1	0.4
	[Seepage] Weathered Bedrock	Saturated Only	1e-07	1	0.4

Color	Name	Category	Kind	Parameters
	Drainage	Hydraulic	Water Rate	0 m³/sec
	Rainfall_2010-2015	Hydraulic	Water Flux	Rainfall 2010-2015 - 30% Infiltration



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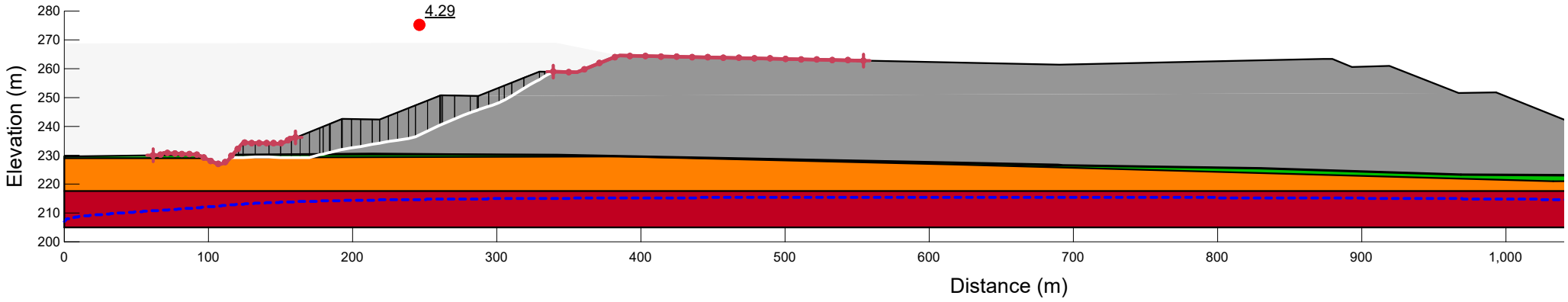
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section B: Long Term - 05-20 years

Date: 12/01/2023 | Job No: 119224.02 | Appendix A-40

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	[Drained] Compacted Clay	Mohr-Coulomb	20						1	28
	[Drained] Fresh Bedrock	Hoek-Brown	20	175,000	10	30	0.1	800		
	[Drained] Rejects	Mohr-Coulomb	18						1	30
	[Drained] Surface Soil	Mohr-Coulomb	21						1	21
	[Drained] Weathered Bedrock	Hoek-Brown	20	50,000	10	30	0.6	800		



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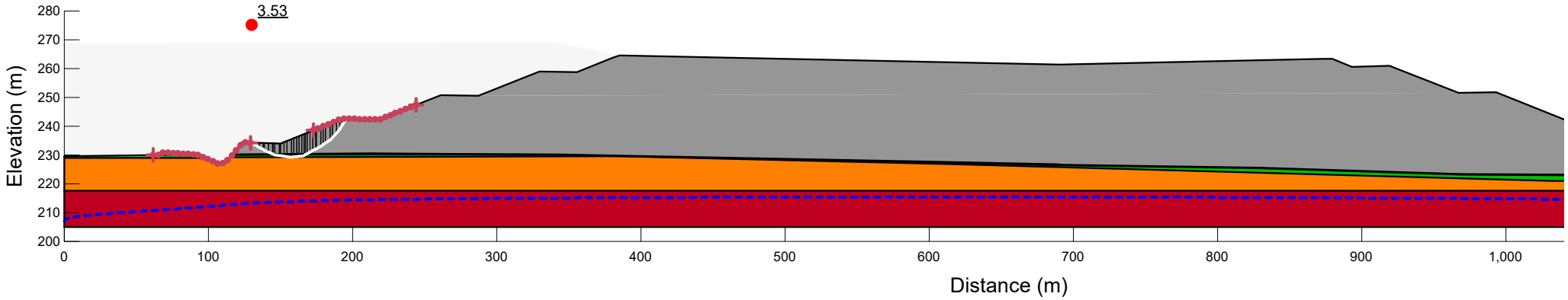
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section B: LHS Slope - Long Term - Drained - 05-20 years

Date: 12/01/2023 | Job No: 119224.02 | Appendix A-41

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	[Drained] Compacted Clay	Mohr-Coulomb	20						1	28
	[Drained] Fresh Bedrock	Hoek-Brown	20	175,000	10	30	0.1	800		
	[Drained] Rejects	Mohr-Coulomb	18						1	30
	[Drained] Surface Soil	Mohr-Coulomb	21						1	21
	[Drained] Weathered Bedrock	Hoek-Brown	20	50,000	10	30	0.6	800		



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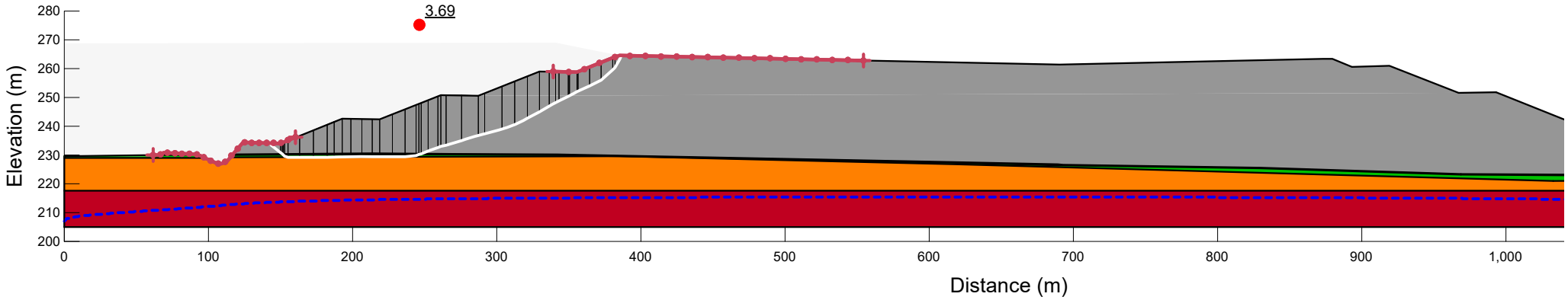
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section B: LHS Slope - Long Term - Drained - 05-20 years - Local

Date: 13/01/2023 | Job No: 119224.02 | Appendix A-42

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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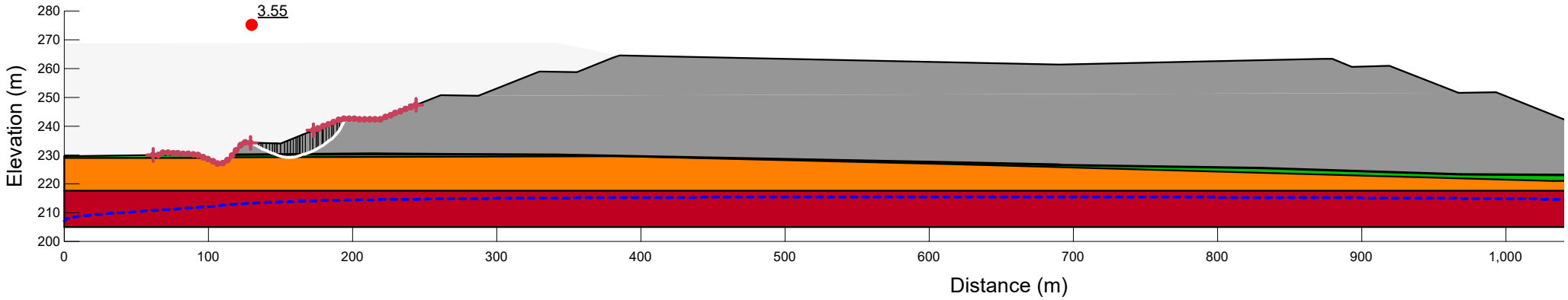
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section B: LHS Slope - Long Term - Undrained - 05-20 years

Date: 12/01/2023 | Job No: 119224.02 | Appendix A-43

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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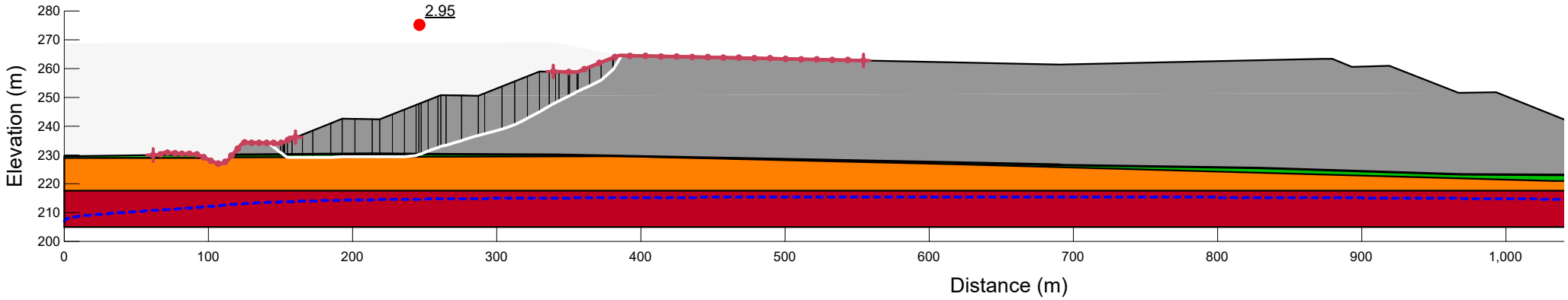
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section B: LHS Slope - Long Term - Undrained - 05-20 years - Local

Date: 13/01/2023 | Job No: 119224.02 | Appendix A-44

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Softened Drained] Rejects (20% Reduction)	Mohr-Coulomb	18			1	24.8					
	[Softened Undrained] Compacted Clay (20% Reduction)	SHANSEP	20	32	0.28							
	[Softened Undrained] Surface Soil (20% Reduction)	SHANSEP	18	36	0.19							



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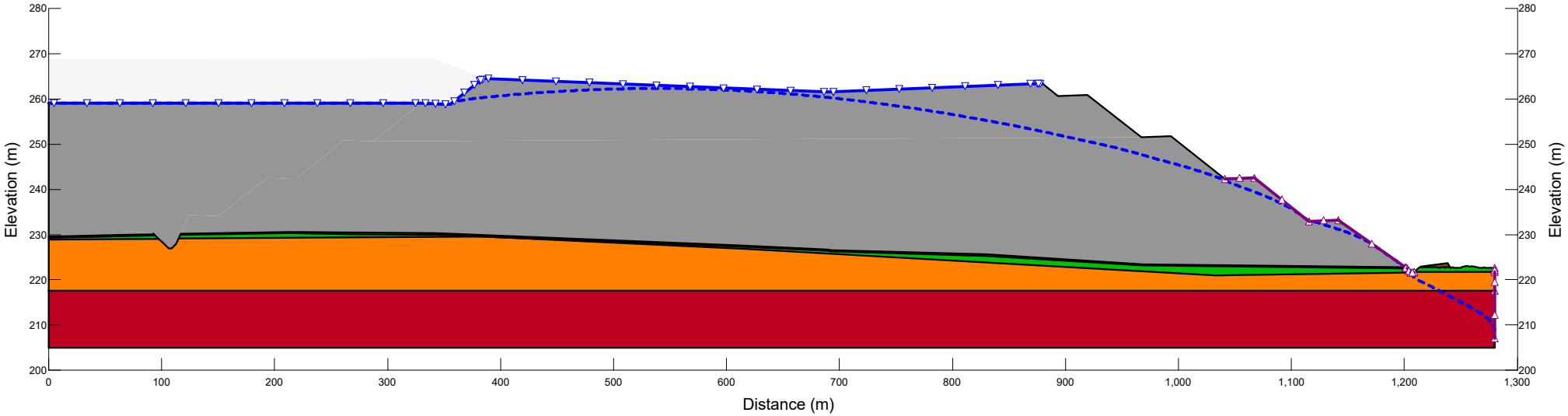
Section B: LHS Slope - Post-Seismic - 05-20 years

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Color	Name	Hydraulic Material Model	Sat Kx (m/sec)	Ky'/Kx' Ratio	Volumetric Water Content
	[Seepage] Compacted Clay	Saturated Only	1e-09	1	0.4
	[Seepage] Fresh Bedrock	Saturated Only	1e-07	1	0.4
	[Seepage] Rejects	Saturated Only	1e-06	1	0.4
	[Seepage] Surface Soil	Saturated Only	1e-06	1	0.4
	[Seepage] Weathered Bedrock	Saturated Only	1e-07	1	0.4

Color	Name	Category	Kind	Parameters
	Drainage	Hydraulic	Water Rate	0 m³/sec
	Rainfall_2010-2015	Hydraulic	Water Flux	Rainfall 2010-2015 - 30% Infiltration



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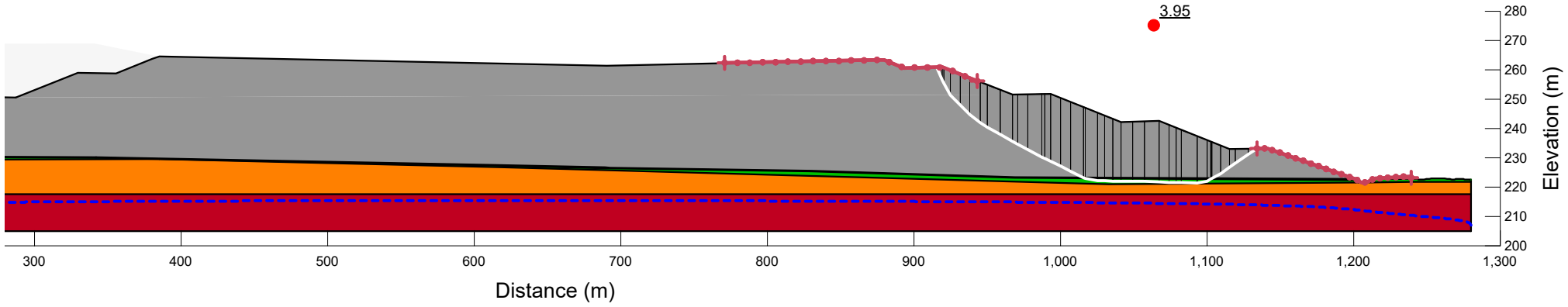
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section B: End of Construction (EoC) - 20-50 years

Date: 12/01/2023 | Job No: 119224.02 | Appendix A-46

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	[Drained] Compacted Clay	Mohr-Coulomb	20						1	28
	[Drained] Fresh Bedrock	Hoek-Brown	20	175,000	10	30	0.1	800		
	[Drained] Rejects	Mohr-Coulomb	18						1	30
	[Drained] Surface Soil	Mohr-Coulomb	21						1	21
	[Drained] Weathered Bedrock	Hoek-Brown	20	50,000	10	30	0.6	800		



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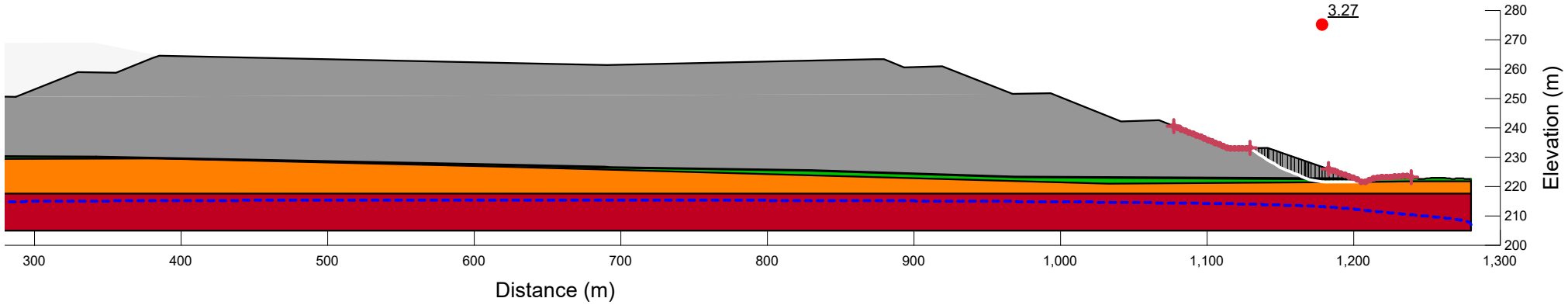
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section B: RHS Slope - Long Term - Drained - 05-20 years

Date: 12/01/2023 | Job No: 119224.02 | Appendix A-47

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	[Drained] Compacted Clay	Mohr-Coulomb	20						1	28
	[Drained] Fresh Bedrock	Hoek-Brown	20	175,000	10	30	0.1	800		
	[Drained] Rejects	Mohr-Coulomb	18						1	30
	[Drained] Surface Soil	Mohr-Coulomb	21						1	21
	[Drained] Weathered Bedrock	Hoek-Brown	20	50,000	10	30	0.6	800		



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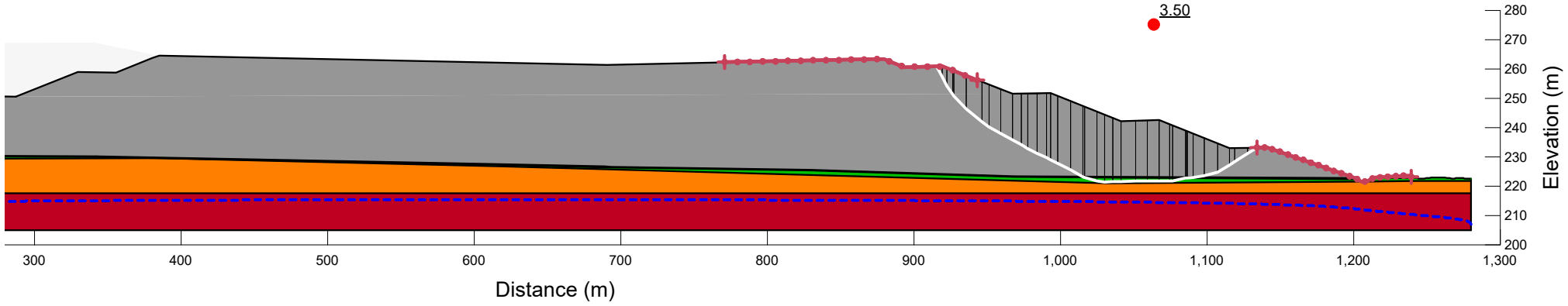
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section B: RHS Slope - Long Term - Drained - 05-20 years - Local

Date: 13/01/2023 | Job No: 119224.02 | Appendix A-48

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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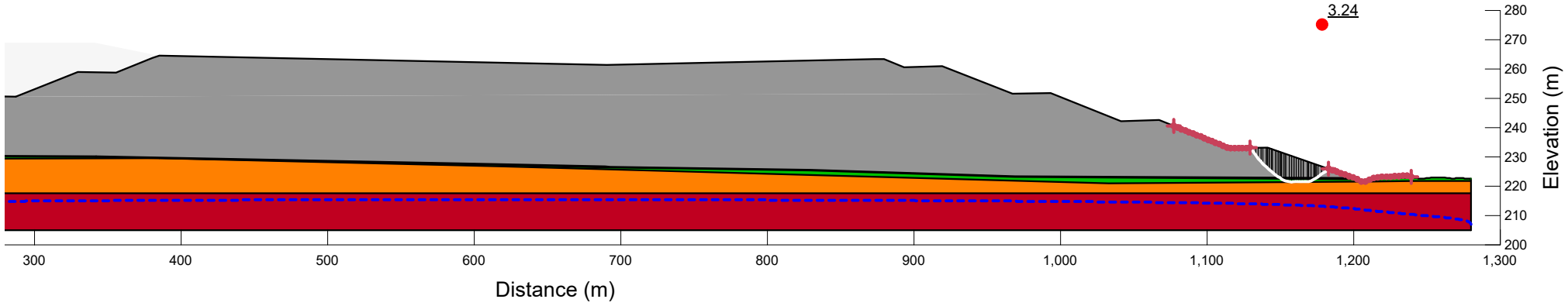
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section B: RHS Slope - Long Term - Undrained - 05-20 years

Date: 12/01/2023 | Job No: 119224.02 | Appendix A-49

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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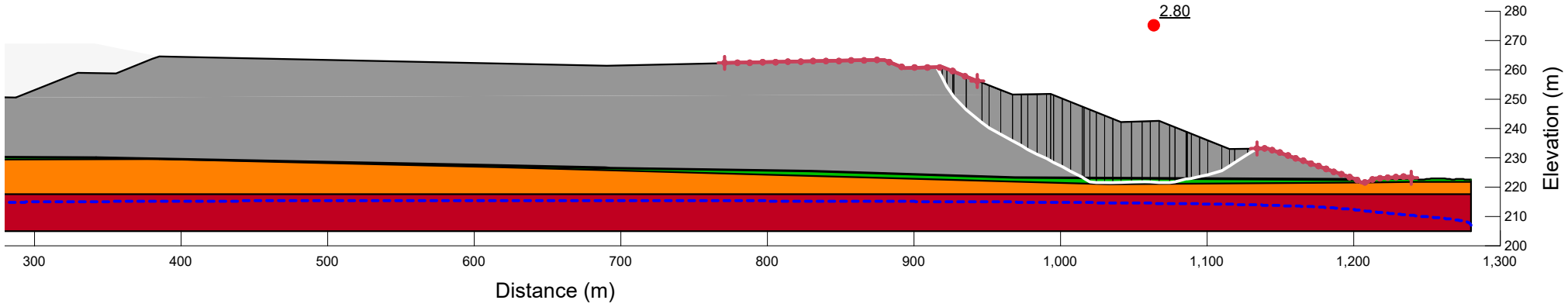
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section B: RHS Slope - Long Term - Undrained - 05-20 years - Local

Date: 13/01/2023 | Job No: 119224.02 | Appendix A-50

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Softened Drained] Rejects (20% Reduction)	Mohr-Coulomb	18			1	24.8					
	[Softened Undrained] Compacted Clay (20% Reduction)	SHANSEP	20	32	0.28							
	[Softened Undrained] Surface Soil (20% Reduction)	SHANSEP	18	36	0.19							



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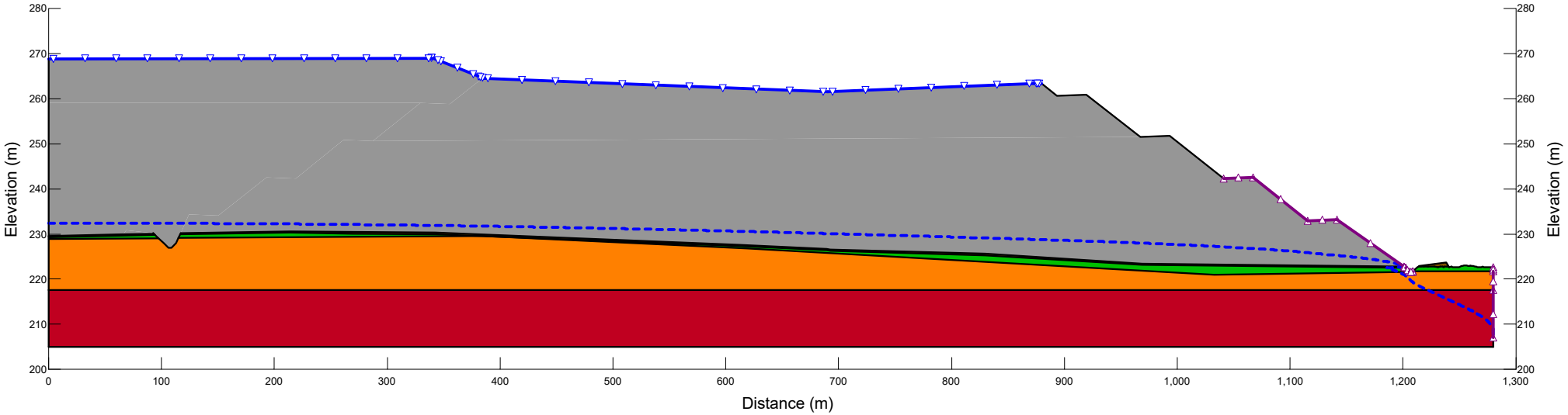
Section B: RHS Slope - Post-Seismic - 05-20 years

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Color	Name	Hydraulic Material Model	Sat Kx (m/sec)	Ky'/Kx' Ratio	Volumetric Water Content
	[Seepage] Compacted Clay	Saturated Only	1e-09	1	0.4
	[Seepage] Fresh Bedrock	Saturated Only	1e-07	1	0.4
	[Seepage] Rejects	Saturated Only	1e-06	1	0.4
	[Seepage] Surface Soil	Saturated Only	1e-06	1	0.4
	[Seepage] Weathered Bedrock	Saturated Only	1e-07	1	0.4

Color	Name	Category	Kind	Parameters
	Drainage	Hydraulic	Water Rate	0 m³/sec
	Rainfall_2010-2015	Hydraulic	Water Flux	Rainfall 2010-2015 - 30% Infiltration



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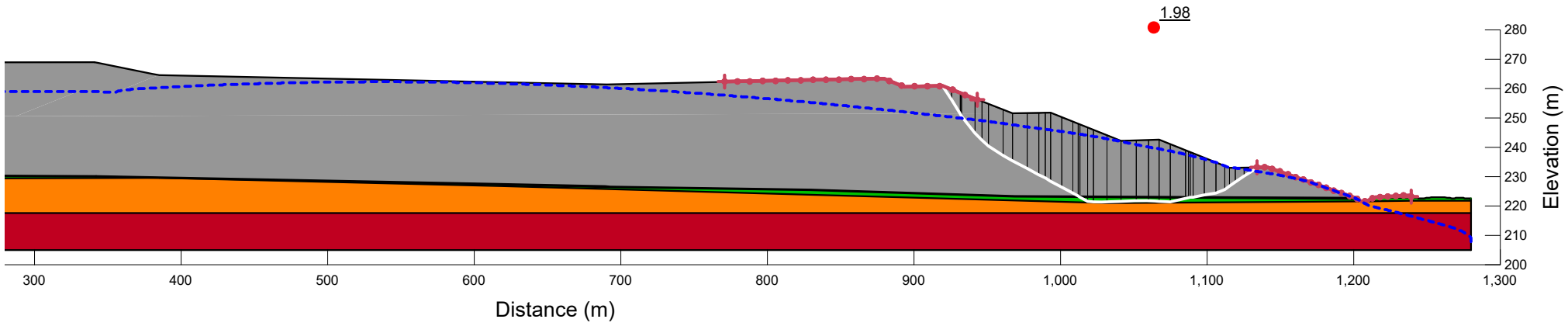
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section B: Long Term - 20-50 years

Date: 12/01/2023 | Job No: 119224.02 | Appendix A-52

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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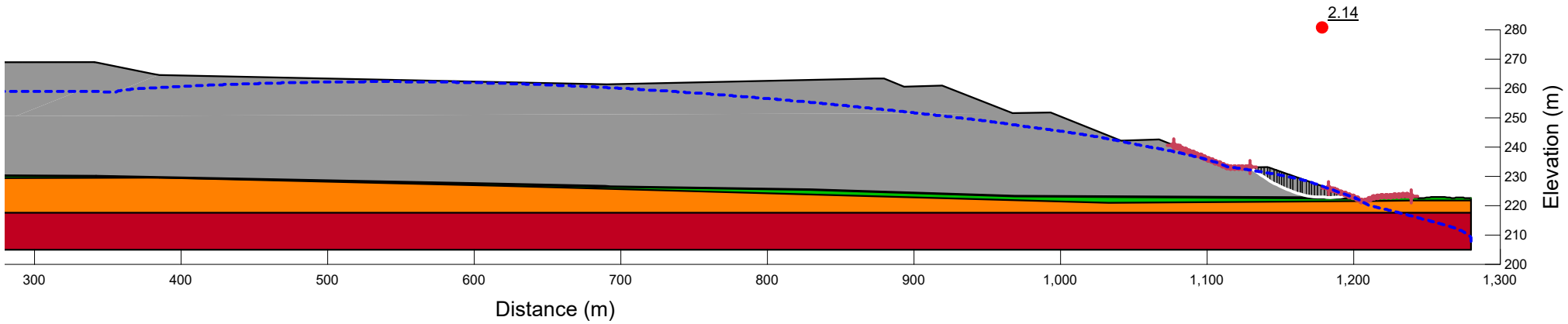
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section B: EoC - 20-50 years

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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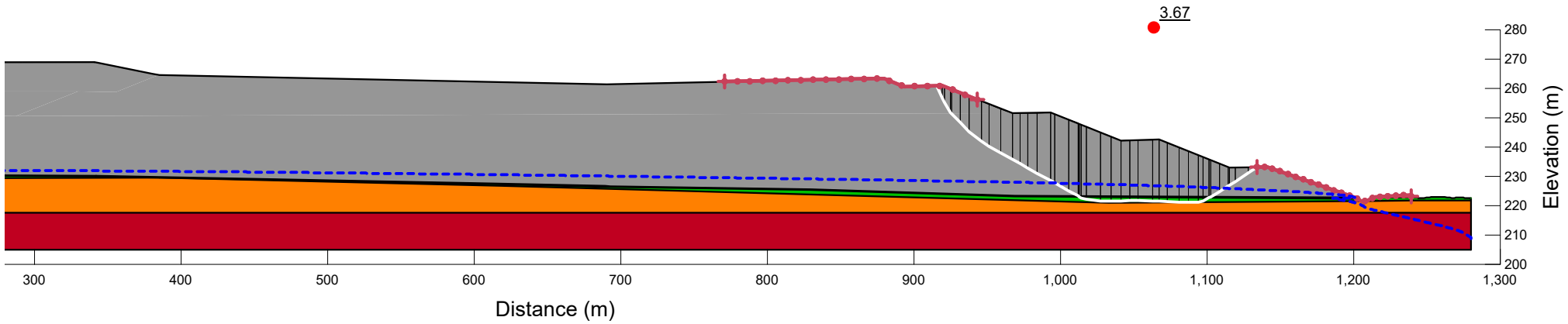
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section B: EoC - 20-50 years - Local

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	[Drained] Compacted Clay	Mohr-Coulomb	20						1	28
	[Drained] Fresh Bedrock	Hoek-Brown	20	175,000	10	30	0.1	800		
	[Drained] Rejects	Mohr-Coulomb	18						1	30
	[Drained] Surface Soil	Mohr-Coulomb	21						1	21
	[Drained] Weathered Bedrock	Hoek-Brown	20	50,000	10	30	0.6	800		



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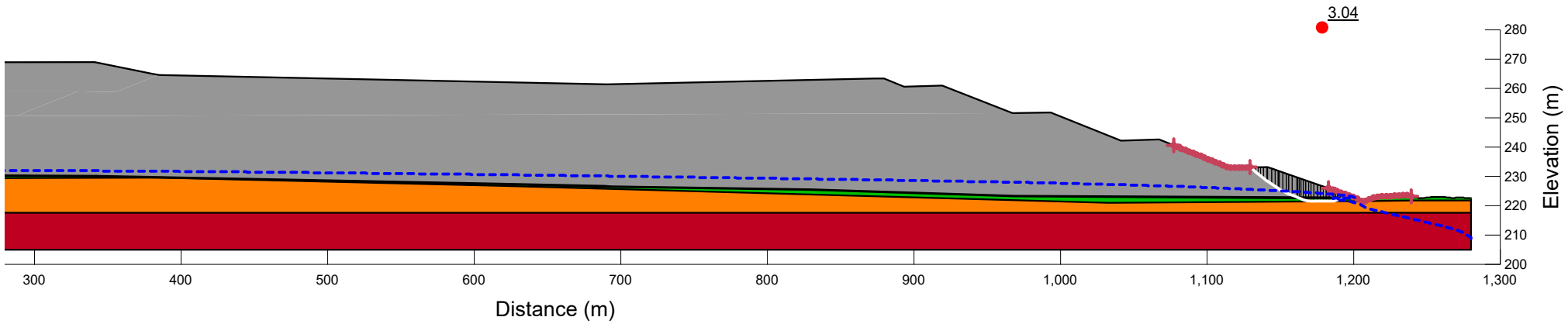
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section B: Long Term - Drained - 20-50 years

Date: 12/01/2023 | Job No: 119224.02 | Appendix A-55

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	[Drained] Compacted Clay	Mohr-Coulomb	20						1	28
	[Drained] Fresh Bedrock	Hoek-Brown	20	175,000	10	30	0.1	800		
	[Drained] Rejects	Mohr-Coulomb	18						1	30
	[Drained] Surface Soil	Mohr-Coulomb	21						1	21
	[Drained] Weathered Bedrock	Hoek-Brown	20	50,000	10	30	0.6	800		



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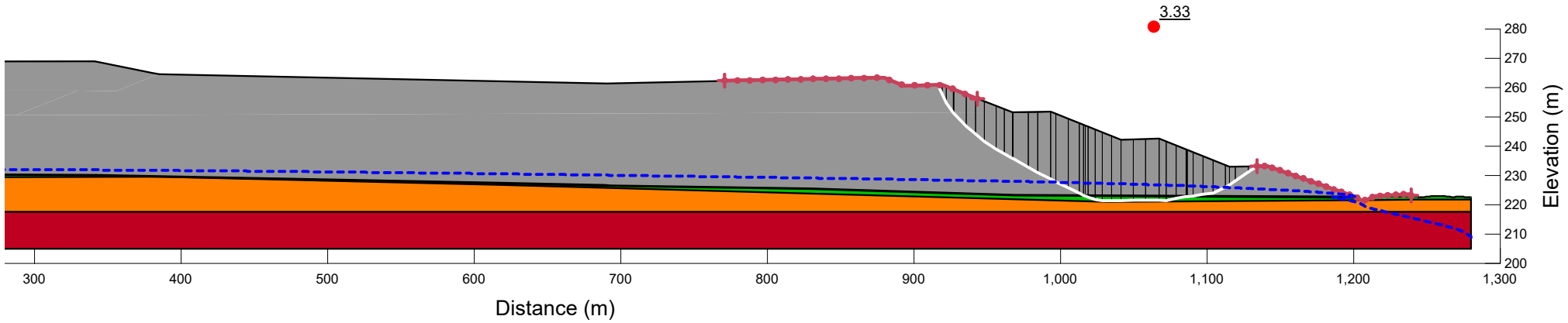
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section B: Long Term - Drained - 20-50 years - Local

Date: 13/01/2023 | Job No: 119224.02 | Appendix A-56

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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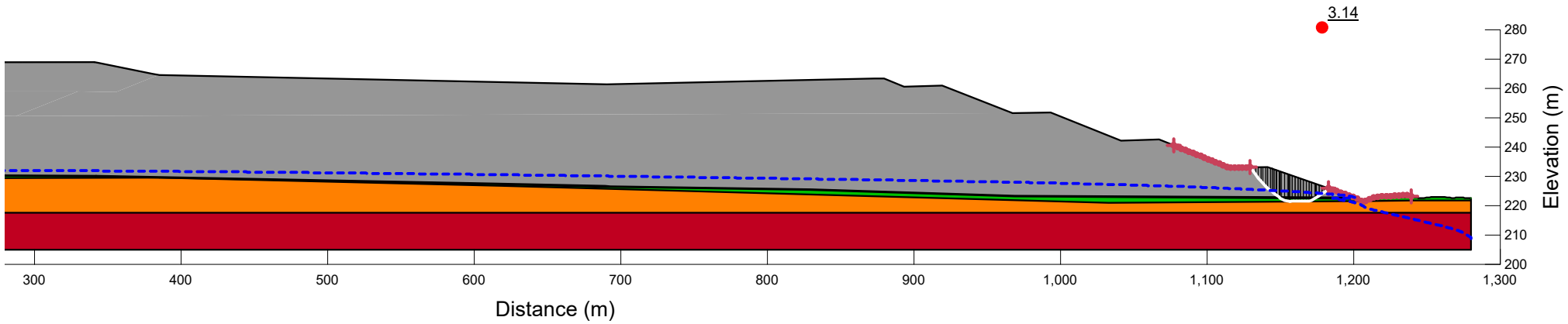
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section B: Long Term - Undrained - 20-50 years

Date: 12/01/2023 | Job No: 119224.02 | Appendix A-57

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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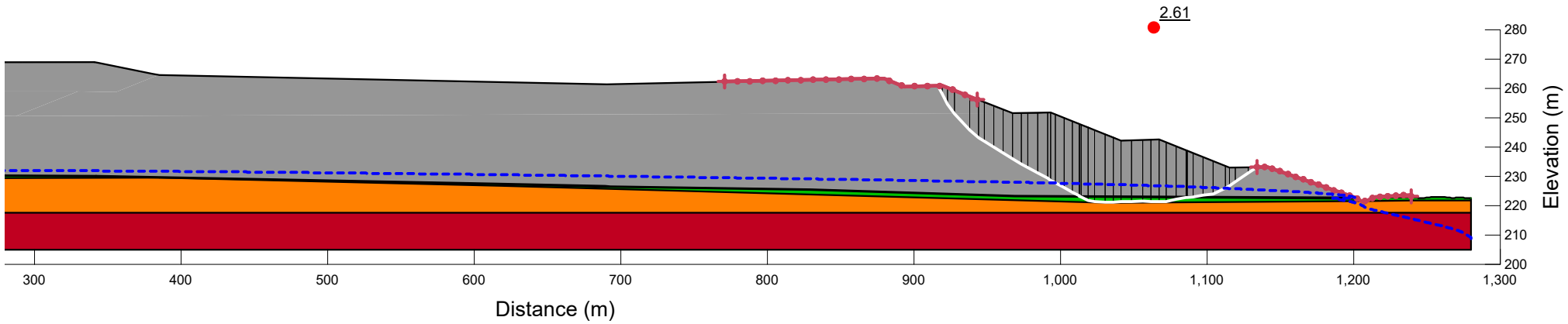
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section B: Long Term - Undrained - 20-50 years - Local

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Softened Drained] Rejects (20% Reduction)	Mohr-Coulomb	18			1	24.8					
	[Softened Undrained] Compacted Clay (20% Reduction)	SHANSEP	20	32	0.28							
	[Softened Undrained] Surface Soil (20% Reduction)	SHANSEP	18	36	0.19							



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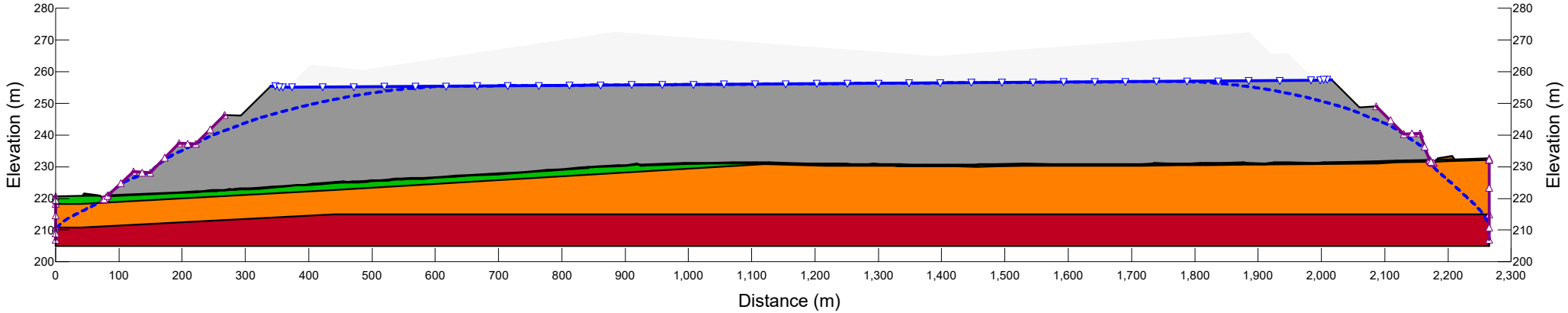
Section B: Post-Seismic - 20-50 years

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Color	Name	Hydraulic Material Model	Sat Kx (m/sec)	Ky'/Kx' Ratio	Rotation (°)	Volumetric Water Content
	[Seepage] Compacted Clay	Saturated Only	1e-09	1	0	0.4
	[Seepage] Fresh Bedrock	Saturated Only	1e-07	1	0	0.4
	[Seepage] Rejects	Saturated Only	1e-06	1	0	0.4
	[Seepage] Surface Soil	Saturated Only	1e-06	1	0	0.4
	[Seepage] Weathered Bedrock	Saturated Only	1e-07	1	0	0.4

Color	Name	Category	Kind	Parameters
	Drainage	Hydraulic	Water Rate	0 m³/sec
	Rainfall_2010-2015	Hydraulic	Water Flux	Rainfall 2010-2015 - 30% Infiltration



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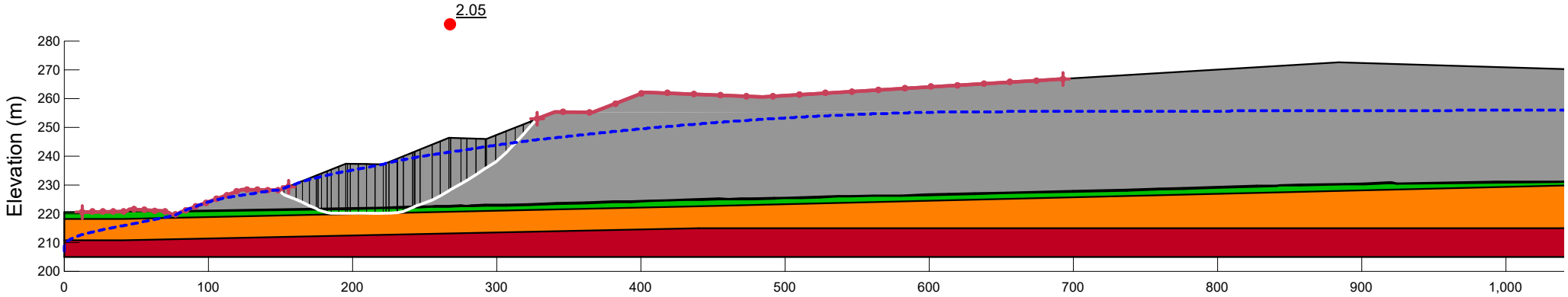
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section C: End of Construction (EoC) - 20-50 years

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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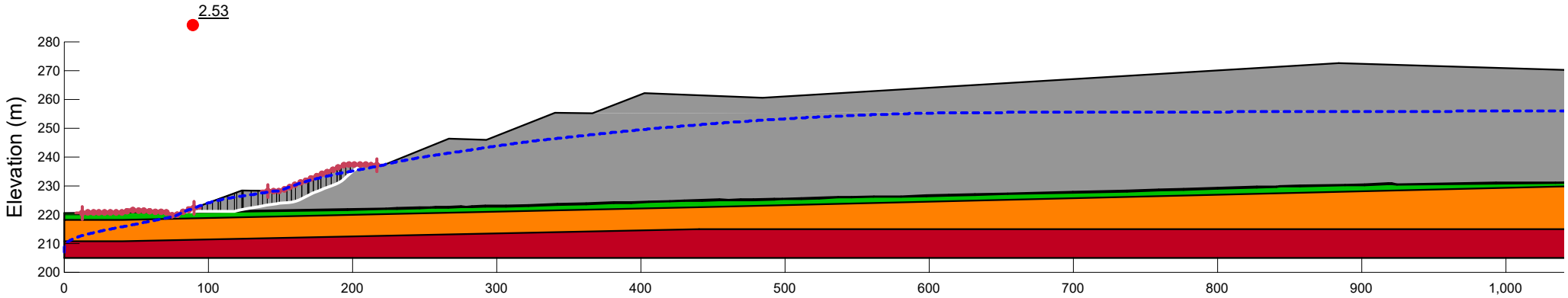
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section C: EoC - LHS Slope - 20-50 years

Date: 12/01/2023 | Job No: 119224.02 | Appendix A-61

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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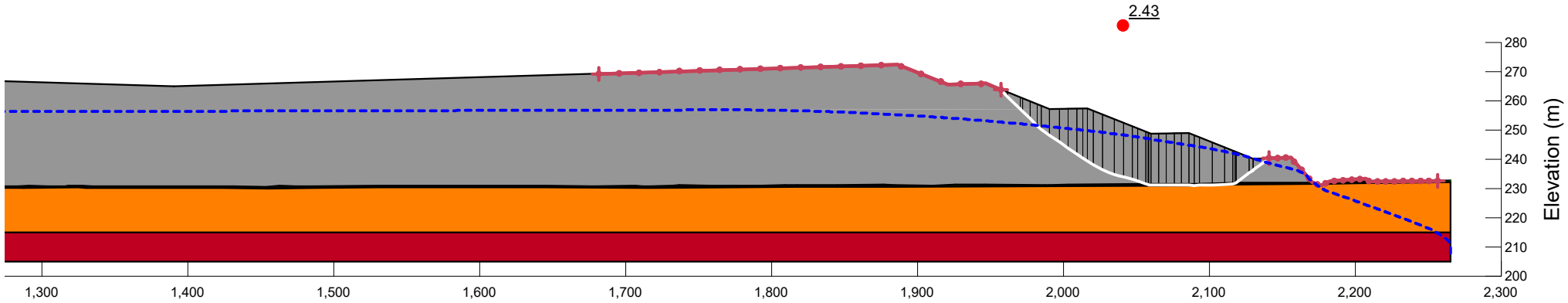
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section C: EoC - LHS Slope - 20-50 years - Local

Date: 13/01/2023 | Job No: 119224.02 | Appendix A-62

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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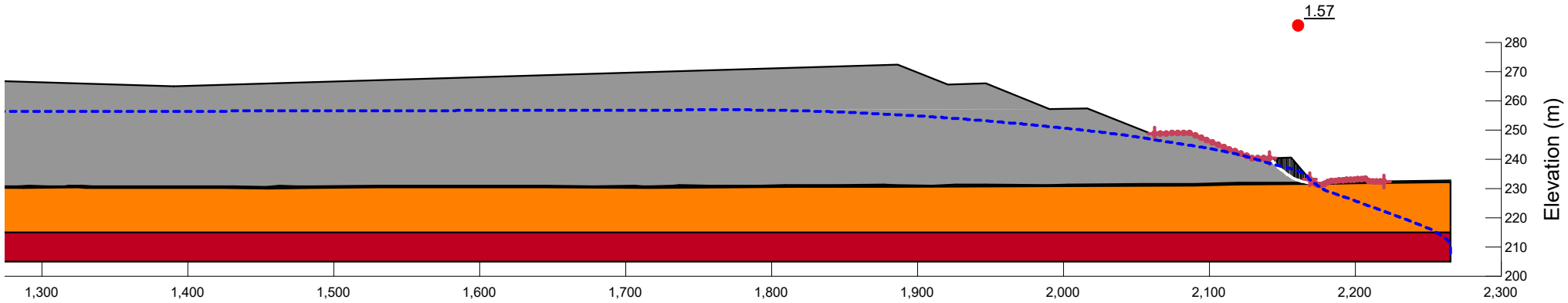
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section C: EoC - RHS Slope - 20-50 years

Date: 12/01/2023 | Job No: 119224.02 | Appendix A-63

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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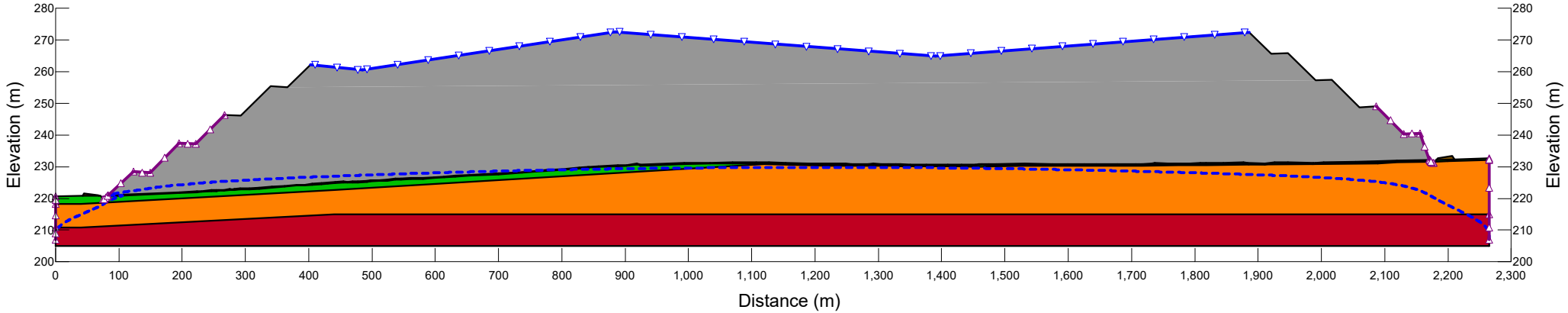
Section C: EoC - RHS Slope - 20-50 years - Local

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Color	Name	Hydraulic Material Model	Sat Kx (m/sec)	Ky'/Kx' Ratio	Rotation (°)	Volumetric Water Content
	[Seepage] Compacted Clay	Saturated Only	1e-09	1	0	0.4
	[Seepage] Fresh Bedrock	Saturated Only	1e-07	1	0	0.4
	[Seepage] Rejects	Saturated Only	1e-06	1	0	0.4
	[Seepage] Surface Soil	Saturated Only	1e-06	1	0	0.4
	[Seepage] Weathered Bedrock	Saturated Only	1e-07	1	0	0.4

Color	Name	Category	Kind	Parameters
	Drainage	Hydraulic	Water Rate	0 m³/sec
	Rainfall_2010-2015	Hydraulic	Water Flux	Rainfall 2010-2015 - 30% Infiltration



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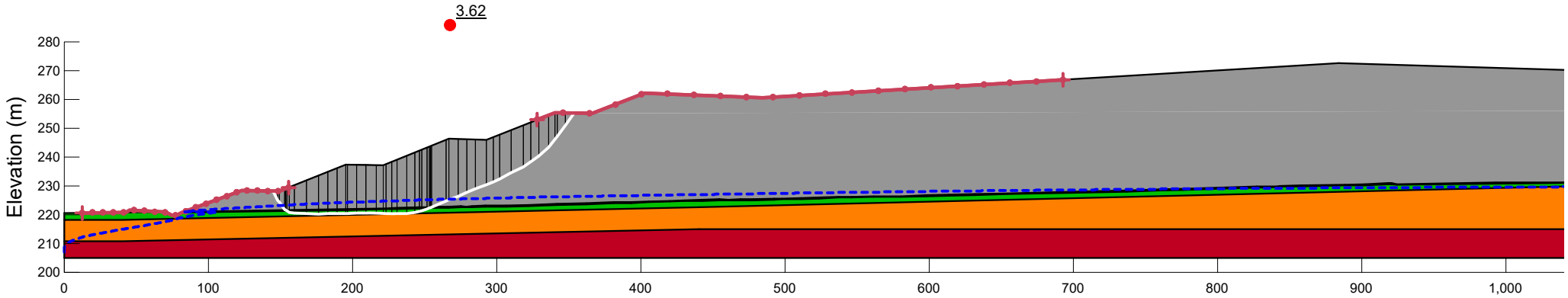
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section C: Long Term - 20-50 years

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	[Drained] Compacted Clay	Mohr-Coulomb	20						1	28
	[Drained] Fresh Bedrock	Hoek-Brown	20	175,000	10	30	0.1	800		
	[Drained] Rejects	Mohr-Coulomb	18						1	30
	[Drained] Surface Soil	Mohr-Coulomb	21						1	21
	[Drained] Weathered Bedrock	Hoek-Brown	20	50,000	10	30	0.6	800		



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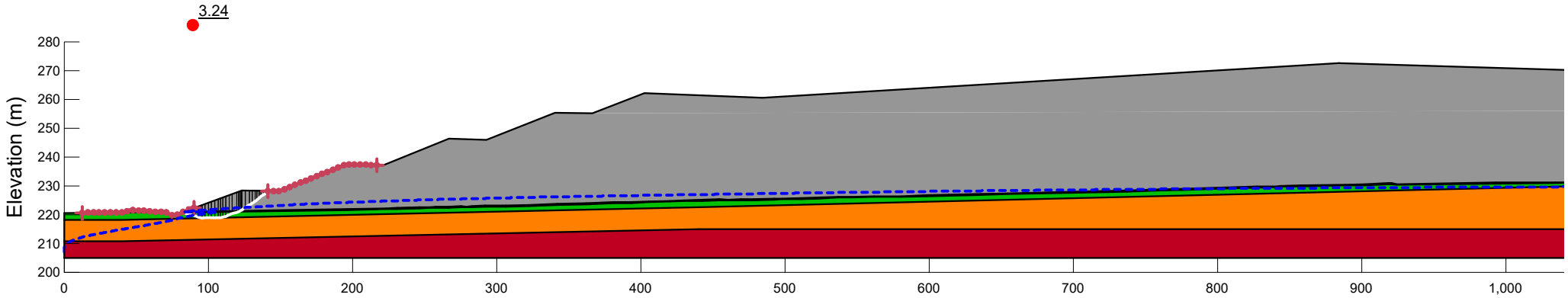
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section C: LHS Slope - Long Term - Drained - 20-50 years

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	[Drained] Compacted Clay	Mohr-Coulomb	20						1	28
	[Drained] Fresh Bedrock	Hoek-Brown	20	175,000	10	30	0.1	800		
	[Drained] Rejects	Mohr-Coulomb	18						1	30
	[Drained] Surface Soil	Mohr-Coulomb	21						1	21
	[Drained] Weathered Bedrock	Hoek-Brown	20	50,000	10	30	0.6	800		



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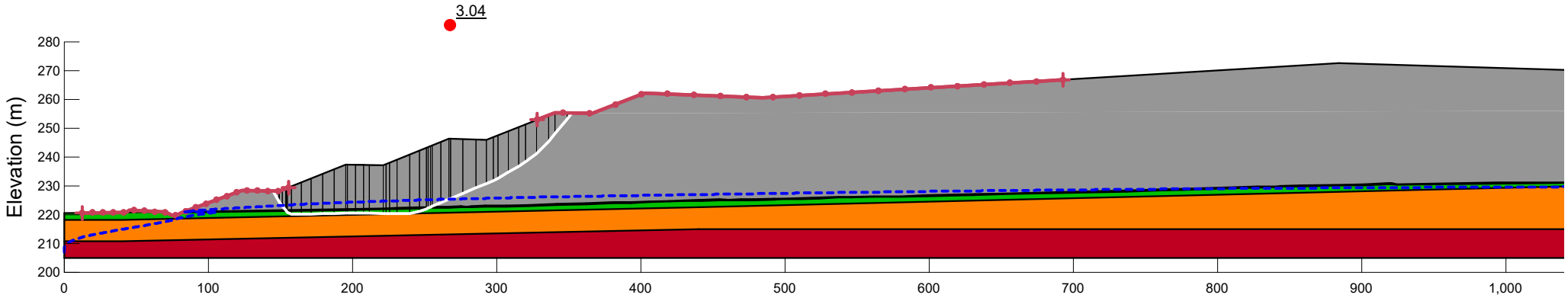
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section C: LHS Slope - Long Term - Drained - 20-50 years - Local

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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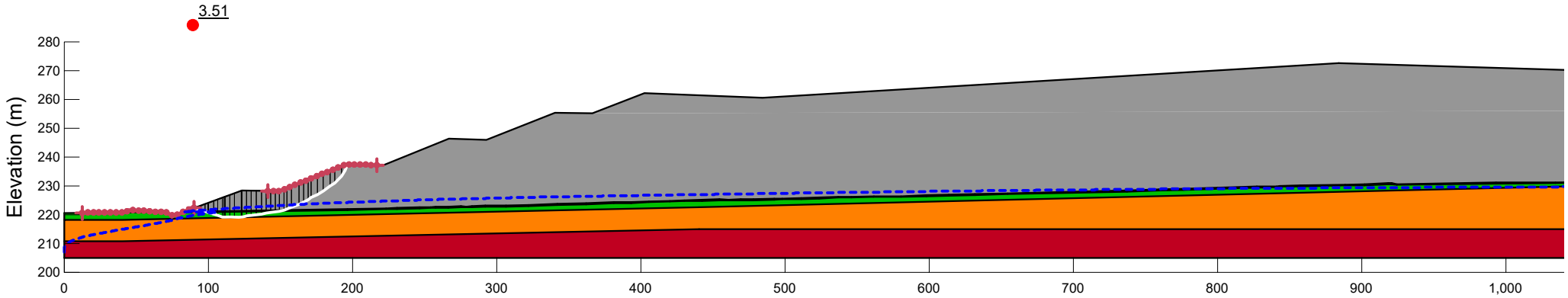
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section C: LHS Slope - Long Term - Undrained - 20-50 years

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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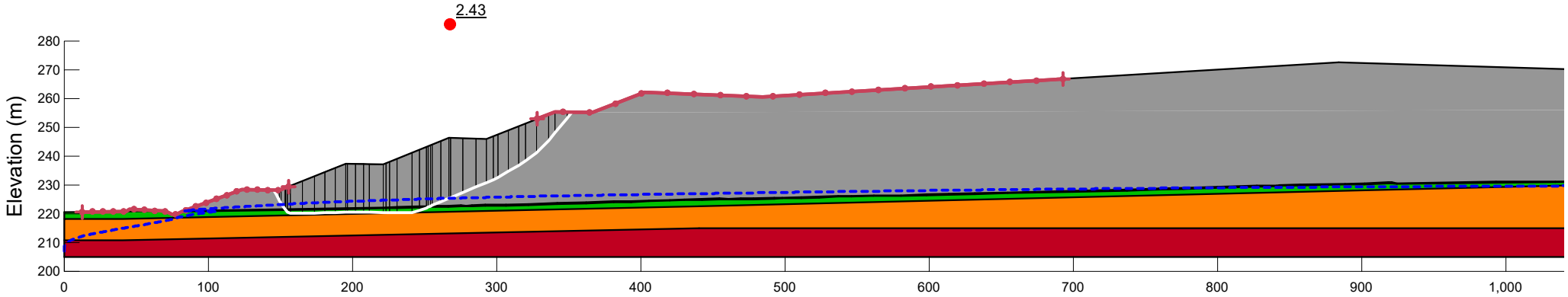
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section C: LHS Slope - Long Term - Undrained - 20-50 years - Local

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Softened Drained] Rejects (20% Reduction)	Mohr-Coulomb	18			1	24.8					
	[Softened Undrained] Compacted Clay (20% Reduction)	SHANSEP	20	32	0.28							
	[Softened Undrained] Surface Soil (20% Reduction)	SHANSEP	21	36	0.19							



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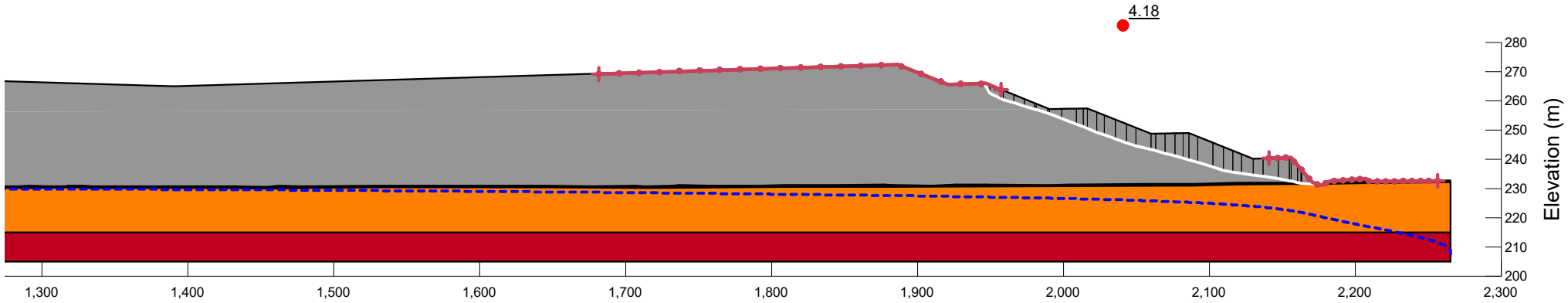
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Section C: LHS Slope - Post-Seismic - 20-50 years

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	[Drained] Compacted Clay	Mohr-Coulomb	20						1	28
	[Drained] Fresh Bedrock	Hoek-Brown	20	175,000	10	30	0.1	800		
	[Drained] Rejects	Mohr-Coulomb	18						1	30
	[Drained] Surface Soil	Mohr-Coulomb	21						1	21
	[Drained] Weathered Bedrock	Hoek-Brown	20	50,000	10	30	0.6	800		



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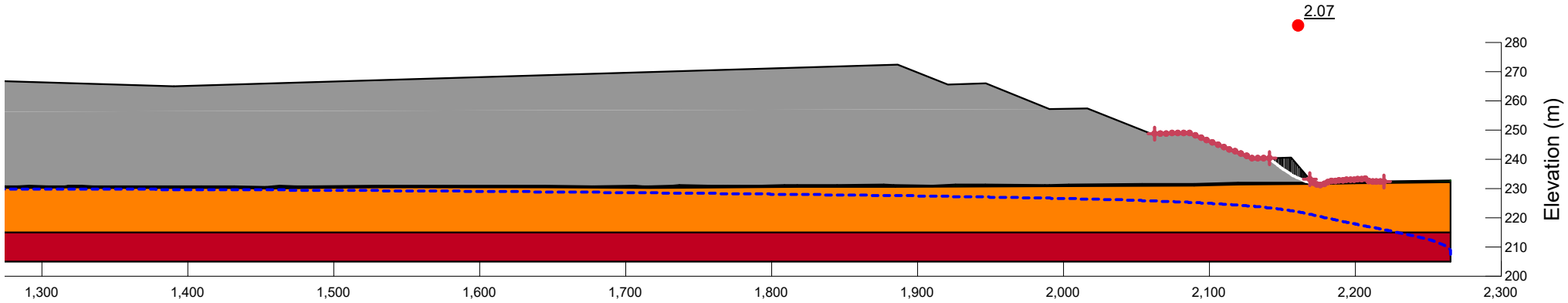
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section C: RHS Slope - Long Term - Drained - 20-50 years

Date: 12/01/2023 | Job No: 119224.02 | Appendix A-71

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	[Drained] Compacted Clay	Mohr-Coulomb	20						1	28
	[Drained] Fresh Bedrock	Hoek-Brown	20	175,000	10	30	0.1	800		
	[Drained] Rejects	Mohr-Coulomb	18						1	30
	[Drained] Surface Soil	Mohr-Coulomb	21						1	21
	[Drained] Weathered Bedrock	Hoek-Brown	20	50,000	10	30	0.6	800		



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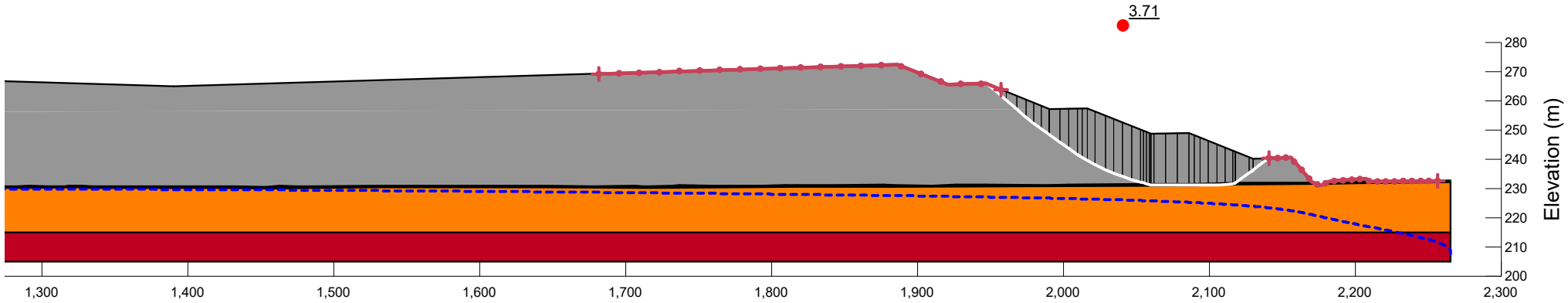
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section C: RHS Slope - Long Term - Drained - 20-50 years - Local

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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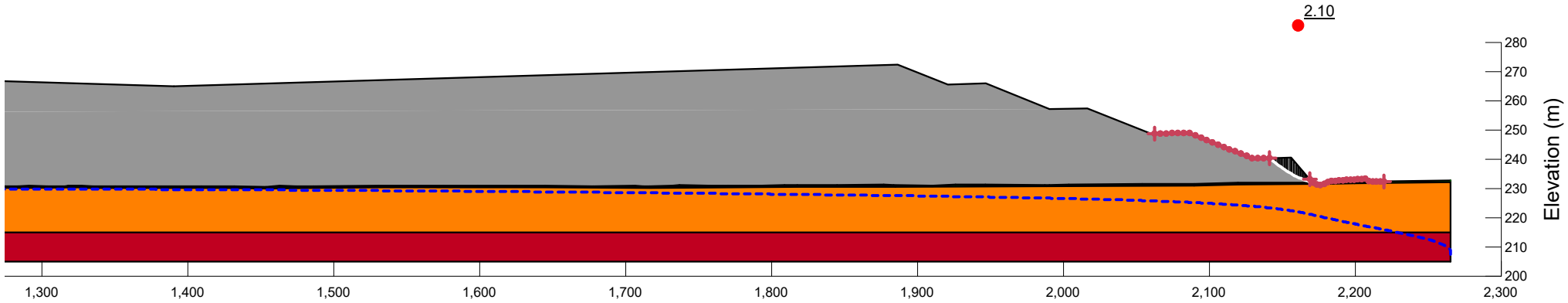
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section C: RHS Slope - Long Term - Undrained - 20-50 years

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Rejects	Mohr-Coulomb	18			1	30					
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Undrained] Compacted Clay	SHANSEP	20	40	0.35							
	[Undrained] Surface Soil	SHANSEP	21	45	0.24							



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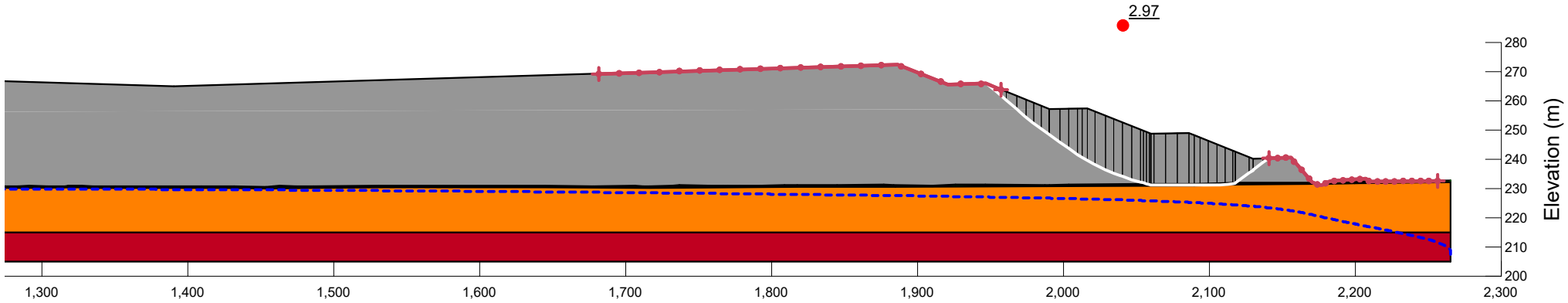
DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section C: RHS Slope - Long Term - Undrained - 20-50 years - Local

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	UCS Intact (kPa)	Intact Rock Parameter mi	Geological Strength Index GSI	Disturbance Factor D	Max Confining Stress Sigma 3 (kPa)
	[Drained] Fresh Bedrock	Hoek-Brown	20					175,000	10	30	0.1	800
	[Drained] Weathered Bedrock	Hoek-Brown	20					50,000	10	30	0.6	800
	[Softened Drained] Rejects (20% Reduction)	Mohr-Coulomb	18			1	24.8					
	[Softened Undrained] Compacted Clay (20% Reduction)	SHANSEP	20	32	0.28							
	[Softened Undrained] Surface Soil (20% Reduction)	SHANSEP	21	36	0.19							



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DREA FINAL LANDFORM DESIGN - STABILITY ASSESSMENT

Section C: RHS Slope - Post-Seismic - 20-50 years

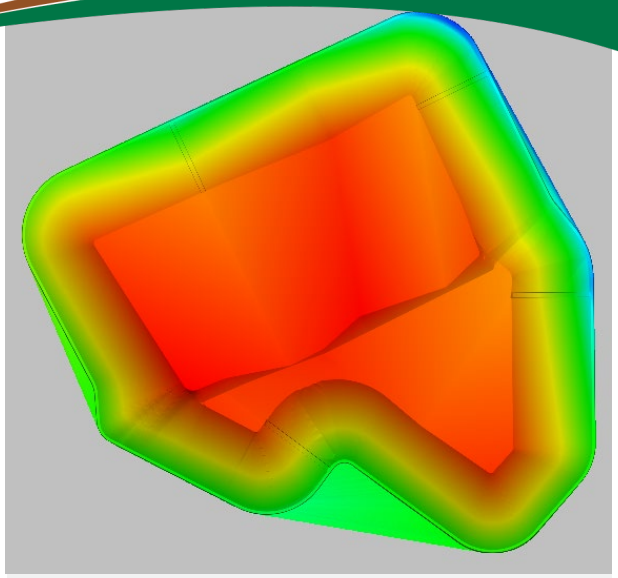
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APPENDIX B – DREA LANDFORM EVOLUTION MODELLING REPORT

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DRY REJECTS EMPLACEMENT AREA LANDFORM EVOLUTION MODELLING – EAGLE DOWNS



Report prepared for ATC Williams

February 2023

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Report Title: Dry rejects emplacement area landform evolution modelling– Eagle Downs

Client: ATC Williams Pty Ltd

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Version Number	Prepared by:	Reviewed by:	Date
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1 INTRODUCTION

ATC Williams Pty Ltd (ATCW) are assisting Eagle Downs Coal Management with the preparation of a Progressive Rehabilitation Closure Plan for the Eagles Down coal mine (Eagle Downs) near Moranbah, QLD. As part of this, ATCW are developing a rehabilitation design for the Dry Rejects Emplacement Area (DREA). ATCW have engaged Landloch Pty Ltd (Landloch) undertake landform evolution modelling (LEM) for the three-dimensional (3D) final landform design and assess long-term erosional performance of the DREA.

To assess long-term erosional stability of the final landform design, Landloch have used the SIBERIA landform evolution model. SIBERIA is a sophisticated 3D model that simulates erosion and deposition and predicts the long-term change in the shape of channels and hillslopes in a catchment. The model requires two types of input:

a) A digital elevation model (DEM) of the landform to be modelled; and
b) Input parameters for the key runoff and erosion model equations.

The model runs with a DEM that is used to define the 3D shape of the surface. SIBERIA evolves (changes in shape) the DEM over time in response to runoff and erosion potential. The runoff and erosion potential of a material is specific to both the infiltration capacity and erodibility of the different materials[1], and the rainfall characteristics of the climate in which the landform is positioned[2].

This report outlines the:

- Methodology used to establish the input DEM;
- Methodology used to derive the required input parameters for SIBERIA; and
- Results of the long-term SIBERIA LEM.

1.1 Scope of work

The following scope of work was undertaken and reported in this document:

- Review existing closure and materials characterisation data and develop site and material-specific SIBERIA input parameters.
- Input the final landform design DEM developed by ATCW into SIBERIA.
- Conduct 3D LEM using the site and material-specific input parameters, and the rehabilitation design DEM.

[1] Different materials modelled at the same location will have different model input parameters.
[2] The same material modelled at multiple locations with different rainfall characteristics will have different model input parameters.

2 DATA REVIEW

To develop input parameters for SIBERIA, information is required on the proposed rehabilitation strategy and the materials to be used on the surface of the rehabilitated landform. Documents provided to Landloch for review were as follows:

- *Eagle Downs Closure Plan* (South 32 2020);
- *Geochemical and Physical Assessment of Drift Spoil, Coal and Coal Rejects Materials* (RGS 2022a); and
- *Topsoil Quality Assessment* (RGS 2022b).

2.1 Rehabilitation strategy

The *Eagle Downs Closure Plan* (South 32 2020) provides detail on the proposed closure strategy for Eagle Downs, including the DREA. The conceptual closure design for the DREA involves capping the rejects with 0.25m of topsoil overlying 1m of subsoil, with deep ripping to 0.6m along the contour. Data on the physical and chemical characteristics of the topsoils and subsoils to be used for rehabilitation are not included in the document.

The closure plan also states that the '*current design philosophy is to provide an erosion resistant cover using rock and a rock/soil surface mulching layer to support vegetation.*' Given this, the rehabilitated surface of the DREA was assumed to be comprised of a vegetated soil/rock mix layer over the entire final landform surface (landform top and batters). No details on the type or characteristics of the rock to be used in the soil/rock mix, nor the percentage of vegetative groundcover to be established are included in the closure plan.

Overall, the closure plan provides general guidance on the material types to be used for rehabilitation, and the indicates an intent to establish vegetation on the rehabilitated DREA surface. However, there are several knowledge gaps:

- Physical and chemical characteristics of the topsoil to be used as a cover material is lacking.
- Detail on the proposed source and characteristics of waste rock to be used as an armouring element within the cover material is lacking.
- The target vegetative groundcover percentage to be established on the surface of the DREA is not stated.

2.2 Source of rock armour

To determine a potential source of rock armour, Landloch reviewed the *Geochemical and Physical Assessment of Drift Spoil, Coal and Coal Rejects Materials* (RGS 2022a) at Eagle Downs. This assessment included geochemical and geotechnical characterisation of the overburden and interburden materials, which are potential sources of rock armour. Samples were collected from one drill hole, with 6 samples within the overburden (comprised of sandstone) and 9 samples within the interburden (comprised of siltstone and siltstone with sandstone bands). Of the materials assessed, sandstone sourced from the overburden appears to be geochemically benign (not potentially acid forming or prone to generation of acid or metalliferous drainage) and

relatively competent (not prone to significant weathering or breakdown). However, the volumes of sandstone to be generated, the mean size of the rock fragments when blasted, and the particle size distribution (i.e. percentage of fines) are unknown.

With no other information available, Landloch has assumed that sandstone will be used as the source of rock armour and is suitable for use. The availability of this resource for use in rehabilitation must be confirmed through additional future studies of rehabilitation materials.

2.3 Soil properties

The characteristics of the topsoils are outlined the *Topsoil Quality Assessment* (RGS 2022b). Samples were collected in June 2022, with one composite sample from each of the 17 topsoil stockpiles sent for physical and chemical analysis (17 samples in total). Results indicate that the topsoils are typically suitable for use as growth medium, with no major limitations. Based on this, Landloch have assumed that the stockpiles sampled are representative of the topsoils to be used for rehabilitation of the DREA.

2.4 Vegetation groundcover

No data was available on potential vegetative groundcover percentages that may be achieved on the rehabilitated DREA. Photographs taken as part of the *Topsoil Quality Assessment* (RGS 2022b) show the establishment of dense grass cover on the stockpiled topsoils, noting that only two photos of the stockpiles were included in the document. The images appear to indicate that grass can be reliably established on the topsoils. Given that the proposed rehabilitation surface is comprised of topsoil mixed with a rock armour, it can be reasonably assumed that vegetative groundcover can be established on the rehabilitated surface, but as a percentage that is lower than would likely establish on topsoil alone.

For the purposes of this project Landloch have assumed that the final rehabilitation surface will comprise a vegetative groundcover of 50%.

2.5 Proposed cover materials

The proposed cover layer to be modelled is assumed to be comprised of a sandstone/topsoil mix with a vegetative groundcover percentage of 50%. The current plan indicates a 0.25m thick layer of topsoil over a 1.0m thick layer of subsoil. It makes no mention of the inclusion of the rock armour element; this will have an impact on the volumes of the topsoil, subsoil, and rock armour that would be identified for use in rehabilitation activities.

If 0.25m topsoil is mixed into a rock armour, the resultant thickness of the upper layer will be deeper than 0.25m. At this stage, it is difficult to predict the actual thickness of the layer that would result because the size of the interstitial void space (the air-filled gaps around the larger rock fragments) within the rock armour material is not currently known. However, for the sake of illustration, mixing a 0.25m thick layer of topsoil into

the same thickness of rock armour material with 10% interstitial void space[3] would create a layer that is 0.475m thick. Alternatively, reduction of the thickness of the subsoil layer could be considered. However, the change in the plant available water that would occur if this were reduced must also be considered as it may have a significant impact on the ability of vegetation to establish and grow. Landloch notes these as topics for consideration in future cover material assessments.

3 LANDFORM DESIGN

The final landform design DEM for the DREA was supplied to Landloch by ATCW. Engineering drawings of the DREA final landform design are provided in Figure 1 and 2.

The design has a footprint of ~410ha, and is comprised of uniform-gradient outer batters and a water-shedding top surface.

The outer batters are typically 40m high but can vary in height from 37m to 47m. A uniform batter gradient of 13% (7.4°) is used for all outer batters.

There are four drainage structures present on the outer batters; two on the northern batter, one on the eastern batter, and one on the southern batter. Each drainage structure is ~30m wide and runs from the top to the bottom of the landform.

The top surface is ~175ha in size and has a variable relief that can be as high as 10m in some sections. The top surface is designed to shed runoff from the top surface into each of the four drainage structures. The gradient of the top surface is typically <5% but can be as steep as 10% in some areas.

[3] The interstitial void space of blasted waste rock is often largely filled with the fines created during blasting.

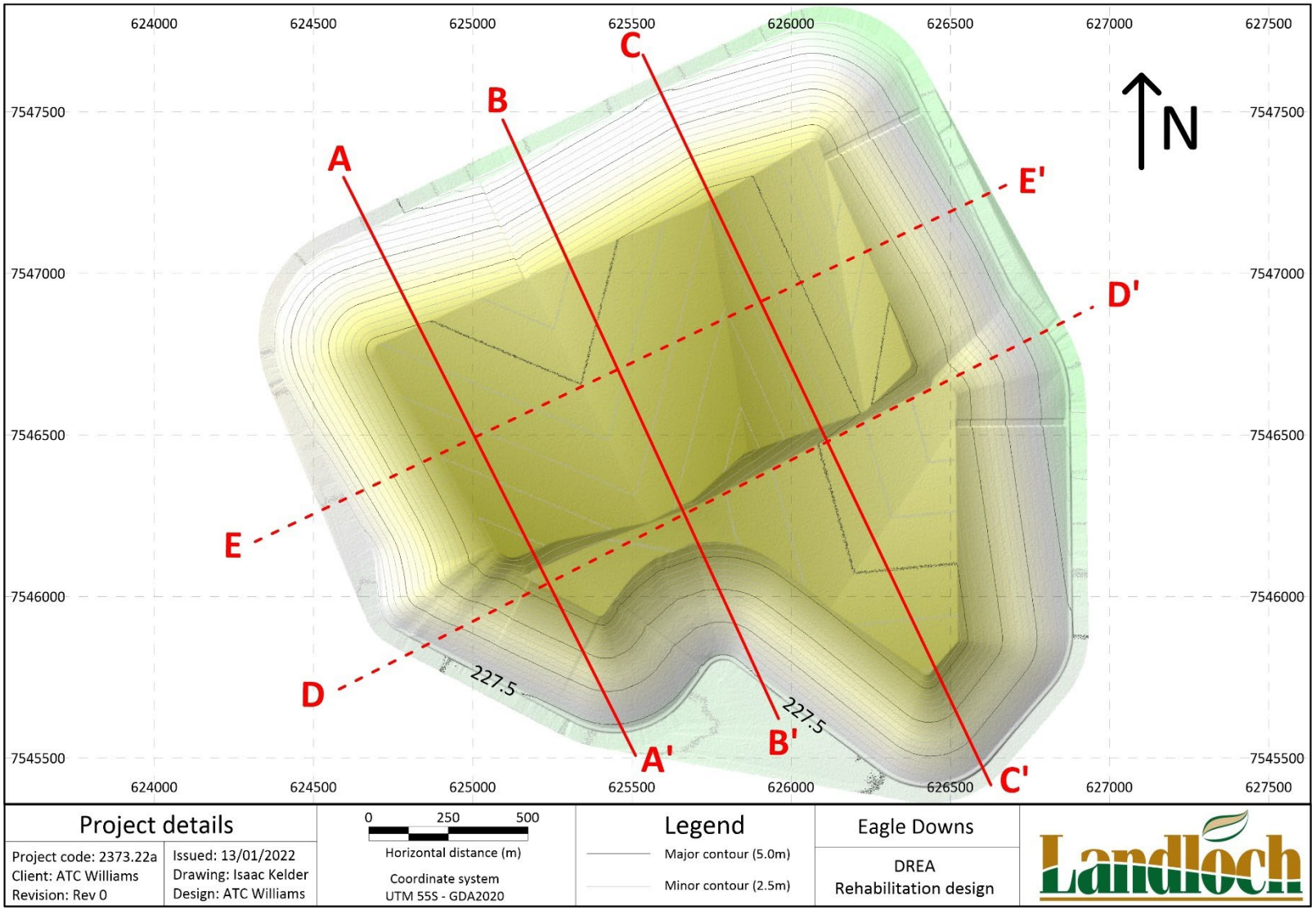


Figure 1: DREA final landform design

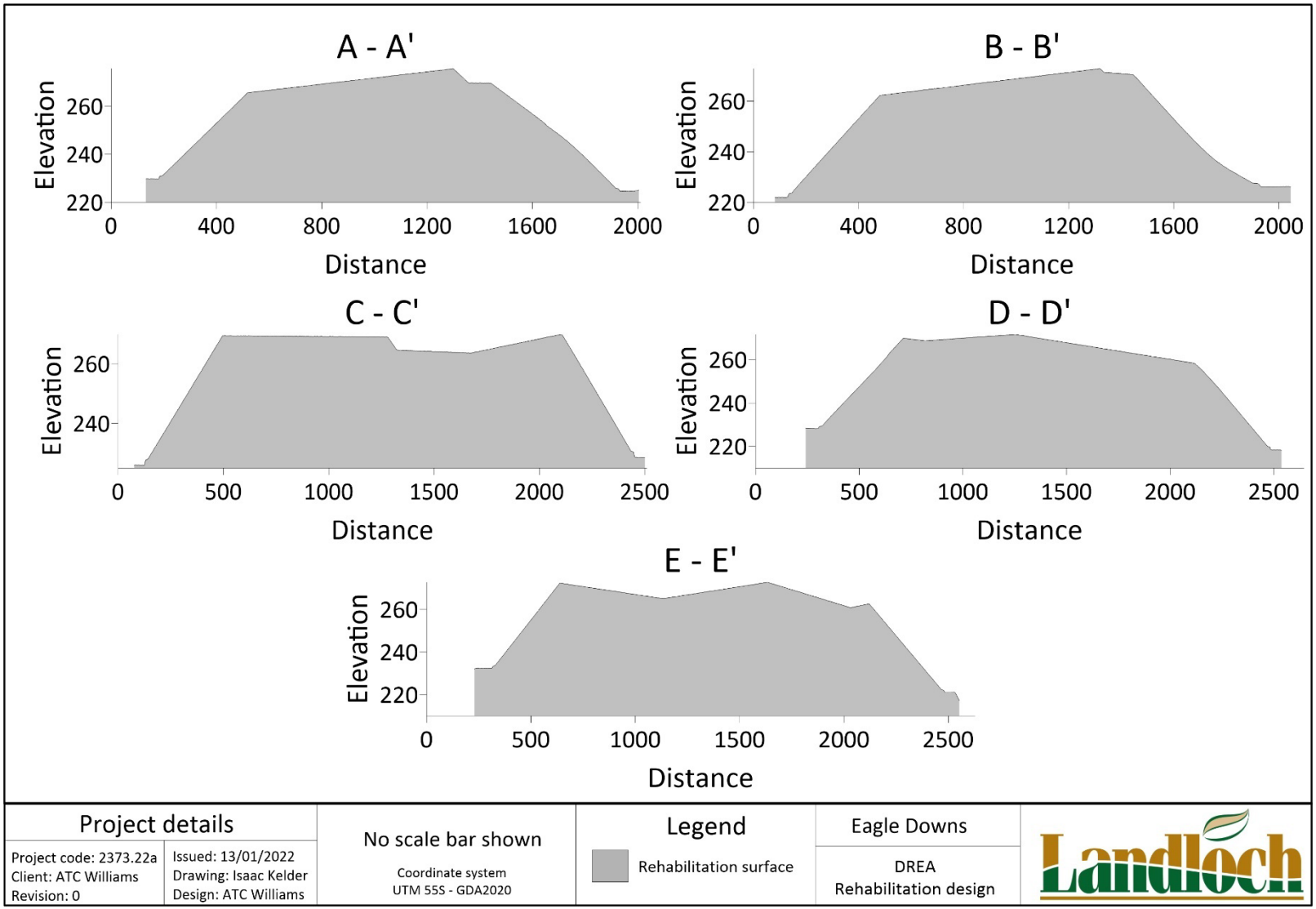


Figure 2: Cross sections of DREA final landform design

4 SIBERIA LANDFORM EVOLUTION MODEL

The SIBERIA landform evolution model predicts the long-term, 3D development of channels and hillslopes (e.g. landform batters) in a catchment on the basis of runoff, erosion, and deposition. It has been successfully applied to explain aspects of the geomorphology of natural landforms (Willgoose 1994) and has been widely used to assess the evolution of constructed waste landform shapes on a range of mine sites across Australia and overseas (Willgoose 1995; Willgoose and Riley 1993; Boggs *et al.* 2000; Hancock *et al.* 2003; Hancock and Willgoose 2004; Mengler *et al.* 2004; Hancock and Turley 2006).

SIBERIA has been subjected to numerous validation studies. In general, the validation studies indicate that SIBERIA's predictions of landform evolution are reasonable provided the model is suitably parameterised (Hancock *et al.* 2000; Hancock *et al.* 2002; Hancock *et al.* 2003; 3). In one validation study (Hancock and Willgoose 2004), it was noted that erosion rates predicted by SIBERIA for a catchment in the Northern Territory compared favourably to erosion estimates derived using the caesium-137 method. As the two erosion assessment methods use independent input information, the reported agreement is particularly significant.

SIBERIA solves for two variables:

1. Elevation, from which slope geometries are determined, and
2. An indicator function that determines where erosion features (channels) exist.

Changes to the predicted erosion features is governed by an activation threshold that is dependent on the runoff discharge and gradient of the slope. When the activation threshold is exceeded, an erosion feature is predicted to develop. In this way, it is possible for a modelled surface to initially have no erosion features and for rills/gullies to develop where the activation threshold is exceeded.

The rate at which rills and gullies develop is controlled by a channelisation function. SIBERIA does not directly input rainfall or material erodibility parameters. Rather, the SIBERIA input parameters define the channelisation function that is a function of both runoff and erosion (Willgoose *et al.* 1989). As a result, SIBERIA parameters are specific to both the rainfall regime and the material being considered and must be derived for each specific material located within each specific location.

4.1 SIBERIA input parameters

SIBERIA predicts the long-term average change in elevation of a node (i.e. a point in the landscape with size based on grid resolution) by predicting the volume of sediment lost from that node. The rate of sediment transport through a node (q_s in units of m^3/y) is determined by the equation:

$$q_s = \beta_1 \times q^{m_1} \times S^{n_1} \qquad 1)$$

where β_1 is the sediment transport rate coefficient (unitless), q is discharge (m^3/y), m_1 is the discharge exponent (unitless), S is the slope (m/m), and n_1 is the slope exponent (unitless).

SIBERIA does not directly model discharge, but uses sub-grid effective parameterisation which relates discharge to the area draining through a node as:

$$q = \beta_3 \times A^{m_3} \qquad 2)$$

where β_3 is the coefficient between discharge and area (unitless), A is area (m^2), and m_3 is the exponent of the area in discharge (unitless).

To run SIBERIA, the parameters β_1, m_1, n_1, β_3, and m_3 are needed. There is interaction between all 5 parameters, with the result that an almost infinite number of parameter sets will all show the same rate of erosion, though some aspects of the pattern of erosion that is predicted will vary. Fixed values for β_3, n_1, and m_3 are adopted where possible, reducing the difficulty of deriving parameter values. If the batter to be modelled is identical to the batter for which erosion data are available for calibration, m_3 and β_3 can be taken as 1.0, and for situations where slope gradient does not affect slope erodibility, n_1 can be taken as 1.5 (Willgoose pers. comm.). Where steeper slopes are subject to a changing level of armouring along the slope length, n_1 may be as low as 0.7 (Evans *et al.* 1998). For this study, an n_1 value of 1.5 was used.

Therefore, two key parameters require fitting against runoff and erosion data: β_1 and m_1. Effectively, the β_1 parameter could be described as an erosion rate parameter, as it primarily controls the rate of sediment movement. The m_1 parameter could be described as primarily controlling erosion responses to changes in slope length.

4.2 Derivation of parameters

The input parameters for SIBERIA are derived by fitting the SIBERIA model equations to time series data of runoff and erosion. However, in most instances sufficiently long series of these paired data are not available for the landforms of interest. Therefore, Landloch has developed an alternative approach for developing the required SIBERIA input parameters through coupling it with output from the Water Erosion Prediction Project (WEPP) runoff/erosion model. WEPP is used to provide the required time series data for the generation of SIBERIA input parameters. The broad approach to calibration is to:

1. Measure runoff and erosion on materials using laboratory-based rainfall simulation and flume techniques to derive calibrated infiltration and erodibility parameters.
2. Run the WEPP model for batter geometries consistent with those within the rehabilitated landform design. Generate data sets of runoff and erosion for those batter geometries and materials of interest using long (100-year), site-specific climate sequences that contain a wide range of rainfall events, including rare and extreme events.
3. Analyse the WEPP runoff and erosion model output and fit to the SIBERIA model equations to derive SIBERIA input parameters.

For Eagle Downs, infiltration and erodibility parameters for the site materials were not available. As such, surrogate indicators of infiltration capacity and erodibility (e.g. particle size distribution and exchangeable cations) were used to select similar materials from Landloch's database of infiltration and erodibility parameters. These parameters were used for Eagle Downs, assuming that:

- Sandstone rock armour will be mixed into the topsoil to generate a surface with 30% rock cover once mixed and armoured under rain, and
- Grass will produce 50% vegetative groundcover.

Using the data for this cover materials, WEPP was run for batter geometries consistent with the DREA final landform design using a long-term (100 year) climate file generated for Moranbah. Outputs from WEPP were then used to fit the SIBERIA model equations and derive the required input parameters. Completion of this process facilitated the operation of SIBERIA with a calibrated parameter set for the landform, with parameters outlined in Table 1.

Landloch note that these parameters are considered reasonable for use in preliminary modelling, however erodibility testing of the materials proposed to be used for rehabilitation should be conducted when practicable.

Table 1: SIBERIA parameters for the proposed cover material.

Material	β_1	m_1
Topsoil/rock mix (30% rock cover) with 50% vegetative groundcover	0.006321	0.9161

4.3 Target long-term erosion rate

When erosion models are used to develop designs for minesite landforms, a target erosion rate is required to define acceptable landform design options. When this target is exceeded, the design is said to be unacceptable; when the target is not exceeded, the design is said to be acceptable.

Landloch adopts target rates at which rill erosion risk is significantly reduced. Such values vary to some degree depending on the perceived risk associated with the site; whether erosion potential could become high over time or whether exposure of encapsulated materials may be of concern.

For Moranbah, erosion risk is moderate due to relatively high rainfall erosivity and the low infiltration potential of the cover material. Generally, erosion rates in the order of 5-10t/ha/y are associated with surfaces with a low tendency for rilling.

Over the long term (e.g. 300 years in this report), the cumulative effect of even low erosion rates can be somewhat noticeable. A rate of 2t/ha/y would yield a soil loss of

90mm over 300 years. However, it would be expected that soil development[4] within the cover layer would balance and compensate for the slow loss of topsoil.

4.4 Model settings

Parameters for the cover material were applied across the entire surface of the DEM (including the four drainage structures). The parameters are applied for the entire depth of the capping layer (1.25m). Erosion that occurs beyond this depth of the capping layer is excluded from the SIBERIA outputs, as the underlying material (dry rejects) will have erodibility characteristics that are different to the cover materials. This is consistent with the capacity of the model, and the fact that the cover material will be applied consistently across the final landform.

SIBERIA was run for a 300-year period. The following SIBERIA statistics were produced at year 50, 100, 150, 200, 250 and 300:

- Maximum gully depth (m);
- Average erosion (t/ha/y) of the outer batters for each output year; and
- Cumulative average outer batter erosion (mm).

The output from the SIBERIA model was also processed to produce a series of visualisations for each model run. These included:

- Depth of material movement as a means of showing gully depth. Scaling was adopted that showed erosion/deposition ±0.3m in green, deposition >0.3m in blue, and erosion >0.3m in red. A gully is defined in this report as an erosion feature with a depth greater than 0.3m. Where such features are not modelled, the landform is said to not have gully erosion. Features such as rill may still occur on a landform that is not gullied.
- Rate of erosion as a means of showing areas that do not meet the target erosion rate. Scaling was adopted that showed mean average annual erosion <5.0t/ha/y in green, 5.0–7.5t/ha/y in yellow, 7.5–10t/ha/y in orange, and >10t/ha/y in purple.

The input DEM was developed by ATCW. This DEM was gridded by Landloch at a spacing of 2.0m and a random roughness of ±0.1m was added to the gridded data to reduce triangulation artefacts, and to better represent a surface comprised of rocky material. Calibration of the model included the same level of roughness.

[4] Soil formation through alteration of the underlying subsoils and overburdens and through deposition of wind-blown sediments.

5 RESULTS

Statistical results for the SIBERIA simulation conducted with the capping layer model parameters applied to the surface are provided in Table 2. Visual outputs of the SIBERIA simulations for 300 years are given in Figure 3 and 4. Visualisations for all modelled years are given in Appendix A.

Table 2: Maximum gully depth, average annual erosion, and cumulative erosion on the batter slopes of the DREA at Eagle Downs.

Simulation year	Maximum gully depth (m)*	Average erosion (t/ha/y)	Cumulative erosion (mm)
50	-	4.9	16
100	0.3	4.0	30
150	0.4	3.7	42
200	0.5	3.6	54
250	0.6	3.5	66
300	0.7	3.4	77

* A gully is defined in this report as an erosion feature with a depth greater than 0.3m. A '-' is used to indicate that no gullies were predicted (i.e. no erosion features >0.3m deep).

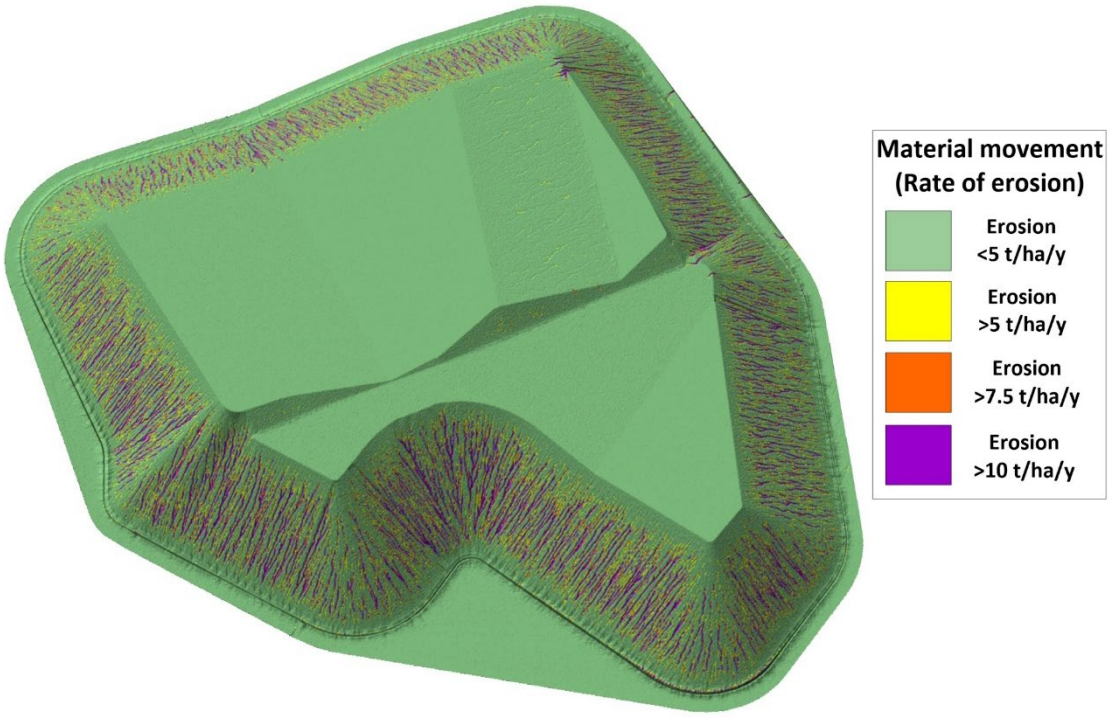


Figure 3: SIBERIA output for DREA final landform design, showing erosion rate at year 300 with 30% sandstone mixed into topsoil, and 50% vegetative contact cover.

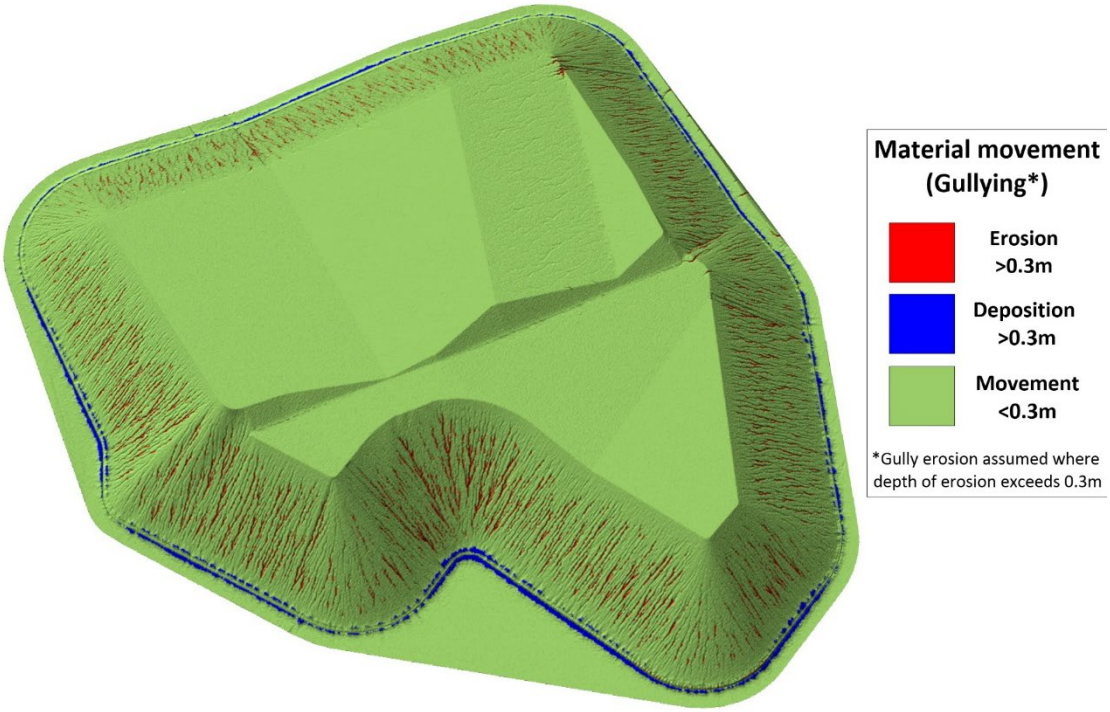


Figure 4: SIBERIA output for DREA final landform design, showing gully depth at year 300 with 30% sandstone mixed into topsoil, and 50% vegetative contact cover.

6 DISCUSSION

6.1 Erosion rates and gully depths

The DREA rehabilitation design is predicted to erode at a long-term average annual rate (over the outer batters) of 4.9t/ha/y by year 50, decreasing to 3.4t/ha/y by year 300. These rates are within the target long-term average annual erosion rate of <5t/ha/y. Erosion rates are generally consistent across the outer batters. Erosion of the top surface is predicted to be less than that measured for the outer batters.

Cumulative erosion rates are typically low, with a predicted average soil loss of 77mm on the outer batters by year 300. It is expected that this rate of erosion would be compensated by soil development[5] within the cover layer. However, consideration should be made to the depth of the cover layer to ensure it continues to function effectively in the long-term.

Gully erosion is predicted to occur by year 50 to a depth of 0.3m, with gully depth increasing to 0.7m by year 300. The current cover layer is proposed to be at least 1.25m thick and comprised of soils and rock armour. A 0.25m thick layer of topsoils mixed into the same thickness of rock armour could create a surface layer that is ~0.5m thick. Given that under this layer, a subsoil layer will be present before the dry rejects are reached, the maximum predicted gully erosion (0.7m) is not likely to to erode through the cover layer into the underlying rejects within 300 years.

[5] Soil formation through alteration of the underlying subsoils and overburdens and through deposition of wind-blown sediments.

Based on the predicted erosion rates, it was concluded that the current final landform design for the DREA is generally erosionally stable and will not result in erosion that will expose the underlying dry rejects within the modelled period of 300 years.

6.2 Landform design

The design principles of the landform, and the 3D shape play a role in both the rates of erosion and the depth of gully erosion that are predicted.

The use of a water shedding design that concentrates runoff down the four drainage structures present a potential risk to the long-term erosional stability of the landform. Failure (i.e. overtopping or tunnelling) of any of the four drainage structures may result in uncontrolled discharge of concentrated runoff down the batter slopes, resulting in an increase in the rate of erosion and depth of gullying at these locations. This can be seen in Figure 5 (inset 1), where the gully erosion is exacerbated on the top of the outer batter due to uncontrolled discharge of runoff from the top surface.

It is also noted that engineered structures typically have a set design life. As such, these structures will eventually fail over time (e.g. hundreds of years), which will change the hydrology of the landform and impact on erosional stability.

There is a concentration of surface water runoff on the southern section of the batters, driven by the 3D curvature of the outer batter (Figure 5 inset 2). The inward curvature of the outer batter results in an increase in gully depth, with a predicted maximum gully depth of 1.0m. Additional rock armour (i.e. >30%) could be applied to this section to reduce the depth of predicted gully erosion.

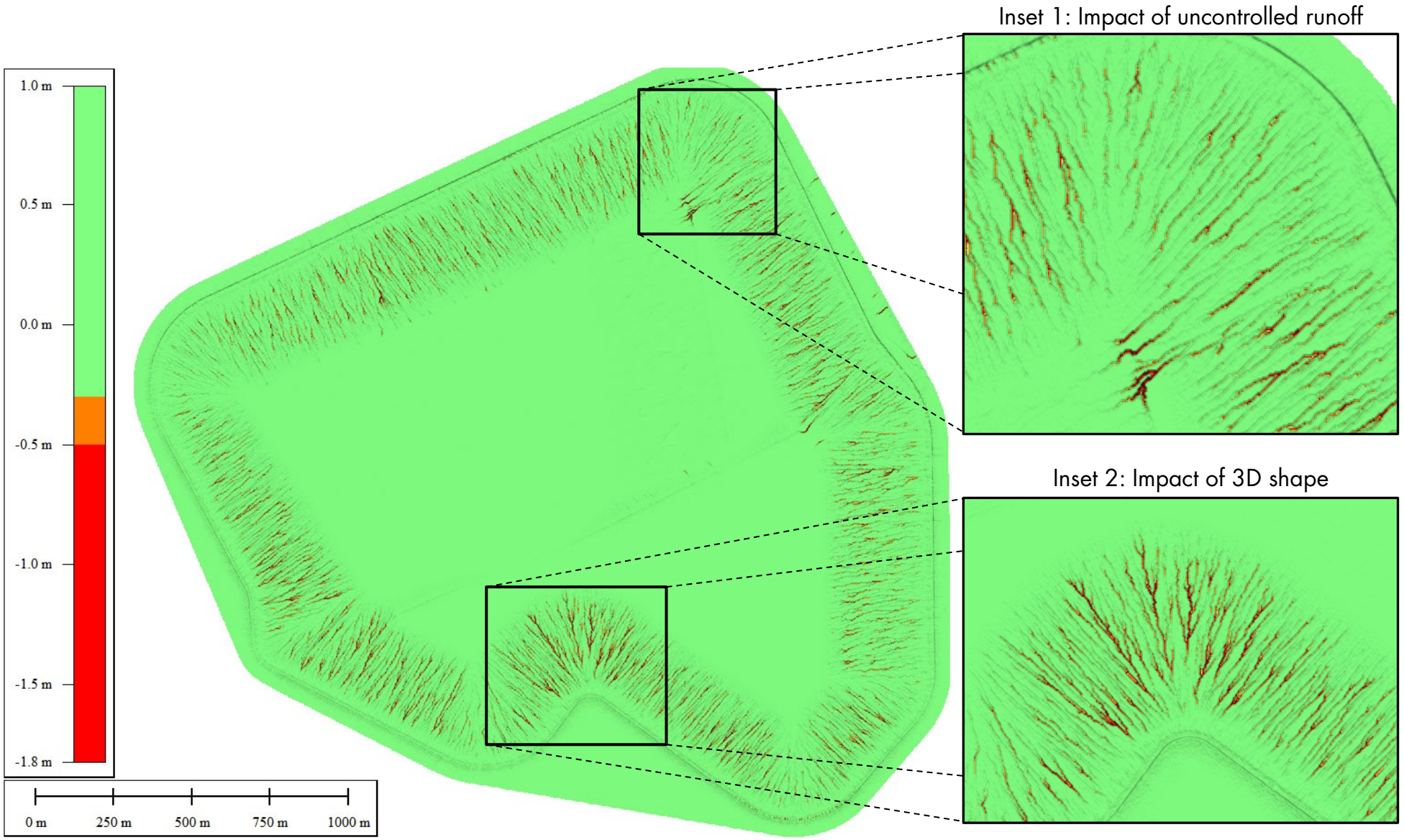


Figure 5: Examples of impact of uncontrolled discharge from the top of the landform (inset 1) and 3D shape (inset 2) on erosion.

6.3 Cover layer

The success of the capping layer is contingent on the type of rock, the mean size of the rock and the physical and chemical characteristics of the fines. Landloch have assumed that the cover layer will be comprised of a rock armour (sandstone has been assumed) mixed with topsoil such that a 30% rock cover is produced once the surface is armoured under rain. The rock armour is also assumed to be geochemically benign, fresh (or only slightly weathered), and durable in the long-term (not prone to weathering). The properties of the rock armour material should be confirmed through testing prior to its placement to ensure it meets the minimum requirements, as well as its availability (volumes).

Additionally, it is assumed that a vegetative groundcover of 50% will be established on the landform top and outer batters. It is vital that vegetation is established rapidly following rehabilitation, as the landform will be prone to erosion until such time sufficient vegetative groundcover is established. Vegetative groundcover levels above 50% will improve the erosional performance of the landform.

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APPENDIX A: LEM VISUALISATIONS

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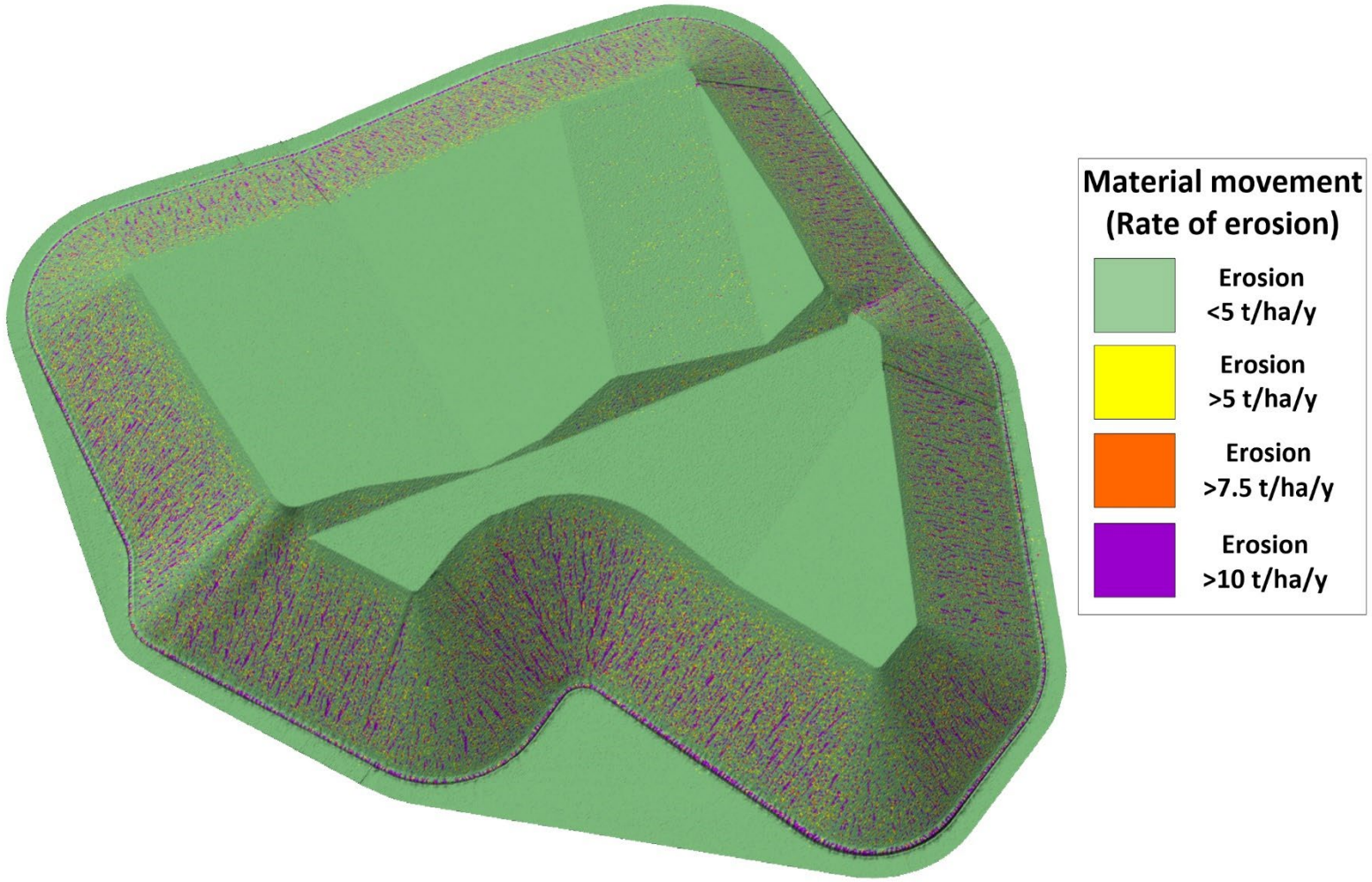


Figure A1: SIBERIA output for DREA final landform design, showing erosion rate at year 50 with 30% sandstone mixed into topsoil, and 50% vegetative contact cover.

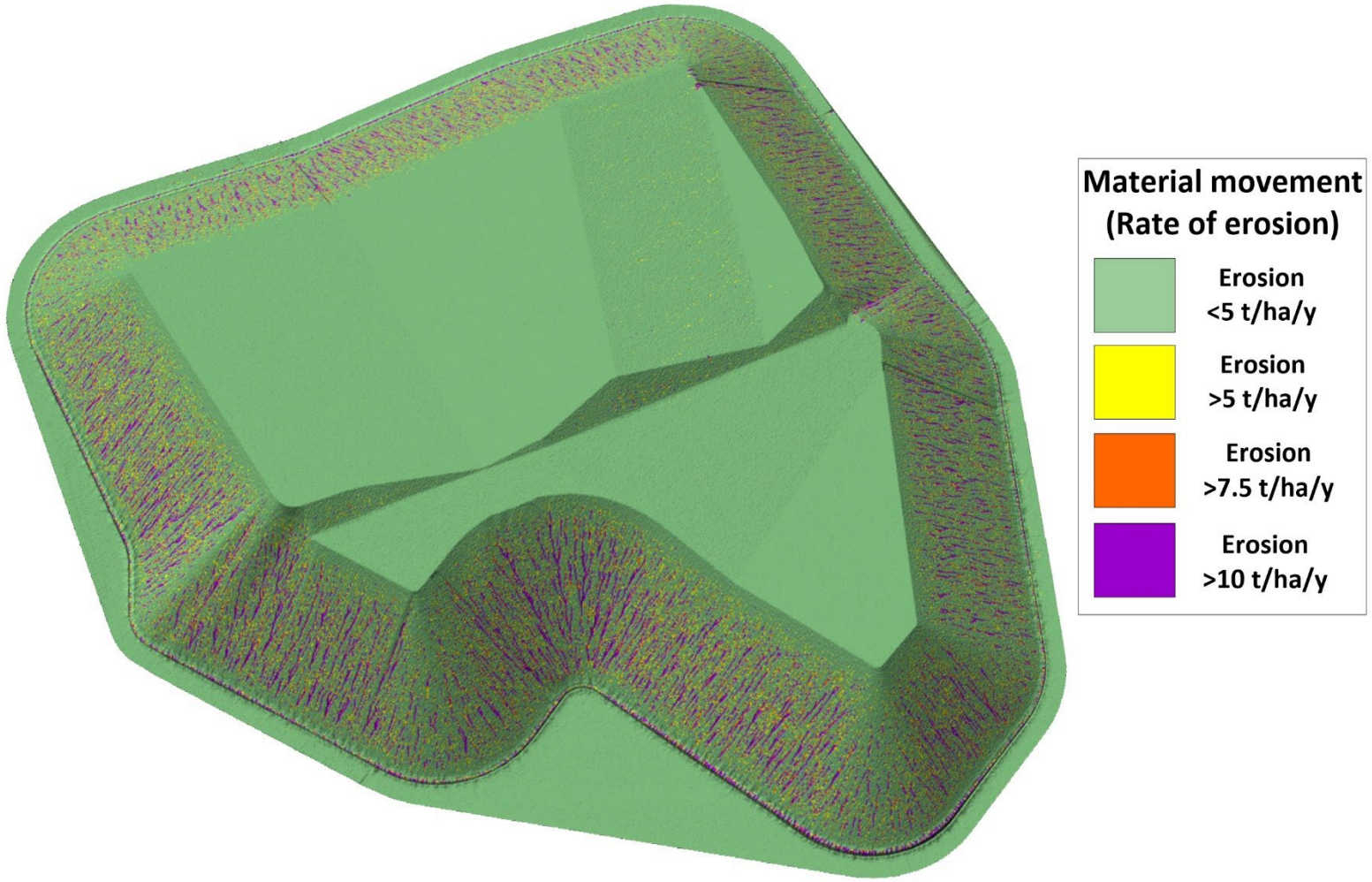


Figure A2: SIBERIA output for DREA final landform n design, showing erosion rate at year 100 with 30% sandstone mixed into topsoil, and 50% vegetative contact cover.

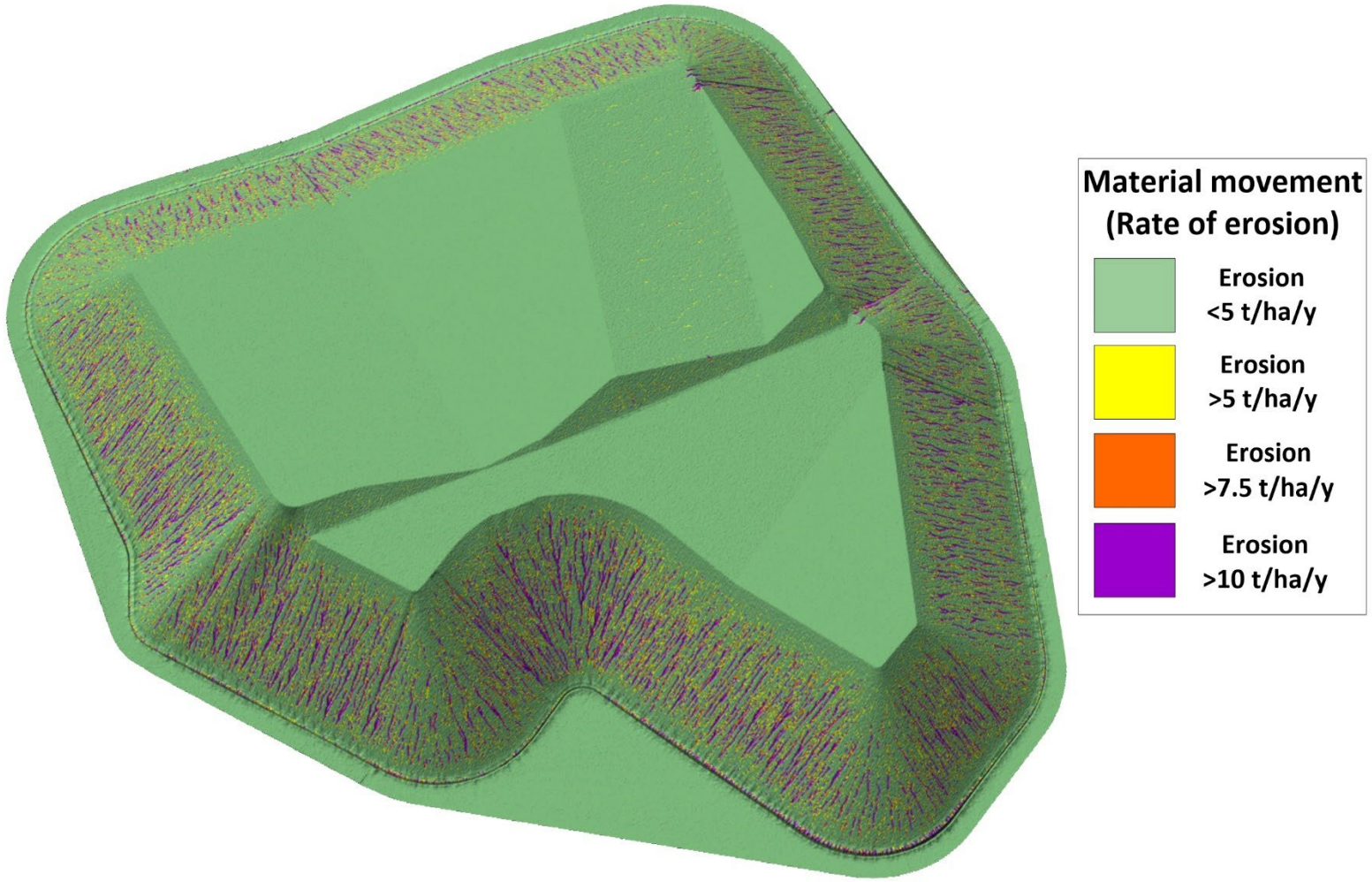


Figure A3: SIBERIA output for DREA final landform design, showing erosion rate at year 150 with 30% sandstone mixed into topsoil, and 50% vegetative contact cover.

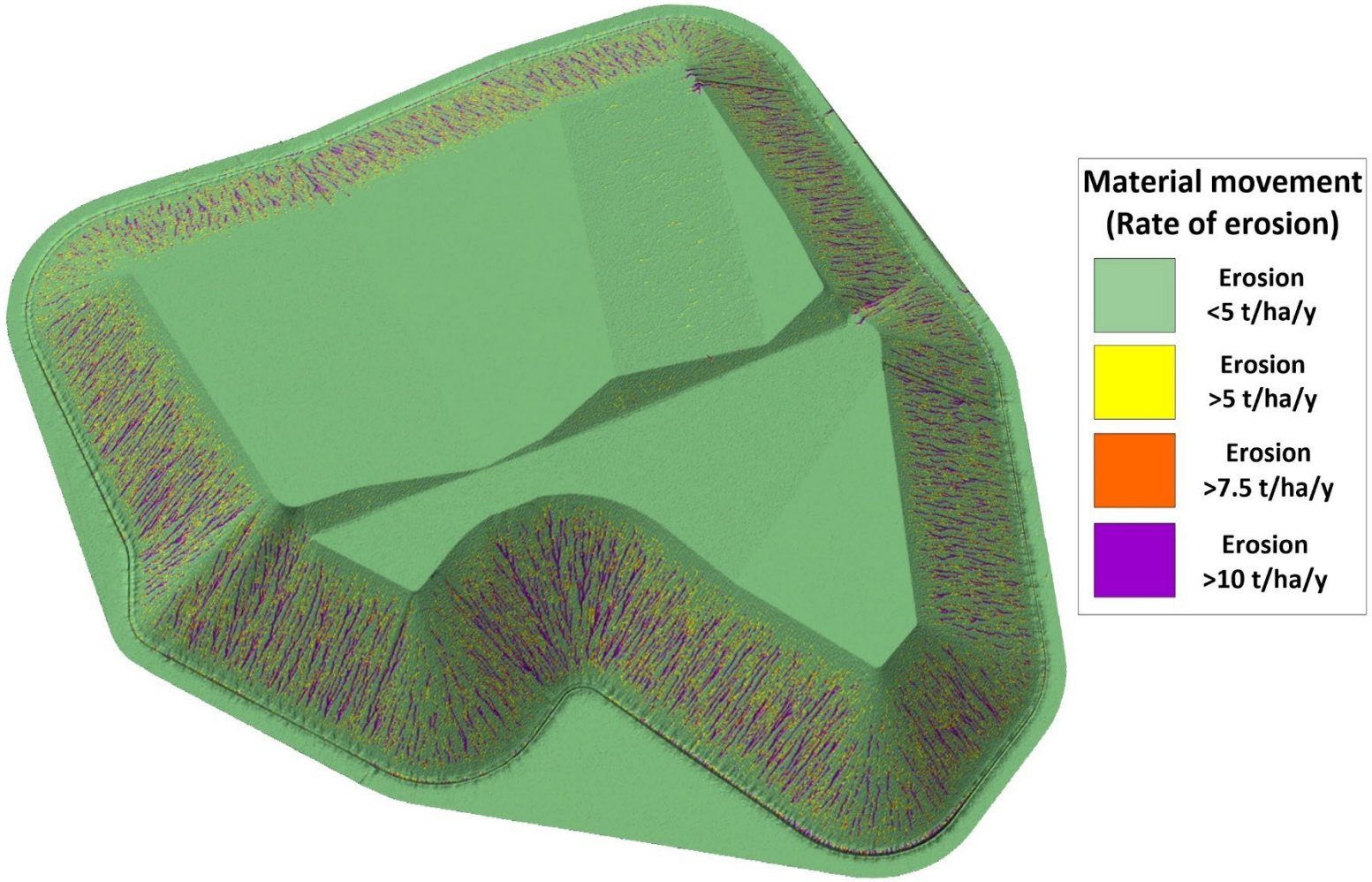


Figure A4: SIBERIA output for DREA final landform design, showing erosion rate at year 200 with 30% sandstone mixed into topsoil, and 50% vegetative contact cover.

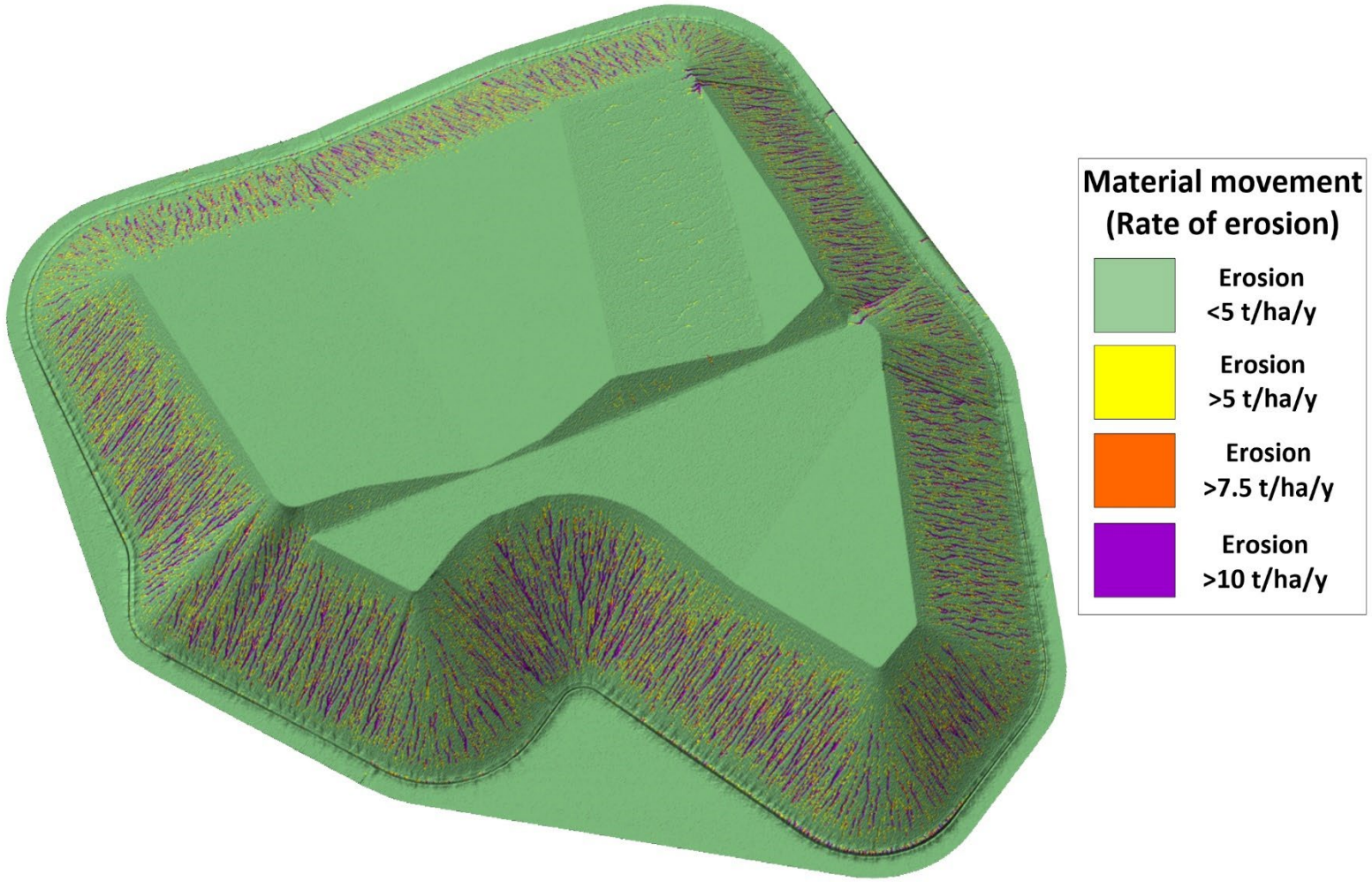


Figure A5: SIBERIA output for DREA final landform design, showing erosion rate at year 250 with 30% sandstone mixed into topsoil, and 50% vegetative contact cover.

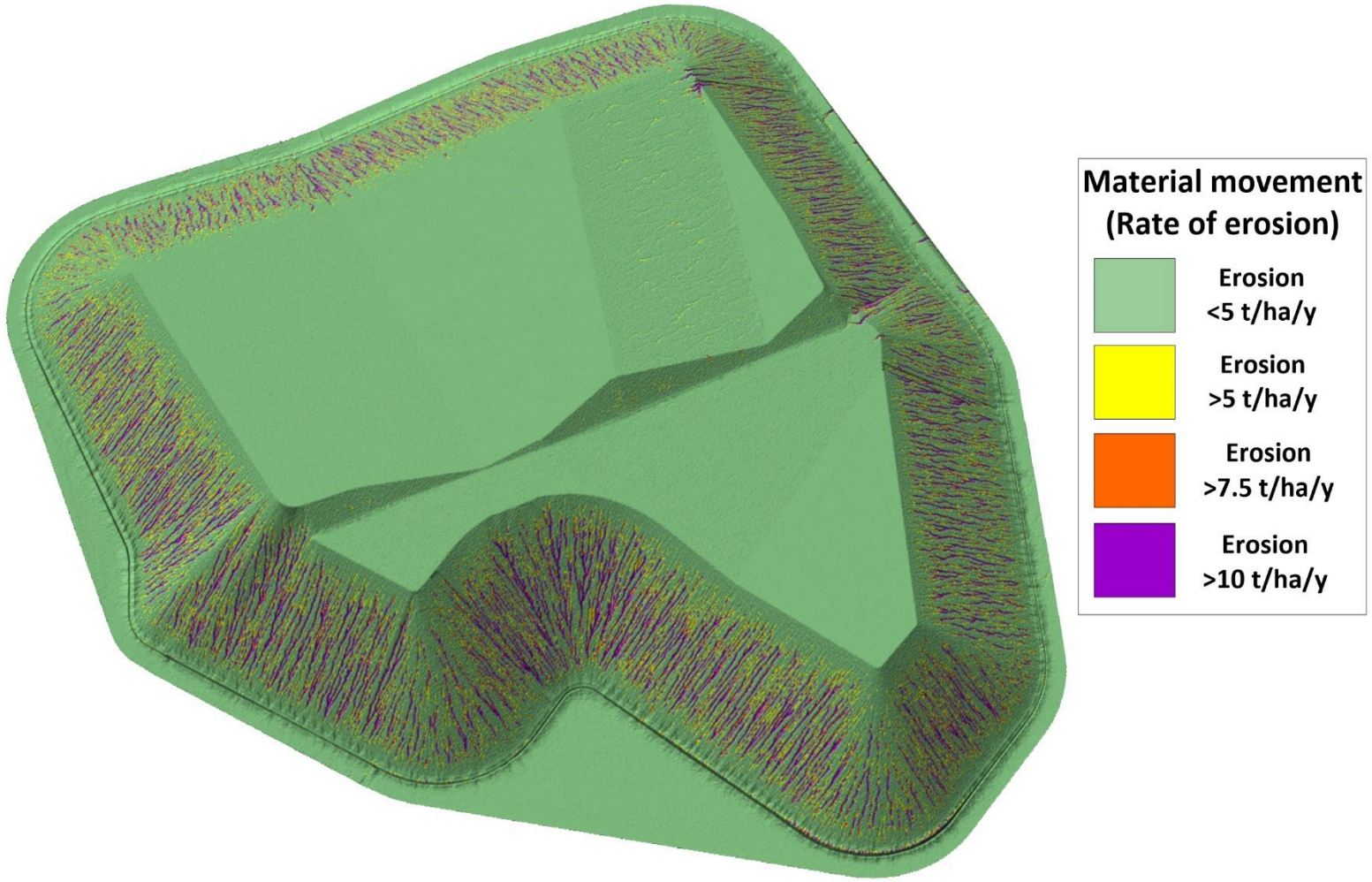


Figure A6: SIBERIA output for DREA final landform design, showing erosion rate at year 300 with 30% sandstone mixed into topsoil, and 50% vegetative contact cover.

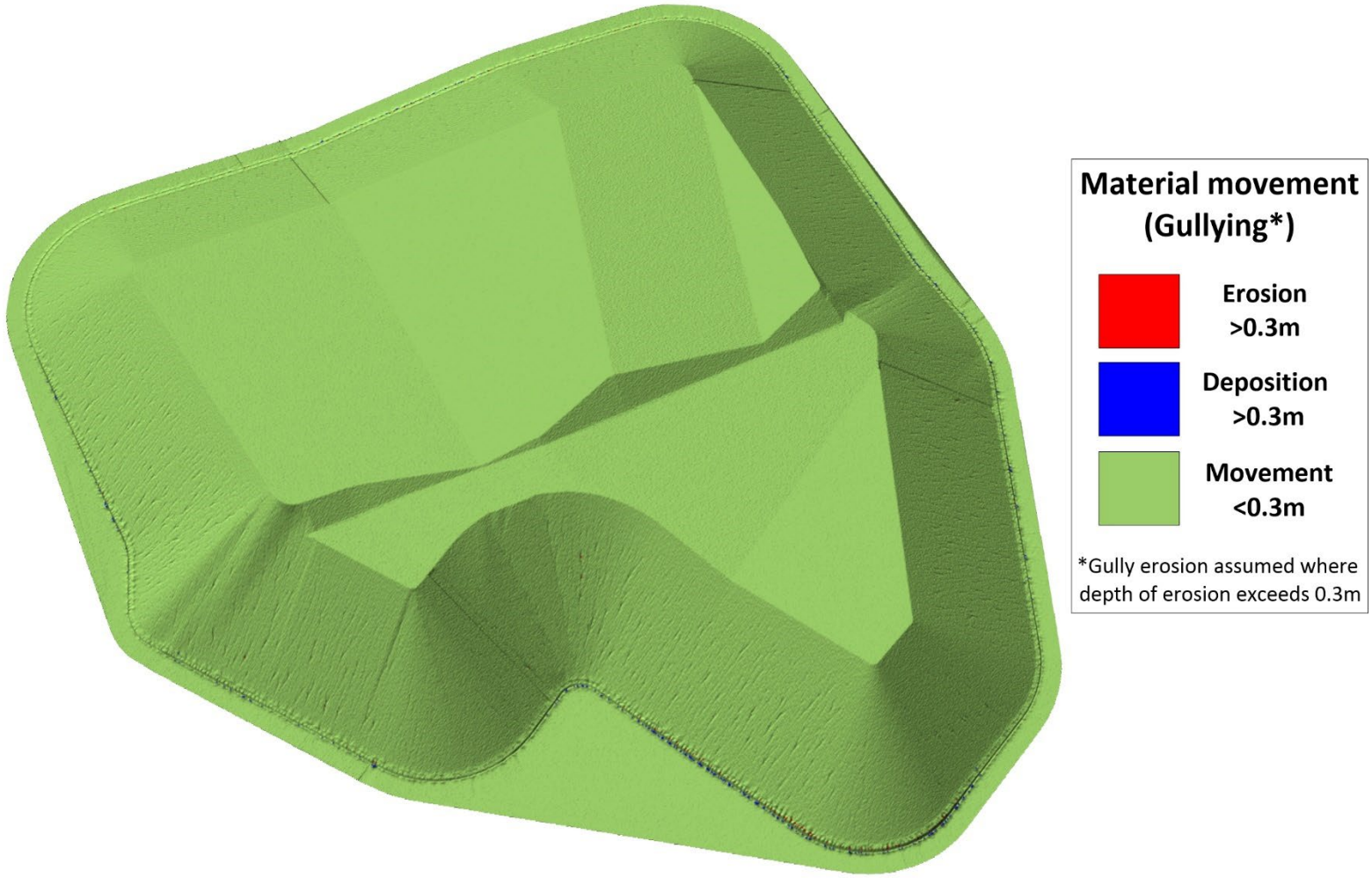


Figure A7: SIBERIA output for DREA final landform design, showing gully depth at year 50 with 30% sandstone mixed into topsoil, and 50% vegetative contact cover.

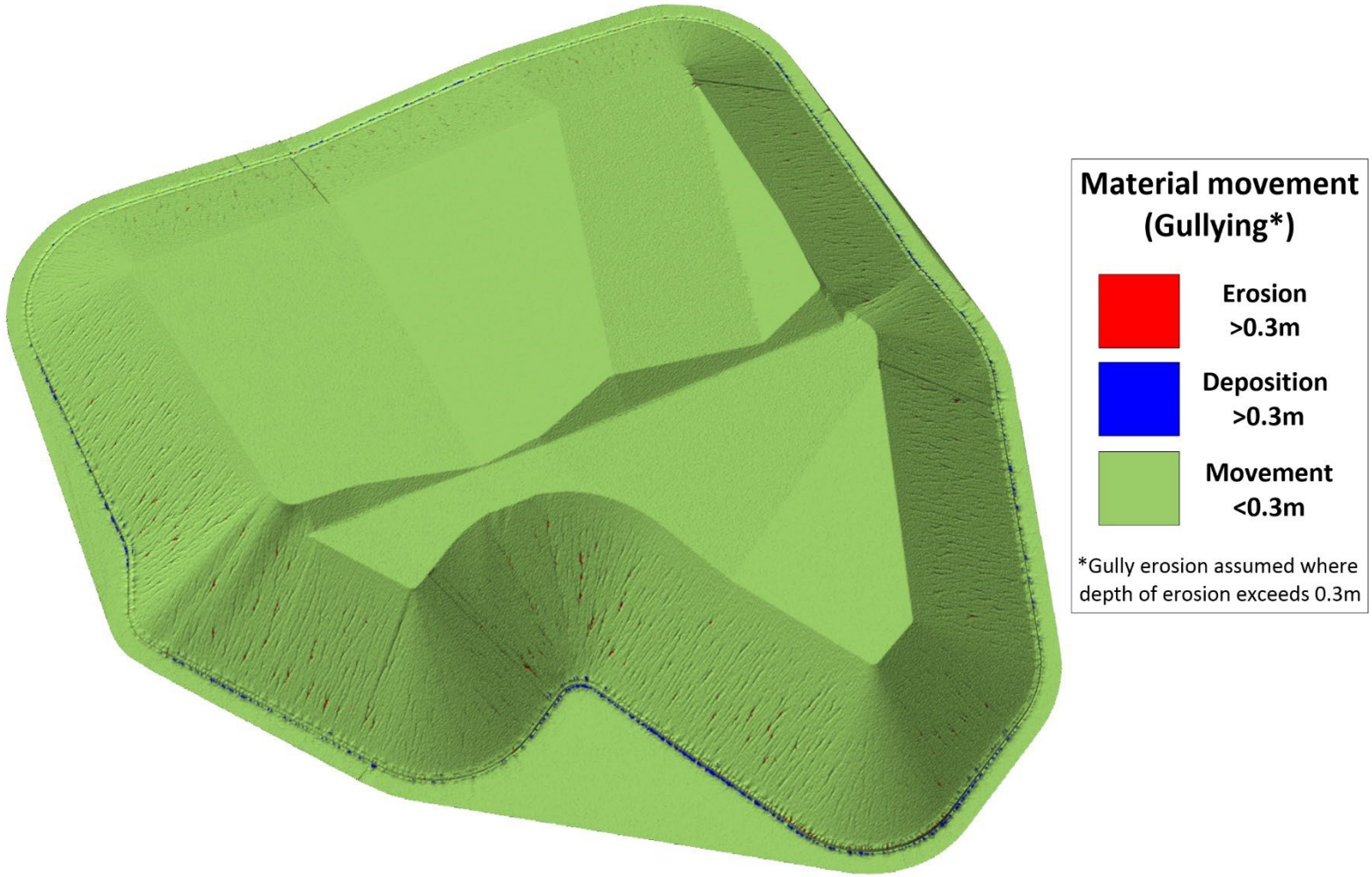


Figure A8: SIBERIA output for DREA final landform design, showing gully depth at year 100 with 30% sandstone mixed into topsoil, and 50% vegetative contact cover.

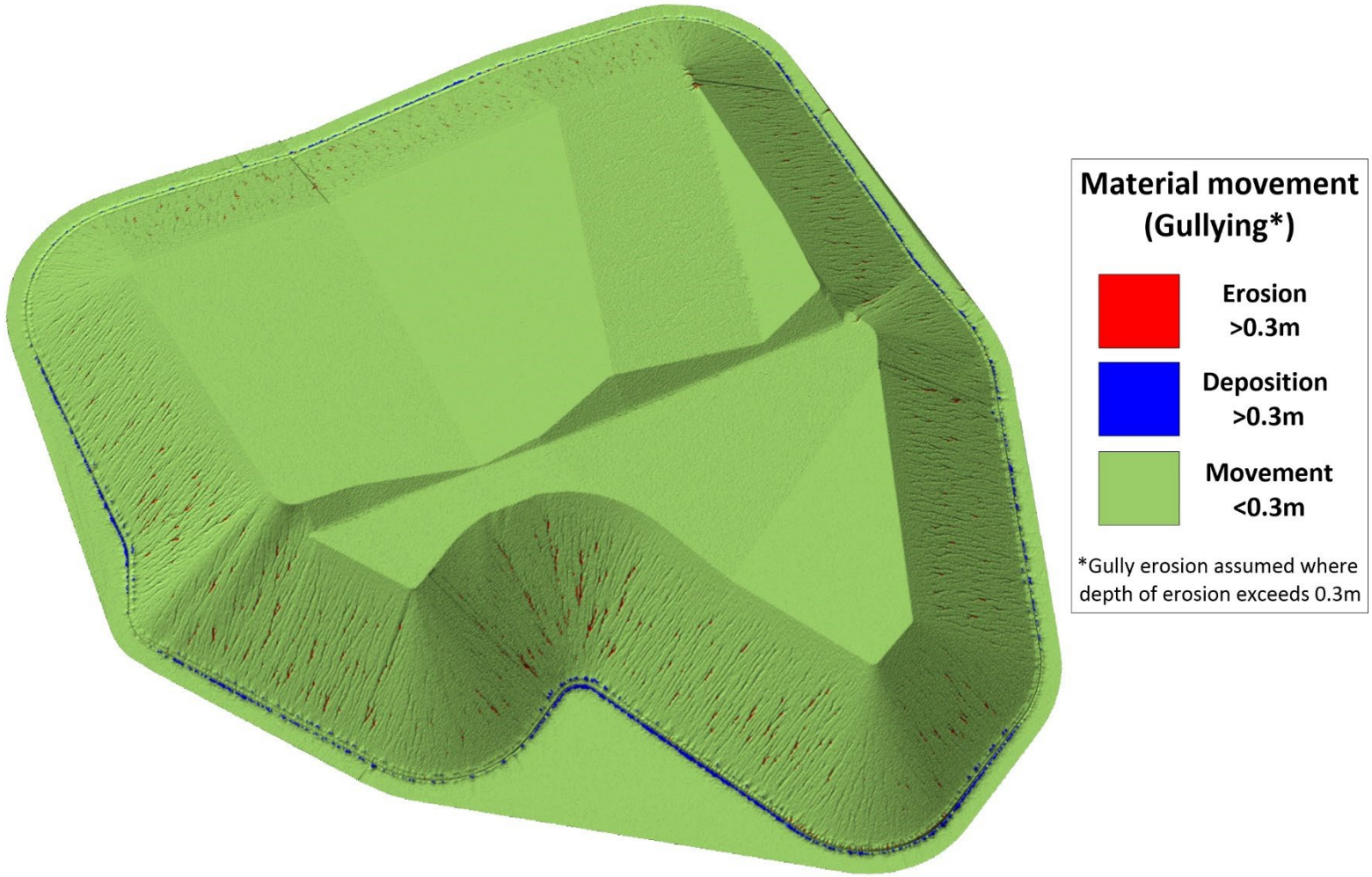


Figure A9: SIBERIA output for DREA final landform design, showing gully depth at year 150 with 30% sandstone mixed into topsoil, and 50% vegetative contact cover.

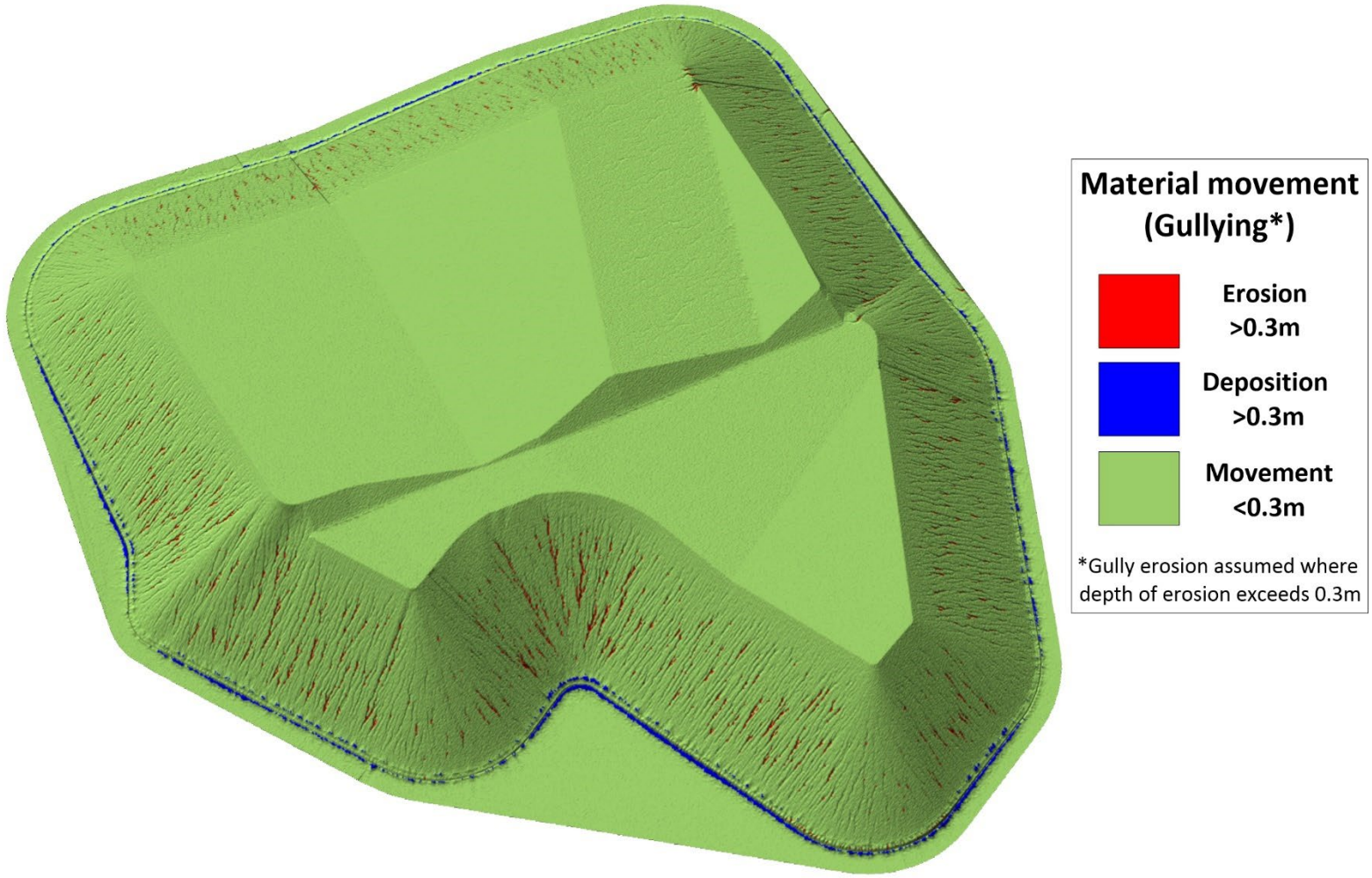


Figure A10: SIBERIA output for DREA final landform design, showing gully depth at year 200 with 30% sandstone mixed into topsoil, and 50% vegetative contact cover.

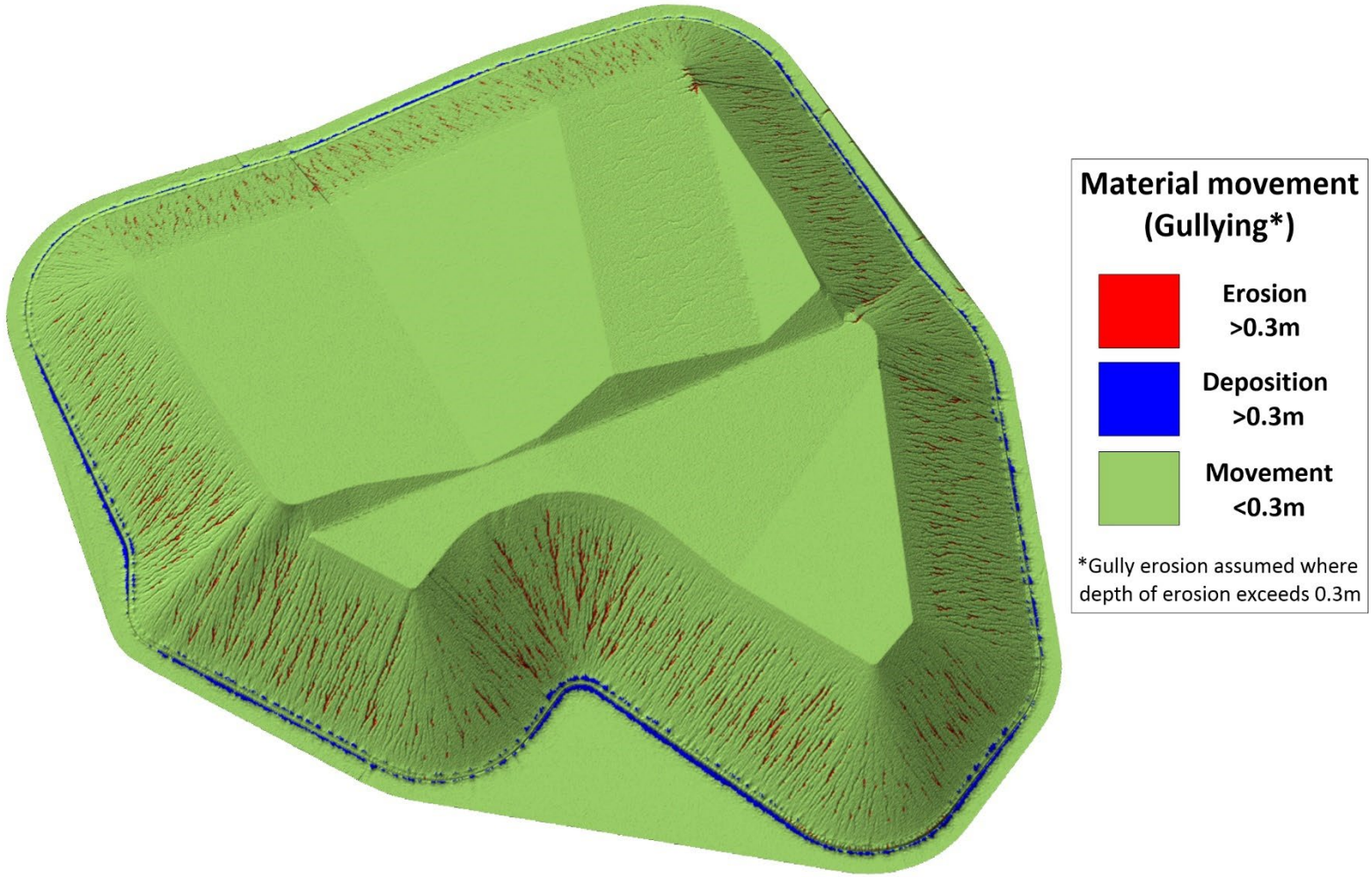


Figure A11: SIBERIA output for DREA final landform design, showing gully depth at year 250 with 30% sandstone mixed into topsoil, and 50% vegetative contact cover.

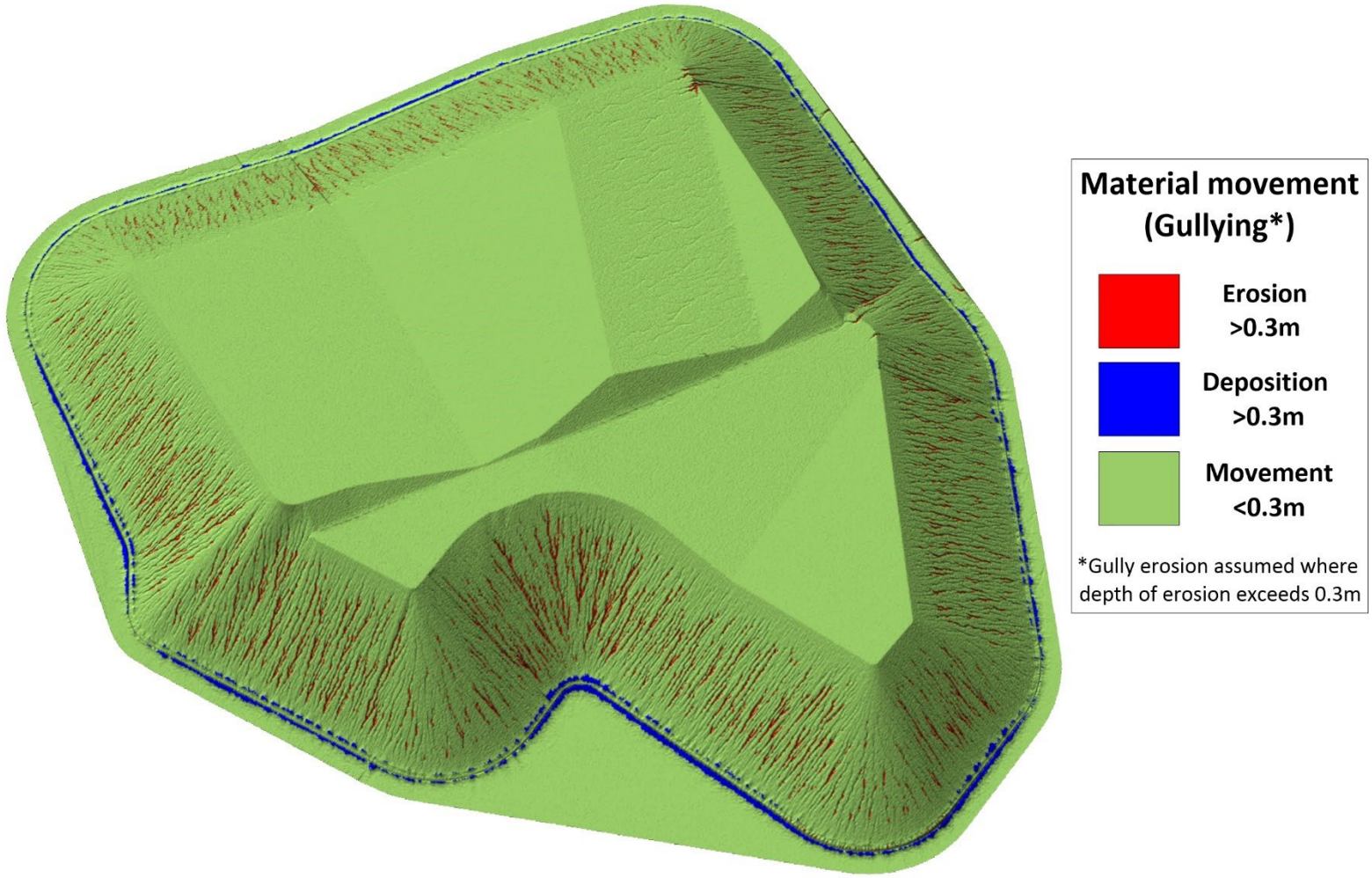


Figure A12: SIBERIA output for DREA final landform design, showing gully depth at year 300 with 30% sandstone mixed into topsoil, and 50% vegetative contact cover.

Appendix J. Review of Matters of State Environmental Significance

ECO SOLUTIONS
& MANAGEMENT

EAGLE DOWNS PROJECT
REVIEW OF MATTERS OF STATE ENVIRONMENTAL SIGNIFICANCE

RPMGlobal

October 2022

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Appendix G: Fauna species recorded in the ecology study area

Symbols and Abbreviations

*	(Preceding a plant species name) plant species not native to Australia
BAMM	Biodiversity Assessment and Mapping Methodology
Biosecurity Act	(Queensland) Biosecurity Act 2014
BoM	Bureau of Meteorology
BPA	Biodiversity Planning Assessment
DAF	(Queensland) Department of Agriculture and Fisheries
DAWE	Former (Commonwealth) Department of Agriculture, Water and the Environment
DCCEEW	(Commonwealth) Department of Climate Change, Energy, the Environment and Water
DES	(Queensland) Department of Environment and Science
NRME	(Queensland) Department of Natural Resources, Mines and Energy
DoR	(Queensland) Department of Resources
DotE	Former (Commonwealth) Department of the Environment
EA	Environmental Authority
EHP	(Queensland) Department of Environment and Heritage Protection
EO Act	(Queensland) Environmental Offsets Act 2014
EP Act	(Queensland) Environmental Protection Act 1994
EPBC Act	(Commonwealth) Environment Protection and Biodiversity Conservation Act 1999
GBO	General biosecurity obligation
GES	General ecological significance
GPS	Global positioning system
ha	Hectares
HES	High ecological significance

HRA	High risk area
km	Kilometres
LFC Tool	Landscape Fragmentation and Connectivity Tool
ML	Mining lease
MLES	Matters of local environmental significance (EO Act)
MNES	Matters of national environmental significance (EPBC Act)
MSES	Matters of state environmental significance (EO Act)
NC Act	(Queensland) Nature Conservation Act 1992
NC Regulation	(Queensland) Nature Conservation (Wildlife) Regulation 2006
QEOP	Queensland Environmental Offsets Policy 2014
RE	Regional Ecosystem as defined under the Queensland Vegetation Management Regulation 2000
REDD	Regional Ecosystem Description Database
SPRAT	Species Profile and Threats Database
SRI Guideline	Queensland Environmental Offsets Policy Significant Residual Impact Guideline
TSSC	Threatened Species Scientific Committee
VM Act	(Queensland) Vegetation Management Act 1999
WoNS	Weeds of National Significance
WPA	Wetland protection area

Glossary

Term	Definition
Biodiversity Status	This is a Queensland Government classification dependent on condition of remnant vegetation *in addition* to the criteria used to determine class under the Queensland *Vegetation Management Act 1999*. This classification is used for a range of planning and management applications, i.e. to determine environmentally sensitive areas. A regional ecosystem is listed as 'endangered' if: ▪ Less than 10% of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss; or ▪ 10-30% of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss and the remnant vegetation is less than 10,000 ha; or ▪ It is a rare regional ecosystem subject to a threatening process. A regional ecosystem is listed as 'of concern' if: ▪ 10-30% of its pre-clearing extent remains unaffected by moderate degradation and/or biodiversity loss. A regional ecosystem is listed as 'no concern at present' if: ▪ The degradation criteria listed above for 'endangered' or 'of concern' regional ecosystems is not met.
Bioregion	A geographically distinct biological region, which is a reporting unit for assessing the status of native ecosystems and their level of protection. Australia is divided into 89 bioregions. Bioregions form part of the regional ecosystem classification code system. The project is located largely in the Northern Bowen Basin sub-region of the Brigalow Belt Bioregion.
Ecology study area	An area defined for the purposes of this baseline terrestrial ecology study shown on Figure 2 and which comprises the entirety of Mining Lease (ML) 70389.
Matters of state environmental significance (MSES)	A matter of State environmental significance listed in Schedule 2 of the Queensland Environmental Offsets Regulation 2014, including: ▪ Regulated vegetation ▪ Connectivity areas ▪ Wetlands and watercourses ▪ High preservation areas of wild river areas ▪ Protected wildlife habitat ▪ Protected areas ▪ Highly protected zones of State marine parks ▪ Fish habitat areas ▪ Waterways providing for fish passage

Term	Definition
	▪ Marine plants ▪ Legally secured offset areas.
Matters of local environmental significance (MLES)	A matter described in Section 5(3) of the Queensland Environmental Offset Regulation 2014 as a matter of local environmental significance for which an environmental offset is required under a local planning instrument.
NC Act conservation status	Under the *Nature Conservation Act 1992*, native wildlife may be prescribed as: Extinct: ▪ There is no reasonable doubt the last member of the species had died. Extinct in the wild: ▪ The wildlife is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or ▪ The wildlife is not known to survive in its known or expected habitat, in its past range, over a period appropriate for the life cycle or form of the wildlife. Critically endangered: ▪ The wildlife has undergone or is suspected to have undergone a very large reduction in numbers; or ▪ It is likely that a very large reduction in the wildlife's numbers is imminent; or ▪ The wildlife's geographic distribution is precarious for the survival of the wildlife and very restricted; or ▪ The estimated total number of mature individuals is very low and it is likely the number will continue to decline at a very high rate, or continue to decline, and its geographic distribution is precarious for the survival of the wildlife; or ▪ The estimated total number of mature individuals is extremely low; or ▪ The probability of the wildlife' extinction in the wild is at least 50% in the immediate future. Endangered: ▪ There have not been thorough searches conducted for the wildlife and the wildlife has not been seen in the wild over a period that is appropriate for the life cycle or form of the wildlife; or ▪ The habitat or distribution of the wildlife has been reduced to an extent that the wildlife may be in danger of extinction; or

Term	Definition
	▪ The population size of the wildlife has declined, or is likely to decline, to an extent that the wildlife may be in danger of extinction; or ▪ The survival of the wildlife in the wild is unlikely if a threatening process continues. Vulnerable: ▪ The population is decreasing because of threatening processes; or ▪ The population has been seriously depleted and its protection is not secured; or ▪ The population, while abundant, is at risk because of threatening processes; or ▪ The population is low or localised or depends on limited habitat that is at risk because of threatening processes. Near Threatened: ▪ The population size or distribution of the wildlife is small and may become smaller; or ▪ The population size of the wildlife has declined, or is likely to decline, at a rate higher than the usual rate for population changes for the wildlife; or ▪ The survival of the wildlife in the wild is affected to an extent that the wildlife is in danger of becoming vulnerable. Least Concern: ▪ The Wildlife is common or abundant and is likely to survive in the wild.
Region	The local area surrounding the study area, including the landscape within 25 km of the project site.
Regional ecosystem	A vegetation community within a bioregion that is consistently associated with a particular combination of geology, landform and soils.
Regulated vegetation	Vegetation regulated through the *Planning Act 2017*
Remnant vegetation	Defined under the Queensland *Vegetation Management Act 1999* as, woody vegetation that has not been cleared or vegetation that has been cleared but where the dominant canopy has >70% of the height and >50% of the cover relative to the undisturbed height and cover of that stratum and is dominated by species characteristic of the vegetation's undisturbed canopy.

Term	Definition
Significant species and vegetation	Refers to: ▪ Species listed as endangered, vulnerable or near *threatened under the Queensland Nature* Conservation Act 1992 ▪ Regional ecosystems with an endangered or of concern biodiversity status or *Vegetation Management Act 1999* status.
Special least concern	Defined under the Queensland Nature Conservation (Wildlife) Regulation 2006 as: a) the echidna (*Tachyglossus aculeatus*) b) the platypus (*Ornithorhynchus anatinus*) c) a least concern bird to which any of the following apply i. Agreement Between the Government of Australia and the Government of Japan for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment (JAMBA) ii. Agreement Between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment (CAMBA) iii. Agreement Between the Government of Australia and the Government of the Republic of Korea on the Protection of Migratory Birds and Exchanges of Notes (ROKAMBA) iv. Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).
Vegetation management Act status	This is a statutory classification under the Queensland *Vegetation Management Act 1999*. A regional ecosystem is listed as 'endangered' if: ▪ Remnant vegetation for the regional ecosystem is less than 10% of its pre-clearing extent across the bioregion; or 10-30% of its pre-clearing extent remains and the remnant vegetation for the regional ecosystem is less than 10,000 ha. A regional ecosystem is listed as 'of concern' if: ▪ Remnant vegetation for the regional ecosystem is 10-30% of its pre-clearing extent across the bioregion; or more than 30% of its pre-clearing extent remains and the remnant vegetation extent for the regional ecosystem is less than 10,000 ha. A regional ecosystem is listed 'least concern' if: ▪ Remnant vegetation for the regional ecosystem is over 30% of its pre-clearing extent across the bioregion, and

Term	Definition
	the remnant vegetation area for the regional ecosystem is greater than 10,000 ha.

1 Introduction

Eco Solutions & Management was commissioned by RPMGlobal, on behalf of Eagle Downs Coal Management (the proponent), to complete a review of Queensland Matters of State Environmental Significance (MSES) as part of an environmental authority (EA) amendment application for the Eagle Downs Mine (the project).

1.1 Project description

Eagle Downs Mine is an underground coal mine. The Eagle Downs Mine received an Environmental Authority (EA) in 2011 and has been on care and maintenance since 2015. Mining activities conducted to date are limited to the partial excavation of the underground mine access drifts and associated surface facilities, and coal seam gas drainage trials.

1.2 Regional context

The Eagle Downs Mine is located approximately 25 km south-east of Moranbah in Central Queensland (Figure 1). The project is located within the Northern Bowen Basin subregion of the Brigalow Belt Bioregion in central Queensland and within the Isaac River drainage sub-basin of the Fitzroy Drainage Basin. The region experiences sub-tropical conditions with average temperatures ranges recorded in Moranbah of between 20.3°C and 35.5°C in the warmer months, and 8.5°C and 24.1°C in the colder months (BoM, 2021). The region receives an annual average rainfall of approximately 523.7 mm with a pronounced wet season. Approximately 70% of the annual rainfall is typically recorded between November and March, inclusive (BoM, 2021).

The predominant land uses in the locality are cattle grazing and coal mining. The Eagle Downs mining lease (ML) 70389 adjoins the eastern extent of the Peak Downs mine (MLs 1775 and 70411) and occurs between the Winchester Downs Project (MLA 700049 and 700050) and the Moranbah South mineral development licenses (MDLs 377 and 277) (Figure 2).

No World Heritage Areas or other conservation areas are located in the region.

1.3 Description of the ecology study area

The terrestrial ecology study area covers the full extent of Eagle Downs mining lease (ML) 70389 (Figure 2). The ecology study area comprises gently undulating plains with the Isaac River located approximately 3.5 km to the north-east and Cherwell Creek approximately 1.5 km to the north. A number of smaller drainage channels traverse the site and flow in an east or south-easterly direction towards the Isaac River. These drainage features are all ephemeral systems.

The Peak Downs Mine Road borders the western boundary of the ecology study area and the Goonyella Rail System dissects the south-eastern corner.

The ecology study area is currently used for cattle grazing and has been partially cleared of remnant vegetation, although extensive areas of natural grasslands and grassy open woodland are present throughout the centre of the ecology study area. The existing surface infrastructure for the Eagle Downs Mine is located close to the south-western boundary of the ecology study area.

1.4 Study objectives

This report assesses the terrestrial ecological values in relation to MSES within the ecology study area and specifically:

- describes the current regulatory requirements relevant to determining MSES within a ML
- describes the methodologies used during the post-wet season flora and fauna surveys across the ecology study area, which were designed with reference to the flora and fauna survey guidelines of the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) and the Queensland Department of Environment and Science (DES)
- provides a comprehensive flora and fauna inventory of the ecology study area
- provides certified Queensland Herbarium remnant regional ecosystem (RE) mapping based on field-validated RE mapping developed in accordance with the '*Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland, version 5.1*', current at the time of the surveys (Neldner et al. 2020)
- assesses the likelihood of occurrence for MSES protected under the Queensland *Vegetation Management Act 1999* (VM Act), Queensland *Nature Conservation Act 1992* (NC Act) and Queensland *Environmental Offsets Act 2014* (EO Act).

2 Regulatory framework

2.1 Queensland Vegetation Management Act 1999

The VM Act is administered by the Queensland Department of Natural Resources, Mines and Energy (NRME). The VM Act, in conjunction with the Queensland *Planning Act 2016,* regulates the clearing of native vegetation in Queensland. The VM Act's objectives include the preservation of remnant endangered ecosystems and vegetation in areas of high nature conservation value or lands vulnerable to land degradation. Permits under either the VM Act or Planning Act for vegetation clearing are not required for the project, given it will be located within a ML, and therefore vegetation clearing for the project will be regulated by the EA issued under the *Environmental Protection Act 1994*.

The VM Act provides for the classification of remnant vegetation into regional ecosystems (REs) which form the basis of the assessment of vegetation communities. REs are defined by (Sattler & Williams, 1999) as vegetation communities in a bioregion that are consistently associated with a particular combination of geology, landform and soil. The Queensland Government maintains RE maps illustrating the distribution of REs throughout Queensland and these are updated periodically to reflect refinements that have been made through ground-truthing these communities.

Remnant vegetation is referred to under the VM Act as vegetation where the dominant canopy has >70% of the height and >50% of the cover, relative to the height and canopy cover of the pristine (undisturbed) vegetation community. Remnant vegetation must also be dominated by species characteristic of the vegetation community in its pristine condition.

REs are assigned one of the following three categories under the VM Act (Sattler & Williams, 1999):

- endangered: Remnant vegetation that is less than 10% of its pre-clearing extent across the bioregion; or 10 – 30% of its pre-clearing extent remains and the remnant area is less than 10,000 ha
- of concern: Remnant vegetation that is 10 – 30% of its pre-clearing extent across the bioregion; or more than 30% of its pre-clearing extent remains and the remnant area is less than 10,000 ha
- least concern: Remnant vegetation that is over 30% of its pre-clearing extent across the bioregion and the remnant area is greater than 10,000 ha.

The Queensland government also assigns a biodiversity status to each RE, in addition to the status under the VM Act. The biodiversity status has no formal regulatory meaning under the VM Act but is used for a variety of planning and management applications.

2.2 Queensland Nature Conservation Act 1992

The NC Act is the key piece of legislation in Queensland relating to the protection and management of biodiversity and threatened species. It establishes a framework for the identification, gazettal and management of protected areas (such as National Parks) and the protection of native flora and fauna (protected wildlife) listed under the Queensland *Nature Conservation (Animals) Regulation*

2020 and *Nature Conservation (Plants) Regulation 2020*. The NC Act is administered by DES.

The NC Act classifies native flora and fauna species into categories of conservation significance including extinct in the wild, endangered, vulnerable, near threatened, special least concern and least concern in recognition of how threatened they are and what action needs to be taken to protect them.

Impacts to, and offsetting for species listed as endangered, vulnerable and special least concern (non-migratory species) under the NC Act are considered in detail within this report. There is no requirement under the EO Act to offset impacts to least concern, near threatened or special least concern (migratory) species. However, special least concern (migratory species) that are concurrently listed under the EPBC Act and which have been recorded or have a high or moderate likelihood of occurrence in the study area have been assessed and considered within this report.

The NC Act and associated regulations require that the following approvals be obtained, where relevant to the project:

- where there is a requirement for the clearing of plants protected under the NC Act (including endangered, vulnerable and near threatened species) a clearing permit under the NC Act will be required
- where the activities of the proponent may cause disturbance to animal breeding places, the proponent will engage a spotter catcher to conduct pre-clearing surveys, as necessary, in accordance with the Queensland Section 335 of *Nature Conservation (Animals) Regulation 2020* (NCA Regulation)
- any spotter catcher employed by the project must be in possession of a Rehabilitation Permit (spotter catcher endorsement) for managing fauna during clearing activities (section 200 of NCA Regulation)
- if it is necessary to remove animals posing a threat to human health or property, a Damage Mitigation Permit under section 162 of the NCA Regulation is required.

2.3 Queensland Biosecurity Act 2014

The Queensland *Biosecurity Act 2014* (Biosecurity Act) provides a framework for the control and management of pests, weeds, diseases, and contaminants, along with creating an overarching general biosecurity obligation for the State. The key principle of the Act is shared responsibility for the mitigation of biosecurity risks.

The Biosecurity Act lists biosecurity matters as either prohibited or restricted. Prohibited matters are biosecurity matters that are not yet found in Queensland. Restricted matters are biosecurity matters found in Queensland that require restrictions to reduce, control or contain the matter. The Act details seven categories of restricted matters based on the level on mitigation required. The seven categories of restricted matters are:

- Category 1 and 2 must be reported to DAF within 24 hours of becoming aware of their presence
- Category 3 must not be distributed or released into the environment
- Category 4 must not be moved or spread into other areas of the State

- Category 5 are those that have a high risk of negatively impacting the environment, and must not be kept
- Category 6 must not be kept or fed
- Category 7 must be killed and disposed of if caught or found.

Some restricted matters fall into multiple categories, and therefore require several different management measures for their control.

Further to prohibited or restricted matters declared under the Act, the Biosecurity Act also recognises other invasive species (such as Cane Toads) as species which fall under a general biosecurity obligation (GBO). A GBO means that, while there is no legal requirement for control of these pests, reasonable and practical steps must be undertaken to minimise their spread.

The Biosecurity Act is administered by DAF.

2.4 Queensland Environmental Protection Act 1994

The EP Act is administered by the DES and was established to protect Queensland's environment, while allowing for development that improves the total quality of life, both now and in the future.

The EP Act uses a number of mechanisms to achieve its objectives, including the following that are relevant to this report:

- requirement for mining projects to obtain an EA prior to operation
- requirement for an environmental impact assessment process in support of an EA application.

2.5 Queensland Environmental Offsets Policy

The Queensland *Environmental Offsets Policy (Version 1.10)* (QEOP) (DES, 2021b) came into effect on 3 March 2021. The EO Act, *Environmental Offsets Regulation 2014* (EO Regulation) and the QEOP comprise the Queensland Environmental Offsets Framework. According to this framework, it is necessary to provide offsets for any significant, residual impacts on Matters of State Environmental Significance (MSES).

The EO Regulation prescribes a number of MSES that are potentially relevant to terrestrial ecology. These include:

- regulated vegetation under the VM Act that are:
  - endangered REs
  - of concern REs
  - REs that intersect with wetlands identified on the vegetation management wetlands map
  - REs that comprise an area of essential habitat, in accordance with the VM Act, for protected wildlife
  - REs located within a defined distance from the defining banks of a relevant watercourse
- connectivity areas, comprising remnant REs that contain an area of land that is required for ecosystem functioning (i.e. a connectivity area)

- wetlands in a WPA or a HES wetland as shown on the map of referrable wetlands
- a designated precinct in a strategic environmental area
- high risk areas identified on the flora survey trigger map that contains flora species that are listed as endangered or vulnerable under the NC Act
- areas not identified as a high risk area on the flora survey trigger map, to the extent that the area contains flora species that are listed as endangered or vulnerable under the NC Act
- a Koala habitat area
- habitat for terrestrial fauna species that are listed as special least concern (as defined within the EO Regulation), vulnerable or endangered under the NC Act
- protected areas
- legally secured offset areas.

At present, high-value regrowth vegetation under the VM Act is not listed as a prescribed environmental matter under the EO Act.

DES released guidelines, Queensland Environmental Offsets Policy Significant Residual Impact Guideline (SRI Guideline) (EHP, 2014), in December 2014, which have been used where relevant in this report, and have been used to determine if offsets are required.

2.6 Government mapping

2.6.1 Map of Referable Wetlands

DES has a range of policies and programs to manage wetlands. As part of a broader policy of wetland protection, and in accordance with schedule 12, part 2 of the Queensland *Environmental Protection Regulation 2008* (EP Regulation), the DES has prepared a map of referable wetlands. The map of referable wetlands includes:

- wetland protection areas (WPAs), which comprise:
  - wetlands of high ecological significance (HES wetlands) located within Great Barrier Reef catchments
  - trigger areas that represent the area of hydrological influence of HES wetlands; outside urban areas, the trigger area is 500 m from the edge of a HES wetland
- wetlands of general ecological significance (GES wetlands).

WPAs and HES wetlands contain wetland environmental values as listed under section 81A of the EP Regulation. WPAs are derived using a mapping method developed by the DES called the Aquatic Biodiversity Assessment and Mapping Method. Significant residual impacts on WPAs are required to be offset in accordance with the Queensland Environmental Offsets Framework. GES wetlands are mapped for the purpose of establishing environmental values and are not protected wetlands or MSES (DES, 2021h).

The map also identified high ecological values waters management intent (HEV). HEVs are listed under the 'Environmental Protection (Water and Wetland Biodiversity) Policy 2019' and encompass waters in which the biological integrity of the water is effectively unmodified or highly valued (e.g. waters used for the supply of drinking).

2.6.2 Vegetation Management Wetlands Map

The Queensland government has produced a vegetation management wetlands map under section 20AA of the VM Act. This map shows wetlands, as defined under the VM Act. It is used primarily to regulate vegetation clearing in areas mapped as wetlands.

Significant residual impacts on REs that intersect with an area shown as a wetland on the vegetation management wetlands map are required to be offset (to the extent of the intersection).

2.6.3 Vegetation Management Watercourse Map

The Queensland Government has produced a vegetation management watercourse map under section 20AB of the VM Act. This map shows watercourses, as defined under the VM Act. It is used primarily to regulate vegetation clearing in proximity of watercourses. The map is produced based on desktop information and includes stream order mapping under the Strahler method.

Significant residual impacts on REs located within a defined distance of watercourses are required to be offset.

2.6.4 Queensland Essential Habitat mapping

Essential habitat is mapped by DES and is vegetation in which a species that is endangered, vulnerable or near threatened has been known to occur.

2.6.5 Koala Conservation Plan mapping

The Queensland Government has produced mapping of Koala Districts, priority areas and habitat areas as required under Division 3, Section 8 of the *Nature Conservation (Koala) Conservation Plan 2017*. The Koala Conservation Plan maps focus efforts for habitat protection, restoration and threat mitigation towards areas with the highest likelihood of achieving the best conservation outcomes for Koalas.

A at present, Koala habitat areas have only been identified by the Queensland Government within Koala District A.

2.6.6 Queensland Wetland Data Springs mapping

The Queensland Government has prepared the Queensland Wetland Data Springs mapping, which show the location of springs in the state. These springs are dependent on the surface expression of groundwater and their locations are used to infer the location of potential groundwater dependent ecosystems (GDEs).

2.7 Biodiversity Planning Assessments

The Biodiversity Assessment and Mapping Methodology (BAMM) has been prepared to provide a consistent approach for assessing biodiversity values at the landscape scale in Queensland using vegetation mapping data generated or

approved by the Queensland Herbarium as a fundamental basis. It is being used by DES to generate Biodiversity Planning Assessments (BPAs) for each of Queensland's bioregions, including the Brigalow Belt Bioregion where the project is located.

BPAs are developed in two stages:

1) diagnostic criteria: involves the integration of ecological criteria using BAMM to determine the relative Biodiversity Significance
2) supplementary/expert panel criteria: allows for the refinement of the mapped information from Stage 1 by incorporating local knowledge and expert opinion.

The methodology has application for identifying areas with various levels of significance solely for biodiversity reasons. These include threatened ecosystems or taxa, large tracts of habitat in good condition and buffers to wetlands or other types of habitat important for the maintenance of biodiversity or ecological processes.

3 Methodology

A detailed description of the methodology used to prepare this ecological assessment is provided in Appendix A. The methodology includes the following:

- Desktop searches of Commonwealth and State databases and mapping, literature reviews, local previous ecology assessments and aerial photography, which formed the basis for the field work program and preparation of this report. Database search results are provided in Appendices B and C.
- Flora surveys were undertaken over nine days in the post-wet season in 2021 (9 to 17 March, inclusive). These surveys were conducted in accordance with the '*Methodology for Surveying and Mapping of Regional Ecosystems and Vegetation Communities in Queensland, Version 5.1* (Neldner et al., 2020), which was current at the time of the surveys, to collect information on listed flora species, vegetation communities, and habitat types. The field flora survey comprised:
    - 16 detailed secondary sites
    - 75 tertiary sites
    - 69 quaternary sites
    - 9 photo points
    - targeted flora species and ecological community surveys
    - random traverses
    - collection of ancillary information.

  Each of the secondary sites were upgraded to habitat quality plots in accordance with the Queensland Department of Environment and Science's (DES) '*Guide to determining terrestrial habitat quality, version 1.3*' (Habitat Quality Guide) (DES, 2020a).

  Additional data pertaining to groundcover characteristics and cover of woody vegetation was used in conjunction with floral inventories from secondary sites to assess vegetation communities against the key diagnostic criteria and condition thresholds specified in the conservation advice for a number of TECs.

  The location of each secondary, tertiary and quaternary vegetation assessment site is shown in Figure 3.
- Fauna surveys were undertaken over nine days in the post-wet season in 2021 (13 to 21 April, inclusive). These surveys were conducted in accordance with various Commonwealth fauna survey guidelines that were current at the time of the surveys, to detect/determine the likelihood of occurrence of various fauna species and determine the extent and quality of fauna habitat within the ecology study area. The field work consisted of systematic and supplementary survey sites and opportunistic observations and included:
    - Elliot traps: 400 trap nights
    - Pitfall traps: 64 trap nights
    - Funnel traps: 96 trap nights

- Infrared cameras: 16 trap nights
- Spotlighting: 18 person hours (plus 5 person hours from a vehicle)
- Call playback: 17 sessions
- Bird surveys: 30 person hours
- Active searches: 14 person hours
- Anabat recordings: 8 nights
- Harp trap: 4 trap nights.

The location of each fauna survey site is shown in Figure 4. Records of fauna at the ecology study area were also made opportunistically while undertaking other activities on site such as driving between systematic trap sites and supplementary survey sites.

- Likelihood of occurrence assessments for threatened species based on the species' known ranges, preferred habitat, and ecology study area characteristics (Appendices D and E).
- Submission of field-validated vegetation to the Queensland Herbarium as part of RE map amendment request, resulting in new certified remnant RE mapping.

4 Desktop results

The results of the desktop searches are provided in Appendix B. A detailed description of the values of the ecology study area based on the desktop review is provided in Appendix C and summarised below.

The majority of the ecology study area is characterised by quaternary residual and colluvial basalt-derived black soil and silt deposits, with bands of the Rewan Group, and Rangal Coal and Fort Cooper coal measures in the centre and north-eastern corner of the study area (Figure 5). The *Soils and land suitability assessment study* (GJR Holdings, 2008) that was produced as part of initial studies for the Eagle Downs project, was also reviewed as part of the desktop review process to qualify land zone mapping.

The Queensland Government's vegetation mapping, current at the time of the field surveys, is shown in Figure 6. Ten VM Act REs have been mapped by the Queensland government within the ecology study area, including three endangered, two of concern and five least concern REs. Queensland Government certified RE mapping has since been updated based on field-validated vegetation mapping undertaken as part of this assessment and is discussed in Section 5.

In addition to remnant vegetation, the Queensland Government mapped one small polygon of high-value regrowth vegetation containing least concern RE 11.9.2. This polygon was mapped across a portion of the Goonyella rail corridor where it connects with Ripstone Creek (eastern tributary) in the southern portion of the ecology study area.

All drainage lines within the ecology study area are identified as 1st and 2nd order vegetation management watercourses or drainage features (Figure 6). All drainage lines intersect with remnant REs mapped by the Queensland Government (Figure 6).

No vegetation management wetlands have been mapped by the Queensland Government within or adjacent to the project site (Figure 6). Additionally, the Queensland Springs Database indicated that no spring wetlands are located within the project site.

The various desktop searches identified 10 significant flora species and 22 significant fauna species as either being recorded or having the potential to be present within the 25 km database search area (Table 1).

Table 1: Significant flora and fauna species returned from database searches

Common name/Species name	Status[1]	Source[2]
	NC Act	
Flora		
King Bluegrass (*Dichanthium queenslandicum*)	V	PMST, WO,AVH
Aristida annua (no common name)	V	PMST
Quassia (*Samadera bidwillii*)	V	PMST
Capparis humistrata (no common name)	E	WO,AVH
Solanum adenophorum (no common name)	E	WO,AVH
*Solanum elachophyllum (*no common name)	E	WO,AVH
Story's Wattle (*Acacia storyi*)	NT	AVH
Bertya pedicellata (no common name)	NT	WO,AVH

Common name/Species name	Status[1]	Source[2]
	NC Act	
Native Frangipani (*Cerbera dumicola*)	NT	WO,AVH
Plunkett Mallee (*Eucalyptus curtisii*)	NT	AVH
Birds		
Curlew Sandpiper (*Calidris ferruginea*)	CR	PMST
Australian Painted Snipe (*Rostratula australis*)	E	PMST
Black-throated Finch (southern) (*Poephila cincta cincta*)	E	PMST
Star Finch (*Neochmia ruficauda ruficauda*)	E	PMST
Grey Falcon (*Falco hypoleucos*)	V	PMST
Painted Honeyeater (*Grantiella picta*)	V	PMST
Red Goshawk (*Erythrotriorchis radiatus*)	E	PMST
Squatter Pigeon (southern) (*Geophaps scripta scripta*)	V	PMST,WO,ALA
White-throated Needletail (*Hirundapus caudacutus*)	V	ALA
Glossy Black-cockatoo (*Calyptorhynchus lathami*)	V	ALA
Mammals		
Corben's Long-eared Bat (*Nyctophilus corbeni*)	V	PMST
Ghost Bat (*Macroderma gigas*)	E	PMST
Greater Glider (*Petauroides volans*)	E	PMST,WO,ALA
Koala (*Phascolarctos cinereus*)	E	PMST,WO,ALA
Large-eared Pied Bat (*Chalinolobus dwyeri*)	V	WO
Coastal Sheath-tail Bat (*Taphozous australis*)	NT	WO
Short-beaked Echidna (*Tachyglossus aculeatus*)	SL	WO, ALA
Reptiles		
Allan's Lerista (*Lerista allanae*)	E	PMST,WO
Dunmall's Snake (*Furina dunmalli*)	V	PMST
Ornamental Snake (*Denisonia maculata*)	V	PMST,WO,ALA,EH
Yakka Skink (*Egernia rugosa*)	V	PMST
Common Death Adder (*Acanthophis antarcticus*)	V	WO,ALA

[1]Status:

- NC Act Status – CR, Critically endangered; E, Endangered, V, Vulnerable; NT, Near threatened; SL, Special least concern; C, Least concern

[2]Source:

- ALA – Atlas of Living Australia (Table B2 of Appendix B)
- AVH - – Australasian Virtual Herbarium (Table B1 of Appendix B)
- EH – Queensland Government essential habitat mapping
- PMST – Protected Matters Search Tool (PMST database results contained in Appendix B)
- WO – Wildlife Online database (Wildlife Online database search results contained in Appendix B).

It should be noted that the EBPC Act Protected Matters Search Tool identifies significant species based on a combination of actual records and/or predictive modelling and does not necessarily indicate that a species has actually been recorded from the search area.

A description of each of the significant flora and fauna species listed in Table 1, their preferred habitat and likelihood of occurrence within the ecology study area is provided in Appendices D and E respectively.

Database searches (Appendix B) also identified a number of birds listed as migratory NC Act as potentially occurring in the search area. However, special least concern (migratory) and near threatened species are not listed as MSES

under the EO Act and therefore, have not been considered further in this assessment.

A number of 1st and 2nd order vegetation management watercourses occur within the ecology study area and some of these intersect with the remnant vegetation mapped for the ecology study area. There are no vegetation management wetlands mapped by the Queensland Government within the ecology study area (Figure 6).

No high-risk areas (HRAs) are mapped within the ecology study area on the Protected Plants Flora Survey Trigger Map (Appendix B). Essential habitat is mapped for the Ornamental Snake within the ecology study area and areas immediately to the north-west of the ecology study area are mapped as essential habitat for the Greater Glider.

The ecology study area is located within Koala District C on the Koala Conservation Plan mapping. There are no Koala habitat areas mapped within or adjacent to the ecology survey area. As stated in Section 2.6.5, at present Koala habitat areas have only been identified by the Queensland Government within Koala District A.

The Queensland Springs Database indicated that no spring wetlands are located within the ecology study area. The nearest springs are approximately 145 km to the south-west of the ecology study area.

No referable wetlands or high ecological value waters are mapped for the ecology study area.

Remnant of concern and endangered vegetation within the ecology study area has been mapped as supporting state significant biodiversity values, while least concern remnant area are considered to have local biodiversity significance. State-wide and regional ecological corridors are mapped to the north-east and north-west of the ecology study area in association with the Isaac River and Cherwell Creek, although not within the ecology study area itself (Figure 7).

The BoM GDE mapping indicates that terrestrial and aquatic GDEs are potentially present in within the ecology study area. Vegetation associated with J B Gully in the north-west and along Ripstone Creek in the south has been identified as having a low potential for groundwater interaction. A small section of J B Gully in the far west of the ecology study area is mapped as having a high potential to support aquatic GDEs.

A number of flora and fauna studies have been undertaken within a 25 km radius of the ecology study area over the last several years, as part of the environmental approval process for various other mining projects. A summary of the most relevant studies is provided in Appendix C. The most significant are the seasonal surveys that were undertaken for the Eagle Downs Project as part of the impact assessment and approvals process for the project. These surveys were undertaken in 2007 and 2008 and encompassed ML70389, in which the current ecology study area is located. Areas of endangered and of concern remnant vegetation were mapped across the previous study area at that time. No threatened or near threatened flora was identified, although the Ornamental Snake was recorded at one location in the north-east of the ML near a 1st order drainage channel, in Brigalow woodland (RE 11.4.9) on deep cracking clays.

5 Flora results

Approximately half of the ecology study area was found to support remnant vegetation and high-value regrowth vegetation. The balance of the ecology study area supports non-remnant vegetation including cleared grazing paddocks, cultivation areas, farm infrastructure and roads. These historic clearing for agricultural land uses and mining activities has resulted in some fragmentation of remnant vegetation within the ecology study area, particularly in the south-eastern and northern areas. Field-validated remnant RE mapping for the ecology study area is provided in Figure 8. The ground-truthed RE mapping was used to determine the presence of vegetation communities that are considered to be MSES, as well as providing a site-specific map of vegetation that may provide habitat for flora and fauna species that are also considered MSES.

As part of the EA amendment process for this project, the field-validated mapping undertaken for the ecology study area was submitted to the Queensland Herbarium as part of an RE map amendment request. The Queensland Herbarium adopted many of the proposed changes and as part of their assessment used submitted vegetation, land resource and geological information, to reinterpret the vegetation mapping in some locations, particularly with regard to land zones. This resulted in new Queensland Herbarium certified RE mapping for the ecology study area, which is also shown in Figures 8 and 9. As required by the Queensland Government as part of the EA amendment process, this report will refer to certified RE mapping when discussing vegetation and a combination of certified RE mapping and field-validated habitat features when discussing habitat.

Certified remnant vegetation mapped within the ecology study area includes 12 RE types detailed in Table 2.

Table 2: Certified remnant regional ecosystems in the ecology study area

RE Code	Short description[1]	Status[1]		Remnant area (ha)
		VM Act	Bio-diversity	
11.3.1	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains	Endangered	Endangered	27.7
11.3.2	*Eucalyptus populnea* woodland on alluvial plains	Of concern	Of concern	7.4
11.3.3	*Eucalyptus coolabah* woodland on alluvial plains	Of concern	Of concern	82.8
11.3.7	*Corymbia* spp. open woodland on alluvial plains	Least concern	Of concern	2.5
11.3.21	*Dichanthium sericeum* and/or *Astrebla* spp. grassland on alluvial plains. Cracking clay soils	Of concern	Endangered	42.4
11.3.25	*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines	Least concern	Of concern	28.3
11.4.8	*Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains	Endangered	Endangered	7.2
11.4.9	*Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains	Endangered	Endangered	5.4
11.5.3	*Eucalyptus populnea* +/- *E. melanophloia* +/- *Corymbia*	Least concern	No concern at present	11.0

RE Code	Short description[1]	Status[1]		Remnant area (ha)
		VM Act	Bio-diversity	
	clarksoniana woodland on Cainozoic sand plains and/or remnant surfaces			
11.9.2	*Eucalyptus melanophloia* +/- *E. orgadophila* woodland to open woodland on fine-rained sedimentary rocks	Least concern	No concern at present	727.6
11.9.3	*Dichanthium* spp., *Astrebla* spp. grassland on fine-grained sedimentary rocks	Least concern	No concern at present	1,272.6
11.9.5	*Acacia harpophylla* and/or *Casuarina cristata* open forest to woodland on fine-grained sedimentary rocks	Endangered	Endangered	54.0

[1] Short description, VM Act status and Biodiversity status taken from the REDD (Queensland Herbarium, 2021).

5.1 Regulated vegetation

In accordance with the DES guidance note '*How to Address Environmentally Sensitive Areas and Offset Requirements in an Application for an Environmental Authority* for *Resource Activities*' (DES, 2018), if the on-ground values differ from the mapped values, the EO Act framework allows the administering authority to accept the ground-truthed values. However, as the field-validated mapping was submitted to the Queensland Herbarium and the assessment resulted in a new certified RE map for the ecology study area, the remainder of this report, including the impact assessment, discusses certified RE mapping shown on Figures 8 and 9.

Areas of certified remnant vegetation within the ecology study area are listed as MSES – Regulated vegetation under the EO Act where they:

- contain endangered or of concern REs; or
- intersect with mapped vegetation management watercourses or wetlands.

The presence/absence of each of these MSES is described in the following sections.

High-value regrowth vegetation is not an MSES under the EO Act and therefore will not be discussed in this section.

5.1.1 Endangered and of concern REs

As outlined in Table 2 and shown on Figure 9, the following endangered and of concern REs are present within the ecology study area:

- RE 11.3.1 – Brigalow (*Acacia harpophylla*) forest on alluvial plains
- RE 11.3.2 – Poplar Box (*Eucalyptus populnea*) woodland
- RE 11.3.3 – Coolabah (*Eucalyptus coolabah*) woodland
- RE 11.3.21 – Natural grassland on alluvial plains
- RE 11.4.8 – Dawson River Gum (*Eucalyptus cambageana*) and Brigalow open forest
- RE 11.4.9 – Brigalow shrubby woodland on clay plains
- RE 11.9.5 – Brigalow open forest on sedimentary rocks.

5.1.2 Vegetation management watercourses

In accordance with the EO Act, remnant REs that occur within certain distances of watercourses are classified as MSES.

All of the Queensland Government mapped vegetation management drainage lines that dissect the ecology study area intersect with remnant vegetation within the footprint (Figure 9).

Appendix 3 of the Queensland Environmental Offsets Policy (QEOP), lists the following defined distances for measuring regulated vegetation near watercourses in non-coastal bioregions, in which the project site is located:

- stream order 1 or 2 = 25 m from the defining bank
- stream order 3 or 4 = 50 m from the defining bank
- stream order 5 or greater = 100m from the defining bank (DES, 2020b).

Using these distances, approximately 94.2 ha of remnant vegetation occurs within the defined distances of each of these drainage lines and involves all REs, except REs 11.4.8 and 11.4.9 (Figure 9).

5.1.3 Vegetation management wetlands

There are no vegetation management wetlands mapped within the ecology study area (Figure 6).

5.2 Connectivity areas

Connectivity areas are defined under the EO Act as –

A patch of land is considered a connectivity area when:

- *the area is of sufficient size or configured in a way that maintains ecosystem functioning; and*
- *the regional ecosystem will remain despite a threatening process within the meaning of the section 12 of the NC Act.*

Only remnant (i.e. Category B) REs are considered to contribute to connectivity areas. These communities connect with larger polygons of remnant vegetation in the ecology study area and broader locality. However, it is noted that the ecology study area is located in a highly fragmented landscape, which is reflected by the ecology study area not being mapped as forming part of or adjoining any state or regional ecological corridors (Figure 7).

5.3 Flora species

A total of 268 flora species were recorded within the ecology study area during the surveys. This included 225 (84%) native species and 43 (16%) exotic species representing 64 families and 175 genera. The dominant family groups include Poaceae, Fabaceae, Chenopodiaceae, Malvaceae, Asteraceae, Myrtaceae and Cyperaceae. The results of this survey are listed in Appendix F where the flora inventories have been grouped into their respective RE type.

5.3.1 Threatened flora

Six threatened flora species listed under the NC Act were returned from database searches as occurring or potentially occurring in the search area. None of these

species were identified in the ecology study area during the field surveys. However one species, King Bluegrass (*Dichanthium queenslandicum*), was considered to have a moderate likelihood to occur. This species is discussed in the following section.

King Bluegrass

Species overview

King Bluegrass is listed as vulnerable under the NC Act. This is a tufted grass growing to approximately 80 cm in height. It is typically confined to natural grassland areas on heavy, black, clay soils of the Central Highlands and to a lesser extent, the Darling Downs and Burke Pastoral Districts (Sharp & Simon, 2002; Fletcher, 2001). It is known from three main locations in Queensland; 1) Hughenden district, 2) Nebo to Monto and west to Clermont and Rolleston and 3) the Dalby district (TSSC, 2013b).

This species has been recorded within 9 km north of the ecology study area as part of surveys undertaken for the Moranbah South Project (Ecological Survey & Management, 2013b) and approximately 2 km to the east of the ecology study area as part of surveys undertaken for the Winchester South Project (Ecological Survey & Management, 2013a).

Likelihood of occurrence in the ecology study area

MODERATE (Appendix D)

Potential habitat in the ecology study area

This species was not recorded within the ecology study area during the field surveys. Moranbah is well within the known distribution of this species, there are known records within 10 km of the ecology study area, and the natural grassland communities within the ecology study area provide potential habitat. However, the majority of these natural grassland communities were in relatively poor condition at the time of the field surveys as a result of grazing pressure and infiltration by exotic grasses. This, in combination with the lack of records of this species within the ecology study area, despite targeted searches, indicates this species only has a moderate likelihood to occur. Known nearby populations of this species were inspected at the time of the field survey and confirmed to be flowering at the time. It is considered likely that if this species was present in the ecology study area, individuals would also have been flowering and therefore the species would have been readily detectable.

King Bluegrass habitat accounts for approximately 1,324.7 ha within the ecology study area and comprises remnant REs 11.3.21 and 11.9.3 (Figure 10).

5.3.2 Near threatened flora

No near threatened flora species listed under the NC Act were identified or considered likely to occur in the ecology study area (refer Appendix D). Furthermore, near threatened species are not listed MSES under the EO Act.

5.3.3 Exotic species

Queensland restricted species

At the State level, the *Biosecurity Act 2014* provides a framework and powers for improved management pf pest plants, under which control of pest plants by land owners is enforceable. Three State restricted invasive plants were recorded during the field flora survey (Table 3). One of these, Parthenium, is also listed as a Weed of National Significance (WoNS).

Harrisia Cactus and Velvety Tree Pear were uncommonly detected within the ecology study area, usually as only one or two individuals or small populations, and these weeds were not present in all communities.

Table 3: State listed restricted invasive plants in the ecology study area

Common name/Species name	WoNS	Biosecurity Status[1]	REs recorded within
Harrisia Cactus *Harrisia martinii*	-	Restricted (Category 3)	REs 11.3.3, 11.4.9, 11.9.2
Velvet Prickly Pear *Opuntia tomentosa*	✓	Restricted (Category 3)	REs 11.4.9, 11.9.2, 11.9.3
Parthenium *Parthenium hysterophorus*	✓	Restricted (Category 3)	REs 11.3.3, 11.4.9, 11.9.2, 11.9.3

Non-declared species

The remaining 40 exotic species are non-restricted and were recorded throughout the ecology study area. Buffel Grass and Indian Bluegrass, were common and present in all vegetation communities and at the vast majority of vegetation survey sites undertaken in the ecology study area. Spiked Malvastrum, Spiny Sida (**Sida spinosa*), Pig Weed (**Portulaca oleracea*), Prickly Acacia (**Vachellia farnesiana*), Red Natal (**Melinis repens*), **Moorochloa eruciformis* (no common name) and Hyssopleaf Sandmat (**Euphorbia hyssopifolia*), were commonly encountered in low numbers throughout the majority of REs present (refer Appendix F).

6 Fauna results

6.1 Habitat and landscape connectivity

The maintenance of landscape connectivity between patches of habitat is a fundamental aspect of conservation ecology (Endler, 1977; Forman, 1995). Habitat corridors are often recommended to maintain and/or enhance landscape connectivity (Bennett et al., 1999).

The ecology study area and surrounding area has largely been cleared of native vegetation with a significant proportion of the vegetation that remains being natural grassland communities or open grassy woodlands, which have some natural grazing values without the need for broadscale clearing. As a result connectivity in the landscape is limited to the north of the ecology study area, where vegetation communities within the ecology study area connect with woodlands on sand plains and riparian communities along Cherwell Creek and its tributaries. Connectivity of these communities ultimately extend to the north-east and meet with vegetation associated with the Isaac River, and to the west and meet with extensive remnant communities associated with the Cherwell and Harrow Ranges.

Vegetation associated with the smaller order drainage features is highly fragmented or cleared and therefore these features form limited landscape connectivity. Extensive landscape clearing for mining and agricultural purposes has occurred in the local landscape to the south-west and south-east of the ecology study area.

6.2 Habitat assessment

The habitats of the ecology study area have been heavily disturbed and many of the patches of eucalypt woodland have been fragmented through agricultural and infrastructure clearing, and Brigalow and eucalypt communities in particular, have been affected by dieback in the canopy. Nonetheless, the remnant and regrowth vegetation communities present provide habitat for a range of native fauna species, including species of conservation significance. Similarly, non-remnant areas supporting specific features such as gilgai, also contribute to the habitat matrix for some species within the ecology study area. The following major habitat types occur within the ecology study area.

- Open eucalypt woodlands (REs 11.3.2, 11.3.7, 11.5.3, 11.5.9, 11.9.2) – The patches of open grassy eucalypt woodland within the ecology study area were considered to be low to moderate habitat quality. Some of these areas do not exhibit high-value regrowth or remnant characteristics. These areas tended to be somewhat fragmented through clearing for agriculture and infrastructure. These areas had a low abundance of hollow-bearing trees (i.e. just greater than 1 hollow per hectare), few areas of deep leaf litter, moderate to low levels of fallen timber and a moderate cover of exotic species particularly Buffel Grass.
- Riparian vegetation (REs 11.3.3 and 11.3.25) – These types of habitats are highly restricted in the ecology study area and provide relatively low habitat value due to their cleared, fragmented or modified state. Fringing vegetation is narrow and hollow-bearing trees are generally still in low abundance. Low levels of fallen timber was observed and in many areas the ground cover layer had a high cover of weed species.

- Brigalow woodland - Areas of Brigalow within the ecology study area were of moderate habitat value. Almost all areas of Brigalow were affected by canopy dieback causing fragmentation of the canopy. The patches of Brigalow had a low to moderate abundance fallen timber due to the high number of dead trees present but had very few areas of deep leaf litter. Brigalow areas had a high cover of exotic grass species, particularly Buffel Grass. Most patches of Brigalow on landzone 4 (REs 11.3.1, 11.4.8 and 11.4.9) contained some areas of gilgai ranging from small and shallow to relatively deep and well-developed. However, gilgai were generally absent from areas of areas of RE 11.9.5.
- Natural grasslands - Natural grassland habitats present (REs 11.3.21 and 11.9.3) within the ecology study area are considered to be of moderate habitat value as, with the exception of the presence of weed species, they are considered to be in moderate condition. However, as natural grasslands lack the structural complexity of wooded habitat types, they may support a lower diversity and abundance of fauna species with the possible exception of reptiles (Da Silva & Bates, 2002).
- Cleared, exotic pasture - These areas of the ecology study area are considered to be of low habitat value for fauna as they lack virtually all habitat elements. In general, they provide suitable habitat for only those generalist species that are able to adapt to such highly modified environments. However, where specific features such as gilgai are present, these areas can provide habitat for a wider range of species.

6.3 Fauna species

A total of 122 native terrestrial fauna species were recorded during the fauna survey and comprising 4 amphibians, 78 birds, 21 reptiles and 19 mammals. In addition, 7 introduced fauna species were recorded. A complete species list for the survey is provided in Appendix G.

6.3.1 Threatened fauna

Two threatened fauna species listed under the NC Act were recorded within the ecology study area during the fauna survey, namely:

- Squatter Pigeon (southern) (vulnerable)
- Ornamental Snake (vulnerable).

The likelihood of occurrence assessment (Appendix E) identified four additional listed threatened species that are considered to have a moderate or higher likelihood to occur, including:

- Australian Painted Snipe (endangered) - high
- Greater Glider (southern) (endangered) - high
- Koala (endangered) - high
- White-throated Needletail (vulnerable) – moderate.

These six species are discussed in more detail in the following sections. All other threatened species were considered to have a low likelihood of occurring the ecology study area due to lack of suitable habitat (Appendix E).

Squatter Pigeon (southern)

Species overview

The Squatter Pigeon (southern) is listed as vulnerable under the NC Act. This species is known to inhabit tropical dry, open sclerophyll woodlands and occasionally open savannah. It appears to favour sandy soil dissected with low gravelly ridges and is less common on heavy soils with dense grass cover. It is nearly always found in close association with permanent water (Higgins & Davies, 1996). This species is also often recorded from areas that do not support remnant vegetation, but in these areas it seems to be associated with clear, disturbed sites such as tracks and stockyards (DAWE 2020a; S. Marston pers. obs.). These habitat areas are likely to provide breeding, foraging and dispersal habitat.

Presence and habitat within the ecology study area

PRESENT (Appendix E)

A total of 18 individuals of this species were recorded at three locations across the ecology study area (Figure 11). A flock of 16 birds were recorded in regrowth RE 11.3.3 associated with the drainage line in the northern portion of the ecology study area. A solitary bird was recorded in regrowth Brigalow vegetation (RE 11.4.9) near a farm dam in the south-eastern portion of the ecology study area. Another individual was recorded in remnant Poplar Box woodland (RE 11.5.3) in the southern portion of the ecology study area.

With reference to the SPRAT profile (DAWE, 2021i) for this species, the following habitat has been identified within the ecology study area, based on the findings of the field survey.

- Breeding habitat – grassy woodlands dominated by *Eucalyptus*, *Corymbia*, *Acacia* or *Callitris* tree species, on sandy or gravelly soils (including but not limited to areas mapped as Queensland land zones 3, 5 or 7) within 1 kilometre of a waterbody (Figure 11).
- Foraging habitat – grassy woodlands dominated by *Eucalyptus*, *Corymbia*, *Acacia* or *Callitris* tree species, on sandy or gravelly soils (including but not limited to areas mapped as Queensland land zones 3, 5 or 7) within 3 kilometres of a waterbody (Figure 11).
- Dispersal habitat – forest or woodland occurring between patches of foraging or breeding habitat which facilitates movement between patches of foraging habitat, breeding habitat and/or waterbodies. Includes cleared and disturbed/degraded areas with scattered trees within 100 m of foraging and breeding habitats (Figure 11).

Within the ecology study area, suitable waterbodies for this species primarily consisted of constructed dams and cattle troughs. Drainage lines within the ecology study area were not considered to be waterbodies for the purposes of mapping Squatter Pigeon habitat, given they are unlikely to hold water for extended periods of time and no pools were evident during the field surveys. The locations of waterbodies within and adjacent to the ecology study area are shown on Figure 11.

Based on the above definitions, foraging habitat overlaps to some extent with breeding habitat (i.e. in areas ≤1 km from a waterbody). Some areas of vegetation on land zones 4, 8 and 9 (where within the relevant distance of a

waterbody) have been included in the breeding and/or foraging habitat shown on Figure 11. These areas were observed in the field to be characterised by low rises with sandy soils that are preferred by the Squatter Pigeon. Similarly, areas of regrowth and non-remnant vegetation on sandy soils with sufficient tree cover have been included in the breeding and/or foraging habitat mapping (where within the relevant distance of a waterbody).

The following areas of Squatter Pigeon habitat occur within the ecology study area (Figure 11):

- 221.9 ha of breeding and foraging habitat (i.e. includes the overlap with foraging habitat ≤1 km from a waterbody)
- 922.8 ha of foraging habitat (i.e. foraging habitat between 1 and 3 km from a waterbody)
- 41.3 ha of dispersal habitat.

Ornamental Snake

Species overview

The Ornamental Snake is listed as vulnerable under the NC Act. The Ornamental Snake is found in close association with frogs, which form the majority of its prey. It is known to prefer woodlands and open forests associated with moist areas, particularly gilgai (melon-hole) mounds and depressions with clay soils but is also known from lake margins, wetlands and waterways (DAWE, 2021f).

The Species Profile and Threats Database (SPRAT) Profile and Draft Referral Guidelines for the nationally listed Brigalow Belt reptiles specifically describe 'pure grassland associated with gilgais' and 'cleared areas formerly mapped as open-forests to woodlands associated with gilgai formations and wetlands i.e. REs 11.3.3, 11.4.3, 11.4.6, 11.4.8, 11.4.9 and 11.5.16' as suitable habitat for this species (DAWE, 2021f; SEWPaC, 2011).

The Ornamental Snake requires microhabitat features such as cracking clay soils, rotting logs or stumps, coarse woody debris, leaf litter or surface rock. These features are required because they either support the prey food of this species (i.e. frogs) or provide refuge habitat for the Ornamental Snake (DAWE, 2021f).

Presence and habitat within the ecology study area

PRESENT (Appendix E)

Eight Ornamental Snakes were identified in the ecology study area during the field surveys. Six individuals were recorded from within moist areas in the riparian corridor associated with the two drainage lines in the southern portion of the ecology study area (Figure 12). One individual was recorded from within Brigalow regrowth vegetation supporting gilgai (i.e. RE 11.4.8) in the southern portion of the ecology study area (Figure 12). Another individual was recorded from Brigalow vegetation with gilgai (i.e. RE 11.3.1) associated with the drainage line in the northern portion of the ecology study area (Figure 12).

This species is found in close association with frogs, which form the majority of its prey. It is known to prefer woodlands and open forests associated with moist areas, particularly gilgai (melon-hole) mounds and depressions with clay soils but is also known from lake margins, wetlands and waterways. Microhabitat in the

form of logs and coarse woody debris and ground litter provides shelter for the Ornamental Snake (DAWE, 2020). The SPRAT Profile and Draft referral guidelines for the nationally listed Brigalow Belt reptiles' (SEWPaC, 2011) specifically describe 'pure grassland associated with gilgais' and 'cleared areas formerly mapped as open-forests to woodlands associated with gilgai formations and wetlands' as suitable habitat for this species (DAWE, 2020; SEWPaC, 2011).

Based on the above, habitat for the Ornamental Snake identified in the ecology study area encompasses areas of:

- Brigalow vegetation (i.e. REs 11.3.1, 11.4.8, 11.4.9 and 11.9.5)
- high-value regrowth and non-remnant Brigalow vegetation supporting gilgai
- cleared areas supporting gilgai
- moist riparian vegetation associated with drainage lines in the southern portion of the ecology study area.

The extent of gilgai formations in non-remnant and cleared areas was determined using aerial photograph interpretation (gilgai have a distinct aerial signature) and/or mapping of boundaries in the field with a GPS.

There are approximately 276.1 ha of habitat for the Ornamental Snake in the ecology study area (Figure 12).

Australian Painted Snipe

Species overview

The Australian Painted Snipe (*Rostratula australis*) is listed as endangered under the NC Act. This secretive, cryptic, crepuscular (active at dawn, dusk and during the night) species occurs in terrestrial shallow wetlands, both ephemeral and permanent, usually freshwater but occasionally brackish. Known habitats include shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans, inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains. These habitats typically have rank emergent tussocks of grass, sedges, rushes or reeds, or samphire and often with clumps of Lignum (DAWE, 2021t). This species has been known to use wetland areas that are either lined with trees or that have some scattered fallen or washed-up timber (DAWE, 2021t).

Likelihood of occurrence in the ecology study area

HIGH (Appendix E)

Potential habitat in the ecology study area

Australian Painted Snipe was not recorded in the ecology study area during the field surveys. However, this species has been recorded adjacent to the ecology study area in 2012 in suitable habitat associated with the large dam in JB Gully (Figure 13). Despite the age of this record, the Australian Painted Snipe is considered to have a high likelihood to occur within the ecology study area, given:

- the proximity of the historic record to the ecology study area
- the wetland habitat the species was recorded in extends into the ecology study area

- this species is a very cryptic bird that is known to inconsistently use habitats
- it has a broad distribution and is thought to move significant distances to suitable habitat and uses modified ephemeral wetland habitats, including inundated grassland, in response to seasonal conditions (DAWE, 2021t)
- the ecology study area is within the known distribution and supports wetland habitat known to be used by this species.

The dam associated with JB Gully where the species has previously been recorded and areas of remnant Brigalow vegetation observed to be supporting gilgai in the field (i.e. representative of REs 11.4.8 and 11.4.9) are considered to provide potential breeding and foraging habitat for the Australian Painted Snipe within the ecology study area. Regrowth and non-remnant Brigalow vegetation and cleared areas supporting gilgai in the ecology study area is considered to provide potential foraging habitat for this species. Many of the gilgai support a matrix of fringing vegetation and exposed mud, and individuals have been recorded foraging within similar habitat in the region S. Marston pers. obs.; DPM Enviroscienses 2018). However, it is more likely that this species uses these non-remnant habitats opportunistically during the wet season when gilgai are holding water. Non-remnant areas of gilgai habitat in the ecology study area generally lack canopy cover that forms part of the breeding habitat requirements for this species (DAWE, 2021t).

Given the above, a total of 40.0 ha of potential habitat for the Australian Painted Snipe has been mapped in the ecology study area (Figure 13), consisting of:

- 17.9 ha of potential breeding and foraging habitat
- 22.1 ha of temporary foraging habitat.

Greater Glider

Species overview

The Greater Glider is listed as endangered under the NC Act. The Greater Glider is a nocturnal species and uses tree hollows during the day to rest (van Dyck & Strahan, 2008). It may glide over distances of up to 100 m, however, it appears to have low dispersal ability and typically small home ranges of 1 to 4 ha. The species has an almost exclusive diet of eucalypt leaves and occasionally flowers or buds (van Dyck & Strahan, 2008; DCCEEW, 2022). Although it is known to feed on a range of eucalypt species across its range, it is likely to only forage on, or den in, one or two species in any one area (van Dyck & Strahan, 2008; Eyre, 2002; Smith et al., 2007).

The Greater Glider occurs in a range of eucalypt-dominated habitats, including low open forests on the coast to tall forests in the ranges and low woodland westwards of the Dividing Range. It does not use rainforest habitats (van Dyck & Strahan, 2008; van Dyck et al., 2013). This species favours taller, montane, moist eucalypt forests on fertile soils, with relatively old trees and abundant hollows and a diversity of eucalypt species (DCCEEW, 2022).

Likelihood of occurrence in the ecology study area

HIGH (Appendix E)

Potential habitat in the ecology study area

This species was not recorded during the field surveys. However there are records in the broader region and suitable habitat present within the ecology study area. Approved conservation advice for this species indicates that taller, moist eucalypt forests or woodlands that contain hollow-bearing trees with the density of at least 1 hollow/ha are considered as habitat for the Greater Glider in southern Queensland (DCCEEW, 2022).

Given the above, approximately 972.1 ha of potential habitat for the Greater Glider has been identified in the ecology study area consisting of (Figure 14):

- remnant vegetation communities dominated by eucalypt species (i.e. excluding REs 11.3.21, 11.4.9, 11.9.3 and 11.9.5).

Remaining areas of regrowth or non-remnant woodland vegetation with one or more of the following characteristics have not been included as Greater Glider habitat:

- no habitat trees were present (i.e. *Acacia* species were the dominant species), and/or
- the vegetation was not mature enough to have developed hollows, and/or
- the area was highly disturbed and fragmented area, with:
  - poor or no connectivity to areas of mapped Greater Glider habitat (i.e. patches <1 ha and >100 m from other connected patches were excluded as unlikely to be viable habitat), and
  - evidence of extensive die back and/or very, poor canopy health, which was particularly evident in non-remnant vegetation across the northern portion of the ecology study area where generally <1% of canopy species were observed to be alive and with limited epicormic growth.

Koala

Species overview

The Koala is listed as endangered under the NC Act. It is widespread in sclerophyll forest and woodland on foothills and plains on both sides of the Great Dividing Range from about Chillagoe, Queensland to Mt Lofty Ranges in South Australia (Menkhorst & Knight, 2011). In Queensland the species is thought to occur in eight bioregions; Einasleigh Uplands, Wet Tropics, Desert Uplands, Central Mackay Coast, Mitchell Grass Downs, Mulga Lands, Brigalow Belt North and Brigalow Belt South. In many locations Koalas occur as widespread, low density and fragmented populations (DAWE, 2022).

Koalas in Queensland use a range of habitats, including moist coastal forests, southern and central western sub-humid woodlands, and a number of euclaypt woodlands adjacent to waterbodies in the semi-arid western parts of the state (DAWE, 2022). The diet of this species is restricted to the foliage of *Eucalyptus*, *Corymbia* and *Angophora* species, and may comprise as few as two preferred tree species in any given location (DAWE, 2022). The abundance of primary food trees

is thought to influence the density of Koalas in a population (Phillips & Callaghan, 2011).

Home ranges for this species have been found to be highly variable and dependant on life history stage, soil fertility, habitat quality and nutritional requirements whereby home ranges can vary between 3 and 500 ha in different locations (DAWE, 2022).

Habitat modelling, described in the Conservation Advice for *Phascolarctos cinereus* (Koala) combined populations of Queensland, New South Wales and the Australian Capital Territory (Koala Conservation Advice), has shown that habitats for this species occur where the mean maximum summer temperatures are 23-26^{o}C and mean annual rainfall between 700 and 1500 mm. Modelling also showed that Koala occupancy is strongly dependent on annual rainfall and the distance to water features (DAWE, 2022). The DAWE describes refuge habitat as patches that are resilient to drying conditions due to favourable hydrological systems, e.g. drainage lines and riparian zones (DAWE, 2022).

Likelihood of occurrence in the ecology study area

HIGH (Appendix E)

Potential habitat in the ecology study area

This species was not recorded during the field surveys. However, it has been recorded in the broader region and the ecology study area supports suitable habitat in the form of woodland communities containing Koala food trees. A 2021 review of Koala habitat assessment criteria and methods by the Australian National University (ANU) lists locally important and ancillary habitat trees for the Koala by region (closely aligned with bioregions in Queensland). All *Eucalyptus* and *Corymbia* species, as well as Brigalow, Sally Wattle (*Acacia salicina*) and Black Tea Tree (*Melaleuca bracteata*), recorded in the ecology study area (refer Appendix F) have been listed as either locally important or ancillary Koala habitat trees in the Brigalow Belt bioregion within the review (Youngentob et al. 2021).

With the exception of natural grassland communities (i.e. REs 11.3.21 and 11.9.3), all areas of remnant vegetation within the ecology study area are considered to provide habitat for the Koala due to the presence and moderate to abundant cover of Koala food and habitat trees. In addition, areas of regrowth and non-remnant vegetation with a sufficient cover of habitat trees (i.e. >10% cover) and connectivity to remnant woodlands, were also included as habitat.

Areas of non-remnant vegetation with one or more of the following characteristics have not been included as Koala habitat:

- a very sparse cover of Koala habitat trees (<10%) with poor or no connectivity to mapped Koala habitat, or
- no Koala habitat trees were present, or
- the area was highly disturbed and fragmented area, with:
  - poor or no connectivity to mapped Koala habitat, and
  - evidence of extensive die back and/or very, poor canopy health, which was particularly evident in non-remnant vegetation across the northern portion of the ecology study area where generally <1% of canopy species were observed to be alive and with limited epicormic growth.

Approximately 1,060.2 ha of potential habitat for the Koala is present in the ecology study area (Figure 15).

White-throated Needletail

Species overview

This species is almost exclusively aerial and occurs over forests, woodlands, farmlands, plains, lakes and towns (Pizzey et al., 2012). It is known from above mainly wooded areas, and larger tracts of vegetation, particularly forest. The species roosts in tree hollows in tall trees on ridge-tops, on bark or rock faces (DAWE, 2021j; DotE, 2015).

Likelihood of occurrence in the ecology study area

MODERATE (APPENDIX E)

Potential habitat in the ecology study area

This species was not recorded during the field surveys. There is a moderate likelihood that the White-throated Needletail could overfly the ecology study area as part of wider foraging movements. There is no evidence of traditional roost sites within the ecology study area or surrounding area. It is considered unlikely that the ecology study area provides important habitat for this species as large tracts of forest vegetation and breeding habitat are not present within or adjacent to the ecology study area.

Nonetheless, areas of remnant vegetation within the ecology study area are considered to provide potential foraging habitat for this species. Remnant forested and woodland communities are more likely to support a greater diversity and abundance of insects than cleared, disturbed or open grassland areas. A total of 963.6 ha of potential foraging habitat for the White-throated Needletail has been mapped in the ecology study area (Figure 16).

6.3.2 Near threatened fauna

No near threatened fauna species listed under the NC Act were identified or considered likely to occur in the ecology study area (refer Appendix E). Furthermore, near threatened species are not listed MSES under the EO Act.

6.3.3 Special least concern fauna

One special least concern fauna species listed under the NC Act was recorded during the field surveys, namely the Short-beaked Echidna (*Tachyglossus aculeatus*). An overview of the Short-beaked Echidna and presence of suitable habitat within the ecology study area is provided below.

Short-beaked Echidna

Species overview

The Short-beaked Echidna occurs in almost all terrestrial habitats except intensively managed farmland. It shelters in logs, crevices, burrows or piles of litter and feeds on ants, termites and other soil invertebrates, particularly beetle larvae (Menkhorst & Knight, 2011).

Presence and habitat in the ecology study area

PRESENT

This species was recorded at two locations in the ecology study area during the field survey; an individual was recorded while spotlighting at Trap Site 1 and tracks of this species were recorded at Supplementary Site 18 (Figure 17). This species is known from a wide range of habitats including grazing land and is likely to occur throughout the ecology study area. However, areas of remnant and regrowth vegetation are likely to be of greater habitat value for this species due to the presence of fallen timber. Approximately 1,011.2 ha of foraging habitat is present in the ecology study area for this species.

6.3.4 Feral animals

Six feral animals were recorded during the seasonal field surveys in the ecology study area (Appendix G). These species are listed under the Queensland *Biosecurity Act 2014*. Table 4 provides a description of the presence of feral animals in the ecology study area. Survey site locations are shown on Figure 4.

Table 4: Feral animals in the ecology study area

Species	Status[1]	Abundance and occurrence in the ecology study area
Brown Hare (*Lepus capensis*)	Restricted (Categories 3, 4, 5 and 6)	This species was occasionally recorded incidentally and while spotlighting at supplementary site S13.
Cane Toad (*Rhinella marina*)	GBO	The Cane Toad was not abundant and recorded at three supplementary sites while spotlighting; S1, S11 and S16.
Dog (*Canis lupus*)	Restricted (Categories 3,4, 5 and 6)	This species was recorded in low numbers opportunistically in the ecology study area.
European Rabbit (*Oryctolagus cuniculus*)	Restricted (Categories 3,4, 5 and 6)	This species was observed in moderate numbers at supplementary site S3 while active searching, S18 while spotlighting, and opportunistically in the ecology study area.
Feral Pig (*Sus scrofa*)	Restricted (Categories 3,4 and 6)	Tracks of this species were recorded at one location in the ecology study area; at supplementary site S15.
House Mouse (*Mus musculus*)	GBO	This species was recorded infrequently in the ecology study area. It was recorded while spotlighting at two locations; trap site TS3 and supplementary site S7.

[1]Status under *Biosecurity Act 2014*:

- Restricted – the species is a restricted invasive animal for which specific restrictions are in place
- GBO – a general biodiversity obligation exists for this species.

6.4 Essential habitat

The majority of remnant vegetation mapped in the ecology study area by the Queensland Government has been identified as supporting essential habitat for the Ornamental Snake (Section 4, Figure 6).

It should be noted that the DES information sheet '*How to Address Environmentally Sensitive Areas and Offset Requirements in an Application for an Environmental Authority for Resource Activities*' (DES, 2018), advises that the ground-truthing of suitable habitat for species, should be utilised over government mapping of habitat, given government mapping "does not have clear boundaries" for REs or essential habitat, nor does it "verify the 'true' extent and value" of the mapped vegetation as essential habitat for a species.

As a result of the field surveys undertaken for this project, the on-ground extent of remnant vegetation within the ecology study area has been verified, and largely adopted and certified by the Queensland Herbarium, and differs from the Queensland Government remnant vegetation mapping that underlies the essential habitat mapping. The likelihood of occurrence assessment for threatened fauna species was based on the likelihood of significant fauna to use this field-validated remnant vegetation as habitat. This ground-truthed and Queensland Herbarium certified mapping therefore takes precedence over the Queensland Government mapping of essential habitat.

7 Summary of MSES

The MSES outlined in Table 5 have been identified as being present or likely to be present in the ecology study area.

Table 5: Summary of MSES recorded or likely to occur in the ecology study area

MSES	Status[1]		Likelihood of occurrence	Total area in the ecology study area[1] (ha)
	VM Act	NC Act		
Significant flora and fauna species				
King Bluegrass (*Dichanthium queenslandicum*)	NA	Vulnerable	Moderate	1,324.7
Squatter Pigeon (southern) (*Geophaps scripta scripta)*	NA	Vulnerable	Present	1,144.7[2]
Ornamental Snake (*Denisonia maculata*)	NA	Vulnerable	Present	276.1
Australian Painted Snipe (*Rostratula australis*)	NA	Vulnerable	High	40.0[3]
Greater Glider (*Petauroides volans*)	NA	Endangered	High	972.1
Koala (*Phascolarctos cinereus*)	NA	Endangered	High	1,060.2
White-throated Needletail (*Hirundapus caudacutus*)	NA	Vulnerable	Moderate	963.6
Short-beaked Echidna (*Tachyglossus aculeatus*)	NA	Special least concern	Present	1,011.2
Regulated vegetation[4] – Endangered and of concern REs				
RE 11.3.1	Endangered	NA	Present	27.7
RE 11.3.2	Of concern	NA	Present	7.4
RE 11.3.3	Of concern	NA	Present	82.8
RE 11.3.21	Of concern	NA	Present	42.4
RE 11.4.8	Endangered	NA	Present	7.2
RE 11.4.9	Endangered	NA	Present	5.4
RE 11.9.5	Endangered	NA	Present	54.0
Regulated vegetation[4] – Watercourse REs				
RE 11.3.1	Endangered	NA	Present	6.4
RE 11.3.2	Of concern	NA	Present	2.3
RE 11.3.3	Of concern	NA	Present	21.3
RE 11.3.7	Least concern	NA	Present	0.3
RE 11.3.21	Of concern	NA	Present	12.2
RE 11.3.25	Least concern	NA	Present	11.4
RE 11.5.3	Least concern	NA	Present	0.7
RE 11.9.2	Least concern	NA	Present	2.0

MSES	Status[1]		Likelihood of occurrence	Total area in the ecology study area[1] (ha)
	VM Act	NC Act		
RE 11.9.3	Least concern	NA	Present	37.0
RE 11.9.5	Least concern	NA	Present	0.6
Connectivity areas				
Field-validated remnant vegetation	Various	NA	Present	2,268.9[5]

[1] Total areas should not be combined, totals may overlap.
[2] Habitat area excludes dispersal habitat.
[3] Habitat area includes marginal habitat.
[4] Only Queensland Herbarium certified remnant vegetation has been included, as high-value regrowth and non-remnant vegetation do not form MSES.
[5] Includes remnant grassland communities

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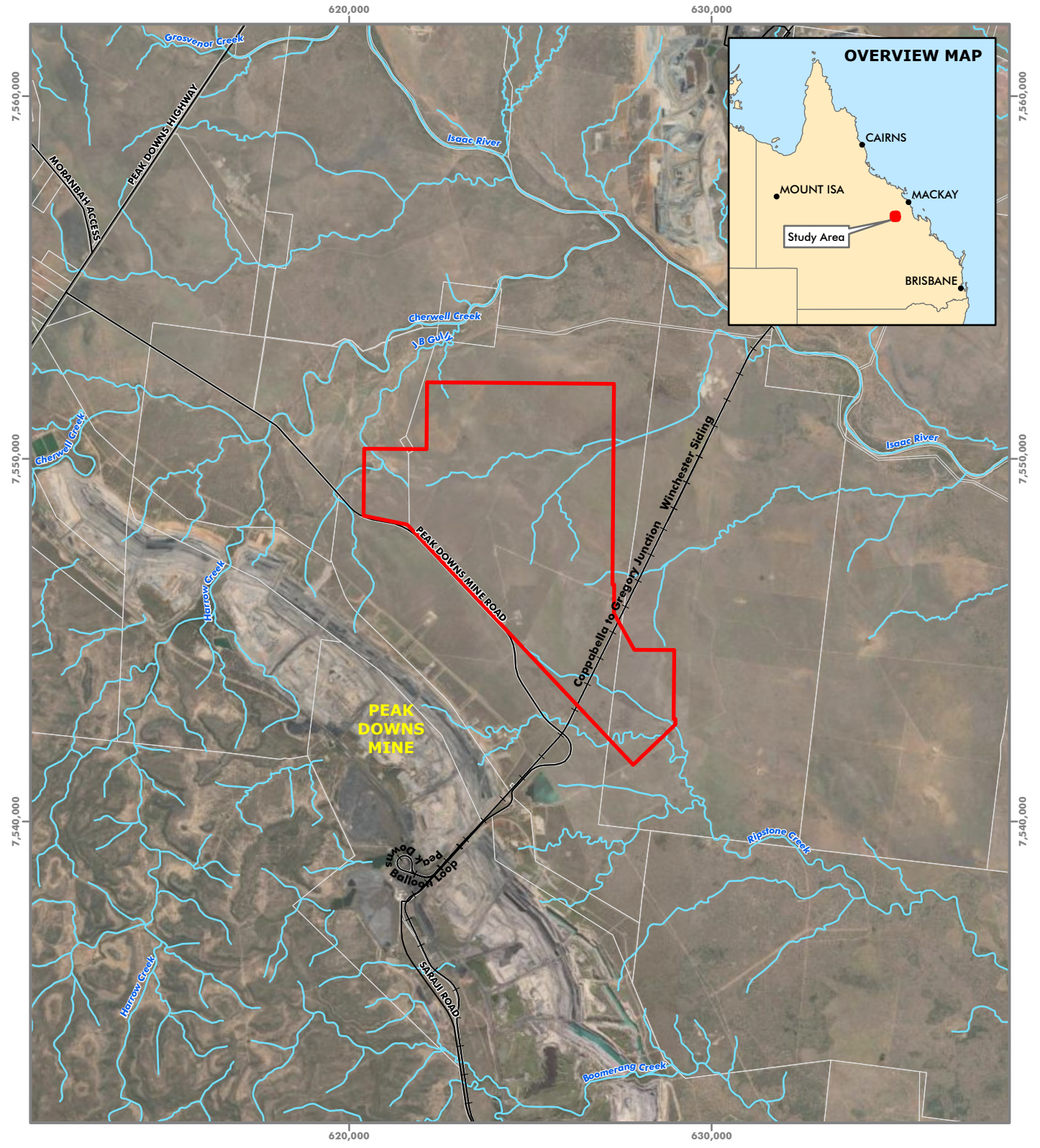
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Figures



Legend

- ML 70389
- Road
- Railway
- Vegetation Management Act watercourse
- Cadastral boundary

Figure 1 : Location of the ecology study area

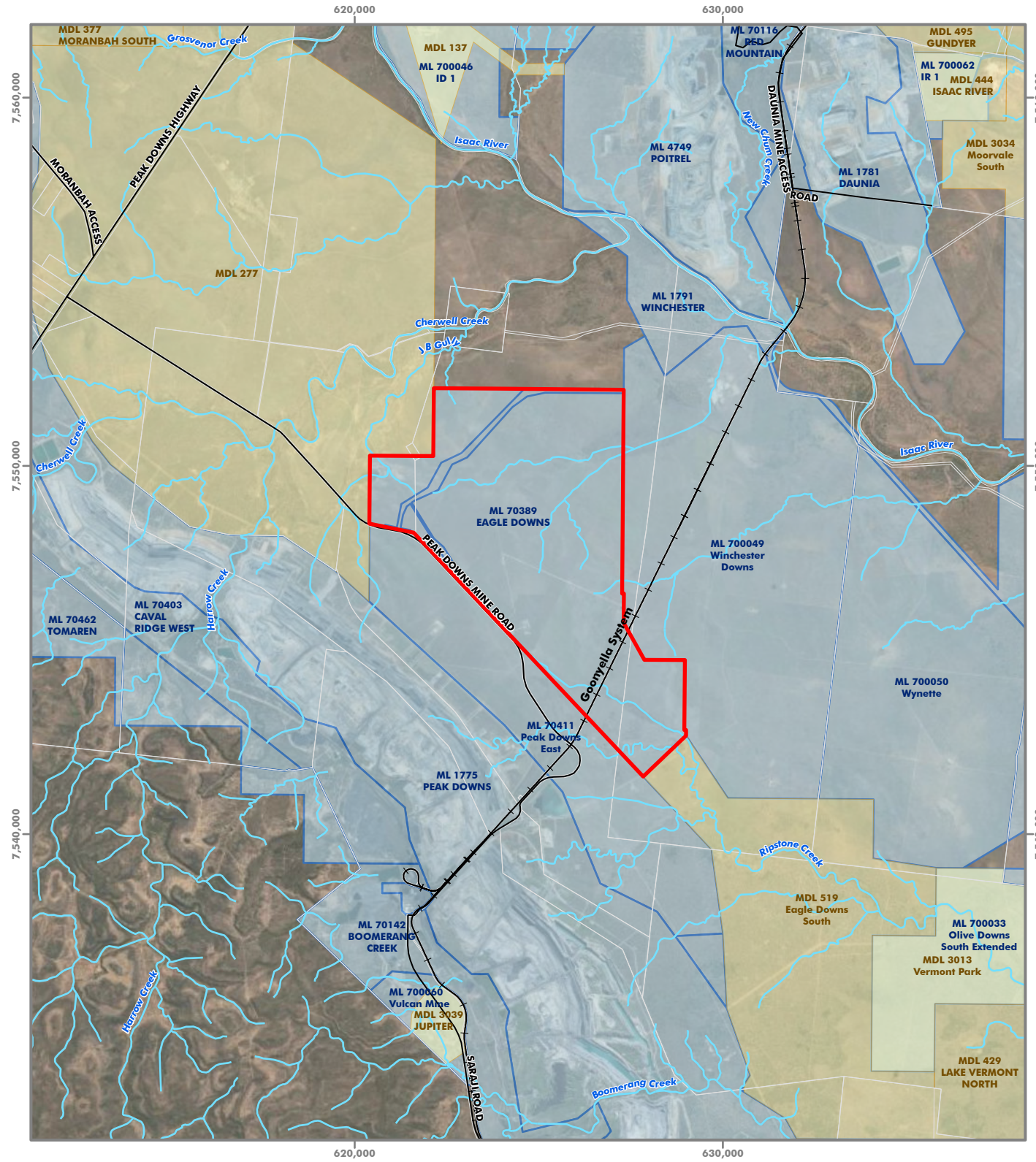
Eagle Downs Project - Review of Matters of State Environmental Significance

Map Number: 22043_MSES_01_A
Date: 13 October 2022
Map Projection: GDA 1994 MGA Zone 55
Imagery: (c) Digital Globe
Data: Roads, Rail, Watercourse, DCDB - (c)DNRM 2022

0 1 2 4 6
Kilometers

N

ECO SOLUTIONS & MANAGEMENT



Legend

- ML 70389
- Road
- Railway
- Vegetation Management Act watercourse
- Cadastral boundary
- Mineral Development Licence
- Mining Lease

Figure 2 : Project setting

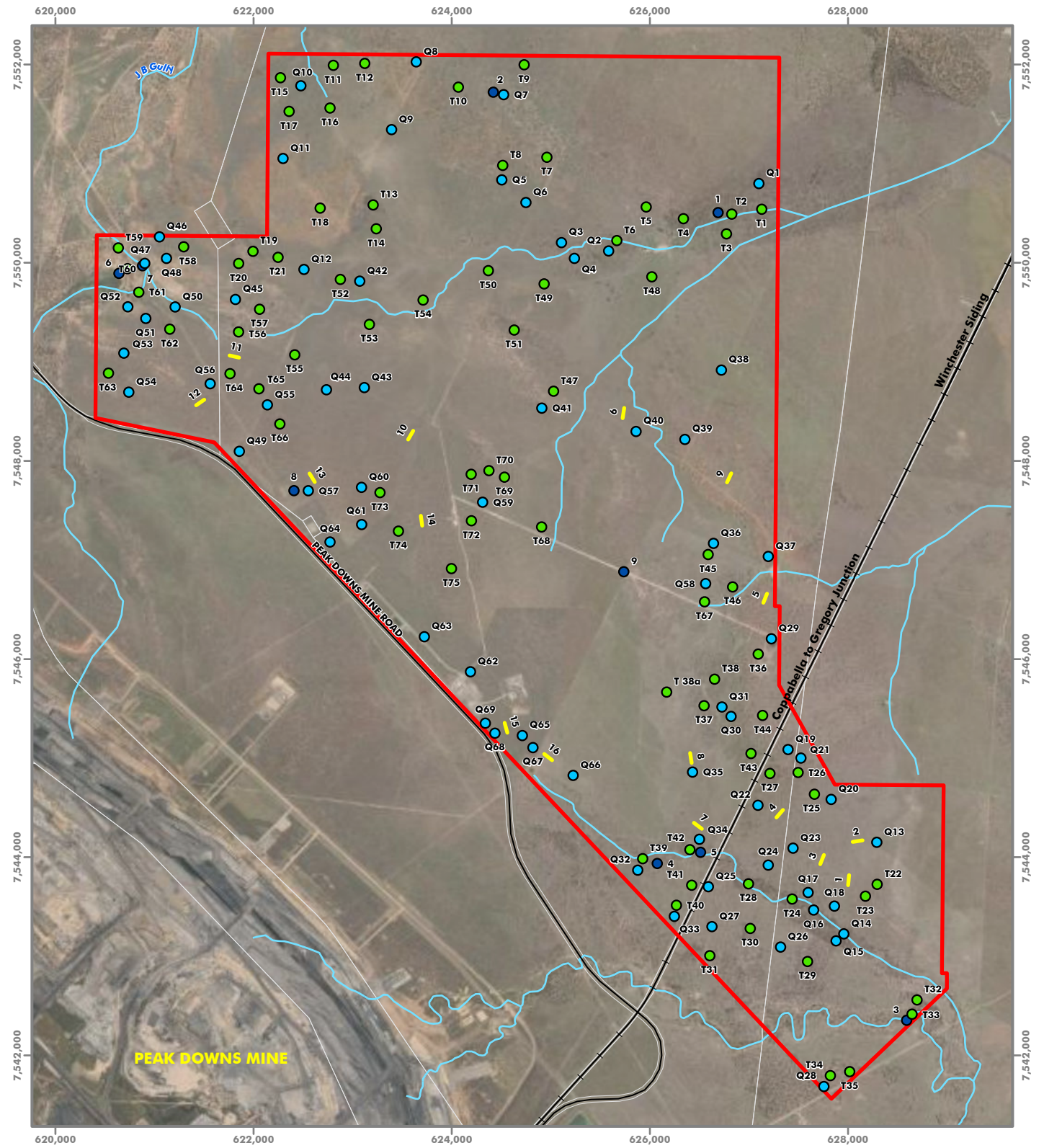
Eagle Downs Project - Review of Matters of State Environmental Significance

Map Number: 22043_MSES_02_A
Date: 13 October 2022
Map Projection: GDA 1994 MGA Zone 55
Imagery: (c) Digital Globe
Data: Roads, Rail, Watercourse, DCDB - (c)DNRM 2022

0 1 2 4 6
Kilometers

N

ECO SOLUTIONS & MANAGEMENT



Legend

- ML 70389
- Road
- Railway
- Vegetation Management Act watercourse
- Cadastral boundary

Vegetation assessment sites

- Tertiary site
- Quaternary site
- Photo point
- Habitat quality plot

Figure 3 : Flora survey sites

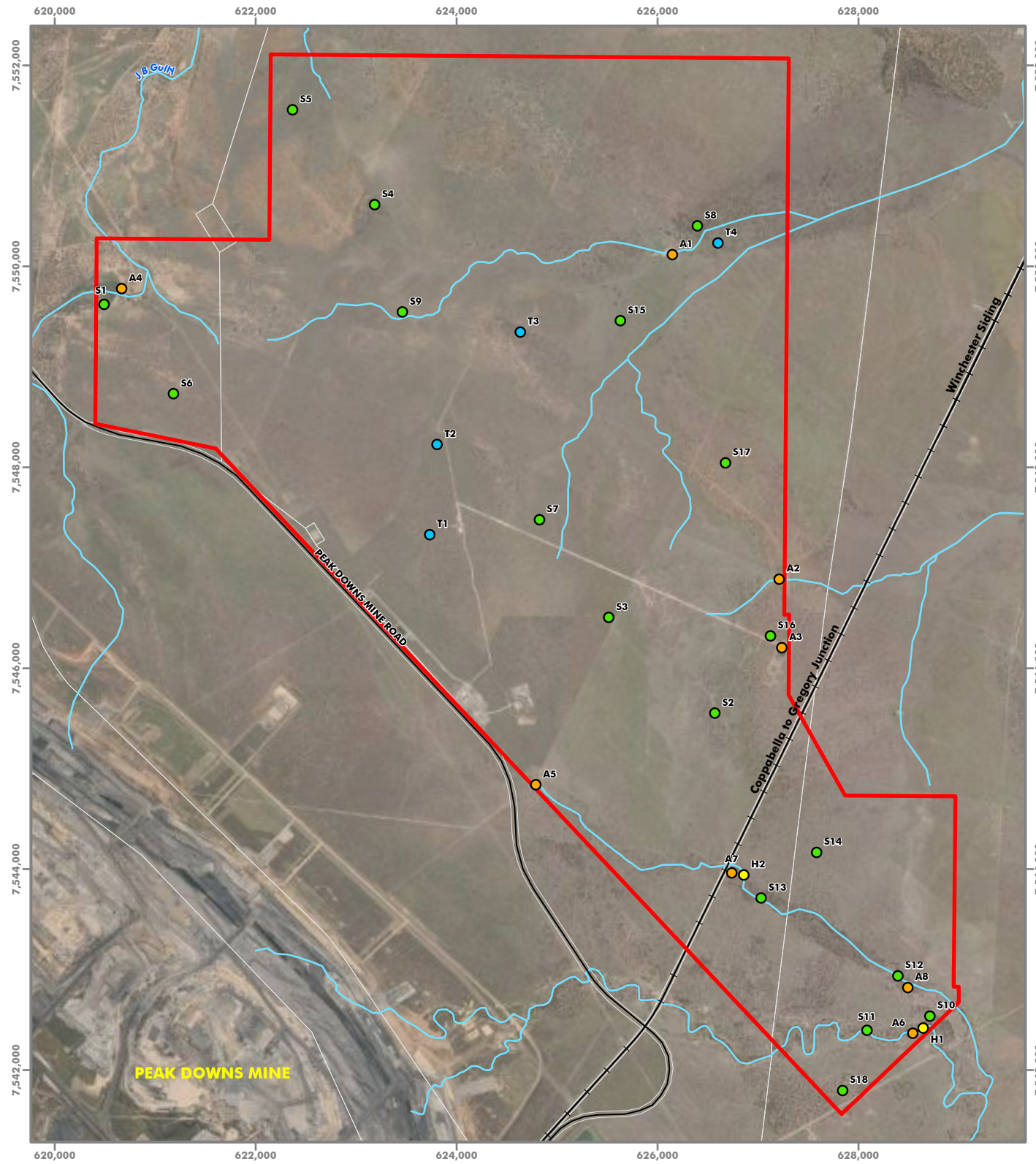
Eagle Downs Project - Review of Matters of State Environmental Significance

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Date: 19 October 2022
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Imagery: (c) Digital Globe
Data: Roads, Rail, Watercourse, DCDB - (c)DNRM 2022

0 0.5 1 2 3
Kilometers

N

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Legend

- ML 70389
- Road
- Railway
- Vegetation Management Act watercourse
- Cadastral boundary

Fauna survey sites

- Anabat site
- Harp trap site
- Supplementary survey site
- Systematic trap site

Figure 4 : Fauna survey sites

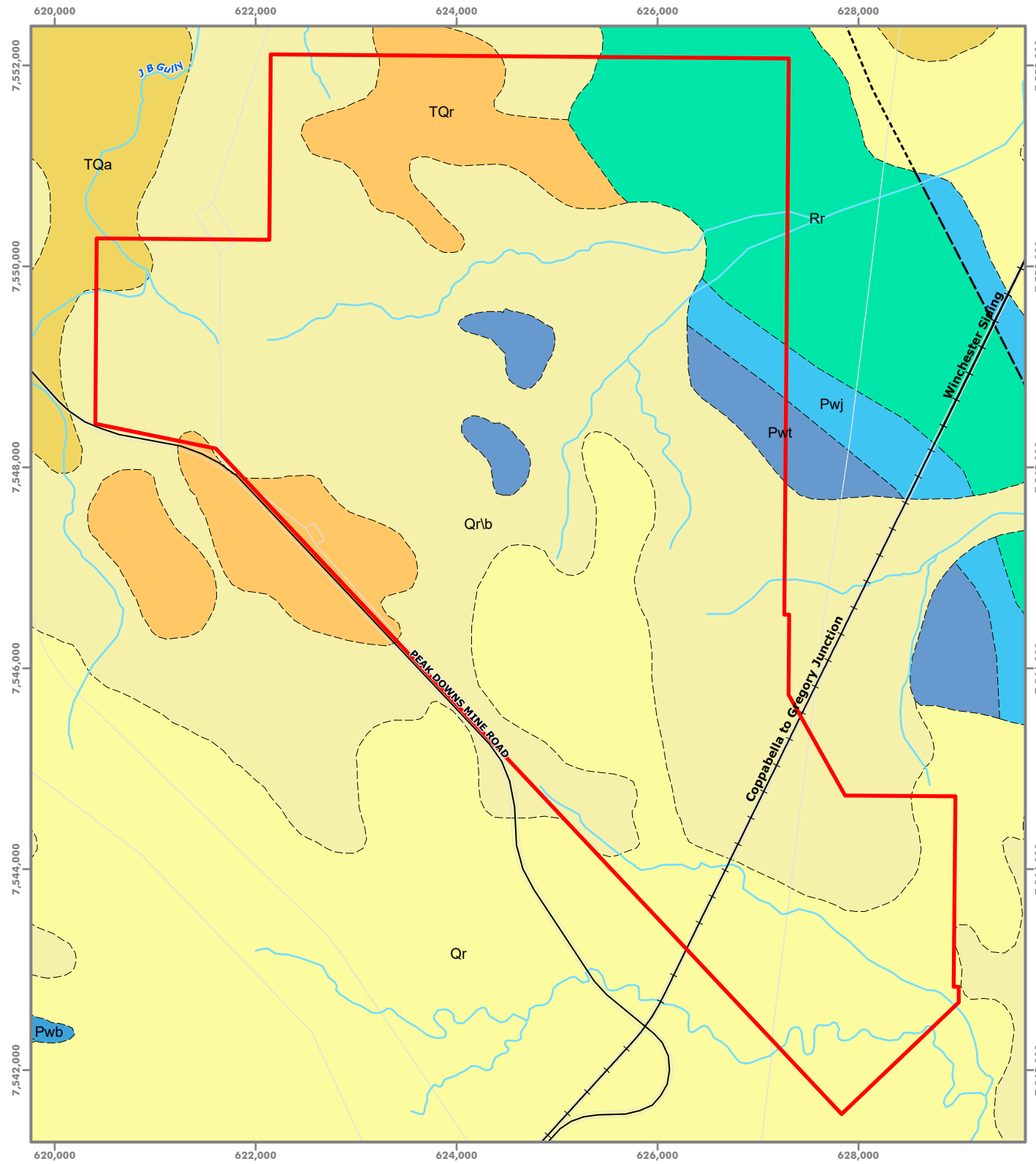
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Imagery: (c) Digital Globe
Data: Roads, Rail, Watercourse, DCDB - (c)DNRM 2022

0 0.5 1 2 3
Kilometers

N

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Legend

- ML 70389
- Road
- Railway
- Vegetation Management Act watercourse
- Cadastral boundary

Map Symbol	Rock Unit Name	Lithology	Dominant Rock	Age
Pwt	Fort Cooper Coal Measures	Lithic sandstone, conglomerate, mudstone, carbonaceous shale, coal, tuff, tuffaceous (cherty) mudstone	SEDIMENTARY ROCK	LATE PERMIAN
Qr	Qr-QLD	Clay, silt, sand, gravel and soil; colluvial and residual deposits	COLLUVIUM	QUATERNARY
Qr\b	Qr\b-QLD	Black soil, silt and mud; residual and colluvial deposits (commonly basalt-derived or over limestone in Georgina Basin)	COLLUVIUM	QUATERNARY
Pwj	Rangal Coal Measures	Calcareous sandstone, calcareous shale, mudstone, coal, concretionary limestone	ARENITE-MUDROCK	LATE PERMIAN
Rr	Rewan Group	Lithic sandstone, pebbly lithic sandstone, green to reddish brown mudstone and minor volcanilithic pebble conglomerate (at base)	ARENITE-MUDROCK	EARLY TRIASSIC - MIDDLE TRIASSIC
TQa	TQa-QLD	Locally red-brown mottled, poorly consolidated sand, silt, clay, minor gravel; high-level alluvial deposits (generally related to present stream valleys but commonly dissected)	ALLUVIUM	LATE TERTIARY - QUATERNARY
TQr	TQr-QLD	Clay, silt, sand, gravel and soil; colluvial and residual deposits (generally on older land surfaces)	COLLUVIUM	LATE TERTIARY - QUATERNARY

Figure 5 : Geology mapping

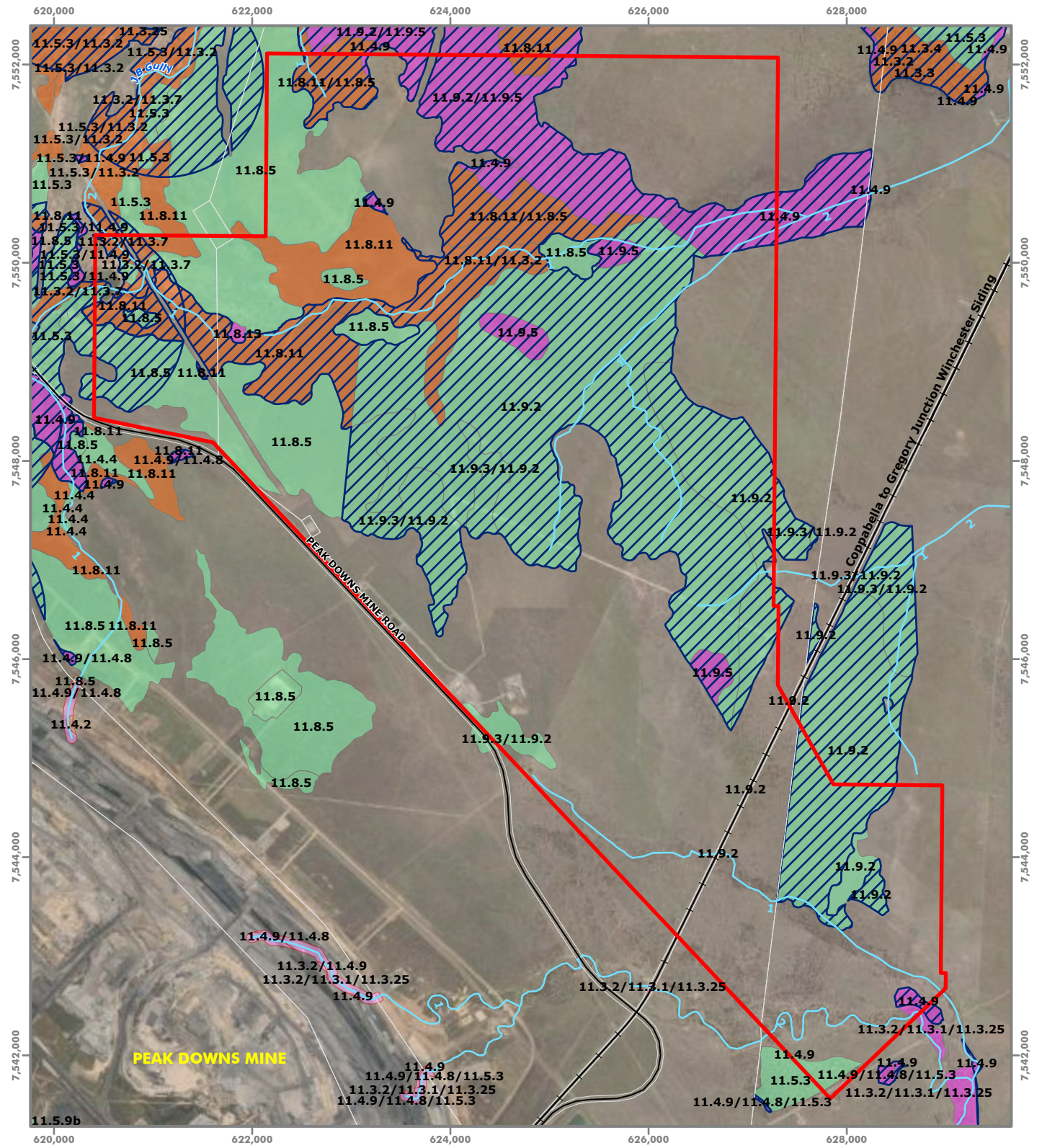
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Data: Roads, Rail, Watercourse, DCDB - (c)DNRM 2022

0 0.5 1 2
Kilometers

N

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Legend

- ML 70389
- Road
- Railway
- Vegetation Management Act watercourse
- Cadastral boundary
- Vegetation Management Essential Habitat - V10.0

Vegetation Management Regional Ecosystem Map - V12.0

- Category A or B containing endangered
- Category A or B containing of concern
- Category A or B that is of least concern
- Category C or R containing endangered
- Category C or R containing of concern
- Category C or R that is of least concern

Figure 6 : Queensland Government Version 12 regional ecosystem mapping (2021)

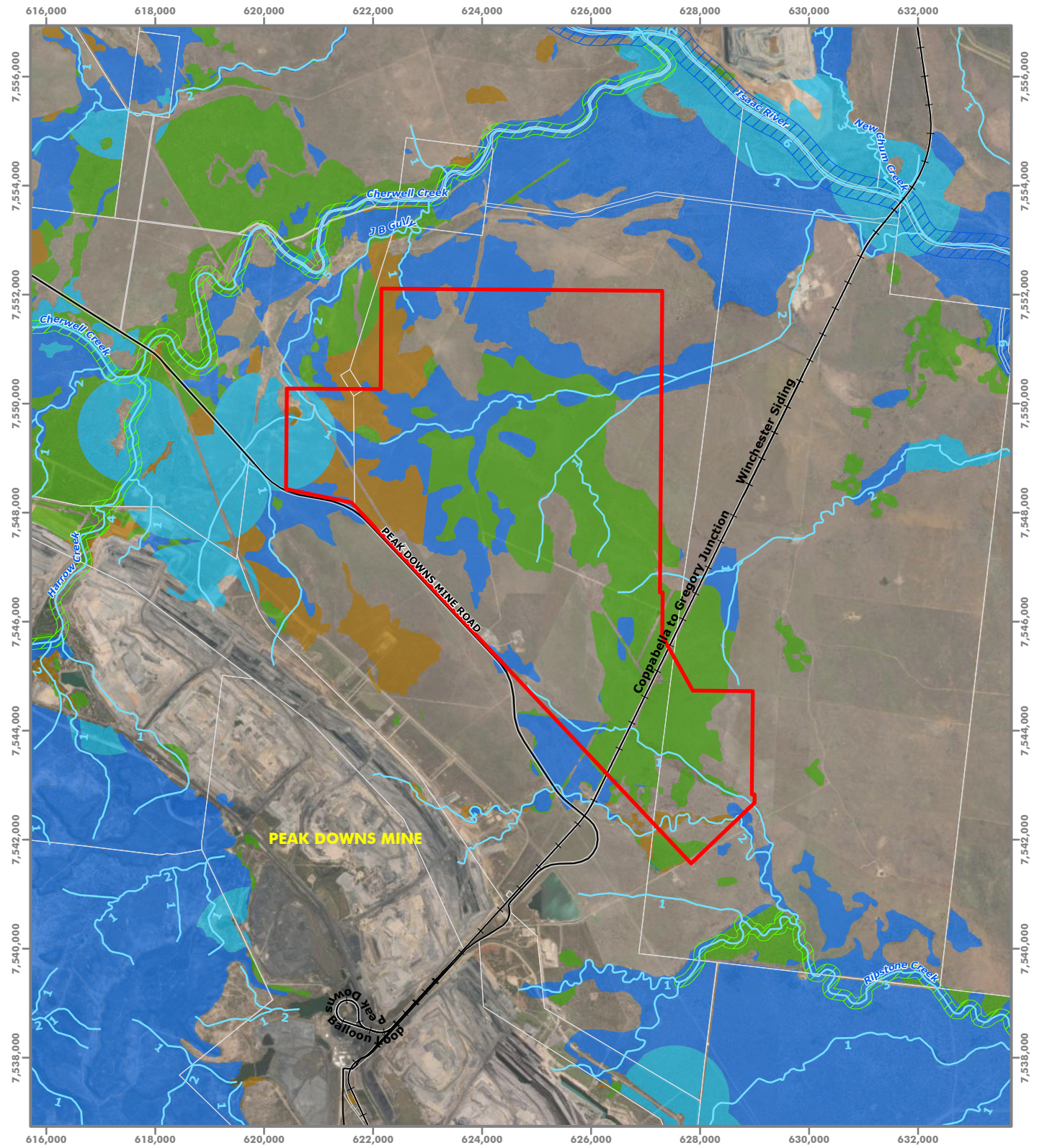
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Imagery: (c) Digital Globe
Data: Roads, Rail, Watercourse, DCDB - (c)DNRM 2022

0 0.5 1 2 3
Kilometers

N

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Legend

- ML 70389
- Road
- Railway
- Vegetation Management Act watercourse
- Cadastral boundary

Ecological Corridors

- State
- Regional

Biodiversity Significance

- State Habitat for EVNT taxa
- State
- Regional
- Local or Other Values

Figure 7 : Biodiversity Planning Assessment mapping

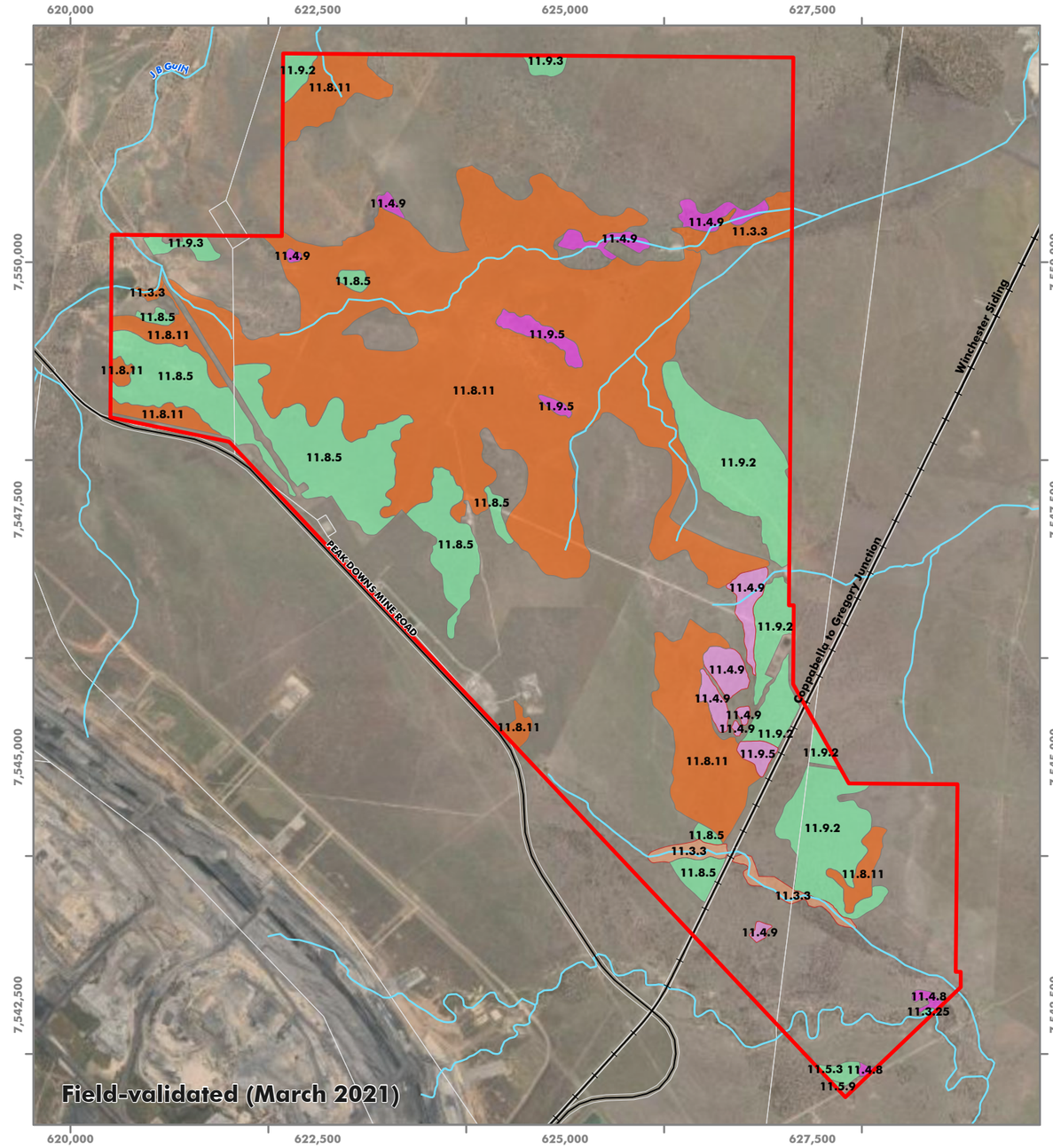
Eagle Downs Project - Review of Matters of State Environmental Significance

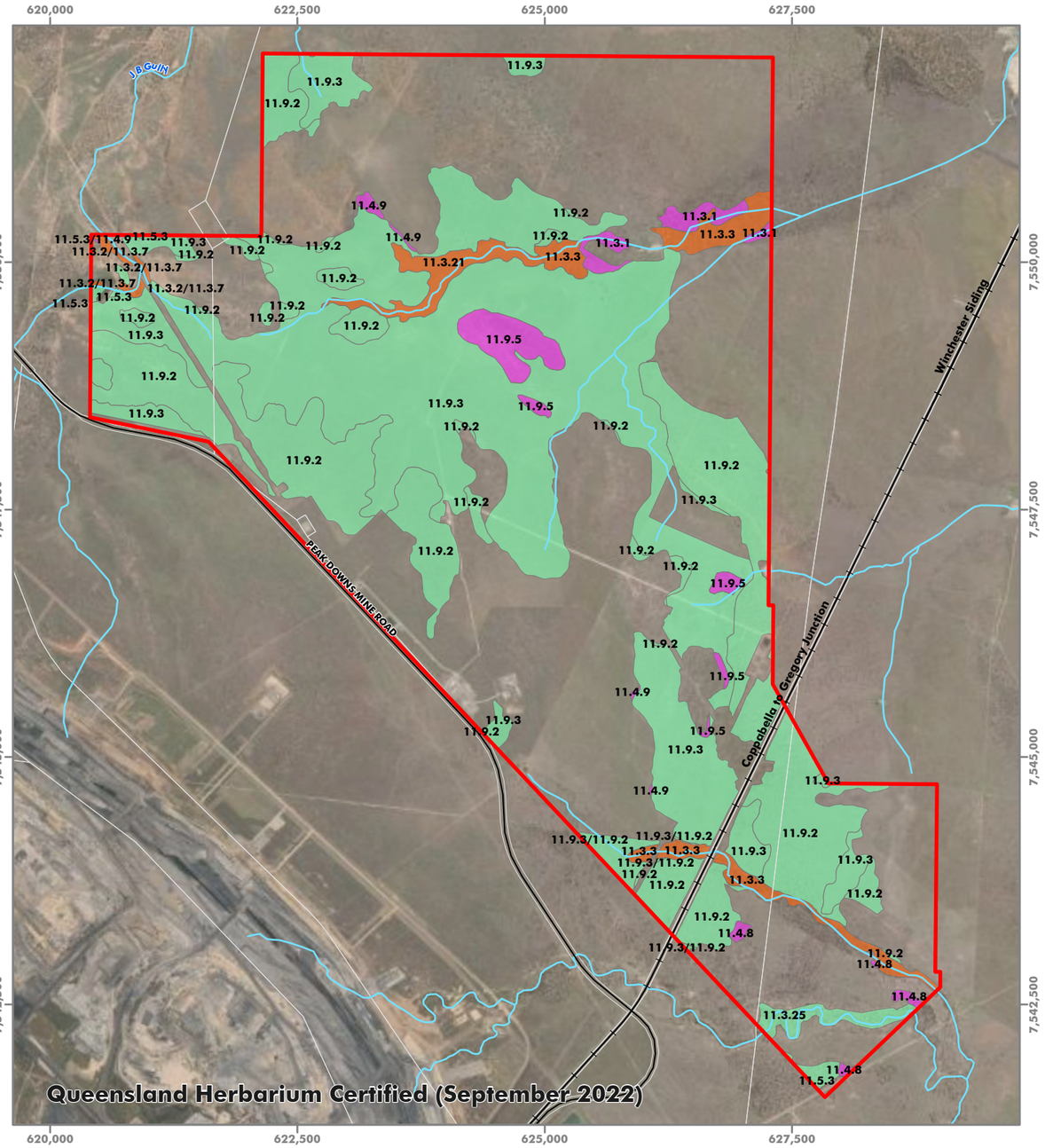
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Map Projection: GDA2020 MGA Zone 55
Imagery: (c) Digital Globe
Data: Roads, Rail, Watercourse, DCDB - (c)DNRM 2022

0 1 2 4 6
Kilometers

N

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Legend

- ML 70389
- Road
- Railway
- Vegetation Management Act watercourse
- Cadastral boundary

Remnant vegetation

- Endangered
- Of concern
- Least concern

High value regrowth

- Endangered
- Of concern

N

0 0.5 1 2 3

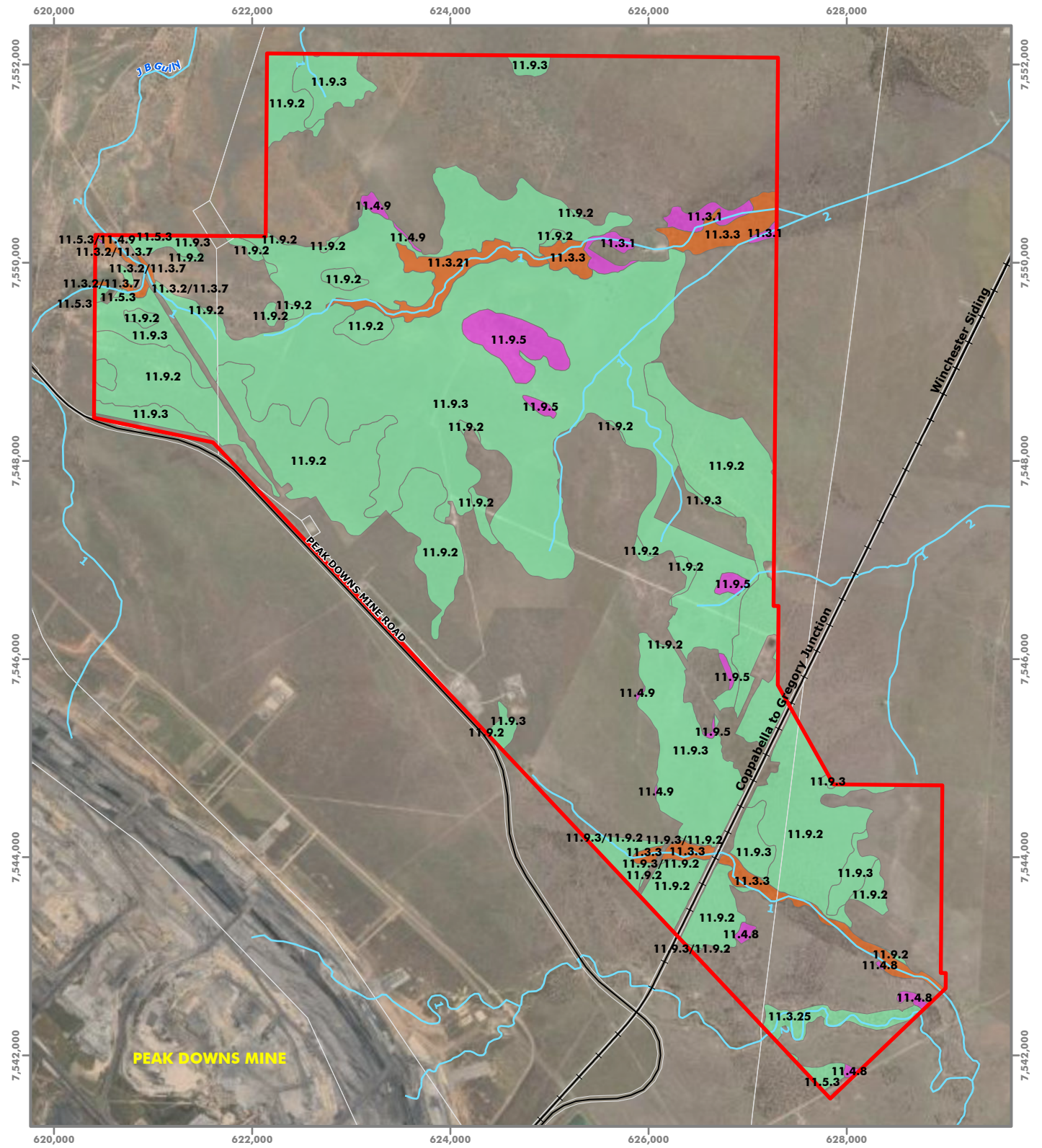
Kilometres

Figure 8 : Comparison of field-validated and certified Queensland Herbarium remnant RE mapping

Eagle Downs Project - Review of Matters of State Environmental Significance

Map Number: 22043_MSES_08_B
Date: 19 October 2022
Map Projection: GDA 1994 MGA Zone 55
Imagery: (c)Digital Globe
Data: Roads, Railway, Watercourse - (c)DNRM 2022

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Legend

- ML 70389
- Road
- Railway
- Vegetation Management Act watercourse
- Cadastral boundary

Vegetation Management Act status

- Endangered
- Of concern
- Least concern

Figure 9 : Certified Queensland Herbarium remnant RE mapping (September 2022)

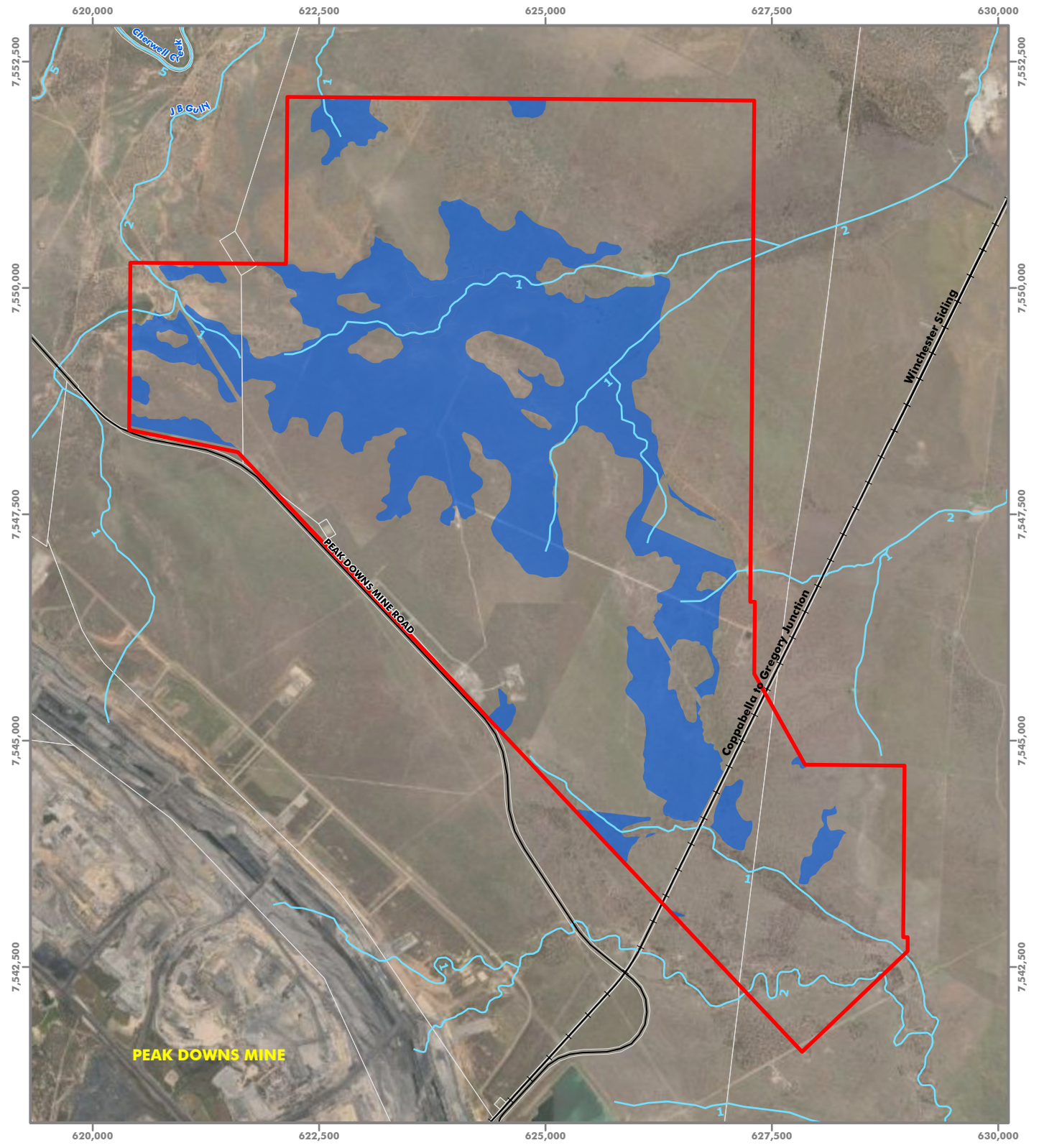
Eagle Downs Project - Review of Matters of State Environmental Significance

Map Number: 22043_MSES_09_A
Date: 19 October 2022
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Imagery: (c) Digital Globe
Data: Roads, Rail, Watercourse, DCDB - (c)DNRM 2022

0 0.5 1 2 3
Kilometers

N

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Legend

- ML 70389
- Road
- Railway
- Vegetation Management Act watercourse
- Cadastral boundary

Habitat mapping

- King Bluegrass (*Dichanthium queenslandicum*) - Vulnerable

Figure 10 : Potential King Bluegrass habitat

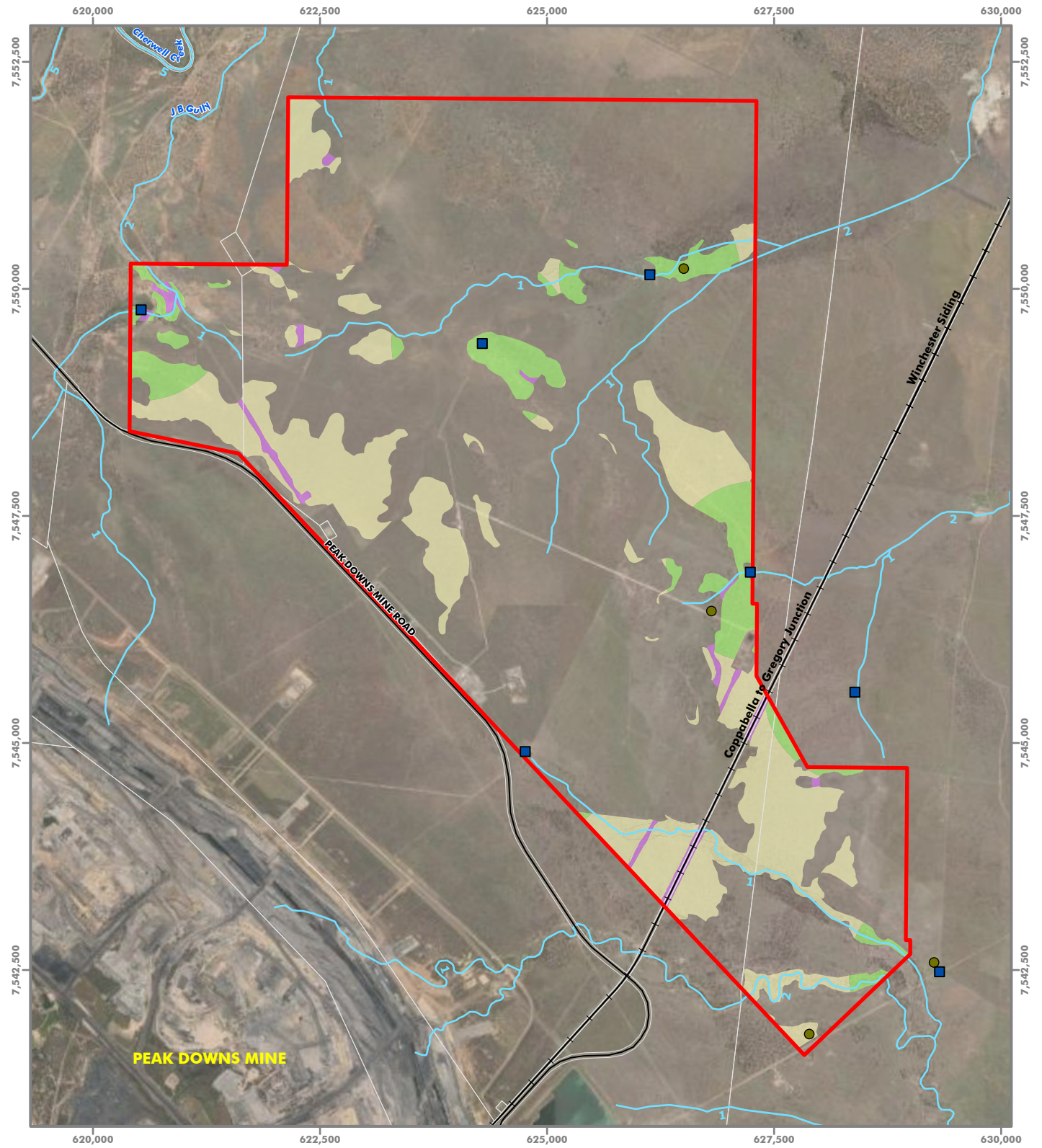
Eagle Downs Project - Review of Matters of State Environmental Significance

Map Number: 22043_MSES_10_B
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Imagery: (c) Digital Globe
Data: Roads, Rail, Watercourse, DCDB - (c)DNRM 2022

0 0.5 1 2 3
Kilometres

N

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Legend

- ML 70389
- Road
- Railway
- Vegetation Management Act watercourse
- Cadastral boundary
- Water point

Recorded location

- Squatter Pigeon (southern) (*Geophaps scripta scripta*) – Vulnerable

Habitat mapping

- Breeding and foraging habitat - Squatter Pigeon (southern) (*Geophaps scripta scripta*) – Vulnerable
- Foraging habitat - Squatter Pigeon (southern) (*Geophaps scripta scripta*) – Vulnerable
- Dispersal habitat - Squatter Pigeon (southern) (*Geophaps scripta scripta*) – Vulnerable

Figure 11 : Squatter Pigeon records and habitat

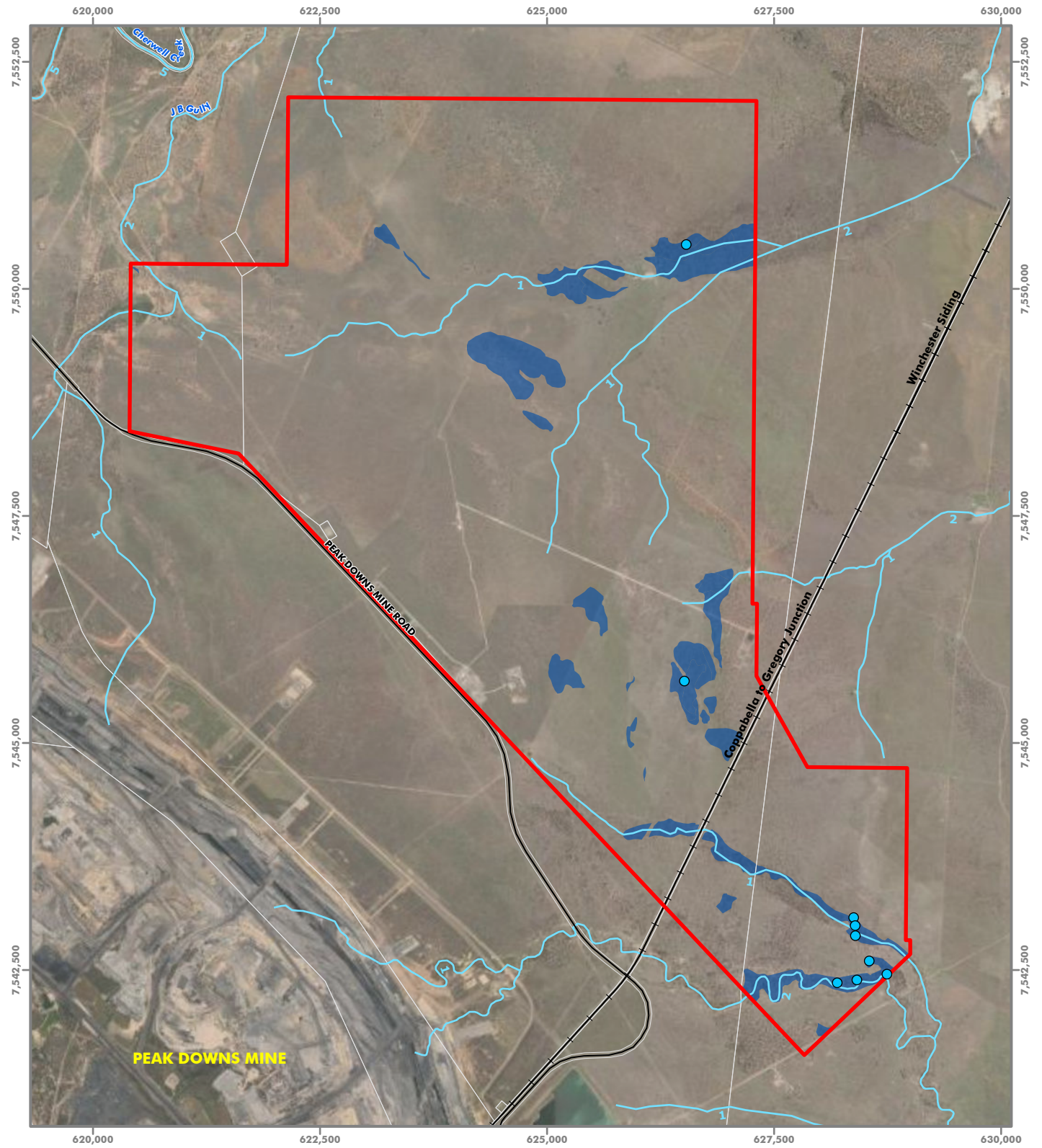
Eagle Downs Project - Review of Matters of State Environmental Significance

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Imagery: (c) Digital Globe
Data: Roads, Rail, Watercourse, DCDB - (c)DNRM 2022

0 0.5 1 2 3
Kilometres

N

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Legend

- ML 70389
- Road
- Railway
- Vegetation Management Act watercourse
- Cadastral boundary

Recorded locations

- Ornamental Snake (*Denisonia maculata*) – Vulnerable

Habitat mapping

- Ornamental Snake (*Denisonia maculata*) – Vulnerable

Figure 12 : Ornamental Snake records and habitat

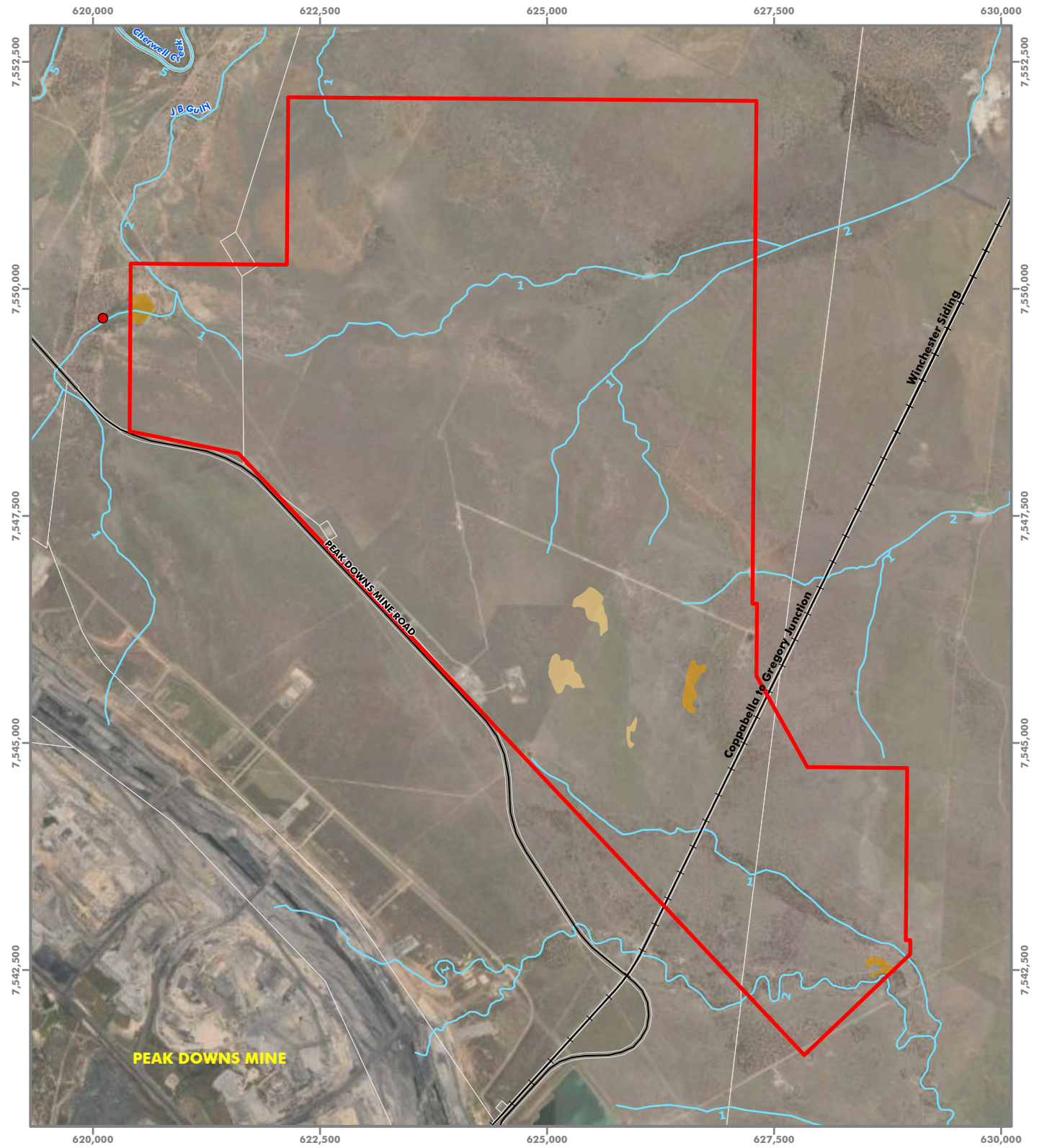
Eagle Downs Project - Review of Matters of State Environmental Significance

Map Number: 22043_MSES_12_B
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Imagery: (c) Digital Globe
Data: Roads, Rail, Watercourse, DCDB - (c)DNRM 2022

0 0.5 1 2 3
Kilometres

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Legend

- ML 70389
- Road
- Railway
- Vegetation Management Act watercourse
- Cadastral boundary

Historic record

- Australian Painted Snipe (*Rostratula australis*) - Endangered - (Ecological Survey and Management 2012)

Habitat mapping

- Breeding and foraging habitat - Australian Painted Snipe (*Rostratula australis*) - Endangered
- Marginal foraging habitat - Australian Painted Snipe (*Rostratula australis*) - Endangered

Figure 13 : Potential Australian Painted Snipe habitat

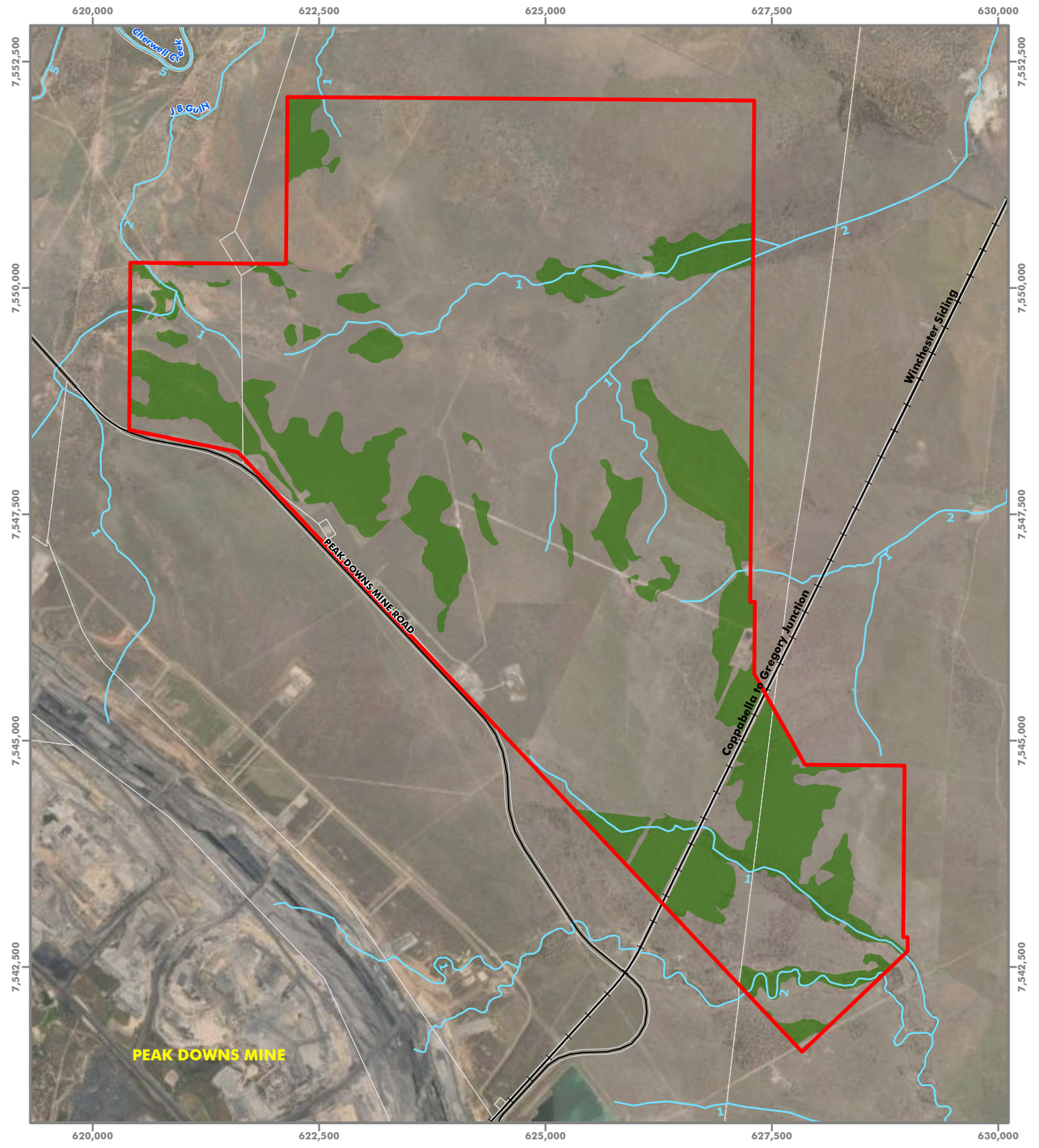
Eagle Downs Project - Review of Matters of State Environmental Significance

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Date: 19 October 2022
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Imagery: (c) Digital Globe
Data: Roads, Rail, Watercourse, DCDB - (c)DNRM 2022

0 0.5 1 2 3
Kilometres

N

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Legend

- ML 70389
- Road
- Railway
- Vegetation Management Act watercourse
- Cadastral boundary

Habitat mapping

- Greater Glider (*Petauroides volans*) – Endangered

Figure 14 : Potential Greater Glider habitat

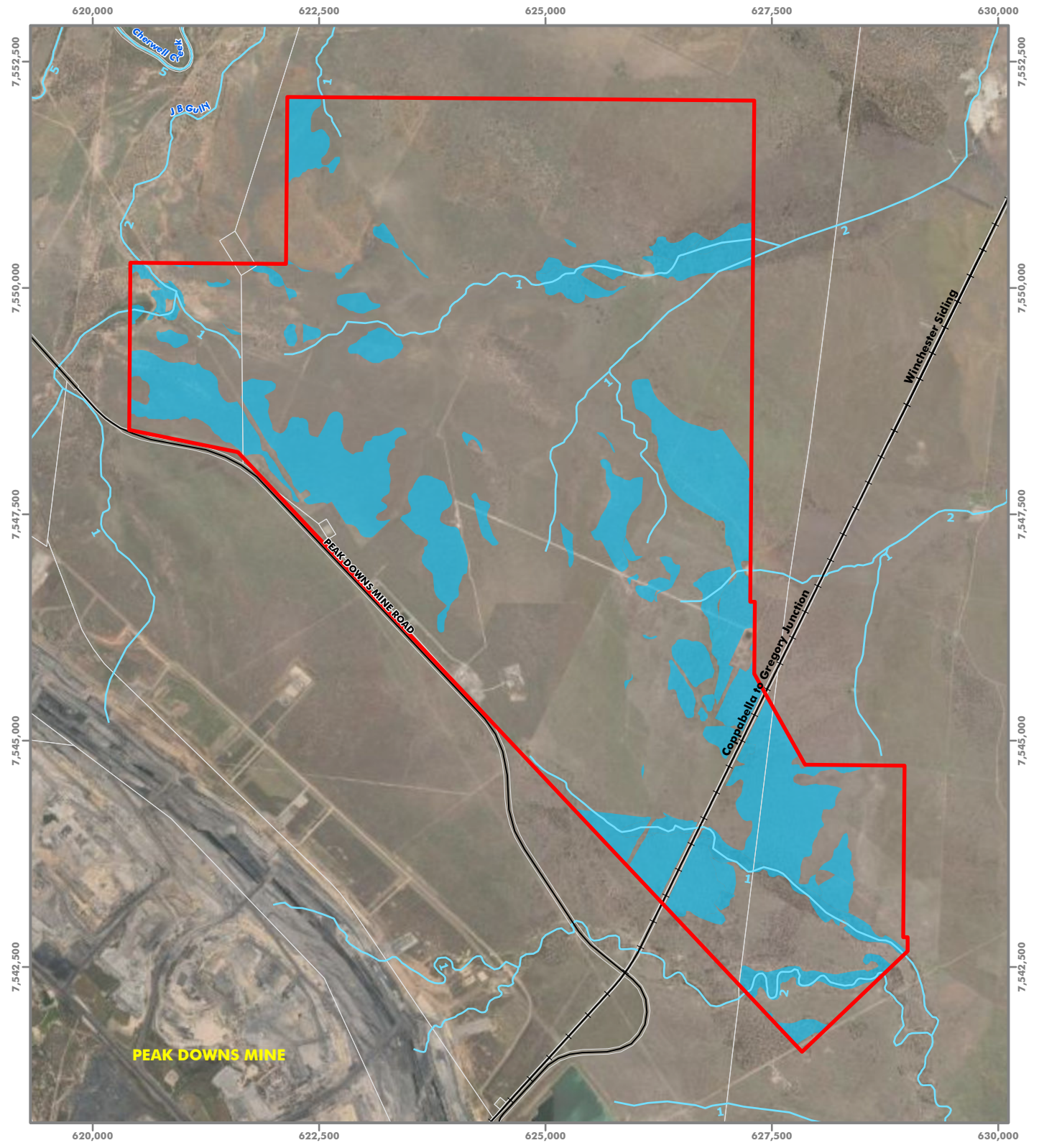
Eagle Downs Project - Review of Matters of State Environmental Significance

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Date: 19 October 2022
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Imagery: (c) Digital Globe
Data: Roads, Rail, Watercourse, DCDB - (c)DNRM 2022

0 0.5 1 2 3
Kilometres

N

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Legend

- ML 70389
- Road
- Railway
- Vegetation Management Act watercourse
- Cadastral boundary

Habitat mapping

- Koala (*Phascolarctos cinereus*) – Endangered

Figure 15 : Potential Koala habitat

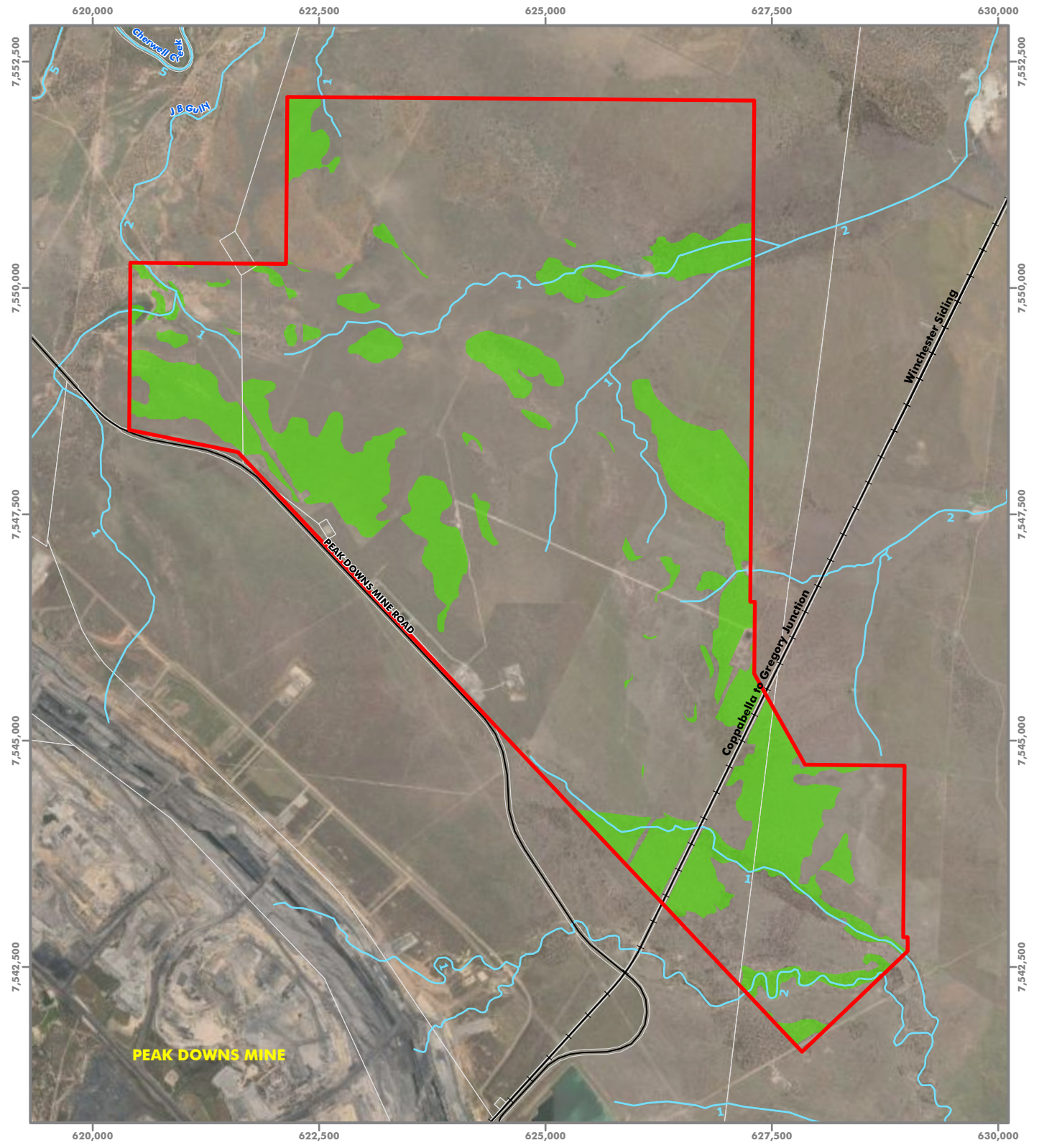
Eagle Downs Project - Review of Matters of State Environmental Significance

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Date: 19 October 2022
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Imagery: (c) Digital Globe
Data: Roads, Rail, Watercourse, DCDB - (c)DNRM 2022

0 0.5 1 2 3
Kilometres

N

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Legend

- ML 70389
- Road
- Railway
- Vegetation Management Act watercourse
- Cadastral boundary

Habitat mapping

- White-throated Needletail (*Hirundapus caudacutus*) - Vulnerable

Figure 16: Potential White-throated Needletail habitat

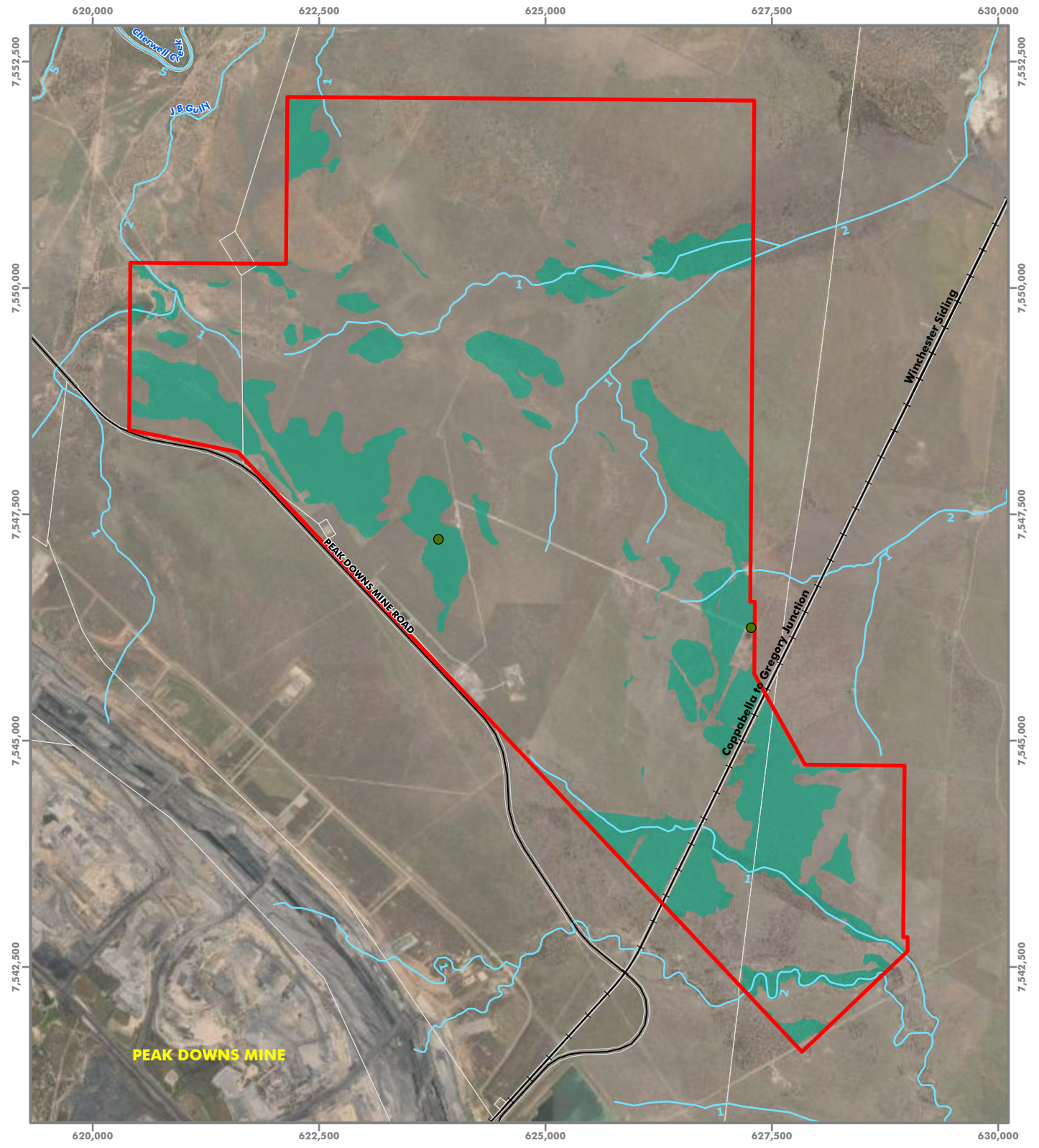
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Imagery: (c) Digital Globe
Data: Roads, Rail, Watercourse, DCDB - (c)DNRM 2022

0 0.5 1 2 3
Kilometres

N

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Legend

- ML 70389
- Road
- Railway
- Vegetation Management Act watercourse
- Cadastral boundary

Recorded location

- Short-beaked Echidna (*Tachyglossus aculeatus*) – Special Least Concern

Habitat mapping

- Short-beaked Echidna (*Tachyglossus aculeatus*) – Special Least Concern

Figure 17 : Short-beaked Echidna records and habitat

Eagle Downs Project - Review of Matters of State Environmental Significance

Map Number: 22043_MSES_17_C
Date: 19 October 2022
Map Projection: GDA 1994 MGA Zone 55
Imagery: (c) Digital Globe
Data: Roads, Rail, Watercourse, DCDB - (c)DNRM 2022

0 0.5 1 2 3
Kilometres

N

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Appendix A

Detailed methodology

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This appendix provides a detailed description of the methodologies used in the preparation of this ecological assessment.

A1 Nomenclature

A1.1 Flora

Application of flora scientific names in this report follows Brown and Bostock (Brown and Bostock 2020). In the first occurrence in the text, common names (if one exists) will be followed by its scientific name. Common names for flora were derived from Harden et al. (2018), Harden et al. (2007), Brooker and Kleinig (2008), Maslin (Maslin 2001), Hacker (1990), Tothill and Hacker (1996), Sharp and Simon (2002), and Auld and Medd (2002). Use of an asterisk (*) indicates the species is not native to Queensland, e.g. Common Lantana (**Lantana camara*). Following the first in-text reference, species will be referred to by common name only, where one exists.

A1.2 Fauna

Taxonomy and nomenclature for fauna species within this report follows the following references:

- amphibians – Tyler and Knight (2011)
- reptiles – Wilson and Swann (2013)
- birds – Pizzey et al. (2012)
- mammals (except bats) – Menkhorst and Knight (2011)
- bats – Churchill (2009)
- nomenclature (Macdonald 2013).

Common names are used where a species has an accepted common name with the scientific name provided at the first instance of the name appearing in the text. Common names for fauna are sourced from the references listed above or where no common name is provided, searches are made for other widely accepted common names.

A2 Desktop study

A2.1 Database searches and government mapping

Database searches were undertaken for the ecology study area and surrounding area to identify records or potential occurrences of threatened, near threatened, migratory and/or special least concern flora and fauna species and endangered and of concern vegetation communities. Database searches were undertaken within a 25 km radius of the boundary of the ecology study area. The search radius is considered to be representative of the broader region and an appropriate size given the number of surveys that have been conducted in the region.

Desktop searches covered the following databases and government mapping sources:

- EPBC Act Protected Matters Search Tool, accessed 16 April 2021 (DAWE 2021) (Appendix B)
- Queensland Wildlife Online database, accessed 16 April 2021 (DES 2021a) (Appendix B)
- Australasian Virtual Herbarium database, accessed 16 April 2021 (CHAH 2021)(Appendix B, Table B1)
- The Atlas of Living Australia[1], accessed 19 May 2021 (CSIRO 2021)
- Vegetation management regional ecosystem map Version 12.0 (DR 2021a) and Vegetation management essential habitat map Version 10.0, at 1:100 000 scale (DR 2021b)
- Protected Plants Flora Survey Trigger Map, Version 7.1, accessed 14 April 2021 (DES 2021b) (Appendix B)
- Geological Survey of Queensland 1:100 000 mapping (NRM 2011)
- Koala Conservation Plan Map - version 6.1.3, accessed on 17 August 2018 (DES 2021c)
- Atlas of Groundwater Dependent Ecosystems, accessed 11 April 2021 (National Water Commission 2021).
- Queensland Wetland Data Springs Mapping (DES 2019).
- Map of Referable Wetlands – Great Barrier Reef wetland protection areas and Queensland Wetland Environmental Values, accessed 14 April 2021 (DES 2021d).
- Vegetation management wetlands map - version 6.12 (DR 2021c).
- Vegetation management watercourse and drainage feature map version 4.0 (DR 2021d).
- The Biodiversity Assessment and Mapping Methodology (BAMM) (Queensland Herbarium Science and Technology 2018). The BAMM has been prepared to provide a consistent approach for assessing biodiversity values at the landscape scale in Queensland using vegetation mapping data generated or approved by the Queensland Herbarium as a fundamental basis. It is being used by DES to generate Biodiversity Planning Assessments (BPAs) for each of Queensland's bioregions, including the Brigalow Belt Bioregion where the project is located.

[1] The Atlas of Living Australia is a publicly available database that is populated by a wide range of contributors including 'citizen-based' contributors. The database does not allow for every individual observation to be validated, therefore, this database has been used as secondary supporting information.

BPAs are developed in two stages:

1) diagnostic criteria: involves the integration of ecological criteria using BAMM to determine the relative Biodiversity Significance
2) supplementary/expert panel criteria: allows for the refinement of the mapped information from Stage 1 by incorporating local knowledge and expert opinion.

The methodology has application for identifying areas with various levels of significance solely for biodiversity reasons. These include threatened ecosystems or taxa, large tracts of habitat in good condition and buffers to wetlands or other types of habitat important for the maintenance of biodiversity or ecological processes.

Three biodiversity significance levels are mapped for any given region as follows:

- State biodiversity significance - areas assessed as being significant for biodiversity at the bioregional or state scales
- Regional biodiversity significance - areas assessed as being significant for biodiversity at the sub-bioregional scale
- Local biodiversity significant and/or other values - local values that are of significance at the local government scale.

The BPA mapping is for planning purposes and does not provide any specific statutory protection.

A2.2 Literature review and previous studies

Previous surveys and assessment carried out across the Eagle Downs ML were reviewed, including seasonal flora and fauna surveys undertaken in 2007/2008 for the Eagle Downs Project Environmental Impact Statement (EIS) and targeted Natural Grassland TEC surveys in 2010. The surveys completed in relation to the recent amendment to the existing Environmental Authority for Eagle Downs Mine (i.e. issued in 2011) to facilitate proposed changes to surface infrastructure layout also contributed to preparation of this report. Studies within, adjacent to or in the region, i.e. 25 km of the ecology study area, were reviewed where available.

A2.3 Review of aerial photography

Aerial photography (combination of imagery flown on 2016, 2019 and 2020 was used for this assessment. Digital Globe photography was viewed in relation to relevant biodiversity spatial layers. Aerial photography was used to identify features for ground-truthing during the field surveys, to identify appropriate survey locations and for determining and characterising potential terrestrial flora and fauna habitats.

A2.4 Regional ecosystem mapping

The Queensland Government produces regulated vegetation maps and supporting RE maps showing the distribution of remnant REs throughout Queensland. These published maps are produced using Landsat satellite imagery, aerial photography and field based ground-truthing. Prior to and during the field surveys the

Queensland Government's Vegetation Management regional ecosystem (RE) version 12 maps at 1:100,000 scale were in effect. This mapping was reviewed prior to field surveys to inform survey locations.

As part of the EA amendment process for the project, the Queensland Government requires field-validated mapping to be submitted to the Queensland Herbarium as part of a map amendment request. This process allows for Queensland Government specialists to review the proposed remnant RE mapping amendments and incorporation of those amendments, where approved, into the current Queensland Government certified RE mapping.

The field-validated mapping for the ecology study area was submitted for consideration by the Queensland Herbarium. The Queensland Herbarium adopted many of the proposed RE changes and as part of their assessment used submitted vegetation, land resource and geological information, to reinterpret the field-validated vegetation mapping in some locations. Their assessment resulted in new certified RE mapping for the ecology study area and surrounding areas in September 2022. This current certified mapping was subsequently used to prepare this review of MSES.

A2.5 Geological mapping

A review of geological mapping of the ecology study area has been undertaken and is provided in Figure 5, Section 4 and Section C1.1 of Appendix C. The geological mapping was reviewed in order to gain an understanding of the geology within the ecology study area and to provide an indication of likely land zones for assigning REs.

A2.6 Soil mapping

A review of the soil mapping for the ecology study area has been undertaken and is provided in Section C1.2 of Appendix C. The soil mapping was reviewed in order to correlate vegetation types and habitat preferences of particular flora and fauna, to soil types present in the ecology study area (GJR Holdings 2008).

A3 Terrestrial ecology field surveys

The terrestrial ecology field surveys referred to in this report were completed in March and April of 2021 over two survey periods. The following sections present the methodologies used during these field surveys.

A3.1 Survey team

Five ecologists contributed to the field surveys and preparation of this terrestrial ecology assessment. The team and their qualifications are outlined in Table A1.

Table A1: Ecology survey team

Team Member	Title	Years of experience	Qualifications	Role
Steve Marston	Principal Ecologist	25	BEnvEng (Hons) MWildMgt	Fauna field survey lead and technical review
Chris Hansen	Principal Botanist	19	BSc (Hons)	Flora field survey lead and technical review
Michael O'Connor	Ecologist	9	BESc	Fauna field survey
Monica Campbell	Senior Ecologist	13	BSc (Hons); PhD (Plant Ecology)	Reporting
Meredith Watherston	Principal Ecologist	18	BSc (Env)	Reporting

A3.2 Permits

The field surveys were undertaken under the following permits and approvals that were current at the time of the surveys:

- Animal Ethics Committee Approval: CA 2018/06/1200 (valid from 25 August 2018 to 25 August 2021)
- Scientific Purposes Permit: WA0027391 (valid from 26 October 2020 to 25 October 2025)

A3.3 Coordinate system and map datum

Positional data was collected using a geographic positioning system with an accuracy of 3 to 5 m. Positional locations were recorded using the Latitude and Longitude coordinate system. All locations presented in this report are within zone 55K. The map datum used was WGS84.

A3.4 Survey timing

Post-wet season terrestrial flora and fauna surveys were conducted in order to field-validate the type, distribution and remnant status of vegetation communities and develop an inventory of flora and fauna species present. The following surveys were conducted:

- flora survey - 9 days (9 - 17 March, inclusive)
- fauna survey - 9 days (13 - 21 April, inclusive).

Field surveys were completed at these times in order to capture the effects of seasonality and rainfall on the abundance of flora and fauna species.

A3.5 Climatic conditions

Climate data has been collected since 2012 from the Bureau of Meteorology (BoM) weather station at Moranbah Airport (Station No.: 034035), which is the closest BoM meteorological station to the ecology study area.

A3.5.1 Rainfall patterns

Monthly rainfall averages recorded at the BoM Moranbah Airport weather station (no. 034035) are provided in Table A2. Given the rainfall records at this station cover a period of 10 years, the data is considered to reflect recent regional rainfall patterns. Actual monthly rainfall totals recorded in March and April 2021 at the BoM Moranbah Airport weather station are also provided in Table A2. This data was used to show average regional rainfall information at the time of the surveys and in the preceding years.

As can be seen from Table A2, actual rainfall was slightly below average in the six months (i.e. September 2020 – February 2021) preceding the post-wet season surveys in March and April 2021. However, above average rainfall was received in December 2020 and January 2021, which appears to have resulted in a flush of growth and good conditions around the time of the field surveys. The mean annual rainfall for the region is 523.7 mm (BoM 2021).

Table A2: Monthly recorded rainfall for the local area

Month	Mean annual rainfall (mm)	Actual total rainfall (mm)					
		2016	2017	2018	2019	2020	2021
January	92.0	*52.6*	*60.2*	*20.4*	*60.0*	*100.2*	*124.4*
February	92.2	*260.0*	*19.2*	*183.4*	*26.8*	*76.4*	*16.2*
March	89.3	*53.6*	257.8	*13.0*	*145.6*	*53.2*	*58.0*
April	25.2	*0.0*	*0.0*	*8.0*	*7.4*	*5.2*	*37.4*
May	30.2	*5.0*	*101.2*	*16.0*	*4.0*	*52.6*	-
June	16.7	*85.0*	*0.0*	*0.4*	*24.8*	*11.8*	-
July	28.0	*123.6*	*1.6*	*4.8*	*11.6*	*15.4*	-
August	9.0	*10.0*	*1.2*	*4.8*	*5.4*	*15.0*	-
September	8.3	*11.8*	*0.4*	*0.0*	*0.2*	*16.0*	-
October	24.0	*7.8*	*86.0*	*70.0*	*13.4*	*18.6*	-
November	38.3	*42.2*	*39.4*	*18.8*	*16.6*	*4.8*	-
December	63.0	*180.8*	*16.2*	*26.6*	*9.0*	*115.0*	-

Source: (BoM 2021)
Note: Data in grey italics represent observations which have not been fully quality controlled

A3.5.2 Weather conditions during the surveys

Daily weather conditions recorded at the BoM's weather station at Moranbah Airport weather station for the two weeks preceding, as well as during the period of the seasonal ecology surveys, are presented in Table A3.

The weather conditions during both post-wet season surveys were characterised by clear, warm to hot days and mild to cool nights (Table A3). Although very little rainfall was recorded in the two weeks before both the surveys and rainfall was only experienced at the end of the survey period (Table A3). The post-wet season surveys were undertaken following higher than average rainfall during the two months, i.e. December and January (Table A2). The conditions at the time of the surveys were therefore conducted in optimal conditions for vegetative vigour and inflorescence set, particularly for herbaceous and graminoid (grass) species. Similarly, the weather conditions during and preceding the wet season fauna surveys were considered favourable for the detection of all groups of vertebrate fauna, including amphibians and wetland bird species.

Table A3: Daily weather conditions for the two weeks preceding and during the ecology surveys

Date	Temperature		Rainfall (mm)
	Min (°C)	Max (°C)	
Prior to and during the flora survey			
23 February 2021	24.7	39.9	*0.0*
24 February 2021	22.8	36.1	*2.8*
25 February 2021	21.6	34.8	*6.4*
26 February 2021	21.5	33.3	*0.0*
27 February 2021	23.3	33.6	*0.0*
28 February 2021	23.8	29.2	*0.0*
1 March 2021	22.5	28.4	*1.0*
2 March 2021	22.4	35.9	*0.4*
3 March 2021	21.5	37.2	*0.2*
4 March 2021	22.2	34.5	*0.0*
5 March 2021	20.5	34.6	*0.0*
6 March 2021	21.8	37.6	*0.0*
7 March 2021	21.6	34.9	*0.0*
8 March 2021	20.0	35.4	*0.0*
9 March 2021	19.4	35.0	*0.0*
10 March 2021	20.3	36.9	*0.0*
11 March 2021	21.8	34.9	*0.0*
12 March 2021	20.8	36.0	*0.0*
13 March 2021	21.1	35.9	*0.0*
14 March 2021	21.0	36.4	*0.0*
15 March 2021	23.1	35.8	*0.0*

Date	Temperature		Rainfall (mm)
	Min (°C)	Max (°C)	
16 March 2021	21.1	34.9	*0.2*
17 March 2012	20.9	30.1	*18.8*
Prior to and during fauna survey			
30 March 2021	19.7	32.1	*0.0*
31 March 2021	18.8	31.2	*0.0*
1 April 2021	*17.9*	*30.7*	*0.0*
2 April 2021	*17.5*	*30.6*	*0.0*
3 April 2021	*17.9*	*29.1*	*0.0*
4 April 2021	*19.7*	*25.3*	*3.8*
5 April 2021	*20.6*	*23.4*	*3.0*
6 April 2021	*21.2*	*27.4*	*4.8*
7 April 2021	*19.7*	*30.0*	*0.2*
8 April 2021	*18.3*	*32.2*	*0.0*
9 April 2021	*17.4*	*34.0*	*0.0*
10 April 2012	*18.5*	*34.8*	*0.0*
11 April 2021	*17.2*	*35.5*	*0.0*
12 April 2021	*18.8*	*29.1*	*0.0*
13 April 2012*	*16.3*	*31.2*	*0.0*
14 April 2021	*16.1*	*30.7*	*0.0*
15 April 2021	*12.7*	*31.2*	*0.0*
16 April 2021	*16.1*	*32.0*	*0.0*
17 April 2021	*15.0*	*31.8*	*0.0*
18 April 2021	*18.7*	*30.8*	*0.0*
19 April 2021	*17.7*	*31.3*	*0.0*
20 April 2021	*17.9*	*31.2*	*0.0*
21 April 2021	*19.7*	No record	*4.4*

Source: (BoM 2021)
Note: Survey dates indicated in grey highlight

A3.6 Flora field survey methods

The field flora surveys were designed specifically to:

- validate the Queensland Government RE vegetation mapping that was current at the time of the surveys, and better define the distribution and proportionate composition of REs within mixed polygons of more than one RE type
- target threatened flora species and vegetation communities identified from database searches and their habitats
- produce a comprehensive floral inventory for all vegetation assessment sites and the ecology study area as a whole.

A3.6.1 Site selection

The field flora surveys were carried out in compliance with the '*Methodology for Surveying and Mapping of Regional Ecosystems and Vegetation Communities in Queensland, Version 5.1*' (Neldner et al. 2020), which was current at the time survey. Assessment sites were conducted throughout the ecology study area so as to thoroughly assess mapped remnant vegetation. Multiple sites were conducted within each RE type across the ecology study area.

The validation and mapping of remnant and high-value regrowth vegetation was undertaken at a total of 160 vegetation assessment sites and 9 photo points. Of the 160 vegetation assessment sites, 16 were detailed secondary sites, 75 were tertiary sites and 69 quaternary sites.

Detailed flora species lists were collated at all secondary sites (Figure 3) and traverse lists were compiled to account for additional species that were recorded outside of the secondary site plots. The less detailed sampling (tertiary and quaternary assessment sites) was conducted to provide additional information relating to the vegetative structure and to assist in mapping the extent and distribution of the identified REs within the ecology study area. The photo points were undertaken to capture supplementary field-validation information or record a noteworthy landscape, vegetation or habitat feature. Relevant observations and a series of photos were taken at these points. The location of the vegetation assessment sites and photo points are shown in Figure 3.

Each of the secondary sites was upgraded to habitat quality plots (HQPs) and additional vegetation condition data was collected at these HQPs in accordance with the Queensland Department of Environment and Science's (DES) '*Guide to determining terrestrial habitat quality, version 1.3*' (Habitat Quality Guide) (DES 2020a). These plots were primarily positioned in vegetation communities that will most likely be directly impacted by the proposed project. The HQPs were installed in order to:

- collect 'site condition' data that is required for assessing land-based offsets
- assist with determining whether vegetation communities meet the condition criteria for TECs that are likely to occur within the ecology study area.

The remnant status of existing vegetation was determined by comparing the existing predominant canopy with the undisturbed predominant canopy. The Queensland Herbarium defines the predominant canopy under the VM Act, as the Ecologically Dominant Layer (EDL), namely, that stratum of the vegetation that contains the most above ground biomass. The EDL can be defined in terms of growth form, height, cover density and species. In the majority of cases, the EDL is equivalent to the upper stratum (Walker and Hopkins 1990).

The crown cover definitions and associated crown separation descriptions (e.g. sparse) were also applied to the lower strata to allow a consistent description of the spatial distribution of the respective vegetation layers.

The landform description upon which the field-validated vegetation communities occurred was based on simple erosional landform patterns characterised by relief and modal slope and described by Speight (1990).

A3.6.2 Secondary sites

Data at each secondary site was collected in accordance with the Queensland Herbarium's secondary site assessment methodology current at the time of the surveys (Neldner et al. 2020). Data recorded at each secondary site (Figure 3) included:

- date and precise location (with reference to handheld GPS)
- soils, slope, aspect and landform observations
- ground-layer, mid-stratum and canopy species composition and abundance
- structural characteristics
- condition and disturbance of existing vegetation communities (including distribution of weed species)
- quantitative and qualitative species composition within a 1,000 m^2 quadrat, and documentation of ancillary species identified within the immediate area or during foot traverse
- basal area of vegetation (Bitterlich Stick methodology)
- photographs of the community (north, east, south, west, groundcover and soils).

A3.6.3 Tertiary sites

Data recorded at each tertiary site (Figure 3) included:

- date and precise location (with reference to handheld GPS)
- soils, slope, aspect and landform observations
- ground-layer, mid-stratum and canopy species composition and abundance
- structural characteristics
- basal area of vegetation (Bitterlich Stick methodology)
- condition and disturbance of existing vegetation communities (including distribution of weed species)
- photographs of the community.

A3.6.4 Quaternary sites

Data recorded at each quaternary site (Figure 3) included:

- precise location (with reference to handheld GPS)
- ground-cover, mid-stratum and canopy species composition and abundance
- structural characteristics of the EDL
- condition
- limited photographs of the community.

A3.6.5 Photo monitoring sites

Data recorded at each of the nine photo monitoring sites (Figure 3) included:

- precise location (with reference to handheld GPS)
- a description of the vegetation community, flora habitat value or feature of interest
- photographs of the vegetation community, flora habitat value or feature of interest.

A3.6.6 Habitat quality plots

Each HQP (Figure 3) involved a 100 m x 50 m plot in which a series of 10 ecological condition attributes were recorded in accordance with the Habitat Quality Guide. Attributes recorded are outlined in Table A4. The median vegetation height data was measured using a laser rangefinder (hypsometer) and the diameter of trees measured at breast height (nominally 1.3 m above the ground) with a diameter at breast height (DBH) tape.

In addition to the information collected in Table A4, the following was noted at each HQP:

- orientation of the HQP
- date and precise location (with reference to handheld GPS)
- soils, slope, aspect and landform observations.

Table A4: Habitat quality plot ecological condition criteria

Habitat quality plot component	Ecological condition parameter
100 m transect	▪ Tree canopy cover ▪ Tree sub-canopy cover ▪ Native shrub cover Measured as projected foliage cover that intercepts the transect line.
100 m x 50 m plot	▪ Number of large eucalypt trees ▪ Number of large non-eucalypt trees ▪ Tree canopy height – median canopy height ▪ Recruitment of canopy species – proportion of dominant canopy species that are regenerating ▪ Native tree species richness – number of species present
50 m x 20 m plot	▪ Coarse woody debris – length of all logs >10 cm diameter, 0.5 m in length
50 m x 10 m plot	▪ Native shrub, grass and forbs/other species richness ▪ Non-native plant cover – cover of exotic species as a component of the overall vegetation cover
1 m x 1 m quadrats	Cover (%) of: ▪ Native perennial grass ▪ Organic litter ▪ Native forbs and other species

Habitat quality plot component	Ecological condition parameter
	▪ Native shrubs (<1 m in height) ▪ Non-native grass ▪ Non-native forbs and shrubs

A3.6.7 Targeted species surveys

Significant flora species listed under the NC Act that were recorded or predicted to occur from database searches (Appendix D) were reviewed and, where relevant, formed the focus of targeted flora species surveys. Detailed traverses of habitat that was considered suitable for significant flora species were undertaken.

A3.6.8 Vegetation mapping

Queensland Government mapped REs in the ecology study area were validated in the field using the survey data as previously described in Sections A3.6.1 to A3.6.5, and utilised the latest geology mapping (NRM 2011). The boundaries of vegetation types were mapped in the field using a GPS and/or aerial photograph interpretation.

A3.6.9 Random traverses

In addition to secondary, tertiary and quaternary assessment sites, large portions of the ecology study area were traversed on foot and the random meander technique applied (Cropper 1993). The purpose of random traverses was to ensure adequate site coverage and to establish a comprehensive floral species list. This method is also essential for the detection of cryptic, pest and other significant species. This method was supplemented with 'educated walks' (Garrard et al. 2008) in habitat areas that possessed a higher likelihood of supporting threatened flora species.

A3.6.10 Ancillary information

Other field characteristics such as areas of weed infestation, habitat areas for significant species and regional connectivity were recorded and described. Photographic records were taken throughout the ecology study area, capturing each community type, habitat type and the broader landscape.

A3.6.11 Flora inventory and abundance

A comprehensive flora species list, including native and introduced species, was compiled for the ecology study area. Relative abundance of flora species was assessed on a site-by-site basis, with detailed inventories compiled at all secondary assessment sites.

In relation to vegetation structure, abundance estimates were determined for species within each stratum of the community, with particular focus on the EDL as it is by these species that the community is defined, and from this, the RE determined (Neldner et al. 2020)met.

The relative abundance of species was based on the Braun-Blanquet technique, (Mueller-Dombois and Ellenberg 2003 Whittaker 1975).

A3.7 Fauna field survey methods

A3.7.1 Overview of survey effort

A variety of faunal survey methods were used, including systematic trap sites, spotlighting, call playback, infrared cameras, active searching, supplementary survey sites, harp traps, Anabat survey sites and observation (e.g. bird surveys and opportunistic observations).

Sites selected for each of the survey methods were determined through desktop review of aerial photography, RE mapping and database search results in order to stratify survey effort across major habitat types for species likely to occur in the ecology study area. The desktop information was initially used to design the survey, which was then refined where necessary in the field, once an on-ground appreciation for the vegetation communities and habitat features (e.g. locations of wetlands, Brigalow communities, watercourses) could be obtained.

Table A5 details the survey effort conducted during the survey. The following sections describe the methods used during the survey and locations of the survey sites.

Table A5: Fauna survey effort

Survey technique	Survey effort	Target fauna
Elliot traps (small and large)	400 trap nights	Small mammals, some reptiles
Pitfall traps	64 trap nights	Small mammals, reptiles and frogs
Funnel traps	96 trap nights	Small mammals, reptiles (including Ornamental Snake) and frogs
Infrared cameras	16 nights	Medium to large mammals (including Koala), and reptiles
Spotlighting (including by vehicle)	18 person hours on foot, 5 person hours by vehicle	Mammals (including Koala, Greater Glider), reptiles (including Ornamental Snake), nocturnal birds
Call playback	17 sessions	Owls and Koala
Bird survey	30 person hours	Birds (including Squatter Pigeon, Australian Painted Snipe, Migratory birds)
Active searching	14 person hours	All conservation significant species, including small mammals, reptiles, and birds
Anabat	8 nights	Bats
Harp trap	4 trap nights	Bats
Opportunistic/incidental bird survey	124 diurnal person hours, 48 nocturnal person hours	Birds (including Squatter Pigeon, Australian Painted Snipe, migratory birds), macropods, Koala, Greater Glider, medium to large reptiles

A3.7.2 Systematic trap sites

A total of four systematic trap sites were established in areas of native vegetation throughout the ecology study area during the terrestrial fauna survey (Figure 4).

Each systematic trap site consisted of:

- 4 pitfall traps (20 L bucket)
- 6 funnel traps
- 25 small Elliot traps
- 1 infrared camera with bait station of chicken pieces, apple and sweet potato.

All traps were open for four nights. The survey comprised a total of 560 trap nights (trap nights refers to the total number of traps that were open for a total number of nights e.g. 4 traps open for 5 nights equates to 20 trap nights). Elliot and cage traps were baited with a mixture of rolled oats, honey, peanut butter and vanilla essence. Cage traps were also baited with chicken necks and apple in addition to the standard bait. Traps were located 5 to 10 m apart and positioned close to suitable microhabitat features such as fallen logs, dense grass tussocks or areas of surface rock. Traps were checked early in the morning and any animals captured were identified and immediately released.

Pitfall traps comprised three 20 L buckets dug into the ground with a drift fence that intersected the mouth of each bucket and extended beyond the line of buckets to guide fauna towards the buckets. A water soaked sponge, leaf litter and a small piece of polystyrene foam was placed in each bucket to provide moisture and shelter for animals captured. The polystyrene foam is able to be used as a floatation device for captured animals so that they do not drown in the event of heavy rain. An insecticide powder was also sprinkled in and around the lip of pitfall traps to reduce the incidence of ant related trap deaths. Three sets of two funnel traps were also located along the drift fence to capture larger lizards and snakes that could escape or avoid the buckets. Funnel traps were covered with a towel to provide shelter for captured animals. Pitfall and funnel traps were also checked in the afternoon and opportunistically during the day.

A Reconyx HC500 infrared camera was also set up at each of the systematic trap sites for 4 nights. The cameras were set on a bait station of chicken, apple and sweet potato.

A minimum of one person hour of spotlighting and active searching was conducted at each systematic trap site, as well as one person hour of bird survey each morning while traps were being checked (refer Sections A3.7.4, A3.7.6 and A3.7.7).

A brief description of the location and habitat attributes of each of the systematic trap sites is provided in Table A6.

Table A6: Descriptions of habitat at each systematic fauna trap site

Survey site ID	Site location	Vegetation description	Representative photograph
TS1	Central southern portion of the ecology study area	Remnant Mountain Coolabah (*Eucalyptus coolabah*) woodland. Very sparse shrub layer of scattered Klunkerberry (*Carissa ovata*) and Wilga (*Geijera parviflora*). Sparse mature hollow-bearing trees and fallen timber. Deep leaf litter very sparse to absent. Groundcover predominantly native species but Buffel Grass and Red Natal Grass (**Melinis repens*) present in low abundance. Just greater than 1 hollow/hectare.	
TS2	Central portion of the ecology study area	Remnant natural grassland. No habitat structure. Some infiltration of Buffel Grass, Red Natal Grass and Parthenium (**Parthenium hysterophorus*).	

Survey site ID	Site location	Vegetation description	Representative photograph
TS3	Central portion of the ecology study area	Remnant Brigalow, with mid-dense shrub layer of Klunkerberry, Scrub Leopardwood (*Flindersia dissosperma*), Peach Bush (*Ehretia membranifolia*). No gilgai, some minor soil cracking. Sparse to absent hollow-bearing trees. Moderate cover of fallen timber, groundcover predominantly Buffel Grass, with some native species present.	
TS4	North-eastern portion of the ecology study area between 1st and 2nd order drainage channels	Remnant Coolabah woodland with a sub-canopy of Brigalow. A shrub layer of Whitewood (*Atalaya hemiglauca*), Klunkerberry, Western Rosewood (*Alectryon oleifolius* subsp. *elongatus*). Canopy dieback evident. Abundant hollow-bearing trees, moderate cover of fallen timber. Groundcover mostly exotic, with some natives present in some areas.	

A3.7.3 Supplementary survey sites

A total of 18 supplementary survey sites (S1 to S18) were conducted across the ecology study area, using spotlighting, bird survey and/or active searching.

A description of the location, survey techniques and vegetation type of the supplementary survey sites is provided in Table A7. Techniques employed at supplementary sites included spotlighting, bird survey and/or active searching.

Table A7: Description of supplementary survey sites

Survey site ID	Site location	Survey techniques	Vegetation description
S1	Far western boundary of ecology study area adjacent to a dam	Active search, bird survey, spotlighting and call playback	Dam within cleared and disturbed areas, with lots of dead trees and some fringing weedy vegetation.
S2	Central-southern portion of the ecology study area	Spotlighting and call playback	Brigalow regrowth with some well-developed gilgai, sparse hollow-bearing trees, abundant fallen timber, native and exotic groundcover.
S3	Central portion of the ecology study area	Spotlighting	Gilgai in cleared paddock. Gilgai supports native grasses with some sedges interspersed with expanses of Buffel Grass. Fallen timber absent.
S4	North-west portion of the ecology study area	Active search, bird survey	Remnant Brigalow with some Red-flowered Bauhinia (*Lysiphyllum carronii*), Wilga, Scrub Boonaree (*Alectryon diversifolius*) and dense patches of Klunkerberry. No hollows, very slight gilgai relief. Abundant fallen timber, although mostly small diameter. Abundant decorticating bark. Groundcover mostly Buffel Grass, with some areas of native species present. Lots of dieback of trees in areas.
S5	North-west portion of the ecology study area	Active search, bird survey	Natural grassland comprising native grasses with very sparse Mountain Coolabah. Fallen timber, hollows and leaf litter very sparse.
S6	Western portion of the ecology study area	Spotlighting and call playback	Remnant Mountain Coolabah open woodland (. Sparse hollow-bearing trees, although >1 per hectare. Sparse fallen timber and leaf litter virtually absent.
S7	Central portion of ecology study area	Spotlighting	Remnant natural grassland. Very sparse trees, fallen timber absent.
S8	North-eastern portion of ecology study area	Active search, bird survey, spotlighting and call playback	Fragmented Brigalow with scattered Mountain Coolabah. Some hollow stags present, moderate abundance of fallen timber. Groundcover predominately Buffel Grass. No gilgai, but small braided drainage channels present.

Survey site ID	Site location	Survey techniques	Vegetation description
S9	Central portion of ecology study area	Active search and bird survey	Remnant natural grassland,. Grazed with some Parthenium present. No hollow-bearing trees, very sparse dead trees.
S10	South-eastern corner of ecology study area	Spotlighting and call playback	Remnant Brigalow with Dawson River Gum (*Eucalyptus cambageana*). Moderate abundance of hollow-bearing trees and fallen timber. Well-developed gilgai. Some areas of deep leaf litter, groundcover predominately Buffel Grass. Gilgai bare of native species.
S11	South-eastern of ecology study area along Ripstone Creek (western tributary)	Active search, bird survey, spotlighting and call playback	Cleared and disturbed areas along Ripstone Creek, with narrow fringe of vegetation, including Queensland Blue Gum (*Eucalyptus tereticornis* subsp. *tereticornis*), Brigalow, Red-flowered Bauhinia. Moderate to high abundance of hollow-bearing trees, sparse fallen timber, groundcover predominately exotic.
S12	South-eastern portion of ecology study area along Ripstone Creek (eastern tributary)	Spotlighting and call playback	Cleared and disturbed areas along Ripstone Creek, fringed with Brigalow, Red-flowered Bauhinia and scattered Mountain Coolabah. Sparse hollow-bearing trees, moderate cover of fallen timber and sparse deep leaf litter. Groundcover mostly exotic species.
S13	South-eastern portion of ecology study area along Ripstone Creek (eastern tributary)	Active search, bird survey, spotlighting and call playback	Regrowth Brigalow with Mountain Coolabah fringing Ripstone Creek. Sparse hollow-bearing trees, moderate abundance of fallen timber, although mostly small diameter. Groundcover mostly exotic species.
S14	South-eastern portion of ecology study area	Active search and bird survey	Remnant Mountain Coolabah open woodland. Sparse hollow-bearing trees (likely < 1 per hectare). Very sparse fallen timber. Leaf litter absent. Groundcover mostly native grasses
S15	North-eastern portion of ecology study area	Spotlighting and call playback	Remnant natural grassland. Grazed, very sparse trees, no hollow-bearing trees, sparse to absent fallen timber.
S16	Central-eastern boundary of ecology study area	Active search, bird survey, spotlighting	Remnant Silver-leaved Ironbark (*Eucalyptus melanophloia*) open woodland with occasional Klunkerberry. Predominately native grass species and exotic herbs. Sparse abundance of hollows, sparse to moderate woody debris

Survey site ID	Site location	Survey techniques	Vegetation description
		and call playback	and sparse to absent areas of deep leaf litter. Most likely <1 (<10 cm diameter) hollows per hectare.
S17	Central-eastern portion of ecology study area	Active search and bird survey	Remnant Silver-leaved Ironbark open woodland on red soils. Significant canopy dieback in areas. Sparse hollow bearing trees (<1 per hectare), very sparse fallen timber. Deep leaf litter absent. Groundcover mix of exotic pasture species and native species.
S18	Southern corner of ecology study area	Spotlighting and call playback	Remnant Poplar Box woodland with a small patch of Dawson River Gum. Dense patches of carissa in understorey. Sparse to moderate abundance of hollow-bearing trees. Moderate cover of fallen timber. Groundcover a mix of exotic and native species.

A3.7.4 Spotlighting

Spotlighting was undertaken on foot in the vicinity of each systematic trap site and 12 of the additional supplementary survey sites for one person hour per site and one supplementary survey site for two person hours. Fauna were located from eye shine or direct observation and identified. The distinctive calls of some fauna were also used to identify their presence. A total of 18 person hours were spent spotlighting on foot during the surveys. Spotlighting was also undertaken opportunistically from a slow-moving vehicle along tracks within the ecology study area where it was safe to do so. This is an ideal method for detecting nocturnal reptiles and amphibians.

A3.7.5 Call playback

Call playback involved broadcasting a recorded call of an owl or arboreal mammal through a megaphone in an effort to elicit a territorial response from any animals that hear the call. Animals either call in response to the recording and/or move in to the location that the call was played from. The call is played and then approximately 2 - 3 minutes are spent listening for a response and looking for animals that have moved into the area without calling. Call playback was undertaken in the vicinity of each systematic trap site. Following the call playback session, spotlighting was conducted of the immediate area to locate any owls that had flown into the area without calling and had not been seen during the call playback. The calls of the following species were played over 17 sessions during the survey:

- Barking Owl (*Ninox connivens*)
- Barn Owl (*Tyto alba*)
- Eastern Grass Owl (*Tyto longimembris*) – Natural grassland habitats only
- Masked Owl (*Tyto novaehollandiae*)
- Southern Boobook (*Ninox novaeseelandiae*)
- Koala (*Phascolarctos cinereus*).

A3.7.6 Bird surveys

During the checking of traps on each transect in the early morning, 30-minute bird surveys were conducted with all birds seen and heard recorded. The order in which systematic trap sites were checked was varied each morning to ensure that sites were surveyed for birds at slightly different times each day. Targeted bird surveys were undertaken at water bodies (i.e. farm dams) and at the supplementary survey sites. Opportunistic records of birds were also made while undertaking other activities throughout the ecology study area. A total of approximately 30 person hours were spent undertaking bird surveys during the field survey.

A3.7.7 Active searches

Active searching was conducted to detect reptiles, frogs and small ground dwelling mammals. It involved the searching of suitable microhabitat such as logs, bark, deep leaf litter, surface rocks and shedding bark. Active searching was undertaken for one person hour at each of the 4 systematic trap sites and at 10 of the additional supplementary sites. A total of 14 person hours were spent active searching during the field surveys.

A3.7.8 Anabat

The Anabat surveys involved the use of an SD1 Anabat detector to record the echolocation calls of micro bats as they foraged. A sonogram was then produced using software that allows for comparison against reference calls for identification. Unfortunately, some species of bat have very similar and/or quiet calls and cannot be positively distinguished via Anabat (e.g. *Nyctophilus* species). Therefore, a probability rating is provided for calls identified. All Anabat calls were analysed by Greg Ford, an Anabat call analysis specialist.

Anabat units were deployed for one night from dusk until dawn at a total of eight sites across the ecology study area (A1 – A8). Anabat survey sites were selected on the basis of having suitable flyways, flowering trees that attract insects or water that attracts insects and bats.

A3.7.9 Harp traps

Harp traps (HT) were used to capture bats during the survey and were set at two locations (HT1 – HT2) for two nights resulting in a total of four trap nights. Harp traps were located in suitable flyways such as small waterways or tracks. Harp traps comprise two banks of vertical microfilament line offset from one another. Bats fly into one of these wires and drop into a bag beneath the trap where they can be collected for identification. Captured bats were kept in a quiet cool location and released on the night following their capture.

A3.7.10 Opportunistic observations

Records of fauna were also made opportunistically while undertaking other activities, such as moving between trap sites, throughout the survey period.

A3.7.11 Habitat assessment

The quality of fauna habitat in the ecology study area was assessed on the basis of the following criteria:

- **Low:** Many fauna habitat elements in low quality areas have been removed or altered such as mature, hollow-bearing trees, fallen timber and deep leaf litter. Remnants are often small in size, support substantial weed infestations of high or moderate threat weeds (e.g. Buffel Grass (**Cenchrus ciliaris*)) and are poorly connected to other areas of remnant vegetation.
- **Moderate:** Some habitat components are present but others are lacking. For example, a remnant may have a reasonably intact understorey but lack mature canopy species and fallen timber. Some weed infestations are present but are relatively small in size or comprise species of low to moderate threat. Linkages with other remnant habitats in the landscape may be lacking or somewhat tenuous.
- **High:** Most habitat components are present (e.g. old-growth trees, fallen timber, lack of weeds and deep leaf litter), the remnant is large enough to support species that are typically associated with large intact areas of habitat and it is well connected or contiguous with other areas of native vegetation.

These criteria were adapted for treeless habitat types such as grasslands as appropriate.

A4 Field survey standards

A number of guidelines have been consulted in the development of methods for the field surveys, particularly with regard to survey timing and techniques employed to target threatened species most likely to occur within the ecology study area.

Threatened species survey guidelines used to inform the requirements of the terrestrial flora and fauna surveys included:

- Commonwealth guidelines:
  - *Survey guidelines for Australia's threatened birds* (DEWHA 2010a)
  - *Survey guidelines for Australia's threatened bats* (DEWHA 2010b)
  - *Survey guidelines for Australia's threatened reptiles* (SEWPaC 2011a)
  - *Survey guidelines for Australia's threatened mammals* (SEWPaC 2011b)
  - *Referral guideline for 14 birds listed as migratory species under the EPBC Act* (DotE 2015)
  - *Draft Referral guidelines for the nationally listed Brigalow Belt reptiles* (SEWPaC 2011c)

  - SPRAT databases for relevant listed species and communities that were listed at the time of the surveys.

- Queensland guidelines:
  - *Flora Survey Guidelines – Protected Plants Nature Conservation Act 1992, Version 2.01* (DES 2020b)
  - *Terrestrial Vertebrate Fauna Survey Guidelines for Queensland, Version 3.0* (Queensland Herbarium 2018).

The Commonwealth guidelines provide specific survey guidelines for individual threatened flora and fauna species and ecological communities listed under Commonwealth legislation, while the Queensland survey guidelines provide general guidance on the survey methodology and minimum effort advice for detection of all species. For all target species, a combination of two or more recommended survey techniques were employed.

Table A8 provides a comparison of published threatened species survey guidelines against the survey effort undertaken for the terrestrial flora and fauna surveys within the study area.

Table A8: Comparison of field survey effort with Queensland survey guidelines for listed threatened fauna species considered to potentially occur in the ecology study area

Note: this table includes only those fauna species which were determined as having a moderate or high likelihood of occurrence within the ecology study area prior to the commencement of the field surveys (refer to Appendix E).

Commonwealth guidelines Survey guidelines	Queensland guidelines	Survey effort and method
Australian Painted Snipe (*Rostratula australis*) – endangered		
▪ Targeted stationary observations at dawn or dusk: 1- hours/ 5 days ▪ A brief spotlight search shortly after dusk ▪ Land-based area searches or line transects: 10 person hours/ 3 days ▪ Detection by sighting or flushing ▪ Call playback is not considered useful ▪ Survey effort is not defined for very large sites, i.e. greater than 50 ha	▪ Required survey intensity of ≥3 replicate fauna trapping sites in each habitat type (NB: if the assessment unit is highly restricted in extent, it may not be possible to establish three replicate sites). The following is required at each site: - Diurnal bird survey (incl. scat and sign searches): 6 x 5-10 minute area searches of 100 x 100 m area - Spotlighting: 2 x 30 person minutes search of 100 x 100 m area - Incidental observations	▪ Land-based area searches (bird survey) – 30 person hours over 9 days, including 4 person hours over 4 days in Brigalow, gilgai and drainage line habitat ▪ Spotlighting (Brigalow, gilgai and drainage line habitat habitat): 7 person hours over 4 nights) ▪ Drive spotlighting 5 person hours from slow moving vehicle over 5 nights ▪ Sighting (active searching) - 14 person hours over 9 days ▪ Diurnal incidental observations: 124 person hours over 9 days ▪ Nocturnal incidental observations: 48 person hours over 5 nights. Total survey effort compliant with survey guidelines. It is noted that suitable habitat for this species in the form of wetlands and gilgai were not holding water during the seasonal surveys. Further surveys following high rainfall may increase the probability of recording this species. However, it is a very cryptic bird that is known to inconsistently use habitats and there is no guarantee that it would be recorded even during favourable conditions.
Squatter Pigeon (southern) *Geophaps scripta scripta* – vulnerable		
▪ Slow drive surveys along bitumen roads, dirt roads and tracks at a constant speed (20 km/hr): 2 x same route on consecutive days, including	▪ Required survey intensity of ≥3 replicate fauna trapping sites in each habitat type (NB: if the assessment unit is highly restricted in extent, it	▪ Land-based area searches (bird survey) – 30 person hours over 9 days ▪ Spotlighting: 18 person hours over 5 nights

Commonwealth guidelines Survey guidelines	Queensland guidelines	Survey effort and method
all unsealed roads and around the perimeter of the ecology study area. Drive each route in both directions each time. ▪ Waterbody surveys: 2 x consecutive days, including all waterbodies ▪ Area searches or transect surveys in suitable habitat: 15 person hours/3 days ▪ Flushing surveys or land-based area searches or line transects: 10 person hours/3 days ▪ Call playback is not considered useful ▪ Survey effort is not defined for very large sites, i.e. greater than 50 ha	may not be possible to establish three replicate sites). The following is required at each site: - Diurnal bird survey (incl. scat and sign searches): 6 x 5-10 minute area searches of 100 x 100 m area - Incidental observations.	▪ Drive spotlighting 5 person hours from slow moving vehicle over 5 nights ▪ Sighting (active searching) - 14 person hours over 9 days ▪ Diurnal incidental observations: 124 person hours over 9 days ▪ Nocturnal incidental observations: 48 person hours over 5 nights. Total survey effort partially compliant with survey guidelines. Flushing surveys are required by DAWE, however, this survey technique was considered unnecessary for this survey as the Squatter Pigeon (southern) remains common in the broader Moranbah region. Also previous experience in this area has shown that this species is typically recorded incidentally during surveys. The survey methods that were employed during the current surveys did result in the Squatter Pigeon (southern) being recorded within the study area, and therefore flushing surveys were not required.
White-throated Needletail (*Hirundapus caudacutus*) – vulnerable		
White-throated Needletail not included in 'Survey guidelines for Australia's threatened Birds 2010', as it was listed as vulnerable in 2019.	▪ Required survey intensity of ≥3 replicate fauna trapping sites in each habitat type (NB: if the assessment unit is highly restricted in extent, it may not be possible to establish three replicate sites). The following is required at each site: - Diurnal bird survey (incl. scat and sign searches): 6 x 5-10 minute area searches of 100 x 100 m area - Incidental observations.	▪ Land-based area searches (bird survey) – 30 person hours over 9 days ▪ Sighting (active searching) - 14 person hours over 9 days ▪ Diurnal incidental observations: 124 person hours over 9 days ▪ Nocturnal incidental observations: 48 person hours over 5 nights. Total survey effort compliant with survey guidelines.
Greater Glider (*Petauroides volans*) – endangered		
▪ Daytime searches of potentially suitable habitat resources for den	▪ Required survey intensity of ≥3 replicate fauna trapping sites in	▪ Spotlighting: 18 person hours over 5 nights

Commonwealth guidelines Survey guidelines	Queensland guidelines	Survey effort and method
sites and food trees and other signs (feeding, scratches on tree trunks): approx. 50-100m interval transects over 2 hours/per hectare in a 5 ha site. Stratify for large sites ▪ Direct daytime searches: ≥4 x 100m transects/5ha. Stratify for large sites ▪ Stag watching at dusk: 30 mins before and 60 mins after dusk ▪ Spotlighting along transects, tracks or roads: ≥2 x 200m transects/5ha on foot over ≥2 nights. Stratify for large sites ▪ Call detection/call playback of the species and predatory owls: 2 sites/stratification unit up to 200ha duplicated over 2 separate nights, in conjunction with stag watching ▪ Arboreal cage traps if necessary: 10 traps per site, ≥2 sites/5 ha, over 4 consecutive nights (i.e. 80 trap nights). Stratify for large sites.	each habitat type (NB: if the assessment unit is highly restricted in extent, it may not be possible to establish three replicate sites). The following is required at each site: - Nocturnal active searching: 2 x 30 person-minutes searches of 100 x 100m area - Spotlighting: 2 x 30 person-minutes searches of 100 x 100 m area - Scat and sign search: each survey site and incidentally - Incidental observations.	▪ Drive spotlighting 5 person hours from slow moving vehicle over 5 nights ▪ Sighting (active searching) - 14 person hours over 9 days ▪ Nocturnal incidental observations: 48 person hours over 5 nights. Total survey effort partially compliant with survey guidelines Stag watching and cage traps were not used. Survey techniques and effort is consistent with the Queensland guideline however, the minimum replicate sites (i.e. 3 replicate trap sites/assessment unit or habitat type) were not applied.
Koala (*Phascolarctos cinereus*) – endangered		
Koala not included in 'Survey guidelines for Australia's threatened mammals 2011', as it was listed as vulnerable in 2012. Referral Guidelines:	▪ Line transects: (no minimum number stipulated for large sites) ▪ Call playback: 2 sessions at each systematic site ▪ Spotlighting: 2 x 30 minute search per site ▪ Scat and sign searches: search each systematic site and incidentally	▪ Call playback: 17 sessions over 5 nights ▪ Infrared cameras: 16 trap nights ▪ Spotlighting: 18 person hours over 5 nights ▪ Drive spotlighting 5 person hours from slow moving vehicle over 5 nights ▪ Sighting (active searching) - 14 person hours over 9 days ▪ Diurnal incidental observations: 124 person hours over 9 days

Commonwealth guidelines Survey guidelines	Queensland guidelines	Survey effort and method
▪ Faecal pellet searches using Spot Assessment Technique (SAT), particularly for drier sites ▪ Diurnal strip transect searches (<30ha) ▪ Nocturnal spotlighting ▪ Call playback ▪ Remote sensor activated cameras ▪ Survey effort not specified – site and habitat specific	▪ Incidental observations ▪ As a minimum, three 'replicate' generic survey sites should be established per assessment unit (NB: if the assessment unit is highly restricted in extent, it may not be possible to establish three replicate sites).	▪ Nocturnal incidental observations: 48 person hours over 5 nights. Total survey effort partially compliant with survey guidelines. No diurnal strip transects were undertaken or formal SAT surveys completed as this species, or signs of its presence, were recorded during active searching and spotlighting activities.
Ornamental Snake (*Denisonia maculata*) – vulnerable		
▪ Diurnal active searches: 1.5 person hours/ha of habitat over ≥ 3 days and nights ▪ Spotlighting: 1.5 person hours/ ha of habitat over ≥ 3 nights ▪ Driving roads at night: opportunistically ▪ Pitfall transects could be trialled: 6 x 20 L buckets evenly distributed under 30 m drift fence in microhabitat (not in wet habitats)/4 nights (2 replicates/ habitat type) ▪ Funnel transects could be trialled: 2 along drift fence (1 at each end)/4 nights (2 replicates/ habitat type) ▪ All methods likely to yield low returns Records should be supported by good quality photos, close-up of the head, body and tail dorsally, ventrally and	▪ Required survey intensity of ≥3 replicate fauna trapping sites in each habitat type (NB: if the assessment unit is highly restricted in extent, it may not be possible to establish three replicate sites). The following is required at each site: - Nocturnal active search: 2 x 30 person minute search per survey site - Pitfall trapping: 4 buckets at 7.5 m intervals on T-design, 45 m fence/4 nights - Funnel trapping: 6 funnels at 3 m from distal ends of T-design, 45 m fence/4 nights - Diurnal active searches: 2 x 30 person-minute search in 2 different survey sites	▪ Pitfall traps: 64 trap nights ▪ Funnel traps: 96 trap nights ▪ Spotlighting (Brigalow, gilgai and drainage line habitat habitat): 7 person hours over 4 nights) ▪ Drive spotlighting 5 person hours from slow moving vehicle over 5 nights ▪ Sighting (active searching) - 14 person hours over 9 days ▪ Infra-red camera: 16 trap nights. Total survey effort partially compliant with survey guidelines. Survey techniques used were is consistent with the Queensland guidelines and this species was recorded during the surveys. However, the duration of active searching and spotlighting required for the Ornamental Snake under the DAWE survey guidelines for Brigalow Belt reptiles was not achieved. The DAWE guidelines require 348 hours of spotlighting over more than three days and nights in suitable habitat (note 232.1 ha of suitable habitat has been identified in the study area). This equates to several weeks of survey in gilgai habitat alone in the study area. No systematic trap sites were located within gilgai habitat as required by the Queensland survey guideline. The majority of gilgai

Commonwealth guidelines Survey guidelines	Queensland guidelines	Survey effort and method
laterally and lodged with the Queensland Museum	- Camera trapping: 1 camera/ survey site x ≥4 nights - Incidental observations.	habitat was located in cleared paddock and therefore targeted survey techniques were considered most appropriate to survey these areas. Similarly, potential habitat in the form of remnant Brigalow and wetland communities within the study area, were quite small and targeted survey techniques were again determined to be the most appropriate means of survey in these habitats. The survey methods and effort used during the field survey was sufficient to detect this species at a number of locations within the study area.

A5 Likelihood of occurrence

A5.1 Vegetation community assessment

Flora surveys were conducted at a scale and intensity to sufficiently identify vegetation communities present. Vegetation communities not recorded during the field surveys were therefore considered to have a low likelihood to occur within the ecology study area.

A5.2 Significant species assessment

Database searches identified threatened and migratory species that potentially occur in the ecology study area. The likelihood of these species occurring was then assessed based on the results of the field surveys.

The likelihood of species occurring in the ecology study area was classified using the criteria presented in Table A9. The assessment was based on the species' known ranges and habitat preferences, which were assessed against the characteristics of the ecology study area observed during field surveys.

Table A9: Criteria to assess potential for species to occur in the ecology study area

Likelihood to occur	Definition
Present	The species was recorded in the ecology study area during the field surveys.
High	The species was not recorded within the ecology study area during the field surveys but is known to occur within the surrounding area, and habitat of suitable quality exists within the ecology study area.
Moderate	The species was not recorded in the ecology study area during the field surveys, although it is known to occur in the wider region. Habitat was identified for the species in the ecology study area during the field surveys; however, it is marginal, fragmented and/or small in size, or degraded.
Low	The species was not recorded in the ecology study area during the field surveys. The species is either: a) unlikely to occur in the wider region and due to the lack of, or extremely poor quality habitat in the ecology study area, the species is not expected to occur in the ecology study area; or b) may forage periodically in the wider region and may overfly the ecology study area, but the habitat in the ecology study area is generally not suitable.

A6 Threatened species habitat mapping

Habitat mapping was undertaken for threatened flora and fauna species that were recorded as being present in the ecology study area or that were assessed as having a high or moderate likelihood to occur in the ecology study area (refer to Section A5, Appendices D and E).

Habitat mapping was based on detailed certified Queensland Herbarium RE mapping to assign areas of habitat based on known habitat preferences, field observations from the ecology study area and previous experience, where applicable.

Habitat preferences for the Australian Painted Snipe, Squatter Pigeon, Greater Glider, Koala, Ornamental Snake and White-throated Needletail were derived from a combination of SPRAT profiles, conservation advice as well as any relevant published research. The habitat mapping criteria for each species are described in Sections 5.3 and 6.3.

A7 Limitations

Ecological surveys often fail to record all species of flora and fauna present on a site for a variety of reasons such as seasonal absence or reduced activity during certain seasons. The timing of the surveys in late spring and late summer following good rainfall was considered suitable for the detection of all faunal groups. However, the ecology and nature of rare and/or cryptic species means that such species are potentially not recorded during short surveys.

As shown in Table A2, rainfall in the six months preceding the survey periods was slightly below average and there was limited rainfall in the local area in the weeks before the flora and fauna surveys. However, above average rainfall in December and January prior to the survey appears to have resulted in a flush of new growth. Despite this, the generally poor wet season yielded average conditions for the identification of herbaceous and graminoid annuals and perennials that often require prime conditions and high summer rainfall for optimal plant vigour and inflorescence set. It is possible that many annual herbs and grasses may have completed their growth cycle for the season and therefore were not recorded. This report overcomes these limitations by assessing impacts not only on species recorded during the field survey, but on species that are potentially present (based on known distribution and habitat availability). Section A5 provides further detail on this approach.

In combination with drier conditions in the weeks leading up to the fauna survey, mild day time and cool night temperatures were experienced in the region leading up to and during the fauna survey. This often makes detection of some groups of animals, e.g. amphibians and reptiles, difficult due to their inactivity in these conditions.

Appendix B

Database search results

Australian Government
Department of Agriculture, Water and the Environment

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

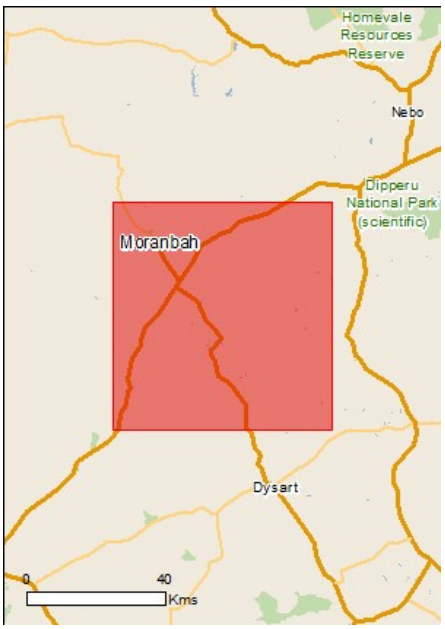
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

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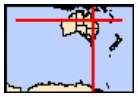
Summary
Details
- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

Caveat
Acknowledgements



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2015

Coordinates
Buffer: 0.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	5
Listed Threatened Species:	25
Listed Migratory Species:	11

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	16
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	21
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Brigalow (Acacia harpophylla dominant and co-dominant)	Endangered	Community known to occur within area
Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin	Endangered	Community likely to occur within area
Poplar Box Grassy Woodland on Alluvial Plains	Endangered	Community likely to occur within area
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	Community likely to occur within area
Weeping Myall Woodlands	Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area
Geophaps scripta scripta Squatter Pigeon (southern) [64440]	Vulnerable	Species or species habitat known to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat may occur within area
Neochmia ruficauda ruficauda Star Finch (eastern), Star Finch (southern) [26027]	Endangered	Species or species habitat likely to occur within area
Poephila cincta cincta Southern Black-throated Finch [64447]	Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Mammals		
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda	Endangered	Species or species

Name	Status	Type of Presence
[Dambimangari], Wiminji [Martu] [331]		habitat likely to occur within area
Macroderma gigas		
Ghost Bat [174]	Vulnerable	Species or species habitat likely to occur within area
Nyctophilus corbeni		
Corben's Long-eared Bat, South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat may occur within area
Petauroides volans		
Greater Glider [254]	Vulnerable	Species or species habitat known to occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)		
Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
Pteropus poliocephalus		
Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Plants		
Aristida annua		
[17906]	Vulnerable	Species or species habitat likely to occur within area
Dichanthium queenslandicum		
King Blue-grass [5481]	Endangered	Species or species habitat likely to occur within area
Dichanthium setosum		
bluegrass [14159]	Vulnerable	Species or species habitat likely to occur within area
Eucalyptus raveretiana		
Black Ironbox [16344]	Vulnerable	Species or species habitat likely to occur within area
Samadera bidwillii		
Quassia [29708]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Denisonia maculata		
Ornamental Snake [1193]	Vulnerable	Species or species habitat known to occur within area
Egernia rugosa		
Yakka Skink [1420]	Vulnerable	Species or species habitat may occur within area
Elseya albagula		
Southern Snapping Turtle, White-throated Snapping Turtle [81648]	Critically Endangered	Species or species habitat likely to occur within area
Furina dunmalli		
Dunmall's Snake [59254]	Vulnerable	Species or species habitat may occur within area
Lerista allanae		
Allan's Lerista, Retro Slider [1378]	Endangered	Species or species habitat likely to occur within area
Rheodytes leukops		
Fitzroy River Turtle, Fitzroy Tortoise, Fitzroy Turtle, White-eyed River Diver [1761]	Vulnerable	Species or species habitat likely to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		

Name	Threatened	Type of Presence
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat may occur within area

Extra Information

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence

Name	Status	Type of Presence
Birds		
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat known to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Acacia nilotica subsp. indica Prickly Acacia [6196]		Species or species habitat may occur within area
Cryptostegia grandiflora Rubber Vine, Rubbervine, India Rubber Vine, India Rubbervine, Palay Rubbervine, Purple Allamanda [18913]		Species or species habitat likely to occur within area
Jatropha gossypifolia Cotton-leaved Physic-Nut, Bellyache Bush, Cotton-leaf Physic Nut, Cotton-leaf Jatropha, Black Physic Nut [7507]		Species or species habitat likely to occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Parthenium hysterophorus Parthenium Weed, Bitter Weed, Carrot Grass, False Ragweed [19566]		Species or species habitat likely to occur within area
Vachellia nilotica Prickly Acacia, Blackthorn, Prickly Mimosa, Black Piquant, Babul [84351]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus Asian House Gecko [1708]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-21.90601 147.92537,-21.906006 148.494043,-22.45239 148.49404,-22.45239 147.92537,-21.90601 147.92537

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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Queensland Government

Wildlife Online Extract

Search Criteria: Species List for a Defined Area
Species: All
Type: All
Status: All
Records: All
Date: All
Latitude: 21.906 to 22.4523
Longitude: 147.9253 to 148.4940
Email: monica.campbell@ecosm.com.au
Date submitted: Friday 16 Apr 2021 12:27:30
Date extracted: Friday 16 Apr 2021 12:30:07

The number of records retrieved = 856

Disclaimer

As the DSITIA is still in a process of collating and vetting data, it is possible the information given is not complete. The information provided should only be used for the project for which it was requested and it should be appropriately acknowledged as being derived from Wildlife Online when it is used.

The State of Queensland does not invite reliance upon, nor accept responsibility for this information. Persons should satisfy themselves through independent means as to the accuracy and completeness of this information.

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Feedback about Wildlife Online should be emailed to wildlife.online@science.dsitia.qld.gov.au

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	amphibians	Bufonidae	*Rhinella marina*	cane toad	Y			18
animals	amphibians	Hylidae	*Litoria rothii*	northern laughing treefrog		C		2
animals	amphibians	Hylidae	*Litoria caerulea*	common green treefrog		C		9
animals	amphibians	Hylidae	*Cyclorana brevipes*	superb collared frog		C		3
animals	amphibians	Hylidae	*Cyclorana verrucosa*	rough collared frog		C		2/1
animals	amphibians	Hylidae	*Litoria latopalmata*	broad palmed rocketfrog		C		10
animals	amphibians	Hylidae	*Cyclorana alboguttata*	greenstripe frog		C		4
animals	amphibians	Hylidae	*Cyclorana novaehollandiae*	eastern snapping frog		C		8
animals	amphibians	Hylidae	*Litoria inermis*	bumpy rocketfrog		C		5
animals	amphibians	Hylidae	*Litoria rubella*	ruddy treefrog		C		8
animals	amphibians	Hylidae	*Litoria nasuta*	striped rocketfrog		C		1
animals	amphibians	Hylidae	*Litoria fallax*	eastern sedgefrog		C		1
animals	amphibians	Limnodynastidae	*Limnodynastes tasmaniensis*	spotted grassfrog		C		12
animals	amphibians	Limnodynastidae	*Limnodynastes terraereginae*	scarlet sided pobblebonk		C		3
animals	amphibians	Limnodynastidae	*Platyplectrum ornatum*	ornate burrowing frog		C		26
animals	amphibians	Limnodynastidae	*Limnodynastes salmini*	salmon striped frog		C		8
animals	amphibians	Limnodynastidae	*Limnodynastes peronii*	striped marshfrog		C		1
animals	birds	Acanthizidae	*Smicrornis brevirostris*	weebill		C		43
animals	birds	Acanthizidae	*Pyrrholaemus sagittatus*	speckled warbler		C		3
animals	birds	Acanthizidae	*Acanthiza chrysorrhoa*	yellow-rumped thornbill		C		5
animals	birds	Acanthizidae	*Sericornis frontalis*	white-browed scrubwren		C		1
animals	birds	Acanthizidae	*Acanthiza reguloides*	buff-rumped thornbill		C		4
animals	birds	Acanthizidae	*Acanthiza apicalis*	inland thornbill		C		2
animals	birds	Acanthizidae	*Gerygone olivacea*	white-throated gerygone		C		27
animals	birds	Acanthizidae	*Acanthiza nana*	yellow thornbill		C		9
animals	birds	Accipitridae	*Aviceda subcristata*	Pacific baza		C		1
animals	birds	Accipitridae	*Haliastur sphenurus*	whistling kite		C		30
animals	birds	Accipitridae	*Accipiter fasciatus*	brown goshawk		C		3
animals	birds	Accipitridae	*Circus approximans*	swamp harrier		C		1
animals	birds	Accipitridae	*Elanus axillaris*	black-shouldered kite		C		5
animals	birds	Accipitridae	*Circus assimilis*	spotted harrier		C		2
animals	birds	Accipitridae	*Milvus migrans*	black kite		C		12
animals	birds	Accipitridae	*Aquila audax*	wedge-tailed eagle		C		17
animals	birds	Accipitridae	*Haliaeetus leucogaster*	white-bellied sea-eagle		C		5
animals	birds	Accipitridae	*Accipiter cirrocephalus*	collared sparrowhawk		C		4
animals	birds	Accipitridae	*Hieraaetus morphnoides*	little eagle		C		1
animals	birds	Acrocephalidae	*Acrocephalus australis*	Australian reed-warbler		C		10
animals	birds	Aegothelidae	*Aegotheles cristatus*	Australian owlet-nightjar		C		1
animals	birds	Alaudidae	*Mirafra javanica*	Horsfield's bushlark		C		5
animals	birds	Anatidae	*Cygnus atratus*	black swan		C		12
animals	birds	Anatidae	*Aythya australis*	hardhead		C		17
animals	birds	Anatidae	*Anas superciliosa*	Pacific black duck		C		26
animals	birds	Anatidae	*Chenonetta jubata*	Australian wood duck		C		26
animals	birds	Anatidae	*Dendrocygna eytoni*	plumed whistling-duck		C		8
animals	birds	Anatidae	*Anas gracilis*	grey teal		C		24
animals	birds	Anatidae	*Anas castanea*	chestnut teal		C		1

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Anatidae	*Dendrocygna arcuata*	wandering whistling-duck		C		2
animals	birds	Anatidae	*Nettapus coromandelianus*	cotton pygmy-goose		C		7
animals	birds	Anhingidae	*Anhinga novaehollandiae*	Australasian darter		C		20
animals	birds	Ardeidae	*Bubulcus ibis*	cattle egret		C		2
animals	birds	Ardeidae	*Ardea pacifica*	white-necked heron		C		13
animals	birds	Ardeidae	*Ardea intermedia*	intermediate egret		C		11
animals	birds	Ardeidae	*Egretta garzetta*	little egret		C		4
animals	birds	Ardeidae	*Ardea alba modesta*	eastern great egret		C		19
animals	birds	Ardeidae	*Nycticorax caledonicus*	nankeen night-heron		C		4
animals	birds	Ardeidae	*Egretta novaehollandiae*	white-faced heron		C		21
animals	birds	Artamidae	*Artamus leucorynchus*	white-breasted woodswallow		C		19
animals	birds	Artamidae	*Cracticus nigrogularis*	pied butcherbird		C		50
animals	birds	Artamidae	*Artamus minor*	little woodswallow		C		1
animals	birds	Artamidae	*Artamus cinereus*	black-faced woodswallow		C		11
animals	birds	Artamidae	*Gymnorhina tibicen*	Australian magpie		C		72
animals	birds	Artamidae	*Strepera graculina*	pied currawong		C		14
animals	birds	Artamidae	*Cracticus torquatus*	grey butcherbird		C		32
animals	birds	Burhinidae	*Burhinus grallarius*	bush stone-curlew		C		2
animals	birds	Cacatuidae	*Nymphicus hollandicus*	cockatiel		C		5
animals	birds	Cacatuidae	*Eolophus roseicapilla*	galah		C		30
animals	birds	Cacatuidae	*Cacatua sanguinea*	little corella		C		1
animals	birds	Cacatuidae	*Cacatua galerita*	sulphur-crested cockatoo		C		33
animals	birds	Campephagidae	*Coracina novaehollandiae*	black-faced cuckoo-shrike		C		36
animals	birds	Campephagidae	*Coracina tenuirostris*	cicadabird		C		7
animals	birds	Campephagidae	*Coracina papuensis*	white-bellied cuckoo-shrike		C		2
animals	birds	Campephagidae	*Lalage tricolor*	white-winged triller		C		10
animals	birds	Campephagidae	*Coracina maxima*	ground cuckoo-shrike		C		1
animals	birds	Casuariidae	*Dromaius novaehollandiae*	emu		C		16
animals	birds	Charadriidae	*Vanellus miles*	masked lapwing		C		13
animals	birds	Charadriidae	*Elseyornis melanops*	black-fronted dotterel		C		12
animals	birds	Charadriidae	*Vanellus miles novaehollandiae*	masked lapwing (southern subspecies)		C		8
animals	birds	Ciconiidae	*Ephippiorhynchus asiaticus*	black-necked stork		C		4
animals	birds	Cisticolidae	*Cisticola exilis*	golden-headed cisticola		C		13
animals	birds	Climacteridae	*Climacteris picumnus*	brown treecreeper		C		2
animals	birds	Columbidae	*Geophaps scripta scripta*	squatter pigeon (southern subspecies)		V	V	31
animals	birds	Columbidae	*Geopelia humeralis*	bar-shouldered dove		C		13
animals	birds	Columbidae	*Phaps chalcoptera*	common bronzewing		C		4
animals	birds	Columbidae	*Geopelia cuneata*	diamond dove		C		2
animals	birds	Columbidae	*Geopelia striata*	peaceful dove		C		23
animals	birds	Columbidae	*Ocyphaps lophotes*	crested pigeon		C		26
animals	birds	Coraciidae	*Eurystomus orientalis*	dollarbird		C		23
animals	birds	Corcoracidae	*Struthidea cinerea*	apostlebird		C		49
animals	birds	Corcoracidae	*Corcorax melanorhamphos*	white-winged chough		C		8
animals	birds	Corvidae	*Corvus orru*	Torresian crow		C		94
animals	birds	Corvidae	*Corvus bennetti*	little crow		C		1
animals	birds	Cuculidae	*Centropus phasianinus*	pheasant coucal		C		12

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Cuculidae	*Cacomantis variolosus*	brush cuckoo		C		1
animals	birds	Cuculidae	*Eudynamys orientalis*	eastern koel		C		4
animals	birds	Cuculidae	*Chalcites minutillus*	little bronze-cuckoo		C		2
animals	birds	Cuculidae	*Scythrops novaehollandiae*	channel-billed cuckoo		C		10
animals	birds	Cuculidae	*Cacomantis pallidus*	pallid cuckoo		C		8
animals	birds	Cuculidae	*Chalcites lucidus*	shining bronze-cuckoo		C		2
animals	birds	Cuculidae	*Chalcites basalis*	Horsfield's bronze-cuckoo		C		5
animals	birds	Cuculidae	*Cacomantis flabelliformis*	fan-tailed cuckoo		C		1
animals	birds	Dicruridae	*Dicrurus bracteatus*	spangled drongo		C		3
animals	birds	Estrildidae	*Neochmia modesta*	plum-headed finch		C		2
animals	birds	Estrildidae	*Neochmia temporalis*	red-browed finch		C		1
animals	birds	Estrildidae	*Taeniopygia guttata*	zebra finch		C		2
animals	birds	Estrildidae	*Taeniopygia bichenovii*	double-barred finch		C		24
animals	birds	Estrildidae	*Lonchura castaneothorax*	chestnut-breasted mannikin		C		3
animals	birds	Eurostopodidae	*Eurostopodus mystacalis*	white-throated nightjar		C		2
animals	birds	Falconidae	*Falco longipennis*	Australian hobby		C		4
animals	birds	Falconidae	*Falco cenchroides*	nankeen kestrel		C		22
animals	birds	Falconidae	*Falco berigora*	brown falcon		C		13
animals	birds	Gruidae	*Antigone rubicunda*	brolga		C		21
animals	birds	Halcyonidae	*Todiramphus pyrrhopygius*	red-backed kingfisher		C		6
animals	birds	Halcyonidae	*Todiramphus macleayii*	forest kingfisher		C		12
animals	birds	Halcyonidae	*Todiramphus sanctus*	sacred kingfisher		C		10
animals	birds	Halcyonidae	*Dacelo novaeguineae*	laughing kookaburra		C		37
animals	birds	Halcyonidae	*Dacelo leachii*	blue-winged kookaburra		C		8
animals	birds	Hirundinidae	*Petrochelidon nigricans*	tree martin		C		10
animals	birds	Hirundinidae	*Petrochelidon ariel*	fairy martin		C		13
animals	birds	Hirundinidae	*Hirundo neoxena*	welcome swallow		C		8
animals	birds	Jacanidae	*Irediparra gallinacea*	comb-crested jacana		C		2
animals	birds	Laridae	*Chroicocephalus novaehollandiae*	silver gull		C		2
animals	birds	Laridae	*Gelochelidon nilotica*	gull-billed tern		SL		1
animals	birds	Laridae	*Chlidonias hybrida*	whiskered tern		C		1
animals	birds	Maluridae	*Malurus lamberti*	variegated fairy-wren		C		13
animals	birds	Maluridae	*Malurus cyaneus*	superb fairy-wren		C		1
animals	birds	Maluridae	*Malurus melanocephalus*	red-backed fairy-wren		C		37
animals	birds	Megaluridae	*Megalurus timoriensis*	tawny grassbird		C		3
animals	birds	Megaluridae	*Cincloramphus mathewsi*	rufous songlark		C		4
animals	birds	Meliphagidae	*Manorina melanocephala*	noisy miner		C		17
animals	birds	Meliphagidae	*Melithreptus lunatus*	white-naped honeyeater		C		1
animals	birds	Meliphagidae	*Acanthagenys rufogularis*	spiny-cheeked honeyeater		C		3
animals	birds	Meliphagidae	*Melithreptus albogularis*	white-throated honeyeater		C		34
animals	birds	Meliphagidae	*Plectorhyncha lanceolata*	striped honeyeater		C		19
animals	birds	Meliphagidae	*Melithreptus gularis*	black-chinned honeyeater		C		1
animals	birds	Meliphagidae	*Lichmera indistincta*	brown honeyeater		C		15
animals	birds	Meliphagidae	*Gavicalis virescens*	singing honeyeater		C		24
animals	birds	Meliphagidae	*Manorina flavigula*	yellow-throated miner		C		20
animals	birds	Meliphagidae	*Entomyzon cyanotis*	blue-faced honeyeater		C		35

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Meliphagidae	*Caligavis chrysops*	yellow-faced honeyeater		C		2
animals	birds	Meliphagidae	*Meliphaga lewinii*	Lewin's honeyeater		C		3
animals	birds	Meliphagidae	*Myzomela obscura*	dusky honeyeater		C		1
animals	birds	Meliphagidae	*Philemon citreogularis*	little friarbird		C		20
animals	birds	Meliphagidae	*Philemon corniculatus*	noisy friarbird		C		39
animals	birds	Meropidae	*Merops ornatus*	rainbow bee-eater		C		38
animals	birds	Monarchidae	*Myiagra inquieta*	restless flycatcher		C		4
animals	birds	Monarchidae	*Myiagra rubecula*	leaden flycatcher		C		13
animals	birds	Monarchidae	*Grallina cyanoleuca*	magpie-lark		C		54
animals	birds	Monarchidae	*Monarcha melanopsis*	black-faced monarch		SL		1
animals	birds	Motacillidae	*Anthus novaeseelandiae*	Australasian pipit		C		15
animals	birds	Nectariniidae	*Dicaeum hirundinaceum*	mistletoebird		C		10
animals	birds	Neosittidae	*Daphoenositta chrysoptera*	varied sittella		C		8
animals	birds	Oriolidae	*Sphecotheres vieilloti*	Australasian figbird		C		3
animals	birds	Oriolidae	*Oriolus sagittatus*	olive-backed oriole		C		11
animals	birds	Otididae	*Ardeotis australis*	Australian bustard		C		11
animals	birds	Pachycephalidae	*Pachycephala rufiventris*	rufous whistler		C		22
animals	birds	Pachycephalidae	*Colluricincla megarhyncha*	little shrike-thrush		C		1
animals	birds	Pachycephalidae	*Colluricincla harmonica*	grey shrike-thrush		C		12
animals	birds	Pardalotidae	*Pardalotus striatus*	striated pardalote		C		64
animals	birds	Passeridae	*Passer domesticus*	house sparrow	Y			1
animals	birds	Pelecanidae	*Pelecanus conspicillatus*	Australian pelican		C		12
animals	birds	Petroicidae	*Microeca fascinans*	jacky winter		C		6
animals	birds	Petroicidae	*Petroica goodenovii*	red-capped robin		C		2
animals	birds	Phalacrocoracidae	*Phalacrocorax sulcirostris*	little black cormorant		C		17
animals	birds	Phalacrocoracidae	*Microcarbo melanoleucos*	little pied cormorant		C		19
animals	birds	Phalacrocoracidae	*Phalacrocorax varius*	pied cormorant		C		4
animals	birds	Phalacrocoracidae	*Phalacrocorax carbo*	great cormorant		C		1
animals	birds	Phasianidae	*Coturnix pectoralis*	stubble quail		C		2
animals	birds	Phasianidae	*Coturnix ypsilophora*	brown quail		C		10
animals	birds	Podargidae	*Podargus strigoides*	tawny frogmouth		C		11
animals	birds	Podicipedidae	*Tachybaptus novaehollandiae*	Australasian grebe		C		17
animals	birds	Podicipedidae	*Podiceps cristatus*	great crested grebe		C		8
animals	birds	Pomatostomidae	*Pomatostomus temporalis*	grey-crowned babbler		C		28
animals	birds	Psittacidae	*Platycercus adscitus*	pale-headed rosella		C		40
animals	birds	Psittacidae	*Platycercus adscitus palliceps*	pale-headed rosella (southern form)		C		2
animals	birds	Psittacidae	*Trichoglossus haematodus moluccanus*	rainbow lorikeet		C		35
animals	birds	Psittacidae	*Aprosmictus erythropterus*	red-winged parrot		C		17
animals	birds	Psittacidae	*Trichoglossus chlorolepidotus*	scaly-breasted lorikeet		C		2
animals	birds	Ptilonorhynchidae	*Ptilonorhynchus maculatus*	spotted bowerbird		C		6
animals	birds	Ptilonorhynchidae	*Ptilonorhynchus nuchalis*	great bowerbird		C		2
animals	birds	Rallidae	*Gallirallus philippensis*	buff-banded rail		C		1
animals	birds	Rallidae	*Porphyrio melanotus*	purple swamphen		C		11
animals	birds	Rallidae	*Gallinula tenebrosa*	dusky moorhen		C		12
animals	birds	Rallidae	*Porzana fluminea*	Australian spotted crake		C		1
animals	birds	Rallidae	*Fulica atra*	Eurasian coot		C		10

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Recurvirostridae	*Himantopus himantopus*	black-winged stilt		C		8
animals	birds	Rhipiduridae	*Rhipidura rufifrons*	rufous fantail		SL		1
animals	birds	Rhipiduridae	*Rhipidura albiscapa*	grey fantail		C		27
animals	birds	Rhipiduridae	*Rhipidura leucophrys*	willie wagtail		C		38
animals	birds	Scolopacidae	*Tringa stagnatilis*	marsh sandpiper		SL		3
animals	birds	Scolopacidae	*Tringa nebularia*	common greenshank		SL		1
animals	birds	Scolopacidae	*Calidris acuminata*	sharp-tailed sandpiper		SL		1
animals	birds	Strigidae	*Ninox connivens*	barking owl		C		1
animals	birds	Strigidae	*Ninox boobook*	southern boobook		C		6
animals	birds	Threskiornithidae	*Threskiornis spinicollis*	straw-necked ibis		C		11
animals	birds	Threskiornithidae	*Threskiornis molucca*	Australian white ibis		C		8
animals	birds	Threskiornithidae	*Platalea flavipes*	yellow-billed spoonbill		C		5
animals	birds	Threskiornithidae	*Platalea regia*	royal spoonbill		C		11
animals	birds	Threskiornithidae	*Plegadis falcinellus*	glossy ibis		SL		1
animals	birds	Timaliidae	*Zosterops lateralis*	silvereye		C		1
animals	birds	Turnicidae	*Turnix varius*	painted button-quail		C		2
animals	birds	Tytonidae	*Tyto delicatula*	eastern barn owl		C		2
animals	insects	Nymphalidae	*Tirumala hamata hamata*	blue tiger				1
animals	insects	Nymphalidae	*Euploea corinna*	common crow				4
animals	insects	Nymphalidae	*Danaus petilia*	lesser wanderer				1
animals	insects	Nymphalidae	*Hypolimnas bolina nerina*	varied eggfly				1
animals	insects	Nymphalidae	*Junonia villida villida*	meadow argus				4
animals	insects	Nymphalidae	*Acraea andromacha andromacha*	glasswing				1
animals	insects	Papilionidae	*Papilio demoleus sthenelus*	chequered swallowtail				1
animals	insects	Papilionidae	*Papilio anactus*	dainty swallowtail				2
animals	insects	Pieridae	*Cepora perimale scyllara*	caper gull (Australian subspecies)				1
animals	insects	Pieridae	*Belenois java teutonia*	caper white				6
animals	insects	Pieridae	*Elodina parthia*	striated pearl-white				1
animals	insects	Pieridae	*Catopsilia pomona*	lemon migrant				6
animals	mammals	Bovidae	*Bos taurus*	European cattle	Y			1
animals	mammals	Canidae	*Canis familiaris (dingo)*	dingo				2
animals	mammals	Canidae	*Canis familiaris*	dog	Y			5
animals	mammals	Canidae	*Vulpes vulpes*	red fox	Y			2
animals	mammals	Canidae	*Canis sp.*		Y			1
animals	mammals	Cervidae	*Axis axis*	chital	Y			3
animals	mammals	Dasyuridae	*Sminthopsis macroura*	stripe-faced dunnart		C		3
animals	mammals	Dasyuridae	*Planigale tenuirostris*	narrow-nosed planigale		C		2
animals	mammals	Dasyuridae	*Sminthopsis crassicaudata*	fat-tailed dunnart		C		1
animals	mammals	Emballonuridae	*Taphozous troughtoni*	Troughton's sheathtail bat		C		4
animals	mammals	Emballonuridae	*Taphozous australis*	coastal sheathtail bat		NT		1
animals	mammals	Emballonuridae	*Saccolaimus flaviventris*	yellow-bellied sheathtail bat		C		12
animals	mammals	Felidae	*Felis catus*	cat	Y			3
animals	mammals	Leporidae	*Oryctolagus cuniculus*	rabbit	Y			12
animals	mammals	Macropodidae	*Wallabia bicolor*	swamp wallaby		C		2
animals	mammals	Macropodidae	*Lagorchestes conspicillatus*	spectacled hare-wallaby		C		1
animals	mammals	Macropodidae	*Notamacropus dorsalis*	black-striped wallaby		C		2

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animals	mammals	Macropodidae	*Osphranter robustus*	common wallaroo		C		2
animals	mammals	Macropodidae	*Petrogale inornata*	unadorned rock-wallaby		C		4
animals	mammals	Macropodidae	*Macropus giganteus*	eastern grey kangaroo		C		17
animals	mammals	Macropodidae	*Osphranter rufus*	red kangaroo		C		1
animals	mammals	Miniopteridae	*Miniopterus schreibersii oceanensis*	eastern bent-wing bat		C		5
animals	mammals	Miniopteridae	*Miniopterus australis*	little bent-wing bat		C		6
animals	mammals	Molossidae	*Austronomus australis*	white-striped freetail bat		C		1
animals	mammals	Molossidae	*Mormopterus lumsdenae*	northern free-tailed bat		C		9
animals	mammals	Molossidae	*Mormopterus sp.*			C		1
animals	mammals	Molossidae	*Mormopterus ridei*	eastern free-tailed bat		C		6
animals	mammals	Molossidae	*Chaerephon jobensis*	northern freetail bat		C		11
animals	mammals	Muridae	*Mus musculus*	house mouse	Y			8
animals	mammals	Muridae	*Pseudomys delicatulus*	delicate mouse		C		5
animals	mammals	Muridae	*Hydromys chrysogaster*	water rat		C		5
animals	mammals	Muridae	*Rattus fuscipes*	bush rat		C		1
animals	mammals	Muridae	*Pseudomys gracilicaudatus*	eastern chestnut mouse		C		5
animals	mammals	Muridae	*Rattus rattus*	black rat	Y			1
animals	mammals	Peramelidae	*Isoodon macrourus*	northern brown bandicoot		C		3
animals	mammals	Petauridae	*Petaurus notatus*	Krefft's glider		C		6
animals	mammals	Petauridae	*Petaurus norfolcensis*	squirrel glider		C		1
animals	mammals	Phalangeridae	*Trichosurus vulpecula*	common brushtail possum		C		9
animals	mammals	Phascolarctidae	*Phascolarctos cinereus*	koala		V	V	91
animals	mammals	Potoroidae	*Aepyprymnus rufescens*	rufous bettong		C		10
animals	mammals	Pseudocheiridae	*Petauroides armillatus*	central greater glider		V	V	75
animals	mammals	Pteropodidae	*Pteropus scapulatus*	little red flying-fox		C		3
animals	mammals	Suidae	*Sus scrofa*	pig	Y			7
animals	mammals	Tachyglossidae	*Tachyglossus aculeatus*	short-beaked echidna		SL		16
animals	mammals	Vespertilionidae	*Scotorepens sanborni*	northern broad-nosed bat		C		2
animals	mammals	Vespertilionidae	*Scotorepens balstoni*	inland broad-nosed bat		C		7
animals	mammals	Vespertilionidae	*Chalinolobus picatus*	little pied bat		C		13
animals	mammals	Vespertilionidae	*Vespadelus troughtoni*	eastern cave bat		C		8
animals	mammals	Vespertilionidae	*Vespadelus baverstocki*	inland forest bat		C		7
animals	mammals	Vespertilionidae	*Chalinolobus dwyeri*	large-eared pied bat		V	V	1
animals	mammals	Vespertilionidae	*Scotorepens greyii*	little broad-nosed bat		C		16
animals	mammals	Vespertilionidae	*Nyctophilus gouldi*	Gould's long-eared bat		C		3
animals	mammals	Vespertilionidae	*Chalinolobus morio*	chocolate wattled bat		C		6
animals	mammals	Vespertilionidae	*Nyctophilus bifax*	northern long-eared bat		C		1
animals	mammals	Vespertilionidae	*Chalinolobus sp.*			C		5
animals	mammals	Vespertilionidae	*Nyctophilus sp.*			C		3
animals	mammals	Vespertilionidae	*Chalinolobus nigrogriseus*	hoary wattled bat		C		10
animals	mammals	Vespertilionidae	*Chalinolobus gouldii*	Gould's wattled bat		C		16
animals	reptiles	Agamidae	*Pogona barbata*	bearded dragon		C		7
animals	reptiles	Agamidae	*Amphibolurus burnsi*	Burns's dragon		C		2
animals	reptiles	Agamidae	*Chlamydosaurus kingii*	frilled lizard		C		1
animals	reptiles	Agamidae	*Diporiphora australis*	tommy roundhead		C		11
animals	reptiles	Boidae	*Antaresia maculosa*	spotted python		C		14

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animals	reptiles	Boidae	*Aspidites melanocephalus*	black-headed python		C		5
animals	reptiles	Carphodactylidae	*Nephrurus asper*	spiny knob-tailed gecko		C		3
animals	reptiles	Chelidae	*Chelodina longicollis*	eastern snake-necked turtle		C		1
animals	reptiles	Chelidae	*Emydura sp.*			C		1
animals	reptiles	Colubridae	*Dendrelaphis punctulatus*	green tree snake		C		1
animals	reptiles	Colubridae	*Tropidonophis mairii*	freshwater snake		C		2
animals	reptiles	Colubridae	*Boiga irregularis*	brown tree snake		C		3
animals	reptiles	Diplodactylidae	*Oedura monilis sensu lato*	ocellated velvet gecko		C		4
animals	reptiles	Diplodactylidae	*Lucasium steindachneri*	Steindachner's gecko		C		22
animals	reptiles	Diplodactylidae	*Diplodactylus platyurus*	eastern fat-tailed gecko		C		12
animals	reptiles	Diplodactylidae	*Strophurus williamsi*	soft-spined gecko		C		6
animals	reptiles	Diplodactylidae	*Amalosia rhombifer*	zig-zag gecko		C		1
animals	reptiles	Diplodactylidae	*Oedura monilis*	ocellated velvet gecko		C		5
animals	reptiles	Diplodactylidae	*Diplodactylus vittatus*	wood gecko		C		1
animals	reptiles	Elapidae	*Hoplocephalus bitorquatus*	pale-headed snake		C		7
animals	reptiles	Elapidae	*Brachyurophis australis*	coral snake		C		1
animals	reptiles	Elapidae	*Acanthophis antarcticus*	common death adder		V		1
animals	reptiles	Elapidae	*Pseudonaja textilis*	eastern brown snake		C		10
animals	reptiles	Elapidae	*Demansia psammophis*	yellow-faced whipsnake		C		3
animals	reptiles	Elapidae	*Cryptophis boschmai*	Carpentaria whip snake		C		10
animals	reptiles	Elapidae	*Denisonia maculata*	ornamental snake		V	V	27
animals	reptiles	Elapidae	*Suta suta*	myall snake		C		18
animals	reptiles	Elapidae	*Furina diadema*	red-naped snake		C		2
animals	reptiles	Gekkonidae	*Heteronotia binoei*	Bynoe's gecko		C		28
animals	reptiles	Gekkonidae	*Gehyra versicolor*			C		1
animals	reptiles	Gekkonidae	*Gehyra catenata*	chain-backed dtella		C		10
animals	reptiles	Gekkonidae	*Gehyra dubia*	dubious dtella		C		24/1
animals	reptiles	Pygopodidae	*Pygopus schraderi*	eastern hooded scaly-foot		C		1
animals	reptiles	Pygopodidae	*Lialis burtonis*	Burton's legless lizard		C		4
animals	reptiles	Pygopodidae	*Paradelma orientalis*	brigalow scaly-foot		C		1
animals	reptiles	Scincidae	*Cryptoblepharus pannosus*	ragged snake-eyed skink		C		2
animals	reptiles	Scincidae	*Carlia pectoralis sensu lato*			C		16
animals	reptiles	Scincidae	*Cryptoblepharus pulcher pulcher*	elegant snake-eyed skink		C		5
animals	reptiles	Scincidae	*Cryptoblepharus virgatus sensu lato*			C		7
animals	reptiles	Scincidae	*Ctenotus spaldingi*	straight-browed ctenotus		C		19
animals	reptiles	Scincidae	*Bellatorias frerei*	major skink		C		1
animals	reptiles	Scincidae	*Carlia schmeltzii*	robust rainbow-skink		C		3
animals	reptiles	Scincidae	*Lerista punctatovittata*	eastern robust slider		C		1
animals	reptiles	Scincidae	*Pygmaeascincus timlowi*	dwarf litter-skink		C		2
animals	reptiles	Scincidae	*Morethia taeniopleura*	fire-tailed skink		C		4
animals	reptiles	Scincidae	*Ctenotus taeniolatus*	copper-tailed skink		C		15
animals	reptiles	Scincidae	*Morethia boulengeri*	south-eastern morethia skink		C		7
animals	reptiles	Scincidae	*Tiliqua scincoides*	eastern blue-tongued lizard		C		2
animals	reptiles	Scincidae	*Cryptoblepharus sp.*			C		1
animals	reptiles	Scincidae	*Lygisaurus foliorum*	tree-base litter-skink		C		10
animals	reptiles	Scincidae	*Carlia munda*	shaded-litter rainbow-skink		C		4

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	reptiles	Scincidae	*Carlia vivax*	tussock rainbow-skink		C		3
animals	reptiles	Scincidae	*Carlia rubigo*	orange-flanked rainbow skink		C		10
animals	reptiles	Scincidae	*Lerista fragilis*	eastern mulch slider		C		11
animals	reptiles	Scincidae	*Ctenotus ingrami*	unspotted yellow-sided ctenotus		C		1
animals	reptiles	Scincidae	*Lerista allanae*	Allan's lerista		E	E	1/1
animals	reptiles	Scincidae	*Tiliqua rugosa*	shingle-back		C		1
animals	reptiles	Scincidae	*Menetia greyii*	common dwarf skink		C		2
animals	reptiles	Scincidae	*Eulamprus sp.*			C		1
animals	reptiles	Typhlopidae	*Anilios unguirostris*	claw-snouted blind snake		C		1
animals	reptiles	Typhlopidae	*Anilios ligatus*	robust blind snake		C		1
animals	reptiles	Typhlopidae	*Anilios affinis*	small-headed blind snake		C		1
animals	reptiles	Varanidae	*Varanus tristis*	black-tailed monitor		C		5
fungi	lecanoromycetes	Cladoniaceae	*Cladia muelleri*			C		1/1
fungi	lecanoromycetes	Cladoniaceae	*Ramalinora glaucolivida*			C		1/1
fungi	lecanoromycetes	Lecideaceae	*Lecidea*					3/3
fungi	lecanoromycetes	Parmeliaceae	*Xanthoparmelia ballingalliana*			C		2/2
fungi	lecanoromycetes	Parmeliaceae	*Xanthoparmelia exuviata*			C		1/1
fungi	lecanoromycetes	Physciaceae	*Rinodina*					1/1
fungi	lecanoromycetes	Porinaceae	*Porina subargillacea*			C		1/1
fungi	lecanoromycetes	Teloschistaceae	*Caloplaca cinnabarina*			C		1/1
fungi	lichinomycetes	Peltulaceae	*Peltula placodizans*			C		1/1
plants	land plants	Acanthaceae	*Brunoniella australis*	blue trumpet		C		13
plants	land plants	Acanthaceae	*Rostellularia adscendens*			C		26/1
plants	land plants	Acanthaceae	*Pseuderanthemum variabile*	pastel flower		C		2/1
plants	land plants	Acanthaceae	*Rostellularia adscendens var. hispida*			C		1/1
plants	land plants	Acanthaceae	*Harnieria sp. (Lornesleigh E.J.Thompson+ CHA75)*			C		1/1
plants	land plants	Acanthaceae	*Dipteracanthus australasicus subsp. corynothecus*			C		1/1
plants	land plants	Aizoaceae	*Trianthema portulacastrum*	black pigweed	Y			3
plants	land plants	Aizoaceae	*Trianthema triquetra*	red spinach		C		1
plants	land plants	Amaranthaceae	*Ptilotus*					1
plants	land plants	Amaranthaceae	*Nyssanthes erecta*			C		1/1
plants	land plants	Amaranthaceae	*Alternanthera nana*	hairy joyweed		C		1/1
plants	land plants	Amaranthaceae	*Gomphrena celosioides*	gomphrena weed	Y			5
plants	land plants	Amaranthaceae	*Alternanthera denticulata*	lesser joyweed		C		1
plants	land plants	Amaranthaceae	*Alternanthera denticulata var. micrantha*			C		6
plants	land plants	Amaryllidaceae	*Crinum*					1
plants	land plants	Apiaceae	*Eryngium plantagineum*	long eryngium		C		2/2
plants	land plants	Apocynaceae	*Hoya australis subsp. australis*			C		1/1
plants	land plants	Apocynaceae	*Parsonsia lanceolata*	northern silkpod		C		3/2
plants	land plants	Apocynaceae	*Wrightia versicolor*			C		1/1
plants	land plants	Apocynaceae	*Cerbera dumicola*			NT		2/1
plants	land plants	Apocynaceae	*Wrightia saligna*			C		1/1
plants	land plants	Apocynaceae	*Alyxia ruscifolia*			C		1/1
plants	land plants	Apocynaceae	*Alstonia constricta*	bitterbark		C		2/1
plants	land plants	Apocynaceae	*Marsdenia*					1
plants	land plants	Apocynaceae	*Carissa ovata*	currantbush		C		10

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plants	land plants	Apocynaceae	*Marsdenia australis*	doubah		C		1
plants	land plants	Asphodelaceae	*Bulbine bulbosa*	golden lily		C		2
plants	land plants	Asteraceae	*Parthenium hysterophorus*	parthenium weed	Y			41
plants	land plants	Asteraceae	*Pterocaulon sphacelatum*	applebush		C		2
plants	land plants	Asteraceae	*Sphaeromorphaea subintegra*			C		1/1
plants	land plants	Asteraceae	*Apowollastonia spilanthoides*			C		10/3
plants	land plants	Asteraceae	*Senecio pinnatifolius var. pinnatifolius*			C		2
plants	land plants	Asteraceae	*Gamochaeta pensylvanica*		Y			1/1
plants	land plants	Asteraceae	*Acanthospermum hispidum*	star burr	Y			2/1
plants	land plants	Asteraceae	*Euchiton involucratus*			C		3
plants	land plants	Asteraceae	*Cyanthillium cinereum*			C		1/1
plants	land plants	Asteraceae	*Vittadinia pustulata*			C		1/1
plants	land plants	Asteraceae	*Pterocaulon redolens*			C		6
plants	land plants	Asteraceae	*Peripleura hispidula*			C		2
plants	land plants	Asteraceae	*Rutidosis leucantha*			C		1/1
plants	land plants	Asteraceae	*Praxelis clematidea*		Y			1/1
plants	land plants	Asteraceae	*Coronidium rupicola*			C		1/1
plants	land plants	Asteraceae	*Emilia sonchifolia*		Y			2
plants	land plants	Asteraceae	*Calotis cuneifolia*	burr daisy		C		2/1
plants	land plants	Asteraceae	*Tridax procumbens*	tridax daisy	Y			1/1
plants	land plants	Asteraceae	*Sonchus oleraceus*	common sowthistle	Y			1
plants	land plants	Asteraceae	*Blumea axillaris*			C		1/1
plants	land plants	Asteraceae	*Calotis dentex*	white burr daisy		C		1/1
plants	land plants	Asteraceae	*Bidens pilosa*		Y			2
plants	land plants	Asteraceae	*Sphaeromorphaea australis*			C		1/1
plants	land plants	Boraginaceae	*Ehretia membranifolia*	weeping koda		C		1
plants	land plants	Boraginaceae	*Trichodesma zeylanicum*			C		5
plants	land plants	Brassicaceae	*Cardamine hirsuta*	common bittercress	Y			1/1
plants	land plants	Byttneriaceae	*Hannafordia shanesii*			C		1/1
plants	land plants	Cactaceae	*Opuntia stricta*		Y			1
plants	land plants	Cactaceae	*Opuntia*					1
plants	land plants	Cactaceae	*Harrisia martinii*		Y			10
plants	land plants	Cactaceae	*Opuntia tomentosa*	velvety tree pear	Y			6
plants	land plants	Caesalpiniaceae	*Senna barclayana*			C		1
plants	land plants	Caesalpiniaceae	*Lysiphyllum carronii*	ebony tree		C		2
plants	land plants	Caesalpiniaceae	*Senna artemisioides subsp. zygophylla*			C		1
plants	land plants	Caesalpiniaceae	*Cassia brewsteri*			C		15
plants	land plants	Caesalpiniaceae	*Senna costata*			C		1/1
plants	land plants	Caesalpiniaceae	*Lysiphyllum*					2
plants	land plants	Caesalpiniaceae	*Senna*					2
plants	land plants	Caesalpiniaceae	*Chamaecrista absus var. absus*			C		1/1
plants	land plants	Campanulaceae	*Wahlenbergia gracilis*	sprawling bluebell		C		6
plants	land plants	Campanulaceae	*Wahlenbergia queenslandica*			C		1/1
plants	land plants	Capparaceae	*Capparis mitchellii*			C		1
plants	land plants	Capparaceae	*Capparis loranthifolia*			C		1
plants	land plants	Capparaceae	*Capparis humistrata*			E		1/1

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plants	land plants	Capparaceae	*Capparis lasiantha*	nipan		C		11
plants	land plants	Capparaceae	*Capparis umbonata*			C		1/1
plants	land plants	Capparaceae	*Capparis anomala*			C		5
plants	land plants	Capparaceae	*Capparis*					2
plants	land plants	Caryophyllaceae	*Polycarpaea longiflora*			C		5
plants	land plants	Casuarinaceae	*Allocasuarina luehmannii*	bull oak		C		2
plants	land plants	Casuarinaceae	*Casuarina cunninghamiana subsp. cunninghamiana*			C		2
plants	land plants	Casuarinaceae	*Casuarina cunninghamiana*			C		1
plants	land plants	Celastraceae	*Denhamia disperma*			C		2
plants	land plants	Celastraceae	*Denhamia cunninghamii*			C		2/1
plants	land plants	Celastraceae	*Elaeodendron australe var. australe*			C		1/1
plants	land plants	Chenopodiaceae	*Enchylaena tomentosa var. tomentosa*			C		3
plants	land plants	Chenopodiaceae	*Maireana microphylla*			C		2
plants	land plants	Chenopodiaceae	*Sclerolaena lanicuspis*			C		1/1
plants	land plants	Chenopodiaceae	*Sclerolaena tetracuspis*	brigalow burr		C		1/1
plants	land plants	Chenopodiaceae	*Sclerolaena muricata var. villosa*			C		3
plants	land plants	Chenopodiaceae	*Sclerolaena muricata var. muricata*			C		2
plants	land plants	Chenopodiaceae	*Salsola australis*			C		2
plants	land plants	Chenopodiaceae	*Enchylaena tomentosa*			C		10
plants	land plants	Chenopodiaceae	*Dysphania melanocarpa forma melanocarpa*			C		1/1
plants	land plants	Cleomaceae	*Arivela viscosa*			C		6
plants	land plants	Clusiaceae	*Hypericum gramineum*			C		2/2
plants	land plants	Combretaceae	*Terminalia oblongata subsp. oblongata*			C		1
plants	land plants	Commelinaceae	*Commelina diffusa*	wandering jew		C		4
plants	land plants	Commelinaceae	*Commelina*					1
plants	land plants	Convolvulaceae	*Polymeria longifolia*	polymeria		C		17
plants	land plants	Convolvulaceae	*Xenostegia tridentata*			C		1/1
plants	land plants	Convolvulaceae	*Jacquemontia paniculata*			C		4/2
plants	land plants	Convolvulaceae	*Evolvulus alsinoides var. decumbens*			C		1
plants	land plants	Convolvulaceae	*Ipomoea brownii*			C		1/1
plants	land plants	Convolvulaceae	*Ipomoea calobra*			C		1/1
plants	land plants	Convolvulaceae	*Ipomoea plebeia*	bellvine		C		1
plants	land plants	Convolvulaceae	*Polymeria pusilla*			C		7
plants	land plants	Convolvulaceae	*Evolvulus alsinoides*			C		5
plants	land plants	Convolvulaceae	*Ipomoea lonchophylla*			C		30
plants	land plants	Cucurbitaceae	*Cucurbitaceae*					1
plants	land plants	Cucurbitaceae	*Cucumis melo*			C		5
plants	land plants	Cucurbitaceae	*Cucumis anguria var. anguria*	West Indian gherkin	Y			1/1
plants	land plants	Cyperaceae	*Cyperus distans*			C		1
plants	land plants	Cyperaceae	*Cyperus gilesii*			C		24
plants	land plants	Cyperaceae	*Scleria brownii*			C		1/1
plants	land plants	Cyperaceae	*Cyperus gracilis*			C		1/1
plants	land plants	Cyperaceae	*Cyperus concinnus*			C		2
plants	land plants	Cyperaceae	*Cyperus exaltatus*	tall flatsedge		C		7
plants	land plants	Cyperaceae	*Cyperus flaccidus*			C		1/1
plants	land plants	Cyperaceae	*Cyperus javanicus*			C		1/1

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plants	land plants	Cyperaceae	*Cyperus compressus*		Y			1/1
plants	land plants	Cyperaceae	*Cyperus pulchellus*			C		1/1
plants	land plants	Cyperaceae	*Scleria sphacelata*			C		1/1
plants	land plants	Cyperaceae	*Cyperus isabellinus*			C		1/1
plants	land plants	Cyperaceae	*Cyperus alopecuroides*			C		1/1
plants	land plants	Cyperaceae	*Cyperus alterniflorus*			C		1/1
plants	land plants	Cyperaceae	*Fimbristylis depauperata*			C		1/1
plants	land plants	Cyperaceae	*Cyperus conicus var. conicus*			C		1/1
plants	land plants	Cyperaceae	*Schoenoplectiella dissachantha*			C		3
plants	land plants	Cyperaceae	*Cyperus polystachyos var. polystachyos*			C		1/1
plants	land plants	Cyperaceae	*Cyperus betchei*			C		2
plants	land plants	Cyperaceae	*Scleria rugosa*			C		1/1
plants	land plants	Cyperaceae	*Cyperus iria*			C		1/1
plants	land plants	Cyperaceae	*Cyperus fulvus*			C		1/1
plants	land plants	Droseraceae	*Drosera*					1
plants	land plants	Ebenaceae	*Diospyros humilis*	small-leaved ebony		C		3/1
plants	land plants	Erythroxylaceae	*Erythroxylum australe*	cocaine tree		C		5
plants	land plants	Euphorbiaceae	*Ricinus communis*	castor oil bush	Y			1
plants	land plants	Euphorbiaceae	*Euphorbia coghlanii*			C		6
plants	land plants	Euphorbiaceae	*Euphorbia drummondii*			C		8
plants	land plants	Euphorbiaceae	*Adriana tomentosa var. tomentosa*			C		1/1
plants	land plants	Euphorbiaceae	*Croton insularis*	Queensland cascarilla		C		1/1
plants	land plants	Euphorbiaceae	*Euphorbia*					1/1
plants	land plants	Euphorbiaceae	*Bertya pedicellata*			NT		11/10
plants	land plants	Fabaceae	*Zornia*					1
plants	land plants	Fabaceae	*Desmodium*					1
plants	land plants	Fabaceae	*Tephrosia*					2/2
plants	land plants	Fabaceae	*Crotalaria*					1
plants	land plants	Fabaceae	*Indigofera*					1
plants	land plants	Fabaceae	*Cullen tenax*	emu-foot		C		9
plants	land plants	Fabaceae	*Glycine falcata*			C		14
plants	land plants	Fabaceae	*Zornia areolata*			C		1/1
plants	land plants	Fabaceae	*Glycine tabacina*	glycine pea		C		1
plants	land plants	Fabaceae	*Lablab purpureus*	lablab	Y			1/1
plants	land plants	Fabaceae	*Vigna lanceolata*			C		29
plants	land plants	Fabaceae	*Crotalaria juncea*	sunhemp	Y			17/1
plants	land plants	Fabaceae	*Galactia muelleri*			C		7
plants	land plants	Fabaceae	*Glycine latifolia*			C		2
plants	land plants	Fabaceae	*Rhynchosia minima*			C		11
plants	land plants	Fabaceae	*Tephrosia filipes*			C		3
plants	land plants	Fabaceae	*Crotalaria montana*			C		4
plants	land plants	Fabaceae	*Glycine tomentella*	woolly glycine		C		1/1
plants	land plants	Fabaceae	*Indigofera hirsuta*	hairy indigo		C		1/1
plants	land plants	Fabaceae	*Sesbania cannabina*			C		8
plants	land plants	Fabaceae	*Zornia muelleriana*			C		1
plants	land plants	Fabaceae	*Aeschynomene indica*	budda pea		C		2

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plants	land plants	Fabaceae	*Desmodium filiforme*			C		1/1
plants	land plants	Fabaceae	*Desmodium tortuosum*	Florida beggar-weed	Y			1/1
plants	land plants	Fabaceae	*Galactia tenuiflora*			C		2
plants	land plants	Fabaceae	*Stylosanthes hamata*		Y			13/1
plants	land plants	Fabaceae	*Stylosanthes scabra*		Y			4
plants	land plants	Fabaceae	*Indigofera linifolia*			C		11
plants	land plants	Fabaceae	*Pycnospora lutescens*	pycnospora		C		1/1
plants	land plants	Fabaceae	*Desmodium brachypodum*	large ticktrefoil		C		1/1
plants	land plants	Fabaceae	*Desmodium macrocarpum*			C		6/4
plants	land plants	Fabaceae	*Tephrosia dietrichiae*			C		1/1
plants	land plants	Fabaceae	*Desmodium campylocaulon*			C		8
plants	land plants	Fabaceae	*Macroptilium atropurpureum*	siratro	Y			5
plants	land plants	Fabaceae	*Vigna radiata var. sublobata*			C		5
plants	land plants	Fabaceae	*Rhynchosia minima var. minima*			C		18
plants	land plants	Fabaceae	*Galactia tenuiflora var. lucida*			C		1/1
plants	land plants	Fabaceae	*Tephrosia filipes subsp. filipes*			C		1/1
plants	land plants	Fabaceae	*Sesbania cannabina var. cannabina*			C		2
plants	land plants	Fabaceae	*Zornia muriculata subsp. angustata*			C		1/1
plants	land plants	Fabaceae	*Zornia muriculata subsp. muriculata*			C		1/1
plants	land plants	Fabaceae	*Zornia muelleriana subsp. muelleriana*			C		1/1
plants	land plants	Fabaceae	*Macroptilium lathyroides var. semierectum*		Y			1
plants	land plants	Frullaniaceae	*Frullania*					1/1
plants	land plants	Goodeniaceae	*Goodenia glabra*			C		18
plants	land plants	Goodeniaceae	*Goodenia sp. (Mt Castletower M.D.Crisp 2753)*			C		2/2
plants	land plants	Goodeniaceae	*Goodenia grandiflora*			C		3/3
plants	land plants	Haloragaceae	*Haloragis stricta*			C		13
plants	land plants	Hemerocallidaceae	*Dianella longifolia*			C		3
plants	land plants	Hemerocallidaceae	*Dianella*					1
plants	land plants	Juncaceae	*Juncus subglaucus*			C		1/1
plants	land plants	Lamiaceae	*Mentha*					1
plants	land plants	Lamiaceae	*Teucrium junceum*			C		1/1
plants	land plants	Lamiaceae	*Clerodendrum floribundum*			C		2
plants	land plants	Lamiaceae	*Teucrium integrifolium*			C		1/1
plants	land plants	Lamiaceae	*Basilicum polystachyon*			C		4
plants	land plants	Lamiaceae	*Leucas lavandulifolia*		Y			1/1
plants	land plants	Lamiaceae	*Prostanthera collina*			C		1/1
plants	land plants	Lamiaceae	*Ocimum tenuiflorum*			C		3
plants	land plants	Laxmanniaceae	*Eustrephus latifolius*	wombat berry		C		3/1
plants	land plants	Laxmanniaceae	*Lomandra multiflora*			C		3
plants	land plants	Laxmanniaceae	*Lomandra longifolia*			C		2/2
plants	land plants	Laxmanniaceae	*Laxmannia gracilis*	slender wire lily		C		1/1
plants	land plants	Linderniaceae	*Torenia crustacea*			C		1/1
plants	land plants	Loganiaceae	*Mitrasacme*					1/1
plants	land plants	Loganiaceae	*Mitrasacme micrantha*			C		1/1
plants	land plants	Loranthaceae	*Lysiana subfalcata*			C		1/1
plants	land plants	Malvaceae	*Hibiscus sp. (Emerald S.L.Everist 2124)*			C		1/1

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plants	land plants	Malvaceae	*Sida sp. (Aramac E.J.Thompson+ JER192)*			C		1/1
plants	land plants	Malvaceae	*Sida sp. (Musselbrook M.B.Thomas+ MRS437)*			C		2
plants	land plants	Malvaceae	*Sida*					14/2
plants	land plants	Malvaceae	*Sida spinosa*	spiny sida	Y			25/1
plants	land plants	Malvaceae	*Sida corrugata*			C		22
plants	land plants	Malvaceae	*Abutilon hannii*			C		2
plants	land plants	Malvaceae	*Sida cordifolia*		Y			4
plants	land plants	Malvaceae	*Sida fibulifera*			C		2/2
plants	land plants	Malvaceae	*Sida trichopoda*			C		15/1
plants	land plants	Malvaceae	*Abutilon fraseri*	dwarf lantern flower		C		1
plants	land plants	Malvaceae	*Hibiscus sturtii*			C		2/1
plants	land plants	Malvaceae	*Sida atherophora*			C		1/1
plants	land plants	Malvaceae	*Sida everistiana*			C		1
plants	land plants	Malvaceae	*Sida hackettiana*			C		4
plants	land plants	Malvaceae	*Sida cunninghamii*			C		2
plants	land plants	Malvaceae	*Gossypium australe*			C		1/1
plants	land plants	Malvaceae	*Hibiscus splendens*	pink hibiscus		C		2/2
plants	land plants	Malvaceae	*Hibiscus divaricatus*			C		2/2
plants	land plants	Malvaceae	*Hibiscus meraukensis*	Merauke hibiscus		C		1
plants	land plants	Malvaceae	*Hibiscus verdcourtii*			C		1/1
plants	land plants	Malvaceae	*Abelmoschus ficulneus*	native rosella		C		12/1
plants	land plants	Malvaceae	*Abutilon leucopetalum*			C		6
plants	land plants	Malvaceae	*Abutilon micropetalum*			C		1/1
plants	land plants	Malvaceae	*Malvastrum americanum*		Y			28
plants	land plants	Malvaceae	*Hibiscus heterophyllus*			C		1/1
plants	land plants	Malvaceae	*Hibiscus krichauffianus*			C		1/1
plants	land plants	Malvaceae	*Hibiscus sturtii var. sturtii*			C		1/1
plants	land plants	Malvaceae	*Sida rohlenae subsp. rohlenae*			C		1
plants	land plants	Malvaceae	*Malvastrum americanum var. stellatum*			C		1/1
plants	land plants	Malvaceae	*Sida sp. (Charters Towers E.J.THompson+ CHA456)*			C		2/2
plants	land plants	Marsileaceae	*Marsilea mutica*	shiny nardoo		C		3
plants	land plants	Marsileaceae	*Marsilea drummondii*	common nardoo		C		1
plants	land plants	Meliaceae	*Owenia x reliqua*			C		1/1
plants	land plants	Meliaceae	*Owenia acidula*	emu apple		C		6
plants	land plants	Menispermaceae	*Tinospora smilacina*	snakevine		C		1
plants	land plants	Mimosaceae	*Acacia excelsa*			C		3
plants	land plants	Mimosaceae	*Acacia faucium*			C		1/1
plants	land plants	Mimosaceae	*Acacia conferta*			C		1/1
plants	land plants	Mimosaceae	*Acacia cowleana*			C		1/1
plants	land plants	Mimosaceae	*Acacia oswaldii*	miljee		C		2/1
plants	land plants	Mimosaceae	*Acacia salicina*	doolan		C		3
plants	land plants	Mimosaceae	*Acacia shirleyi*	lancewood		C		30/1
plants	land plants	Mimosaceae	*Acacia fodinalis*			C		1/1
plants	land plants	Mimosaceae	*Acacia leiocalyx*			C		1
plants	land plants	Mimosaceae	*Acacia catenulata*	bendee		C		1
plants	land plants	Mimosaceae	*Acacia flavescens*	toothed wattle		C		3

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plants	land plants	Mimosaceae	*Acacia rhodoxylon*	ringy rosewood		C		3
plants	land plants	Mimosaceae	*Albizia canescens*			C		1/1
plants	land plants	Mimosaceae	*Acacia harpophylla*	brigalow		C		7
plants	land plants	Mimosaceae	*Acacia bancroftiorum*			C		2/2
plants	land plants	Mimosaceae	*Vachellia farnesiana*		Y			23
plants	land plants	Mimosaceae	*Archidendropsis basaltica*	red lancewood		C		3
plants	land plants	Mimosaceae	*Neptunia gracilis forma gracilis*			C		24
plants	land plants	Mimosaceae	*Acacia leiocalyx subsp. leiocalyx*			C		1
plants	land plants	Mimosaceae	*Acacia julifera subsp. curvinervia*			C		5/5
plants	land plants	Mimosaceae	*Acacia*					3
plants	land plants	Mimosaceae	*Acacia crassa*			C		1
plants	land plants	Molluginaceae	*Glinus lotoides*	hairy carpet weed		C		1/1
plants	land plants	Moraceae	*Ficus opposita*			C		2
plants	land plants	Myrsinaceae	*Myrsine variabilis*			C		1/1
plants	land plants	Myrtaceae	*Eucalyptus*					3
plants	land plants	Myrtaceae	*Corymbia aureola*			C		12/12
plants	land plants	Myrtaceae	*Gossia bidwillii*			C		1/1
plants	land plants	Myrtaceae	*Eucalyptus crebra*	narrow-leaved red ironbark		C		3/1
plants	land plants	Myrtaceae	*Melaleuca nervosa*			C		3/2
plants	land plants	Myrtaceae	*Eucalyptus exserta*	Queensland peppermint		C		1/1
plants	land plants	Myrtaceae	*Eucalyptus populnea*	poplar box		C		10
plants	land plants	Myrtaceae	*Corymbia dallachiana*			C		4
plants	land plants	Myrtaceae	*Corymbia tessellaris*	Moreton Bay ash		C		4
plants	land plants	Myrtaceae	*Corymbia trachyphloia subsp. trachyphloia*			C		1/1
plants	land plants	Myrtaceae	*Eucalyptus persistens*			C		1/1
plants	land plants	Myrtaceae	*Eucalyptus thozetiana*			C		4/4
plants	land plants	Myrtaceae	*Melaleuca fluviatilis*			C		1/1
plants	land plants	Myrtaceae	*Melaleuca leucadendra*	broad-leaved tea-tree		C		2
plants	land plants	Myrtaceae	*Melaleuca viridiflora*			C		2
plants	land plants	Myrtaceae	*Corymbia erythrophloia*	variable-barked bloodwood		C		4
plants	land plants	Myrtaceae	*Eucalyptus orgadophila*	mountain coolibah		C		1
plants	land plants	Myrtaceae	*Eucalyptus tholiformis*			C		2/2
plants	land plants	Myrtaceae	*Micromyrtus capricornia*			C		1/1
plants	land plants	Myrtaceae	*Eucalyptus apothalassica*			C		4
plants	land plants	Myrtaceae	*Eucalyptus drepanophylla*			C		1/1
plants	land plants	Myrtaceae	*Lysicarpus angustifolius*	budgeroo		C		2/2
plants	land plants	Myrtaceae	*Corymbia citriodora subsp. citriodora*			C		15
plants	land plants	Myrtaceae	*Eucalyptus camaldulensis subsp. acuta*			C		2
plants	land plants	Myrtaceae	*Myrtaceae*					2
plants	land plants	Myrtaceae	*Melaleuca*					1
plants	land plants	Myrtaceae	*Corymbia*					3
plants	land plants	Myrtaceae	*Corymbia clarksoniana*			C		4/2
plants	land plants	Nyctaginaceae	*Boerhavia dominii*			C		2
plants	land plants	Nyctaginaceae	*Boerhavia sp. (St George A.Hill AQ399299)*			C		1/1
plants	land plants	Nyctaginaceae	*Boerhavia burbidgeana*			C		1
plants	land plants	Oleaceae	*Jasminum didymum subsp. lineare*			C		1

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plants	land plants	Onagraceae	*Ludwigia octovalvis*	willow primrose		C		3
plants	land plants	Orchidaceae	*Cymbidium canaliculatum*			C		2
plants	land plants	Orthotrichaceae	*Macromitrium aurescens*			C		2/2
plants	land plants	Oxalidaceae	*Oxalis*					1
plants	land plants	Oxalidaceae	*Oxalis radicosa*			C		4/1
plants	land plants	Passifloraceae	*Passiflora foetida*		Y			1/1
plants	land plants	Phrymaceae	*Glossostigma diandrum*			C		1/1
plants	land plants	Phyllanthaceae	*Synostemon rhytidospermus*			C		1/1
plants	land plants	Phyllanthaceae	*Phyllanthus maderaspatensis*			C		3
plants	land plants	Phyllanthaceae	*Phyllanthus virgatus*			C		11
plants	land plants	Phyllanthaceae	*Flueggea leucopyrus*			C		1/1
plants	land plants	Phyllanthaceae	*Phyllanthus sp. (Pentland R.J.Cumming 9742)*			C		2
plants	land plants	Phyllanthaceae	*Phyllanthus maderaspatensis var. maderaspatensis*			C		2
plants	land plants	Picrodendraceae	*Petalostigma pubescens*	quinine tree		C		9
plants	land plants	Pittosporaceae	*Pittosporum spinescens*			C		1/1
plants	land plants	Pittosporaceae	*Pittosporum angustifolium*			C		1
plants	land plants	Pittosporaceae	*Bursaria spinosa subsp. spinosa*			C		1
plants	land plants	Plantaginaceae	*Scoparia dulcis*	scoparia	Y			1/1
plants	land plants	Poaceae	*Cymbopogon refractus*	barbed-wire grass		C		1
plants	land plants	Poaceae	*Dichanthium fecundum*	curly bluegrass		C		1
plants	land plants	Poaceae	*Dichanthium sericeum*			C		31
plants	land plants	Poaceae	*Enneapogon truncatus*			C		22
plants	land plants	Poaceae	*Eragrostis lacunaria*	purple lovegrass		C		3/2
plants	land plants	Poaceae	*Eragrostis schultzii*			C		1/1
plants	land plants	Poaceae	*Eragrostis tenellula*	delicate lovegrass		C		12/1
plants	land plants	Poaceae	*Panicum decompositum*			C		3
plants	land plants	Poaceae	*Paspalum mandiocanum*		Y			1/1
plants	land plants	Poaceae	*Alloteropsis cimicina*			C		2/2
plants	land plants	Poaceae	*Cymbopogon bombycinus*	silky oilgrass		C		3/1
plants	land plants	Poaceae	*Dichanthium aristatum*	angleton grass	Y			2/2
plants	land plants	Poaceae	*Digitaria breviglumis*			C		1
plants	land plants	Poaceae	*Elytrophorus spicatus*			C		3
plants	land plants	Poaceae	*Eragrostis parviflora*	weeping lovegrass		C		6
plants	land plants	Poaceae	*Eremochloa bimaculata*	poverty grass		C		1/1
plants	land plants	Poaceae	*Heteropogon contortus*	black speargrass		C		23
plants	land plants	Poaceae	*Iseilema vaginiflorum*	red flinders grass		C		34/1
plants	land plants	Poaceae	*Pseudoraphis paradoxa*	slender mudgrass		C		1/1
plants	land plants	Poaceae	*Alloteropsis semialata*	cockatoo grass		C		2
plants	land plants	Poaceae	*Aristida queenslandica*			C		1
plants	land plants	Poaceae	*Bothriochloa ewartiana*	desert bluegrass		C		31/1
plants	land plants	Poaceae	*Brachyachne convergens*	common native couch		C		33
plants	land plants	Poaceae	*Enteropogon acicularis*	curly windmill grass		C		2
plants	land plants	Poaceae	*Enteropogon unispiceus*			C		1/1
plants	land plants	Poaceae	*Moorochloa eruciformis*		Y			9/1
plants	land plants	Poaceae	*Panicum queenslandicum*			C		8
plants	land plants	Poaceae	*Paspalidium criniforme*			C		2/1

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plants	land plants	Poaceae	*Paspalidium globoideum*	sago grass		C		22/1
plants	land plants	Poaceae	*Setaria paspalidioides*			C		2/2
plants	land plants	Poaceae	*Thyridolepis xerophila*			C		1
plants	land plants	Poaceae	*Urochloa mosambicensis*	sabi grass	Y			4/1
plants	land plants	Poaceae	*Ancistrachne uncinulata*	hooky grass		C		2/2
plants	land plants	Poaceae	*Dactyloctenium radulans*	button grass		C		3
plants	land plants	Poaceae	*Digitaria hystrichoides*	umbrella grass		C		1/1
plants	land plants	Poaceae	*Eragrostis megalosperma*			C		2/2
plants	land plants	Poaceae	*Sporobolus actinocladus*	katoora grass		C		1/1
plants	land plants	Poaceae	*Cenchrus pennisetiformis*		Y			1/1
plants	land plants	Poaceae	*Paspalidium albovillosum*			C		2/2
plants	land plants	Poaceae	*Bothriochloa erianthoides*	satintop grass		C		2
plants	land plants	Poaceae	*Thyridolepis mitchelliana*	mulga mitchell grass		C		1
plants	land plants	Poaceae	*Dichanthium queenslandicum*			V	E	2/2
plants	land plants	Poaceae	*Diplachne fusca var. fusca*			C		1/1
plants	land plants	Poaceae	*Eriochloa pseudoacrotricha*			C		25
plants	land plants	Poaceae	*Eragrostis longipedicellata*			C		2/2
plants	land plants	Poaceae	*Hyparrhenia rufa subsp. rufa*		Y			2/2
plants	land plants	Poaceae	*Cynodon dactylon var. dactylon*		Y			1
plants	land plants	Poaceae	*Aristida calycina var. praealta*			C		1/1
plants	land plants	Poaceae	*Dinebra decipiens var. peacockii*			C		1/1
plants	land plants	Poaceae	*Aristida benthamii var. benthamii*			C		2/2
plants	land plants	Poaceae	*Aristida holathera var. holathera*			C		4/3
plants	land plants	Poaceae	*Chloris divaricata var. divaricata*	slender chloris		C		3/1
plants	land plants	Poaceae	*Bothriochloa bladhii subsp. bladhii*			C		1/1
plants	land plants	Poaceae	*Dichanthium sericeum subsp. sericeum*			C		6/3
plants	land plants	Poaceae	*Urochloa holosericea subsp. velutina*			C		1/1
plants	land plants	Poaceae	*Bothriochloa decipiens var. decipiens*			C		2/2
plants	land plants	Poaceae	*Aristida queenslandica var. dissimilis*			C		1
plants	land plants	Poaceae	*Panicum decompositum var. decompositum*			C		24/1
plants	land plants	Poaceae	*Panicum queenslandicum var. acuminatum*			C		2/2
plants	land plants	Poaceae	*Aristida jerichoensis var. jerichoensis*			C		1/1
plants	land plants	Poaceae	*Aristida jerichoensis var. subspinulifera*			C		4/4
plants	land plants	Poaceae	*Aristida queenslandica var. queenslandica*			C		1/1
plants	land plants	Poaceae	*Calyptochloa gracillima subsp. gracillima*			C		3/3
plants	land plants	Poaceae	*Eriachne mucronata forma (Alpha C.E.Hubbard 7882)*			C		2/2
plants	land plants	Poaceae	*Poaceae*					3
plants	land plants	Poaceae	*Aristida*					6
plants	land plants	Poaceae	*Eriachne*					1/1
plants	land plants	Poaceae	*Digitaria*					1/1
plants	land plants	Poaceae	*Eragrostis*					6
plants	land plants	Poaceae	*Paspalidium*					1
plants	land plants	Poaceae	*Perotis rara*	comet grass		C		1/1
plants	land plants	Poaceae	*Eriachne rara*			C		2/2
plants	land plants	Poaceae	*Eulalia aurea*	silky browntop		C		1/1
plants	land plants	Poaceae	*Chloris gayana*	rhodes grass	Y			4

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
plants	land plants	Poaceae	*Melinis repens*	red natal grass	Y			17
plants	land plants	Poaceae	*Chloris inflata*	purpletop chloris	Y			12
plants	land plants	Poaceae	*Chloris virgata*	feathertop rhodes grass	Y			9
plants	land plants	Poaceae	*Eriachne obtusa*			C		3
plants	land plants	Poaceae	*Panicum effusum*			C		4/2
plants	land plants	Poaceae	*Sehima nervosum*			C		1/1
plants	land plants	Poaceae	*Setaria surgens*			C		1/1
plants	land plants	Poaceae	*Aristida ingrata*			C		1/1
plants	land plants	Poaceae	*Chloris truncata*			C		5
plants	land plants	Poaceae	*Eriochloa crebra*	spring grass		C		32/2
plants	land plants	Poaceae	*Themeda avenacea*			C		1
plants	land plants	Poaceae	*Themeda triandra*	kangaroo grass		C		19/1
plants	land plants	Poaceae	*Triraphis mollis*	purple plumegrass		C		1/1
plants	land plants	Poaceae	*Aristida muricata*			C		1/1
plants	land plants	Poaceae	*Astrebla lappacea*	curly mitchell grass		C		7
plants	land plants	Poaceae	*Cenchrus ciliaris*		Y			54/1
plants	land plants	Poaceae	*Digitaria brownii*			C		1/1
plants	land plants	Poaceae	*Digitaria papposa*			C		1/1
plants	land plants	Poaceae	*Enneapogon virens*			C		2/1
plants	land plants	Poaceae	*Entolasia stricta*	wiry panic		C		1
plants	land plants	Poaceae	*Eragrostis pilosa*	soft lovegrass	Y			1/1
plants	land plants	Poaceae	*Eriochloa procera*	slender cupgrass		C		3
plants	land plants	Poaceae	*Mnesithea formosa*			C		1/1
plants	land plants	Poaceae	*Paspalidium rarum*			C		1/1
plants	land plants	Poaceae	*Sporobolus caroli*	fairy grass		C		5
plants	land plants	Poaceae	*Sporobolus creber*			C		15
plants	land plants	Poaceae	*Thellungia advena*	coolibah grass		C		4/1
plants	land plants	Poaceae	*Urochloa piligera*			C		2
plants	land plants	Poaceae	*Aristida benthamii*			C		3
plants	land plants	Poaceae	*Aristida latifolia*	feathertop wiregrass		C		30/2
plants	land plants	Poaceae	*Aristida leptopoda*	white speargrass		C		12
plants	land plants	Poaceae	*Aristida personata*			C		4
plants	land plants	Poaceae	*Astrebla elymoides*	hoop mitchell grass		C		3
plants	land plants	Poaceae	*Astrebla squarrosa*	bull mitchell grass		C		26
plants	land plants	Poaceae	*Chloris divaricata*			C		1/1
plants	land plants	Poaceae	*Chrysopogon fallax*			C		7/4
plants	land plants	Poaceae	*Digitaria bicornis*			C		1
plants	land plants	Poaceae	*Echinochloa colona*	awnless barnyard grass	Y			2/1
plants	land plants	Poaceae	*Eragrostis brownii*	Brown's lovegrass		C		3/2
plants	land plants	Poaceae	*Eragrostis sororia*			C		8/4
plants	land plants	Poaceae	*Eriachne mucronata*			C		1
plants	land plants	Poaceae	*Ophiuros exaltatus*			C		3
plants	land plants	Poaceae	*Aristida gracilipes*			C		1/1
plants	land plants	Poaceae	*Cymbopogon ambiguus*	lemon grass		C		2/1
plants	land plants	Poaceae	*Digitaria ammophila*	silky umbrella grass		C		10/2
plants	land plants	Poaceae	*Digitaria ramularis*			C		1/1

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
plants	land plants	Poaceae	*Enneapogon gracilis*	slender nineawn		C		1/1
plants	land plants	Poaceae	*Enteropogon ramosus*			C		4/1
plants	land plants	Poaceae	*Eragrostis elongata*			C		2/1
plants	land plants	Poaceae	*Eragrostis speciosa*			C		1/1
plants	land plants	Poaceae	*Leptochloa digitata*			C		2
plants	land plants	Poaceae	*Megathyrsus maximus*		Y			2
plants	land plants	Poaceae	*Sporobolus sessilis*			C		1
plants	land plants	Poaceae	*Bothriochloa pertusa*		Y			11/3
plants	land plants	Polygalaceae	*Polygala crassitesta*			C		13
plants	land plants	Polygalaceae	*Polygala pycnantha*			C		1/1
plants	land plants	Polygonaceae	*Persicaria attenuata*			C		1/1
plants	land plants	Pontederiaceae	*Monochoria cyanea*			C		5
plants	land plants	Portulacaceae	*Portulaca pilosa*		Y			1
plants	land plants	Portulacaceae	*Portulaca oleracea*	pigweed	Y			3
plants	land plants	Pottiaceae	*Trichostomum brachydontium*			C		1/1
plants	land plants	Proteaceae	*Hakea lorea subsp. lorea*			C		2/1
plants	land plants	Proteaceae	*Grevillea pteridifolia*	golden parrot tree		C		2/1
plants	land plants	Proteaceae	*Grevillea juncifolia*	honeysuckle spider flower		C		1
plants	land plants	Proteaceae	*Grevillea parallela*			C		1
plants	land plants	Proteaceae	*Hakea chordophylla*			C		1
plants	land plants	Proteaceae	*Persoonia falcata*			C		5
plants	land plants	Proteaceae	*Grevillea striata*	beefwood		C		1
plants	land plants	Proteaceae	*Grevillea*					2
plants	land plants	Pteridaceae	*Adiantum atroviride*			C		1/1
plants	land plants	Pteridaceae	*Cheilanthes sieberi subsp. sieberi*			C		1
plants	land plants	Rhamnaceae	*Alphitonia excelsa*	soap tree		C		3
plants	land plants	Rhamnaceae	*Ventilago viminalis*	supplejack		C		9/1
plants	land plants	Rubiaceae	*Spermacoce brachystema*			C		2
plants	land plants	Rubiaceae	*Pavetta australiensis var. australiensis - Pavetta granitica*			C		1/1
plants	land plants	Rubiaceae	*Paranotis mitrasacmoides subsp. trachymenoides*			C		6
plants	land plants	Rubiaceae	*Psydrax odorata subsp. australiana*			C		1/1
plants	land plants	Rubiaceae	*Psydrax odorata*			C		1
plants	land plants	Rubiaceae	*Pavetta granitica*			C		1/1
plants	land plants	Rubiaceae	*Larsenaikia ochreata*			C		4/3
plants	land plants	Rubiaceae	*Richardia brasiliensis*	white eye	Y			1/1
plants	land plants	Rubiaceae	*Spermacoce multicaulis*			C		1
plants	land plants	Rubiaceae	*Scleromitrion galioides*			C		1/1
plants	land plants	Rubiaceae	*Dolichocarpa coerulescens*			C		1/1
plants	land plants	Rutaceae	*Acronychia laevis*	glossy acronychia		C		1/1
plants	land plants	Rutaceae	*Geijera salicifolia*	brush wilga		C		1/1
plants	land plants	Rutaceae	*Murraya ovatifoliolata*			C		1/1
plants	land plants	Rutaceae	*Flindersia dissosperma*			C		5
plants	land plants	Santalaceae	*Santalum lanceolatum*			C		3
plants	land plants	Sapindaceae	*Dodonaea viscosa subsp. spatulata*			C		1/1
plants	land plants	Sapindaceae	*Alectryon diversifolius*	scrub boonaree		C		2

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
plants	land plants	Sapindaceae	*Atalaya hemiglauca*			C		5
plants	land plants	Sapindaceae	*Dodonaea lanceolata*			C		1
plants	land plants	Sapindaceae	*Alectryon oleifolius subsp. elongatus*			C		3
plants	land plants	Sapindaceae	*Diploglottis macrantha*			C		1
plants	land plants	Sapindaceae	*Atalaya*					5
plants	land plants	Sapotaceae	*Planchonella pohlmaniana*			C		1/1
plants	land plants	Scrophulariaceae	*Eremophila mitchellii*			C		3
plants	land plants	Scrophulariaceae	*Eremophila bignoniiflora*	eurah		C		1
plants	land plants	Scrophulariaceae	*Eremophila longifolia*	berrigan		C		1
plants	land plants	Scrophulariaceae	*Myoporum acuminatum*	coastal boobialla		C		2/1
plants	land plants	Scrophulariaceae	*Eremophila maculata*			C		7
plants	land plants	Scrophulariaceae	*Eremophila deserti*			C		3
plants	land plants	Scrophulariaceae	*Eremophila debilis*	winter apple		C		4
plants	land plants	Solanaceae	*Solanum esuriale*	quena		C		8
plants	land plants	Solanaceae	*Datura stramonium*	common thornapple	Y			3
plants	land plants	Solanaceae	*Solanum adenophorum*			E		1/1
plants	land plants	Solanaceae	*Solanum elachophyllum*			E		1/1
plants	land plants	Solanaceae	*Solanum parvifolium subsp. parvifolium*			C		2/2
plants	land plants	Sparrmanniaceae	*Corchorus trilocularis*			C		15
plants	land plants	Sparrmanniaceae	*Grewia latifolia*	dysentery plant		C		4
plants	land plants	Stylidiaceae	*Stylidium eglandulosum*			C		1/1
plants	land plants	Thymelaeaceae	*Pimelea haematostachya*			C		19
plants	land plants	Thymelaeaceae	*Pimelea microcephala*			C		1
plants	land plants	Verbenaceae	*Lantana camara*	lantana	Y			1
plants	land plants	Verbenaceae	*Glandularia aristigera*		Y			1
plants	land plants	Verbenaceae	*Verbena macrostachya*			C		1
plants	land plants	Violaceae	*Afrohybanthus enneaspermus*			C		1
plants	land plants	Zygophyllaceae	*Tribulus eichlerianus*	bull head		C		1
plants	land plants	Zygophyllaceae	*Tribulus terrestris*	caltrop		C		1

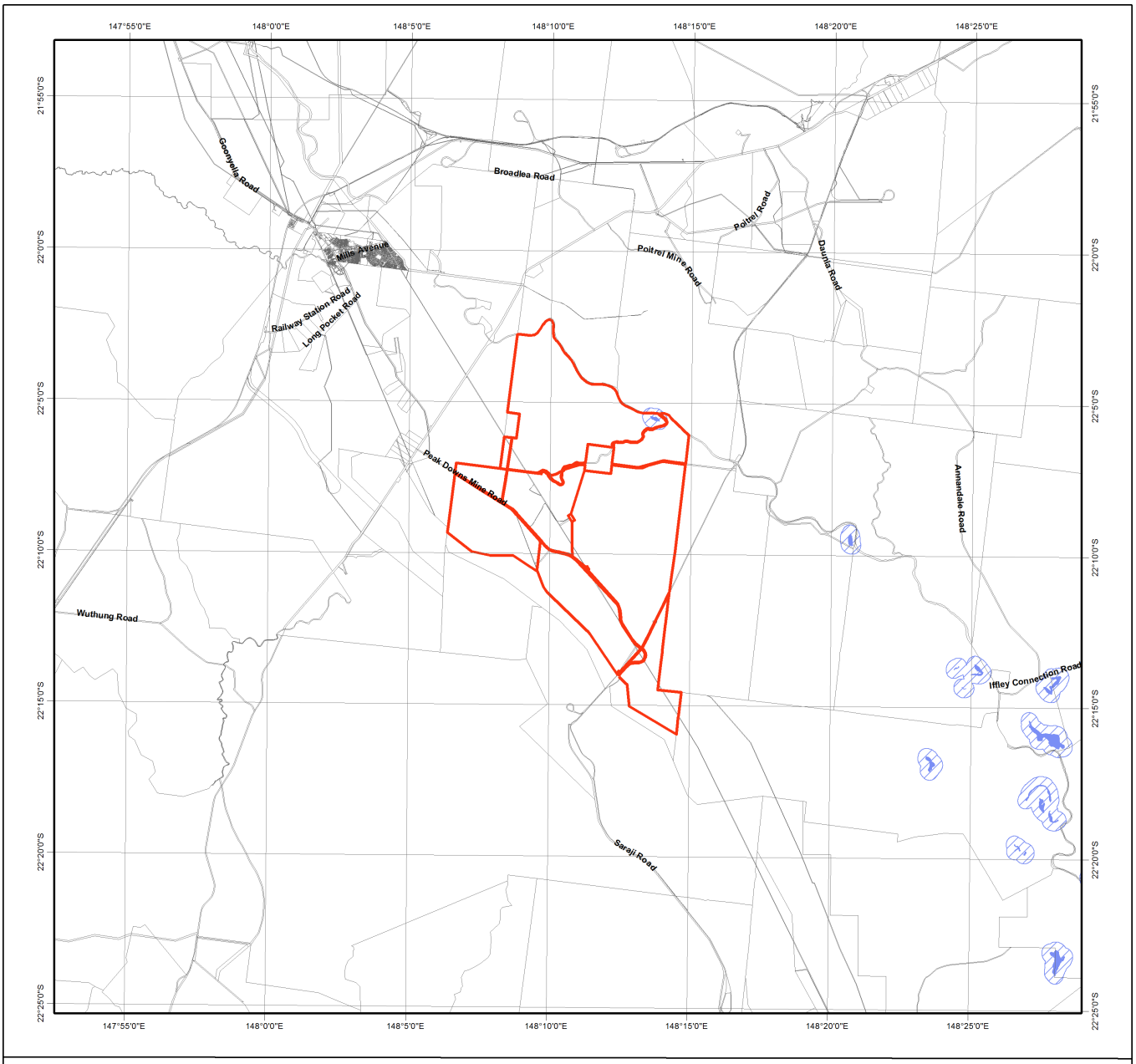
CODES

I - Y indicates that the taxon is introduced to Queensland and has naturalised.

Q - Indicates the Queensland conservation status of each taxon under the *Nature Conservation Act 1992.* The codes are Extinct in the Wild (PE), Endangered (E), Vulnerable (V), Near Threatened (NT), Least Concern (C) or Not Protected ( ).

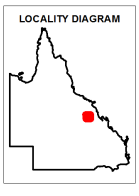
A - Indicates the Australian conservation status of each taxon under the *Environment Protection and Biodiversity Conservation Act 1999.* The values of EPBC are Conservation Dependent (CD), Critically Endangered (CE), Endangered (E), Extinct (EX), Extinct in the Wild (XW) and Vulnerable (V).

Records – The first number indicates the total number of records of the taxon for the record option selected (i.e. All, Confirmed or Specimens).
This number is output as 99999 if it equals or exceeds this value. The second number located after the / indicates the number of specimen records for the taxon.
This number is output as 999 if it equals or exceeds this value.



Map of Great Barrier Reef Wetland Protection Areas

- Selected Lot and Plan
- Cadastral Boundary
- Wetland in a wetland protection area
- Great Barrier Reef wetland protection area



N

Note:
This map shows the location of wetland protection areas which are defined under the Environmental Protection Regulation 2008. Within wetland protection areas, certain types of development involving high impact earthworks are made assessable under Schedule 3 of the Sustainable Planning Regulation 2009.

The Department of State Development, Manufacturing, Infrastructure and Planning is the State Assessment Referral Agency (SARA) under Schedule 7 of the Sustainable Planning Regulation 2009 for assessable development involving high impact earthworks within wetland protection areas. The Department of Environment and Science is a technical agency.

The policy outcome and assessment criteria for assessing these applications are described in the State Development Assessment Provisions (SDAP) *State Code 9 : Great Barrier Reef Wetland Protection Areas.*

This map is produced at a scale relevant to the size of the lot on plan identified and should be printed at A4 size in portrait orientation. Consideration of the effects of mapped scale is necessary when interpreting data at a large scale.

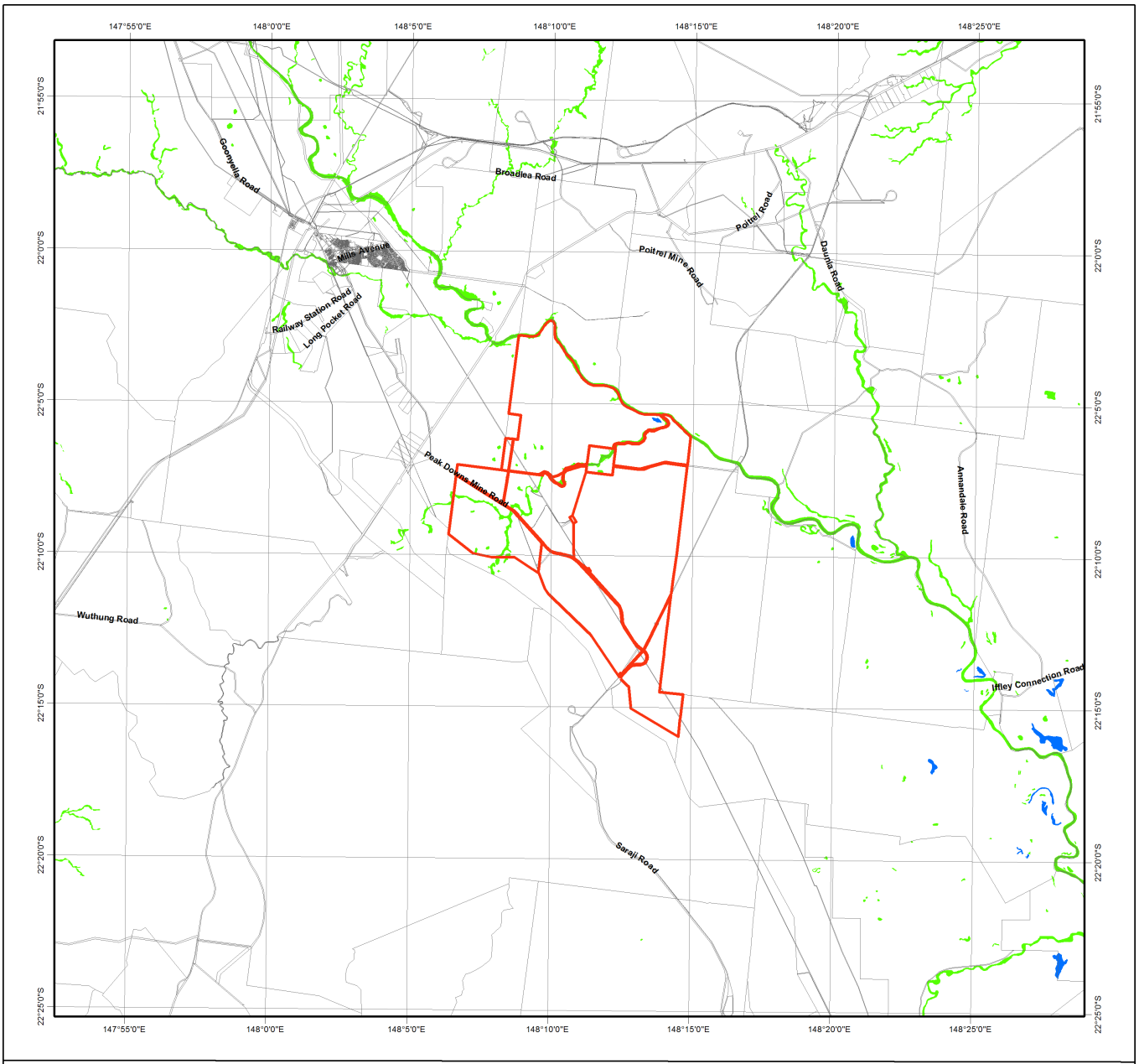
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0 3300 6600 9900 13200 16500 m

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Map of Queensland Wetland Environmental Values

Selected Lot and Plan

Cadastral Boundary

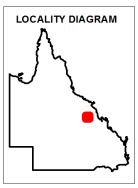
High ecological values waters management intent

Wetlands assessed under section 7

GBR wetland of high ecological significance

Wetland of high ecological significance

Wetland of general ecological significance



N

Note:
This map shows the location of wetlands on the Map of Queensland Wetland Environmental Values under the Environmental Protection (Wetland and Water Biodiversity) Policy 2019. The map also shows high ecological value waters management intent under Schedule 2 of the Environmental Protection (Water and Wetland Biodiversity) Policy 2019.

Wetlands are assessed for ecological significance using the environmental values for wetlands in section 7 of the Environmental Protection (Wetland and Water Biodiversity) Policy 2019. Wetlands are considered either High Ecological Significance (HES) or of General Ecological Significance (GES) for the purposes of the environmental values.

This map is produced at a scale relevant to the size of the lot on plan identified and should be printed at A4 size in portrait orientation. Consideration of the effects of mapped scale is necessary when interpreting data at a large scale.

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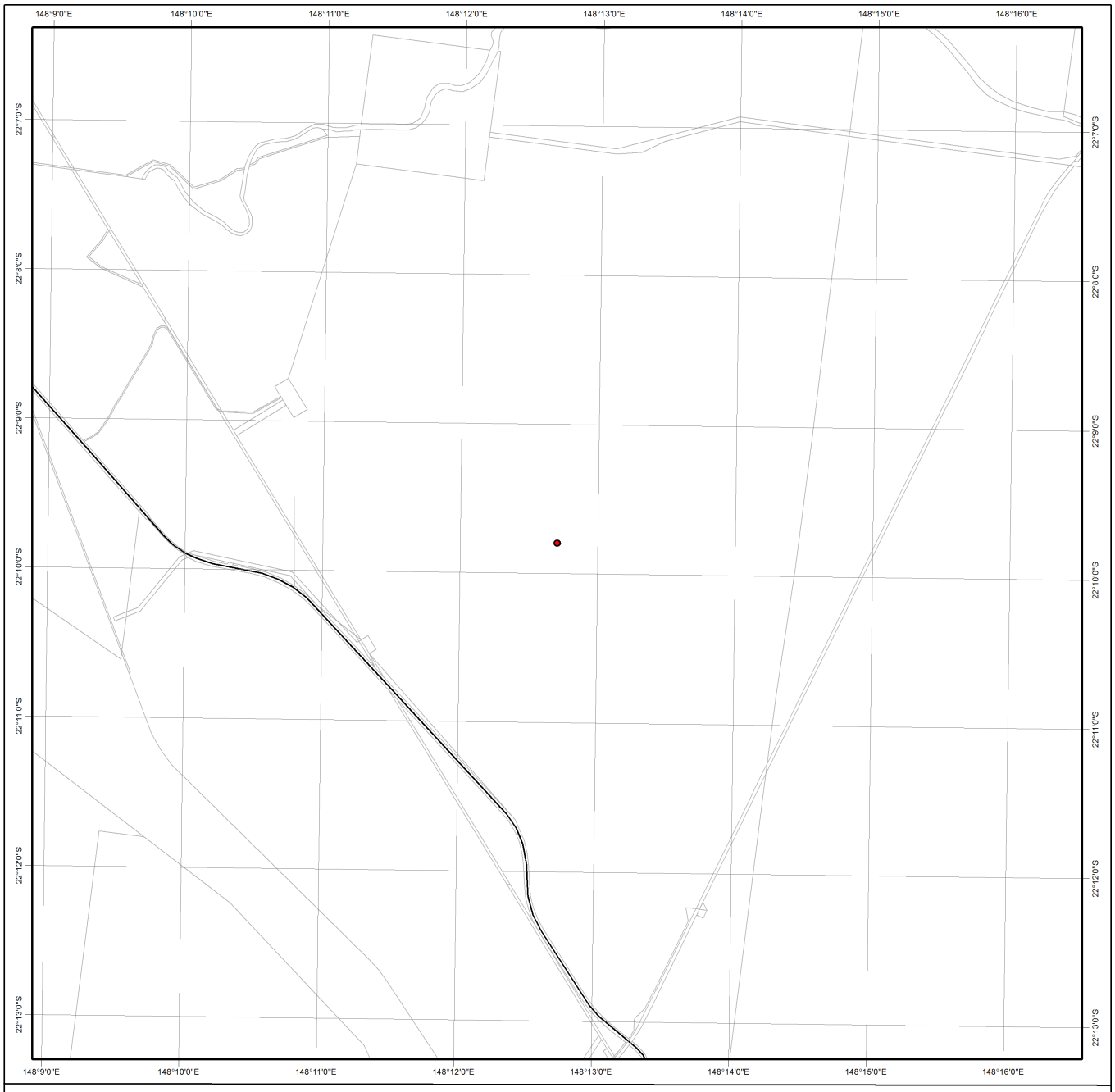
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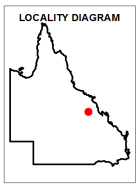
14/04/2021 10:41:32
Longitude: 148.21175 Latitude: -22.16328



Protected Plants Flora Survey Trigger Map

Legend

- Coordinates
- High risk area
- Other land parcel boundaries
- Freeways / motorways / highways
- Secondary roads / streets



N

0 480 960 1,440 1,920 2,400 m

This product is projected into:
GDA 1994 Queensland Albers

This map shows areas where particular provisions of the Nature Conservation Act 1992 apply to the clearing of protected plants.

Land parcel boundaries are provided as locational aid only.

This map is produced at a scale relevant to the size of the area selected and should be printed as A4 size in portrait orientation.

For further information or assistance with interpretation of this product, please contact the Department of Environment and Science at palm@des.qld.gov.au

Disclaimer:
While every care is taken to ensure the accuracy of the data used to generate this product, the Queensland Government makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaim all responsibility and all liability (including without limitation, liability in negligence) for all expenses, losses, damages (including indirect or consequential damages) and costs which might be incurred as a consequence of reliance on the data, or as a result of the data being inaccurate or incomplete in any way and for any reason.

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Protected plants flora survey trigger map

The protected plants flora survey trigger map identifies 'high risk areas' where endangered, vulnerable or near threatened plants are known to exist or are likely to exist. Under the *Nature Conservation Act 1992* (the Act) it is an offence to clear protected plants that are 'in the wild' unless you are authorised or the clearing is exempt, for more information see section 89 of the Act.

Please see the Department of Environment and Science webpage on the clearing of protected plants for information on what exemptions may apply in your circumstances, whether you may need to undertake a flora survey, and whether you may need a protected plants clearing permit.

Updates to the data informing the flora survey trigger map

The flora survey trigger map will be reviewed, and updated if necessary, at least every 12 months to ensure the map reflects the most up-to-date and accurate data available.

Species information

Please note that flora survey trigger maps do not identify species associated with 'high risk areas'. While some species information may be publicly available, for example via the Queensland Spatial Catalogue, the Department of Environment and Science does not provide species information on request. Regardless of whether species information is available for a particular high risk area, clearing plants in a high risk area may require a flora survey and/or clearing permit. Please see the Department of Environment and Science webpage on the clearing of protected plants for more information.

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Table B1: Australia's Virtual Herbarium database results for the search area

Family	Scientific name	NC Act Status[1]
Malvaceae	*Abelmoschus ficulneus*	C
Malvaceae	*Abutilon fraseri*	C
Malvaceae	*Abutilon indicum*	C
Malvaceae	*Abutilon micropetalum*	C
Malvaceae	*Abutilon oxycarpum*	C
Mimosaceae	*Acacia bancroftiorum*	C
Mimosaceae	*Acacia catenulata*	C
Mimosaceae	*Acacia conferta*	C
Mimosaceae	*Acacia cowleana*	C
Mimosaceae	*Acacia crassa*	C
Mimosaceae	*Acacia faucium*	C
Mimosaceae	*Acacia flavescens*	C
Mimosaceae	*Acacia fodinalis*	C
Mimosaceae	*Acacia harpophylla*	C
Mimosaceae	*Acacia holosericea*	C
Mimosaceae	*Acacia julifera*	C
Mimosaceae	*Acacia leiocalyx*	C
Mimosaceae	*Acacia leptocarpa*	C
Mimosaceae	*Acacia leptostachya*	C
Mimosaceae	*Acacia longispicata*	C
Mimosaceae	*Acacia oswaldii*	C
Mimosaceae	*Acacia rhodoxylon*	C
Mimosaceae	*Acacia salicina*	C
Mimosaceae	*Acacia shirleyi*	C
Mimosaceae	***Acacia storyi***	**NT**
Asteraceae	*Acanthospermum hispidum*	*
Amaranthaceae	*Achyranthes aspera*	C
Rutaceae	*Acronychia laevis*	C
Pteridaceae	*Adiantum atroviride*	SL
Euphorbiaceae	*Adriana tomentosa*	C
Fabaceae	*Aeschynomene indica*	C
Violaceae	*Afrohybanthus enneaspermus*	C
Violaceae	*Afrohybanthus stellarioides*	C
Mimosaceae	*Albizia canescens*	C
Sapindaceae	*Alectryon connatus*	C
Sapindaceae	*Alectryon oleifolius subsp. elongatus*	C
Casuarinaceae	*Allocasuarina luehmannii*	C
Poaceae	*Alloteropsis cimicina*	C
Poaceae	*Alloteropsis semialata*	C
Rhamnaceae	*Alphitonia excelsa*	C

Family	Scientific name	NC Act Status[1]
Apocynaceae	*Alstonia constricta*	C
Amaranthaceae	*Alternanthera angustifolia*	C
Amaranthaceae	*Alternanthera nana*	C
Apocynaceae	*Alyxia ruscifolia*	C
Loranthaceae	*Amyema miquelii*	C
Loranthaceae	*Amyema villiflora*	C
Poaceae	*Ancistrachne uncinulata*	C
Myrtaceae	*Angophora costata*	C
Asteraceae	*Apowollastonia spilanthoides*	C
Mimosaceae	*Archidendropsis basaltica*	C
Poaceae	*Aristida benthamii*	C
Poaceae	*Aristida calycina*	C
Poaceae	*Aristida caput-medusae*	C
Poaceae	*Aristida gracilipes*	C
Poaceae	*Aristida holathera*	C
Poaceae	*Aristida ingrata*	C
Poaceae	*Aristida jerichoensis*	C
Poaceae	*Aristida latifolia*	C
Poaceae	*Aristida leptopoda*	C
Poaceae	*Aristida personata*	C
Poaceae	*Aristida queenslandica*	C
Rubiaceae	*Asperula conferta*	C
Poaceae	*Astrebla squarrosa*	C
Sapindaceae	*Atalaya hemiglauca*	C
Chenopodiaceae	*Atriplex lindleyi*	C
Pittosporaceae	*Auranticarpa rhombifolia*	C
Caesalpiniaceae	*Bauhinia carronii*	C
Euphorbiaceae	*Bertya oleifolia*	C
Euphorbiaceae	***Bertya pedicellata***	**NT**
Euphorbiaceae	*Beyeria viscosa*	C
Asteraceae	*Blumea axillaris*	C
Nyctaginaceae	*Boerhavia* sp. (St George A.Hill AQ399299)	C
Convolvulaceae	*Bonamia media*	C
Poaceae	*Bothriochloa bladhii*	C
Poaceae	*Bothriochloa decipiens*	C
Poaceae	*Bothriochloa ewartiana*	C
Poaceae	*Bothriochloa pertusa*	*
Poaceae	*Brachyachne convergens*	C
Poaceae	*Brachyachne tenella*	C
Sterculiaceae	*Brachychiton rupestris*	SL
Phyllanthaceae	*Breynia oblongifolia*	C
Acanthaceae	*Brunoniella australis*	C

Family	Scientific name	NC Act Status[1]
Asphodelaceae	*Bulbine bulbosa*	C
Pittosporaceae	*Bursaria incana*	C
Fabaceae	*Cajanus confertiflorus*	C
Asteraceae	*Calotis cuneifolia*	C
Asteraceae	*Calotis dentex*	C
Asteraceae	*Calotis hispidula*	C
Asteraceae	*Calotis lappulacea*	C
Asteraceae	*Calyptocarpus vialis*	*
Poaceae	*Calyptochloa gracillima*	C
Fabaceae	*Canavalia papuana*	C
Capparaceae	*Capparis canescens*	C
Capparaceae	***Capparis humistrata***	**E**
Capparaceae	*Capparis lasiantha*	C
Capparaceae	*Capparis spinosa*	C
Capparaceae	*Capparis umbonata*	C
Brassicaceae	*Cardamine hirsuta*	*
Apocynaceae	*Carissa spinarum*	C
Apocynaceae	*Cascabela thevetia*	*
Caesalpiniaceae	*Cassia brewsteri*	C
Casuarinaceae	*Casuarina cristata*	C
Casuarinaceae	*Casuarina cunninghamiana*	C
Poaceae	*Cenchrus ciliaris*	*
Poaceae	*Cenchrus pennisetiformis*	*
Apocynaceae	***Cerbera dumicola***	**NT**
Caesalpiniaceae	*Chamaecrista absus*	C
Pteridaceae	*Cheilanthes sieberi*	C
Pteridaceae	*Cheilanthes tenuifolia*	C
Poaceae	*Chloris inflata*	C
Poaceae	*Chloris divaricata*	C
Poaceae	*Chloris gayana*	*
Poaceae	*Chloris virgata*	*
Asteraceae	*Chrysocephalum apiculatum*	C
Poaceae	*Chrysopogon fallax*	C
Rutaceae	*Citrus glauca*	C
Cleomaceae	*Cleome viscosa*	C
Lamiaceae	*Clerodendrum floribundum*	C
Rubiaceae	*Coelospermum reticulatum*	C
Commelinaceae	*Commelina cyanea*	C
Commelinaceae	*Commelina ensifolia*	C
Sparrmanniaceae	*Corchorus trilocularis*	C
Asteraceae	*Coronidium rupicola*	C
Myrtaceae	*Corymbia aureola*	C

Family	Scientific name	NC Act Status[1]
Myrtaceae	*Corymbia citriodora*	C
Myrtaceae	*Corymbia clarksoniana*	C
Myrtaceae	*Corymbia dichromophloia*	C
Myrtaceae	*Corymbia leichhardtii*	C
Myrtaceae	*Corymbia papuana*	C
Myrtaceae	*Corymbia terminalis*	C
Myrtaceae	*Corymbia tessellaris*	C
Myrtaceae	*Corymbia torelliana*	C
Myrtaceae	*Corymbia trachyphloia*	C
Fabaceae	*Crotalaria dissitiflora*	C
Fabaceae	*Crotalaria juncea*	*
Fabaceae	*Crotalaria laburnifolia*	*
Fabaceae	*Crotalaria medicaginea*	C
Euphorbiaceae	*Croton insularis*	C
Cucurbitaceae	*Cucumis myriocarpus*	*
Commelinaceae	*Cyanotis axillaris*	C
Asteraceae	*Cyanthillium cinereum*	C
Poaceae	*Cymbopogon ambiguus*	C
Poaceae	*Cymbopogon bombycinus*	C
Poaceae	*Cymbopogon obtectus*	C
Poaceae	*Cymbopogon queenslandicus*	C
Poaceae	*Cymbopogon refractus*	C
Apocynaceae	*Cynanchum viminale*	C
Poaceae	*Cynodon dactylon*	*
Cyperaceae	*Cyperus alopecuroides*	C
Cyperaceae	*Cyperus compressus*	*
Cyperaceae	*Cyperus difformis*	C
Cyperaceae	*Cyperus fulvus*	C
Cyperaceae	*Cyperus gracilis*	C
Cyperaceae	*Cyperus iria*	C
Cyperaceae	*Cyperus isabellinus*	C
Cyperaceae	*Cyperus javanicus*	C
Cyperaceae	*Cyperus polystachyos*	C
Cyperaceae	*Cyperus rigidellus*	C
Poaceae	*Dactyloctenium radulans*	C
Celastraceae	*Denhamia cunninghamii*	C
Celastraceae	*Denhamia disperma*	C
Fabaceae	*Desmodium brachypodum*	C
Fabaceae	*Desmodium filiforme*	C
Fabaceae	*Desmodium macrocarpum*	C
Fabaceae	*Desmodium tortuosum*	*
Hemerocallidaceae	*Dianella nervosa*	C

Family	Scientific name	NC Act Status[1]
Poaceae	*Dichanthium aristatum*	*
Poaceae	***Dichanthium queenslandicum***	**V**
Poaceae	*Dichanthium sericeum*	C
Poaceae	*Digitaria ammophila*	C
Poaceae	*Digitaria breviglumis*	C
Poaceae	*Digitaria brownii*	C
Poaceae	*Digitaria divaricatissima*	C
Poaceae	*Digitaria eriantha*	*
Poaceae	*Digitaria hystrichoides*	C
Poaceae	*Digitaria ramularis*	C
Poaceae	*Dinebra decipiens*	C
Poaceae	*Dinebra ligulata*	C
Ebenaceae	*Diospyros humilis*	C
Poaceae	*Diplachne fusca*	C
Sapindaceae	*Diploglottis macrantha*	C
Acanthaceae	*Dipteracanthus australasicus*	C
Sapindaceae	*Dodonaea lanceolata*	C
Sapindaceae	*Dodonaea viscosa*	C
Polygonaceae	*Duma florulenta*	C
Chenopodiaceae	*Dysphania melanocarpa*	C
Poaceae	*Echinochloa colona*	*
Chenopodiaceae	*Einadia nutans*	C
Celastraceae	*Elaeodendron australe*	C
Chenopodiaceae	*Enchylaena tomentosa*	C
Poaceae	*Enneapogon gracilis*	C
Poaceae	*Enneapogon nigricans*	C
Poaceae	*Enneapogon polyphyllus*	C
Poaceae	*Enneapogon robustissimus*	C
Poaceae	*Enneapogon virens*	C
Poaceae	*Enteropogon acicularis*	C
Poaceae	*Enteropogon paucispiceus*	C
Poaceae	*Enteropogon ramosus*	C
Poaceae	*Entolasia stricta*	C
Poaceae	*Eragrostis brownii*	C
Poaceae	*Eragrostis elongata*	C
Convolvulaceae	*Eragrostis lacunaria*	C
Poaceae	*Eragrostis longipedicellata*	C
Poaceae	*Eragrostis megalosperma*	C
Poaceae	*Eragrostis parviflora*	C
Poaceae	*Eragrostis sororia*	C
Poaceae	*Eragrostis speciosa*	C
Poaceae	*Eragrostis tenellula*	C

Family	Scientific name	NC Act Status[1]
Poaceae	*Eremochloa bimaculata*	C
Scrophulariaceae	*Eremophila bignoniiflora*	C
Myrtaceae	*Eremophila deserti*	C
Scrophulariaceae	*Eremophila maculata*	C
Scrophulariaceae	*Eremophila mitchellii*	C
Poaceae	*Eriachne mucronata*	C
Poaceae	*Eriachne obtusa*	C
Poaceae	*Eriachne rara*	C
Poaceae	*Eriochloa crebra*	C
Poaceae	*Eriochloa procera*	C
Poaceae	*Eriochloa pseudoacrotricha*	C
Apiaceae	*Eryngium plantagineum*	C
Fabaceae	*Erythrina vespertilio*	C
Erythroxylaceae	*Erythroxylum australe*	C
Myrtaceae	*Eucalyptus alba*	C
Myrtaceae	*Eucalyptus apothalassica*	C
Myrtaceae	*Eucalyptus cambageana*	C
Myrtaceae	*Eucalyptus coolabah*	C
Myrtaceae	*Eucalyptus crebra*	C
Myrtaceae	*Eucalyptus decorticans*	C
Myrtaceae	*Eucalyptus exserta*	C
Myrtaceae	*Eucalyptus melanophloia*	C
Myrtaceae	*Eucalyptus orgadophila*	C
Myrtaceae	*Eucalyptus persistens*	C
Myrtaceae	*Eucalyptus platyphylla*	C
Myrtaceae	*Eucalyptus populnea*	C
Myrtaceae	*Eucalyptus tereticornis*	C
Myrtaceae	*Eucalyptus tholiformis*	C
Myrtaceae	*Eucalyptus thozetiana*	C
Myrtaceae	*Eucalyptus victrix*	C
Poaceae	*Eulalia aurea*	C
Euphorbiaceae	*Euphorbia drummondii*	C
Euphorbiaceae	*Euphorbia tannensis*	C
Laxmanniaceae	*Eustrephus latifolius*	C
Convolvulaceae	*Evolvulus alsinoides*	C
Santalaceae	*Exocarpos latifolius*	C
Moraceae	*Ficus opposita*	C
Cyperaceae	*Fimbristylis dichotoma*	C
Rutaceae	*Flindersia australis*	C
Rutaceae	*Flindersia dissosperma*	C
Phyllanthaceae	*Flueggea leucopyrus*	C
Fabaceae	*Galactia tenuiflora*	C

Family	Scientific name	NC Act Status[1]
Asteraceae	*Gamochaeta pensylvanica*	*
Rutaceae	*Geijera parviflora*	C
Rutaceae	*Geijera salicifolia*	C
Molluginaceae	*Glinus lotoides*	C
Phrymaceae	*Glossostigma diandrum*	C
Fabaceae	*Glycine latifolia*	C
Fabaceae	*Glycine tabacina*	C
Fabaceae	*Glycine tomentella*	C
Amaranthaceae	*Gomphrena celosioides*	*
Haloragaceae	*Gonocarpus acanthocarpus*	C
Goodeniaceae	*Goodenia* sp. (Mt Castletower M.D.Crisp 2753)	C
Goodeniaceae	*Goodenia glabra*	C
Goodeniaceae	*Goodenia grandiflora*	C
Myrtaceae	*Gossia bidwillii*	C
Malvaceae	*Gossypium australe*	C
Proteaceae	*Grevillea latifolia*	C
Proteaceae	*Grevillea parallela*	C
Proteaceae	*Grevillea pteridifolia*	C
Proteaceae	*Grevillea striata*	C
Sparrmanniaceae	*Grewia latifolia*	C
Sparrmanniaceae	*Grewia retusifolia*	C
Sparrmanniaceae	*Grewia retusifolia*	C
Amaranthaceae	*Guilleminea densa*	*
Proteaceae	*Hakea lorea*	C
Byttneriaceae	*Hannafordia shanesii*	C
Poaceae	*Heteropogon contortus*	C
Malvaceae	*Hibiscus brachysiphonius*	C
Malvaceae	*Hibiscus cannabinus*	C
Malvaceae	*Hibiscus divaricatus*	C
Malvaceae	*Hibiscus* sp. (Emerald S.L.Everist 2124)	C
Malvaceae	*Hibiscus heterophyllus*	C
Malvaceae	*Hibiscus krichauffianus*	C
Malvaceae	*Hibiscus splendens*	C
Malvaceae	*Hibiscus sturtii*	C
Malvaceae	*Hibiscus verdcourtii*	C
Apocynaceae	*Hoya australis*	C
Violaceae	*Hybanthus enneaspermus*	C
Violaceae	*Hybanthus stellarioides*	C
Poaceae	*Hyparrhenia rufa*	*
Clusiaceae	*Hypericum gramineum*	C
Fabaceae	*Indigofera colutea*	C
Fabaceae	*Indigofera hirsuta*	C

Family	Scientific name	NC Act Status[1]
Fabaceae	*Indigofera pratensis*	C
Convolvulaceae	*Ipomoea brownii*	C
Convolvulaceae	*Ipomoea calobra*	C
Convolvulaceae	*Ipomoea eriocarpa*	C
Convolvulaceae	*Ipomoea gracilis*	C
Convolvulaceae	*Ipomoea plebeia*	C
Convolvulaceae	*Ipomoea polymorpha*	C
Poaceae	*Iseilema vaginiflorum*	C
Convolvulaceae	*Jacquemontia paniculata*	C
Juncaceae	*Juncus subglaucus*	C
Fabaceae	*Lablab purpureus*	*
Rubiaceae	*Larsenaikia ochreata*	C
Laxmanniaceae	*Laxmannia gracilis*	C
Lamiaceae	*Leucas lavandulifolia*	*
Campanulaceae	*Lobelia concolor*	SL
Laxmanniaceae	*Lomandra longifolia*	C
Myrtaceae	*Lophostemon grandiflorus*	C
Onagraceae	*Ludwigia octovalvis*	C
Loranthaceae	*Lysiana subfalcata*	C
Myrtaceae	*Lysicarpus angustifolius*	C
Fabaceae	*Macroptilium atropurpureum*	*
Chenopodiaceae	*Maireana microphylla*	C
Malvaceae	*Malvastrum americanum* var. *americanum*	*
Apocynaceae	*Marsdenia australis*	C
Plantaginaceae	*Mecardonia procumbens*	*
Poaceae	*Megathyrsus maximus*	*
Myrtaceae	*Melaleuca bracteata*	C
Myrtaceae	*Melaleuca fluviatilis*	C
Myrtaceae	*Melaleuca nervosa*	C
Pentapetaceae	*Melhania oblongifolia*	C
Poaceae	*Melinis repens*	*
Convolvulaceae	*Merremia dissecta*	C
Myrtaceae	*Micromyrtus capricornia*	C
Loganiaceae	*Mitrasacme micrantha*	C
Loganiaceae	*Mitrasacme pygmaea*	C
Poaceae	*Moorochloa eruciformis*	*
Rutaceae	*Murraya paniculata*	*
Scrophulariaceae	*Myoporum acuminatum*	C
Myrsinaceae	*Myrsine variabilis*	C
Mimosaceae	*Neptunia dimorphantha*	C
Mimosaceae	*Neptunia monosperma*	C
Solanaceae	*Nicotiana megalosiphon*	C

Family	Scientific name	NC Act Status[1]
Menyanthaceae	*Nymphoides geminata*	SL
Amaranthaceae	*Nyssanthes erecta*	C
Lamiaceae	*Ocimum tenuiflorum*	C
Rubiaceae	*Oldenlandia coerulescens*	C
Rubiaceae	*Oldenlandia galioides*	C
Rubiaceae	*Oldenlandia mitrasacmoides*	C
Boraginaceae	*Omphalolappula concava*	C
Cactaceae	*Opuntia stricta*	*(RI)
Cactaceae	*Opuntia tomentosa*	*(RI)
Meliaceae	*Owenia acidula*	C
Meliaceae	*Owenia reliqua*	C
Oxalidaceae	*Oxalis radicosa*	C
Poaceae	*Panicum decompositum*	C
Poaceae	*Panicum effusum*	C
Poaceae	*Panicum queenslandicum*	C
Poaceae	*Panicum simile*	C
Apocynaceae	*Parsonsia eucalyptophylla*	C
Apocynaceae	*Parsonsia lanceolata*	C
Apocynaceae	*Parsonsia straminea*	C
Asteraceae	*Parthenium hysterophorus*	*(RI)
Poaceae	*Paspalidium albovillosum*	C
Poaceae	*Paspalidium caespitosum*	C
Poaceae	*Paspalidium criniforme*	C
Poaceae	*Paspalidium globoideum*	C
Poaceae	*Paspalidium rarum*	C
Poaceae	*Paspalum mandiocanum*	*
Passifloraceae	*Passiflora foetida*	*
Rubiaceae	*Pavetta australiensis*	C
Rubiaceae	*Pavetta granitica*	C
Poaceae	*Perotis rara*	C
Polygonaceae	*Persicaria attenuata*	C
Proteaceae	*Persoonia amaliae*	C
Proteaceae	*Persoonia falcata*	C
Picrodendraceae	*Petalostigma pubescens*	C
Caesalpiniaceae	*Petalostylis labicheoides*	C
Verbenaceae	*Phyla nodiflora*	C
Phyllanthaceae	*Phyllanthus carpentariae*	C
Phyllanthaceae	*Phyllanthus simplex*	C
Phyllanthaceae	*Phyllanthus virgatus*	C
Thymelaeaceae	*Pimelea haematostachya*	C
Pittosporaceae	*Pittosporum angustifolium*	C
Pittosporaceae	*Pittosporum spinescens*	C

Family	Scientific name	NC Act Status[1]
Sapotaceae	*Planchonella pohlmaniana*	C
Lamiaceae	*Plectranthus diversus*	C
Caryophyllaceae	*Polycarpaea corymbosa*	C
Polygalaceae	*Polygala pycnantha*	C
Polygonaceae	*Polygonum plebeium*	C
Portulacaceae	*Portulaca filifolia*	C
Portulacaceae	*Portulaca oleracea*	*
Asteraceae	*Praxelis clematidea*	*
Lamiaceae	*Prostanthera collina*	C
Acanthaceae	*Pseuderanthemum variabile*	C
Asteraceae	*Pseudognaphalium luteoalbum*	C
Poaceae	*Pseudoraphis paradoxa*	C
Rubiaceae	*Psydrax forsteri*	C
Rubiaceae	*Psydrax odorata*	C
Rubiaceae	*Psydrax saligna*	C
Asteraceae	*Pterocaulon redolens*	C
Asteraceae	*Pterocaulon serrulatum*	C
Fabaceae	*Pycnospora lutescens*	C
Ranunculaceae	*Ranunculus sceleratus*	*
Myrtaceae	*Rhodamnia pauciovulata*	C
Fabaceae	*Rhynchosia australis*	C
Fabaceae	*Rhynchosia minima*	C
Rubiaceae	*Richardia brasiliensis*	*
Zygophyllaceae	*Roepera apiculata*	C
Acanthaceae	*Rostellularia adscendens*	C
Asteraceae	*Rutidosis leucantha*	C
Chenopodiaceae	*Salsola australis*	C
Santalaceae	*Santalum lanceolatum*	SL
Goodeniaceae	*Scaevola depauperata*	C
Poaceae	*Schizachyrium fragile*	C
Cyperaceae	*Scleria brownii*	C
Cyperaceae	*Scleria sphacelata*	C
Chenopodiaceae	*Sclerolaena tetracuspis*	C
Plantaginaceae	*Scoparia dulcis*	*
Poaceae	*Sehima nervosum*	C
Caesalpiniaceae	*Senna artemisioides*	C
Caesalpiniaceae	*Senna clavigera*	C
Caesalpiniaceae	*Senna coronilloides*	C
Caesalpiniaceae	*Senna costata*	C
Caesalpiniaceae	*Senna gaudichaudii*	C
Byttneriaceae	*Seringia hookeriana*	C
Fabaceae	*Sesbania campylocarpa*	C

Family	Scientific name	NC Act Status[1]
Poaceae	*Setaria oplismenoides*	C
Poaceae	*Setaria paspalidioides*	C
Poaceae	*Setaria surgens*	C
Malvaceae	*Sida* sp. (Aramac E.J.Thompson+ JER192)	C
Malvaceae	*Sida atherophora*	C
Malvaceae	*Sida cordifolia*	*
Malvaceae	*Sida everistiana*	C
Malvaceae	*Sida fibulifera*	C
Malvaceae	*Sida hackettiana*	C
Malvaceae	*Sida pleiantha*	C
Malvaceae	*Sida rohlenae*	C
Malvaceae	*Sida spinosa*	*
Malvaceae	*Sida trichopoda*	C
Solanaceae	***Solanum adenophorum***	**E**
Solanaceae	***Solanum elachophyllum***	**E**
Solanaceae	*Solanum esuriale*	C
Solanaceae	*Solanum galbinum*	C
Solanaceae	*Solanum parvifolium*	C
Solanaceae	*Solanum seaforthianum*	*
Solanaceae	*Solanum stelligerum*	C
Poaceae	*Sorghum plumosum*	C
Rubiaceae	*Spermacoce multicaulis*	C
Asteraceae	*Sphaeromorphaea australis*	C
Asteraceae	*Sphaeromorphaea littoralis*	C
Asteraceae	*Sphaeromorphaea subintegra*	C
Poaceae	*Sporobolus advenus*	C
Poaceae	*Sporobolus australasicus*	C
Poaceae	*Sporobolus caroli*	C
Poaceae	*Sporobolus scabridus*	C
Loganiaceae	*Strychnos psilosperma*	C
Stylidiaceae	*Stylidium eglandulosum*	SL
Fabaceae	*Stylosanthes hamata*	*
Fabaceae	*Swainsona galegifolia*	C
Fabaceae	*Swainsona luteola*	C
Fabaceae	*Swainsona queenslandica*	C
Phyllanthaceae	*Synostemon rhytidospermus*	C
Fabaceae	*Tephrosia dietrichiae*	C
Fabaceae	*Tephrosia filipes*	C
Combretaceae	*Terminalia oblongata*	C
Lamiaceae	*Teucrium integrifolium*	C
Lamiaceae	*Teucrium junceum*	C
Lamiaceae	*Teucrium puberulum*	C

Family	Scientific name	NC Act Status[1]
Poaceae	*Themeda avenacea*	C
Poaceae	*Themeda triandra*	C
Menispermaceae	*Tinospora smilacina*	C
Aizoaceae	*Trianthema triquetrum*	C
Asteraceae	*Tridax procumbens*	*
Poaceae	*Triraphis mollis*	C
Meliaceae	*Turraea pubescens*	C
Poaceae	*Urochloa foliosa*	C
Poaceae	*Urochloa holosericea*	C
Poaceae	*Urochloa mosambicensis*	*
Poaceae	*Urochloa piligera*	C
Mimosaceae	*Vachellia bidwillii*	C
Rhamnaceae	*Ventilago viminalis*	C
Asteraceae	*Verbesina encelioides*	*
Fabaceae	*Vigna vexillata*	C
Asteraceae	*Vittadinia pustulata*	C
Asteraceae	*Vittadinia sulcata*	C
Campanulaceae	*Wahlenbergia gracilis*	SL
Campanulaceae	*Wahlenbergia queenslandica*	SL
Poaceae	*Walwhalleya subxerophila*	C
Thymelaeaceae	*Wikstroemia indica*	C
Apocynaceae	*Wrightia saligna*	C
Apocynaceae	*Wrightia versicolor*	C
Convolvulaceae	*Xenostegia tridentata*	C
Fabaceae	*Zornia areolata*	C
Fabaceae	*Zornia dyctiocarpa*	C
Fabaceae	*Zornia muelleriana*	C
Fabaceae	*Zornia muriculata*	C
Fabaceae	*Zornia prostrata*	C

[1]Status: NC Act status: E, Endangered; V, Vulnerable; SL, Special least concern; C, Least concern; * introduced taxa; RI; Restricted invasive plant under *Biosecurity Act 2014*

Table B2: Atlas of Living Australia database results for the search area

Family	Common name	Species name	NC Act Status[1]
Amphibians			
Limnodynastidae	Brown-striped Frog	*Limnodynastes peronii*	C
Bufonidae	Cane Toad	*Rhinella marina*	*
Limnodynastidae	Crucifix Frog	*Notaden bennettii*	C
Hylidae	Eastern Dwarf Tree Frog	*Litoria fallax*	C
Hylidae	Green Tree Frog	*Litoria caerulea*	C
Hylidae	Gunther's Frog	*Litoria latopalmata*	C
Hylidae	New Holland Frog	*Cyclorana novaehollandiae*	C
Limnodynastidae	Ornate Burrowing Frog	*Platyplectrum ornatum*	C
Hylidae	Peters' Frog	*Litoria inermis*	C
Hylidae	Red Tree Frog	*Litoria rubella*	C
Hylidae	Roth's Tree Frog	*Litoria rothii*	C
Hylidae	Rough Frog	*Cyclorana verrucosa*	C
Limnodynastidae	Salmon Striped Frog	*Limnodynastes salmini*	C
Hylidae	Short-footed Frog	*Cyclorana brevipes*	C
Limnodynastidae	Spotted Grass Frog	*Limnodynastes tasmaniensis*	C
Hylidae	Striped Burrowing Frog	*Cyclorana alboguttata*	C
Hylidae	Water-holding Frog	*Cyclorana platycephala*	C
Birds			
Corcoracidae	Apostlebird	*Struthidea cinerea*	C
Anhingidae	Australasian Darter	*Anhinga novaehollandiae*	C
Oriolidae	Australasian Figbird	*Sphecotheres vieilloti*	C
Podicipedidae	Australasian Little Grebe	*Tachybaptus novaehollandiae*	C
Recurvirostridae	Australasian pied stilt	*Himantopus himantopus*	C
Falconidae	Australian Hobby	*Falco longipennis*	C
Artamidae	Australian Magpie	*Gymnorhina tibicen*	C
Aegothelidae	Australian Owlet-nightjar	*Aegotheles cristatus*	C
Pelecanidae	Australian pelican	*Pelecanus conspicillatus*	C
Motacillidae	Australian Pipit	*Anthus novaeseelandiae*	C
Corvidae	Australian Raven	*Corvus coronoides*	C
Acrocephalidae	Australian Reed Warbler	*Acrocephalus australis*	C
Rallidae	Australian Spotted Crake	*Porzana fluminea*	C
Threskiornithidae	Australian White Ibis	*Threskiornis moluccus*	C
Alcedinidae	Azure Kingfisher	*Ceyx azureus*	C
Strigidae	Barking Owl	*Ninox connivens*	C

Family	Common name	Species name	NC Act Status[1]
Tytonidae	Barn Owl	*Tyto alba*	C
Columbidae	Bar-shouldered Dove	*Geopelia humeralis*	C
Ardeidae	Black Bittern	*Ixobrychus flavicollis*	C
Falconidae	Black Falcon	*Falco subniger*	C
Meliphagidae	Black Honeyeater	*Sugomel niger*	C
Accipitridae	Black Kite	*Milvus migrans*	C
Anatidae	Black Swan	*Cygnus atratus*	C
Accipitridae	Black-breasted Buzzard	*Hamirostra melanosternon*	C
Meliphagidae	Black-chinned Honeyeater	*Melithreptus gularis*	C
Campephagidae	Black-faced cuckoo-shrike	*Coracina novaehollandiae*	C
Monarchidae	**Black-faced Monarch**	***Monarcha melanopsis***	**SL**
Artamidae	Black-faced Woodswallow	*Artamus cinereus*	C
Charadriidae	Black-fronted Dotterel	*Elseyornis melanops*	C
Ciconiidae	Black-necked Stork	*Ephippiorhynchus asiaticus*	C
Accipitridae	Black-shouldered Kite	*Elanus axillaris*	C
Rallidae	Black-tailed Native-hen	*Tribonyx ventralis*	C
Meliphagidae	Blue-faced Honeyeater	*Entomyzon cyanotis*	C
Alcedinidae	Blue-winged Kookaburra	*Dacelo leachii*	C
Gruidae	Brolga	*Grus rubicunda*	C
Falconidae	Brown Falcon	*Falco berigora*	C
Meliphagidae	Brown Honeyeater	*Lichmera indistincta*	C
Megaluridae	Brown Songlark	*Cincloramphus cruralis*	C
Climacteridae	Brown Treecreeper	*Climacteris picumnus*	C
Psittacidae	Budgerigar	*Melopsittacus undulatus*	C
Acanthizidae	Buff-rumped Thornbill	*Acanthiza reguloides*	C
Burhinidae	Bush Stone-curlew	*Burhinus grallarius*	C
Laridae	**Caspian Tern**	***Hydroprogne caspia***	**SL**
Ardeidae	Cattle Egret	*Ardea ibis*	C
Cuculidae	Channel-billed Cuckoo	*Scythrops novaehollandiae*	C
Estrildidae	Chestnut-breasted Munia	*Lonchura castaneothorax*	C
Campephagidae	Cicadabird	*Coracina tenuirostris*	C
Cacatuidae	Cockatiel	*Nymphicus hollandicus*	C
Accipitridae	Collared Sparrowhawk	*Accipiter cirrocephalus*	C
Jacanidae	Comb-crested Jacana	*Irediparra gallinacea*	C
Columbidae	Common Bronzewing	*Phaps chalcoptera*	C
Sturnidae	Common myna	*Acridotheres tristis*	C
Anatidae	Cotton Pygmy-goose	*Nettapus coromandelianus*	C

Family	Common name	Species name	NC Act Status[1]
Oreoididae	Crested Bellbird	*Oreoica gutturalis*	C
Podicipedidae	Crested Grebe	*Podiceps cristatus*	C
Columbidae	Crested Pigeon	*Ocyphaps lophotes*	C
Columbidae	Diamond Dove	*Geopelia cuneata*	C
Estrildidae	Double-barred Finch	*Stizoptera bichenovii*	C
Meliphagidae	Dusky Honeyeater	*Myzomela obscura*	C
Rallidae	Dusky Moorhen	*Gallinula tenebrosa*	C
Artamidae	Dusky Woodswallow	*Artamus cyanopterus*	C
Tytonidae	Eastern Barn Owl	*Tyto javanica*	C
Coraciidae	Eastern broad-billed Roller	*Eurystomus orientalis*	C
Ardeidae	Eastern Great Egret	*Ardea modesta*	C
Petroicidae	Eastern Yellow Robin	*Eopsaltria australis*	C
Casuariidae	Emu	*Dromaius novaehollandiae*	C
Rallidae	Eurasian Coot	*Fulica atra*	C
Hirundinidae	Fairy Martin	*Petrochelidon ariel*	C
Cuculidae	Fan-tailed Cuckoo	*Cacomantis flabelliformis*	C
Alcedinidae	Forest Kingfisher	*Todiramphus macleayii*	C
Anatidae	Freckled Duck	*Stictonetta naevosa*	C
Cacatuidae	Galah	*Eolophus roseicapilla*	C
Cacatuidae	**Glossy Black-cockatoo**	***Calyptorhynchus lathami***	**V**
Threskiornithidae	**Glossy Ibis**	***Plegadis falcinellus***	**SL**
Cisticolidae	Golden-headed Cisticola	*Cisticola exilis*	C
Ptilonorhynchidae	Great Bowerbird	*Ptilonorhynchus nuchalis*	C
Phalacrocoracidae	Great Cormorant	*Phalacrocorax carbo*	C
Anatidae	Green Pygmy-goose	*Nettapus pulchellus*	C
Scolopacidae	Greenshank	*Tringa nebularia*	C
Artamidae	Grey Butcherbird	*Cracticus torquatus*	C
Anatidae	Grey duck	*Anas superciliosa*	C
Rhipiduridae	Grey Fantail	*Rhipidura albiscapa*	C
Accipitridae	Grey Goshawk	*Accipiter novaehollandiae*	C
Phasianidae	Grey Quail	*Coturnix pectoralis*	C
Pachycephalidae	Grey Shrike-thrush	*Colluricincla harmonica*	C
Anatidae	Grey teal	*Anas gracilis*	C
Anatidae	Grey Whistler	*Dendrocygna eytoni*	C
Pomatostomidae	Grey-crowned Babbler	*Pomatostomus temporalis*	C
Campephagidae	Ground Cuckoo-shrike	*Coracina maxima*	C
Laridae	**Gull-billed Tern**	***Gelochelidon nilotica***	**SL**

Family	Common name	Species name	NC Act Status[1]
Anatidae	Hardhead	*Aythya australis*	C
Podicipedidae	Hoary-headed Grebe	*Poliocephalus poliocephalus*	C
Cuculidae	Horsfield's Bronze-cuckoo	*Chalcites basalis*	C
Alaudidae	Horsfield's Bushlark	*Mirafra javanica*	C
Passeridae	House sparrow	*Passer domesticus*	C
Acanthizidae	Inland Thornbill	*Acanthiza apicalis*	C
Ardeidae	Intermediate Egret	*Ardea intermedia*	C
Petroicidae	Jacky Winter	*Microeca fascinans*	C
Accipitridae	Kahu	*Circus approximans*	C
Alcedinidae	Kookaburra	*Dacelo novaeguineae*	C
Monarchidae	Leaden Flycatcher	*Myiagra rubecula*	C
Accipitridae	Letter-winged Kite	*Elanus scriptus*	C
Meliphagidae	Lewin's Honeyeater	*Meliphaga lewinii*	C
Phalacrocoracidae	Little Black Cormorant	*Phalacrocorax sulcirostris*	C
Cuculidae	Little Bronze-cuckoo	*Chalcites minutillus*	C
Cacatuidae	Little Corella	*Cacatua sanguinea*	C
Corvidae	Little Crow	*Corvus bennetti*	C
Accipitridae	Little Eagle	*Hieraaetus morphnoides*	C
Ardeidae	Little Egret	*Egretta garzetta*	C
Meliphagidae	Little Friarbird	*Philemon citreogularis*	C
Psittacidae	Little Lorikeet	*Parvipsitta pusilla*	C
Phalacrocoracidae	Little Pied Cormorant	*Microcarbo melanoleucos*	C
Artamidae	Little Woodswallow	*Artamus minor*	C
Anseranatidae	Magpie Goose	*Anseranas semipalmata*	C
Monarchidae	Magpie-lark	*Grallina cyanoleuca*	C
Anatidae	Maned Duck	*Chenonetta jubata*	C
Scolopacidae	Marsh sandpiper	*Tringa stagnatilis*	C
Charadriidae	Masked Lapwing	*Vanellus miles*	C
Artamidae	Masked Woodswallow	*Artamus personatus*	C
Nectariniidae	Mistletoebird	*Dicaeum hirundinaceum*	C
Anatidae	Musk Duck	*Biziura lobata*	C
Falconidae	Nankeen Kestrel	*Falco cenchroides*	C
Ardeidae	Nankeen night heron	*Nycticorax caledonicus*	C
Meliphagidae	Noisy Friarbird	*Philemon corniculatus*	C
Meliphagidae	Noisy Miner	*Manorina melanocephala*	C
Oriolidae	Olive-backed Oriole	*Oriolus sagittatus*	C
Accipitridae	Pacific Baza	*Aviceda subcristata*	C

Family	Common name	Species name	NC Act Status[1]
Cuculidae	Pacific Koel	*Eudynamys orientalis*	C
Turnicidae	Painted Button-quail	*Turnix varius*	C
Psittacidae	Pale-headed Rosella	*Platycercus adscitus*	C
Cuculidae	Pallid Cuckoo	*Cacomantis pallidus*	C
Columbidae	Peaceful Dove	*Geopelia striata*	C
Falconidae	Peregrine Falcon	*Falco peregrinus*	C
Centropodidae	Pheasant Coucal	*Centropus phasianinus*	C
Estrildidae	Pictorella Mannikin	*Heteromunia pectoralis*	C
Artamidae	Pied Butcherbird	*Cracticus nigrogularis*	C
Phalacrocoracidae	Pied Cormorant	*Phalacrocorax varius*	C
Artamidae	Pied Currawong	*Strepera graculina*	C
Recurvirostridae	Pied Stilt	*Himantopus himantopus*	C
Anatidae	Pink-ear	*Malacorhynchus membranaceus*	C
Estrildidae	Plum-headed Finch	*Neochmia modesta*	C
Rallidae	Purple Swamphen	*Porphyrio porphyrio*	C
Meropidae	Rainbow Bee-eater	*Merops ornatus*	C
Psittacidae	Rainbow Lorikeet	*Trichoglossus haematodus*	C
Turnicidae	Red-backed Button-quail	*Turnix maculosus*	C
Maluridae	Red-backed Fairy-wren	*Malurus melanocephalus*	C
Alcedinidae	Red-backed Kingfisher	*Todiramphus pyrrhopygius*	C
Estrildidae	Red-browed Finch	*Neochmia temporalis*	C
Petroicidae	Red-capped Robin	*Petroica goodenovii*	C
Meliphagidae	Red-headed Honeyeater	*Myzomela erythrocephala*	C
Charadriidae	Red-kneed Dotterel	*Erythrogonys cinctus*	C
Psittacidae	Red-winged Parrot	*Aprosmictus erythropterus*	C
Monarchidae	Restless Flycatcher	*Myiagra inquieta*	C
Columbidae	Rock Dove	*Columba livia*	C
Threskiornithidae	Royal Spoonbill	*Platalea regia*	C
Rhipiduridae	**Rufous Fantail**	***Rhipidura rufifrons***	**SL**
Megaluridae	Rufous Songlark	*Cincloramphus mathewsi*	C
Pachycephalidae	Rufous Whistler	*Pachycephala rufiventris*	C
Alcedinidae	Sacred Kingfisher	*Todiramphus sanctus*	C
Psittacidae	Scaly-breasted Lorikeet	*Trichoglossus chlorolepidotus*	C
Meliphagidae	Scarlet Honeyeater	*Myzomela sanguinolenta*	C
Scolopacidae	**Sharp-tailed Sandpiper**	***Calidris acuminata***	**SL**
Cuculidae	Shining Bronze-cuckoo	*Chalcites lucidus*	C
Cuculidae	Shining cuckoo	*Chrysococcyx lucidus*	C

Family	Common name	Species name	NC Act Status[1]
Laridae	Silver Gull	*Chroicocephalus novaehollandiae*	C
Timaliidae	Silvereye	*Zosterops lateralis*	C
Meliphagidae	Singing Honeyeater	*Gavicalis virescens*	C
Strigidae	Southern Boobook	*Ninox novaeseelandiae*	C
Dicruridae	Spangled Drongo	*Dicrurus bracteatus*	C
Acanthizidae	Speckled Warbler	*Chthonicola sagittata*	C
Meliphagidae	Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*	C
Ptilonorhynchidae	Spotted Bowerbird	*Ptilonorhynchus maculatus*	C
Accipitridae	Spotted Harrier	*Circus assimilis*	C
Charadriidae	Spur-winged plover	*Vanellus miles*	C
Columbidae	**Squatter Pigeon**	***Geophaps scripta***	**V**
Threskiornithidae	Straw-necked Ibis	*Threskiornis spinicollis*	C
Pardalotidae	Striated Pardalote	*Pardalotus striatus*	C
Meliphagidae	Striped Honeyeater	*Plectorhyncha lanceolata*	C
Cacatuidae	Sulphur-crested Cockatoo	*Cacatua galerita*	C
Maluridae	Superb Fairy-wren	*Malurus cyaneus*	C
Phasianidae	Swamp Quail	*Coturnix ypsilophora*	C
Podargidae	Tawny Frogmouth	*Podargus strigoides*	C
Megaluridae	Tawny Grassbird	*Megalurus timoriensis*	C
Corvidae	Torresian Crow	*Corvus orru*	C
Hirundinidae	Tree Martin	*Petrochelidon nigricans*	C
Psittacidae	Turquoise Parrot	*Neophema pulchella*	C
Neosittidae	Varied Sittella	*Daphoenositta chrysoptera*	C
Maluridae	Variegated Fairy-wren	*Malurus lamberti*	C
Accipitridae	Wedge-tailed Eagle	*Aquila audax*	C
Acanthizidae	Weebill	*Smicrornis brevirostris*	C
Hirundinidae	Welcome Swallow	*Hirundo neoxena*	C
Acanthizidae	Western Gerygone	*Gerygone fusca*	C
Scolopacidae	**Whimbrel**	***Numenius phaeopus***	**SL**
Laridae	Whiskered tern	*Chlidonias hybrida*	C
Anatidae	Whistling Duck	*Dendrocygna arcuata*	C
Accipitridae	Whistling Kite	*Haliastur sphenurus*	C
Campephagidae	White-bellied Cuckoo-shrike	*Coracina papuensis*	C
Accipitridae	White-bellied sea-eagle	*Haliaeetus leucogaster*	C
Artamidae	White-browed woodswallow	*Artamus superciliosus*	C
Ardeidae	White-faced Heron	*Egretta novaehollandiae*	C
Meliphagidae	White-naped Honeyeater	*Melithreptus lunatus*	C

Family	Common name	Species name	NC Act Status[1]
Ardeidae	White-necked Heron	*Ardea pacifica*	C
Meliphagidae	White-plumed Honeyeater	*Ptilotula penicillata*	C
Acanthizidae	White-throated Gerygone	*Gerygone olivacea*	C
Meliphagidae	White-throated Honeyeater	*Melithreptus albogularis*	C
Apodidae	White-throated Needletail	*Hirundapus caudacutus*	C
Caprimulgidae	White-throated Nightjar	*Eurostopodus mystacalis*	C
Corcoracidae	White-winged Chough	*Corcorax melanorhamphos*	C
Maluridae	White-winged Fairy-wren	*Malurus leucopterus*	C
Campephagidae	White-winged Triller	*Lalage sueurii*	C
Otididae	Wild Turkey	*Ardeotis australis*	C
Rhipiduridae	Willie Wagtail	*Rhipidura leucophrys*	C
Acanthizidae	Yellow Thornbill	*Acanthiza nana*	C
Threskiornithidae	Yellow-billed Spoonbill	*Platalea flavipes*	C
Acanthizidae	Yellow-tail	*Acanthiza chrysorrhoa*	C
Meliphagidae	Yellow-throated Miner	*Manorina flavigula*	C
Estrildidae	Zebra Finch	*Taeniopygia guttata*	C
Mammals			
Macropodidae	Black-striped Wallaby	*Notamacropus dorsalis*	C
Cervidae	Chital Deer	*Axis axis*	*(RI)
Vespertilionidae	Chocolate Wattled Bat	*Chalinolobus morio*	C
Phalangeridae	Common Brushtail Possum	*Trichosurus vulpecula*	C
Muridae	Common Rock-rat	*Zyzomys argurus*	C
Macropodidae	Common Wallaroo	*Osphranter robustus*	C
Muridae	Delicate Mouse	*Pseudomys delicatulus*	C
Canidae	Dingo	*Canis familiaris*	*(RI)
Vespertilionidae	Eastern Cave Bat	*Vespadelus troughtoni*	C
Macropodidae	Eastern Grey Kangaroo	*Macropus giganteus*	C
Dasyuridae	Fat-tailed Dunnart	*Sminthopsis crassicaudata*	C
Vespertilionidae	Gould's Long-eared Bat	*Nyctophilus gouldi*	C
Vespertilionidae	Gould's Wattled Bat	*Chalinolobus gouldii*	C
Pseudocheiridae	**Greater Glider**	***Petauroides volans***	**V**
Vespertilionidae	Hoary Wattled Bat	*Chalinolobus nigrogriseus*	C
Muridae	House Mouse	*Mus musculus*	*
Phascolarctidae	**Koala**	***Phascolarctos cinereus***	**V**
Miniopteridae	Little Bentwing-bat	*Miniopterus australis*	C
Vespertilionidae	Little Broad-nosed Bat	*Scotorepens greyii*	C
Vespertilionidae	Little Pied Bat	*Chalinolobus picatus*	C

Family	Common name	Species name	NC Act Status[1]
Pteropodidae	Little Red Flying-fox	*Pteropus scapulatus*	C
Dasyuridae	Narrow-nosed Planigale	*Planigale tenuirostris*	C
Peramelidae	Northern Brown Bandicoot	*Isoodon macrourus*	C
Molossidae	Northern Mastiff Bat	*Chaerephon jobensis*	C
Suidae	Pig	*Sus scrofa*	*(RI)
Leporidae	Rabbit	*Oryctolagus cuniculus*	*(RI)
Molossidae	Ride's Free-tailed Bat	*Ozimops ridei*	C
Potoroidae	Rufous Bettong	*Aepyprymnus rufescens*	C
Tachyglossidae	**Short-beaked Echidna**	***Tachyglossus aculeatus***	**SL**
Macropodidae	Spectacled Hare-wallaby	*Lagorchestes conspicillatus*	C
Dasyuridae	Stripe-faced Dunnart	*Sminthopsis macroura*	C
Petauridae	Sugar Glider	*Petaurus breviceps*	C
Macropodidae	Swamp Wallaby	*Wallabia bicolor*	C
Macropodidae	Unadorned Rock-wallaby	*Petrogale inornata*	C
Muridae	Water-rat	*Hydromys chrysogaster*	C
Emballonuridae	Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	C
Reptiles			
Agamidae	Bearded Dragon	*Pogona barbata*	C
Varanidae	Black-headed Monitor	*Varanus tristis*	C
Pythonidae	Black-headed Python	*Aspidites melanocephalus*	C
Diplodactylidae	Box-patterned Gecko	*Lucasium steindachneri*	C
Pygopodidae	Brigalow Scaly-foot	*Paradelma orientalis*	C
Colubridae	Brown Tree Snake	*Boiga irregularis*	C
Agamidae	Burns' Dragon	*Amphibolurus burnsi*	C
Pygopodidae	Burton's Snake-lizard	*Lialis burtonis*	C
Elapidae	Carpentaria Snake	*Cryptophis boschmai*	C
Gekkonidae	Chain-backed Dtella	*Gehyra catenata*	C
Typhlopidae	Claw-snouted Blind Snake	*Anilios unguirostris*	C
Elapidae	**Common Death Adder**	***Acanthophis antarcticus***	**V**
Scincidae	Common Dwarf Skink	*Menetia greyii*	C
Colubridae	Common Tree Snake	*Dendrelaphis punctulatus*	C
Scincidae	Copper-tailed Skink	*Ctenotus taeniolatus*	C
Elapidae	Coral Snake	*Brachyurophis australis*	C
Elapidae	Curl Snake	*Suta suta*	C
Scincidae	Dark-flecked Garden Sunskink	*Lampropholis delicata*	C
Gekkonidae	Dubious Dtella	*Gehyra dubia*	C
Scincidae	Dwarf Litter-skink	*Pygmaeascincus timlowi*	C

Family	Common name	Species name	NC Act Status[1]
Scincidae	Eastern Barred Wedgesnout Ctenotus	*Ctenotus strauchii*	C
Elapidae	Eastern Brown Snake	*Pseudonaja textilis*	C
Diplodactylidae	Eastern Fat-tailed Gecko	*Diplodactylus platyurus*	C
Scincidae	Eastern Mulch-slider	*Lerista fragilis*	C
Scincidae	Eastern Robust Slider	*Lerista punctatovittata*	C
Diplodactylidae	Eastern Spiny-tailed Gecko	*Strophurus williamsi*	C
Scincidae	Elegant Snake-eyed Skink	*Cryptoblepharus pulcher*	C
Scincidae	Fire-tailed Skink	*Morethia taeniopleura*	C
Scincidae	Inland Snake-eyed Skink	*Cryptoblepharus australis*	C
Diplodactylidae	Ocellated Velvet Gecko	*Oedura monilis*	C
Scincidae	Open-litter Rainbow-skink	*Carlia pectoralis*	C
Scincidae	Orange-flanked Rainbow Skink	*Carlia rubigo*	C
Elapidae	**Ornamental Snake**	***Denisonia maculata***	**V**
Elapidae	Pale-headed Snake	*Hoplocephalus bitorquatus*	C
Scincidae	Ragged Snake-eyed Skink	*Cryptoblepharus pannosus*	C
Typhlopidae	Robust Blind Snake	*Anilios ligatus*	C
Scincidae	Robust Rainbow-skink	*Carlia schmeltzii*	C
Carphodactylidae	Rough Knob-tail	*Nephrurus asper*	C
Scincidae	Shaded-litter Rainbow-skink	*Carlia munda*	C
Typhlopidae	Small-headed Blind Snake	*Anilios affinis*	C
Scincidae	South-eastern Morethia Skink	*Morethia boulengeri*	C
Pythonidae	Spotted Python	*Antaresia maculosa*	C
Scincidae	Straight-browed Ctenotus	*Ctenotus spaldingi*	C
Scincidae	Striped Snake-eyed Skink	*Cryptoblepharus virgatus*	C
Agamidae	Tommy Roundhead	*Diporiphora australis*	C
Scincidae	Tree-base Litter-skink	*Lygisaurus foliorum*	C
Scincidae	Unspotted Yellow-sided Ctenotus	*Ctenotus ingrami*	C
Diplodactylidae	Wood Gecko	*Diplodactylus vittatus*	C

[1]Status: NC Act: V, Vulnerable; SL, Special least concern; C, Least concern;
* introduced taxa; RI; Restricted invasive animal under *Biosecurity Act 2014*

Appendix C

Desktop results

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C1 Overview of environmental values

C1.1 Geology

As shown on Figure 5 and listed in Table C1, the majority of the ecology study area is characterised by quaternary residual and colluvial basalt-derived black soil and silt deposits, with bands of the Rewan Group, and Rangal Coal and Fort Cooper coal measures in the centre and north-eastern corner of the ecology study area. There are also older areas of late Tertiary-Quaternary colluvial deposits in the west and north-west of the ecology study area. The ecology study area captures just a small section of red-brown mottled alluvial deposits in the far west, associated with J B Gully (DR 2018).

Equivalent Land Zones (as defined by Wilson and Taylor (2012)) are also listed in Table C1, as these are relevant to assigning field-validated vegetation communities to REs within the ecology study area.

Table C1: Surface geology mapping within the ecology study area

Map symbol	Geological unit	Lithology	Dominant rock type	Equivalent land zone
Pwj	Rangal coal measures	Calcareous sandstone, calcareous shale, mudstone, coal, concretionary limestone	Arenite-mudrock	9
Pwt	Fort Cooper coal measures	Lithic sandstone, conglomerate, mudstone, carbonaceous shale, coal, tuff, tuffaceous (cherty) mudstone	Sedimentary rock	9
TQr	Late Tertiary-Quaternary colluvium	Clay, silt, sand, gravel and soil; colluvial and residual deposits (generally on older land surfaces)	Colluvium	8
TQa	Late Tertiary-Quaternary alluvium	Locally red-brown mottled, poorly consolidated sand, silt, clay, minor gravel; high-level alluvial deposits (generally related to present stream valleys but commonly dissected)	Alluvium	3
Qr/b	Quaternary colluvium	Black soil, silt and mud; residual and colluvial deposits (commonly basalt-derived or over limestone in Georgina Basin)	Colluvium	8
Qr	Quaternary colluvium	Clay, silt, sand, gravel and soil; colluvial and residual deposits	Colluvium	8
Rr	Rewan Group	Lithic sandstone, pebbly lithic sandstone, green to reddish brown mudstone and minor Volcanilithic pebble conglomerate (at base)	Arenite-mudrock	9

C1.2 Soils

The majority of the ecology study area is mapped as supporting grey self-mulching cracking clays. The far south-east corner is mapped as hard pedal yellow duplex soils (Bureau of Rural Sciences 2009).

C1.3 Surface water

The ecology study area is located in the Fitzroy River catchment. The ecology study area is characterised by relatively low undulating plains that drain via minor drainage channels towards the north-east and south-east towards the Isaac River, which at its nearest point is approximately 3.5 km to the north-east of the ecology study area (Figure 2).

All of the watercourses and drainage lines within the ecology study area have been mapped as either 1st or 2nd order vegetation management drainage lines on the Queensland Government Vegetation Management Supporting Map (Figure 6). All drainage lines in the ecology study area are tributaries of the Isaac River, which is a 6th order watercourse at its nearest point to the ecology study area.

C2 Queensland Government mapping

C2.1 Regional ecosystems

Queensland Government Version 12 mapping was originally reviewed at the time of field surveys and indicated that a large portion of the ecology study area supported a mosaic of remnant communities, primarily comprising a mixture of natural grasslands and eucalypt grassy open woodlands (i.e. REs 11.8.5, 11.8.11, 11.9.2 and 11.9.3) (Figure 6). No areas of high-value regrowth vegetation are mapped for the ecology study area. However, as a result of field-validated mapping submitted as part of this project to the Queensland Herbarium as described in Section A2.4 of Appendix A, the Queensland Government mapping has released updated certified remnant RE mapping and therefore this more current mapping will be discussed for the remainder of the report. Table C2 provides a list of remnant REs mapped and certified by the Queensland Herbarium within the ecology study area. No high-value regrowth mapping is included in the current certified mapping.

Table C2: Queensland Government Version 12 mapped REs within the ecology study area

RE Code	Short description[1]	Status[1]	
		VM Act	Bio-diversity
11.3.1	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains	Endangered	Endangered
11.3.2	*Eucalyptus populnea* woodland on alluvial plains	Of concern	Of concern
11.3.3	*Eucalyptus coolabah* woodland on alluvial plains	Of concern	Of concern
11.3.7	*Corymbia* spp. open woodland on alluvial plains	Least concern	Of concern
11.3.21	*Dichanthium sericeum* and/or *Astrebla* spp. grassland on alluvial plains. Cracking clay soils	Of concern	Endangered
11.3.25	*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines	Least concern	Of concern

RE Code	Short description[1]	Status[1]	
		VM Act	Bio-diversity
11.4.8	*Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains	Endangered	Endangered
11.4.9	*Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains	Endangered	Endangered
11.5.3	*Eucalyptus populnea* +/- *E. melanophloia* +/- *Corymbia clarksoniana* woodland on Cainozoic sand plains and/or remnant surfaces	Least concern	No concern at present
11.9.2	*Eucalyptus melanophloia* +/- *E. orgadophila* woodland to open woodland on fine-rained sedimentary rocks	Least concern	No concern at present
11.9.3	*Dichanthium* spp., *Astrebla* spp. grassland on fine-grained sedimentary rocks	Least concern	No concern at present
11.9.5	*Acacia harpophylla* and/or *Casuarina cristata* open forest to woodland on fine-grained sedimentary rocks	Endangered	Endangered

[1] Short description, VM Act and Biodiversity status defined under the Regional Ecosystem Description Database (REDD) (Queensland Herbarium 2021).

C2.2 Vegetation management wetlands and watercourses

The Queensland Government Version 12 Vegetation Management Supporting Map indicates that there are no vegetation management wetland areas within the ecology study area (Figure 6). A number of 1st and 2nd order drainage lines are located within the ecology study area and intersect with remnant vegetation (Figure 6).

C2.4 Referable wetlands

The search of the referable wetlands map shows there are no WPAs, HES, HEV or GES wetlands within or adjacent to the ecology study area (Appendix B).

C2.5 Groundwater dependent ecosystems

The Australian Groundwater Dependent Ecosystem Toolbox (GDE Toolbox), commissioned by the National Water Commission (2011), defines groundwater dependent ecosystems (GDEs) as:

> "Ecosystems that require access to groundwater to meet all or some of their water requirements so as to maintain the communities of plants and animals, ecological processes they support, and ecosystem services they provide" (Richardson et al. 2011).

Terrestrial GDEs

The National Atlas of Groundwater Dependent Ecosystems identified that most of the vegetation within the ecology study area has not been identified as potential GDEs. There are vegetated areas in the north-west along J B Gully and along Ripstone Creek (western tributary) in the south that are mapped as having low potential to interact with groundwater.

Vegetation in the vicinity of J B Gully is mapped by the Queensland Government as remnant alluvial woodlands of Poplar Box (*Eucalyptus populnea*) or *Corymbia* spp. woodlands (REs 11.3.2 and 11.3.7). Sand plains and/or remnant surfaces

flanking the alluvial soils associated with J B Gully is mapped as Poplar Box +/- Silver-leaved Ironbark (*E. melanophloia*) +/- Long-fruited Bloodwood (*Corymbia clarksoniana*) woodland (RE 11.5.3).

Potential GDEs in the south along Ripstone Creek correspond with areas mapped as remnant and non-remnant by the Queensland Government. Remnant areas are mapped as mixed eucalypt spp. woodland on sand plains (RE 11.5.3) and Brigalow (*Acacia harpophylla*) woodland on clay plains (RE 11.4.9).

Aquatic GDEs

A small section of J B Gully in the far west of the ecology study area is mapped as having a high potential to support aquatic GDEs. This area is not mapped as remnant by the Queensland Government and has been dammed at some point in the past.

No other areas have been mapped as being likely to support aquatic GDEs.

Springs

The Queensland Government has prepared the Queensland Wetland Data Springs mapping, which show the location of springs in the state. These springs are dependent on the surface expression of groundwater and their locations are used to infer the location of potential GDEs. A search of the Queensland Springs Database indicated that no spring wetlands are located within the ecology study area.

C2.6 Protected plants high risk areas

No high risk areas (HRAs) are mapped within the ecology study area on the Protected Plants Flora Survey Trigger Map (Appendix B).

C2.7 Essential habitat

No essential habitat for conservation significant flora is mapped within or adjacent to the ecology study area (Figure 6). Extensive areas of remnant vegetation, particularly natural grassland communities are mapped as essential habitat for Ornamental Snake (*Denisonia maculata*) within the ecology study area. This species is listed as vulnerable under the EPBC Act and NC Act.

Areas to the north-west of the ecology study area are also mapped as essential habitat for the Greater Glider (*Petauroides volans*), also listed as vulnerable under the EPBC Act and NC Act.

C2.7 Koala habitat areas

The Queensland Government has produced mapping of Koala districts, priority areas and habitat areas as required under Division 3, Section 8 of the Nature Conservation (Koala) Conservation Plan 2017. The Koala Conservation Plan maps focus efforts for habitat protection, restoration and threat mitigation towards areas with the highest likelihood of achieving the best conservation outcomes for koalas.

The ecology study area is located within Koala District C on the Koala Conservation Plan mapping. However, there are no Koala habitat areas mapped within or adjacent to the study area.

C2.8 Critical habitat

The ecology study area is not within an area identified as Critical Habitat under the NC Act.

C3. Matters of state environmental significance

C3.1 Regulated vegetation

With reference to the Queensland Government Version 12 mapping (Figure 6) and Queensland Herbarium certified mapping (Figure 9) and outlined in Section C2, the ecology study area supports regulated vegetation in the form of:

- remnant endangered vegetation (including REs 11.3.1, 11.4.8, 11.4.9 and 11.9.5)
- remnant of concern vegetation (including REs 11.3.2, 11.3.3 and 11.3.21)
- remnant vegetation intersecting a watercourse, i.e. 1st and 2nd order watercourses, including J B Gully and Ripstone Creek (eastern and western tributaries) as well as a number of unnamed drainage channels
- essential habitat for Ornamental Snake.

C3.2 NC Act listed flora

Database searches returned three endangered, three vulnerable flora, and four near threatened species listed under the NC Act as potentially occurring within the search area:

- *Solanum adenophorum* (no common name) – endangered
- *Solanum elachophyllum* (no common name) – endangered
- *Capparis humistrata* (no common name) – endangered
- *Aristida annua* (no common name) – vulnerable
- King Bluegrass (*Dichanthium queenslandicum*) –vulnerable
- Quassia (*Samadera bidwillii*) – vulnerable
- Story's Wattle (*Acacia storyi*) – near threatened
- *Bertya pedicellata* (no common name) – near threatened
- Native Frangipani (*Cerbera dumicola*) – near threatened
- Plunkett Mallee (*Eucalyptus curtisii*) – near threatened.

A description of the preferred habitat of these species and an assessment of the likelihood of occurrence within the ecology study area is outlined in Appendix E. Species that were recorded or are considered likely to occur in the ecology study area are discussed in Section 5.5.2.

C3.2 NC Act listed fauna

Database searches identified a total of 21 threatened, near threatened or special least concern terrestrial fauna species listed under the NC Act as follows:

Birds:

- Curlew sandpiper (*Calidris ferruginea*) – critically endangered (
- Australian Painted Snipe (*Rostratula australis*) - endangered (EPBC Act and NC Act)
- Black-throated Finch (southern) (*Poephila cincta cincta*) – endangered
- Star Finch (eastern) (*Neochmia ruficauda ruficauda*) – endangered
- Grey Falcon (*Falco hypoleucos*) – vulnerable
- Painted Honeyeater (*Grantiella picta*) – vulnerable
- Red Goshawk (*Erythrotriorchis radiatus*) –endangered
- Glossy Black-cockatoo (*Calyptorhynchus lathami*) - vulnerable
- Squatter Pigeon (southern) (*Geophaps scripta scripta*) – vulnerable
- White-throated Needletail (Hirundapus caudacutus) –vulnerable

Mammals:

- Corben's Long-eared Bat (*Nyctophilus corbeni*) – vulnerable
- Ghost Bat (*Macroderma gigas*) –endangered
- Greater Glider (*Petauroides volans*) – endangered
- Koala (*Phascolarctos cinereus*) – endangered
- Large-eared Pied Bat (*Chalinolobus dwyeri*) – vulnerable
- Short-beaked Echidna (*Tachyglossus aculeatus*) – special least concern

Reptiles:

- Common Death Adder (*Acanthophis antarcticus*) - vulnerable
- Allan's Lerista (*Lerista allanae*) – endangered Dunmall's Snake (*Furina dunmalli*) – vulnerable
- Ornamental Snake (*Denisonia maculata*) – vulnerable
- Yakka Skink (*Egernia rugosa*) – vulnerable

One near threatened fauna species listed under the NC Act, namely Coastal Sheathtail Bat (*Taphozous australis*), was returned from the database searches. This is likely to be an erroneous record as this species is restricted to a very narrow coastal zone in Queensland that extends no more than a few kilometres inland (DES 2021b). It is also noted that this species is similar in appearance to Troughton's Sheathtail Bat (*Taphozous troughtoni*) (Churchill 2009), which has been recorded in the Moranbah region.

Several special least concern migratory birds were also identified in database search results as potentially occurring in the search area (Appendix B). However,

special least concern migratory species are not listed as MSES under the EO Act and therefore, have not been considered further in this assessment.

Queensland Government essential habitat mapping (Figure 6) also shows potential habitat for the Ornamental Snake and Greater Glider within or in close proximity to the ecology study area (DR 2021).

A description of the preferred habitat of the species listed above and an assessment of the likelihood of occurrence within the ecology study area is outlined in Appendix E. NC Act listed fauna that were recorded or are considered likely to occur in the ecology study area are discussed in Section 6.2.

C4 Biodiversity Planning Assessment Mapping

The DES has prepared a Biodiversity Planning Assessment for the region. Within the ecology study area, the Queensland Government mapped least concern remnant vegetation overlaid with essential habitat is mapped as being of regional biodiversity significance, while of concern and endangered remnant mapped communities are mapped as being of state biodiversity significance. Other least concern remnant areas of are considered to have local biodiversity significance (Figure 7).

State and regional ecological corridors are mapped to the north-east and north-west respectively, in association with Isaac River and Cherwell Creek. However, the ecology study area is not located within any ecological corridors (Figure 7)

C5 Previous studies in the region

A number of flora and fauna studies have been undertaken within a 25 km radius of the ecology study area over the last several years, as a part of the environmental approval process for various other mining projects. Of most relevant are studies undertaken across the Isaac Downs, Isaac Plains, Olive Downs, Carborough Downs MLs, given their proximity to the ecology study area (Figure 2).

C5.1 Eagle Downs Project

Seasonal flora and fauna surveys were undertaken for the Eagle Downs Project as part of the environmental impact assessment and approvals process for the project. These surveys encompassed mining lease area (MLA) 70389, which corresponds with the current ML and ecology study area.

Flora surveys were conducted over eight days in September 2007 and April 2008. These surveys were conducted in accordance with the *Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland* (EPA 2005). Sampling involved 61 survey sites, 28 sample plots and several walking/driving transects over approximately 2 km (Hansen Bailey 2009).

Fauna surveys were conducted over nine days in August/September 2007 and March 2008. The fauna surveys comprised:

- trapping - Elliott A, Elliott B, Arboreal Elliott B, Cage traps, Pitfall traps, funnel traps, harp traps, hair tubes

- spotlighting and call playback
- diurnal and nocturnal bird searches (targeted and incidental)
- diurnal and nocturnal amphibian and reptile searches (targeted and incidental)
- targeted field searches
- Anabat (stationary and mobile)
- stag watching.

Trapping effort involved a total of 1,046 traps set over 1,062 total trap nights, 159.5 hours of ultrasonic recording and call playback over 33 recording nights (Hansen Bailey 2009).

A total of 2,094 ha of endangered REs (11.4.9, 11.8.13, 11.9.5) and 13 ha of concern REs (11.3.2 and 11.8.11) were recorded within the study area during the previous surveys (Hansen Bailey 2009).

No currently listed threatened or otherwise significant flora species were recorded in the study area as part of the previous surveys. One currently listed fauna species, the Ornamental Snake, listed as vulnerable under the NC Act, was recorded at one location in Brigalow woodland (RE 11.4.9) on deep cracking clays. The original Eagle Downs Project Flora and Fauna Impact Assessment for the project also lists an unconfirmed record of Sheath-tail Bat (*Taphozous australis*/*georgianus*) (Hansen Bailey 2009). This species is currently listed as near threatened under the NC Act, however, this record is considered likely to be a more common *Taphozous* species, as *T. australis* is not known from the area and restricted in distribution to within a short distance from the coast.

C5.2 Isaac Downs Mine

The Isaac Downs project is located approximately 6 km north of the ecology study area on the northern side of the Isaac River. Flora and fauna surveys of the study area for this project were undertaken in February – March and September - October 2018.

The study area was mapped as comprising a mosaic of varied vegetation communities on a range of landforms, including lateritic jumps, basalt plains, sand plains and alluvial and riparian areas associated with the Isaac River. The studies found endangered and of concern remnant REs in the study area and included REs 11.3.1, 11.3.2, 11.3.4, 11.4.8, 11.4.9, 11.8.11 and 11.9.7a. Vegetation management wetland communities were also recorded in the study area (Ecological Survey & Management 2020).

One NC Act listed near threatened plant, *Bertya pedicellata* (no common name), was identified in the study area within RE 11.7.2 on a lateritic jump-up. No other NC Act listed flora species were recorded (Ecological Survey & Management 2020).

Four NC Act listed fauna species were identified in the study area, including: Squatter Pigeon (southern), Greater Glider, Koala, Ornamental Snake and extensive areas of habitat were mapped for these species within the study area, in association with eucalypt woodlands, gilgai and riparian and alluvial vegetation

associated with the Isaac River and its tributaries. The NC Act listed special least concern Short-beaked Echidna was also recorded (Ecological Survey & Management 2020).

C5.3 Isaac Plains East

The Isaac Plains East project is located approximately 15 km north of the ecology study area. Studies were undertaken for this open cut coal mine project in September/October 2015 and February/March 2016. The studies found the majority of the study area had previously been cleared and supported non-remnant vegetation. A fragmented distribution of remnant woodland (comprising Long-fruited Bloodwood and Poplar Box) and riparian communities persist. The majority of remnant vegetation was found to support least concern REs, with relatively small areas of remnant of concern vegetation present in the form of alluvial woodlands (REs 11.3.2 and 11.3.4).

No threatened flora species listed under the NC Act were recorded within the study area during the field surveys. However, small populations of *Bertya pedicellata* (near threatened under the NC Act) were identified in RE 11.7.2 associated with lateritic jump-ups in the eastern part of the study area.

Three threatened fauna species were recorded in the study area, namely Squatter Pigeon, Greater Glider and Ornamental Snake. The Squatter Pigeon and Ornamental Snake are listed as vulnerable and the Greater Glider as endangered under the NC Act.

Two migratory bird species were recorded in the study area. One mammal species, the Short-beaked Echidna, listed as special least concern under the NC Act was recorded.

C5.4 Olive Downs Mine

The Olive Downs Mine is a large open cut coal mine project also located in the Moranbah region, approximately 10 km east of the ecology study area, and which flanks the Isaac River.

Flora studies were undertaken in November 2016, and March, May-June, September and November 2017 as part of the EIS for the project. These studies found endangered and of concern communities within the study area, including remnant REs 11.3.1, 11.3.2, 11.3.3/c, 11.3.4, 11.4.8, 11.4.9, 11.5.17 and 11.5.18. The Brigalow TEC, listed under the EPBC Act was also recorded in the study area and represented by REs 11.3.1, 11.4.8 and 11.4.9. Two sub-populations of *Bertya pedicellata*, listed as near threatened under the NC Act, were recorded in the study area in remnant RE 11.7.2. A number of wetland communities were also mapped (DPM Envirosciences 2018a).

Fauna surveys were also undertaken for the project in November 2016 and April-May, September and November 2017. As a result of these surveys five significant fauna species were recorded in the study area, including Ornamental Snake, Australian Painted Snipe, Squatter Pigeon (southern), Koala and Greater Glider listed under the NC Act. Extensive areas of potential habitat was mapped for these

five threatened species throughout the study area. The NC Act special least concern Short-beaked Echidna was also recorded (DPM Enviroscienses 2018b).

C5.5 Carborough Downs

Surveys completed for the Carborough Downs project, which is located approximately 17 km north of the ecology study area, identified remnant vegetation in the form of Brigalow communities, Poplar Box woodlands, Lancewood low woodlands and Ironbark/Bloodwood communities (AARC 2004).

Two individuals of *Persoonia amaliae* (no common name) were recorded on the sandstone escarpment that extends through the western portion of the Carborough Downs ecology study area. At the time of the surveys this species was listed as 'rare' under the NC Act, but currently this species is 'least concern'. No other threatened or near threatened flora species were recorded during the surveys (AARC 2004).

Squatter Pigeon was recorded from within Poplar Box woodland during the ecology surveys. Ten bird species listed as migratory at the time of the surveys were also recorded (AARC 2004). The Short-beaked Echidna was recorded across the ecology study area, but the majority of records came from the denser vegetation associated with the escarpment (AARC 2004).

C5.6 Other studies

Other projects within 25 km of the ecology study area that have involved ecological surveys include Annandale East, G200s Project, Grosvenor Mine, Caval Ridge Mine, Poitrel Mine and the Moranbah South Project (Figure 2). These surveys identified the following listed threatened fauna species, as relevant to the project, as being present or likely to be present in the region:

- Australian Painted Snipe
- Squatter Pigeon
- Greater Glider
- Koala
- Ornamental Snake
- Short-beaked Echidna.

The surveys also noted large areas of land that had been cleared in the past for grazing activities. Areas of remnant vegetation were noted to typically comprise eucalypt and wattle woodlands, with some areas supporting remnant endangered and of concern REs.

Appendix D

Likelihood of occurrence assessment – Significant flora

Table D1: Likelihood of significant flora identified from databases to occur in the ecology study area

Species name/ Common name	NC Act Status	Record source1	Habitat preferences	Likelihood to occur in the ecology study area
Acacia storyi Story's Wattle	Near threatened	AVH	***Distribution:*** This species is mainly known from Blackdown Tableland, with three other populations outside this location (DES, 2021c). ***General habitat preferences:*** It occurs on sandstone plateaux, on sandy and shallow skeletal soils over sandstone. Vegetation is characterised by open forests or tall open forests of *Eucalyptus tereticornis*, *Aristida spp.* also *E. hendersonii*, *E. cloeziana*, *E. melanoleuca* and *E. propinqua* (DES, 2021c). ***Notable features:*** Flowering has been recorded between April and September and pods mature between august and December (DES, 2021c). ***Dispersal mode:*** Explosive release; invertebrate dispersed, particularly ants – arillate seed. ***Nearest record:*** A 1962 record this species is located approximately 11 km north-west of the ecology study area (CSIRO, 2021).	LOW Underlying geology is generally not suitable for this species within the ecology study area. Furthermore, this is a distinctive species that was not recorded in the ecology study area.
Aristida annua No common name	Vulnerable	PMST	***Distribution:*** This grass species is restricted to central Queensland in the Emerald and Springsure districts, i.e. the Brigalow Belt North and South Bioregions and the Fitzroy Natural Resource Management Region (TSSC, 2014). ***Habitat preferences:*** The species occurs in eucalypt woodland and is restricted to black clay soils, basalt soils and possibly disturbed sites. This species is associated with the Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin TEC (TSSC, 2014).	LOW Although potentially suitable habitat is present within the ecology study area, the ecology study area is outside its known distribution and this species was not recorded within potentially suitable habitat despite targeted searches for threatened grass species.

Species name/ Common name	NC Act Status	Record source1	Habitat preferences	Likelihood to occur in the ecology study area
			Notable features: It is a poorly understood species. This is a distinctive grass as it is the only annual *Aristida* with a convolute lemma and an open panicle. This species flowers between March and June (TSSC, 2014). ***Dispersal mode:*** Wind and mammal dispersed – awned seeds assist with wind movement and attachment to mammals. ***Nearest record:*** There are no published records for this species within 25 km of the ecology study area.	
Bertya pedicellata No common name	Near threatened	AVH WO	***Distribution:*** This species is confined to central and south-east Queensland, from near Aramac in the west, Eaglefield (north of Moranbah) in the north, to Yeppoon in the east and Gayndah in the south-east. There are two isolated records from the Warwick district and the Border Ranges in the far south of Queensland (CSIRO, 2021). ***Habitat preferences:*** This species typically grows on rocky hillsides in eucalypt forests or woodlands, *Acacia* woodlands or shrublands, and open heathland or vine thicket communities (DES, 2021d). It is known to occur in skeletal to shallow sandy, sandy clay or clay loams overlaying rhyolite, trachyte or sandstone substrates. Associated species include *Corymbia trachyphloia*, *Dodonaea filifolia*, *Acacia catenulata, A. curvinervia*, *A. shirleyi*, *A. rhodoxylon*, *A. sparsiflora*, *Eucalyptus crebra*, *A. harpophylla* and *E. decorticans* (DES, 2021d). ***Notable features:*** An extensively branched shrub growing to 6 m tall (DES, 2021d).	LOW Suitable habitat in the form of rocky hillsides with eucalypt or wattle communities, open heathland or vine thickets are not present within the ecology study area. This species was not recorded in the study area during the field survey.

Species name/ Common name	NC Act Status	Record source1	Habitat preferences	Likelihood to occur in the ecology study area
			Dispersal mode: Unknown – seeds have never been seen. ***Nearest record:*** Ecological Survey & Management has recorded this species approximately 10 km north of the ecology study area as part of flora surveys for the Isaac Downs project (Ecological Survey & Management, 2020b).	
Capparis humistrata No common name	Endangered	AVH WO	***Distribution:*** The species is known from between Marlborough and Bouldercombe and further north near Dingo, in central Queensland (DES, 2021e). ***Habitat preferences:*** A spreading shrub to 1.5 m in height, it occurs in *Eucalyptus* woodland with a shrubby understory, on stony hard ridges and serpentinite soils. Also known from the margins of Brigalow forest on sandy soil (DES, 2021e). ***Notable features:*** Flowers have been observed in march, May and December. Fruits have been observed in November and December (DES, 2021e). ***Dispersal mode:*** The fruit being a smooth globular berry indicates it is most likely vertebrate dispersed. ***Nearest record:*** The nearest published record for this species is from 1998 and located approximately 34 km north-west of the ecology study area. The next nearest published records of this species are at least 150 km south-east of the ecology study areain the vicinity of Marlborough (CSIRO, 2021).	LOW Soils derived from serpentinite are not present within the ecology study area. Furthermore, there is only one record of this species in the broader region, despite numerous surveys having been undertaken.
Cerbera dumicola Native Frangipani	Near threatened	AVH WO	***Distribution:*** Coastal and sub-coastal central Queensland (Society for Growing Australia Plants, 2007). ***Habitat preferences:*** This species grows mostly in Lancewood scrubs but has been recorded in eucalypt	LOW Suitable habitat for this species in the form of lateritic jump-ups supporting

Species name/ Common name	NC Act Status	Record source1	Habitat preferences	Likelihood to occur in the ecology study area
			woodland and open forest (DES, 2021f). This species tends to be associated with lateritic jump-up features in the landscape (C. Hansen personal observations of numerous populations in central Queensland). ***Notable features:*** This is a latex producing shrub that can grow to 4 m (Fletcher, 2001). Flowering has been recorded in October (DES, 2021f). ***Dispersal mode:*** Vertebrate dispersed – fleshy fruited drupe. Water dispersed – woody endocarp assists floatation. ***Nearest record:*** There is a 2018 record of this species approximately 23 km west of the ecology study area on the western side of the Cherwell and Harrow Ranges (CSIRO, 2021).	REs 11.7.1, 11.7.2 and 11.7.3 are not present within the ecology study area. This is a very distinctive species with bright green foliage that seems more aligned with a tropical plant but can be deciduous during extended periods of no rainfall. Therefore, individuals of this species would have been detected if they were present in the ecology study area during the flora survey, during which optimal conditions were experienced due to above average rainfall totals in the local region in the few months preceding the survey.
Dichanthium queenslandicum King Bluegrass	Vulnerable	AVH PMST WO	***Distribution:*** This species is known from three disjunct populations: 1) Hughenden district, 2) Nebo to Monto and west to Clermont and Rolleston, and 3) Dalby district (TSSC, 2013a). ***Habitat preferences:*** This grass is confined to natural tussock grassland areas on heavy black cracking clay soils. It mainly occurs in association with other species of blue grasses (i.e. *Dichanthium* spp. and *Bothriochloa* spp.). It is strongly associated with the natural bluegrass grasslands of central and southern Queensland, including the EPBC Act listed natural grassland ecological communities (TSSC, 2013a). Recorded only from well-managed and conservatively grazed properties (Sharp & Simon, 2002; Fletcher, 2001). ***Notable features:*** A perennial grass growing to 80 cm in height (TSSC, 2013a).	**MODERATE** Natural grassland communities throughout the ecology study area provide potentially suitable habitat for this species, specifically remnant REs 11.3.21 and 11.9.3 (Figure 9). However, a large portion of these grassland communities were in poor condition at the time of the field surveys as a result of grazing pressure. Furthermore, this species was not recorded in the ecology study area despite targeted searches as part of the current survey or in 2010 as part of targeted natural grassland surveys undertaken by Ecological Survey &

Species name/ Common name	NC Act Status	Record source1	Habitat preferences	Likelihood to occur in the ecology study area
			Dispersal mode: Wind and mammal dispersed – awned seeds assist with wind movement and attachment to mammals. ***Nearest record:*** This species has been recorded by Ecological Survey & Management approximately 9 km north-west of the ecology study areaas part of flora surveys for the Moranbah South Project (Ecological Survey & Management, 2013b).	Management within the ecology study area (EcoSM, 2010).
Eucalyptus curtisii Plunkett Mallee	Near threatened	AVH	Low: This is likely to be an erroneous record as this species is restricted to south-east Queensland and the AVH database details this record at the 'corner of Old Cleveland and Creek Roads, near Belmont' (CSIRO, 2021).	
Samadera bidwillii Quassia	Vulnerable	PMST	***Distribution:*** This species is known from a number of locations between Scawfell Island, near Mackay and Goomboorian, north of Gympie. It occurs in the Burnett Mary, Fitzroy, Mackay Whitsunday and Burdekin Natural Resource Management regions (TSSC, 2008). ***Habitat preferences:*** It occurs in lowland rainforest or on rainforest margins as well as open forest and woodland communities. It is often found adjacent to temporary or permanent watercourses up to 510 m in altitude. A number of eucalypts are commonly associated with this species namely *Corymbia citriodora*, *C. intermedia*, *Eucalyptus propinqua*, *E. acmenoides*, *E. tereticornis*, *E. siderophloia*, *E. moluccana, E. cloeziana* and *E. fibrosa*. (TSSC, 2008). It grows on lithosols, skeletal soils, loam soils, sands, silts and sands with clay subsoils (DAWE, 2021u) ***Notable features:*** It bears red fruits and flowers from November to March (TSSC, 2008).	LOW There are no areas of preferred habitat in the form of lowland rainforest within or adjacent to the ecology study area. Further, there are no known records in close proximity to the ecology study area. Additionally, this is a highly distinctive species that would have been detectable during the field survey.

Species name/ Common name	NC Act Status	Record source1	Habitat preferences	Likelihood to occur in the ecology study area
			Dispersal mode: Gravity, wind and/or water dispersed – no specific morphological features that aid secondary dispersal. Ants may also disperse seeds. ***Nearest record:*** There are no published records for this species within 25 km of the ecology study area.	
Solanum adenophorum No common name	Endangered	AVH WO	***Distribution:*** This species is known from the Dingo-Nebo-Clermont area in Queensland (CSIRO, 2021). ***Habitat preferences:*** It occurs in deep cracking clay soils in Brigalow (*Acacia harpophylla*) and Gidgee (*Acacia cambageana*) communities (DES, 2021g). ***Notable features:*** It flowers in October and fruits in May, September and October (DES, 2021g). ***Dispersal mode:*** Vertebrate dispersed, particularly birds – multi-seeded fleshy fruit. ***Nearest record:*** The nearest published record for this species is from 2019 and located approximately 8 km east of the southern end of the ecology study area(CSIRO, 2021).	LOW Potentially suitable habitat for this species is present in the form of Brigalow communities on heavy clay soils (i.e. RE 11.4.8 and 11.4.9), although these communities occur outside the ecology study area. However, the overall condition of these habitats is poor, due to historic management (i.e. thinning), intensive grazing, trampling and the prevalence of Buffel Grass within the groundcover layer. This vegetatively distinct species was not recorded in potentially suitable habitat during the flora survey, during which optimal conditions were experienced due to above average rainfall totals in the local region in the few months preceding the survey.
Solanum elachophyllum No common name	Endangered	AVH WO	***Distribution:*** This species is known only from limited collections in the Leichhardt pastoral district of Queensland between Middlemount and Theodore (Bean, 2013). ***Habitat preferences:*** occurs on cracking clay soils associated with Brigalow, Belah, and Macropteranthes	LOW Potentially suitable habitat for this species is present in the form of Brigalow communities on heavy clay soils (i.e. RE 11.4.8 and 11.4.9), although these communities occur

Species name/ Common name	NC Act Status	Record source1	Habitat preferences	Likelihood to occur in the ecology study area
			dominated vine thickets or Eucalyptus cambageana woodlands (Bean, 2013). ***Notable features:*** prostrate or sprawling sub-shrub to 30 cm in height with numerous prickles on branchlets (Bean, 2013) ***Dispersal mode:*** Vertebrate dispersed, particularly birds - multi-seeded fleshy fruit (Bean, 2013). ***Nearest record:*** The nearest published record for this species is from 2018 and located approximately 14 km east of the ecology study area(CSIRO, 2021).	outside the ecology study area. However, the overall condition of these habitats is poor, due to historic management (i.e. thinning), intensive grazing, trampling and the prevalence of Buffel Grass within the groundcover layer. This vegetatively distinct species was not recorded in potentially suitable habitat during the flora survey, during which optimal conditions were experienced due to above average rainfall totals in the local region in the few months preceding the survey.

Note: This LOOT considers only terrestrial flora species that were returned from database searches for the search area.

[1]Record source:

- AVH – Australasian Virtual Herbarium (refer to Table B1 of Appendix B)
- PMST – Protected Matters Search Tool (refer to PMST database results contained in Appendix B)
- WO – Wildlife Online (refer to Wildlife Online database results contained in Appendix B)

Appendix E

Likelihood of occurrence assessment – Significant fauna

Table E1: Likelihood of significant fauna identified from databases to occur in the ecology study area

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
Birds				
Australian Painted Snipe *Rostratula australis*	Endangered	PMST	***Distribution:*** The Australian Painted Snipe has been recorded at wetlands in all states of Australia. It is most common in eastern Australia. The Fitzroy Basin of Central Queensland is considered an important area for the species (TSSC, 2013c). This population is considered to occur as a single, contiguous breeding population (DAWE, 2021t). ***General habitat preferences:*** This secretive, cryptic, crepuscular (active at dawn, dusk and during the night) species occurs in terrestrial shallow wetlands, both ephemeral and permanent, usually freshwater but occasionally brackish. They also use inundated grasslands, salt-marsh, dams, rice crops, sewage farms and bore drains with rank emergent tussocks of grass, sedges, rushes or reeds or samphire, and often with scattered clumps of Lignum (*Muehlenbeckia florulenta*), canegrass or sometimes tea trees (TSSC, 2013c). ***Foraging habitat:*** The species feeds on vegetation, seeds, and invertebrates including crustaceans and molluscs as well as insects, worms and other invertebrates. Foraging habitats are not well understood (Marchant & Higgins, 1994).	**HIGH** The species was previously recorded by Ecological Survey & Management, during surveys in 2012, at a large dam along J B Gully approximately 300 m west of the ecology study area. Remnant Brigalow vegetation and cleared paddocks containing gilgai within the ecology study area, provide suitable seasonal habitat for this species.

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
			Breeding habitat: Requirements are specific and include shallow wetlands with areas of bare wet mud and both upper and canopy cover nearby. Almost all records of nests occur on or near small islands in freshwater wetlands characterised by a combination of very shallow water, exposed mud, dense low cover and sometimes some tall dense cover. Although this species uses modified habitat, it doesn't necessarily breed in these habitats. It most likely breeds in response to wetland conditions rather than during a particular season (DAWE, 2021t). ***Nearest record:*** This species was recorded during the field survey approximately 300 m to the west of the project at a large dam located along J B Gully (Figure 13). The nearest published record is approximately 31 km north-east of the ecology study area (CSIRO, 2021).	
Black-throated Finch (southern) *Poephila cincta cincta*	Endangered	PMST	***Distribution:*** The Black-throated Finch (southern) occurs at two general locations: in the Townsville region, where it is considered to be locally common at a few sites around Townsville; and Charters Towers (Garnett & Crowley, 2000). It has also been recorded at scattered sites in central-eastern Queensland (between Aramac and Great Basalt Wall National Park). DAWE considers birds recorded	LOW Broadly suitable wetland, grassland and open woodland habitat is present in the ecology study area. However, available species records and habitat modelling (CSIRO, 2021) indicate that the ecology study area is outside of the known range of this species. Furthermore, this species

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
			since 1998, at the following locations to be part of the southern subspecies: ▪ Townsville and its surrounds (Giru, Serpentine Lagoon, Toonpan, and near Ross River Dam) ▪ Ingham, and sites nearby (near Mutarnee [at Ollera Creek], and near Mount Fox) ▪ scattered sites in central-eastern Queensland (Great Basalt Wall, Yarrowmere Station, Moonoomoo Station, Doongmabulla Station, Fortuna Station and Aramac) (DAWE, 2021s). ***General habitat preferences:*** This species is known from dry, open grassy woodlands and forests and grasslands of the sub-tropics and tropics with seeding grasses and ready access to water (Higgins et al., 2006). Also thought to probably require a mosaic of different habitat in the wet season to find seed (Garnett et al., 2011). Black-throated Finch mainly inhabit dry open to very open eucalypt woodlands with dense grassy ground cover and typically dominated by *Eucalyptus*, *Corymbia* and *Melaleuca*, and often along watercourses or in the vicinity of water (Marchant et al., 2006; DAWE, 2021s). Almost all recent records of this species, south of the tropics, have been from riparian habitat. It is thought that permanent	has not been recorded within 25 km of the ecology study area despite the numerous fauna surveys that have been completed in the Moranbah region.

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
			sources of water and surrounding habitat provides refuge for this species during the dry season and particularly during drought conditions. This species has been recorded in degraded habitats such as heavily grazed paddocks (DAWE, 2021s). This species has undergone a significant range contraction from the southern parts of its former distribution. It has not been recorded in south-east Queensland since the early 80s and is now thought to be extinct in NSW. It is noted as being mostly absent from the coastal plain but occasionally recorded from the area around Townsville and Ingham (Higgins et al., 2006). ***Foraging habitat:*** This subspecies is thought to require a mosaic of different habitats in which it can find seed during the wet season (DAWE, 2021s). ***Breeding habitat***: Nests are often built in a hollow branch of a tree, or in a fork of a tree, shrub or sapling. It is not uncommon for nests to be placed in other sites, such as in tall grass, amongst mistletoe, beneath active raptor nests, or in an old nest of a Babbler (*Pomatostomus* spp.) or Diamond Firetail (*Stagonopleura guttata*). Nest sites tend to be located in close proximity to permanent water, i.e. approximately 400 m (DAWE, 2021s).	

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
			Nearest Record: There are no published records for this species within 25 km of the ecology study area.	
Curlew Sandpiper *Calidris ferruginea*	Critically endangered	PMST	***Distribution:*** This species occurs along the coasts but is also widespread inland. In Queensland there are scattered records in the Gulf of Carpentaria, widespread records along the coast, south of Cairns, and sparsely scattered records inland (DAWE, 2021c). ***General habitat preferences:*** Near the coast it inhabits intertidal mudflats in sheltered areas, such as estuaries, bays inlets and lagoons and non-tidal swamps, lakes, lagoons, ponds in saltworks and sewage farms. Inland they are occasionally recorded around ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand. They will use fresh and brackish habitats and floodwaters (DAWE, 2021c). ***Foraging habitat:*** This species usually wades and forages in waters 15-30 mm deep, but up to 60 mm deep at the edge of saltmarsh, emergent vegetation and inundated saltflats. It feeds on invertebrates, including worms, molluscs, crustaceans and insects, as well as seeds (DAWE, 2021c). ***Roosting habitat:*** The species usually roosts on bare dry shingle, shell or sand beaches, sand	LOW This species is only recorded occasionally from suitable inland habitats. Constructed farm dams in the ecology study area are also considered unsuitable given their sloped banks do not give rise to extensive bare, wet mud banks that this species typically uses for foraging.

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
			spits and islets and sometimes in dunes (DAWE, 2021c). ***Nearest record:*** There are no published records for this species within 25 km of the ecology study area.	
Glossy Black-cockatoo *Calyptorhynchus lathami*	Vulnerable	ALA	***Distribution:*** There are two subspecies which occur on the Australian mainland; *C. l. erebus* which occurs in the north and central east coast of Queensland and *C. l. lathami*, which occurs from Gympie south into New South Wales and into the central western plains of New South Wales (Hourigan, 2012). Only *C. l. erebus* would occur in the region in which the ecology study area is located. ***General habitat preferences:*** This species prefers woodland areas dominated by she-oak (*Allocasuarina*), or open sclerophyll forests and woodlands with a stratum of Allocasuarina beneath *Eucalyptus*, *Corymbia* or *Angophora*. They have also been recorded in mixed *Allocasuarina*, *Casuarina*, *Callitris* and Brigalow woodland assemblages (Hourigan, 2012). ***Foraging habitat:*** They feed exclusively on the seeds of nine species of *Allocasuarina* and *Casuarina*, although within any given area feeding may be restricted to only two species (Hourigan, 2012).	LOW Suitable foraging habitat containing *Allocasuarina* or *Casuarina* species is not present within the ecology study area. There are no recent records of this species within close proximity to the ecology study area.

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
			Roosting habitat: They will roost in pairs or groups of up to 40 individuals in the upper branches of live trees (Hourigan, 2012). ***Nesting habitat:*** This species nests in hollows, approximately 10-20 m above the ground, in large old trees (living or dead) and often in close proximity to other nests of breeding pairs (Hourigan, 2012). ***Nearest record:*** The nearest record of this species to the ecology study area is approximately 27 km. This is an historic undated record and the subspecies is not provided. There are two other records within approximately 50 m of the ecology study area to the east and south-east. One of these is also undated and the other is from 1971. A subspecies is not attributed to either record (CSIRO, 2021).	
Grey Falcon *Falco hypoleucos*	Vulnerable	PMST	***Distribution:*** This species occurs in low densities across arid and semi-arid Australia, including the Murray-Darling Basin, Eyre Basin, central Australia and Western Australia (Marchant S. & Higgins, 1993; TSSC, 2019). The species is mainly found where annual rainfall is less than 500 mm, except when wet years are followed by drought, when the species might become marginally more widespread, although it is essentially confined to the arid and semi-arid zones at all times. In Queensland, the	LOW The species is typically associated with more arid areas of Queensland. The species is a rare vagrant closer to the coast when wet years in arid and semi-arid areas are followed by drought. Furthermore, this species has not been recorded within 25 km of the ecology study area despite the

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
			species is generally absent from the Cape York Peninsula and areas east of the Great Dividing Range (TSSC, 2019). ***General habitat preferences:*** The Grey Falcon is typically associated with timbered lowland plains, particularly *Acacia* shrublands that are crossed by tree-lined water courses. The species has been observed hunting in treeless areas and frequents tussock grassland and open woodland, especially in winter (TSSC, 2019). ***Breeding habitat:*** This species breed in old nests of other birds, particularly those of other raptors or corvids. The nests chosen are usually in the tallest trees along watercourses, particularly River Red Gum (*Eucalyptus camaldulensis*) and Coolibah (*E. coolabah*), but falcons also nest in telecommunication towers (TSSC, 2019). ***Nearest record:*** There are no published records for this species within 25 km of the ecology study area.	numerous fauna surveys that have been completed in the Moranbah region.
Painted Honeyeater *Grantiella picta*	Vulnerable	PMST	***Distribution:*** This species is sparsely distributed from south-eastern Australia to north-western Queensland and eastern Northern Territory. Greatest concentrations, including all breeding records, come from south of 26°, on inland slopes of the Great Dividing Range between the Grampians in Victoria and	LOW This species has not been recorded within 25 km of the ecology study area. Available species records and habitat modelling (CSIRO, 2021) indicate that the ecology study

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
			Roma in Queensland. After breeding, many birds move to semi-arid regions such as north-eastern South Australia, central and western Queensland and central Northern Territory. This species is considered to have a single population (TSSC, 2015a). ***General habitat preferences:*** This species occurs in mistletoes in eucalypt forests, woodlands, riparian woodlands of black box and river red gum, box-ironbark-yellow gum woodlands, acacia-dominated woodlands, paperbarks, casuarinas, Callitris, and trees on farmland or gardens. Prefers woodlands with a higher number of mature trees, as these generally support more mistletoes. More common in larger remnant tracts, rather than narrow remnant strips (TSSC, 2015a). ***Breeding habitat:*** Breeding season is closely aligned with fruiting of mistletoe, therefore north-south movements have been observed. It has been known to breed in narrow roadside strips if ample mistletoe fruit is present. The species appears to prefer mistletoe as a nest substrate and is likely to be attracted to habitats where mistletoe is prevalent and parasitism rates are high (TSSC, 2015a). ***Nearest record:*** There are no published records for this species within 25 km of the ecology study area.	area is outside of the known range of this species. Woodland vegetation communities in the ecology study area do not support a high abundance of mistletoe to provide suitable habitat for this species.

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
Red Goshawk *Erythrotriorchis radiatus*	Endangered	PMST	***Distribution:*** This species occurs in a patchy, widespread distribution across coastal and sub-coastal Australia. Historically it occurred from the north-east tip of New South Wales, across Queensland and the Northern Territory, to the north of Western Australia (TSSC, 2015b). ***General habitat preferences:*** This species inhabits tall open forests and woodlands, tropical savannas traversed by wooded or forested rivers, and the edges of rainforests, usually on fertile soils. In partly cleared parts of eastern Queensland it is associated with gorge and escarpment country (TSSC, 2015b). The species avoids both very dense and very open habitats. They are solitary and secretive birds and hunt mainly from ambush. Their prey is mostly birds, but also mammals, reptiles and insects (Marchant & Higgins, 1994). ***Breeding habitat:*** Nests are restricted to trees taller than 20 m and within 1 km of a watercourse or wetland. It is thought to rarely breed in areas with fragmented native vegetation (Garnett et al., 2011). Home ranges of 120 km^2 and 200 km^2 for females and males, respectively have been recorded (Marchant & Higgins, 1994). ***Nearest record:*** There are no published records for this species within 25 km of the ecology study area.	LOW The region, including the ecology study area, lacks extensive intact forested areas preferred by this species. There are no known records of this species in close proximity to the ecology study area despite the large number of surveys conducted in the Moranbah region.

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
Squatter Pigeon (southern subspecies) *Geophaps scripta scripta*	Vulnerable	ALA PMST WO	***Distribution:*** The southern sub-species of the Squatter Pigeon (southern subspecies) is described as occurring south of the Burdekin River-Lynd divide in the southern region of Cape York Peninsula to the Border Rivers region of northern New South Wales, and from the east coast to Hughenden, Longreach and Charleville (Higgins & Davies, 1996). The known distribution of the southern sub-species overlaps with the known distribution of the northern subspecies (DAWE, 2021i). ***General habitat preferences:*** This species is known from tropical dry, open sclerophyll woodlands and sometimes savannah with *Eucalyptus*, *Corymbia*, *Acacia* or *Callitris* species in the overstorey. The groundcover layer is patchy consisting of native, perennial tussock grasses or a mix of grasses and low shrubs or forbs. However, the groundcover layer rarely exceeds 33% of the ground area. It appears to favour sandy soil dissected with low gravely ridges and is less common on heavier soils with dense grass cover. It is nearly always found in close association i.e. within 3 km, with permanent water. While the species is unlikely to move far from woodland trees, where scattered trees still occur and the distance of cleared land between remnant trees or patches of habitat does not exceed 100 m, individuals may be found foraging in, or moving across	**PRESENT** 16 individuals of this species were recorded across three locations within the ecology study area during the survey in high-value regrowth RE 11.4.9 and remnant RE 11.5.3 (Figure 11). The ecology study area supports suitable for this species in the form of remnant and regrowth open-woodland or scrub dominated by *Eucalyptus*, *Corymbia*, and *Acacia* species, on sandy or gravelly soils, within 3 km of a suitable, permanent or seasonal waterbody.

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
			modified or degraded environments (DAWE, 2021i). ***Foraging habitat:*** Natural foraging habitat for the Squatter Pigeon (southern) is 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, within 3 km of a suitable, permanent or seasonal waterbody (DAWE, 2021i)(Squatter Pigeon Workshop, 2011). In Central Queensland the Squatter Pigeon is frequently observed in cattle yards where water troughs are present (EcoSM observations). ***Breeding habitat:*** This occurs on well-draining, stony rises occurring on sandy or gravelly soils or on low 'jump-ups' and escarpments (i.e. land zones 5 and 7), within 1 km of a suitable, permanent waterbody ***Dispersal habitat:*** This can be any forest or woodland occurring between patches of foraging or breeding habitat, and suitable waterbodies and may include denser patches of vegetation not suitable for foraging or breeding. Where scattered trees still occur, and the distance of cleared land between remnant trees or patches of habitat does not exceed 100 m, the species may forage or disperse through degraded environments (DAWE, 2021i).	

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
			Nearest record: This species was recorded within the ecology study area during the field survey (Figure 11).	
Star Finch (eastern) *Neochmia ruficauda ruficauda*	Endangered	PMST	***Distribution:*** The distribution of the Star Finch is poorly known. It is thought to occur between Bowen in the north, Winton in the west and Wowan in the south (DAWE, 2021o). However, this species' range has largely contracted to southern Cape York. There have not been any confirmed records from the Cairns to Townsville region for some time and none were recorded during the Birds Australia Atlas project. Recent records around Rockhampton are thought likely to be aviary escapees (Higgins et al., 2006). ***General habitat preferences:*** This species usually inhabits low dense damp grasslands bordering wetlands and waterways and also open savannah woodlands near water or subject to inundation but is absent from expanses of open country and uplands, usually occurring in valleys (Higgins et. al. 2006). It also occurs in cleared or suburban areas. Woodland communities in which it occurs include *Eucalyptus coolabah*, *E. tereticornis*, *E. tessellaris*, *Melaleuca leucadendra*, *E. camaldulensis* and *Casuarina cunninghamii* (DAWE, 2021o). ***Foraging habitat:*** It feeds on grass and shrub seeds, most likely from *Arundinella*,	LOW The ecology study area is not considered to provide suitable dense damp grasslands and woodlands associated with waterways and wetlands that is preferred by this species. Available species records and habitat modelling (CSIRO, 2021) indicate that the ecology study area is outside of the known range of this species. Furthermore, it has not been recorded within 25 km of the ecology study area despite the numerous fauna surveys that have been completed in the Moranbah region.

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
			Brachyachne, Chloris, *Chrysopogon*, *Digitaria*, *Echinochloa*, *Heterachne*, *Iselema*, *Oryza*, *Panicum*, *Setaria*, *Sorghum*, *Themeda*, *Urochloa*, *Casuarina*, *Fimbristylis* and *Tridax* species. It also feeds on insects (DAWE, 2021o). It has been recorded foraging, in the shade of eucalypt species, on the ground. ***Breeding habitat:*** Nests are thought to be bottle-shaped and placed in trees, amongst grass, sedges or reeds, at heights of approximately 3-9 m above the ground (DAWE, 2021o). ***Nearest record:*** There are no published records for this species within 25 km of the ecology study area.	
White-throated Needletail *Hirundapus caudacutus*	Vulnerable	ALA	***Distribution:*** This species is widespread in eastern and south-eastern Australia, occurring as non-breeding vagrants in the Northern Territory and Western Australia. It occurs in all coastal regions of eastern Queensland and New South Wales, extending inland onto the western slopes of the Great Divide and occasionally on to inland plains (DAWE, 2021j). ***General habitat preferences:*** This species is almost exclusively aerial that occurs over forests, woodlands, farmlands, plains, lakes and towns (Pizzey et al., 2012). It is known from above mainly wooded areas, and larger tracts of vegetation, particularly forest. The species	**MODERATE** There are no nearby records of this species to the ecology study area, however, they have been recorded in the broader region and forested habitats in the ecology study area may provide broadly suitable foraging habitat. This species may therefore overfly the ecology study area as part of a broader foraging range.

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
			roosts in tree hollows in tall trees on ridge-tops, on bark or rock faces and it is thought to have traditional roost sites (DotE, 2015). Large tracts of native forest vegetation may be considered important in Australia (DotE, 2015). ***Roosting habitat:*** The species has been recorded roosting in trees in foliage and hollows in forests and woodlands, although this is probably uncommon. It is thought to also roost aerially. They possibly alight or take refuge during adverse conditions (DAWE, 2021j). ***Foraging habitat:*** This species forages aerially, from just above the ground to heights up to 'cloud level' over forested and open areas. They have been recorded above disturbed areas, e.g. in the vicinity of bushfires or slashed paddocks, in areas of updraughts or in whirlwinds and often along the edges of low pressure systems (DAWE, 2021j). ***Nearest record:*** The nearest record of this species is from 2012 approximately 27 km north-east of the ecology study area near Coppabella (CSIRO, 2021).	
Mammals				
Coastal Sheath-tail Bat *Taphozous australis*	Near threatened	WO	Low: This is likely to be an erroneous record as this species is restricted to a very narrow coastal zone in Queensland that extends no more than a few kilometres inland (DES, 2021a).	

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
Corben's Long-eared Bat *Nyctophilus corbeni*	Vulnerable	PMST	***Distribution:*** In Queensland, this species is mainly recorded in the Brigalow Belt South Bioregion, extending eastwards to the Bunya Mountains National Park, as far north as the Expedition Range and Dawson River areas and west into the Mulga Lands Bioregion and west of Bollon (DAWE, 2021p). ***General habitat preferences:*** Corben's Long-eared Bat occurs in a range of inland woodland vegetation types, including box, ironbark and cypress pine woodlands as well as Buloke woodland, Brigalow woodland, Belah woodland, Smooth-barked Apple (*Angophora leiocarpa*) woodland, River Red Gum (*Eucalyptus camaldulensis*) woodland and dry sclerophyll forest. It is known from habitat dominated by various eucalypt and bloodwood species and various types of tree mallee, being most abundant in vegetation with a distinct canopy and a dense cluttered shrub layer (TSSC, 2015c). ***Foraging habitat:*** This insectivorous bat feeds in flight, by gleaning vegetation and during ground foraging. It feeds on beetles, bugs, moths, grasshoppers, crickets, ants, spiders and	LOW The ecology study area lacks large intact tracts of forest, with the native vegetation present, comprising mostly open woodlands lacking the dense cluttered shrub layer preferred by this species. There are no known records within 25 km of the ecology study area despite the numerous fauna surveys that have been completed in the Moranbah region. Furthermore, the Moranbah region is beyond the known distribution of this species.

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
			mosquitoes. Foraging tends to be concentrated around patches of trees (TSSC, 2015c). ***Roosting habitat:*** Occurs solitarily under exfoliated bark and in the crevices on trees (TSSC, 2015c). ***Breeding habitat:*** Maternity roosts are likely to occur in colonies in larger tree cavities. Breeding is thought to occur around November, although there is little information about this (TSSC, 2015c). ***Nearest record:*** There are no published records for this species within 25 km of the ecology study area.	
Ghost Bat *Macroderma gigas*	Endangered	PMST	***Distribution:*** It is predicted, based on analysis of historic climatic data, fossils, and modelling that the Ghost Bat is a geographically relictual species in southern, arid landscapes, present only because caves provide suitable roost microclimates (TSSC, 2016). Although this species is thought to once occupy much of Australia, its current range is discontinuous across northern Australia, with colonies known in the Pilbara, Kimberly, northern Northern Territory, the Gulf of Carpentaria, coastal and near coastal eastern Queensland from Cape York to near Rockhampton and the Riversleigh and Cammoweal districts in western Queensland and occupying both arid and lush rainforest	LOW The ecology study area does not support preferred habitat for this species in the form of mountainous cave and escarpment features. The Cherwell and Harrow Ranges support potentially suitable habitat. However, the eastern edge of these ranges are located at least 5 km west of the ecology study area, therefore placing the ecology study area out of the known foraging range of this species (i.e. 2 km).

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
			habitats (TSSC, 2016; van Dyck & Strahan, 2008). ***General habitat preferences:*** Habitat is comprised of thicket, open woodland, and spinifex and black soil grasslands (van Dyck & Strahan, 2008; van Dyck et al., 2013). Monsoon forests, open savannah woodland, tall open forest, deciduous vine forest and tropical rainforest is also used (Churchill, 2009). Cave habitat is important for roosting and breeding (van Dyck & Strahan, 2008). Ghost bats usually require a number caves to move between seasonally (TSSC, 2016). ***Foraging habitat:*** This species feeds on frogs, lizards, birds, small mammals and sometimes other bats (van Dyck & Strahan, 2008; TSSC, 2016). It captures prey on the ground and then returns to an established feeding site, e.g. rock overhang or small cave, to feed (van Dyck & Strahan, 2008). It is known to forage up to 2 km from the roost cave and will use the same foraging area each night. Foraging areas are approximately 60 ha in size (Churchill, 2009; TSSC, 2016). ***Roosting habitat:*** Caves provide suitable roost microclimates and it is known to rest during the day in large sandstone or limestone caves, boulder piles, shallow escarpments or deep rock fissures and mines (TSSC, 2016; van Dyck &	There are no records of this species 25 km of the ecology study area despite the numerous fauna surveys that have been completed in the Moranbah region.

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
			Strahan, 2008; Churchill, 2009). This species appears to require caves with specific temperature and humidity ranges (TSSC, 2016). Groups of greater than 100 individuals is unusual (van Dyck & Strahan, 2008). ***Breeding habitat:*** Breeding is likely to occur in July or August with young being born between September and November. Nursery colonies are formed separately to males (van Dyck & Strahan, 2008). Only 14 breeding sites are currently known (TSSC, 2016). Young are fully weaned by about March each year but may be left in nurseries or forage with the mother up until this age (Churchill, 2009). There is a tendency for breeding caves to have multiple entrances (TSSC, 2016). ***Nearest record:*** There are no published records for this species within 25 km of the ecology study area.	
Greater Glider *Petauroides volans*	Endangered	ALA EH PMST WO	***Distribution:*** This species is restricted to eastern Australia, between Proserpine in north Queensland and Wombat State Forest in central Victoria. It occurs from sea level up to 1,200 m above sea level (DCCEEW, 2022). ***General habitat preferences:*** The Greater Glider occurs in a range of eucalypt-dominated habitats, including low open forests on the coast to tall forests in the ranges and low woodland westwards of the Dividing Range. It does not	**HIGH** There are no large waterways supporting large and abundant trees and hollows in the ecology study area. However, given the close proximity of nearby records and the presence of hollow-bearing trees throughout the forested areas (remnant and regrowth) of the ecology study area, at a likely

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
			use rainforest habitats (van Dyck & Strahan, 2008; van Dyck et al., 2013). This species favours taller, montane, moist eucalypt forests on fertile soils, with relatively old trees and abundant hollows and a diversity of eucalypt species (DCCEEW, 2022). ***Foraging habitat:*** The Greater Glider has an almost exclusive diet of eucalypt leaves and occasionally flowers or buds (van Dyck & Strahan, 2008; DCCEEW, 2022). Although the species is known to feed on a range of eucalypt species, in any particular area it is likely to only forage on one or two species (van Dyck & Strahan, 2008). ***Breeding habitat:*** Breeding occurs between March and June and a single young is born each year (van Dyck & Strahan, 2008; DCCEEW, 2022). The young stays with the mother or is left in the nest and becomes independent at about 9 months (Menkhorst & Knight, 2011). ***Notable features:*** This species appears to have low dispersal ability and typically small home ranges of 1-4 ha. In lower productivity forests, home ranges may be as large as 19 ha. Male home ranges generally do not overlap (DCCEEW, 2022). It may glide over distances of up to 100 m. It is a nocturnal species and uses tree hollows during the day to rest (van Dyck & Strahan, 2008).	abundance of at least 1 per hectare, it is considered likely this species will use the ecology study area.

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
			Nearest record: Essential habitat is mapped immediately to the north-west of the ecology study area and this species was recorded by Ecological Survey & Management along lower reaches of J B Gully and upper reaches of Cherwell Creek within 2 km of the ecology study area, as part of other surveys in the region (unpublished record).	
Koala *Phascolarctos cinereus*	Endangered	ALA PMST WO	***Distribution:*** This species is widespread in sclerophyll forest and woodlands on foothills and plains on both sides of the Great Dividing Range from about Chillagoe, Queensland to Mt Lofty Ranges in South Australia (Menkhorst & Knight, 2011). In Queensland the species is thought to occur in eight bioregions; Einaslieigh Uplands, Wet Tropics, Desert Uplands, Central Mackay Coast, Mitchell Grass Downs, Mulga Lands, Brigalow Belt North and Brigalow Belt South. In many locations Koalas occur in widespread, low density and fragmented populations (DAWE, 2022). ***General habitat preferences:*** Koalas in Queensland use a range of habitats (typically dominated by *Eucalyptus* species), including moist coastal forests, southern and central western sub-humid woodlands and a number of eucalypt woodlands adjacent to waterbodies in the semi-arid western parts of the state (DAWE, 2022). These habitats may include forests or	**HIGH** This species is known from the region and there are a number of known records within 25 km of the ecology study area. Given the close record of this species to the ecology study area and connectivity of woodland habitat between this record and the ecology study area, it is considered highly likely this species would use forest and woodland habitat within the ecology study area. All forested areas supporting food trees would provide potential habitat for this species in the ecology study area.

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
			woodlands, road-side and rail vegetation and paddock trees, safe intervening ground matrix for travelling between trees and patches (DAWE, 2022). ***Foraging habitat:*** The diet of the Koala is highly specialised and relies on species of the Euclaykptus, Corymbia and Angophora genera. While the Koala may use more than 400 species of tree for their food and habitat requirements, preferred tree species will vary by habitat type and location across their range, with primary food species varying in different habitats and potentially comprising as few as two species in any given location (DAWE, 2022). ***Refuge habitat:*** Areas where microclimats provide refuge from heat, and perennial water results in leaf-water content remaining high, e.g. deep gullies, caves, cliffs or dense vegetation. climate refugia for this species includes drainage lines, riparian zones and patches that are resilient to drying conditions due to favourable hydrological systems (DAWE, 2022). ***Nearest record:*** This species was recorded by Ecological Survey & Management approximately 2 km to the west of the ecology study area in 2019.	

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
Large-eared Pied Bat *Chalinolobus dwyeri*	Vulnerable	WO	***Distribution:*** Records exist from Shoalwater Bay Queensland, through to the vicinity of Ulladulla, New South Wales in the south (Hoye, 2005). Much of the known distribution is within New South Wales. In Queensland, further records are known from sandstone escarpments in the Carnarvon, Expedition Ranges and Blackdown Tablelands (TSSC, 2012). ***General habitat preferences:*** The Large-eared pied Bat occurs in a variety of habitats including dry and wet sclerophyll forest; Cyprus Pine (Callitris glauca) dominated forest; tall pen eucalypt forest with a rainforest sub-canopy; sub-alpine woodland; and sandstone outcrop country (DAWE, 2021e). Habitat modelling based on surveys in the southern Sydney region suggest that the Large-eared pied Bat is largely restricted to the interface of sandstone escarpment)for roost habitat) and relatively fertile valleys (for foraging habitat) (Pennay, 2008). ***Roosting habitat:*** Arch caves with dome roofs (that need to be deep enough to allow juvenile bats to learn to fly safely inside) and with indentations in the roof (presumably to allow the capture of heat) (DAWE, 2021e; Pennay, 2008).	LOW There is only one potential record within 50 km of the ecology study area despite the numerous fauna surveys that have been completed in the Moranbah region. Furthermore, suitable sandstone outcrops and escarpment are not present in or in close proximity to the ecology study area and the Moranbah region is beyond the known distribution of this species.

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
			No roost sites have been observed in Queensland. ***Breeding habitat:*** The species requires a combination of sandstone cliff/escarpment to provide roosting habitat that is adjacent to higher fertility sites, particularly box gum woodlands or river/rainforest corridors, which are used for foraging (TSSC, 2012). ***Nearest record:*** There is one Wildlife Online record within 25 km of the ecology study area, however, locations are not provided with these database results (DES, 2021i). The Atlas of Living Australia does not identify any records within 50 km from the ecology study area (CSIRO, 2021).	
Short-beaked Echidna *Tachyglossus aculeatus*	Special least concern	ALA WO	***Distribution:*** This species occurs throughout mainland Australia and Tasmania, as well as King, Flinders and Kangaroo Islands (Menkhorst & Knight 2011). ***General habitat preferences:*** This species occurs in almost all terrestrial habitats except intensively managed farmland. It shelters in logs, crevices, burrows or piles of litter and feeds on ants, termites and other soil invertebrates, particularly beetle larvae (Menkhorst & Knight, 2011).	**HIGH** This species is highly ubiquitous in the landscape and is regularly recorded in the Moranbah region. All wooded remnant and high-value regrowth forest and woodland communities in the ecology study area are likely to form habitat for this species.

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
			Nearest record: This species was recorded in the ecology study area during the field survey (Figure 17).	
Reptiles				
Allan's Lerista *Lerista allanae*	Endangered	PMST WO	***Distribution:*** This species is restricted to the area around Clermont and Capella (Borsboom et al., 2010) based on six records of this species in 2010. Prior to these records the species was thought to be potentially extinct. ***General habitat preferences:*** Historically this species was known only from black soil downs (undulating plains formed on basalt, shale, sandstone and unconsolidated sediments) of the Oxford land system in the Brigalow Belt North Bioregion (DAWE, 2021l). Early specimens were found several centimetres under the surface of black-red soil, under tussocks of grass on farmland. Habitats include: Mountain Coolabah (*Eucalyptus orgadophila*)/Red Bloodwood (*E. erythrophloia*) open woodlands and Black Tea-tree (*Melaleuca bracteata*) closed scrub to low closed-forest gravely hills, ridges and gullies; and scattered *Bauhinia spp*. on plains (DAWE, 2021l). Recent records of this species are from loose friable, weakly alkaline to alkaline surface soils or leaf litter beneath trees and shrubs. Soils are described as chocolate to dark chocolate-coloured, non-cracking clay-based soils (30-65% clay content) in REs 11.8.5 and	LOW While potentially suitable habitat for this species is present in the ecology study area, in the form of non-cracking clay-based soils (i.e. land zone 8), there are no local records of this species and it is thought to be entirely restricted to an area between Clermont and Capella. Furthermore, this species has not been recorded within 25 km of the ecology study area despite the numerous fauna surveys that have been completed in the Moranbah region.

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
			11.8.11/11.8.5 (Borsboom et al., 2010). This species has been recorded in disturbed areas and adjacent Buffel Grass areas (Borsboom et al., 2010). ***Foraging habitat:*** This species feeds on termites (DAWE, 2021l). ***Breeding habitat:*** There is no life cycle information available for this species. ***Nearest record:*** Although the Wiildlife Online database identifies one record of this species within 25 km of the ecology study area (DES, 2021i). The Atlas of Living Australia identifies the nearest record of this species as an undated record approximately 36 km south-west of the ecology study area (CSIRO, 2021).	
Common Death Adder *Acanthophis antarcticus*	Vulnerable	ALA WO	***Distribution:*** This species is known from the Gulf region, central Queensland, New South Wales and southern parts of South Australia and Western Australia (Hines, 2014). ***General habitat preferences***: Occurs in a variety of habitats containing deep leaf litter, including, rainforests, wet sclerophyll forests, woodland, grasslands, chenopod dominated shrublands, and coastal heathlands (Hines, 2014). Habitat with deep intact leaf litter is preferred (Wilson & Swann, 2013; Hines, 2014).	LOW Areas of deep litter that provide potential habitat for this species are very sparse to absent across the ecology study area.

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
			Foraging habitat: The Common Death Adder feeds on insects, frogs, small mammals, lizards and birds (Hines, 2014). ***Nearest record:*** This species has been recorded in 2012 approximately 14 km east of the ecology study area on the Isaac River (CSIRO, 2021).	
Dunmall's Snake *Furina dunmalli*	Vulnerable	PMST	***Distribution:*** This snake occurs in the Brigalow Belt South and Nandewar bioregions from near the Queensland border south to Ashford in New South Wales (DAWE, 2021h). ***General habitat preferences:*** Dunmall's Snake has been found in a broad range of habitats between 200-500 m above sea level. Habitats including forests and woodlands on clay or clay loam soils dominated by Brigalow (*Acacia harpophylla*), other wattles such as *A. burrowii*, *A. deanii*, *A. leiocalyx*, native Cypress (*Callitris spp.*) or Bull Oak and various Spotted Gum (*Corymbia citriodora* ssp. *variegata*), Ironbark (*Eucalyptus crebra* and *E. melanophloia*), White Cypress Pine (*Callitris glaucophylla*) and Bull Oak open forest and woodland associations on sandstone derived soils. It has rarely been found on the edge of dry vine scrub and in hard ironstone country. It shelters under fallen timber and ground litter and may use cracks in alluvial clay soils. The Dunmall's Snake feeds on small skinks and geckos (DAWE, 2021h).	LOW Some remnant forest and woodland vegetation within the ecology study area provides broadly suitable habitat for this species. However, these areas have been heavily fragmented and altered through agricultural land use and lack deep leaf litter and abundant coarse woody debris. There are no known records within 25 km of the ecology study area despite the numerous fauna surveys that have been completed in the Moranbah region. The nearest record of this species is over 85 km south-west of the ecology study area near Clermont (CSIRO, 2021).

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
			Notable features: This is a very secretive snake with few known records. The high number of mid-body scales (21) and small yellow flecks over the temporal region and lips will generally distinguish this snake from other similar species (DAWE, 2021h). ***Nearest record:*** There are no published records for this within 25 km of the ecology study area.	
Ornamental Snake *Denisonia maculata*	Vulnerable	ALA EH PMST WO	***Distribution:*** This snake species is known from the Brigalow Belt North and parts of the Brigalow Belt South Bioregions, with the main occurrences in the drainage system of the Fitzroy and Dawson Rivers (DAWE, 2021f). ***General habitat preferences:*** This snake is found in close association with frogs which form the majority of its prey. It is known to prefer woodlands and open forests associated with moist areas, particularly gilgai (melon-hole) mounds and depressions with clay soils but is also known from lake margins, wetlands and waterways. This species has been recorded mostly in Brigalow (*Acacia harpophylla*), Gidgee (*Acacia cambagei*), Blackwood (*Acacia argyrodendron*) or Coolabah (*Eucalyptus coolabah*) - dominated vegetation communities or pure grassland associated with gilgais. REs in which it has been recorded include; 11.4.3, 11.4.6, 11.4.8 and 11.4.9 and 11.3.3 and	**PRESENT** This species was recorded at numerous locations during spotlighting in the ecology study area. Habitat occurs in the ecology study area in association with gilgai mounds and depressions in remnant, high-value regrowth Brigalow vegetation and cleared paddocks. Most areas associated with drainage lines within the ecology study area also provide potential habitat for this species.

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
			11.5.16. It shelters in logs, under coarse woody debris and in ground litter. It appears to prefer a diversity of gilgai size and depth and with some fringing groundcover vegetation and ground timber and where soils are of a high clay content with deep-cracking characteristics. Habitat patches greater than 10 ha and connected to larger areas of remnant vegetation are preferred (DAWE, 2021f). The Draft Referral guidelines for the nationally listed Brigalow Belt reptiles describes gilgai depressions and mounds as being important habitat with habitat connectivity between gilgais and other suitable habitats also being important (SEWPaC, 2011). ***Foraging habitat:*** It prefers habitats where there is an abundance of burrowing frog species (DAWE, 2021f). ***Refuge habitat:*** This species seeks refuge in soil cracks on gilgai mounds within habitat areas (DAWE, 2021f). ***Nearest record:*** This species was recorded at numerous locations in the ecology study area during the field survey.	
Yakka Skink *Egernia rugosa*	Vulnerable	PMST	***Distribution:*** The distribution of this species is highly fragmented. It extends from the coast to the hinterland of sub-humid to semi-arid eastern Queensland. It has been recorded between the Queensland/New South Wales border to Mungkan Kandju National Park on	LOW Areas of surface rock preferred by this species are not present within the ecology study area and vegetation communities present

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
			Cape York Peninsula, and from Bundaberg and the region west of Gympie to Mariala National Park west of Charleville (DAWE, 2021g). ***General habitat preferences:*** This species occurs in woodland and open forest habitats, wet/dry sclerophyll forest and ecotonal rainforest habitats. This species is commonly found in cavities under and between partly buried rocks, logs or tree stumps, root cavities and abandoned animal burrows. The species often takes refuge in large hollow logs and has been known to excavate deep burrow systems, sometimes under dense ground vegetation (Wilson, 2005; Cogger, 2000). In cleared habitat, this species can persist where there are shelter sites such as raked log piles, deep gullies, tunnel erosion/sinkholes and rabbit warrens. The species has also been found sheltering under sheds and loading ramps. This species is not generally found in trees or rocky habitats (Chapple, 2003). ***Feeding habitat:*** This species burrows and feeds on soft plant material and fruits as well as a variety of invertebrates that venture into or near the burrow entrance. This species defecates in a pile outside burrow entrances. ***Nearest record*:** There are no published records for this within 25 km of the ecology study area.	have a low abundance of coarse woody debris. There are no known records within 25 km of the ecology study area despite the numerous fauna surveys that have been completed in the Moranbah region. The nearest record of this species is over 150 km south of the ecology study area (CSIRO, 2021).

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
Migratory birds				
Black-faced Monarch *Monarcha melanopsis*	Special least concern (migratory)	ALA WO	***Distribution/Habitat preferences:*** Rainforest, eucalypt woodlands and forest (mainly wet sclerophyll), coastal scrubs, rainforest gullies with a dense understorey of ferns and/or shrubs (DAWE, 2021m; DotE, 2015; Pizzey et al., 2012). In Queensland this species occurs on the eastern slopes of the Great Divide. Also occasionally occurs further inland (DAWE, 2021m). ***Nearest record:*** This species has been recorded approximately 7 km south-west of the ecology study area at tailings ponds at the Peak Downs Mine infrastructure area (CSIRO, 2021).	LOW Complex vegetation associated with drainage lines is not present in the ecology study area. Open grassy woodland, natural grassland and Brigalow communities, which form the dominant habitats in the ecology study area are likely to be less suitable for this species.
Caspian Tern *Hydroprogne caspia*	Special least concern (migratory)	ALA	***Distribution/Habitat preferences:*** Sheltered coastal embayments and those with sandy or muddy margins are preferred. They also occur on near-coastal or inland terrestrial wetlands that are either fresh or saline, especially lakes (including ephemeral lakes), waterholes, reservoirs, rivers and creeks (DAWE, 2021k). ***Nearest record:*** There are two records approximately 25 km south-east of the ecology study area (CSIRO, 2021).	LOW This species prefers coastal wetland habitats. Suitable wetland habits are highly limited in the ecology study area.
Common Greenshank *Tringa nebularia*	Special least concern (migratory)	ALA PMST WO	***Distribution/Habitat preferences:*** This species occurs mainly in coastal regions with some scattered records south of a line from near Dalby to Mt Guide. It occurs in a variety of inland wetlands and sheltered coastal habitats of varying salinity. This species uses permanent and ephemeral terrestrial wetlands, including swamps, lakes, dams, rivers, creeks, billabongs, waterholes and inundated floodplains,	**MODERATE** Suitable seasonal wetland habitat for this species may be provided by gilgai habitat in the ecology study area during the wet season, e.g. December to April, when gilgai holds water. The large dam in the west of the ecology

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
			claypans, saltflats mudflats, saltmarsh, mangroves, seagrass, embayments, harbours, river estuaries, deltas and lagoons. It will also use artificial wetlands and impoundments. It generally does not occur in dry grassland (DAWE, 2021v). ***Nearest record:*** This species has been recorded approximately 7 km south-west of the ecology study area at tailings ponds at the Peak Downs Mine infrastructure area (CSIRO, 2021). It was also recorded by Ecological Survey & Management in 2019 approximately 11 km north-west of the ecology study area.	study area along J B Gully may also be suitable. It is noted that gilgai was not holding water during the field survey.
Common Sandpiper *Actitis hypoleucos*	Special least concern (migratory)	PMST	***Distribution/Habitat preferences:*** Occurs in a range of coastal wetland habitats, and some inland wetlands with varying levels of salinity. Generally occurs on muddy margins or rocky shores, which may be narrow or steep, and rarely found on mudflats. Forages in shallow water or edges of wetlands. May also use grassy areas adjoining wetlands (DAWE, 2021a). ***Nearest record:*** There are no published records for this species within 25 km of the ecology study area.	LOW Preferred coastal wetland habitat is not present within or immediately adjacent to the ecology study area. Farm dams in the ecology study area are considered unsuitable given their generally small size, sloped banks and lack of extensive bare, wet mud banks that this species typically uses for foraging.
Fork-tailed Swift *Apus pacificus*	Special least concern (migratory)	ALA PMST	***Distribution/Habitat preferences:*** Aerial species that flies over open habitat sometimes over forests and cities (Pizzey et al., 2012). Sometimes occurs above rainforests, wet sclerophyll forest or pine plantations (DAWE, 2021b). It occurs in a range of habitat from inland open plains to wooded areas, where it is exclusively aerial (DAWE, 2021b).	**MODERATE** This species may overfly the ecology study area as part of a larger foraging.

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
			Nearest record: The nearest record is approximately 30 km north-west of the ecology study area (CSIRO, 2021).	
Glossy Ibis *Plegadis falcinellus*	Special least concern (migratory)	ALA WO	***General distribution and habitat:*** This species prefers foraging and breeding in freshwater marshes at the edges of lakes, rivers, lagoons, flood-plains, wet meadows, swamps, reservoirs, sewage ponds, rice-fields and cultivated areas under irrigation. Occasionally found in coastal locations. Sometimes recorded in wooded swamps, artificial wetlands and in mangroves for breeding. The species roosts in trees or shrubs usually near water bodies (DAWE, 2021r). ***Nearest record:*** Ecological Survey & Management has recorded this species approximately 8 km to the south-west of the ecology study area (DAWE, 2021r). Ecological Survey & Management have also recorded this species approximately 10 km north-west of the ecology study area in 2019.	**MODERATE** Suitable seasonal wetland habitat for this species may be provided by gilgai habitat in the ecology study area during the wet season, e.g. December to April, when gilgai holds water. The large dam in the west of the ecology study area along J B Gully may also be suitable. It is noted that gilgai was not holding water during the field survey.
Gull-billed Tern *Gelochelidon nilotica*	Special least concern (migratory)	WO	***Distribution/Habitat preferences:*** Inhabit coastal environments, including freshwater swamps, brackish and salt lakes, beaches and estuarine mudflats, floodwaters, sewage farms, irrigated croplands and grasslands (BirdLife Australia, 2021). ***Nearest record:*** This species has been recorded approximately 7 km south-west of the ecology study area at tailings ponds at the Peak Downs Mine infrastructure area (CSIRO, 2021).	LOW This species is primarily associated with coastal environments and the study area is located at least 130 km inland. Coastal wetland habitat this species is typically associated with are not present within or adjacent to the ecology study area.
Latham's Snipe *Gallinago hardwickii*	Special least concern (migratory)	PMST	***Distribution/Habitat preferences:*** Soft wet ground or shallow water with tussocks, wet paddocks, seepage below dams, irrigated areas, scrub or open woodland (Pizzey et al., 2012).	**MODERATE** This is a very cryptic species, which may explain lack of records in the Moranbah region. Therefore, as with

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
			Nearest record: This species has not been recorded within 25 km of the ecology study area.	the Australian Painted Snipe, wetland habitat containing gilgai and a large dam along J B Gully, within the ecology study area, provide suitable seasonal habitat for this species.
Marsh Sandpiper *Tringa stagnatilis*	Special least concern (migratory)	ALA WO	***Distribution/Habitat preferences:*** This species uses coastal and inland wetlands. The wetlands can be fresh or saltwater. Typical habitats include: estuarine and mangrove mudflats, beaches, shallows of swamps, lakes, billabongs, temporary flood waters, sewage ponds and saltworks (Morcombe & Stewart, 2013). ***Nearest record:*** There are no records within 25 km of the ecology study area.	LOW This species is typically associated with coastal habitats and the ecology study area located at least 130 km inland. The ecology study area lacks lacustrine wetland habitats such as lakes and billabongs typically used by this species while inland.
Oriental Cuckoo *Cuculus optatus*	Special least concern (migratory)	PMST	***Distribution/Habitat preferences:*** Non-breeding habitat occurs in Australia and is characterised by monsoonal rainforest, vine thickets, wet sclerophyll forest or open Casuarina, Acacia or Eucalyptus woodlands. Frequently in ecotones between habitats. This habitat is considered important under the EPBC Act (DotE, 2015). ***Nearest record:*** This species has not been recorded within 25 km of the ecology study area.	LOW This species is not known from within 25 km of the ecology study area. This species prefers dense forest habitats, which are not present in the ecology study area.
Osprey *Pandion haliaetus*	Special least concern (migratory)	PMST	***Distribution/Habitat preferences:*** This species occurs in littoral and coastal habitats and terrestrial wetlands of tropical and temperate Australia and offshore islands. The Osprey has been occasionally observed further inland along major rivers. This species requires extensive areas of fresh, brackish or saline waters for foraging (DAWE, 2021q) Important habitat under the EPBC Act is considered to be bays,	LOW This species has not been recorded in close proximity to the ecology study area, and large water bodies are not located within or adjacent to the ecology study area.

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
			estuaries, along tidal stretches of large coastal rivers, mangrove swamps, coral and rock reefs, terrestrial wetlands and coastal lands of tropical and temperate Australia and offshore islands. They are generally found on or near the coast but also range inland along large rivers, mainly in northern Australia. They nest in trees that are usually dead or with dead tops, rocky coastlines and on artificial structures (DotE, 2015). ***Nearest record:*** This species has not been recorded within 25 km of the ecology study area.	
Pectoral Sandpiper *Calidris melanotos*	Special least concern (migratory)	PMST	***Distribution/Habitat Preferences:*** In Queensland this species mainly occurs in shallow fresh to saline wetlands around Cairns, although there have been few records near Mt Isa, Longreach and Oakley (DAWE, 2021d). This 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. They forage in shallow water or soft mud at the edge of wetlands (Higgins & Davies, 1996) ***Nearest record:*** There are no published records for this species within 25 km of the ecology study area.	LOW This species is primarily associated with coastal environments and the ecology study area is located at least 130 km inland. Farm dams in the ecology study area are considered unsuitable given their generally small size, sloped banks and lack of extensive bare, wet mud banks that this species typically uses for foraging. Open fringing vegetation is also generally lacking around these dams.
Rufous Fantail *Rhipidura rufifrons*	Special least concern (migratory)	ALA WO	***Distribution/Habitat preferences:*** Rainforest, wet eucalypt forests, monsoon forests, paperbarks, sub-inland and coastal scrubs, mangroves, watercourses, parks (Pizzey et al., 2012). ***Nearest record:*** This species has been recorded approximately 20 km north of the ecology study area	LOW This species prefers dense forest habitats which are not present in the ecology study area.

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
			along Smoky Creek (Ecological Survey & Management, 2020a).	
Satin Flycatcher *Myiagra cyanoleuca*	Special least concern (migratory)	PMST	***Distribution/Habitat preferences:*** Heavily vegetated gullies in forests and taller woodlands. During migration, this species prefers coastal forests, woodlands, mangroves, gardens and open country (Pizzey et al., 2012). More common in tall wet sclerophyll forest, often in gullies or along watercourses. In woodlands this species prefers open, grassy habitats. Habitat becomes more varied during migration and includes most wooded habitats except rainforests, although wintering birds may use rainforests in northern Queensland. All habitats are considered important under the EPBC Act (DotE, 2015). ***Nearest record:*** There are no published records for this species within 25 km of the ecology study area.	LOW Complex vegetation associated with drainage lines is not present in the ecology study area. Open grassy woodland, natural grassland and Brigalow communities, which form the dominant habitats in the ecology study area are likely to be less suitable for this species.
Sharp-tailed Sandpiper *Calidris acuminata*	Special least concern (migratory)	ALA PMST WO	***Distribution/Habitat Preferences:*** The Sharp-tailed Sandpiper prefers muddy edges of shallow, fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation. This includes lagoons, swamps, lakes and pools near the coast, and dams, waterholes, soaks, bore drains and bore swamps, saltpans and hypersaline saltlakes inland. They also occur in saltworks and sewage farms (Higgins & Davies, 1996). They use flooded paddocks, sedgelands and other ephemeral wetlands, but leave when they dry. They use intertidal mudflats in sheltered bays, inlets, estuaries or seashores, and also swamps and creeks lined with mangroves. They tend to occupy coastal	LOW Farm dams in the ecology study area are considered unsuitable given their generally small size, sloped banks and lack of extensive bare, wet mud banks that this species typically uses for foraging.

Common name/ Species name	NC Act Status	Record source[1]	Habitat preferences	Likelihood to occur in the ecology study area
			mudflats mainly after ephemeral terrestrial wetlands have dried out, moving back during the wet season (Higgins & Davies, 1996). ***Nearest record:*** This species has been recorded approximately 7 km south-west of the ecology study area at tailings ponds at the Peak Downs Mine infrastructure area (CSIRO, 2021).	
Yellow Wagtail *Motacilla flava*	Special least concern (migratory)	PMST	***Distribution/Habitat Preferences:*** Non-breeding habitat occurs in Australia and is characterised by mostly well-watered open grasslands and the fringes of wetlands. Roosts in mangrove and other dense vegetation (DAWE, 2021n). Well-watered open grasslands and the fringes of wetlands as well as roosting habitat in mangroves and other dense vegetation is considered important habitat for this species in Australia (DotE, 2015). ***Nearest record:*** This species has not been recorded within 25 km of the ecology study area.	LOW The ecology study area does not support suitable habitat for this species in the form of well-watered open grasslands. There are no naturally occurring wetlands in the ecology study area. Furthermore, this species has not been recorded in the Moranbah region despite numerous surveys having been completed in the region.

[1]Source:

- ALA – Atlas of Living Australia (Table B2 of Appendix B)
- EH – Queensland Government essential habitat mapping
- PMST – Protected Matters Search Tool (PMST database results contained in Appendix B)
- WO – Wildlife Online database (Wildlife Online database search results contained in Appendix B).

Appendix F

Flora species recorded in the ecology study area

Table F1: Flora species recorded across the ecology study area

Scientific name	Common name	NC Act Status[1]	RE type					Incidental
			11.3.3	11.4.9	11.9.2	11.9.3	11.9.5	
Abelmoschus ficulneus	Native Rosella	LC				+		
Abultion otocarpum	*ncn*	LC			+			
Abutilon guineense	*ncn*	LC	1		1-2			
Abutilon malvifolium	Mallow-flowered Lantern Flower	C	1-2		+-1			
Abutilon oxycarpum var. *oxycarpum*	Lantern Bush	C		**+**				
Acacia excelsa subsp. *excelsa*	Ironwood	C			3	1-5		
Acacia harpophylla	Brigalow	C	3-4	4 - 5	1-2		4 - 5	
Acacia holosericea	Velvet Wattle	C						
Acacia salicina	Sally Wattle	C	4		1-3	+-1		
Achyranthes aspera	Chaff Flower	C	1-2	1				
Aeschynomene indica	Buddha Pea	*		1				
Afrohybanthus enneaspermus	Purple Spade Flower	C			+-1	+-1	2-4	
Alectryon diversifolius	Scrub Boonaree	C	2	3	1(t)	1		
Alectryon oleifolius subsp. *elongatus*	Western Rosewood	C	2-3		1(t)	1		
Alphitonia excelsa	Red Ash	C						x
Alstonia constricta	Bitterbark	C			1(t)			
Alternanthera denticulata	Lesser Joyweed	C	2			1		
Alternanthera nana	(a) Joyweed	C			+			
Alternanthera pungens	Khaki Weed	*	2-3					
Alysicarpus bupleurifolius	*ncn*	*	1			1		
Alysicarpus muelleri	*ncn*	C				+		
Ammannia multiflora	Jerry-jerry	C		1				
Amyema biniflora	*ncn*	C	1					
Amyema maidenii subsp. *maidenii*	*ncn*	C		1				
Amyema quandang var. bancroftii	Grey Mistletoe	C	1	1				

Scientific name	Common name	NC Act Status[1]	RE type					Incidental
			11.3.3	11.4.9	11.9.2	11.9.3	11.9.5	
Apowollastonia spilanthoides	*ncn*	C			+			
Archidendropsis basaltica	Dead Finish	C			1-5	1		
Aristida latifolia	Kerosene Grass	C			1-4	3-4		
Aristida leptopoda	White Speargrass	C			1-2	1-4		
Aristida ramosa	Purple Wiregrass	C			+			
Astrebla elymoides	Hoop Mitchell Grass	C	3 - 4	3	1	1		
Astrebla lappacea	Curly Mitchell Grass	C				2		
Astrebla squarrosa	Bull Mitchell Grass	C	3		1	1-2		
Atalaya hemiglauca	Whitewood	C	2	3	+-4	+-1	2	
Atriplex muelleri	*ncn*	C						
Basilicum polystachyon	Native Basil	C			1	1		
Boerhavia dominii	Tarvine	C	2	2	2			
Bothriochloa bladhii subsp. *bladhii*	Forest Bluegrass	C	1		3-5	3 - 5		
Bothriochloa decipiens var. *cloncurrensis*	ncn	C			1			
Bothriochloa ewartiana	Forest Bluegrass	C	4		2-5	1-5		
Bothriochloa pertusa	Indian Bluegrass	*	2-5		1-4	1-3		
Brachyachne convergens	Native Couch	C	2	2	1-2	1-4		
Brunoniella australis	ncn	C			1-2	+-2		
Calotis scabiosifolia var. *scabiosifolia*	Rough Burr Daisy	C	2		1	1		
Camptacra barbata	ncn	C			1	+-1		
Capparis anomala	Warrior Bush	C	1	2				
Capparis lasiantha	Nipan	C		2	+-1			
Capparis loranthifolia	Narrow-leaved Bumble Tree	C		1				
Capparis mitchellii	Wild Orange	C			+		2	
Carissa ovata	Klunkerberry	C	1	2	1-2		4	
Cassia brewsteri	Leichardt Bean	C			+-4	+-4		

Scientific name	Common name	NC Act Status[1]	RE type					Incidental
			11.3.3	11.4.9	11.9.2	11.9.3	11.9.5	
Cassia tomentella	Velvet Cassia	C					+	
Casuarina cristata	Belah	C		1				
Cenchrus ciliaris	Buffel Grass	*	1-2	2 - 4	2 - 3	1- 4	2 - 4	
Cheilanthes sieberi subsp. *sieberi*	Mulga Fern	C					1	
Chloris gayana	Rhodes Grass	*						
Chloris inflata	Purple-top Chloris	*	2					
Chrysopogon fallax	Golden Beard Grass	C			2 - 3	1-2		
Citrus glauca	Desert Lime	C	1	2 - 3			3	
Clematicissus opaca	Forest Grape	C		1				
Cleome viscosa	Sticky Cleome	C	2		+-1			
Commelina diffusa	Native Wandering Jew	C	1	2	1-2	+-1		
Corchorus trilocularis	Native Jute	C	2	2	1-2	1-2		
Corymbia dallachiana	Dallachy's Gum	C			1-4	+		
Corymbia erythrophloia	Variable-barked Bloodwood	C			+-4	+		
Corymbia tessellaris	Carbeen	C						x
Crinum flaccidum	River Lily	SL						x
Crotalaria juncea	Sunn Hemp	*			+-1			
Crotalaria medicaginea	Tre-foil Rattlepod	C						
Crotalaria novae-hollandiae	New Holland Rattlepod	C						x
Cucumis maderaspatanus	*ncn*	C			1			
Cyanthillium cinereum	ncn	C			1			
Cymbidium canaliculatum	Black Orchid	SL	1	1				
Cymbopogon refractus	Barbed Wire Grass	C			+			
Cynanchum viminale subsp. *brunonianum*	Caustic Vine	C					+	
Cynodon dactylon	Green Couch	*	+					
Cyperus betchei	*ncn*	C	2		1-2	1		

Scientific name	Common name	NC Act Status[1]	RE type					Incidental
			11.3.3	11.4.9	11.9.2	11.9.3	11.9.5	
Cyperus bifax	*ncn*	C			2	2		
Cyperus concinnus	*ncn*	C					1	
Cyperus fulvus	*ncn*	C			+			
Cyperus gilesii	*ncn*	C				1-2		
Cyperus gracilis	Whisker Grass	C	1					
Cyperus rigidellus	*ncn*	C				1		
Cyperus victoriensis	*ncn*	C	1		2	2 - 3		
Dactyloctenium radulans	Button Grass	C			1		1	
Datura leichhardtii	*ncn*	*				1		
Datura stramonium	Common Thorn Apple	*			+			
Dendrophthoe homoplastica	*ncn*	C			1			
Denhamia cunninghamii	Yellowberry	C			1-2	+		
Denhamia oleaster	Stiff Denhamia	C					1	
Desmodium campylocaulon	Creeping Tick-trefoil	C	2	2	1	1-2		
Desmodium muelleri	*ncn*	C						
Dianella revoluta	*Blue Flax-lily*	C			+			
Dichanthium sericeum subsp. *sericeum*	Queensland Bluegrass	C	2	2	2-5	2-4		
Digitaria divaricatissima var. *divaricatissima*	Umbrella Finger Grass	C			+-1	+		
Digitaria eriantha	Blue Digit	*						x
Dinebra decipiens	*ncn*	C					1	
Diospyros humilis	Small-leaved Ebony	C					1	
Diplachne fusca var. *fusca*	Brown Beetle Grass	C					1	
Diplocyclos palmatus	Native Bryony	C		1			1	
Dipteracanthus australasicus subsp. corynothecus	*ncn*	C	1	2	1			
Dodonaea viscosa subsp. *viscosa*	Sticky Hop-bush	C						x
Dysphania carinata	Green Crumbweed	C	1					x

Scientific name	Common name	NC Act Status[1]	RE type					Incidental
			11.3.3	11.4.9	11.9.2	11.9.3	11.9.5	
Dysphania melanocarpa forma *melanocarpa*	*ncn*	C						x
Dysphania pumilio	*ncn*	C						
Echinochloa colona	Awnless Barnyard Grass	*						x
Ehretia membranifolia	Peach Bush	C	2	2	+-1			
Einadia nutans subsp. *nutans*	*ncn*	C					1	
Einadia polygonoides	Climbing Saltbush	C	2					
Enchylaena tomentosa	Ruby Saltbush	C	1	1	+	+-1		
Enneapogon gracilis	Slender Nine-awn	C			3			
Enneapogon lindleyanus	Cone-top Nine-awn	C			1			
Enneapogon polyphyllus	Leafy Nine-awn	C						
Enneapogon robustissimus	*ncn*	C			1-2	1-2		
Enteropogon acicularis	Twirly Windmill Grass	C	1		+			
Enteropogon ramosus	Curly Windmill Grass	C	1					
Eragrostis exigua	*ncn*	C				1		
Eragrostis lacunaria	Purple Lovegrass	C					1	
Eragrostis minor	Stinkgrass	*						x
Eragrostis parviflora	Weeping Lovegrass	C	1					
Eremophila debilis	Winter Apple	C		1	+-1			
Eremophila deserti	Turkey Bush	C					1	
Eremophila maculata	*ncn*	C	+					
Eremophila mitchellii	False Sandalwood	C		1			1	
Erigeron sumatrensis	ncn	*						x
Eriochloa crebra	Early Spring Grass	C	2-4	2-3	2-4	2-4		
Eriochloa procera	Early Spring Grass	C	1			1		
Eryngium plantagineum	*ncn*	C			+			
Erythroxylum australe	Cocaine Bush	C			1			

Scientific name	Common name	NC Act Status[1]	RE type					Incidental
			11.3.3	11.4.9	11.9.2	11.9.3	11.9.5	
Eucalyptus cambageana	Dawson River Gum	C					1	x
Eucalyptus coolabah	Coolabah	C	5-6	2				
Eucalyptus melanophloia	Silver-leaved Ironbark	C			5	1		
Eucalyptus orgadophila	Mountain Coolabah	C			3-6	+-1		
Eucalyptus tereticornis subsp. *tereticornis*	Queensland Blue Gum	C						x
Eulalia aurea	Silky Browntop	C			1	1-3		
Euphorbia hirta	Asthma Plant	*						x
Euphorbia hyssopifolia	Hyssopleaf Sandmat	*		1	+-1	1		
Euphorbia tannensis subsp. *eremophila*	ncn	C						x
Eustrephus latifolius	Wombat Berry	C	1	1	+-2			
Evolvulus alsinoides var. *villosicalyx*	*ncn*	C			1-2	+		
Ficus opposita	Sandpaper Fig	C						x
Fimbristylis dichotoma	*ncn*	C						x
Flindersia dissosperma	Scrub Leopardwood	C	+					
Flueggea leucopyrus	Currant Bush	C						x
Galactia tenuiflora	*ncn*	C			1-2	1-2		
Geijera parviflora	Wilga	C	1	2				
Glinus lotoides	Hairy Carpet Weed	C						x
Glinus oppositifolius	*ncn*	C						x
Glycine falcata	*ncn*	C	2		1	1-2		
Glycine tabacina	Glycine Pea	C			1			
Glycine tomentella	Woolly Glycine	C			1-2	2		
Gomphrena celosioides	Gomphrena Weed	*	1			+		
Goodenia glabra	*ncn*	C						x
Grewia latifolia	Dysentry Bush	C			+-2	+		
Haloragis aspera	*ncn*	C			1			x

Scientific name	Common name	NC Act Status[1]	RE type					Incidental
			11.3.3	11.4.9	11.9.2	11.9.3	11.9.5	
Harrisia martinii	Harrisia Cactus	*(RI)	1-2	1	+			
Heliotropium indicum	*ncn*	*						x
Heliotropium tenuifolium	*ncn*	C			1	+		
Heteropogon contortus	Black Speargrass	C			1- 4	1-4		
Hibiscus brachysiphonius	*ncn*	C				+		
Hibiscus verdcourtii	Bladder Ketmia	C	2	2	1-2	+-2		
Indigofera colutea	*ncn*	C			1			x
Indigofera linifolia	*ncn*	C				+-1		
Indigofera linnaei	*ncn*	C			+-2			
Ipomoea lonchophylla	ncn	C	2	2	1	1-2		
Ipomoea plebeia	Bell Vine	C						x
Iseilema vaginiflorum	Red Flinders Grass	C	3	2	1-2	1-3		
Jacquemontia paniculata	*ncn*	C						x
Jasminum didymum subsp. *lineare*	ncn	C	1		1-2	1		
Jasminum didymum subsp. *racemosum*	ncn	C		2				
Leptochloa digitata	Umbrella Canegrass	C						x
Lobelia concolor	*ncn*	SL						x
Lomandra longifolia	Spiny-headed Mat Rush	C						x
Lotus australis	ncn	C				+		
Lysiana subfalcata	Lemon Mistletoe	C					1	
Lysiphyllum carronii	Red-flowered Bauhinia	C	2-4	3	1	+-1	4	
Lysiphyllum hookeri	Pegunny	C				1		
Macroptilium lathyroides	Phasey Bean	*			+			
Maireana microphylla	Blue Saltbush	C	1		1			
Malvastrum americanum var. *americanum*	Spiked Malvastrum	*	1-2	2	1-2	1-2	1	

Scientific name	Common name	NC Act Status[1]	RE type					Incidental
			11.3.3	11.4.9	11.9.2	11.9.3	11.9.5	
Malvastrum coromandelianum subsp. *coromandelianum*	False Mallow	*	2					
Marsdenia australis	Native Pear	C			+-1	+		
Marsdenia viridiflora subsp. *viridiflora*	Native Pear	C					1	
Megathyrsus maximus var. *pubiglumis*	Green Panic	*						x
Melaleuca bracteata	Black Tea Tree	C						x
Melhania oblongifolia	Melhania	C		2	+-1			
Melinis repens	Red Natal Grass	*			1-2	1-2		
Moorochloa eruciformis	ncn	*				1-2		
Neptunia gracilis forma *gracilis*	ncn	C	2	2	1-2	1-2		
Nyssanthes erecta	*ncn*	C	1	2				
Ocimum tenuiflorum	Holy Basil	C						x
Ophiuros exaltatus	ncn	C				1		
Opuntia tomentosa	Velvety Tree Pear	*(RI)		1	+-1	+		
Owenia acidula	Emu Apple	C		3		+-1	1	
Oxalis perennans	*ncn*	C	+			+		
Panicum antidotale	Blue Panic	*						
Panicum decompositum var. *decompositum*	Native Millet	C	2		1-4	1-4		
Parsonsia lanceolata	Rough Silkpod	C					1	
Parthenium hysterophorus	Parthenium	*(RI)	2-3	2	+-2	1-3		
Paspalidium caespitosum	Brigalow Grass	C	1					
Paspalidium globoideum	*ncn*	C	1			1		
Passiflora foetida	Stinking Passionfruit	*						x
Peripleura hispidula	ncn	C			+			
Perotis rara	Comet Grass	C						x
Phyllanthus maderaspatensis	*ncn*	C	2	2	+-2	+-1		

Scientific name	Common name	NC Act Status[1]	RE type					Incidental
			11.3.3	11.4.9	11.9.2	11.9.3	11.9.5	
Phyllanthus virgatus	*ncn*	C			+-1	1		
Physalis peruviana	*ncn*	*	1					
Pimelea haematostachya	ncn	C				+-2		
Pittosporum angustifolium	Weeping Pittosporum	C			+			
Pittosporum spinescens	Wallaby Apple	C			+		2	
Plumbago zeylanica	*ncn*	C		1				
Polymeria ambigua	Creeping Polymeria	C	1					
Polymeria longifolia	Peak Downs Curse	C	2		1	2		
Portulaca filifolia	Native Pigweed	C		1				
Portulaca oleracea	Pigweed	*	1-2	1	1	+-1		
Pseuderanthemum variabile	*ncn*	C		1				
Psydrax odorata forma *buxifolia*	Stiff-leaved Canthium	C					1	
Psydrax oleifolia	Myrtle Bush	C	+	2	+			
Pterocaulon serrulatum	Pineapple Bush	C						x
Ptilotus nobilis	*ncn*	C				1		
Rhynchosia minima var. australis	*ncn*	C	2	2	1-2	1-2		
Rorippa eustylis	*ncn*	C						x
Rostellularia adscendens	Pink Tongues	C	1	2	1-2	1-2		
Rutidosis leucantha	*ncn*	C			1	+		
Salsola australis	Soft Roly Poly	C						x
Santalum lanceolatum	Northern Sandalwood	SL		2		1		
Sclerolaena bicornis var. *bicornis*	*ncn*	C			1			
Sclerolaena muricata	*ncn*	C				+-1		
Sclerolaena tetracuspis	*ncn*	C					1	
Scoparia dulcis	Scoparia	*						x
Sehima nervosum	*ncn*	C			+-2	+		

Scientific name	Common name	NC Act Status[1]	RE type					Incidental
			11.3.3	11.4.9	11.9.2	11.9.3	11.9.5	
Senna barclayana	ncn	C			1			
Senna coronilloides	Brigalow Senna	C		1				
Sesbania cannabina	Sesbania Pea	C	1					
Sida cordifolia	Flannel Weed	*						x
Sida fibulifera	*ncn*	C				1		
Sida hackettiana	Shrub Sida	C			2	1		
Sida pleiantha	*ncn*	C	1		+-1	+-2		
Sida spinosa	*Spiny Sida*	*	2	2	1-2	1-2		
Sida trichopoda	*ncn*	C	2		1	+-2		
Solanum esuriale	*ncn*	C		1	1	1		
Solanum nigrum	Blackberry Nightshade	*						x
Solanum parvifolium	*ncn*	C					+	
Sporobolus actinocladus	Katoora Grass	C						
Sporobolus caroli	Fairy Grass	C	2	2 - 3	+	+		
Sporobolus creber	Slender Rat's Tail Grass	C			1	1-2		
Stachytarpheta jamaicensis	Snakeweed	*						x
Stemodia pubescens	*ncn*	C				1		
Stylosanthes scabra	Shrubby Stylo	*	1		1-2			
Tephrosia juncea	*ncn*	C			1	2		
Tephrosia leptopoda	*ncn*	C			1			
Terminalia oblongata subsp. *oblongata*	Yellowwood	C	3-4	3 - 4	1			
Themeda avenacea	Native Oatgrass	C				+		
Themeda triandra	Kangaroo Grass	C			1-2	1-2		
Trianthema portulacastrum	*ncn*	*	2	1	1			
Trianthema triquetra	Red Spinach	C			+			
Tribulus micrococcus	*ncn*	C	2		1			

Scientific name	Common name	NC Act Status[1]	RE type					Incidental
			11.3.3	11.4.9	11.9.2	11.9.3	11.9.5	
Urochloa mosambicensis	Sabi Grass	*	2		+-5			
Vachellia farnesiana	Prickly Acacia	*			+-1	1-2		
Ventilago viminalis	Vine Tree	C			+	1-2		
Verbena macrostachya	*ncn*	C			+	1		
Verbesina encelioides	Crownbeard	*						x
Vigna luteola	*ncn*	*			2	2		
Vigna radiata var. *sublobata*	*ncn*	C			1	+-1		
Vittadinia cuneata	*ncn*	C				1		
Vittadinia sulcata	*ncn*	C			1			
Wahlenbergia gracilis	*ncn*	SL			1	1		
Zornia muriculata	*ncn*	C			1			

[1]Status: NC Act status: E, Endangered; V, Vulnerable; SL, Special least concern; C, Least concern; * introduced taxa; RI; Restricted invasive plant under *Biosecurity Act 2014*

Appendix G

Fauna species recorded in the ecology study area

Table G1: Fauna species recorded at each trap site and incidentally across the ecology study area

Common name	Scientific name	NC Act Status[1]	Incidental	Trap site[2]			
				TS1	TS2	TS3	TS4
Birds							
Apostlebird	*Struthidea cinerea*	C	x				
Australian Owlet-nightjar	*Aegotheles cristatus*	C	x	x			Sp
Australian Bustard	*Ardeotis australis*	C				x	
Australasian Grebe	*Tachybaptus novaehollandiae*	C	x				
Australian Pelican	*Pelecanus conspicillatus*	C	x				
Australasian Pipit	*Anthus novaeseelandiae*	C			x		
Australian Bustard	*Tachybaptus novaehollandiae*	C			x		
Australian Hobby	*Falco longipennis*	C	x				
Australian Magpie	*Cracticus tibicen*	C			x	x	x
Black Kite	*Milvus migrans*	C	x				
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	C				x	x
Black-faced Woodswallow	*Artamus cinereus*	C	x				
Black-fronted Dotterel	*Elseyornis melanops*	C	x				
Blue-faced Honeyeater	*Entomyzon cyanotis*	C	x				x
Brolga	*Grus rubicunda*	C	x				
Brown Falcon	*Falco berigora*	C					x
Brown Quail	*Coturnix ypsilophora*	C	x				
Channel-billed Cuckoo	*Scythrops novaehollandiae*	C	x				
Cockatiel	*Nymphicus hollandicus*	C		x			
Crested Pigeon	*Ocyphaps lophotes*	C	x	x			
Double-barred Finch	*Taeniopygia bichenovii*	C	x				
Emu	*Dromaius novaehollandiae*	C	x				

Common name	Scientific name	NC Act Status[1]	Incidental	Trap site[2]			
				TS1	TS2	TS3	TS4
Eurasian Coot	*Fulica atra*	C	x				
Galah	*Eolophus roseicapillus*	C			x	x	x
Grey Butcherbird	*Cracticus torquatus*	C				x	
Grey Fantail	*Rhipidura albiscapa*	C	x				
Grey Teal	*Anas gracilis*	C	x				
Grey-crowned Babbler	*Pomatostomus temporalis*	C		x	x	x	x
Ground Cuckoo-shrike	*Coracina maxima*	C	x				x
Horsfield's Bushlark	*Mirafra javanica*	C			x		
Laughing Kookaburra	*Dacelo novaeguineae*	C	x				
Little Friarbird	*Philemon citreogularis*	C				x	
Magpie-lark	*Grallina cyanoleuca*	C	x			x	
Masked Lapwing	*Vanellus miles*	C	x				
Mistletoebird	*Dicaeum hirundinaceum*	C				x	
Nankeen Kestrel	*Falco cenchroides*	C	x		x		
Noisy Friarbird	*Philemon corniculatus*	C		x			
Noisy Miner	*Manorina melanocephala*	C	x				
Pacific Black Duck	*Anas superciliosa*	C	x				
Pale-headed Rosella	*Platycercus adscitus*	C		x			x
Pallid Cuckoo	*Cacomantis pallidus*	C	x				
Peaceful Dove	*Geopelia striata*	C	x				
Pheasant Coucal	*Centropus phasianinus*	C		x			
Pied Butcherbird	*Cracticus nigrogularis*	C		x		x	x
Pink-eared Duck	*Malacorhynchus membranaceus*	C	x				
Plumed Whistling-Duck	*Dendrocygna eytoni*	C	x				
Red-backed Fairy-wren	*Malurus melanocephalus*	C			x		

Common name	Scientific name	NC Act Status[1]	Incidental	Trap site[2]			
				TS1	TS2	TS3	TS4
Red-winged Parrot	*Aprosmictus erythropterus*	C		x			x
Rufous Songlark	*Cincloramphus mathewsi*	C	x				
Rufous Whistler	*Pachycephala rufiventris*	C	x				
Singing Honeyeater	*Lichenostomus virescens*	C	x		x	x	
Southern Boobook	*Ninox novaeseelandiae*	C	x				
Squatter Pigeon	***Geophaps scripta***	**V**	x				
Striated Pardalote	*Pardalotus striatus*	C		x		x	x
Striped Honeyeater	*Plectorhyncha lanceolata*	C					x
Tawny Frogmouth	*Podargus strigoides*	C	x			x	
Torresian Crow	*Corvus orru*	C		x		x	
Wedge-tailed Eagle	*Aquila audax*	C	x				
Weebill	Smicrornis brevirostris	C	x				
Whistling Kite	*Haliastur sphenurus*	C	x				
White-throated Honeyeater	*Melithreptus albogularis*	C	x				
Willie Wagtail	*Rhipidura leucophrys*	C			x		
Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*	C	x				
Yellow-throated Miner	*Manorina flavigula*	C		x		x	x
Mammals							
Brown Hare	*Lepus capensis*	*RI (C3,4,5,6)	x				
Common Brushtail Possum	*Trichosurus vulpecula*	LC					Sp
Dingo, Domestic Dog	*Canis lupus*	*RI (C3,4,6)	x				
Eastern Grey Kangaroo	*Macropus giganteus*	LC		As		As	
European Rabbit	*Oryctolagus cuniculus*	*RI (C3,4,5,6)	x				
House Mouse	*Mus musculus*	-				Sp	
Little Red Flying-fox	*Pteropus scapulatus*	C	x				

Common name	Scientific name	NC Act Status[1]	Incidental	Trap site[2]			
				TS1	TS2	TS3	TS4
Short-beaked Echidna	***Tachyglossus aculeatus***	**SL**		**Sp**			
Reptiles							
Black-headed Python	*Aspidites melanocephalus*	C					As
Bynoe's Gecko	*Heteronotia binoei*	C		As, Fu		Pf, Sp	Fu, As
Chain-backed Dtella	*Gehyra catenata*	C				As	As
Dubious Dtella	*Gehyra dubia*	C					As
Eastern Brown Snake	*Pseudonaja textilis*	C	x				
Eastern Stone Gecko	*Diplodactylus vittatus*	C					Sp
Elegant Snake-eyed Skink	*Cryptoblepharus pulcher*	C					Pf
Fire-tailed Skink	*Morethia taeniopleura*	C				Pf	
Iridescent Litter-skink	*Lygisaurus foliorum*	C		As			
Ragged Snake-eyed Skink	*Cryptoblepharus pannosus*	C					Sp
Robust Blind Snake	Anilios ligatus	C					Sp
South-eastern Morethia Skink	*Morethia boulengeri*	C		As		As	

[1]Status: V, Vulnerable; SL, Special least concern (non-migratory); C, Least concern; *Introduced species; RI(C3,3,4,5,6), Restricted invasive (Category no) animal under Queensland's *Biosecurity Act 2014*
[2] Trap method for record: As, Active search; Fu, Funnel; Pf, Pitfall; Sp, Spotlight; X, Present

Table G2: Fauna species recorded at supplementary survey sites across the ecology study area

Common name	Scientific name	NC Act Status[1]	Supplementary sites[2]																
			Supp 1	Supp 2	Supp 3	Supp 4	Supp 5	Supp 6	Supp 7	Supp 8	Supp 9	Supp 10	Supp 11	Supp 12	Supp 13	Supp 14	Supp 15	Supp 16	Supp 17	Supp 18
Amphibians																				
Broad-palmed Rocket Frog	*Litoria latopalmata*	C	Sp																	
Bumpy Rocket Frog	*Litoria inermis*	C	Sp																	
Cane Toad	*Rhinella marina*	*	Sp										Sp					Sp		
Spotted Marsh Frog	*Limnodynastes tasmaniensis*	C	Sp																	
Desert Tree Frog	*Litoria rubella*	C	Sp																	
Birds																				
Apostlebird	*Struthidea cinerea*	C															x			
Australian Owlet-nightjar	*Aegotheles cristatus*	C							Sp					Sp						
Australasian Darter	*Anhinga novaehollandiae*	C	x																	
Australasian Pipit	*Anthus novaeseelandiae*	C									x									
Australian Magpie	*Cracticus tibicen*	C			x	x	x			x			x		x	x			x	
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	C			x					x			x		x				x	
Blue-faced Honeyeater	*Entomyzon cyanotis*	C								x			x							
Black-winged Stilt	*Himantopus himantopus*	C	x																	
Brown Falcon	*Falco berigora*	C				x					x		x							
Channel-billed Cuckoo	*Scythrops novaehollandiae*	C											x							
Cockatiel	*Nymphicus hollandicus*	C			x		x													
Crested Pigeon	*Ocyphaps lophotes*	C					x													
Double-barred Finch	*Taeniopygia bichenovii*	C											x							
Eastern Great Egret	*Ardea modesta*	C	x																	
Galah	*Eolophus roseicapillus*	C			x					x			x		x					

Common name	Scientific name	NC Act Status[1]	Supplementary sites[2]																	
			Supp 1	Supp 2	Supp 3	Supp 4	Supp 5	Supp 6	Supp 7	Supp 8	Supp 9	Supp 10	Supp 11	Supp 12	Supp 13	Supp 14	Supp 15	Supp 16	Supp 17	Supp 18
Grey Butcherbird	*Cracticus torquatus*	C				x														
Grey Fantail	*Rhipidura albiscapa*	C											x				x			
Grey Shrike-thrush	*Colluricincla harmonica*	C								x										
Grey Teal	*Anas gracilis*	C	x																	
Grey-crowned Babbler	*Pomatostomus temporalis*	C			x					x			x		x					
Ground Cuckoo-shrike	*Coracina maxima*	C				x														
Magpie-lark	*Grallina cyanoleuca*	C	x		x										x		x			
Masked Lapwing	*Vanellus miles*	C	x															Sp		
Mistletoebird	*Dicaeum hirundinaceum*	C								x							x			
Nankeen Kestrel	*Falco cenchroides*	C				x					x									
Pale-headed Rosella	*Platycercus adscitus*	C								x					x					
Pallid Cuckoo	*Cacomantis pallidus*	C																		
Peaceful Dove	*Geopelia striata*	C											x							
Pied Butcherbird	*Cracticus nigrogularis*	C			x											x	x			
Pied Currawong	*Strepera graculina*	C											x							
Rainbow Lorikeet	*Trichoglossus haematodus*	C											x							
Red-chested Button-quail	*Turnix pyrrhothorax*	C							Sp											
Royal Spoonbill	*Platalea regia*	C	x																	
Rufous Whistler	*Pachycephala rufiventris*	C											x							
Singing Honeyeater	*Lichenostomus virescens*	C								x			x							
Striated Pardalote	*Pardalotus striatus*	C											x		x		x			
Striped Honeyeater	*Plectorhyncha lanceolata*	C								x							x			
Tawny Frogmouth	*Podargus strigoides*	C													Sp			Sp		
Torresian Crow	*Corvus orru*	C	x		x	x				x			x				x		x	
Yellow-billed Spoonbill	*Platalea flavipes*	C	x																	
Wedge-tailed Eagle	*Aquila audax*	C														x				

Common name	Scientific name	NC Act Status[1]	Supplementary sites[2]																
			Supp 1	Supp 2	Supp 3	Supp 4	Supp 5	Supp 6	Supp 7	Supp 8	Supp 9	Supp 10	Supp 11	Supp 12	Supp 13	Supp 14	Supp 15	Supp 16	Supp 17	Supp 18
Weebill	Smicrornis brevirostris	C											x				x			
Welcome Swallow	*Hirundo neoxena*	C								x										
Whistling Kite	*Haliastur sphenurus*	C	x																x	
White-throated Gerygone	*Gerygone albogularis*	C											x							
Willie Wagtail	*Rhipidura leucophrys*	C	x																	
Yellow-throated Miner	*Manorina flavigula*	C	x			x				x					x	x				
Mammals																				
Brown Hare	*Lepus capensis*	*RI (C3,4,5,6)													Sp					
Common Brushtail Possum	*Trichosurus vulpecula*	C		Sp														Sp		
Eastern Grey Kangaroo	*Macropus giganteus*	C														x				Sp
European Rabbit	*Oryctolagus cuniculus*	*RI (C3,4,5,6)			As															Sp
Feral Pig	*Sus scrofa*	*RI (C3,4,6)															Tt			
House Mouse	*Mus musculus*	*							Sp											
Short-beaked Echidna	***Tachyglossus aculeatus***	**SL**																		Tt
Sugar Glider	*Petaurus breviceps*	C										Sp								
Reptiles																				
Box-patterned Gecko	*Lucasium steindachneri*	C											Sp					Sp		Sp
Brown Tree Snake	*Boiga irregularis*	C		Sp																Sp
Bynoe's Gecko	*Heteronotia binoei*	C	Sp	Sp	As	As				Sp			Sp	Sp	Sp AS					
Carpentaria Snake	*Cryptophis boschmai*	C																		Sp

Common name	Scientific name	NC Act Status[1]	Supplementary sites[2]																
			Supp 1	Supp 2	Supp 3	Supp 4	Supp 5	Supp 6	Supp 7	Supp 8	Supp 9	Supp 10	Supp 11	Supp 12	Supp 13	Supp 14	Supp 15	Supp 16	Supp 17	Supp 18
Chain-backed Dtella	*Gehyra catenata*	C	Sp			As				Sp As		Sp	Sp		As			Sp		Sp
Eastern Stone Gecko	*Diplodactylus vittatus*	C			As															
Fire-tailed Skink	*Morethia taeniopleura*	C											As				As		As	
Ocellated Velvet Gecko	*Oedura monilis*	C										Sp								
Orange-flanked Rainbow-skink	*Carlia rubigo*	C															As			
Ornamental Snake	***Denisonia maculata***	**V**		Sp						Sp		Sp	Sp	Sp						
Robust Blind Snake	Anilios ligatus	C																Sp		
South-eastern Morethia Skink	*Morethia boulengeri*	C					As													
Spotted Python	*Antaresia maculosa*	C		Sp																
Tree-base Rainbow-skink	*Lygisaurs foliorum*	C											As							
Zigzag Velvet Gecko	*Amalosia rhombifer*	C								Sp										

[1]NC Act Status: V, Vulnerable; SL, Special least concern (non-migratory); C, Least concern; *Introduced species; RI(C3,3,4,5,6), Restricted invasive (Category no) animal under Queensland's *Biosecurity Act 2014*
[2] Detection method for record: As, Active search Sp, Spotlight; Tt, Track or trace; X, Present.

Table G3: Microbats recorded across the ecology study area

Common name	Scientific name	NC Act Status[1]	Supplementary Sites	Harp Trap Sites		Anabat Sites[2]							
				HT1	HT2	AB 1	AB 2	AB 3	AB 4	AB 5	AB 6	AB 7	AB 8
Northern Freetail Bat	*Chaerephon jobensis*	C				♦	♦	♦	♦	♦	♦	♦	♦
Gould's Wattled Bat	*Chalinolobus gouldii*	C				♦	♦	♦	♦	♦	♦	♦	♦
Chocolate Wattled Bat	*Chalinolobus morio*	C				□	♦	♦	♦	♦		□	
Hoary Wattled Bat	*Chalinolobus nigrogriseus*	C				♦	♦	♦					♦
Little Pied Bat	*Chalinolobus picatus*	C				♦	♦	♦	♦	♦	♦		♦
Eastern Bent-winged Bat	*Miniopterus orianae*	C					♦			♦	♦		
Northern Free-tailed Bat	*Mormopterus (Ozimops) lumsdenae*	C				♦	♦	♦	♦	♦	♦		
Eastern Free-tailed Bat	*Mormopterus (Ozimops) ridei*	C				♦	♦	♦	♦	♦	□	♦	□
Yellow-bellied Sheath-tailed Bat	*Saccolaimus flaviventris*	C	S6			♦	♦	♦	♦	♦	♦	♦	♦
Inland Broad-nosed Bat	*Scotorepens balstoni*	C				♦	♦		♦		□		
Northern Broad-nosed Bat	*Scotorepens sanborni*	C				♦	♦	♦	♦	♦	♦		♦
	Nyctophilus sp.				♦					♦			
Little Broad-nosed Bat	*Scotorepens greyii*	C			♦	♦	♦	♦	♦				
Bristle-faced Freetail Bat	*Setirostris eleryi*	C					♦	♦	♦				♦
Inland Forest Bat	*Vespadelus braverstocki*	C					♦	♦	♦		♦		♦
Eastern Cave Bat	*Vespadelus troughtoni*	C				□	♦	♦	□	♦	♦	□	♦

[1]NC Act Status: C, Least concern
[2] Record type: ♦ = at least one call from the site was attributed unequivocally to the species; □ = calls similar to those of the species were recorded, but could not be reliably identified

Appendix K. Geotechnical Assessment

Rock Doctors Consulting

Progressive Rehabilitation and Closure Plan.

Geotechnical Assessment (Section 3.6.4)

[Doc No: 29.11.2022.ED /C]

Doc No:					
Rev	**Description**	**Prepared**	**Reviewed**	**Approved**	**Date**
A	Initial write up	Chris Strawson			08/11/2022
B	Review		Ian Clarke		16/11/2022
C	Final Draft	Chris Strawson		Chris Strawson	17/11/2022
D	Revision RPM input		Helen Wood	Chris Strawson	23/11/2022

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List of Abbreviations

Abbreviation	Explanation
CMRR	Coal Mine Roof Rating
FS	Feasibility Study
FoS	Factor of Safety
HR	Hydraulic Radius (Geotechnical)
IRMR	In Situ Rock Mass Rating. (Rock fracturing)
ML	Mining Lease
OEM	Original Equipment Manufacturer
PRC plans	Guideline Progressive rehabilitation and closure plans (PRC plans) (ESR/2019/4964) (2021)
RMR	Rock Mass Rating
RQD	Rock Quality Designation
SHMS	Safety and Health Management Plan
UCS	Unconfined Compressive Strength
UG	Underground

1. Introduction

Eagle Downs Metallurgical Coal Project, involves the construction, development and operation of an underground longwall metallurgical coal mine in Queensland's Bowen Basin.

The Eagle Downs site is located approximately 20km south of the mining town of Mooranbah, in central Queensland

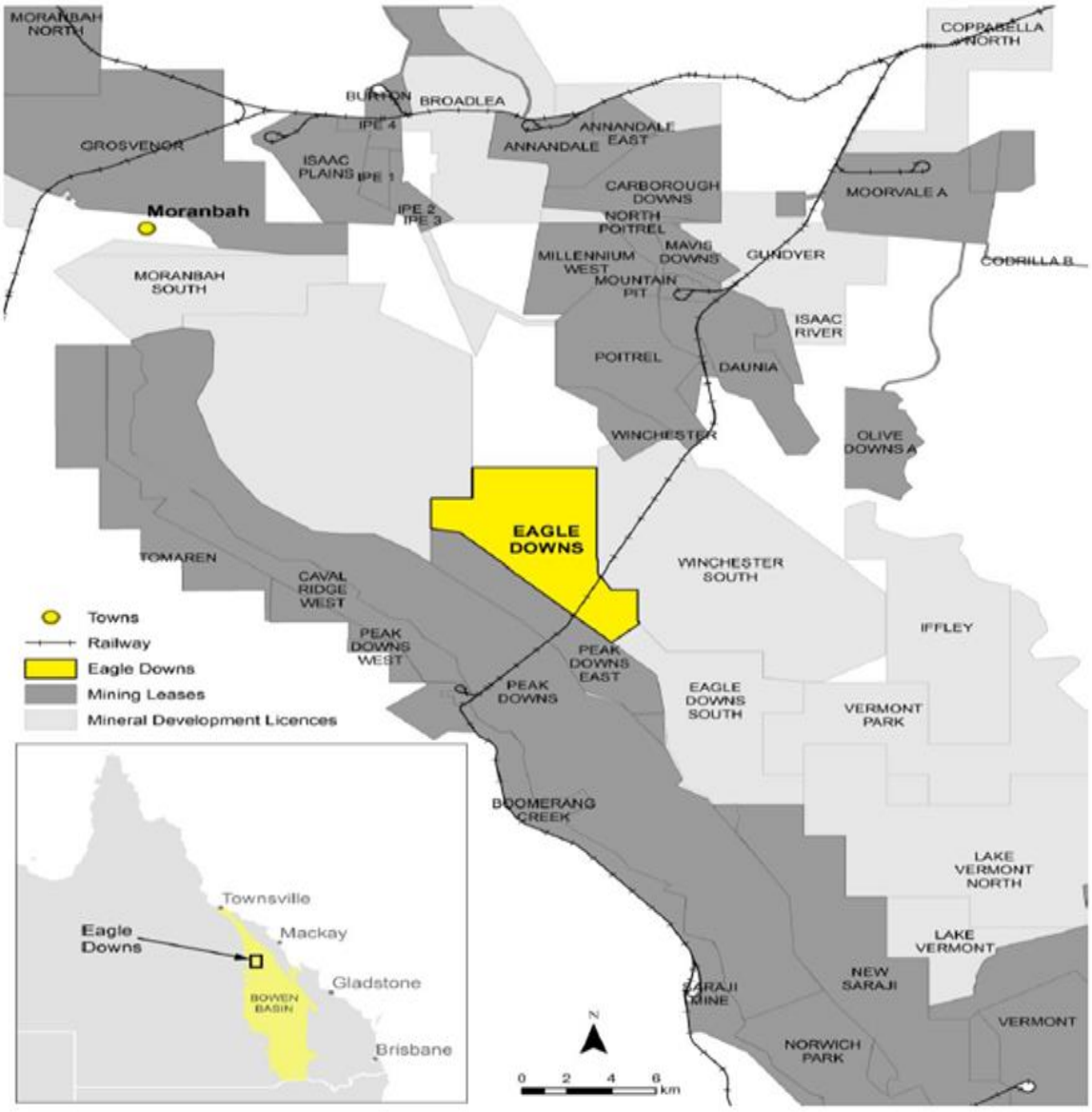


Figure 1.1 Geographical positioning of Eagle Downs Mine

The mining operations propose the mining of three seams, The Harrow Creek Upper and Lower seams (HCU and HCL), with the deeper Dysart seam (DY),, with mining principally using the longwall mining system. In addition, in two of the seams, due to the seam thickness, it may be possible to utilise Longwall top Coal Caving (LTCC) to improve the extraction ratio.

Development will use continuous miners to form the roadways, with typical roadway dimensions of 5.4m wide x 3.5m high planned.

The mining output is planned to be approximately 7Mt – 9Mt per annum, with mining planned to continue for approximately 30 to 40 years, depending on the extraction rate.

On completion of mining, the operations will cease, when the mine will then be sealed off and rehabilitation of the mining area and closure of the mine will be undertaken.

All three target seams dip towards the northeast, at an average grade of around 1 in 10

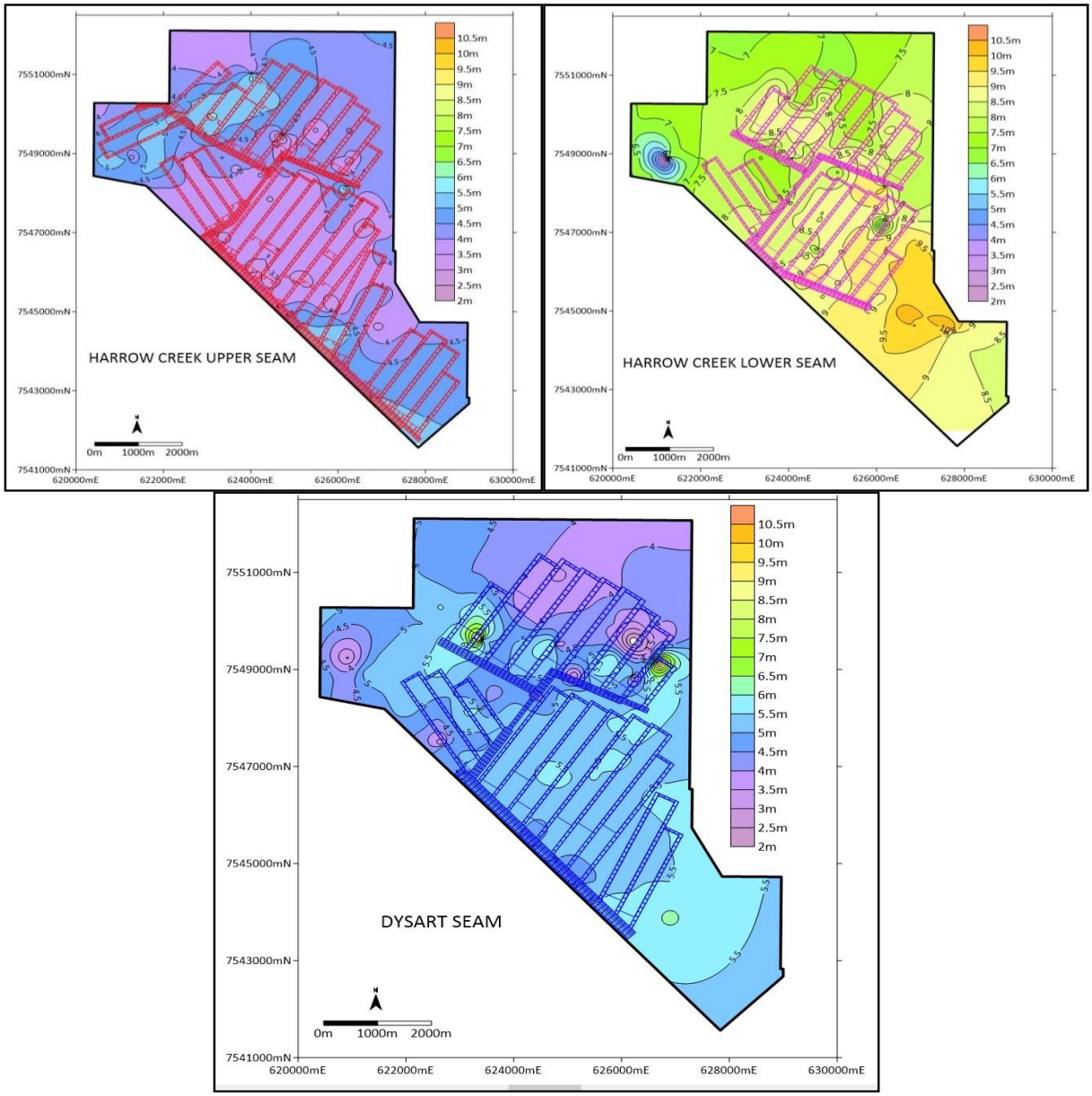


Figure 1.2 Plans showing the general layouts for the three target seams

1.1. Topography

The Eagle Downs mining area is located between the northern part of the Harrow Range to the west and the Isaac River to the east (AGE, 2008). The topography consists of gently undulating terrain with an overall gradient to the east, towards the Isaac River.

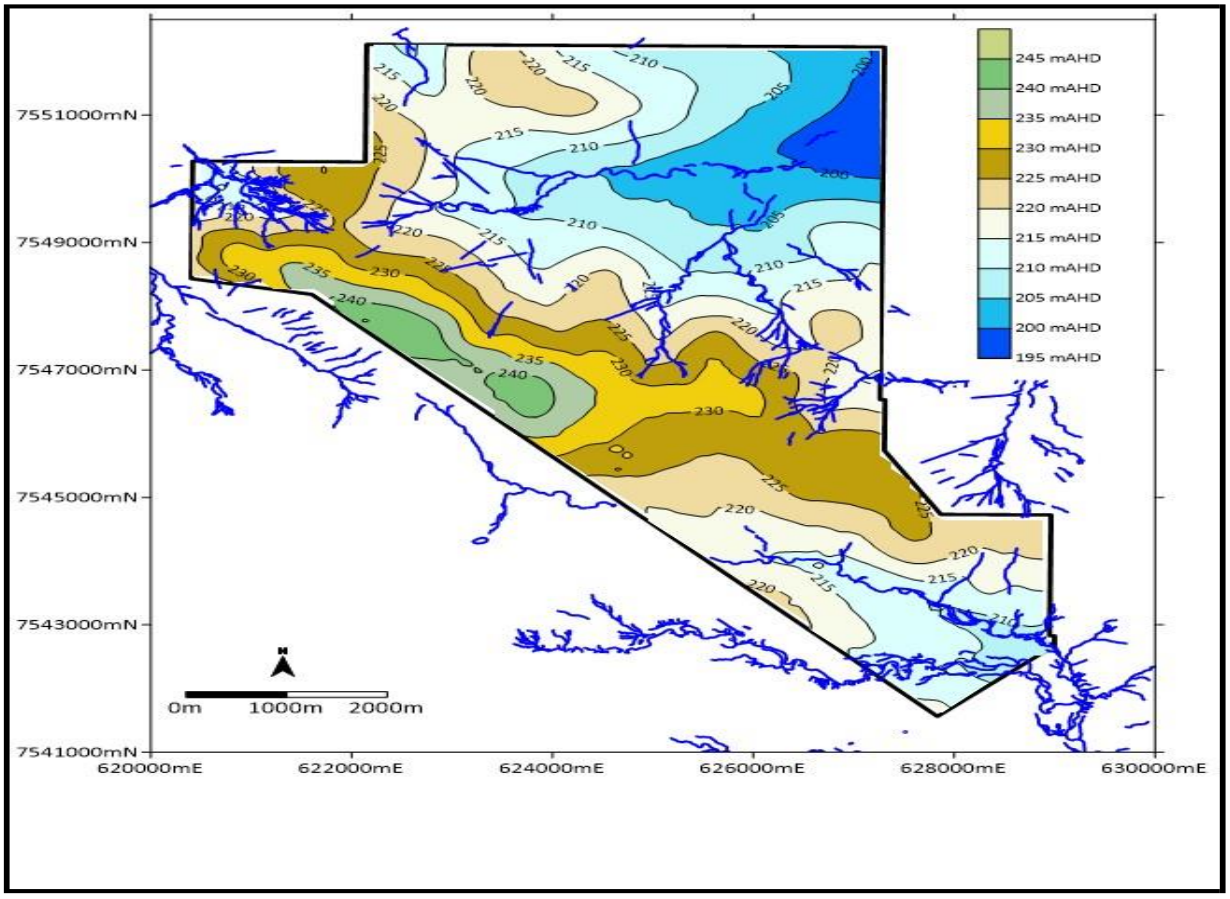


Figure 1.3 Plan of Eagle Downs lease, showing the rivers and creeks

Local relief ranges from about 245 m (AHD) in the west, to 200m (AHD) in the east, with a number of small ephemeral gullies draining the area. Some gullies drain to Cherwell Creek, which is to the north of the northern boundary of the MLA. This creek flows in an easterly direction to discharge into the Isaac River. (AGE, 2008). Other gullies drain east and dissipate before reaching the Isaac River. The most southerly gully draining the MLA flows to the south-east and further downstream to the Isaac River.

The area has been extensively cleared for cattle grazing, with only minor areas of woodlands remaining.

.

1.1 Closure Plan

In order to ensure that the closure of the mine complies with regulatory requirements, and as part of the closure plan, Rock Doctors Consulting was engaged to review the proposed and current underground workings from the perspective of final closure of the mining operations.

In particular the following aspects of the mine design and closure plan were considered.

- Pillar design and strengths
- Roadway stability
- Subsidence
- Ground water and
- Sealing of access to the workings

Are considered, with emphasis on the long term impacts on surface subsidence and the ability to ensure the underground mining operations remain securely sealed in perpetuity.

The report provides recommendations for a forward work plan for permanent sealing of the underground operations

1.2 Scope of Work

Assessment of the long-term stability of the abandoned workings, specifically focussed on the following:

- Pillars
- Roadways and large excavations
- Sealing of surface openings
- Sealing of surface exploration and service boreholes
- Sealing of Vent Shafts and Boreholes
- Sealing of Main Shafts and Declines
- Post Closure Risk Assessment.

Additional information is provided on these aspects in the sections following.

1.1.1. Pillars

All pillars left in place in the underground workings, from those close to the longwall workings, through to those in the outbye areas will be assessed for long term stability, including:

- Consideration of the installed support used to prevent pillar deterioration
- Loads imposed on the pillars from previous and adjacent workings, including abutment and superimposed loads
- Geological profiles for the immediate roof and floor for the various pillars, to ascertain any potential areas of weakness

- Possible impacts of groundwater on the stability of the roof, floor and pillars, post closure
- Identification of smaller pillars or pillars with additional loading
- Calculation of the loads on and strengths of the normal pillars, as well as any potentially high risk pillars to determine the Factor of Safety and hence a probability of failure
- Impacts of the failure of any pillars and potential for failure of contiguous pillars.
- Possible mitigate methods, should any areas of low stability be identified.

1.1.2. Roadways and large excavations

There are a number of larger excavations planned for the underground workings, associated with all three seams. Due to the larger spans of these excavations, long term stability may be compromised, leading to deterioration of pillars and added failure of the workings.

The assessment will consider:

- The installed support, used to prevent deterioration of these open workings
- Impacts of ground water on the long term stability of these workings
- Consideration of the impacts to the stability of the area, should any of these workings deteriorate to the point of failure and collapse.

1.1.3. Sealing of Surface Openings

As part of the rehabilitation and closure requirements, it is critical that all major openings between the surface and the underground workings must be sealed in a manner that will provide for long term stability and sealing. In addition, all openings from surface into the underground workings must, as a requirement of the Queensland Coal Mining Safety and Health Regulations 2020, be sealed to comply with regulation 325, which states:

Types of seals for mine entrances and other parts of mine

- The underground mine manager for an underground mine must ensure each seal installed at an entrance from the surface to the underground mine is a type E seal.
- In this section
  A type E seal" means a ventilation control device capable of withstanding an overpressure of 70kPa.

There are numerous examples of coal mine workings, where openings to surface have not been adequately sealed, leading to oxidisation of the workings and ultimately spontaneous combustion of the coal in the workings. The resulting fires are virtually impossible to control, once they have taken hold. The workings release toxic gasses and significantly increased subsidence. In operations close to the surface, the heat and gas has led to significant environmental damage to the surface.

1.1.3.1. Sealing of surface exploration and service boreholes

Surface exploration boreholes have been drilled in the area over a number of years, with the majority being known and grouted. There are likely to be additional exploration boreholes drilled, prior to the completion of operations on site.

The scope of work will include:

- Provision of a sign off process to provide certainty regarding identification of all holes, including the grouting/ sealing of all holes
- A review of planned grouting procedures to ensure it complies with the requirements for adequate sealing of mine workings
- Provision of recommended grouting and sealing plans for all surface boreholes.

1.1.3.2. Sealing of Ventilation Shafts and Boreholes

This includes:

- The identification of proposed/ current ventilation and other large diameter vertical holes intersecting the workings
- The provision of an assessment processes, ensuring optimal positioning for sealing of these openings
- Provision of possible methods for sealing of these openings, including remediation requirements and methods. This will ensure not only minimisation of air flows, but also prevent any access to the workings by personnel or animals
- Where required, the provision of designs, drawings and SWP's for the sealing particular operations.

1.1.3.3. Sealing of Main Shafts and Declines

Crucial in not only minimising air flow in and out of the sealed workings, the sealing of the main drifts and declines must prevent access to the workings by personnel and animals. The report will include:

- The identification of all proposed / current inclined or vertical drifts and shafts used for the transport of men, materials or for coal clearance.
- Identification processes to assess the optimal positions for sealing of these openings
- Provision of designs for the sealing and sealing processes required for the permanent sealing of these openings, including remediation requirements and methods
- Designs will include generic drawings and SWP's for the sealing operations
- Detailing regarding the sealing materials required for long term sealing of mine workings

- Optimal positioning of seals and associated water and gas management systems
- Long term stability of the roadways and drifts in the areas where sealing is proposed
- Possible additional support or remediation requirements to ensure long term stability in these areas
- Guidelines for the assessment of the stability of the roadway, prior to the installation of the seals
- Methods for remote construction and placement of permanent seals
- Assessment of ground water impacts on sealing materials and the surrounding rockmass
- Monitoring requirements for gas and water.

1.1.3.4. Post Closure Risk Assessment

Included in the report, will be:

- An assessment of residual risks
- Subsidence risks and possible connection between the surface and underground workings
- Overall stability of all workings
- Possible adverse effects to surface infrastructure and natural landforms
- Possible impacts on surface water and impacts of underground water and groundwater interactions.
- Any long term monitoring requirements, post closure.

The above broadly covers the extent of works required to adequately cover this sub section of item 3.6.4 of the PRC Plans.

1.2. Data Acquisition and Characterisation

The information used for this report is based on drawings, borehole data etc for the Feasibility Study, completed in 2021. The Eagle Downs longwall mining area is covered by closely spaced drill holes undertaken as part of successive exploration drilling programs, as shown below.

These drill holes record the geological sequence of the overburden and coal seams, as well as the sediments immediately below the target seams, used for the determination of the pillar, roof and floor strengths

A number of plans of the underground workings, as well as reports detailing the geology, geotechnical environment, surface subsidence and ground water have been provided to RDC for use in compiling this report (Table 1).

Table 1 Geotechnical assumptions used for the calculations

Interval	Lithology	Observations		Comment
All	-	-	The Principal Horizontal Stress is 0.75- 1.5, NE-SW	Need to consider for long term roof and floor stability.
HCU Depth		200m - 600m from surface	Vertical stress 5.5 - 19 MPa	Mine design to accommodate stress, thicker pillars and more support needed at high stress points,
HCU Roof	Roof Unit 101 Laminated siltstone, av thick 3.7m	Average Strength 26 MPa	Horizontal fractures in bolting zone. Laminated roof unit, susceptible to horizontal stress damage. AR assumed as 2. CMRR ranges from low 40s (coal only) to 50s.	Evaluate support installed in the HCU roof for long term stability
HCU Seam	Coal		XXX m thick, extraction height YYY	Consider pillar designs and stability
HCU Floor	Floor Unit 101, carbonaceous mudstone, av thick 0.87m	Average Strength 17.5 MPa	Weak or open horizontal fractures	High clay content, may deteriorate when wet. Consider floor weakness when doing pillar calculations
HCU-HCL interburden	Sandstones, siltstones - 0-75m thick Two channels HLS12 and HLS14 - combine into HLS10	High strength 50-80 MPa	HLS10 strongest, no weak points for caving - potential for spanning. Where two channels exist separately- an intervening unit will likely allow caving.	HCL Longwall panel width of 180-200m to manage stress. Minimum thickness of at least 20m between mine designs to reduce interseam interactions. Manage thick, potentially massive sandstone units above HCL with inseam mechanical breakage. Consider additional loading on pillars along longwalls.
HCLDepth		300-650m from surface	Vertical stress 6.5 - 20.5 MPa	Pillar stability at these depths
HCL Roof			Logged fracture spacing 150mm and greater thus Competent roof material AR is 1-5-3, assume 2 CMRR average 44	Thick (6.3-10m) HCL Seam thus 3.5m longwall roof is always coal. Top Coal Caving planned to remove coal above longwall panels. Same support recommended as HCU Seam. Check if this is appropriate over the long term
HCL Seam	Coal – banded	Average strength 7 MPa		Top coal caving - additional standing support in the tailgate. Pillar slenderness ratios. Check stability
HCL Floor	Floor unit 101 - carbonaceous siltstone average thick 0.88m	Average strength 32MPa	Some clay - high gamma response. Three slaking tests - two poor, one moderate slaking	Generally competent floor, but consider weakness on pillar stability.
HCL-DY interburden	No large thick and strong sandstone channels	50-100m thick, average 65m	Vertical stress 9.3 - 22.3MPa.	No need to use narrow panels to manage roof conditions.
DY Depth		400-700m from surface		Since seams above will have been mined and fully collapsed, the assessment is that multi-stress interactions will have minimal impact on mining.

Interval	Lithology	Observations		Comment
				Longwall panels offset - aligned with HCU Seam
DY Roof	Carbonaceous siltstone and sandstone (similar to HCU) - some thin mudstone bands		Logged fractures, no less than 200mm apart, some intervals of no fractures - generally competent roof	Mining roof will range from small amount of coal to full coal roof - CMRR from 38-50, some top coal caving considered where coal remains in roof Check for pillar slenderness ratios and stresses at depth
DY Seam		3.6-6.1m thick		
DY Floor	Floor units 0.3m carbonaceous mudstone and 1.4m of siltstone		High gamma in geophysics - clayey nature	DY floor material stronger and slightly less prone to slaking, easier for floor control in this seam compared to others. May still have floor weakness and pillar punching

2. Mine layout and Pillars

The three workings have two distinct areas, the longwall mining panels, where full or partial caving is allowed to take place in a controlled manner during mining operations. In these areas, the roof is allowed to collapse and the overall ground profiles reflect the mining below, though somewhat reduced.

These impacts are detailed in the report by Gordon Geotechnics, detailing the anticipated subsidence from mining the three seams.

Top coal caving longwall mining is planned in the Harrow Creek Lower and Dysart seams. Due to the thickness of the Harrow Creek Upper Seam, single pass longwall extraction only is planned. In some parts of the Harrow Creek Lower Seam mining area, the top coal caving is planned to be turned off due to the occurrence of massive sandstone strata in the overburden.

The majority of longwall panels in all three seams are 330 m wide (rib to rib). Several panels have been narrowed to 300 m wide (rib to rib) to Maximise recovery between the faults and one panel in the Harrow Creek Lower Seam is 280 m wide (rib to rib).

The chain pillars vary from 39 m wide (solid dimension) in the shallowest part of the area, up to 85 m wide (solid dimension) in the deepest part of the area. There are various combinations of longwall extraction, ranging from single seam of either the HCU, HCL and DY seams, to extraction of all three seams. In some areas, either the HCU and DY seams or HCL and DY seams only are mined. These different combinations were considered in the Gordon Geotechniques Subsidence report

The longwall subsidence report provided by Gordon Geotechniques appears to have used a non-offset layout, which ultimately provides a more conservative (worst case) estimate of the anticipated subsidence. Once mining commences, and the actual offset of the longwall pillars in the three seams has been finalised, it is recommended that an updated subsidence model and report is completed.

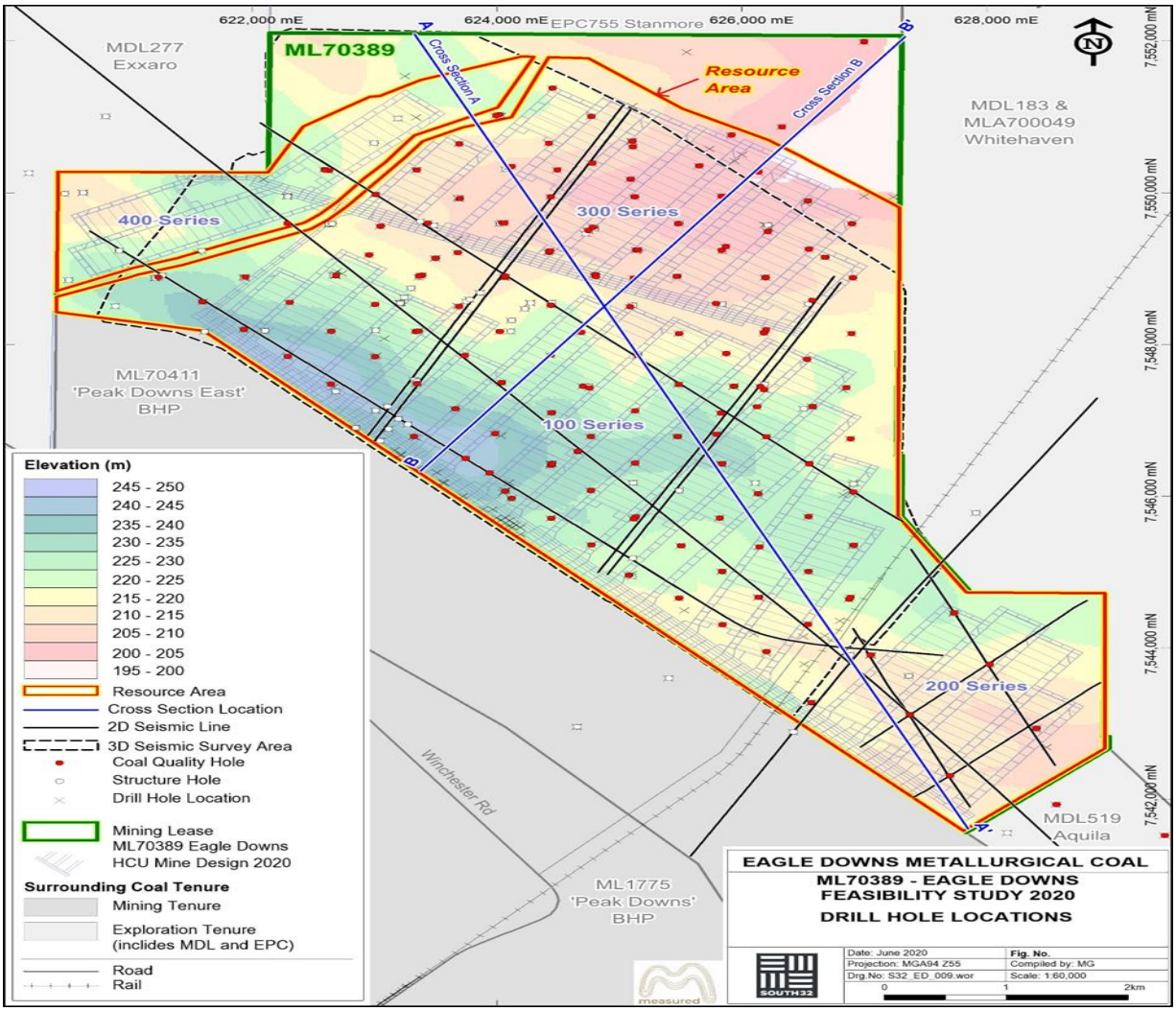


Figure 2.1 Plan view of eagle Downs, showing the boreholes used for the study

Geophysical logs are also available in the majority of the boreholes and provide additional data on the rock and coal seam properties. This density of data provides a high level of confidence in the geological variables used as inputs into the subsidence models for the Eagle Downs longwall mining area.

The Eagle Downs underground area is located in the northern part of the Bowen Basin to the west of the Nebo Syncline. The target coal seams are in the Mooranbah Coal Measures, which are overlain by the Fort Cooper Coal Measures. The Fort Cooper Coal Measures are unconformably overlain by a thin veneer of unconsolidated to semi-consolidated Tertiary sediments and localized unconsolidated Quaternary sediments.

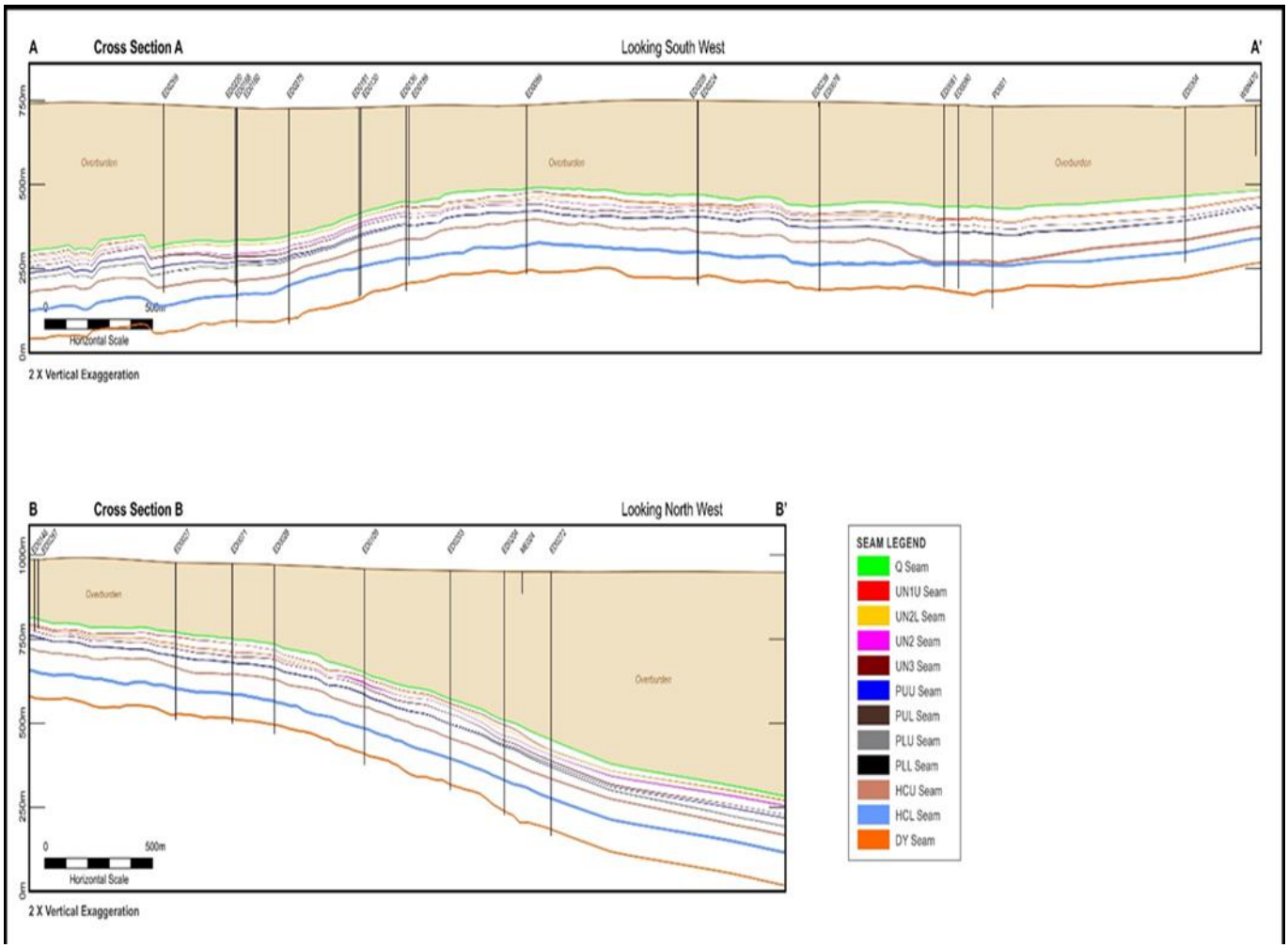


Figure 2.2 Vertically exaggerated long sections, E-W and N-S showing the coal seams

In the south of the project area, the HCU and HCL seams coalesce to form a single 12m to 15m thick seam. Only the HCU can practically be mined in this area, although the longwall is able to cut to maximum height through this area. Non-coal sediments consist of moderately weak to strong sandstones, siltstones and minor mudstones. Sandstone and siltstone are codominant.

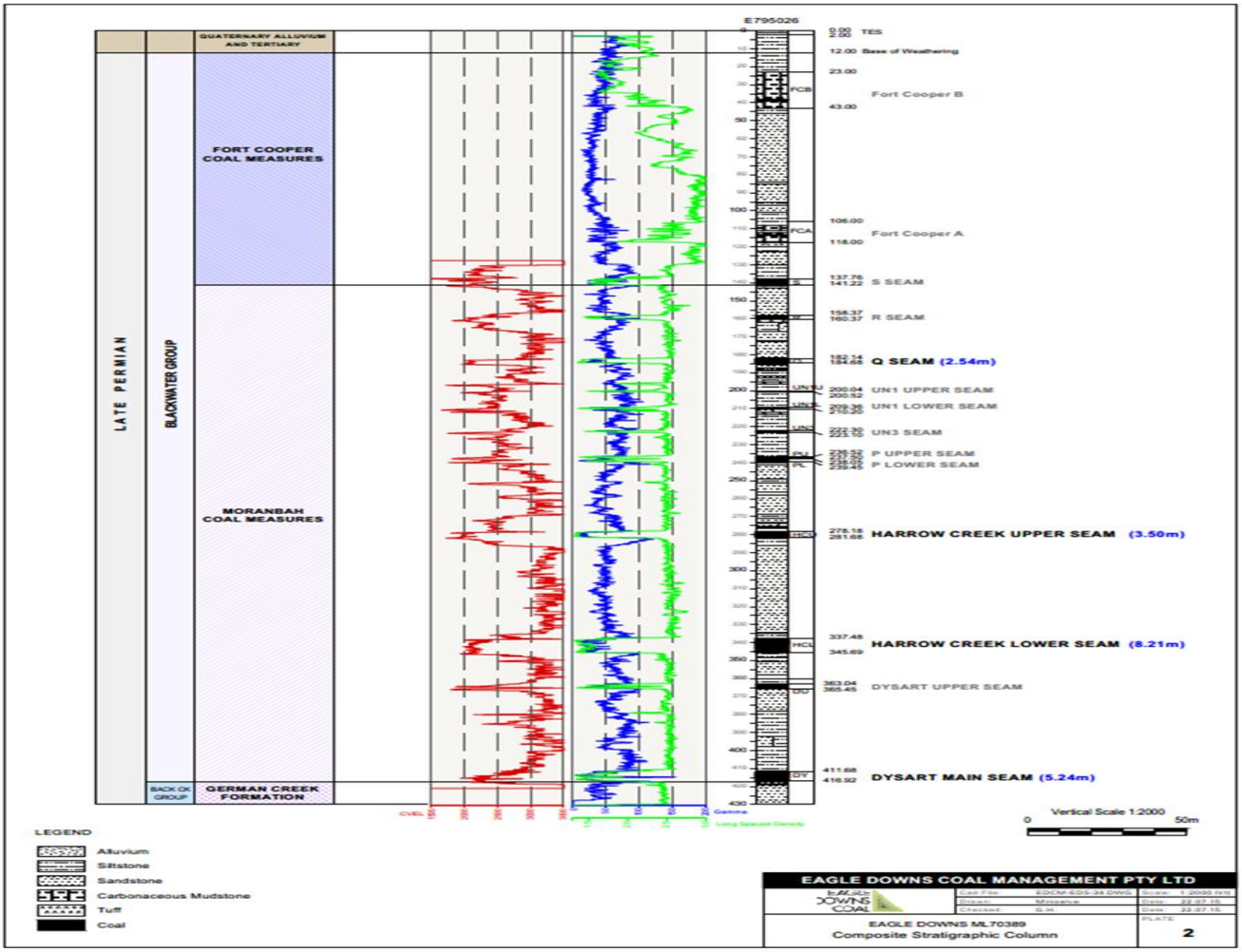


Figure 2.3 General vertical section through the coal measures, Eagle Downs

2.1. HCU Seam

There are three seams that are proposed to be mined, the HCU, the HCL and the DY seams

The HCU seam is the main target seam at the Eagle Downs site, lying approximately 110m below the Q seam. It averages 4m in thickness and ranges in depth from 250m in the south-west to more than 600m in the north-east. South of the coalesced HC seam, which occurs south of the railway line, the HCU seam thickens up to 7m.

The reported geotechnical dataset indicates that there are very few Unconfined Compressive Strength (UCS) results for the HCU seam coal itself. IMC reported only two UCS tests on HCU seam coal from borehole E795041. These are 6.7MPa and 13.8MPa respectively, which represent weak-to-moderate coal strengths. Bulk coal strengths for this seam in this area are generally taken as 8.0 MPa for modelling purposes.

The HCU Roof Unit 101, is described as a ‘laminated siltstone’, with an average thickness of 3.74m. This is sufficiently thick to form the major bolting horizon, although this varies considerably across the lease area. The immediate roof of the HCU seam is a predominantly

siltstone-based material that is interspersed with varying proportions of sandstone and mudstone, the latter typically presenting as sub-horizontal bedding.

The 40 lab-based UCS tests for HCU Roof Unit 101 (immediate roof), provide a range from 5.1MPa to 48.5MPa, with an average of 26MPa. For a sandstone/siltstone UCS of 26MPa, the associated typical value of E is found to be in the order of 8.8 GPa. The highly laminated nature of this roof beam does make it susceptible to horizontal stress damage.

The HCU Floor Unit 101 is described as a 'carbonaceous mudstone', with an average thickness of 0.87m. This is thick enough to result in trafficability issues, if it were to substantially deteriorate during roadway development. The lab-based UCS tests for HCU Floor Unit 101 range from 2.2 MPa to 29.3MPa, with an average of 16.6MPa. this floor is likely to weaken when wet and may allow for floor heave or pillar punching under load.

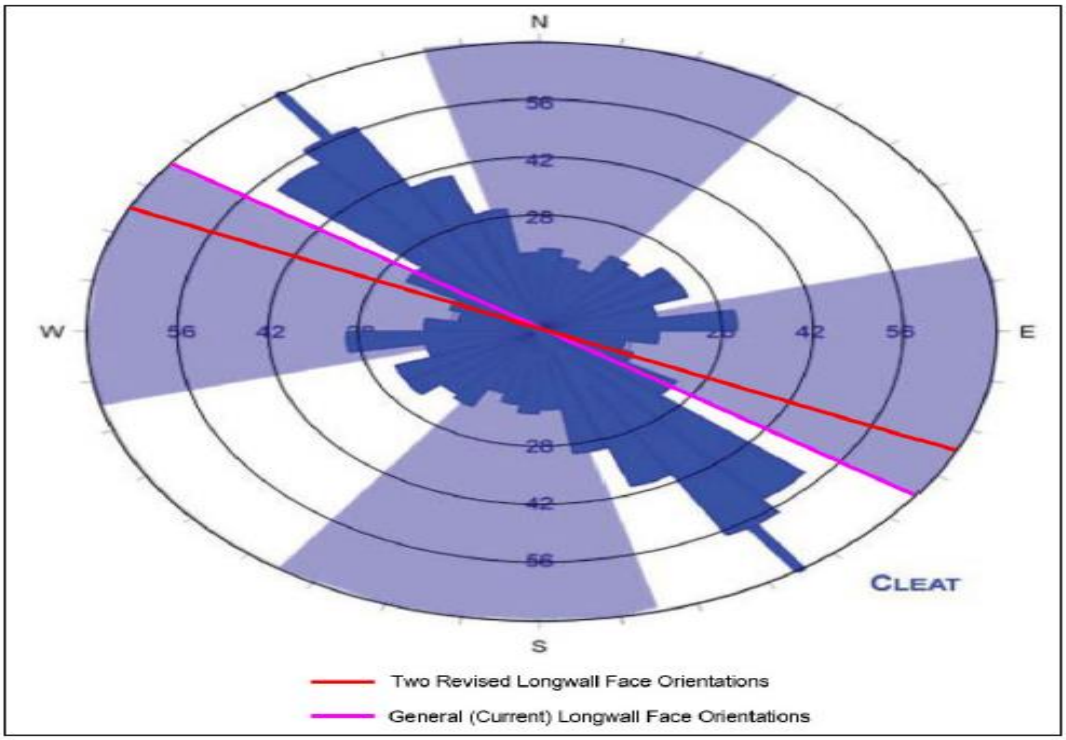


Figure 2.4 Plan showing the coal cleating direction for all three seams

While the in-situ strength of the coal is taken as between 7MPa and 8MPa, the jointing and cleating of the coal may compromise the integrity, effectively reducing the strength, often in one direction. Slabbing and spalling along the maingate and tailgate ribs, leading to a reduction in the effective pillar dimensions and consequent reduction in the pillar Factor of Safety (FoS).

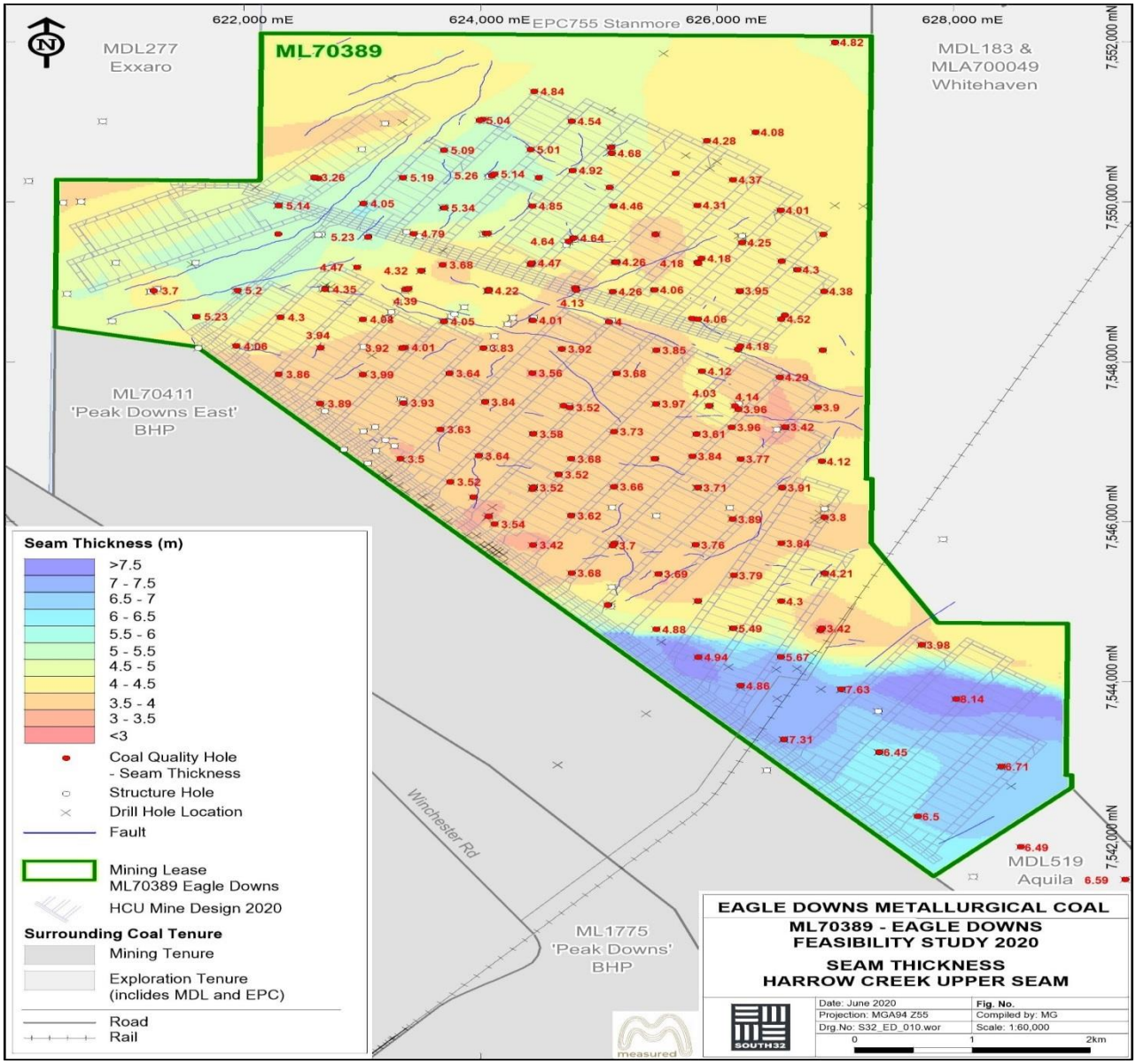


Figure 2.5 Plan of the HCU seam, showing the seam thickness

2.1.1. Coal Mine Roof rating (CMRR)

The CMRR provides a number (rating of the structural competence) for a section of the roof, up to a particular depth into the roof, above the roadway. This CMRR number, between 0 and 100, provides guidance regarding anticipated conditions and primary and secondary support requirements.

The CMRR only assesses the nature of the roof material up to a specific depth into the roof, generally the primary bolting horizon (bolt length). The CMRR rating incorporates the following into the analysis:

- Uniaxial Compressive Strength (UCS) of the rock within the designated height above the roadway.
- Spacing and continuity of horizontal bedding planes and joints.

- Cohesion and roughness of the discontinuities.
- Groundwater and moisture sensitivity of the strata.
- Any stronger beds or strata that may provide good anchorage for support tendons.

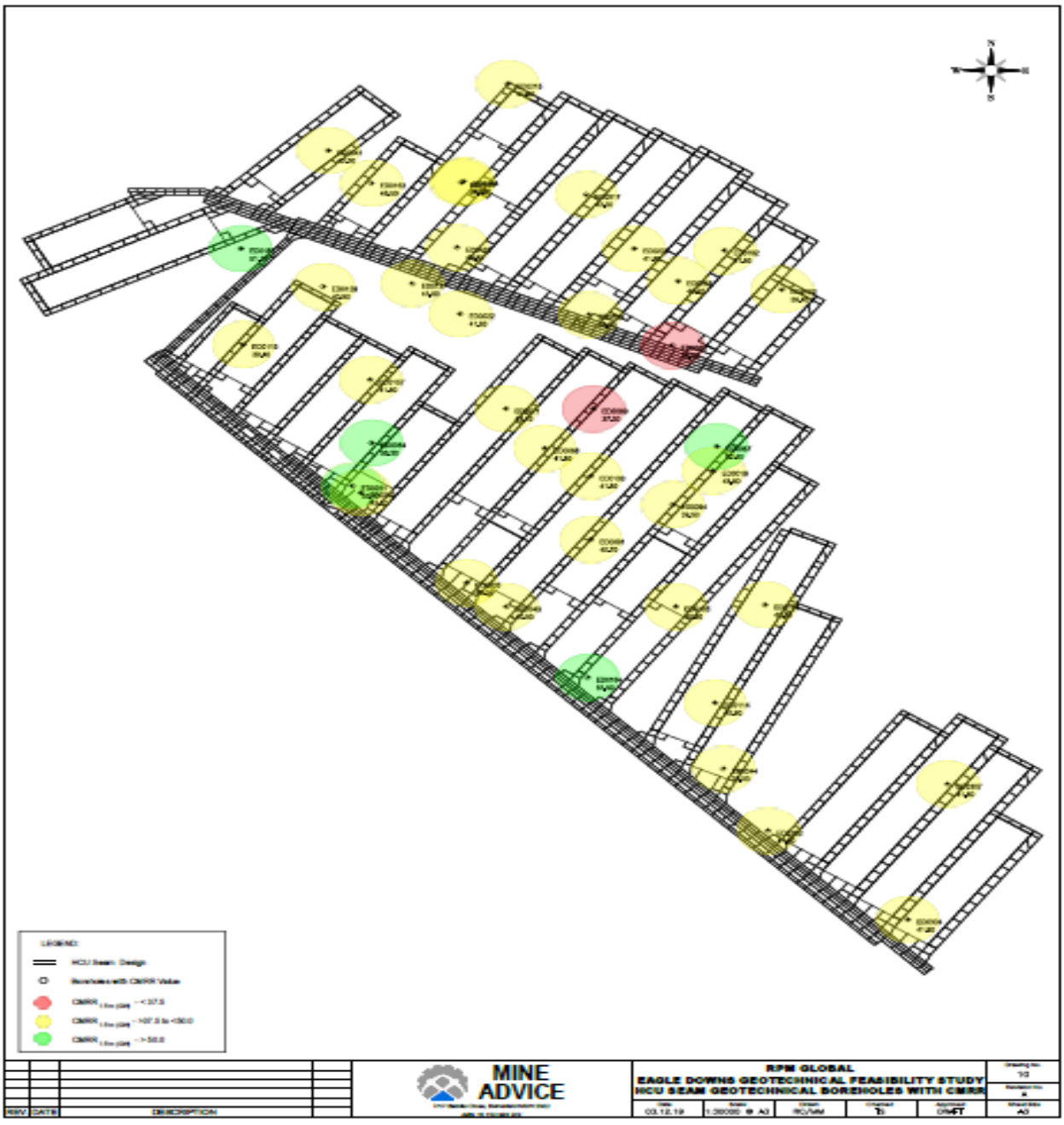


Figure 2.6 Plan of the HCU seam showing CMMR values for the roof. Green are good, Yellow are poor and Red are very low

2.1.2. Geological Structure

There are several regional fault zones that impact on the project. East of the Isaac River and beyond the limit of drilling at the project, there is a large-scale thrust system, the Isaac Thrust. While not measured, there may be some localised stress changes impacting the mine due to this structured zone.

The Geological structures are well defined by 500m spaced drilling, which complements 2D and 3D seismic surveys, which have identified a mixture of normal faults, thrust faults and seam rolls, with varying confidence levels across the project resource area.

The correlation between the Velseis and Integrated Geoscience interpretation of the multiple seismic studies undertaken over the lease is good for confident and probable structures, but less so for anomalies.

There are two main orientations of faulting, NE–SW and NW–SE, which fits in with the regional structural framework. The principal structural features (faults with throw greater than 10m) are:

- Two normal faults in the center of the project area, oriented NW–SE, with throws of up to 17m.
- A NE–SW oriented normal fault, almost parallel to the railway line (in the series 200 area), with a maximum throw of 17m.
- A NE–SW oriented normal fault, almost parallel to the railway line (in the series 200 area), with a maximum throw of 17m.

Medium sized faults between 3m and 10m exist across the area. Smaller throw faults (less than 3m) also occur across the area, in similar orientations to the larger faults. Integrated Geoscience has suggested that there could be many more of these smaller faults that have not been identified by the seismic surveys, as they are below the resolution of the seismic surveys.

The structures are potential areas for possible crack propagation to surface, though the subsidence modelling indicates that this will not be an issue.

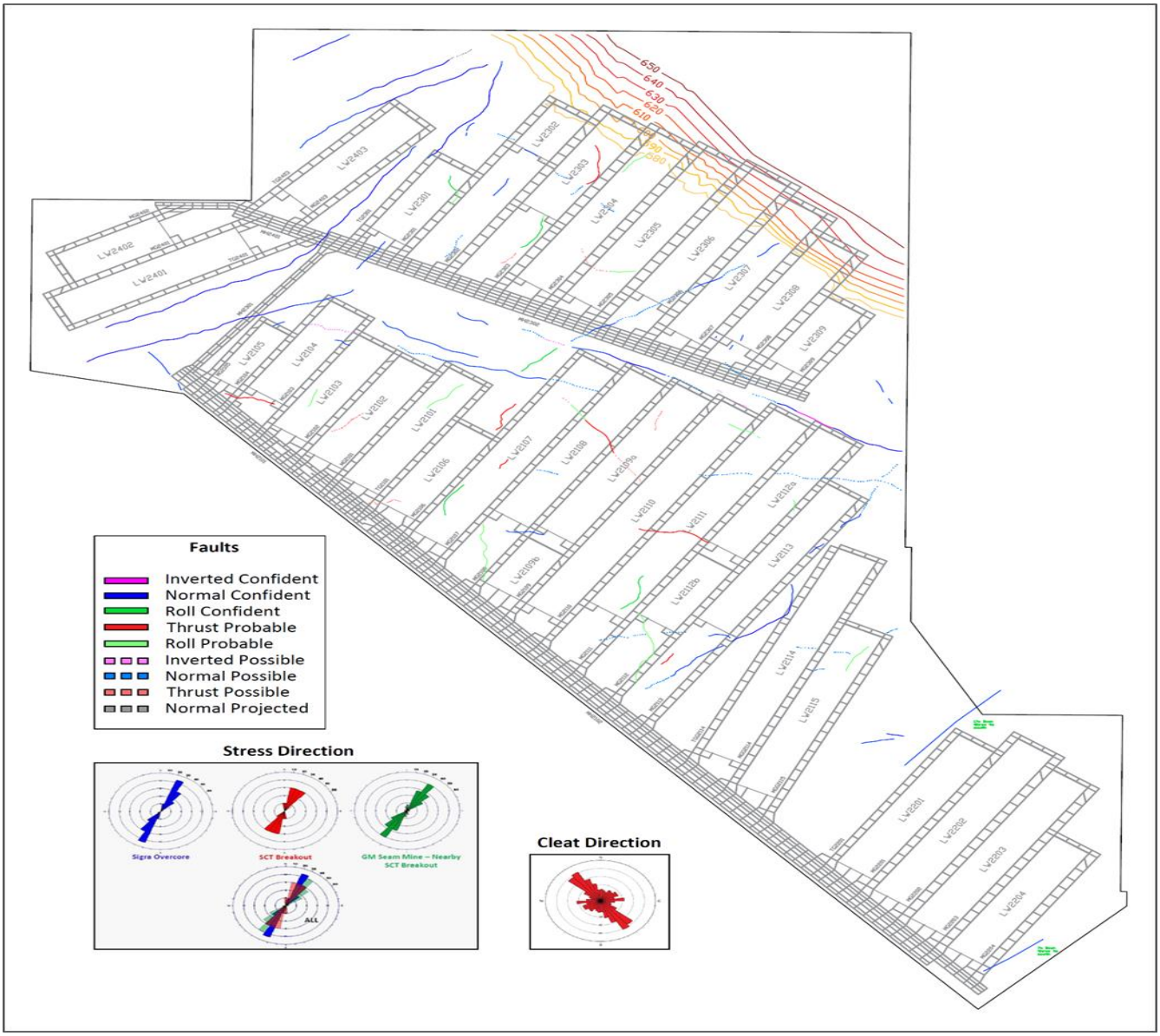


Figure 2.7 Plan of the HCU seam, showing the major structures and the principle stress directions

2.1.3. Depth of Cover

The HCU seam varies in depth between 230m to just under 800m on the project lease. This correlates to a vertical stress variation of between 5.5MPa and 19MPa, although the mining depth will be limited to approximately 600m (14.3MPa). The mains pillars, gateroad pillars and roof support regimes have been designed to accommodate the largest depth (and stress) for each longwall panel, hence they are extremely conservatively designed for the outbye areas of the longwall panels.

The increase in vertical stress will require the corresponding increase in pillar dimensions and at a certain point, may require additional support in highly stressed areas such as the tailgate. The longwall gateroad pillars have been designed to suit the “worst case” conditions, at the start of each longwall block, in the deepest area. This has resulted in pillars larger than required in the outbye

areas, due to the higher stress levels in the deeper inbye areas. This assists with roadway protection in the shallower areas of the retreating longwall panels.

2.1.4. In Situ Stresses

Vertical and horizontal stresses have a large impact on mining, particularly in the sedimentary, multi seam environs of the Bowen Basin. There have been several stress measurements undertaken at the project, providing certainty regarding the anticipated stress conditions anticipated underground. Both Sigra and SCT have been involved with the stress measurements. Both companies are well known for their stress measurement abilities.

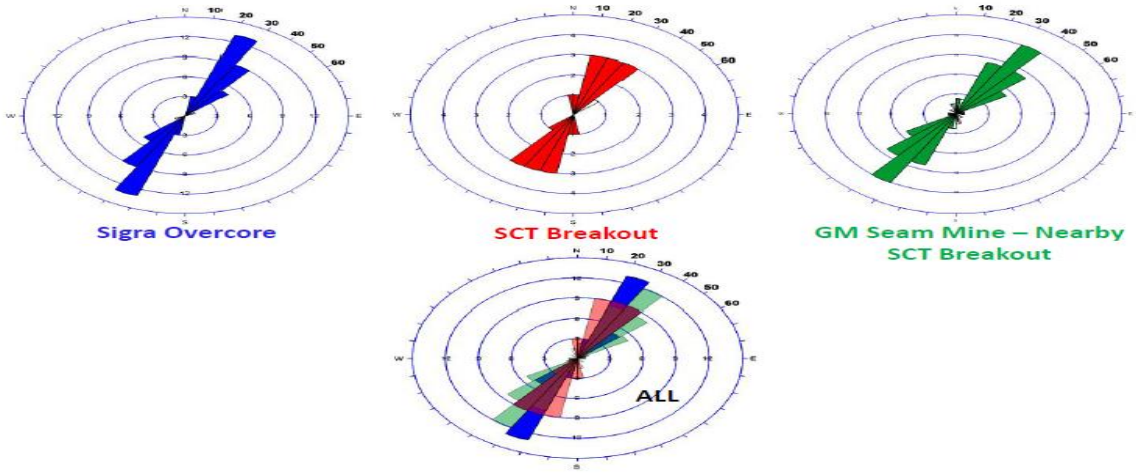


Figure 2.8 Direction of the principle horizontal stress in the HCU Seam

The vertical stresses can be relatively accurately calculated, as detailed in the seam depth discussion, however the horizontal stresses are a function of the Poisson ratio and the tectonic stresses. Local stress measurements indicate the horizontal stresses to be between 1.5 (Major horizontal stress) and 0.75 (Minor horizontal stress), times the vertical stress and orientated in NE / SW and NW / SE directions. The gateroads have been orientated to run parallel, or close to parallel to this stress direction, thereby reducing roadway roof stresses in the gateroads, leading to increased longer term roof stability.

Table 2 Typical tectonic stress environment for QLD coal operations

Location	Tectonic stress factor range (average)	Major to minor conversion Factor (average)
QLD German Creek/Lilyvale seam	0.47–0.7 (0.6)	0.47–0.58 (0.54)
QLD Rangal Coal Measures	0.41–0.56 (0.51)	0.44–0.55 (0.52)
QLD Moranbah Coal Measures	0.64–0.66 (0.65)	0.54 (0.54)
Eagle Downs Coal Project (Assumed / Measured)	0.6	0.44

The Minor horizontal stress will be orientated across the gateroads, with the clamping forces generated in the roof assisting with roof stability. The Major horizontal stress, aligned parallel to the gateroads, will however cause elevated horizontal stresses in the roof and floor in the cut throughs where additional support will be installed, as per the proposed designs.

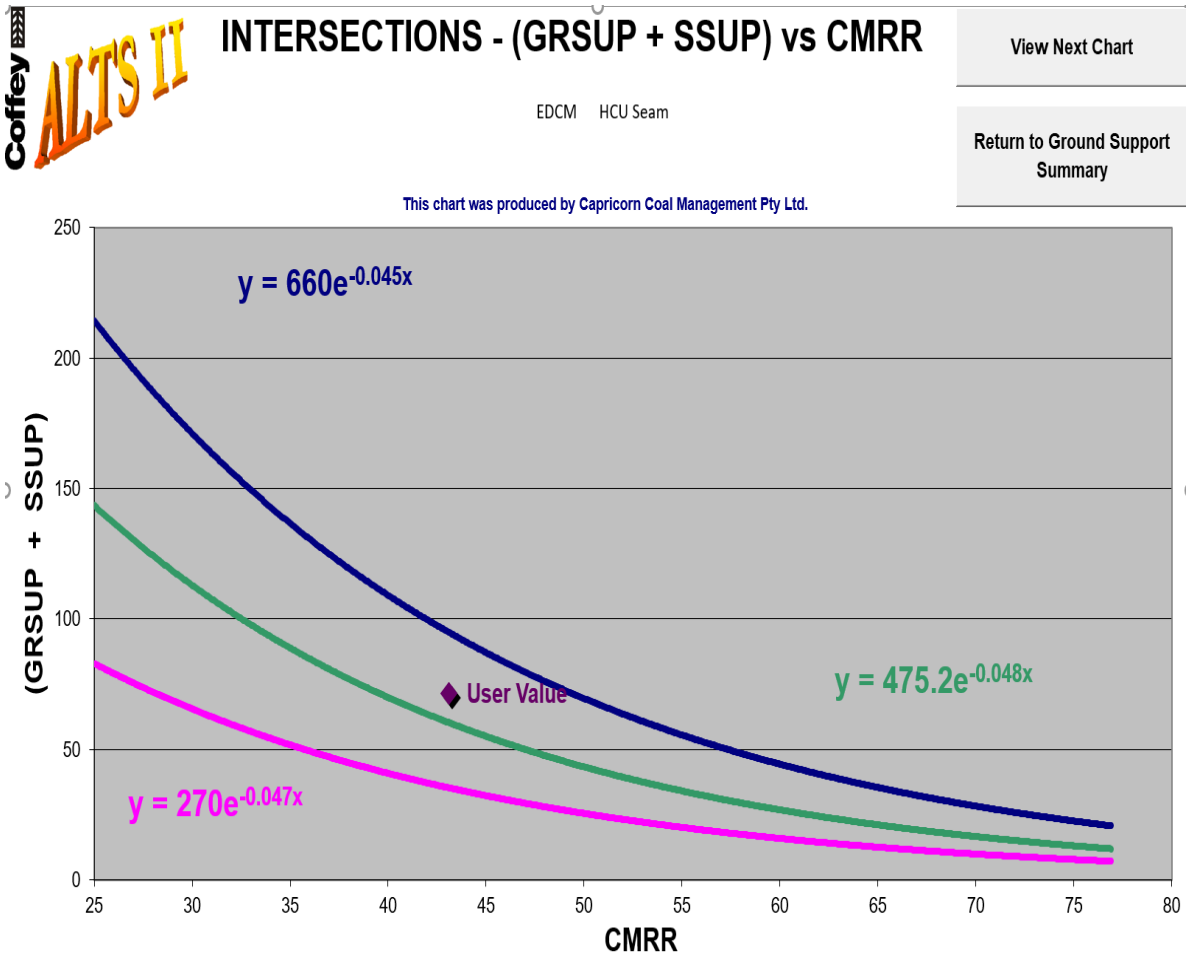


Figure 2.9 ALTS chart showing the Roof CMRR vs roadway support for Eagle Downs wrt the Australian Data base for similar operations

2.1.5. Roof Support

A conservative roof support regime has been recommended as part of the FS, with the total of the primary and secondary supports positioned towards the median of the Australian data base for the various depths. This is likely to lead to generally stable excavations, particularly the areas with larger spans. The use of long cables in particular is likely to lead to long term stable excavations.

2.1.6. Pillar Design

The pillars in the FS have been designed to ensure long term stability of the workings. All mains pillars have Factors of Safety of over 2.5 for the deeper 300 areas and in excess of 4.5 in the shallower 100 and 200 areas.

The chain pillars have been designed to ensure gateroad stability at the deepest part of each longwall block (inbye end). The chain pillars are therefore generally over designed for the shallower outbye ends of the panels. Chain pillar Factors of Safety vary between 1.3 and 1.6 at the inbye end of the panels. For the highest stressed zone, the tailgate corner, these drop to close to 1.0.

With pillar w/h ratios of +5, there is a very low probability of failure, with the installed ground support providing localised additional support for the most highly stressed area, the tailgate corner, which are within normal guidelines. Details regarding the FoS and probabilities of failure are provided in the appendix.

A select number of smaller pillars, or pillars at increased depth have been assessed to understand the FoS and probability of failure. These are detailed below for the HCU seam (Table 3).

Table 3 Selected Pillars in the HCU seam with determination of the FoS during and post mining

Panel / Position	LW2204 Worst at 420m	LW2401 at Max 420m	LW21005 at Min 300m	LW2307 at Max 575m	LW2112 at Min 425m
No LW Abutment	3.4	4.1	4.8	3.0	4.1
Single LW abutment	1.4	1.7	2.0	1.3	1.7
Tailgate Corner dual abutments	1.0	1.1	1.4	0.8	1.1

The areas with a final FoS of below 1.5 are likely to fail over the long term, however as all these are close to the longwall workings, the roof deflections will have been captured as part of the subsidence analysis by Gordon Geotechniques. It is highly unlikely that any additional surface subsidence will be reflected as a result of these localised pillars, which will generally crush, lowering the roof by less than 2.0m in the area.

The Mains roadway pillars are all massively over designed, with FoS of over 5 in all cases and w:h ratios of +7, indicating long term stability. These pillars will need to be supported and protected from damage during mining to ensure they retain their dimensions.

2.2. HCL Seam

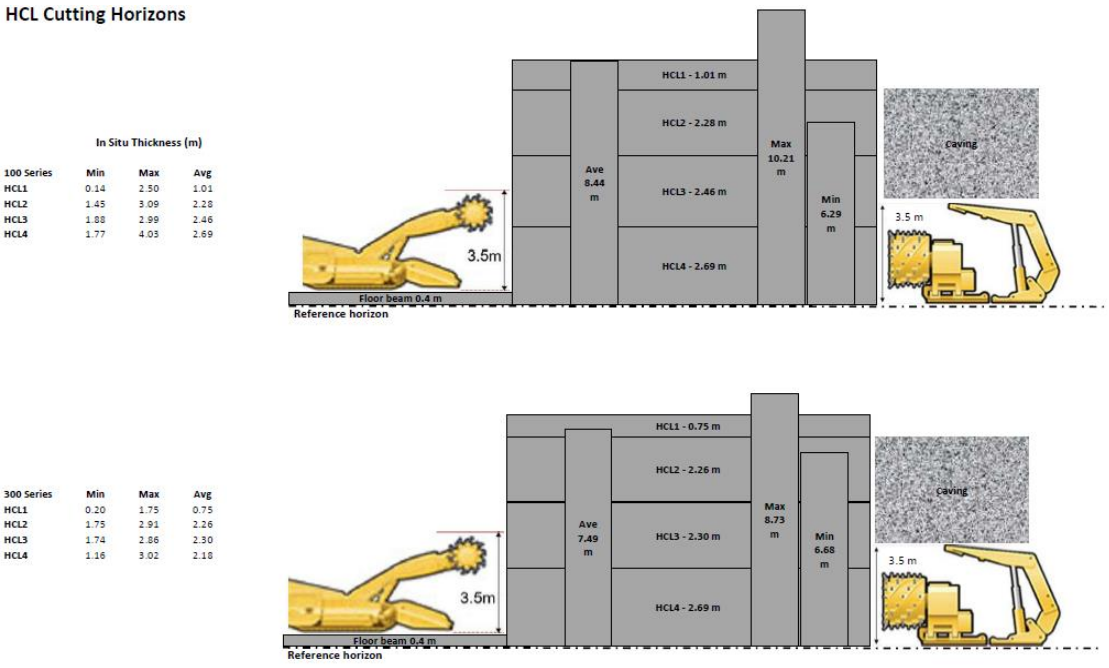
2.2.1. Geotechnical Environment

The dominant geotechnical factors relating to structure, stress directions and relative magnitudes, cleating and jointing in the HCU seam are all able to be directly inferred down to the HCL seam, with obvious offsets to the faulting and increases in the stress levels due to depth. This allows for ease of assessment of the geotechnical impacts in the HCL seam. The vertical stress increases by up to 1.5 MPa, where the Interburden is thickest, which in turn will increase the horizontal stresses by approximately 0.4 MPa in both directions.

The shallowest coal in the HCL seam is approximately 300m below the surface, reaching 600m towards the North East. The seam thickness ranges from 6.3m to over 10.0m. It averages 8m in the central and northern regions of the project area and thins to 6m in the 200 series area, where it coalesces with the HCU seam. The single thick seam will be mined as part of the HCU 200's mining layout.

The seam is quite banded in nature, with four identifiable plies and a fifth ply occasionally occurring at the base. The typical cutting ranges are shown below. In development mining will take place in the lower portion of the seam, leaving coal and carbonaceous material in the roof, while the longwall will utilise Top Coal Caving (TCC) to increase extraction.

Figure 2.10 Cutting horizons shown for the HCL seam



2.2.2. HCU-HCL Interburden

The interburden between the HCU and the HCL seams rapidly thickens away from the coalescence zone in the South. Towards the North, it thickens to approximately 50m and reaches 75m thick in some places. The Interburden contains two major sandstone channels, the HSL14 and HSL12, that vary in thickness across the lease, exceeding 55m thick where they join to form the HSL10, towards the center of the lease.

The composition and thickness of the Interburden and in particular the sandstone channels has been subject to a number of studies and recent additional testing to understand the cave-ability of these areas. The two strong sandstone channels, HSL12 and HSL 14, which are separate in the North, join together to form the thicker HSL 10, which is the channel of most concern from a pillar loading and caving perspective.

Where the two channels are separate, they are less massive and more likely to cave, reducing the likelihood of pillar overload close to the longwall faces. Where the single massive HSL 10 occurs, this sandstone channel is more likely to span over the longwall, causing weighting events and impacting on roof and pillar stability.

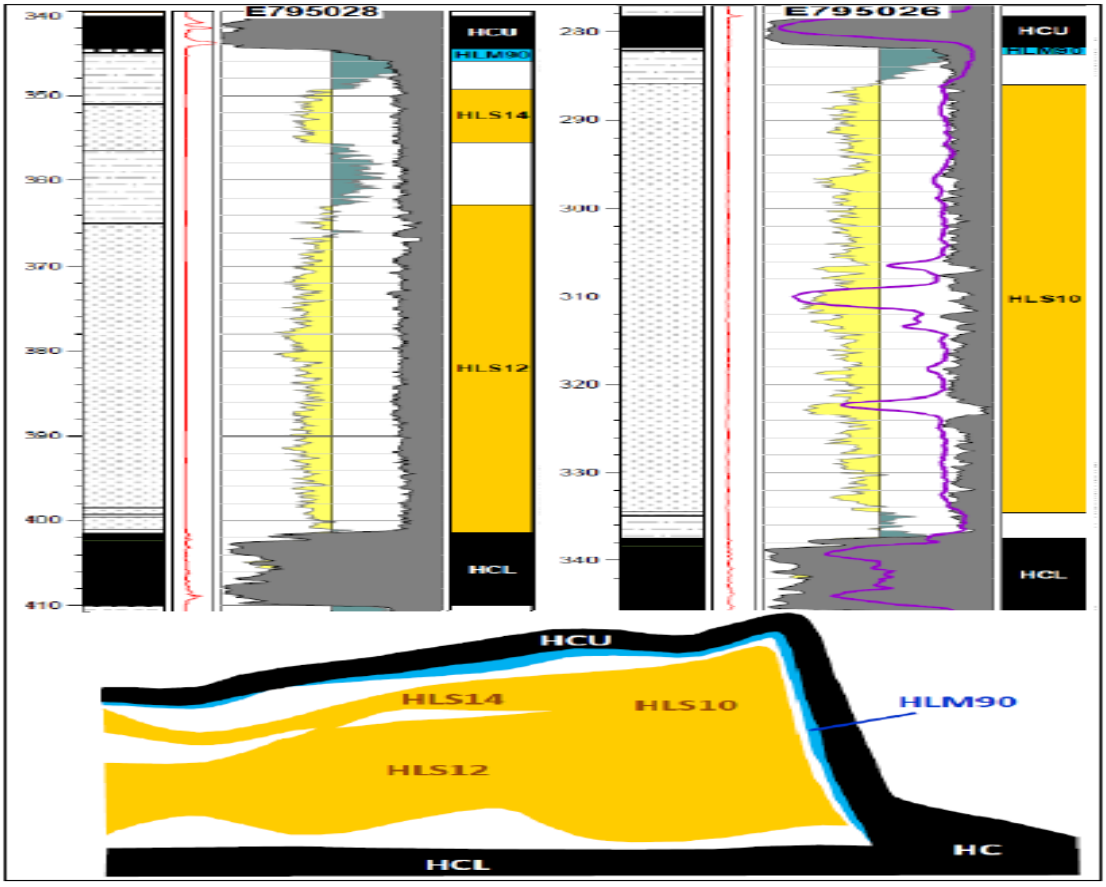


Figure 2.11 HCU and HCL Coalescence zone and interburden thickness

To reduce the impacts of weighting events on the longwalls in this area, it is proposed to reduce the width of the longwall panels to between 180m and 220m, which will allow for bridging across the longwall between the two lines of gate road pillars. While this will reduce the effective surface subsidence, it will increase the load on the pillars, possibly leading to failure. Due to the strong nature of the roof beam however, this will have a reduced subsidence impact on surface and has been taken into account in the subsidence report.

2.2.3. Pillars and Longwall layout

The pillar design for the HCU was briefly discussed, however the layout of the lower seams and the interaction of pillars and longwalls needs further clarification. There are a number of alignments that may be used, when deciding on the vertical layout of the longwall panel:

- Gateroads aligned Vertically. In this layout, the gateroads sit one above the other, with the longwalls directly stacked above each other.
    - The size of the pillars needing to increase due to depth, resulting in the width of the longwall decreasing, with reduced production per shear.
    - Fair gateroad conditions due to larger pillars, though stresses from pillars above may cause issues with gateroad development.
    - Considerable subsidence impacts, due to the addition effect of the panels alignment.
- Half Panel Offset. In this layout, the longwall panels are offset by half a panel width, which positions the gateroads beneath the goaf of the upper longwall.
    - Pillar dimensions may not need to be increased due to stress shadow effects from the longwall goaf above.
    - Reduced subsidence, however pillar loading may be higher, leading to later pillar deterioration.
- Semi Offset longwalls. In this layout, the gateroads of the lower seam are all offset by a slight distance, to allow the following to occur:
    - Move the lower gateroads away from immediately below those above, placing them under an area already caved, thereby reducing the vertical stresses and allowing the gateroads to be driven in relatively benign conditions.
    - Due to the reduction in vertical stress, the chain pillars in the lower seam may not need to be increased in size and will generally have longer term stability.

The last option was chosen by the FS, which allows for mining the HCL and DY seams, beneath the previously goafed HCU and then HCL seams. This layout provides the best geotechnical outcomes. An offset of approximately 30m is proposed, generally ensuring long term pillar stability.

It appears that this layout has been used by Gordon Geotechniques, though this should be confirmed at the time of closure, due to the possible additional subsidence and pillar failure impacts.

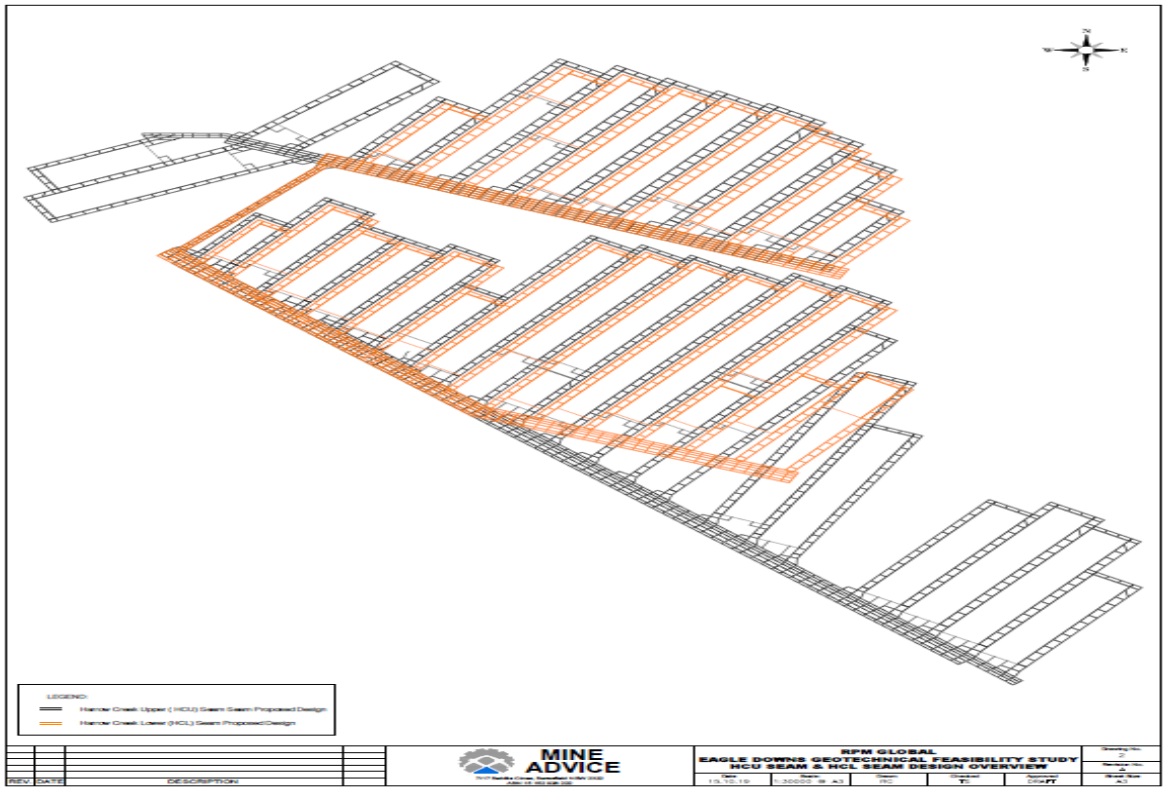


Figure 2.12 Plan showing the overlay planned for the HCU and HCL seams

The HCl seam is generally much thicker than the HCU seam, although there are several stone and clay bands in the seam. Similar to the HCU roadway design, it is proposed to leave approximately 0.5m of coal in the floor to provide protection to the weaker claystone below the coal. With the thicker seam, on average, the entire bolting horizon will be in coal. A similar roof support regime is planned for the HCL seam workings, which while providing stability during mining operations, may deteriorate quicker, due to the weaker overall strength and weather ability of the coal roof.

Table 4 Seam mining heights for the various areas

Area	Minimum (m)	Maximum (m)	Average (m)
100's Mining Area Seam Thickness (m)	6.29	10.21	8.44
100's Mining Area roof coal beam (m)	2.3	6.2	4.4
300's Mining Area Seam thickness (m)	6.68	8.73	7.49
300's Mining Area roof coal beam (m)	2.7	4.7	3.5

2.2.4. Immediate Floor of the HCL Seam

The immediate HCL floor unit 101 is a carbonaceous siltstone with an average thickness of 0.88m, which is thick enough to cause issues, should it start to break up during development or longwall retreat. The lithological descriptions for the immediate floor material of the HCL seam is similar to the HCU seam, where clay rich material may cause issues with pillar punching or floor heave, particularly when wet. This has been considered in the pillar strength assessments.

Table 5 Selected pillars in the HCL seam with relevant FoS for mining and after extraction

Panel / Position	LW5011 Worst at 475m	LW3101 at Max 460m	LW3113 at Min 370m	LW3309 at Max 575m
No LW Abutment	3.9	4.3	4.6	2.7
Single LW abutment	1.6	1.8	1.8	1.7
Tailgate Corner dual abutments	1.1	1.2	1.5	1.0

2.3. Dysart (DY) Seam

As per the HCL seam, the DY seam structure and stress regime may be translated down from the HCU and HCL seams, with obvious offsets for the dip of any structure. The Interburden between the seams varies between 50m thick to the east and 100m thick to the north west.

This will increase the vertical stresses by approximately 1.2MPa and 2.4MPa, with corresponding increases in the horizontal stresses. The depth of the DY seam varies between 400m and 750m, so virgin rock stress will be in the order of 9.4MPa to 17.7 MPa.

- The DY seam varies in thickness between 3.6m and 6.1m, as shown below, with development mining leaving between 0.4m and 0.5m of coal on the floor for protection.
- With 0.5m of coal in the floor, there will be between 0.4m and 2.0m in the roof, which will form some part of the bolting horizon. The initial two meters of roof above the strata is comprised of a carbonaceous siltstone and sandstone, similar to the HCU seam, however contains a number of thin mudstone bands, which may weaken the roof slightly.
- While CMRR values have not been calculated for this roof, typically with a roof comprising of little coal, through to a full coal roof, CMRR values will vary from 38 to 50, with an average of 42, which has been applied to the DY seam bolted interval for roadway roof support assessment purposes.

The longwall top coal caving (LTCC) will have a cut height of 3.5m and a cave height ranging from 0m to2.4m, with an average of 1.5m.

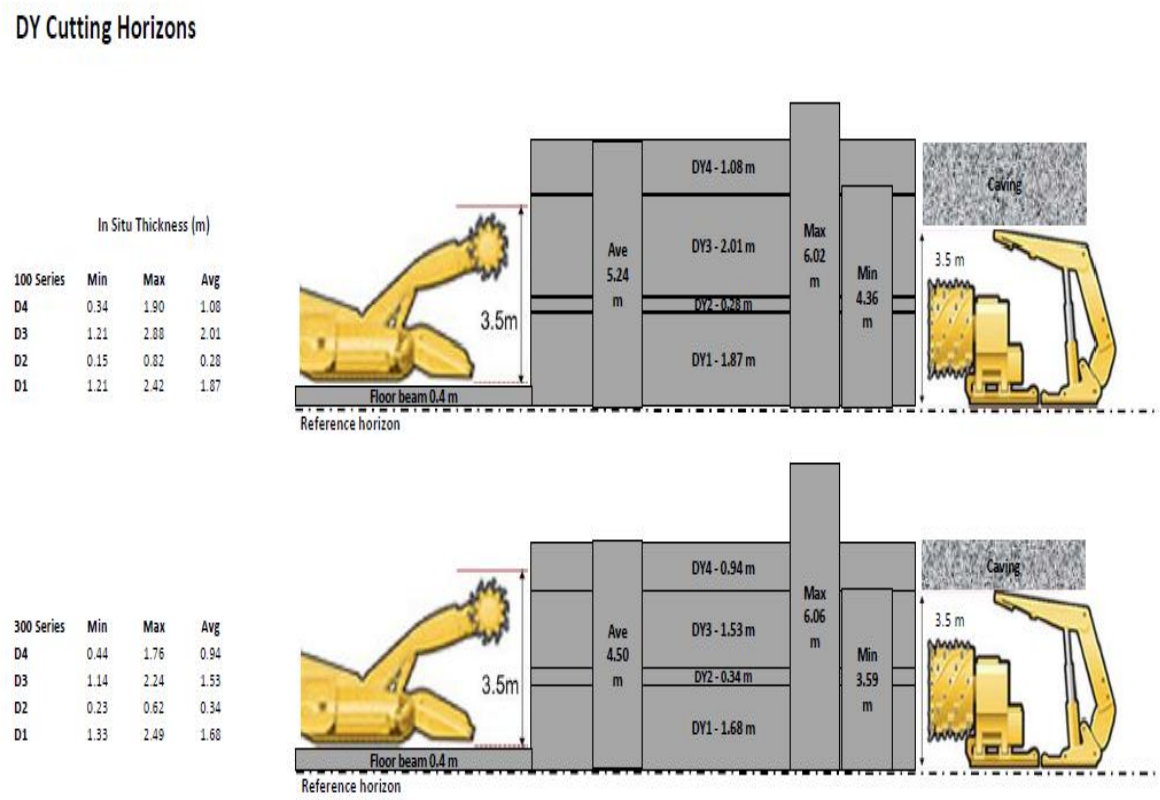


Figure 2.13 Planned cutting horizons in the DY seam

2.3.1. Mining layout DY Seam

Offset panel layouts, as per the HCU / HCL seams will be used, with the panels stepped back to align with the HCU seam, though in the slight shadow created by the HCL seam.

Table 6 Selected pillars for the DY seam with final FoS calculated

Panel / Position	LW4115 Worst at 530m	LW4302 at Max 450m	LW4103 at Min 490m	LW4309 at Max 590m
No LW Abutment	3.7	4.3	4.8	3.3
Single LW abutment	1.6	1.8	1.9	1.5
Tailgate Corner dual abutments	1.2	1.3	1.3	1.1

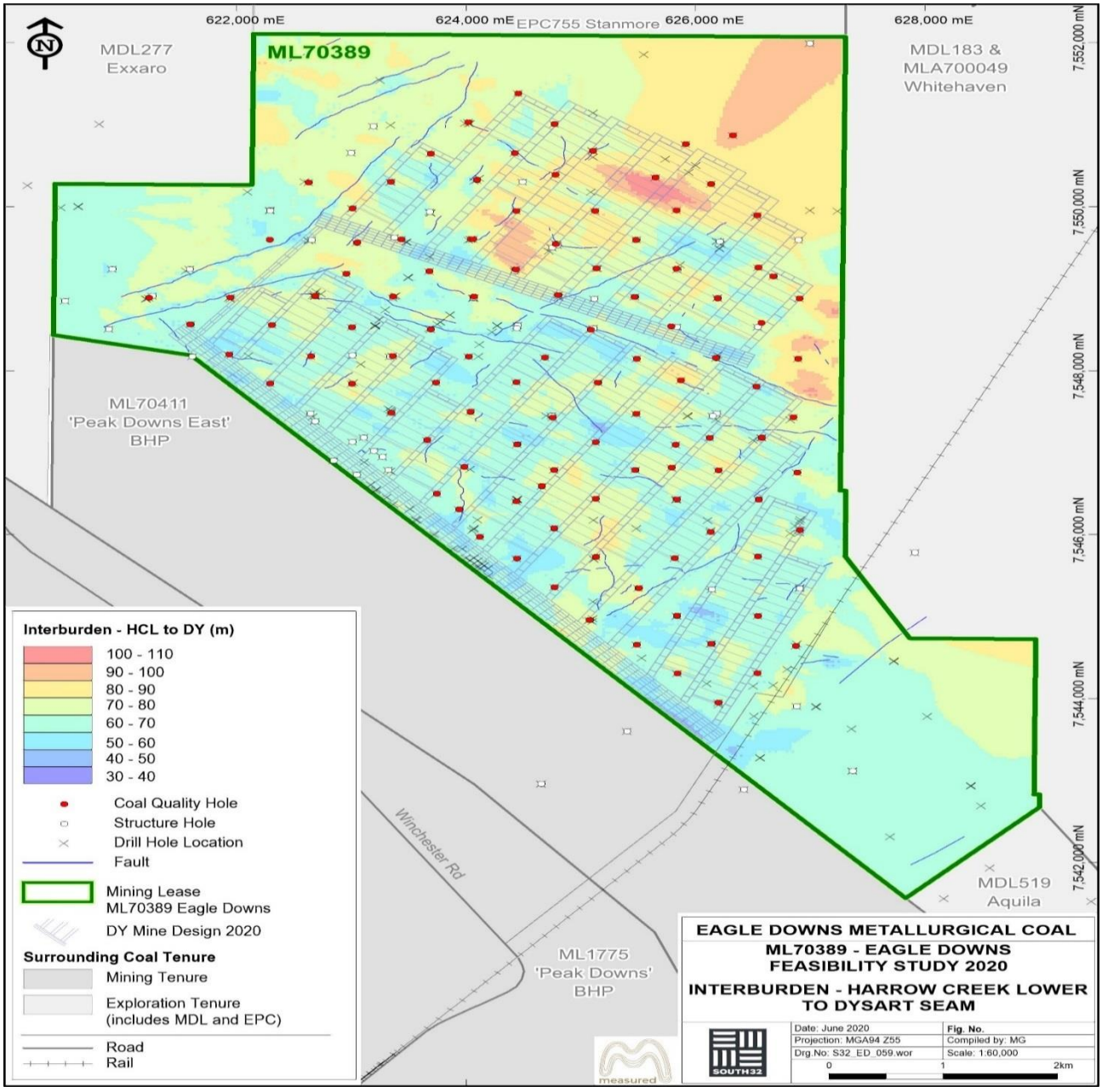


Figure 2.14 Plan showing the typical interburden between the HCL and the DY seams

3. Subsidence

The major impacts of longwall mining and any pillar or roadway collapse is manifested on surface as subsidence. Due to the depth of workings and the nature of the material above the seams, the subsidence is unlikely to lead to direct connections between the surface and the sealed underground workings and the surface.

Anticipated subsidence has been modelled by a number of consultants over the years, with Gordon Geotechniques having recently completed a detailed subsidence study, including modelling of the anticipated surface subsidence.

Gordon Geotechniques uses the SDPS program to predict subsidence, which takes into account the rock mass properties and is generally very accurate at predicting surface subsidence and any possible linkages between the surface and underground.

This methodology is widely used throughout QLD and NSW to generate predictions of longwall mining subsidence effects and inform environmental impact and engineering assessments. It should be highlighted that the SDPS methodology can only predict the overall or systematic deformations. All subsidence surveys reveal small scale variations from the smooth profile predicted by this method. These deformations can be related to localised movements of blocky rock that is a feature of all coal mine overburdens.

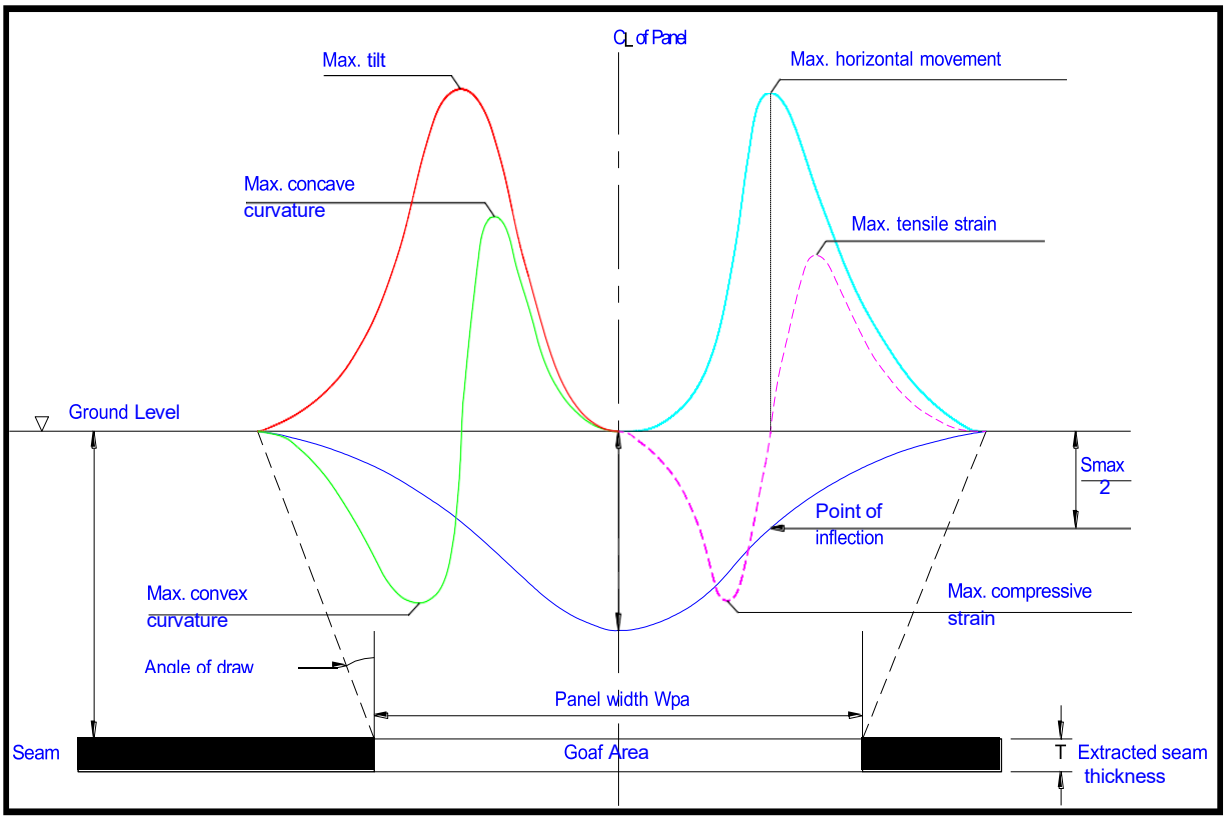


Figure 3.1 Typical subsidence profile for a single seam longwall mine, showing main areas of measurement

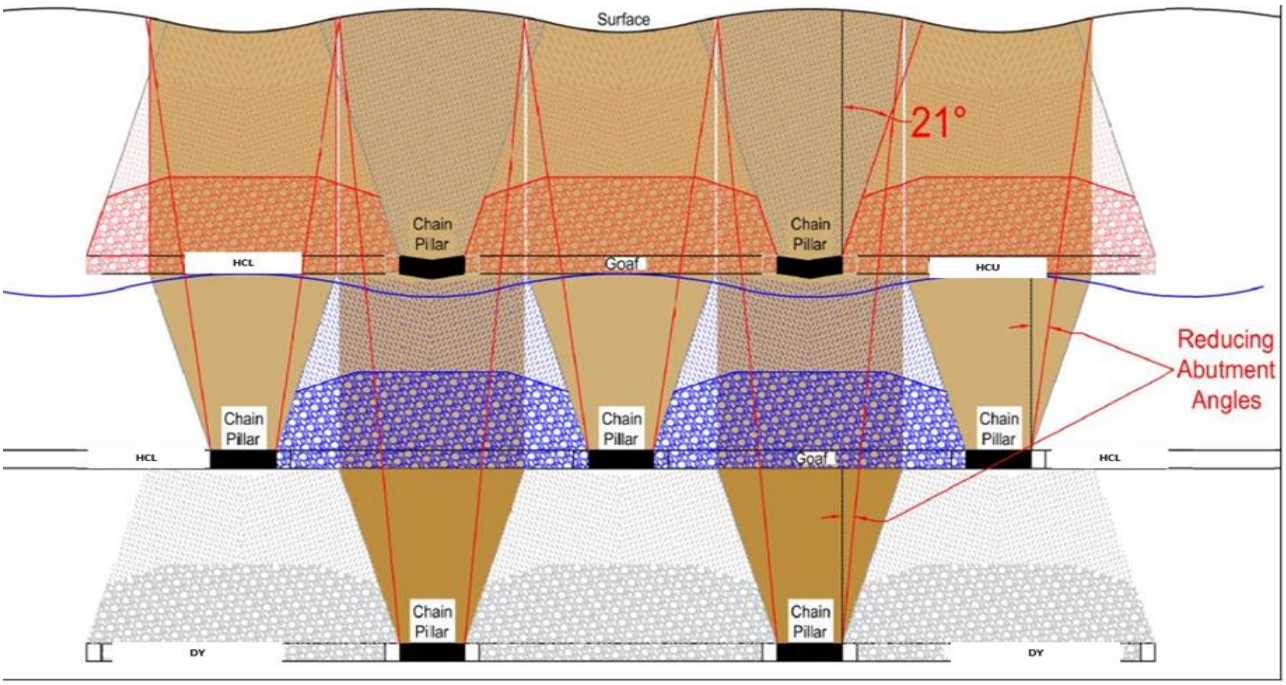
3.1. Multi Seam Subsidence

The additional ground movement in a multi-seam mining environment is dependent upon the thickness and strength of the interburden between the seams, as well as the thickness of the seams to be extracted.

In the case of the combined Harrow Creek Upper, Harrow Creek Lower and Dysart seam extraction, the total subsidence at any point is a simple addition of individual values for each seam. The same is not true of the strain and tilts. SDPS has the facility to allow models to be run with the three layouts simultaneously, to provide outputs of these parameters.

The subsidence modelling assumed the following range of effective thicknesses (based on 80% LTCC recovery) are extracted by the longwall:

- HCU Seam – 3.5-4.2 m – single pass longwall extraction only.
- HCL Seam – 3.5-7.1 m – both single pass and LTCC.



- DY Seam – 3.5-5.2 m – both single pass and LTCC.

Figure 3.2 Multi seam layout, showing half offset block deformation profile

3.1.1. Chain Pillar Deformation

The chain pillars between the longwall panels will act to reduce the magnitude of subsidence deformation between each individual longwall panel and therefore the total subsidence over each series of panels.

The depth of cover increases along the length of the panels and the associated chain pillars. In these circumstances, the chain pillars may deform differently along their lengths and this will influence the total subsidence associated with each series of longwall panels.

The key considerations in modelling the effects of chain pillar deformation on the total subsidence are:

- When a longwall panel extracts the coal, the overburden load that was carried by coal is redistributed onto the chain pillars on either side of the longwall panel.
- With this increase in overburden load, the coal that forms the chain pillars in the Eagle Downs longwall mining area is expected to experience some level of compression.
- Significantly, in areas of overlying goaf the overburden load will be reduced and so to the amount of compression.

Analysis of the Harrow Creek Upper Seam chain pillars developed in virgin ground conditions indicates that at the planned range of depth the chain pillars are not expected to yield. Where the Harrow Creek Lower Seam and Dysart Seam chain pillars are located below overlying goaf, yield is not anticipated due to the reduction in loading conditions, consistent with data presented by Mills and Wilson (2021) at Ashton Mine in NSW.

3.1.2. Negative Pillar Subsidence Factor

In order to model the influence of chain pillars, SDPS provides the ability to model each series of panels (also termed a super panel). In this mode, SDPS models the negative subsidence (upsidence) of the chain pillars instead of the panels.

In the HCL and DY seams, additional super panels were defined to allow modelling of longwall extraction in virgin mining areas, not located below overlying workings.

The width of these active chain pillars is equal to the distance between the compensated panel boundaries. The feature of this method is that the chain pillars can be given their own negative subsidence factor in the prediction, allowing greater control over subsidence due to compression of the pillar system.

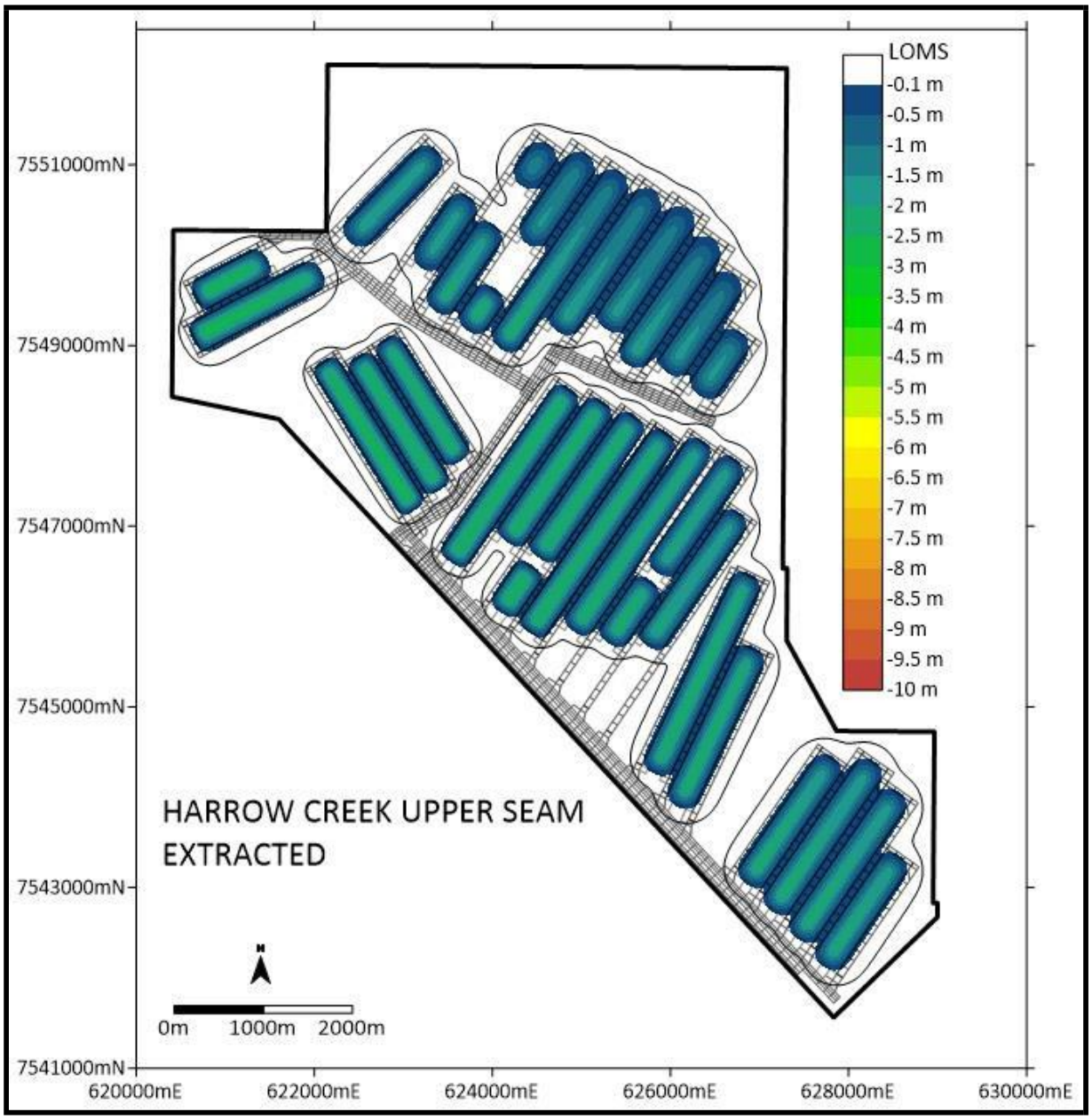


Figure 3.3 Predicted Surface Subsidence with the HCU seam extracted. **(Gordon Geotechniques)**

With the subsequent extraction of the Harrow Creek Lower Seam, the maximum subsidence increases to 7 m in the shallower part of the area. Similarly, the subsidence reduces to 3-3.5 m in the deeper part of the area.

The reduction in subsidence due to the reduced extraction height in the sandstone zone in the Harrow Creek Lower Seam is also evident.

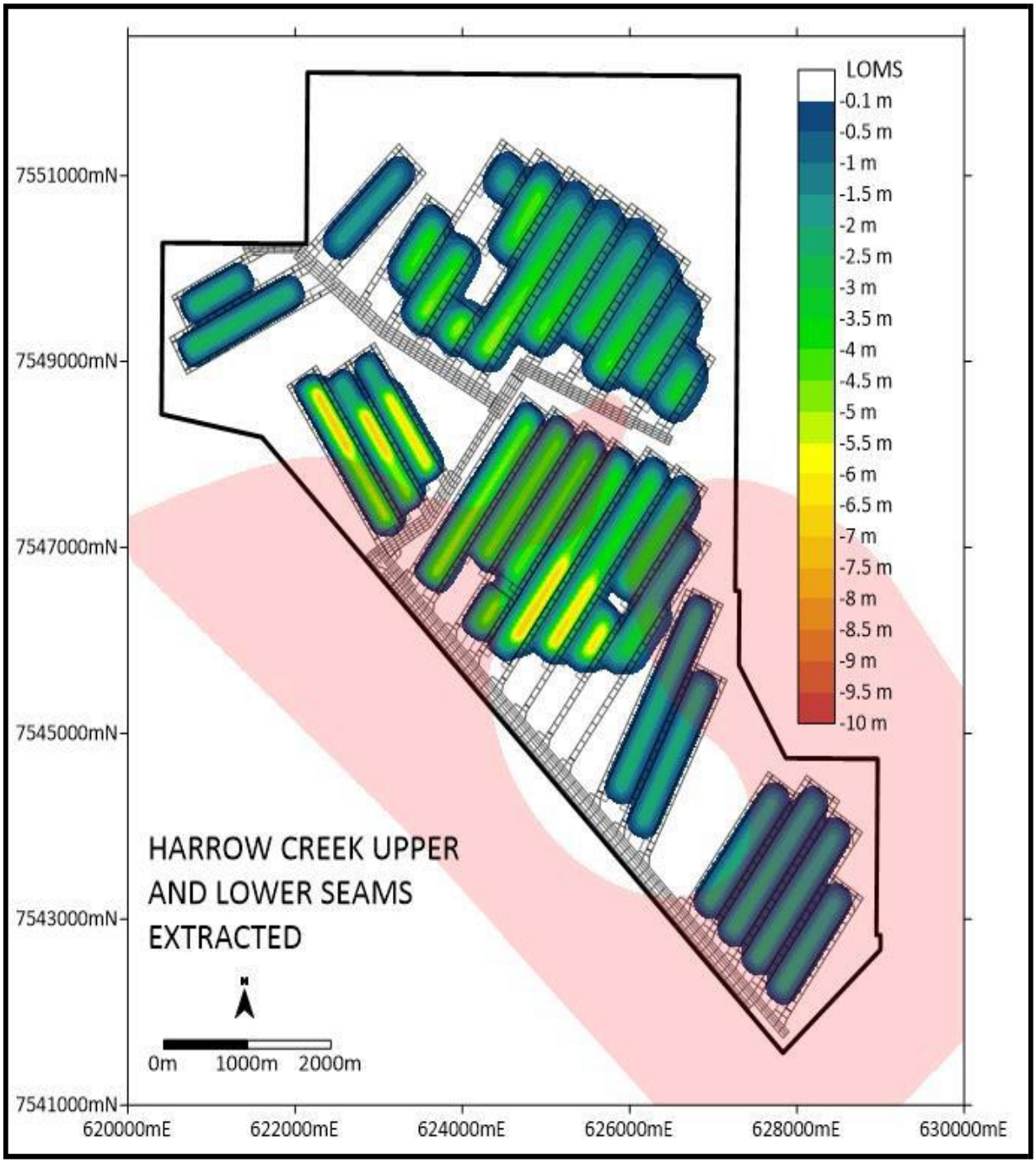


Figure 3.4 Predicted surface subsidence with the HCU and HCL seams extracted.
(Gordon Geotechniques)

Once the extraction of all three target seams has been completed, a maximum subsidence of 10 m is predicted in the shallower south-western part of the mining area.

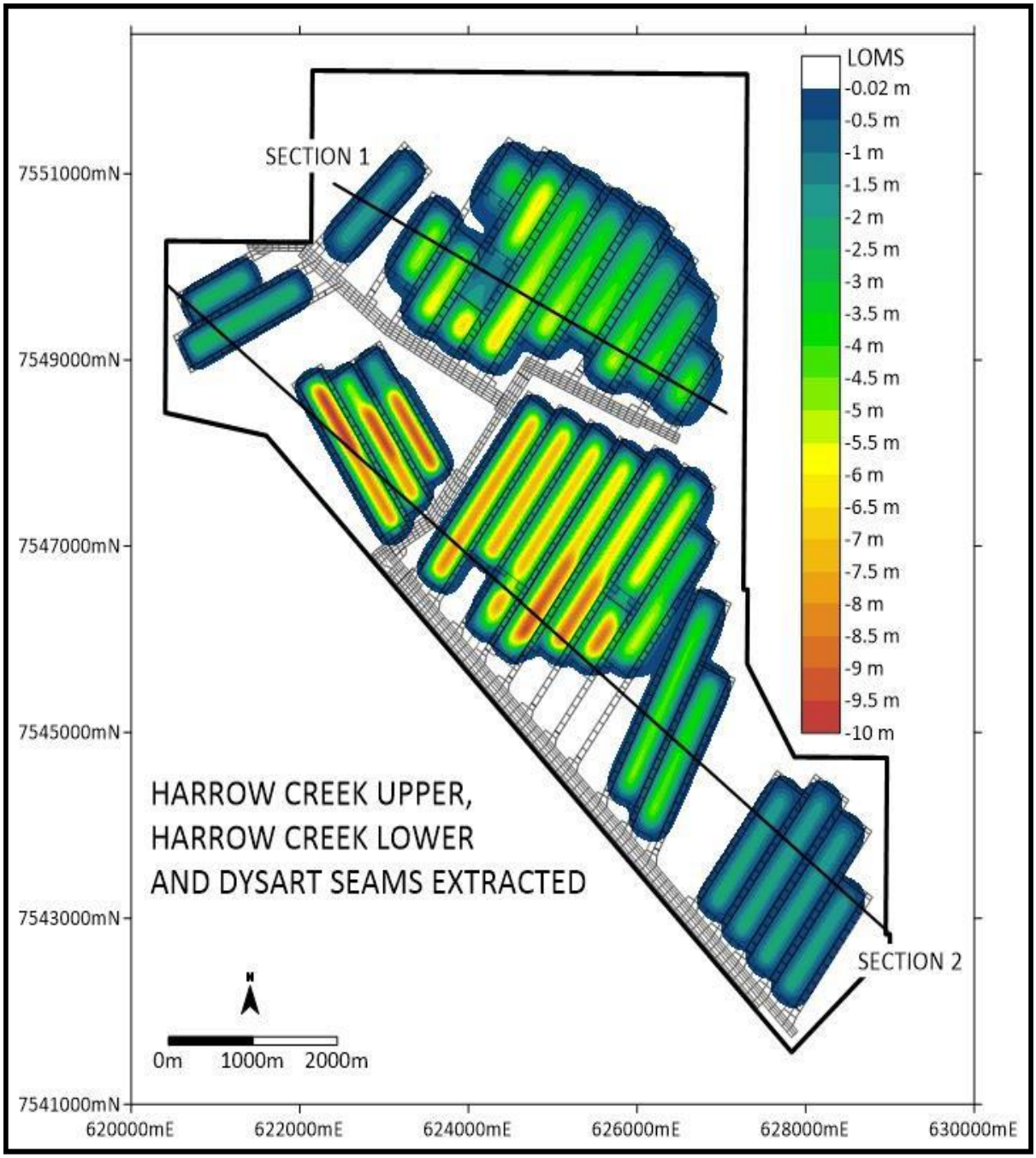


Figure 3.5 Predicted subsidence with all three seams extracted. **(Gordon Geotechniques)**

Any small areas where localised pillar failure may occur, due to the factors discussed earlier are relatively insignificant when considering the larger levels of overall vertical subsidence due to the longwall mining operations. Pillar failures will contribute as little as 0.2m to any localised area of failure, when translated to surface as part of the subsidence profile.

Maximum horizontal movements of up to 3.8 m are predicted in those areas where all three seams have been extracted.

Once longwall extraction is completed in all three seams, the maximum tensile and compressive strains are 53 mm/m and 68 mm/m respectively.

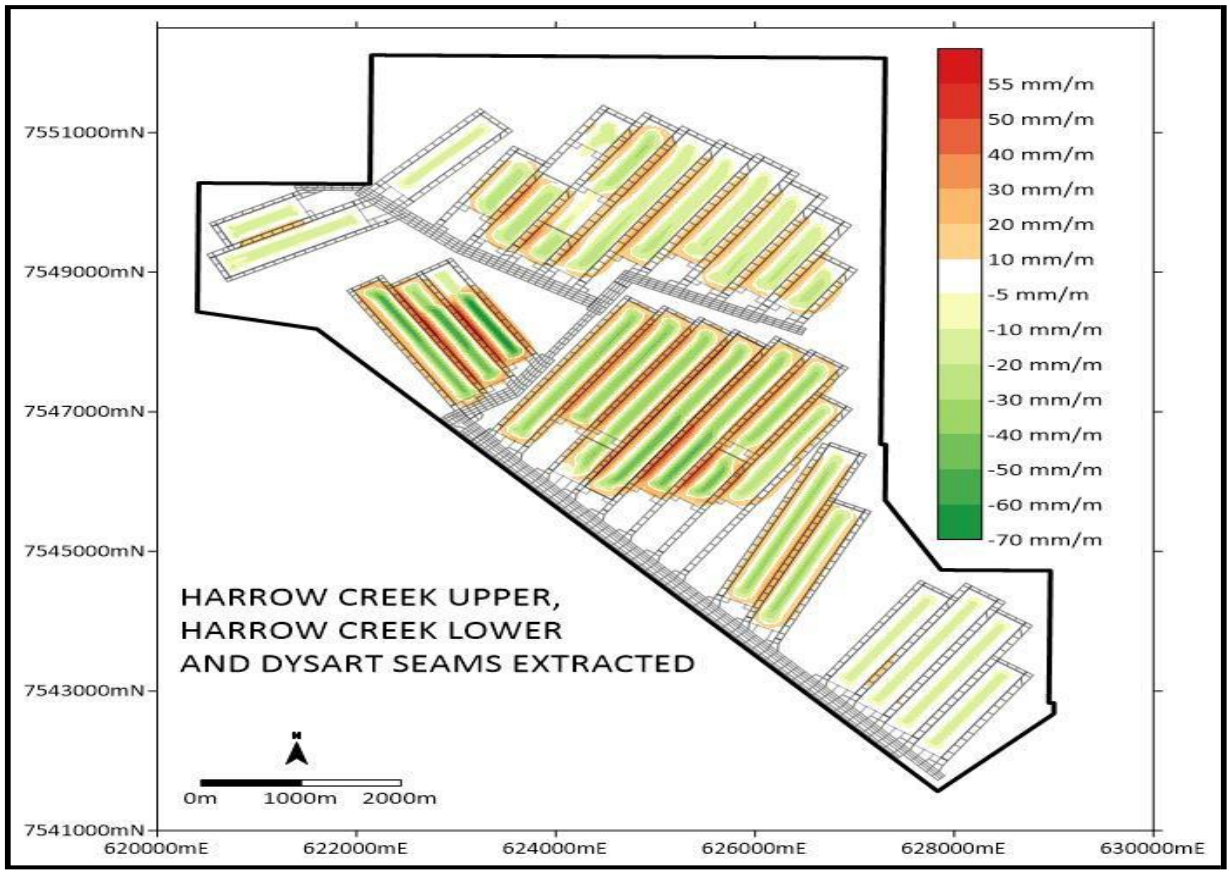


Figure 3.6 Predicted surface tilt following extraction of all three seams. **(Gordon Geotechniques)**

The subsidence predictions are final subsidence values after longwall mining is completed. The nature of the longwall mining method means that subsidence does not increase further over time. Based on subsidence monitoring at other mines in the Bowen Basin typically greater than 97% of the maximum subsidence will occur within 6 weeks after longwall mining is completed, assuming an industry average retreat rate of 100 m/week.

3.2. Subsurface Cracking

Longwall mining methods can induce a range of subsurface subsidence effects. In the context of changes to the hydrogeological regime, the key issue associated with longwall subsidence is the creation of subsurface subsidence cracks in the rock mass. These cracks may provide new flow paths for groundwater and alter the permeability of the strata overlying longwall mining areas.

For operating longwall mines, it is possible to measure key subsurface subsidence cracking characteristics including the height of cracking above the extracted coal seam. This information can be correlated to measured changes in the water regime, for example, decreases in groundwater levels in boreholes or inflows to underground mining areas.

This provides accurate site-specific data on the known characteristics and impacts of subsurface subsidence cracking within the geological sequence.

It is strongly recommended that during normal mining operations, these types of instrumentation and measurement regimes are undertaken on a regular basis.

A range of different methodologies are used to determine the heights of subsurface subsidence cracking associated with existing mining operations, such as:

- Borehole extensometers.
- Piezometer records.
- Drilling records.
- Comparison of permeability testing and
- Microseismic monitoring.

Alternative models are available which relate the height of continuous cracking to the mining induced tensile strains and depths of cover. However, the overall concept of dividing the rock mass into different cracking zones is common to all methods and is a well-established and valid approach to explain the measured differences in field observations arising from subsurface subsidence cracking (Gale, 2008).

Measured data taken from comparable mining operations in equivalent geology can also be used to assist with the prediction of the likely extent of each subsurface cracking zone and, in particular, the boundary between discontinuous and continuous zones of subsurface subsidence cracking.

The behavior of the subsided rock mass can also be assessed using numerical modelling methods. Commercially available modelling software includes the Fast Lagrangian Analysis of Continua (FLAC) model. Numerical modelling of subsurface cracking requires robust calibration, verification and validation to minimise the potential for erroneous results and requires reference to measured data.

Consequently, numerical modelling would not provide a higher level of accuracy than empirical methods in the prediction of subsurface cracking, as the basis of the predictions would be essentially the same.

Monitoring information from North Goonyella mine, in the area, used microseismic activity to monitor the height above the longwall where breaking and cracking of the strata occurs. The figure below (Figure 4.7) shows that the majority of microseismic activity (crack propagation), occurred within the immediate 120m above the seam.

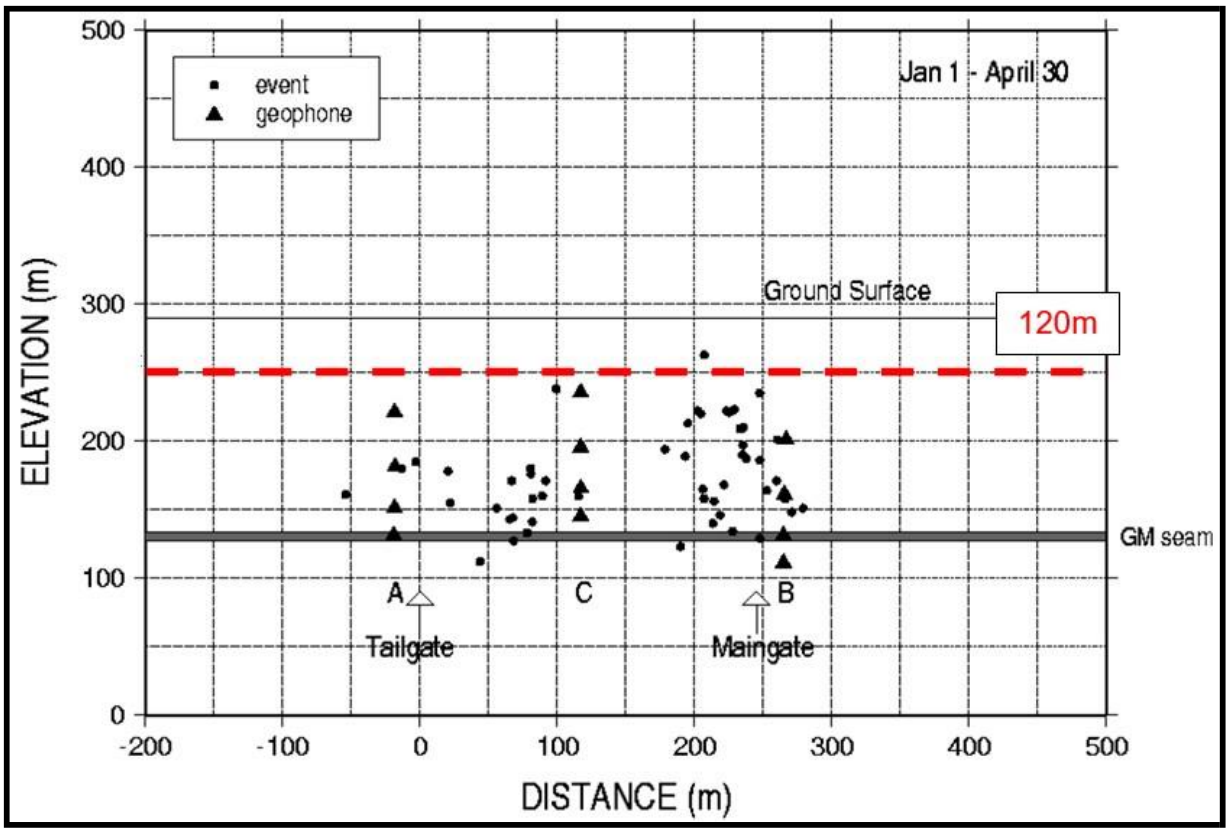


Figure 3.7 Seismic activity above the longwall at North Goonyella

This indicates that there is a very low probability of any cracks, formed by the underground longwall mining propagating to surface and providing a continuous channel for oxygen ingress or toxic / flammable gas leakage for any depths below approximately 220m.

The estimation of the height and behavior of subsurface subsidence cracking for multi-seam mining is complicated by the lack of monitoring data available.

Table 7 Measured Surface interactions Longwall mines Australia and UK

Mining Area	Height of Continuous Cracking	Discussion/Evidence
Crinum, QLD	90-100 m	Height to overlying basalt/sand aquifers in the Tertiary (Seedsman and Dawkins, 2006).
NSW	100-150 m	The potential for surface water to flow into underground longwall workings is recognised if the longwall panel is less than 100 m to 150 m below the surface (Seedsman and Dawkins, 2006).

Oaky Creek and German Creek, QLD	<160 m	For ponded water at cover depths greater than 160 m, remedial works are generally not required Unrestricted inflow generally occurs to a height of about 120 m above the active mine area,
Kestrel, QLD	<115 m	Microseismic monitoring of LW101. (Kelly and Gale, 1999).
North Goonyella	<120 m	Microseismic monitoring of LW3. (Kelly and Gale, 1999).
Wyee, NSW	40-63 m	Wide panels and strong, massive roof strata (Forster and Enever, 1992).
Cooranbong, NSW	58 m	Wide panels and strong, massive roof strata (Forster and Enever, 1992).
Wistow Mine, UK	77 m	Limestone aquifer (Whittaker and Reddish, 1989).
UK	<105 m of rock head	Guideline to minimise the risk of inflow (Gale, 2008).
Northern Bowen Basin	<170-250 m	Longwalls (312 m wide and 4.5 m high) successfully extracted beneath the Isaac River.

Due to potential weakening of the overburden strata in the discontinuous cracking zone in overlying goaf, the zone of continuous cracking is conservatively inferred to extend to 180 m above the upper seam extracted, which in the majority of the area is the Harrow Creek Upper Seam.

This 50% increase from the predicted continuous cracking height for single seam extraction should more than adequately account for the uncertainty associated with multi-seam extraction and therefore provide a conservative basis for the purposes of assessing potential worst case groundwater impacts.

3.2.1. Connective Cracking to the Surface

In any areas where the depth of cover to the extracted coal seam is less than the combined height of connective cracking and surface crack depth, connective cracking to the surface could potentially occur.

The shallowest depth of extraction in the Eagle Downs area is 270 m in the western Harrow Creek Upper Seam area. As such, connective cracking to the surface is not anticipated.

4. Groundwater

The impacts of groundwater on the stability of the workings and overall long term mine closure are generally relatively benign for underground longwall operations, due to the fact that the majority of roof collapse (goafing) and surface subsidence impacts occur within a short time after extraction of the coal.

The impacts of water may however impact on the stability of the pillars and often effects the roof of larger openings.

Umwelt (2021) produced a comprehensive groundwater review for the project, which addresses a number of issues regarding long term impacts of water inflows and outflows.

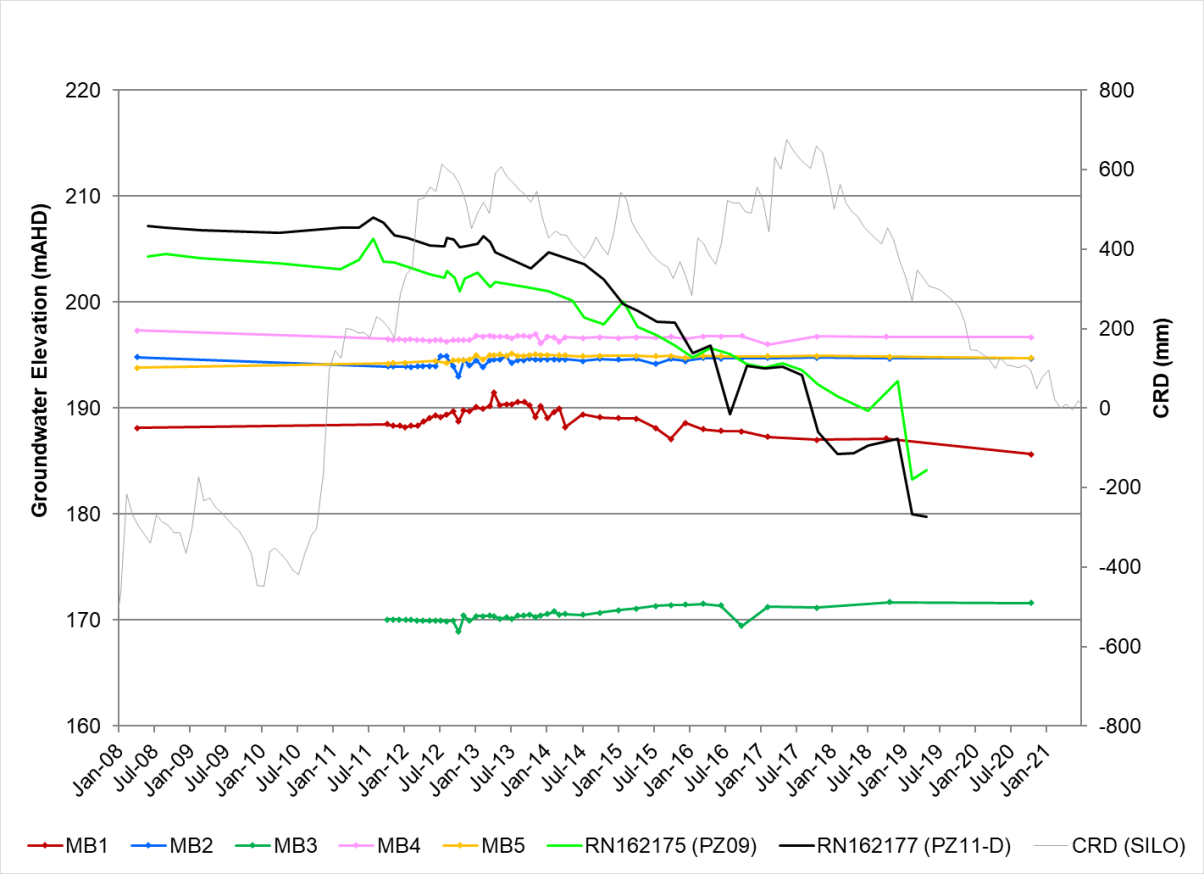


Figure 4.1 Graph showing approximate height of groundwater in current Eagle Down bores. (subtract mAHD from 216.7 to get height below borehole collar)

Current groundwater flows and levels are impacted by adjacent mining and gas extraction operations, with flows generally towards operating mines in the vicinity.

The average current (historical) height of water for the bores on site is ± 25m below the collar of the bore, and assuming connectivity through shafts, bores, gas management holes and subsidence fracturing, it is highly likely that this level of standing water in the bores will lead to flooding of the mining operations once pumping from underground stops and the underground is sealed off.

Quite how quickly this will occur is hard to assess, though inflow values from mines within 5km of site estimate average inflows of between 0.8ML/day and 175ML/day. This is a large

variation, however using the mean of 88ML/day, into the combined void created by the three seams will take approximately 6.2 years to fill to the level of the current bores.

There will be the need for continued bore monitoring, though mainly to monitor possible pollutants from the past mining operations.

With all pumping stopped and the surface openings sealed off, any groundwater make will build up in the workings.

There are risks and opportunities associated with the water inflows:

Risks:

- Saturation of high clay content materials in the immediate roof of the workings. This could lead to deterioration of the roof and falls of ground. Falls of ground decrease the width to height ratio of the pillars and effectively reduce the FoS of the pillars and possible pillar failure.
- Saturation of the clay rich materials in the floor of the workings, which will weaken the floor and could lead to pillar punching into the floor, or floor heave. This may reduce the FoS of the pillars, leading to possible pillar failure.
- Water flows through the workings, which could lead to erosion of the floor in some areas. Again, this could increase the pillar height and reduce the FoS, leading to localised pillar failure.
- Long term deterioration of the coal, due to acid or alkali water build up. This may lead to localised pillar failure.

Opportunities:

- Replacement of oxygen in the air with water, significantly slowing the oxidation (weathering) process of the coal, including possible spontaneous combustion.
- Replacement of explosive gases in the air with water, reducing the propensity for an explosive atmosphere to form.
- The pressure of water acting on the ribs of the pillars will provide some additional confinement to the pillars, increasing the short term strength of the pillars.
- Increase in pore water pressure in the coal, which will reduce the stresses on the coal within the pillars, resulting in an increase in the FoS, and increased stability.

5. Sealing Ventilation and large Bore shafts

There will be a number of shafts blind bored, or drilled between surface and the underground workings. These will include main ventilation shafts, fresh air and return raises, and possibly large diameter dropholes (>300mm diameter).

These require specific sealing off to ensure they are adequately closed and then filling to surface from a safety perspective. Due to the difficulty in installing any device mid shaft, these are generally filled with material, then sealed and then topped off to surface with material and topsoil.

5.1. Method of Sealing

Once the shaft or bore is no longer needed, or the mine is in the process of closing, the following process (or similar) should be employed:

- If there are multiple access points below the shaft in the underground workings, construct light weight stoppings (sprayed gypsum or similar, 100mm thick) close to the shaft, to contain any material dropped down the shaft.
- Ensure these walls have at least a 600mm2 aperture near the top of the wall to allow for air to escape when material is dumped down the shaft.
- Ensure the area underground is securely barricaded off prior to any material being placed into the shaft.
- Remove all cables, steelwork or conductive materials in the shaft or into the workings to create a minimum of a five meter gap to prevent lightening spark issues
- Once approval has been received, use a fine gravel to slowly dump into the shaft, to fill the shaft to just above the level of the incoming underground roadways. This must be done carefully to ensure the material confining walls are not damaged during the pour
- A chute, attached to the collar of the shaft should be used, as this prevents any vehicle from getting too close to the shaft, and will allow for regulation of the material flows into the shaft.
- Once the gravel is placed to at least 2m above the top of any entries into the shaft, it is possible to pump low strength (7% cement) high slump concrete into the shaft. Care must be taken to ensure the concrete does not build up on the sides of the shaft and end up blocking the shaft, prior to adequate filling of the bottom.
- Continue pumping (calculate the volumes required) until the shaft has been filled with this concrete to a thickness of a minimum of three times the diameter of the shaft or bore. (3x D). This concrete plug will form the basis of the permanent 50 psi rated plug seal.
- Allow the concrete plug a minimum of 28 days to cure before completely filling the shaft / bore with waste material and topping off with a minimum of five meters of topsoil.

- While filling the shaft, ensure material is constantly wetted down to assist with compaction. The shaft / bore will require topping up to bring the fill to the natural surface level after approximately three months.
- Use the chute to ensure ease of filling and safety of personnel.
- Ensure that volumetric calculations are done to confirm that the shaft has been completely filled and does not have any voids in the fill material.
- Cover or seal as required by the Mines Inspectorate.

6. Sealing of Boreholes

The sealing of the surface to seam exploration boreholes is important to minimise any gaseous exchange between the surface and the workings, following closure of the mine.

6.1. Borehole Identification

During the PFS and FS, a concerted effort was made to determine the state of all known boreholes. This consisted of:

- Entering all borehole data into the Acquire Database. As there has been exploration conducted over many years, there is always the chance that one or more exploration holes have not been logged, though this is unlikely, considering the detail of the process.
- All holes were examined on surface to ensure that their sealing status could be confirmed. There were thirteen holes, where this was the case. Of these, there were six that were not able to be located, although clearing of the areas was undertaken. This could be due to incorrect coordinate inputs; or the holes, having been sealed, may have been covered over.
- There were eighteen holes, where the sealing was not considered to be adequate, with re-sealing, using grout has since been undertaken.
- All other exploration holes in the Acquire database were considered to be correctly sealed.

All exploration and surface to seam holes drilled on site are now entered into the Acquire database for the site, which will ensure a record of their position and sealing status will be kept. It is imperative that this database is safely stored and kept up to date, during the progress of the mining operations, through to closure.

6.2. Sealing of Boreholes

(Exploration, gas drainage, cement dropholes, water monitoring etc diameter up to 300mm)

During the course of the FS, a standard method of sealing boreholes, was provided to the site Geological team and the drillers. This has been entered into the Acquire file notes for future reference. As a minimum, the process consists of:

- Ensuring the borehole is not to be used for any further data gathering, or geotechnical measurements. This requires a sign off by the Geologist / Geotechnical Engineer.
- Removal of any temporary casing in the borehole, to a minimum depth of 30m, or to the length of the casing installed. Ensure there is no other steel or conductive material in the hole for a minimum of five meters to prevent lightening spark issues.
- Installation of a packer or wadding into the hole, at a minimum depth of 30m below the collar RL for the borehole.
- Mixing of a cement based grout, minimum cement ratio to be 20%. This grout must be able to flow and be pumped into the hole. Slump +350mm
- Pumping of the hole to ensure that there is a minimum of 10m of grout in the hole above the packer or wadding. This should use a pipe down into the hole, which is slowly withdrawn as the hole is pumped and filled with grout.
- Allow the grout to set (minimum of 24 hours) before filling the balance of the hole with soil from the surrounding area.
- Rehabilitation of the area, including all sumps and pits.
- Positioning of a survey peg in the area of the borehole for later reference.
- Updating the Acquire database with the latest information.

6.3. Timing

Once the borehole has been fully used by the geologist for exploration, a maximum time of six months may be allowed for the Geotechnical personnel to utilise the hole. If it is not to be used by the geotechnical personnel, it will be required to be signed off and must be sealed and grouted within three months of the sign off.

No hole may be left un-grouted for more than nine months from completion of drilling, unless it is being used by the mine for other purposes.

Six months prior to the intended cessation of mining operations and closure of the mine, all exploration boreholes must be examined in the Acquire database. Any hole that is still un-grouted and not being used must be grouted and entered into the database as completely sealed.

7. Sealing Main Shafts and Declines

The Eagle Downs operations are planning to use the two partially completed declines to provide access for personnel and materials, with the second housing the coal clearance conveyor system. Both will be intake airways.

Return and additional intake airways will be via vertical shafts, sunk in various areas of the mine to optimise ventilation flows and cooling of the underground operations.

7.1. Sealing of the Underground Workings

When considering the sealing of the underground mining operations, it is important to ensure:

- A safe and simple seal up.
- Stable environment during the time the drifts are sealed.
- Permanent sealing of the underground operations in perpetuity.
- Ensuring long term stability of the workings, prior to sealing up.
- The realisation that the workings will still “breathe”, due to daily and weather related changes in barometric pressure, and that sealing will still allow for transfer of gasses between the sealed underground workings and the surface atmosphere..
- Ability to obtain approvals from the Queensland Mines Inspectorate.

To achieve the sealing requirements, the following must be considered:

- Temporary (if required) and permanent sealing.
- Atmospheric monitoring in the sealed drifts and requirements for ensuring workings remain inert.
- Control of water during the sealing process.
- Protection of existing infrastructure external to the drifts where required.
- Inspections required prior to seal up.
- Formal Risk Assessments and sign off.

Additional detail is provided in the following sections, with approximate timing and costs for the process.

7.2. Sealing Requirements

As the drifts will be permanently sealed, a Mine Closure and Sealing plan will have to be completed. It is required to be provided to, and signed off by the Mining Inspectorate (Department of Natural Resources, Mines and Energy, QLD). The drift seals will require to

be rated to 50 psi (350kPa) for permanent sealing, as detailed in the Coal Mining Regulations (2000).

Prior to the construction of these large permanent rated seals, it will be necessary to ensure that temporary seals are in place, and the underground workings are innertised. This will allow the permanent construction teams to start work on the seals in the drifts and the outer protection seals in the portals.

Generally, as part of the closure process, positions for these permanent and temporary seals are identified in the drifts, and infrastructure in these areas is removed, while the mine workings are still ventilated.

Normally, two temporary seals are constructed, with hatches that may be closed when required, and with piping and connections to allow for innertising gasses to be pumped into the mine. The two seals (per drift) are separated to provide for a chamber, which is filled with innertising gasses. This “balancing chamber” assists with ensuring only inert gasses enter the mine, during the normal “breathing process”, significantly reducing risks of spontaneous combustion or explosions in the workings.

The temporary and permanent seals are commonly used in underground coal mines, with several contractors available to provide the material and undertake their construction.

If, following a risk assessment, it is not deemed possible to allow workers to enter the drifts behind temporary seals, there are two other options available:

- Construction of the permanent seals, with ventilation hatches installed in the seals. These seals will need to be thicker to allow for the localised weakening of the hatches. Generally seals of this type are constructed using a pumped concrete or grout as the fabric of the seal, due to the ease of use and long term stability of the materials.

  The seals are able to be constructed with the hatches open, allowing for reduced ventilation circulating through the mine. Once the seals have been completed, the hatches are manually or remotely shut and the void in the hatch is pumped full with a low shrink grout, or concrete, thus ensuring a long term rated seal.

- Construction of a backing wall with a door in both drifts and installation of filler pipes into the area. Once the construction is complete, both doors are shut and the area is pumped with a known quantity of concrete (generally a low strength of approximately 5MPa to 7MPa, until a plug of sufficient thickness has been formed to provide the required rated long term seal. Typically, due to the dip of the drifts, this type of seal (rated to 350kPa) will be approximately 12m to 20m thick at the base of the seal and thinner at the roof (approx. 3m-4m).

7.3. Lightening protection

It has been demonstrated that lightening is able to travel down a number of pathways into abandoned coal mine workings causing sparks that have led to explosions in these operations.

These pathways include old cables, metal pipes, and even steel roof support and mesh. It is therefore a requirement to ensure a significant gap in these pathways is provided. In the area of the permanent seals, all cables and pipes must be cut and removed for a distance of approximately 5m, with all roof and rib mesh removed for the same distance.

As the removal of roof mesh may lead to deterioration of the roadway, generally, these areas are filled (as part of the seal construction), with a strong non degrading fill material, which provides support to the roof and ribs.

The fill material is also able to provide the permanent sealing, thereby maximising the effectiveness of the fill.

7.4. Position of the Seals

The permanent 350kPa seals must be installed into the drifts to ensure that they will not allow for any chimney effect to surface, should the roof of the drifts collapse on the inbye side at a later stage.

8. Infrastructure

Infrastructure in the areas of the drift, where the seals are to be installed must be removed, prior to any reduction in ventilation or ventilation changes. Included for removal in these areas will be:

- Components of the conveyor system, including conveyor structure and belting.
- HT Cables and LT wiring in both drifts. This must include all supporting catenary wiring.
- Water pipes, both for supply to the mine and for dewatering (dewatering may be split at the position of the seals for possible use during construction).
- Any other inbye piping (grout, inertisation to inbye areas, stone dust etc).
- Drift lock and drift lighting cables.
- Steel support elements that connect across the areas where the seals are to be installed.
- Any ventilation ducting that may be installed during the seal construction processes.

9. Legislative Requirements

The relevant legislative acts, regulations and guidelines relating to underground mine closure are outlined in this section. These requirements will need to be complied with, and implemented for mine closure.

Prior to sealing the drifts, a seal up management plan must be provided to the inspectorate, to ensure that the process is complete and meets the requirements, under the relevant legislation.

These are listed below, with notes on the recommended process and compliance with the relevant legislation / standards.

9.1. MDG6001

Guidelines for the Permanent Filling and Capping of Surface Entries to Coal Mines.

While MDG6001 provides guidelines regarding the permanent sealing of underground coal mine workings, these are New South Wales based. No such guidelines currently exist in Queensland, however it has become common practice in Queensland to refer to Mine Design Guidelines in such circumstances.

The relevant considerations are:

- When a shaft or drift is to be sealed, a risk assessment must be completed, which not only considers the sealing and seal up process, but also the risks that may be associated with any possible future removal of the seals and re-entry into the workings.
- The drawing up and application of a detailed procedure for the sealing process, including adequate supervision.
- Provision for permanent sealing should be considered in the construction of temporary seals.

To address the guideline, a risk assessment will be required to be undertaken prior to commencing any sealing of the EDCM drifts, including the re-ventilating and re-entry. Completion of the risk assessment will confirm details of the sealing process, including the sealing and re-entry process.

9.2. Recognised Standard 09.

Monitoring of Sealed Areas. Coal Mining Safety and Health Act 1999

This Queensland standard provides guidance regarding sealing and monitoring of the atmosphere behind seals in coal mines. This will only be required during the time between completion of the temporary seals, the use of a balancing chamber and the completion of the permanent seals.

The relevant considerations are:

- Location of Monitoring points. While guidance has been provided in this report regarding the positioning of the tube bundle lines, a formal risk assessment is required to confirm the adequacy of the proposed monitoring points.
- Parameters to be monitored. While the drifts have minimal coal seam exposure, the underground workings will be subject to the full suite of underground coal mine gasses. During the time of sealing, ventilation quantities are significantly reduced, while there will still be sufficient oxygen in the underground atmosphere to allow for an explosive gas mix, or spontaneous combustion.
- The time frames for monitoring are generally relatively short and if inertisation and balancing chambers are used, these risks are reduced.
- Tube bundle or similar monitoring will still be required during the final seal up process. Gasses to be monitored include:
    - Carbon Monoxide
    - Carbon Dioxide
    - Methane
    - Oxygen
    - Hydrogen
    - Ethylene
    - and Ethane.

To ensure regular and accurate sampling of these gasses during the seal up process, it is recommended that the existing mine gas sampling and monitoring system remains in place and is connected to the correct monitoring positions, to minimise risks during construction.

- Sampling Frequency. The standard requires a frequency appropriate to the anticipated rate of change of the gas mixture behind the seal. This should be at a rate sufficient to adequately predict explosive mixtures and identify leakage.

There are four sealed area types that the guideline considers:

- Type 1. A sealed area where the atmosphere progresses from essentially fresh air Non-Explosive, to an inert atmosphere without going through the Explosion Risk Safety Zone. A subset of this type is the sealed area atmosphere that does not go inert but retains an oxygen concentration above 8% even though there is NOT sufficient methane to generate an explosive atmosphere.
- Type 2 Explosion Risk. A sealed area where the atmosphere progresses from essentially fresh air into the Explosion Risk Safety Zone.
- Type 3 Fuel Rich. A sealed area where the atmosphere has progressed from the explosive risk zone, to a point where the levels of explosive gasses are above the explosive range for that gas.(Fuel Rich atmosphere).

- Type 4 Abnormal Oxidation and/or Spontaneous Combustion A sealed area which is, or is suspected to be, undergoing abnormal oxidation and/or spontaneous combustion. Such sealed areas will interact not only with the seam gas but may liberate their own explosive mixture of gas.

9.3. Progression of works

During the sealing process, and turning off of the regular ventilation systems, it is likely that the workings will progress through from being a Type 1 zone, through to a type 3 zone, with the high risk type 2 zone, being part of this transition.

As part of the safety regime, it is recommended that the temporary seals and balancing chambers are constructed, with the ventilation system still operational, to prevent an explosive mixture of gasses forming during the construction process.

At this time, the preparation work for the final seals may also be completed, with all personnel able to work in a safe, ventilated environment.

Once the temporary seals and balancing chambers are complete, the doors may be closed and the main fans turned off. The inbye atmosphere is then remotely monitored, using the tube bundle or other systems, until a stable fuel rich (Type 3) environment forms and stabilises.

At this point it is possible for personnel to re-enter the drifts to complete the final seals and associated works. Monitoring of the inbye atmosphere will still be required during this construction process, and until the seals are signed off as having been constructed to a minimum of 50psi (350kPa) rating.

9.4. Coal Mining Safety and Health Regulation 2020-Reg 156

The site senior executive for an underground mine must ensure that the underground mine, when sealed, has facilities allowing the following:

- The use of inertisation equipment from a safe position.
- The monitoring of the atmosphere behind the seal from a safe position.

9.4.1. Remote Innertising Equipment

The ability to remotely innertise the drifts, following the construction of the temporary seals and balancing chamber, without allowing personnel to be within the possible blast zone is readily achievable. This may be done by remoting the inertisation pipeline and a duplicate bleeder pipeline to a position away from the blast zone.

As this will be ensuring inertisation of a large part of the initial underground workings, it is recommended that at least two 100mm or 150mm diameter pipes are installed in each drift for this purpose. These must be led away from the seals to a safe position on surface where they are able to be connected to the innertisation source. They must be fitted with valves to prevent gas exchange unless required.

9.4.2. Monitoring of the Atmosphere inbye of the Seals.

The use of a minimum of three tube bundle lines through each seal will ensure compliance, though it is recommended that additional lines into other parts of the workings are deployed. Three of the tube bundle lines through the seals should end at approximately 10m, 50m and 200m inbye, to provide a good picture of any explosive range fringe.

9.5. Inspectorate

The Coal Mining Safety and Health Act of 1999 requires the approval of the inspectorate for the permanent sealing of an area of the mine, or the entire mining operation. This must include a seal up management plan as part of the closure and rehabilitation plan.

A submission to the Inspectorate will be required that must include:

- A detailed description of the areas to be permanently sealed.
- All entries to be sealed and the proposed sealing methodologies described.
- Engineering designs and ratings for all sealing systems provided, including specific positioning of the seals in all openings.
- Systems and schedule for gas monitoring and inertisation.
- Results of the sealing risk assessments and Safe Work Procedures required to undertake the works in a safe and controlled manner.

A minimum of 8 weeks should be allowed for the relevant discussions with the regulator, and approvals from the inspectorate, once the necessary information has been provided

9.6. Physical Inspections Required (Prior to seal up)

Comprehensive Engineering inspections of all large mine openings, including the two drifts will be required to the start of seal up. This will include the following:

- Mechanical inspection to assess any currently installed hardware that may require removal or additional protection prior to seal up.
- De-energising of all underground electrical equipment. A specific sign off sheet will be required to ensure that this is completed as required.
- Inspection of the ground conditions and any installed support (shaft lining visual or inspection camera, drift support condition etc).
- Any monitoring instrument readings for instruments installed in the drifts or elsewhere in surface openings.
- In the drifts, stable zones must be identified for the placement of the temporary and permanent seals, as well as for the final surface protection seal. In particular, the permanent seals must be in stable ground, at a depth where it is not possible for any chimney effects to allow for connection to surface.

(generally a minimum of 5 times the effective drift diameter, or at least 30m from surface.

- Any structured zones, which must be avoided for positioning the seals.
- Water control. Any water that enters the drift above the seals will build up against the seals, unless specific one way valves are in place to allow the water to enter the mine workings.
- Correct installation of the tube bundle lines, including a check for leaks and bump testing, prior to the start of sealing operations.
- Installation of the dewatering pumps and hoses (if required), in the areas where the seals are to be built, to prevent damage to the seals during the construction process.
- Sign off on the above by a statutory official.

10. Timing and cost

An estimate of the costs and time taken to seal the drifts is provided below. This is based on actual quoted prices (2022) for the supply of components, as well as estimates of the labour costs, based on recent similar work at other operations in Australia and New Zealand.

The sealing of the two drifts, including gas and water management have been estimated to cost approximately$560,000.00. The approximate timing of 130 days may be anticipated for completion of the works.

11. Conclusion

The long term stability of the workings and any impacts due to instability of the roadways or extracted areas, manifesting on the surface topography (above that modelled by Gordon Geotechniques), are not considered to be of concern in the long term.

With longwall mining used to extract coal from all three seams, all areas inbye of the longwall face (behind the face), will have caved, allowing the roof to collapse, up to the mining extraction height.

This caving progresses almost vertically upwards behind the mining face, with the immediate and upper roof strata deforming and flexing relatively quickly and manifesting in subsidence on the surface. For a single longwall, the surface subsidence is typically approximately 60% of the original mining cut height. This decreases as the depth of mining increases, with very deep mines (+1000m) typically showing minimal subsidence on surface.

With the mining of multiple coal seams, the surface subsidence is a factor of the total extracted coal seams, though this depends on the longwall offset and other geological factors, such as strong sediments etc.

By allowing the caving to occur, the stresses on the pillars that remain are significantly reduced, allowing for very long term stability of the overall mined out areas. It is likely that a number of the roadways will collapse and fall in over the years, however with widths of typically up to 6.0m, the vertical impacts will only be to approximately 7m above the roadway roof, therefore having no impact on the overall surface subsidence.

With the progression of time, pillar collapse will occur, with some of the pillars in the deeper areas and close to the longwall take off faces being the most likely to fail. The pillars generally spall from the ribs, which then fills the roadway with broken material, providing confinement for the remnant pillars, resulting in marginal vertical deformation of the roof. In the case of Eagle Downs Mining operations, this will be in the order of 0.5m to 3.5m, and only in localised areas.

The surface impacts will be minor, as opposed to bord and pillar mining, with possible multiple pillar collapses, resulting in significantly impacts on the surface profiles, and possible fracturing through to surface creating leakage pathways.

At Eagle Downs, any pillar collapses, after sealing will not impact on the surface.

Most importantly, there will be no fracturing of the sedimentary strata above the mining horizons that will continue to surface and possibly form interconnecting pathways for gas exchange that could lead to escaping flammable gas, or ingress of oxygen and potential spontaneous combustion.

Effective sealing of the major and minor entries from surface to the workings is imperative, as that will be the major method of ensuring the above gas issues do not impact the safety and stability of the sealed mine.

Due to the depth of the workings and the design of the longwall and development, it is highly unlikely that any additional subsidence, over and above that detailed in the Gordon Geotechniques report may be anticipated.

The modelling in that report is relatively conservative and provides an over estimate of the likely subsidence. As detailed below, regular monitoring during the mining activities will allow for a regular check on the subsidence as it occurs and comparison with that modelled in the report.

While there is a small possibility of localised collapse and possible chimneying above the two portals, this is highly unlikely, due to the use of concrete arches in the upper portal and significant support in the lower areas of the portal, below the concrete arches. Failure in these zones is highly unlikely.

The placement of the final rated seal is however important, and this should be at sufficient depth that any occurrence of chimneying inbye of the seal and possible linkage to surface is negated.

Groundwater inflows will be sufficient to effectively flood the workings, over an approximate 2 to 3 year period. This will assist with stabilizing the workings, by:

- Excluding oxygen and reducing flammable gas release rates and volumes in the workings

- Increase the pore pressure and reduce the stress on the coal that form up the underground pillars
- Provide confinement of the pillars and increase their load carrying capacity
- Reduce the oxidation and weathering of the coal in the pillars, thereby increasing their anticipated life
- Prevention of spontaneous combustion of the coal when exposed to air.

The groundwater will stabilise in the workings and over time, become a net ground water source for recharge of the aquifers in the area.

11.1. Recommendations

As is good engineering practice, a review of the predictions should be conducted as any new geological/geotechnical data and subsidence monitoring becomes available. This practice can be implemented through the Subsidence Management Plan, requiring a review by a suitably qualified and experienced person.

As the future sealing of the Eagle Downs operations will occur many years in the future, it is likely that sealing methods and materials will have changed from those proposed in this document. There are however a number of points that will remain important:

- Ensuring the planning for closure and identification of all surface to working connections are noted during the mining operations, to guarantee that all are identified and sealed as part of the closure process.
- Regular monitoring of the surface subsidence. This may use survey pegs, or the larger scale and more accessible satellite INSAR SAT. Photogrammetry system. This will allow for identification of any anomalies in the subsidence profiles and ongoing comparisons with the subsidence predictions. If there are large discrepancies, this work may require updating
- Regular monitoring of groundwater inflows and quantities pumped, to ensure these are available for any groundwater studies required as part of the ongoing mining activities and for the final closure plans
- Consideration of the long term stability requirements for any materials used for sealing of the mining operations. Currently, cement based products are used, as these, when used correctly, have been shown to provide long term stable sealing solutions.
- Confirming the position / placement of the seals in each of the roadways or other surface to working connections. The seals must not be placed too close to the surface, as deterioration of the material above the seals may occur, leading to interconnection at a later date.

  A minimum of 50m below surface is recommended for the placement of the final seals, however this will have to be determined and signed off on by a RPEQ geotechnical engineer, following an assessment of the stability of each mine entry.

- Ensuring the construction position for seals is in a geotechnically stable area to prevent failure around the seal, again, possibly leading to an interconnection at a later date. This will form part of the Geotechnical Engineer sign off
- Constructing of stable, strong seals at the portals. These do not require rating, however a guide is to use a minimum of 70kPa seals for this closure work. These seals are in place to prevent any unauthorised access to the abandoned workings.

  This may be in the form a large plug type seal, starting deeper in the access drifts and completed to surface, combining both functions for sealing and access prevention, or a separate final rated seal, situated deeper into the access drift and then a separate surface closure seal.
- Provision of an inspection and sign off system to ensure all openings to surface are identified, sealed off as required and signed off by a statutory official as part of the sealing plan
- Provision of a management and monitoring plan for the sealed workings. Typically, this includes:
  - Some form of tube bundle or similar system that will allow the atmospheric conditions in various parts of the mine to be monitored in perpetuity. (Monitoring may consist of bag samples or more sophisticated methods may be required).
  - A monitoring regime, ensuring that the required samples are taken, tested and the information conveyed to the correct authorities on a regular basis and in a timely manner. The sampling regime will typically start with regular short term (days or weeks) sampling, and once the underground environment is inert, this is extended to 6 monthly or annually.
  - The adoption of a Triggered Action Response Plan for the monitoring of the underground workings. This will ensure that the correct responses are made, should any of the pre-defined triggers be exceeded
  - Inertisation pipelines and control equipment is provided in the final seals that will allow for inert gasses to be pumped into the workings, should the monitoring indicate non optimal behavior of the underground atmosphere
- Completion of all works identified by the Mining Inspectorate as part of the closure and sealing plan
- The naming of a responsible entity, who will be tasked with the monitoring and control of the abandoned workings in perpetuity.

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13. Appendix

Table 8 Recommended support for roadways and intersections. HCU, HCL and DY seams

Support Type	Mains Driveage	Gateroad Driveage	Secondary Support	Cut Throughs
Roof Bolts	2.1m fully encapsulated X grade bolts. 6 bolt pattern on 1.0m spacing	2.1m fully encapsulated X grade bolts. 6 bolt pattern on 1.0m spacing	Spot Bolts as required	2.1m fully encapsulated X grade bolts. 6 bolt pattern on 1.0m spacing
Roof Mesh	1.2m x 4.8m steel mesh sheets. Effective 1.0m spacing	1.2m x 4.8m steel mesh sheets. Effective 1.0m spacing	Installed on development	1.2m x 4.8m steel mesh sheets. Effective 1.0m spacing
6m/8m Grouted Cables	Only in areas of structural weakness	Across all cut through intersections	2 cables on a 2.0m spacing for entire length of tailgate	As required by monitoring or inspections
Standing Support	Not required	Installed in Maingate cut throughs as required	In Tailgate as part of longwall startup and in weaker zones	Installed in Tailgate cut throughs
Rib Support	Two 1.5m bolts into each rib on a 1.0m spacing. Added bolt where height over 3.8m	Two 1.5m bolts into each rib on a 1.0m spacing. Added bolt where height over 3.8m	Longer rib bolts as required in weaker areas. Cutable bolts on block side in all gate roads	Additional bolts in cut through if required by poor conditions
Rib Mesh	Steel rib mesh for all belt and travel roads	Steel rib mesh for all belt and travel roads	Cutable mesh on block side where conditions are poor	May require steel mesh for cut throughs in poor ground

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Final 28.5.16.pdf

Type C seal Pike River 19.1.17.pdf

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Grasstree 2.75m Shaft sealup.Rev2.pdf

GT.DRG.5.4.20.Rev1.pdf

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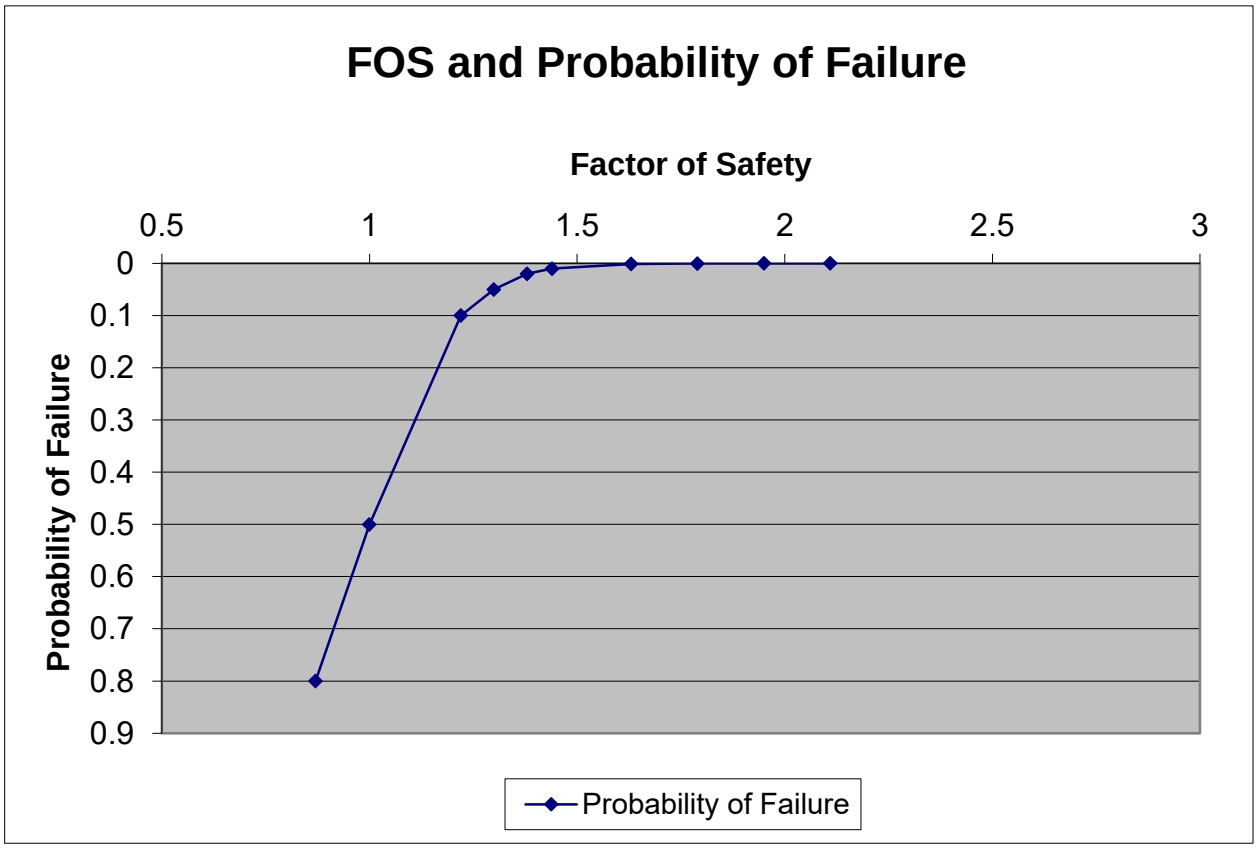


Figure 13.1 Graph of Failure vs FoS for pillar design

Table 9 Table of probability of failure vs FoS for pillar design

Factor of Safety	Probability of Failure	Odds
0.87	Greater Than 0.8	Almost Certain
0.87	0.8	8 in 10
1	0.5	5 in 10
1.22	0.1	1 in 10
1.3	0.05	5 in 100
1.38	0.02	2 in 100
1.44	0.01	1 in 100
1.63	0.001	1 in 1,000
1.79	0.0001	1 in 10,000
1.95	0.00001	1 in 100,000
2.11	0.000001	1 in 1,000,000
2.12	Less than 0.000001	Less than 1 in 1,000,000

Appendix L. Subsidence Prediction Report

GORDON GEOTECHNIQUES PTY LTD
ACN 127 420 839

DRAFT

SUBSIDENCE PREDICTION REPORT FOR THE EAGLE DOWNS UNDERGROUND PROJECT

Prepared for Eagle Downs Coal Management Pty Ltd

NOVEMBER 2021

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List of Abbreviations

AHD - Australian Height Datum
ALPS - Analysis of Longwall Pillar Stability
ASL - Above Sea Level
EIS - Environmental Impact Statement
FLAC - Fast Lagrangian Analysis of Continua
GGPL - Gordon Geotechniques Pty Ltd
LOMS - Limit of Measurable Subsidence
SDPS - Surface Deformation Prediction System
S_{max} - Maximum Subsidence

Glossary

Angle of Draw	The angle of inclination from the vertical of the line connecting the goaf edge of the underground workings and the limit of measurable subsidence.
Aquifer	A saturated, permeable, geologic unit that can transmit significant quantities of ground water under ordinary hydraulic gradients and is permeable enough to yield economic quantities of water to wells.
Chain Pillar	The block of coal left unmined between the longwall extraction panels.
Compensation Width	Distance from the rib edge to the inflexion point or point of half the maximum subsidence.

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Empirical	Based or acting on observation and experiment, not on theory.
Floor	Strata immediately below the extracted seam.
Goaf	That part of a mine from which the coal has been partially or wholly removed.
Groundwater	The supply of fresh water found beneath the ground surface, usually in aquifers, which supply wells and springs.
Hydrogeology	The branch of geology dealing with the waters below the earth's surface and with the geological aspects of surface waters.
Influence Function	A type of function used to solve inhomogeneous differential equations subject to specific initial conditions or boundary conditions.
Longwall Mining	A form of underground coal mining where a face of coal is mined in a single slice.
Maingate	The gateroad in which the longwall panel conveyor is installed.
Modulus	The ratio between applied stress and resultant strain.
Overburden	Sequence of strata above the extracted seam.
Pillar	Coal that is not extracted within the underground workings.
Roof	Strata immediately above the extracted seam.
Stratigraphy	A branch of geology that studies rock layers and layering. It is primarily used in the study of sedimentary and layered volcanic rocks.
Subsidence	Sinking or settlement of the land surface, due to any of several processes. As commonly used, the term relates to the vertical downward movement of natural surfaces although small-scale horizontal components may be present. The term does not include landslides, which have large-scale horizontal displacements, or settlements of artificial fills.
Strain	Relative change in the volume, area or length of a body as a result of stress. The change is expressed in terms of the amount of displacement measured in the body divided by its original volume, area, or length, and referred to as either a volume strain, areal strain, or one dimensional strain, respectively. The unit measure of strain is dimensionless, as its value represents the fractional change from the former size.
Tailgate	Roadway on the other side of the longwall panel to the Maingate.
Tilt	The rate of change in vertical subsidence between two points divided by the horizontal distance between those two points.
Voussoir Beam	A single beam with vertical joints.

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1 INTRODUCTION

Gordon Geotechniques Pty Ltd (GGPL) was commissioned to complete a subsidence assessment as part of the Environmental Impact Statement (EIS) being prepared for the Eagle Downs underground project.

1.1 Project Description

The Eagle Downs underground project is located in the Bowen Basin, adjacent to the existing Peak Downs open cut mine, approximately 25 km south-east of Moranbah (**Figure 1**). The project involves the extraction in descending stratigraphic order of the Harrow Creek Upper (HCU), the Harrow Creek Lower (HCL) and Dysart (DY) seams.

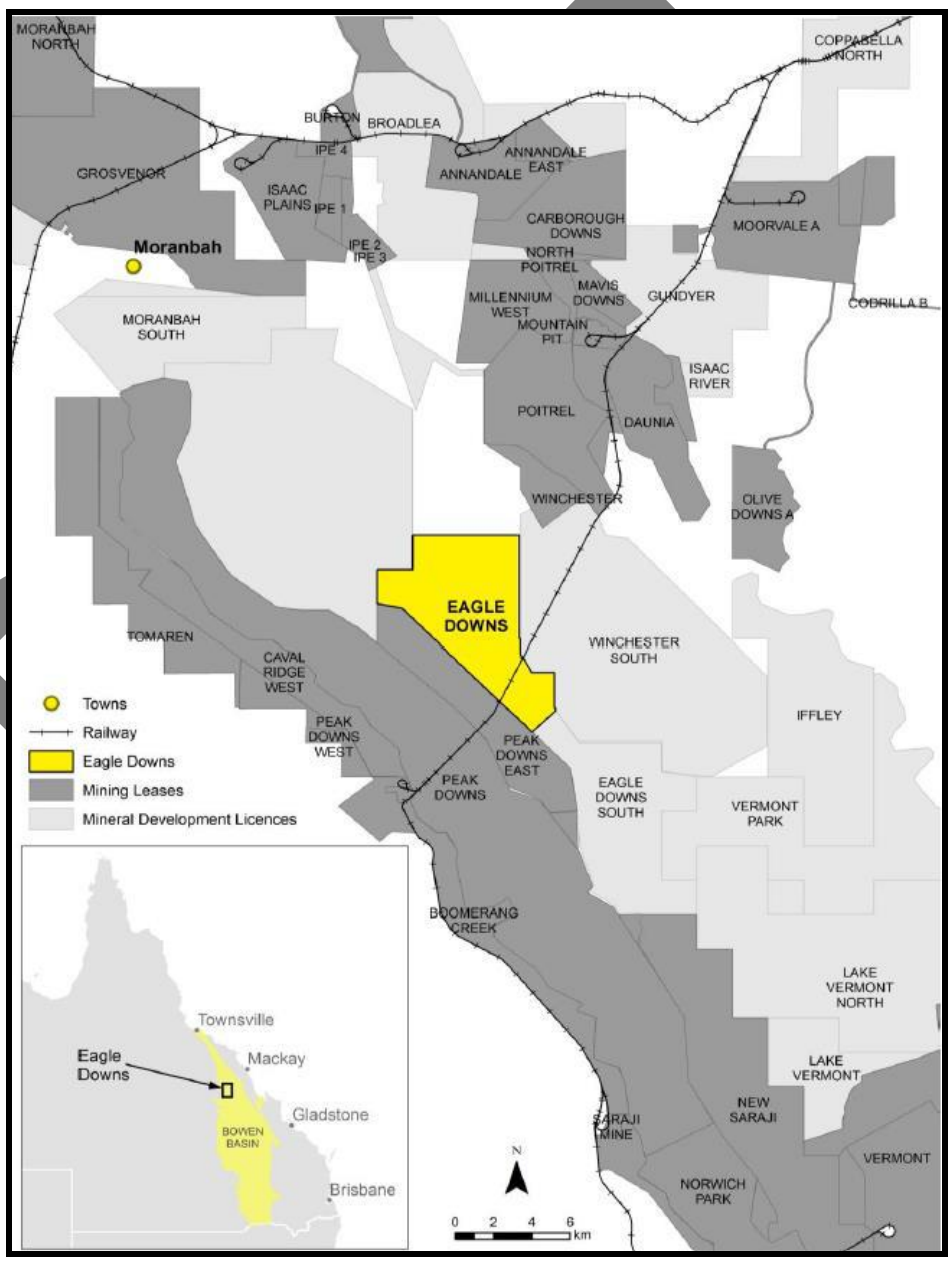


Figure 1. Location Plan (South32, 2020).

The Project area is 2 km to the east and down-dip of the Peak Downs open cut mine operated by the BHP Billiton Mitsubishi Alliance (**Figure 1 and Figure 2**). Queensland Rail's Norwich Park branch railway passes through the southern end of the MLA (**Figure 1 and Figure 2**).

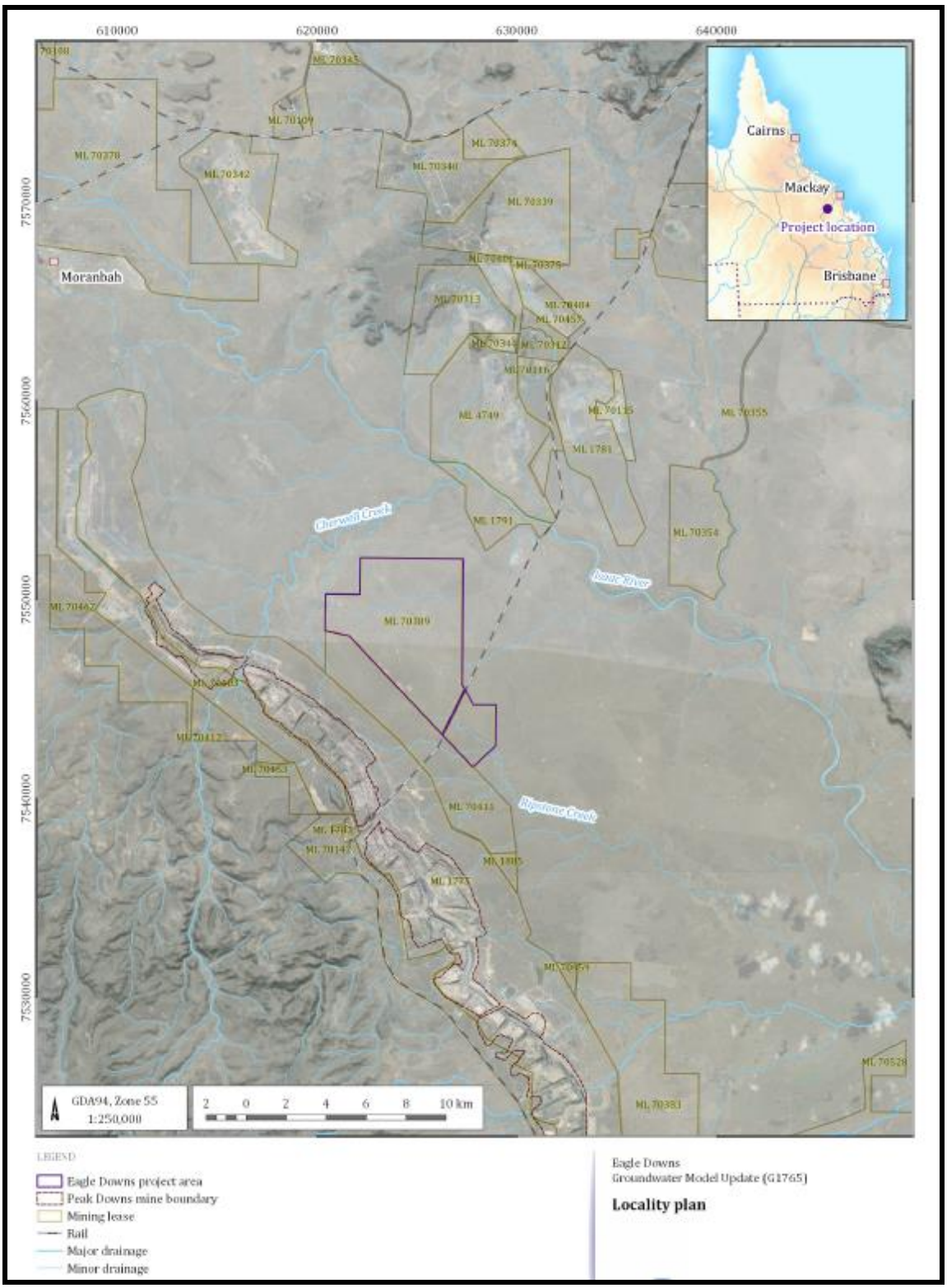


Figure 2. Regional Location Plan (AGE, 2016)

1.2 Scope of Work

This report includes the development of subsidence predictions and an assessment of subsidence effects for the Eagle Downs longwall mining operations, in all three target seams (**Figure 3**).

When interpreting **Figure 3**, it should be highlighted that the Dysart Seam chain pillars (blue) directly underlie the Harrow Creek Upper Seam chain pillars (orange). The Harrow Creek Lower Seam chain pillars (light blue) are offset from the overlying Harrow Creek Upper Seam chain pillars by between typically 40-130 m (**Figure 3**).

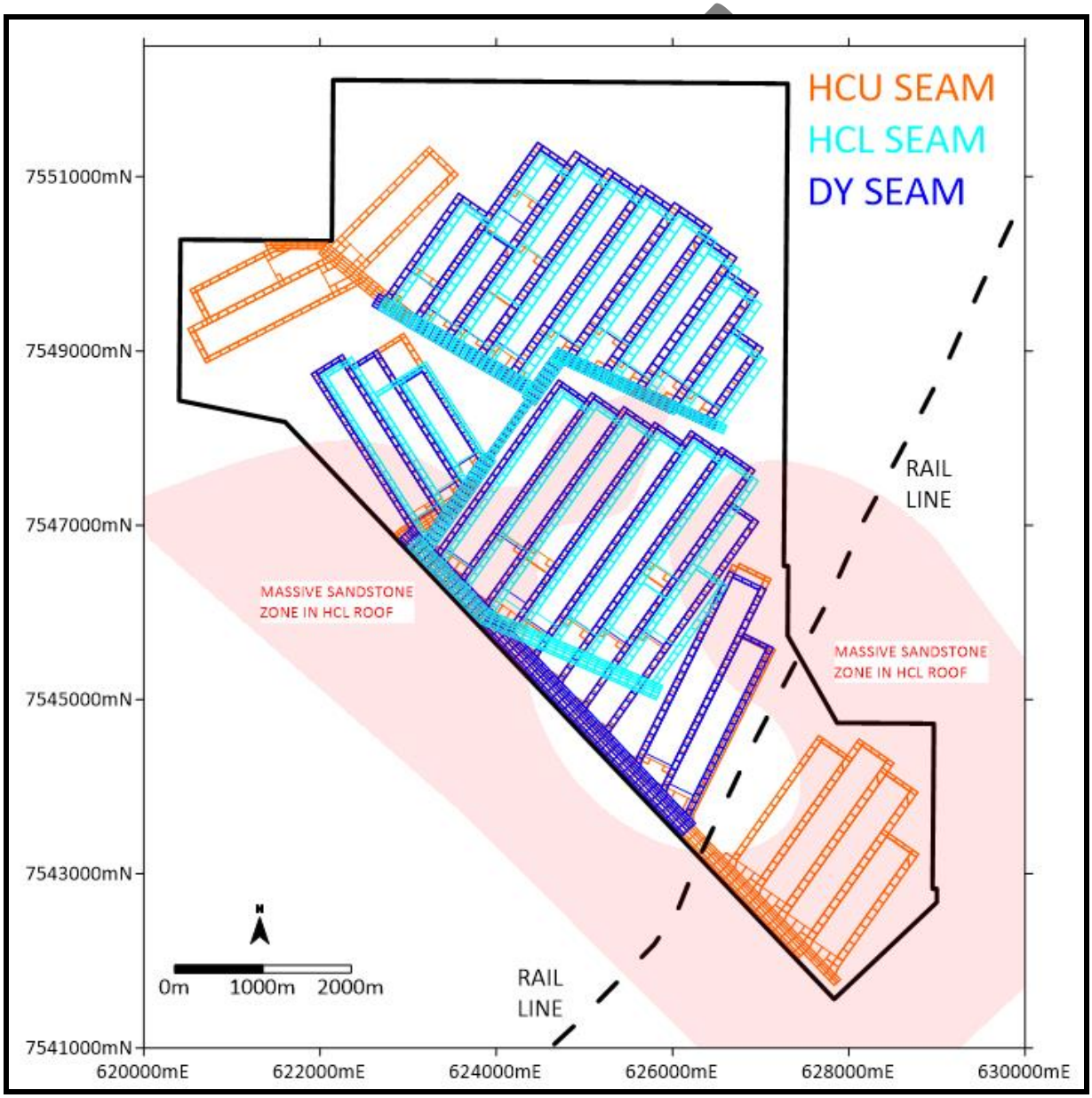


Figure 3. Longwall Panel Layout.

The required scope of work to complete the subsidence study for the Eagle Downs underground project includes the following:

- Generate subsidence predictions for the underground panels after extraction of each seam.
- Provide digital subsidence contours in dxf or dwg format including a contour line for the limit of measurable subsidence.
- Description of the project mine plan and geology.
- Detailed description of the subsidence prediction methodology and any associated limitations and limits of accuracy.
- Description of the predicted subsidence effects including:
    - The nature of the subsidence predictions including vertical subsidence, strains and tilts.
    - The nature and extent and location of predicted surface cracking.
    - The nature and extent of subsurface strata cracking and associated effects on strata permeability.
    - Assessment of potential for hydraulic connectivity to the surface due to subsurface cracking.
- Preparation of a report.

1.3 Mine Layout

Top coal caving longwall mining is planned in the Harrow Creek Lower and Dysart seams (**Figure 3**). Due to the thickness of the Harrow Creek Upper Seam, single pass longwall extraction only is planned (**Figure 3**).

In some parts of the Harrow Creek Lower Seam mining area, the top coal caving is planned to be turned off due to the occurrence of massive sandstone strata in the overburden (**Figure 3**).

The majority of longwall panels in all three seams are 330 m wide (rib to rib). Several panels have been narrowed to 300 m wide (rib to rib) to maximise recovery between the faults and one panel in the Harrow Creek Lower Seam is 280 m wide (rib to rib).

The chain pillars vary from 39 m wide (solid dimension) in the shallowest part of the area, up to 85 m wide (solid dimension) in the deepest part of the area (**Figure 3**).

As shown in **Figure 3**, there are various combinations of longwall extraction, ranging from single seam of either the HCU, HCL and DY seams, to extraction of all three seams. In some areas, either the HCU and DY seams or HCL and DY seams only are mined (**Figure 3**). These different combinations have been considered in the subsidence modelling presented later in this report.

1.4 Topography

The Eagle Downs mining area is located between the northern part of the Harrow Range to the west and the Isaac River to the east (AGE, 2008). The topography consists of gently undulating terrain with an overall gradient to the east, towards the Isaac River (**Figure 4**).

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Local relief ranges from about 245 m (AHD) in the west, to 200m (AHD) in the east, with a number of small ephemeral gullies draining the area (**Figure 4**). Some gullies drain to Cherwell Creek, which is to the north of the northern boundary of the MLA. This creek flows in an easterly direction to discharge into the Isaac River. (AGE, 2008).

Other gullies drain east and dissipate before reaching the Isaac River. The most southerly gully draining the MLA flows to the south-east and further downstream to the Isaac River (**Figure 4**).

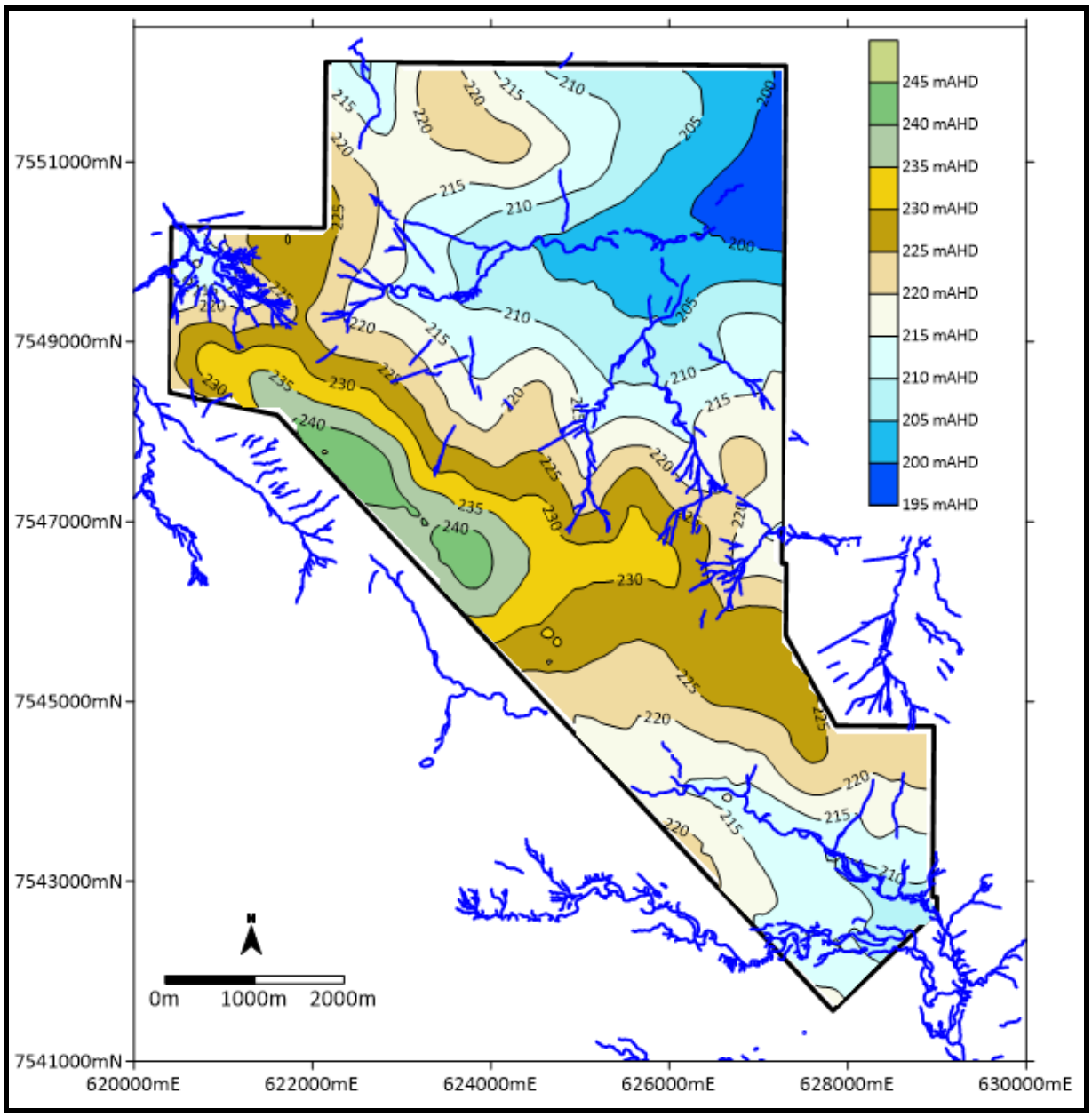


Figure 4. Surface Topography and Drainage Lines (m AHD).

The area has been extensively cleared for cattle grazing, with only minor areas of woodlands remaining (**Figure 5**).

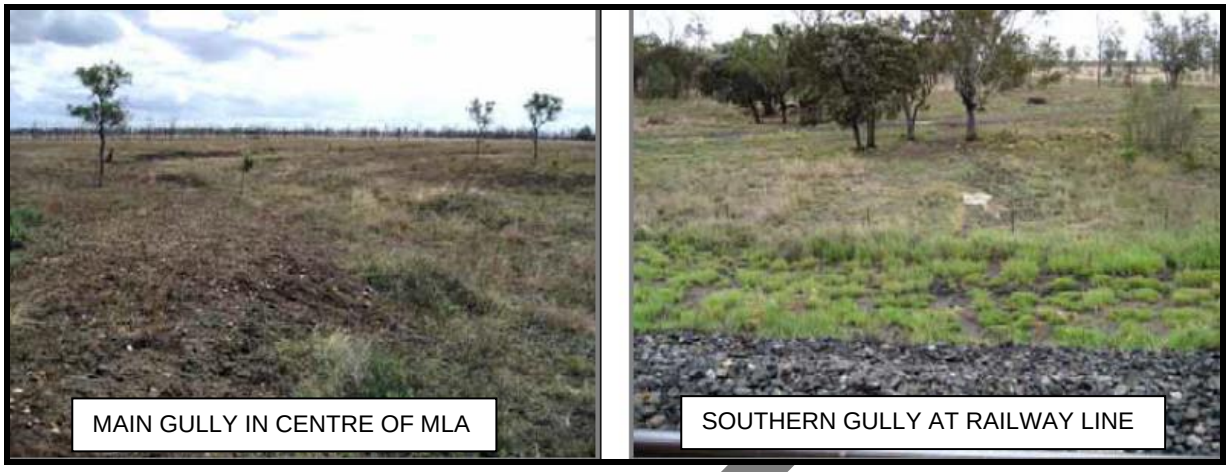


Figure 5. Photographs of Gullies and Surface Topography (AGE, 2008).

1.5 Report Structure

Section 1 of this report introduces the project, including the Eagle Downs longwall layout, and the project setting.

Section 2 details the engineering geology, stratigraphy, depth of cover and coal seam thickness.

Sections 3, 4 and 5 describe the subsidence assessment methodology, subsidence predictions and potential subsidence effects of the project, respectively.

Section 6 provides the key conclusions of the subsidence assessment.

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2 ENGINEERING GEOLOGY

2.1 Geological Data

The Eagle Downs longwall mining area is covered by closely spaced drill holes undertaken as part of successive exploration drilling programs, as shown in **Figure 6**. These drill holes record the geological sequence of the overburden and coal seams, as well as the sediments immediately below the target seams.

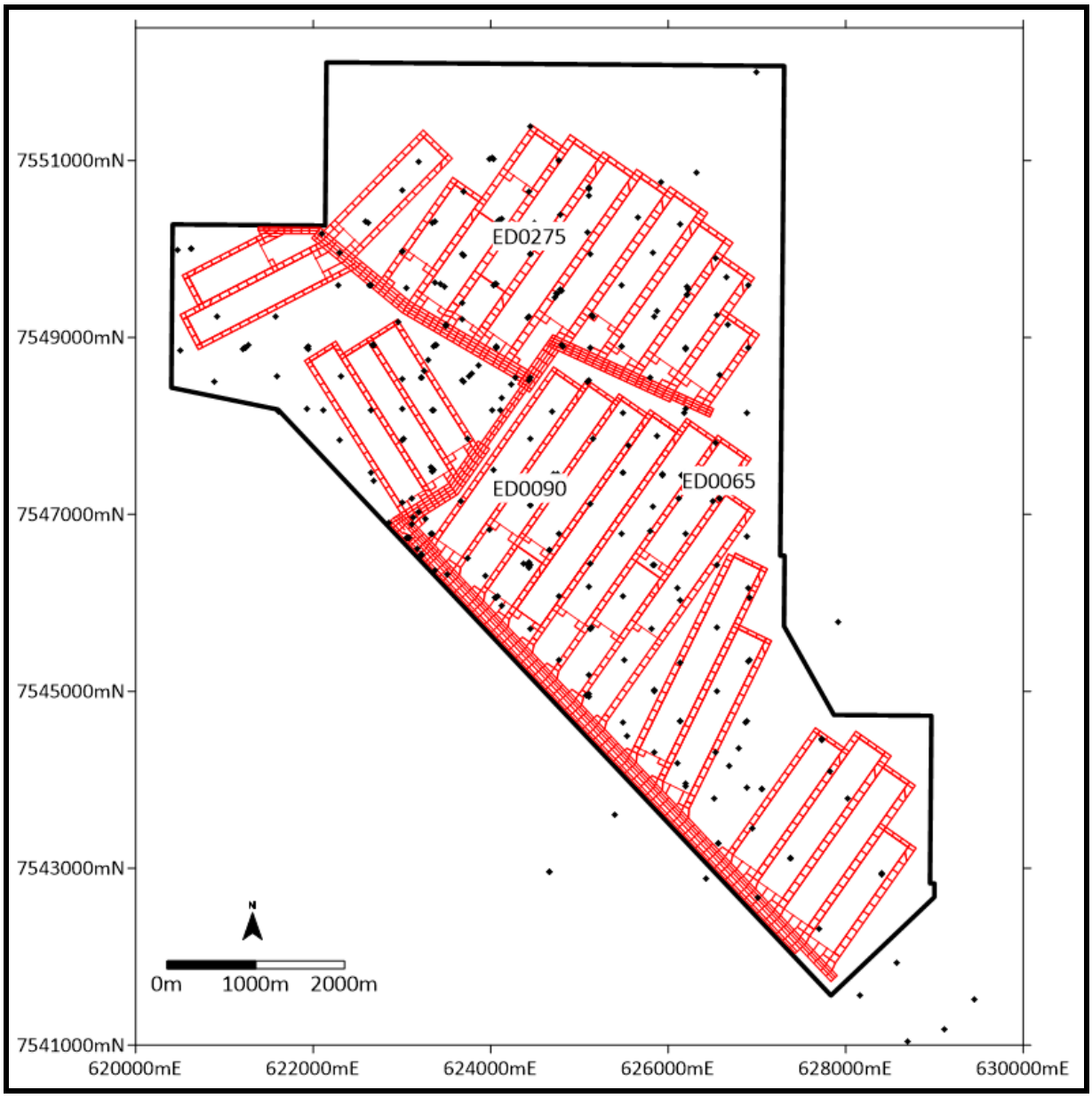


Figure 6. Location of Exploration Boreholes.

Geophysical logs are also available in the majority of the boreholes and provide additional data on the rock and coal seam properties. This density of data provides a high level of confidence in the geological variables used as inputs into the subsidence models for the Eagle Downs longwall mining area.

2.2 Geology Overview

2.2.1 Stratigraphy

The Eagle Downs underground area is located in the northern part of the Bowen Basin to the west of the Nebo Synclinorium. The target coal seams are in the Moranbah Coal Measures, which are overlain by the Fort Cooper Coal Measures (**Figure 7**). The Fort Cooper Coal Measures are unconformably overlain by a thin veneer of unconsolidated to semi-consolidated Tertiary sediments and localized unconsolidated Quaternary sediments (**Figure 8**).

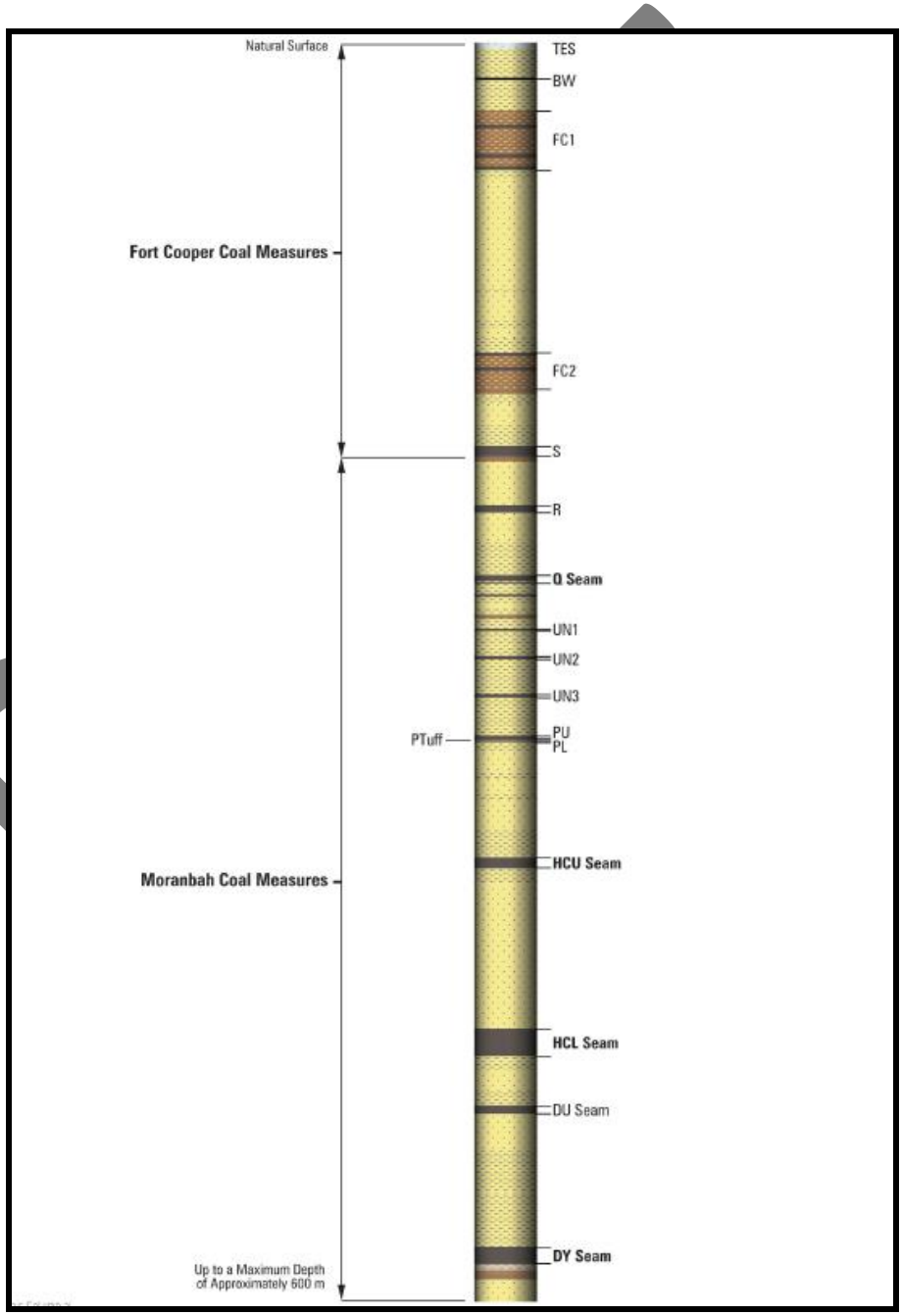


Figure 7. Regional Stratigraphy (IMC, 2008).

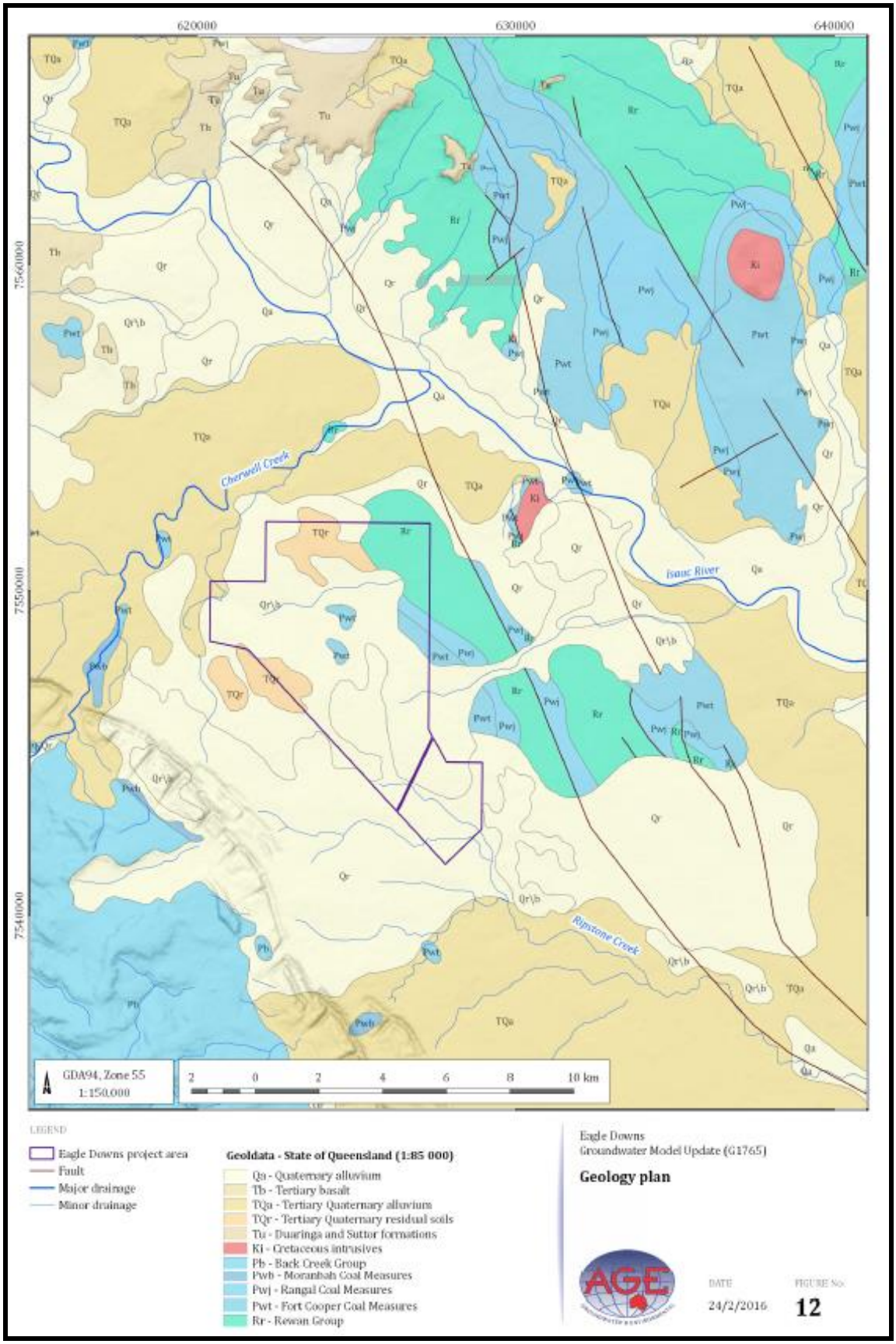


Figure 8. Regional Geology Plan (AGE, 2016).

2.2.2 Depth to Weathering

The weathering profile includes the Tertiary sands and clays, as well as weathered Permian strata. The depth of weathering is typically between 10 to 30 m above the proposed mining area (**Figure 9**).

There is a shallow aquifer associated with the upper weathered zone of the Fort Cooper Coal Measures, however the groundwater yield from this shallow aquifer is quite low (AGE, 2008).

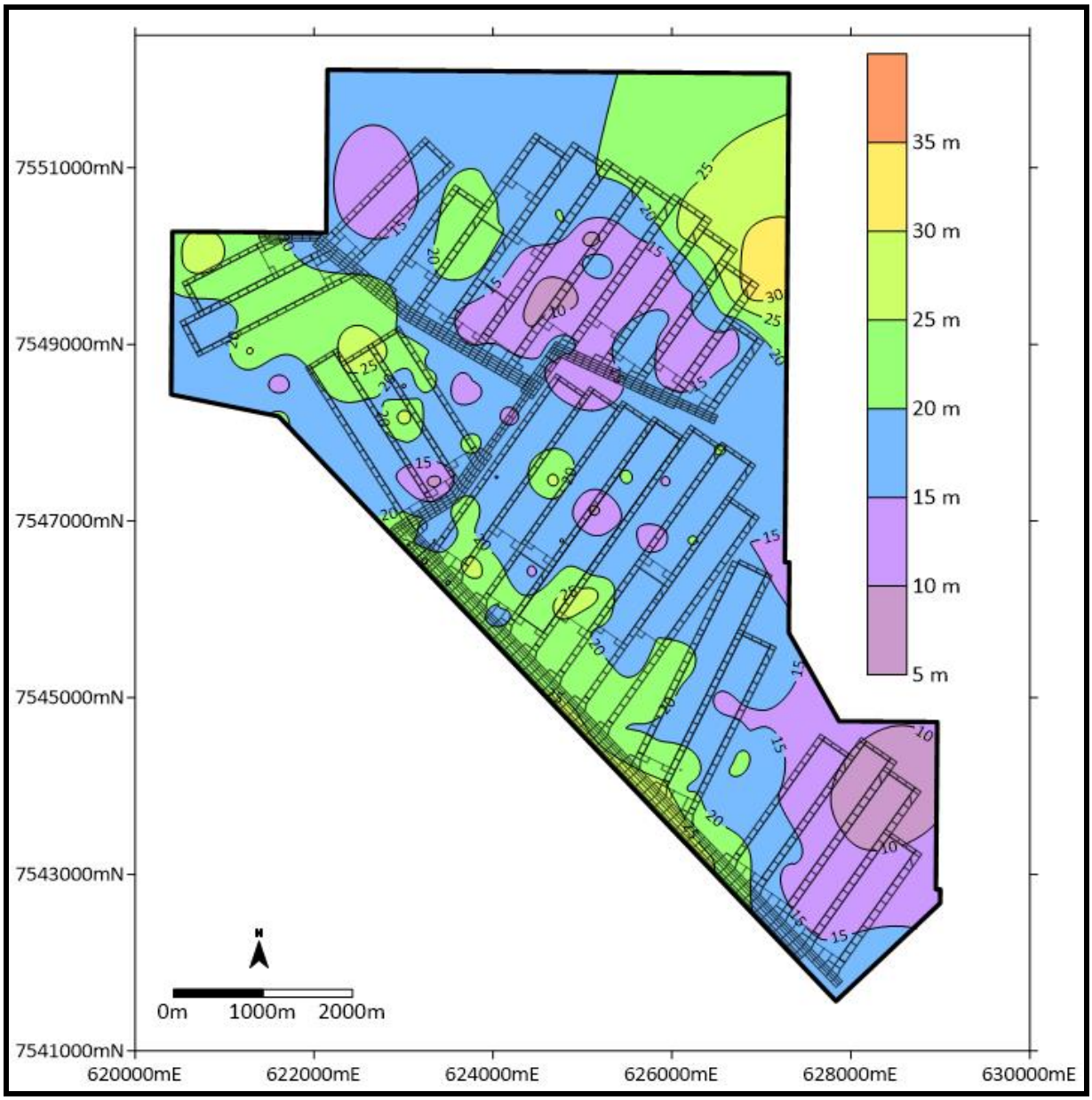


Figure 9. Depth of Weathering (m).

2.2.3 Tertiary

The Tertiary sediments in the Eagle Downs mining area are thin and are typically <4 m thick over the proposed longwall panels (**Figure 10**).

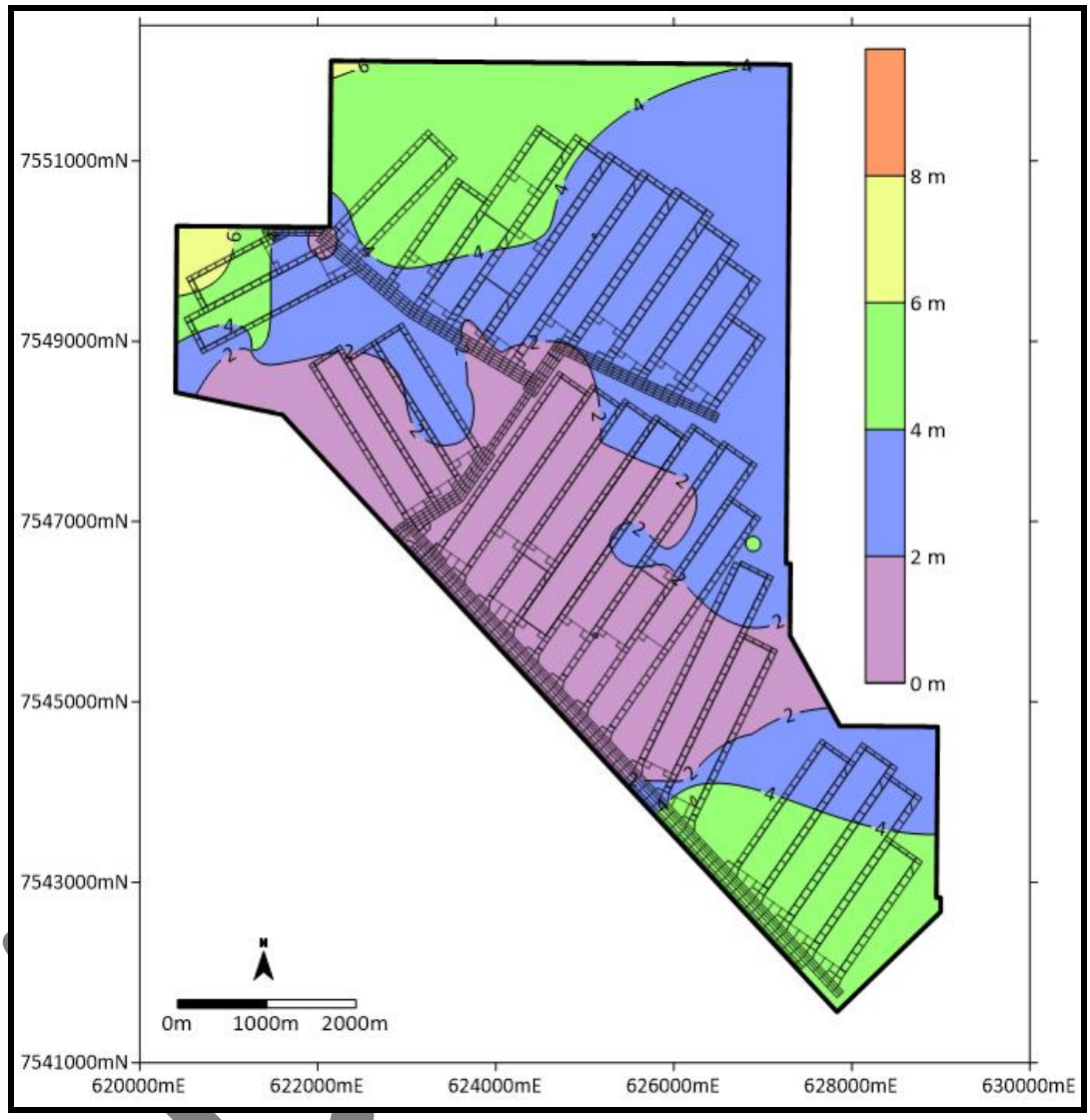


Figure 10. Thickness of Tertiary Sediments (m).

2.2.4 Target Coal Seams

2.2.4.1 Seam Thickness

In the proposed Eagle Downs longwall area, the Harrow Creek Upper Seam is typically 3.5-5 m thick (**Figure 11**). The planned cutting range of the longwall in this seam is 3.5-4.2 m.

Longwall panels in the underlying Harrow Creek Lower Seam are in an area where the seam thickness is 7-9.5 m thick and amenable to Longwall Top Coal Caving

(LTCC). Maximum equivalent recovery heights are up to 7.1 m for an 80% cave recovery.

In those areas where massive sandstone occurs above the Harrow Creek Lower Seam, the LTCC may be turned off during longwall retreat (**Figure 3**). In these areas, 3.5 m of coal will be extracted.

In the underlying Dysart Seam, the thickness ranges from 3.5-5.5 m (**Figure 11**). Longwall extraction is planned at 3.5 m, with some areas thick enough for LTCC.

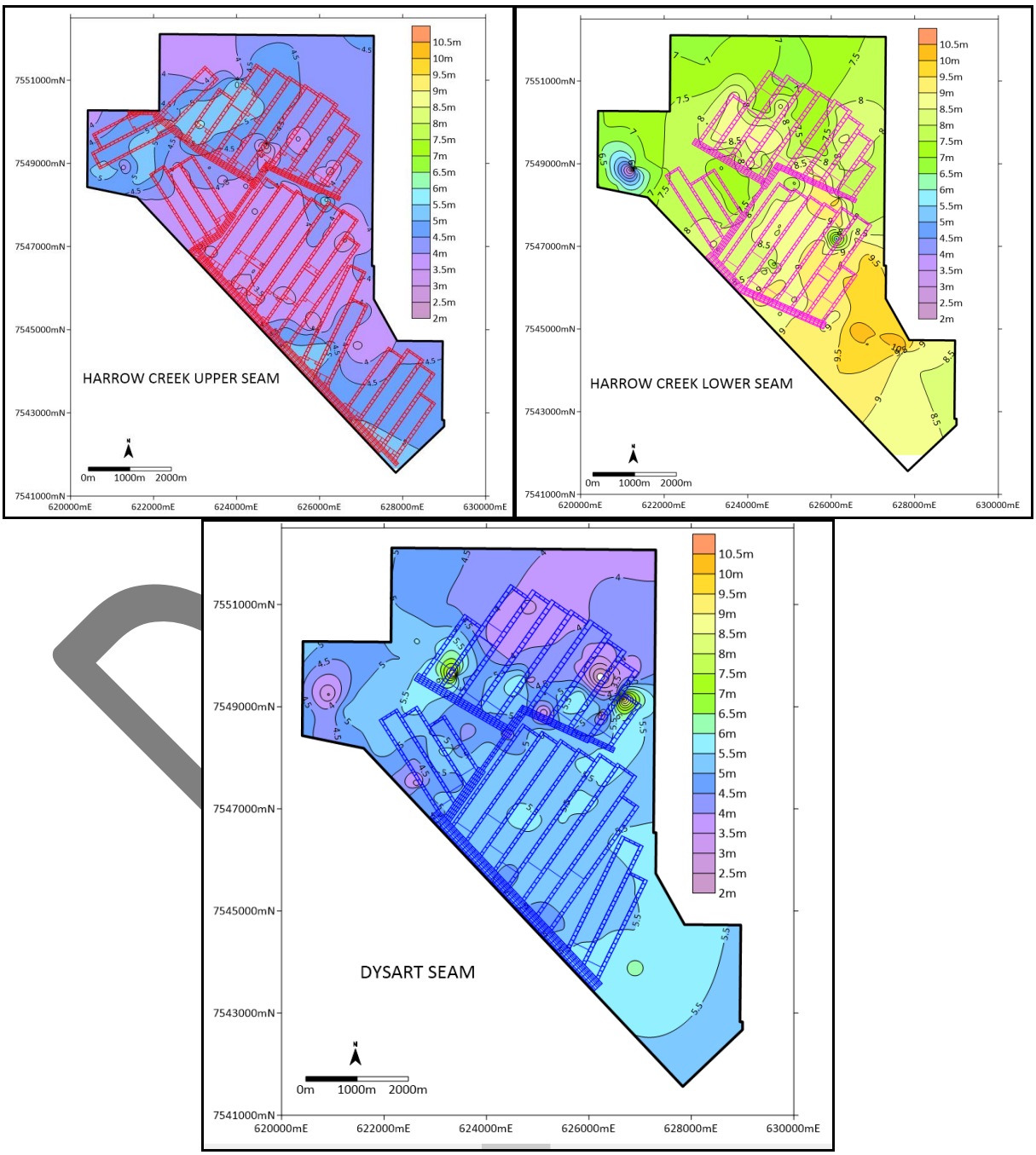


Figure 11. Seam Thickness (m).

2.2.4.2 Depth of Cover

Longwall extraction in the Harrow Creek Upper Seam is planned at depths ranging from 270 m in the western part of the area and approaching 650 m in the north-eastern part of the underground area (**Figure 12**).

Depths in the underlying Harrow Creek Lower and Dysart seams exceed 700 m and 800 m respectively in the deeper north-eastern part of the area (**Figure 12**).

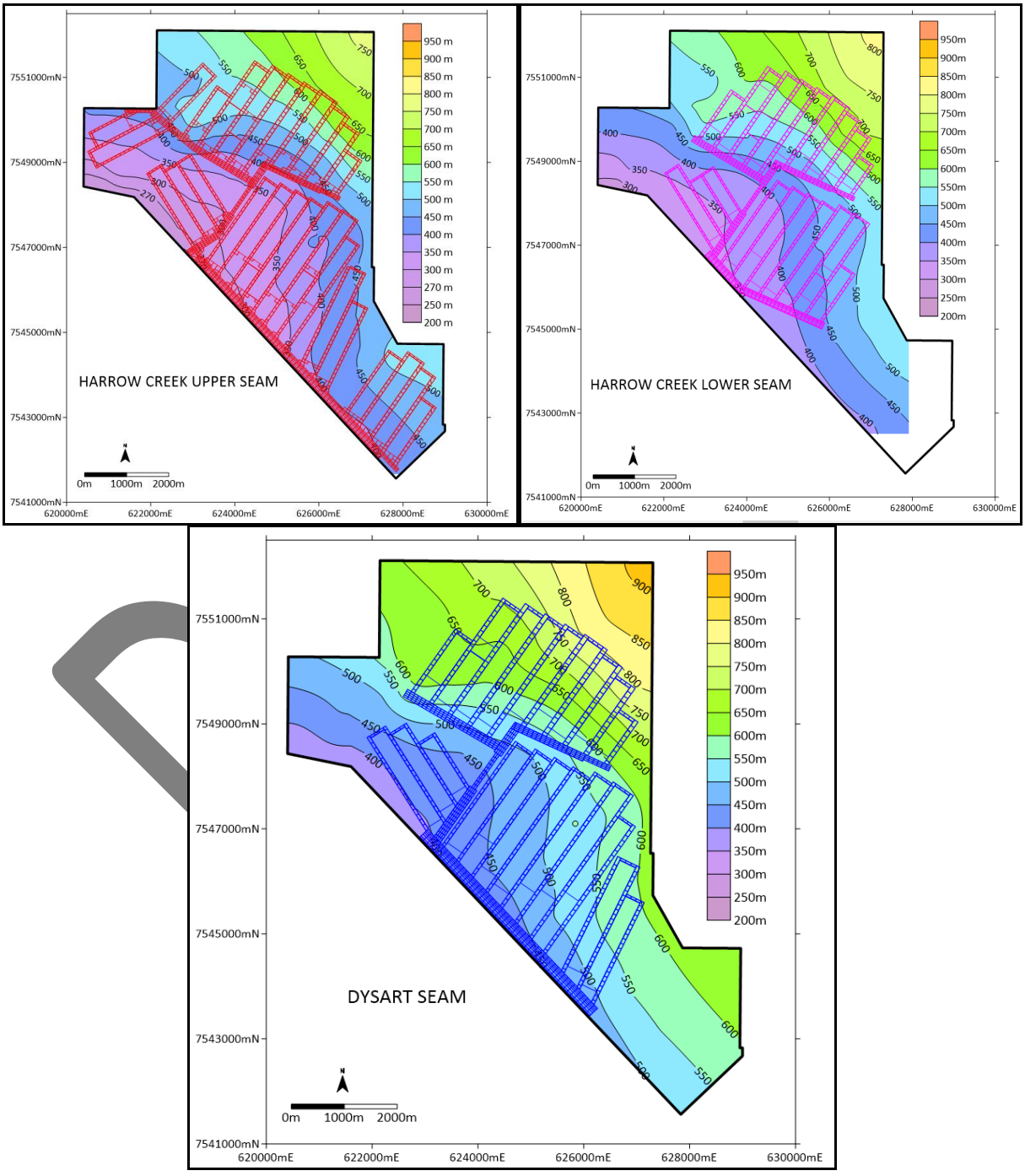


Figure 12. Depth of Cover (m).

2.2.4.3 Interburden Thickness

The interburden between the Harrow Creek Upper and Harrow Creek Lower seams is typically 40-60 m in the proposed mining area (**Figure 13**). To the northwest, the interburden thins locally to <35 m (**Figure 13**). Similarly, the interburden thins rapidly towards the southeast, where the two seams coalesce (**Figure 13**).

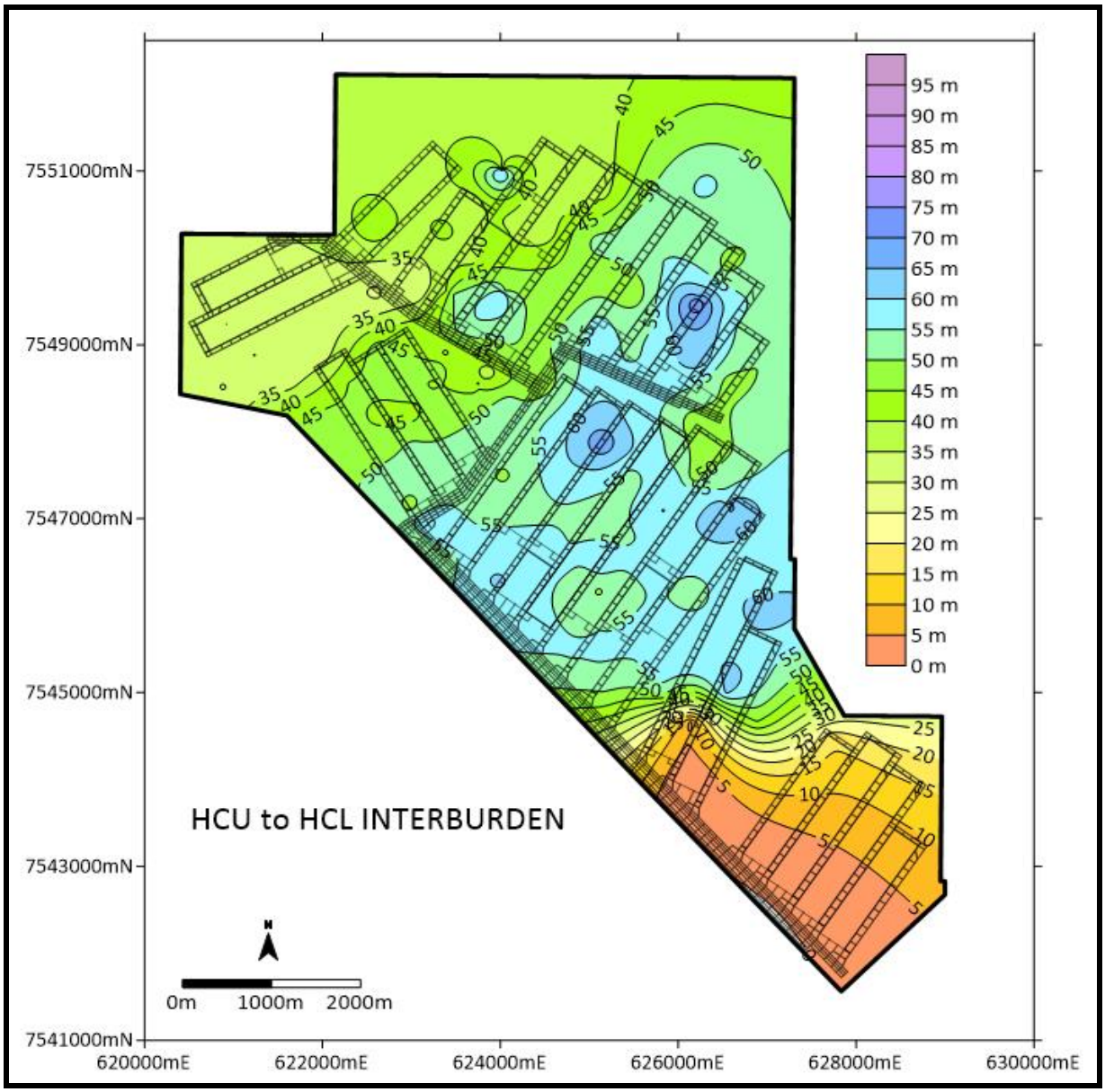


Figure 13. Interburden Thickness between Harrow Creek Upper and Lower Seams (m).

The interburden between the Harrow Creek Lower and Dysart seams is typically 60-80 m in the majority of the planned mining area (**Figure 14**). Localised thinning and thickening of the interburden occurs towards the west and northeast respectively (**Figure 14**).

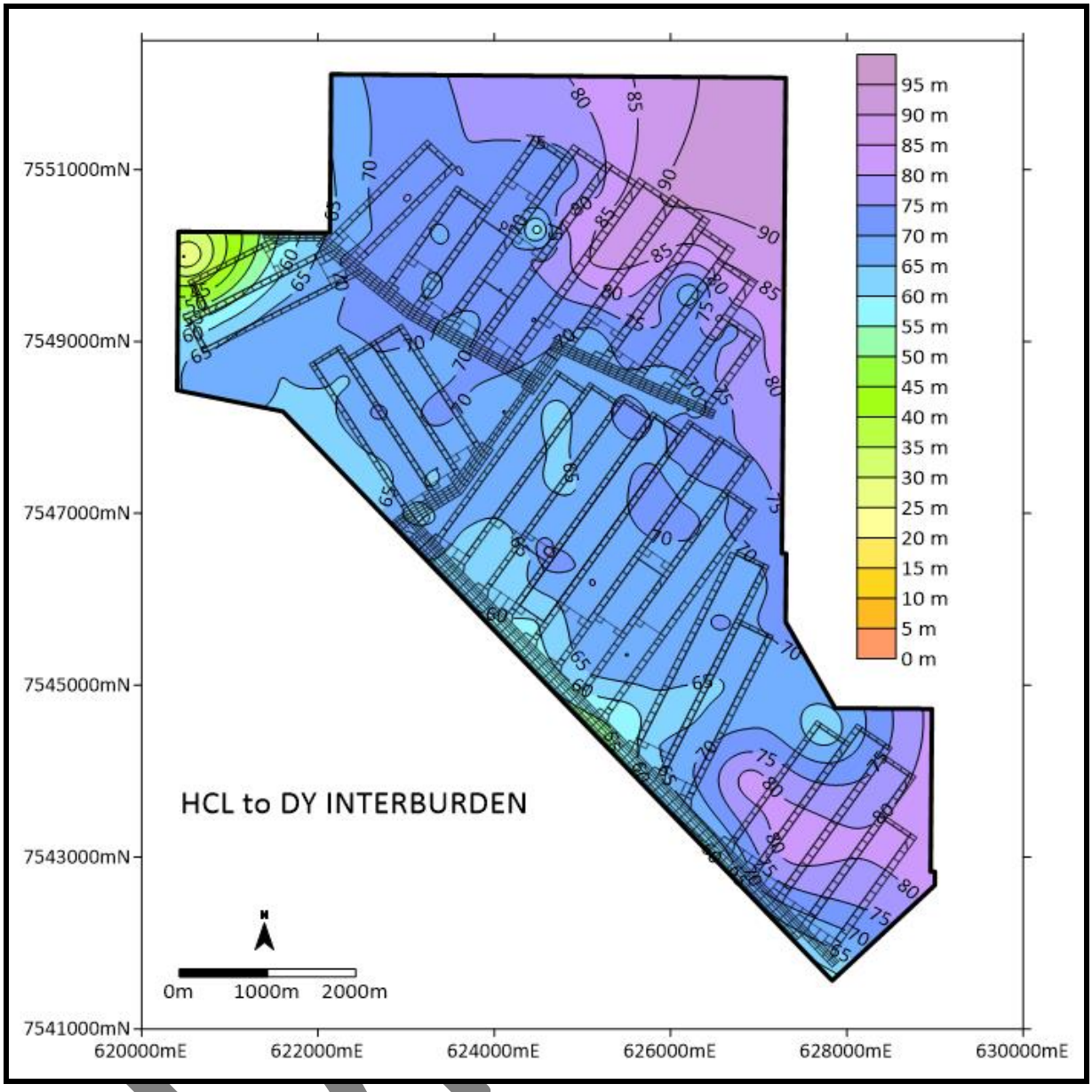


Figure 14. Interburden Thickness between Harrow Creek Lower and Dysart Seams (m).

2.2.4.4 Seam Levels

All three target seams dip towards the northeast, at an average grade of around 1 in 10 (**Figure 15**).

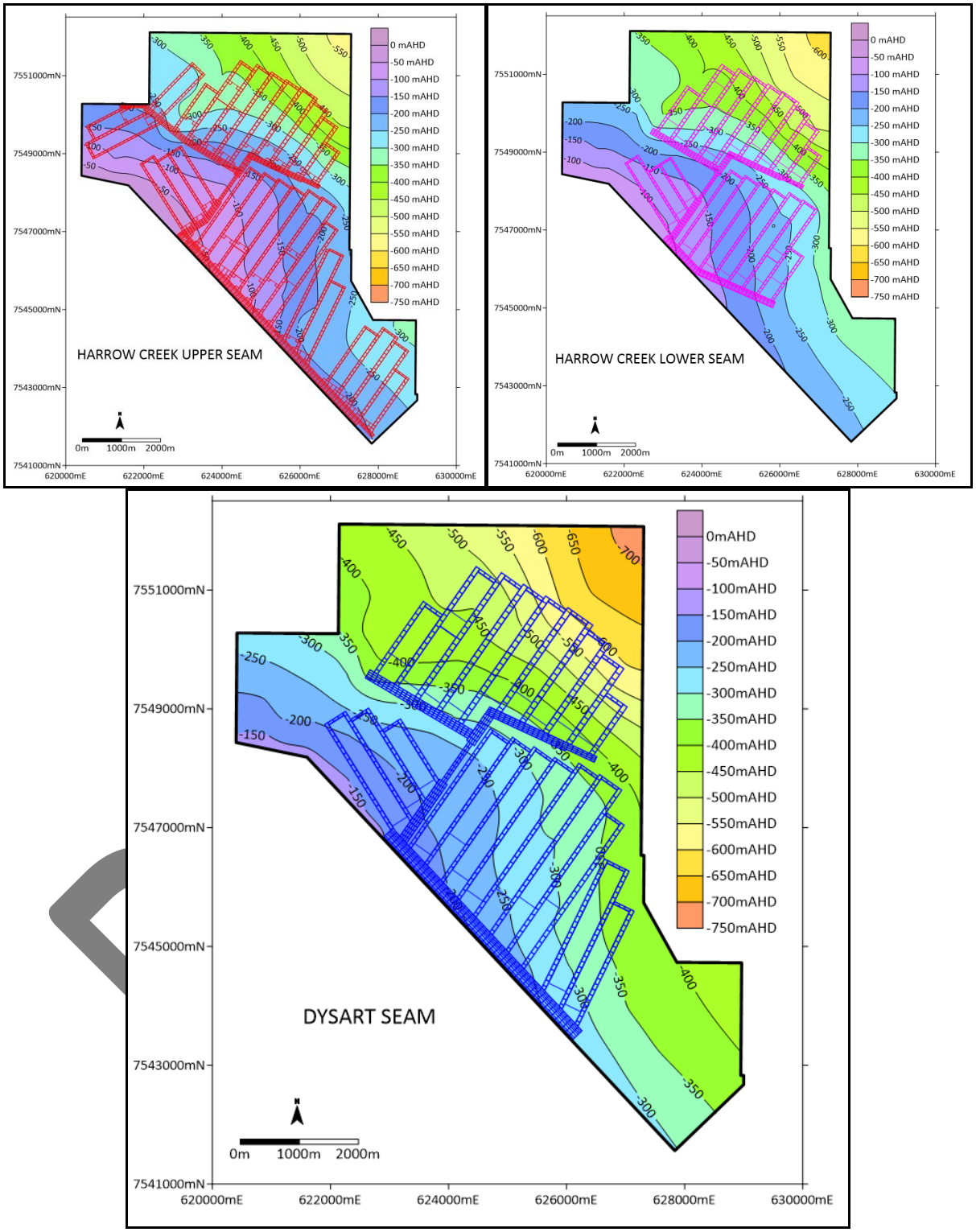


Figure 15. Seam Floor Levels (m AHD).

These characteristics are also evident in the 3D surface plot of the Harrow Creek Upper Seam (**Figure 16**).

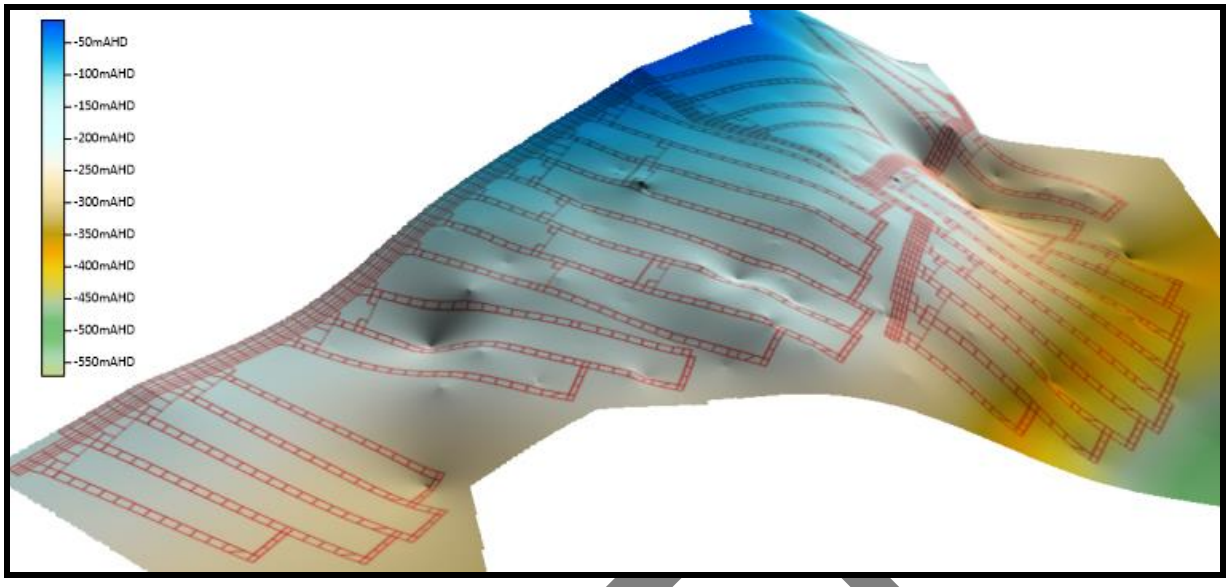


Figure 16. 3D Surface Plot of Harrow Creek Upper Seam Floor Levels (m AHD).

2.2.4.5 Faults

Both normal and reverse faults have been identified in the Eagle Downs underground area (**Figure 17**). This faulting style is consistent with neighbouring mining areas in the Moranbah Coal Measures.

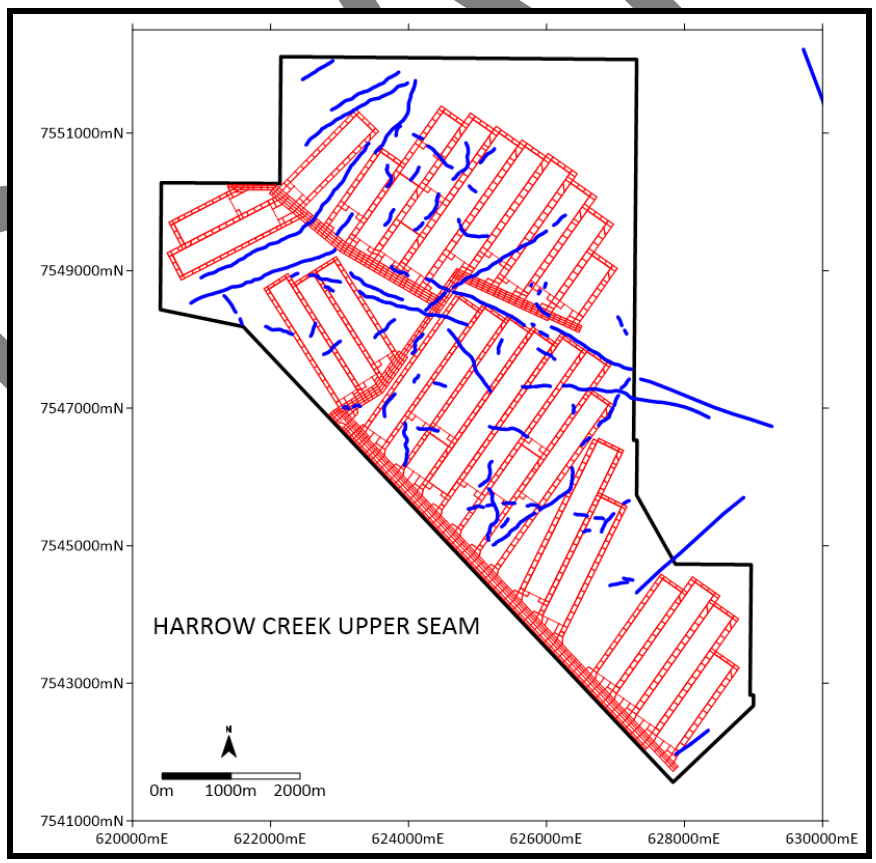


Figure 17. Geological Faults – Harrow Creek Upper Seam.

3 SUBSIDENCE PREDICTION METHODOLOGY

The majority of longwall panels in the Eagle Downs longwall mining area will create an extraction void approximately 341 m wide. As detailed earlier, to avoid geological features, several panels have been reduced to 280-300 m wide (rib to rib).

The longwall panels will be developed with two heading gateroads located along the panel length. Chain pillar widths will vary from 39-85 m (solid dimension).

3.1 SDPS Subsidence Modelling Method

GGPL has used the Surface Deformation Prediction System (SDPS) program (Carlson Software Inc), to predict the subsidence that will occur due to extraction of the three target seams in the Eagle Downs longwall mining area.

The SDPS program uses an influence function method that assumes the shape of a subsided surface can be modelled with a Gaussian (bell shaped) curve. This technique is a proven and reliable prediction methodology. This methodology is widely used throughout QLD and NSW to generate predictions of longwall mining subsidence effects and inform environmental impact and engineering assessments (Byrnes, 2003).

The method requires calibration to existing survey data and mine geometry. The following inputs are required:

- Panel Layouts (corrected by the Panel Adjustment Factor as detailed in Section 3.2.4).
- Seam Thickness.
- Depth of Cover.
- Influence Angle.
- Subsidence Factor (maximum subsidence (Smax)/extracted thickness ratio).
- Strain Coefficient.

It should be highlighted that the SDPS methodology can only predict the overall or systematic deformations. All subsidence surveys reveal small scale variations from the smooth profile predicted by this method. These deformations can be related to localised movements of blocky rock that is a feature of all coal mine overburdens.

Published multi-seam longwall experience has also been referenced from elsewhere in the Australian and overseas mining industry.

Based on subsidence data from the Bowen Basin presented in the South Galilee EIS (SGPL, 2012) and also subsidence studies by GGPL, the following parameters were used for modelling in the proposed Eagle Downs longwall mining area. Discussion on how these calibrated inputs were developed is provided in Sections 3.2 to 3.4 and the subsidence prediction results are presented in Section 4:

- Panel Adjustment Factor of 0.2.

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- Influence Angle of 70º.
- Strain Coefficient of 0.35.
- Maximum Subsidence Factor of 65% for extraction in virgin ground.
- Subsidence Factors in areas of overlying goaf areas (based on interburden thicknesses):
    - HCL Seam below extracted HCU Seam – 90%
    - DY Seam below extracted HCU Seam – 75% (no HCL extraction).
    - DY Seam below extracted HCL Seam – 85% (no HCU extraction).
    - DY Seam below extracted HCU and HCL seams – 95%,

3.2 Subsidence Modelling

3.2.1 Subsidence Behaviour

The subsidence above longwall panels is comprised of two main components namely sag and strata compression. Depending on the depth of cover and width of extraction these components combine in various proportions (**Figure 18**).

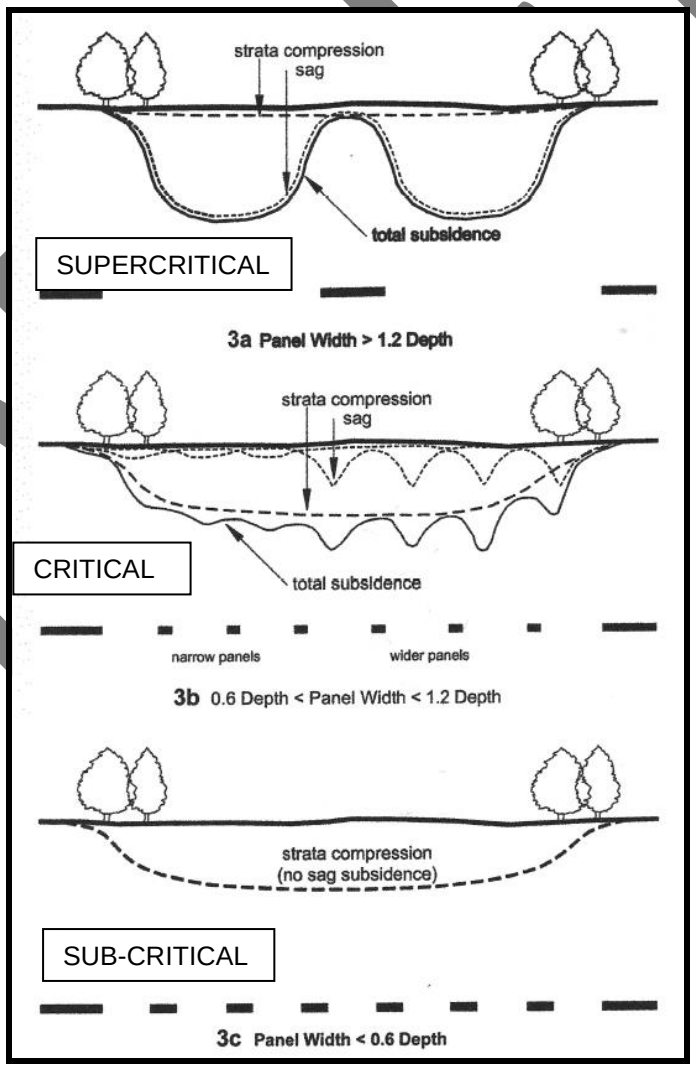


Figure 18. Effect of Panel Width (AUSIMM, 2009).

In the deeper part of the Eagle Downs longwall mining area, where the panel width: depth of cover ratios are <1.2 (critical), the total subsidence is anticipated to be a combination of both sag and a component of strata compression, as shown in **Figure 18**.

In the shallower areas where the panel width: depth of cover ratios are >1.2 (supercritical), the majority of the subsidence is anticipated to be due to sag (**Figure 18**).

The general shape of a cross section through a subsidence bowl (**Figure 19**) reveals a number of key features that can be used as a frame of reference:

- The areal extent of subsidence is defined by the angle of draw. The angle of draw is measured from the edge of the extraction void to the limit of measurable subsidence (LOMS). Conventionally, the LOMS is the point of 20 mm of vertical subsidence (not zero). Subsidence less than 20 mm will have a negligible effect, as it cannot be differentiated from natural ground surface variations due to soil moisture changes.
- Maximum tilt should correspond with zero strain.
- The subsidence at the point of maximum tilt and zero strain should be half the maximum vertical movement.
- The maximum tilts or strains do not necessarily correspond with the edge of the extraction.
- The typical subsidence profile is smooth over the cross section.

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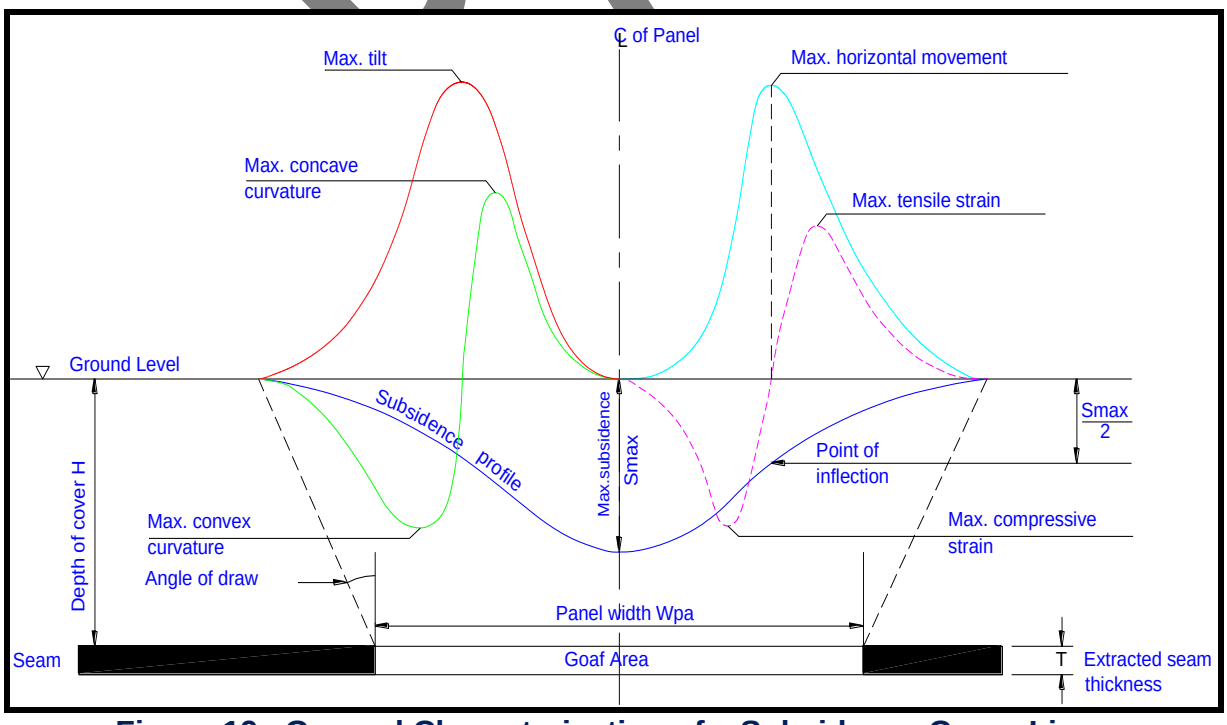


Figure 19. General Characterisation of a Subsidence Cross Line.

These parameters characterise the surface deformations above the extracted longwall panels and provide context to the resulting impacts.

3.2.2 Subsidence Factor

3.2.2.1 Single Seam

The subsidence factor is the ratio of maximum subsidence (S_{max}) to extracted coal seam thickness (T). This ratio is the percentage of the extracted thickness underground, measured as subsidence on the surface.

As the panel width to depth of cover ratio decreases, the maximum subsidence correspondingly decreases (**Figure 20**). This decrease occurs as the subsidence behaviour transitions from supercritical to subcritical and finally to bridging behaviour (**Figure 20**).

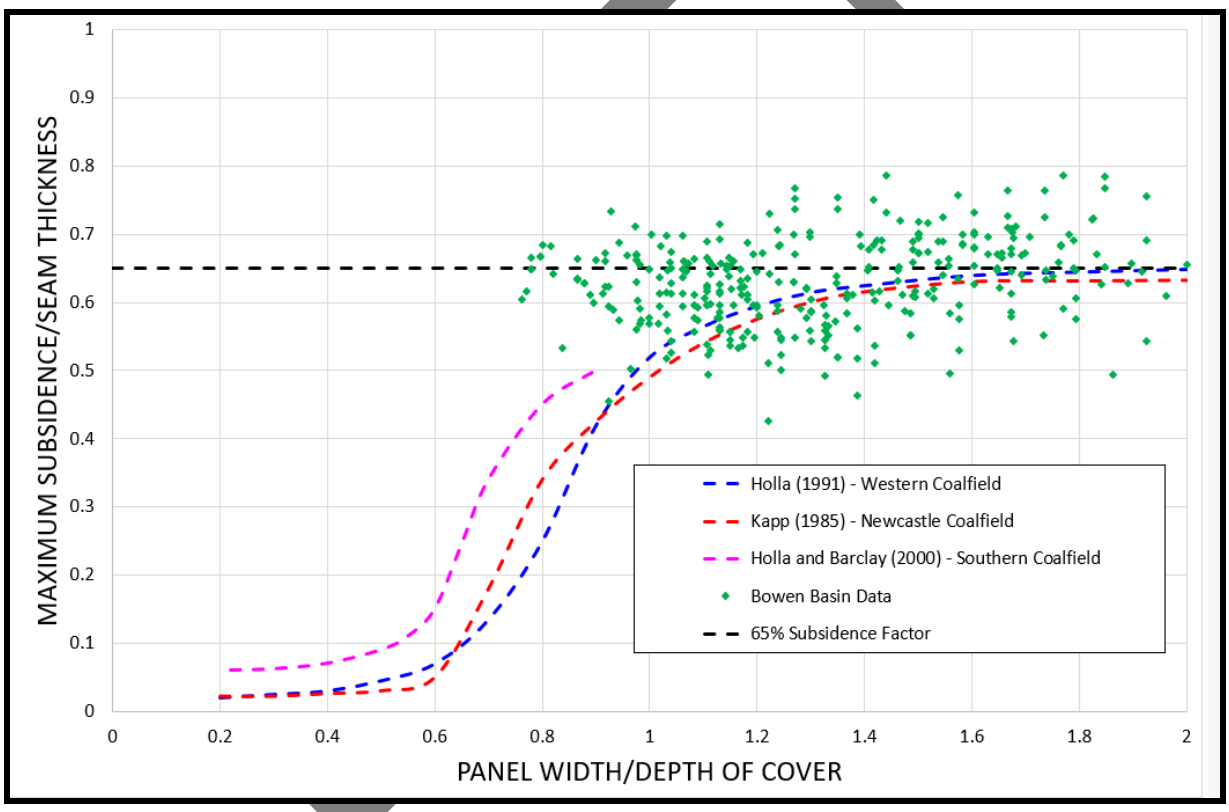


Figure 20. Sag Subsidence over Single Longwall Panels in Virgin Ground.

Based on the Bowen Basin data set, supercritical behaviour characterised by sag subsidence is anticipated in the shallower parts of the Eagle Downs area (**Figure 20**). In the deeper part of the mining area, the panel width to depth ratio does reduce to <0.7.

It should be highlighted that an empirical curve has not been developed for the Bowen Basin due to fact that the majority of the extraction has been carried out at panel width:depth of cover ratios >0.8 (**Figure 20**).

The available Bowen Basin data validates the application of a 65% subsidence factor to the Eagle Downs longwall area for single seam extraction in virgin ground in the shallower part of the area (**Figure 20**).

3.2.2.2 Multi-Seam

Multi-seam longwall extraction subsidence data has been reported by Li et al (2010) and Mills and Wilson (2021). The subsidence factor for the extraction of the underlying seam ranges from 70-110% (**Figure 21**). The interburden thickness in the data set ranges from 13-85 m, which is comparable with the interburden thicknesses in the Eagle Downs area (**Figure 21**).

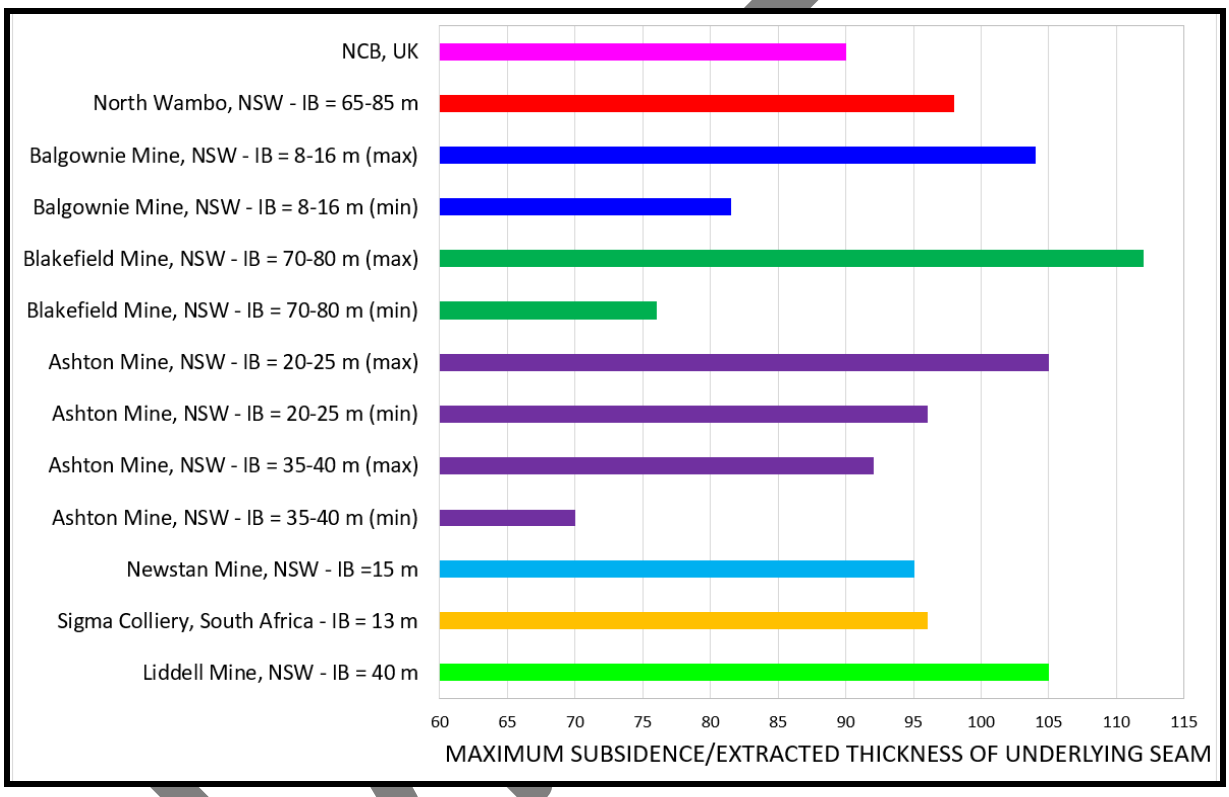


Figure 21. Subsidence Factor for the Extraction of the Underlying Seam.

Based on this published multi-seam data and consideration of the interburden thickness in the Eagle Downs area, the following subsidence factors have been applied to different combinations of extraction below overlying goaf areas (**Figure 21**):

- HCL Seam below extracted HCU Seam – 90%
- DY Seam below extracted HCU Seam – 75% (no HCL extraction).
- DY Seam below extracted HCL Seam – 85% (no HCU extraction).
- DY Seam below extracted HCU and HCL seams – 95%,

It is highlighted that even in the high strength overburden strata at Sigma and Newstan collieries, the subsidence factors were around 95% (**Figure 21**).

MSEC (2012) also proposed that the additional ground movement in a multi-seam mining environment is dependent upon the thickness of the interburden between the seams, as well as the thickness of the seams to be extracted.

In the case of the combined Harrow Creek Upper, Harrow Creek Lower and Dysart seam extraction, the total subsidence at any point is a simple addition of individual values for each seam. The same is not true of the strain and tilts. SDPS has the facility to allow models to be run with the three layouts simultaneously, to provide outputs of these parameters.

3.2.3 Influence Angle

The influence angle (β) is defined as:

$$\text{Tan } \beta = \text{Depth/Radius of Influence}$$

The influence angle is approximately 90º minus the angle of draw and is therefore a key parameter in the prediction of the shape of the subsidence profile above longwall panels (Agioutantis and Karmis, 2002). Based on data from the Bowen Basin, an influence angle of 70º has been adopted for the Eagle Downs area (**Figure 22**).

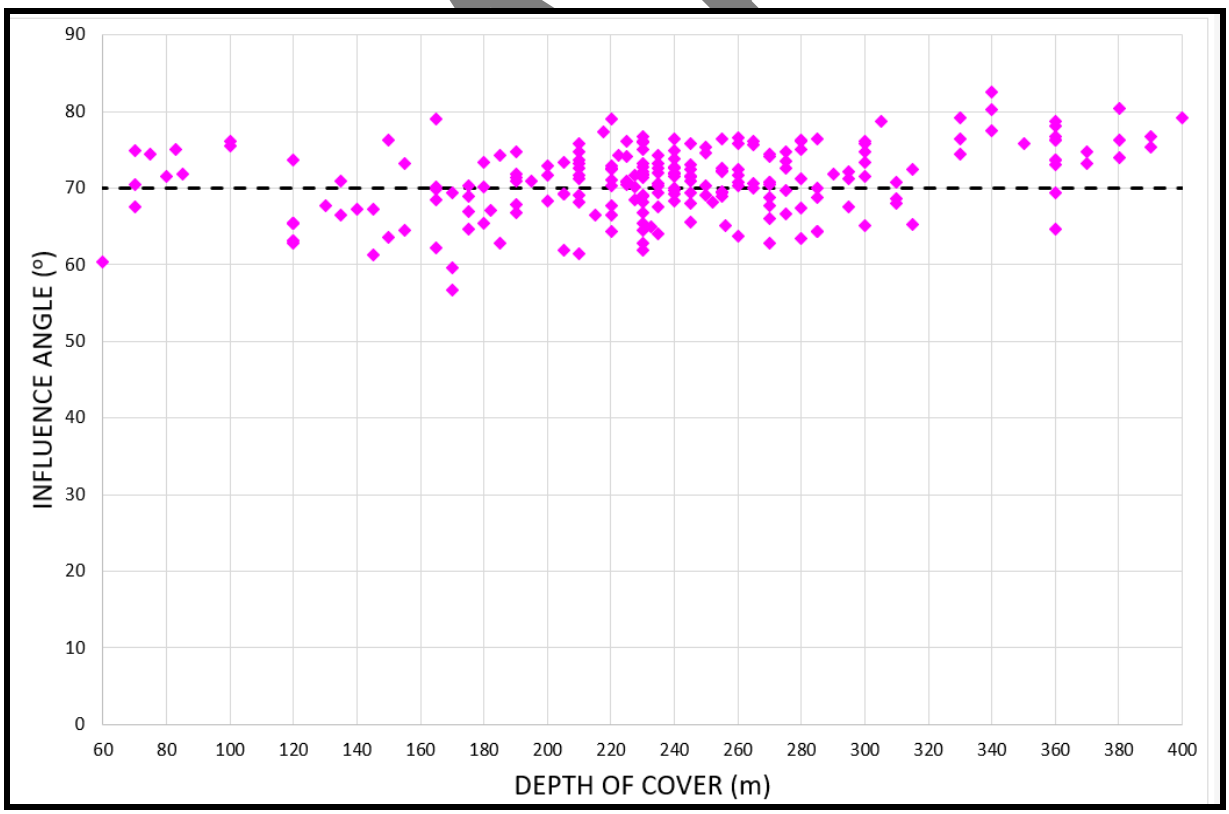


Figure 22. Influence Angle Data – Bowen Basin.

3.2.4 Panel Adjustment Factor

The panel adjustment factor is the compensation width divided by the depth of cover, where the compensation width is the distance measured from the rib edge to the inflection point or point of half maximum subsidence (**Figure 19**).

Based on data from the Bowen Basin, a panel adjustment factor of 0.2 has been adopted for the Eagle Downs area (**Figure 23**).

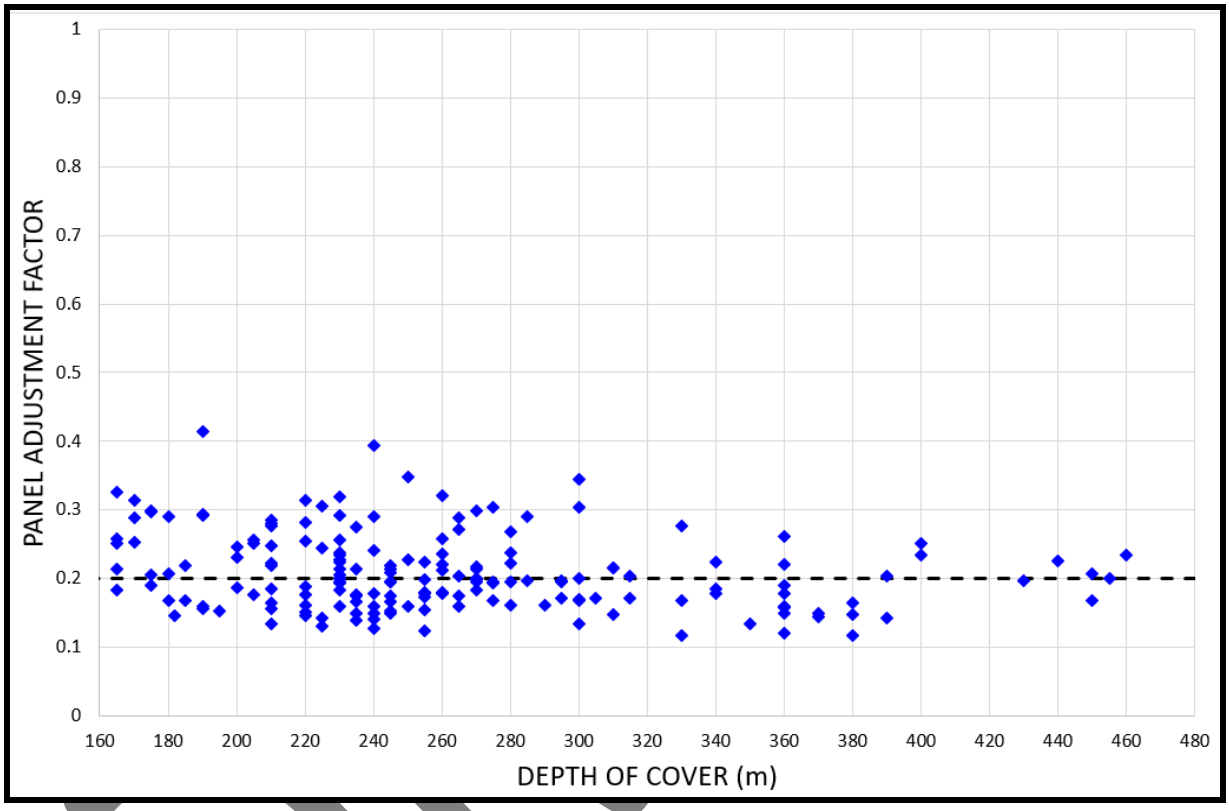


Figure 23. Panel Adjustment Factor Data – Bowen Basin.

SDPS models the extraction of each longwall panel using the projection of the points of inflexion, rather than the panel width (**Figure 19**). For wide extraction panels, the position of the inflexion points is a linear proportion of the depth of cover.

The modelled and proposed extents of each Harrow Creek Upper Seam longwall panel are shown in **Figure 24**.

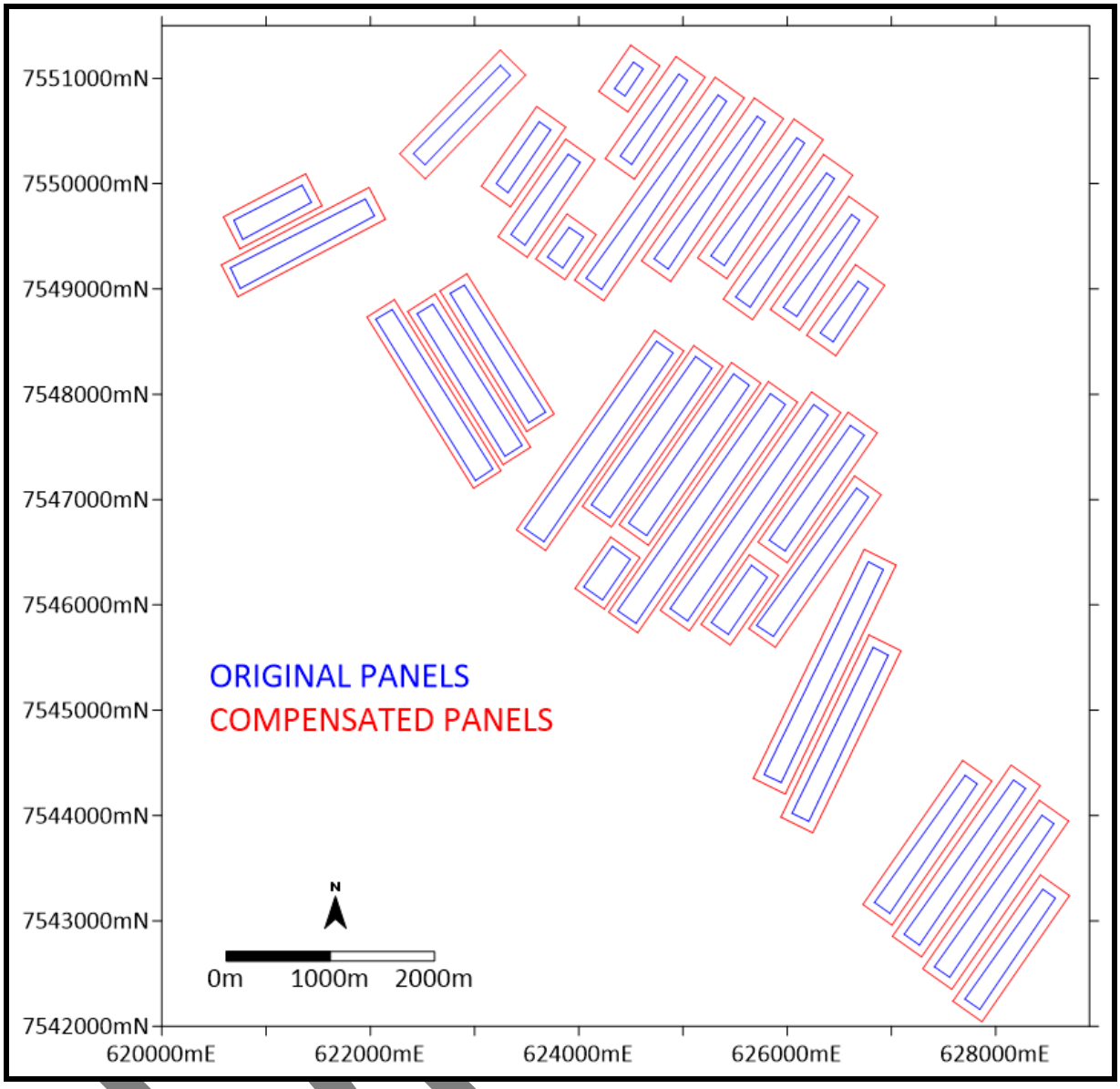


Figure 24. Original Longwall Panels and Compensated Panels – Harrow Creek Upper Seam.

3.2.5 Strain Coefficient

The strain coefficient influences the strain predicted by the model. Increasing the strain coefficient increases the predicted strain, while reducing the strain coefficient decreases the predicted strain.

A strain coefficient of 0.35 has been adopted for the SDPS modelling. This value corresponds to the upper limit of strain coefficient values (i.e. maximum strain) that can be modelled using SDPS. This value is therefore high and is expected to result in conservative predictions of strain and associated cracking in the Eagle Downs longwall mining area.

It is also at the high end of the range of values used at other Bowen Basin mines, and is therefore comparatively conservative in the prediction of surface cracking (SGPL, 2012).

3.2.6 Mining Height

The subsidence modelling assumed the following range of effective thicknesses (based on 80% LTCC recovery) are extracted by the longwall:

- HCU Seam – 3.5-4.2 m – single pass longwall extraction only.
- HCL Seam – 3.5-7.1 m – both single pass and LTCC.
- DY Seam – 3.5-5.2 m – both single pass and LTCC.

3.3 Chain Pillar Deformation

The chain pillars between the longwall panels will act to reduce the magnitude of subsidence deformation between each individual longwall panel and therefore the total subsidence over each series of panels.

The depth of cover increases along the length of the panels and the associated chain pillars. In these circumstances, the chain pillars may deform differently along their lengths and this will influence the total subsidence associated with each series of longwall panels.

The key considerations in modelling the effects of chain pillar deformation on the total subsidence are discussed in Sections 3.3.1 and 3.3.2.

3.3.1 Negative Pillar Subsidence Factor

In order to model the influence of chain pillars, SDPS provides the ability to model each series of panels (also termed a super panel). In this mode, SDPS models the negative subsidence (upsidence) of the chain pillars instead of the panels. The adopted SDPS model arrangement for the Harrow Creek Upper Seam layout is shown in **Figure 25**, where the super panel boundaries are shown in purple and the chain pillars in green.

In the HCL and DY seams, additional super panels were defined to allow modelling of longwall extraction in virgin mining areas, not located below overlying workings.

The width of these active chain pillars is equal to the distance between the compensated panel boundaries. The feature of this method is that the chain pillars can be given their own negative subsidence factor in the prediction, allowing greater control over subsidence due to compression of the pillar system.

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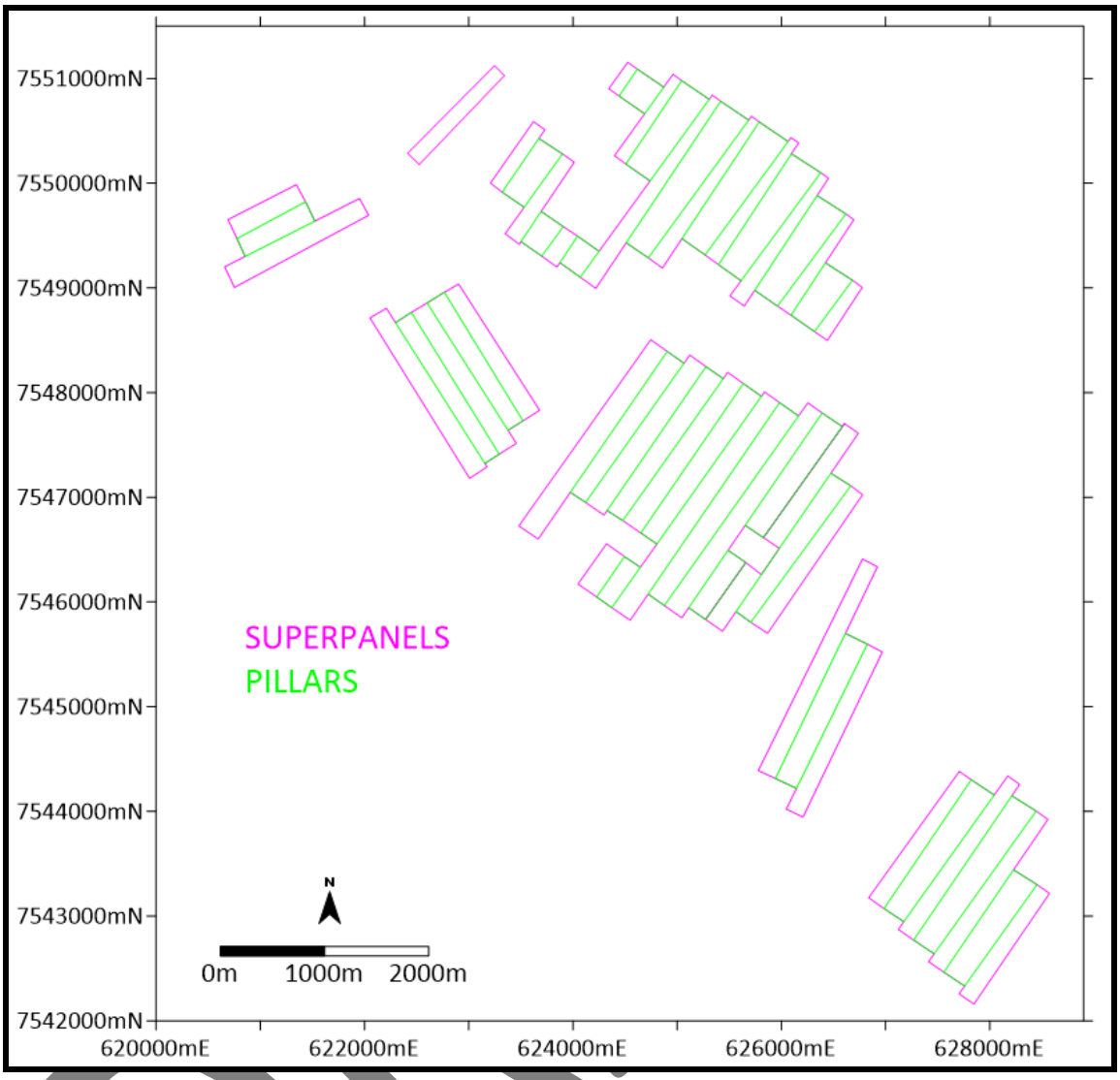


Figure 25. Super Panels and Active Pillars with Compensated Geometries – Harrow Creek Upper Seam.

3.3.2 Stable Pillars to Yielding Pillars

When a longwall panel extracts the coal, the overburden load that was carried by coal is redistributed onto the chain pillars on either side of the longwall panel. With this increase in overburden load, the coal that forms the chain pillars in the Eagle Downs longwall mining area is expected to experience some level of compression. Significantly, in areas of overlying goaf the overburden load will be reduced and so to the amount of compression.

Analysis of the Harrow Creek Upper Seam chain pillars developed in virgin ground conditions indicates that at the planned range of depth the chain pillars are not expected to yield (**Figure 26**).

Where the Harrow Creek Lower Seam and Dysart Seam chain pillars are located below overlying goaf, yield is not anticipated due to the reduction in loading

conditions, consistent with data presented by Mills and Wilson (2021) at Ashton Mine in NSW.

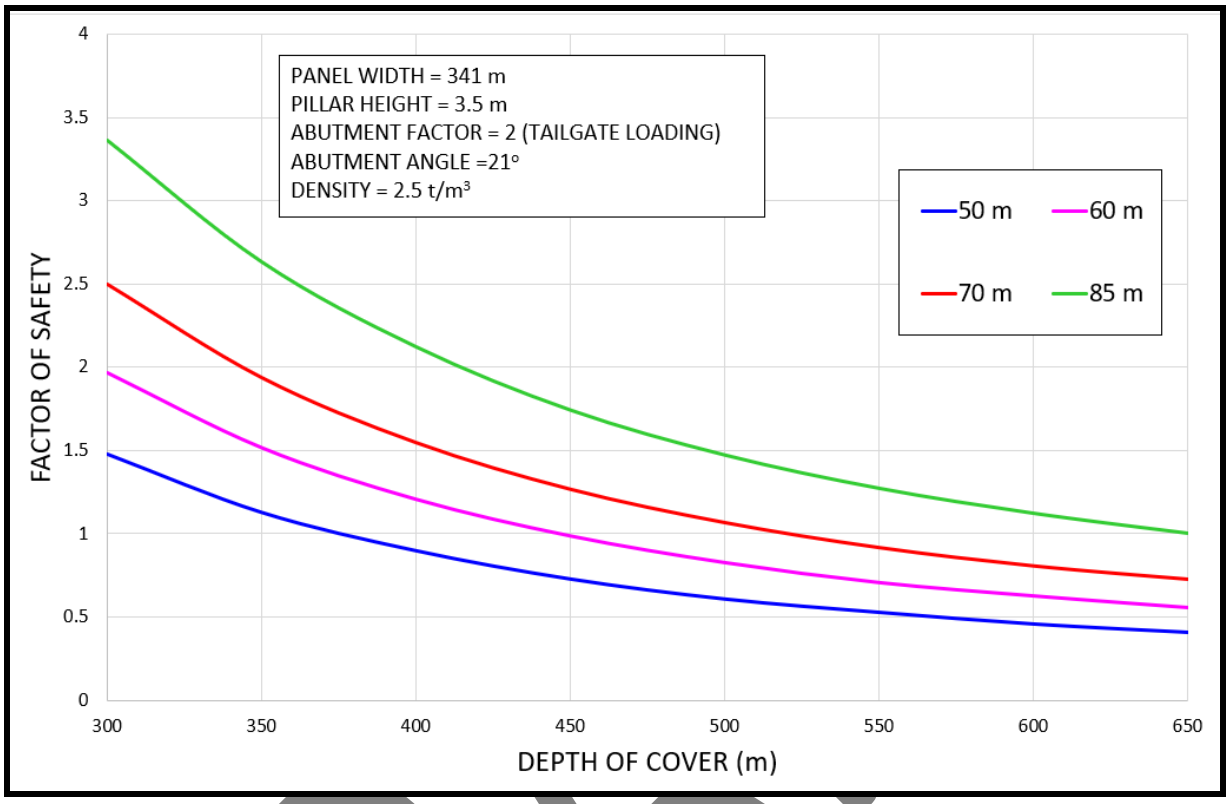


Figure 26. Analysis of Chain Pillars using the ALPS Pillar Design Methodology.

3.4 Massive Spanning Units

The two sandstone channels, HSL12 and HSL14 above the Harrow Creek Lower Seam, coalesce in parts of the proposed mining area to form the thicker HSL10 (**Figure 3 and Figure 27**).



Figure 27. HCU-HCL Sandstone Borehole ED087 (South32, 2020)

This unit has the potential to span during longwall retreat causing periodic weighting events (South32, 2020).

As detailed by South32 (2020)., the thickest occurrence of the sandstone is in borehole ED089C where the it is 45 m thick at 400 m depth of cover. The spanning capability of this unit can be assessed using a voussoir beam analysis, assuming a 20^{o} caving angle and overburden strength and modulus properties of 80 MPa and 16 GPa, respectively (Sofianos and Kapensis, 1998).

The analysis indicates that a 45 m thick massive unit, located 10 m above the seam, is not able to span a 341 m wide longwall panel at this depth of cover. It should be clarified that prior to caving, periodic weighting events may still be experienced on the longwall face.

To assess the potential for the presence of massive units in the Permian overburden the geophysical gamma log measured in the exploration boreholes can be used. The variability in the gamma response of the overburden in three holes across the Eagle Downs longwall mining area above each seam indicates that the thicker massive units typically occur in the HCL overburden (**Figure 28 to Figure 30**). The location of these holes is shown on **Figure 6**.

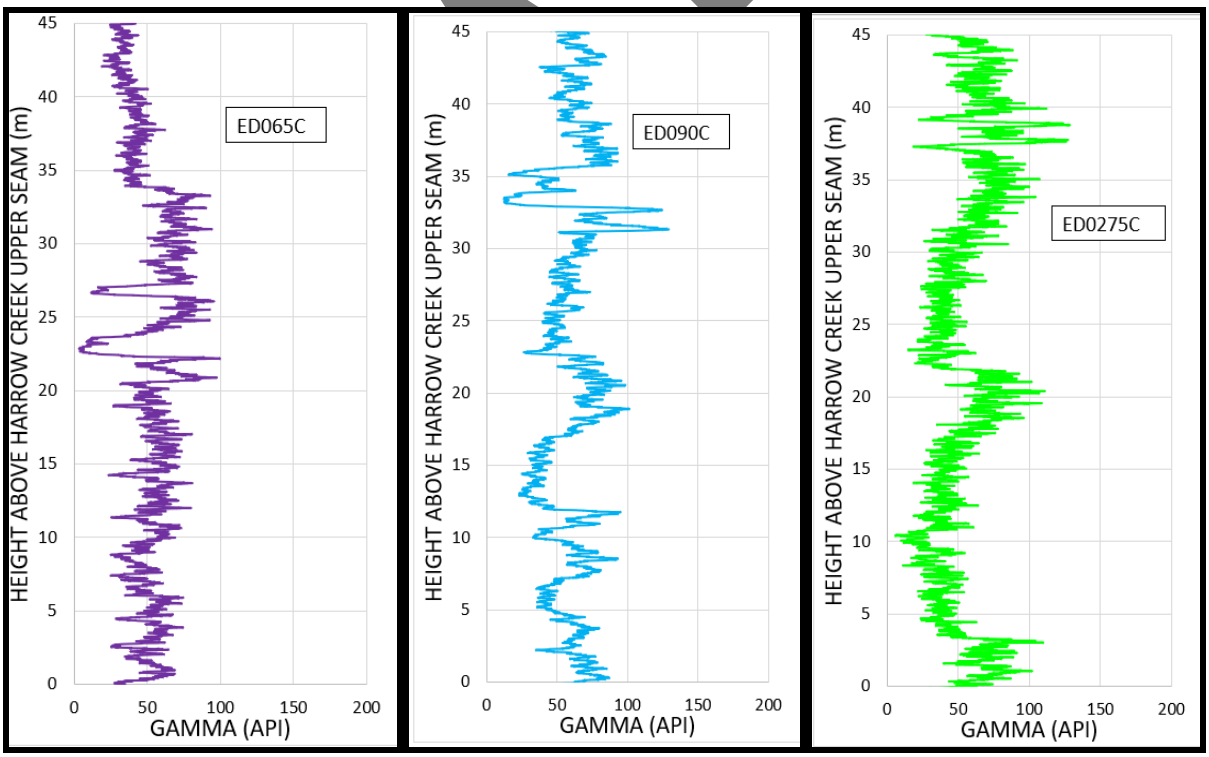


Figure 28. Gamma Response of Harrow Creek Upper Seam Overburden.

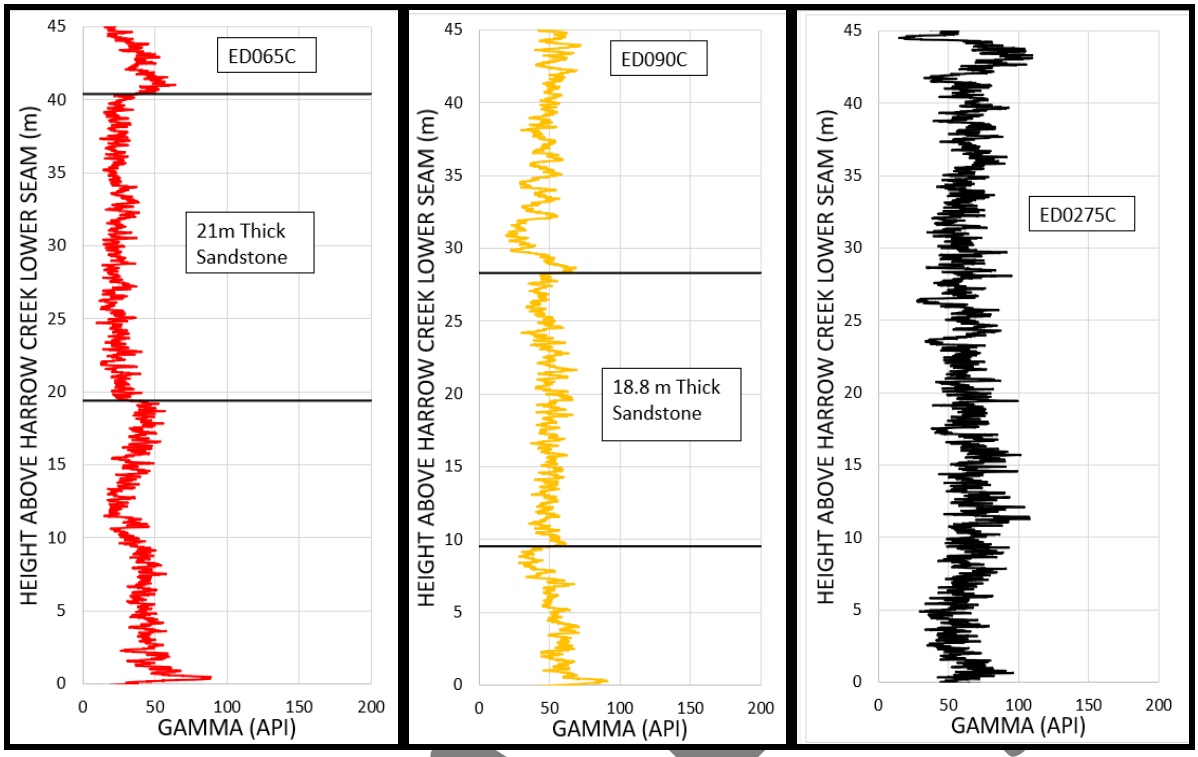


Figure 29. Gamma Response of Harrow Creek Lower Seam Overburden.

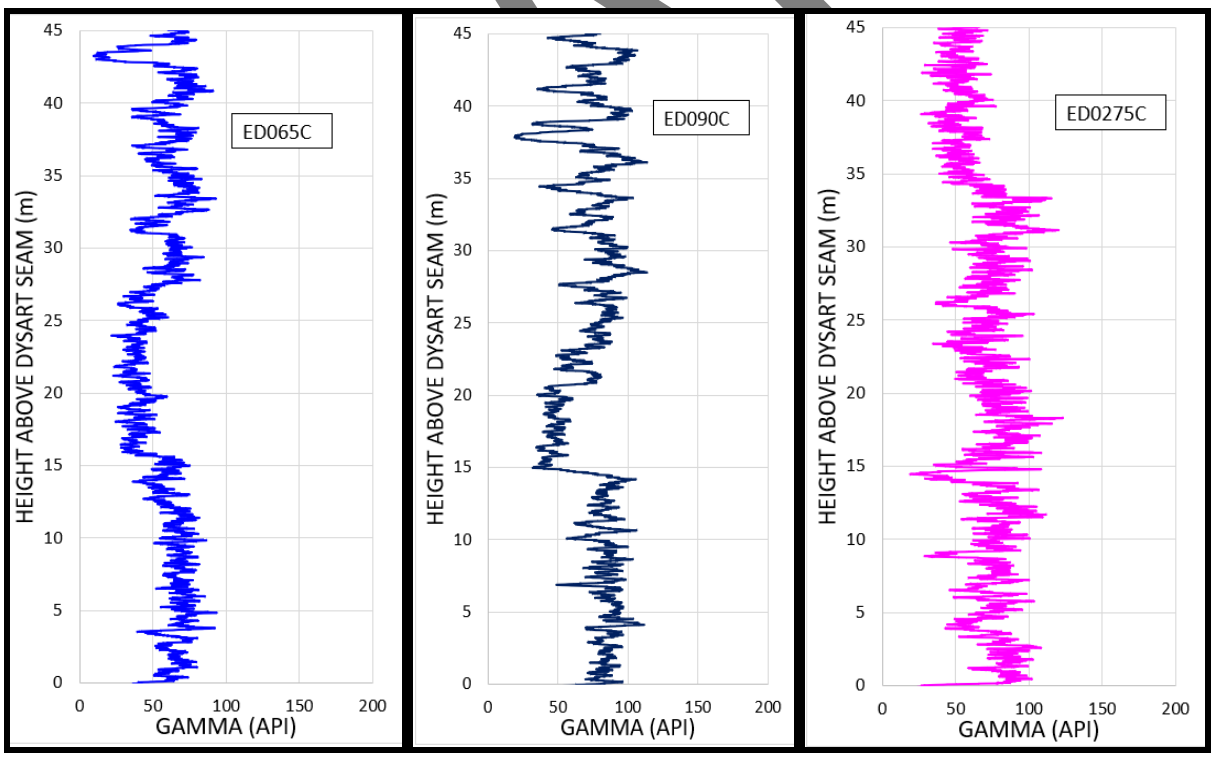


Figure 30. Gamma Response of Dysart Seam Overburden.

4 SUBSIDENCE PREDICTIONS

4.1 Subsidence

4.1.1 Over Longwall Panels

The predicted maximum subsidence from mining of the Harrow Creek Upper Seam is 2.6 m and occurs in the shallower part of the area (**Figure 31**). In the deeper northern panels, the subsidence reduces to <1.5 m (**Figure 31**).

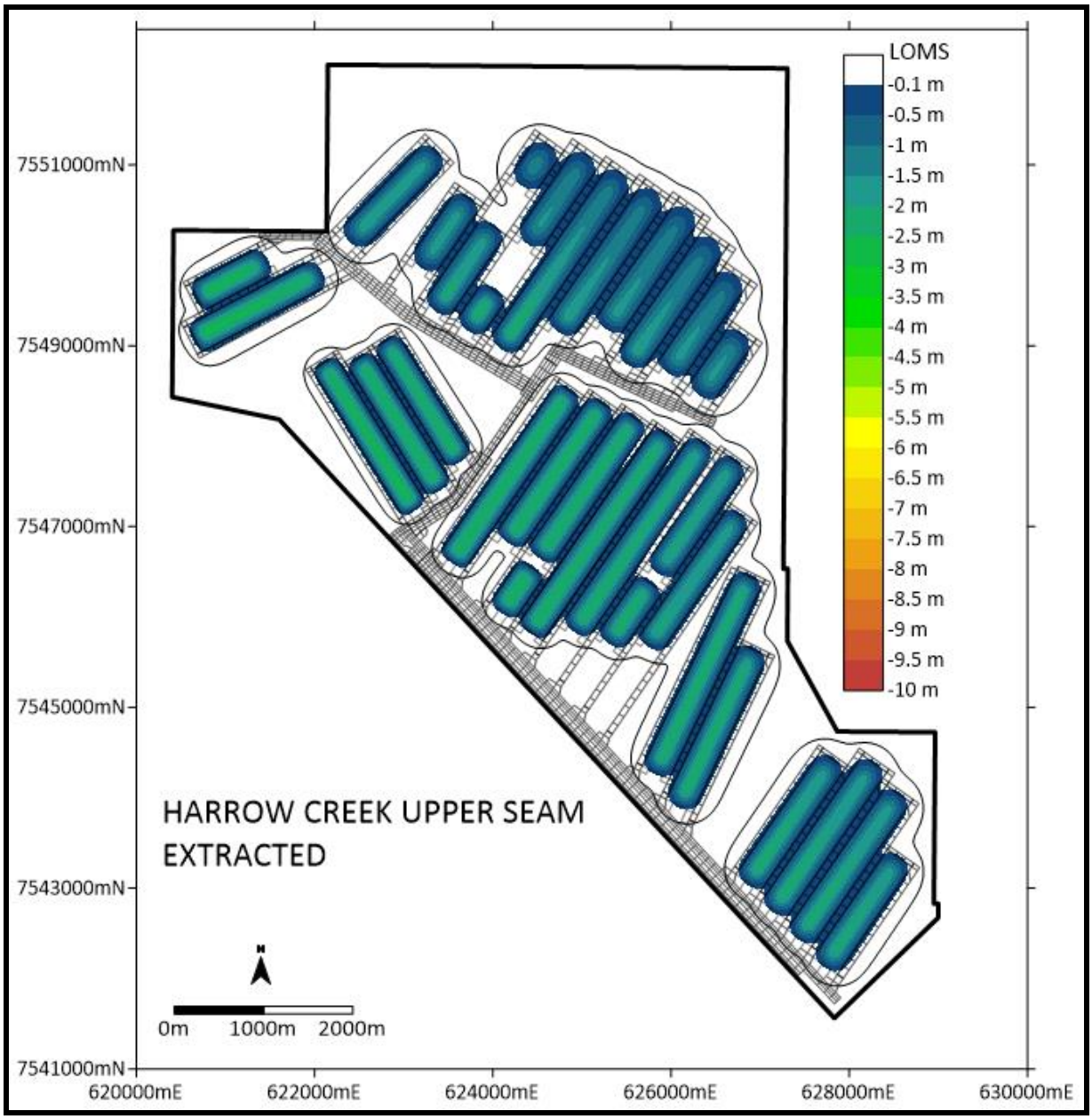


Figure 31. Subsidence after Extraction of the HCU Seam (m).

With the subsequent extraction of the Harrow Creek Lower Seam, the maximum subsidence increases to 7 m in the shallower part of the area (**Figure 32**). Similarly, the subsidence reduces to 3-3.5 m in the deeper part of the area (**Figure 32**).

The reduction in subsidence due to the reduced extraction height in the sandstone zone in the Harrow Creek Lower Seam is also evident in **Figure 32**.

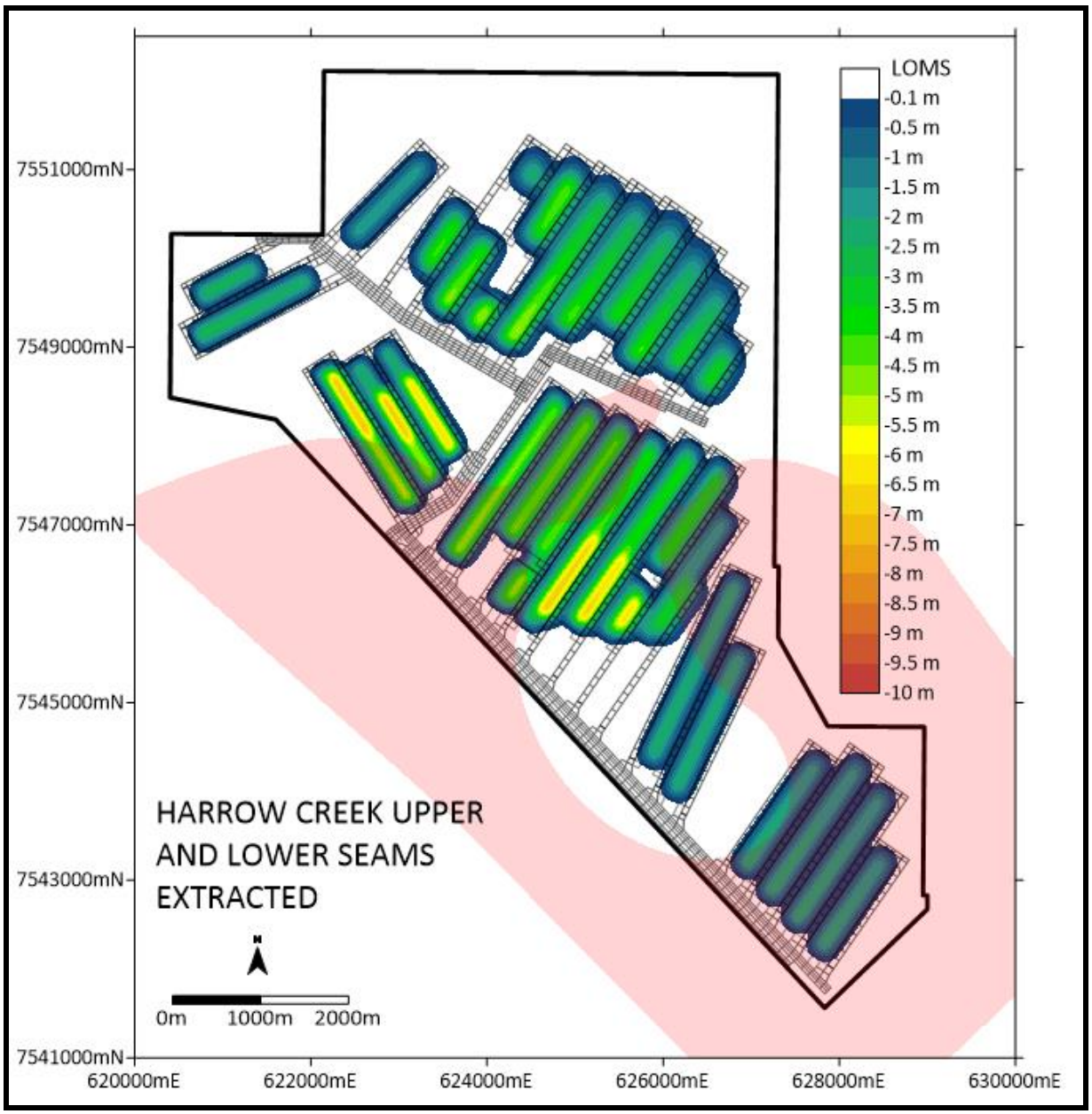


Figure 32. Subsidence after Extraction of the HCU and HCL Seams (m).

Once the extraction of all three target seams has been completed, a maximum subsidence of 10 m is predicted in the shallower south-western part of the mining area (**Figure 33**).

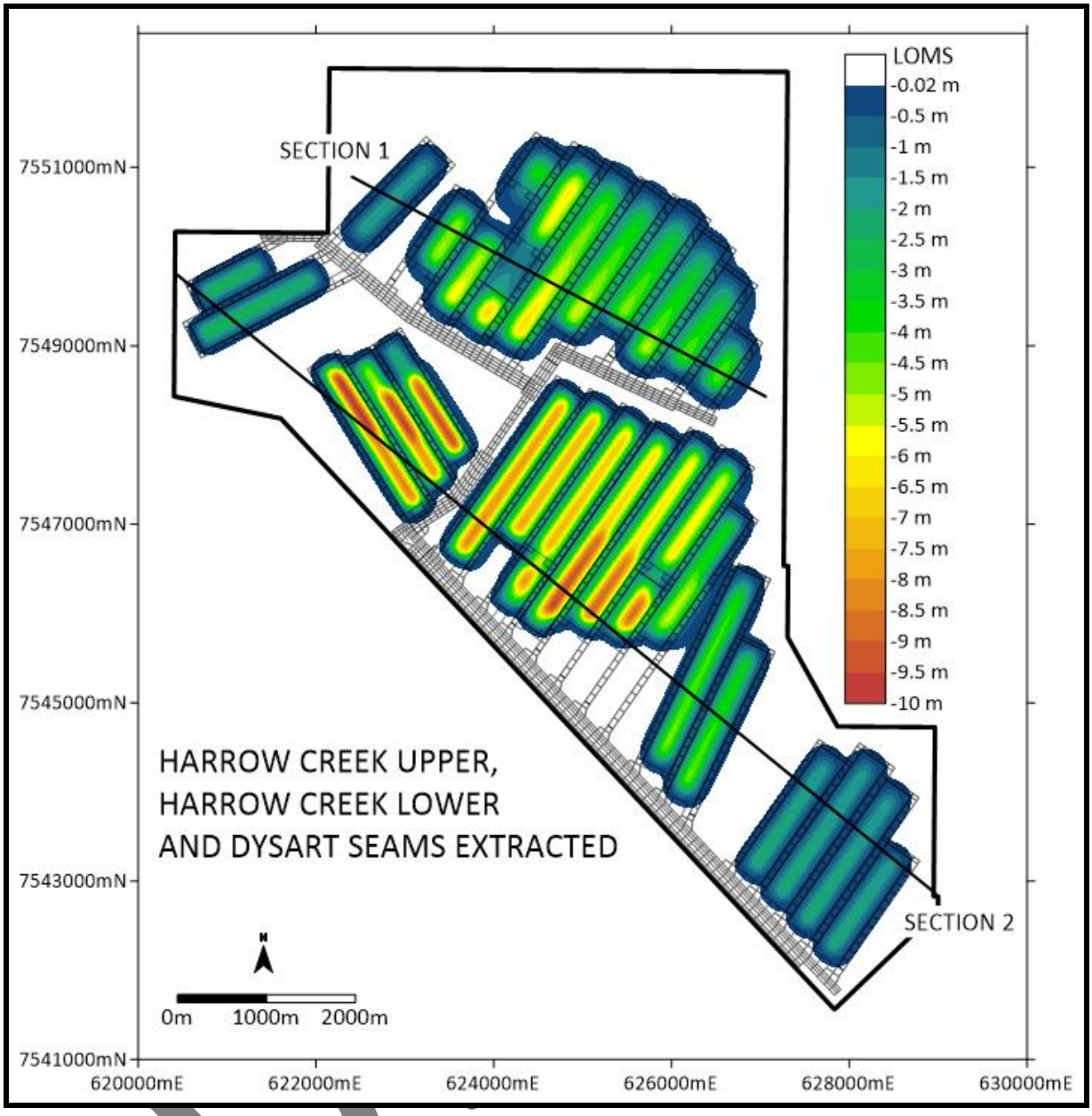


Figure 33. Subsidence after Extraction of the HCU, HCL and DY Seams (m).

Two cross sections across the northern and southern part of the area illustrate the variability in the predicted subsidence (**Figure 34 and Figure 35**). It should be highlighted that these sections have a **very high** vertical: horizontal scale exaggeration.

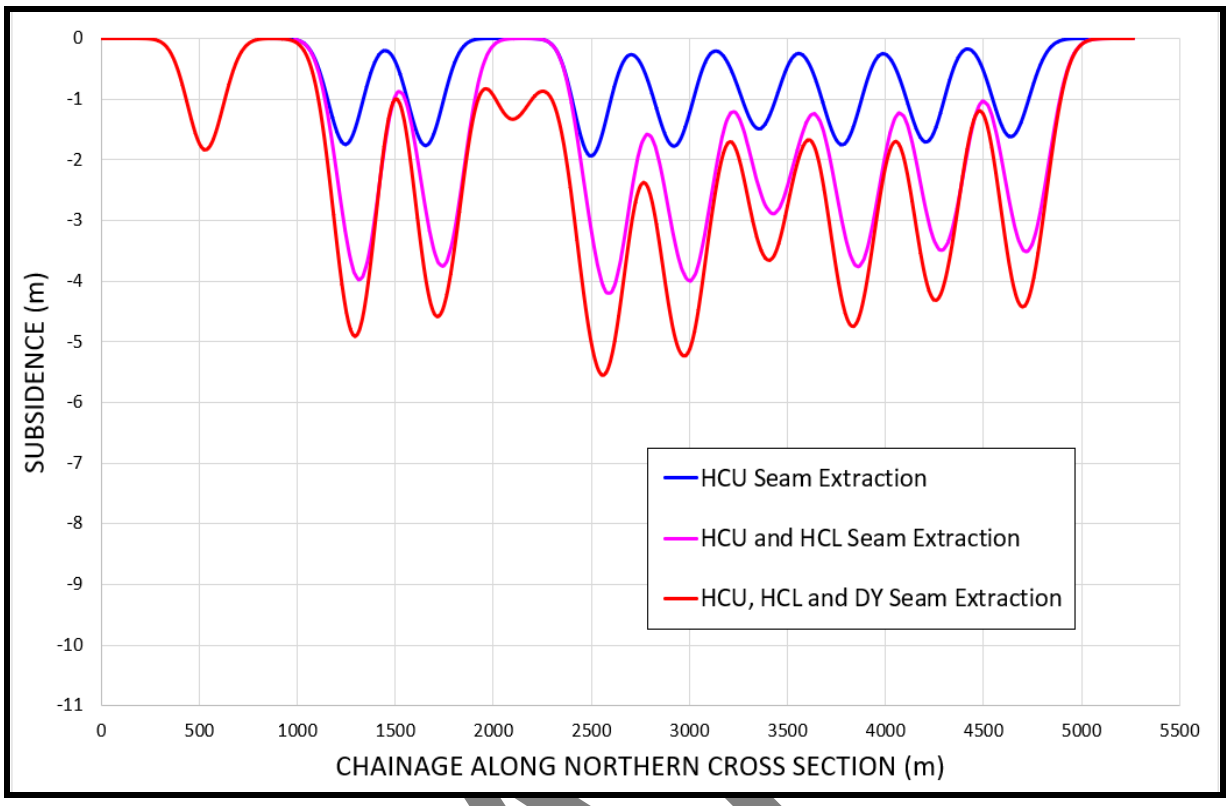


Figure 34. Subsidence - Northern Cross Section 1.

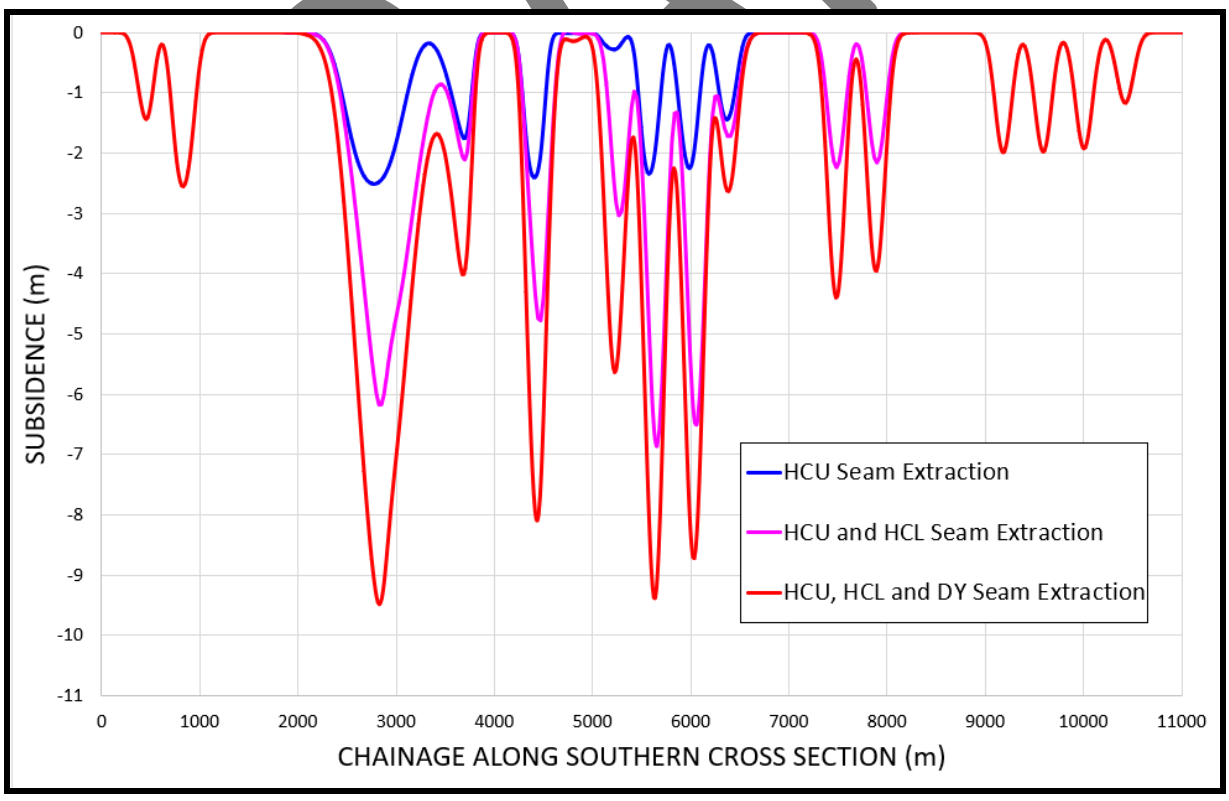


Figure 35. Subsidence – Southern Cross Section 2.

4.1.2 Subsided Topography

Figure 36 shows the predicted topographic surface over the Eagle Downs area at the completion of longwall mining, with a z axis exaggeration of 20. The distinct ridges above the chain pillars and troughs over the goaf areas are clearly evident in this figure (**Figure 36**). These troughs may become areas for the ponding of water.

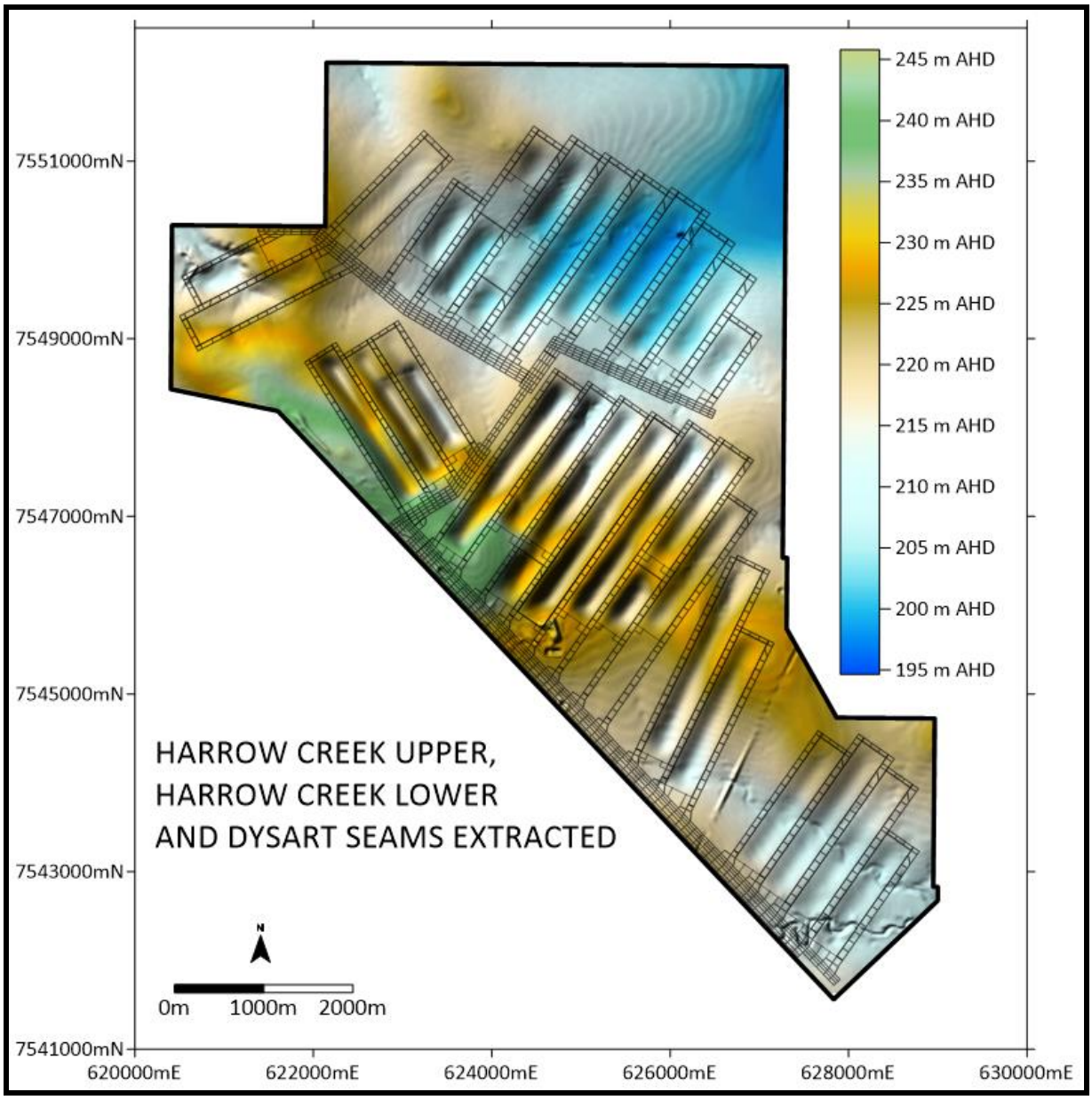


Figure 36. Post Mining Topography after Extraction of the Three Target Seams (Z=20).

4.2 Horizontal Movements

As well as vertical subsidence, horizontal ground movements also occur at the surface due to underground mining. These movements are more relevant if key surface infrastructure is located above the longwall extraction area.

The maximum horizontal ground movements predicted at the surface after the extraction of the Harrow Creek Lower Seam are typically less than 1 m in the proposed longwall mining area (**Figure 37**).

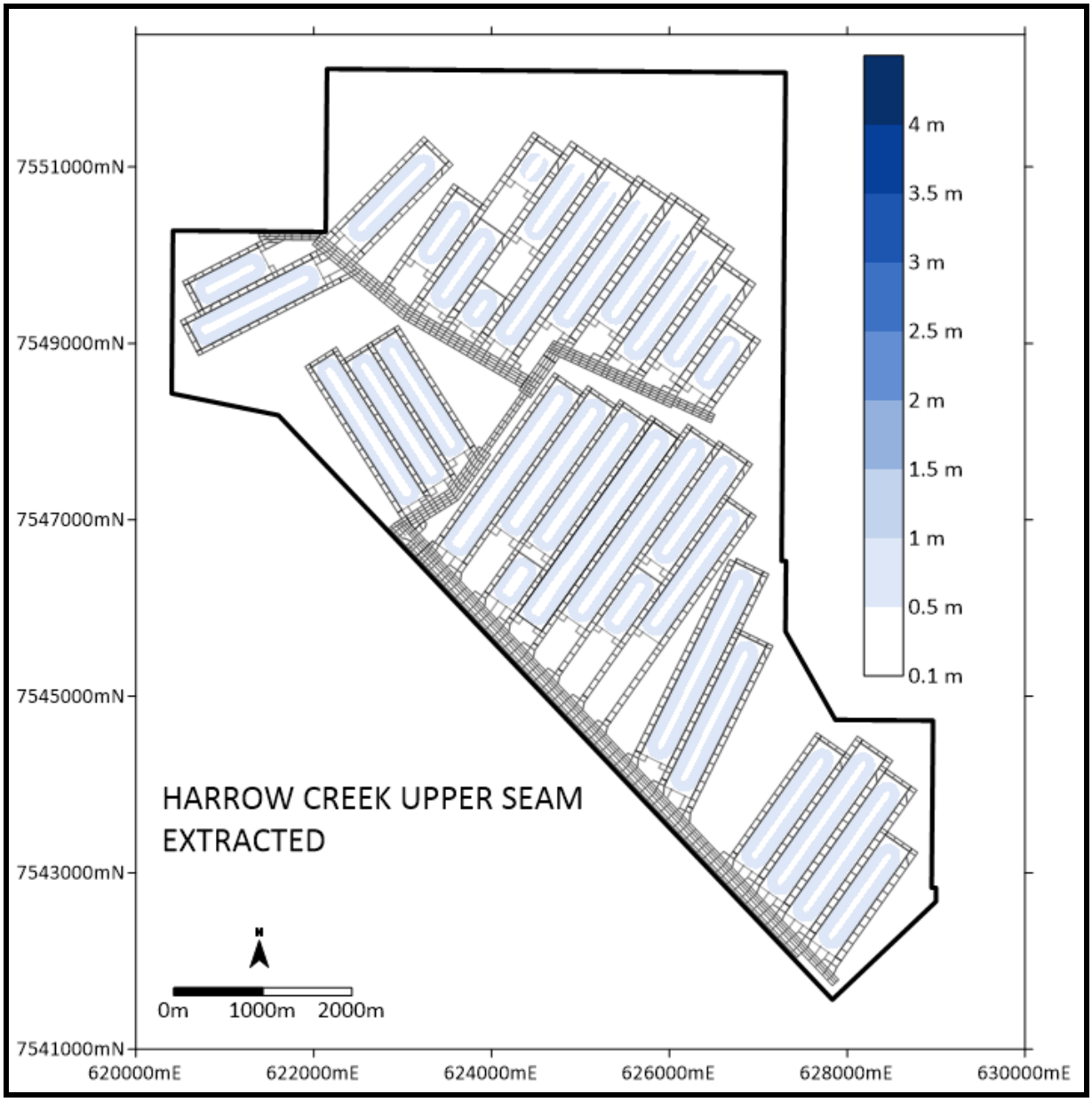


Figure 37. Horizontal Movement after Extraction of the HCU Seam (m).

After the extraction of both the Harrow Creek Upper and Harrow Creek Lower seams, the maximum horizontal movement predicted is up to 2.6 m in the shallower part of the area (**Figure 38**). This reduces to <1.8 m in the deeper part of the mining area (**Figure 38**).

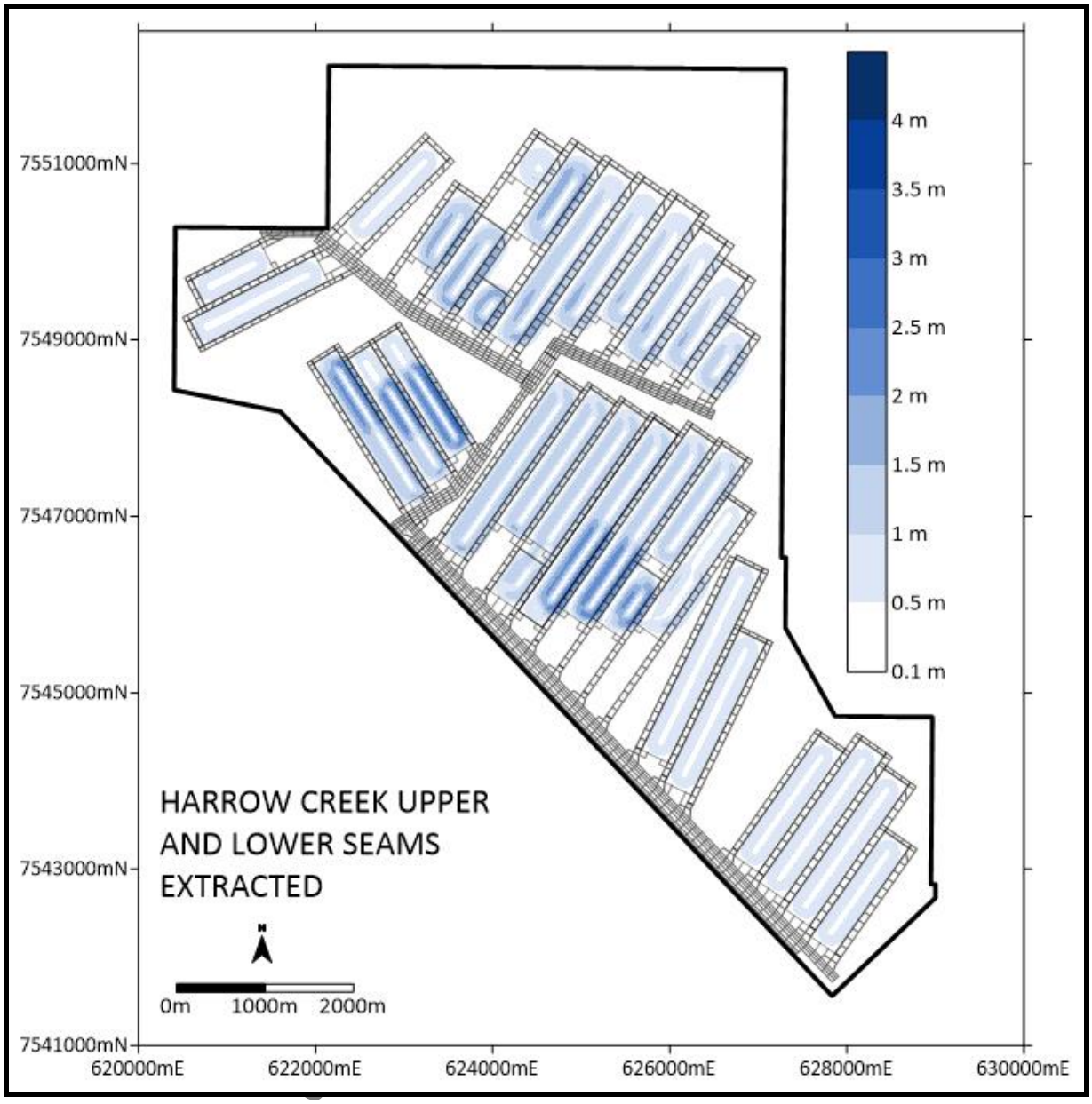


Figure 38. Horizontal Movement after Extraction of the HCU and HCL Seams (m).

Maximum horizontal movements of up to 3.8 m are predicted in those areas where all three seams have been extracted (**Figure 39**).

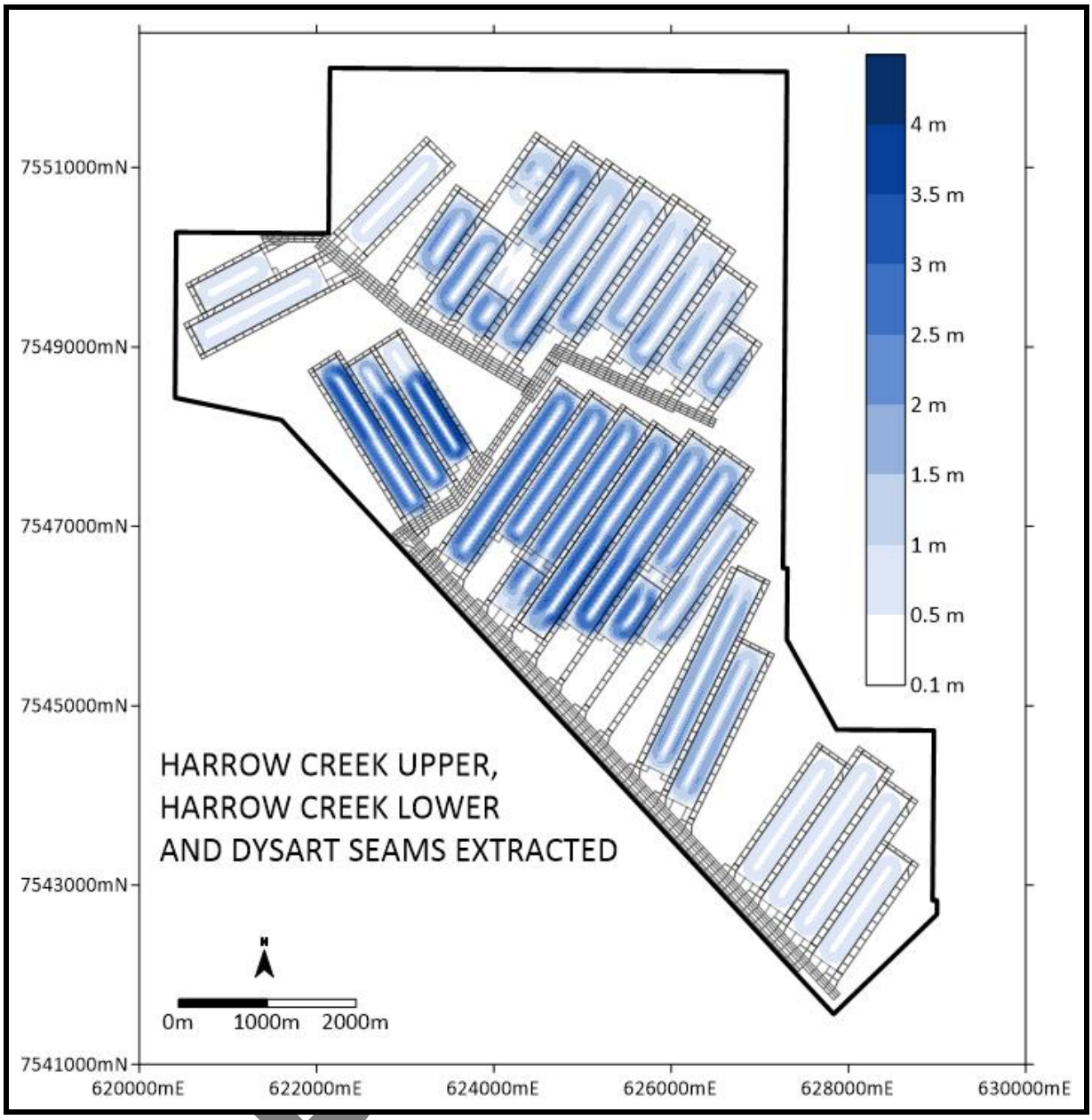


Figure 39. Horizontal Movement after Extraction of the HCU, HCL and DY Seams (m).

4.3 Strain

Surface strain is caused by bending and horizontal movements in the strata. Measured strain is determined from monitored survey data by calculating the horizontal change in length of a section of a subsidence profile and dividing this by the initial horizontal length of that section.

The maximum tensile strains due to extraction of the Harrow Creek Upper Seam range in magnitude up to 14 mm/m (**Figure 40**). Maximum compressive strains range up to 16 mm/m (**Figure 40**).

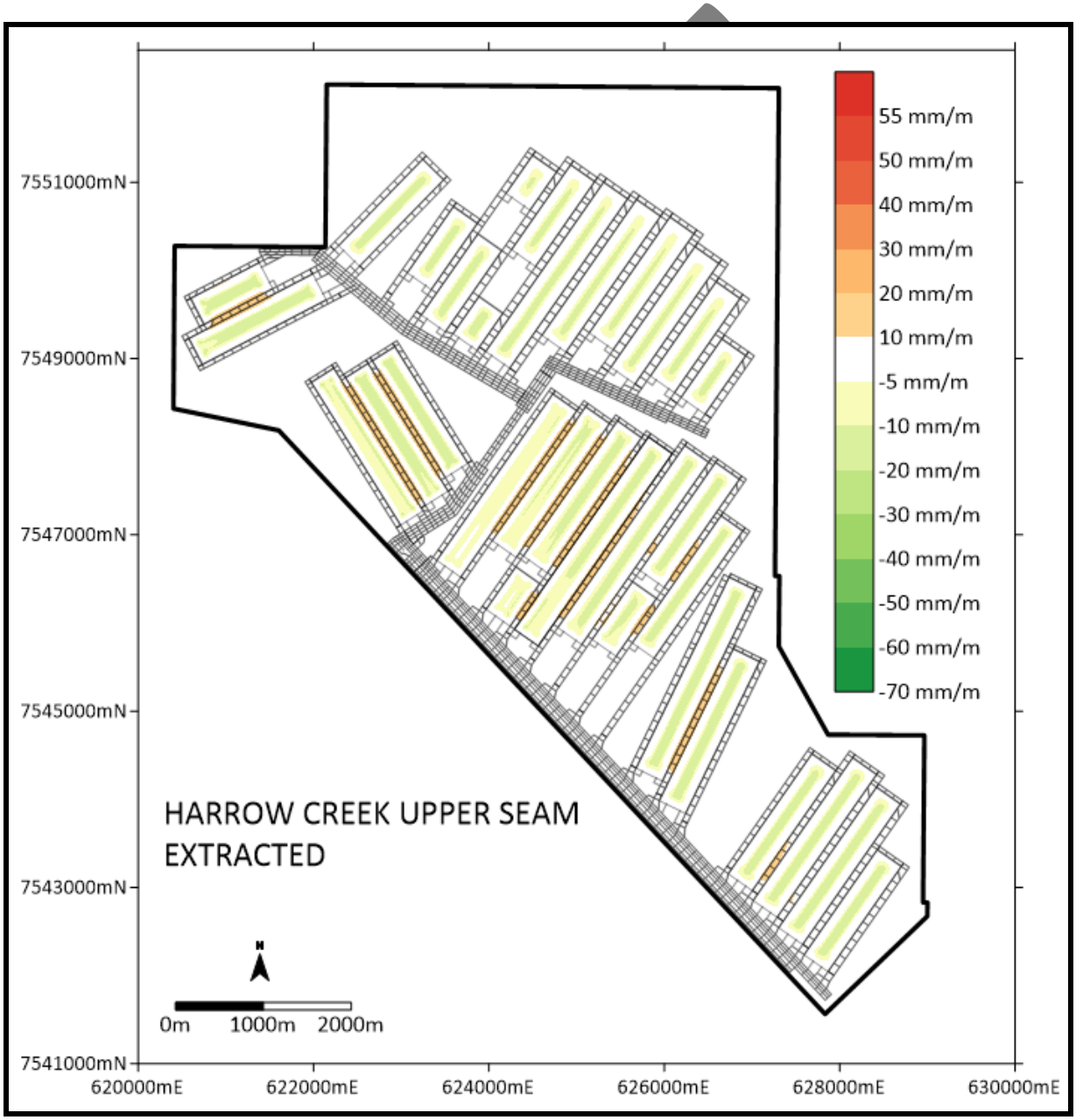


Figure 40. Strain after Extraction of the HCU Seam (m).

The maximum tensile and compressive strains increase to 38 mm/m and 49 mm/m respectively, after the completion of extraction in the Harrow Creek Lower Seam (**Figure 41**).

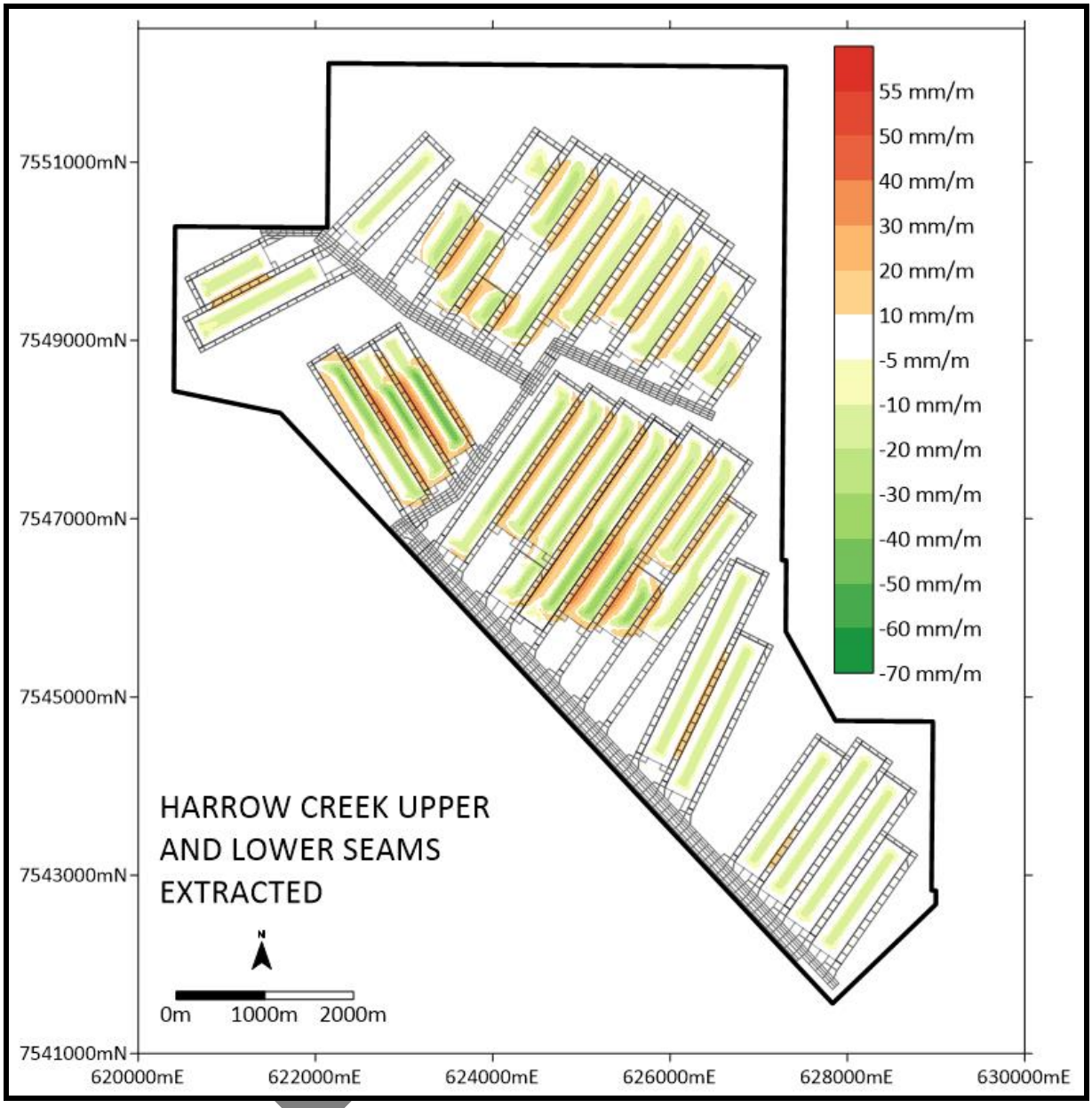


Figure 41. Strain after Extraction of the HCU and HCL Seams (m).

Once longwall extraction is completed in all three seams, the maximum tensile and compressive strains are 53 mm/m and 68 mm/m respectively (**Figure 42**).

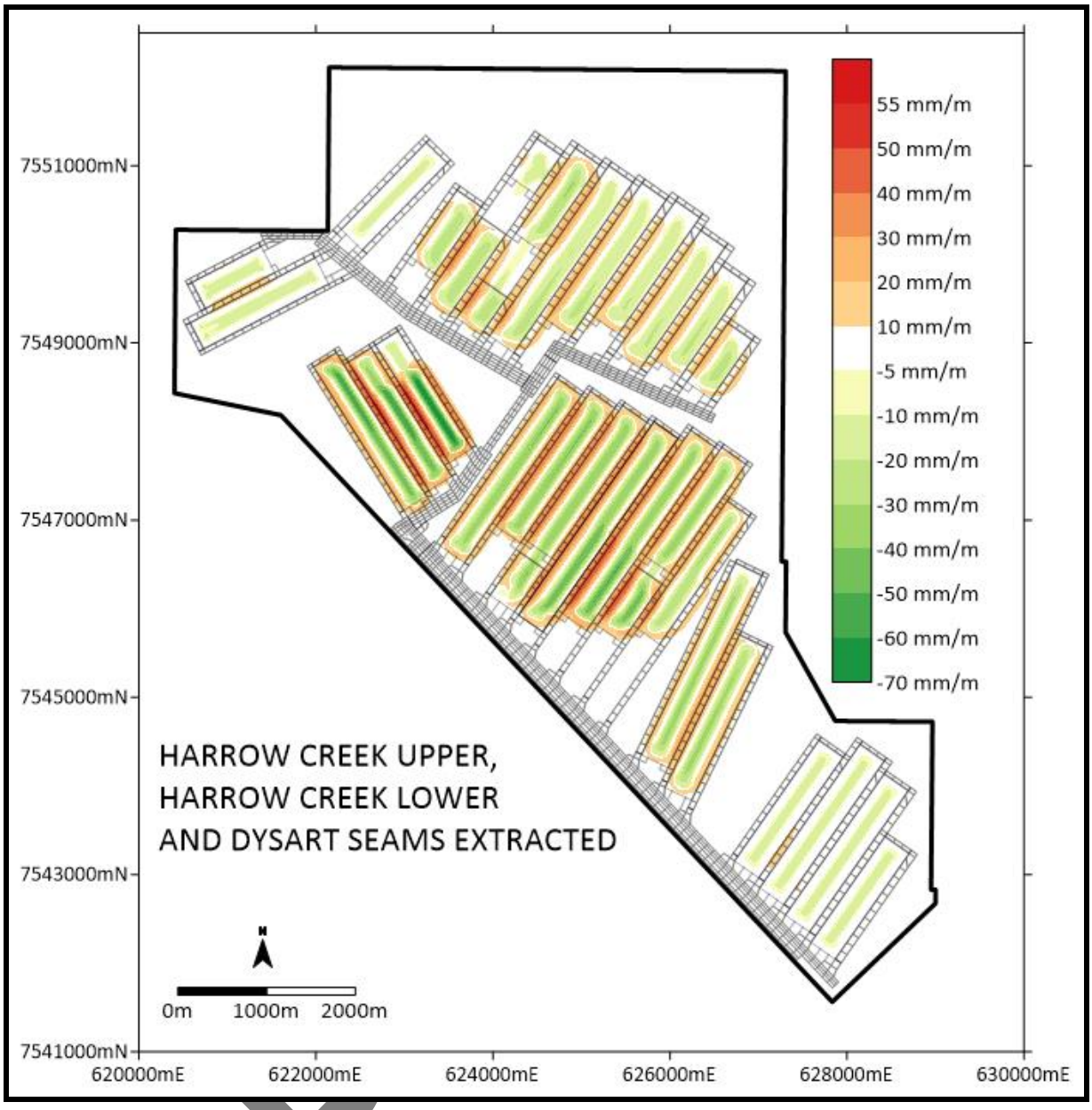


Figure 42. Strain after Extraction of the HCU, HCL and DY Seams (m).

4.4 Tilt

Tilt is the slope of subsided land over a given distance and is calculated by determining the change in subsidence between two points and dividing this by the distance between those points. The physical result of this is that post mine surface slopes become steeper in localized areas along the edges of the subsidence troughs.

The maximum tilts developed due to longwalling in the Harrow Creek Upper Seam range up to 2.1% or 21 mm/m (**Figure 43**).

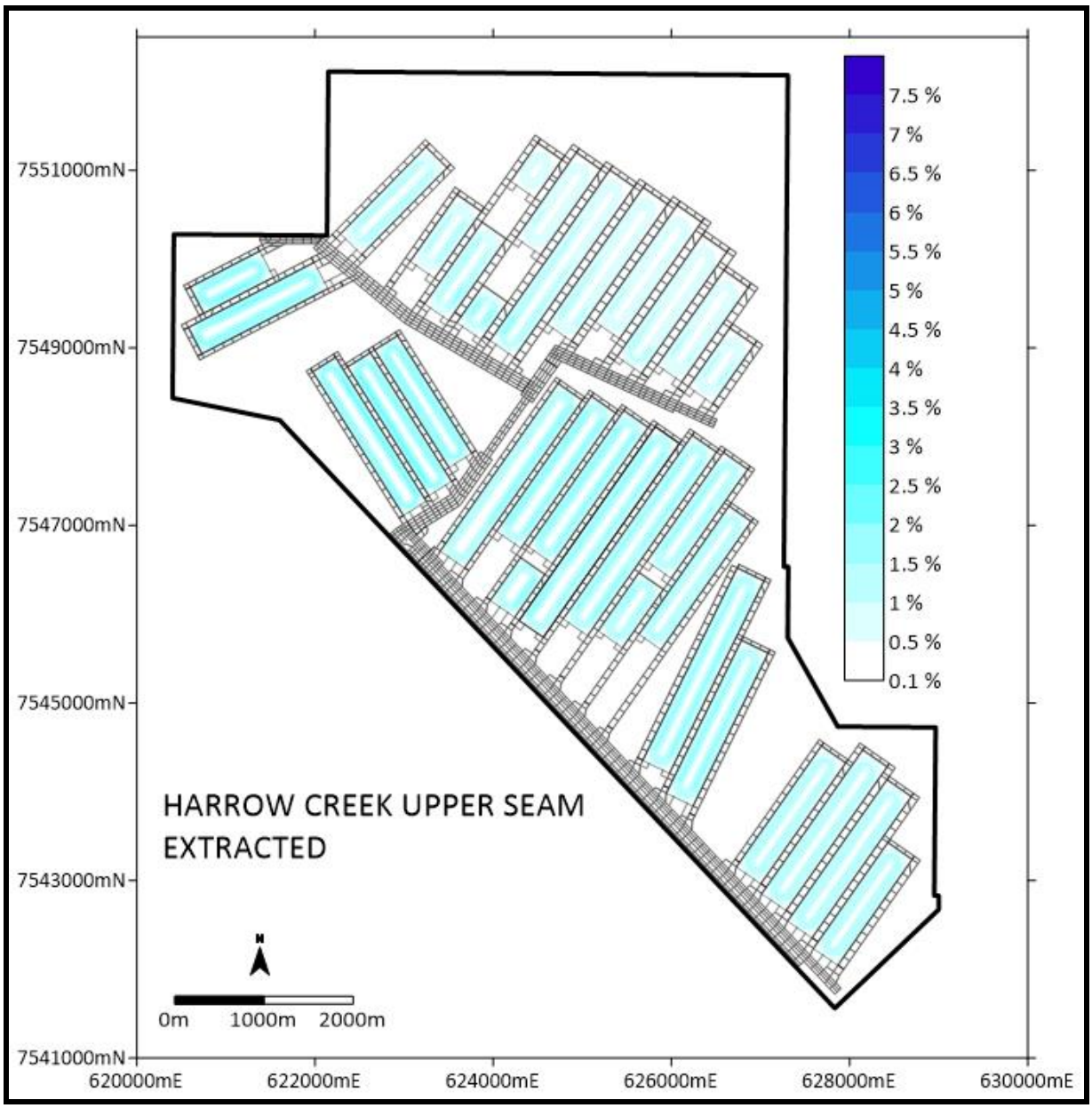


Figure 43. Tilt after Extraction of the HCU Seam (m).

With the extraction of the underlying Harrow Creek Lower Seam the maximum tilts increase to 5.2 % or 52 mm/m (**Figure 44**).

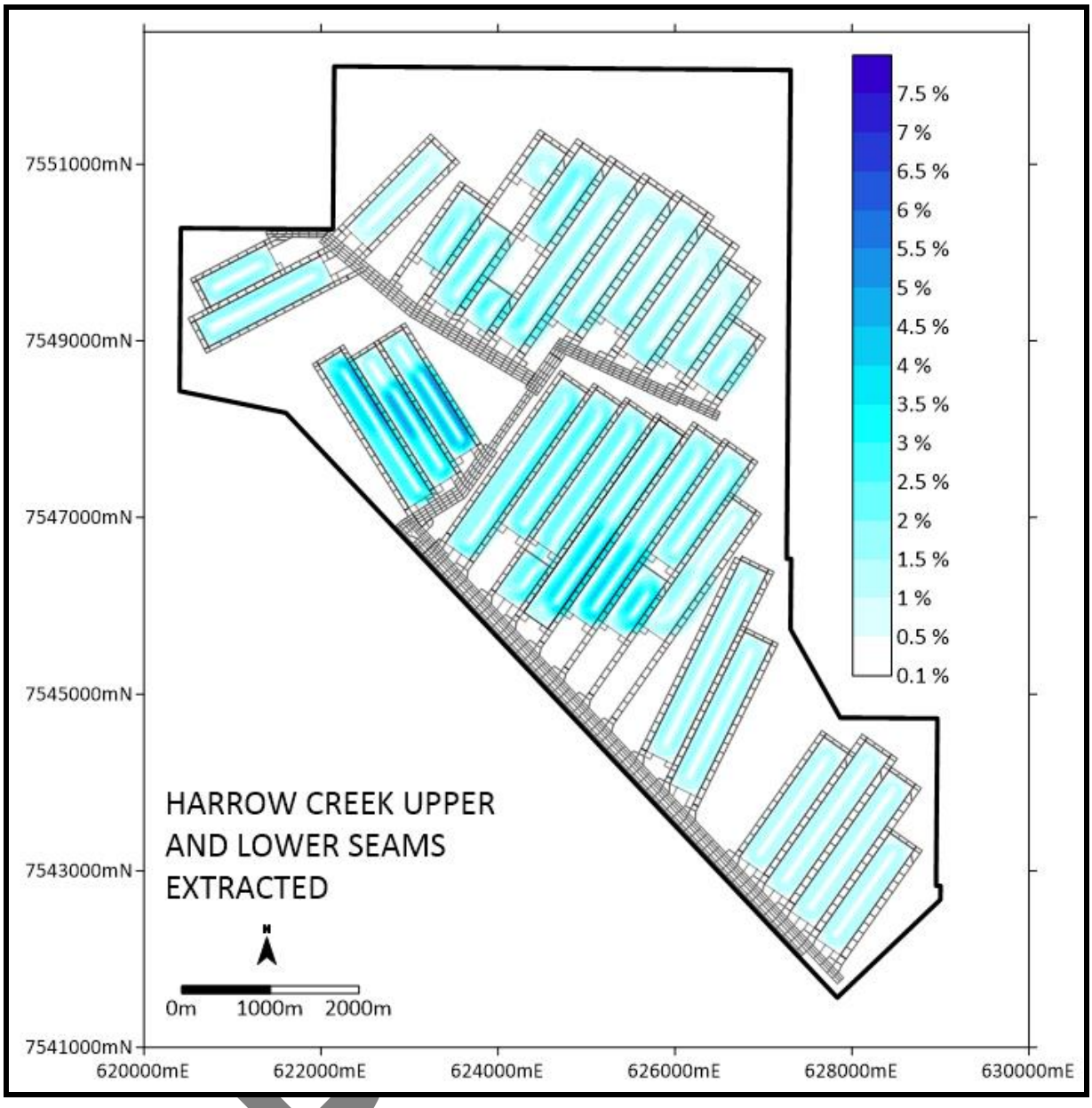


Figure 44. Tilt after Extraction of the HCU and HCL Seams (m).

The extraction of the Dysart Seam, increases the maximum tilt in the shallower part of the mining area to 7.2% (**Figure 45**).

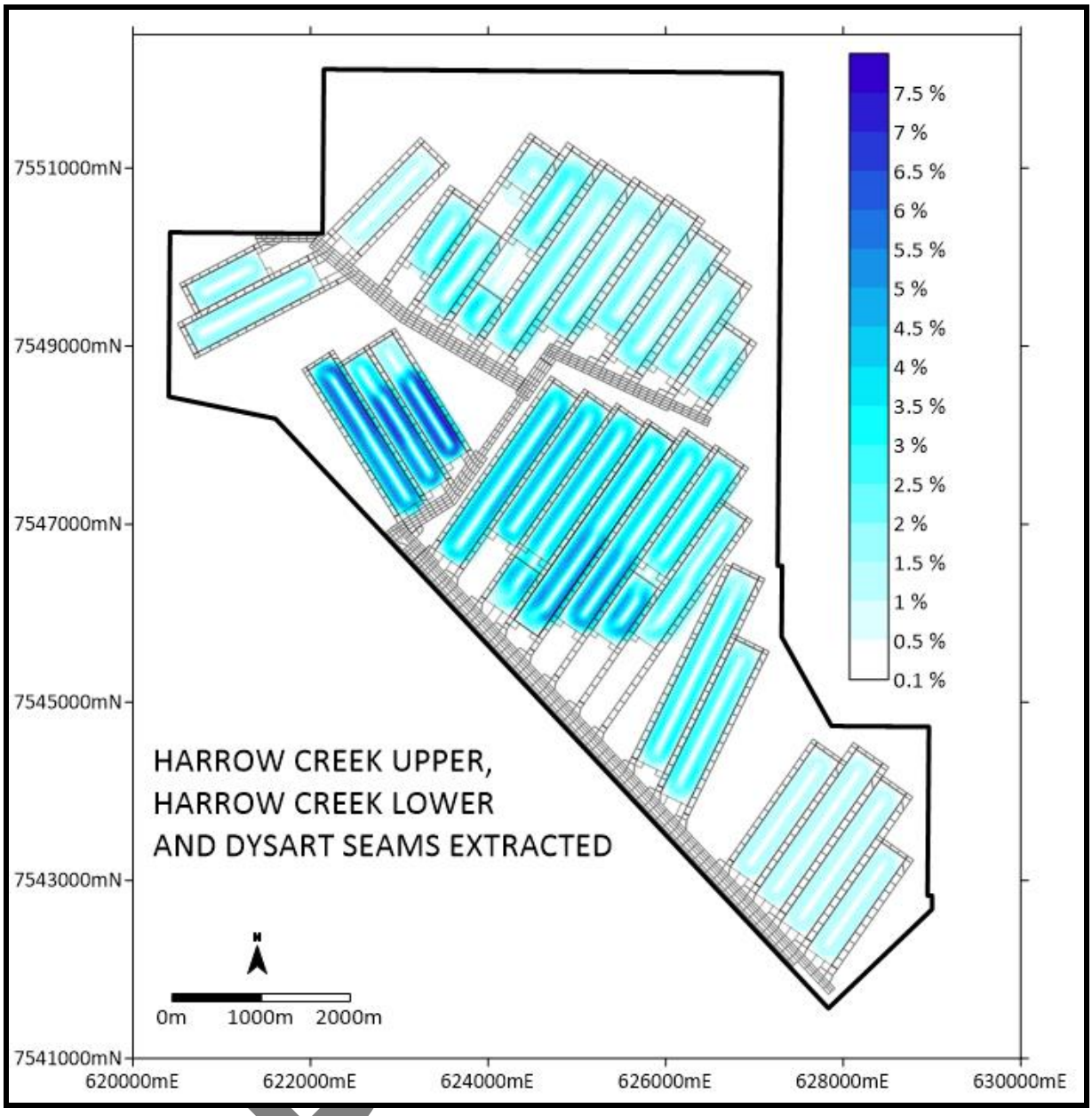


Figure 45. Tilt after Extraction of the HCU, HCL and DY Seams (m).

4.5 Limitations of the Subsidence Predictions

The subsidence predictions are final subsidence values after longwall mining is completed. The nature of the longwall mining method means that subsidence does not increase further over time. Based on subsidence monitoring at other mines in the Bowen Basin typically greater than 97% of the maximum subsidence will occur within 6 weeks after longwall mining is completed, assuming an industry average retreat rate of 100 m/week.

Based on the available data for the Eagle Downs longwall mining area, there are no localised features or variations in the geology, geotechnical conditions or surface topography that are considered likely to result in any significant deviations from the subsidence predictions presented in this report.

As is good engineering practice, a review of the predictions should be conducted as any new geological/geotechnical data and subsidence monitoring becomes available. This practice can be implemented through the Subsidence Management Plan, requiring a review by a suitably qualified and experienced person.

Overall, the subsidence predictions are based on well-established methodologies that have been proven to provide reliable predictions at numerous similar mining operations. In any areas of uncertainty, conservative assumptions have been applied. The predictions are therefore considered suitable for assessing the potential significant impacts of subsidence on the environment.

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5 OVERVIEW OF GENERAL SUBSIDENCE EFFECTS

The previous section has documented the predicted surface deformations associated with longwalling in the Eagle Downs area. This section reviews the effects that these deformations may have on both the overburden rock mass and the surface.

5.1 Subsurface Cracking

5.1.1 Background to Subsurface Subsidence Cracking

Longwall mining methods can induce a range of subsurface subsidence effects. In the context of changes to the hydrogeological regime, the key issue associated with longwall subsidence is the creation of subsurface subsidence cracks in the rock mass. These cracks may provide new flow paths for groundwater and alter the permeability of the strata overlying longwall mining areas. The potential changes in the hydrogeological characteristics of the rock mass are dependent upon a number of variables that may affect the behaviour of subsurface subsidence cracking, such as:

- Mine geometry.
- Extracted seam thickness.
- Thickness and geomechanical properties of the overburden.
- Presence of tuffaceous horizons that may restrict the vertical flow of groundwater and
- The bulking and compaction of the goaf material.

For operating longwall mines, it is possible to measure key subsurface subsidence cracking characteristics including the height of cracking above the extracted coal seam. This information can be correlated to measured changes in the water regime, for example decreases in groundwater levels in boreholes or inflows to underground mining areas. This provides accurate site-specific data on the known characteristics and impacts of subsurface subsidence cracking within the geological sequence.

A range of different methodologies are used to determine the heights of subsurface subsidence cracking associated with existing mining operations, such as:

- Borehole extensometers.
- Piezometer records.
- Drilling records.
- Comparison of permeability testing and
- Microseismic monitoring.

5.1.2 Prediction of Subsurface Subsidence Cracking Effects due to Single Seam Extraction

The prediction of subsurface subsidence cracking above single seam extraction longwall panels has been extensively studied using both empirical and numerical modelling methods.

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Models based upon empirical evidence such as observation and measurement are commonly used to predict the effects of subsidence. Empirical hydrogeological models for subsided strata are typically based on the interpretation of water inflow events.

The most commonly cited empirical model developed for predicting subsurface subsidence cracking effects on groundwater and surface water is the Bai and Kendorski (1995) model (**Figure 46**). The key principle of this model is that subsurface subsidence cracking can be characterised by the following zones:

- **Constrained** zone – unaffected by subsurface subsidence cracking.
- **Dilated** (or **discontinuous** cracking) zone – no changes in vertical permeability, possible changes in horizontal permeability and storativity.
- **Fractured** (or **continuous** cracking) zone – changes in vertical and horizontal permeability are possible.

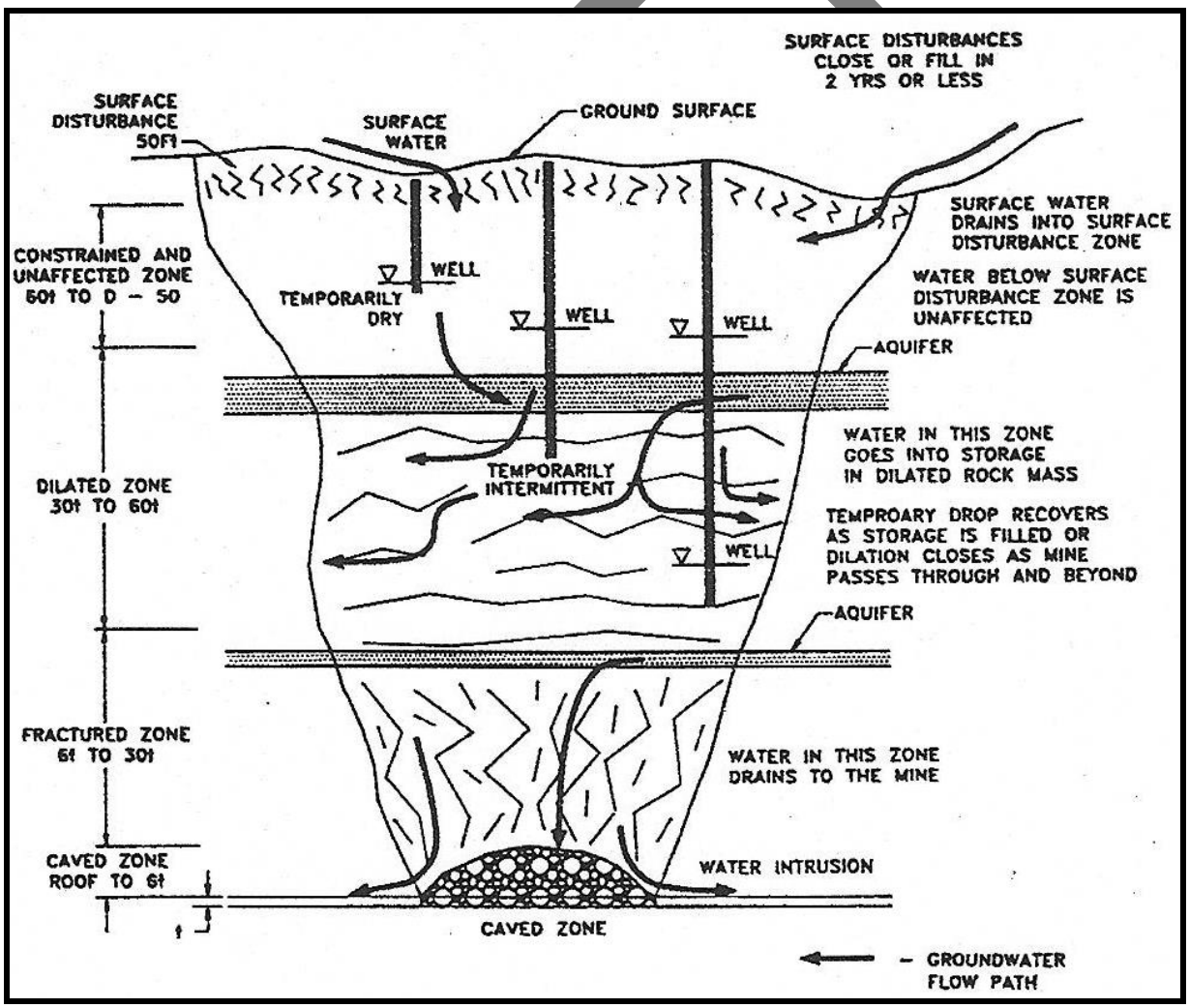


Figure 46. Hydrogeological Model for Fracturing above Longwalls (Bai and Kendorski, 1995).

In this model, cracking within the **dilated** (or **discontinuous** cracking) zone is dominantly horizontal, with negligible vertical cracks. In this zone, there may be an increase in horizontal permeability but this is not likely to result in significant inflows to the underground workings. The **fractured** zone nomenclature is related to the zone of vertical hydraulic connectivity (or unrestricted **continuous** inflow) and does not imply the limit of all cracking.

This hydrogeological model concludes that water will enter an underground mine or be lost from an aquifer or surface water body if:

- The zone of **continuous** subsurface cracking intersects the water body, or
- There is a connection between the **continuous** subsurface cracking zone and any surface subsidence cracking.

The heights of subsurface subsidence cracking in hydrogeological models such as that of Bai and Kendorski are related to extracted coal thickness. In **Figure 46**, the **fractured** zone is shown to range from 6 to 30 times the extracted seam thickness.

Alternative models are available which relate the height of continuous cracking to the mining induced tensile strains and depths of cover. However, the overall concept of dividing the rock mass into different cracking zones is common to all methods and is a well-established and valid approach to explain the measured differences in field observations arising from subsurface subsidence cracking (Gale, 2008).

Measured data taken from comparable mining operations in equivalent geology can also be used to assist with the prediction of the likely extent of each subsurface cracking zone and, in particular, the boundary between **discontinuous** and **continuous** zones of subsurface subsidence cracking.

The behaviour of the subsided rock mass can also be assessed using numerical modelling methods. Commercially available modelling software includes the Fast Lagrangian Analysis of Continua (FLAC) model. Numerical modelling of subsurface cracking requires robust calibration, verification and validation to minimise the potential for erroneous results and requires reference to measured data.

Consequently, numerical modelling would not provide a higher level of accuracy than empirical methods in the prediction of subsurface cracking, as the basis of the predictions would be essentially the same.

5.1.3 Prediction of Subsurface Subsidence Cracking Effects due to Multi-Seam Extraction

GGPL is not aware of empirical studies examining the height of subsurface cracking above multi-seam longwalls, however, some physical modelling work by Ghabraie and Ren (2014) is detailed below to provide an understanding of the subsurface strata movement in a multi-seam longwall mine.

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Ghabraie and Ren built a physical model to investigate the mechanism of surface and subsurface movements of the strata in a multi-seam longwall environment (**Figure 47**). The upper seam, located 24 m above the lower seam, was extracted first. The panel width in both seams was 120 m and the extraction height was 4.5 m. The depth of cover above the upper seam was 80 m, indicating supercritical subsidence behaviour (panel width to depth of cover ratio of 1.5).

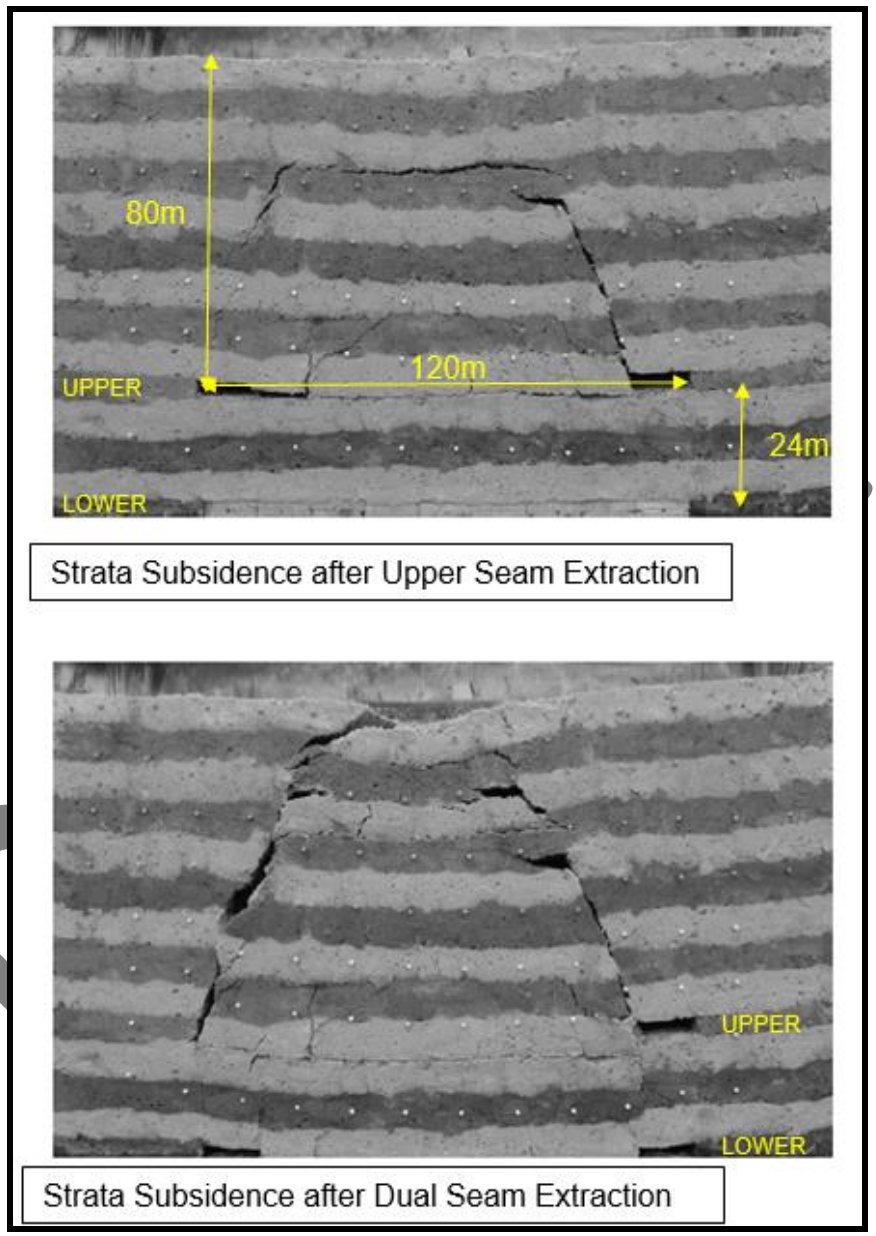


Figure 47. Results of Physical Modelling of Multi-Seam Subsidence (Ghabraie and Ren, 2014).

As shown in **Figure 47**, some reworking of the upper seam goaf occurs when the lower seam is extracted. The model indicates that the height of cracking above the upper seam is increased once both seams are extracted. It is noted that additional cracking was not observed outside the previously caved zone. A conceptual model for this reworking of the upper seam goaf is shown in **Figure 48**.

Ghabraie and Ren (2014) found that the initial cracks formed by the extraction of the upper seam could change the crack propagation above the lower seam. Subsidence from the extraction of the lower seam opens up existing cracks and induces greater bedding separation. This is highlighted by the different displacement profiles for the two mining scenarios (**Figure 48**).

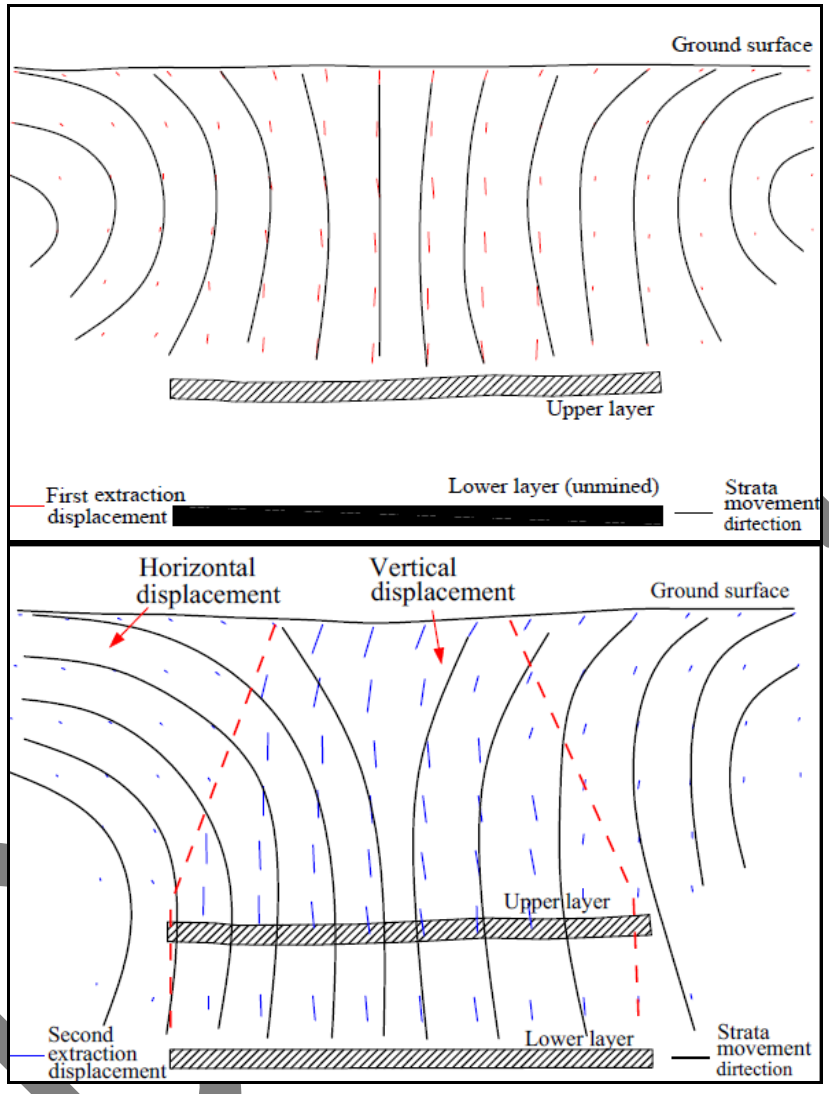


Figure 48. Displacement Profiles of Upper and Lower Seam Extraction (Ghabraie and Ren, 2014).

The subsurface strata cracking profile after extraction of the upper seam shows a balanced movement between horizontal and vertical components (**Figure 48**). In comparison, after the lower seam is extracted, the vertical movement is mainly restricted to a wedge shaped area, shown by dotted red line in **Figure 48**. Outside this wedge area, the horizontal displacement is the predominant displacement component.

The interburden between the seams in the Eagle Downs area is 40-80 m and slightly thicker than the Ghabraie and Ren model in **Figure 47**. The extraction height is similar to the proposed extraction heights in all three seams. It is also noted that the depth of cover and panel width are somewhat less than in the Eagle Downs area.

In summary, whilst the physical model has some differences to the proposed multi-seam mining in the Eagle Downs area, it provides useful insight to the potential subsurface cracking mechanism, particularly the reworking of the upper seam goaf material.

5.1.4 Comparative Assessment of Subsurface Subsidence Cracking Predictions for Single Seam Extraction

5.1.4.1 Microseismic Monitoring Data

Microseismic monitoring involves the use of geophones installed in boreholes to record the development of fractures by measuring microseismic events. Microseismic monitoring is one of the most reliable tools for determining the interface between continuous and discontinuous subsurface subsidence cracking. Published monitoring data is available from two Bowen Basin longwall mines.

At North Goonyella Mine, microseismic monitoring of a 250 m wide longwall panel, at approximately 150 m depth of cover was carried out. The extraction height was up to 4 m high. As shown in **Figure 49**, the majority of microseismic events occur within 120 m of the extracted seam. These results indicate the monitored limit of continuous cracking is 120 m.

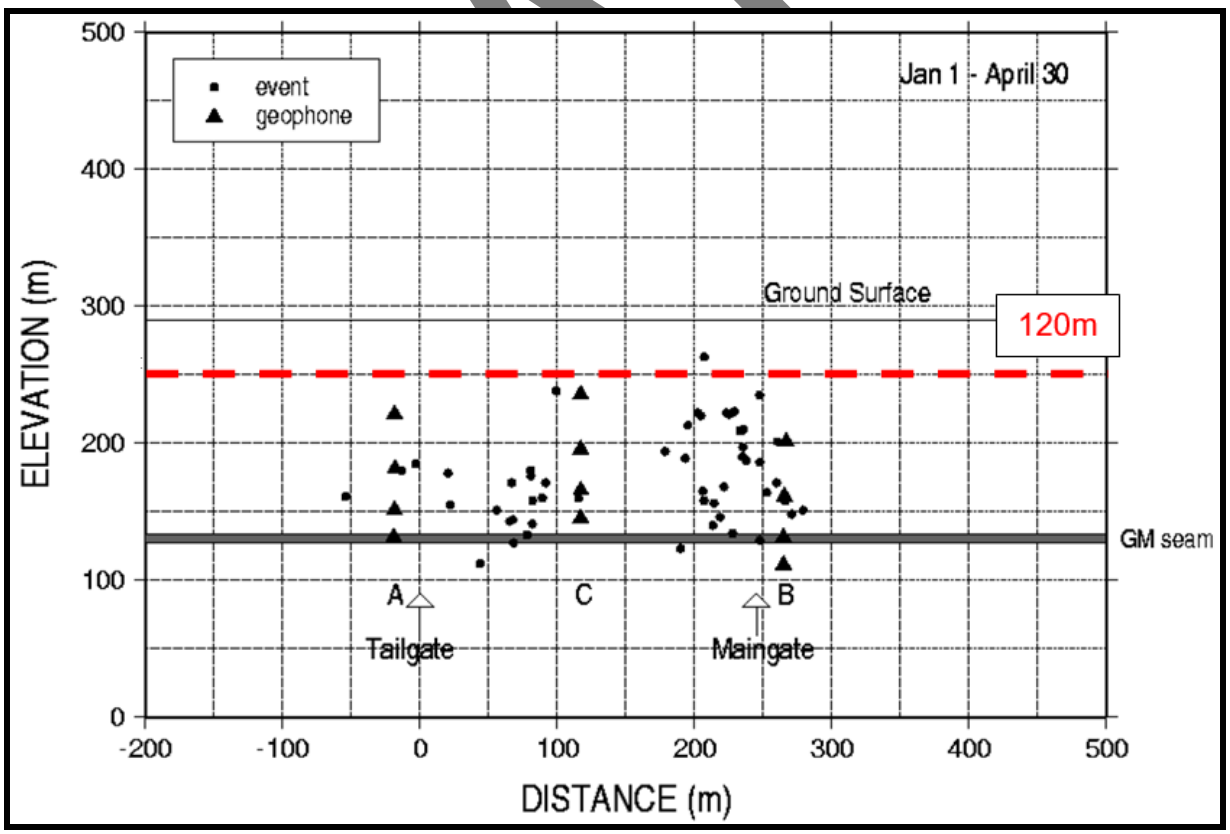


Figure 49. Location of Microseismic Events above LW3 at the North Goonyella Mine (Kelly and Gale, 1999).

Similarly, microseismic monitoring above the 200 m wide, LW101 panel at Kestrel Mine indicates a marked reduction in events (i.e. cracking) at 90 m above the seam (**Figure 50**). This was taken to be the limit of monitored continuous cracking. No microseismic events were recorded higher than 120 m above the extracted seam (**Figure 50**). The depth of cover and extraction height in this area of the mine was 220 m and 3 m, respectively.

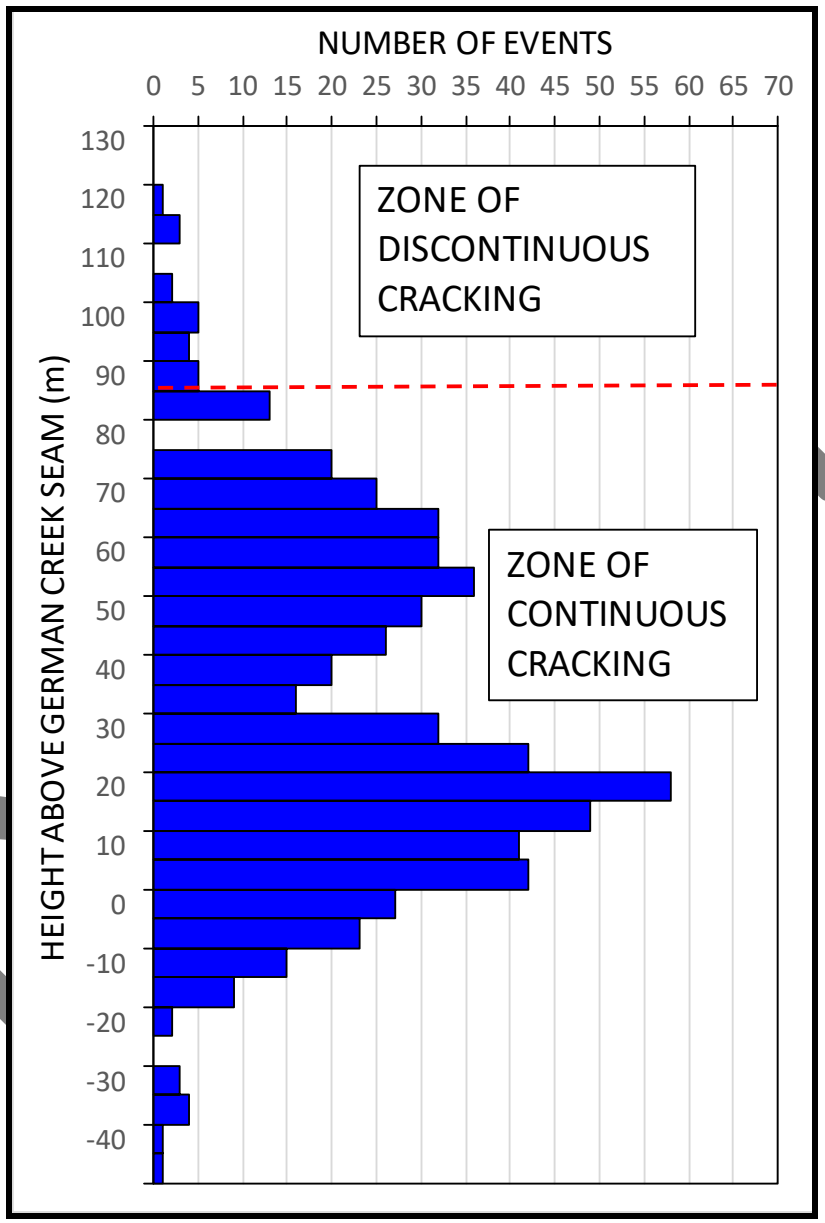


Figure 50. Location of Microseismic Events around LW101 at Kestrel Mine (Reproduced from Kelly and Gale, 1999).

5.1.4.2 Water Inflow Events in the Bowen Basin

Seedsman and Dawkins (2006) provide a comprehensive summary of subsurface subsidence cracking and water inflow events in the Bowen Basin. Seedsman and Dawkins report that:

- No major **surface water** inflows to longwall mining areas have occurred in the Bowen Basin where the depth of cover has exceeded **120 m**; and
- No major groundwater inflows to longwall mining areas have occurred in the Bowen Basin where the distance from the seam to the **aquifers** is more than approximately **90 m**.

Klenowski (2000) reports on the inflow of water at the Oaky Creek Mine and the German Creek mining complex in the central part of the Bowen Basin. These mines target the German Creek Coal Measures, which comprise a sequence of sandstones, siltstones, mudstones and coal seams.

Klenowski concluded that unrestricted inflow (i.e. from the zone of **continuous** cracking) generally occurs to a height of about 120 m above the active mine area. The inflow rates for different heights of cracking in the German Creek mining complex, as well as other comparable mining operations, extracting single seam longwalls, throughout the Bowen Basin, Australia and overseas, are plotted in **Figure 51**.

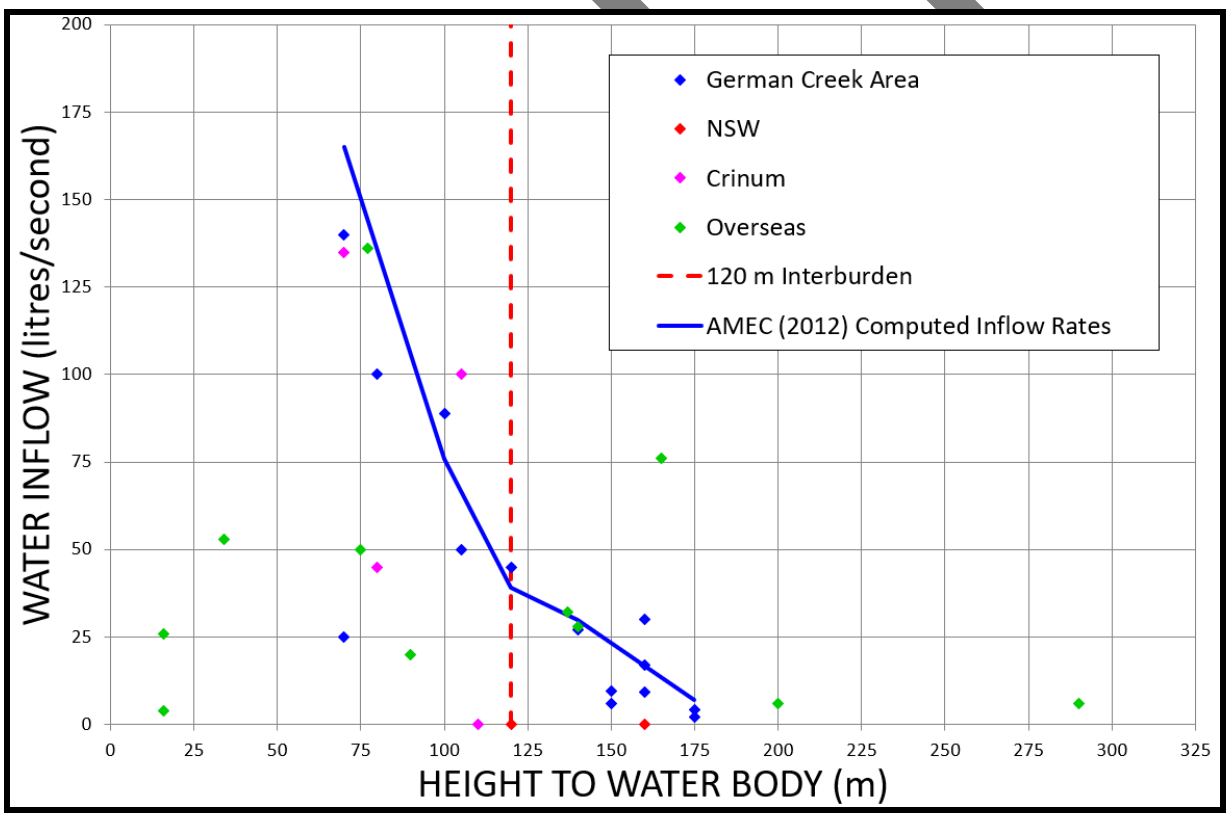


Figure 51. Summary of Water Inflow Events.

Evidence from Crinum Mine and Kestrel Mine, suggests that the presence of Tertiary clay materials in the overburden within the cracking zone may have retarded water inflow rates to underground workings (Seedsman and Dawkins, (2006) and Gale, (2008)).

5.1.4.3 Numerical Modelling

Published numerical modelling studies by Gale (2008) in the Oaky Creek area showed a distinct decrease in the vertical conductivity to around 10^{-6} m/s, at beyond 90 to 100 m above the coal seam (**Figure 52**). This is also consistent with the field observations described above. The progressive reduction in vertical conductivity from 1 m/s close to the extracted seam, decreasing to 10^{-4} m/s at the top of continuous cracking zone is shown in **Figure 52**.

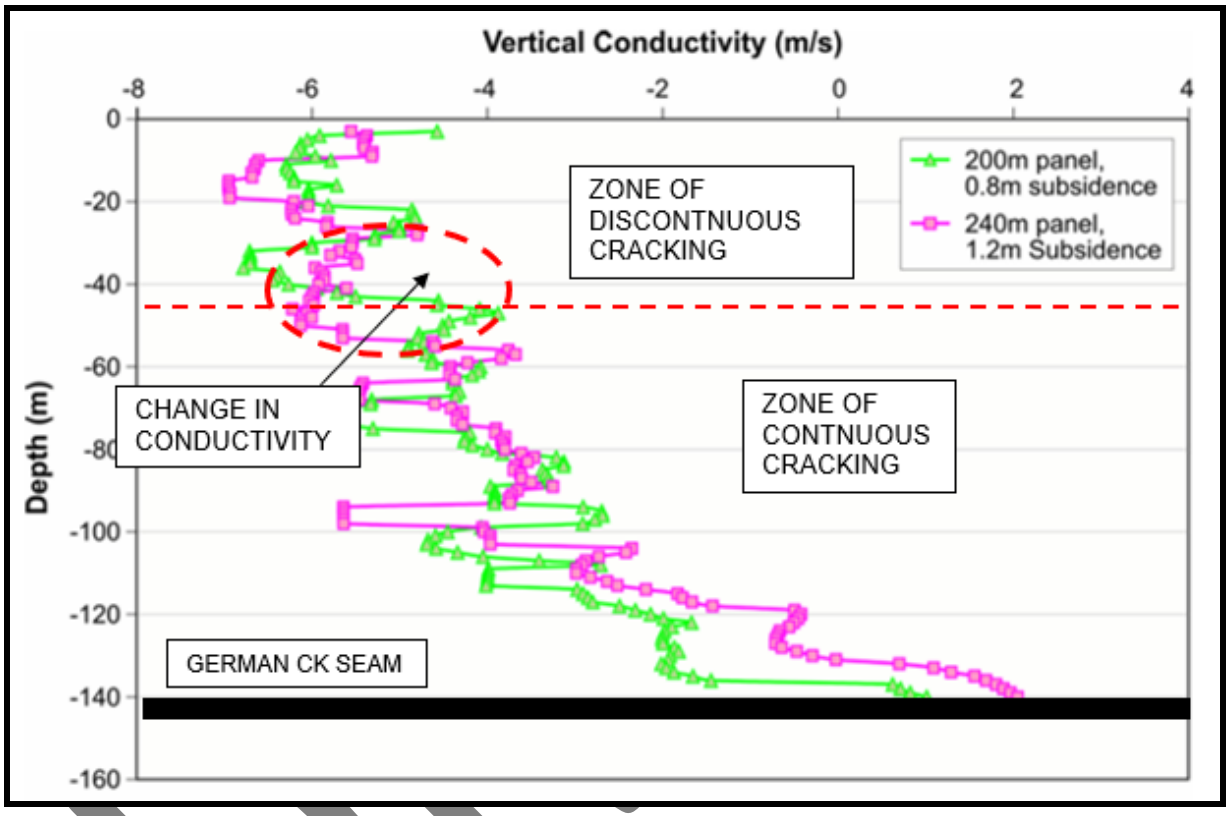


Figure 52. Vertical Conductivity through a Numerical Model in the Southern-Oaky Creek Area (Gale, 2008).

5.1.4.4 Summary of Data

Field observations of heights of subsurface subsidence cracking from mines in QLD, NSW and overseas are summarised in **Table 1**.

Gale (2008) also reports that 105 m of rock head is used as a standard buffer distance to minimise the risk of inflow events in the UK.

These thicknesses are consistent with monitoring conducted in NSW mines, where the potential for surface water to flow into underground longwall workings is recognised if the longwall panel is less than 100 m to 150 m below the surface.

Mining Area	Height of Continuous Cracking	Discussion/Evidence
Crinum, QLD	90-100 m	Height to overlying basalt/sand aquifers in the Tertiary (Seedsman and Dawkins, 2006).
NSW	100-150 m	The potential for surface water to flow into underground longwall workings is recognised if the longwall panel is less than 100 m to 150 m below the surface (Seedsman and Dawkins, 2006).
Oaky Creek and German Creek, QLD	<160 m	For ponded water at cover depths greater than 160 m, remedial works are generally not required and standard underground pumping systems are capable of handling minor increases in flow (Klenowski, 2000). Unrestricted inflow generally occurs to a height of about 120 m above the active mine area, with inflow rates progressively reducing as the depth of cover increases above 120 m (Klenowski, 2000).
Kestrel, QLD	<115 m	Microseismic monitoring of LW101. (Kelly and Gale, 1999).
North Goonyella	<120 m	Microseismic monitoring of LW3. (Kelly and Gale, 1999).
Wyee, NSW	40-63 m	Wide panels and strong, massive roof strata (Forster and Enever, 1992).
Cooranbong, NSW	58 m	Wide panels and strong, massive roof strata (Forster and Enever, 1992).
Wistow Mine, UK	77 m	Limestone aquifer (Whittaker and Reddish, 1989).
UK	<105 m of rock head	Guideline to minimise the risk of inflow (Gale, 2008).
Northern Bowen Basin	<170-250 m	Longwalls (312 m wide and 4.5 m high) successfully extracted beneath the Isaac River.

Table 1. Field Observations and Guidelines for the Height of Cracking.

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5.1.5 Conclusions

The estimation of the height and behaviour of subsurface subsidence cracking is a complex issue and there is no simple calculation to estimate the height of the continuous and discontinuous zones.

5.1.5.1 Single Seam Extraction

Based upon the measured data, microseismic monitoring and empirical guidelines the subsurface subsidence cracking predictions due to single seam longwall extraction in the Eagle Downs area can be summarised as:

- A zone of **continuous** cracking extending up to approximately **120 m** above the extracted seam; and
- A zone of **discontinuous** cracking extending no higher than **180 m** above the extracted seam.

This is consistent with the available data from other longwall mining operations in QLD, NSW and overseas and hence provides a robust basis for the assessment of potential groundwater impacts associated with continuous cracking in single seam longwall mining areas.

5.1.5.2 Multi-Seam Extraction

The estimation of the height and behaviour of subsurface subsidence cracking for multi-seam mining is further complicated by the lack of monitoring data available. The physical model studies detailed in Section 5.1.3, provide a better understanding of the failure mechanisms in the overburden.

Due to potential weakening of the overburden strata in the **discontinuous** cracking zone in overlying goaf, the zone of **continuous** cracking is conservatively inferred to extend to **180 m** above the upper seam extracted, which in the majority of the area is the Harrow Creek Upper Seam.

This 50% increase from the predicted continuous cracking height for single seam extraction should more than adequately account for the uncertainty associated with multi-seam extraction and therefore provide a conservative basis for the purposes of assessing potential worst case groundwater impacts.

5.1.5.3 Connective Cracking to the Surface

In any areas where the depth of cover to the extracted coal seam is less than the combined height of connective cracking and surface crack depth, connective cracking to the surface could potentially occur.

The shallowest depth of extraction in the Eagle Downs area is 270 m in the western Harrow Creek Upper Seam area (**Figure 12**). As such, connective cracking to the surface is not anticipated.

5.2 Surface Cracking

5.2.1 Overview

The differential lowering of the ground surface due to subsidence creates areas of residual tensile strain around the perimeter of the subsidence troughs. After longwall mining has been completed, permanent tension cracks can potentially develop in the areas of residual tensile strain.

Although the zone of residual strain (i.e. the zone where surface subsidence cracking can occur) is generally located around the perimeter of each longwall panel, the

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exact location and extent of the zone of residual strain for a particular longwall panel varies depending on the depth of cover, panel and pillar width, and the geology. Less surface cracking (both in terms of number of cracks and size of cracks) occurs when mining is undertaken at greater depths, compared to shallower mining.

Transient tension cracks may also form in areas of transient tensile strain above the retreating longwall. However, these cracks typically close again after a short period (within days) as the longwall retreats and the transient subsidence wave and associated transient tensile strain passes.

5.2.2 Tension Cracks

Subsidence related cracking of the surface will develop in the Eagle Downs longwall mining area. Whether it is discernible from the natural cracking that characterises some of the soils of the Eagle Downs longwall mining area will depend on the interaction between the cracks, the soil, and water. The areas with the highest potential for cracking are those located at the panel edges where the maximum tensile strain occurs (**Figure 40 to Figure 42**).

5.2.2.1 Single Seam

Experience from operating single seam longwall extraction mines in the Bowen Basin indicates the majority of subsidence cracks in the Eagle Downs area are anticipated to be <1 m deep.

It is noted that based on the principles of fracture mechanics, there is likely to be a direct relationship between crack width and crack depth i.e. narrow surface cracks will be shallower than wide cracks.

MSEC (2007) also proposed a relationship between crack width and depth of cover with the severity and frequency of surface cracking reducing as the depth of cover increases (**Figure 53**).

Based on **Figure 53**, and experience at a number of operating Bowen Basin longwall mines, maximum crack widths up to 100 mm could be expected in the shallower parts of the Eagle Downs longwall area, decreasing to <50 mm wide in the deeper areas (**Figure 53**).

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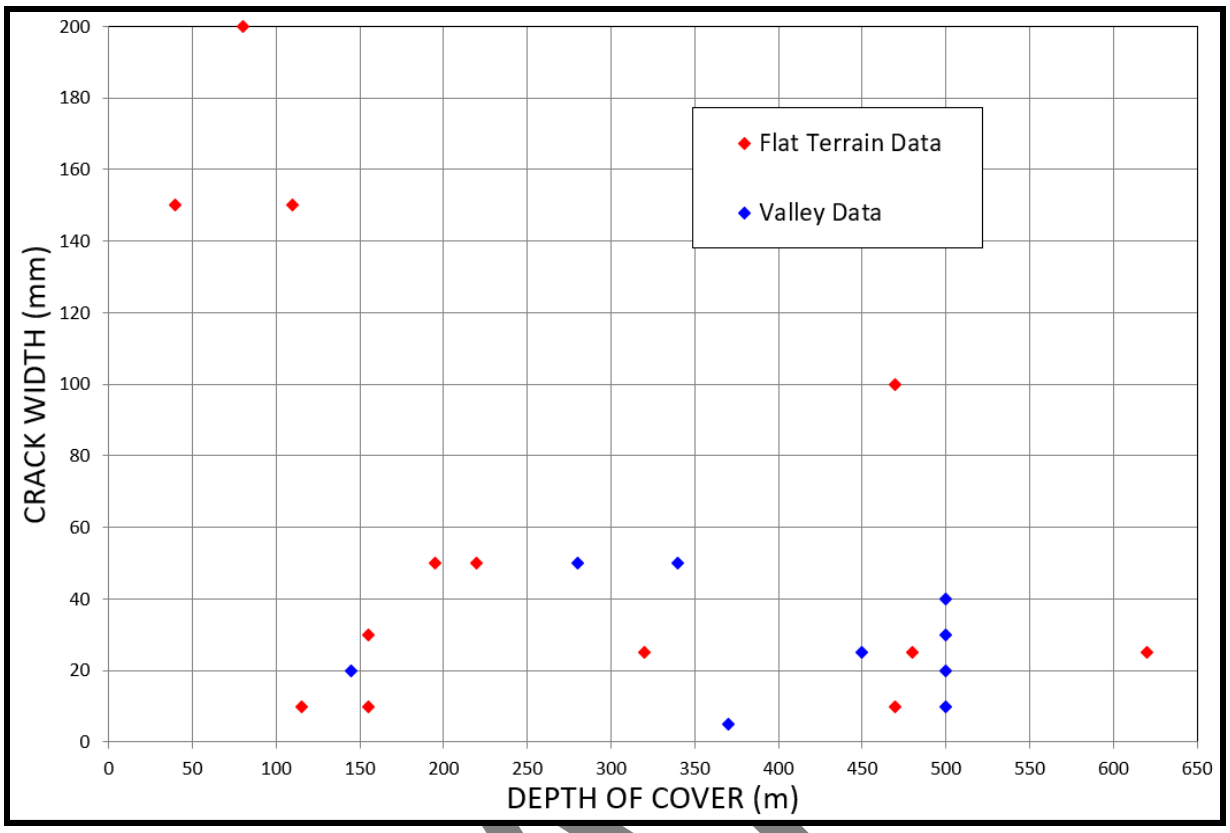


Figure 53. Crack Width and Depth of Cover (reproduced from MSEC, 2007).

5.2.2.2 Multi-Seam

In the multi-seam mining areas, reworking and widening of existing cracks is predicted.

5.2.2.3 Prediction

Based on experience at a number of operating Bowen Basin longwall mines, maximum crack widths up to 100 mm could be expected above the shallower longwalls, decreasing to less than 50 mm in the deeper parts of the Eagle Downs longwall mining area during single seam extraction. Reworking and widening of existing cracks is anticipated in the multi-seam mining areas.

The maximum predicted depth of cracking above the longwall panels in the Eagle Downs longwall mining area is 10-15 m, with the majority of cracks predicted to be less than 1 m deep.

Cracks of this width and depth are amenable to small scale rehabilitation works that are routinely carried out at other longwall mines in the Bowen Basin. This typically involves stripping of the topsoil, excavating and backfilling of the cracks. The topsoil is then respread over the area and the site allowed to regenerate naturally from the seed bank in the topsoil, as well as from rootstock and recruitment from adjacent vegetation. This rehabilitation process can be documented in a Subsidence Management Plan (SMP).

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5.3 Buckling and Heaving

When the near-surface strata break, the resulting blocks of rock interact and can produce localised movements. As well as surface cracking, other subsidence effects include buckling and heaving of the surface.

These types of effects tend to occur less frequently than tension cracks and occur more commonly within the centre of the longwall panel area, rather than around the perimeter.

5.4 Surface Drainage Effects

Subsidence can result in the formation of localised depressions in the surface topography that can cause ponding of surface drainage. The post-subsidence surface topography has been used to assess the potential for ponding detailed in the Surface Water Section of the Eagle Downs EIS.

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6 CONCLUSIONS

The key conclusions from this report include:

1. Based on subsidence data from the Bowen Basin, the following parameters were used for modelling in the proposed Eagle Downs longwall mining area:

    - Panel Adjustment Factor of 0.2.
    - Influence Angle of 70º.
    - Strain Coefficient of 0.35.
    - Maximum Subsidence Factor of 65% for extraction in virgin ground.
    - Subsidence Factors in areas of overlying goaf areas (based on interburden thicknesses):
        - HCL Seam below extracted HCU Seam – 90%
        - DY Seam below extracted HCU Seam – 75% (no HCL extraction).
        - DY Seam below extracted HCL Seam – 85% (no HCU extraction).
        - DY Seam below extracted HCU and HCL seams – 95%,

2. Once the extraction of all three target seams has been completed, a maximum vertical subsidence of 10 m is predicted in the shallower south-western part of the mining area. Horizontal movements of up to 3.8 m are anticipated associated with the vertical subsidence.

3. The maximum tensile strains due to longwall extraction of all three seams range in magnitude up to 53 mm/m. Maximum compressive strains range up to 68 mm/m.

4. The maximum tilts developed at the completion of mining range up to 7.2% or 72 mm/m, which is equivalent to a change in slope of 4.1 degrees.

5. Based on subsidence monitoring at other Bowen Basin longwall mines, greater than 97% of the maximum subsidence will typically occur within 6 weeks after longwall mining is completed, assuming an industry average retreat rate of 100 m/week.

6. There is confidence in the subsidence predictions due to the amount of information available from other Bowen Basin mines. This data has allowed a good calibration to be achieved and provided a sound basis to enable conservative prediction of potential environmental impacts due to subsidence effects. It is not considered that there will be significant deviations from the current predictions due to topographic, geological or geotechnical variations.

7. Based on field measurements and observations in Australia and overseas, continuous subsurface subsidence cracking up to 120 m is predicted in the single seam extraction areas, extending to a conservative 180 m in the multi-seam extraction areas.

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8. The depth of cover above the Eagle Downs longwall mining area indicates that subsurface subsidence cracking is not predicted to extend to the ground surface.

9. Above the continuous cracking zone there may be an increase in horizontal permeability but this is not likely to result in significant inflows to the underground mine workings.

10. Surface subsidence cracks will develop in the proposed longwall mining areas. The areas with the highest potential for cracking are those located at the panel edges where the maximum tensile strain occurs. The widest of these cracks are predicted to extend to no more than 10-15 m below ground level, with the majority <1 m deep. Maximum surface crack widths up to 100 mm could be expected in the shallower parts of the area, decreasing to <50 mm at greater depths. Reworking and widening of existing cracks is predicted where multi-seam mining occurs. Cracks of this size can be readily remediated.

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Appendix M. Topsoil Quality Assessment

TECHNICAL REPORT

Topsoil Quality Assessment

Eagle Downs

Prepared for: Eagle Downs Metallurgical Coal

MINE WASTE AND
WATER MANAGEMENT

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TECHNICAL REPORT

Topsoil Quality Assessment

Eagle Downs

Prepared for: **Eagle Downs Metallurgical Coal**

Limitations and disclaimer:

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This report should be read in full. While the findings presented in this report are based on information that RGS considers reliable unless stated otherwise, the accuracy and completeness of source information cannot be guaranteed, although RGS has taken reasonable steps to verify the accuracy of such source data. RGS has made no independent verification of this information beyond the agreed scope of works and RGS assumes no responsibility for any inaccuracies or omissions outside of RGS's direct control. Furthermore, the information compiled in this report addresses the specific needs of the Client, so may not address the needs of third parties using this report for their own purposes. Thus, RGS and their employees accept no liability for any losses or damage for any action taken or not taken on the basis of any part of the contents of this report. Those acting on information provided in this report do so entirely at their own risk.

This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

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Glossary of terms and acronyms

Acidity	A measure of hydrogen ion (H+) concentration and certain dissolved metals in a solution when titrated to a set pH value; generally expressed as mg/L $CaCO_3$ equivalent..
ABA	Acid Base Account. Evaluation of the balance between acid generation and acid neutralisation processes. Determines the maximum potential acidity (MPA) and the inherent acid neutralising capacity (ANC), as defined below.
ALS	Australian Laboratory Services.
AMD	Acid and metalliferous drainage from mine waste materials characterised by low pH, elevated metal concentrations, high sulfate concentrations and high salinity.
ANC	Acid Neutralising Capacity expressed as kg H_2SO_4 per tonne of sample. A measure of a sample's maximum potential ability to neutralise acid.
ANC:MPA	The ratio of the acid neutralising capacity to the maximum potential acidity of a sample. Used to assess the risk of a sample generating acid conditions.
AS	Australian Standards
Dispersive	Dispersive soil and rock materials are structurally unstable and disperse into basic particles such as sand, silt and clay in water. When a dispersive soil is wet, the basic structure has a tendency to collapse, whereas when it is dry it is prone to surface sealing and crusting.
EC	Electrical Conductivity, expressed as µS/cm.
eCEC	Effective cation exchange capacity provides a measure of the mass of exchangeable cations (Ca, Mg, Na and K) in a sample.
EIS	Environmental Impact Statement.
ESP	Exchangeable sodium percentage provides a measure of the sodicity of a material and propensity to erode.
EA	Emmerson Aggregate
FIMS	Flow Injection Mercury System.
GAI	Geochemical Abundance Index
ICP-MS	Inductively Coupled Plasma Mass Spectrometry
ICP-AES	Inductively Coupled Plasma Atomic Emission Spectrometry.
INAP	International Network on Acid Prevention
LoR	Limit of Reporting. Laboratory detection limit for the reporting of results for a particular geochemical test.
MPA	Maximum Potential Acidity. Calculated by multiplying the total sulfur or sulfide-sulfur (CRS) content of a sample by 30.6 (stoichiometric factor) and expressed as kg H_2SO_4 per tonne.
NAF	Non-Acid Forming. Geochemical classification criterion for a sample that will not generate acid conditions.
NAF_{BARREN}	Non-acid forming and barren of sulfur (i.e. less than or equal to 0.1% sulfur).
NAPP	Net Acid Producing Potential, expressed as kg H_2SO_4 per tonne. Calculated by subtracting the ANC from the MPA.

NMD	Neutral mine drainage typically caused by exposure of sulfide minerals in mine waste materials to oxygen and water and then neutralisation by gangue minerals. Typically characterised by neutral pH and elevated concentrations of salts, sulfate and metals.
Overburden	The waste rock material found overlying the first ore horizon within the stratigraphic profile.
PAF	Potentially Acid Forming. Geochemical classification criterion for a sample that has the potential to generate acid conditions.
PC Titrator	Potentiometric Compact Titrator. PC Titrators are specially designed for routine applications and simple operation, allowing basic titration analysis from a single device.
pH	A measure of hydrogen ion (H^+) concentration.
PSD	Particle size distribution.
S	Sulfur.
SD	Saline Drainage. Water that is elevated in dissolved salts (e.g., Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-, and SO_4^{2-}), but may have acidic, neutral, or alkaline pH.
Slaking	Disintegration of unconfined soil or rock after exposure to air and subsequent immersion in water.
Sodic	Sodic soil and rock materials are characterized by a disproportionately high concentration of sodium (Na) in their cation exchange complex and are innately unstable, exhibiting poor physical and chemical properties, which impede water infiltration, water availability, and ultimately plant growth.
SO_4^{2-}	Sulfate.
Static test	Procedure for characterising the geochemical nature of a sample at a single point in time. Static tests may include measurements of mineral and chemical composition of a sample and the Acid Base Account.
TSS	Total suspended solids is a measurement of the suspended solids concentration in a water sample.
TS	Total sulfur content of a sample generally measured using a 'LECO' analyser expressed as total sulfur%.
w:v	Weight to volume ratio.

1 Background information

1.1 Introduction

RGS Environmental Consultants Pty Ltd (RGS) was commissioned by Eagle Downs Metallurgical Coal to perform a topsoil quality assessment for a proposed underground coal mine situated (the Project) located 25 km south of Moranbah in the Bowen Basin, Central Queensland (**Figure 1-1)**. This document details the sampling, analysis, results, and interpretation for the topsoil quality assessment.

Eagle Downs Coal Management (EDCM) is delivering the Project under the Eagle Downs Coal Joint Venture, a joint venture between Aquila Resources and South32. EDCM is required to prepare a Progressive Rehabilitation and Closure Plan (PRCP) by 2 October 2023. The PRCP is required to meet the requirements in sections 126C and 126D of the *Environmental Protection Act 1994* (EP Act), pursuant to section 754 of the EP Act.

The topsoil quality assessment is required to support both the environmental approval amendment application under the EP Act and the PRCP. An Environmental Impact Statement (EIS) was completed for Eagle Downs mine in 2009. The Project was approved and an environmental authority (EA) EPML00586713 was granted in 2011. The EA has been amended several times since 2011 and the mine is currently operating under the EA which took effect on 3 December 2021.

The aim of the topsoil quality assessment is to characterise soil materials based on their geochemical, nutrient and physical properties. This assessment has been developed in line with Australian guidelines that are routinely used in the mining sector as well as agricultural industries (Isbell, 2016, MacDonald et. al., 1998). The topsoil quality assessment is focused on filling nutrient and physical data gaps needed to inform the PRCP and Rehabilitation Management Plan.

RGS has endeavored to utilise existing soil survey and geological data as background information to inform the soil sampling and analysis program. Seven topsoil stockpiles were established in the first phase of construction prior to 2019. Future areas of development are also be assessed in this document for in-situ soil quality. The management of topsoil stockpiles at decommissioning/closure is detailed in the *Rehabilitation Management Plan (EDC-EXE-80000-EC-PLN-0009)* and *Closure Plan (EDC-FS-81800-EV-RPT-0003)*. In addition, erosion and sediment controls will be implemented in accordance with the *Erosion and Sediment Control Management Plan (EDC-EXE-80000-EV-PLN-0007).*

1.2 Objectives

The objective of the program of work described herein is to provide a stand-alone technical document that will:

- Assist in feasibility study project development;
- Be suitable as an appendix for inclusion in an environmental approval submission; and
- Contribute to fulfillment of the relevant Queensland PRCP guideline requirements.

RGS has completed a program of static geochemistry, physical, and mineralogical tests on representative topsoil stockpile and in-situ soil samples collected from proposed mining areas at the Project in June 2022. The work was completed to provide a better understanding of the soil nutrient, fertility, geochemistry and physical properties which influence its potential use as a rehabilitation material.

The specific objectives were to:

- Assist EDCM to better understand the soil nutrient, fertility, and geochemical characteristics to optimise their current topsoil stockpile management strategy;
- Identify and limit any potential for acid and metalliferous drainage (AMD), including soluble metal/metalloid and salt release;
- Physically characterise soil materials to assess the risk of dispersion, slaking, erosion, and any potential instability when used as a cover for final landforms;

- Characterise in-situ soils in potential mining areas and provide guidelines for managing future topsoil stockpiles; and,
- Minimise the risk of significant environmental harm to the immediate and downstream environment.

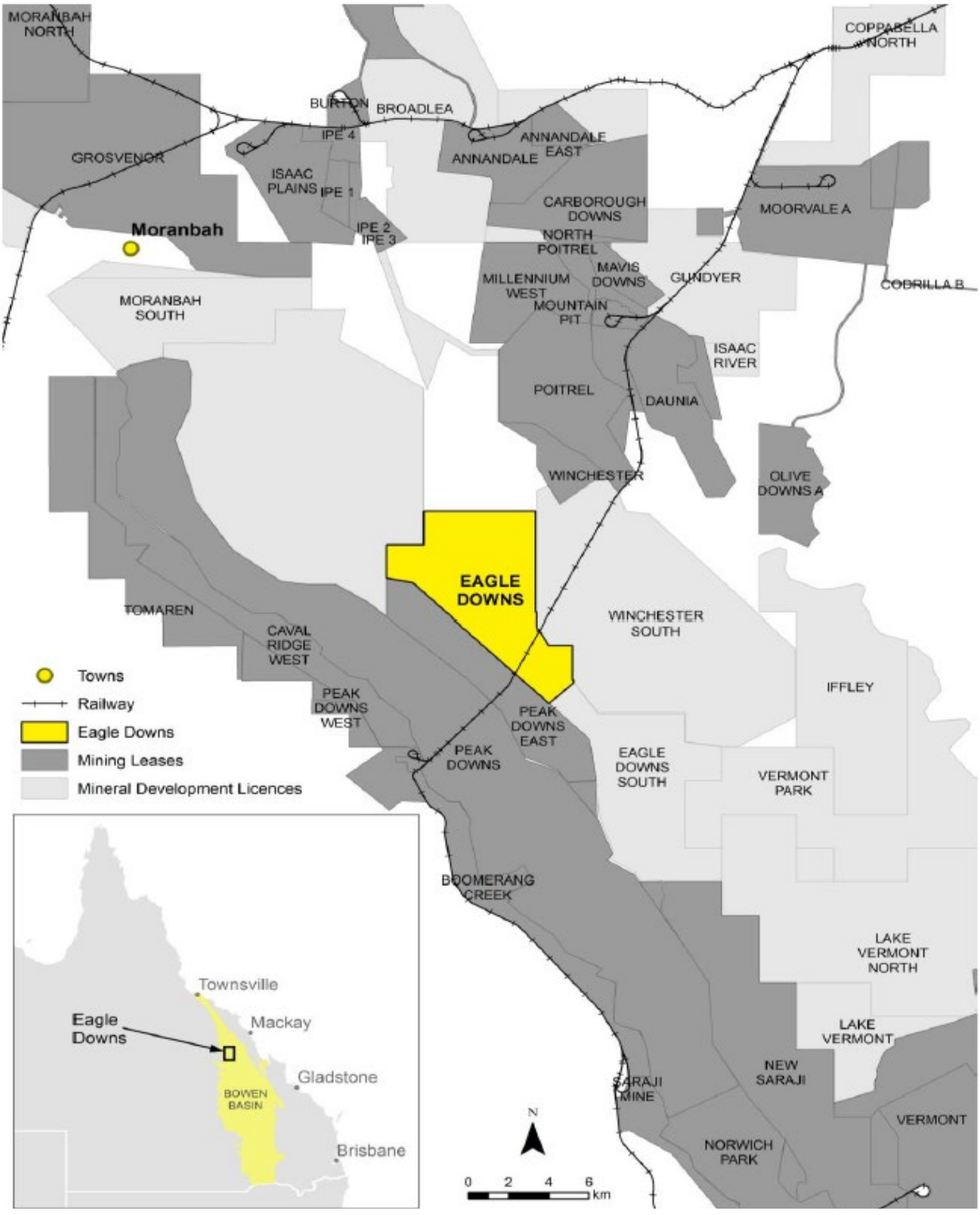


Figure 1-1: Eagle Downs site location

1.3 Scope of work

The RGS scope of was completed using recognised standards and guidelines (AMIRA, 2002, COA, 2016; DME, 1995, DEHP 2013, and INAP, 2022) and in compliance with relevant legislation and regulations.

The scope of work completed in this report includes:

- A desktop study of soil survey and geological data reports for Eagle Downs mine;
- Receipt and management of soil samples collected by EDCM;
- Design and implementation of a characterisation program to assess the soil samples;
- Data tabulation, graphing and interpretation of the geochemical and physical results;
- Provision of recommendations for management of topsoil stockpiles; and
- Production of a draft technical report (this document) for review and comment by EDCM.

1.4 Topsoil stockpile quality assessment limitations

The quality of soil can be assessed in several different ways, including soil classification, soil fertility, geochemical and physical analyses. This section discusses the purpose and limitations of applying these methods to the quality assessment of topsoil stockpiles.

(a) Soil classification

Soil classifications are performed by soil scientists who conduct field surveys to assess the type(s) of soil from observations, such as texture, colour, and structure. The Australian Soil Classification is intended for use on undisturbed (in-situ) soil profiles that have developed naturally. Soil scientists rely on being able to observe the relationships between the O, A, B, and C soil horizons, to correctly classify soils using the guideline. When the soils are disturbed (i.e., by making a topsoil stockpile) this destroys the soil profile and the information contained within it. In general, when the soil is disturbed and re-deposited it becomes an anthroposol, or “human-made soil” and therefore all of the Eagle Downs topsoil stockpiles are “anthroposols” based on the Australian Soil Classification guideline.

However, RGS understands that a universal anthroposol topsoil stockpile classification is neither useful nor practical. Therefore, RGS has classified the soils based on what they were, prior to disturbance. This adds a degree of subjectiveness, as the applied guideline was not intended for this purpose. As the key indicators of soil classification (the structure of the soil profile) have been removed, RGS has matched soil fertility, geochemical, and physical data with previous soil survey data and/or typical characteristics for soil types in the Australian Soil Classification. It should be noted that all soil classifications for topsoil stockpiles are essentially subjective interpretations.

(b) Soil quality analyses

Soil quality (fertility) analyses are routinely performed for agricultural purposes by farmers who wish to verify whether the soil contains sufficient nutrients (e.g., total and plant-available N, P, K, Ca, Mg, trace elements and organic matter) to support their intended crops. Not all soils are suitable to grow crops, and even fertile soils require amelioration (such as fertilisers, gypsum, and compost) to maintain the productive capacity that is expected of agricultural soils. Most mining soils in Australia are unsuitable to grow crops and are naturally low in nutrients. They can, however, support native vegetation and bushland that is adapted to the less-than-ideal specific soil conditions. Australian soils are ancient, strongly weathered and many are salt affected, but native species such as eucalyptus and acacia are able to survive where crops could not.

If a soil does not meet agricultural guidelines, it does not mean that the soil is infertile or unsuitable as a rehabilitation material. There are currently no guidelines on soil fertility for mining soils. Instead, a comparison of the nutrient quality of soils from undisturbed areas (e.g., soil survey data) with topsoil stockpiles can be completed to verify whether the disturbance and long-term storage has adversely impacted their nutrient content.

(c) Geochemical analyses

Geochemical analyses typically involves the measurement of pH, salinity (as electrical conductivity, EC), total sulfur, sulfide sulfur, Acid Neutralising Capacity on all samples, as well as 2-acid digest and soluble metal(loids) on selected samples. While commonly applied to rocks in the assessment of AMD, a geochemical assessment is also relevant for soils, particularly when designing soil cover systems as part of rehabilitation. Geochemical measurements are useful for establishing the soil characteristics of the topsoil stockpile to to classify the soil and predict its future behaviour.

Most undisturbed topsoils exhibit favourable geochemical characteristics (e.g., circumneutral pH, low salinity) compared to underlying units such as subsoil and saprolite (weathered rock). As topsoils represent the most weathered unit in the soil profile, most have already undergone a process of environmental equilibration over many years. However, when subsoils or saprolite materials from depth are mixed with topsoil to be used as a growth medium, rapid weathering occurs and reactive minerals (e.g., feldspar and muscovite) can break down into more stable forms such as clays. The depth of topsoil stripping is therefore a key consideration for topsoil stockpiles, and where this information is not known, geochemical analyses can provide valuable insight regarding the identity of the material from which the stockpile is derived and the extent of soil weathering.

(d) Physical analyses

Soil texture is an important characteristic as it determines whether the soil retains water and nutrients within the free spaces between particles (pores) after rain events, or if the water readily drains and the soil becomes dry. Fine particles (or clay-rich soils) have higher moisture-holding capacity than sandy or gravelly soils, and the quantity and quality of the fine particle fraction (<2 mm) is critical for a successful rehabilitation outcome. Physical analyses such as particle size distribution (PSD) and soil texture analyses can be used as key indicators for soil classification and the prediction of soil behaviour.

Soil structure and aggregate stability are also determined from physical analyses. Soils with good structure clump together and form peds, which provide strength and resist erosion to water and wind. In dispersive soils, the impact of a water droplet causes the weakly cemented soil particles to disintegrate, creating holes and tunnels and an unstable surface that produces surface runoff with a high sediment load. Dispersion and erosion are important considerations when creating a soil cover (e.g., for a waste rock dump), as PRCP guidelines specify that the final landform must be stable.

All four of the soil quality analysis methods described in (a) to (d) contribute towards the topsoil quality assessment, and none of these methods individually are sufficient to fully characterise the soil for the PRCP. Used in combination, soil classification, soil fertility, geochemical, and physical analyses provide a comprehensive understanding of the quality of material in a topsoil stockpile.

1.5 Desktop study

A desktop study of available background information for the Project is included in **Section 7 (Attachment D)**. A summary of the key findings is listed below.

- Regional soil classification is vertosol with deep clays, associated with loamy duplex soils;
- Underlying surface geology is comprised of TQr, Qr, and Qrb,, which are young Quaternary and Tertiary sediments;
- Detailed soil surveys confirm soils are texture contrast (duplex) soils with clay subsoils or relatively uniform clay soils;
- Subsoils are known to have sodic characteristics in some areas, which can be prone to erosion when exposed. Other potential issues can include salinity and acidity at depth;
- Topsoil stripping depths range from 0.15 – 0.3 m;
- “Topsoil of marginal use” (which refers to subsoil or gravelly topsoil) was stripped from 0.3 – 0.6 m;
- Two soil types at topsoil stockpile locations (duplex soils 6-8 g and deep uniform clays 7-8 g)

- Four soil types in DREA area (duplex soils 6-8 g, deep uniform clays 7-8 g, loamy soils 6 g, black cracking clays 8 g)
- One soil type in underground portal area (deep uniform clays 7-8 g)

1.6 Quality, standards, regulation, legislation, and guidelines

RGS has developed this topsoil quality assessment according to several guidance documents for the surveying and assessment of Australian soils which are endorsed by the mining industry. In Australia, the regulatory framework covering the characterisation of soil materials to assess their suitability for rehabilitation and AMD potential, is diverse but generally based on the following key guidance documents/ sources:

- DEHP (2013a). Application Requirements for Activities with Impacts to Land Guideline. Queensland Department of Environment and Heritage Protection.
- DES (2013b). Department of Environment and Science. Application for the certification of progressive rehabilitation: ESR/2015/1563 • Version 2.01 • Effective 23 May 2013.
- DES (2014). Department of Environment and Science. Rehabilitation report: as appropriate for mining resource activities: ESR/2015/1616 • Version 1.04 • Effective 25 June 2014.
- DES (2018). Department of Environment and Science. Rehabilitation requirements: as appropriate for mining resource activities: ESR/2016/1875 • Version 2.01 • Effective 23 May 2014.
- DES (2020) Department of Environment and Science. Residual Risk Assessment Guideline - Interim ESR/2020/5433 • Version 1.00 • Effective: 2 October 2020.

- AS 4482.1-2005 *Guide to the investigation and sampling of sites with potentially contaminated soil.* Standards Australia. Published 2 November 2005.
- Isbell, R. (2016). *The Australian soil classification*. CSIRO publishing.
- McDonald, Ronald C., R. F. Isbell, James G. Speight, Joe Walker, and M. S. Hopkins. *Australian soil and land survey: field handbook*. No. Ed. 2. CSIRO publishing, 1998.
- McKenzie, Neil, Kep Coughlan, and Hamish Cresswell. *Soil physical measurement and interpretation for land evaluation*. Vol. 5. CSIRO Publishing, 2002.
- McKenzie, Neil J., M. J. Grundy, R. Webster, and A. J. Ringrose-Voase, eds. *Guidelines for surveying soil and land resources*. CSIRO Publishing, 2008.
- Hazelton, Pam, and Brian Murphy. *Interpreting soil test results: What do all the numbers mean?* CSIRO publishing, 2016.
- Taylor, Graham, and Richard A. Eggleton. *Regolith geology and geomorphology*. John Wiley & Sons, 2001.
    - AMIRA (2002) ARD Test Handbook - Prediction and Kinetic Control of Acid Mine Drainage; AMIRA International. Project P387A Prediction & Kinetic Control of Acid Mine Drainage, Ian Wark Research Institute and Environmental Geochemistry International Pty Ltd.
- Commonwealth of Australia (2016). *Leading Practice Sustainable Development Program for the Mining Industry. Preventing Acid and Metalliferous Drainage*. September, Canberra ACT.

1.6.1 Australian and New Zealand Water Quality Guidelines 2018

The ANZECC & ARMCANZ (2000) Guideline has been superseded by the Australian New Zealand Water Quality Guideline (ANZG, 2018). The ANZG (2018) water quality framework can be used to provide beneficial outcomes for some mine sites.

1.6.2 Leading Practice Sustainable Development Program for the Mining Industry

The mining industry guidelines within the Australian Leading Practice Sustainable Development Program have been developed by a selected group of industry professionals. RGS was the peer reviewer of the AMD Prevention and Management Guideline (COA, 2016).

1.6.3 PRCP Requirements

The need to comply with the PRCP guideline (DES, 2019) has influenced the program of work recommended to be completed for the Eagle Downs topsoil quality assessment.

In the PRCP guideline, geochemical and chemical analysis is referenced on pages 18, 27, 28, 29, 30 and 66 and physical analysis is referenced on pages 27, 28 and 66.

For the PRCP, the number of samples needed to inform life of mine planning decisions varies and is (in part) a subjective process that considers the variation in soil types and properties.

In order to address PRCP Guideline requirements, RGS has planned a topsoil quality assessment to ensure there is adequate coverage to characterise and classify the topsoil stockpiles and in-situ soil at the DREA and underground portal areas.

The need for **geochemica**l and **physical** testing is clearly defined in the PRCP Guideline i.e., the soil characterisation report should achieve the following outcomes:

- Sampling regime meets best practice standards, is spatially representative of all stockpiled topsoil;
- Definition of sodic potential; porosity and permeability; erosion; and water holding potential.
- Assessment of potential for AMD;
- Recognition of the fact that not all Non-Acid Forming (NAF) materials are the same:
    - NAF material can range in its physical properties from being sand or clay to fresh volcanic rock that will resist weathering for millennia, and it is this aspect of material characterisation that becomes critical when stable constructed mine landforms are being designed;
    - NAF material may not generate acid conditions, but may contain elevated sodium, chloride and sulfate content and have the potential to leach saline drainage;

2 Sampling and analysis program

2.1 Sampling program

In Australia, the regulatory framework covering the characterisation of topsoil materials to assess their geochemical and physical properties is diverse but generally based on the key guidance documents/sources detailed in **Section 1.6.**

According to the guidance documents, the actual number of samples is project specific. A sufficient number of samples were taken to accurately characterise the nature, distribution, and variability of critical parameters in each material type. Prior to analysis it was difficult to know whether the topsoil stockpiles would be comprised of (i) different soil types mixed together, and/or (ii) topsoil only, or topsoil and subsoil. Due to this knowledge gap, the selection of representative topsoil samples was reliant on the number of samples and their location (i.e., spatial coverage). Based on the detailed soil survey (**Section 7, Attachment D**) it is likely that each topsoil stockpile contains only one soil type.

The dry reject emplacement area (DREA) and underground portal areas are currently undisturbed and sampling occurred from the in-situ soil profile. As these materials have not been stockpiled, soil profile information (A horizon, B horizon, etc) were still evident and topsoil could readily be distinguished from subsoil based on depth. The selection of representative samples in these areas was specified by depth and the sample location.

2.1.1 Sampling procedure

EDCM performed the sample collection in June 2022 as directed by RGS and based on the information provided in the soil sampling analysis plan (SaAP). EDCM sent the collected samples directly to RGS to implement the analysis phase of the SaAP.

The soil sample collection was carried out by EDCM personnel that were physically fit and trained in manual handling procedures. Samples were collected with either a shovel or hand trowel over several days to manage fatigue and minimise exposure to weather conditions. The depth of excavation was approximately 0.2 m for both topsoil stockpiles and in-situ soil samples. The number of samples at each topsoil stockpile location was chosen primarily on the stockpile volume which is included in **Table 2-1**.

The sampling program developed for the Eagle Downs topsoil quality assessment has been designed to collect samples that are representative of materials that will be used in soil covers during the rehabilitation phase. The overall sampling and analysis program has been designed to provide characterisation information collected through implementation of the SSAP and can be used by Eagle Downs to inform any future topsoil characterisation and assessment program e.g., topsoils likely to be disturbed during mining operations.

A summary of the total sampling program for this topsoil quality assessment is provided in **Table 2-2** .

Table 2-1: Topsoil stockpile sample selection program

Location	Stockpile volume	Material type	Depth	Number of samples
EDC TS 01	31,538.0 m^3	Topsoil stockpile	0 – 0.2 m	5
EDC TS 02	11,301.0 m^3	Topsoil stockpile	0 – 0.2 m	2
EDC TS 03		Topsoil stockpile	0 – 0.2 m	2
EDC TS 04	3,920.5 m^3	Topsoil stockpile	0 – 0.2 m	2
EDC TS 05	7,378.5 m^3	Topsoil stockpile	0 – 0.2 m	3
EDC TS 06	1,300 m^3	Topsoil stockpile	0 – 0.2 m	1
EDC TS 07	5,000 m^3	Topsoil stockpile	0 – 0.2 m	2
Total				17

Table 2-2: Summary of topsoil sampling

Sampling area	Sample type	Number of samples	Client ID
Topsoil stockpiles	Topsoil stockpile	17	TS01-1 to TS07-17
Underground portal area	In-situ	4	Natural 26-29
Undisturbed, vegetated areas	In-situ	3	Natural 30-32
DREA – 5 and 20 year shell	In-situ	5	DREA-21 to DREA-25
DREA – 50 year shell	In-situ	3	DREA-18 to DREA-20
Total		**32**	

2.1.2 Sample locations

Sampling locations were selected to represent the variability in soil types across each sampling area. Sampling locations for topsoil stockpiles (n=17) and in-situ samples (n=15) are shown in **Figure 2-1**. At each location, the sampler also was requested to provide:

- GPS location coordinates;
- Photograph of the excavated hole;
- Photograph of background (e.g., vegetation, topography, mine infrastructure); and,
- Photograph of the topsoil sample when contained in the bucket (include label).

This information was collated and is included in the soil logs in **Section 7 (Attachment C)**.

2.1.3 Sample containers, labelling, and dispatch

EDCM supplied 32 x 20 L plastic buckets (with lids) to contain the samples. Buckets were labelled with permanent marker (1) on the outside, and (2) on the lid of the bucket with the stockpile name (where applicable) or sampling location, and a unique Client ID. RGS also assigned each bucket a unique RGS ID upon receipt. The Client ID and/or the RGS ID were specified in laboratory certificates as described in **Section 7 (Attachment E** and **Attachment F)**.

A labelled cardboard tag with the Client ID was placed inside each bucket to identify the samples when taking photographs of the samples inside the buckets and provided a contingency in the unlikely event that the permanent marker was smudged or rubbed off.

The buckets were loaded onto two wooden pallets, which were wrapped and transported directly to the RGS laboratory via truck courier. Samples were stored in a cool, dry location while awaiting freight. Samples were registered and weighed upon arrival at RGS. Each bucket had an ‘as received’ mass of 12 to 16 kg (i.e., including moisture).

2.1.4 Sample composites

Individual samples were selected for composites (n=12) based on the results of the initial screen (**Table 2-3**).

Table 2-3: Summary of selected composites

#	RGS ID	Number of samples	Code	Description
1	C101	5	TS01	Composite of TS01 stockpile samples
2	C102	2	TS02	Composite of TS02 stockpile samples
3	C103	2	TS03	Composite of TS03 stockpile samples
4	C104	2	TS04	Composite of TS04 stockpile samples
5	C105	3	TS05	Composite of TS05 stockpile samples
6	C106	1	TS06	Composite of TS06 stockpile samples
7	C107	2	TS07	Composite of TS07 stockpile samples
8	C108	1	NAT-31	Natural 31 – relatively low pH and EC
9	C109	2	UG-Mod pH	Underground portal – relatively mod pH and EC
10	C110	4	NAT-High pH	Natural/Underground – relatively high pH and EC
11	C111	4	DREA-50	DREA – 50 year shell – relatively low pH and EC
12	C112	4	DREA-20	DREA – 5 and 20 year shell – relatively high pH and EC

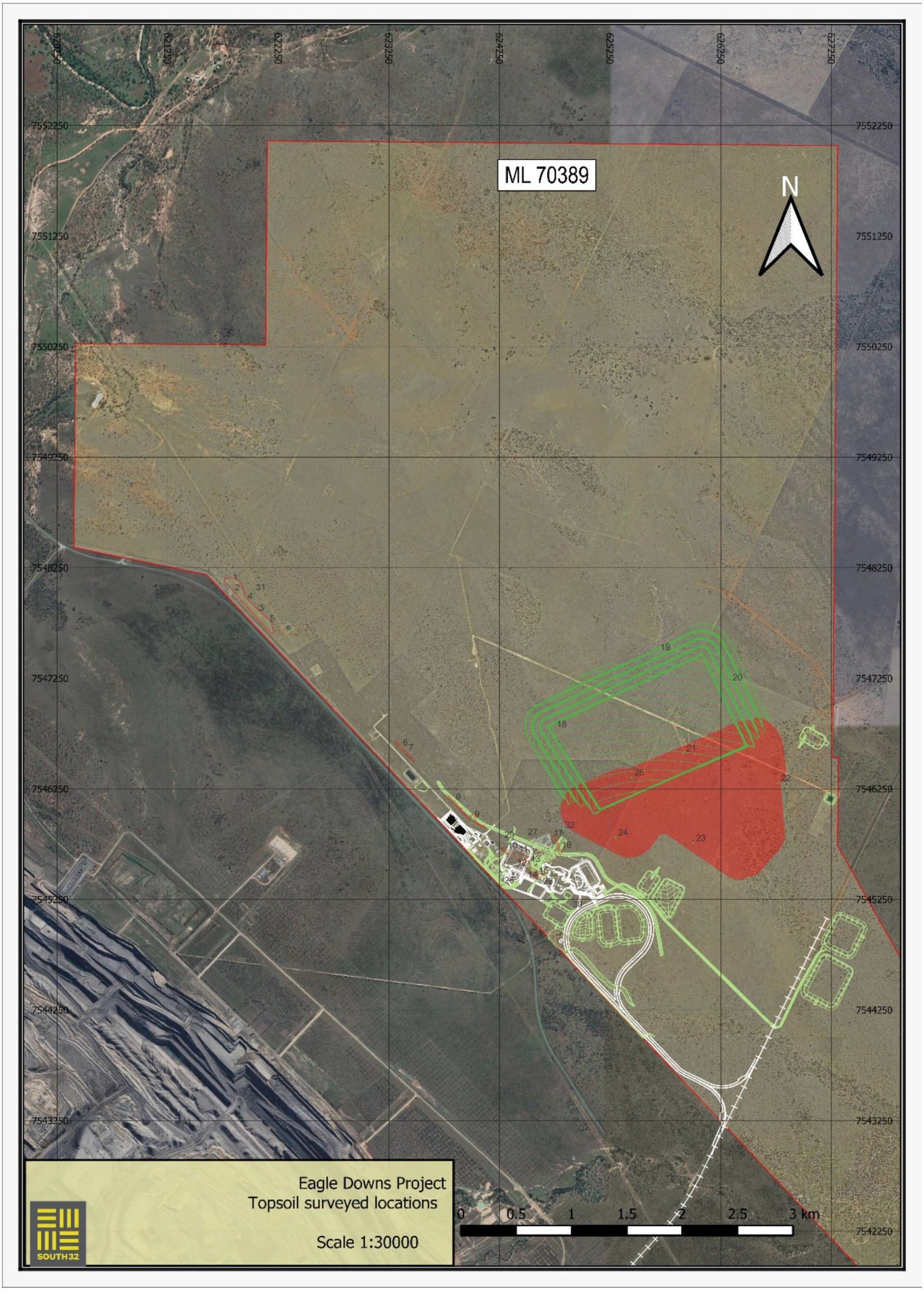


Figure 2-1: Topsoil sampling locations

2.2 Analysis program

The topsoil stockpile and in-situ samples were subjected to soil fertility, geochemical and physical analyses to determine their characteristic properties. This section describes the analysis program and the methods used for each test.

2.2.1 Static geochemical and soil fertility characterisation program

To characterise the acid producing potential of the topsoil stockpile and in-situ samples (n=32), initial screening analyses was completed including determination of pH, EC, total sulfur, sulfide sulfur, acid neutralising capacity (ANC) and net acid production potential (NAPP). Selected composite samples (n=12) were then subjected to further geochemical and soil fertility analyses such as cation exchange capacity (CEC), exchangeable sodium percentage (ESP), acidity/alkalinity, total metals/metalloids in whole rock, and static leach tests as described in **Table 2-4**.

Table 2-4: Geochemical and soil fertility analytical program

Static Geochemical Analyses	ALS Code	Method Code	Samples
Sample preparation (cut, bag, crush and pulp)	EN/34	---	32
pH and EC (1:5 sample:water)	IN-4S		32
NAPP (includes ANC, Total S)	ASS-1	III. Coastech Research (Canada)	32
pH, EC, exchangeable cations, ESP, Chloride (1:5), pH ($CaCl_2$) nitrogen suite, Colwell P and K, DTPA extractable Fe, Cu, Zn and Mn, Organic Matter	AG-3	APHA 4500-NH_3 B, APHA 4500 NO_3- B, APHA 4500 NO_3- – I/NO_2- -B, Thermo Scientific Method D08727 and NEMI: 9171, APHA 4500 Norg – D.	12
Total Metals/Metalloids (Al, As, B, Cd, Cr, Co, Cu, Fe, Hg, P, Pb, Mn, Ni, Sb, V, Zn + Ca, K, Mg, Na + trace elements) using a 2-acid digest	EG005T	2 acid aqua regia digest	12
Leach method	EN35	---	12
pH and EC (1:5 sample:water))	IN-4S	APHA 4500 H+ - B and APHA 2510 B	12
Acidity as $CaCO_3$	ED038P	APHA 2310 B	12
Dissolved Cations (Ca, Mg, Na, K)	NT-01	APHA 3120B, APHA 3125B	12
Dissolved anions (Cl, SO_4, F, Alkalinity)	NT-02A	APHA 2320 B	12
Soluble Metals/Metalloids (Al, As, B, Cd, Cr, Co, Cu, Fe, P, Pb, Mn, Ni, Sb, V, Zn + Ca, K, Mg, Na + trace elements) in 1:5 water extracts	EG020F (ME-02)	USEPA 6020 ICP/MS	12

2.2.2 Physical characterisation program

RGS also completed physical analyses on selected composite samples (n=12) at ALS Stafford, Trilab, as well as specialised testing at Soil Water Group and Levay and Co. external laboratories, as described in **Table 2-5**. Analyses included particle size distribution (PSD), Emerson class, soil water characteristic curves (SWCC), and mineralogy by x-ray diffraction (XRD).

Three (3) individual samples were selected for XRD analysis that were geochemically diverse compared to the overall sample set and likely to represent different soil types. This provided a greater contrast in mineralogy than would otherwise be obtained for composite samples. The three selected individual samples are described in **Table 2-6**.

Table 2-5: Physical analytical program

Physical Analyses	Trilab Code	Samples
Dry (at 85˚ C) and crush	EN20PR	12
Moisture content	AS4133 2.1.1	32
As received bulk density on samples	AS4133 2.1.1	32
Emerson Aggregate Test	AS 1289.3.8.1	12
Particle Size Distribution including Hydrometer to 0.014 mm	AS1289 3.6.3	12
Soil Water Characteristic Curve (SWCC) (Soil Water Group)	n/a	12
XRD – quantitative (Levay & Co.)	n/a	3

Table 2-6: Selected XRD individual samples

Client ID	RGS ID	Sample type	Properties (relative to other samples)
Natural-31	2021090_0009	In-situ	Low pH, low ANC, low EC
TS01-03	2021090_0010	Topsoil stockpile	High pH, mod ANC, high EC
TS01-01	2021090_0016	Topsoil stockpile	Mod pH, high ANC, mod EC

2.2.3 Methodology

2.2.3.1 Static geochemical testing

Static geochemical tests were completed to quantify the likely chemical attributes of the soils and to assess the risk for acidic, saline, and metalliferous drainage ((collectively referred to as Acid and Metalliferous Drainage (AMD)). Composite samples were then subjected to more detailed static (multi-element) tests. All individual samples were pulverized to <0.075 mm for the initial static geochemical tests.

Acid Base Account

Actual Acidity

The actual acidity in a sample material can be divided into soluble acidity and retained acidity. Soluble acidity is the acidity measured using a 1:5 (w:v) (sample:water) extract. Retained acidity is the acidity that is not recorded in the extract. In this assessment, soluble acidity has been measured as pH using a 1:5 w:v (soil water) water extract to describe the activity of hydrogen ions (H^+) and hydroxide ions (OH^-) in solution.

Analyses:

- pH (1:5 w:v)

Salinity

Salinity, or the concentration of salt in soils, is measured by Electrical Conductivity (EC) in water extracts. EC indicates the quantity of soluble salt released from a sample material. When water interacts with materials with elevated EC, saline leachate has the potential to occur.

A dilute water extract (EC 1:5) is the standard measure of EC in soils samples, although more concentrated or less concentrated extracts can be used for specific applications.

Analyses:

- EC (1:5 w:v)

Maximum Potential Acidity

The Maximum Potential Acidity (MPA) of a sample material is calculated from total sulfur, which includes the concentrations elemental sulfur, sulfur present in sulfide and sulfate minerals, and organic sulfur.

MPA can be calculated using total sulfur data and, by convention, it is assumed that the sulfide sulfur is present as pyrite (FeS_2). Therefore, the stoichiometry of pyrite oxidation is used to calculate a theoretical maximum amount of sulfuric acid that could be generated, which is generally expressed in kg H_2SO_4 / tonne. However, this calculation ignores that not all sulfur will contribute to the generation of acidity (e.g., sulfate sulfur in gypsum and barite and organic sulfur).

Sulfur can be present within acid producing primary minerals such as pyrite and marcasite (FeS_2), chalcopyrite ($CuFeS_2$) and bornite (Cu_5FeS_4) and non-acid producing primary minerals such as galena (PbS) and sphalerite (ZnS). Sulfur can also be also present as numerous non-acid producing secondary minerals such as alunite ($KAl_3(SO_4)_2(OH)_6$), gypsum ($CaSO_4.2H_2O$) through to minerals such as jarosite ($KFe^{3+}{}_3(OH)_6(SO4)_2$) that can store and release acid and trace, major and minor elements.

Total sulfur values below 0.1 kg H_2SO_4 / tonne are regarded as negligible or barren of sulfur, and hence the MPA can be calculated directly from this conservative value.

Analyses:

- Total sulfur [Leco method];

Acid Neutralising Capacity

The Acid Neutralising Capacity (ANC) of a sample material can be measured using a version of the Sobek method, which involves the digestion of a pulp sample with 0.5 M hydrochloric acid (HCl), followed by the boiling and addition of 5 mL of 30 % hydrogen peroxide (H_2O_2). The sample is then back titrated with sodium hydroxide (NaOH) to measure the amount of acid consumed by reaction with the sample and provides the ANC expressed in kg H_2SO_4/t, which represents the capacity of the solids to neutralise acid.

The primary minerals in mine waste materials that are readily able to neutralise acidity are calcium and magnesium carbonates (e.g., calcite, $CaCO_3$ and dolomite, $CaMg(CO_3)_2$). Secondary neutralising minerals that can account for the measurement of ANC include basic silicates such as calcic feldspars, olivine, amphiboles, and biotite. However, due to their slower dissolution rates, their contribution to the overall ANC is generally considered to be limited in the short-term under ambient conditions. Felsic silicates such as sodic and potassic feldspars, muscovite, most clay minerals, and quartz do not contribute significantly to the ANC. In addition, carbonate minerals that contain iron and/or manganese (e.g., siderite, $FeCO_3$) do not contribute to the ANC measurement.

Analyses:

- Acid Neutralising Capacity (ANC) [AMIRA, 2002].

Net Acid Producing Potential

The MPA and ANC results are used to calculate the Net Acid Producing Potential (NAPP) of a sample material and the NAPP value provides an indication of whether that sample is Potentially Acid Forming (PAF) or Non-Acid Forming (NAF). The NAPP is calculated by subtracting the ANC value from the MPA value.

Multi-element testing

Total metals and metalloids

The total elemental content in a solid sample does not infer that the elements are mobile but provides an indication of any elemental enrichment. The total metal and metalloids analysis involves a 2 acid-digestion using a 1:1 ratio of hydrochloric acid (HCl) and nitric acid (HNO_3), followed by trace element analysis by ICP-MS. This incomplete digestion is applicable to environmental applications as it does not dissolve the entire silicate matrix or other highly resilient minerals, such as zircon.

Analyses:

- Total cations (Ca, Mg, Na and K) [HCl and HNO_3 acid digest followed by ICP-AES];
- Total metals/metalloids (Al, As, B, Ba, Be, Cd, Cr, Co, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Sb, Se, Th, U, V, Zn) in solids [HCl and HNO_3 acid digest followed by ICP-MS / -AES];

Water solubility testing (shake flask extractions)

The short-term solubility and mobility of metals and metalloids within a solid sample are evaluated using shake flask extractions at a 1:5 w:v ratio for 16 hours, followed by analysis by ICP-MS/AES.

Water solubility results provide an indication of which elements may be susceptible to environmental mobility but are not directly comparable to water quality guidelines. This is because the results are derived from leachate, which can be influenced by a combination of different physical parameters, such as size fraction, surface area, permeability, and temperature. Any comparison with water quality guidelines generally requires some knowledge of water quality, material balance, hydrology and other field parameters and application of some form of numerical modelling.

Analyses:

- Acidity and alkalinity (as $CaCO_3$ mg/L) (1:5 w:v water extracts);
- Major cations (Ca, Mg, Na and K) [ICP-AES/MS (1:5 w:v water extracts)];
- Major anions (Cl, F, and SO_4) [ICP-AES/MS and PC Titrator (1:5 w:v water extracts)];
- Soluble metals/metalloids (Al, As, B, Ba, Be, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Sb, Se, Th, U, V, Zn) [ICP-AES/MS (1:5 w:v water extracts)];

2.2.3.2 Soil quality

Soil nutrients

Soil quality describes the capability of the soil to maintain healthy plant growth under any given climatic regime. It is usually a function of the physical, chemical, and biological characteristics of the soil. To assess the available soil nutrients, soil samples are subjected to an agricultural suite.

Mining soils are not agricultural soils, and therefore the expectation that rehabilitation materials will meet cropping guidelines is unrealistic. Nutrient levels available for plants are usually low, but most mining soils will provide adequately for native vegetation without amelioration, as evidenced in undisturbed areas. Soil nutrient analyses are intended to provide baseline data to assess any impact on the soil caused by mining disturbance. Soils that have been stored during the mining process with the intent they are to be used later for rehabilitation can be expected to be less fertile and it is often recommended that topsoil stockpiles are “turned over” or allowed to revegetate to maintain soil nutrients.

Analyses:

- AG-3 Agricultural Suite:
  - pH ($CaCl_2$ method) [Rayment and Lyons, 2011];
  - Total organic carbon (TOC) in soil samples [APHA 5310 B]
  - Total organic matter (TOM) in soil samples [Walkley Black, AS 1289. 4.1.1-1997];
  - DTPA* extractable metals (Cu, Fe, Mn, and Zn) [Rayment and Lyons, 2011];
  - Nitrogen (N) nutrients (TN, TKN, NO_2, NO_3, NH_3 and NO_x) [APHA 4500];
  - Total and bicarbonate extractable phosphorous (P) (Colwell) [Rayment and Lyons, 2011];
  - Bicarbonate extractable potassium (K) (Colwell) [Rayment and Lyons, 2011];
  - Exchangeable cations [ICP-AES] [Rayment and Lyons, 2011.

- Exchangeable Sodium Percentage (ESP).

*DTPA is an acronym for diethylenetriamine pentaacetic acid.

Salinity class characterisation

Exchangeable Sodium Percentage (ESP) is used in the classification of saline and alkaline soils or to determine if a sodium hazard exists. Under agricultural conditions, samples with ESP values less than 6 % are considered non-sodic, and greater than 14 % are considered strongly sodic and may be susceptible to dispersion and erosion (Isbell, 2016[1]; and Northcote and Skene, 1972[2]).

Rengasamy et. al. (1984)[3] derived relationships between sodium adsorption ratio (SAR) and total cation concentration (TCC) (and by calculation ESP and EC) values to classify soils into Class 1, Class 2A, Class 2B (dispersive soils) and Class 3A and Class 3B (flocculated soils).

Carbon:nitrogen ratio

The carbon:nitrogen (C:N) ratio can be described as the relationship between energy available to the plant (C) and the amount of tissue it can build (N) (**Figure 2-2**). There is always more C than N in organic matter. When an organic substrate has a low C:N ratio of 15:1 or less, rapid mineralisation and release of N occurs for plant uptake. When the C:N ratio is too high (35:1 or more), microbes become immobilised. Soil microorganisms require a minimal C:N ratio of 8:1, but function optimally on a C:N ratio of between 20:1 and 30:1 (Brust, 2019[4]).

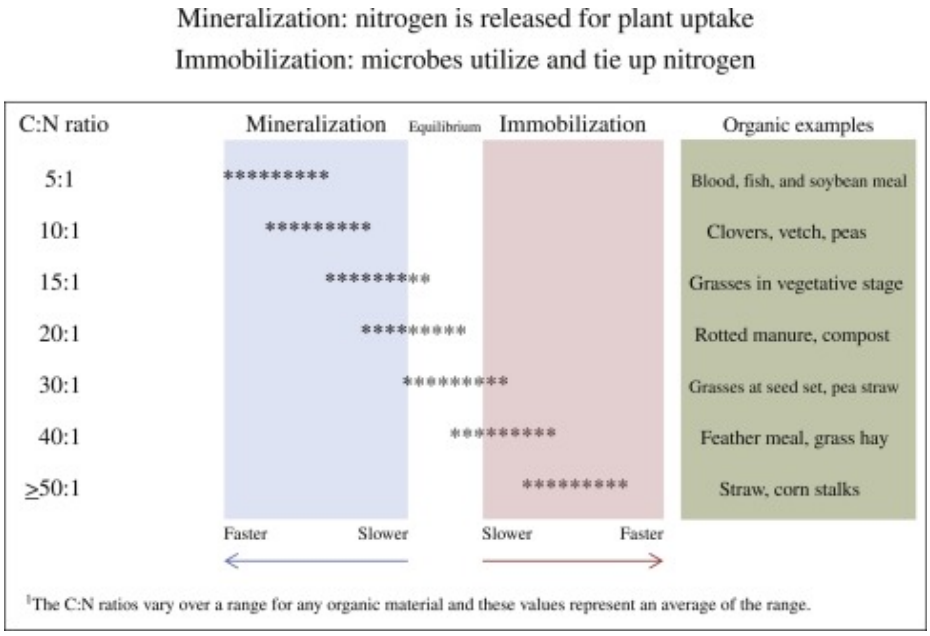


Figure 2-2: Carbon:nitrogen ratio

[1] Isbell, R. F. (2016). *The Australian soil classification*. CSIRO publishing.
[2] Northcote, K. H., & Skene, J. K. M. (1972). Australian soils with saline and sodic properties, Commonwealth Scientific and Industrial Research Organization. *CSIRO). Soil Publ*, *27*, 62.
[3] Rengasamy, P., et al. "Identification of dispersive behaviour and the management of red-brown earths." *Soil Research* 22.4 (1984): 413-431.
[4] Brust, G. E. (2019). Management strategies for organic vegetable fertility. In Safety and practice for organic food (pp. 193-212). Academic Press.

2.2.3.3 Physical testing

Physical testing of mine materials helps to determine their engineering properties from a geotechnical perspective. In many instances, an analysis of the physical properties can be used to interpret changes in geochemical behaviour over time, e.g., changes in permeability due to weathering. Material type (i.e., rock or soil) should be considered when selecting an appropriate physical test. Particle size distribution (grading), Emerson Class, and Soil Water Characteristic Curves (SWCC) are generally suited for soil samples or weathered rock samples that have been crushed.

Particle size distribution

The objective of the particle size distribution (PSD) analysis is to group an assembly of particles of various shapes into separate ranges of sizes to determine the relative proportion by weight of each size range.

The PSD method employs sieving and sedimentation of a soil/water/dispersant suspension to separate the particles. The sedimentation technique is based on an application of Stokes' law to a soil/water suspension and periodic measurement of the density of the suspension (Gee et al., 1986)[5].

Analysis:

- Grading with Hydrometer (includes Particle Density) [AS 1289.3.6.1]

Emerson Class testing

The Emerson Class method is a physical analytical method used to qualify if a clay or soil ped will disperse or will flocculate in solution (**Figure 2-3**). The Emerson Class test can be used as a general guide to sodicity. The aggregate test can be used only as a general guide because of the large number of factors that determine whether dispersion occurs, such as sodicity, salinity, clay type, history of working and speed of wetting (Hazelton and Murphy, 2016)[6].

Dispersion describes the behaviour of clay particles separating from one other in a moist soil: dispersion can cause soil aggregates to breakdown and the dispersed clay to clog soil pores: structural decline and erosion usually result (Baxter and Williamson, 2001)[7].

Flocculated soils are favourable soils for rehabilitation because they contain particles which, when dispersed in a solution, remain in contact and adhere to each other forming clumps of a larger size (Baxter and Williamson, 2001). The flocculated clays tend to be stable hence result in a resilient soil structure. Flocculated clays encourage soils to aggregate, and soils with stable aggregates allow water infiltration and drainage, provide pore spaces for air and water storage, enhance soil flora and fauna, and are more resistant to erosion.

Analysis:

- Emerson Class number (on aggregates) [AS 1289.3.8.1]

[5] Gee, Glendon W., and Dani Or. "2.4 Particle-size analysis." *Methods of soil analysis: Part 4 physical methods* 5 (2002): 255-293.
[6] Hazelton, P. and Murphy, B. (2016). Crouch, R., Reynolds, K.C., Hicks, R.W., and Greentree, D.A. (2007). Soils and their use of earthworks. In '*Interpreting soil test results: What do all the numbers mean?'* pp. 24-27. CSIRO publishing.
[7] Baxter and Williamson (2001). *Know your soils.* Part 1 – Introduction to soils. Technical bulletin produced by Department of Natural Resources and Environment, State of Victoria, 2001.

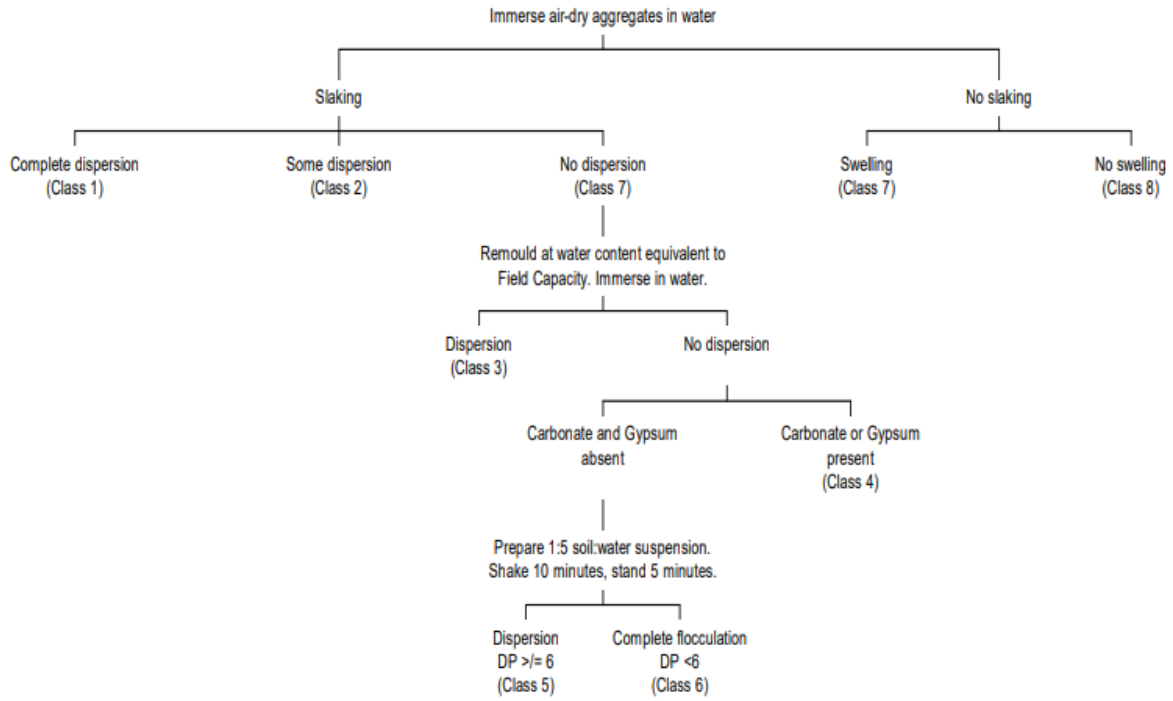


Figure 2-3: Emerson Class classifications

Soil Water Characteristic Curves

The Soil-Water Characteristic Curve (SWCC), also known as a retention curve, shows the relationship between matric suction and water content. It is used to determine the hydraulic and mechanical behaviour of unsaturated soils and to help predict water storage. SWCC are also used in geotechnical engineering to evaluate and predict the failure of slopes during heavy rainfall events. Matric suction refers to the height at which water can be drawn up (i.e., capillary rise) into an unsaturated soil.

SWCCs are typically sigmoidal in shape and include a sharp transition zone that precedes residual conditions. Volumetric moisture content can be plotted against the pressure head (soil matrix potential) using van Genuchten parameters to generate water retention curves for different soil textures.

Analysis:

- Water Retention (Pressure Plate Method) including derived Van Genuchten parameters

Mineralogy

The mineralogy of mine materials can be determined through x-ray diffraction (XRD) analysis by studying the crystallographic structure. The sample material is irradiated with incident x-rays and the intensities, and the scattering angles of x-rays that leave the material are measured.

The angle between the crystal facies is unique to each mineral, and thus leads to qualitative identification. With specialised techniques, modal amounts of minerals (semi-quantitative analysis) can also be determined, including the identification of fine-grained minerals, such as single and mixed-layer clays, which can be difficult to classify by optical methods. XRD spectra from the analysed material are matched to known mineral databases and can be mounted under different treatments to provide greater certainty to the classification.

Analysis:

- Mineralogy by semi-quantitative X-Ray Diffraction (XRD)

3 Results

3.1 Static geochemical testing

3.1.1 Acid Base Account

The Acid Base Account results for the soil samples (n=32) are provided in **Table B1** (**Attachment B**) and are summarised in this section.

3.1.1.1 pH

The $pH_{1:5}$ value for the individual soil samples ranges from 6.9 to 8.9 (median 8.4) as illustrated in **Figure 3-1**. The $pH_{1:5}$ value is between pH 8 and pH 9 and is slightly alkaline for 81% of the soil samples. The remaining samples (n=6) have a pH value between pH 6.9 and pH 7.8 and are typically neutral.

The median $pH_{1:5}$ value for topsoil stockpiles is pH 8.5, whereas the median $pH_{1:5}$ value for natural, underground portal areas, and DREA samples is pH 8.1. The results confirm that topsoil stockpile soils have slightly higher alkalinity than in-situ samples.

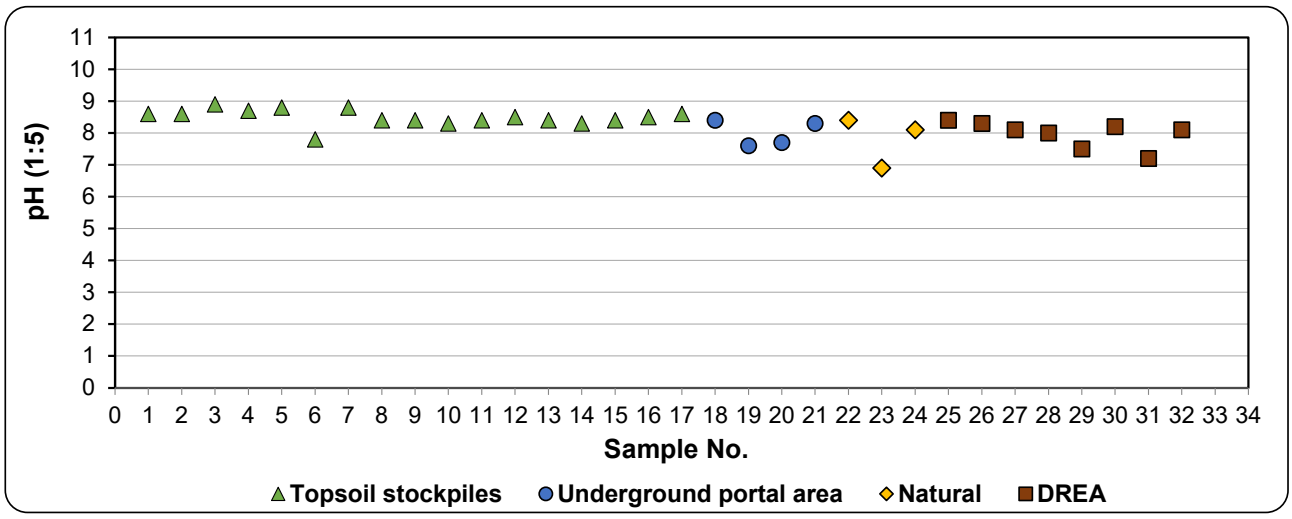


Figure 3-1: pH results for soil samples

3.1.1.2 Electrical Conductivity

The $EC_{1:5}$ value for the individual soil samples ranges from 12 to 136 µS/cm and has a median value of 86 µS/cm as shown in **Figure 3-2**. The median $EC_{1:5}$ for topsoil stockpiles is 104 µS/cm. The median $EC_{1:5}$ for natural and underground portal areas is 77 µS/cm and for DREA samples, the median $EC_{1:5}$ is 58 µS/cm.

The EC results confirm that the topsoil stockpile samples have slightly higher salinity (as measured by EC) than in-situ samples.

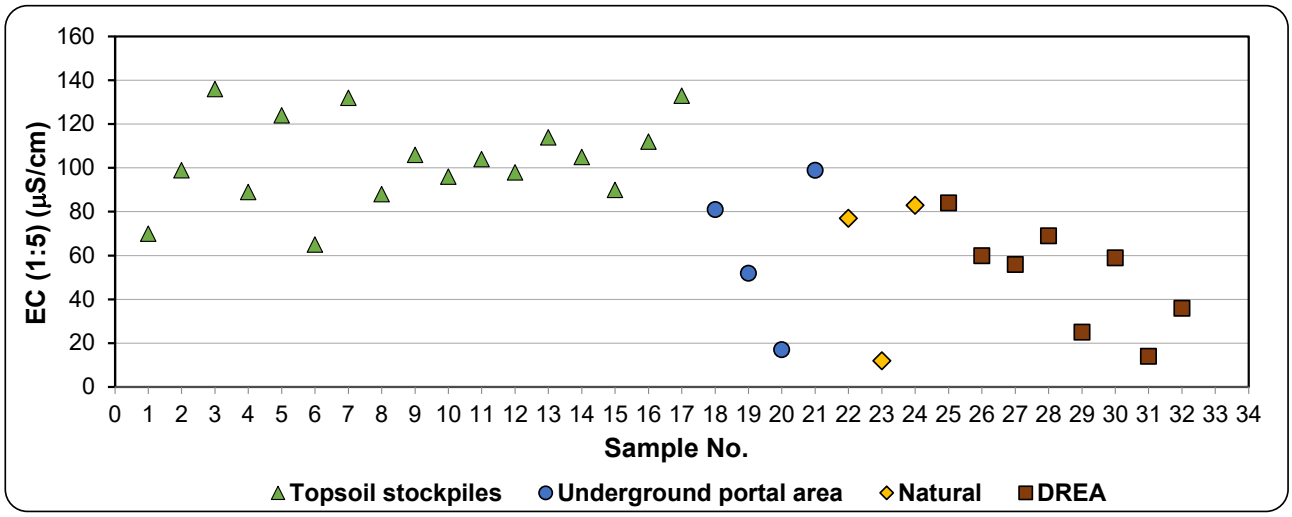


Figure 3-2: Electrical conductivity (EC) values for soil samples

3.1.1.3 Total sulfur

The total sulfur content of the soil samples ranges from below the limit of reporting (LoR) <0.01 to 0.02 %S (median 0.01 %S) (**Figure 3-3**) and is less than the median crustal abundance of 0.07 %S (Bowen 1979), which is generally rounded up to 0.1 %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.

The median total sulfur content of topsoil stockpiles is 0.02%S, whereas the median total sulfur content of in-situ samples is 0.01%S. However, as all of these soil samples are considered barren of sulfur, the difference between these two sets of results is negligible.

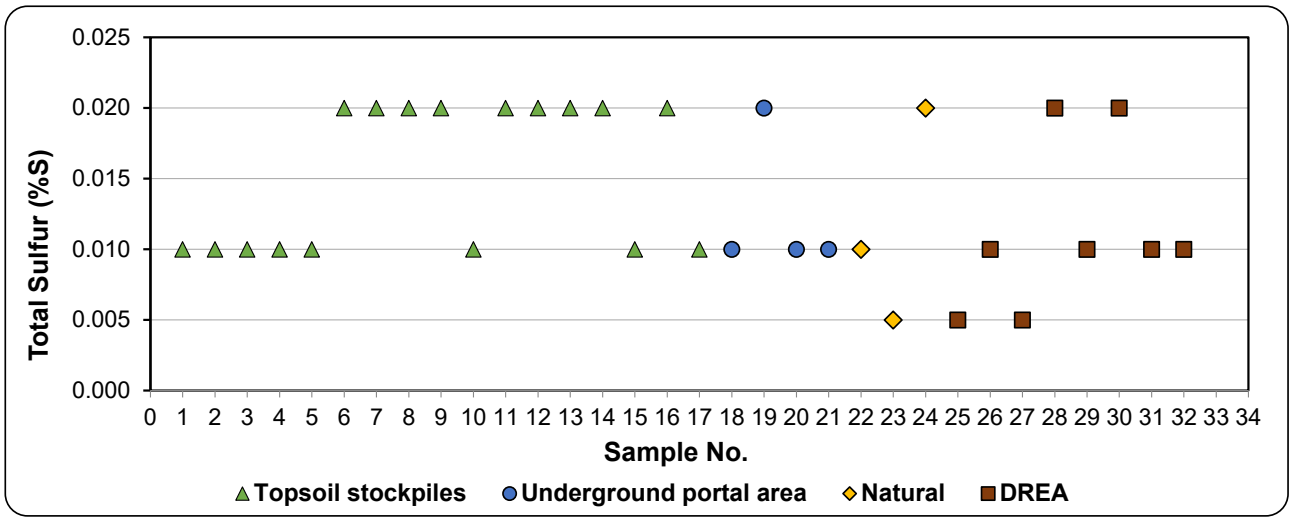


Figure 3-3: Total sulfur values for soil samples

3.1.1.4 Maximum Potential Acidity

Based on the total sulfur content, the maximum potential acidity (MPA) that could be generated by the soil samples (n=32) ranges from (below the LoR) 0.2 to 0.6 kg H_2SO_4/t; and has a median value of 0.3 kg H_2SO_4/t.

3.1.1.5 Acid Neutralising Capacity

The Acid Neutralising Capacity (ANC) of the soil samples ranges from 5 to 218 kg H_2SO_4/t and has a median value of 24 kg H_2SO_4/t. The median ANC of the topsoil stockpile samples is 46 kg H_2SO_4/t. By comparison, the median ANC of natural and underground portal areas is 16 kg H_2SO_4/t and DREA samples is 13 kg H_2SO_4/t. Overall, the topsoil stockpile samples have more ANC available than in-situ samples.

ANC:MPA Ratio: The ANC:MPA ratio for the samples ranges from 16 to 711 and has a median value of 71 (**Figure 3-4**). In simplistic terms, this means that the ANC values are in the soil samples are much lower than the MPA values and materials with an ANC:MPA of 3 or more have negligible risk of acid production.

NAPP: The NAPP for the soil samples ranges from -218 to -5 kg H_2SO_4/t (median -24 kg H_2SO_4/t) and are negative for all samples (**Figure 3-5**). This verifies that all of the soil samples have a low risk of acid generation.

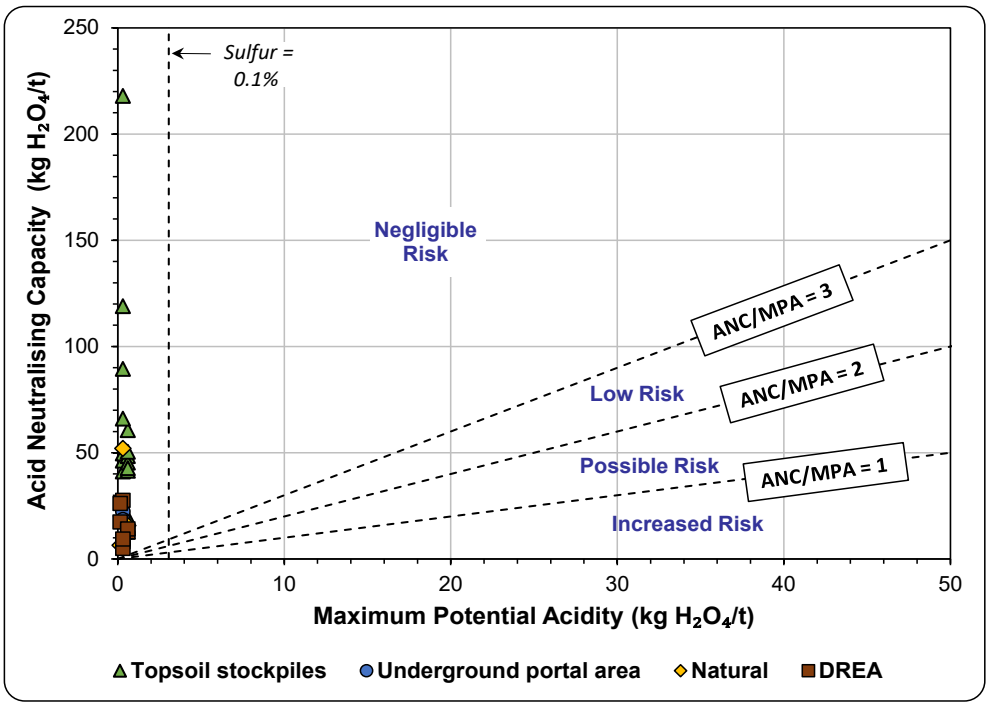


Figure 3-4: ANC versus MPA for soil samples

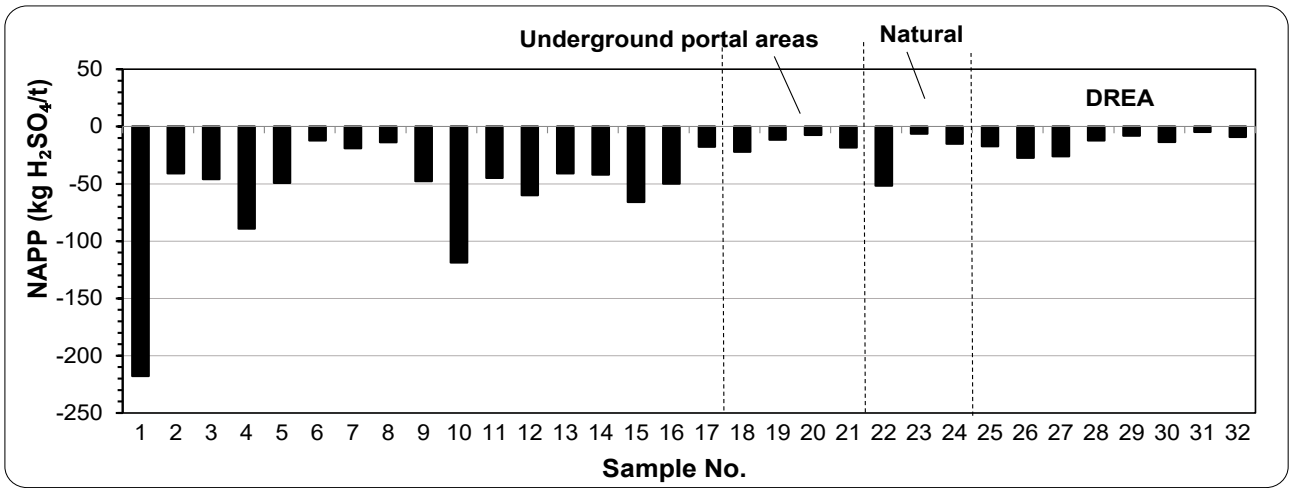


Figure 3-5: NAPP values for soil samples

3.1.1.6 Geochemical classification

Table 3-1 provides a summary of the Acid Base Account criteria used by RGS to provide a geochemical classification for the soil samples (AMIRA, 2002, COA, 2016 and INAP, 2022). The results indicate that all of the soil samples (n=32) are classified as Non-Acid Forming (NAF) (Barren).

Table 3-1: Geochemical classification criteria

Geochemical Classification	Total Sulfur [1] (%)	ANC: MPA Ratio	NAPP (kg H_2SO_4/t)	Number of Samples (n=32)	% of Samples
Non-Acid Forming (Barren)	≤ 0.1	-	-	32	100 %
Non-Acid Forming	> 0.1	≥ 2	≤ -5	0	0 %
Uncertain	> 0.1	< 2	> -5 and ≤ +5	0	0 %
Potentially Acid Forming	> 0.1	< 2	> 5	0	0 %

3.1.2 Multi-element testing

3.1.2.1 Total multi-elements in solids

Multi-element testing was completed on 12 soil composite samples as described in **Section 2.1.4** to identify any elements that may be present at concentrations of environmental concern with respect to materials handling, storage, revegetation and water quality. The results of the analyses are presented in **Table B2** (**Attachment B)** and summarised here.

To provide some context, RGS has compared the total metal/metalloid concentration in the soil samples to National Environmental Protection Council (NEPC) Health-based Investigation Levels (HIL(C)) for soils in public open spaces (NEPC, 2013). The multi-element test results show that the coal reject materials have low total metal and metalloid concentrations in solids, below the applied NEPC (HIL(C)) guideline for soils.

To provide additional context, the multi-element results are compared to the median background concentration (median crustal abundance) of those elements in unmineralised soils. From this comparison, a geochemical abundance index (GAI) is calculated. The GAI quantifies an assay result for a particular element in terms of the median crustal abundance for that element. The index, based on a log (2) scale, is expressed in seven integer increments (0 to 6), which correspond to enrichment factors from 0 to over 96 times median crustal abundance, as shown in **Table 3-2.**

Table 3-2: Geochemical Abundance Index (GAI) enrichment factors

GAI	Enrichment Factor	GAI	Enrichment Factor
0	Less than 3-fold enrichment	**4**	24 – 48 fold enrichment
1	3 – 6 fold enrichment	**5**	48 – 96 fold enrichment
2	6 – 12 fold enrichment	**6**	Greater than 96 fold enrichment
3	12 – 24 fold enrichment		

As a general rule, a GAI of 3 or greater signifies enrichment that may warrant further examination. This is particularly the case with some environmentally important 'trace' elements more so than with major rock-forming elements. Elements identified as enriched may not necessarily be a concern for revegetation, drainage water quality or public health, but their significance should still be evaluated. The GAI provides an indication of metals/metalloids that may be enriched relative to the median crustal abundance, however the following points should also be considered:

- The median crustal abundance varies between different literature sources, therefore affecting the calculated GAI values.
- If a sample is shown to be enriched relative to the median crustal abundance, there is no direct correlation that that particular sample will also leach metals/metalloids at elevated concentrations. The mobility of metals/metalloids is dependent on mineralogy, adsorption/desorption and the environment in which it occurs.
- Whilst some element concentrations can be elevated relative to the median crustal abundance, the nature of a mining deposit means the background levels are generally expected to be elevated.

Similarly, because an element is not enriched does not mean it will never be a concern, because under some conditions (e.g., low pH) the solubility of common environmentally important elements such as Al, Cu, Cd, Fe and Zn increases significantly.

Table B2 (**Attachment B**) provides total metal/metalloid concentrations for the 12 composite soil samples. The relative enrichment of metals/metalloids in these samples compared to median crustal abundance (GAI) is presented in **Table B3** (**Attachment B**).

The GAI results indicate that all of metals and metalloids tested in the soil samples have GAI values less than 3 and are not enriched compared to unmineralised soils (Bowen, 1979; INAP, 2022).

3.1.2.2 Soluble multi-elements in water extracts

The water extracts from a 1:5 (w:v) 16-hour deionised leach of the composite soil samples were tested for pH, EC, acidity, alkalinity and dissolved metals and metalloids and the results are provided in **Table B4** (**Attachment B**).

The pH and EC results for individual soil samples have already been discussed in **Section 3.1.1** and the water extract results on the 12 composite samples confirm that the soil samples are pH neutral to slightly alkaline and have low EC values.

The total alkalinity in the water extracts from the composite samples is generally elevated and ranges from 270 to 5,040 mg $CaCO_3$/L. The majority of the alkalinity is in the form of bicarbonate (HCO_3) in the samples. Acidity values in the water extracts are much lower than the alkalinity values for all composite soil samples, resulting in positive net alkalinity values (i.e., the alkalinity is greater than the acidity).

The concentration of major cations in the water extracts of the soil composites is low and dominated by calcium (Ca) and sodium (Na) along with lower concentrations of magnesium (Mg) and potassium (K).

The concentration of major anions is dominated by bicarbonate (HCO_3) and the sulfate (SO_4) concentrations are two orders of magnitude less than the applied livestock drinking water guideline of 1,000 mg/L (ANZG, 2018).. The concentration of fluoride (F) is slightly elevated in the water extracts from 2 of the 12 soil samples compared to the applied livestock drinking water guideline of 2 mg/L (ANZG, 2018). However, the median fluoride concentration is well below this applied guideline value and given that the soil samples represent both topsoil stockpiles and in-situ materials, this anion are likely to be naturally occurring.

The concentration of dissolved trace metals/metalloids tested in the water extracts from the composite samples is generally low and below the laboratory limit of reporting (LoR) for all elements tested except for aluminium (Al) (2 samples) and copper (Cu) (1 sample), which can have dissolved concentrations marginally higher than the applied guideline values for aquatic freshwater ecosystem (95 % species protection level) for these elements.

All of the trace metal/metalloid concentrations are well below the applied Livestock Drinking Water guidelines (ANZG, 2018) and the potential for soils to influence the quality of surface and groundwater resources is therefore low.

3.2 Soil quality

3.2.1 Exchangeable cations

Soil characterisation results for the 12 composite soil samples are presented in **Attachment B** and summarised in **Table 3-3.** Guidelines for classifying soils by agricultural standards are provided in **Table 3-4** (Hazelton and Murphy, 2016). Mining soils are not required to meet these standards to be suitable for rehabilitation; however, deficiencies can be used to predict the types of issues that may occur.

The $pH_{1:5}$ and $EC_{1:5}$ results for the soil composite samples are presented here but were discussed for individual samples in **Section 3.1.1**. The $pH_{1:5}$ and $EC_{1:5}$ results for both individual and composite samples are comparable, verifying the reproducibility of the test method.

Cation exchange capacity (CEC) results for topsoil stockpile samples range from 16.4 to 25.0 meq/100g (median 21.0 meq/100g) and for in-situ samples range from 15.6 to 25.2 meq/100g (median 18.0 meq/100g). These results infer that effective cation exchange capacity (eCEC) is moderate for all soil composites.

The exchangeable sodium percentage (ESP) results for topsoil stockpile samples range from 0.1 to 2.0 % (median 0.1 %) and for in-situ samples range from 0.1 to 1.4 % (median 0.1 %). Soils with ESP values less than 6 % are considered non-sodic, and all of the soil composite samples fall within this category.

The exchangeable cation concentrations for Ca, Mg, K, and Na show that the composite samples have high concentrations of exchangeable Ca. Exchangeable Mg and K are moderate, and exchangeable Na concentrations are generally low. The Ca:Mg ratio for the topsoil stockpile samples ranges from 5.6 to 12.9 (median 10.3) and shows that these soils are low in Mg compared to Ca. By comparison, in-situ soil samples have a balanced Ca to Mg ratio ranging from 4.5 to 9.3 (median 6.6). All of these soils have good structural stability and are unlikely to have erosion issues (Hazelton and Murphy, 2016).

Table 3-3: Summary of soil characterisation results

		Topsoil stockpiles			In-situ samples		
Parameter	**Analysis**	**Min**	**Max**	**Median**	**Min**	**Max**	**Median**
pH	Acidity/alkalinity	8.3	8.7	**8.4**	7.1	8.4	**8.0**
Electrical Conductivity (EC) (µS/cm) (1:5)	Salinity	128	145	**140**	21	131	**58**
Exchangeable Ca (meq/100g)	Exchangeable Cations	14.3	22.4	**18.3**	13.2	19.8	**15.3**
Exchangeable Mg (meq/100g)	Exchangeable Cations	1.4	3.5	**1.8**	2.0	4.4	**2.1**
Exchangeable K (meq/100g)	Exchangeable Cations	0.4	0.9	**0.6**	0.3	0.8	**0.5**
Exchangeable Na (meq/100g)	Exchangeable Cations	0.1	0.5	**0.1**	0.05	0.3	**0.1**
Cation exchange capacity (CEC) (meq/100g)	Soil fertility	16.4	25.0	**21.0**	15.6	25.2	**18.0**
Exchangeable Sodium Percentage (ESP) (%)	Sodicity	0.1	2.0	**0.1**	0.1	1.4	**0.1**
Calcium/Magnesium Ratio	Soil stability	5.6	12.9	**10.3**	4.5	9.3	**6.6**
Magnesium/Potassium Ratio	Soil stability	1.8	8.3	**3.1**	2.9	7.2	**4.5**

Table 3-4: Soil characterisation guidelines

Parameter	Very low	Low	Moderate	High	Very high
Exchangeable Ca	0-2	2-5	5-10	10-20	>20
Exchangeable Mg	0-0.3	0.3-1.0	1-3	3-8	>8
Exchangeable K	0-0.2	0.2-0.3	0.3-0.7	0.7-2.0	>2
Exchangeable Na	0-0.1	0.1-0.3	0.3-0.7	0.7-2.0	>2
Cation Exchange Capacity (CEC) (meq/100g)	<6	6-12	12-25	25-40	>40
	Non-sodic		Sodic	Strongly sodic	
Exchangeable Sodium Percentage (ESP) (%)	0-6		6-14	>14	
	Ca deficient	Ca (low)	Balanced	Mg (low)	Mg deficient
Ca/Mg ratio	<1	1-4	4-6	6-10	>10
	Mg deficient	Mg (low)	Balanced	K (low)	K deficient
Mg/K ratio	<0.6	0.6-1.2	1.2-1.8	1.8-2.4	>2.4

Relationships between the exchangeable cations help to classify the soil types based on their geochemical characteristics.

Figure 3-6 demonstrates that for all the soil composites, including both topsoil stockpiles and in-situ samples (natural, underground portal, and DREA areas), the majority of cation exchange capacity (CEC) is provided by exchangeable Ca, which is typically high (**Table 3-4**). Where there is a significant difference between CEC and exchangeable Ca, other exchangeable cations are contributing. This is true for Composite 7 (TS07) and Composite 8 (Natural-31), which have relatively high exchangeable Mg (3.5 and 4.4 meq/100g respectively) (**Figure 3-7**), as well as a low Ca:Mg ratio of 4.5 to 5.6 (**Figure 3-8**).

Exchangeable sodium is elevated in Composite 1 (TS01), composite 7 (TS07), and composite 12 (DREA-20) and ranges from 0.3 to 0.5 meq/100g (**Figure 3-7**). These selected composites also have the highest ESP values, which range from 1.4 to 2.0 % (**Figure 3-8**). Results verify that there is no correlation between exchangeable Na and other exchangeable cations. Exchangeable K has a small range of 0.4 to 0.9 meq/100g and is generally consistent across all soil composites (**Figure 3-7**).

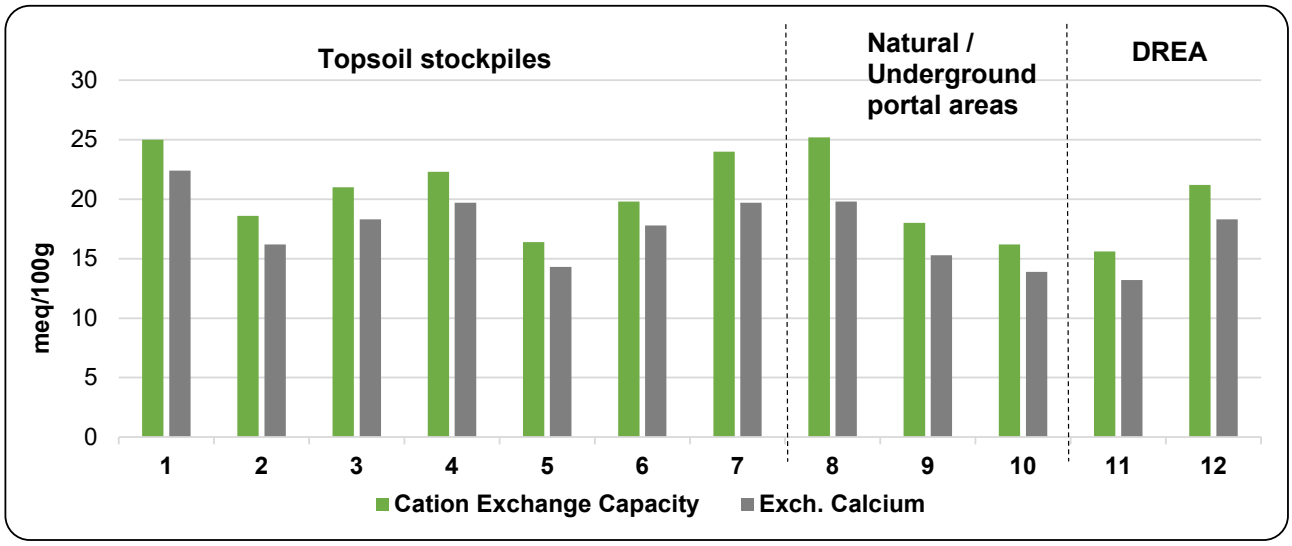


Figure 3-6: Cation Exchange Capacity and exchangeable calcium

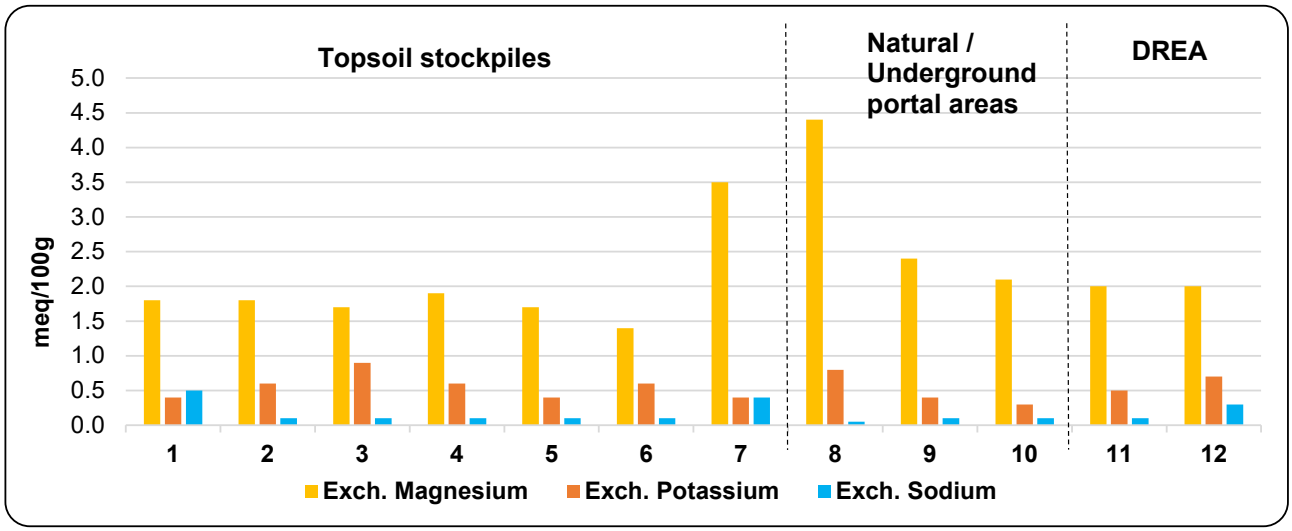


Figure 3-7: Exchangeable magnesium, potassium, and sodium

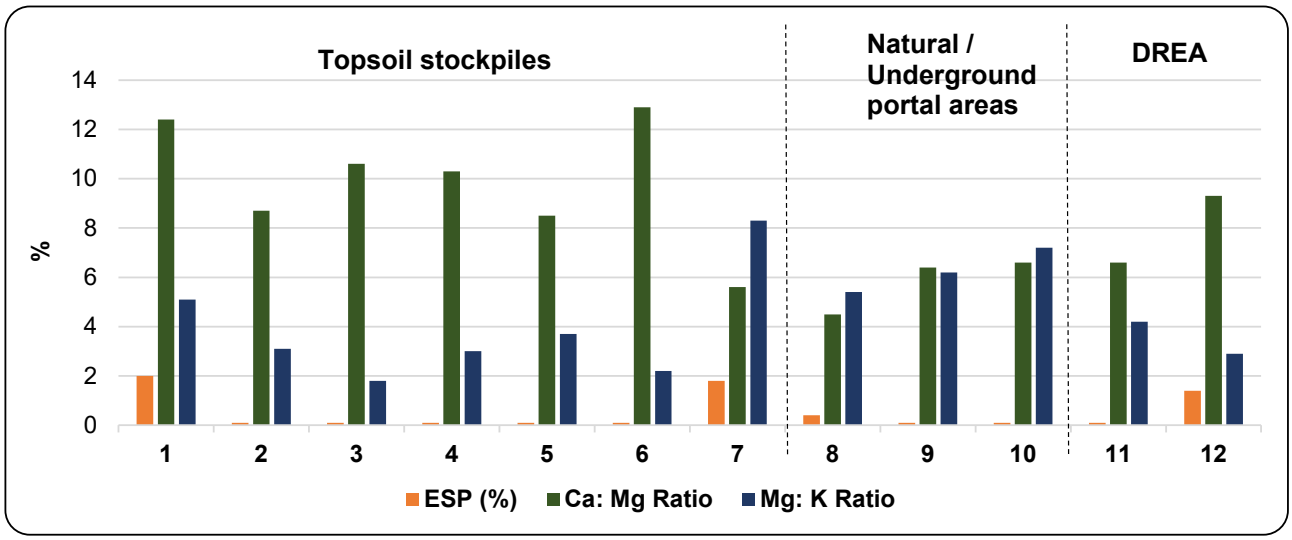


Figure 3-8: Exchangeable Sodium Percentage (ESP), Ca : Mg ratio, and Mg : K ratio

3.2.2 Soil salinity classification

Salinity classification of the soil composites based on Rengasamy (1984) is shown in **Figure 3-9**.

The soil salinity classification is calculated from ESP and $EC_{1:5}$ results. All of the soil composites (n=12) classify as Class 2A soils which are optimal soils that are neither sodic nor saline. These soils have good structure and stability, are not expected to be susceptible to dispersion or erosion, will support vegetation, and are suitable for general landform rehabilitation activities.

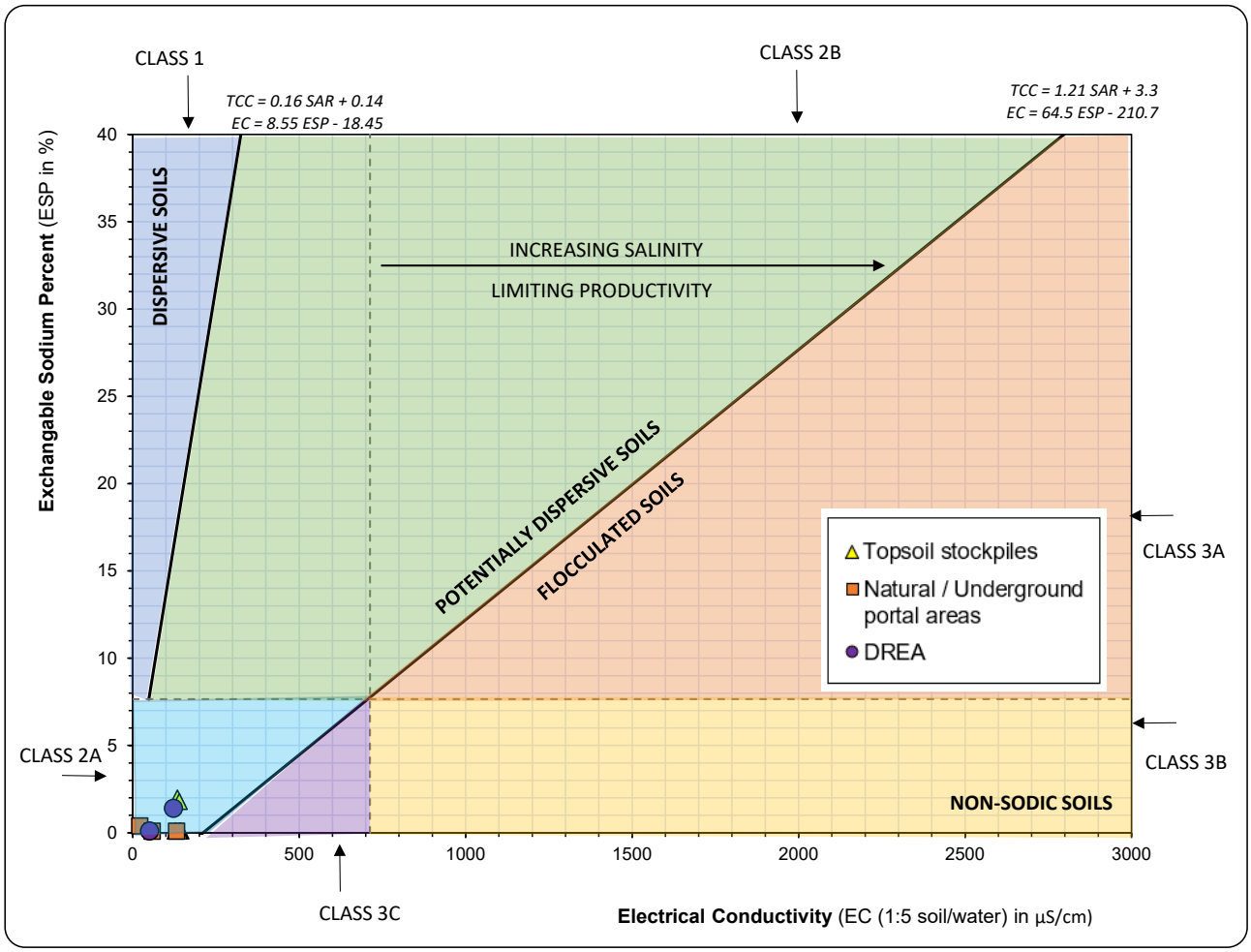


Figure 3-9: Soil salinity classification

3.2.3 Soil nutrients

3.2.3.1 Organic matter and TOC

Organic matter comprises 2.5 % to 4.1 % (median of 3.8 %) of topsoil stockpiles and 2.8 % to 4.6 % (median 3.8 %) of in-situ samples (natural, underground, and DREA areas) (**Figure 3-10**). Composite 8 (Natural-31) has the highest amount of organic matter, and Composite 1 (TS01) has the lowest.

Total organic carbon (TOC) is 1.4 % to 2.4 % (median 2.2 %) in topsoil stockpiles and 1.6 % to 2.7 % (median 2.2 %) for in-situ samples. These results verify that there is no significant difference in organic matter and TOC between topsoil stockpile samples and in-situ soil.

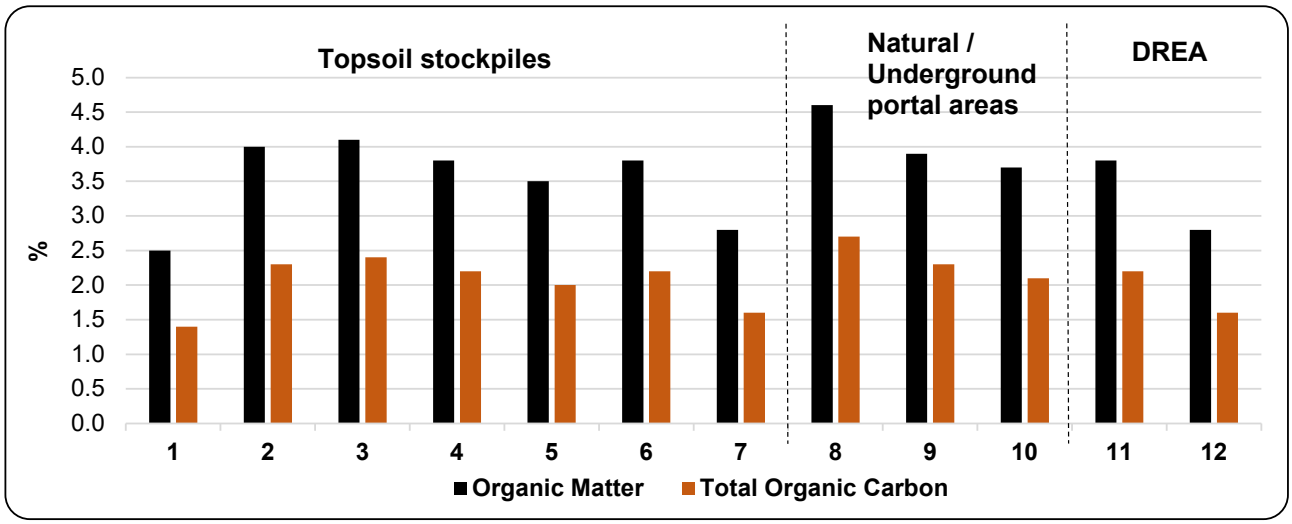


Figure 3-10: Organic matter and total organic) carbon

3.2.3.2 Total N and total P

Total nitrogen (as N) is 770 to 1580 mg/kg (median of 1,310 mg/kg) in topsoil stockpiles and 780 to 1,560 mg/kg (median 1,360 mg/kg) for in-situ samples (natural, underground, and DREA areas) (**Figure 3-11**). Composite 2 (TS02) has the highest concentration of total N and Composite 1 (TS01) and Composite 12 (DREA-20) have the lowest.

Total phosphorous (as P) ranges from 179 to 331 mg/kg (median 265 mg/kg) for topsoil stockpiles and 190 to 315 (median 288 mg/kg) for in-situ samples. Total P is relatively consistent across all of the soil composites. There is no significant difference between topsoil stockpiles and in-situ samples for Total N or Total P.

3.2.3.3 Bicarbonate extractable K and P

Bicarbonate extractable potassium (K) (Colwell) method measures the amount of K available for plant uptake, and is 306 to 895 mg/kg (median 624 mg/kg) for topsoil stockpiles and 393 to 498 mg/kg (median 464 mg/kg) for in-situ samples (**Figure 3-11**). Composite 3 (TS03) has the highest concentration of bicarbonate extractable K and Composite 1 (TS01) has the lowest. Based on these results, it bicarbonate extractable K is marginally greater in topsoil stockpile samples.

Critical values for extractable K that begin to limit plant growth are 80 to 200 mg/kg (Hazelton and Murphy, 2007; Gourley 1999). As the median extractable K value is above this upper critical limit, it is unlikely that K fertiliser will be required for these soils.

Bicarbonate extractable phosphorous (P) is not shown, but ranges from 2.5 to 12.0 mg/kg (median 2.5 mg/kg) for topsoil stockpiles and is 2.5 mg/kg for all in-situ samples. The range in bicarbonate extractable P concentrations demonstrates that this nutrient is slightly higher in topsoil stockpiles.

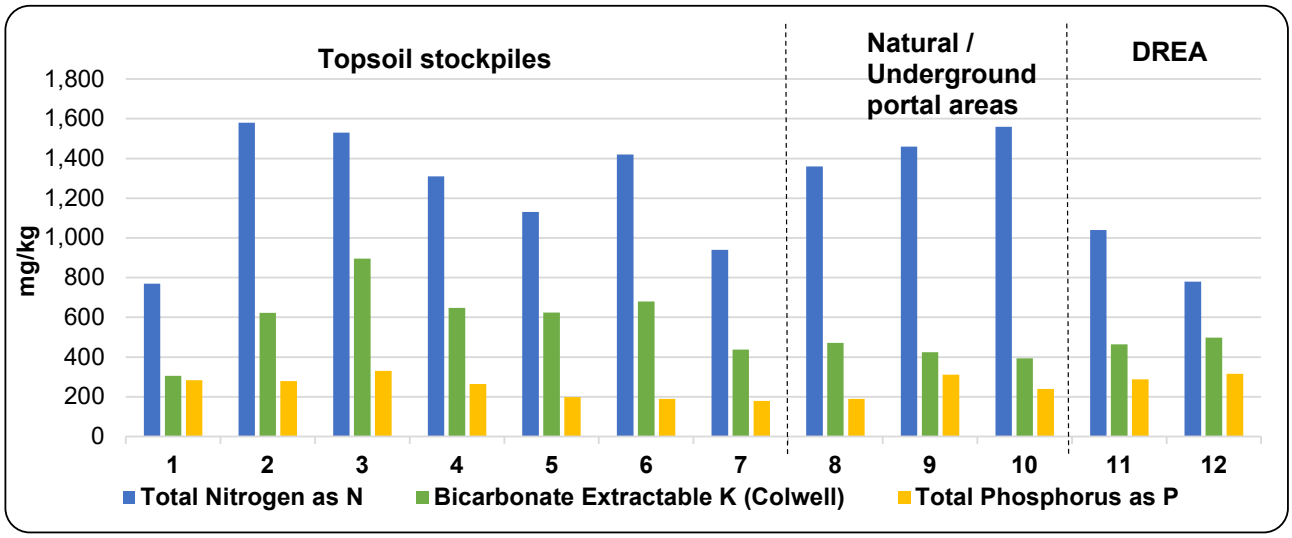


Figure 3-11: Total N, and bicarbonate extractable K and P

3.2.3.4 Carbon:nitrogen ratio

Desirable carbon:nitrogen (C:N) ratios are explained in **Section 2.2.3.2**. The TOC and total N values for the 12 soil composite samples are summarised in **Table 3-5** and show that C:N ratios range from 13:1 to 21:1 (median 17:1), present a good balance for soil microbes and are ideal for "grasses in a vegetative state" (i.e., pasture but not cropping) (Brust, 2019).

The C:N ratio for topsoil stockpiles ranges from 15:1 to 18:1 (median 17:1), and is less variable than in-situ samples, which have a range of 13:1 to 21:1 (median 20:1).

Table 3-5: C:N ratios for soil samples

#	Composite	TOC (%)	Total N (mg/kg)	Total N (%)	C:N Ratio
1	TS01	1.4	770	0.077	18:1
2	TS02	2.3	1580	0.158	15:1
3	TS03	2.4	1530	0.153	16:1
4	TS04	2.2	1310	0.131	17:1
5	TS05	2	1130	0.113	18:1
6	TS06	2.2	1420	0.142	15:1
7	TS07	1.6	940	0.094	17:1
8	NAT-31	2.7	1360	0.136	20:1
9	UG-Mod pH	2.3	1460	0.146	16:1
10	NAT-High pH	2.1	1560	0.156	13:1
11	DREA-50	2.2	1040	0.104	21:1
12	DREA-20	1.6	780	0.078	21:1

3.2.3.5 Exchangeable (DTPA) metals

Concentrations of metals extracted with diethylenetriamine pentaacetic acid (DTPA) measures common micronutrients required by plants, such as copper (Cu), iron (Fe), manganese (Mn), and zinc (Zn). Results for the 12 soil composite samples are shown in **Table 3-6**. Concentrations of DPTA extractable Cu and Zn are comparable for all soil samples.

The concentration of DTPA extractable Fe is 9.6 to 14.5 mg/kg (median 11.6 mg/kg) for topsoil stockpiles and 12.3 to 19.1 mg/kg (median 16.8 mg/kg) for in-situ soil samples. Similarly, the concentration of DTPA

extractable Mn is 6.1 to 15.7 mg/kg (median 10.6 mg/kg) for topsoil stockpiles and 9.0 to 38.6 mg/kg (median 20.2 mg/kg) for in-situ soil samples (**Figure 3-12**).

The results verify that levels of DTPA extractable Fe and Mn are slightly higher for in-situ samples, however, all micronutrients are above critical levels for cropping guidelines (based on Lindsay and Norvell, 1978) with the exception of Zn. As mining soils are not expected to meet agricultural guidelines, the levels of Zn are sufficient for the growth of native vegetation, as demonstrated in undisturbed areas.

Table 3-6: DPTA extractable metals

	Topsoil stockpiles (mg/kg)			In-situ samples (mg/kg)			
	Min	Max	Median	Min	Max	Median	Critical levels
Copper (Cu)	0.5	1.9	**1.3**	0.5	3.2	**1.5**	0.2
Iron (Fe)	9.6	14.5	**11.6**	12.3	19.1	**16.8**	4.5
Manganese (Mn)	6.1	15.7	**10.6**	9.0	38.6	**20.2**	1.0
Zinc (Zn)	0.5	0.5	**0.5**	0.5	0.5	**0.5**	0.8

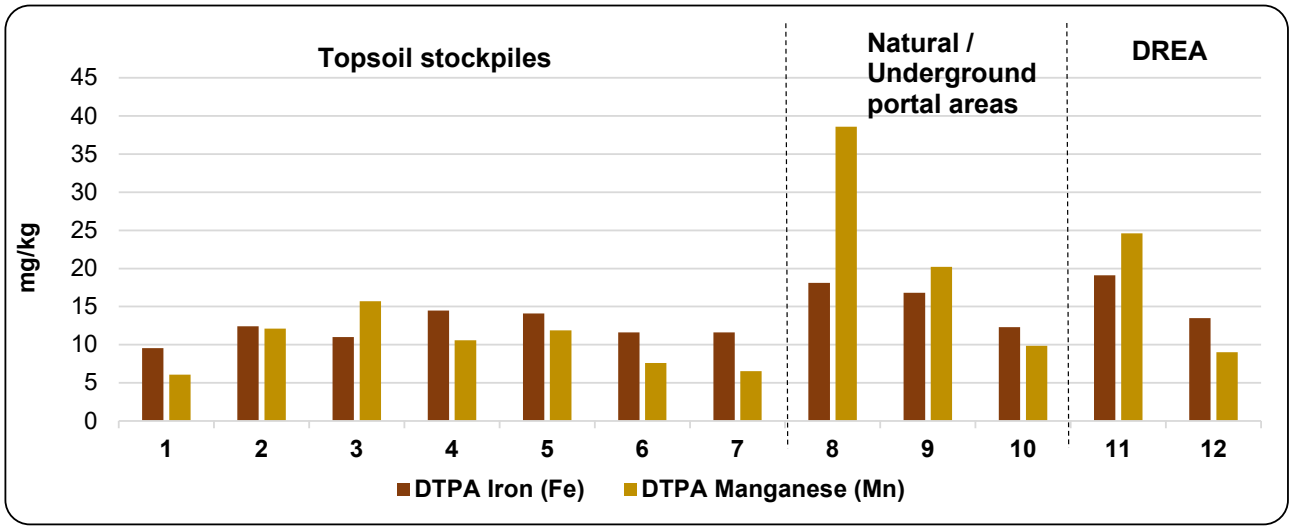


Figure 3-12: Concentrations of DTPA extractable Fe and Mn

3.3 Physical testing

3.3.1 Moisture content

A complete set of physical testing results for the 12 composite soil samples from Trilab laboratory are provided in **Attachment G.**

The soil moisture content is the mass of water held in the excavated soil compared to dry soil (after it is heated in an oven to 100°C). The amount of water held will depend on the soil texture (clay, silt, sand, or gravel) as well as the structure of the soil e.g., compaction.

The soil moisture contents for the soil composites are shown in **Figure 3-13** and range from 21.4 to 24.7 % (median 22.8 %) for topsoil stockpiles and 16.6 to 26.6 % (median 19.3 %) for in-situ samples (natural, underground portal, and DREA areas). The in-situ samples show wider variance in soil moisture contents. Composite 12 (DREA-20) has the highest soil moisture content and Composite 8 (Natural-31) has the lowest.

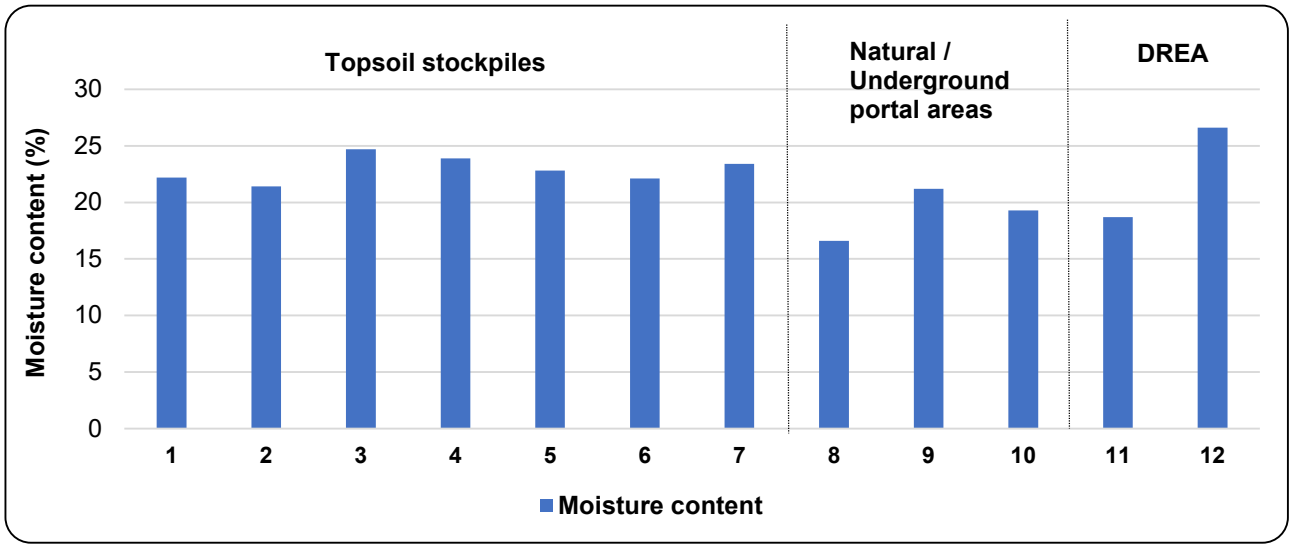


Figure 3-13: Soil moisture content

3.3.2 Emerson class

Explanatory information regarding Emerson class classifications, their relationship to dispersibility, and their applications has been included in **Section 2.2.3.3**.

The 12 soil composites analysed for Emerson Class are described as ranging from brown sandy clays to brown clays and all but one sample is classified as Emerson Class 4 (calcite) (**Table 3-7**). This class shows some slaking but no dispersion, and carbonate or gypsum are present. The exception is composite 8 (Natural-31), which is classified as Emerson Class 5, which shows some slaking but no dispersion, and carbonate or gypsum are absent.

These Emerson Class classifications (4c and 5) are described as aggregated materials that are generally stable but may not hold water in a dam (for example).

Table 3-7: Emerson class soil classifications

Composite No.	1	2	3	4	5	6
Client ID	TS01	TS02	TS03	TS04	TS05	TS06
Description	CLAY - brown	CLAY - brown	CLAY - brown	Sandy CLAY - brown	CLAY - brown	Sandy CLAY - brown
Emerson Class Number	**4c**	**4c**	**4c**	**4c**	**4c**	**4c**

Composite No.	7	8	9	10	11	12
Client ID	TS07	NAT - 31	UG – Mod pH	NAT – High pH	DREA – 50	DREA – 20
Description	Sandy CLAY - brown	CLAY - brown	CLAY - brown	CLAY - brown	CLAY - brown	CLAY - brown
Emerson Class Number	**4c**	**5**	**4c**	**4c**	**4c**	**4c**

3.3.3 Particle size distribution

The 12 composite soil samples underwent particle size distribution (PSD) with hydrometer analysis (150 to 0.0014 mm) to determine their proportions of gravel, sand, silt, and clay (**Table 3-8** and **Figure 3-14**).

The composite soil samples represent materials that are predominantly clay. Natural samples and those collected from underground portal areas are slightly coarser and contain a higher proportion of sand and less silt than other samples. In contrast, DREA samples are relatively fine and contain a higher proportion of silt and less sand than other samples. All of the composite soil samples contain a very low proportion of gravel (<3%).

Table 3-8: Summary of PSD results

	Clay (<0.002 mm)	Silt (0.002 – 0.02 mm)	Sand (0.02 – 2.0 mm)	Gravel (> 2.0 mm)
Topsoil stockpiles	42 – 53 %	17 – 23 %	27 – 37 %	0 – 3 %
Natural / Underground portal	41 – 52 %	14 – 19 %	29 – 44 %	0 – 1 %
DREA	40 – 53 %	23 – 27 %	23 – 32 %	1 %

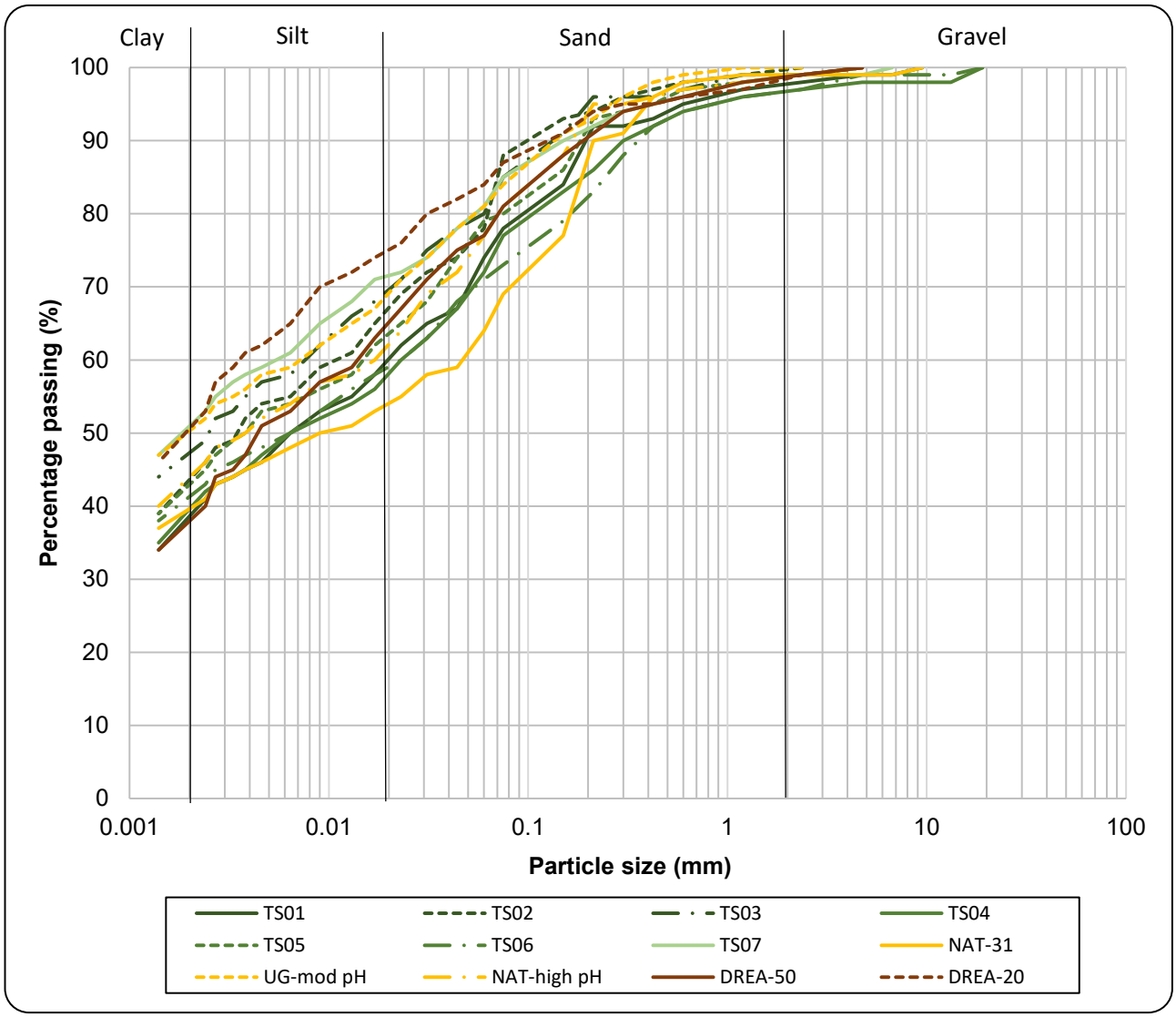


Figure 3-14: Particle size distribution for soil samples

3.3.4 Soil texture classification

Using the PSD results and proportions (0 – 100%) of clay (< 0.002 mm PSD), silt (> 0.002 to < 0.02 mm PSD), and sand (> 0.02 to < 2 mm PSD), the 12 soil composite samples have been plotted on a soil texture classification triangle (**Figure 3-15**).

All of the soil samples plot in the clay quadrant of the soil texture triangle and are therefore considered to have the same soil texture classification. The sample that shows the most difference to others is Composite 8 (Natural-31), which has a relatively high proportion of sand (44 %) and is low in silt (14 %). This sample has been annotated in **Figure 3-15**. Composite 12 (DREA-20) is close to being classified as a clay loam because unlike other samples, it contains even proportions of sand and silt (23 %).

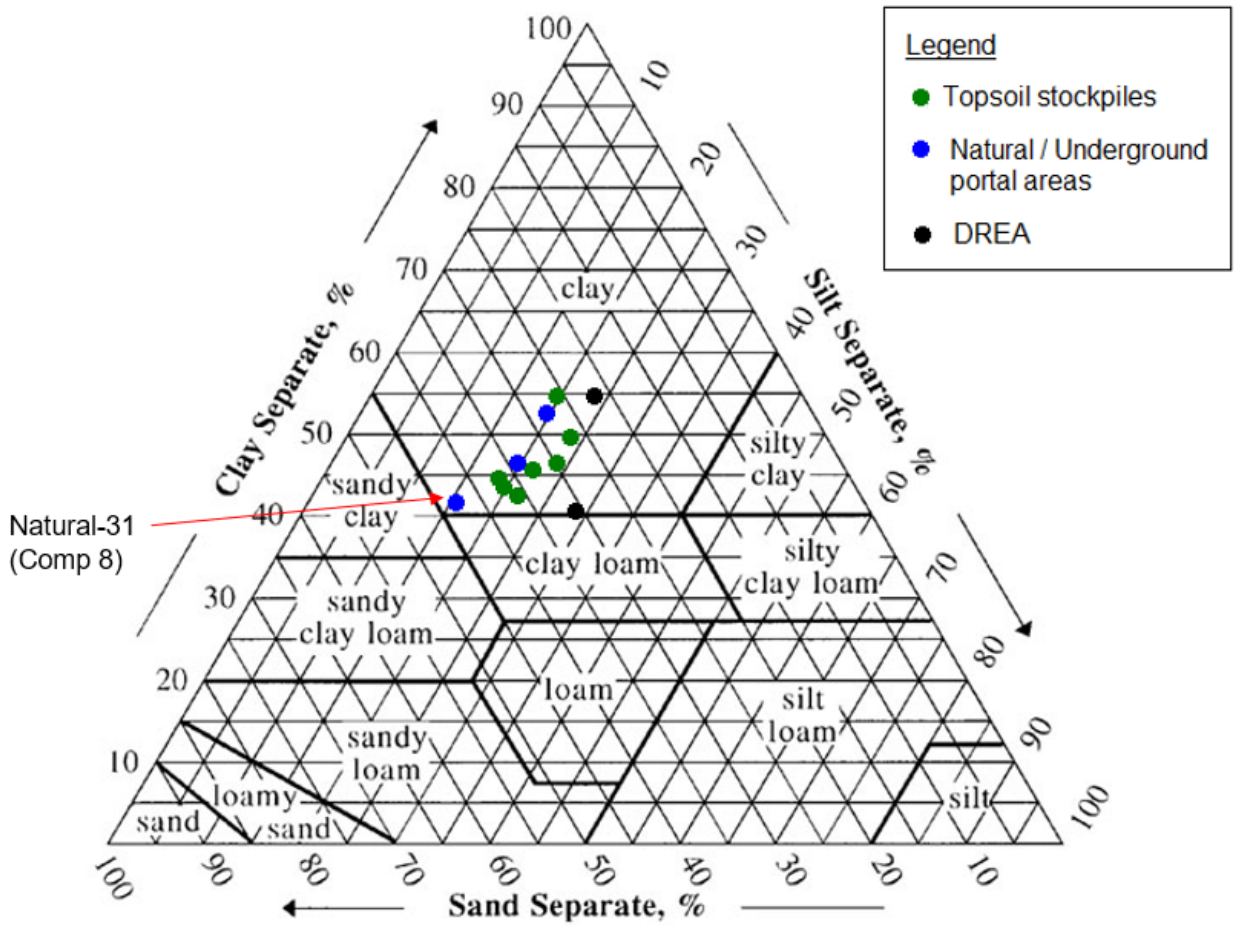


Figure 3-15: Soil texture classification

3.3.5 Soil Water Characteristic Curves

A complete set of SWCC results from Soil Water Group laboratory are provided in **Attachment H.**

SWCCs measure the limits of water storage capacity in a soil material. The upper limit of saturation is called field capacity, and the lower limit is called the permanent wilting point. Between these two limits is the plant available water. After a rainfall event saturates the soil, there will be infiltration due to gravity which is referred to as drainage. During this process, the soil moisture decreases, and the rate at which it decreases is dependent on the soil texture class. It is expected that soils with higher clay content will retain water for longer than sandy soils.

Water retention can be measured by plotting the pressure head (which relates to the height at which water can be drawn or sucked up, i.e., through capillary rise) against soil moisture (**Figure 3-16**). SWCCs can be used to determine van Genuchten parameters, i.e., residual water content (θ_r) and the saturated water content (θ_s). The inflexion point of the curve indicates the field capacity of the soil, and upper and lower transition zones infer the wilting point and saturation, respectively. The data obtained from the water retention curves is summarised in **Table 3-9**.

The data bars and graph show that the topsoil stockpiles and in-situ soil samples have water retention curves that are typical of loamy silt rather than pure clay, which would have higher field capacity. This is advantageous,

as it decreases the likelihood that the soils will become waterlogged. There is little variation across the soil samples and topsoil stockpiles generally have slightly higher water retention than in-situ samples.

Within the data set, TS07 behaves most like a clay and holds water, whereas DREA-20 and NAT-31 have a coarser, more free draining sandy texture. Overall, the data confirm that these soils are likely to have good water retention but will drain reasonably well after a rain event. The water retention curves verify the favourable characteristics of the soil, and the establishment of vegetation over time will continue to improve the water holding capacity of the soil.

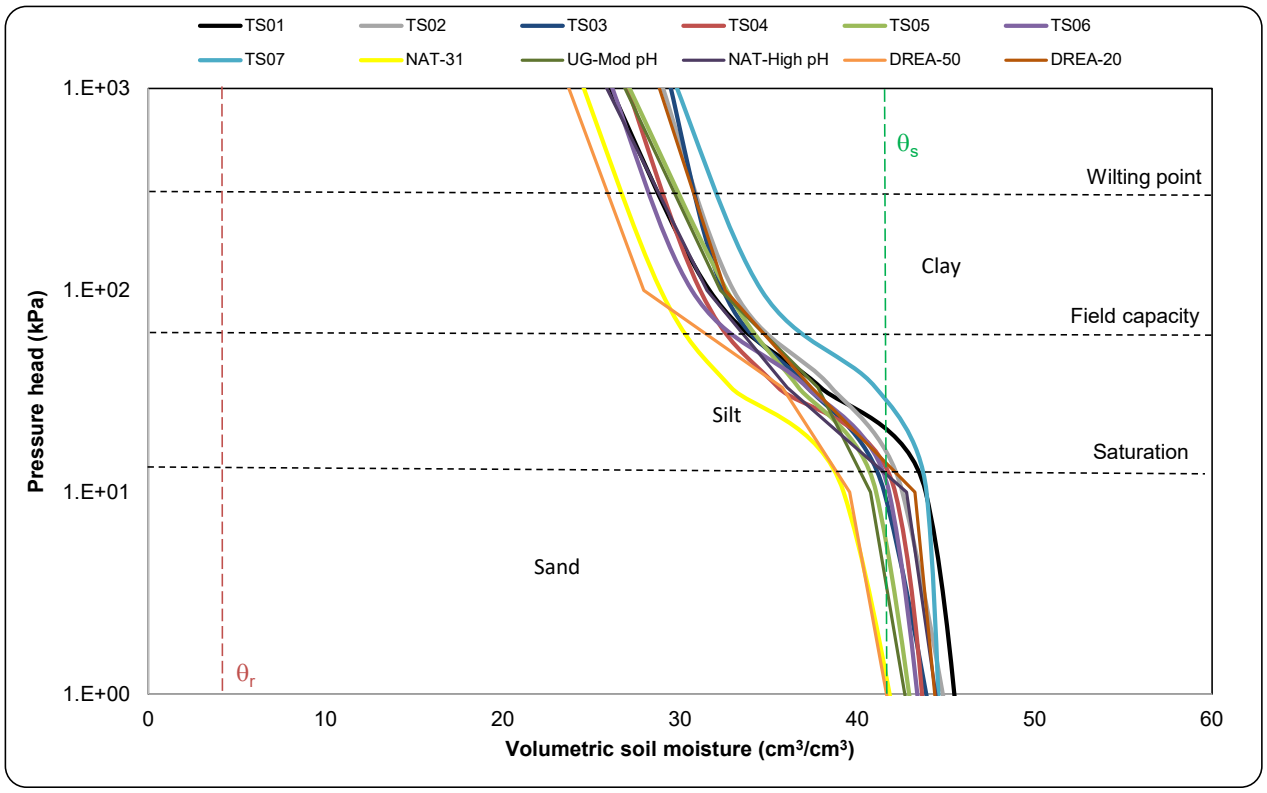


Figure 3-16: Water retention curves using van Genuchten parameters

Table 3-9: Water retention curve data

Sample	Pit	Residual water content (θ_r) (cm^3/cm^3)	Saturated water content (θ_s) (cm^3/cm^3)	Wilting point (cm^3/cm^3)	Field capacity (cm^3/cm^3)	Saturation (cm^3/cm^3)
ME Comp 1	TS01	0.228	0.475	25.133	37.924	47.554
ME Comp 2	TS02	0.249	0.487	28.372	38.520	48.739
ME Comp 3	TS03	0.271	0.479	28.996	37.200	47.921
ME Comp 4	TS04	0.254	0.454	26.359	35.531	45.381
ME Comp 5	TS05	0.298	0.460	26.204	36.675	45.873
ME Comp 6	TS06	0.235	0.455	25.436	37.153	45.710
ME Comp 7	TS07	0.284	0.450	29.033	41.014	45.312
ME Comp 8	NAT-31	0.218	0.459	23.818	32.870	45.880
ME Comp 9	UG-Mod pH	0.228	0.466	25.941	37.776	46.540
ME Comp 10	NAT-High pH	0.219	0.478	24.861	36.030	47.707
ME Comp 11	DREA-50	0.195	0.456	22.968	35.758	45.796
ME Comp 12	DREA-20	0.271	0.466	28.168	37.410	46.594

3.3.6 Mineralogy

The mineralogical results for the three selected individual soil samples are presented in **Table 3-10** and **Figure 3-17** to **Figure 3-19**. Results verify that the samples are predominantly quartz and montmorillonite (a shrink/swell clay), with albite (sodium feldspar), minor amounts of illite and kaolinite (also clays), and trace pyrite (FeS_2, 0 to 0.3 %).

The proportion of calcite ($CaCO_3$) in each sample is variable, and sample TS01-01 is elevated in this carbonate mineral, which explains its high ANC. The proportion of albite and pyrite appears to be influencing pH and EC, as TS01-03 is slightly elevated in these minerals and could be weathering to produce calcium and sodium sulfate salts (Na^+, Ca^{2+}, $SO4^{2-}$). Sample Natural-31 appears to be low in these reactive minerals (calcite, albite, and pyrite) and in addition may have a low surface area as it is high in coarse sand (**Section 3.3.3**).This combination of factors may explain the lower pH, EC, and ANC values for Natural-31.

Table 3-10: Summary of mineralogical results by XRD

	Natural-31	TS01-03	TS01-01
%	2021090_0006	2021090_0010	2021090_0016
Quartz	47.1	46.6	36.9
Montmorillonite	35.8	31.1	24.5
Albite	7.5	12.2	7.7
Calcite	2	3.7	26.3
Kaolinite	2.5	3.2	2.2
Illite	5	2.9	2.4
Pyrite	0.1	0.3	ND
Total	100	100	100

ND = Not detected

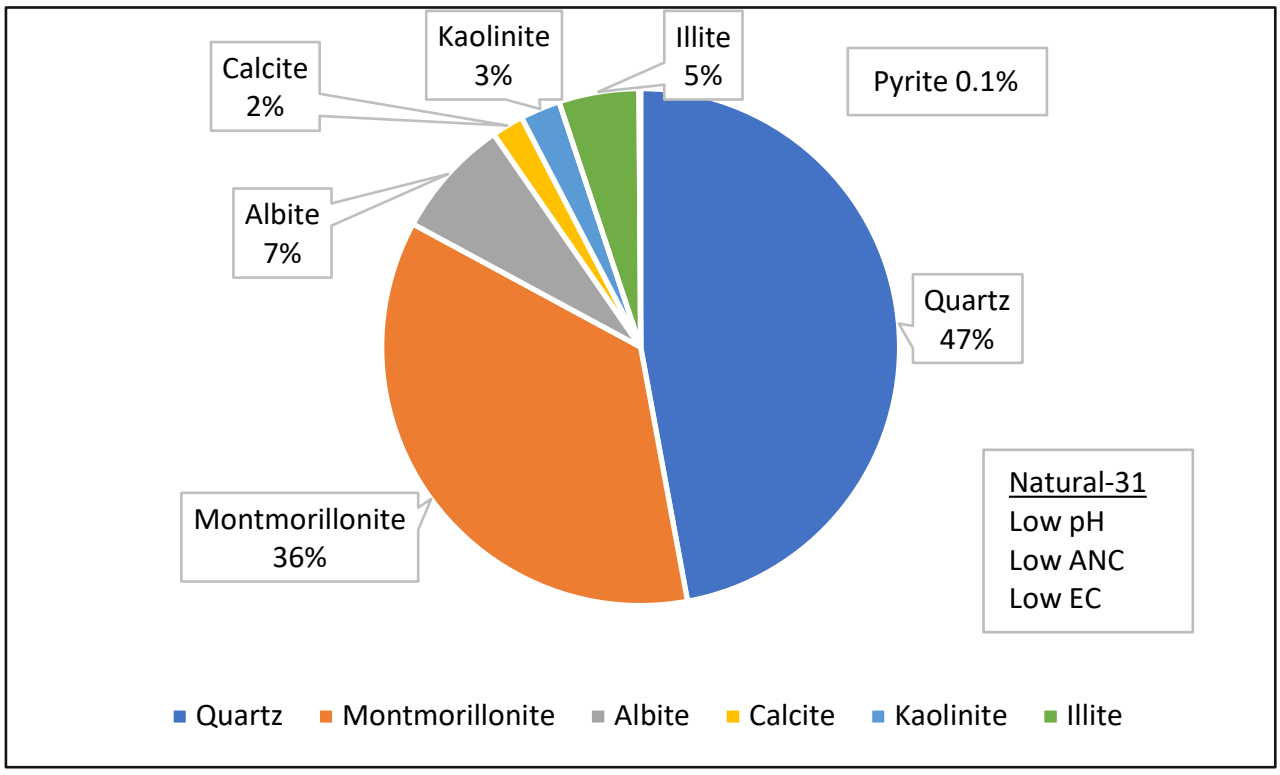


Figure 3-17: Mineral composition of sample 2021090_0006 (Natural-31)

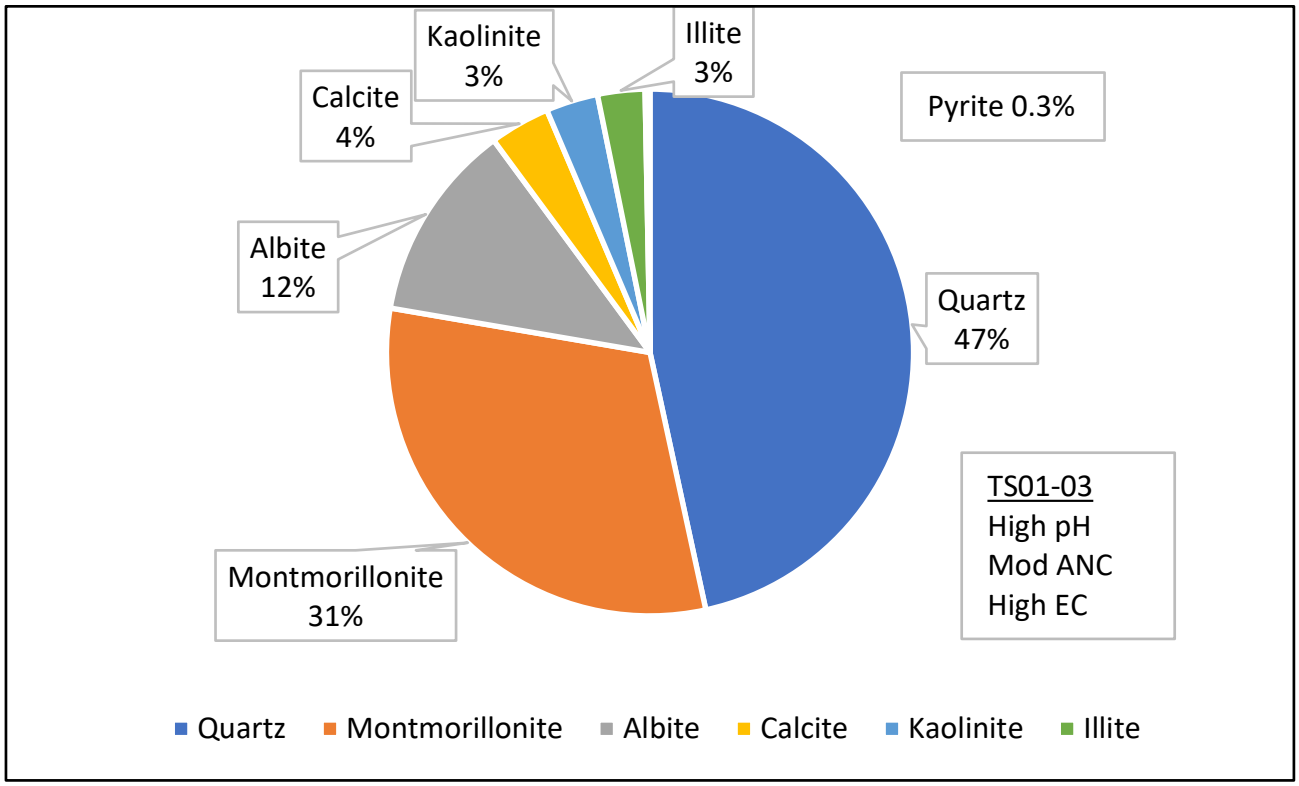


Figure 3-18: Mineral composition of sample 2021090_0010 (TS01-03)

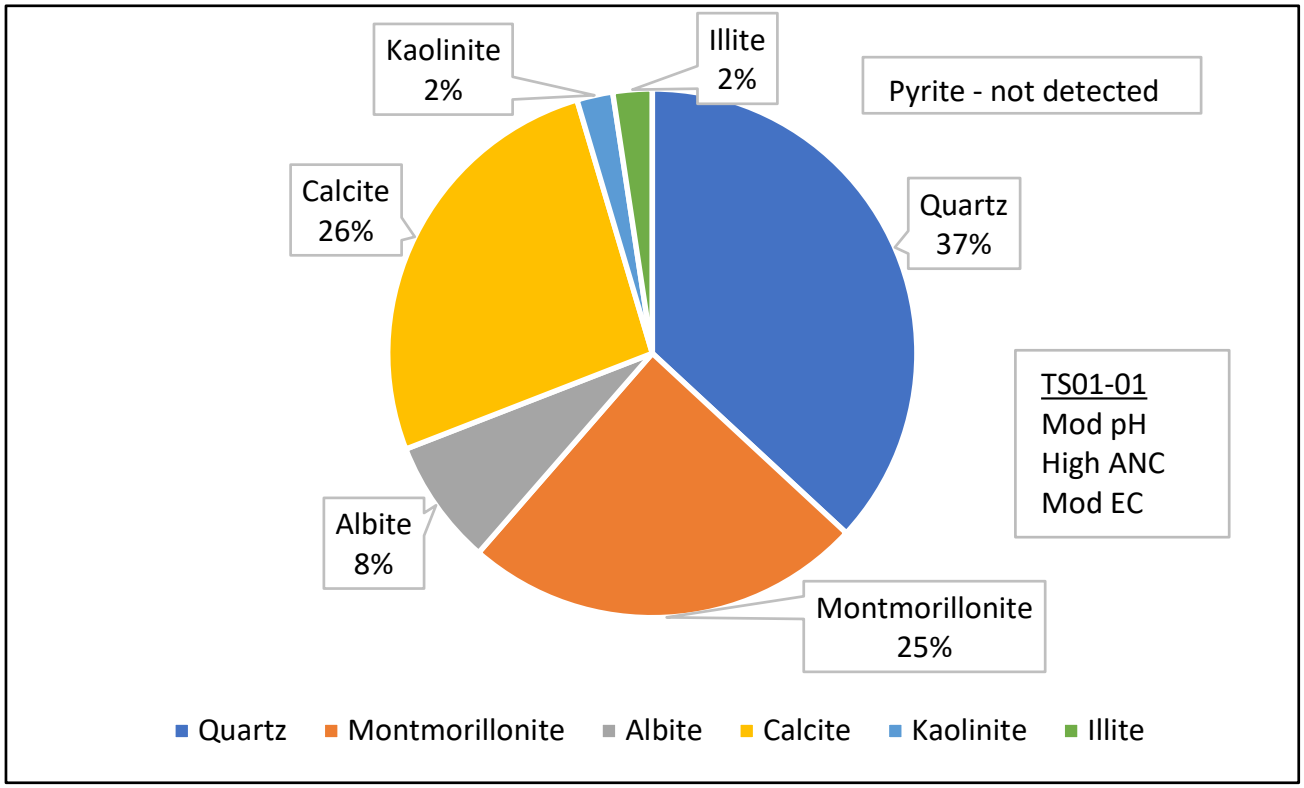


Figure 3-19: Mineral composition of sample 2021090_0016 (TS01-01)

4 Discussion

4.1 Soil characteristics

The disturbance of in-situ soil and development of topsoil stockpiles predominantly affects the geochemistry of the soil materials. This could potentially be due to the expansion (swell) of voids between the soil particles, which can then trap additional moisture during rainfall events when compared to in-situ soil, which has more compaction. Higher porosity and moisture content is likely to increase the reactive surface area of the soil, resulting in higher EC values as crystallised salts dissolve and minerals continue to weather.

ANC results verify that the topsoil stockpiles have higher buffering capacity and are also higher in exchangeable Ca compared to in-situ samples. The concentration of exchangeable Ca is likely to be related to the dissolution of calcite ($CaCO_3$) minerals in the presence of trace oxidising pyrite (FeS_2), a geochemical reaction that occurs when the soil is disturbed and exposed to the atmosphere. This reaction produces minor acidity, which is then is buffered by calcite, to produce neutral to alkaline pH values. Some macronutrients (bicarbonate extractable K and P) are also higher in topsoil stockpiles. This ready supply of soil nutrients may in fact be preferable to in-situ soil for newly established vegetation.

Excluding moisture content, the physical properties of the soil such as PSD and Emerson Class as well as organic matter, TOC, total N, and total P appear to be the same, before and after stockpiling. The only disadvantage of topsoil stockpiling in terms of soil geochemical and nutrient properties appears to be the slight reduction in DTPA extractable Fe and Mn values, which are nevertheless more than sufficient for plant growth based on the conservative values in agricultural guidelines.

4.2 Soil classification

Collation and interpretation of the soil test information, as well as previous knowledge from the desktop study (**Section 7.1, Attachment D**), allows a subjective assessment of the soil types in the topsoil stockpiles to be made. **Table 4-1** summarises the moist appropriate classifications for materials represented by the soil samples tested. All of the topsoil stockpile soils, and all but one in-situ samples (Sample NAT-31) have been classified as deep uniform clays 7-8 g (vertosols). It is stressed that this is a subjective assessment and classification based on the topsoil only, as key information such as soil horizons (e.g., subsoil) and soil structures, and textures such as transitions and soil crusts are not preserved in topsoil stockpile samples.

Sample NAT-31 is classified as a vertosol, but is Emerson Class 5, has a higher proportion of sand (44%) and relatively low $pH_{1:5}$ which suggests it is likely associated with duplex soils/cracking clays 6-8 g. This sample material may have weathered from TQr (Tertiary-Quaternary Residual Soils and Colluvial Deposits clay, silt, sand and gravel) rather than Qrb (Quaternary Residual Soil and Colluvial Deposits mainly black soils derived from basalt) (**Table 7-1** and **Figure 7-11**)

Vertosols are defined as soils with a clay texture of 35 % or more clay with thin surface crusty horizons 0.03 thick. These clay soils have strong shrink-swell properties that exhibit cracking when dry, as well as slickensides and/or lenticular peds and may exhibit gilgai microrelief (Isbell, 2016). Vertosols are very common in Australia and are often calcareous throughout. Vertosols have high soil fertility, a large water holding capacity, and a good ability to supply plant nutrients. Vertosols are prized for their agricultural value and make excellent rehabilitation soils (QLD Govt, 2013).

Table 4-1: Soil classifications

Soil type	Description	Australian soil classification (ASC)	Soil classification	Overall soil quality	Limitations
6–8 g	Thin fine sandy to silt loamy surface with yellow-brown alkaline sodic medium to heavy clay subsoils, in association with dark grey or dark brown cracking clay soils	Chromosols, Sodosols or Calcarosols (Type 6) **Vertosols (Type 8)**	NAT-31	Very good to excellent (Class 2A)	None
7–8 g	Association of medium to deep uniform or gradational clays with hard coarse-structured subsoils and dark grey to dark brown with locally intensive linear gilgai formation	Dermosols or Hydrosols (Type 7) **Vertosols (Type 8)**	TS01 to TS07, NAT-26 to NAT-30, and all DREA	Excellent (Class 2A)	None

5 Conclusions and recommendations

5.1 Conclusions

RGS has completed a topsoil quality assessment for the Project and has characterised soil materials based on their geochemical, nutrient and physical properties. The key study findings are summarised as follows.

- The static geochemical test results demonstrate that the soil samples have negligible potential to generate acid and generally have excess buffering capacity. Soil samples are classified as NAF (Barren).
- Geochemically, inherent acid-producing minerals are low, but there is some minor variation in buffering capacity based on calcite content.
- Soil samples do not contain any significantly enriched concentrations of total metal/metalloid concentrations compared to applied guideline values and/or un-mineralised soils.
- The concentration of dissolved trace metals/metalloids released into initial contact water is low and typically below the laboratory LoR. A minor exception is F, which can have a dissolved concentration in a few soil samples slightly above the applied Livestock Drinking Water guideline value (ANZG, 2018), but is likely to be naturally occurring.
- The soil quality assessment verifies that the soils have moderate cation exchange capacity, are non-sodic, and contain sufficient exchangeable cations and nutrients for plant growth.
- The soils classify as Class 2A soils based on salinity and sodicity and have no expected limitations.
- Physically, the soils are rich in clay with lesser proportions of silt and sand, and therefore have good moisture and stability characteristics suitable for most earthworks.
- All soil samples are classified as Vertosols and contain shrink/swell clays (montmorillonite) that may show some cracking when dry.
- Topsoil stockpiles show a slight increase in potential nutrients and buffering capacity over in-situ soil samples from the underground portal and DREA areas.
- All soil samples assessed are expected to be suitable for use as rehabilitation materials.

5.2 Recommendations

Topsoil stockpiles contain active microbes that require nourishment if soil quality is to be preserved. Preferably, the height of stockpiles should be limited to less than 2 m to reduce load compaction, and topsoil should be used as soon as possible after it is excavated, avoiding storage for longer than 2 years. If extended storage is required, the stockpile should be allowed to revegetate and periodically ‘turned over’ to allow air into the topsoil for microbes and reduce natural compaction over time.

Additional soil sampling is recommended for any development areas outside the scope of this assessment.

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7 Attachments

Attachment A: Acid and Metalliferous Drainage

The use of consistent terminology is required for the project.

Mined materials may include the following.

- Mine waste – mine waste includes overburden, tailings, rejects, low grade ore, process residue.
- Rehabilitation materials – material to be utilised for cover systems and water management drains that could include oxide (e.g., **soil**, or fully weathered non-consolidated units such as clay that can be free dug without blasting), transition (include oxide and fresh material) or fresh (competent un-weathered rock) geological units.
- Cover materials – material selectively placed within the upper profile of the rehabilitated landform in a cover system. Cover systems are constructed from rehabilitation materials. Cover systems should be designed and constructed to meet specific objectives and design criteria. Chemical and physical characterisation of rehabilitation materials is required to ensure that the cover system will meet the objectives and design criteria.

In Australia, the term Acid and Metalliferous Drainage (AMD) is defined as incorporating acidic metalliferous drainage, neutral metalliferous drainage, and saline drainage (COA, 2016).

Standard industry terms used to classify the Net Acid Producing Potential (NAPP**)** of mined materials include:

- AF (Acid Forming) – highly reactive material that can produce acid rapidly (days to weeks).
- PAF (Potentially Acid Forming) - has the potential to produce acid.
- PAF- LC (Potentially Acid Forming - Low Capacity) - has the potential to produce minor amounts of acid.
- NAF (Non-Acid Forming) - will not produce acid but may leach salts and some metals due to the presence of low sulfide bearing material.
- NAF (Barren) (Non-Acid Forming (Barren)) – is unlikely to produce acid or leach salts due to the absence of sulfide minerals (typically less than 0.1 % total sulfur).
- AC (Acid Consuming) – has some acid neutralising capacity (ANC) that will contribute to ongoing acid neutralisation e.g. calcite in Basalt.

General industry terms that can be used to describe water quality at mines include the following.

- Acid Mine Drainage.
- Acid Rock Drainage.
- Acid and Metalliferous Drainage.
- Neutral Mine Drainage.
- Saline Drainage.
- Mine Impacted Water.

Water on mines includes surface water and groundwater. Groundwater can be considered as water that is present in non-mined ground that has the potential to enter pits (operational pits, backfilled pits or decommissioned pits). After groundwater enters a pit, it will become mine impacted water. Mine impacted water could leave a pit and enter the groundwater system in the receiving environment or become surface water that may then be pumped from the pit. Surface water is present in dams, creeks, and process plants. Seepage from landforms can drain to groundwater or it may appear as resurgent seepage to surface water.

The term mine impacted water is used as a general term to describe water which contacts disturbed ground and that may include water in:

- Seepage from waste rock dumps or coal rejects (in-pit or ex-pit);
- Operating or decommissioned pits; and
- Back-filled pits.

Mine impacted water can be classified as having:

- Acid, neutral or alkaline pH;
- Variable concentrations of major ions (salts e.g., calcium, magnesium, potassium, sodium, chloride, sulfate, boron or fluoride); and
- Variable concentrations of metals (e.g., Al, Fe, Mn and Zn) or metalloids (e.g., Mo, Se and V) with the concentrations often linked to pH.

Potential sources of acid in mine impacted water at mine sites can include the following.

- Oxidation of sulfide minerals such as pyrite that produce sulfuric acid (INAP, 2009).
- Rainfall and leaching of cations such as calcium (Ca^{2+}), magnesium (Mg^{2+}), potassium (K^{+}) and sodium (Na^{+}) that reduce soil pH by atmospheric carbonic, nitric or sulfuric acid.
- Organic matter decay.

Potential sources of salts in mine impacted water at mine sites that can include the following.

- Oxidation of sulfide minerals, the production of sulfuric acid and subsequent neutralisation reactions that mobilise major ions such as sulfate (SO_4^{2-}) and calcium.
- Chemical weathering of adjacent soil and rock by sulfuric acid that releases major ions such as sodium, potassium, magnesium and chloride.
- The mobilisation of sodium chloride (NaCl) or sodium bi-carbonate ($NaHCO_3$) that are present within geological units and groundwater and then released in fluxes as mined materials are extracted (blasted), processed (crushed) and placed into mine landforms.

Potential sources of metals (e.g. Al, Fe, Mn, and Zn) and metalloids (oxyanions such as Mo, Se and V) in water at mine sites can include elements present:

- As ancillary minerals within primary sulfide minerals like pyrite or marcasite;
- In the solid phase of geological units in a range of minerals; and
- In pore water.

Pathways by which AMD is mobilised

AMD is mobilised by water and is transported from the source materials along aqueous physical pathways into the receiving environment. The salts, metals and metalloids in aqueous phases can be taken up by aqueous flora and fauna via aqueous biophysical pathways.

Salts, metals, and metalloids present as exchangeable or less soluble fractions (e.g., carbonate or oxide fractions) can also be relocated via physical pathways in the aqueous environment as suspended sediment or bedload sediment.

Salts, metals, and metalloids present in soluble or exchangeable fractions within mined material or process waste can also be taken up by plants via terrestrial biophysical pathways.

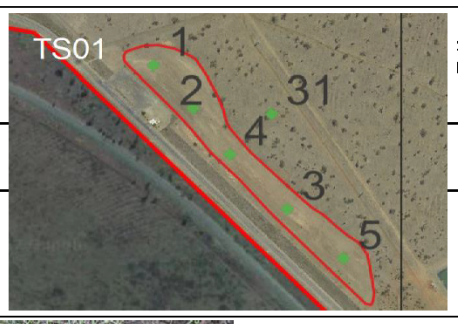
Wind borne erosion is another pathway whereby salts, metals and metalloids can be moved from the source to the receiving environment.

Attachment B: Geochemical characterisation summary tables

Attachment C: Soil logs

TOPSOIL QUALITY ASSESSMENT

Stockpile: Name: **TS01**; Top of Profile: **0.0 m**; Bottom of Profile: **~0.2 m**; Page 1 / 1



Sampling locations

Client: Eagle Downs Metallurgical Coal
Location: Bowen Basin
Project: 2021090 Eagle Downs

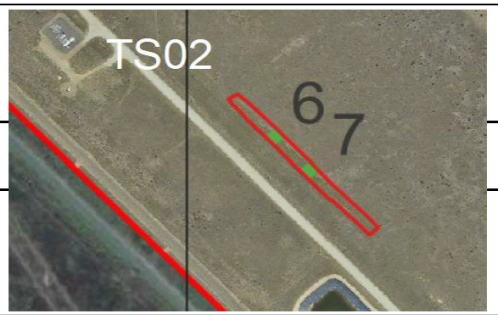
Sampling method: Manual / shovel
Container: 20 L plastic bucket
GCS: GDA 94 / z54

Graphic	Lithology / Material Type	Description	GPS Coordinates	Estimated Depth from (m)	Estimated Depth to (m)	Bulk density (t/m^3)	Sample photographs	RGS ID and Mass
	Topsoil	**Colour:** Brown; **Field particle size:** Clay/sand/silt, some gravel; **Texture / consolidation:** Loose; **Moisture:** Moist; **Weathering / age:** Extremely weathered; **Vegetation:** Vegetated, roots present	621813 X 7548122 Y	0	0.2	1.48		TS01-1 2021090_0016 15.5 kg
	Topsoil	**Colour:** Dark brown; **Field particle size:** Mostly clay/silt, no gravel; **Texture / consolidation:** Aggregated; **Moisture:** Wet; **Weathering / age:** Extremely weathered; **Vegetation:** Vegetated, roots present	621883 X 7548039 Y	0	0.2	1.42		TS01-2 2021090_0008 12.8 kg
	Topsoil	**Colour:** Dark brown; **Field particle size:** Mostly clay/silt, no gravel; **Texture / consolidation:** Slightly aggregated; **Moisture:** Wet; **Weathering / age:** Extremely weathered; **Vegetation:** Vegetated, roots present	622049 X 7547841 Y	0	0.2	1.32		TS01-3 2021090_0010 13.4 kg
	Topsoil	**Colour:** Brown; **Field particle size:** Clay/sand/silt, some gravel; **Texture / consolidation:** Slightly aggregated; **Moisture:** Moist; **Weathering / age:** Extremely weathered; **Vegetation:** Vegetated, roots present	621948 X 7547948 Y	0	0.2	1.38		TS01-4 2021090_0015 15.4 kg
	Topsoil	**Colour:** Brown; **Field particle size:** Mostly clay/silt, no gravel; **Texture / consolidation:** Aggregated; **Moisture:** Moist; **Weathering / age:** Extremely weathered; **Vegetation:** Vegetated, roots present	622148 X 7547744 Y	0	0.2	1.37		TS01-5 2021090_0011 15.7 kg

Figure 7-1: Soil log for TS01

TOPSOIL QUALITY ASSESSMENT

Stockpile: Name: **TS02**; Top of Profile: **0.0 m**; Bottom of Profile: **~0.2 m**; Page 1 / 1



Sampling locations

Client: Eagle Downs Metallurgical Coal
Location: Bowen Basin
Project: 2021090 Eagle Downs

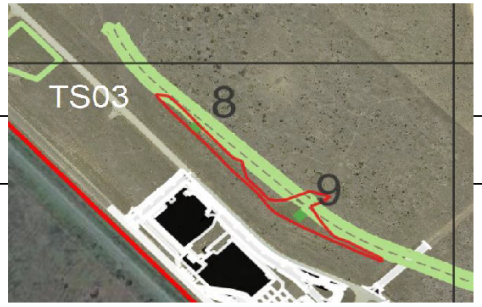
Sampling method: Manual / shovel
Container: 20 L plastic bucket
GCS: GDA 94 / z54

Graphic	Lithology / Material Type	Description	GPS Coordinates	Estimated Depth from (m)	Estimated Depth to (m)	Bulk density (t/m^3)	Sample photographs	RGS ID and Mass
	Topsoil	**Colour:** Dark brown **Field particle size:** Mostly clay/silt, no gravel **Texture / consolidation:** Slightly aggregated **Moisture:** Moist **Weathering / age:** Extremely weathered **Vegetation:** Vegetated, roots present	623358 X 7546624 Y	0	0.2	1.44	 	TS02-6 2021090_0007 12.5 kg
	Topsoil	**Colour:** Dark brown **Field particle size:** Mostly clay/silt, no gravel **Texture / consolidation:** Aggregated **Moisture:** Wet **Weathering / age:** Extremely weathered **Vegetation:** Vegetated, roots present	623402 X 7546581 Y	0	0.2	1.47	 	TS02-7 2021090_0012 13.6 kg

Figure 7-2: Soil log for TS02

SAMPLE PROFILE

Stockpile: Name: **TS03**; Top of Profile: **0.0 m**; Bottom of Profile: **~0.2 m**; Page 1 / 1



Sampling locations

Client: Eagle Downs Metallurgical Coal
Location: Bowen Basin
Project: 2021090 Eagle Downs

Sampling method: Manual / shovel
Container: 20 L plastic bucket
GCS: GDA 94 / z54

Graphic	Lithology / Material Type	Description	GPS Coordinates	Estimated Depth from (m)	Estimated Depth to (m)	Bulk density (t/m^3)	Sample photographs	RGS ID and Mass
	Topsoil	**Colour:** Dark brown **Field particle size:** Mostly clay/silt, no gravel **Texture / consolidation:** Slightly aggregated **Moisture:** Moist **Weathering / age:** Extremely weathered **Vegetation:** Vegetated, roots present	623830 X 7546134 Y	0	0.2	1.24	 	TS03-8 2021090_0001 15.2 kg
	Topsoil	**Colour:** Brown **Field particle size:** Mostly clay/silt, no gravel **Texture / consolidation:** Slightly aggregated **Moisture:** Moist **Weathering / age:** Extremely weathered **Vegetation:** Vegetated, roots present	624000 X 7545976 Y	0	0.2	1.26	 	TS03-9 2021090_0004 14.7 kg

Figure 7-3: Soil log for TS03

TOPSOIL QUALITY ASSESSMENT

Stockpile: Name: TS04 | Top of Profile: 0.0 m | Bottom of Profile: ~0.2 m | Page 1 / 1



Sampling locations

Client:	Eagle Downs Metallurgical Coal
Location:	Bowen Basin
Project:	2021090 Eagle Downs
Sampling method:	Manual / shovel
Container:	20 L plastic bucket
GCS:	GDA 94 / z54

Graphic	Lithology / Material Type	Description	GPS Coordinates	Estimated Depth from (m)	Estimated Depth to (m)	Bulk density (t/m^3)	Sample photographs	RGS ID and Mass
	Topsoil	**Colour:** Dark brown **Field particle size:** Mostly clay/silt, no gravel **Texture / consolidation:** Aggregated **Moisture:** Moist **Weathering / age:** Extremely weathered **Vegetation:** Vegetated, roots present	624400 X 7545660 Y	0	0.2	1.33	  	TS04-11 2021090_0023 14.4 kg
	Topsoil	**Colour:** Dark brown **Field particle size:** Mostly clay/silt, no gravel **Texture / consolidation:** Aggregated **Moisture:** Moist **Weathering / age:** Extremely weathered **Vegetation:** Vegetated, roots present	624463 X 7545627 Y	0	0.2	1.30	 	TS04-12 2021090_0017 14.0 kg

Figure 7-4: Soil log for TS04

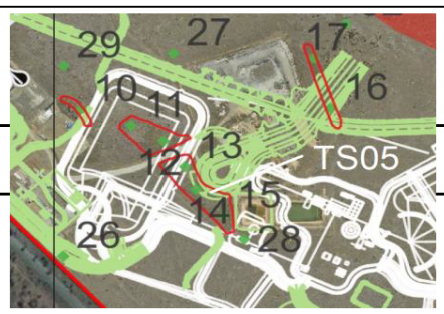
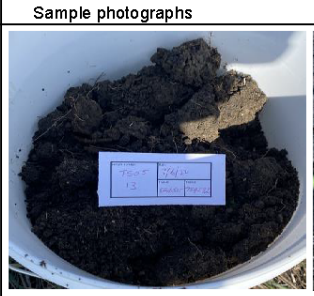
TOPSOIL QUALITY ASSESSMENT				Stockpile:	Name: TS05 Top of Profile: 0.0 m Bottom of Profile: ~0.2 m Page 1 / 1			 Sampling locations	
Client:	Eagle Downs Metallurgical Coal			Sampling method:	Manual / shovel				
Location:	Bowen Basin			Container:	20 L plastic bucket				
Project:	2021090 Eagle Downs			GCS:	GDA 94 / z54				
Graphic	Lithology / Material Type	Description	GPS Coordinates	Estimated Depth from (m)	Estimated Depth to (m)	Bulk density (t/m^3)	Sample photographs		RGS ID and Mass
	Topsoil	**Colour:** Dark brown **Field particle size:** Mostly clay/silt, no gravel **Texture / consolidation:** Aggregated **Moisture:** Moist **Weathering / age:** Extremely weathered **Vegetation:** Vegetated, roots present	624505 X 7545572 Y	0	0.2	1.24			TS05-13 2021090_0002 14.0 kg
	Topsoil	**Colour:** Dark brown **Field particle size:** Mostly clay/silt, no gravel **Texture / consolidation:** Slightly aggregated **Moisture:** Moist **Weathering / age:** Extremely weathered **Vegetation:** Vegetated, roots present	624526 X 7545523 Y	0	0.2	1.31			TS05-14 2021090_0003 14.0 kg
	Topsoil	**Colour:** Dark brown **Field particle size:** Mostly clay/silt, no gravel **Texture / consolidation:** Slightly aggregated **Moisture:** Moist **Weathering / age:** Extremely weathered **Vegetation:** Vegetated, roots present	624580 X 7545466 Y	0	0.2	1.34			TS05-15 2021090_0025 14.4 kg

Figure 7-5: Soil log for TS05

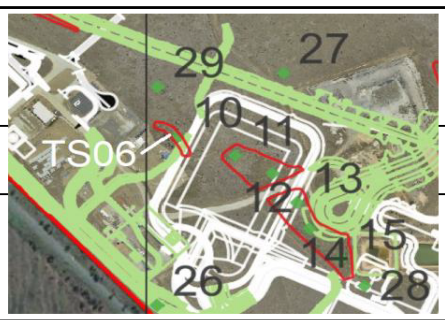
TOPSOIL QUALITY ASSESSMENT				Stockpile:	Name: TS06 Top of Profile: 0.0 m Bottom of Profile: ~0.2 m Page 1 / 1			 Sampling locations	
Client:	Eagle Downs Metallurgical Coal			Sampling method:	Manual / shovel				
Location:	Bowen Basin			Container:	20 L plastic bucket				
Project:	2021090 Eagle Downs			GCS:	GDA 94 / z54				
Graphic	Lithology / Material Type	Description	GPS Coordinates	Estimated Depth from (m)	Estimated Depth to (m)	Bulk density (t/m^3)	Sample photographs		RGS ID and Mass
	Topsoil	**Colour:** Dark brown **Field particle size:** Mostly clay/silt, no gravel **Texture / consolidation:** Aggregated **Moisture:** Very moist **Weathering / age:** Extremely weathered **Vegetation:** Vegetated, roots present	624301 X 7545695 Y	0	0.2	1.47			TS06-10 2021090_0024 14.3 kg

Figure 7-6: Soil log for TS06

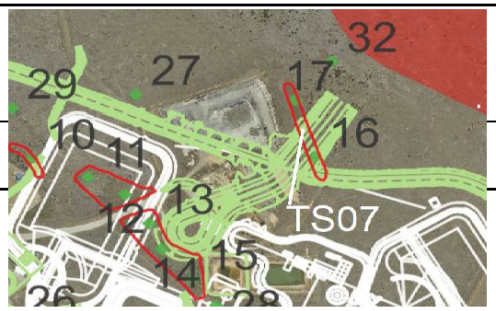
TOPSOIL QUALITY ASSESSMENT				Stockpile:	Name: TS07 Top of Profile: 0.0 m Bottom of Profile: ~0.2 m Page 1 / 1			 Sampling locations		
Client:	Eagle Downs Metallurgical Coal			Sampling method:	Manual / shovel					
Location:	Bowen Basin			Container:	20 L plastic bucket					
Project:	2021090 Eagle Downs			GCS:	GDA 94 / z54					
Graphic	Lithology / Material Type	Description	GPS Coordinates	Estimated Depth from (m)	Estimated Depth to (m)	Bulk density (t/m^3)	Sample photographs			RGS ID and Mass
	Topsoil	**Colour:** Dark brown **Field particle size:** Mostly clay/silt, no gravel **Texture / consolidation:** Aggregated **Moisture:** Very moist **Weathering / age:** Extremely weathered **Vegetation:** Vegetated, roots present	624789 X 7545698 Y	0	0.2	1.47				TS07-16 2021090_0021 16.3 kg
	Topsoil	**Colour:** Dark brown **Field particle size:** Mostly clay/silt, no gravel **Texture / consolidation:** Aggregated **Moisture:** Moist **Weathering / age:** Extremely weathered **Vegetation:** Vegetated, roots present	624756 X 7545805 Y	0	0.2	1.27				TS07-17 2021090_0019 15.2 kg

Figure 7-7: Soil log for TS07

TOPSOIL QUALITY ASSESSMENT

In-situ: Name: **Natural** | Top of Profile: **0.0 m** | Bottom of Profile: **~0.2 m** | Page 1 / 1

Client: Eagle Downs Metallurgical Coal
Location: Bowen Basin
Project: 2021090 Eagle Downs

Sampling method: Manual / shovel
Container: 20 L plastic bucket
GCS: GDA 94 / z54

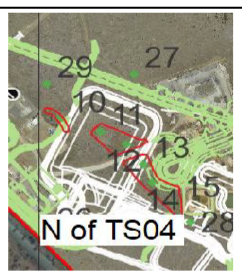
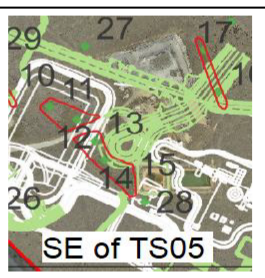
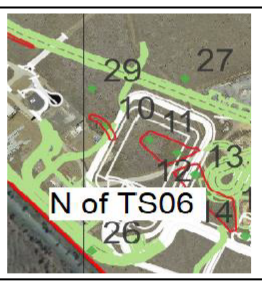
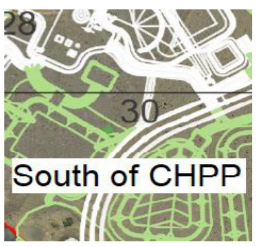
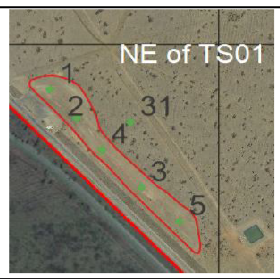
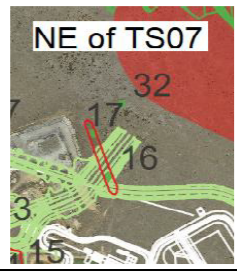
Graphic	Lithology / Material Type	Description	GPS Coordinates	Estimated Depth from (m)	Estimated Depth to (m)	Bulk density (t/m^3)	Sample photographs	RGS ID and Mass
	Topsoil	**Colour:** Dark brown **Field particle size:** Clay/sand/silt, some gravel **Texture / consolidation:** Slightly aggregated **Moisture:** Moist **Weathering / age:** Extremely weathered **Vegetation:** Vegetated, roots present	624268 X 7545379 Y	0	0.2	1.29	  	Natural-26 2021090_0032 15.6 kg
	Topsoil	**Colour:** Dark brown **Field particle size:** Mostly clay/silt, no gravel **Texture / consolidation:** Slightly aggregated **Moisture:** Moist **Weathering / age:** Extremely weathered **Vegetation:** Vegetated, roots present	624482 X 7545815 Y	0	0.2	1.23	  	Natural-27 2021090_0026 14.7 kg
	Topsoil	**Colour:** Dark brown **Field particle size:** Mostly clay/silt, no gravel **Texture / consolidation:** Aggregated **Moisture:** Wet **Weathering / age:** Extremely weathered **Vegetation:** Vegetated, roots present	624620 X 7545416 Y	0	0.2	1.47	  	Natural-28 2021090_0022 13.6 kg
	Topsoil	**Colour:** Dark brown **Field particle size:** Mostly clay/silt, no gravel **Texture / consolidation:** Aggregated **Moisture:** Moist **Weathering / age:** Extremely weathered **Vegetation:** Vegetated, roots present	624269 X 7545789 Y	0	0.2	1.18	  	Natural-29 2021090_0018 14.4 kg
	Topsoil	**Colour:** Dark brown **Field particle size:** Mostly clay/silt, no gravel **Texture / consolidation:** Slightly aggregated **Moisture:** Moist **Weathering / age:** Extremely weathered **Vegetation:** Vegetated, roots present	624887 X 7545160 Y	0	0.2	1.25	  	Natural-30 2021090_0031 13.3 kg
	Topsoil	**Colour:** Dark brown **Field particle size:** Mostly clay/silt, no gravel **Texture / consolidation:** Aggregated **Moisture:** Moist **Weathering / age:** Extremely weathered **Vegetation:** Vegetated, roots present	622021 X 7548028 Y	0	0.2	1.16	  	Natural-31 2021090_0009 15.2 kg
	Topsoil	**Colour:** Brown **Field particle size:** Mostly clay/silt, no gravel **Texture / consolidation:** Aggregated **Moisture:** Moist **Weathering / age:** Extremely weathered **Vegetation:** Vegetated, roots present	625915 X 7546571 Y	0	0.2	1.28	  	Natural-32 2021090_0020 16.3 kg

Figure 7-8: Soil log for Natural samples (incl. underground portal area #26-29 and undisturbed #30-32)

TOPSOIL QUALITY ASSESSMENT

In-situ: Name: **DREA** | Top of Profile: **0.0 m** | Bottom of Profile: **~0.2 m** | Page 1 / 1

Client: Eagle Downs Metallurgical Coal | Location: Bowen Basin | Project: 2021090 Eagle Downs

Sampling method: Manual / shovel | Container: 20 L plastic bucket | GCS: GDA 94 / z54

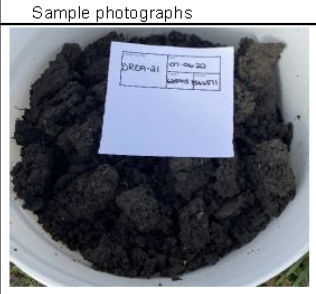
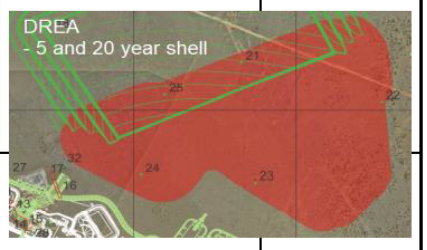
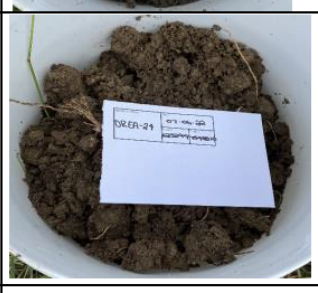
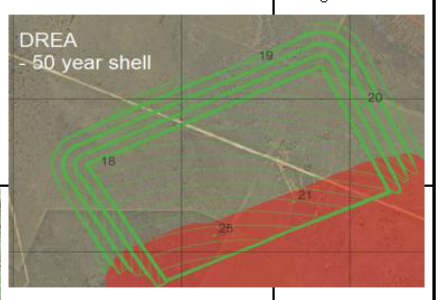
Graphic	Lithology / Material Type	Description	GPS Coordinates	Estimated Depth from (m)	Estimated Depth to (m)	Bulk density (t/m^3)	Sample photographs	RGS ID and Mass
	Topsoil	**Colour:** Dark brown **Field particle size:** Mostly clay/silt, no gravel **Texture / consolidation:** Aggregated **Moisture:** Wet **Weathering / age:** Extremely weathered **Vegetation:** Vegetated, roots present	625915 X 7546571 Y	0	0.2	1.37	  	DREA-21 2021090_0030 14.5 kg
	Topsoil	**Colour:** Dark brown **Field particle size:** Mostly clay/silt, no gravel **Texture / consolidation:** Aggregated **Moisture:** Wet **Weathering / age:** Extremely weathered **Vegetation:** Vegetated, roots present	626771 X 7546304 Y	0	0.2	1.24	 	DREA-22 2021090_0006 12.2 kg
	Topsoil	**Colour:** Dark brown **Field particle size:** Mostly clay/silt, no gravel **Texture / consolidation:** Slightly aggregated **Moisture:** Wet **Weathering / age:** Extremely weathered **Vegetation:** Vegetated, roots present	626001 X 7545760 Y	0	0.2	1.25	 	DREA-23 2021090_0027 14.6 kg
	Topsoil	**Colour:** Dark brown **Field particle size:** Mostly clay/silt, no gravel **Texture / consolidation:** Slightly aggregated **Moisture:** Moist **Weathering / age:** Extremely weathered **Vegetation:** Vegetated, roots present	625299 X 7545810 Y	0	0.2	1.44	 	DREA-24 2021090_0013 13.7 kg
	Topsoil	**Colour:** Dark brown **Field particle size:** Mostly clay/silt, no gravel **Texture / consolidation:** Aggregated **Moisture:** Moist **Weathering / age:** Extremely weathered **Vegetation:** Vegetated, roots present	625444 X 7546353 Y	0	0.2	1.23	 	DREA-25 2021090_0029 12.7 kg
	Topsoil	**Colour:** Brown **Field particle size:** Mostly clay/silt, no gravel **Texture / consolidation:** Slightly aggregated **Moisture:** Slightly moist **Weathering / age:** Extremely weathered **Vegetation:** Vegetated, roots present	624744 X 7546792 Y	0	0.2	1.20	  	DREA-18 2021090_0028 12.7 kg
	Topsoil	**Colour:** Dark brown **Field particle size:** Mostly clay/silt, no gravel **Texture / consolidation:** Slightly aggregated **Moisture:** Slightly moist **Weathering / age:** Extremely weathered **Vegetation:** Vegetated, roots present	625681 X 7547488 Y	0	0.2	1.34	 	DREA-19 2021090_0014 14.2 kg
	Topsoil	**Colour:** Dark brown **Field particle size:** Mostly clay/silt, no gravel **Texture / consolidation:** Slightly aggregated **Moisture:** Moist **Weathering / age:** Extremely weathered **Vegetation:** Vegetated, roots present	626331 X 7547213 Y	0	0.2	1.31	 	DREA-20 2021090_0005 14.6 kg

Figure 7-9: Soil log for DREA area

Attachment D: Desktop study

7.1 Desktop study

As described in **Section 1.4**, existing soil surveys provide valuable information for soil classification. They also give an indication of the extent of soil variability within the project area, which impacts the number of samples required to provide sufficient representation of stockpiled and in-situ material. This section is a review of the available information relevant to perform a quality assessment of topsoils in the project area.

7.1.1 Regional soil map

The regional soil map of the Eagle Downs site is shown in **Figure 7-1** and is based upon the Atlas of Australian Soils (CSIRO 1991). The key soil types expected to be encountered in the project area are vertosols, chromosols, sodosols, and tenosols. **Table 7-1** describes the properties of these soil classifications. ML 70389 is regionally classified as vertosol (CB6), with deep clays and some gilgai microrelief, closely associated with loamy duplex soils. Chromosols, sodosols, and tenosols are less likely to be encountered, but may be present in localised areas.

Table 7-1: Regional soil classifications

Symbol	Code	Classification	Description
	CB6	Vertosol	Moderately undulating lands with widely spaced shallow valleys: dominant soils are shallow to moderately **deep grey clays** which often have a prominent linear gilgai on slopes. The chief forms are (Ug5.22) and (Ug5.23), but brown clays (Ug5.32, Ug5.33, and Ug5.22.
	CC30	Vertosol	Gently undulating or level plains with moderate or occasionally strong (2-3 ft) gilgai microrelief: dominant soils are **deep clays** (Ug5.24) with also (Ug5.25), (Ug5.35), and occasionally (Ug5.16). Closely associated are thin-surfaced **loamy duplex soils** Ug5.24).
	Rf8	Chromosol	Alluvial plains adjacent to major streams: dominant soils away from the stream levees are **fine silty or loamy-surfaced brown duplex soils** (Db1.13), (Db1.33), (Db1.32), and (Db1.43). The A horizon depth ranges from 8 to 15 in. in thickness.
	Ub81	Sodosol	Gently undulating plains: dominant are **sandy duplex soils** with moderately deep (12-15 in.) A horizons. The chief forms are (Dy3.42) and (Dy3.32) but also commonly occurring are (Dy3.43), (Dy3.22), (Dy5.42), (Dy5.43), and (Dy5.32) together with similar (Dy3.42).
	Va52	Sodosol	Undulating or gently undulating lands with occasional small low sandstone cuestas or mesas near the margins of the unit: dominant are mostly **sandy duplex soils with deep A horizons** (10-20 in.); the lower A2 and upper B horizons often have many ironstone.
	J10	Tenosol	Hilly deeply dissected plateaux consisting of level **stony plateau surfaces**, high bluffs and cliffs bordering narrow valleys, and some undulating colluvial slopes and alluvial flats; massive sandstone outcrop is common: dominant soils of the higher sites.

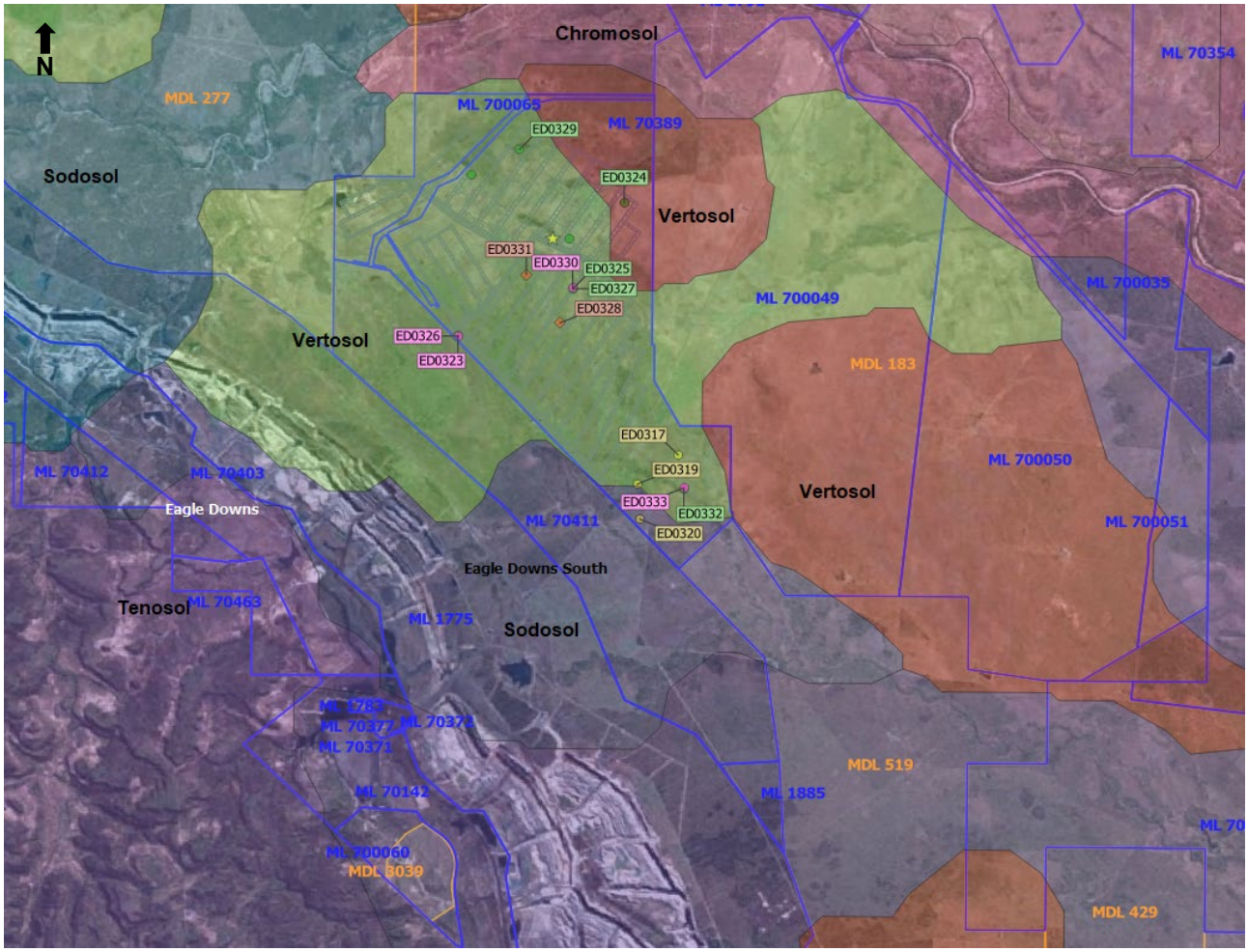


Figure 7-10: Regional soil map

7.1.2 Surface geology

The surface geology of the project area (**Figure 7-2**) is important as the parent materials influence the soil types that form through weathering. The geological regimes that occur within ML 70389 are summarised in **Table 7-2** (Golder 2020). TQr and Qr are of particular interest in this assessment due to their proximity to the topsoil stockpile locations (discussed in **Section 7.1.3.2**). TQr, Qr, and Qrb are young Quaternary and Tertiary sediments that have formed by rainwash at the base of hillslopes (colluvium) or deposited by running water in a floodplain (alluvium). Soils that have formed from older Triassic and Permian geologies (e.g., Rr and Pwt) are present in the NE area of ML 70389 and may be encountered during the sampling of the DREA area, but it is unlikely that these rocks were parent materials for the topsoil stockpiles.

Table 7-2: Surface geology

Geological code	Description
Qr	Quaternary Colluvial and Slopewash Deposits and Alluvium on watercourses, terraces and minor floodplains
Qrb	Quaternary Residual Soil and Colluvial Deposits mainly black soils derived from basalt
TQa	Tertiary-Quaternary Older Alluvial Deposits in tributary and majorstream valleys, comprising poorly consolidated sediments, sand, silt, clay and minor gravel
TQr	Tertiary-Quaternary Residual Soils and Colluvial Deposits clay, silt, sand and gravel
Rr	Triassic Rewan Group lithic sandstone, pebbly lithic sandstone, green to reddish-brown mudstone and minor volcanilithic (basal) pebble conglomerate
Pwi	Permian Rangal Coal Measures calcareous sandstone, calcareous shale, mudstone, coal, and some concretionary limestone
Pwt	Late Permian Fort Cooper Coal Measures (Pwt): lithic sandstone, conglomerate, mudstone, carbonaceous shale, coal and tuffaceous (cherty) mudstone.

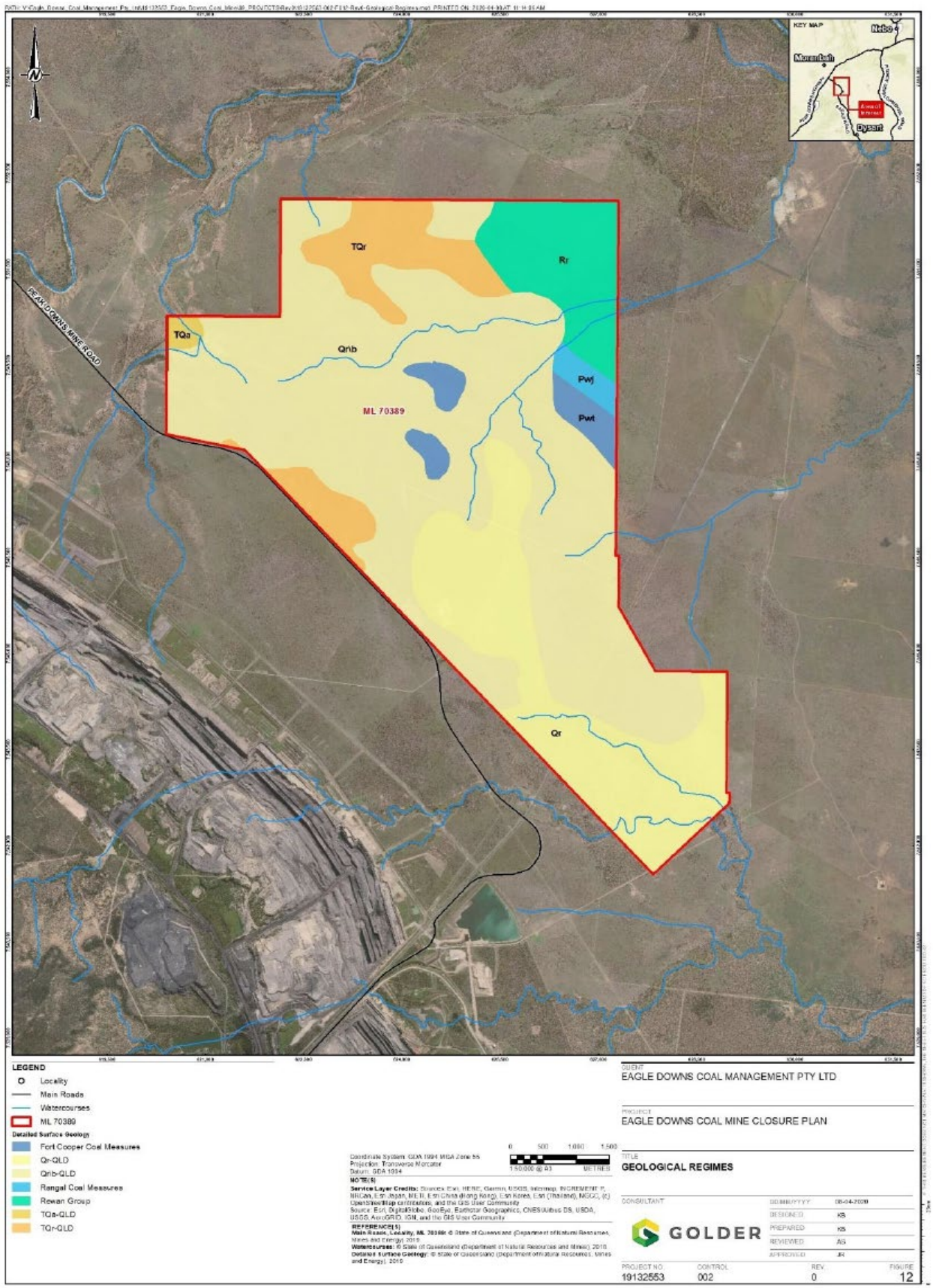


Figure 7-11: Surface geology map

7.1.3 Detailed soil survey

A soils and land suitability assessment of ML 70389 was conducted by GJR Holdings (2008).

"The majority of soils across the project area tend to be texture contrast (duplex) soils with clay subsoils or relatively uniform clay soils. The subsoils are known to be sodic in areas, which can be prone to erosion when exposed. Other limitations include salinity and acidity at depth." (GJR Holdings, 2008).

Soil survey results are mapped in **Figure 7-3** and **Figure 7-4** and described in **Table 7-3**. Nine soil types were identified, but three soil types (6-8, 6-8g, and 7-8g) had greater occurrence than the other six (5.1, 5.2, 2-5.2, 6, 7-8, and 8).

7.1.3.1 Known soil limitations

GJR Holdings (2008) identified sodicity and erosion as key issues which may limit potential rehabilitation use of the soils as growth media. Salinity and acidity issues could also arise if subsoils are used in place of topsoils, as these properties were observed to increase with depth.

Topsoil stripping depths are described in the Plan of Operations August 2011 – July 2012 (Hansen Bailey 2011) and range from 0.15 – 0.3 m. "Topsoil of marginal use" (which may refer to subsoil or gravelly topsoil) was stripped from 0.3 – 0.6 m. It is not currently known if these two topsoil classes were separately stockpiled.

7.1.3.2 Topsoil stockpiles

The locations of the topsoil stockpiles are shown in **Figure 7-3**. Provided that the topsoil stockpiles have not been transported and are constructed of local materials, they will contain similar material to the in-situ surveys at that location.

The soil types at these topsoil stockpile locations are:

- Duplex soils/cracking clays 6-8 g (chromosols, sodosols, calcarosols, or vertosols) (EDC TS 01)
- Deep uniform clays 7-8 g (dermosols, hydrosols, or vertosols) (EDC TS 02 to EDC TS 06)

It is possible, however, that when the topsoil was stripped, different soil types were mixed together during the excavation and stockpiling process. Therefore, the topsoil stockpiles may be a heterogeneous mixture of different soil types, and/or they could be laterally variable depending on how the material was dumped. The geochemical and physical analyses will provide information to verify the characteristics of the topsoil stockpiles.

Soil classification terms used in **Table 7-3** from GJR Holdings (2008) are explained below.

(a) Duplex soils (TQr, Pwt, QrO, Qr, Rr)

The term duplex is used in Australia for soils with contrasting texture between soil horizons and are also termed "texture contrast soils". In duplex soils, the B horizon is dominated by a texture class one and a half (or more) finer than the A horizon. In addition, the clear to sharp change between the two horizons must occur within 0.1 m. Topsoils may range from coarse sand to clay loam and the subsoils from light to heavy clay. Some duplex soils are distinguished by the presence of an A2 bleached horizon, a character also used as a diagnostic key for these types of soils.

(b) Cracking clays and heavy clays (Qrb, TQr, Qr, Pwj, Rr, Pwt)

Heavy cracking clay soils mainly belong to vertosols and vertic subgroups of other soils and occur in (sub) tropical areas with a pronounced dry season. The poor internal drainage and extremely slow hydraulic conductivity leads to water logging and delays in planting crops. Wide deep cracks in the dry season permit easy entry of rainfall and water moves freely into the cracks. Although chemically rich, these soils under sustained, high-input systems, may suffer from fertility problems on account of limited availability of nitrogen, phosphorous and micronutrients. The presence of heavy clays may be associated with a microrelief called gilgai that is a result of the continuous churning of these soils.

(c) Alluvial soils (TQa)

Alluvial soils include loose clay, silt, sand, or gravel that has been deposited by running water in a stream bed, on a floodplain, or in an alluvial fan or beach. These soils are formed through slow processes of rock transformation. Alluvial soils remove sediments and nutrients flowing in the adjacent water. Floods periodically deposit new sediment at the surface, so alluvial soils can have a unique layered appearance. Dark and light colors alternate, along with assorted sizes of round gravel particles. This unique layering process is called stratification and is evident in many floodplains. Alluvial soils are typically coarse and have good drainage compared to clay-rich soils.

7.1.3.3 DREA and underground portal areas

The locations of the DREA and underground portal sampling areas are shown in **Figure 7-4**. As these topsoil samples will be collected from in-situ soil profiles, the soil types at these locations are expected to be as specified in the detailed soil survey by GJR Holdings (2008).

The soils in the DREA area in the proposed 5, 20, and 50-year layout are:

- Predominantly duplex soils/cracking clays 6-8g (chromosols, sodosols, calcarosols, or vertosols).
- Some deep uniform clays 7-8g (dermosols, hydrosols, or vertosols)
- Occasional loamy soils with heavy clay subsoils 6 ((chromosols, sodosols, calcarosols, or vertosols)
- Occasional black cracking clay 8 (vertosols)

The soils in the underground portal area appear to be uniform, and are comprised of:

- Deep uniform clays 7-8g (dermosols, hydrosols, or vertosols)

The DREA proposed 50-year layout covers a much larger area than the underground portal area. The DREA may contain up to 4 different soil types, whereas the underground portal area contains only 1 soil type. The variability in soil types in each of these areas has impacted the number of samples that will be collected at each location.

7.1.4 References

CSIRO (1991). Digital atlas of Australian Soils. Spatial data file available online for download from: https://www.asris.csiro.au/themes/Atlas.html. Accessed 20 May 2022.

GJR Holdings (2008). Eagle Downs Project - Soils and land suitability assessment study. Technical document produced for Hansen Bailey. October 2008.

Golder (2020). Eagle Downs Closure Plan. Technical report for project job number C260.C.0001. Documber number EDC-FS-81800-EV-RPT-003. June 2020.

Hansen Bailey (2011). Eagle Downs Coal Mine – Plan of Operations 1 August 2011 – 31 July 2012. Technical document produced for Eagle Downs Coal Management Pty Ltd. 7 July 2011.

Table 7-3: Soil types and management considerations

Soil type	Description	Australian soil classification (ASC)	Geological regimes	Management considerations
5.1	Sandy loam to clay loamy surface duplex soils with reddish to orange-brown to acidic clay subsoils	Chromosol or Kurosol	TQr Pwt	Subsoils may be moderately dispersive and erosion-prone if exposed
5.2	Thick sandy surface acidic yellow-brown duplex soils	Chromosol or Kurosol	Qr0	Subsoils may have low permeability and are often dispersive and erosion-prone where exposed.
2–5.2	As for type 5.2, with some uniform coarse-textured sandy alluvial soils	Rudosols (Type 2) Chromosol or Kurosol (Type 5)	TQa	Subsoil often imperfect to poorly drained and can be dispersive.
6	Thin fine sandy to silt loamy surface with yellow-brown alkaline sodic medium to heavy clay subsoils	Chromosols, Sodosols or Calcarosols	Qrb	Poorly drained, subject to surface water ponding. Subsoils can be prone to dispersion if exposed (high ESP).
6–8	As for Type 6, in association with dark grey or dark brown cracking clay soils	Chromosols, Sodosols or Calcarosols (Type 6) Vertosols (Type 8)	TQr Qr Pwj	Low permeability, increased salinity with depth, high levels of sodium and magnesium in the subsoils—prone to erosion by dispersion if exposed.
6–8g	Mosaic of fine sandy to loamy surface alkaline duplex soils and dark grey to dark brown cracking clay soils with intensive melon-hole gilgai development	Chromosols, Sodosols or Calcarosols (Type 6) Vertosols (Type 8)	Qr Rr	Subsoils likely to be dispersive and prone to erosion if exposed, subsoils can be strongly acid and sodic with depth. Gilgai can result in ponding of water.
7–8	Association of medium to deep uniform or gradational clays with hard coarse-structured subsoils and dark grey to dark brown	Dermosols or Hydrosols (Type 7) Vertosols (Type 8)	Qrb	Subsoils with low permeability, strongly alkaline and sodic with depth.
7–8g	As for soil association 7–8, with locally intensive linear gilgai formation	Dermosols or Hydrosols (Type 7) Vertosols (Type 8)	Qrb	Subsoils with low permeability, strongly alkaline and sodic with depth.
8	Medium to deep dark grey to brownish black cracking clay soils	Vertosols	Qrb Pwt	Low permeabilty and potential waterlogging. Can be strongly acidic, saline and sodic with depth.

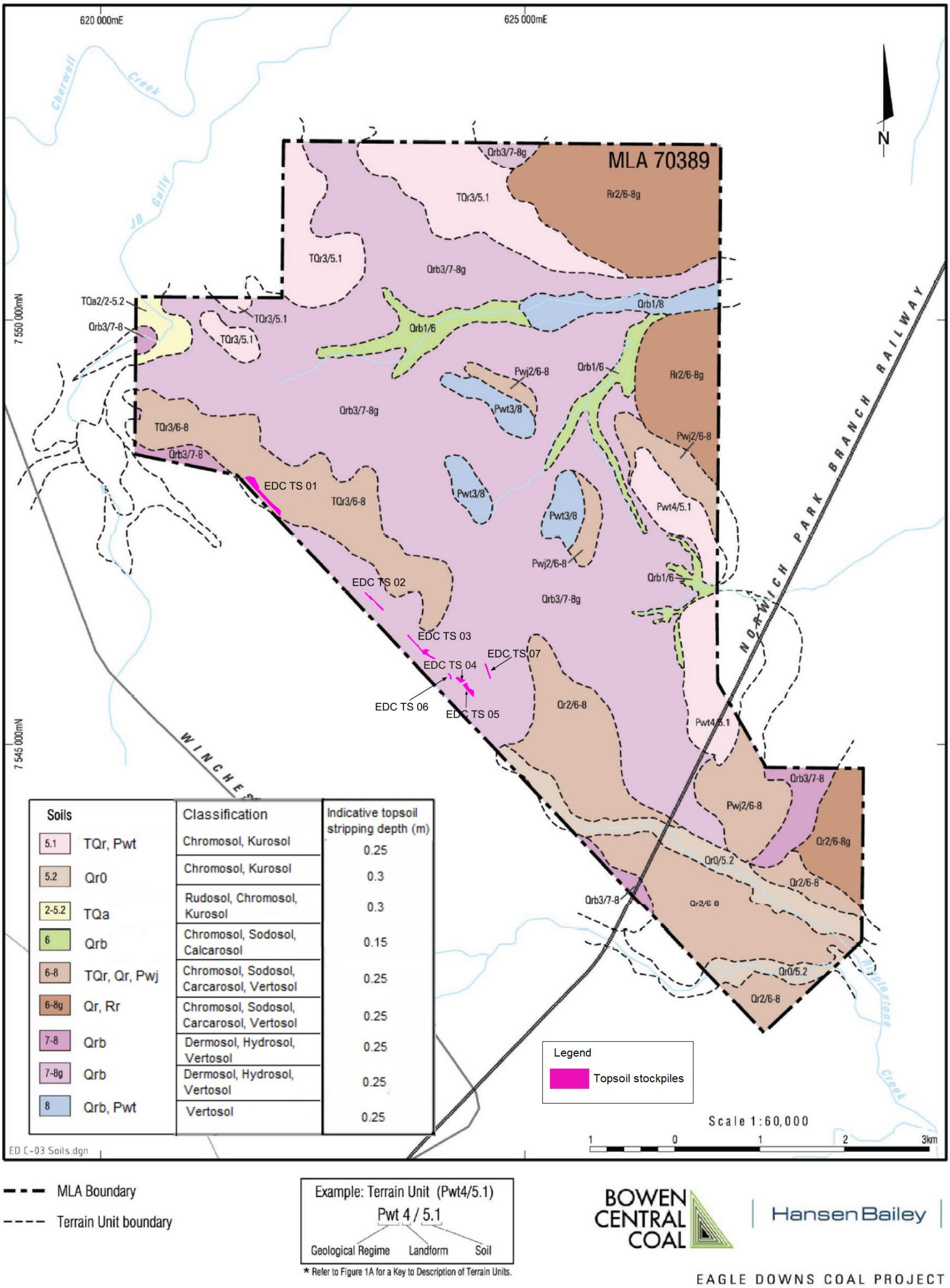


Figure 7-12: Location of topsoil stockpiles relative to soil survey

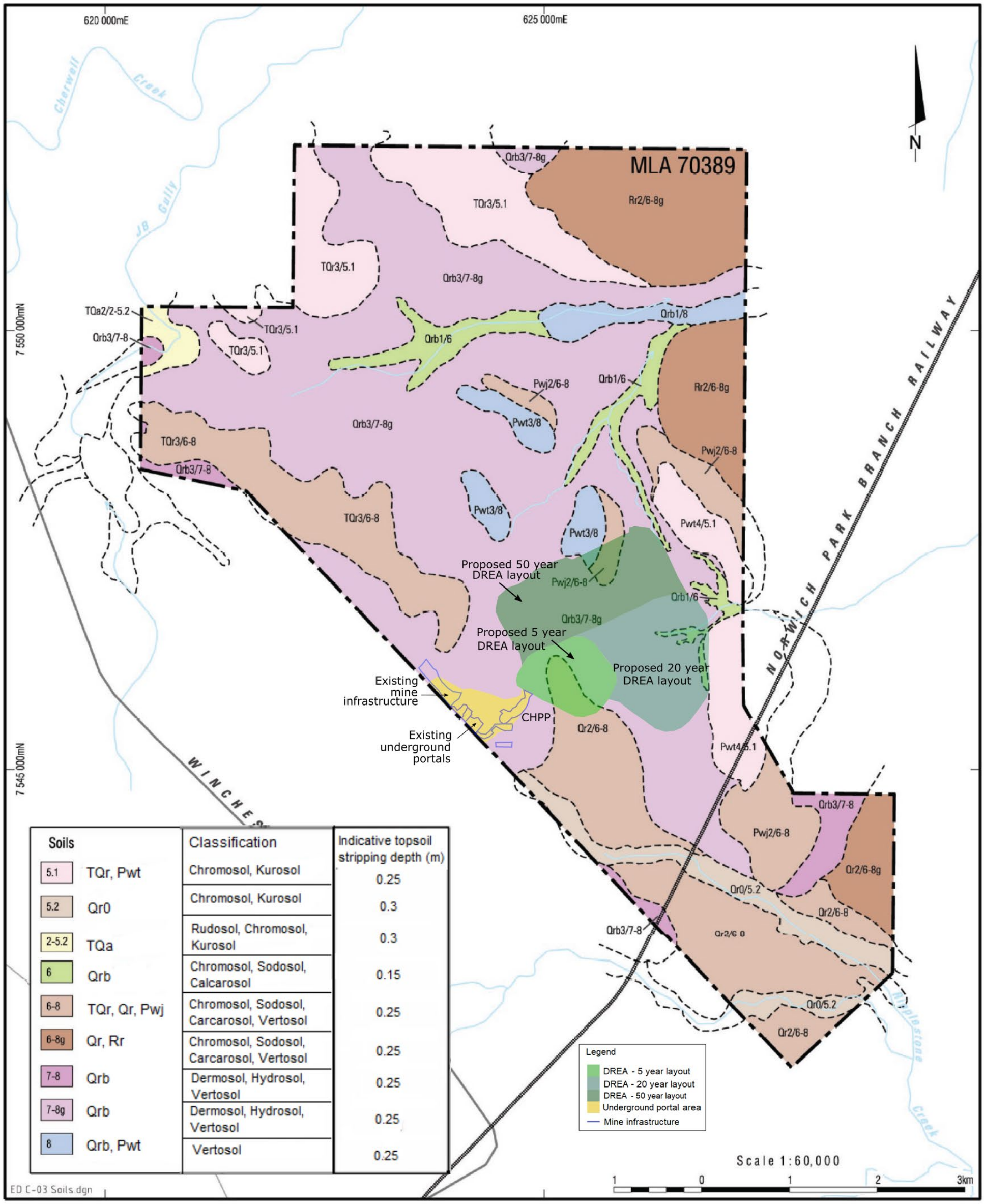


Figure 7-13: Location of DREA and underground portal sampling areas relative to soil survey

Attachment E: ALS laboratory certificates

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2218407**	Page	: 1 of 10
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MELINDA HILTON	Contact	: Customer Services EB
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4107	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2021090 Eagle Downs	Date Samples Received	: 24-Jun-2022 15:45
Order number	: ----	Date Analysis Commenced	: 28-Jun-2022
C-O-C number	: ----	Issue Date	: 05-Jul-2022 09:22
Sampler	: ASITHA JAJASINGHE		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 33		
No. of samples analysed	: 33		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Inorganics, Stafford, QLD
Layla Hafner	Laboratory Technician	Brisbane Acid Sulphate Soils, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ASS: EA013 (ANC) Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong; 5- Lime.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_0001	2021090_0002	2021090_0003	2021090_0004	2021090_0005
			Sampling date / time	24-Jun-2022 00:00	24-Jun-2022 00:00	24-Jun-2022 00:00	24-Jun-2022 00:00	24-Jun-2022 00:00
Compound	CAS Number	LOR	Unit	EB2218407-001	EB2218407-002	EB2218407-003	EB2218407-004	EB2218407-005
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.4	8.5	8.4	8.4	8.1
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-13.7	-60.0	-40.9	-47.8	-9.1
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	88	98	114	106	36
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	14.3	60.6	41.5	48.4	9.4
ANC as CaCO3	----	0.1	% CaCO3	1.5	6.2	4.2	4.9	1.0
Fizz Rating	----	0	Fizz Unit	1	2	2	2	0
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	34.1	19.1	19.8	21.2	19.5
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.02	0.02	0.02	0.01

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_0006	2021090_0007	2021090_0008	2021090_0009	2021090_0010
			Sampling date / time	24-Jun-2022 00:00	24-Jun-2022 00:00	24-Jun-2022 00:00	24-Jun-2022 00:00	24-Jun-2022 00:00
Compound	CAS Number	LOR	Unit	EB2218407-006	EB2218407-007	EB2218407-008	EB2218407-009	EB2218407-010
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.3	7.8	8.6	6.9	8.9
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-27.3	-12.2	-40.9	-6.5	-46.0
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	60	65	99	12	136
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	27.6	12.8	41.2	6.5	46.3
ANC as CaCO3	----	0.1	% CaCO3	2.8	1.3	4.2	0.7	4.7
Fizz Rating	----	0	Fizz Unit	1	1	2	0	2
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	20.2	17.4	20.9	13.8	22.4
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.01	0.02	0.01	<0.01	0.01

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_0011	2021090_0012	2021090_0013	2021090_0014	2021090_0015
			Sampling date / time	24-Jun-2022 00:00	24-Jun-2022 00:00	24-Jun-2022 00:00	24-Jun-2022 00:00	24-Jun-2022 00:00
Compound	CAS Number	LOR	Unit	EB2218407-011	EB2218407-012	EB2218407-013	EB2218407-014	EB2218407-015
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.8	8.8	8.0	7.2	8.7
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-49.3	-18.9	-12.2	-4.7	-89.2
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	124	132	69	14	89
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	49.6	19.5	12.8	5.0	89.5
ANC as CaCO3	----	0.1	% CaCO3	5.0	2.0	1.3	0.5	9.1
Fizz Rating	----	0	Fizz Unit	2	1	1	0	2
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	21.4	18.8	18.8	12.1	16.6
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.01	0.02	0.02	0.01	0.01

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_0016	2021090_0017	2021090_0018	2021090_0019	2021090_0020
			Sampling date / time	24-Jun-2022 00:00	24-Jun-2022 00:00	24-Jun-2022 00:00	24-Jun-2022 00:00	24-Jun-2022 00:00
Compound	CAS Number	LOR	Unit	EB2218407-016	EB2218407-017	EB2218407-018	EB2218407-019	EB2218407-020
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.6	8.4	8.3	8.6	8.1
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-218	-44.8	-18.3	-17.7	-15.1
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	70	104	99	133	83
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	218	45.4	18.6	18.0	15.7
ANC as CaCO3	----	0.1	% CaCO3	22.2	4.6	1.9	1.8	1.6
Fizz Rating	----	0	Fizz Unit	3	2	1	1	1
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	12.3	19.0	15.8	17.9	12.0
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.01	0.02	0.01	0.01	0.02

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_0021	2021090_0022	2021090_0023	2021090_0024	2021090_0025
			Sampling date / time	24-Jun-2022 00:00	24-Jun-2022 00:00	24-Jun-2022 00:00	24-Jun-2022 00:00	24-Jun-2022 00:00
Compound	CAS Number	LOR	Unit	EB2218407-021	EB2218407-022	EB2218407-023	EB2218407-024	EB2218407-025
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.5	7.7	8.3	8.4	8.3
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-49.8	-7.3	-119	-65.8	-42.1
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	112	17	96	90	105
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	50.4	7.6	119	66.1	42.7
ANC as CaCO3	----	0.1	% CaCO3	5.1	0.8	12.2	6.7	4.4
Fizz Rating	----	0	Fizz Unit	2	1	3	2	2
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	19.5	18.4	19.2	18.3	17.1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.01	0.01	0.01	0.02

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_0026	2021090_0027	2021090_0028	2021090_0029	2021090_0030
			Sampling date / time	24-Jun-2022 00:00	24-Jun-2022 00:00	24-Jun-2022 00:00	24-Jun-2022 00:00	24-Jun-2022 00:00
Compound	CAS Number	LOR	Unit	EB2218407-026	EB2218407-027	EB2218407-028	EB2218407-029	EB2218407-030
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	7.6	8.1	8.2	7.5	8.4
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-11.6	-26.1	-13.5	-8.0	-17.4
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	52	56	59	25	84
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	12.2	26.1	14.1	8.3	17.4
ANC as CaCO3	----	0.1	% CaCO3	1.2	2.6	1.4	0.8	1.8
Fizz Rating	----	0	Fizz Unit	1	1	1	1	1
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	13.6	19.6	15.3	13.9	20.6
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	<0.01	0.02	0.01	<0.01

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_0031	2021090_0032	----	----	----
			Sampling date / time	24-Jun-2022 00:00	24-Jun-2022 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2218407-031	EB2218407-032	--------	--------	--------
				Result	Result	----	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**8.4**	**8.4**	----	----	----
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-51.7**	**-22.0**	----	----	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**77**	**81**	----	----	----
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**52.0**	**22.3**	----	----	----
ANC as CaCO3	----	0.1	% CaCO3	**5.3**	**2.3**	----	----	----
Fizz Rating	----	0	Fizz Unit	**2**	**1**	----	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	**18.6**	**17.4**	----	----	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.01**	**0.01**	----	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **SOIL**)			Sample ID	**pH and EC of DI water**	**----**	**----**	**----**	**----**
			Sampling date / time	24-Jun-2022 00:00	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB2218407-033**	**--------**	**--------**	**--------**	**--------**
				Result	----	----	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**5.6**	**----**	**----**	**----**	**----**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	<1	**----**	**----**	**----**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2220279**	Page	: 1 of 15
Client	: **RGS ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MELINDA HILTON	Contact	: Customer Services EB
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4108	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3344 1222	Telephone	: +61-7-3243 7222
Project	: 2021090 Eagle Downs	Date Samples Received	: 12-Jul-2022 16:50
Order number	: ----	Date Analysis Commenced	: 14-Jul-2022
C-O-C number	: ----	Issue Date	: 22-Jul-2022 09:45
Sampler	: PRIYA RAJENDRAN		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 13		
No. of samples analysed	: 13		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Layla Hafner	Laboratory Technician	Brisbane Acid Sulphate Soils, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ED037 (Alkalinity): NATA accreditation does not cover the performance of this service.
- ED038 (Acidity): NATA accreditation does not cover the performance of this service.
- ALS is not NATA accredited for the analysis of Exchangeable Aluminium and Exchange Acidity in soils when performed under ALS Method ED005.
- ALS is not NATA accredited for the analysis of Exchangeable Cations on Alkaline Soils when performed under ALS Method ED006.
- EK040P (Fluoride - Soluble) - Particular samples required dilution prior to analysis due to matrix interferences. LOR values have been adjusted accordingly.
- EG005T (Total Metals by ICP-AES): 2021090_C109 (EB2220279-009) shows poor duplicate results due to sample heterogeneity. This has been confirmed by visual inspection.
- EG005T (Total Metals by ICP-AES): EB2220255-002 shows poor matrix spike recovery due to sample heterogeneity. This has been confirmed by visual inspection.
- ED006 (Exchangeable Cations on Alkaline Soils): EB2219558-004 shows poor duplicate results due to sample heterogeneity. This has been confirmed by visual inspection.
- EG020-T (Total Metals by ICP-MS): Sample 2021090_C109 (EB2220279-009) shows poor duplicate results due to sample heterogeneity. Confirmed by visual inspection.
- EG020-T (Total Metals by ICP-MS): Sample EB2220255-002 shows poor matrix spike recovery due to sample heterogeneity. Confirmed by visual inspection.
- ED007 and ED008: When Exchangeable Al is reported from these methods, it should be noted that Rayment & Lyons (2011) suggests Exchange Acidity by 1M KCl - Method 15G1 (ED005) is a more suitable method for the determination of exchange acidity (H+ + Al3+).

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_C101	2021090_C102	2021090_C103	2021090_C104	2021090_C105
			Sampling date / time	05-Jul-2022 00:00	05-Jul-2022 00:00	05-Jul-2022 00:00	05-Jul-2022 00:00	05-Jul-2022 00:00
Compound	CAS Number	LOR	Unit	EB2220279-001	EB2220279-002	EB2220279-003	EB2220279-004	EB2220279-005
				Result	Result	Result	Result	Result
EA001: pH in soil using 0.01M CaCl extract								
pH (CaCl2)	----	0.1	pH Unit	7.8	7.6	7.7	7.8	7.8
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.7	8.3	8.4	8.4	8.4
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	134	145	142	128	140
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	17.8	17.1	20.0	19.0	18.5
ED006: Exchangeable Cations on Alkaline Soils								
ø Exchangeable Calcium	----	0.2	meq/100g	22.4	16.2	18.3	19.7	14.3
ø Exchangeable Magnesium	----	0.2	meq/100g	1.8	1.8	1.7	1.9	1.7
ø Exchangeable Potassium	----	0.2	meq/100g	0.4	0.6	0.9	0.6	0.4
ø Exchangeable Sodium	----	0.2	meq/100g	0.5	<0.2	<0.2	<0.2	<0.2
ø Cation Exchange Capacity	----	0.2	meq/100g	25.0	18.6	21.0	22.3	16.4
ø Exchangeable Sodium Percent	----	0.2	%	2.0	<0.2	<0.2	<0.2	<0.2
ø Calcium/Magnesium Ratio	----	0.2	-	12.4	8.7	10.6	10.3	8.5
ø Magnesium/Potassium Ratio	----	0.2	-	5.1	3.1	1.8	3.0	3.7
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	100	mg/kg	306	623	895	647	624
ED037: Alkalinity								
ø Total Alkalinity as CaCO3	----	1	mg/kg	25200	8100	7200	8100	8100
ø Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/kg	24300	8100	7200	8100	8100
ø Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/kg	900	<5	<5	<5	<5
ED038A: Acidity								
Acidity	----	1	mg/kg	<5	114	99	53	64
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	10	20	<10	10
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	<10	<10	<10	<10	<10
ED092: DTPA Extractable Metals								
ø Copper	7440-50-8	1.00	mg/kg	1.04	1.65	1.89	1.02	1.28
ø Iron	7439-89-6	1.00	mg/kg	9.55	12.4	11.0	14.5	14.1
ø Manganese	7439-96-5	1.00	mg/kg	6.06	12.1	15.7	10.6	11.9
ø Zinc	7440-66-6	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	2021090_C101	2021090_C102	2021090_C103	2021090_C104	2021090_C105
				Sampling date / time	05-Jul-2022 00:00	05-Jul-2022 00:00	05-Jul-2022 00:00	05-Jul-2022 00:00	05-Jul-2022 00:00
Compound	CAS Number	LOR	Unit		EB2220279-001	EB2220279-002	EB2220279-003	EB2220279-004	EB2220279-005
					Result	Result	Result	Result	Result
ED093S: Soluble Major Cations									
Calcium	7440-70-2	10	mg/kg		40	110	100	100	100
Magnesium	7439-95-4	10	mg/kg		<10	10	<10	<10	10
Sodium	7440-23-5	10	mg/kg		120	30	20	20	30
Potassium	7440-09-7	10	mg/kg		<10	20	40	10	20
EG005(ED093)S : Soluble Metals by ICPAES									
Boron	7440-42-8	1	mg/kg		<1	<1	<1	<1	<1
Iron	7439-89-6	1	mg/kg		<1	<1	<1	<1	<1
EG005(ED093)T: Total Metals by ICP-AES									
Aluminium	7429-90-5	50	mg/kg		11400	11700	14000	13200	11900
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Iron	7439-89-6	50	mg/kg		16800	17600	18400	23200	19200
Calcium	7440-70-2	50	mg/kg		51800	10400	12100	12900	31700
Magnesium	7439-95-4	50	mg/kg		2380	2330	2550	2750	2630
Sodium	7440-23-5	50	mg/kg		310	110	120	80	120
Potassium	7440-09-7	50	mg/kg		1120	1570	2080	1450	1330
Sulfur as S	63705-05-5	50	mg/kg		90	180	200	180	180
Phosphorus	7723-14-0	50	mg/kg		240	170	250	180	140
EG020S: Soluble Metals by ICPMS									
Arsenic	7440-38-2	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Selenium	7782-49-2	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	7440-43-9	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt	7440-48-4	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Chromium	7440-47-3	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Thorium	7440-29-1	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Copper	7440-50-8	0.01	mg/kg		<0.01	<0.01	0.01	<0.01	<0.01
Manganese	7439-96-5	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Molybdenum	7439-98-7	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Nickel	7440-02-0	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Lead	7439-92-1	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Antimony	7440-36-0	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	7440-61-1	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
Vanadium	7440-62-2	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Aluminium	7429-90-5	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	2021090_C101	2021090_C102	2021090_C103	2021090_C104	2021090_C105
				Sampling date / time	05-Jul-2022 00:00	05-Jul-2022 00:00	05-Jul-2022 00:00	05-Jul-2022 00:00	05-Jul-2022 00:00
Compound	CAS Number	LOR	Unit		EB2220279-001	EB2220279-002	EB2220279-003	EB2220279-004	EB2220279-005
					Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS									
Arsenic	7440-38-2	0.1	mg/kg		2.2	2.6	3.0	2.0	2.0
Cerium	7440-45-1	0.1	mg/kg		29.7	31.7	28.4	30.3	32.7
Germanium	7440-56-4	0.1	mg/kg		0.7	0.8	0.8	0.9	0.9
Selenium	7782-49-2	1	mg/kg		<1	<1	<1	<1	<1
Silver	7440-22-4	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Barium	7440-39-3	0.1	mg/kg		298	350	352	258	280
Caesium	7440-46-2	0.1	mg/kg		0.3	0.3	0.3	0.2	0.2
Niobium	7440-03-1	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Thallium	7440-28-0	0.1	mg/kg		<0.1	<0.1	0.1	<0.1	<0.1
Beryllium	7440-41-7	0.1	mg/kg		0.7	0.8	0.8	0.6	0.6
Cadmium	7440-43-9	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Palladium	7440-05-3	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Bismuth	7440-69-9	0.1	mg/kg		0.1	0.1	0.1	0.1	0.1
Cobalt	7440-48-4	0.1	mg/kg		9.4	13.3	11.7	13.6	14.4
Platinum	7440-06-4	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	7440-47-3	0.1	mg/kg		4.8	7.1	6.8	11.3	10.7
Rhenium	7440-15-5	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Copper	7440-50-8	0.1	mg/kg		12.7	22.0	24.7	15.9	15.7
Gold	7440-57-5	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Thorium	7440-29-1	0.1	mg/kg		1.1	0.6	0.6	0.6	0.6
Gallium	7440-55-3	0.1	mg/kg		2.8	3.4	3.5	3.9	3.6
Manganese	7439-96-5	0.1	mg/kg		947	1300	1100	1120	1080
Strontium	7440-24-6	0.1	mg/kg		92.2	108	111	87.9	102
Tungsten	7440-33-7	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Hafnium	7440-58-6	1	mg/kg		<1	<1	<1	<1	<1
Molybdenum	7439-98-7	0.1	mg/kg		0.1	0.2	0.2	0.1	0.1
Nickel	7440-02-0	0.1	mg/kg		7.1	9.6	9.1	11.0	9.9
Indium	7440-74-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Lead	7439-92-1	0.1	mg/kg		10.5	12.6	13.1	11.4	11.6
Antimony	7440-36-0	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Lanthanum	7439-91-0	0.1	mg/kg		10.6	9.1	10.4	10.8	15.1
Uranium	7440-61-1	0.1	mg/kg		0.2	0.2	0.2	0.2	0.3
Zinc	7440-66-6	0.5	mg/kg		18.6	22.1	27.1	18.8	15.1
Lithium	7439-93-2	0.1	mg/kg		2.8	2.2	2.3	2.6	2.0
Rubidium	7440-17-7	0.1	mg/kg		4.1	4.3	5.2	4.7	4.2

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_C101	2021090_C102	2021090_C103	2021090_C104	2021090_C105
			Sampling date / time	05-Jul-2022 00:00	05-Jul-2022 00:00	05-Jul-2022 00:00	05-Jul-2022 00:00	05-Jul-2022 00:00
Compound	CAS Number	LOR	Unit	EB2220279-001	EB2220279-002	EB2220279-003	EB2220279-004	EB2220279-005
				Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS - Continued								
Vanadium	7440-62-2	1	mg/kg	39	52	53	58	56
Tin	7440-31-5	0.1	mg/kg	0.4	0.4	0.5	0.5	0.4
Tellurium	22541-49-7	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Titanium	7440-32-6	1	mg/kg	16	22	20	32	28
Yttrium	7440-65-5	0.1	mg/kg	8.3	9.0	9.7	9.4	12.5
Zirconium	7440-67-7	0.5	mg/kg	<0.5	0.6	0.7	<0.5	<0.5
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EK040S: Fluoride Soluble								
Fluoride	16984-48-8	1	mg/kg	8	4	2	2	3
EK055: Ammonia as N								
Ammonia as N	7664-41-7	20	mg/kg	<20	<20	<20	<20	<20
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	<0.1	0.4	0.3	<0.1	<0.1
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	1.2	11.8	8.3	7.1	9.8
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	1.2	12.2	8.6	7.1	9.8
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	770	1570	1520	1300	1120
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	770	1580	1530	1310	1130
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	284	279	331	265	198
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	<5	12	10	6
EP004: Organic Matter								
Organic Matter	----	0.5	%	2.5	4.0	4.1	3.8	3.5
Total Organic Carbon	----	0.5	%	1.4	2.3	2.4	2.2	2.0

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_C106	2021090_C107	2021090_C108	2021090_C109	2021090_C110
			Sampling date / time	05-Jul-2022 00:00	05-Jul-2022 00:00	05-Jul-2022 00:00	05-Jul-2022 00:00	05-Jul-2022 00:00
Compound	CAS Number	LOR	Unit	EB2220279-006	EB2220279-007	EB2220279-008	EB2220279-009	EB2220279-010
				Result	Result	Result	Result	Result
EA001: pH in soil using 0.01M CaCl extract								
pH (CaCl2)	----	0.1	pH Unit	7.7	7.8	6.4	7.1	7.7
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.3	8.7	7.1	7.8	8.4
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	130	140	21	58	131
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	18.6	18.8	11.7	16.2	16.2
ED006: Exchangeable Cations on Alkaline Soils								
ø Exchangeable Calcium	----	0.2	meq/100g	17.8	19.7	----	15.3	13.9
ø Exchangeable Magnesium	----	0.2	meq/100g	1.4	3.5	----	2.4	2.1
ø Exchangeable Potassium	----	0.2	meq/100g	0.6	0.4	----	0.4	0.3
ø Exchangeable Sodium	----	0.2	meq/100g	<0.2	0.4	----	<0.2	<0.2
ø Cation Exchange Capacity	----	0.2	meq/100g	19.8	24.0	----	18.0	16.2
ø Exchangeable Sodium Percent	----	0.2	%	<0.2	1.8	----	<0.2	<0.2
ø Calcium/Magnesium Ratio	----	0.2	-	12.9	5.6	----	6.4	6.6
ø Magnesium/Potassium Ratio	----	0.2	-	2.2	8.3	----	6.2	7.2
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	----	----	19.8	----	----
Exchangeable Magnesium	----	0.1	meq/100g	----	----	4.4	----	----
Exchangeable Potassium	----	0.1	meq/100g	----	----	0.8	----	----
Exchangeable Sodium	----	0.1	meq/100g	----	----	<0.1	----	----
Cation Exchange Capacity	----	0.1	meq/100g	----	----	25.2	----	----
Exchangeable Sodium Percent	----	0.1	%	----	----	0.4	----	----
Calcium/Magnesium Ratio	----	0.1	-	----	----	4.5	----	----
Magnesium/Potassium Ratio	----	0.1	-	----	----	5.4	----	----
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	100	mg/kg	680	438	472	425	393
ED037: Alkalinity								
ø Total Alkalinity as CaCO3	----	1	mg/kg	6300	9450	2250	1350	5400
ø Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/kg	6300	8550	2250	1350	5400
ø Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/kg	<5	900	<5	<5	<5
ED038A: Acidity								
Acidity	----	1	mg/kg	92	<5	454	287	96
ED040S : Soluble Sulfate by ICPAES								

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_C106	2021090_C107	2021090_C108	2021090_C109	2021090_C110
			Sampling date / time	05-Jul-2022 00:00	05-Jul-2022 00:00	05-Jul-2022 00:00	05-Jul-2022 00:00	05-Jul-2022 00:00
Compound	CAS Number	LOR	Unit	EB2220279-006	EB2220279-007	EB2220279-008	EB2220279-009	EB2220279-010
				Result	Result	Result	Result	Result
ED040S : Soluble Sulfate by ICPAES - Continued								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	20	<10	<10	<10
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	<10	<10	<10	<10	<10
ED092: DTPA Extractable Metals								
ø Copper	7440-50-8	1.00	mg/kg	<1.00	1.50	<1.00	1.52	1.37
ø Iron	7439-89-6	1.00	mg/kg	11.6	11.6	18.1	16.8	12.3
ø Manganese	7439-96-5	1.00	mg/kg	7.61	6.55	38.6	20.2	9.87
ø Zinc	7440-66-6	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	<1.00
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	110	60	<10	40	90
Magnesium	7439-95-4	10	mg/kg	<10	<10	<10	<10	10
Sodium	7440-23-5	10	mg/kg	<10	100	<10	30	40
Potassium	7440-09-7	10	mg/kg	30	<10	<10	<10	<10
EG005(ED093)S : Soluble Metals by ICPAES								
Boron	7440-42-8	1	mg/kg	<1	<1	<1	<1	<1
Iron	7439-89-6	1	mg/kg	<1	<1	<1	<1	<1
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	13600	13700	10800	13200	12200
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Iron	7439-89-6	50	mg/kg	25800	20400	25600	22600	23400
Calcium	7440-70-2	50	mg/kg	16000	38700	4900	7920	10000
Magnesium	7439-95-4	50	mg/kg	2750	3640	2070	2890	3060
Sodium	7440-23-5	50	mg/kg	<50	360	<50	140	150
Potassium	7440-09-7	50	mg/kg	1390	1280	1650	1260	930
Sulfur as S	63705-05-5	50	mg/kg	200	230	170	200	180
Phosphorus	7723-14-0	50	mg/kg	130	150	130	200	200
EG020S: Soluble Metals by ICPMS								
Arsenic	7440-38-2	0.01	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium	7782-49-2	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	7440-43-9	0.01	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt	7440-48-4	0.01	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium	7440-47-3	0.01	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Thorium	7440-29-1	0.01	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	7440-50-8	0.01	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_C106	2021090_C107	2021090_C108	2021090_C109	2021090_C110
			Sampling date / time	05-Jul-2022 00:00	05-Jul-2022 00:00	05-Jul-2022 00:00	05-Jul-2022 00:00	05-Jul-2022 00:00
Compound	CAS Number	LOR	Unit	EB2220279-006	EB2220279-007	EB2220279-008	EB2220279-009	EB2220279-010
				Result	Result	Result	Result	Result
EG020S: Soluble Metals by ICPMS - Continued								
Manganese	7439-96-5	0.01	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Molybdenum	7439-98-7	0.01	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Nickel	7440-02-0	0.01	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Lead	7439-92-1	0.01	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Antimony	7440-36-0	0.01	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	7440-61-1	0.01	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Vanadium	7440-62-2	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aluminium	7429-90-5	0.1	mg/kg	<0.1	<0.1	**1.1**	<0.1	<0.1
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.1	mg/kg	**1.6**	**2.4**	**2.3**	**2.2**	**2.1**
Cerium	7440-45-1	0.1	mg/kg	**27.3**	**29.2**	**19.1**	**38.5**	**37.1**
Germanium	7440-56-4	0.1	mg/kg	**0.8**	**0.8**	**0.7**	**0.9**	**0.9**
Selenium	7782-49-2	1	mg/kg	<1	<1	<1	<1	<1
Silver	7440-22-4	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Barium	7440-39-3	0.1	mg/kg	**215**	**509**	**101**	**466**	**376**
Caesium	7440-46-2	0.1	mg/kg	**0.2**	**0.3**	**0.5**	**0.3**	**0.3**
Niobium	7440-03-1	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	**0.1**
Thallium	7440-28-0	0.1	mg/kg	<0.1	<0.1	<0.1	**0.1**	**0.1**
Beryllium	7440-41-7	0.1	mg/kg	**0.6**	**0.6**	**0.5**	**0.7**	**0.7**
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Palladium	7440-05-3	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Bismuth	7440-69-9	0.1	mg/kg	**0.1**	**0.1**	<0.1	**0.1**	**0.1**
Cobalt	7440-48-4	0.1	mg/kg	**11.9**	**12.5**	**8.8**	**16.8**	**17.3**
Platinum	7440-06-4	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	7440-47-3	0.1	mg/kg	**11.8**	**10.9**	**8.3**	**12.1**	**14.3**
Rhenium	7440-15-5	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Copper	7440-50-8	0.1	mg/kg	**12.5**	**19.6**	**7.8**	**19.0**	**18.0**
Gold	7440-57-5	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Thorium	7440-29-1	0.1	mg/kg	**0.6**	**1.0**	**0.6**	**0.6**	**0.6**
Gallium	7440-55-3	0.1	mg/kg	**4.3**	**3.7**	**3.2**	**3.9**	**3.8**
Manganese	7439-96-5	0.1	mg/kg	**727**	**949**	**698**	**1520**	**1370**
Strontium	7440-24-6	0.1	mg/kg	**67.4**	**168**	**34.1**	**88.3**	**98.5**
Tungsten	7440-33-7	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Hafnium	7440-58-6	1	mg/kg	<1	<1	<1	<1	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_C106	2021090_C107	2021090_C108	2021090_C109	2021090_C110
			Sampling date / time	05-Jul-2022 00:00	05-Jul-2022 00:00	05-Jul-2022 00:00	05-Jul-2022 00:00	05-Jul-2022 00:00
Compound	CAS Number	LOR	Unit	EB2220279-006	EB2220279-007	EB2220279-008	EB2220279-009	EB2220279-010
				Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS - Continued								
Molybdenum	7439-98-7	0.1	mg/kg	<0.1	0.2	0.2	0.2	0.2
Nickel	7440-02-0	0.1	mg/kg	9.1	11.8	7.1	12.2	14.2
Indium	7440-74-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Lead	7439-92-1	0.1	mg/kg	10.1	11.8	7.2	16.0	12.6
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Lanthanum	7439-91-0	0.1	mg/kg	8.8	13.5	6.5	13.5	12.1
Uranium	7440-61-1	0.1	mg/kg	0.2	0.4	0.1	0.3	0.4
Zinc	7440-66-6	0.5	mg/kg	16.5	19.2	15.0	18.5	16.6
Lithium	7439-93-2	0.1	mg/kg	2.9	2.8	4.1	2.5	2.7
Rubidium	7440-17-7	0.1	mg/kg	4.6	4.2	8.9	5.1	4.6
Vanadium	7440-62-2	1	mg/kg	64	55	49	61	58
Tin	7440-31-5	0.1	mg/kg	0.4	0.5	0.4	0.5	0.5
Tellurium	22541-49-7	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Titanium	7440-32-6	1	mg/kg	30	35	26	28	53
Yttrium	7440-65-5	0.1	mg/kg	8.2	11.7	6.2	10.7	9.7
Zirconium	7440-67-7	0.5	mg/kg	<0.5	0.5	<0.5	0.6	0.6
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EK040S: Fluoride Soluble								
Fluoride	16984-48-8	1	mg/kg	<1	12	<5	<5	2
EK055: Ammonia as N								
Ammonia as N	7664-41-7	20	mg/kg	<20	<20	<20	<20	<20
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	0.2	<0.1	0.1	1.1	0.6
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	5.5	7.2	3.9	4.8	4.3
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	5.7	7.2	4.0	5.9	4.9
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	1410	930	1360	1450	1560
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	1420	940	1360	1460	1560
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	190	179	190	311	239

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_C106	2021090_C107	2021090_C108	2021090_C109	2021090_C110
			Sampling date / time	05-Jul-2022 00:00	05-Jul-2022 00:00	05-Jul-2022 00:00	05-Jul-2022 00:00	05-Jul-2022 00:00
Compound	CAS Number	LOR	Unit	EB2220279-006	EB2220279-007	EB2220279-008	EB2220279-009	EB2220279-010
				Result	Result	Result	Result	Result
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	<5	<5	<5	<5
EP004: Organic Matter								
Organic Matter	----	0.5	%	**3.8**	**2.8**	**4.6**	**3.9**	**3.7**
Total Organic Carbon	----	0.5	%	**2.2**	**1.6**	**2.7**	**2.3**	**2.1**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_C111	2021090_C112	pH and EC of DI water	----	----
			Sampling date / time	05-Jul-2022 00:00	05-Jul-2022 00:00	05-Jul-2022 00:00	----	----
Compound	CAS Number	LOR	Unit	EB2220279-011	EB2220279-012	EB2220279-013	--------	--------
				Result	Result	Result	----	----
EA001: pH in soil using 0.01M CaCl extract								
pH (CaCl2)	----	0.1	pH Unit	6.9	7.5	----	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.0	8.4	5.6	----	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	51	123	<1	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	14.9	19.7	----	----	----
ED006: Exchangeable Cations on Alkaline Soils								
ø Exchangeable Calcium	----	0.2	meq/100g	13.2	18.3	----	----	----
ø Exchangeable Magnesium	----	0.2	meq/100g	2.0	2.0	----	----	----
ø Exchangeable Potassium	----	0.2	meq/100g	0.5	0.7	----	----	----
ø Exchangeable Sodium	----	0.2	meq/100g	<0.2	0.3	----	----	----
ø Cation Exchange Capacity	----	0.2	meq/100g	15.6	21.2	----	----	----
ø Exchangeable Sodium Percent	----	0.2	%	<0.2	1.4	----	----	----
ø Calcium/Magnesium Ratio	----	0.2	-	6.6	9.3	----	----	----
ø Magnesium/Potassium Ratio	----	0.2	-	4.2	2.9	----	----	----
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	100	mg/kg	464	498	----	----	----
ED037: Alkalinity								
ø Total Alkalinity as CaCO3	----	1	mg/kg	1800	3600	----	----	----
ø Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/kg	1800	3600	----	----	----
ø Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/kg	<5	<5	----	----	----
ED038A: Acidity								
Acidity	----	1	mg/kg	241	85	----	----	----
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	10	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	<10	<10	----	----	----
ED092: DTPA Extractable Metals								
ø Copper	7440-50-8	1.00	mg/kg	2.28	3.20	----	----	----
ø Iron	7439-89-6	1.00	mg/kg	19.1	13.5	----	----	----
ø Manganese	7439-96-5	1.00	mg/kg	24.6	9.01	----	----	----
ø Zinc	7440-66-6	1.00	mg/kg	<1.00	<1.00	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_C111	2021090_C112	pH and EC of DI water	----	----
			Sampling date / time	05-Jul-2022 00:00	05-Jul-2022 00:00	05-Jul-2022 00:00	----	----
Compound	CAS Number	LOR	Unit	EB2220279-011	EB2220279-012	EB2220279-013	--------	--------
				Result	Result	Result	----	----
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	**10**	**50**	----	----	----
Magnesium	7439-95-4	10	mg/kg	<10	<10	----	----	----
Sodium	7440-23-5	10	mg/kg	**60**	**100**	----	----	----
Potassium	7440-09-7	10	mg/kg	<10	<10	----	----	----
EG005(ED093)S : Soluble Metals by ICPAES								
Boron	7440-42-8	1	mg/kg	<1	<1	----	----	----
Iron	7439-89-6	1	mg/kg	<1	<1	----	----	----
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**10400**	**14800**	----	----	----
Boron	7440-42-8	50	mg/kg	<50	<50	----	----	----
Iron	7439-89-6	50	mg/kg	**21800**	**18200**	----	----	----
Calcium	7440-70-2	50	mg/kg	**5710**	**22500**	----	----	----
Magnesium	7439-95-4	50	mg/kg	**1760**	**2410**	----	----	----
Sodium	7440-23-5	50	mg/kg	**210**	**320**	----	----	----
Potassium	7440-09-7	50	mg/kg	**1430**	**2360**	----	----	----
Sulfur as S	63705-05-5	50	mg/kg	**120**	**120**	----	----	----
Phosphorus	7723-14-0	50	mg/kg	**170**	**290**	----	----	----
EG020S: Soluble Metals by ICPMS								
Arsenic	7440-38-2	0.01	mg/kg	<0.01	<0.01	----	----	----
Selenium	7782-49-2	0.1	mg/kg	<0.1	<0.1	----	----	----
Cadmium	7440-43-9	0.01	mg/kg	<0.01	<0.01	----	----	----
Cobalt	7440-48-4	0.01	mg/kg	<0.01	<0.01	----	----	----
Chromium	7440-47-3	0.01	mg/kg	<0.01	<0.01	----	----	----
Thorium	7440-29-1	0.01	mg/kg	<0.01	<0.01	----	----	----
Copper	7440-50-8	0.01	mg/kg	<0.01	<0.01	----	----	----
Manganese	7439-96-5	0.01	mg/kg	<0.01	<0.01	----	----	----
Molybdenum	7439-98-7	0.01	mg/kg	<0.01	<0.01	----	----	----
Nickel	7440-02-0	0.01	mg/kg	<0.01	<0.01	----	----	----
Lead	7439-92-1	0.01	mg/kg	<0.01	<0.01	----	----	----
Antimony	7440-36-0	0.01	mg/kg	<0.01	<0.01	----	----	----
Uranium	7440-61-1	0.01	mg/kg	<0.01	<0.01	----	----	----
Zinc	7440-66-6	0.05	mg/kg	<0.05	<0.05	----	----	----
Vanadium	7440-62-2	0.1	mg/kg	<0.1	<0.1	----	----	----
Aluminium	7429-90-5	0.1	mg/kg	**0.5**	<0.1	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_C111	2021090_C112	pH and EC of DI water	----	----
			Sampling date / time	05-Jul-2022 00:00	05-Jul-2022 00:00	05-Jul-2022 00:00	----	----
Compound	CAS Number	LOR	Unit	EB2220279-011	EB2220279-012	EB2220279-013	--------	--------
				Result	Result	Result	----	----
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.1	mg/kg	**5.4**	**4.5**	----	----	----
Cerium	7440-45-1	0.1	mg/kg	**46.4**	**48.1**	----	----	----
Germanium	7440-56-4	0.1	mg/kg	**1.1**	**1.2**	----	----	----
Selenium	7782-49-2	1	mg/kg	<1	<1	----	----	----
Silver	7440-22-4	0.1	mg/kg	<0.1	<0.1	----	----	----
Barium	7440-39-3	0.1	mg/kg	**435**	**520**	----	----	----
Caesium	7440-46-2	0.1	mg/kg	**0.5**	**0.6**	----	----	----
Niobium	7440-03-1	0.1	mg/kg	<0.1	<0.1	----	----	----
Thallium	7440-28-0	0.1	mg/kg	**0.2**	**0.2**	----	----	----
Beryllium	7440-41-7	0.1	mg/kg	**0.9**	**1.0**	----	----	----
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	----	----	----
Palladium	7440-05-3	0.1	mg/kg	<0.1	<0.1	----	----	----
Bismuth	7440-69-9	0.1	mg/kg	**0.2**	**0.2**	----	----	----
Cobalt	7440-48-4	0.1	mg/kg	**11.9**	**13.0**	----	----	----
Platinum	7440-06-4	0.1	mg/kg	<0.1	<0.1	----	----	----
Chromium	7440-47-3	0.1	mg/kg	**12.5**	**13.2**	----	----	----
Rhenium	7440-15-5	0.1	mg/kg	<0.1	<0.1	----	----	----
Copper	7440-50-8	0.1	mg/kg	**27.1**	**35.1**	----	----	----
Gold	7440-57-5	0.1	mg/kg	<0.1	<0.1	----	----	----
Thorium	7440-29-1	0.1	mg/kg	**1.0**	**1.1**	----	----	----
Gallium	7440-55-3	0.1	mg/kg	**3.5**	**3.8**	----	----	----
Manganese	7439-96-5	0.1	mg/kg	**1220**	**1370**	----	----	----
Strontium	7440-24-6	0.1	mg/kg	**106**	**144**	----	----	----
Tungsten	7440-33-7	0.1	mg/kg	<0.1	<0.1	----	----	----
Hafnium	7440-58-6	1	mg/kg	<1	<1	----	----	----
Molybdenum	7439-98-7	0.1	mg/kg	**0.3**	**0.1**	----	----	----
Nickel	7440-02-0	0.1	mg/kg	**11.2**	**16.2**	----	----	----
Indium	7440-74-6	0.1	mg/kg	<0.1	<0.1	----	----	----
Lead	7439-92-1	0.1	mg/kg	**22.0**	**17.6**	----	----	----
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	----	----	----
Lanthanum	7439-91-0	0.1	mg/kg	**15.0**	**19.1**	----	----	----
Uranium	7440-61-1	0.1	mg/kg	**0.4**	**0.4**	----	----	----
Zinc	7440-66-6	0.5	mg/kg	**18.6**	**16.9**	----	----	----
Lithium	7439-93-2	0.1	mg/kg	**2.0**	**2.1**	----	----	----
Rubidium	7440-17-7	0.1	mg/kg	**6.4**	**8.9**	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021090_C111	2021090_C112	pH and EC of DI water	----	----
			Sampling date / time	05-Jul-2022 00:00	05-Jul-2022 00:00	05-Jul-2022 00:00	----	----
Compound	CAS Number	LOR	Unit	EB2220279-011	EB2220279-012	EB2220279-013	--------	--------
				Result	Result	Result	----	----
EG020T: Total Metals by ICP-MS - Continued								
Vanadium	7440-62-2	1	mg/kg	**56**	**60**	----	----	----
Tin	7440-31-5	0.1	mg/kg	**0.5**	**0.5**	----	----	----
Tellurium	22541-49-7	0.5	mg/kg	<0.5	<0.5	----	----	----
Titanium	7440-32-6	1	mg/kg	**24**	**22**	----	----	----
Yttrium	7440-65-5	0.1	mg/kg	**11.8**	**13.9**	----	----	----
Zirconium	7440-67-7	0.5	mg/kg	<0.5	<0.5	----	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	----	----	----
EK040S: Fluoride Soluble								
Fluoride	16984-48-8	1	mg/kg	<5	**16**	----	----	----
EK055: Ammonia as N								
Ammonia as N	7664-41-7	20	mg/kg	<20	<20	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	**0.4**	**0.4**	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	**3.9**	**4.9**	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	**4.3**	**5.3**	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**1040**	**780**	----	----	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	**1040**	**780**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**288**	**315**	----	----	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	<5	----	----	----
EP004: Organic Matter								
Organic Matter	----	0.5	%	**3.8**	**2.8**	----	----	----
Total Organic Carbon	----	0.5	%	**2.2**	**1.6**	----	----	----

Attachment F: Trilab laboratory certificates

Trilab
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EMERSON CLASS NUMBER TEST REPORT

Test Method: AS 1289 3.8.1

Client	RGS Environmental Pty Ltd	**Report No.**	22071595-EM
		Workorder No.	10076
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	22/08/2022
		Report Date	29/08/2022
Project	2021090 - Eagle Downs Soils		

Sample No.	22071595	22071596	22071597	22071598	22071599	22071600	22071601
Client ID	1 - 2021090_C101	2 - 2021090_C102	3 - 2021090_C103	4 - 2021090_C104	5 - 2021090_C105	6 - 2021090_C106	7 - 2021090_C107
Depth (m)	Not Supplied	Not Supplied	Not Supplied	Not Supplied	Not Supplied	Not Supplied	Not Supplied
Description	CLAY trace sand - brown	CLAY trace sand - brown	CLAY - brown	Sandy CLAY - brown	CLAY trace sand - brown	Sandy CLAY - brown	CLAY trace sand - brown
Emerson Class Number	**4 (Calcite)**	**4 (Calcite)**	**4 (Calcite)**	**4 (Calcite)**	**4 (Calcite)**	**4 (Calcite)**	**4 (Calcite)**

Sample No.	22071602	22071603	22071604	22071605	22071606	-	-
Client ID	8 - 2021090_C108	9 - 2021090_C109	10 - 2021090_C110	11 - 2021090_C111	12 - 2021090_C112	-	-
Depth (m)	Not Supplied	Not Supplied	Not Supplied	Not Supplied	Not Supplied	-	-
Description	Sandy CLAY - brown	CLAY trace sand - brown	CLAY trace sand - brown	CLAY trace sand - brown	CLAY trace sand - brown	-	-
Emerson Class Number	**5**	**4 (Calcite)**	**4 (Calcite)**	**4 (Calcite)**	**4 (Calcite)**	**-**	**-**

Sample No.	-	-	-	-	-	-	-
Client ID	-	-	-	-	-	-	-
Depth (m)	-	-	-	-	-	-	-
Description	-	-	-	-	-	-	-
Emerson Class Number	**-**	**-**	**-**	**-**	**-**	**-**	**-**

NOTES/REMARKS:

Sample/s supplied by the client

Tested with Distilled water at 21.4°C

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Tested at Trilab Brisbane Laboratory

Authorised Signatory



Joshua Hawley

NATA ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.
Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.
Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
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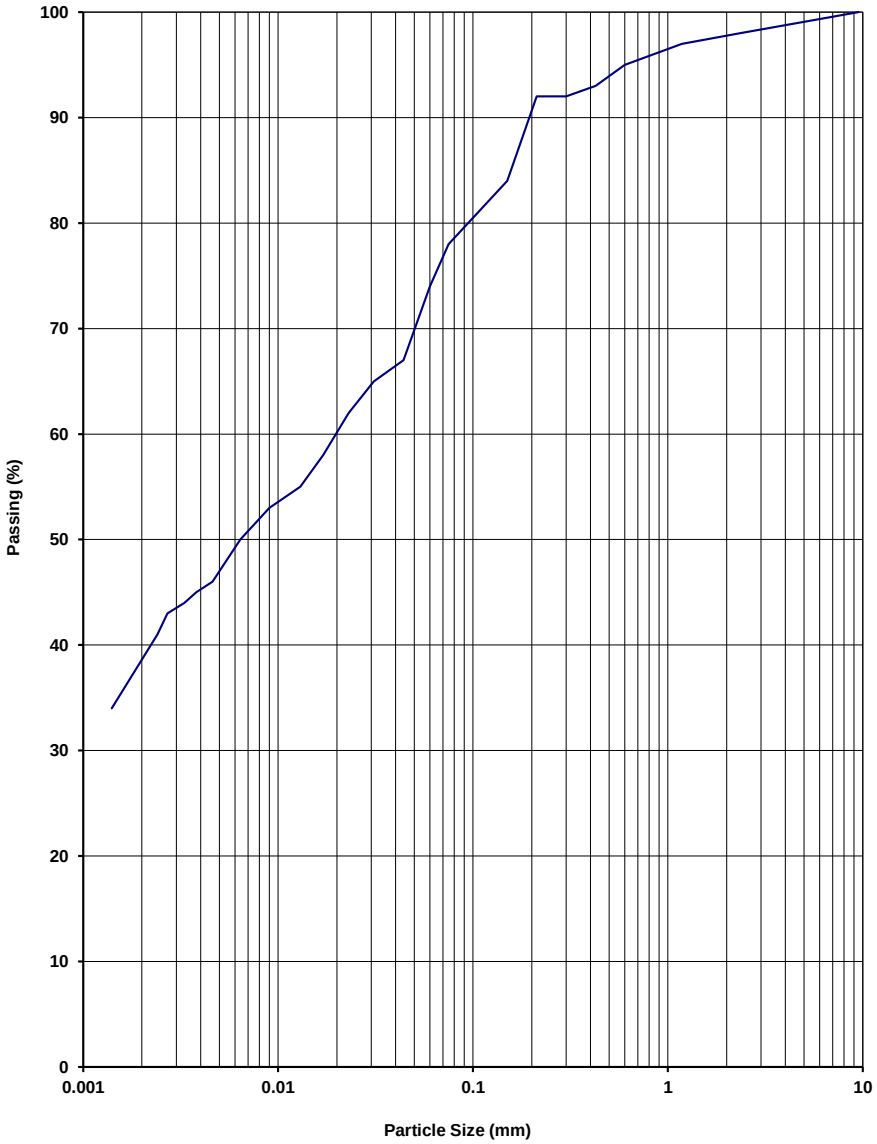
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PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.1, 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	22071595-G
		Workorder No.	0010076
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	8/8/2022
		Report Date	29/8/2022
Project	2021090 - Eagle Downs Soils		
Client ID	1 - 2021090_C101	**Depth (m)**	Not Supplied

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	100
6.7	99
4.75	99
2.36	98
1.18	97
0.600	95
0.425	93
0.300	92
0.212	92
0.150	84
0.075	78
0.06	74
0.044	67
0.031	65
0.023	62
0.017	58
0.013	55
0.009	53
0.0064	50
0.0046	46
0.0038	45
0.0033	44
0.0027	43
0.0024	41
0.0014	34



NOTES/REMARKS: -

Moisture Content 22.2% -2.36mm Soil Particle Density(t/m^3) 2.42

Sample/s supplied by the client

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Laboratory No. 9926

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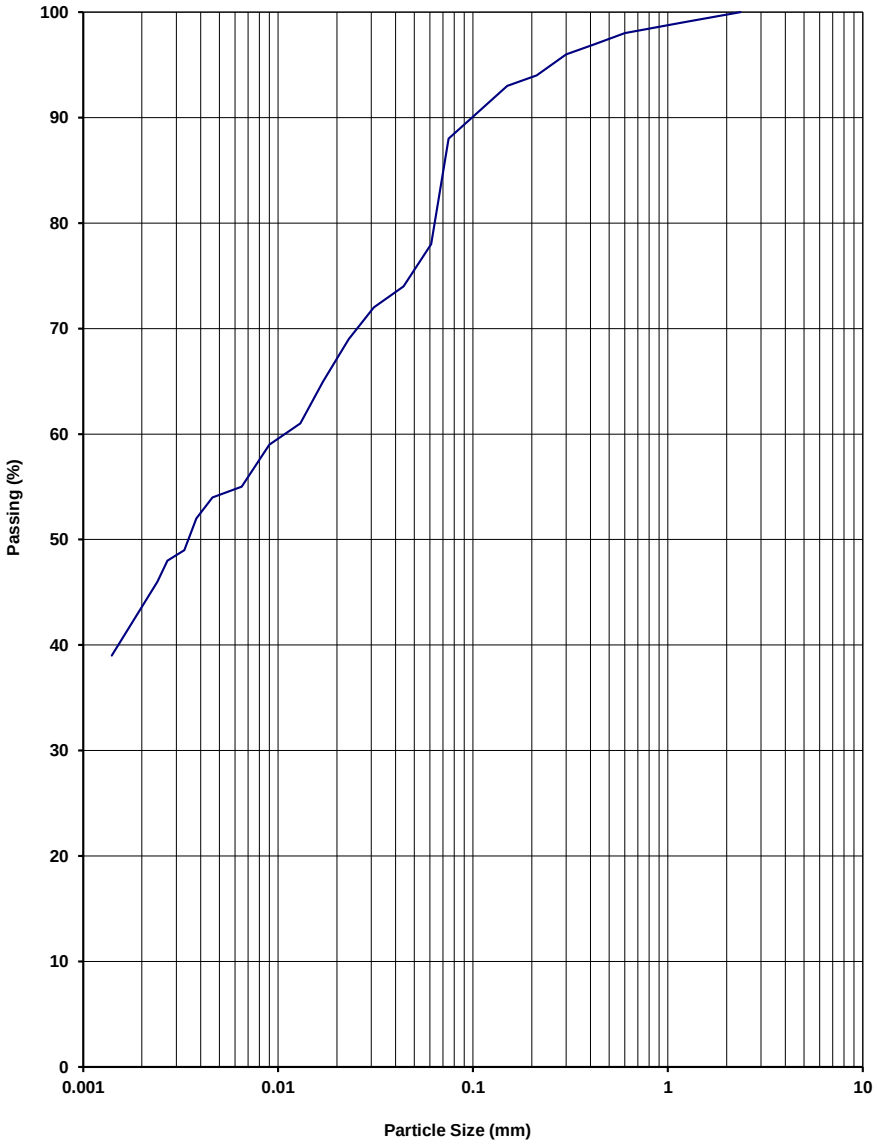
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PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.1, 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	22071596-G
		Workorder No.	0010076
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	8/8/2022
		Report Date	29/8/2022
Project	2021090 - Eagle Downs Soils		
Client ID	2 - 2021090_C102	**Depth (m)**	Not Supplied

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	
4.75	
2.36	100
1.18	99
0.600	98
0.425	97
0.300	96
0.212	94
0.150	93
0.075	88
0.061	78
0.044	74
0.031	72
0.023	69
0.017	65
0.013	61
0.009	59
0.0065	55
0.0046	54
0.0038	52
0.0033	49
0.0027	48
0.0024	46
0.0014	39



NOTES/REMARKS: -

Moisture Content 21.4% -2.36mm Soil Particle Density(t/m^3) 2.39

Sample/s supplied by the client

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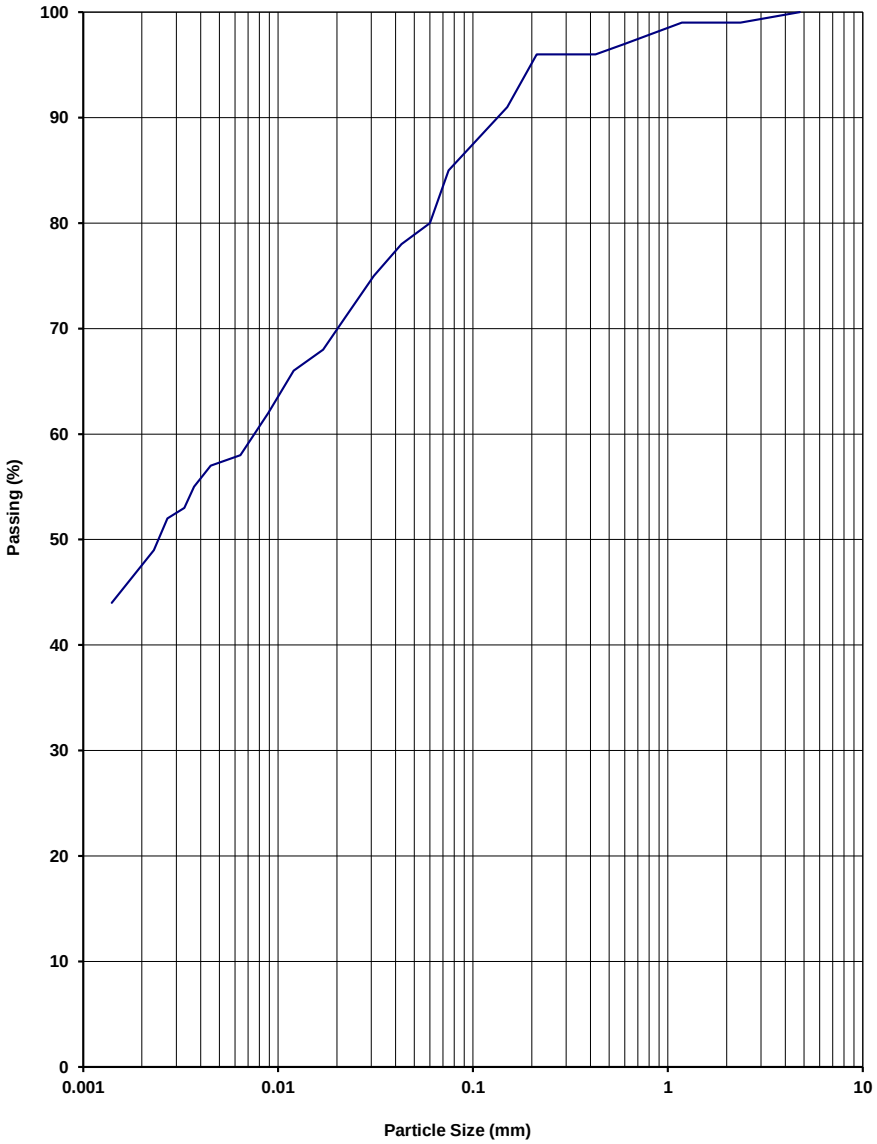
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PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.1, 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	22071597-G
		Workorder No.	0010076
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	8/8/2022
		Report Date	29/8/2022
Project	2021090 - Eagle Downs Soils		
Client ID	3 - 2021090_C103	**Depth (m)**	Not Supplied

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	
4.75	100
2.36	99
1.18	99
0.600	97
0.425	96
0.300	96
0.212	96
0.150	91
0.075	85
0.06	80
0.043	78
0.031	75
0.022	71
0.017	68
0.012	66
0.0089	62
0.0064	58
0.0045	57
0.0037	55
0.0033	53
0.0027	52
0.0023	49
0.0014	44



NOTES/REMARKS: -

Moisture Content 24.7% -2.36mm Soil Particle Density(t/m^3) 2.39

Sample/s supplied by the client

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Tested at Trilab Brisbane Laboratory

Authorised Signatory

Joshua Hawley

Laboratory No. 9926

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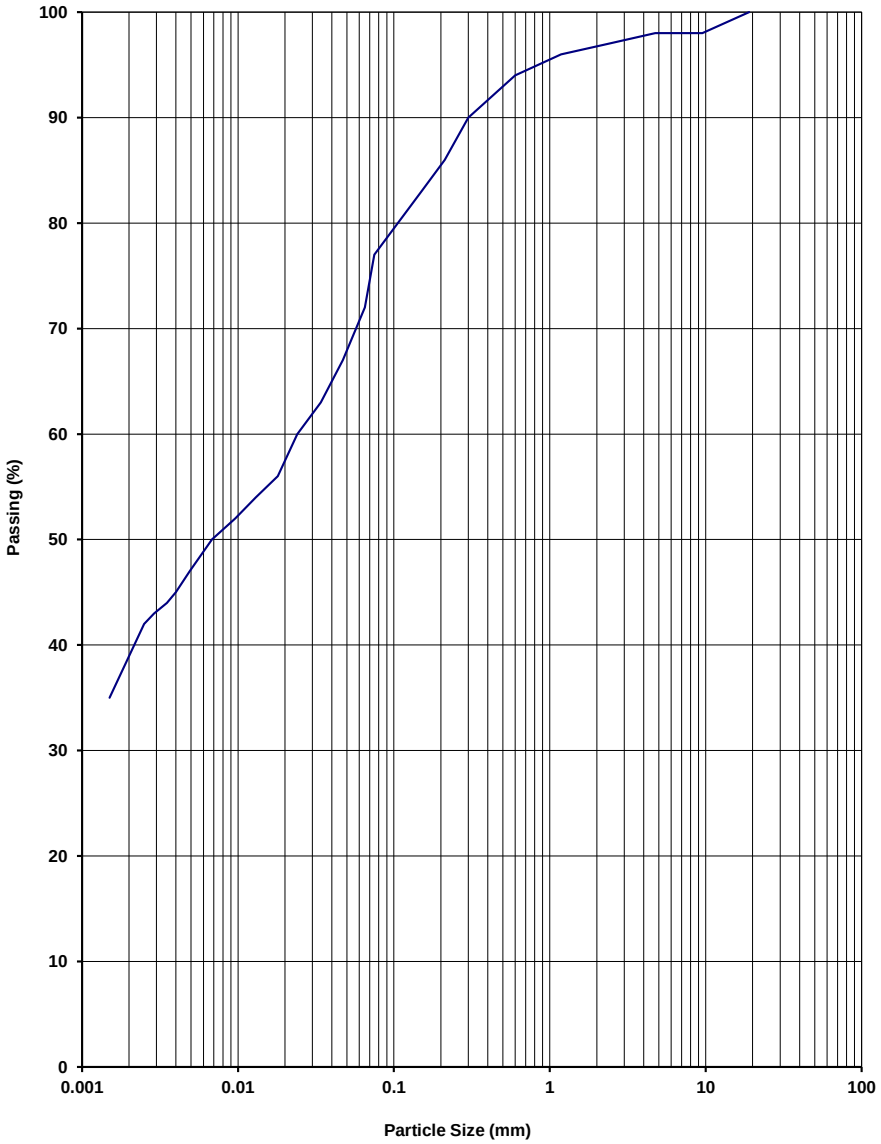
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PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.1, 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	22071598-G
		Workorder No.	0010076
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	8/8/2022
		Report Date	29/8/2022
Project	2021090 - Eagle Downs Soils		
Client ID	4 - 2021090_C104	**Depth (m)**	Not Supplied

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	100
13.2	98
9.5	98
6.7	98
4.75	98
2.36	97
1.18	96
0.600	94
0.425	92
0.300	90
0.212	86
0.150	83
0.075	77
0.065	72
0.047	67
0.034	63
0.024	60
0.018	56
0.013	54
0.0096	52
0.0068	50
0.0049	47
0.004	45
0.0035	44
0.0029	43
0.0025	42
0.0015	35



NOTES/REMARKS: -

Moisture Content 23.9% -2.36mm Soil Particle Density(t/m^3) 2.35

Sample/s supplied by the client

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Tested at Trilab Brisbane Laboratory

Authorised Signatory

Joshua Hawley

Laboratory No. 9926

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Trilab
Soil Rock Calibration

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346A Bilsen Road,
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Ph: +61 7 3265 5656

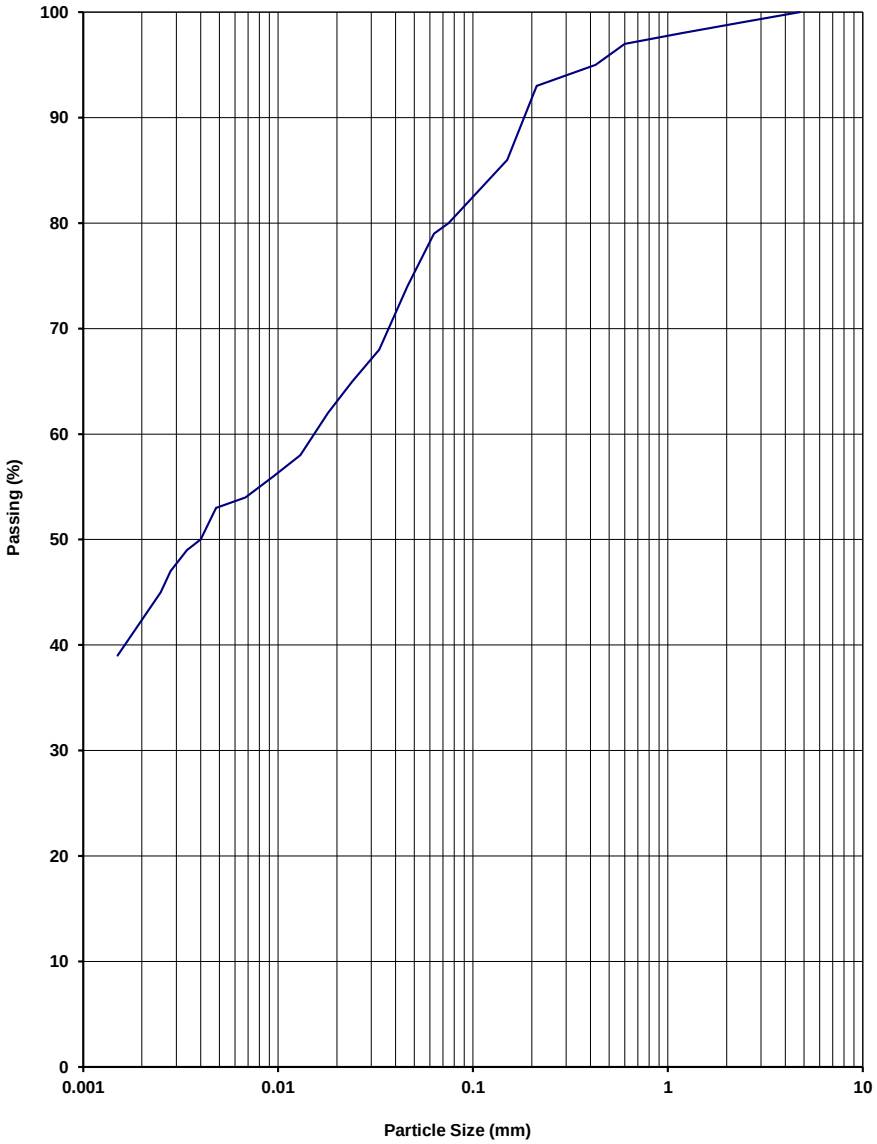
Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.1, 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	22071599-G
		Workorder No.	0010076
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	8/8/2022
		Report Date	29/8/2022
Project	2021090 - Eagle Downs Soils		
Client ID	5 - 2021090_C105	**Depth (m)**	Not Supplied

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	
4.75	100
2.36	99
1.18	98
0.600	97
0.425	95
0.300	94
0.212	93
0.150	86
0.075	80
0.063	79
0.046	74
0.033	68
0.024	65
0.018	62
0.013	58
0.0095	56
0.0068	54
0.0048	53
0.004	50
0.0034	49
0.0028	47
0.0025	45
0.0015	39



NOTES/REMARKS: -

Moisture Content 22.8% -2.36mm Soil Particle Density(t/m^3) 2.36

Sample/s supplied by the client

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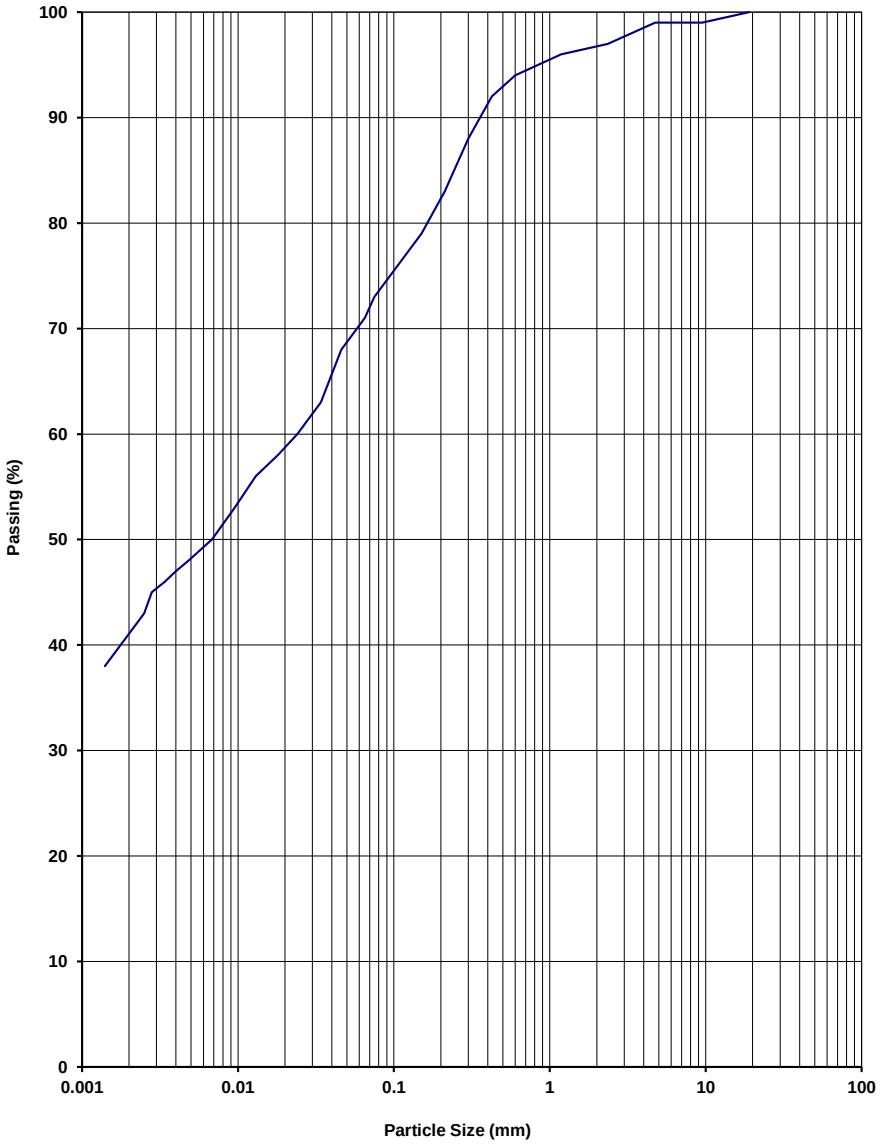
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WA 6107
Ph: +61 8 9258 8323

PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.1, 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	22071600-G
		Workorder No.	0010076
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	8/8/2022
		Report Date	29/8/2022
Project	2021090 - Eagle Downs Soils		
Client ID	6 - 2021090_C106	**Depth (m)**	Not Supplied

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	100
13.2	99
9.5	99
6.7	99
4.75	99
2.36	97
1.18	96
0.600	94
0.425	92
0.300	88
0.212	83
0.150	79
0.075	73
0.065	71
0.046	68
0.034	63
0.024	60
0.018	58
0.013	56
0.0095	53
0.0068	50
0.0048	48
0.004	47
0.0034	46
0.0028	45
0.0025	43
0.0014	38



NOTES/REMARKS: -

Moisture Content 22.1% -2.36mm Soil Particle Density(t/m^3) 2.38

Sample/s supplied by the client

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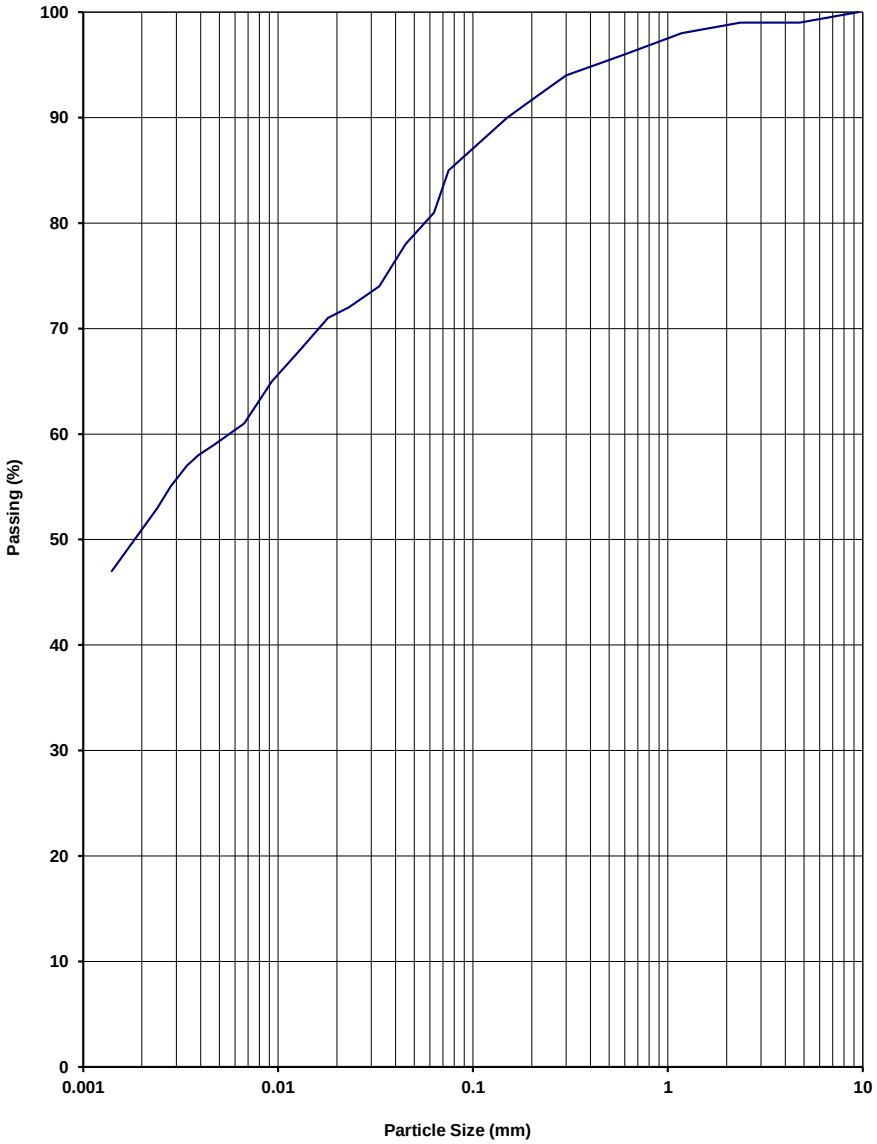
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Ph: +61 8 9258 8323

PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.1, 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	22071601-G
		Workorder No.	0010076
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	8/8/2022
		Report Date	29/8/2022
Project	2021090 - Eagle Downs Soils		
Client ID	7 - 2021090_C107	**Depth (m)**	Not Supplied

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	100
4.75	99
2.36	99
1.18	98
0.600	96
0.425	95
0.300	94
0.212	92
0.150	90
0.075	85
0.063	81
0.045	78
0.033	74
0.023	72
0.018	71
0.013	68
0.0093	65
0.0067	61
0.0047	59
0.0039	58
0.0034	57
0.0028	55
0.0024	53
0.0014	47



NOTES/REMARKS: -

Moisture Content 23.4% -2.36mm Soil Particle Density(t/m^3) 2.32

Sample/s supplied by the client

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Tested at Trilab Brisbane Laboratory

Authorised Signatory

Joshua Hawley

Laboratory No. 9926

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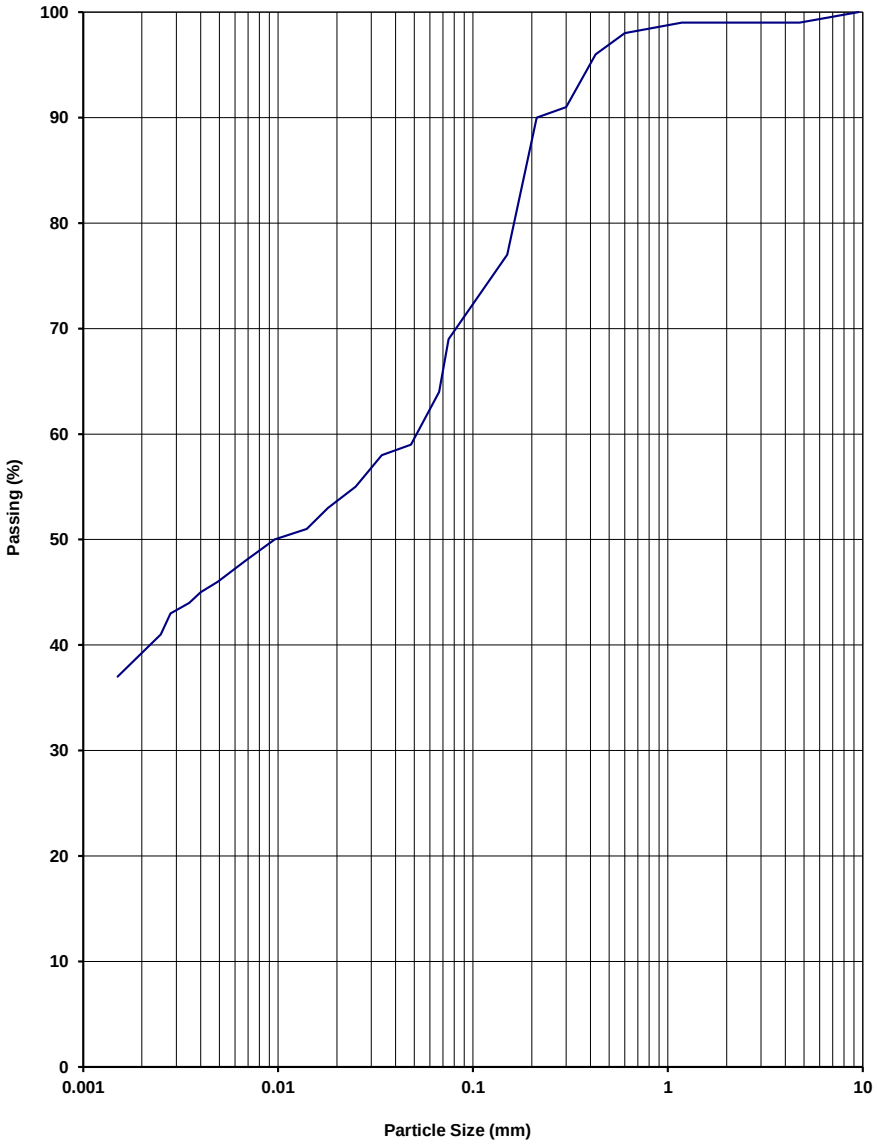
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Queens Park
WA 6107
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PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.1, 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	22071602-G
		Workorder No.	0010076
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	8/8/2022
		Report Date	29/8/2022
Project	2021090 - Eagle Downs Soils		
Client ID	8 - 2021090_C108	**Depth (m)**	Not Supplied

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	100
6.7	99
4.75	99
2.36	99
1.18	99
0.600	98
0.425	96
0.300	91
0.212	90
0.150	77
0.075	69
0.067	64
0.048	59
0.034	58
0.025	55
0.018	53
0.014	51
0.0096	50
0.0068	48
0.0049	46
0.004	45
0.0035	44
0.0028	43
0.0025	41
0.0015	37



NOTES/REMARKS: -

Moisture Content 16.6% -2.36mm Soil Particle Density(t/m^3) 2.38

Sample/s supplied by the client

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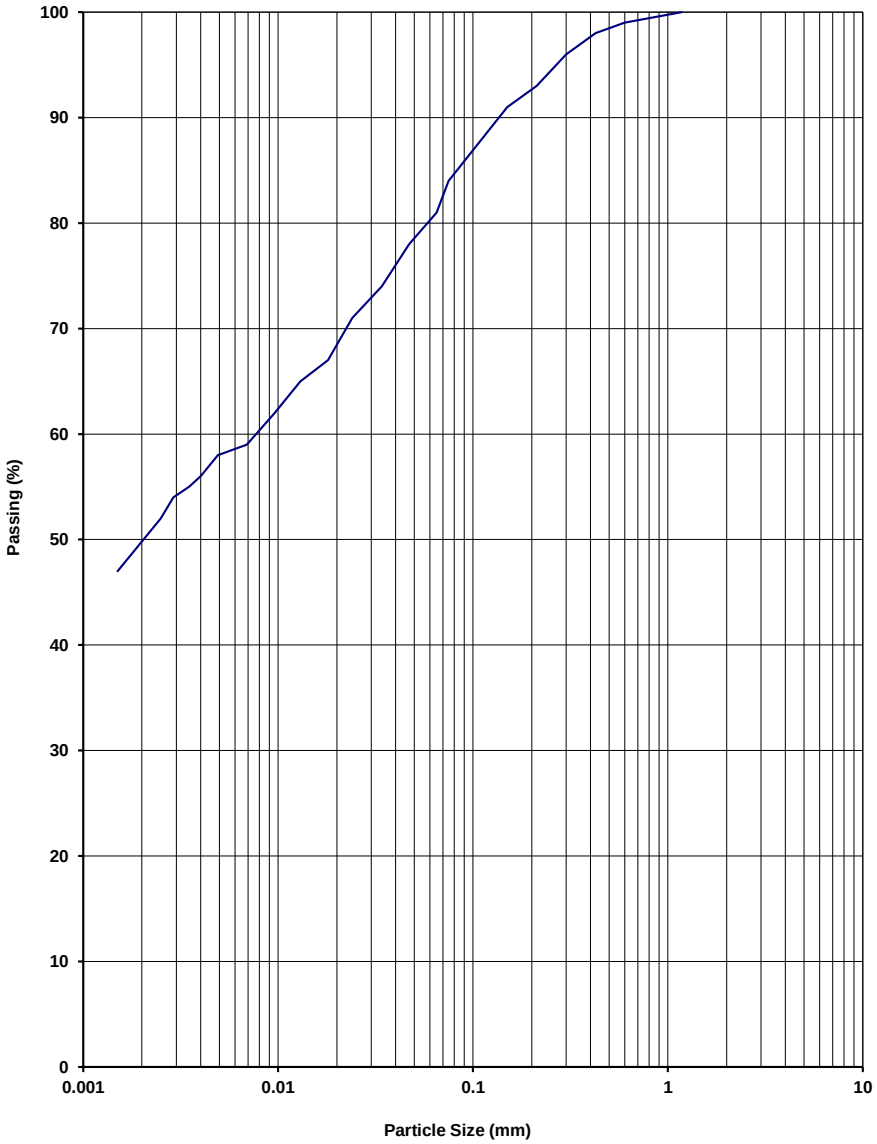
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WA 6107
Ph: +61 8 9258 8323

PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.1, 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	22071603-G
		Workorder No.	0010076
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	8/8/2022
		Report Date	29/8/2022
Project	2021090 - Eagle Downs Soils		
Client ID	9 - 2021090_C109	**Depth (m)**	Not Supplied

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	
4.75	
2.36	
1.18	100
0.600	99
0.425	98
0.300	96
0.212	93
0.150	91
0.075	84
0.065	81
0.047	78
0.034	74
0.024	71
0.018	67
0.013	65
0.0096	62
0.0069	59
0.0049	58
0.004	56
0.0035	55
0.0029	54
0.0025	52
0.0015	47



NOTES/REMARKS: -

Moisture Content 21.2% -2.36mm Soil Particle Density(t/m^3) 2.28

Sample/s supplied by the client

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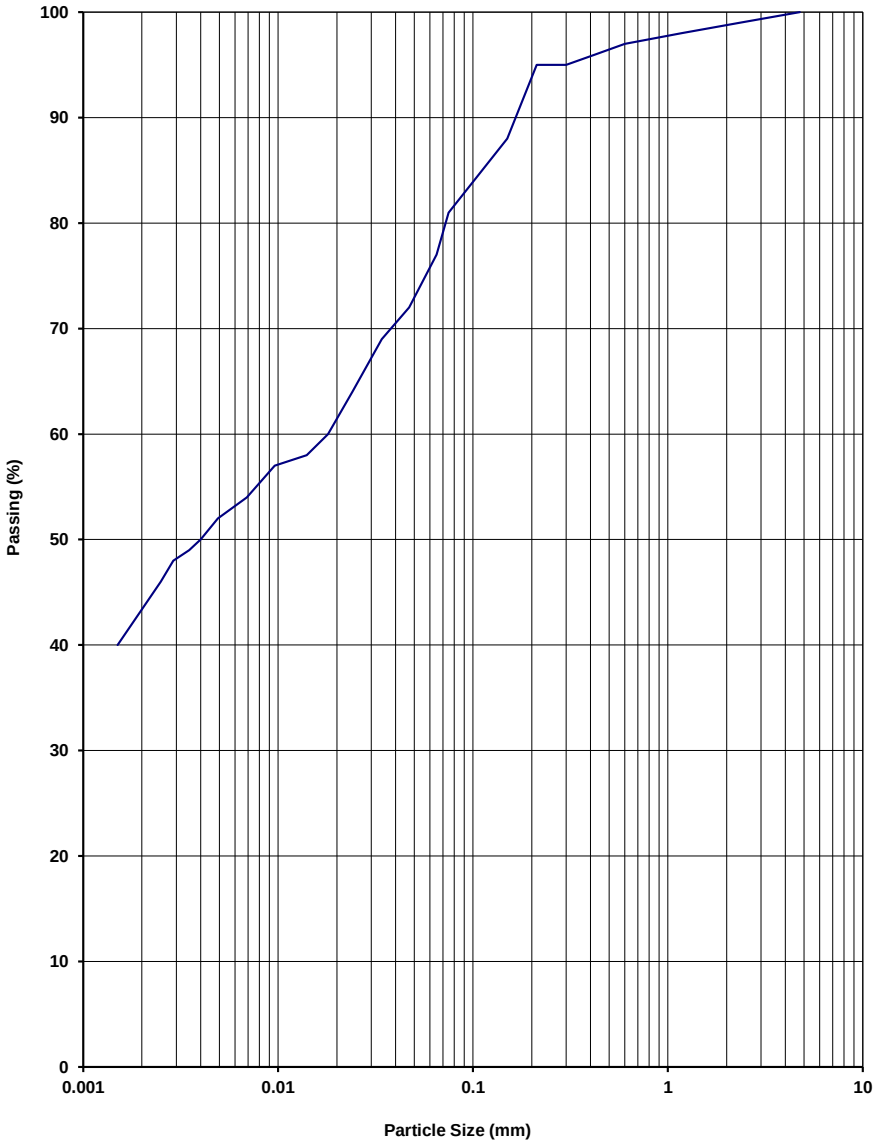
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WA 6107
Ph: +61 8 9258 8323

PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.1, 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	22071604-G
		Workorder No.	0010076
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	8/8/2022
		Report Date	29/8/2022
Project	2021090 - Eagle Downs Soils		
Client ID	10 - 2021090_C110	**Depth (m)**	Not Supplied

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	
4.75	100
2.36	99
1.18	98
0.600	97
0.425	96
0.300	95
0.212	95
0.150	88
0.075	81
0.065	77
0.047	72
0.034	69
0.024	64
0.018	60
0.014	58
0.0096	57
0.0069	54
0.0049	52
0.004	50
0.0035	49
0.0029	48
0.0025	46
0.0015	40



NOTES/REMARKS: -

Moisture Content 19.3% -2.36mm Soil Particle Density(t/m^3) 2.34

Sample/s supplied by the client

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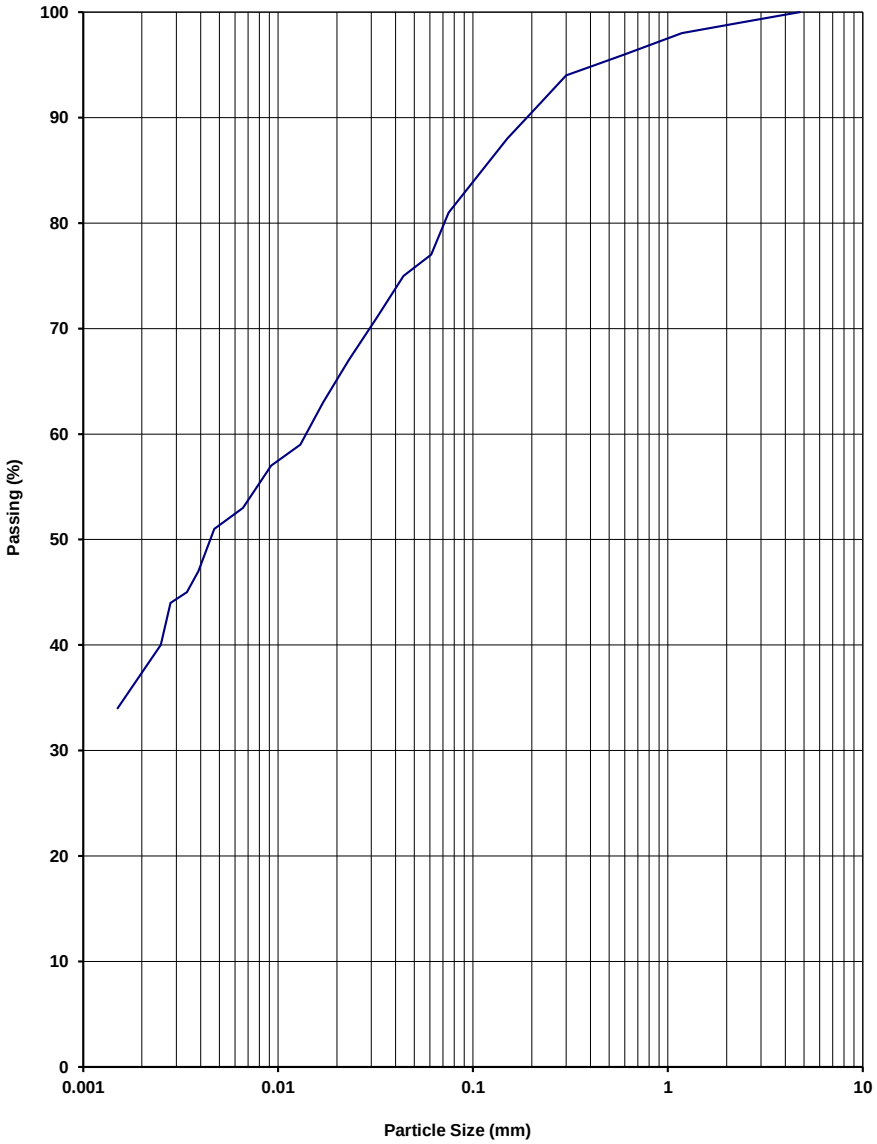
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Ph: +61 8 9258 8323

PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.1, 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	22071605-G
		Workorder No.	0010076
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	8/8/2022
		Report Date	29/8/2022
Project	2021090 - Eagle Downs Soils		
Client ID	11 - 2021090_C111	**Depth (m)**	Not Supplied

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	
4.75	100
2.36	99
1.18	98
0.600	96
0.425	95
0.300	94
0.212	91
0.150	88
0.075	81
0.061	77
0.044	75
0.032	71
0.023	67
0.017	63
0.013	59
0.0092	57
0.0066	53
0.0047	51
0.0039	47
0.0034	45
0.0028	44
0.0025	40
0.0015	34



NOTES/REMARKS: -

Moisture Content 18.7% -2.36mm Soil Particle Density(t/m^3) 2.38

Sample/s supplied by the client

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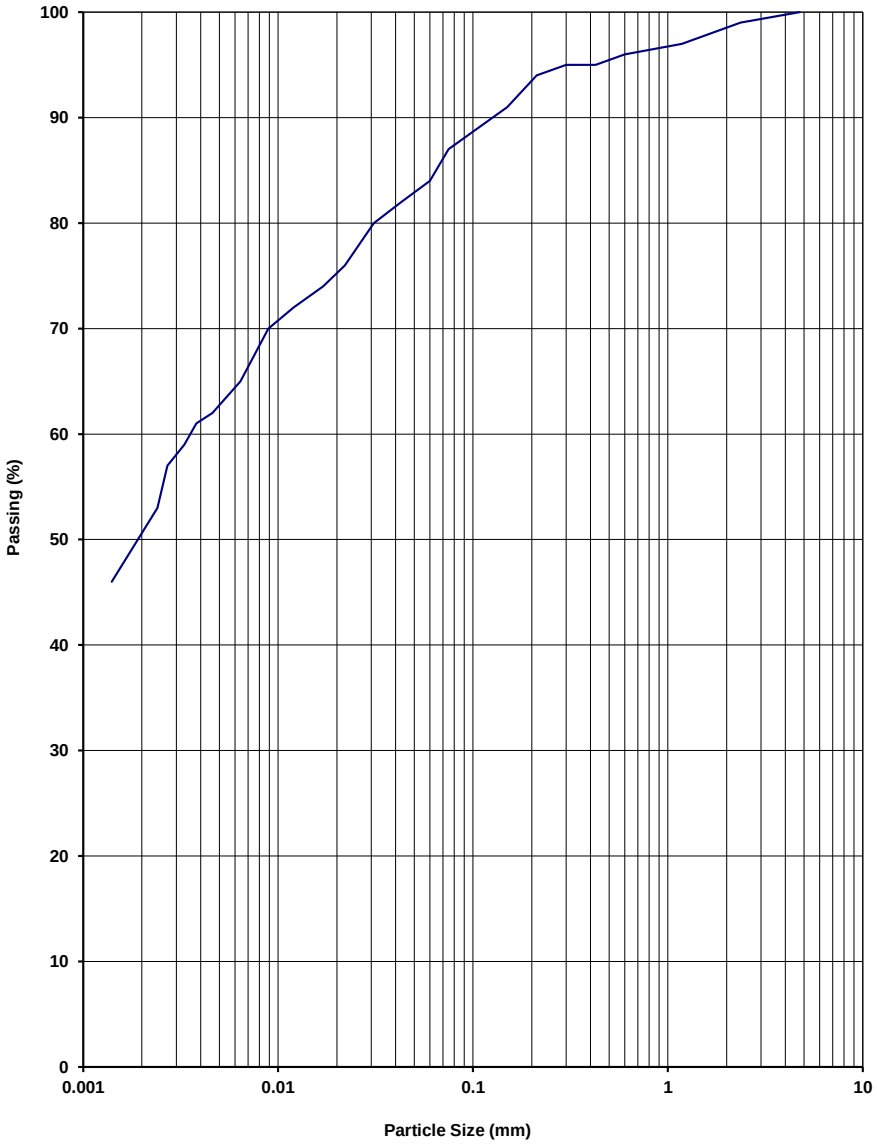
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Queens Park
WA 6107
Ph: +61 8 9258 8323

PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.1, 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	22071606-G
		Workorder No.	0010076
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	8/8/2022
		Report Date	29/8/2022
Project	2021090 - Eagle Downs Soils		
Client ID	12 - 2021090_C112	**Depth (m)**	Not Supplied

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	
4.75	100
2.36	99
1.18	97
0.600	96
0.425	95
0.300	95
0.212	94
0.150	91
0.075	87
0.06	84
0.043	82
0.031	80
0.022	76
0.017	74
0.012	72
0.0089	70
0.0064	65
0.0046	62
0.0038	61
0.0033	59
0.0027	57
0.0024	53
0.0014	46



NOTES/REMARKS: -

Moisture Content 26.6% -2.36mm Soil Particle Density(t/m^3) 2.37

Sample/s supplied by the client

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Attachment G: Levay and Co laboratory certificates

LEVAY & CO. ENVIRONMENTAL SERVICES

Water Quality, Water Treatment and Environmental Pollution Research Laboratories

Job No.
L&C-22-192

REPORT

QXRD Analysis of Three Soil Samples

RGS Job No. 2021090A
Purchase Order No. 2022037

Prepared for:

Dr. Alan M. Robertson,
Director – Principal Geochemist,
RGS Environmental Consultants Pty. Ltd.,
3/30 Lensworth Street,
Coopers Plain. QLD. 4108.

Prepared by:

George Levay,
Levay & Co. Environmental Services,
Unit 8, 62 – 64 West Avenue,
Edinburgh. SA. 5111.

Date: 1st September, 2022

Introduction

Levay & Co. Environmental Services received three samples (RGS Job No. 2021090A Eagle Downs) from RGS Environmental on the 23rd August, 2022 to determine their mineralogical content by (semi-) quantitative x-ray diffraction (QXRD) analysis. The sample details are provided in the table below.

Table 1. List of samples received for QXRD analysis

RGS Sample ID.	Levay & Co. ID.	Sample Description
2021090_0006	22-192-01	Soils
2021090-0010	22-192-02	Soils
2021090_0016	22-192-03	Soils

(Semi) - Quantitative X-Ray Diffraction (QXRD)

X-ray diffraction traces were obtained from the sample with a Panalytical Aeris Research Powder Diffractometer. Operating conditions were 40kV/15mA, Fe Kß filter, step scan 0.01/29 secs˚2Θ at, 1/2˚ divergence and a 1.0˚ ant-scatter slit. Scan range was 5° to 90° 2Θ. Phases were identified by computer search/match of the ICDD PDF4 2022 Database.

Quantitative results have been determined with full pattern Rietveld refinement software. Smectite clay has been identified from sedimented clay fraction samples and glycol intercalation.

Results

The results from QXRD analysis of these samples are shown in Table 2 below. Mineralisation includes silicate (quartz and albite) and clay (montmorillonite, kaolinite and illite), as the dominant phases. Sample ID 2021090_0016 also contains significant amount of carbonate (calcite).

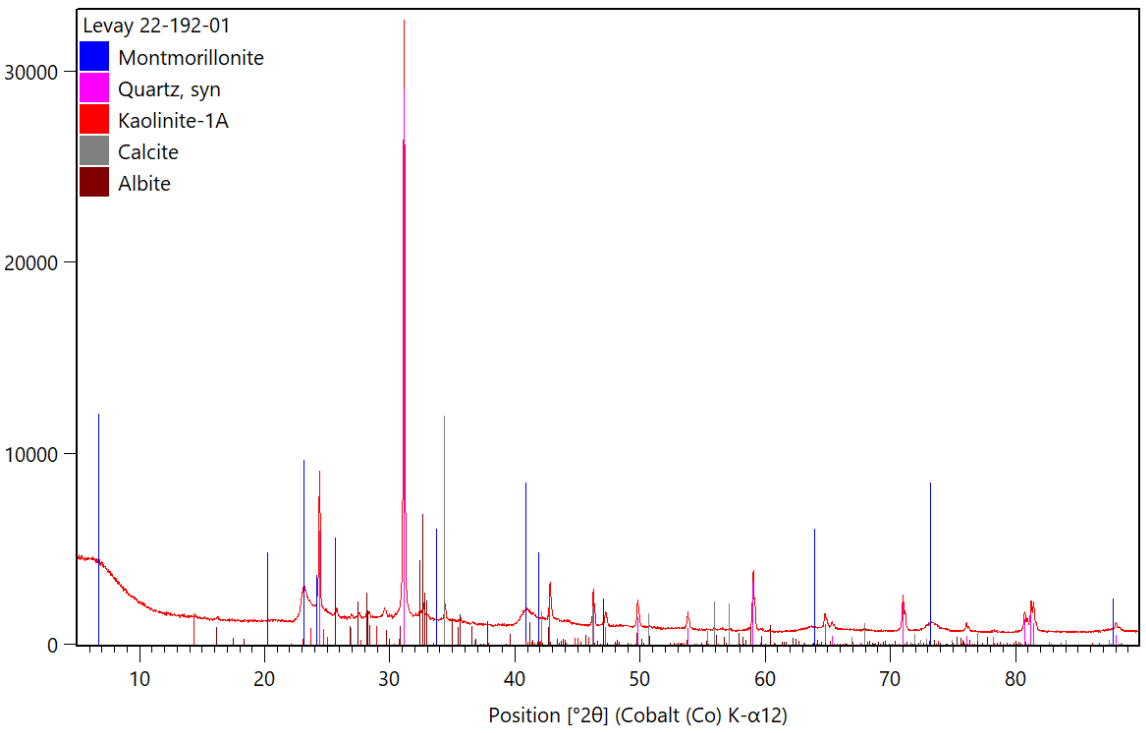
Table 2: QXRD results

Phase	2021090_0006 Weight %[1]	2021090_0010 Weight %[1]	2021090_0016 Weight %[1]
Quartz	47.1	46.6	36.9
Montmorillonite	35.8	31.1	24.5
Albite	7.5	12.2	7.7
Calcite	2.0	3.7	26.3
Kaolinite	2.5	3.2	2.2
Illite	5.0	2.9	2.4
Pyrite	0.1	0.3	ND[2]

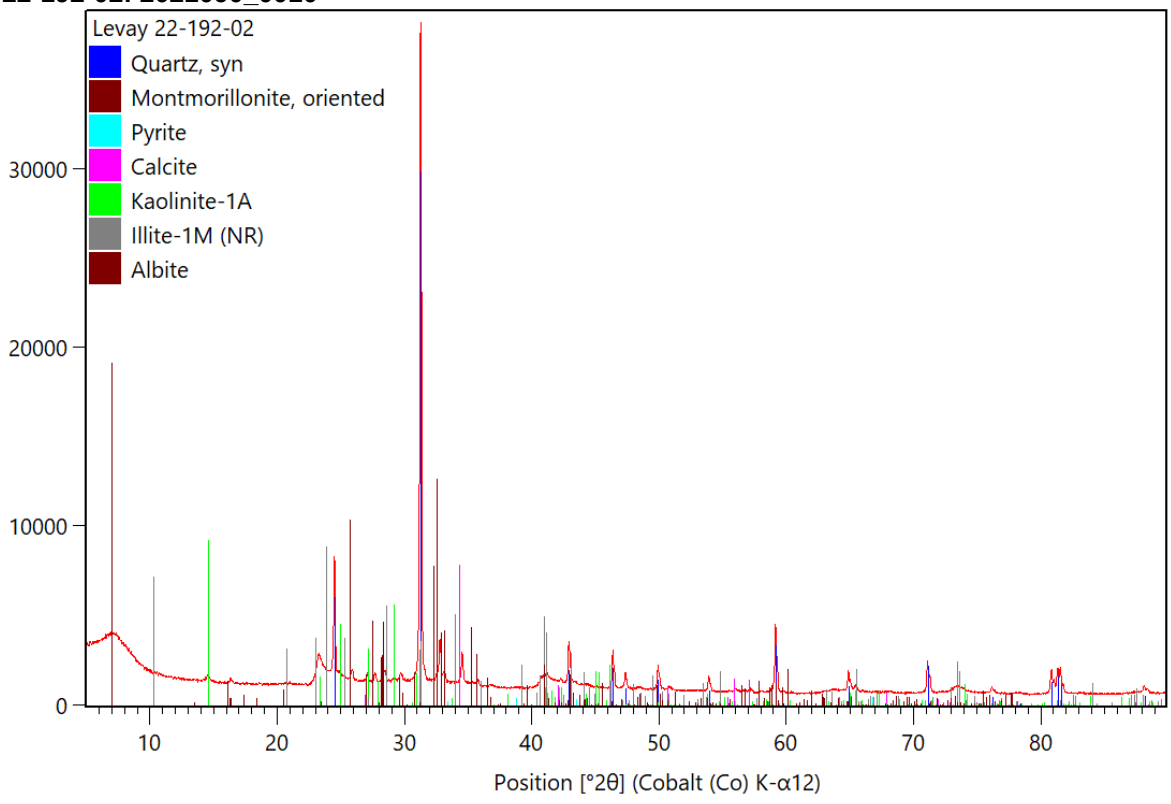
1 Semiquantitative Detection limit ~0.4 wt.%
2 ND = Non Detectable

Results Graphical – Phase ID

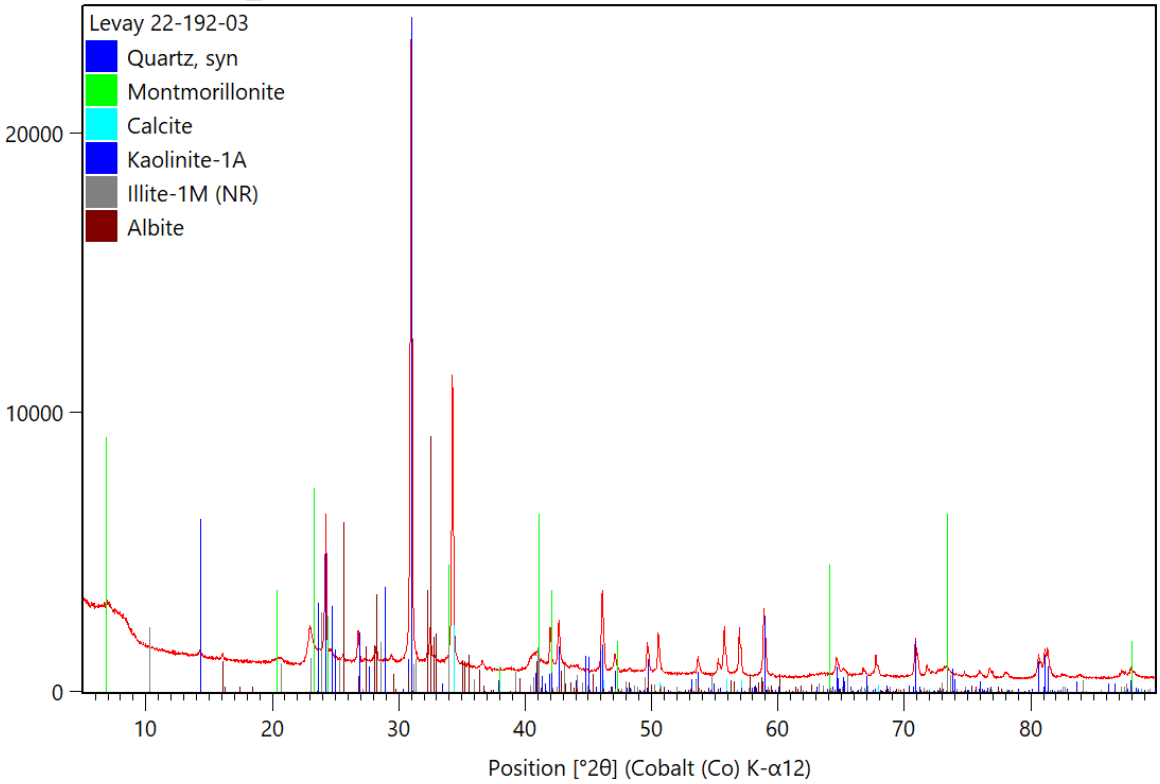
22-192-01: 2021090_0006



22-192-02: 2021090_0010

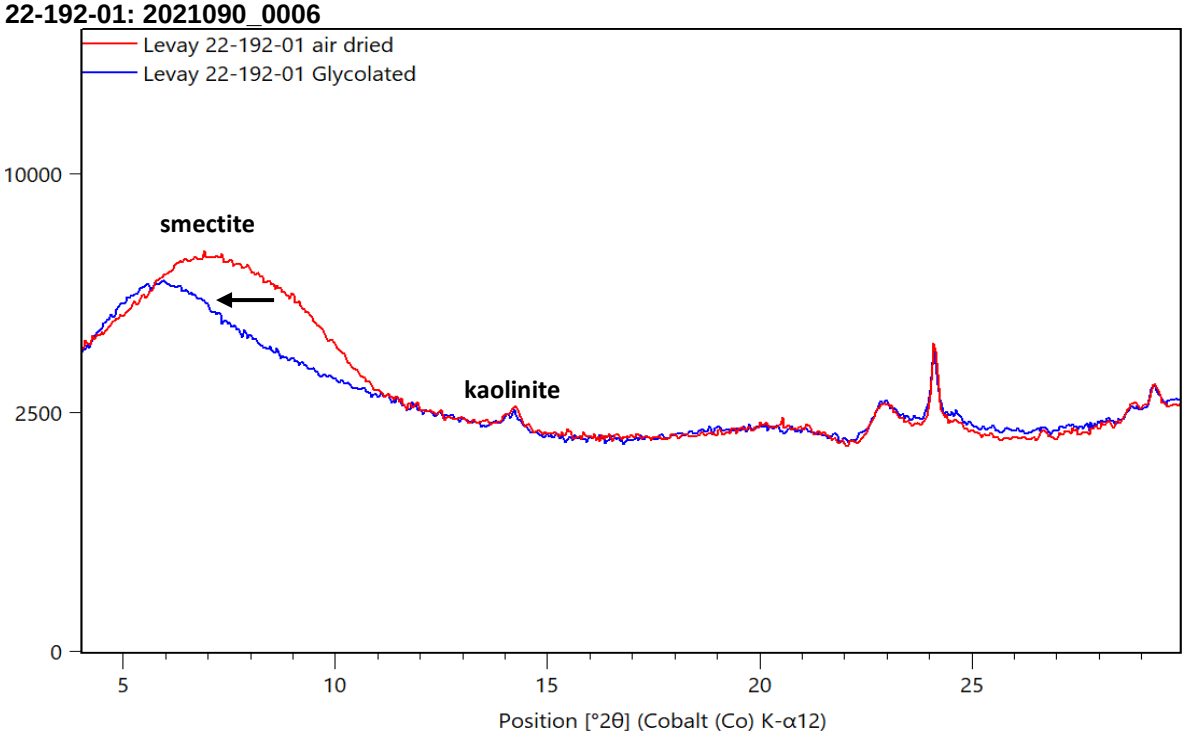


22-192-03: 2021090_0016



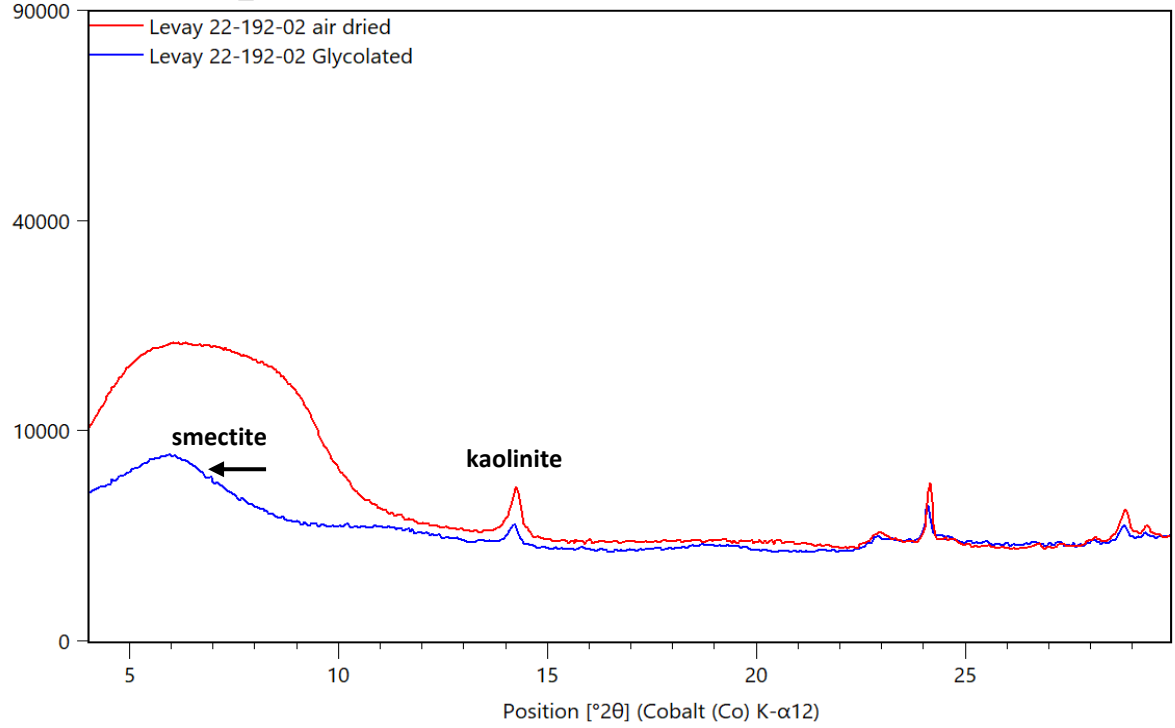
Sedimented and Glycol Treated Samples Results

22-192-01: 2021090_0006



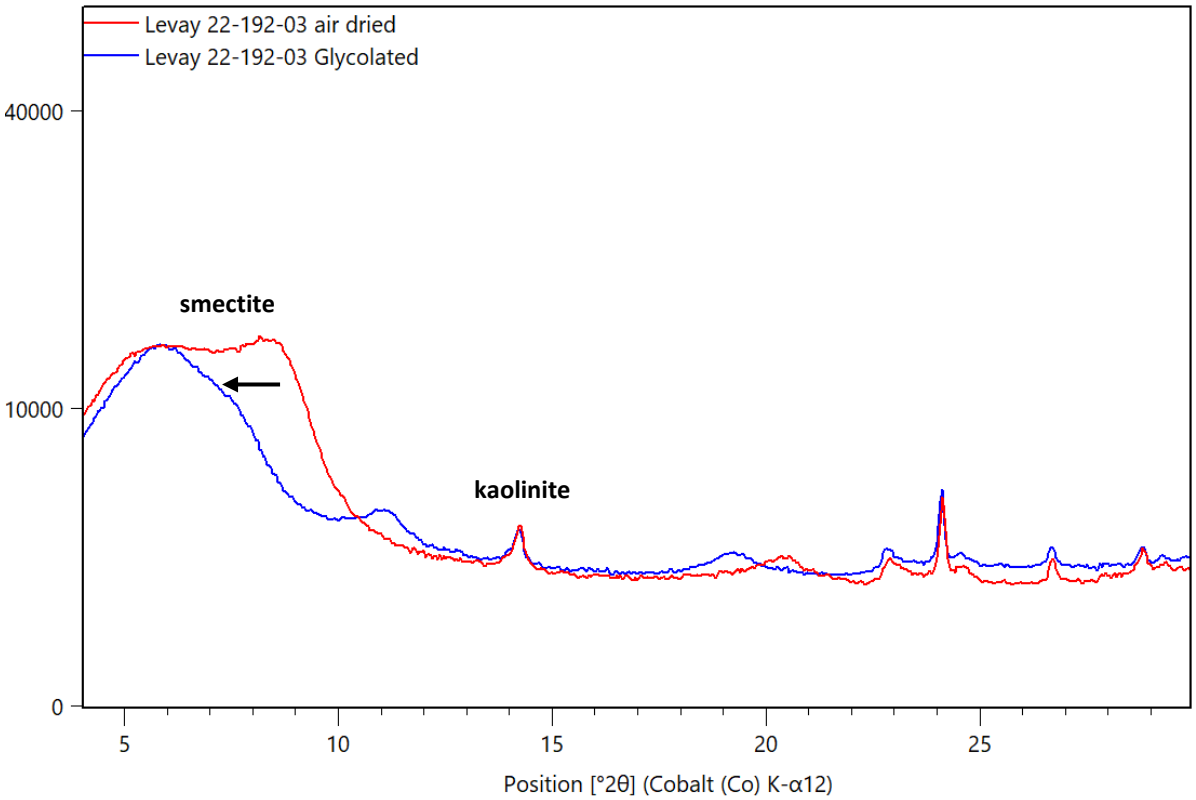
Traces obtained from sedimented air dried and glycolated sample mounts overlaid demonstrate the presence of smectite clay (likely montmorillonite).

22-192-02: 2021090_0010



Traces obtained from sedimented air dried and glycolated sample mounts overlaid demonstrate the presence of smectite clay (likely montmorillonite).

22-192-03: 2021090_0016



Traces obtained from sedimented air dried and glycolated sample mounts overlaid demonstrate the presence of smectite clay (likely montmorillonite).

Attachment H: Soil Water Group laboratory certificates

SOIL WATER ANALYSIS

TEST REPORT

45 Gladstone St
East Perth WA 6006
(08) 9228 3060
(08) 9228 3210
admin@soilwatergroup.com
www.soilwatergroup.com

Client: RGS Environmental Consultants
Client Contact: Melinda Hilton
Project: Eagle Downs Soils
Client Project #:: 2021090
SWA Job No.: JN0804
Date of Analysis: 5th - 30th September 2022
No. Samples Submitted: 12

Method:

- Pressure plate method used in accordance with McKenzie, N., Coughlan, K. and Cresswell, H. (2002). Soil Physical Measurement and Interpretation for Land Evaluation, CSIRO Publishing.
- Samples packed to a bulk density of 1.40 g/cm^3 on the pressure plates.
- Samples equilibrated for a 2 week period.

TEST RESULTS

SWA ID	Client ID	Volumetric Moisture Content (%; v/v)					Derived van Genuchten Parameters			
		0 kPa	10 kPa	33 kPa	100 kPa	1,500 kPa	α (1/cm)	N (-)	θs (cm^3/cm^3)	θr (cm^3/cm^3)
804-01	ME Comp 1	47.55	43.85	37.92	31.65	25.13	0.007	1.517	0.4748	0.2284
804-02	ME Comp 2	48.74	42.53	38.52	33.00	28.37	0.016	1.361	0.4868	0.2492
804-03	ME Comp 3	47.92	41.51	37.20	32.43	29.00	0.017	1.447	0.4788	0.2710
804-04	ME Comp 4	45.38	42.13	35.53	31.13	26.36	0.008	1.630	0.4544	0.2541
804-05	ME Comp 5	45.87	41.05	36.67	32.63	26.20	0.029	1.103	0.4602	0.0298
804-06	ME Comp 6	45.71	41.79	37.15	30.65	25.44	0.007	1.535	0.4551	0.2346
804-07	ME Comp 7	45.31	43.89	41.01	34.58	29.03	0.003	1.884	0.4499	0.2839
804-08	ME Comp 8	45.88	39.22	32.87	28.90	23.82	0.015	1.452	0.4589	0.2179
804-09	ME Comp 9	46.54	40.74	37.78	32.27	25.94	0.011	1.584	0.4659	0.2275
804-10	ME Comp 10	47.71	42.77	36.03	31.52	24.86	0.011	1.419	0.4777	0.2186

SWA ID	Client ID	Volumetric Moisture Content (%; v/v)					Derived van Genuchten Parameters			
		0 kPa	10 kPa	33 kPa	100 kPa	1,500 kPa	α (1/cm)	N (-)	θs (cm^3/cm^3)	θr (cm^3/cm^3)
804-11	ME Comp 11	45.80	39.56	35.76	27.95	22.97	0.011	1.413	0.4558	0.1953
804-12	ME Comp 12	46.59	43.24	37.41	32.54	28.17	0.007	1.626	0.4658	0.2714

APPROVED SIGNATURE FOR



Adam Pratt
Operations Manager



MINE WASTE AND
WATER MANAGEMENT

Appendix N. Baseline BioCondition Data

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-22, 07:57	**Assessor:** Bruce	**Site No:** 1

Coordinates: 0 m: -22.1745, 148.2111; **50 m:** -22.1746, 148.2116

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes:

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	0	na
	Tree species:		
	Non-native cover	15%	0%
50 X 10 m area	**Native shrub species richness**	1	na
	Shrub species: *Sida trichopoda*		
	Native grass species richness	10	11
	Grass species: *Dichanthium sericeum, Panicum queenslandicum, Aristida latifolia, Heteropogon contortus, Paspalidium globoideum, Enneapogon* sp., *Bothriochloa erianthoides, Eriochloa crebra, Panicum decompositum, Cenchrus ciliaris*, Melinis repens*, Iseilema vaginiflorum*		
	Native forb and other species richness	7	17
	Forb species: *Glycine* sp., *Parthenium hysterophorus*, Dianella nervosa, Cyperus* sp., *Indigofera linifolia, Malvastrum americanum var. americanum*, Pimelea haematostachya, Polymeria longifolia*		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	0%	na
	Average perennial grass cover	55%	43%
	Average organic litter cover	18%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



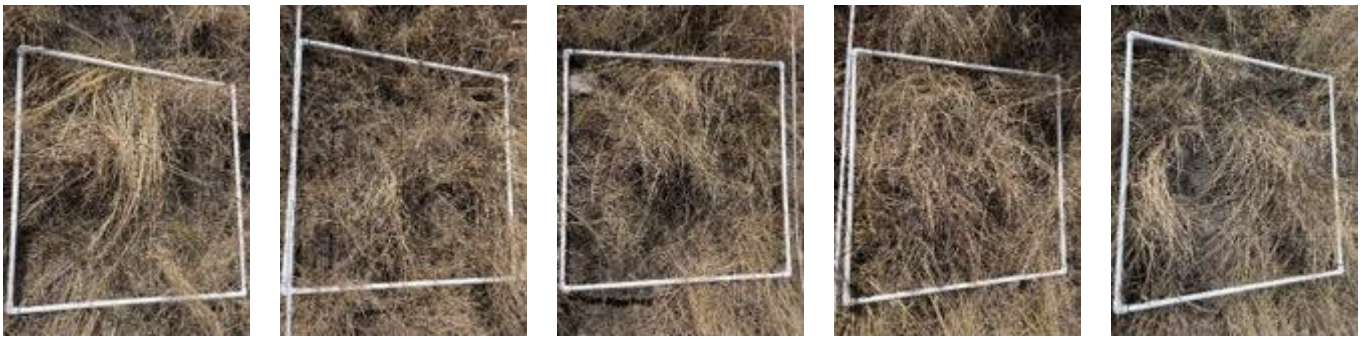
South photo



West photo



Spot photos



Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	7.5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	5
	(i) Native perennial grass cover	5	5
	(J) Litter cover	5	5
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = ≥30% to 75% remnant vegetation OR ≥10% to 30% remnant vegetation AND ≥30% regrowth.	5	4

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (22.5) +(16) / (30 + 20)

= 0.77

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 1 (11.8.11) is 0.77

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 7 *Dichanthium sericeum, Panicum queenslandicum, Aristida latifolia, Paspalidium globoideum, Bothriochloa erianthoides, Eriochloa crebra, Panicum decompositum*
% projective crown cover: 0	
% projective shrub cover: 0	
% projective cover non-woody introduced species: 5 - 29 %	
Patch size:	
Native tussocks: yes	

TEC Determination: good quality TEC

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-22, 09:25	**Assessor:** Bruce, Mick	**Site No:** 2

Coordinates: 0 m: -22.1756, 148.2225; **50 m:** -22.1754, 148.223

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes:

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	0	na
	Tree species:		
	Non-native cover	15%	0%
50 X 10 m area	**Native shrub species richness**	9	na
	Shrub species: *Sida trichopoda, Acacia excelsa* subsp. *excelsa, Eucalyptus orgadophila, Acacia salicina, Solanum nemophilum, Indigofera linifolia, Santalum lanceolatum, Alectryon oleifolius* subsp. *elongatus, Atalaya hemiglauca*		
	Native grass species richness	10	11
	Grass species: *Aristida latifolia, Bothriochloa bladhii, Enneapogon* sp., *Paspalidium globoideum, Iseilema vaginiflorum, Bothriochloa pertusa*, Eriochloa crebra, Panicum queenslandicum, Aristida leptopoda, Sporobolus elongatus, Bothriochloa pertusa*, Melinis repens*, Heteropogon contortus, Cenchrus ciliaris**		
	Native forb and other species richness	9	17
	Forb species: *Phyllanthus virgatus, Pimelea haematostachya, Malvastrum americanum var. americanum*, Parthenium hysterophorus*, Salsola australis, Glycine* sp., *Neptunia* sp., *Cyperus* sp., *Desmodium* sp., *Stylosanthes scabra*, Sida spinosa*, Crotalaria montana, Atriplex muelleri*		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	0.4%	na
	Average perennial grass cover	29.6%	43%
	Average organic litter cover	6.6%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



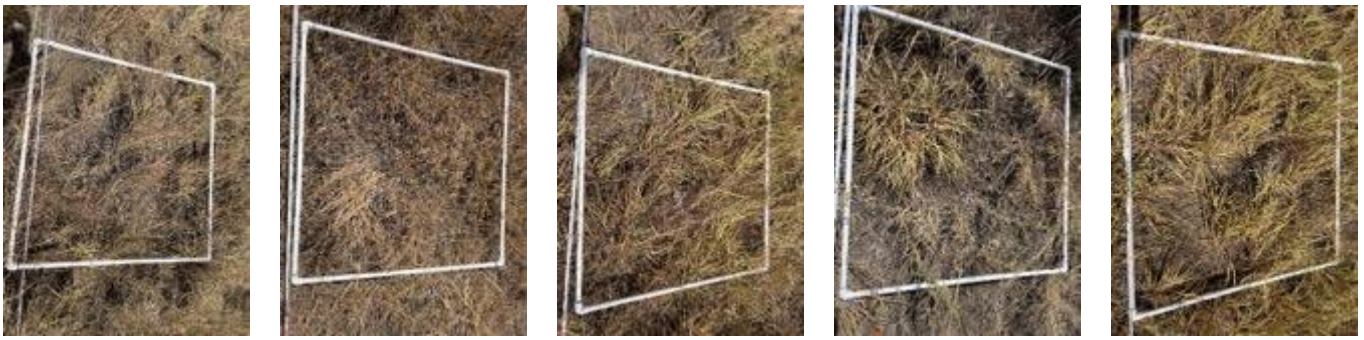
South photo



West photo



Spot photos



Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	7.5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	5
	(i) Native perennial grass cover	5	3
	(J) Litter cover	5	5
2. Landscape attributes	**(k) Patch size =** ≥25 – 100 ha remnant OR ≥25 – 200 ha remnant and regrowth OR >25 – 200 ha regrowth	10	5
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = ≥30% to 75% remnant vegetation OR ≥10% to 30% remnant vegetation AND ≥30% regrowth.	5	4

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (20.5) +(11) / (30 + 20)

= 0.63

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 2 (11.8.11) is 0.63

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 5 *Aristida latifolia, Paspalidium globoideum, Eriochloa crebra, Panicum queenslandicum, Aristida leptopoda*
% projective crown cover: 0	
% projective shrub cover: 0.4	
% projective cover non-woody introduced species: 5 - 29 %	
Patch size:	
Native tussocks: yes	

TEC Determination: good quality TEC

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-22, 11:01	**Assessor:** Bruce, Mick	**Site No:** 3

Coordinates: 0 m: -22.1766, 148.2284; **50 m:** -22.177, 148.2284

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes:

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	0	na
	Tree species:		
	Non-native cover	65%	0%
50 X 10 m area	**Native shrub species richness**	2	na
	Shrub species: *Vachellia farnesiana*, Sclerolaena muricata, Grewia savannicola*		
	Native grass species richness	7	11
	Grass species: *Aristida leptopoda, Eriochloa crebra, Bothriochloa bladhii, Cenchrus ciliaris*, Bothriochloa pertusa*, Iseilema vaginiflorum, Astrebla lappacea, Panicum queenslandicum, Heteropogon contortus*		
	Native forb and other species richness	9	17
	Forb species: *Crotalaria montana, Parthenium hysterophorus*, Neptunia gracilis forma gracilis, Boerhavia* sp.*, Solanum nemophilum, Sida* sp.*, Indigofera linifolia, Rhynchosia minima var. minima, Cyperus* sp.*, Tribulopis* sp.*, Malvastrum americanum var. americanum**		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	0%	na
	Average perennial grass cover	18.8%	43%
	Average organic litter cover	4.4%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



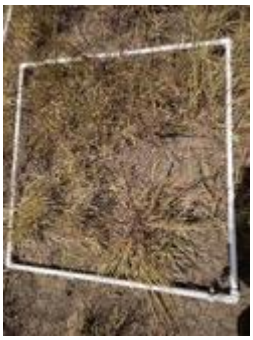
West photo



Spot photos







Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 2.5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	0
	(i) Native perennial grass cover	5	1
	(J) Litter cover	5	3
2. Landscape attributes	**(k) Patch size =** ≥25 – 100 ha remnant OR ≥25 – 200 ha remnant and regrowth OR >25 – 200 ha regrowth	10	5
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = ≥30% to 75% remnant vegetation OR ≥10% to 30% remnant vegetation AND ≥30% regrowth.	5	4

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (9) +(11) / (30 + 20)

= 0.4

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 3 (11.8.11) is 0.4

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 5 *Aristida leptopoda, Aristida latifolia, Eriochloa crebra, Astrebla lappacea, Panicum queenslandicum*
% projective crown cover: 0	
% projective shrub cover: 0	
% projective cover non-woody introduced species: >= 30 %	
Patch size:	
Native tussocks: yes	

TEC Determination: does not meet TEC condition thesholds

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-22, 12:11	**Assessor:** Bruce, Mick	**Site No:** 4

Coordinates: 0 m: -22.1862, 148.2248; **50 m:** -22.1864, 148.2243

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes:

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	0	na
	Tree species:		
	Non-native cover	40%	0%
50 X 10 m area	**Native shrub species richness**	3	na
	Shrub species: *Alectryon diversifolius, Capparis lasiantha, Capparis anomala*		
	Native grass species richness	9	11
	Grass species: *Panicum queenslandicum, Heteropogon contortus, Eriochloa crebra, Cenchrus ciliaris*, Bothriochloa pertusa*, Bothriochloa bladhii, Astrebla elymoides, Brachyachne convergens, Paspalidium globoideum, Iseilema vaginiflorum, Dichanthium setosum*		
	Native forb and other species richness	10	17
	Forb species: *Neptunia gracilis forma gracilis, Crotalaria montana, Atriplex muelleri, Flemingia parviflora, Leichhardtia viridiflora* subsp. *viridiflora, Portulaca oleracea*, Boerhavia* sp., *Phyllanthus virgatus, Rhynchosia minima, Malvastrum americanum var. americanum*, Glycine* sp., *Parthenium hysterophorus*, Abutilon guineense**		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	1.2%	na
	Sub-canopy cover	0%	na
	Shrub cover	1.2%	na
	Average perennial grass cover	2.4%	43%
	Average organic litter cover	5%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos







Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 2.5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	3
	(i) Native perennial grass cover	5	0
	(J) Litter cover	5	3
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = ≥30% to 75% remnant vegetation OR ≥10% to 30% remnant vegetation AND ≥30% regrowth.	5	4

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (11) +(16) / (30 + 20)

= 0.54

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 4 (11.8.11) is 0.54

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 4 *Panicum queenslandicum, Eriochloa crebra, Astrebla elymoides, Paspalidium globoideum*
% projective crown cover: 1.2	
% projective shrub cover: 1.2	
% projective cover non-woody introduced species: >= 30 %	
Patch size:	
Native tussocks: yes	

TEC Determination: does not meet TEC condition thesholds

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-22, 13:49	**Assessor:** Bruce, Mick	**Site No:** 5

Coordinates: 0 m: -22.1934, 148.2251; **50 m:** -22.1938, 148.2252

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes:

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	0	na
	Tree species:		
	Non-native cover	40%	0%
50 X 10 m area	**Native shrub species richness**	1	na
	Shrub species: *Atalaya hemiglauca, Vachellia farnesiana*, Stylosanthes scabra**		
	Native grass species richness	12	11
	Grass species: *Cenchrus ciliaris*, Bothriochloa pertusa*, Aristida latifolia, Heteropogon contortus, Eriochloa crebra, Panicum queenslandicum, Indigofera linifolia, Enneapogon* sp., *Iseilema vaginiflorum, Bothriochloa bladhii, Themeda triandra, Dichanthium sericeum, Astrebla elymoides*		
	Native forb and other species richness	11	17
	Forb species: *Flemingia parviflora, Minuria* sp., *Enchylaena tomentosa var. tomentosa, Neptunia gracilis forma gracilis, Crotalaria montana, Commelina lanceolata, Boerhavia dominii, Portulaca oleracea*, Parthenium hysterophorus*, Cyperus* sp., *Calotis cuneata, Sida spinosa*, Phyllanthus virgatus, Eryngium* sp.		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	0%	na
	Average perennial grass cover	15.8%	43%
	Average organic litter cover	9.4%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos







Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	7.5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	3
	(i) Native perennial grass cover	5	1
	(J) Litter cover	5	5
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = ≥30% to 75% remnant vegetation OR ≥10% to 30% remnant vegetation AND ≥30% regrowth.	5	4

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (16.5) +(16) / (30 + 20)

= 0.65

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 5 (11.8.11) is 0.65

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 6 *Aristida latifolia, Eriochloa crebra, Panicum queenslandicum, Dichanthium sericeum, Astrebla elymoides, Aristida leptopoda*
% projective crown cover: 0	
% projective shrub cover: 0	
% projective cover non-woody introduced species: >= 30 %	
Patch size:	
Native tussocks: yes	

TEC Determination: does not meet TEC condition thesholds

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-22, 15:00	**Assessor:** Bruce, Mick	**Site No:** 6
Coordinates: 0 m: -22.2002, 148.2276; **50 m:** -22.2, 148.2272		
Verified RE: 11.8.11 VM status: Of concern, BD status: Of concern		
Benchmark available? yes		
Notes:		

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	0	na
	Tree species:		
	Non-native cover	9%	0%
50 X 10 m area	**Native shrub species richness**	2	na
	Shrub species: *Archidendropsis basaltica, Ehretia membranifolia*		
	Native grass species richness	10	11
	Grass species: *Aristida latifolia, Panicum queenslandicum, Themeda triandra, Heteropogon contortus, Enneapogon* sp.*, Cenchrus ciliaris*, Iseilema vaginiflorum, Aristida leptopoda, Eriochloa crebra, Bothriochloa bladhii, Bothriochloa pertusa**		
	Native forb and other species richness	8	17
	Forb species: *Parthenium hysterophorus*, Glycine* sp.*, Neptunia gracilis forma gracilis, Rhynchosia minima var. minima, Minuria* sp.*, Portulaca oleracea*, Atriplex muelleri, Indigofera linifolia, Dianella nervosa, Cyperus* sp.		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	3.2%	na
	Average perennial grass cover	36%	43%
	Average organic litter cover	9.4%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos



Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	7.5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	5
	(i) Native perennial grass cover	5	3
	(J) Litter cover	5	5
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = ≥30% to 75% remnant vegetation OR ≥10% to 30% remnant vegetation AND ≥30% regrowth.	5	4

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (20.5) +(16) / (30 + 20)

= 0.73

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 6 (11.8.11) is 0.73

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 4 *Aristida latifolia, Panicum queenslandicum, Aristida leptopoda, Eriochloa crebra*
% projective crown cover: 0	
% projective shrub cover: 3.2	
% projective cover non-woody introduced species: 5 - 29 %	
Patch size:	
Native tussocks: yes	

TEC Determination: good quality TEC

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-22, 16:05	**Assessor:** Bruce, Mick	**Site No:** 7

Coordinates: 0 m: -22.168, 148.2016; **50 m:** -22.1681, 148.2012

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes:

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	0	na
	Tree species:		
	Non-native cover	20%	0%
50 X 10 m area	**Native shrub species richness**	2	na
	Shrub species: *Vachellia farnesiana*, Atalaya hemiglauca, Ventilago viminalis*		
	Native grass species richness	7	11
	Grass species: *Aristida latifolia, Eriochloa crebra, Bothriochloa bladhii, Aristida leptopoda, Heteropogon contortus, Cenchrus ciliaris*, Enneapogon* sp.*, Panicum queenslandicum*		
	Native forb and other species richness	7	17
	Forb species: *Glycine* sp.*, Dianella nervosa, Parthenium hysterophorus*, Neptunia gracilis forma gracilis, Brunoniella australis, Malvastrum americanum var. americanum*, Indigofera linifolia, Oxalis perennans, Lotus australis*		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	0.68%	na
	Average perennial grass cover	43.6%	43%
	Average organic litter cover	9.4%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos







Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 2.5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	5
	(i) Native perennial grass cover	5	5
	(J) Litter cover	5	5
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = >75% remnant vegetation.	5	5

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (20) +(17) / (30 + 20)

= 0.74

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 7 (11.8.11) is 0.74

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 4 *Aristida latifolia, Eriochloa crebra, Aristida leptopoda, Panicum queenslandicum*
% projective crown cover: 0	
% projective shrub cover: 0.68	
% projective cover non-woody introduced species: 5 - 29 %	
Patch size:	
Native tussocks: yes	

TEC Determination: good quality TEC

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-23, 06:53	**Assessor:** Bruce, Mick	**Site No:** 8

Coordinates: 0 m: -22.2043, 148.2429; **50 m:** -22.2046, 148.2425

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes:

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	1	na
	Tree species: *Atalaya hemiglauca*		
	Non-native cover	35%	0%
50 X 10 m area	**Native shrub species richness**	0	na
	Shrub species:		
	Native grass species richness	8	11
	Grass species: *Eriochloa crebra, Aristida latifolia, Bothriochloa bladhii, Cenchrus ciliaris*, Panicum queenslandicum, Themeda triandra, Aristida leptopoda, Enneapogon* sp.*, Heteropogon contortus, Bothriochloa pertusa**		
	Native forb and other species richness	10	17
	Forb species: *Parthenium hysterophorus*, Salsola australis, Lomandra multiflora, Dianella nervosa, Glycine clandestina var. clandestina, Neptunia gracilis forma gracilis, Portulaca oleracea*, Pimelea haematostachya, Cyperus* sp.*, Vachellia farnesiana*, Cyperus* sp.*, Stylosanthes scabra*, Flemingia parviflora, Indigofera linifolia*		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	0%	na
	Average perennial grass cover	14%	43%
	Average organic litter cover	17%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos



Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 2.5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	3
	(i) Native perennial grass cover	5	1
	(J) Litter cover	5	5
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along 50% to 75% of its perimeter.	5	4
	(m) Context = ≥30% to 75% remnant vegetation OR ≥10% to 30% remnant vegetation AND ≥30% regrowth.	5	4

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (14) +(18) / (30 + 20)

= 0.64

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 8 (11.8.11) is 0.64

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 4 *Eriochloa crebra, Aristida latifolia, Panicum queenslandicum, Aristida leptopoda*
% projective crown cover: 0	
% projective shrub cover: 0	
% projective cover non-woody introduced species: 5 - 29 %	
Patch size:	
Native tussocks: yes	

TEC Determination: good quality TEC

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-23, 07:54	**Assessor:** Bruce, Mick	**Site No:** 9

Coordinates: 0 m: -22.2078, 148.2413; **50 m:** -22.2078, 148.2413

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes:

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	0	na
	Tree species:		
	Non-native cover	15%	0%
50 X 10 m area	**Native shrub species richness**	0	na
	Shrub species:		
	Native grass species richness	11	11
	Grass species: *Panicum queenslandicum, Themeda triandra, Aristida leptopoda, Aristida latifolia, Brachyachne convergens, Melinis repens*, Paspalidium globoideum, Cenchrus ciliaris*, Iseilema vaginiflorum, Bothriochloa bladhii, Dichanthium sericeum* subsp. *sericeum, Chrysopogon fallax, Eriochloa crebra*		
	Native forb and other species richness	7	17
	Forb species: *Parthenium hysterophorus*, Neptunia gracilis forma gracilis, Glycine clandestina var. clandestina, Sida trichopoda, Pimelea haematostachya, Cyperus* sp.*, Vachellia farnesiana*, Lomandra multiflora, Rhynchosia minima var. minima*		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	0%	na
	Average perennial grass cover	28.4%	43%
	Average organic litter cover	10%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos







Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	7.5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	5
	(i) Native perennial grass cover	5	3
	(J) Litter cover	5	5
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along 50% to 75% of its perimeter.	5	4
	(m) Context = ≥30% to 75% remnant vegetation OR ≥10% to 30% remnant vegetation AND ≥30% regrowth.	5	4

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (20.5) +(18) / (30 + 20)

= 0.77

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 9 (11.8.11) is 0.77

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 5 *Panicum queenslandicum, Aristida leptopoda, Aristida latifolia, Paspalidium globoideum, Eriochloa crebra*
% projective crown cover: 0	
% projective shrub cover: 0	
% projective cover non-woody introduced species: 5 - 29 %	
Patch size:	
Native tussocks: yes	

TEC Determination: good quality TEC

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-23, 09:56	**Assessor:** Bruce, Mick	**Site No:** 10

Coordinates: 0 m: -22.1928, 148.2087; **50 m:** -22.1932, 148.2087

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes: Some regrowth… potentially, grassland patch smaller then mapped

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	0	na
	Tree species:		
	Non-native cover	5%	0%
50 X 10 m area	**Native shrub species richness**	3	na
	Shrub species: *Capparis lasiantha, Capparis mitchellii, Acacia harpophylla, Vachellia farnesiana**		
	Native grass species richness	12	11
	Grass species: *Panicum queenslandicum, Eriochloa crebra, Heteropogon contortus, Cenchrus ciliaris*, Aristida leptopoda, Aristida latifolia, Bothriochloa bladhii, Dichanthium sericeum, Themeda triandra, Melinis repens*, Enneapogon* sp., *Digitaria* sp., *Chrysopogon fallax, Panicum decompositum*		
	Native forb and other species richness	7	17
	Forb species: *Rhynchosia minima, Dianella nervosa, Glycine clandestina var. clandestina, Parthenium hysterophorus*, Neptunia gracilis forma gracilis, Indigofera linifolia, Brunoniella australis, Malvastrum americanum var. americanum**		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	3.1%	na
	Average perennial grass cover	54%	43%
	Average organic litter cover	20%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos







Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	7.5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	5
	(i) Native perennial grass cover	5	5
	(J) Litter cover	5	5
2. Landscape attributes	**(k) Patch size =** ≥5 – 25 ha remnant AND/OR regrowth.	10	2
	(l) Connectedness = Not connected using any of the below descriptions.	5	0
	(m) Context = <10% remnant vegetation AND <30% native non-remnant vegetation (regrowth).	5	0

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (22.5) +(2) / (30 + 20)

= 0.49

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 10 (11.8.11) is 0.49

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 6 *Panicum queenslandicum, Eriochloa crebra, Aristida leptopoda, Aristida latifolia, Dichanthium sericeum, Panicum decompositum*
% projective crown cover: 0	
% projective shrub cover: 3.1	
% projective cover non-woody introduced species: 5 - 29 %	
Patch size: 1- 4.9 ha	
Native tussocks: yes	

TEC Determination: does not meet TEC condition thesholds

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-23, 11:23	**Assessor:** Bruce, Mick	**Site No:** 11
Coordinates: 0 m: -22.1647, 148.1939; **50 m:** -22.1643, 148.1937		
Verified RE: 11.8.11 VM status: Of concern, BD status: Of concern		
Benchmark available? yes		
Notes:		

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	0	na
	Tree species:		
	Non-native cover	3%	0%
50 X 10 m area	**Native shrub species richness**	2	na
	Shrub species: *Vachellia farnesiana*, Sida trichopoda, Grewia savannicola*		
	Native grass species richness	7	11
	Grass species: *Bothriochloa bladhii, Aristida latifolia, Eriochloa crebra, Panicum decompositum, Dichanthium sericeum, Heteropogon contortus, Themeda triandra, Cenchrus ciliaris**		
	Native forb and other species richness	4	17
	Forb species: *Glycine clandestina var. clandestina, Nyssanthes* sp.*, Flemingia parviflora, Malvastrum americanum var. americanum*, Parthenium hysterophorus*, Rhynchosia minima*		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	0%	na
	Average perennial grass cover	62%	43%
	Average organic litter cover	19.6%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos







Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	2.5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 2.5		
	Forb species richness: 0		
	(h) Non-native plant cover	10	10
	(i) Native perennial grass cover	5	5
	(J) Litter cover	5	5
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = >75% remnant vegetation.	5	5

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (22.5) +(17) / (30 + 20)

= 0.79

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 11 (11.8.11) is 0.79

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 4 *Aristida latifolia, Eriochloa crebra, Panicum decompositum, Dichanthium sericeum*
% projective crown cover: 0	
% projective shrub cover: 0	
% projective cover non-woody introduced species: 0 - 4.9 %	
Patch size:	
Native tussocks: yes	

TEC Determination: best quality TEC

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-23, 12:14	**Assessor:** Bruce, Mick	**Site No:** 12

Coordinates: 0 m: -22.1624, 148.1846; **50 m:** -22.1621, 148.1842

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes:

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	0	na
	Tree species:		
	Non-native cover	4%	0%
50 X 10 m area	**Native shrub species richness**	3	na
	Shrub species: *Vachellia farnesiana*, Owenia acidula, Sida trichopoda, Atalaya hemiglauca*		
	Native grass species richness	8	11
	Grass species: *Aristida latifolia, Bothriochloa bladhii, Eriochloa crebra, Panicum decompositum, Aristida leptopoda, Themeda triandra, Heteropogon contortus, Bothriochloa pertusa*, Cenchrus ciliaris*, Enneapogon* sp.		
	Native forb and other species richness	7	17
	Forb species: *Parthenium hysterophorus*, Sida* sp., *Eremophila debilis, Pimelea haematostachya, Rhynchosia minima, Glycine clandestina var. clandestina, Neptunia gracilis forma gracilis, Sclerolaena muricata, Malvastrum americanum var. americanum**		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	0%	na
	Average perennial grass cover	40.2%	43%
	Average organic litter cover	16%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos



Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 2.5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	10
	(i) Native perennial grass cover	5	5
	(J) Litter cover	5	5
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = >75% remnant vegetation.	5	5

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (25) +(17) / (30 + 20)

= 0.84

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 12 (11.8.11) is 0.84

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 4 *Aristida latifolia, Eriochloa crebra, Panicum decompositum, Aristida leptopoda*
% projective crown cover: 0	
% projective shrub cover: 0	
% projective cover non-woody introduced species: 0 - 4.9 %	
Patch size:	
Native tussocks: yes	

TEC Determination: best quality TEC

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-23, 13:40	**Assessor:** Bruce, Mick	**Site No:** 13

Coordinates: 0 m: -22.1575, 148.1786; **50 m:** -22.1572, 148.1782

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes: Indicator species present but very sparse. B. bladhii very dominant

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	0	na
	Tree species:		
	Non-native cover	25%	0%
50 X 10 m area	**Native shrub species richness**	1	na
	Shrub species: *Sida trichopoda*		
	Native grass species richness	7	11
	Grass species: *Bothriochloa bladhii, Cenchrus ciliaris*, Sporobolus elongatus, Aristida latifolia, Aristida leptopoda, Iseilema vaginiflorum, Eriochloa crebra, Enneapogon* sp.		
	Native forb and other species richness	7	17
	Forb species: *Parthenium hysterophorus*, Rhynchosia minima, Malvastrum americanum var. americanum*, Flemingia parviflora, Boerhavia* sp., *Lomandra confertifolia* subsp. *confertifolia, Phyllanthus virgatus, Pimelea haematostachya, Vachellia farnesiana*, Indigofera linnaei*		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	0%	na
	Average perennial grass cover	13.4%	43%
	Average organic litter cover	13%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos



Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 2.5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	3
	(i) Native perennial grass cover	5	1
	(J) Litter cover	5	5
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = ≥30% to 75% remnant vegetation OR ≥10% to 30% remnant vegetation AND ≥30% regrowth.	5	4

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (14) +(16) / (30 + 20)

= 0.6

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 13 (11.8.11) is 0.6

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 3 *Aristida latifolia, Aristida leptopoda, Eriochloa crebra*
% projective crown cover: 0	
% projective shrub cover: 0	
% projective cover non-woody introduced species: 5 - 29 %	
Patch size:	
Native tussocks: yes	

TEC Determination: good quality TEC

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-23, 14:28	**Assessor:** Bruce, Mick	**Site No:** 14

Coordinates: 0 m: -22.1575, 148.1731; **50 m:** -22.1572, 148.1727

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes: Low abundance of indicator species. Dense B.bladhii

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	0	na
	Tree species:		
	Non-native cover	5%	0%
50 X 10 m area	**Native shrub species richness**	1	na
	Shrub species: *Vachellia farnesiana*, Acacia salicina*		
	Native grass species richness	7	11
	Grass species: *Bothriochloa bladhii, Aristida latifolia, Heteropogon contortus, Eriochloa crebra, Panicum decompositum, Enneapogon polyphyllus, Iseilema vaginiflorum*		
	Native forb and other species richness	15	17
	Forb species: *Rhynchosia minima, Rostellularia adscendens, Capparis lasiantha, Pimelea haematostachya, Parthenium hysterophorus*, Neptunia gracilis forma gracilis, Eremophila debilis, Flemingia parviflora, Indigofera linifolia, Indigofera* sp., *Sida* sp., *Hibiscus* sp., *Cyperus* sp., *Nyssanthes diffusa, Phyllanthus maderaspatensis, Sida spinosa*, Hibiscus brachysiphonius*		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	0%	na
	Average perennial grass cover	58.6%	43%
	Average organic litter cover	20%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos






Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 2.5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	5
	(i) Native perennial grass cover	5	5
	(J) Litter cover	5	5
2. Landscape attributes	**(k) Patch size =** ≥100 – 200 ha remnant OR >200 ha remnant and regrowth OR >200 ha regrowth	10	7
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = ≥30% to 75% remnant vegetation OR ≥10% to 30% remnant vegetation AND ≥30% regrowth.	5	4

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (20) +(13) / (30 + 20)

= 0.66

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 14 (11.8.11) is 0.66

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 3 *Aristida latifolia, Eriochloa crebra, Panicum decompositum*
% projective crown cover: 0	
% projective shrub cover: 0	
% projective cover non-woody introduced species: 5 - 29 %	
Patch size:	
Native tussocks: yes	

TEC Determination: good quality TEC

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-23, 15:20	**Assessor:** Bruce, Mick	**Site No:** 15

Coordinates: 0 m: -22.165, 148.1737; **50 m:** -22.1651, 148.1741

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes:

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	0	na
	Tree species:		
	Non-native cover	35%	0%
50 X 10 m area	**Native shrub species richness**	3	na
	Shrub species: *Vachellia farnesiana*, Sida trichopoda, Atalaya hemiglauca, Sclerolaena muricata*		
	Native grass species richness	11	11
	Grass species: *Bothriochloa bladhii, Eriochloa crebra, Enneapogon* sp.*, Panicum queenslandicum, Sporobolus elongatus, Astrebla elymoides, Aristida leptopoda, Bothriochloa bladhii, Cenchrus ciliaris*, Iseilema vaginiflorum, Dichanthium sericeum, Heteropogon contortus*		
	Native forb and other species richness	5	17
	Forb species: *Parthenium hysterophorus*, Neptunia gracilis forma gracilis, Rhynchosia minima, Malvastrum americanum var. americanum*, Lomandra filiformis, Flemingia parviflora, Sida spinosa*, Crotalaria montana*		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	0%	na
	Average perennial grass cover	17.6%	43%
	Average organic litter cover	10%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos



Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	7.5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	3
	(i) Native perennial grass cover	5	1
	(J) Litter cover	5	5
2. Landscape attributes	**(k) Patch size =** ≥100 – 200 ha remnant OR >200 ha remnant and regrowth OR >200 ha regrowth	10	7
	(l) Connectedness = Connected with adjacent remnant vegetation along 50% to 75% of its perimeter.	5	4
	(m) Context = ≥30% to 75% remnant vegetation OR ≥10% to 30% remnant vegetation AND ≥30% regrowth.	5	4

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (16.5) +(15) / (30 + 20)

= 0.63

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 15 (11.8.11) is 0.63

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 5 *Eriochloa crebra, Panicum queenslandicum, Astrebla elymoides, Aristida leptopoda, Dichanthium sericeum*
% projective crown cover: 0	
% projective shrub cover: 0	
% projective cover non-woody introduced species: >= 30 %	
Patch size:	
Native tussocks: no	

TEC Determination: does not meet TEC condition thesholds

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-24, 06:28	**Assessor:** Bruce, Mick	**Site No:** 16

Coordinates: 0 m: -22.1634, 148.2052; **50 m:** -22.1638, 148.2051

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes: Pretty poor. Scattered Mtn Coolabah and Dalachy gum

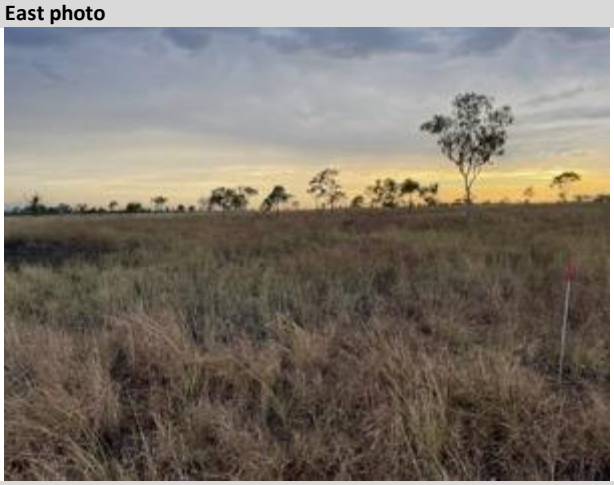
		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	2	na
	Tree species: *Eucalyptus orgadophila, Corymbia dallachiana*		
	Non-native cover	50%	0%
50 X 10 m area	**Native shrub species richness**	1	na
	Shrub species: *Vachellia farnesiana*, Atalaya hemiglauca*		
	Native grass species richness	9	11
	Grass species: *Bothriochloa pertusa*, Panicum queenslandicum, Aristida latifolia, Eriochloa crebra, Cenchrus ciliaris*, Iseilema vaginiflorum, Bothriochloa bladhii, Enneapogon* sp., *Brachyachne convergens, Dichanthium sericeum, Astrebla squarrosa, Melinis repens**		
	Native forb and other species richness	10	17
	Forb species: *Parthenium hysterophorus*, Neptunia gracilis forma gracilis, Sida spinosa*, Rhynchosia minima, Malvastrum americanum var. americanum*, Flemingia parviflora, Indigofera linifolia, Crotalaria montana, Cyperus* sp., *Glycine* sp., *Salsola australis, Trianthema portulacastrum*, Phyllanthus virgatus, Polymeria longifolia*		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	0%	na
	Average perennial grass cover	21%	43%
	Average organic litter cover	6.8%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos







Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 2.5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	3
	(i) Native perennial grass cover	5	1
	(J) Litter cover	5	5
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = >75% remnant vegetation.	5	5

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (14) +(17) / (30 + 20)

= 0.62

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 16 (11.8.11) is 0.62

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 5 *Panicum queenslandicum, Aristida latifolia, Eriochloa crebra, Dichanthium sericeum, Astrebla squarrosa*
% projective crown cover: 0	
% projective shrub cover: 0	
% projective cover non-woody introduced species: 5 - 29 %	
Patch size:	
Native tussocks: yes	

TEC Determination: good quality TEC

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-24, 07:22	**Assessor:** Bruce, Mick	**Site No:** 17

Coordinates: 0 m: -22.1588, 148.203; **50 m:** -22.1584, 148.2031

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes: v. poor condition. Native grass sparse. Weeds abundant, bare ground abundant

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	0	na
	Tree species:		
	Non-native cover	70%	0%
50 X 10 m area	**Native shrub species richness**	1	na
	Shrub species: *Vachellia farnesiana*, Atalaya hemiglauca*		
	Native grass species richness	8	11
	Grass species: *Cenchrus ciliaris*, Bothriochloa pertusa*, Sporobolus elongatus, Panicum queenslandicum, Aristida latifolia, Astrebla elymoides, Brachyachne convergens, Dichanthium sericeum, Iseilema vaginiflorum, Entolasia stricta, Urochloa mosambicensis**		
	Native forb and other species richness	10	17
	Forb species: *Parthenium hysterophorus*, Neptunia gracilis forma gracilis, Rhynchosia minima, Sida trichopoda, Calotis cuneata, Flemingia parviflora, Malvastrum americanum var. americanum*, Sida spinosa*, Phyllanthus maderaspatensis, Desmodium* sp.*, Cullen tenax, Sida rohlenae* subsp. *rohlenae, Polymeria longifolia*		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	0%	na
	Average perennial grass cover	4.4%	43%
	Average organic litter cover	6%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo

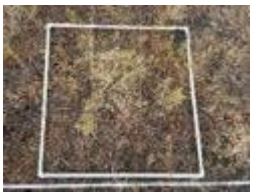


West photo



Spot photos







Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 2.5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	0
	(i) Native perennial grass cover	5	1
	(J) Litter cover	5	3
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = >75% remnant vegetation.	5	5

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (9) +(17) / (30 + 20)

= 0.52

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 17 (11.8.11) is 0.52

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 4 *Panicum queenslandicum, Aristida latifolia, Astrebla elymoides, Dichanthium sericeum*
% projective crown cover: 0	
% projective shrub cover: 0	
% projective cover non-woody introduced species: 5 - 29 %	
Patch size:	
Native tussocks: no	

TEC Determination: does not meet TEC condition thesholds

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-24, 08:20	**Assessor:** Bruce, Mick	**Site No:** 18

Coordinates: 0 m: -22.1541, 148.1982; **50 m:** -22.1538, 148.1984

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes:

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	0	na
	Tree species:		
	Non-native cover	55%	0%
50 X 10 m area	**Native shrub species richness**	3	na
	Shrub species: *Atalaya hemiglauca, Corymbia erythrophloia, Vachellia farnesiana*, Corymbia dallachiana*		
	Native grass species richness	10	11
	Grass species: *Bothriochloa pertusa*, Brachyachne convergens, Bothriochloa bladhii, Iseilema vaginiflorum, Cenchrus ciliaris*, Aristida latifolia, Sporobolus elongatus, Urochloa mosambicensis*, Eriochloa crebra, Astrebla elymoides, Dichanthium sericeum, Astrebla squarrosa, Paspalidium globoideum*		
	Native forb and other species richness	6	17
	Forb species: *Parthenium hysterophorus*, Solanum nemophilum, Jasminum didymum* subsp. *lineare, Sclerolaena muricata, Malvastrum americanum var. americanum*, Flemingia parviflora, Sida spinosa*, Neptunia gracilis forma gracilis, Cullen tenax*		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	2.3%	na
	Sub-canopy cover	0%	na
	Shrub cover	0%	na
	Average perennial grass cover	8%	43%
	Average organic litter cover	7%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos



Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	7.5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	0
	(i) Native perennial grass cover	5	1
	(J) Litter cover	5	5
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = >75% remnant vegetation.	5	5

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (13.5) +(17) / (30 + 20)

= 0.61

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 18 (11.8.11) is 0.61

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 6 *Aristida latifolia, Eriochloa crebra, Astrebla elymoides, Dichanthium sericeum, Astrebla squarrosa, Paspalidium globoideum*
% projective crown cover: 2.3	
% projective shrub cover: 0	
% projective cover non-woody introduced species: >= 30 %	
Patch size:	
Native tussocks: yes	

TEC Determination: does not meet TEC condition thesholds

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-24, 09:09	**Assessor:** Bruce, Mick	**Site No:** 19

Coordinates: 0 m: -22.1492, 148.1961; **50 m:** -22.1489, 148.1964

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes:

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	0	na
	Tree species:		
	Non-native cover	7%	0%
50 X 10 m area	**Native shrub species richness**	3	na
	Shrub species: *Santalum lanceolatum, Sida trichopoda, Vachellia farnesiana*, Atalaya hemiglauca*		
	Native grass species richness	12	11
	Grass species: *Aristida leptopoda, Bothriochloa bladhii, Eriochloa crebra, Panicum decompositum, Astrebla elymoides, Paspalidium globoideum, Iseilema vaginiflorum, Dichanthium sericeum, Digitaria* sp., *Enneapogon* sp., *Heteropogon contortus, Sporobolus elongatus*		
	Native forb and other species richness	8	17
	Forb species: *Flemingia parviflora, Commelina ensifolia, Neptunia gracilis forma gracilis, Sida spinosa*, Brunonia australis, Minuria* sp., *Glycine clandestina var. clandestina, Phyllanthus virgatus, Euphorbia drummondii*		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	0.2%	na
	Average perennial grass cover	42%	43%
	Average organic litter cover	2.4%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos







Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	7.5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	5
	(i) Native perennial grass cover	5	5
	(J) Litter cover	5	3
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = ≥30% to 75% remnant vegetation OR ≥10% to 30% remnant vegetation AND ≥30% regrowth.	5	4

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (20.5) +(16) / (30 + 20)

= 0.73

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 19 (11.8.11) is 0.73

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 6 *Aristida leptopoda, Eriochloa crebra, Panicum decompositum, Astrebla elymoides, Paspalidium globoideum, Dichanthium sericeum*
% projective crown cover: 0	
% projective shrub cover: 0.2	
% projective cover non-woody introduced species: 5 - 29 %	
Patch size:	
Native tussocks: yes	

TEC Determination: good quality TEC

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-24, 10:11	**Assessor:** Bruce, Mick	**Site No:** 20

Coordinates: 0 m: -22.1524, 148.1876; **50 m:** -22.152, 148.1877

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes:

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	0	na
	Tree species:		
	Non-native cover	15%	0%
50 X 10 m area	**Native shrub species richness**	2	na
	Shrub species: *Sida trichopoda, Santalum lanceolatum*		
	Native grass species richness	9	11
	Grass species: *Bothriochloa bladhii, Bothriochloa pertusa*, Aristida latifolia, Panicum decompositum, Panicum queenslandicum, Dichanthium sericeum, Eriochloa crebra, Astrebla elymoides, Iseilema vaginiflorum, Cenchrus ciliaris*, Sporobolus elongatus*		
	Native forb and other species richness	10	17
	Forb species: *Parthenium hysterophorus*, Neptunia gracilis forma gracilis, Flemingia parviflora, Desmodium* sp.*, Sida spinosa*, Glycine clandestina var. clandestina, Alternanthera nana, Malvastrum americanum var. americanum*, Vachellia farnesiana*, Hibiscus tridactylites, Rhynchosia minima var. minima, Portulaca oleracea*, Sida rohlenae* subsp. *rohlenae, Dianella nervosa, Calotis cuneata*		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	0%	na
	Average perennial grass cover	52.4%	43%
	Average organic litter cover	7%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos







Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 2.5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	5
	(i) Native perennial grass cover	5	5
	(J) Litter cover	5	5
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = ≥30% to 75% remnant vegetation OR ≥10% to 30% remnant vegetation AND ≥30% regrowth.	5	4

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (20) +(16) / (30 + 20)

= 0.72

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 20 (11.8.11) is 0.72

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 6 *Aristida latifolia, Panicum decompositum, Panicum queenslandicum, Dichanthium sericeum, Eriochloa crebra, Astrebla elymoides*
% projective crown cover: 0	
% projective shrub cover: 0	
% projective cover non-woody introduced species: 5 - 29 %	
Patch size:	
Native tussocks: yes	

TEC Determination: good quality TEC

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-24, 11:14	**Assessor:** Bruce, Mick	**Site No:** 21
Coordinates: 0 m: -22.1375, 148.1855; **50 m:** -22.1371, 148.1854		
Verified RE: 11.8.11 VM status: Of concern, BD status: Of concern		
Benchmark available? yes		
Notes:		

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	1	na
	Tree species: *Eucalyptus orgadophila*		
	Non-native cover	4%	0%
50 X 10 m area	**Native shrub species richness**	1	na
	Shrub species: *Corymbia dallachiana, Vachellia farnesiana**		
	Native grass species richness	9	11
	Grass species: *Aristida latifolia, Themeda triandra, Bothriochloa bladhii, Eriochloa crebra, Panicum queenslandicum, Aristida leptopoda, Panicum decompositum, Astrebla elymoides, Heteropogon contortus*		
	Native forb and other species richness	9	17
	Forb species: *Parthenium hysterophorus**, *Flemingia parviflora, Glycine clandestina var. clandestina, Minuria* sp., *Brunoniella australis, Eremophila debilis, Malvastrum americanum var. americanum**, *Sida spinosa**, *Vigna lanceolata var. lanceolata, Rhynchosia minima var. minima, Corchorus trilocularis*		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	4.6%	na
	Sub-canopy cover	0%	na
	Shrub cover	0%	na
	Average perennial grass cover	64%	43%
	Average organic litter cover	12%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos



Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 2.5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	10
	(i) Native perennial grass cover	5	5
	(J) Litter cover	5	5
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = ≥30% to 75% remnant vegetation OR ≥10% to 30% remnant vegetation AND ≥30% regrowth.	5	4

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (25) +(16) / (30 + 20)

= 0.82

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 21 (11.8.11) is 0.82

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 6 *Aristida latifolia, Eriochloa crebra, Panicum queenslandicum, Aristida leptopoda, Panicum decompositum, Astrebla elymoides*
% projective crown cover: 4.6	
% projective shrub cover: 0	
% projective cover non-woody introduced species: 0 - 4.9 %	
Patch size:	
Native tussocks: yes	

TEC Determination: best quality TEC

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-24, 13:11	**Assessor:** Bruce, Mick	**Site No:** 22
Coordinates: 0 m: -22.1334, 148.1908; **50 m:** -22.133, 148.191		
Verified RE: 11.8.11 VM status: Of concern, BD status: Of concern		
Benchmark available? yes		
Notes:		

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	0	na
	Tree species:		
	Non-native cover	27%	0%
50 X 10 m area	**Native shrub species richness**	1	na
	Shrub species: *Vachellia farnesiana*, Santalum lanceolatum*		
	Native grass species richness	7	11
	Grass species: *Aristida latifolia, Enneapogon* sp., *Aristida leptopoda, Eriochloa crebra, Sporobolus elongatus, Cenchrus ciliaris*, Bothriochloa pertusa*, Themeda triandra, Iseilema vaginiflorum*		
	Native forb and other species richness	10	17
	Forb species: *Parthenium hysterophorus*, Harrisia martinii*, Brunoniella australis, Pimelea haematostachya, Calotis cuneata, Neptunia gracilis forma gracilis, Rhynchosia minima var. minima, Corchorus trilocularis, Malvastrum americanum var. americanum*, Lomandra confertifolia* subsp. *confertifolia, Sida* sp., *Indigofera linifolia, Flemingia parviflora*		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	0%	na
	Average perennial grass cover	64%	43%
	Average organic litter cover	3.8%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos



Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 2.5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	3
	(i) Native perennial grass cover	5	5
	(J) Litter cover	5	3
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = ≥30% to 75% remnant vegetation OR ≥10% to 30% remnant vegetation AND ≥30% regrowth.	5	4

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (16) +(16) / (30 + 20)

= 0.64

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 22 (11.8.11) is 0.64

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 3 *Aristida latifolia, Aristida leptopoda, Eriochloa crebra*
% projective crown cover: 0	
% projective shrub cover: 0	
% projective cover non-woody introduced species: 5 - 29 %	
Patch size:	
Native tussocks: yes	

TEC Determination: good quality TEC

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-24, 14:37	**Assessor:** Bruce, Mick	**Site No:** 23

Coordinates: 0 m: -22.1321, 148.2113; **50 m:** -22.132, 148.2108

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes: Shrub layer quite dense for grassland with A. hemiglauca, O. acidula, C. brewsterii. Probably RE11.9.3

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	0	na
	Tree species: *Atalaya hemiglauca*		
	Non-native cover	3%	0%
50 X 10 m area	**Native shrub species richness**	8	na
	Shrub species: *Atalaya hemiglauca, Cassia brewsteri, Ventilago viminalis, Alectryon oleifolius* subsp. *elongatus, Carissa ovata, Abutilon oxycarpum, Sida trichopoda, Santalum lanceolatum*		
	Native grass species richness	8	11
	Grass species: *Aristida latifolia, Panicum decompositum, Bothriochloa bladhii, Chrysopogon fallax, Eriochloa crebra, Heteropogon contortus, Themeda triandra, Panicum queenslandicum*		
	Native forb and other species richness	15	17
	Forb species: *Rhynchosia minima var. minima, Vigna lanceolata var. lanceolata, Indigofera linifolia, Melhania oblongifolia, Sida spinosa*, Ocimum* sp., *Eustrephus latifolius, Neptunia gracilis forma gracilis, Pimelea haematostachya, Parthenium hysterophorus*, Malvastrum americanum var. americanum*, Corchorus trilocularis, Sesbania cannabina var. cannabina, Cyperus* sp., *Cyperus* sp., *Achyranthes aspera, Crotalaria montana, Eremophila debilis*		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	5.1%	na
	Average perennial grass cover	62%	43%
	Average organic litter cover	2.2%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos



Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 2.5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	10
	(i) Native perennial grass cover	5	5
	(J) Litter cover	5	3
2. Landscape attributes	**(k) Patch size =** ≥25 – 100 ha remnant OR ≥25 – 200 ha remnant and regrowth OR >25 – 200 ha regrowth	10	5
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = ≥10% to 30% remnant vegetation AND <30% regrowth OR <10% remnant vegetation AND ≥30% regrowth.	5	2

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (23) +(9) / (30 + 20)

= 0.64

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 23 (11.8.11) is 0.64

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 4 *Aristida latifolia, Panicum decompositum, Eriochloa crebra, Panicum queenslandicum*
% projective crown cover: 0	
% projective shrub cover: 5.1	
% projective cover non-woody introduced species: 0 - 4.9 %	
Patch size: 1- 4.9 ha	
Native tussocks: yes	

TEC Determination: best quality TEC

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-25, 06:24	**Assessor:** Bruce, Mick	**Site No:** 24
Coordinates: 0 m: -22.1504, 148.2035; **50 m:** -22.15, 148.2038		
Verified RE: 11.8.11 VM status: Of concern, BD status: Of concern		
Benchmark available? yes		
Notes:		

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	0	na
	Tree species: *Atalaya hemiglauca, Acacia salicina*		
	Non-native cover	25%	0%
50 X 10 m area	**Native shrub species richness**	3	na
	Shrub species: *Atalaya hemiglauca, Sida trichopoda, Capparis lasiantha*		
	Native grass species richness	8	11
	Grass species: *Bothriochloa pertusa*, Cenchrus ciliaris*, Sporobolus elongatus, Iseilema vaginiflorum, Bothriochloa bladhii, Astrebla elymoides, Panicum queenslandicum, Brachyachne convergens, Eriochloa crebra, Aristida latifolia*		
	Native forb and other species richness	10	17
	Forb species: *Parthenium hysterophorus*, Neptunia gracilis forma gracilis, Vachellia farnesiana*, Corchorus trilocularis, Phyllanthus maderaspatensis var. maderaspatensis, Flemingia parviflora, Cullen tenax, Malvastrum americanum var. americanum*, Crotalaria montana, Abutilon oxycarpum, Vigna lanceolata var. lanceolata, Sclerolaena muricata, Polymeria longifolia*		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	5.2%	na
	Sub-canopy cover	0%	na
	Shrub cover	0%	na
	Average perennial grass cover	13.2%	43%
	Average organic litter cover	8%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare



East photo



South photo



West photo



North photo

Spot photos



Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 2.5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	3
	(i) Native perennial grass cover	5	1
	(J) Litter cover	5	5
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = >75% remnant vegetation.	5	5

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (14) +(17) / (30 + 20)

= 0.62

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 24 (11.8.11) is 0.62

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 4 *Astrebla elymoides, Panicum queenslandicum, Eriochloa crebra, Aristida latifolia*
% projective crown cover: 5.2	
% projective shrub cover: 0	
% projective cover non-woody introduced species: 5 - 29 %	
Patch size:	
Native tussocks: no	

TEC Determination: does not meet TEC condition thesholds

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-25, 07:37	**Assessor:** Bruce, Mick	**Site No:** 25

Coordinates: 0 m: -22.1431, 148.203; **50 m:** -22.1433, 148.2035

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes: Potentially RE 11.9.3. vert similar composition to site 23

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	5	na
	Tree species: *Ehretia membranifolia, Cassia brewsteri, Santalum lanceolatum, Atalaya hemiglauca, Terminalia oblongata* subsp. *oblongata, Acacia salicina*		
	Non-native cover	3%	0%
50 X 10 m area	**Native shrub species richness**	7	na
	Shrub species: *Cassia brewsteri, Alectryon oleifolius* subsp. *elongatus, Owenia acidula, Ventilago viminalis, Santalum lanceolatum, Grewia savannicola, Ehretia membranifolia*		
	Native grass species richness	7	11
	Grass species: *Bothriochloa bladhii, Cenchrus ciliaris*, Eriochloa crebra, Panicum decompositum, Aristida* sp., *Chrysopogon fallax, Aristida latifolia, Heteropogon contortus*		
	Native forb and other species richness	16	17
	Forb species: *Sida spinosa*, Rhynchosia minima, Phyllanthus virgatus, Phyllanthus maderaspatensis, Cullen tenax, Rhynchosia minima var. minima, Indigofera linifolia, Parthenium hysterophorus*, Flemingia parviflora, Malvastrum americanum var. americanum*, Glycine* sp., *Ocimum* sp., *Minuria* sp., *Indigofera* sp., *Neptunia gracilis forma gracilis, Brunoniella australis, Abutilon fraseri* subsp. *fraseri, Sida rohlenae* subsp. *rohlenae*		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	7.8%	na
	Average perennial grass cover	91.2%	43%
	Average organic litter cover	0%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos



Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	7.5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 2.5		
	Forb species richness: 5		
	(h) Non-native plant cover	10	10
	(i) Native perennial grass cover	5	5
	(J) Litter cover	5	0
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = ≥30% to 75% remnant vegetation OR ≥10% to 30% remnant vegetation AND ≥30% regrowth.	5	4

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (22.5) +(16) / (30 + 20)

= 0.77

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 25 (11.8.11) is 0.77

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 3 *Eriochloa crebra, Panicum decompositum, Aristida latifolia*
% projective crown cover: 0	
% projective shrub cover: 7.8	
% projective cover non-woody introduced species: 0 - 4.9 %	
Patch size:	
Native tussocks: yes	

TEC Determination: good quality TEC

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-25, 08:47	**Assessor:** Bruce, Mick	**Site No:** 26

Coordinates: 0 m: -22.1523, 148.2108; **50 m:** -22.1523, 148.2113

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes:

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	0	na
	Tree species:		
	Non-native cover	60%	0%
50 X 10 m area	**Native shrub species richness**	0	na
	Shrub species:		
	Native grass species richness	11	11
	Grass species: *Dichanthium sericeum, Aristida latifolia, Astrebla elymoides, Panicum queenslandicum, Panicum decompositum, Bothriochloa pertusa*, Sporobolus elongatus, Enneapogon* sp.*, Eriochloa crebra, Iseilema vaginiflorum, Paspalidium* sp.*, Bothriochloa bladhii*		
	Native forb and other species richness	11	17
	Forb species: *Corchorus trilocularis, Parthenium hysterophorus*, Pimelea haematostachya, Sida* sp.*, Calotis cuneata, Flemingia parviflora, Lythrum* sp.*, Sida spinosa*, Neptunia gracilis forma gracilis, Rhynchosia minima, Crotalaria montana, Phyllanthus maderaspatensis, Opuntia stricta**		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	0%	na
	Average perennial grass cover	29%	43%
	Average organic litter cover	9.4%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos



Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	7.5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	0
	(i) Native perennial grass cover	5	3
	(J) Litter cover	5	5
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = >75% remnant vegetation.	5	5

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (15.5) +(17) / (30 + 20)

= 0.65

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 26 (11.8.11) is 0.65

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 6 *Dichanthium sericeum, Aristida latifolia, Astrebla elymoides, Panicum queenslandicum, Panicum decompositum, Eriochloa crebra*
% projective crown cover: 0	
% projective shrub cover: 0	
% projective cover non-woody introduced species: 5 - 29 %	
Patch size:	
Native tussocks: yes	

TEC Determination: good quality TEC

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-25, 09:31	**Assessor:** Bruce, Mick	**Site No:** 27

Coordinates: 0 m: -22.1459, 148.2109; **50 m:** -22.1459, 148.2114

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes:

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	0	na
	Tree species:		
	Non-native cover	15%	0%
50 X 10 m area	**Native shrub species richness**	2	na
	Shrub species: *Vachellia farnesiana*, Sida trichopoda, Ventilago viminalis*		
	Native grass species richness	7	11
	Grass species: *Panicum decompositum, Aristida latifolia, Eriochloa crebra, Bothriochloa bladhii, Astrebla elymoides, Bothriochloa pertusa*, Heteropogon contortus, Cenchrus ciliaris**		
	Native forb and other species richness	10	17
	Forb species: *Parthenium hysterophorus*, Sida spinosa*, Neptunia gracilis forma gracilis, Enchylaena tomentosa, Commelina ensifolia, Flemingia parviflora, Rhynchosia minima, Corchorus trilocularis, Glycine* sp., *Brunoniella australis, Dianella nervosa, Jasminum didymum* subsp. *lineare*		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	0%	na
	Average perennial grass cover	43%	43%
	Average organic litter cover	8%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos







Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 2.5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	5
	(i) Native perennial grass cover	5	5
	(J) Litter cover	5	5
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = ≥30% to 75% remnant vegetation OR ≥10% to 30% remnant vegetation AND ≥30% regrowth.	5	4

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (20) +(16) / (30 + 20)

= 0.72

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 27 (11.8.11) is 0.72

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 4 *Panicum decompositum, Aristida latifolia, Eriochloa crebra, Astrebla elymoides*
% projective crown cover: 0	
% projective shrub cover: 0	
% projective cover non-woody introduced species: 5 - 29 %	
Patch size:	
Native tussocks: yes	

TEC Determination: good quality TEC

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-25, 10:14	**Assessor:** Bruce, Mick	**Site No:** 28

Coordinates: 0 m: -22.1475, 148.2159; **50 m:** -22.1475, 148.2163

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes:

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	1	na
	Tree species: *Acacia salicina*		
	Non-native cover	4%	0%
50 X 10 m area	**Native shrub species richness**	3	na
	Shrub species: *Atalaya hemiglauca, Cassia brewsteri, Acacia salicina*		
	Native grass species richness	11	11
	Grass species: *Aristida latifolia, Bothriochloa bladhii, Eriochloa crebra, Cenchrus ciliaris*, Panicum decompositum, Astrebla elymoides, Panicum queenslandicum, Heteropogon contortus, Iseilema vaginiflorum, Bothriochloa pertusa*, Dichanthium sericeum, Enneapogon* sp., *Themeda triandra*		
	Native forb and other species richness	11	17
	Forb species: *Parthenium hysterophorus*, Corchorus trilocularis, Sida trichopoda, Neptunia gracilis forma gracilis, Brunoniella australis, Flemingia parviflora, Rhynchosia minima, Cyperus* sp., *Malvastrum americanum var. americanum*, Maireana microphylla, Minuria* sp., *Glycine* sp.		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	2.3%	na
	Average perennial grass cover	56%	43%
	Average organic litter cover	3%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos



Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	7.5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	10
	(i) Native perennial grass cover	5	5
	(J) Litter cover	5	3
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = ≥30% to 75% remnant vegetation OR ≥10% to 30% remnant vegetation AND ≥30% regrowth.	5	4

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (25.5) +(16) / (30 + 20)

= 0.83

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 28 (11.8.11) is 0.83

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 6 *Aristida latifolia, Eriochloa crebra, Panicum decompositum, Astrebla elymoides, Panicum queenslandicum, Dichanthium sericeum*
% projective crown cover: 0	
% projective shrub cover: 2.3	
% projective cover non-woody introduced species: 0 - 4.9 %	
Patch size:	
Native tussocks: yes	

TEC Determination: best quality TEC

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-25, 11:15	**Assessor:** Bruce, Mick	**Site No:** 29

Coordinates: 0 m: -22.1523, 148.2211; **50 m:** -22.1527, 148.2214

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes:

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	0	na
	Tree species:		
	Non-native cover	50%	0%
50 X 10 m area	**Native shrub species richness**	0	na
	Shrub species:		
	Native grass species richness	6	11
	Grass species: *Sporobolus elongatus, Iseilema vaginiflorum, Brachyachne convergens, Astrebla elymoides, Eriochloa crebra, Cenchrus ciliaris*, Bothriochloa pertusa**		
	Native forb and other species richness	2	17
	Forb species: *Parthenium hysterophorus*, Malvastrum americanum var. americanum*, Rhynchosia minima, Neptunia gracilis forma gracilis*		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	0%	na
	Average perennial grass cover	28.2%	43%
	Average organic litter cover	3%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos







Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	2.5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 2.5		
	Forb species richness: 0		
	(h) Non-native plant cover	10	3
	(i) Native perennial grass cover	5	3
	(J) Litter cover	5	3
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = ≥30% to 75% remnant vegetation OR ≥10% to 30% remnant vegetation AND ≥30% regrowth.	5	4

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (11.5) +(16) / (30 + 20)

= 0.55

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 29 (11.8.11) is 0.55

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 2 *Astrebla elymoides, Eriochloa crebra*
% projective crown cover: 0	
% projective shrub cover: 0	
% projective cover non-woody introduced species: 5 - 29 %	
Patch size:	
Native tussocks: yes	

TEC Determination: does not meet TEC condition thesholds

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-25, 11:57	**Assessor:** Bruce, Mick	**Site No:** 30

Coordinates: 0 m: -22.1557, 148.2206; **50 m:** -22.1559, 148.2201

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes:

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	0	na
	Tree species:		
	Non-native cover	15%	0%
50 X 10 m area	**Native shrub species richness**	0	na
	Shrub species: *Vachellia farnesiana**		
	Native grass species richness	7	11
	Grass species: *Sporobolus elongatus, Iseilema vaginiflorum, Cenchrus ciliaris*, Aristida latifolia, Astrebla elymoides, Panicum queenslandicum, Brachyachne convergens, Bothriochloa pertusa*, Paspalidium globoideum*		
	Native forb and other species richness	3	17
	Forb species: *Malvastrum americanum var. americanum*, Parthenium hysterophorus*, Rhynchosia minima, Sida spinosa*, Neptunia gracilis forma gracilis, Flemingia parviflora*		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	0%	na
	Average perennial grass cover	28%	43%
	Average organic litter cover	6%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos







Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	2.5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 2.5		
	Forb species richness: 0		
	(h) Non-native plant cover	10	5
	(i) Native perennial grass cover	5	3
	(J) Litter cover	5	3
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = ≥30% to 75% remnant vegetation OR ≥10% to 30% remnant vegetation AND ≥30% regrowth.	5	4

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (13.5) +(16) / (30 + 20)

= 0.59

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 30 (11.8.11) is 0.59

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 4 *Aristida latifolia, Astrebla elymoides, Panicum queenslandicum, Paspalidium globoideum*
% projective crown cover: 0	
% projective shrub cover: 0	
% projective cover non-woody introduced species: 5 - 29 %	
Patch size:	
Native tussocks: yes	

TEC Determination: good quality TEC

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-25, 13:15	**Assessor:** Bruce, Mick	**Site No:** 31

Coordinates: 0 m: -22.1594, 148.2158; **50 m:** -22.1596, 148.2153

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes:

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	4	na
	Tree species: *Lysiphyllum carronii, Acacia harpophylla, Atalaya hemiglauca, , Ehretia membranifolia*		
	Non-native cover	23%	0%
50 X 10 m area	**Native shrub species richness**	7	na
	Shrub species: *Salsola australis, Sida trichopoda, Vachellia farnesiana*, Ventilago viminalis, Capparis lasiantha, Atalaya hemiglauca, Enchylaena tomentosa, Capparis anomala*		
	Native grass species richness	12	11
	Grass species: *Astrebla elymoides, Aristida latifolia, Panicum queenslandicum, Iseilema vaginiflorum, Cenchrus ciliaris*, Sporobolus elongatus, Bothriochloa pertusa*, Paspalidium globoideum, Brachyachne convergens, Dichanthium sericeum, Eriochloa crebra, Enneapogon* sp., *Bothriochloa bladhii, Aristida leptopoda*		
	Native forb and other species richness	13	17
	Forb species: *Parthenium hysterophorus*, Rhynchosia minima var. minima, Neptunia gracilis forma gracilis, Sida spinosa*, Vigna lanceolata var. lanceolata, Calotis cuneata, Flemingia parviflora, Corchorus trilocularis, Portulaca oleracea*, Rostellularia adscendens, Euphorbia drummondii, Harrisia martinii*, Eustrephus latifolius, Einadia trigonos, Amyema quandang var. quandang, Polygonum* sp., *Polymeria longifolia*		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	0%	na
	Average perennial grass cover	20%	43%
	Average organic litter cover	5%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos







Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	7.5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	5
	(i) Native perennial grass cover	5	1
	(J) Litter cover	5	3
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = >75% remnant vegetation.	5	5

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (16.5) +(17) / (30 + 20)

= 0.67

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 31 (11.8.11) is 0.67

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 7 *Astrebla elymoides, Aristida latifolia, Panicum queenslandicum, Paspalidium globoideum, Dichanthium sericeum, Eriochloa crebra, Aristida leptopoda*
% projective crown cover: 0	
% projective shrub cover: 0	
% projective cover non-woody introduced species: 5 - 29 %	
Patch size:	
Native tussocks: yes	

TEC Determination: good quality TEC

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-25, 14:05	**Assessor:** Bruce, Mick	**Site No:** 32

Coordinates: 0 m: -22.1655, 148.221; **50 m:** -22.1658, 148.2213

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes:

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	0	na
	Tree species: *Alectryon oleifolius* subsp. *elongatus*		
	Non-native cover	40%	0%
50 X 10 m area	**Native shrub species richness**	1	na
	Shrub species: *Alectryon oleifolius* subsp. *elongatus*		
	Native grass species richness	11	11
	Grass species: *Eriochloa crebra, Aristida latifolia, Iseilema vaginiflorum, Panicum queenslandicum, Bothriochloa pertusa*, Bothriochloa bladhii, Cenchrus ciliaris*, Dichanthium sericeum, Enneapogon* sp., *Sporobolus elongatus, Astrebla elymoides, Portulaca oleracea*, Paspalidium globoideum*		
	Native forb and other species richness	5	17
	Forb species: *Parthenium hysterophorus*, Neptunia gracilis forma gracilis, Pimelea haematostachya, Flemingia parviflora, Rhynchosia minima, Malvastrum americanum var. americanum*, Crotalaria montana*		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	0%	na
	Average perennial grass cover	32%	43%
	Average organic litter cover	6%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos



Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	7.5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	3
	(i) Native perennial grass cover	5	3
	(J) Litter cover	5	3
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = ≥30% to 75% remnant vegetation OR ≥10% to 30% remnant vegetation AND ≥30% regrowth.	5	4

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (16.5) +(16) / (30 + 20)

= 0.65

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 32 (11.8.11) is 0.65

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 6 *Eriochloa crebra, Aristida latifolia, Panicum queenslandicum, Dichanthium sericeum, Astrebla elymoides, Paspalidium globoideum*
% projective crown cover: 0	
% projective shrub cover: 0	
% projective cover non-woody introduced species: >= 30 %	
Patch size:	
Native tussocks: yes	

TEC Determination: does not meet TEC condition thesholds

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-25, 14:42	**Assessor:** Bruce, Mick	**Site No:** 33

Coordinates: 0 m: -22.1611, 148.2099; **50 m:** -22.1607, 148.2099

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes: Potentially LZ 9. Also, potentially sparse/open woodland. Numerous stags in plot

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	8.5 m	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	3	na
	Tree species: *Eucalyptus populnea, Acacia harpophylla, Atalaya hemiglauca*		
	Non-native cover	15%	0%
50 X 10 m area	**Native shrub species richness**	5	na
	Shrub species: *Citrus glauca, Ehretia membranifolia, Atalaya hemiglauca, Sida spinosa*, Alectryon oleifolius* subsp. *elongatus, Lysiphyllum carronii*		
	Native grass species richness	10	11
	Grass species: *Dichanthium sericeum, Bothriochloa bladhii, Aristida latifolia, Cenchrus ciliaris*, Eriochloa pseudoacrotricha, Digitaria* sp., *Sporobolus caroli, Panicum queenslandicum, Cyperus* sp., *Enteropogon ramosus, Iseilema vaginiflorum*		
	Native forb and other species richness	9	17
	Forb species: *Parthenium hysterophorus*, Harrisia martinii*, Brunonia australis, Neptunia gracilis forma gracilis, Enchylaena tomentosa, Trianthema triquetra, Leichhardtia viridiflora* subsp. *viridiflora, Boerhavia dominii, Phyllanthus* sp., *Rhynchosia minima var. minima, Malvastrum americanum var. americanum*, Sclerolaena anisacanthoides*		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	4.9%	na
	Sub-canopy cover	0%	na
	Shrub cover	2.6%	na
	Average perennial grass cover	54.2%	43%
	Average organic litter cover	3%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos







Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	7.5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	5
	(i) Native perennial grass cover	5	5
	(J) Litter cover	5	3
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = >75% remnant vegetation.	5	5

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (20.5) +(17) / (30 + 20)

= 0.75

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 33 (11.8.11) is 0.75

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 3 *Dichanthium sericeum, Aristida latifolia, Panicum queenslandicum*
% projective crown cover: 4.9	
% projective shrub cover: 2.6	
% projective cover non-woody introduced species: 5 - 29 %	
Patch size:	
Native tussocks: yes	

TEC Determination: good quality TEC

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-25, 15:41	**Assessor:** Bruce, Mick	**Site No:** 34

Coordinates: 0 m: -22.1677, 148.2108; **50 m:** -22.1673, 148.2109

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes:

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	0	na
	Tree species:		
	Non-native cover	20%	0%
50 X 10 m area	**Native shrub species richness**	0	na
	Shrub species: *Vachellia farnesiana**		
	Native grass species richness	8	11
	Grass species: *Panicum queenslandicum, Bothriochloa pertusa*, Bothriochloa bladhii, Parthenium hysterophorus*, Cenchrus ciliaris*, Eriochloa crebra, Iseilema vaginiflorum, Astrebla elymoides, Enneapogon* sp., *Melinis repens*, Paspalidium globoideum*		
	Native forb and other species richness	9	17
	Forb species: *Flemingia parviflora, Rostellularia adscendens, Neptunia gracilis forma gracilis, Sida trichopoda, Corchorus trilocularis, Commelina lanceolata, Cyperus* sp., *Rhynchosia minima var. minima, Pimelea haematostachya*		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	0%	na
	Average perennial grass cover	22%	43%
	Average organic litter cover	3.4%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos



Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 2.5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	5
	(i) Native perennial grass cover	5	3
	(J) Litter cover	5	3
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = ≥30% to 75% remnant vegetation OR ≥10% to 30% remnant vegetation AND ≥30% regrowth.	5	4

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (16) +(16) / (30 + 20)

= 0.64

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 34 (11.8.11) is 0.64

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 5 *Panicum queenslandicum, Eriochloa crebra, Dichanthium sericeum, Astrebla elymoides, Paspalidium globoideum*
% projective crown cover: 0	
% projective shrub cover: 0	
% projective cover non-woody introduced species: 5 - 29 %	
Patch size:	
Native tussocks: yes	

TEC Determination: good quality TEC

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-26, 06:19	**Assessor:** Bruce, Mick	**Site No:** 35

Coordinates: 0 m: -22.161, 148.1968; **50 m:** -22.1605, 148.1969

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes:

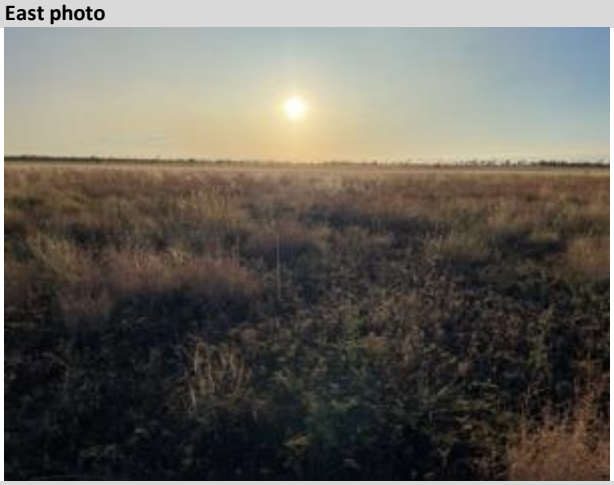
		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	0	na
	Tree species:		
	Non-native cover	3%	0%
50 X 10 m area	**Native shrub species richness**	1	na
	Shrub species: *Vachellia farnesiana*, Sida trichopoda*		
	Native grass species richness	13	11
	Grass species: *Astrebla squarrosa, Aristida latifolia, Eriochloa crebra, Panicum decompositum, Bothriochloa bladhii, Panicum queenslandicum, Cenchrus ciliaris*, Dichanthium sericeum, Iseilema vaginiflorum, Aristida leptopoda, Brachyachne convergens, Bothriochloa pertusa*, Enneapogon* sp., *Urochloa mosambicensis*, Paspalidium globoideum, Sporobolus elongatus*		
	Native forb and other species richness	9	17
	Forb species: *Neptunia gracilis forma gracilis, Parthenium hysterophorus*, Corchorus trilocularis, Desmodium* sp., *Phyllanthus* sp., *Sida spinosa*, Rhynchosia minima, Flemingia parviflora, Trianthema portulacastrum*, Malvastrum americanum var. americanum*, Hemigenia cuneifolia, Vigna lanceolata var. lanceolata, Polymeria longifolia*		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	0%	na
	Average perennial grass cover	27%	43%
	Average organic litter cover	3%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos







Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	7.5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	10
	(i) Native perennial grass cover	5	3
	(J) Litter cover	5	3
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = >75% remnant vegetation.	5	5

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (23.5) +(17) / (30 + 20)

= 0.81

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 35 (11.8.11) is 0.81

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 8 *Astrebla squarrosa, Aristida latifolia, Eriochloa crebra, Panicum decompositum, Panicum queenslandicum, Dichanthium sericeum, Aristida leptopoda, Paspalidium globoideum*
% projective crown cover: 0	
% projective shrub cover: 0	
% projective cover non-woody introduced species: 0 - 4.9 %	
Patch size:	
Native tussocks: yes	

TEC Determination: best quality TEC

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-26, 07:15	**Assessor:** Bruce, Mick	**Site No:** 36

Coordinates: 0 m: -22.1588, 148.1886; **50 m:** -22.1584, 148.1886

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes:

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	0	na
	Tree species:		
	Non-native cover	3%	0%
50 X 10 m area	**Native shrub species richness**	2	na
	Shrub species: *Vachellia farnesiana*, Owenia acidula, Ventilago viminalis*		
	Native grass species richness	10	11
	Grass species: *Heteropogon triticeus, Aristida latifolia, Bothriochloa bladhii, Dichanthium sericeum, Panicum decompositum, Eriochloa crebra, Melinis repens*, Themeda triandra, Cenchrus ciliaris*, Heteropogon contortus, Panicum queenslandicum, Aristida leptopoda*		
	Native forb and other species richness	10	17
	Forb species: *Glycine* sp., *Dianella nervosa, Rhynchosia minima, Oxalis perennans, Parthenium hysterophorus*, Vigna lanceolata var. lanceolata, Phyllanthus maderaspatensis, Neptunia gracilis forma gracilis, Flemingia parviflora, Crotalaria montana, Brunoniella australis*		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	0%	na
	Average perennial grass cover	77%	43%
	Average organic litter cover	5%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos







Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	7.5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	10
	(i) Native perennial grass cover	5	5
	(J) Litter cover	5	3
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = >75% remnant vegetation.	5	5

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (25.5) +(17) / (30 + 20)

= 0.85

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 36 (11.8.11) is 0.85

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 6 *Aristida latifolia, Dichanthium sericeum, Panicum decompositum, Eriochloa crebra, Panicum queenslandicum, Aristida leptopoda*
% projective crown cover: 0	
% projective shrub cover: 0	
% projective cover non-woody introduced species: 0 - 4.9 %	
Patch size:	
Native tussocks: yes	

TEC Determination: best quality TEC

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-26, 07:58	**Assessor:** Bruce, Mick	**Site No:** 37

Coordinates: 0 m: -22.1547, 148.1917; **50 m:** -22.1548, 148.1922

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes:

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	0	na
	Tree species:		
	Non-native cover	2%	0%
50 X 10 m area	**Native shrub species richness**	1	na
	Shrub species: *Ventilago viminalis, Vachellia farnesiana**		
	Native grass species richness	8	11
	Grass species: *Aristida latifolia, Bothriochloa bladhii, Cenchrus ciliaris*, Melinis repens*, Panicum decompositum, Panicum queenslandicum, Dichanthium sericeum, Eriochloa crebra, Astrebla* sp., *Bothriochloa pertusa**		
	Native forb and other species richness	7	17
	Forb species: *Parthenium hysterophorus*, Glycine* sp., *Neptunia gracilis forma gracilis, Brunoniella australis, Sida spinosa*, Corchorus trilocularis, Rhynchosia minima var. minima, Flemingia parviflora, Sclerolaena muricata, Malvastrum americanum var. americanum**		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	0%	na
	Average perennial grass cover	40%	43%
	Average organic litter cover	8%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos



Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 2.5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	10
	(i) Native perennial grass cover	5	5
	(J) Litter cover	5	5
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = >75% remnant vegetation.	5	5

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (25) +(17) / (30 + 20)

= 0.84

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 37 (11.8.11) is 0.84

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 5 *Aristida latifolia, Panicum decompositum, Panicum queenslandicum, Dichanthium sericeum, Eriochloa crebra*
% projective crown cover: 0	
% projective shrub cover: 0	
% projective cover non-woody introduced species: 0 - 4.9 %	
Patch size:	
Native tussocks: yes	

TEC Determination: best quality TEC

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-26, 09:07	**Assessor:** Bruce, Mick	**Site No:** 38

Coordinates: 0 m: -22.1498, 148.1767; **50 m:** -22.1494, 148.1764

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes:

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	1	na
	Tree species: *Eucalyptus orgadophila*		
	Non-native cover	3%	0%
50 X 10 m area	**Native shrub species richness**	0	na
	Shrub species: *Vachellia farnesiana**		
	Native grass species richness	9	11
	Grass species: *Eriochloa crebra, Astrebla squarrosa, Bothriochloa bladhii, Cenchrus ciliaris*, Dichanthium sericeum, Sporobolus elongatus, Panicum queenslandicum, Panicum decompositum, Iseilema vaginiflorum, Aristida latifolia*		
	Native forb and other species richness	7	17
	Forb species: *Parthenium hysterophorus*, Corchorus trilocularis, Rhynchosia minima, Sida spinosa*, Malvastrum americanum var. americanum*, Flemingia parviflora, Sida rohlenae* subsp. *rohlenae, Trianthema portulacastrum*, Cyperus* sp., *Vigna lanceolata var. lanceolata, Pimelea haematostachya, Verbena* sp.		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	5.5%	na
	Sub-canopy cover	0%	na
	Shrub cover	0%	na
	Average perennial grass cover	78%	43%
	Average organic litter cover	7%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos



Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 2.5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	10
	(i) Native perennial grass cover	5	5
	(J) Litter cover	5	5
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = ≥30% to 75% remnant vegetation OR ≥10% to 30% remnant vegetation AND ≥30% regrowth.	5	4

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (25) +(16) / (30 + 20)

= 0.82

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 38 (11.8.11) is 0.82

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 6 *Eriochloa crebra, Astrebla squarrosa, Dichanthium sericeum, Panicum queenslandicum, Panicum decompositum, Aristida latifolia*
% projective crown cover: 5.5	
% projective shrub cover: 0	
% projective cover non-woody introduced species: 0 - 4.9 %	
Patch size:	
Native tussocks: yes	

TEC Determination: best quality TEC

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-26, 10:04	**Assessor:** Bruce, Mick	**Site No:** 39

Coordinates: 0 m: -22.1618, 148.1692; **50 m:** -22.1614, 148.1689

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes:

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	0	na
	Tree species:		
	Non-native cover	17%	0%
50 X 10 m area	**Native shrub species richness**	0	na
	Shrub species:		
	Native grass species richness	5	11
	Grass species: *Bothriochloa bladhii, Cenchrus ciliaris*, Eriochloa crebra, Iseilema vaginiflorum, Heteropogon contortus, Sporobolus elongatus, Enneapogon* sp., *Bothriochloa pertusa**		
	Native forb and other species richness	9	17
	Forb species: *Parthenium hysterophorus*, Corchorus trilocularis, Sida spinosa*, Rhynchosia minima, Malvastrum americanum var. americanum*, Pimelea haematostachya, Flemingia parviflora, Neptunia gracilis forma gracilis, Sclerolaena muricata, Sida rohlenae* subsp. *rohlenae, Lomandra confertifolia* subsp. *confertifolia*		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	0%	na
	Average perennial grass cover	37%	43%
	Average organic litter cover	7%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos



Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 2.5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	5
	(i) Native perennial grass cover	5	3
	(J) Litter cover	5	5
2. Landscape attributes	**(k) Patch size =** ≥100 – 200 ha remnant OR >200 ha remnant and regrowth OR >200 ha regrowth.	10	7
	(l) Connectedness = Connected with adjacent remnant vegetation along >75% of its perimeter OR includes > 500 ha	5	5
	(m) Context = >75% remnant vegetation.	5	5

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (18) +(17) / (30 + 20)

= 0.7

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 39 (11.8.11) is 0.7

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 1 *Eriochloa crebra*
% projective crown cover: 0	
% projective shrub cover: 0	
% projective cover non-woody introduced species: 5 - 29 %	
Patch size:	
Native tussocks: yes	

TEC Determination: does not meet TEC condition thesholds

South32 Eagle Downs Mine BioCondition and Grassland TEC Assessment

Date: 2022-02-26, 11:03	**Assessor:** Bruce, Mick	**Site No:** 40

Coordinates: 0 m: -22.1721, 148.1968; **50 m:** -22.1717, 148.1968

Verified RE: 11.8.11
VM status: Of concern, BD status: Of concern

Benchmark available? yes

Notes:

		Measured	Benchmark ^
100 x 50 m area (0.5 ha)	**Recruitment:**	na	na
	Emergent height	na	na
	Canopy height	na	na
	Sub-canopy height	na	na
	Number of large eucalypt trees (Threshold: na)	na	na
	Number of large non-eucalypt trees (Threshold: na)	na	na
	Native tree species richness	2	na
	Tree species: *Atalaya hemiglauca, Corymbia erythrophloia*		
	Non-native cover	2%	0%
50 X 10 m area	**Native shrub species richness**	3	na
	Shrub species: *Alectryon diversifolius, Atalaya hemiglauca, Vachellia farnesiana**		
	Native grass species richness	12	11
	Grass species: *Themeda triandra, Heteropogon contortus, Aristida leptopoda, Panicum decompositum, Aristida latifolia, Eriochloa crebra, Dichanthium sericeum, Iseilema vaginiflorum, Bothriochloa bladhii, Heteropogon triticeus, Enneapogon* sp.*, Cenchrus ciliaris**		
	Native forb and other species richness	10	17
	Forb species: *Parthenium hysterophorus**, *Neptunia gracilis forma gracilis, Flemingia parviflora, Glycine* sp.*, Cyperus* sp.*, Dianella nervosa, Lomandra confertifolia* subsp. *confertifolia, Rhynchosia minima, Indigofera linifolia, Malvastrum americanum var. americanum**, *Jasminum didymum* subsp. *lineare*		
Plot attributes (actual)	**Emergent cover**	0%	na
	Canopy cover	0%	na
	Sub-canopy cover	0%	na
	Shrub cover	0%	na
	Average perennial grass cover	62.2%	43%
	Average organic litter cover	17%	13%
	Total coarse woody debris (m/ ha):	(x10) = 0	na

^ Benchmark^ (if available) /hectare

North photo



East photo



South photo



West photo



Spot photos



Attribute Scoring		Weighting	Patch score
1. Site-based attributes	**(a) Large trees**	0	na
	(b) Tree canopy height	0	na
	Emergent height: 0		
	Canopy height: 0		
	Subcanopy height: 0		
	(c) Recruitment	0	na
	(d) Tree canopy cover (%)	0	na
	Emergent cover: 0		
	Canopy cover: 0		
	Subcanopy cover: 0		
	(e) Shrub layer cover	0	na
	(f) Coarse woody debris	0	na
	(g) Native plant species richness	10	7.5
	Tree species richness: 0 (na)		
	Shrub species richness: 0 (na)		
	Grass species richness: 5		
	Forb species richness: 2.5		
	(h) Non-native plant cover	10	10
	(i) Native perennial grass cover	5	5
	(J) Litter cover	5	5
2. Landscape attributes	**(k) Patch size =** ≥200 ha remnant.	10	10
	(l) Connectedness = Connected with adjacent remnant vegetation along >10% to <50% of its perimeter OR is	5	2
	(m) Context = ≥30% to 75% remnant vegetation OR ≥10% to 30% remnant vegetation AND ≥30% regrowth.	5	4

BioCondition score

= (a + b + c + d + e + f + g + h + I + j) + (k + l + m) / y^ + z^

= (27.5) +(16) / (30 + 20)

= 0.87

^ y = total weighting for site-based attributes, z = total weighting for landscape

Total BioCondition score for Site 40 (11.8.11) is 0.87

Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Assessment	
Distribution: Occurs within the Brigalow Belt subregion	**Number if indicator species**: 5 *Aristida leptopoda, Panicum decompositum, Aristida latifolia, Eriochloa crebra, Dichanthium sericeum*
% projective crown cover: 0	
% projective shrub cover: 0	
% projective cover non-woody introduced species: 0 - 4.9 %	
Patch size:	
Native tussocks: yes	

TEC Determination: best quality TEC