Foxleigh Progressive Rehabilitation Closure Plan

Foxleigh Coal Mine

CAML Resources Pty Ltd, Nippon Steel Australia Pty Limited, Foxleigh Coal Pty Ltd

Prepared for: Department of Environment and Science

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APPENDICES

Appendix A: Environmental Authority EPML00744813

Appendix B: Queensland Department of Environment and Science (26 July 2021) Progressive rehabilitation and closure plan Transition Notice. Ref. EPML00744813

Appendix C: Department of Environment and Science (11 May 2021) Meeting minutes Foxleigh Coal Mine – Initial PRCP Transition Meeting.

Appendix D: Hansen Bailey (2 April 2012) Foxleigh Plains Project Socio-economic Impact Assessment

Appendix E: Foxleigh Land (12 September 2018) Infrastructure Written Agreement 1

Appendix F: Rees R & Sydney Jones (15 March 2018) ML70171- Agreement for Sale and Purchase - Small

Appendix G: Foxleigh (2023) Stakeholder Engagement Plan

Appendix H: Engeny (August 2023) PRCP Flood Assessment

Appendix I: Groundwater Functions (November 2022) Report on Groundwater Modelling of Foxleigh Coal Mine. Report reference GWF21/01

Appendix J: Engeny (16 May 2023) Foxleigh Landform PRCP Assessment QC1025_011-REP-001-1

Appendix K: RGS Mine Waste and Water Management (20 October 2021) Geochemical characterisation of mining waste, coal, and soil.

Appendix L: Henderson Geotech Pty Ltd (July 2023) Cover Designs for CHPP Waste

Appendix M: Engeny (August 2023) PRCP Residual Voids Geotechnical Assessment

Appendix N: Cartledge Mining and Geotechnics (May 2022) Standard Geotechnical Design Guidelines. MMS010002-AA_Rev 2

Appendix O: WRM (24 March 2023) Final Void Hydrology Report

Appendix P: PRCP Risk Assessment

Appendix Q: Engeny (3 May 2023) Contaminated Lands Guidance QC1025_005-RPT-001-1

Appendix R: Department of Environment and Heritage Protection (1 July 2013) Environmental Impact Assessment Report under the Environmental Protection Act 1994 for the Foxleigh Plains Project.

Appendix S: Part B – PRCP Schedule

Introduction

Foxleigh Mine (Fox), is a metallurgical coal resource located in the Bowen Basin, Queensland. Environmentally relevant activities at Fox are mining black coal, mineral processing, chemical storage, fuel burning, extractive and screening activities and crushing, milling grinding or screening, regulated waste storage and waste disposal. These are undertaken under the conditions of the site's Environment Authority (EA) EPML00744813.

This transitional Progressive Rehabilitation and Closure Plan (PRCP) has been prepared for Fox in accordance with the requirements of the *Mineral and Energy Resources (Financial Provisioning) Act 2018* (MERFP Act). This PRCP has been developed to meet the requirements of the *Environmental Protection Act 1994* (EP Act) and the Progressive Rehabilitation and Closure Plan Guideline (PRCP Guideline) (DES, 2021).

The EA (**Appendix A**) is the land outcome document (LOD) for this transitional PRCP; the EIS Assessment Report is considered a supplementary LOD (see **Appendix Q**).

Table 1: EA Details of Tenements

Environmental Authority Holder:	**CAML Resources Pty Ltd** **Nippon Steel Australia Pty Ltd** **Foxleigh Coal Pty Ltd**
Environmental Authority Number:	EPML00744813 (11 August 2023)
Environmentally Relevant Activities:	ERA13 Mining black coal ERA 31 Mineral processing, Threshold 2 – Processing, in a year, the following quantities of mineral products, other than coke – (b) more than 100,000t. ERA 8 Chemical storage, Threshold 3 – Storing more than 500m3 total quantity of chemicals of Class 1 or C2 combustible liquids under AS 1940 or dangerous goods class 3 under subsection 1(c). ERA 15 Fuel burning – Using fuel burning equipment that is capable of burning at least 500kg of fuel in an hour. ERA 16 Extractive and screening activities, Threshold 3 – Screening, in a year, the following quantity of material – (c) more than 1,000,000t. ERA 33 Crushing, milling grinding or screening – Crushing, grinding, milling or screening more than 5,000t of material in a year. ERA 56 Regulated waste storage – Receiving and storing regulated waste. ERA 60 Waste disposal, Threshold 1 – Operating a facility for disposing of, in a year, the following quantity of waste mentioned in subsection (1)(a) – (a) less than 50,000t
Tenements:	ML 70171, ML 70309, ML 70310, ML 70429, ML 70430, ML 70431, ML 70470

This PRCP comprises two parts:

- *Section A:* Rehabilitation planning - provides information about the site, the rehabilitation plans, and evidence and justification to support the development of the proposed PRCP schedule; and

- *Section B:* PRCP schedule - includes maps of rehabilitation and closure outcomes for the site, and tables of time-based rehabilitation milestones.

Transitional Provisions

Part 27, Chapter 13 of the EP Act sets out the transitional provisions following the commencement of the MERFP Act. In particular, CAML Resources Pty Ltd, Nippon Steel Australia Pty Ltd and Foxleigh Coal Pty Ltd is a 'mining EA holder' for the purposes of the transitional provisions on the basis that, on commencement of the MERFP Act, they were "the holder of an EA (EPML00744813) for a mining activity relating to a mining lease authorising operation" at Fox (Section 750, EP Act).

Furthermore, Section 6 of the PRCP Guideline makes provision for "*existing EA holders who must transition into the new PRCP framework*". As Fox has an approved EA, the site falls under the ambit of the requirements of a transitional PRCP.

Based on the requirements of Section 6 of the PRCP Guideline, the following are applicable to this PRCP:

- A Transition Notice for Fox was issued to Foxleigh Management Pty Ltd (FoxMan), the Operator of the Joint Venture (JV) by the Administrating Authority, dated 26 July 2021. This Transitional Notice requires submission of the Foxleigh PRCP by 1 September 2023 (**Appendix C**).
- The site's Transitional Notice was issued following a pre-notification meeting held between the Administrating Authority and FoxMan, on 11 May 2021 and 21 July 2021. This PRCP is based on the key aspects agreed on by the Administrating Authority during this meeting, as documented in the memo (**Appendix D**).

Aligned to the above, and the PRCP Guideline requirements, the following process for transitioning rehabilitation and closure outcomes from Fox's EA into the site's PRCP schedule has been followed:

- Identifying rehabilitation and closure outcomes in the LOD (EA EPML00744813).
- Identifying post-mining land uses (PMLUs).
- Identifying non-use management areas (NUMAs).
- Defining rehabilitation areas within the PMLU, or improvement areas within the NUMA.
- Identifying rehabilitation milestones.
- Identifying milestone criteria.
- Identifying when the first rehabilitation milestone must commence, and associated completion dates.

Knowledge Base Refinement

Compilation of this PRCP has been supported by the rehabilitation and closure-related knowledge base for Fox at the time of submission of this PRCP (1 September 2023). Relevant studies contributing to this knowledge base have been referenced throughout this PRCP, with key resources provided in the Appendices.

As highlighted by the International Council of Mining and Metals (ICMM) in the Integrated Mine Closure Good Practice Guide, 2nd Edition (2019), *"the collection, updating, use and review of the knowledge base is considered an ongoing and iterative process over the mine life, and will be used to inform iterative refinement and improvement of the rehabilitation and closure planning process over time*". As the rehabilitation and closure knowledge base for Fox develops over time, it will be used to inform ongoing refinement of this PRCP as required.

3. A: Rehabilitation Planning

3.1. Project Planning

Legislative Requirement

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:

- *each resource tenure, including the area of each tenure*
- *the relevant activities to which the application relates*
- *the likely duration of the relevant activities*
- *how and where the relevant activities are to be carried out, including maps.*

PRCP Guideline

The following spatial information must be submitted as part of the PRC Plan:

the location and maximum extent of disturbance footprint for the mine life

- *the PMLUs and NUMAs for the area within the resource tenures*
- *any sensitive receptors.*

In addition to the list above, the PRC Plan must include spatial information outlining the rehabilitation and improvement areas that correspond to the proposed PRCP Schedule. The spatial information must show the locations of the rehabilitation and improvement areas for a 10-year period (minimum).

_____

All spatial information must be prepared and submitted in accordance with the guideline 'Spatial Information

3.1.1. Project Description

Geographic Location

Fox is located 12 km south of the town of Middlemount in the Bowen Basin. The location is displayed in Figure 3-2. Other coal mines located near Fox include Middlemount Coal ~16 km to the northwest, Oak Park ~8 km to the south-west, and Lake Lindsay ~10 km to the south.

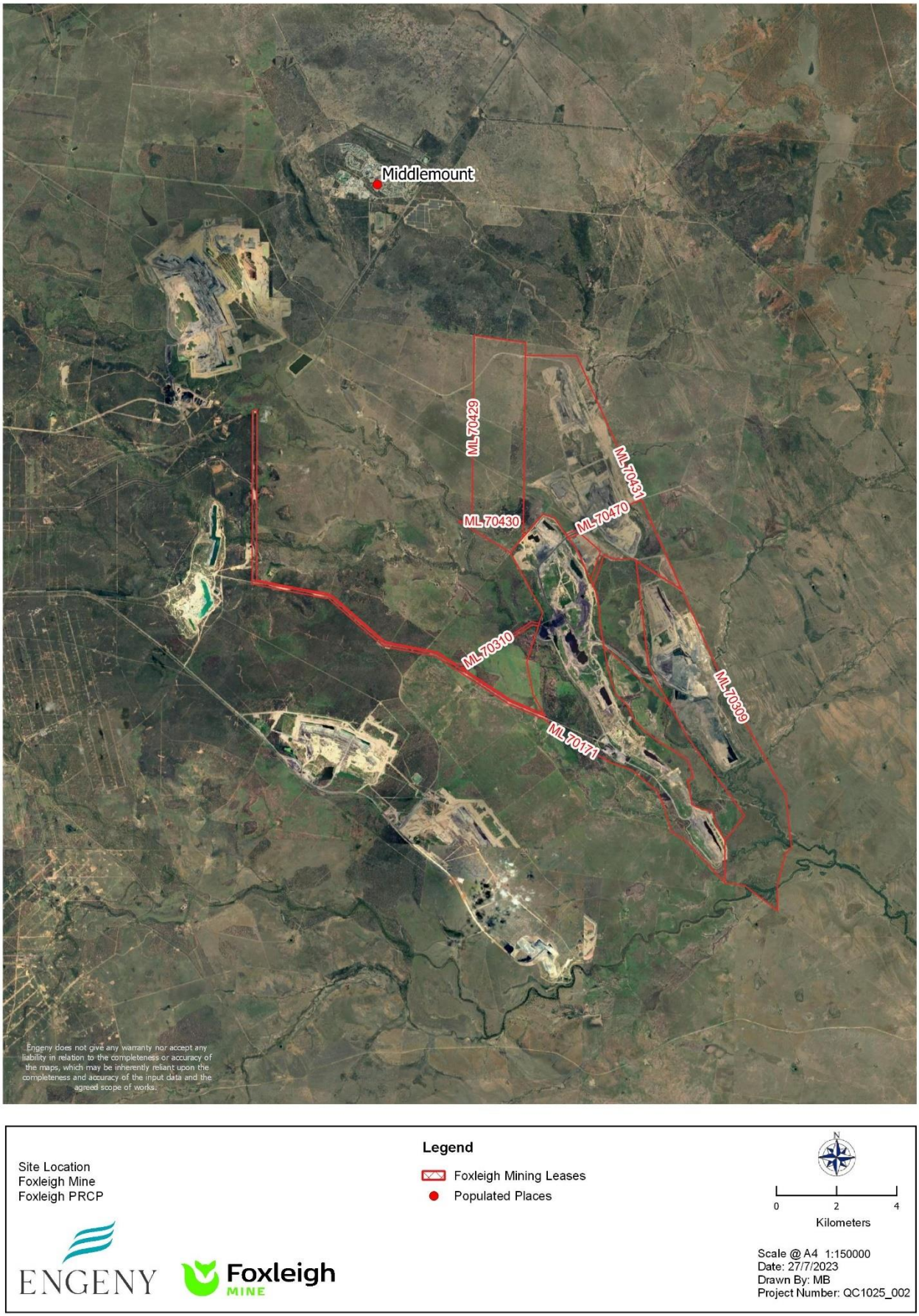


Figure 3-1: Fox Location Map

Mining Tenements

Fox operates on the mining leases (MLs) provided in Table 3-1 and illustrated in Figure 3-2. The Fox EA covers 8,505 hectares (ha).

Table 3-1: Fox Mining Tenements

ML Permit	Permit ID	Authorised Holder Name	Lodge Date	Grant Date	Expiry Date	Area (ha)
ML70171	109623	CAML Resources Pty Ltd	18 January 1999	4 November 1999	30 November 2034	2,495
ML70309	109670	CAML Resources Pty Ltd	18 December 2002	28 October 2004	30 November 2034	2,042
ML70310	109671	CAML Resources Pty Ltd	18 December 2002	2 October 2015	30 November 2034	171
ML70429	109772	CAML Resources Pty Ltd	18 March 2010	22 September 2014	30 November 2034	1,038
ML70430	109773	CAML Resources Pty Ltd	18 March 2010	22 September 2014	30 November 2034	123.1
ML70431	109774	CAML Resources Pty Ltd	6 May 2010	22 September 2014	30 November 2034	2,636
ML70470 (note this ML overlaps with ML70431)	111399	CAML Resources Pty Ltd	21 December 2011	13 November 2012	30 November 2034	434.8

Figure 3-2: Fox Mining Tenements

Primary Mine Features and Infrastructure On-site

The main features and infrastructure approved within the EA for FoxMan are summarised in Table 3-2. The current site layout is shown in Figure 3-3.

Major facilities existing at the mine covered by the EA include:

- CHPP.
- Private haul road for delivery of coal to the Capcoal Mine Rail loop (partial sections).
- Workshop and associated fuel storage and washdown bay.
- Mine Industrial Area (MIA).
- Car parks.
- First aid station and administration offices.
- Explosive magazine.
- Haul road and stockpile hardstands.
- Raw water storage.
- Dirty water and settlement ponds.
- Tailings disposal facilities.
- Fuel storage.
- Power lines, connecting MCC and Transformer at CHPP, and
- Fencing.

Table 3-2: Primary Mine Features and Infrastructure on Site

Mine domain	Description	
Voids	Fox Plains Pit	WC Pit
	Fox Plains North Pit	North WC Pit
	Pipeline Pit	Old NE Pit
	Carlo Creek Pit	NW Pit
	One Tree Pit	NE Pit
	Far South Pit	Void 251
Overburden Dump Piles	OOPD01	OOPD27
	OOPD02	OOPD29 – Old NE
	OOPD03 – Far South	OOPD31 – Old NE
	OOPD04	OOPD32
	OOPD05	OOPD33 – NE
	OOPD06- WC Pit	OOPD34
	OOPD08	OOPD38
	OOPD09- Carlo Creek	OOPD40 – Old NE
	OOPD11	OOPD41 – NW
	OOPD15	OOPD42
	OOPD16 – Pipeline	OOPD43
	OOPD18 – WC North	OOPD44
	OOPD20	OOPD45 – NE
	OOPD21	OOPD46
	OOPD22 – One Tree	OOPD47

Mine domain	Description	
	OOPD23 – Cockatoo Creek OOPD24 OOPD25	OOPD48 – Fox Plains OOPD49 – Fox Plains North OOPD25
Processing Equipment	Coal handling and preparation plant (CHPP) Conveyors and gantries Silo / bin/ hoppers Tank	Aprons/ Sealed areas Concrete Pads and Footings Fences
Infrastructure	Laydown areas (earthen) Laydown areas (gravel/crushed rock)	Access roads Haul roads
Water Storage and Management	Cockatoo Creek ROM Sediment Dam DM02 CHPP Raw Water Storage CHPP ROM Sediment Dam NT Sediment Dam West Workshop Flood Dam Helipond Dam 1	Helipond Dam 2 DM11 Telephone Dam DM19 DM23 Admin Dam
Miscellaneous Activities	Stripped areas Levees	Levees
Tailings Storage Facilities	Old NT Pit (Coarse Rejects)	NT Pit (Tailings) Void 251 (Tailings)

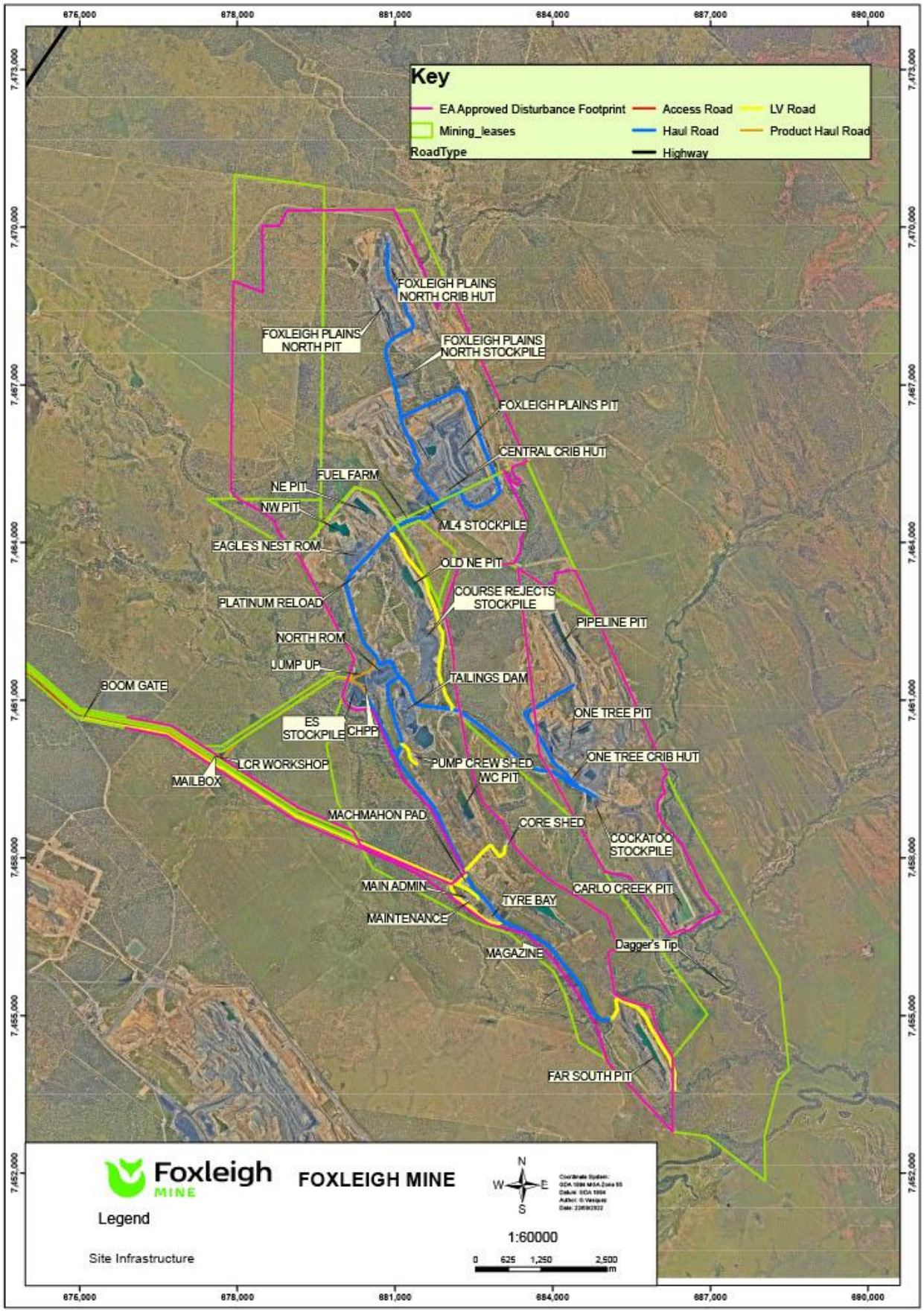


Figure 3-3: Fox Current Site Layout (Engeny, 2023)

Type of Mining Operation

Fox is a conventional open cut mine using truck and shovel fleets. Mining activities occur across multiple pits. Mining commenced at the outcrop of the coal seam to the east of Roper Creek. The overburden is dumped in-pit or into an external Out of Pit Dump (OPD). This method is called “terrace mining”.

The CHPP is located on ML 70171 to the west of the mine. Fine tailings and coarse rejects are disposed to in-pit tailings facilities.

Proposed Duration of Operation

Operations at Fox commenced in December 1999 and based on current approvals and PRCP Life of Mine Plan (LOMP), are expected to continue until 2054.

3.1.2. Baseline Information

PRCP Guideline (Section 3.1)

In addition to the legislative requirements, the following information about the site, where relevant, is considered necessary by the administering authority (as per section 126C(1)(j) of the EP Act) to decide whether to approve the PRCP Schedule:

- *site topography (locally and regionally)*
- *climate (general and specific (rain, evaporation, temperatures)) including long-term projections*
- *geological setting*
- *site hydrology and fluvial networks*
- *groundwater levels and properties*
- *soil types, properties, and productivity*
- *land stability (pre-existing land degradation/erosion and predisposition to ongoing stability issues)*
- *vegetation communities and ecological data (including existing regional ecosystem mapping)*
- *fauna presence and populations*
- *pre-mining land use*
- *identification of underlying landholders*

Transitional PRC Plans must include any baseline information collected as part of an EIS process or original EA application. If this information is unavailable, the reasons should be explained in this section of the rehabilitation planning part. Transitional PRC Plans are not required to demonstrate how aspects of the mine site have been designed for closure for existing or approved disturbance. However, any expansion to an existing site must demonstrate how it has been designed for closure. The rehabilitation/improvement planning must include data from when mining first commenced up until planned surrender. The transitional provisions of the EP Act include an exceptional circumstance for when land is available for rehabilitation.

Site Topography

Regional topography surrounding Fox is generally flat. Fox is situated ~30 km to the east of the Peak Ranges, where the headwaters of Roper Creek and Oaky Creek are located. The general drainage direction of watercourses in the Fox regional area is south-east.

Fox consists of gently undulating slopes, alluvial plains and river terraces (GSS Environmental, 2011). Average surface topography at Fox is ~140 mAHD. The site’s surface topography is displayed in Figure 3-4: Current Surface Topography at Fox .

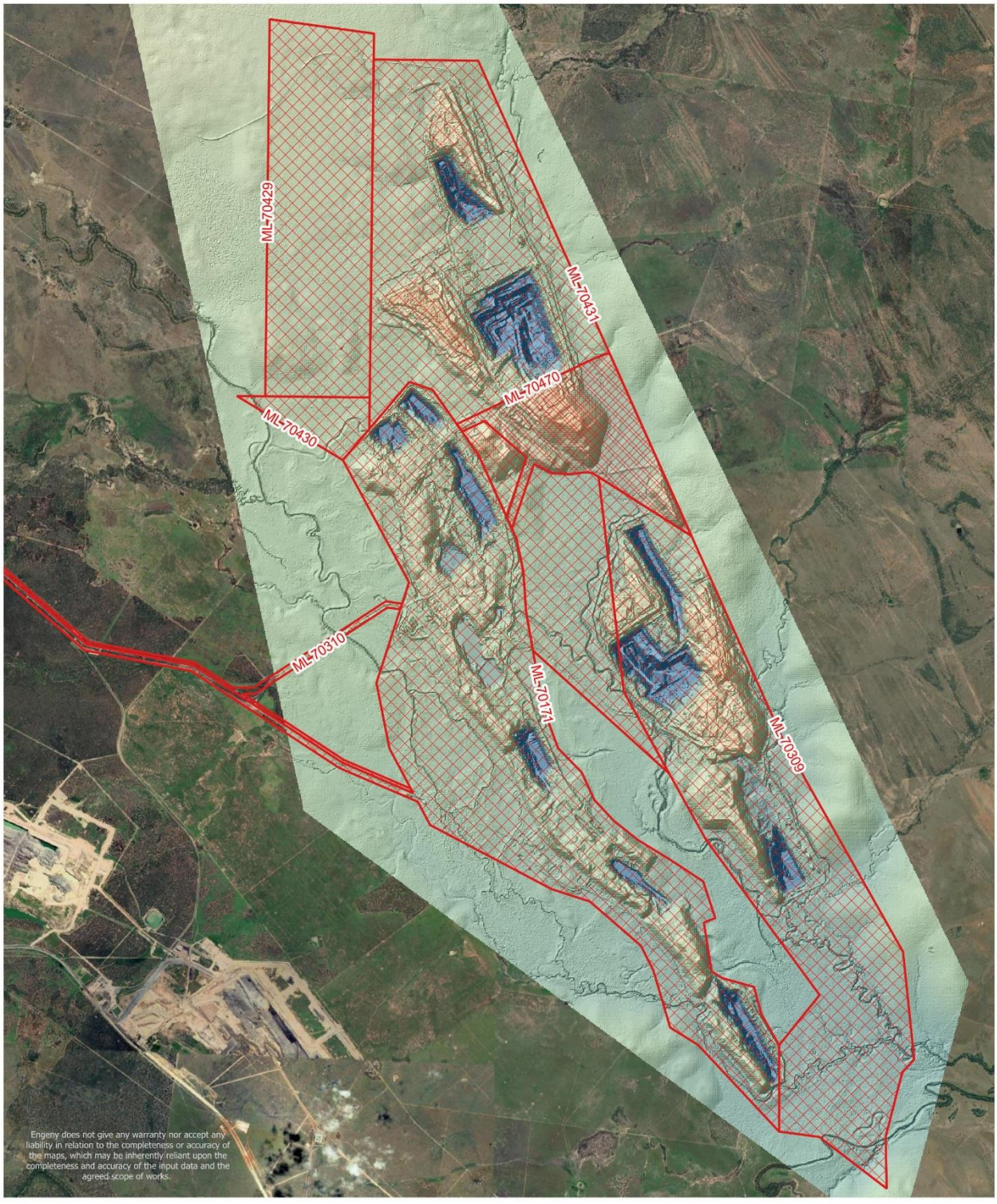


Figure 3-4: Current Surface Topography at Fox (Lidar Data from January 2023)

Climate

Fox is located in a subtropical climatic zone, which is characterised by high summer temperatures, warm dry winters and a distinct wet and dry season (BOM, 2016). Weather data was collected at the Emerald Airport (Station No. 035264) ~ 100 km from site (BOM, 2022) between 1992 and 2022. Since 2019, it has also been collected at Fox (Site Number. 331360). Climate data from 1992 to 2023 is presented in Table 3-3 and summarised in the following sections. Evaporation data is available from 2010 to 2023.

Table 3-3: Monthly climate statistics from Station No. 035264 and Fox weather station (BOM, 2022; Queensland Government, 2023).

Month	Mean Rainfall (mm) (BOM, 2022)	Mean Maximum Temperature (BOM, 2016)	Mean Minimum Temperature (BOM, 2022)	Mean number of days >=30°C (BOM, 2022)	Mean number of days >=35°C (BOM, 2022)	Mean number of days >=40°C (BOM, 2022)	Mean Evaporation (mm) (Queensland Government, 2023)*
January	80.4	34.7	22.3	28.7	15.2	1.2	223.4
February	84.8	33.9	22.1	25.2	10.5	1	175.2
March	58.9	32.9	20.5	27.2	6.5	0.4	172.1
April	29.0	30.0	17.1	16.6	0.5	0	142.2
May	22.4	26.4	13.2	2	0	0	114.5
June	29.7	23.4	10.3	0.1	0	0	90.8
July	18.6	23.4	9.1	0.2	0	0	99.8
August	20.4	25.5	10.1	2.4	0.1	0	135.1
September	25.1	29.1	13.6	12.1	1.4	0	170.8
October	44.4	31.9	17.2	23.1	5.7	0.4	209.2
November	55.8	33.4	19.5	25.6	10.1	0.7	225.9
December	80.0	34.4	21.4	27.9	14.1	1.8	236.6
Annual	543.2			191.1	64.1	5.5	

Temperature

Maximum average temperatures range from 23.4°C in June/July to 34.7°C in January, with minimum average temperatures ranging from 9°C in July to 22°C in January (BOM, 2022).

Rainfall

Rainfall is more prevalent in the summer months during the wet season (December, January and February).

Evaporation

Monthly mean evaporation exceeds rainfall all year round (Queensland Government, 2023) and is greater in the summer months from November to January. The lowest mean monthly evaporation occurs in June.

Wind

Wind records for Emerald Airport for January-March show an easterly predominance of moderate strength (1-30 km/h). Moderate southerly winds (<40 km/h) dominate from April to July. The dominate wind direction switches back to easterlies of a moderate strength from August to December (<40 km/h) (BOM, 2022).

Long-term Climate Projections

Long term temperature data for the Fitzroy Basin is available from the Queensland Future Climate Dashboard (Queensland Government, 2023). Under the Representative Concentration Pathway (RCP) 8.5 Scenario (little curbing of emissions with CO_2 concentration continually rising), temperature, rainfall and evaporation are expected to change. The proportion of change expected for each parameter relative to the reference period (1986 – 2005) is displayed in Table 3-4.

Table 3-4: Projected Rainfall, Temperature and Evaporation Change in 2030, 2050, 2070 and 2090 (Queensland Government, 2023)

	Change in Rainfall (%)			Change in Temperature (°C)	Change in Evaporation (%)		
Year	Annual 50th Percentile	Wet Season 50th Percentile	Dry Season 50th Percentile	Annual 50th Percentile	Annual 50th Percentile	Wet Season 50th Percentile	Dry Season 50th Percentile
2030	1.8	-1.7	-4.5	1.1	6.8	6	0.24
2050	-3.8	-0.02	-9.7	2	16	16	0.56
2070	-3.4	0.07	-19	3.2	24	22	0.92
2090	-2.4	5.8	-26	4.2	31	30	1.7

Geological Setting

Regional

Fox is situated in the central Bowen Basin at the northern end of the Taroom Trough. The Bowen Basin contains Permian to Triassic age sediments. The maximum thickness of the basin is 9,000 m in the depocenter of the Taroom Trough. The depositional history of the Bowen Basin is complex; individual formations are not laterally extensive or easy to correlate across the Basin (Groundwater Functions Pty Ltd, 2023)

Local

The stratigraphy relevant to the project is displayed in Figure 3-5. Descriptions of each formation, from youngest to oldest, are displayed in Table 3-5.

Table 3-5: Geological Description of Stratigraphic Units (Groundwater Functions Pty Ltd, 2023)

Age	Formation Name	Deposit	Description
Quaternary	Alluvial Deposits	Qpa/Qa	Associated with existing creek and river network and colluvial fringing deposits. Broad deposits of floodplain are present in the south of FoxMan.
Tertiary	Duaringa Formation	Tu	Poorly consolidated sediments, including sandstone, mudstone and Tertiary intrusive rocks.
Early Triassic	Rewan Formation	Rr	Mustone, siltstone and clayey sandstone.
Late Permian	Rangal Coal Measures	Pwj	Target unit of the FoxMan operations, subcropping in the western and eastern margins of the site. Comprises of interbedded sandstones, siltstones, mudstones and coal.

Age	Formation Name	Deposit	Description
Late Permian	Burngrove Formation	Pwg	Comprises of siltstone, claystone, sandstone, mudstone and coal. Outcropts to the west of FoxMan.
Late Permian	Fair Hill Formation	Pwt	Comprises of lithic and feldspatic sandstone, minor siltstone and sub-economic coal seams (Hercules, Canis, Lepis and Fair Hill seams).

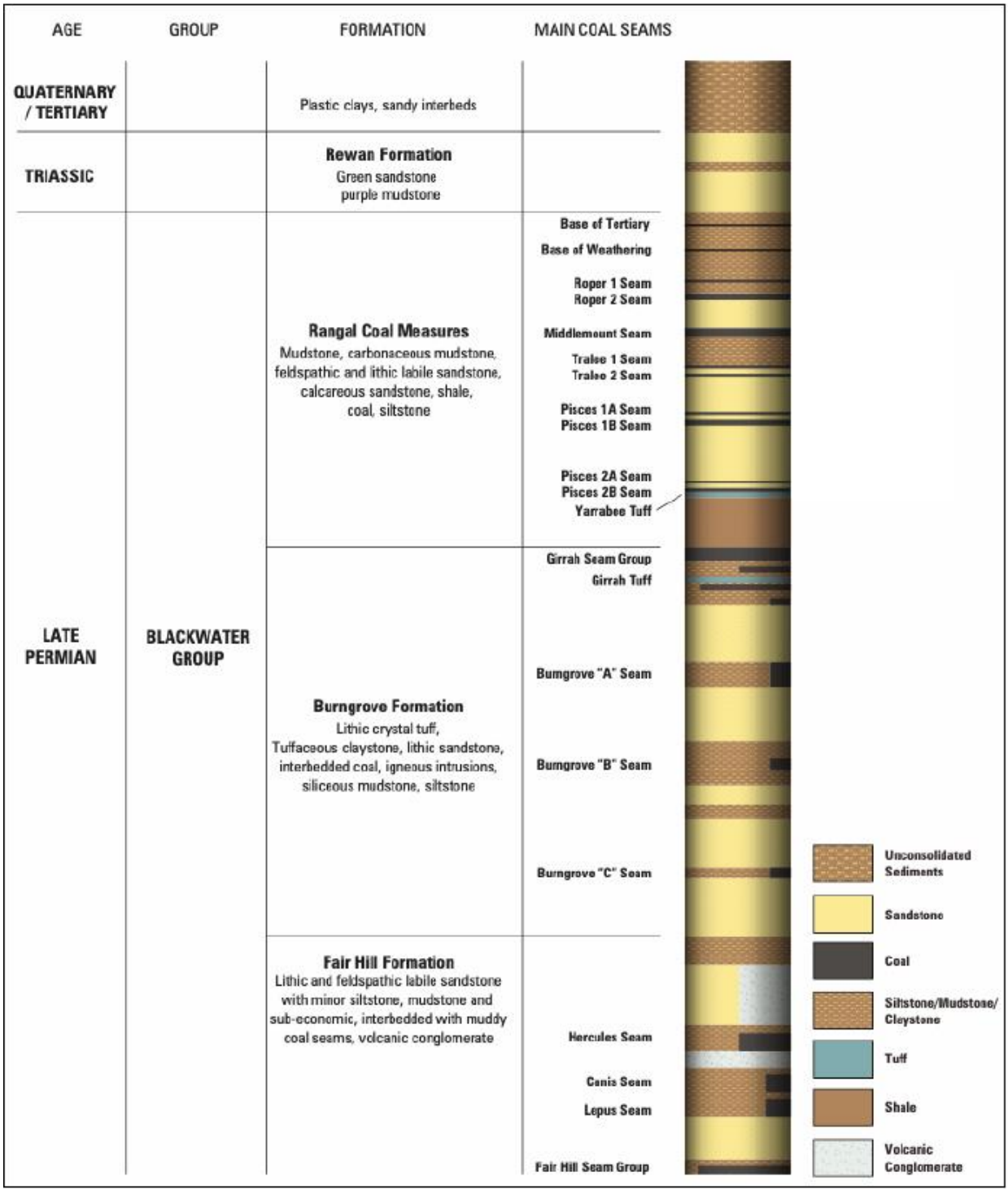


Figure 3-5: Stratigraphic Column for Fox Site (Groundwater Functions Pty Ltd, 2023)

Site Hydrology and Fluvial Networks

Regional

The regional drainage network occurs in a south-easterly direction. The surface water Environmental Values for the Mackenzie north-western tributaries are detailed in the Queensland Government (2011) Mackenzie River Sub Basin Environmental Values and Water quality Objectives Basin No. 130 (part), including all water of the Mackenzie River Sub-basin (Queensland Government, 2011) and summarised in Table 3-6.

Table 3-6: Surface Water Environmental Values

Environmental Value	Mackenzie North-Western Tributaries – Developed Areas Applicability
Aquatic Ecosystems	✓
Irrigation	
Farm Supply	
Stock Water	✓
Aquaculture	
Human Consumer	✓
Primary Recreation	✓
Visual Recreation	✓
Drinking Water	✓
Industrial Use	✓
Cultural and Spiritual Value	✓

Local

Fox is located within the Fitzroy drainage basin, specifically in the Mackenzie River catchment. Fox is located in the Mackenzie North-Western Tributaries. Drainage throughout Fox occurs in a north to south direction. Waterways across the site are ephemeral; flows strongly correlate with rainfall (GSS Environmental, 2011). The location of Fox in relation to regional drainage is displayed in Figure 3-6.

Fox leases cover approximately 68km^2, which is approximately 0.05% of the Fitzroy Basin (142,500km^2) and 0.3% of the Isaac River Sub-basin (22,470km^2). The sub-catchment of the Isaac Western Upland Tributaries, in which Fox is predominantly located, is extensively mined along the coal strike running north-south between the Goonyella Riverside Mine in the north to Norwich Park Mine at the southern sub-catchment boundary.

Waterways in proximity to Fox leases are displayed in Figure 3-7: and summarised in Table 3-7.

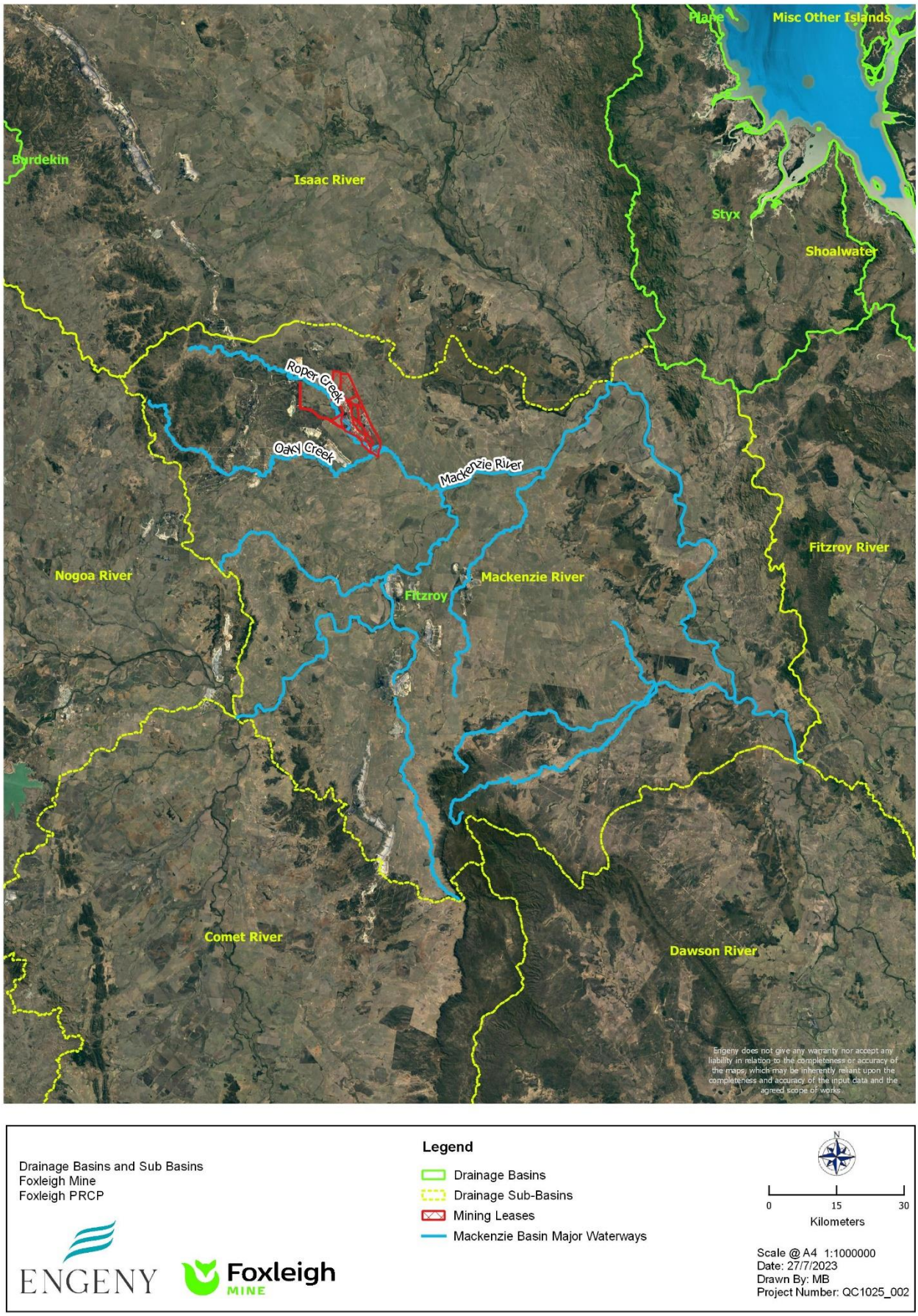


Figure 3-6: Surrounding Basins and Catchments to Fox

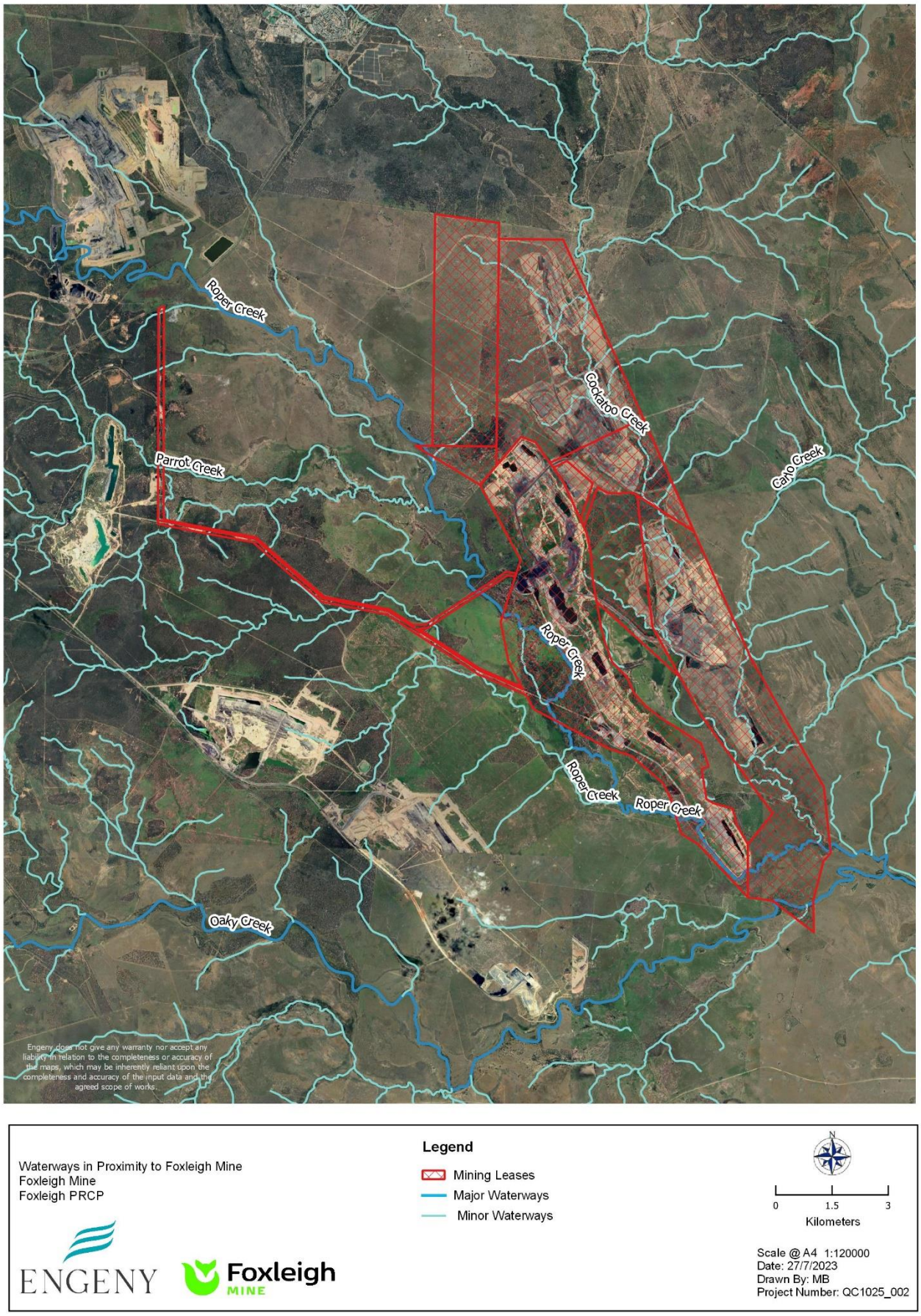


Figure 3-7: Waterways in Proximity to Foxl

Table 3-7: Waterways within the Immediate Proximity of Fox

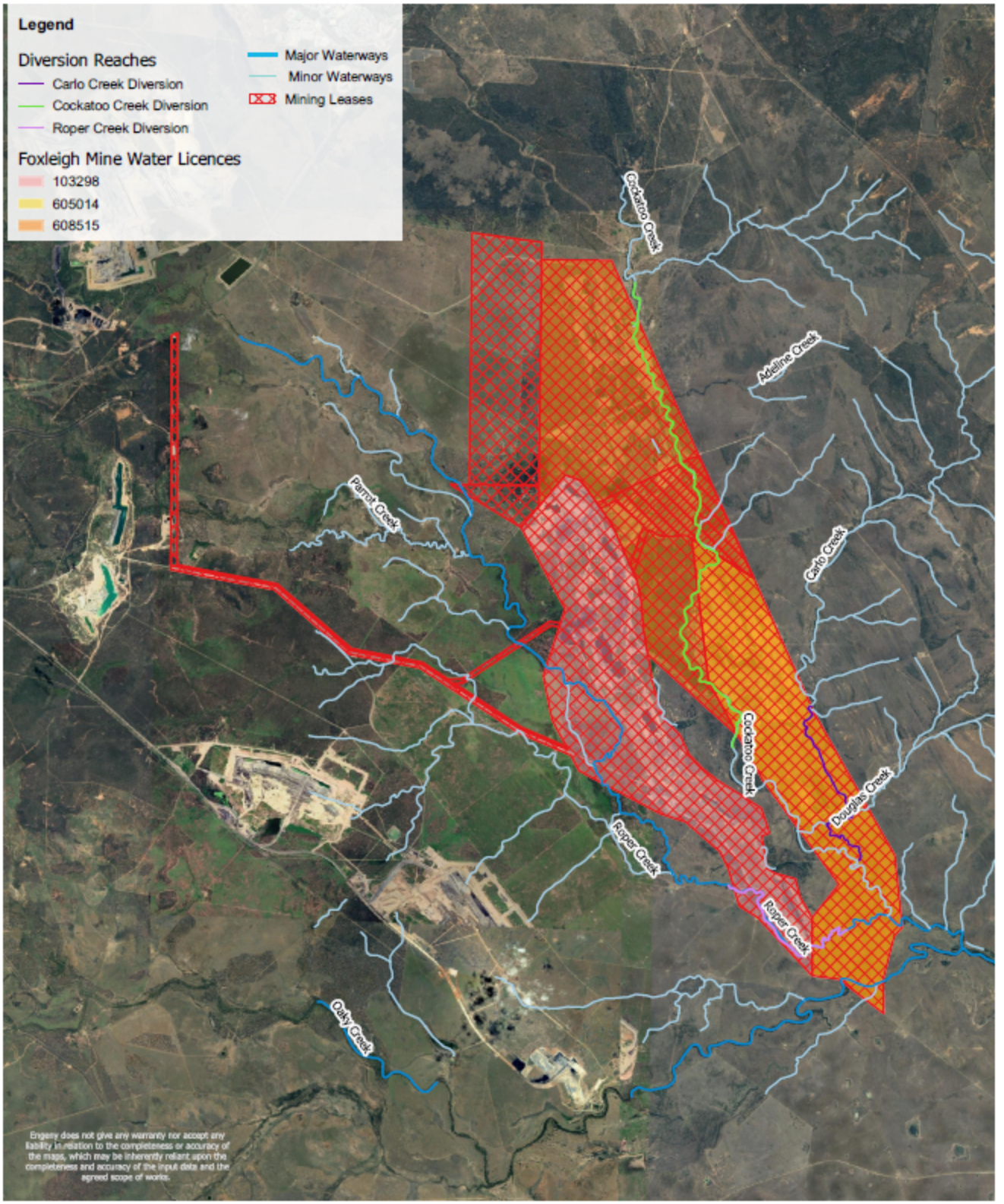
Watercourse	Perennially	Hierarchy	Strahler Stream Order	Comment
Cockatoo Creek	Non-Perennial	Minor	3, 4	Rises 5 km NW of Middlemount and enters the site at the northern end of ML 70431. It is currently diverted along the north-east perimeter of Foxleigh Plains North pits and to the northwest of One Tree Pit (Groundwater Functions Pty Ltd, 2023)
Carlo Creek	Non-Perennial	Minor	4	Drains land to the east of Fox. Converges with Cockatoo Creek to the south of the mine. It has been diverted around Carlo Creek pit into Douglas Creek before converging with Cockatoo Creek (Groundwater Functions Pty Ltd, 2023)
Roper Creek	Non-Perennial	Major	4, 5	Flows south-east on the western side of FoxMan (intersecting ML 70171) before joining Oaky Creek to the south of ML 70309 (Groundwater Functions Pty Ltd, 2023)
Parrot Creek				Rises to the west of the site around Bundoora and German Creek East mines. Converges with Roper Creek (Groundwater Functions Pty Ltd, 2023)
Oaky Creek	Non-Perennial	Major	5	Roper Creek joins Oaky Creek ~2 km southeast. It joins with the Mackenzie River approximately 17 km south-east of the Fox site (Groundwater Functions Pty Ltd, 2023)

Water Licences

Table 3-8 outlines the water licences issued under the *Water Act 2000.* There are three licenced watercourse diversions at Fox. Their locations are displayed in Figure 3-8. Carlo and Cockatoo Creeks have diversion channels directing water flow around the open cut pits and through the lease. Both creeks eventually flow into Roper Creek before entering the Mackenzie River upstream of the Bingegang Weir.

Table 3-8: Water Licences Applicable to Fox (Foxleigh Mine, ND)

Approval number	Approval name	Approval date (most recent update)	Expiry
605014	Carlo Creek Diversion	7 January 2015	30/06/2111
103298	Roper Creek Diversion	23 December 2014	30/06/2111
608515	Cockatoo Creek Diversion	9 March 2020	30/06/2111



Licensed Watercourses in Proximity to Foxleigh Mine
Foxleigh Mine
Foxleigh PRCP

ENGENY

Foxleigh MINE

0 1.5 3
Kilometers

Scale @ A4 1:120,000
Date: 30/8/2023
Drawn By: HB
Project Number: QC1025_002

Water Catchment Areas

The onsite water catchment areas are listed in Table 3-9.

Table 3-9: Water Balance Model Catchment Areas at Fox (Foxleigh Mine, ND)

2021 Water Balance Model Catchment Areas		
ID	**Name**	**Area (ha)**
1	Far South Pit	112
2	WC Pit	97
3	Workshop Flood Dam	32
4	Admin Dam	27
5	HeliPond Dam 1	1
6	WC Spoil Area	61
7	Carlo Creek Pit	193
8	HeliPond Dam 2	16
9	CC Sed Dam 1	31
10	WC North Pit	96
11	OTW Pit	300
12	NT Pit	126
13	NT Sed Dam West	41
14	CHPP ROM Sed Dam	24
15	Raw Water Dam	1
16	Rejects Ramp 1 and 2	57
17	Process Water Dam	2
18	Old Diversion	69
19	10000 Dam	1
20	Pipeline Pit	315
21	Void 251	91
22	Old NE Pit	243
23	NW Pit	70
24	NE Pit	78
25	FP Pit	365
26	Kennys Lagoon	652
27	Carwash Dam	0.04
28	FPN Pit	130
29	Kennys Dam	457

3.1.3. Hydrogeology

A groundwater modelling study was undertaken by appropriately qualified consultants to support the development of this PRCP (Groundwater Functions Pty Ltd, 2023).

Groundwater Environmental Values

Fox is located within the Mackenzie Groundwaters Environmental Values area. The groundwater chemistry zones of the Fox site overlap the "Sodic sequence" which was saline (sodium and chloride) dominated, as well as the "alluvial sequence" which was low-moderate salinity (balanced cations bicarbonate and chloride) Queensland Environment Protection (Water and Wetland Biodiversity) Policy (2009) Mackenzie River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (Part) and Schedule 1 plan WQ1310 - Fitzroy Basin Groundwater Zones Basin 130). Table 3-10 summarises the Environmental Values (EV's) of the Mackenzie Groundwater Environmental values area.

Table 3-10: Groundwater Environmental Values

Environmental Value	Mackenzie Groundwaters Applicability
Aquatic Ecosystems	✓
Irrigation	✓
Farm Supply/Use	✓
Stock Water	✓
Aquaculture	-
Human Consumer	-
Primary Recreation	-
Secondary Recreation	-
Visual Recreation	-
Drinking Water	✓
Industrial Use	✓
Cultural and Spiritual Value	✓

The groundwater monitoring network at Fox is displayed in Table 3-11 and Figure 3-9: . Details from the hydrogeological report are presented in the following sub-sections.

Table 3-11: Fox Groundwater Standpipe Monitoring Network (Groundwater Functions Pty Ltd, 2023)

Bore ID	Easting	Northing	Elevation	Total depth (mbgl)	Formation
P1	680902.9	7459872.3	133.6	29.0	Burngrove
P2	679970.8	7460933.4	134.4	25.5	Burngrove
P3	677790.8	7464724.6	143.2	21.0	Alluvium
P4	687058.1	7456993.5	124.5	58.8	Middlemount seam
P5	686679.2	7456663.6	123.5	109.3	Middlemount seam
P6	684167.1	7457430.4	129.0	22.6	Rewan
P7	683905.2	7463055.1	129.3	57.0	Middlemount seam
P8	682487.2	7463531.6	130.9	33.0	Rewan
P9	686071.3	7458763.9	127.0	11.0	Burngrove
P10	683483.6	7456427.0	127.2	26.0	Burngrove
P11D	686366.4	7453547.2	123.2	93.4	Middlemount seam
P11S	686392.0	7453554.8	122.9	27.2	RCM overburden
P12	687347.3	7455303.0	122.5	12.0	Alluvium / Tertiary

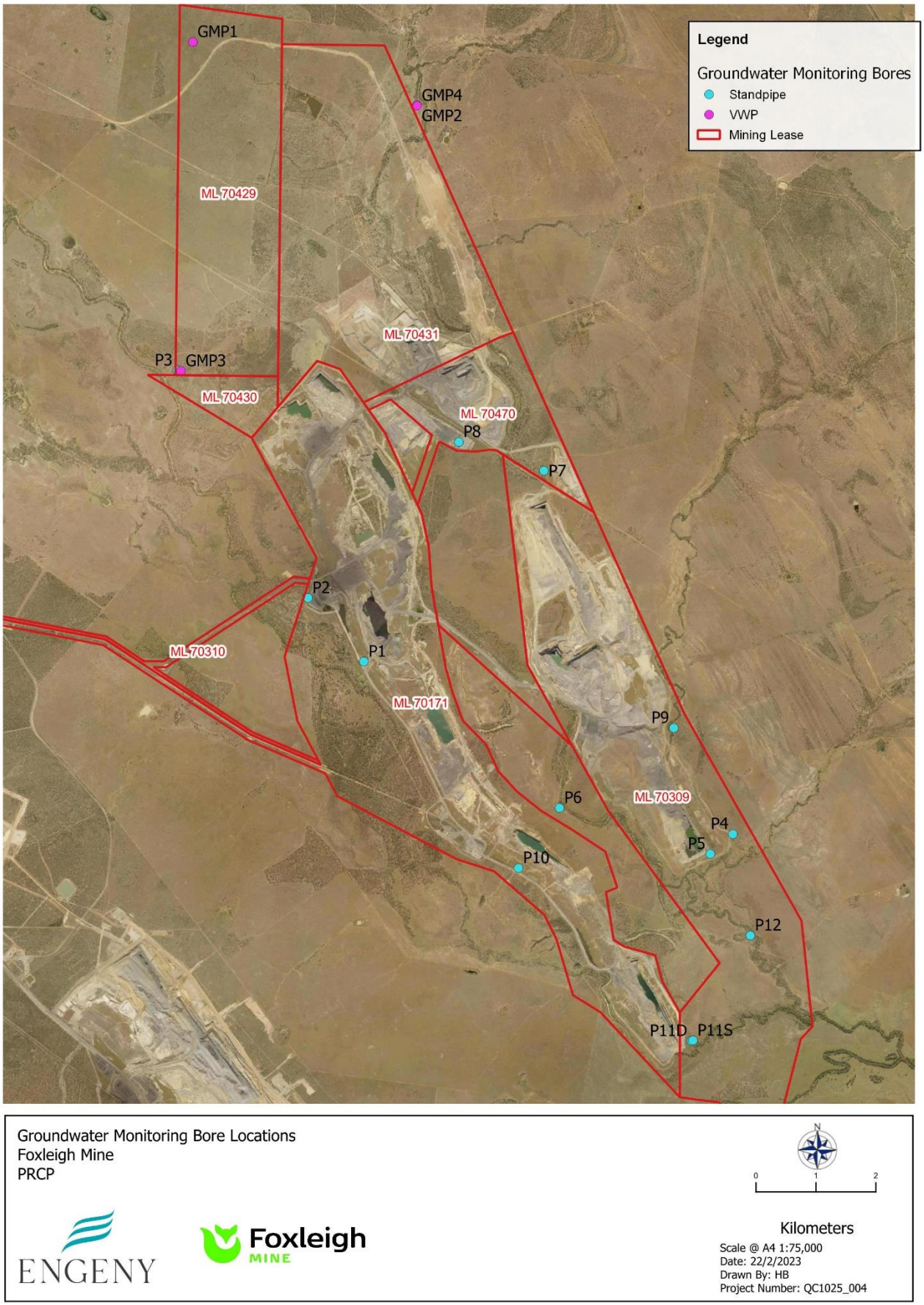


Figure 3-9: Groundwater Monitoring Bore Locations

Conceptual Site Model

Geological strata have been classified into four hydro stratigraphic units (Groundwater Functions Pty Ltd, 2023). Unit designation for conceptual modelling purposes is described in Table 3-12.

Table 3-12: Modelled Hydro stratigraphic Units (Groundwater Functions Pty Ltd, 2023)

HSU	Stratigraphy
1	Alluvium/Colluvium and Duaringa Formation
2	Rewan Formation
3	Rangal Coal Measures overburden and interburden, Burngrove Formation and Fair Hill Formation
4	Rangal Coal Measures (coal seams), Burngrove Formation Coal Seams (Pisces 1)

Quaternary alluvial and colluvial deposits can be grouped with the Tertiary Duaringa Formation based on their relatively similar composition and low grades of diagenesis. There is no evidence of groundwater separation between these sediments in the FoxMan study area (Groundwater Functions Pty Ltd, 2023).

The Rewan Formation is considered a single hydrostratigraphic unit, whilst the Permian inter burden consists of two interleaved hydrostratigraphic units, including the transmissive coal steams and the overburden/interburden and floor measures (including the Burngrove Formation and Fair Hill Formation) as poorly transmissive units (Groundwater Functions Pty Ltd, 2023).

There are five seams present within the Rangal Coal Measures, including the Roper, Middlemount, Tralee, Pisces 1 and Pisces 2 seams. For the purpose of classification, these seams are grouped with the Burngrove Formation coal seam (Pisces 1).

In the pre-mining condition, periods of high rainfall led to ephemeral creek flows, which recharge alluvium and underlying Duaringa Formation. Surface water is disconnected from the alluvium, only recharging alluvial groundwater during flood events. Surface pools remain in place after flows have ceased, as they are perched on creek bed substrates with low hydraulic conductivity. Groundwater flow in the alluvial sediments occur in a south or south easterly direction in the FoxMan study area. In weeks following recharge events, groundwater in the alluvial sediments is depleted by lateral flow down paleochannels and through seepage into underlying, unsaturated Permo-Triassic strata. This would result in minor increases in groundwater levels in Permo-Triassic sediments (Groundwater Functions Pty Ltd, 2023).

Recharge penetrates the Permo-Triassic rocks at the outcrop and subgroup zones of the permeable beds and coal seams. Regional groundwater flow occurs along the dip direction towards the Fox Syncline. North and north-westerly facing Yarrabee and Jellinbah faults on either side of the mine act as barriers to regional groundwater flow by blocking the thick sequences of mudstones against the coal seam aquifers. Once at the water table, the direction of groundwater flow becomes southerly or south easterly (Groundwater Functions Pty Ltd, 2023).

Mining operations consist of opening voids, breaching overburden and exposing conductive coal seams. Groundwater entering voids is lost through the removal of coal and spoil, evaporation, and sump dewatering. Groundwater loss causes localised groundwater sinks occurring in open pits. Exposure of coal seams in open cut pits causes a potential connection along the seam to connect groundwater resources, however monitoring has indicated that groundwater levels in the Permian is not connected to alluvium. Major structural dislocations, such as the Yarrabee and Jellinbah faults effectively isolate the pits from strata to the east and west of the mine (Groundwater Functions Pty Ltd, 2023).

Soil Types, Properties and Productivity

An assessment of soil types was conducted by RGS (2021) with a summary of findings provided in Table 3-13, Table 3-14, Table 3-15, Figure 3-10 and Figure 3-11.

Table 3-13: Fox Soil Descriptions and Characteristics (RGS Environmental Pty Ltd, 2021)

Soil Type	Examples	Horizons (where available)	Particle Size Distribution	Moisture	Peds/ Texture	pH	EC	Colour	Emerson Class
Vertosols	Test Pit 5	Thin surface A horizon, massive B horizon	>35 % clay	Moist to wet (6.6%)	Lenticular peds	8	Low-Moderate (300-700 uS/cm)	Dark Grey	1
Sodosols	Tests Pits 7,11,12	Bleached A horizon, abrupt mottled B horizon	Mostly clay and silt	Moist (4.7%)	Strongly plastic B horizon	7-9	Moderate – Very High (400 – 2000 uS/cm)	Yellowish Brown	2
Chromosols	Test Pits 4,6,10	Strong texture contrast between A, B, and C horizons	Mostly silt and sand	Moist (4.0%)	Large, rounded peds up to 5 cm	7-9	Very Low-Moderate (20-500uS/cm)	Orange Red	2
Arenosols	Test Pit 9	No distinct horizons	Mostly sand	Very dry (2.3%)	Apedal, powdery	6-7	Very Low to Low (5-300uS/cm)	Brown	3
Anthroposols	Test Pits 1,2,3,8	No distinct horizons	Mostly gravel	Dry (3.7%)	No soil aggregation	9-10	Moderate – High (400-1000uS/cm)	Grey	1

Table 3-14: Summary of Fox Soil Types (GSS Environmental, 2011)

Australian Soil Classification	Mapping Unit (Burgess 2010)	Soil Type	Description	Soil Type Identifier
Brown Dermosol (Eutrophic)	Stateschool (Ss)	Sandy clay loam	Overlying labile sandstones, siltstones and shale on alluvial plains and levees.	1
Brown Sodosol (Mesonatric)	Emoh (Eh)	Apedal massive sand Sandy clay loam Sandy clay	Overlying Permian sediments on level to undulating rises. Dominated by open grassland with scattered eucalypt.	2
Brown Chromosol Eutrophic	Roper (Rp)	Sandy clay loam Clay	Occurs within Roper Mapping unit over recent alluvium. Grazing country dominated by open grassland and scattered Eucalyptus vegetation.	3
Brown/Yellow Sodosol (Subnatric)	Foxleigh (Fx)	Sandy loam Clay	Overlies unconsolidated Tertiary and Quarternary Sediments on level to gently undulating plains and rises. Grazing country dominated by open grassland and scattered Eucalypt vegetation.	4
Brown Sodosol (Mesonatric)	Racetrack (Rt)	Fine sandy loam Clay Sandy clay loam	Overlying unconsolidated sediments from alluvial deposits and colluvium on level to undulating plains. Grazing country dominated by open grassland and cleared Brigalow and Eucalypt vegetation.	5
Yellow/Brown Sodosol (Mesonatric)	Parrot (Pr)	Loamy sand Loam Silty Clay	Occurs on gently undulating alluvial plains and levees. Grazing country dominated by open grassland with ironbark open woodland vegetation.	6
Black/Yellow Sodosol (Subnatric)	Honeycomb (Hy)	Fine sandy loam Sandy clay loam	Overlying recent alluvium on alluvial plains and levees. Grazing country dominated by open grassland and scattered Eucalypt vegetation.	7

Australian Soil Classification	Mapping Unit (Burgess 2010)	Soil Type	Description	Soil Type Identifier
Brown Vertosol	Turon (Tr)	Clay	Occurs on strongly developed gillgaied alluvial plains over acidic Tertiary clay. Grazing country dominated by open grasslands with Brigalow and Dawson's gum regrowth.	8
Grey Vertosol/Yellow Sodosol	Tralee (Tl)	Clay	Occurs within gillgaied (one metre deep) alluvial plains. Grazing country dominated by open grasslands with Brigalow regrowth.	9
Grey Vertosol	Thirteen Mile (Tt)	Clay	Overlies alluvial plains and levee banks. Grazing country dominated by open grassland.	10
Grey Vertosol	Langleys (Lg)	Clay	Overlies low lying alluvial floodplains. Grazing country dominated by open grasslands with scattered coolabah in better drained areas.	11
Stratic Rudosol/Grey Kandosol	Blucher (Bc)	Loamy sand Sandy clay loam Sandy clay loam	Overlies recent alluvium on back plains and seasonal swamps within low-lying alluvial flood plains. Grazing country dominated by open grasslands with scattered eucalyptus in better drained areas.	12

Table 3-15: Summary of Chemical Properties of Undisturbed Fox Soil Types (GSS Environmental, 2011)

Soil Type	Horizon	Depth (m)	Clay (%)	pH	EC (uS/cm)	EAT (class)	CEC (cmol +/kg)	ESP %	P(mg/L)	PAWC (mm)
1	A1	0.00 – 0.30	28	7.3	30	3(2)	9	2.2	1	27
	B2.1	0.30 – 0.70	25	8.2	780	2(1)	19.8	18.7	2	50
	B2.2	0.70 – 1.00	30	8.9	1360	2(2)	24.8	24.8	1	0
2	A1	0.30	6	6.9	20	3(1)	7.2	4.2	2	10
	B2.1	0.30 – 0.50	20	8.9	120	2(1)	16.7	22	2	20
	B2.2	0.5 – 1.20	26	9.7	610	2(3)	20.0	25.2	1	0
3	A1	0.00-0.35	18	6.3	20	3(3)	13.7	5.1	9	50
	B2.1	0.35-0.65	38	6.8	150	3(3)	24.3	4.5	4	37
	B2.2	0.65-1.20	20	8.2	300	3(1)	15.8	5.7	7	32
4	A1	0.00-0.35	6	7.2	20	3(1)	6.4	1.6	2	13
	B2.1	0.35-0.90	35	7.5	90	2(3)	18.1	14.4	1	73
	B2.2	0.90-1.20	30	9.7	560	2(3)	20.9	25.4	1	0
5	A1	0.00-0.20	13	6.5	10	8/3(1)	7.9	1.3	2	135
	B2.1	0.20-0.60	39	8.1	290	2(3)	20.8	12	1	45
	B2.2	0.50-1.20	33	9.6	490	3(1)	20.8	14.4	1	44
6	A1	0.00-0.5	7	7.3	30	3(1)	8.7	3.4	1	32

Soil Type	Horizon	Depth (m)	Clay (%)	pH	EC (uS/cm)	EAT (class)	CEC (cmol +/kg)	ESP %	P(mg/L)	PAWC (mm)
	B2.1	0.5-0.80	20	8.2	100	3(2)	16.6	10.8	2	31
	B2.2	0.80-1.20	36	8.9	410	2(1)	35.1	18.5	15	68
7	A1	0.00-0.25	14	6.1	20	3(1)	8.8	1.1	7	18
	B2.1	0.25-0.60	27	7.8	70	3(3)	20.5	6.6	2	43
	B2.2	0.60-1.05	26	9.4	920	2(3)	20.8	39.4	1	0
8	A1	0.00-0.30	47	8.5	90	2(1)	36.3	5.3	4	35
	B2.1	0.30-0.70	42	9.6	240	2(3)	24	14.2	1	61
	B2.2	0.70-1.10	36	9.7	350	1	23.4	25.2	1	0
9	A1	0.00-0.35	46	8.9	120	3(3)	33.3	6.9	3	51
	B2.1	0.35-0.70	44	9	760	2(3)	31.5	18.4	2	59
	B2.2	0.70-1.10	44	8.6	1300	2(3)	33.1	27.8	4	0
10	A1	0.00-0.50	43	7.9	1660	2(3)	30.2	29.1	3	0
	B2.1	0.50-0.90	46	8.3	2570	2(3)	30.8	36	2	0
	B2.2	0.90-1.30	50	8.4	3330	2(1)	33.5	38.5	4	0
11	A1	0.00-0.35	62	8.5	180	2(1)	40.5	9.1	3	71
	B2.1	0.35-0.80	64	9.6	400	1	37.1	23.2	2	0
	B2.2	0.80-1.20	61	8.8	910	1	38.0	22.1	2	0

Soil Type	Horizon	Depth (m)	Clay (%)	pH	EC (uS/cm)	EAT (class)	CEC (cmol +/kg)	ESP %	P(mg/L)	PAWC (mm)
12	A1	0.00-0.30	10	7.1	30	3(1)	11.6	1.7	1	9
	B2.1	0.30-0.80	24	8.4	60	2(1)	18.1	1.7	1	53
	B2.2	0.80-1.00	23	9.4	100	2(2)	18.4	13	1	68

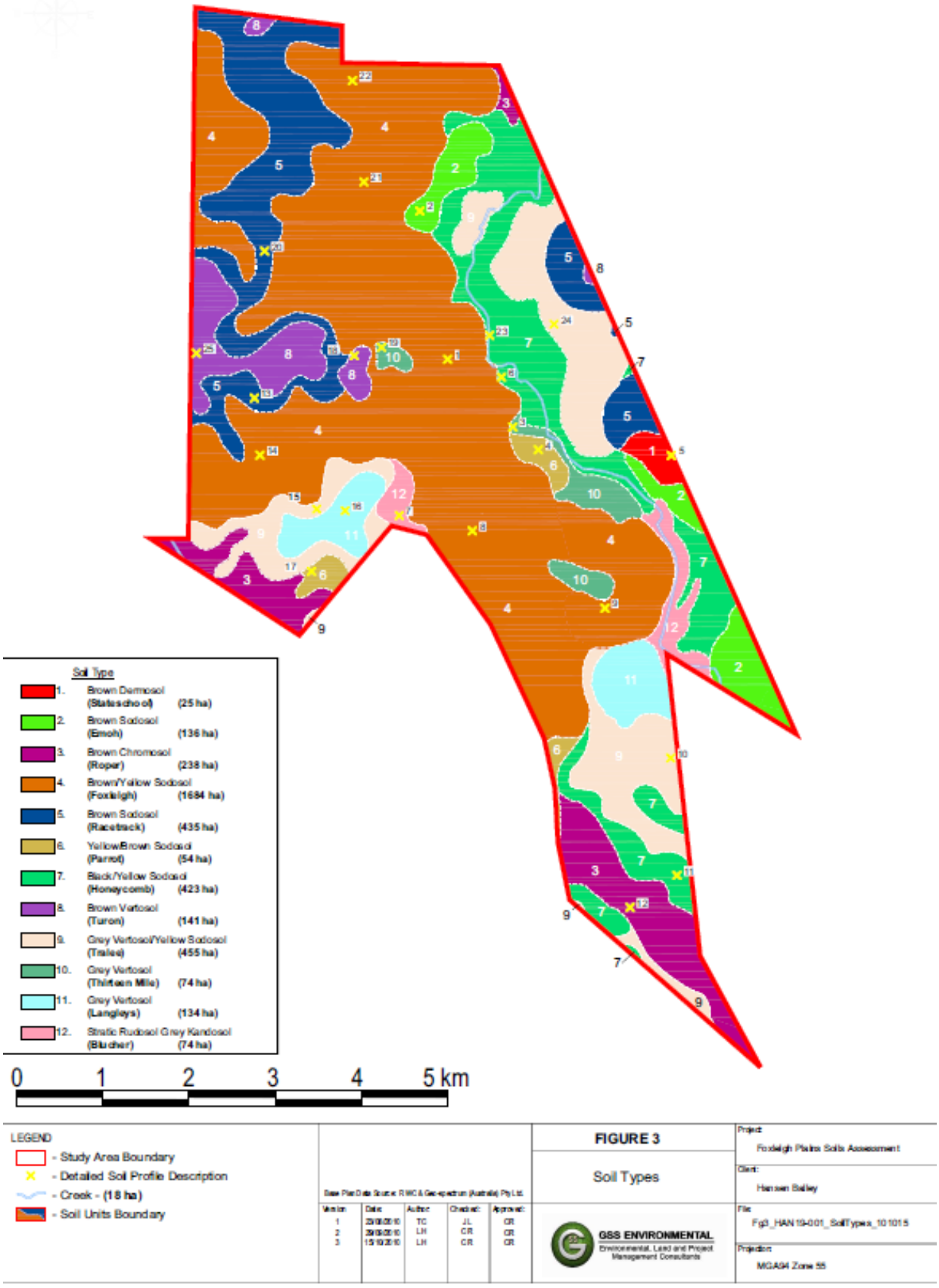


Figure 3-10: Soil Mapping Units across ML70431 (GSS Environmental, 2011).

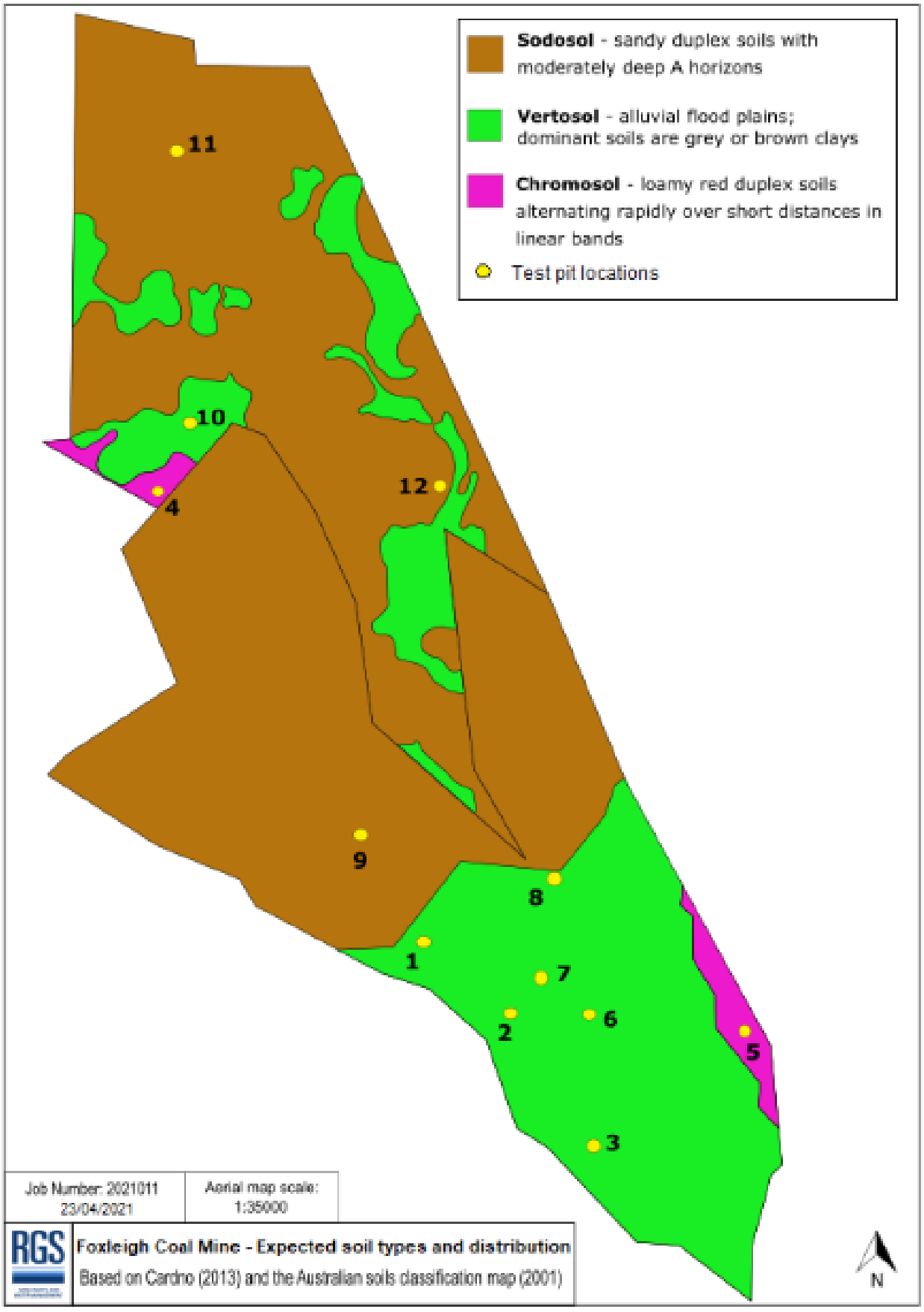


Figure 3-11: Fox Soil Types and Distribution (RGS Environmental Pty Ltd, 2021).

Pre-Mining Land Suitability Cattle Grazing

Pre-mining land suitability of the Fox site was assessed as part of the ML70431 extension EIS in accordance with the *Land Suitability Assessment Techniques guideline* (GSS Environmental, 2011; DME, 1995). The land suitability for grazing of each soil type is displayed in Table 3-16. All soil types were found to be suitable for beef cattle grazing to variable degrees, apart from soil type 10 which was identified for marginal grazing. The majority of the site is Class 3 grazing land, although some areas are of Class 2 grazing land. Identified in baseline studies, the limiting factors of importance for Fox soil types include moisture, salinity, wetness, rockiness, flooding and water erosion. The most significant limitation for the land suitability of Fox soils is moisture (Hansen Bailey, 2012).

For the majority of the soil types identified within the Study Area, physical and chemical analysis demonstrated that the topsoil or A horizon is generally superior and should be saved (GSS Environmental, 2011).

Table 3-16: Pre-mining Suitability for Cattle Grazing at Fox (GSS Environmental, 2011).

Soil Type Identifier	Australian Soil Classification	Land Suitability Class Grazing
1	Brown Dermosol (Eutrophic)	3
2	Brown Sodosol (Mesonatric)	3
3	Brown Chromosol Eutrophic	2
4	Brown/Yellow Sodosol (Subnatric)	3
5	Brown Sodosol (Mesonatric)	3
6	Yellow/Brown Sodosol (Mesonatric)	3
7	Black/Yellow Sodosol (Subnatric)	3
8	Brown Vertosol	2
9	Grey Vertosol/Yellow Sodosol	2
10	Grey Vertosol	4
11	Grey Vertosol	3
12	Stratic Rudosol/Grey Kandosol	3

Land Suitability

The pre-mining topography at Fox was generally flat to undulating, and consistent with the regional landscape. The study area was used for grazing and largely cleared of remnant vegetation (Ecological Survey and Management, 2012). Soil types on site have a low to potentially dispersive nature (Foxleigh Mine, 2021). Most mining waste materials are sodic and may be susceptible to dispersion and erosion (RGS Environmental Pty Ltd, 2021). Water erosion was identified as a limiting factor for baseline soil suitability studies (GSS Environmental, 2011).

Vegetation Communities and Ecological Data

During the 2012 EIS, ecological field surveys were conducted to undertake field validations of ecological communities. A summary of the field validated Regional Ecosystems (REs) is provided in Table 3-17 with additional information gathered during 2022 as part of the Unauthorised Disturbance Area (UDA) investigation. A comparison field validated REs from 2012 and current mapped REs is provided in Figure 3-12 and Figure 3-13.

Table 3-17: Field Validated Regional Ecosystems within Fox (Ecological Survey and Management, 2012)

Regional ecosystem descriptions	RE Code	Remnant (ha)	High Value Regrowth (HVR) (ha)	RE VM Act class	RE Biodiversity status	Fox EIS 2012	Pre-2016	UDA
***Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains**	11.3.1	4.9	124.7	Endangered	Endangered	✓	✓	✓
***Eucalyptus populnea* woodland on alluvial plains**	11.3.2	60.1	3.5	Of Concern	Of Concern	✓	✓	✓
***Eucalyptus coolabah* woodland on alluvial plains**	11.3.3	4.0	0	Of Concern	Of Concern	✓	✓	
***Eucalyptus tereticornis* and/or *Eucalyptus spp.* woodland on alluvial plains**	11.3.4	1.6	0	Of Concern	Of Concern	✓		
***Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines**	11.3.25	29.7	0	Least Concern	Of Concern	✓	✓	
	11.3.25g	7.1	0	Least Concern	Of Concern	✓		
***Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains**	11.4.8	1.0	0	Endangered	Endangered	✓		

Regional ecosystem descriptions	RE Code	Remnant (ha)	High Value Regrowth (HVR) (ha)	RE VM Act class	RE Biodiversity status	Fox EIS 2012	Pre-2016	UDA
***Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains**	11.4.9	0	10.6	Endangered	Endangered	✓		
***Eucalyptus populnea* +/- *E. melanophloia* +/- *Corymbia clarksoniana* woodland on Cainozoic sand plains and/or remnant surfaces**	11.5.3	98.7	0	Least Concern	No Concern at Present	✓	✓	
***Eucalyptus tereticornis* woodland in depressions on Cainozoic sand plains and remnant surfaces**	11.5.17	7.3	0	Endangered	Endangered	✓		
***Acacia harpophylla* and/or *Casuarina cristata* open forest to woodland on fine-grained sedimentary rocks**	11.9.5	0	7.5	Endangered	Endangered	✓		

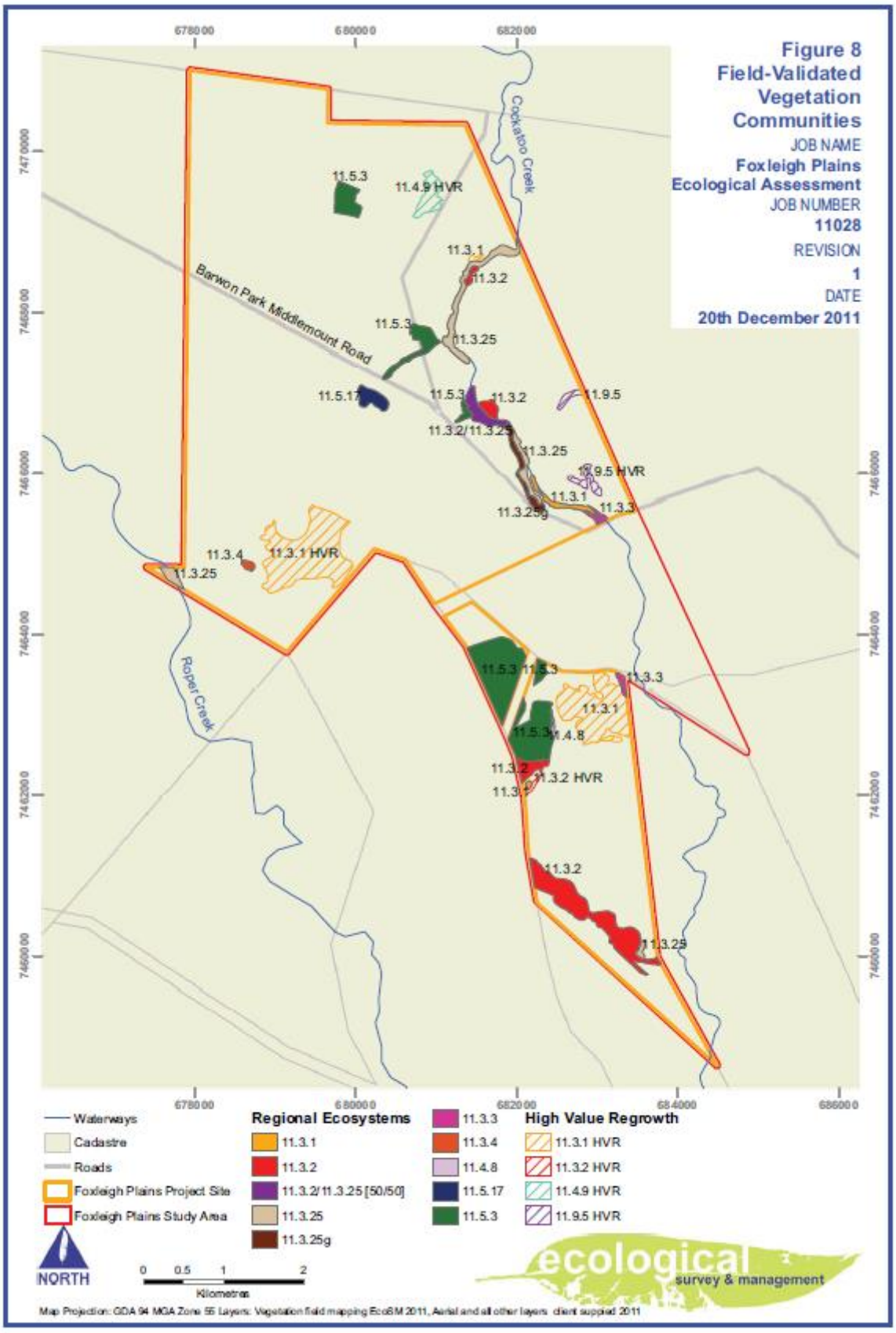


Figure 3-12: Field Validated Regional Ecosystems (Ecological Survey and Management, 2012).

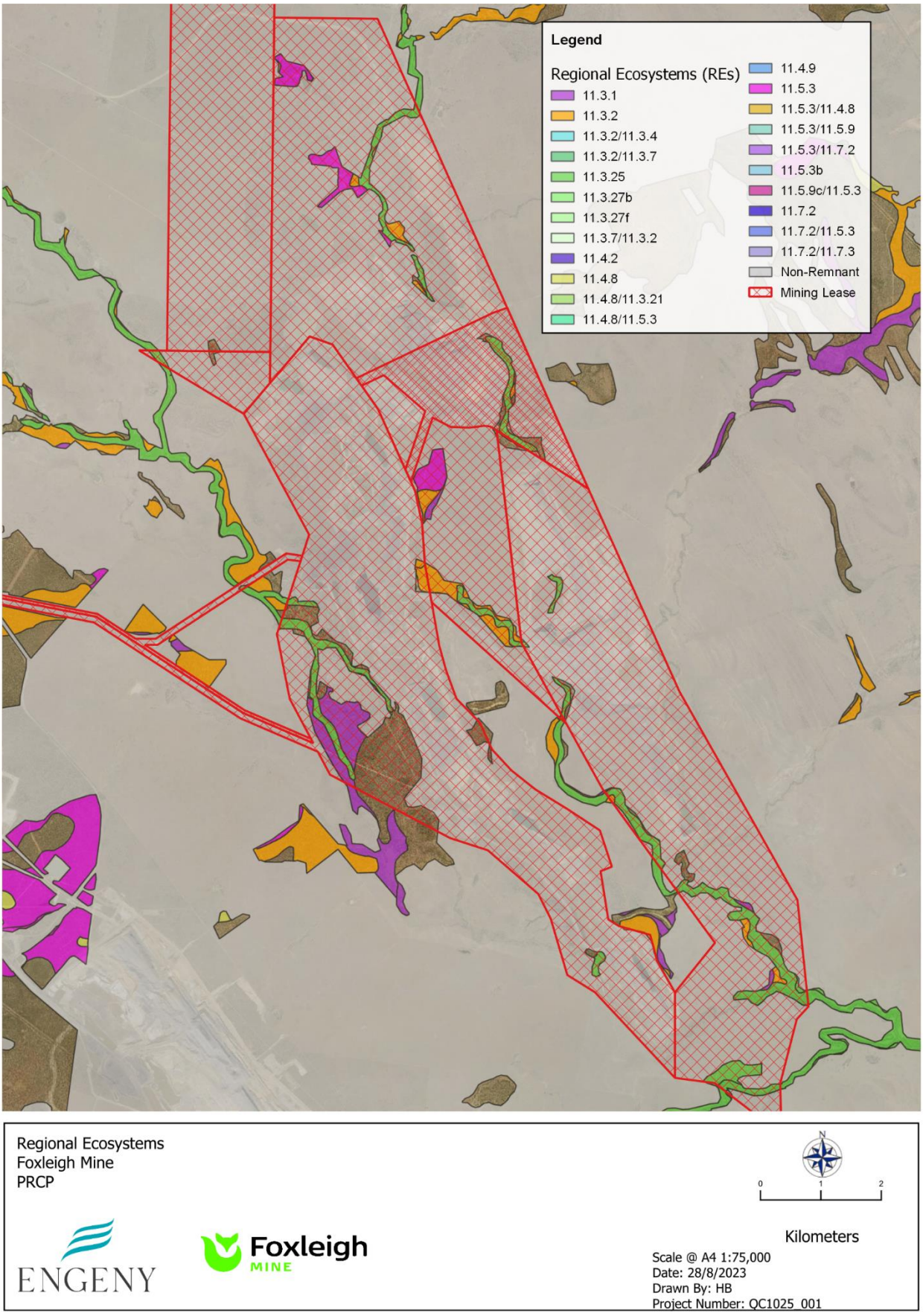


Figure 3-13: Mapped Regional Ecosystems (Queensland Globe , 2023)

Environmentally Sensitive Areas

Vegetation Management Act 1999 (VM Act) Waterways are present across the site's disturbance footprint. These are mapped along the pre-diverted watercourse lines. Category B vegetation, category C vegetation, endangered wildlife habitat, and essential habitat are present within the disturbance footprint. Essential habitat, category B vegetation, and endangered wildlife habitat are predominantly centred around the pre-diverted creek line of Cockatoo Creek (Engeny, 2023). Category A environmentally sensitive areas defined under the *Environmental Protection Regulation 2008* have not been mapped within Fox (Ecological Survey and Management, 2012). Small areas of Endangered RE's (defined as Category B Environmentally Sensitive Areas) have been field validated (Ecological Survey and Management, 2012). Field validated remnant and high-value regrowth are displayed in Table 3-18, in addition to environmentally sensitive areas identified in desktop searches from additional disturbance areas in Pre-2016 and UDA from 2019-2020. Field validated environmentally sensitive areas are displayed in Figure 3-14: whereas mapped areas are displayed in Figure 3-15.

Table 3-18: Environmentally Sensitive Areas (Ecological Survey and Management, 2012)

Regional Ecosystem	VM Status	Biodiversity Status	Remnant (ha) (2012 (Ecological Survey and Management, 2012))	HVR (ha) (2012 (Ecological Survey and Management, 2012))
11.3.1	Endangered	Endangered	4.9	124.7
11.3.2	Of Concern	Of Concern	60.1	3.5
11.3.3	Of Concern	Of Concern	4.0	Nil
11.3.4	Of Concern	Of Concern	1.6	Nil
11.3.25	Least Concern	Of Concern	29.7	Nil
11.3.25g	Least Concern	Of Concern	7.1	Nil
11.4.8	Endangered	Endangered	1.0	Nil
11.4.9	Endangered	Endangered	Nil	10.6
11.5.3	Least Concern	No Concern at Present	98.7	Nil
11.5.17	Endangered	Endangered	7.3	Nil
11.9.5	Endangered	Endangered	Nil	7.5
11.3.1/11.3.3	Endangered/ Of Concern		Nil	Nil
11.5.3/11.3.2	Least Concern/Of Concern		Nil	Nil
11.3.2/11.3.3	Of Concern/Of Concern		Nil	Nil
11.3.1/11.3.2	Endangered/Of Concern		Nil	Nil

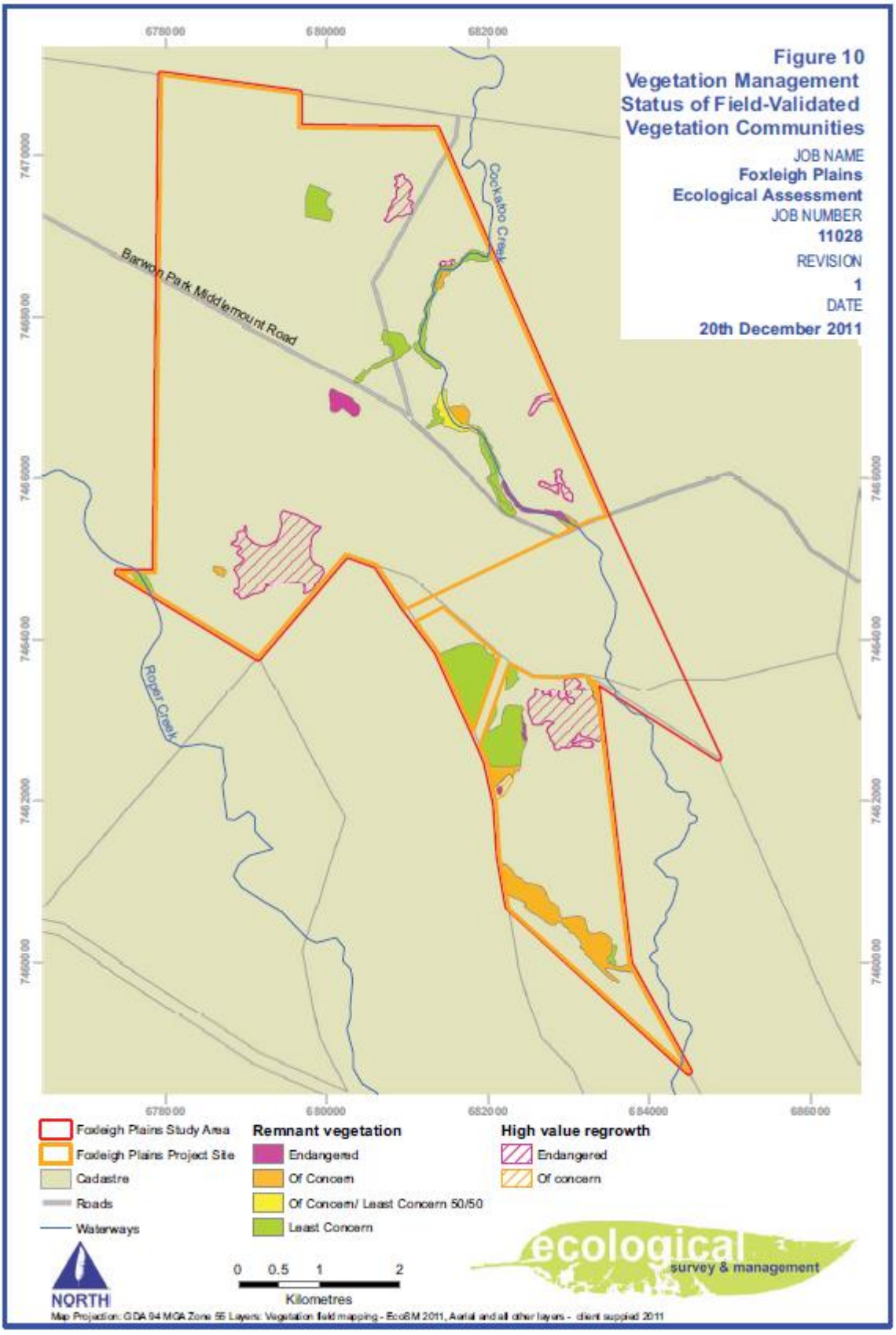


Figure 3-14: Field Validated Environmentally Sensitive Areas (Ecological Survey and Management, 2012)

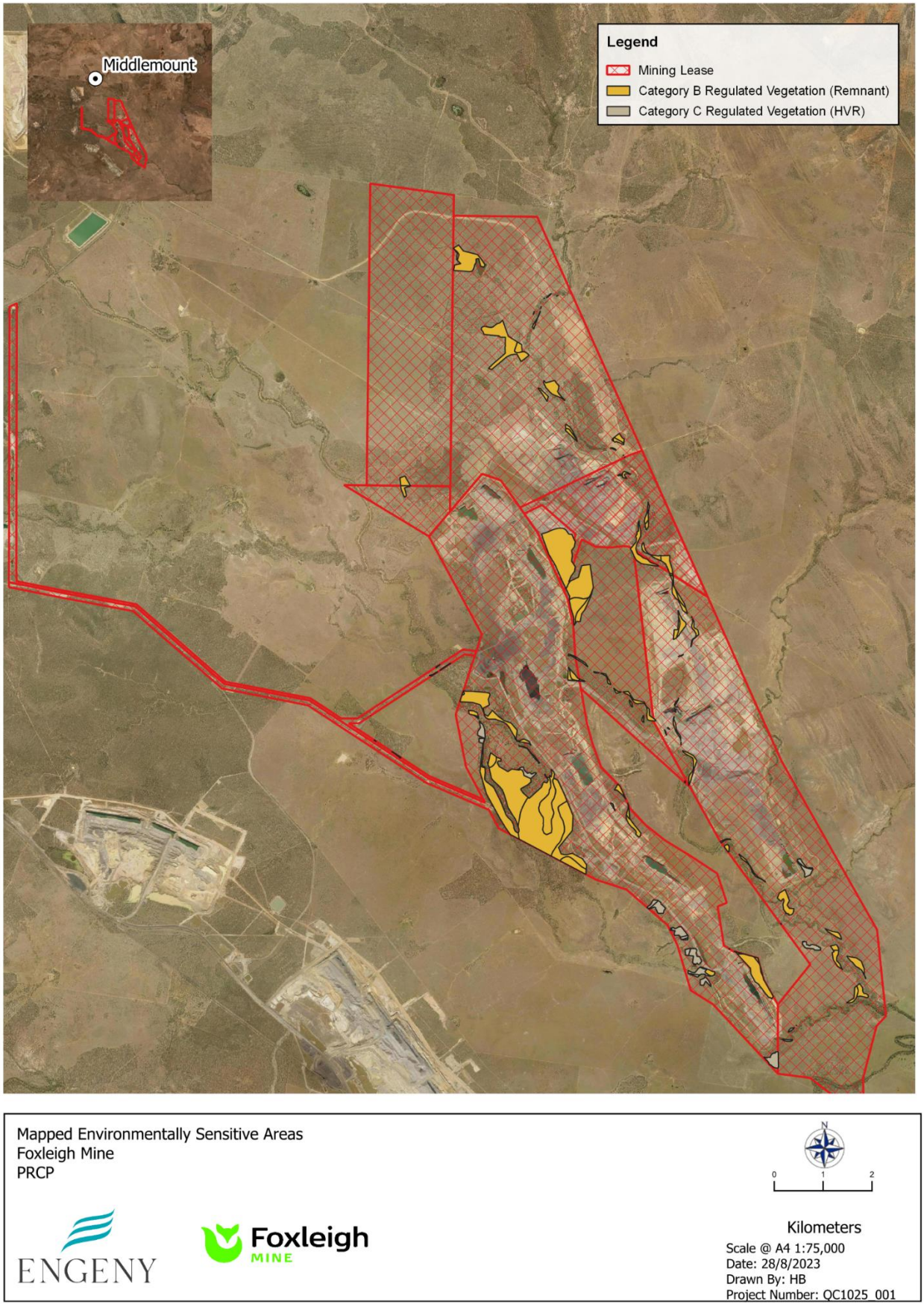


Figure 3-15 : Mapped Environmentally Sensitive Areas (Queensland Globe , 2023)

Threatened Ecological Communities

Field validated threatened ecological communities listed under the *EPBC Act* are listed in Table 3-19.They are representative of the Brigalow Endangered Ecological Community (EEC). Field validated threatened ecological communities are displayed in Figure 3-16:

Table 3-19: Likelihood of Occurrence of Threatened Ecological Communities within Fox

Threatened Ecological Community	EPBC Act status	Field verified RE code	Likelihood of occurrence
Brigalow EEC	Endangered	11.3.1	High – field validated, mapped in association with Cockatoo Creek
	Endangered	11.4.8	High – high, field validated in the south of Fox.
	Endangered	11.4.9	High – field validated, mapped in the north of Fox
	Endangered	11.5.9	High- field validated, occurs to the east of Cockatoo Creek in the north of Fox.

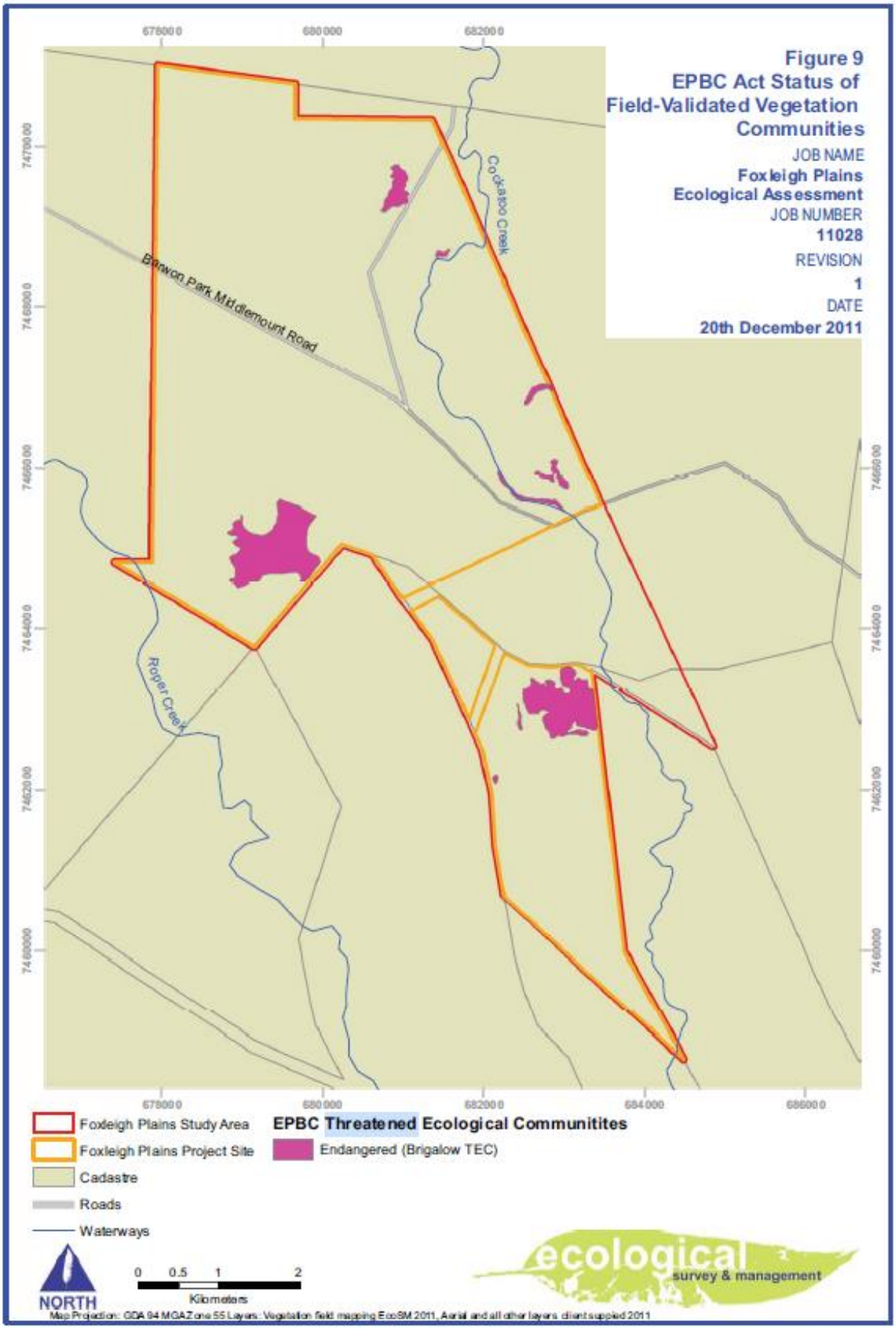


Figure 3-16: Fox Threatened Ecological Communities (Field Validated) (Ecological Survey and Management, 2012)

Conservation Significant Flora Species

Field verified conservation significant flora species are listed in Table 3-20. One species of State conservation significance (*Solanum elachophyllum*) was recorded during the late wet season survey (Ecological Survey and Management, 2012).

Table 3-20: Likelihood of Occurrence of Threatened Flora Species within Fox (Ecological Survey and Management, 2012)

Scientific name	NC Act status	EPBC Act status	Field verified RE code	Likelihood of occurrence
Cerbera dumicola	NT	-	11.3.3 11.3.25	Low
Desmodium marcocarpum	NT	-	11.5.3	Low
Paspalidium scabrifolium	NT	-	11.3.1	Low
Solanum elachophyllum	E	-	NA	Present- recorded in the south of the project from regrowth Brigalow on cracking clays and Poplar Box woodland.

Fauna Presence and Populations

Conservation significant flora species are listed in Table 3-21. *Geophaps scripta scripta* (squatter pigeon) was present on-site during field mapping surveys, listed as vulnerable under the *NC* and *EPCB Acts*. Potential and preferred habitat of the squatter pigeon is displayed in Figure 3-17:

Table 3-21: Likely of Occurrence of Threatened Fauna Species within Fox (Ecological Survey and Management, 2012)

Scientific name	Common name	NC Act status	EPBC Act status	Likelihood of occurrence
Erythrotriorchis radiatus	Red Goshawk	Endangered	Vulnerable	Low to Moderate
Geophaps scripta scripta	Squatter Pigeon (southern)	Vulnerable	Vulnerable	Present
Neochmia ruficauda ruficauda	Star Finch (southern or eastern)	Endangered	Endangered	Low
Rostratula australis	Australian Painted Snipe	Vulnerable	Vulnerable	Moderate
Dasyurus hallucatus	Northern Quoll	Not Listed	Endangered	Low
Nyctophilus timoriensis (southern eastern form)	Greater Long-eared Bat	Vulnerable	Vulnerable	Low to Moderate
Delma torquate	Collared Delma	Vulnerable	Vulnerable	Low
Denisonia maculata	Ornamental Snake	Vulnerable	Vulnerable	High
Egernia rugosa	Yakka skink	Vulnerable	Vulnerable	Low
Furina dunmalli	Dunmall's snake	Vulnerable	Vulnerable	Low
Lerista allanae	Retro Slider	Endangered	Endangered	Low
Paradelma orientalis	Brigalow Scaly-foot	Vulnerable	Vulnerable	Moderate
Rheodytes leukops	Fitzroy River turtle	Vulnerable	Vulnerable	Low

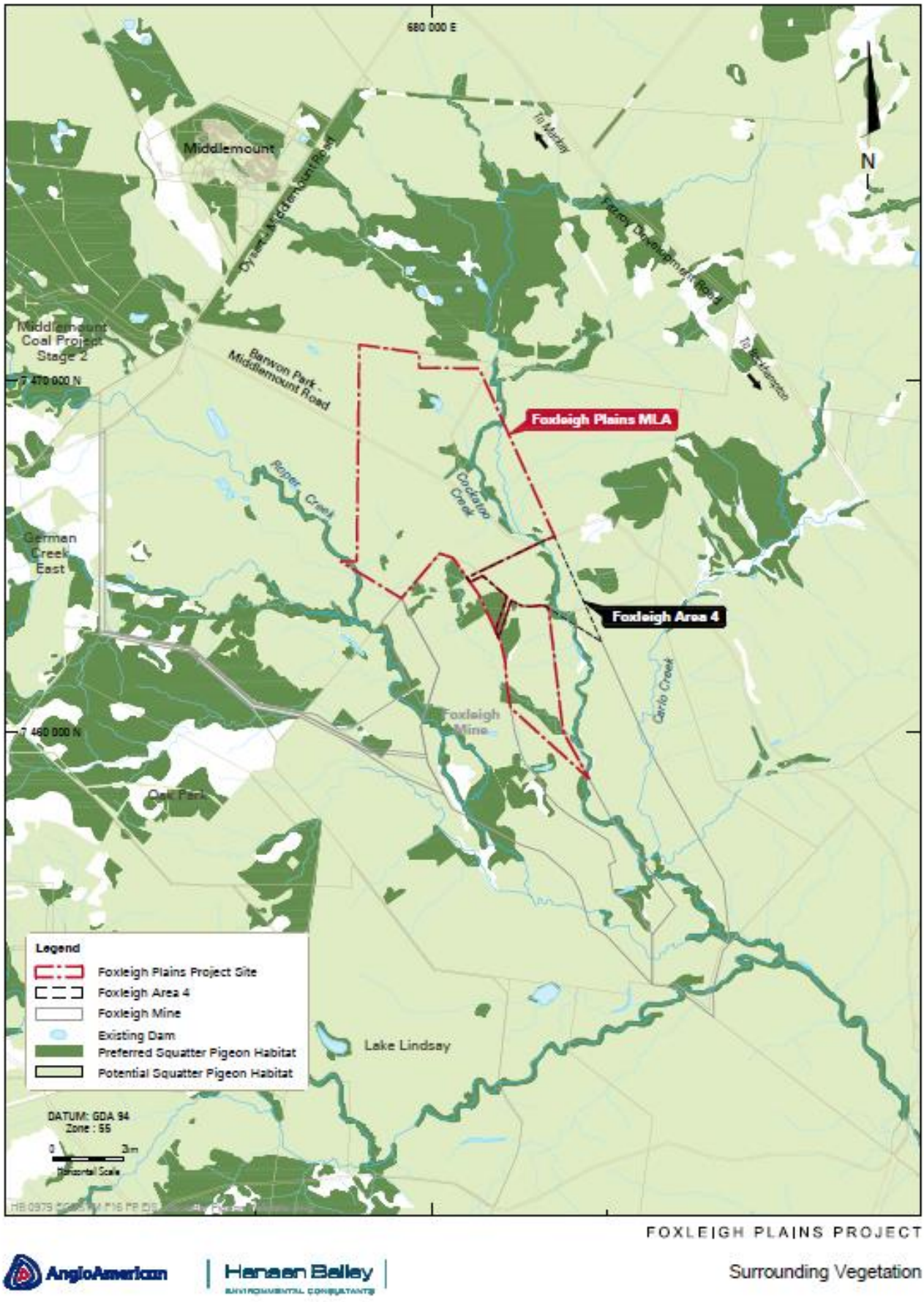


Figure 3-17: Fox Fauna Habitat Mapping for Squatter Pigeon (Ecological Survey and Management, 2012)

Migratory Species

Migratory species identified in the EIS report are listed in Table 3-22.

Table 3-22: Migratory species likely to occur within Fox (Ecological Survey and Management, 2012)

Scientific name	Common name	EPBC Act status	Likelihood of occurrence
Anseranas semipalmata	Magpie Goose	Marine	Moderate – Could occur within the broad open areas of Cockatoo Creek when holding water.
Apus pacificus	Fork-tailed Swift	Marine and Migratory	High – Likely to forage over the project site.
Ardea alba	Great Egret	Marine and Migratory	Present – Observed in the broad areas of Cockatoo Creek during the field survey.
Ardea ibis	Cattle Egret	Marine and Migratory	Moderate – could be present within the broad open areas of Cockatoo Creek when holding water.
Gallinago hardwickii	Latham's Snipe	Marine and Migratory	Moderate – Could occur within the broad open areas of Cockatoo Creek when holding water.
Haliaeetus leucogaster	White-bellied Sea-eagle	Marine and Migratory	Low – Cockatoo Creek lacks large water bodies for this species.
Hirundapus caudacutus	White-throated Needletail	Marine and Migratory	High – Likely to forage over the project site.
Hirundo rustica	Barn Swallow	Marine and Migratory	Low – Not commonly observed in Central Queensland.
Merops ornatus	Rainbow Beeeater	Marine and Migratory	Present – Common in the habitat types present within the project site and recorded during previous survey
Monarcha melanopsis	Black-faced Monarch	Marine and Migratory	Low to Moderate – Could occur in the fringing vegetation along Cockatoo Creek.
Myiagra cyanoleuca	Satin Flycatcher	Marine and Migratory	Low to Moderate – Could occur in the fringing vegetation along Cockatoo Creek.
Painted Snipe	Rostratula benghalensis s. lat.	Vulnerable, Marine and Migratory	Moderate – Could occur within the broad open areas of Cockatoo Creek and the patch of RE 11.5.17 when holding water.

Pre-mining Land Use

Prior to mining commencement, the site was used exclusively for cattle grazing, with two homesteads within the mining lease boundary (Engeny, 2023). These homesteads are now vacant and un-used buildings.

Surrounding Land Use

A search of the Isaac Regional Planning Scheme 2021 Zoning[1] shows the mine and surrounding area is zoned for Rural use. An extract of the Rural Areas (south-east) map with the approximate site location shown in red is presented in Figure 3-18: below.

[1] https://www.isaac.qld.gov.au/downloads/file/4636/zm1-planning-scheme-2021-zoning-gazettal-1-april-2021-pdf (accessed 2 November 2022)

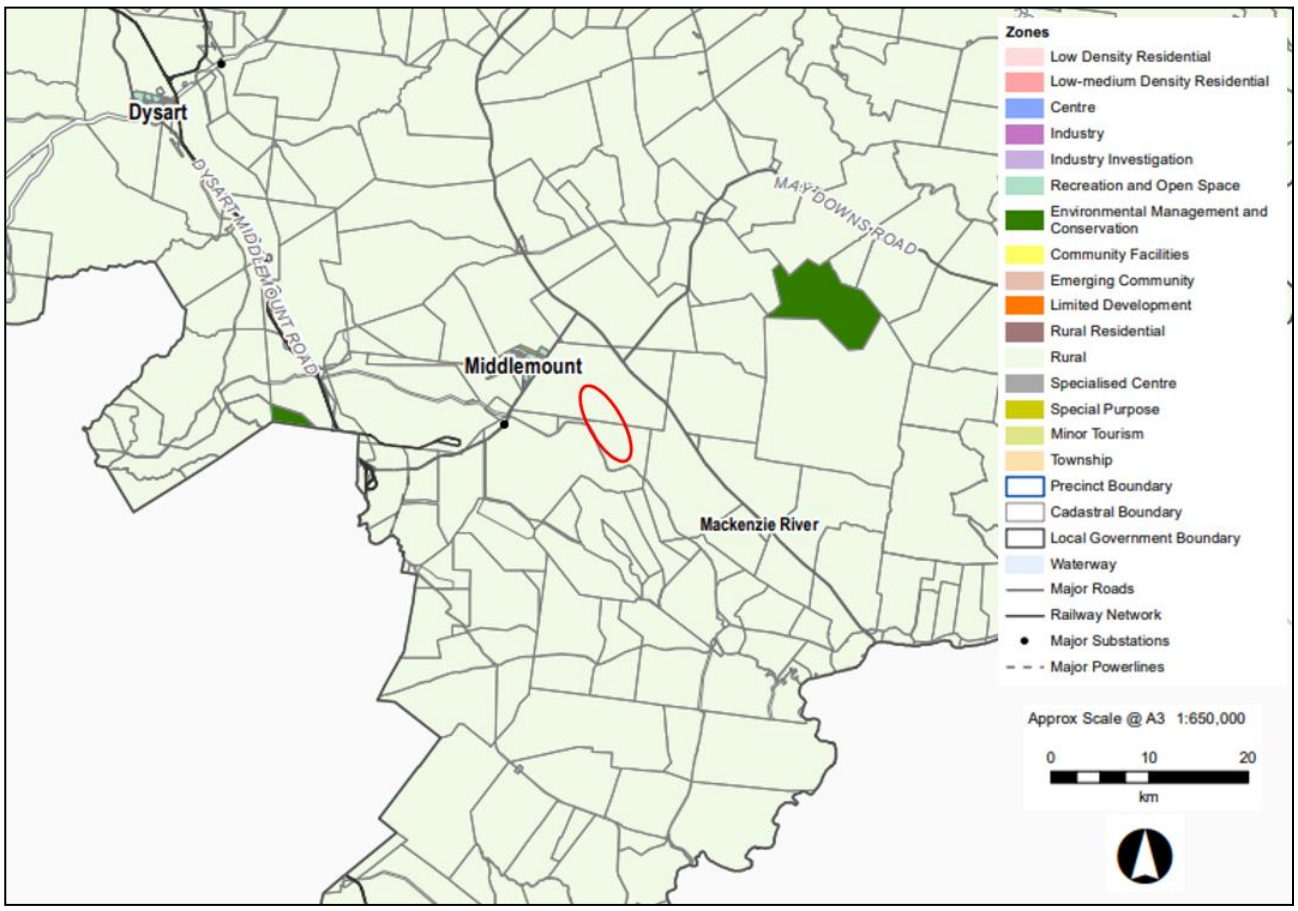


Figure 3-18: Surrounding Land Uses

Underlying Landholders

Ownership of the land underlying the mining leases at Fox are presented in Table 3-23 and Figure 3-19:

Table 3-23: Land Ownership at Fox

Item	Detail		
Real Property Description	Lot 20 on SP276924	Lot 19 on SP276924	Lot 4 on SP293492
Address	5498 Dysart Middlemount Road, Mackenzie River, QLD	162 Lake Lindsay Road Mackenzie River Qld	No official address
Lot area (ha)	5,381	6,785	12,080
Mining Lease	ML70309 ML70310 ML70431 ML70171 ML70470	ML70171 ML70310	ML70171 ML70429 ML70430 ML70431 ML70470
Current Use	Mining	Mining	Mining
Current owner	**Foxleigh Land Pty Ltd a.c.n. 088 327 226**	**Gregory William Small ½ Brian James Small ½ As tenants in common**	**Foxleigh land Pty Ltd a.c.n. 088 327 226**

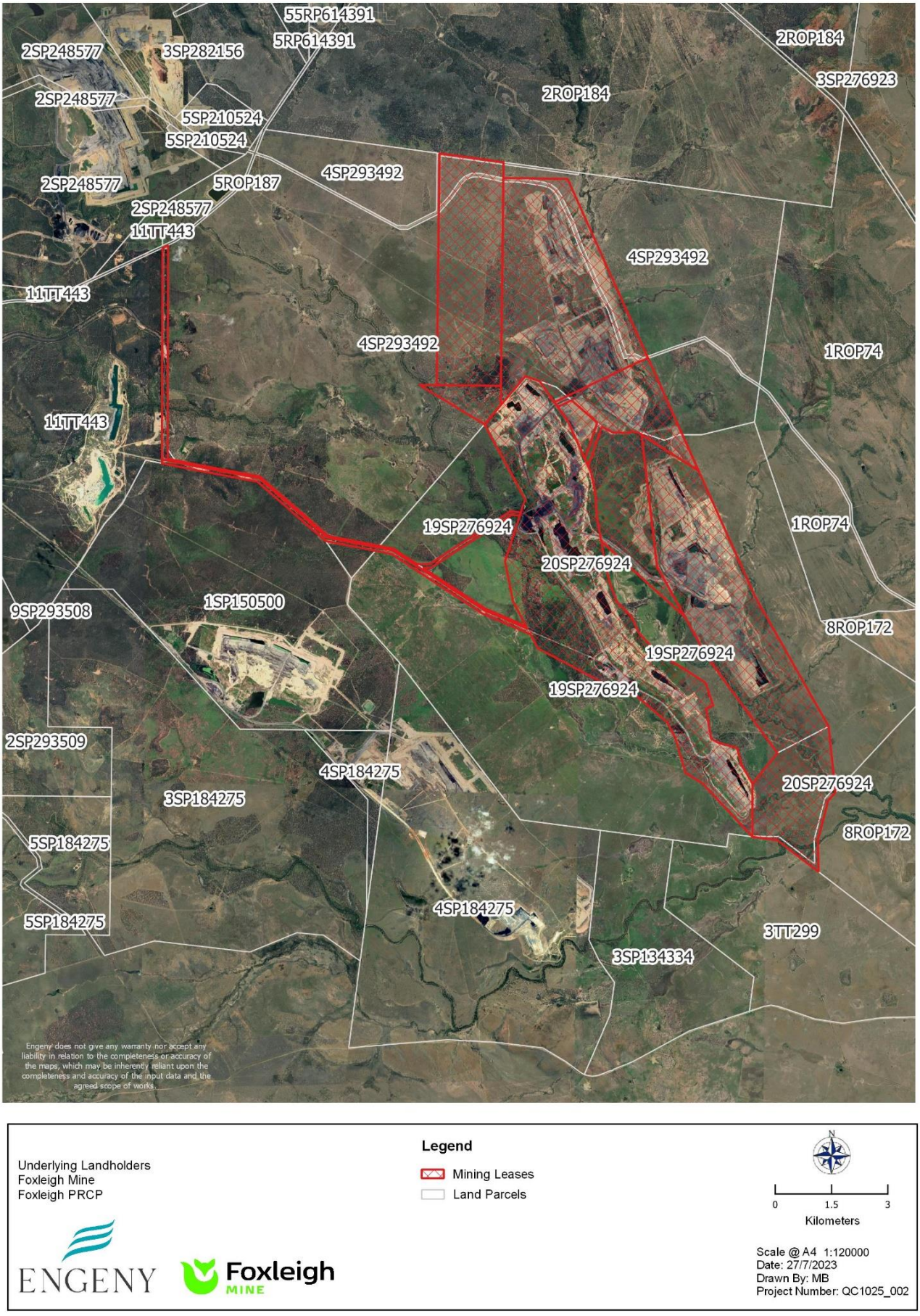


Figure 3-19: Lot and Plan of Underlying Landholders

3.1.4. Design for Closure

As this PRCP for Fox is subject to transitional PRCP arrangements, it is not required to demonstrate how aspects of the mine site have been designed for closure for existing or approved disturbance (PRCP Guideline, Section 3.1).

However, this PRCP has been developed to proactively manage progressive rehabilitation of the FoxMan site to a stable post-mining land use, aiming to minimise long-term management requirements as well as associated closure costs. Importantly, a focused design for closure underpins all sections of this plan, including:

- Engagement with relevant stakeholders to define suitable PMLUs.
- Defining and implementing rehabilitation practices to identify risks that could influence achievement of milestone criteria.
- Demonstrating successful rehabilitation through defined site monitoring to develop a feasible PRCP schedule.

3.1.5. Rehabilitation and Improvement Planning

Legislative Requirement

In accordance with sections 126C(1)(b) and (c)(ii) of the EP Act, the rehabilitation planning part must include:

- *identification of all relevant activities on the mine site.*
- *the predicted duration of each of the relevant activities proposed for the mine site.*
- *the size/extent of the relevant activities.*
- *whether the different relevant activities can be progressively rehabilitated.*

PRC Plan Guideline (Section 3.1)

Under section 126C(1)(j) of the EP Act, transitional PRC Plans must also include the following details about any existing rehabilitation already completed at the time of submission of the proposed PRC Plan:

- *a description of the rehabilitation works previously carried out.*
- *when the rehabilitation works commenced and were completed.*
- *whether the rehabilitation has been applied for or approved as progressively certified under the EP Act.*

Relevant Activities Requiring Rehabilitation

The relevant activities at Fox that will require rehabilitation, and the predicted duration, are provided in Table 3-24 (Foxleigh Mine, 2021).

Table 3-24: Relevant activities requiring rehabilitation at Fox

Relevant Activity	Predicted duration	Availability for progressive rehabilitation
Exploration; drill holes	Available as completed	Areas are progressively rehabilitated as activities are completed.
Roads; laydown and general disturbance	Utilised until the end of mining	Available once mining is complete
General infrastructure; pipelines, buildings, concrete pads, communication towers	Utilised until the end of mining in each defined area	Available once the majority of the rehabilitation of the site is complete.
Overburden Dumps and Soil Piles	Available as mining progresses	Available for progressive rehabilitation as areas reach final position
CHPP and associated infrastructure; coal stockpiles, tailings storage	Utilised until the end of mining	Available once mining is complete
Voids	Utilised until the end of mining	Available for improvement once surrounding spoil dumps are at capacity
Water storage & infrastructure (diversions)	Varying: with the latest utilised until the end of rehabilitation activities	Available for progressive rehabilitation once no longer required for activities and is not being retained as final landform

3.1.6. Rehabilitation Areas (RAs) and Milestones

The Fox Rehabilitation Areas (RAs), as well as the relevant activities associated with each, are detailed in Table 3-25 (and Figure 3-20).

Table 3-25: Rehabilitation areas (RA's), associated with PMLUs and relevant activities for Fox

Rehabilitation area (RA)	PMLU	Area (ha)	Relevant activity
RA1	Cattle Grazing	4,315	• Spoil dumps • Backfilled voids • Borrow pits • Topsoil stockpiles
RA2	Watercourse	137	• Creek diversions and levees

Rehabilitation area (RA)	PMLU	Area (ha)	Relevant activity
RA3	Cattle Grazing	548	• CHPP and associated infrastructure • Administration, crib, office buildings & ablutions • MIA (workshops & associated laydown, hardstand, fuel storage, washdown bay areas) • Coal stockpiles • Haul roads, roads & tracks • Raw and mine affected water storage dams • General infrastructure & disturbance • Fencing • Explosive magazine • Power reticulation network
RA4	Cattle Grazing	199	• Tailings areas
RA5	Native ecosystem corridor	35	• Connectivity corridor for conservation areas

The Rehabilitation Milestones (RMs) for Fox are detailed in Table 3-26 with the Management Milestones (MMs) provided in Table 3-28.

Table 3-26: Rehabilitation milestones for Fox

Rehabilitation Milestone (RM)	
RM1	Infrastructure decommissioning and removal
RM2	Remediation and/or management of contaminated land
RM3	Landform development and reshaping
RM4	Installation of Cover System/Capping
RM5	Existing rehabilitation landform remediation
RM6	Surface preparation (cattle grazing)
RM7	Surface preparation (watercourse)
RM8	Surface preparation (native ecosystem)
RM9	Revegetation (cattle grazing)
RM10	Revegetation (watercourse)
RM11	Revegetation (native ecosystem)
RM12	Achievement of surface requirements (cattle grazing)
RM13	Achievement of surface requirements (watercourse)
RM14	Achievement of surface requirements (native ecosystem)
RM15	Achievement of post-mining land use to a stable condition (cattle grazing)
RM16	Achievement of post-mining land use to a stable condition (watercourse)

Rehabilitation Milestone (RM)	
RM17	Achievement of post-mining land use to a stable condition (native ecosystem)

3.1.7. Improvement Areas and Milestones

The improvement areas (IA) and MM included in the PRCP Schedule for Fox are referred to throughout this PRCP.

An IA is defined in the PRCP Guideline as an *area of land in the NUMA to which a management milestone for the NUMA relates* and a MM is *each significant event or step necessary to achieve best practice management of the area and to minimise risks to the environment* (section 112 of the EP Act).

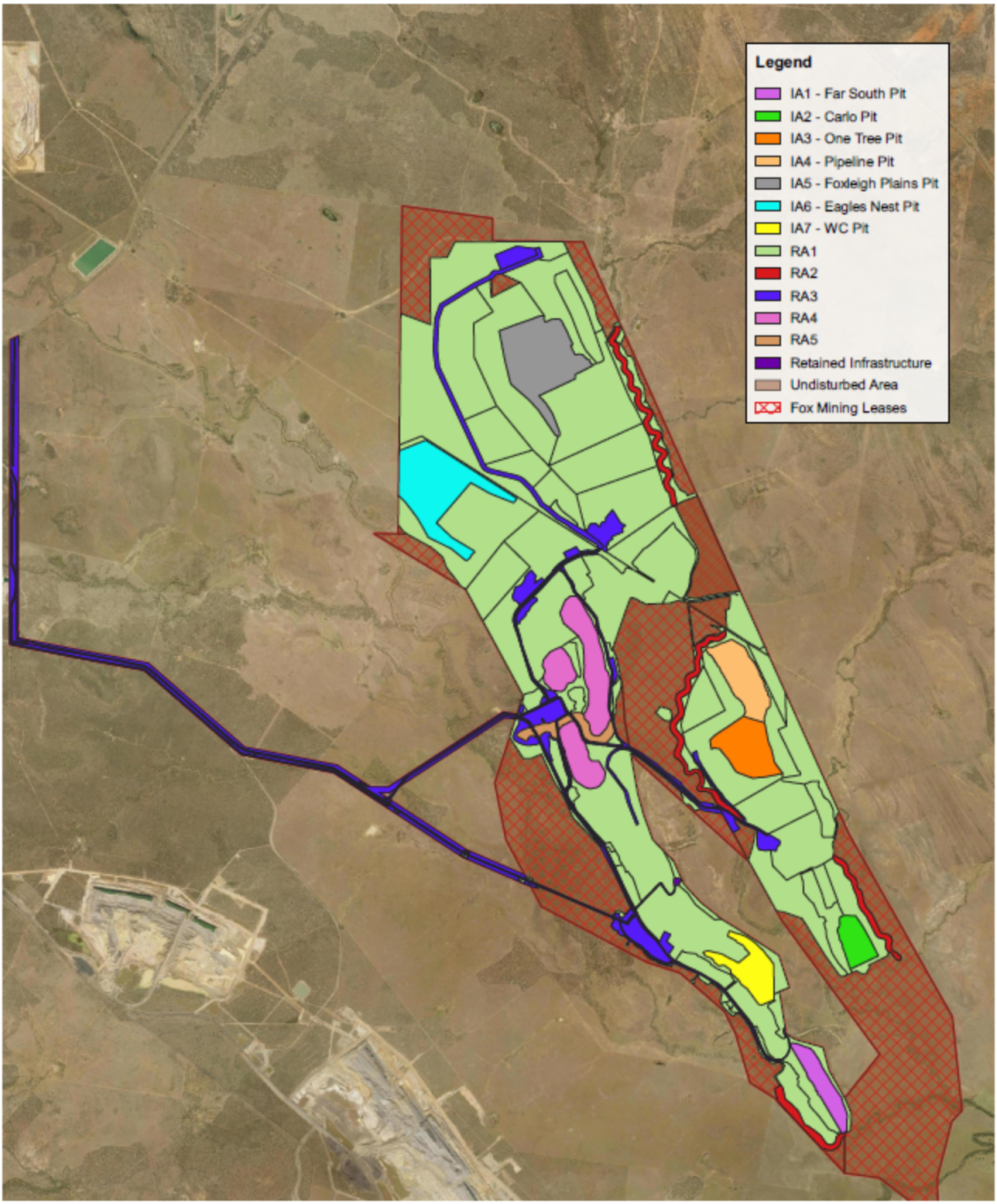
The Fox IAs and associated relevant activities are detailed in Table 3-27 and the MMs are detailed in Table 3-28. IA locations is defined in Table 3-27. Figure 3-20 provides a schematic illustration of the RAs and IAs.

Table 3-27: Improvement areas (IAs) and relevant activities for Fox

Improvement area (IA)	NUMA	Relevant activity
IA1	NUMA	Residual void (Far South)
IA2	NUMA	Residual void (Carlo Creek)
IA3	NUMA	Residual void (One Tree)
IA4	NUMA	Residual void (Pipeline)
IA5	NUMA	Residual void (Fox Plains)
IA6	NUMA	Residual void (Eagles Nest)
IA7	NUMA	Residual void (WC)

Table 3-28: Management Milestones for Fox

Management milestone (MM)	
MM1	Achievement of structural stability
MM2	Achievement of landform design and surface requirements
MM3	Achievement of sufficient improvement not to cause environmental harm and that will be safe and structurally stable



Rehabilitation Areas
Foxleigh Mine
PRCP

ENGENY

Foxleigh MINE

N

0 2

Kilometers

Scale @ A4 1:93,000
Date: 29/8/2023
Drawn By: HB
Project Number: QC1025_001

3.1.8. Existing Rehabilitation

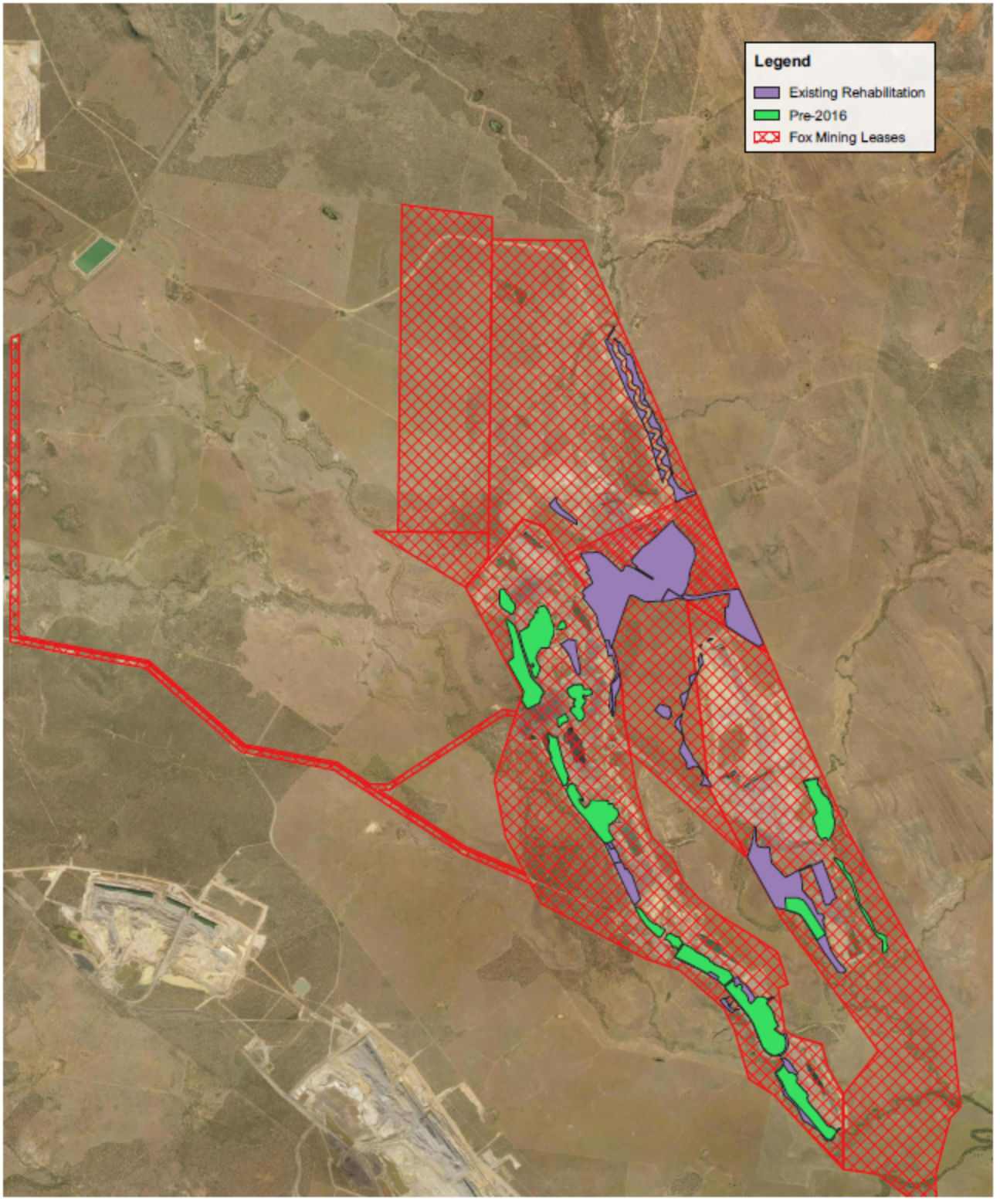
Fox has 1223ha of existing rehabilitation completed, 560 ha of this completed within the last three years. Unfortunately, approximately 450ha of existing rehabilitation will be disturbed by mining operations during the life of the mine when taking an additional strip along previously mined pits. Areas of existing and recent rehabilitation is provided in Figure 3-21.

The existing rehabilitation is identified as completion prior to 2016. The existing rehabilitation was completed to a pre-existing criteria with part of the areas of rehabilitation considered as 'established' and where applicable, retention of these areas has been a focus in development of the PRCP Schedule. During a site wide rehabilitation assessment (Engeny, 2021), some of these areas were identified as requiring rectification works to remove erosion gullies. Where applicable, there areas have been included into the RM.

No rehabilitation areas have been applied for or approved as progressively certified under the *EP Act* as of 1 September 2023.

3.1.9. Retained Infrastructure

The is a total of 745.518ha of retained infrastructure proposed in accordance with the landholder agreements in consistency with the final land use of grazing. This is discussed further in Section 3.2.



Existing and Historic Rehabilitation
Foxleigh Mine
PRCP

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Foxleigh MINE

N

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Kilometers

Scale @ A4 1:93,000
Date: 29/8/2023
Drawn By: HB
Project Number: QC1025_001

3.2. Community Consultation

Legislative Requirement

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

- *details of the consultation undertaken by the applicant in developing the proposed PRC Plan, and*
- *details of how the applicant will undertake ongoing consultation in relation to the rehabilitation to be carried out under the plan.*

PRCP Guideline (Section 3.5)

In developing the proposed PRC Plan, the community should at least be engaged on the plan for the mine, PMLUs or NUMAs, areas of disturbance, rehabilitation and management methods, progressive rehabilitation, and closure timeframes. Ongoing community consultation should continue throughout the stages of the mine life so that progressive rehabilitation and the socio-economic and environmental impacts related to mine closure can be discussed with the community.

Community consultation carried out through different processes (such as an EIS) may be used to address the requirements in section 126C(1)(c) of the EP Act. The details of this consultation must be provided in the rehabilitation planning part of the proposed PRC Plan).

Transitional PRC Plans are still required to meet the legislative requirements in section 126C(1)(c) of the EP Act. All proposed PRC Plans must contain a community consultation plan regardless of whether the site has an existing EA.

Community Consultation Register

A community consultation register was reviewed (from the EIS) (**Appendix D**) as part of the PRCP in compliance with section 126C(1)(c)(iii) of the EP Act and includes:

- Identification of each community member/stakeholder.
- Previous engagements with the community.
- Consultation date(s).
- Description of consultation type.
- Information provided to the community.
- Issues raised/ discussed by the community.
- How issues have been considered.
- Decisions/ outcomes of engagement.
- Commitments made by FoxMan.

A register of current stakeholders has been developed as part of the PRCP and is provided in Table 3-29. Listed stakeholders identified as part of this register are considered as having a genuine, demonstrable and legitimate interest in the ongoing rehabilitation and closure planning at Fox. Table 3-29 documents these identified stakeholders, details on current FoxMan relationships, as well as potential areas of interest with respect to the site's PRCP. Table 3-30 is a consolidated consultation register details a timeline of consultation throughout the history of Fox.

It is noted that there are no underlying landholders or landholders with compensation agreements that entitle them to consultation on rehabilitation outcomes within Fox, excluding the retention of selected tracks and roads. A written agreement between relevant the landholder and Fox detailing agreement for the retention of light vehicle roads and tracks across the mining lease is provided in **Appendix E** & **F**.

Fox has maintained open opportunities for the community and surrounding landholders to submit complaints or concerns regarding the final proposed land uses through the Stakeholder Engagement Plan (**Appendix G**). To date, there have been no received complaints regarding the existing proposed closure landform of Fox.

Table 3-29: Key stakeholders identified as part of the Fox Community Consultation Register

Stakeholder	Details	Potential Areas of Interest
Affected Stakeholders		
Traditional owners • Southern Barada Barna and Southern Kabalbara People (SBK)	This is the identified Aboriginal party for Fox in accordance with the *Aboriginal Cultural Heritage Act 2003*. A Cultural Heritage Management Plan (CHMP) was developed as part of the EIS, and it was determined that the only identified area of cultural significance would not be disturbed as part of the project.	• Potential impacts on cultural landscape or connections to Country • PMLU and landform / landscape • Future access to and ownership of land • Environmental management/stewardship • Employment and business opportunities in rehabilitation, environmental management and monitoring
Petroleum tenement holders • CH4 Pty Ltd	• Tenement holder is not active on the lease and no current plans to utilise tenement. Engagement with tenement holder was conducted as part of EIS.	• PMLU/NUMA and closure landforms/landscape • Rehabilitation schedule
Coal Tenement Holders • Foxleigh Coal Pty Ltd • CAML Resources Pty Ltd • Nippon Steel Australia Pty Ltd	• Fox operates as a joint venture with any ongoing management and closure plans reviewed by parties within the joint venture.	• Water access – underground, surface, water allocations, water pipelines • Environmental management /stewardship • PMLU/NUMA and closure landforms/landscape • Rehabilitation schedule
Easement Holders • Ergon Energy Pty Ltd	• Ergon undertakes line maintenance and vegetation clearing when required, with notification provided to Fox. • Fox operations do not occur in the easement.	• Any impacts to land including access
Landowners within and adjoining the MLA • Kevin Damien Kenny (Lot 4 SP189240)	All three surrounding landholders (Kenny, Small and Campion) operate active cattle farms with free ranging cattle stock.	• Water access – underground, surface, water allocations, water pipelines

Stakeholder	Details	Potential Areas of Interest
• Arthur Edward Small (Lot 15 SP178417) • John Frederick Campion (Lot 2 ROP184) • Foxleigh Land Pty Ltd (Lot 6 SP189240)	Foxleigh Land Pty Ltd is a subsidiary of FoxMan.	• Environmental management /stewardship • PMLU/NUMA and closure landforms/landscape • Rehabilitation schedule • Future access to and ownership of land • Influence on future business/land value due to mining operations and PMLUs
Isaac Regional Council (IRC)	Isaac Regional Council is the local government and planning authority for the Isaac LGA Fox maintains connection with the Council	• Effects on Council services and infrastructure • Management of closure impacts on employment and businesses • Alignment of rehabilitation plans with local and regional planning goals
Interested Stakeholders		
FoxMan workforce (including contractors)	FoxMan's workforce includes approximately 598 personnel including employees and contractors. A small percentage of personnel live in Middlemount, with the rest fly-in/fly-out or drive-in/drive-out	• Timing of closure • Rehabilitation obligations • Employment continuity
CAML Resources Pty Ltd	Fox's JV partners undertake regular engagement to confirm alignment with all proposed management and stages of mining.	• Stakeholder perceptions about closure • Responsible Environmental management
Nippon Steel Australia Pty Ltd		
Foxleigh Coal Pty Ltd		

Stakeholder	Details	Potential Areas of Interest
Local residents and businesses of Middlemount	• FoxMan supports local community through active donations and sponsorship of Middlemount Golf Club, Annual Middlemount Race Club, Middlemount State School, Middlemount Senior Football Club, Middlemount Tennis Club, Community Links Program (CTM) (Capella, Tieri, Middlemount), RACQ Rescue chopper, and Mackay Basketball INC. Local businesses such as but not limited to Middlemount Rural, and BDS Mechanical are used as active vendors for supply of goods and services.	• Local employment and business opportunities • Opportunities to participate in supply chain (e.g., environmental management, rehabilitation) • With closure, loss of jobs and supply opportunities, and changes to demands for services e.g., childcare and schools. • Economic transformation (towards post-mining)
Queensland Government • Department of Resources - Office of the Minister, Deputy Director-General Georesources • DES Office of the Minister, MERPF Act implementation team • Member for Burdekin • Office of the Minister for Regional Development and Manufacturing and Minister for Water	• Fox has constructive working relationships with Department of Resources and DES.	• Legislative compliance • Resource development • Employment opportunities • Public interest • Environmental management • Economic transformation (towards post-mining) • Financial assurance • Environmental risk management • Future land use and landform • Company responses to stakeholder views
Federal Government	The Department of Climate Change Energy and Environment and Water (DCCEEW) is the lead agency for environmental protection at Commonwealth level. Consultation on PRCPs is not required for Federal Government stakeholders but information will be provided to relationship holders to enable them to provide updates if required.	• Offset compliance • Groundwater compliance

Table 3-30: Fox Consolidated Consultation Register

Date	Relevant Stakeholders	Consultation Type	Information Supplied	Issues Addressed	Response / Outcome	Commitment Made by Applicant
1999	Relevant government authorities, interested and affected persons.	Formal notification & submission process for ML 70171	Application details for EA & ML. Includes Environmental Management Overview Strategy (2019)	unavailable	Permit approved, tenure granted 1999.	Compliance with conditions of ML and EA
2004	Relevant government authorities, interested and affected persons.	Formal notification & submission process for ML 70309	Application details for EA amendment and ML. Includes Environmental Management Overview Strategy (2003)	Land management issues including: -post mining land use -progressive rehabilitation - erosion and landform stability of dumps and diversions - management of final voids	Permit approved, tenure granted 2004.	Compliance with conditions of ML and EA
2011	Relevant government authorities	Consultation with regulators	EA amendment application for change in activities on ML 70171 & ML 70309. Includes Environmental Management Plan (2011)	Land management issues including: -post mining land use -progressive rehabilitation - landform design - Voids as water storage	Permit approved	Compliance with conditions of ML and EA
2011	Relevant government authorities, interested and affected persons.	Formal notification & submission process for ML 70470 (Area No. 4)	Application details for EA amendment and ML. Includes Environmental Management Plan (2011)	*unavailable*	Permit approved, tenure granted 2012.	Compliance with conditions of ML and EA
2010-2011	Consolidated consultation undertaken during the EIS development for the Foxleigh Plains Project: - 3 x landholders - 5 x easement holders - Commonwealth government -State government (11 departments) - Isaac Regional Council and councillors - 2 x Environmental groups - Aboriginal parties - Various residents within the Middlemount community	Community information sheet, 24 x one-on-one meetings, small group meetings	Project details and discussion of assessment process and submission timing. Identification of key issues of concern to stakeholders.	Broad range of issues raised including: - workforce accommodation and impact on local economy - attracting residents and families to region - impacts on community services - Stability of the school - rent prices. - environmental and health issues - road traffic - air quality Employment opportunities - housing availability - antisocial behaviour of workforce - impacts on water quality, flood regimes, flora and fauna - blasting and local infrastructure - timely and effective rehabilitation	Broad range of issues raised were included within the assessment scope of the EIS.	Future stakeholder engagement program and SIMP
2012	Relevant government authorities, interested and affected persons.	Formal notification and submission processes for the EA and MLs 70429, 70430 & 70431 (Foxleigh Plains Project).	Application details for EA amendment and ML. Includes Environmental Management Plan (2012)	Land management issues including: -post mining land use -progressive rehabilitation - landform design - Voids as water storage - Rehab monitoring - Rehab success criteria	Permit approved, tenure granted 2014.	Compliance with conditions of ML and EA
2012	EIS stakeholder: - Department of Sustainability, Environment, Water, Population and Communities (Commonwealth)	Submission on the Foxleigh Plains Project EIS.	Draft EIS and associated material	Biodiversity offsets for permanent impacts on MNES	Commitment to fulfilling the Commonwealth offset requirement for the Project.	Development of an Offset Management Strategy.
2012	EIS stakeholder: Department of Aboriginal and Torres Strait Islander and Multicultural Affairs	Submission on the Foxleigh Plains Project EIS.	Draft EIS and associated material	Division of relevant native title applicants and development of a CHMP Employment and training programs	Amendments to EIS text related to relevant native title body.	Commitment to development of a CHMP with Barada Barna People and the Smith family representatives

Date	Relevant Stakeholders	Consultation Type	Information Supplied	Issues Addressed	Response / Outcome	Commitment Made by Applicant
					Response with target for local procurement and employment incorporating opportunities for Indigenous and non-indigenous people.	Commitment for further consultation on the matter of Indigenous employment targets.
2012	EIS stakeholder: Department of Agriculture, Fisheries and Forestry	Submission on the Foxleigh Plains Project EIS.	Draft EIS and associated material	Pest and weed species management	Pest Animal Weed Management Plan will address the specific matters raised.	Development of a Pest Animal and Weed Management Plan.
2012	Department of Agriculture, Fisheries and Forestry	Submission on the Foxleigh Plains Project EIS.	Draft EIS and associated material	Waterway barriers, drainage management, forestry products, tenure/access.	Drainage management commitments have been made in the EIS. Detailed design phase will address relevant matters raised. No commercial timber use is proposed. The proponent will consult further with DAFF.	Further consultation to ensure relevant guidelines and permits are addressed in the detailed design phase.
2012	Department of Community Safety	Submission on the Foxleigh Plains Project EIS.	Draft EIS and associated material	Bushfire risk management, changes to WHS laws, emergency preparedness	Comments noted and confirmation of commitment to address matters raised	Commitment to address bushfire risk management, workplace health and safety, major incident management, emergency preparedness and response, training, and behaviour management.
2012	Department of Education, Training and Employment	Submission on the Foxleigh Plains Project EIS.	Draft EIS and associated material	Impacts to local schools including student numbers, flooding, noise and air quality, road use and employment initiatives	Response provided to all matters raised which have been assessed within the EIS and the SIMP.	Changes made to EIS to figures to ensure schools are clearly represented.
2012	Department of Energy and Water Supply	Submission on the Foxleigh Plains Project EIS.	Draft EIS and associated material	Clarification of water supply volumes and likely sources. Groundwater and surface water modelling and impacts. Diversion design.	EIS text amendment to clarify water demand and potential water supply sources. Clarification of groundwater and surface water monitoring program commitments. Clarification of diversion design commitments.	EIS amendment and commitment to further investigation of additional supply sources and commitment to groundwater and surface water monitoring programs.
2012	Department of Environment and Heritage Protection	Submission on the Foxleigh Plains Project EIS.	Draft EIS and associated material	Broad range of matters including design of diversions and levees, noise impacts, stability of final voids, dust, water quality and management, groundwater, monitoring, rehabilitation criteria, ecological assessment methods, Social Impact Management Plan, stock routes, soil assessment, land suitability, flood impacts.	A range of changes were made to the EIS in response to the DEHP comments.	Future commitments related to monitoring program development, development of rehabilitation success criteria, and the future detailed design of diversions and other infrastructure.
2012	Department of State Development Infrastructure and Planning	Submission on the Foxleigh Plains Project EIS.	Draft EIS and associated material	Comments relating to SIMP commitments and the regional plan as it relates to workers accommodation.	A range of amendment to the SIMP were made to address comments.	Future commitments contained in the amended SIMP.
2012	Department of Transport and Main Roads	Submission on the Foxleigh Plains Project EIS.	Draft EIS and associated material	Matters pertaining to the road impact assessment including traffic movements and intersections.	Clarification of commitments in the EIS provided	EIS commitments remain valid.
2012	Department of Transport and Main Roads	Submission on the Foxleigh Plains Project EIS.	Draft EIS and associated material	Coal dust emissions during rail transport and impacts on ballast.	Wording of EIS to be amended to address the risk and commit to mitigation.	Installation of a veneering system will be undertaken once Queensland Rail Network approval has been obtained.
2012	Queensland Police Service	Submission on the Foxleigh Plains Project EIS.	Draft EIS and associated material	Worker transport and fatigue management, support for key services, traffic management, and road use permits,	Change to EIS made to reflect commitment to fatigue management standards and permitting for road use.	Implementation of fatigue management practices and commitment to permitting for specific road uses.

Date	Relevant Stakeholders	Consultation Type	Information Supplied	Issues Addressed	Response / Outcome	Commitment Made by Applicant
2012	Mackay Regional Council	Submission on the Foxleigh Plains Project EIS.	Draft EIS and associated material	Cumulative impacts to air noise and water	Comments considered.	EIS commitments unchanged.
2012	Capricorn Conservation Council	Submission on the Foxleigh Plains Project EIS.	Draft EIS and associated material	Direct impacts to endangered or of concern vegetation communities	Comments noted or reference provided to EIS assessment.	EIS commitments unchanged.
2012	Fitzroy Basin Association	Submission on the Foxleigh Plains Project EIS.	Draft EIS and associated material	Diversion, topsoil balance, fauna species impacts, monitoring, flood assessment, waterways.	Comments considered with some changes made to the supplementary EIS.	Commitment to amendment of monitoring programs and development of a revegetation plan in line with consultation.
2012	Mackay Conservation Group	Submission on the Foxleigh Plains Project EIS.	Draft EIS and associated material	Flood and release water management, dust and noise impacts on landholders, rehabilitation outcomes, water, groundwater, flora and fauna	Comments considered with some changes made to the supplementary EIS.	Commitment to amend the groundwater monitoring program in line with consultation.
2013	Relevant government authorities interested and affected persons.	Formal notification & submission process for ML 70310. Consultation with: - DEHP - DEEDI - Individual community members - Registered native title groups	Application details for EA amendment and ML. Includes Environmental Management Plan (2012)	Land management issues including: -post mining land use -progressive rehabilitation - landform design - Void use as water storage	Permit approved, tenure granted 2015.	Compliance with conditions of ML and EA
2021-2023	Barada Kabalbara Yetimarala People	Bi-annual Meetings conducted between BKY People and Foxleigh Mine per CHMP. 2020-2021 gap due to COVID-19 Dec-2021 Feb-2022 (CHMP) July -2022 (NAIDOC) Dec-2022 July -2023	Fox provide a presentation either onsite or at agreed location	Typical Meeting format covers: -Indigenous Employment opportunities. -Upcoming cultural clearance work and mine planning outlook. -Reconciliation actions upcoming, i.e., NAIDOC Week, Artifact display. -Rehabilitation program and potential for engagement.	# of employment vacancies and request for BKY referrals. Shared Fox Seed Mix strategy for PMLU. Requested feedback and suggestions from BKY on seed selection.	Continued consultation and engagement with indigenous people.
2022	Middlemount Branch Manager	Informal site visit, observation of existing rehabilitation and suitability for grazing cattle	Verbal discussion: current rehabilitation update, Fox LOMP including rehabilitation of OOPD and voids remaining post mining.	Discussed area of poor vegetation cover, importance of soil analysis as part of rehabilitation to ensure targeting correct issues, much rehab at quality to support low intensity grazing -suggestion of planned grazing trial	All items noted: Soil analysis was completed, and ameliorants calculated using best practice	Commitment to continue reviewing rehab methodology to ensure successful
2023	Adjacent and underlaying landowners	Informal discussion and general LOMP update.	PRCP Rehabilitation Schedule presentation	Discussed whole of site rehabilitation plan. Grazing as predominant PMLU, residual voids will be made safe, stable and left post mining. In general, highwalls and pit lakes will remain and excluded from grazing area, the low wall slopes will as much as practical be reprofiles and rehabilitated to support low intensity grazing.	In general, description is consistent with past communication	Continue open communication

3.3. Post Mining Land Uses

Legislative Requirement

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:

1. *the outcome of consultation with the community in developing the plan, and*
2. *any strategies or plans for the land of a local government, the State or the Commonwealth.*

3.3.1. Nominated PMLUs

PMLUs permitted for Fox under the EA include the following:

- Cattle grazing.
- Watercourse.
- Native ecosystem connectivity corridor.

The proposed PMLUs are illustrated in Figure 3-22 and have been recommended based on the outcomes of rehabilitation and closure studies supporting the PRC plan, listed below:

- Post-mining landforms.
- Land suitability assessments.
- Available topsoil quantity and quality.
- Pre-mining land use.
- Existing vegetation and ecological values.
- Relevant watercourses.

The PMLUs are underpinned by rehabilitation objectives that focus on achieving a safe, stable, non-polluting and sustainable post-mining landscape (as defined in the EA).

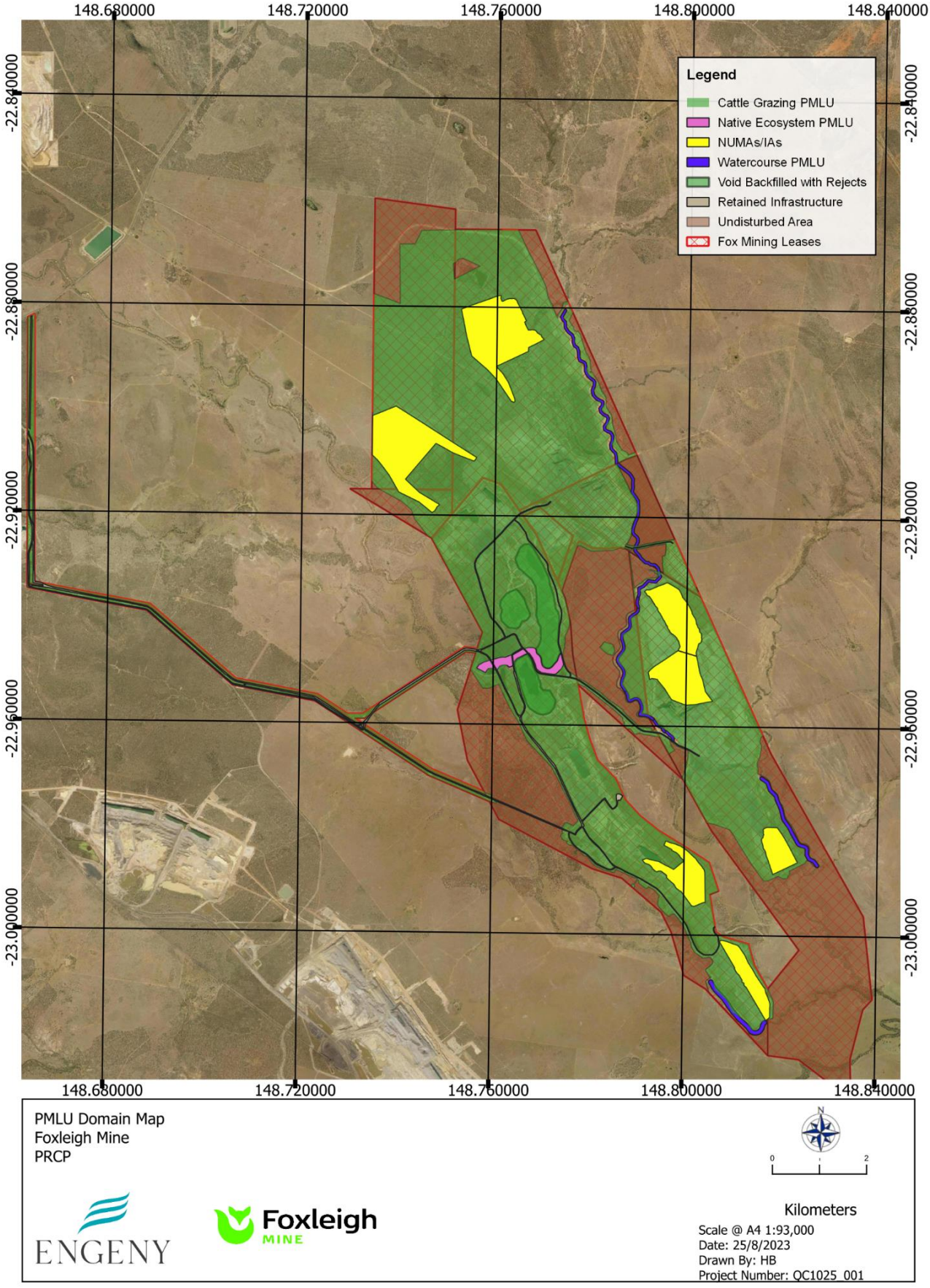


Figure 3-22: Fox Post-mining Land Uses (PMLUs) and Non-use Management Areas (NUMAs)

Cattle Grazing

EA objectives, indicators and acceptance criteria for the PMLU of cattle grazing is displayed in Table 3-32. The relevant EA acceptance criteria has been transitioned into the milestone criteria in the PRCP Schedule for the final milestone of achieving the PMLU to a stable condition.

The assessment of land suitability specified in the EA acceptance criteria (Cattle Grazing Class 4) is based on the Guidelines for Agricultural Land Evaluation in Queensland ((DSITI & DNRM, 2015).

Pre-mining land suitability assessment was completed by GSS Environmental in 2011 (GSS Environmental, 2011). To meet a Class 4 Grazing suitability, the post-mining land suitability will be assessed against the acceptance criteria specified in Table 3-31. This acceptance criteria was adapted from the Department of Minerals and Energy (DME) criteria.

Table 3-31: Class 4 Land Suitability Criteria for Beef Cattle Grazing (DME, 1995)

Parameter	Acceptance Criteria (DME 1995)	Adapted Criteria based on Technical Studies
Plant available water capacity	PAWC50-75	
Nutrient Deficiency	Sands and loams at least 75 cm deep or overlying rock at shallow depth, with bicarbonate P5-10ppm or bicarbonate P>4ppm	
Salinity	Rootzone EC 0.9-1.2 mS/cm Or Rootzone Cl 900-1500 ppm	
Rockiness	90 % surface cobble and rock outcrop	
Soil pH	9 – 10 4.0 - 4.5	
Exchangeable Sodium Percentage (ESP%)	15-30	
Groundcover	No criteria adopted by DME	>60% (Engeny, 2023)
Water erosion (a function of slope % and ESP%)	Slopes 6-12% on sodic rigid soils Or Slopes 9-15% on cracking clays Or Slopes 20-45% on non-sodic rigid soils	
Topography	Many deep gullies make cultivation for sowing pastures impractical, or slopes >15% make cultivation along contours impractical.	

Table 3-32: Fox EA Rehabilitation Objectives: Cattle Grazing PMLU Completion Criteria

Goal	Objective	Indicator	Completion Criteria
1. Safe for humans and wildlife 2. Non polluting 3. Stable 4. Able to sustain agreed post-mining land use	Predominately a self-sustaining, low maintenance pasture vegetation supporting a grazing post mining land use, or a self-sustaining, low maintenance vegetation state with similar structure, composition and function to that of a native terrestrial or riparian ecosystem of the brigalow belt. Establishment of a native ecosystem connectivity corridor between Cockatoo creek and Roper Creek (East to West) in the vicinity of the CHPP infrastructure area. Where agricultural land use applies, to return self-sustaining grazing land that is sustainable and economically viable	Infrastructure removed as required and revegetated to a light grazing post mining land use with a mix of pasture and native grass species or revegetated to a native ecosystem. Potential for erosion of waste dump slopes is reduced by correct spoil placement and functional drainage. Adequate access areas used for agriculture that can be maintained into the future. Suitable vegetation is planted for agricultural uses. Adequate shade and water are available for stock use. Topsoil/growth medium spread minimum 150mm depth, with no bare areas greater than 100m². Ripping to a minimum depth of 50cm at 1m spacing. Revegetation seed mix complies with final agreed land use of grazing or native ecosystem. Outer spoil slopes reshaped to 17% (9.65°). Internally draining spoil slopes reshaped to <45% (24.23°) with appropriate spoil placement, functional drainage and erosion control structures to reduce slope erosion potential. Final rehabilitated spoil dumps will be hills with a mix of pasture and native grass species or native vegetation. Tailing material will be physically and chemically assessed to determine the appropriate capping required. Mineral residue material capped with coarse reject and/or spoil and revegetated with a mix of pasture and native grass species or native vegetation.	Surface water run off quality is similar to the water quality of the surrounding catchment and within the EA conditions. Infrastructure areas land reshaped to slope range <10% (5.71°). Adequate erosion control structures have been installed, with no sites of significant wind or gully erosion that will cause harm to fauna. Vegetation established across areas with a suitable species mix for the agreed final land use of grazing or native ecosystem. Areas where agricultural land use applies, have pasture grass species present and provide stock with nutritional requirements, as well as being capable of setting viable seed and flowering similar to reference sites in the Middlemount area and/or with a land suitability class (grazing) of 4. Spoil flat areas (out of pit and in-pit) surfaces have been constructed to a slope range <10% (5.71°). Spoil slopes (out of pit and in-pit) have been constructed to a slope range < 17% (9.65°). Outer spoil slopes are no longer than 100m between benches. Tailings and mineral residue material capped with an appropriate capping material.

Watercourses

The watercourse PMLU rehabilitation completion criteria from the EA is specified in Table 3-33. These were developed specifically for diversions and flood protection levees. These have been transitioned to the milestone criteria in the PRCP schedule for the final milestone of achieving the PMLU to a stable condition.

As stated in the EA, completion criteria for watercourse PMLU are defined using the detailed diversion design reports for the Cockatoo Creek, Roper Creek and Carlo Creek diversions. The detailed design report is written in accordance with *Guideline: Works that interfere with water in a watercourse – watercourse diversions,* DNRM (2014).

The lateral limits of the watercourse PMLU were defined based on the following considerations:

- 50 m riparian buffer on each diversion.
- Creek diversion designs.

The monitoring methodology for diversions at Fox addresses the diversion condition during its construction, operational and relinquishment phases. Monitoring was designed in accordance with the Australian Coal Association Research Program (ACARP) guidelines for Monitoring and Evaluation Program for Bowen Basin River Diversions (ID&A Pty Ltd, 2001). This guideline sets the standard for monitoring of watercourse diversions within the Bowen Basin and the criteria for assessment. The monitoring methodology is described in Section 3.7.

Table 3-33: Fox EA Rehabilitation Objectives: Watercourse PMLU Indicators and Objectives

Goal	Objective	Indicator	Criteria
			In accordance with H2 (per the as constructed design plans of applicable diversions).
1. Safe for humans and wildlife 2. Nonpolluting 3. Stable 4. Able to sustain agreed post-mining land use.	Creek diversions that operate in equilibrium with adjoining reaches of the watercourse.	Creek diversion must incorporate similar geomorphic and riparian vegetation features to those of the pre-existing watercourse and adjoining landscape.	Permanent watercourse diversion incorporates natural features (including geomorphic and vegetation) present in the landscape and in local watercourses.
		Surface water qualities of flow events through the diversion are similar to the water quality of the surrounding catchment and within the EA conditions.	The permanent watercourse diversion maintains the existing surface water and groundwater systems.
		Remediation of the disturbed area within the watercourse diversion and adjoining floodplain is stable with evidence of vegetation achieving a trajectory of self-sustainability.	Hydraulic characteristics of the permanent watercourse diversion are comparable with other local watercourses and are suitable for the region in which the watercourse diversion is located.
		Topsoil/growth medium spread at a minimum rate of 150mm with no bare areas greater than 100m².	The permanent watercourse diversion maintains sediment transport and water quality regimes that allow the watercourse diversion to be self-sustaining, while minimising nay impacts to upstream and downstream reaches.
		Seed mix includes riparian vegetation.	The permanent watercourse diversion and associated structures maintain equilibrium and functionality and are appropriate for all substrate conditions they encounter.

Native Ecosystem Connectivity Corridor

The native ecosystem connectivity corridor PMLU rehabilitation completion criteria from the EA is specified in Table 3-34. The EA is limited in its definition of the completion criteria for the native ecosystem however the intended purpose is to provide connectivity between the existing conservation areas. Native ecosystem milestone criteria have been based on the surrounding native vegetation and the existing vegetation within the conservation areas in combination with the surrounding PMLU of grazing.

The monitoring methodology is described in Section 3.7.

Table 3-34: Fox EA Rehabilitation Objectives: Native ecosystem connectivity corridor PMLU Indicators and Objectives

Goal	Objective	Indicator	Criteria
1. **Safe for humans and wildlife** 2. **Non-polluting** 3. **Stable** 4. **Able to sustain agreed post-mining land use**	Establishment of a native ecosystem connectivity corridor between Cockatoo creek and Roper Creek (East to West) in the vicinity of the CHPP infrastructure area.	Revegetation seed mix complies with final agreed land use of grazing or native ecosystem.	Vegetation established across areas with a suitable species mix for the agreed final land use of grazing or native ecosystem.

3.3.2. Community Considerations

Achievement of the identified PMLU's (grazing, watercourse, and native ecosystem corridor) is in line with consultation completed to date.

3.4. Non-Use Management Areas

Legislative Requirement

In accordance with sections 126C(1)(d), (g) and (h) of the EP Act, for each proposed non-use management area, the rehabilitation planning part of the PRC plan must:

- *state the reasons the applicant considers the area cannot be rehabilitated to a stable condition*
- *include copies of reports or other evidence relied on by the applicant for each proposed non-use management area*
- *state the extent to which the proposed non-use management area is consistent with the outcome of consultation with the community in developing the plan, and*
- *state the extent to which the non-use management area is consistent with any strategies or plans for the land of a local government, the State or the Commonwealth.*

PRCP Guideline (Section 3.3)

A NUMA is defined in the EP Act as an area of land the subject of a PRC plan that cannot be rehabilitated to a stable condition after all relevant activities for the PRC plan carried out on the land have ended. Proposed NUMAs must be justified under the criteria set out in section 126D (2) of the EP Act.

The rehabilitation planning part of the PRC plan must also include:

a) information demonstrating that the proposed footprint of each NUMA is as small as practicable

b) an assessment of the NUMA location options, having regard to the constraint of the resource location, with an analysis of the potential environmental harm and sensitivity of the surrounding environment of each option

c) a description of the proposed location of each NUMA and the environmental values of the surrounding environment

d) evidence showing how the proposed location will prevent or minimise environmental harm.

In accordance with section 126D(1)(c) of the EP Act, the applicant must develop and implement management milestones within the PRCP schedule which achieve best practice management and minimise environmental harm for any NUMAs contained in the proposed PRC plan. As part of the development of management milestones, the applicant must conduct a NUMA specific risk assessment to identify and quantify risks and associated controls. The risk assessment should have an overarching goal of identifying and controlling any significant risks to the community and the environment.

The proposed PRC plan must include a detailed description of the nominated NUMA(s) for the site. The description must include, but is not limited to:

- *description of the land at surrender*
- *any relevant safety features*
- *completion criteria for measuring whether the NUMA has achieved sufficient improvement.*

Where a NUMA has already been identified in a land outcome document and is able to be transitioned into the PRCP schedule, the applicant is not required to comply with sections 126C(1)(g) or (h) or 126D (2) or (3) of the EP Act. NUMAs transitioned into the PRCP schedule are not required to complete the information requirements under section 126C(1)(j) of the EP Act in this section for those NUMAs. However, the legislative requirements under section 126C(1)(d) of the EP Act still apply.

Where a NUMA has not been pre-approved and is proposed as part of the transition into the PRC plan, the applicant must include all of the requirements identified in this section.

3.4.1. Nominated NUMAs

A non-use management area (NUMA) is defined under Section 112 of the EP Act as an area of land the subject of a PRC plan that cannot be rehabilitated to a stable condition after all relevant activities for the PRC plan carried out on land have ended.
A total of seven (7) final voids are defined in the LODs and have been transitioned into this PRCP and PRCP Schedule. The relevant LOD for Fox remains the EA and the EIS Assessment Report.

In accordance with section 126C(1)(d) and (i) of the EP Act, this section of the PRCP describes:

- The extent to which the final void is consistent with the outcomes of community consultation.
- The extent to which the final void is consistent with strategies or plans for the land of a local government, the State or the Commonwealth; and
- Management of the final void to support the management milestones under the PRCP schedule.

It is noted that this section of the PRC plan does not include the information required by section 126C(1)(g), (h) or 126D (2) or (3) of the EP Act as sites with a NUMA that has previously been addressed in a land outcome document and is able to be transitioned into the PRCP schedule are exempt from having to address this section of the EP Act (DES, 2017).

The EIS outlined that there would be multiple final voids retained at completion of mining operations as part of the proposed landform and decision of these final voids would occur as operations progressed. FoxMan has engaged with DES between April 2021-August 2023 regarding defining the pre-approval of the NUMAs. The current version of the EA provides clear delineation of the location of theses NUMAs (Figure 3-23).

The final voids are proposed to be consistent with the rehabilitation requirements as outlined in Table 3-35, which is consistent with Appendix 2 of the EA (refer to **Appendix A**).

Notwithstanding the above, the legislative requirements under section 126C(1)(d) of the EP Act still apply. 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 NUMA identified in the PRCP Schedule is consistent with:

a) the outcome of consultation with the community in developing the plan, and
b) any strategies or plans for the land of a local government, the State or the Commonwealth.

This is addressed in the sub-sections below.

3.4.2. Community Consultation

The NUMAs are consistent with the outcomes of the community consultation because:

- Rehabilitation and closure documents developed over the course of mining at Fox have consistently noted multiple final voids and stated or inferred that the final voids will be a non-use areas post relinquishment. For example, the Environmental Management Operation System (EMOS, 2003) states that the final voids are intended as part of the final landform. The Plan of Operations (PoO, 2022) also identifies that final land uses includes grazing and final voids acting as water bodies. The EA has also consistently included residual voids in the rehabilitation criteria since approval of the licence.
- These documents have been submitted to and reviewed by Queensland government departments on multiple occasions over the course of mining.
- FoxMan owns all of the pastoral properties underlying Fox. At the time of purchase from Anglo American, FoxMan understood that there would be multiple non-use areas post relinquishment.

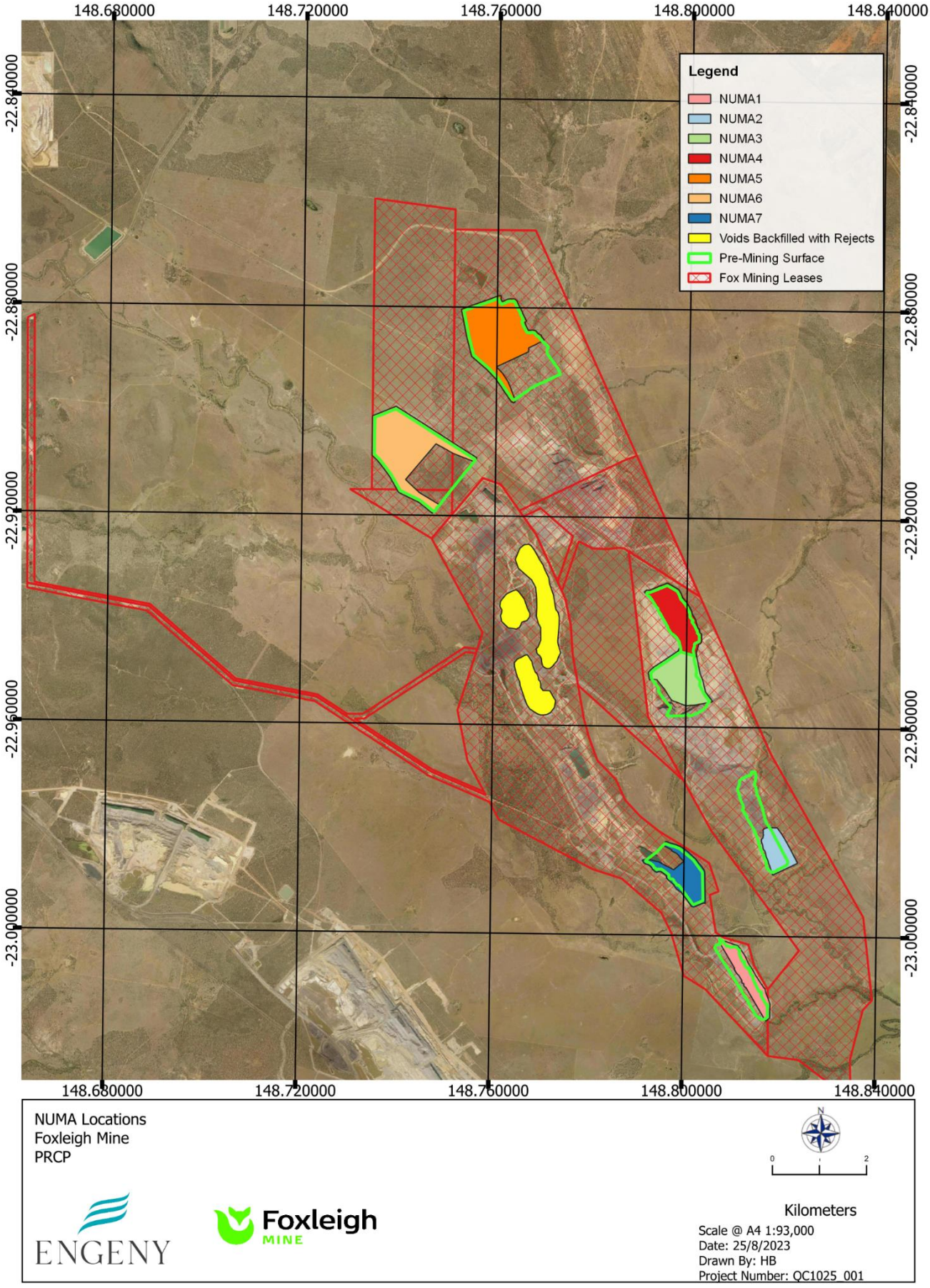


Figure 3-23: NUMA Locations

Table 3-35: Rehabilitation Criteria for Final Voids/NUMAs (excerpt from the EA)

Goal	Objective	Indicator	Criteria
1. Safe for humans and wildlife **2. Non-polluting** **3. Stable**	Residual voids remain as water body surrounded by in-situ pit walls and backfilled spoil. Residual voids will be unsuited to any beneficial land use (i.e., Non-Use Management Area). Residual voids will be safe, stable, and non-polluting. Voids will remain as groundwater sinks and will not release contaminants to the downstream receiving waters, including surrounding groundwater aquifers.	Fencing and exclusion zones are established on the in-situ pit walls for exclusion of humans and cattle. Stable in situ pit walls left standing at the slope created by the final blast and a diversion bank provided at the top for safety and drainage. Any exposed coal seam covered with material to minimise highly saline water leaching into void water stores. Drains are constructed to redirect surface water from flowing over the in-situ pit walls or in-pit spoil dumps. Geotechnical stability and risk assessments conducted to determine the appropriate treatments prior to closure.	All residual voids protected by permanently rehabilitated stable flood protection landforms providing immunity for a minimum 0.1% AEP event. In-situ pit wall and floor slopes <275% <70°) and assessed by a suitably qualified person to be long-term stable as per geotechnical stability risk assessment. Backfilled spoil walls and floor within the NUMA footprint 70% (<35°) and assessed by a suitably qualified person to be long-term stable as per geotechnical stability risk assessment. A suitability qualified person certifies in-situ pit walls to be stable as per geotechnical stability risk assessment. Drainage structures along in-situ pit walls and in-pit spoil dump have been revegetated with native shrub and grass species, with water drainage that flows naturally without pooling or flooding. Modelling confirms voids will remain as groundwater sinks and contaminants will not be released to the receiving environment or groundwater aquifers post-mining. A groundwater monitoring network designed by a suitability qualified person implemented onsite to monitor interaction of residual voids with surrounding aquifers. No groundwater contamination is evidenced by groundwater monitoring over 5 years post mining. Safety fencing and signage erected around pit walls to prevent access to

Relevant Legislation, Plans and Strategies

The extent to which the NUMAs are consistent with local, State and National strategies and plans is outlined in Table 3-36 below.

Table 3-36: Relevant Local, State, and National Strategies and Plans

Strategy or Plan	Purpose	NUMA Consistency
Local/Regional		
Isaac Regional Planning Scheme 2021	The planning scheme has been developed in accordance with the *Planning Act 2015* as a framework for managing development in a way that advances the purpose of the *Planning Act*. It forms the basis for ensuring appropriate development occurs in the Isaac Regional Council.	The region has a long history of mining and the planning scheme for the area of Middlemount will act as a gateway supporting **major mining activities** in the region and further afield. Final voids are a common occurrence with open cut mining operations. As such the existence of a final void (i.e., NUMA) is not inconsistent with the planning scheme.
Isaac Community Strategic Plan 2035	The strategic plan represents an action plan for ensuring the sustainable economic growth across the region through vibrant communities, a strong economy, a healthy environment and sustainable infrastructure.	The strategic plan recognises that mining has and will continue to be industry in the region. As final voids are typical within open cut mining operations, NUMAs are not inconsistent with this plan.
State		
State Planning Policy (SPP) (Department of Infrastructure, Local Government and Planning, 2017)	The SPP expresses the state's interests in land use planning and development. A state interest is defined under the *Planning Act* as an interest that the Planning Minister considers affects an economic or environmental interest of the state or a part of the state or affects the interest of ensuring that the purpose of the Act is achieved. Under the *Planning Act*, local governments must integrate relevant state interests into the planning scheme for their local government area.	The inclusion of NUMAs does not compromise the SPP overlays that apply to Fox being: • Bushfire hazard. • Floodplain hazard. • Agricultural land classification – class A and B • Biodiversity
State Infrastructure Strategy 2022	This strategy is focused on supporting sustainable and key infrastructure development for the state and identifies the significant economic contribution of mining. It outlines a forward plan for recovery from the COVID19 economic impacts.	The strategy recognises mining as a mainstay industry within the region supporting the economy of the region. As final voids are typical within open cut mining operations, NUMAs are not inconsistent with this strategy.
Central Queensland Regional Plan 2013	The plan outlines support for maximising the productive use of key mining resources and providing liveable communities.	The plan recognises mining as a mainstay industry within the region supporting the economy of the region. As final voids are typical within open cut mining operations, NUMAs are not inconsistent with this plan.

Strategy or Plan	Purpose	NUMA Consistency
Central and Western Queensland Infrastructure Plan 2023	The plan is focused on continue supporting of major regional development through setting regional priorities for the region. It acknowledges the critical role that the resource sector provides for continued economic development.	The plan recognises mining as a mainstay industry within the region supporting the economy of the region. As final voids are typical within open cut mining operations, NUMAs are not inconsistent with this plan.
National		
No national strategies or plans were identified as applicable.		

3.4.3. Voids in Flood Plains

Background

A Fox Voids in Flood Plain Assessment (**Appendix H**) was undertaken by Engeny in accordance with *Section 3.4 of the PRCP Guideline and the DES Information Sheet – Voids in Floods Plains* (DES, 2020) to support the evaluation of environmental risks. The assessment was completed by appropriately qualified surface water engineers and is consistent with the requirements of the Australian Rainfall and Runoff guideline (Ball, et al., 2019). Industry standard modelling software packages Unified River Basin Simulator (URBS) Version 2019 (URBS) and TUFLOW were utilised to complete the hydrologic and hydraulic modelling.

The Fox final landform includes seven (7) residual voids as pre-approved NUMAs (Fox Plains Pit, Eagles Nest Pit, One Tree Pit, Pipeline, WC Pit, Carlo Pit and Far South) (Figure 3-23).

As a conservative approach, the final void extents used for modelling were the preliminary extents of the final voids prior to any final landform design considerations and final void backfill that provides for flood protection. These preliminary extents are considered the maximum extents possible and the final proposed residual void extents have been reduced and refined based on the outcomes of the studies undertaken in support of this PRCP. Further details on the final landforms and rehabilitation approach are provided within Section 3.5.

Watercourses

As outlined within DES (2020), a 'Relevant watercourse' is defined as:

> *(a) a watercourse classified as stream order 4 or higher under the Strahler stream order classification system; or*
>
> *(b) if a watercourse mentioned in paragraph (a) is permanently diverted under—*
>
> > *(i) a condition, or proposed condition, of an environmental authority mentioned in the Water Act 2000, section 98; or*
> >
> > *(ii) a water licence or proposed water licence under the Water Act 2000.*
> >
> > *(iii) the watercourse as permanently diverted.*

Five 'Relevant watercourses' with a Strahler stream order of four or greater are present within Fox and/or the catchments, which have the potential to influence flooding within Fox (see Section 3.1.3) for description of watercourses present at Fox. The 'Relevant watercourses' that were considered as part of the Voids in Flood Plain Assessment include (Figure 3-24):

- Parrot Creek (Stream Order 4)
- Roper Creek (Stream Order 5)
- Carlo Creek (Stream Order 4)
- Cockatoo Creek (Stream Order 4)
- Oaky Creek (Stream Order 5)

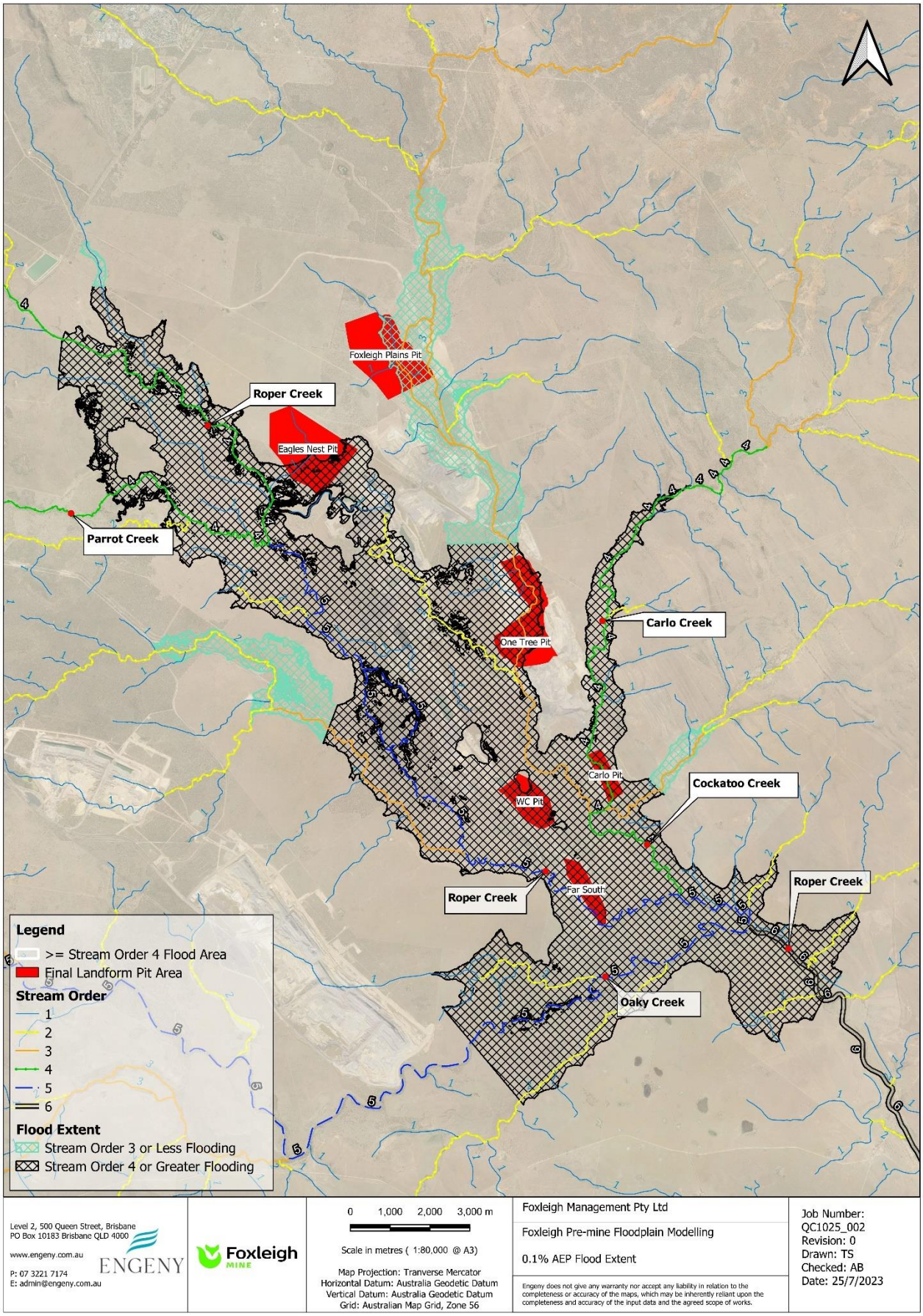


Figure 3-24: Fox Voids in Floodplain Modelling – 0.1 % AEP Flood Extent

Landforms

The intent of the voids in flood plain modelling was to represent the flood plain within the tenement without 'Artificial Features' as defined by DES (2020). As Fox was operational at the time of the voids in flood plain modelling a single source of pre-mining topographical information was not available. The Digital Elevation Model (DEM) for Fox and the contributing upstream catchments has been compiled from the following sources in order of priority:

- LiDAR topographic survey of Fox captured on the 28th of December 2020.
- LiDAR topographic survey of the immediate areas surrounding the mine captured during 2009.
- SRTM Survey data of the wider catchment (1 second resolution).

The pre-mining topography was developed by updating the topography data described above with contours underlying current mine disturbance captured prior to mining activities.

Modelling

Hydrologic modelling was undertaken to estimate runoff hydrographs at various locations throughout the catchments. A single URBS hydrologic model was developed for the Parrot, Roper, Carlo, Cockatoo and Oaky Creek catchments. Calibration of the hydrologic model was undertaken for the January 2013 historical event against rainfall and stream flow gauging data within the Roper Creek catchment for the US Roper Creek (331354), US Carlo Creek (331358), DS Cockatoo Creek (331355), DS Parrot Creek (331306) and Roper Creek Barwon Park (331357) and showed the hydrological model results were suitable for the purpose of this assessment. In accordance with the recommendations of the Australian Rainfall and Runoff (ARR) Guideline (Ball, et al., 2019), a suite of design storm events was simulated in the hydrologic model for the 0.1% AEP event for a large range of design storm durations. The hydrologic model identified the critical storm duration to be the 18-hr and 24-hr storm event.

Hydraulic modelling was undertaken for the areas covered by the hydrologic model for Fox (Parrot, Roper, Carlo, Cockatoo and Oaky creeks) to assess the pre-mining flood extents. As the hydraulic model includes multiple creeks with varying catchment sizes, multiple flood scenarios were simulated to ensure the maximum flooding conditions were captured across Fox. The model was simulated with three varying model focal points where hydrological inputs were changed based on the focal catchment area. The following scenarios were simulated:

- *Upstream creek flooding* – flooding based on flows in Roper Creek (upstream), Cockatoo Creek and Carlo Creek.
- *Downstream Roper Creek flooding 1* – flooding dominated by Roper Creek downstream of the confluence with Carlo Creek and upstream of Oaky Creek.
- *Downstream Roper Creek flooding 2* – flooding dominated by Roper Creek located downstream of the confluence with Oaky Creek.

Details of the voids in flood plain modelling are contained in **Appendix H**.

The results of the Fox model show the maximum extent of Eagles Nest Pit, One Tree Pit, Pipeline Pit, WC Pit, Carlo Pit and Far South are situated wholly or partly within the flood plain associated with a 0.1% AEP event (Figure 1). The Fox Plains Pit does not encroach into the 0.1% AEP event floodplain extent. The final landform will include flood protection landforms to prevent flood ingress into all residual voids.

3.5. Rehabilitation and Management Methodology

Legislative Requirement

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

- *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 PRCP Schedule.*

PRCP Guideline (Section 3.6)

The proposed rehabilitation or management methodologies will underpin the development of the milestone criteria and support how the proposed PMLU will be achieved, or the NUMA will be managed. As per section 126C(1)(j) of the EP Act, the administering authority requires information describing how the proposed rehabilitation or management methodologies have been developed and will be implemented.

This section identifies a number of studies or reports that must be provided in the proposed PRC Plan. If any of the required information outlined below is not relevant to the specific operation, the applicant must provide justification in the PRC Plan outlining why the information is not required.

3.5.1. General Rehabilitation Practices

PRCP Guideline (Section 3.6.1)

This section outlines the range of information that the administering authority considers is necessary to underpin the development of the rehabilitation or management methodologies applicable to new and existing mines for most domains. The applicant must include the information as appendices to the rehabilitation planning part.

Hydrogeology

PRCP Guideline (Section 3.6.1)

Assess the hydrogeology of the site and all connected strata and develop a conceptual model of the mine site's groundwater systems. This information must be integrated into the design of rehabilitation strategies and choice of PMLU or NUMA.

Groundwater Levels and Properties

Key groundwater sources and their hydrogeological characteristics at Fox are summarised in Table 3-37. Hydraulic conductivity of Potentiometric mapping of the mine in its current operational state is provided in Figure 3-25.

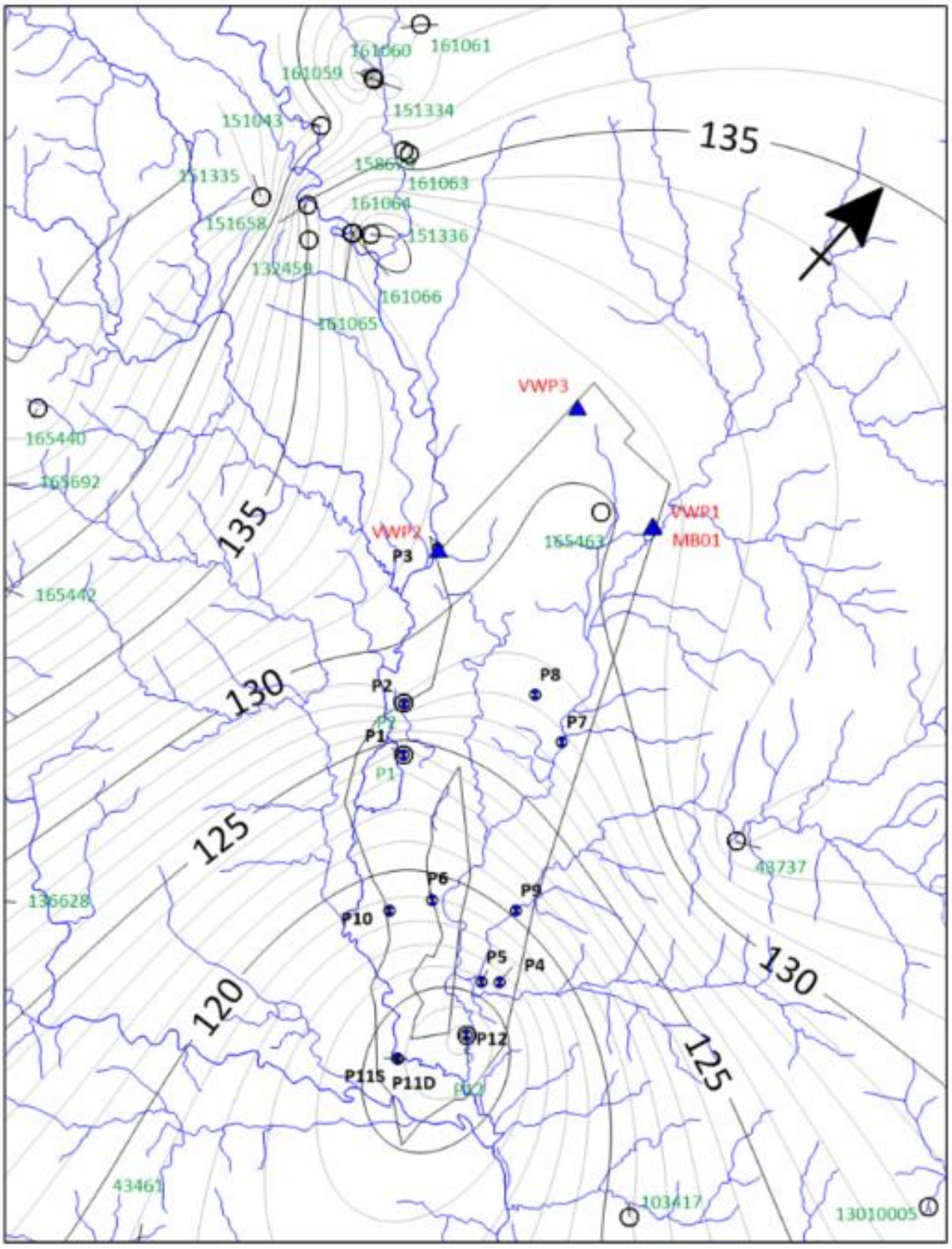


Figure 3-25: Water Table Map compiled using Regional and Local Monitoring Data (Groundwater Functions Pty Ltd, 2023)

Table 3-37: Hydrogeological Units and their Properties (Groundwater Functions Pty Ltd, 2023)

Age	Group	Geological Unit	Description	Groundwater Levels	Hydraulic Conductivity (m/S)	
					Vertical	Horizontal
Quaternary		Alluvium	Associated with stream channels and floodplains of Roper Creek and Cockatoo Creek. Groundwater is typically absent, present only following significant recharge events and occur closer to the base of sediments.	127 – 128 mAHD	4.34×10^{-6}	1.74×10^{-5}
Tertiary	Duaringa Formation	Soft, poorly consolidated sandstones and mudstones	Dry within project area.	N/A (dry)	5.79×10^{-6}	1.45×10^{-6}
Triassic	Rewan Formation	Heterogenous unit of green lithic sandstone, pebble conglomerate and red and green mudstones.	Hydraulically isolated from and/or irresponsive to surface recharge events. Considered an effective aquitard.	116.5mAHD – 117.5 mAHD	1.16×10^{-6}	2.89×10^{-7}
Permian	Rangal Coal Measures			110 mAHD – 116 mAHD	3.47×10^{-7} to 1.16×10^{-8}	1.16×10^{-7} to 1.39×10^{-6}
	Burngrove			117 mAHD – 125 mAHD	1.16×10^{-7}	1.16 10^{-8}

Groundwater Quality

Groundwater quality is monitored in compliance with the site's EA at FPMB01 (GMP4) in the alluvium. Alluvial groundwater is typically highly saline with an average EC of 55,000 µS/cm with a close to neutral average (geometric mean) pH of 7.14 (Groundwater Functions Pty Ltd, 2023).

Additionally, monitoring of field water quality has been conducted at each of the installed standpipe monitoring bores in order to assist in groundwater characterisation. A summary of the groundwater quality in each formation is displayed in Table 3-38 (Groundwater Functions Pty Ltd, 2023).

Table 3-38: Groundwater Monitoring Bore Water Quality Summary (Groundwater Functions Pty Ltd, 2023)

Formation	GWMB ID	pH (Units)	Specific Conductivity (µS/cm)	Turbidity (NTU)	Average Temp (deg C)
Alluvium/Tertiary	P12	6.59	42,765	715.3	28.0
Rewan	P6, P8	6.56	34,084	61.7	26.8
RCM coal seam	P4, P5, P11D	6.89	32,073	16.3	26.1
Permian interburden	P1, P2, P9, P10, P11S	6.81	32,286	36.4	26.8

Groundwater Use

There are 31 existing water bores within a 10 km radius of Fox. Of these, 25 bores are identified as 'monitoring' or 'mine monitoring' bores. Five are identified as 'water supply' bores (Groundwater Functions Pty Ltd, 2023).

The local groundwater monitoring network at Fox comprises of a VWP monitoring network and groundwater monitoring standpipes. The VWP network is displayed in Table 3-39. Groundwater monitoring standpipe details and the location of monitoring bores are discussed in Section 3.7.5.

Table 3-39: Fox VWP Monitoring Network (Groundwater Functions Pty Ltd, 2023)

Bore ID (EA ref)	VWP #	Easting	Northing	Elevation (mAHD)	Sensor		Remarks
					Elevation (mAHD)	Depth (mbgl)	
FPVWP01 (GMP2)	4	681789	7469150	136.8	86.8	50	Burngrove 1
	3				21.8	115	Burngrove 1
	2				-3.2	140	Burngrove 1
	1				-70.2	207	Burngrove
FPVWP02 (GMP3)	4	677853	7464717	142.5	86.5	56	Burngrove 1
	3				38.5	104	Burngrove 1
	2				-1.5	144	Burngrove 1
	1				-59.5	202	Burngrove
FPVWP03 (GMP1)	4	678052	7470201	154.7	76.7	78	Rewan
	3				29.7	125	Rewan 2
	2				4.7	150	Rewan 2
	1				-45.3	200	Rewan 2
FPMB01 (GMP4)		681792	7469139	136.57	121.47	15.1	Alluvium (* 0.57 m)

[1] Re-interpreted from RCM to Burngrove by AGE (AGE, 2021). (*: casing stick-up)
[2] Re-interpreted from RCM to Rewan by AGE (AGE, 2021)

Groundwater Modelling

Groundwater modelling was undertaken by qualified consultants (Groundwater Functions Pty Ltd, 2023) to support the assessment of potential groundwater impacts. The full report is provided in **Appendix I.** A summary of findings is provided in the sections below.

Groundwater Flow Path Simulation/ Contaminant Transport

Based on the current void water quality results, the contaminant of concern in water accumulating in the voids is salinity (Groundwater Functions Pty Ltd, 2023). Particles following a pathway away from the pit indicate the potential for contaminants to migrate towards sensitive environmental values for groundwater. Flooded pit voids may be net groundwater sinks with evaporative losses exceeding groundwater recharge. Flood pits may also be both sources and sinks subject to void geometry and hydrogeology (Groundwater Functions Pty Ltd, 2023).

Post-closure Conceptual Site Model

Backfilling of voids reduces evaporative losses and allows groundwater to recover within the voids. When not backfilled or only partially, groundwater will accumulate and become standing water within the former voids. These water levels may recover above or remain below the original piezometric surface prevalent before mining.

If groundwater levels recover above the original piezometric surface, standing water in the pit may become a source of groundwater recharge to the intersected coal seams and associated Permian strata. Groundwater recharge will likely contain elevated levels of contaminants and may follow pre-mining groundwater flow pathways southward beyond the extent of the mine. This may lead to elevated groundwater levels that discharge to the alluvium on the south of the site.

Alternatively, where evaporation exceeds the filling of the void, the standing water level in the void will remain below the surrounding connected strata. Although contaminants will enter the residual void, the void will remain a groundwater sink and accumulate solutes (Groundwater Functions Pty Ltd, 2023).

Results from the post-closure simulation confirm that each of the six final voids, the pit lake water level remains below regional groundwater levels. This indicates that each void will continue to act as a groundwater sink in perpetuity, drawing in groundwater from the connected Permo-Triassic strata. Predicted groundwater inflow rate from Permo-Triassic strata is predicted to be approximately 30 L/s. Recovery to equilibrium will occur for 450 years after cessation of mining operations in 2055, or at around the year 2505 (Groundwater Functions Pty Ltd, 2023).

Particle tracking indicates that each of the voids is fully acquisitive, meaning that groundwater flows towards the void from all directions, and there is no leakage from any pit lake (Groundwater Functions Pty Ltd, 2023). Predicted water table elevations of Fox post-closure at pit lake equilibrium is depicted in Figure 3-26.

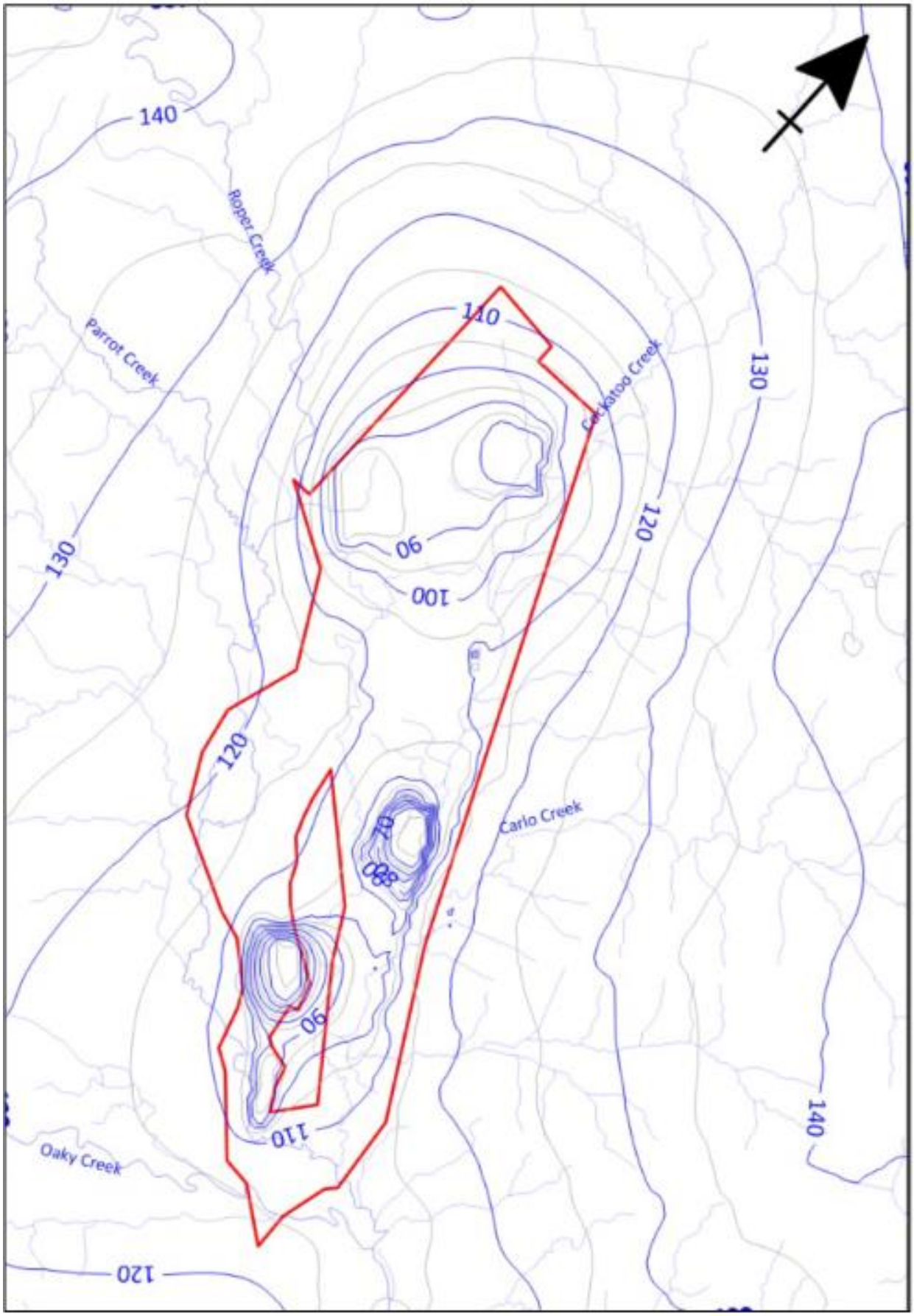


Figure 3-26: Predicted Water Table Elevation at Groundwater and Pit Lake Equilibrium (Groundwater Functions Pty Ltd, 2023)

3.5.2. Flooding

A rehabilitation flood assessment, including hydrologic and hydraulic modelling and development of a flooding risk profile, has been undertaken to support this PRCP. The complete Flood Assessment report is provided in **Appendix H**.

Fox site hydrology and fluvial networks are summarised in Section 3.1.3. The predominant creeks at Fox that have the potential to affect flooding conditions include:

- Parrot Creek.
- Roper Creek.
- Carlo Creek.
- Cockatoo Creek.
- Oaky Creek.

For the purposes of the flood modelling, a final landform DEM was developed utilising topographic datasets, including LiDAR survey from site operations and publicly available data LiDAR data for areas outside of Fox and the final rehabilitated landform design.

An iterative approach was taken with the flood modelling and landform design, with initial modelling undertaken on the preliminary Fox landform design. The results of the initial rehabilitation flood modelling were used to inform further development of the landform design to provide NUMA and other landform protection from flood waters and to minimise potential flood related impacts to the environment and final landform. The rehabilitation flood modelling was then re-run utilising the final landform design presented within this PRCP.

A URBS Version 2016 was adopted to estimate run off hydrographs through Fox. The URBS software is an industry standard rainfall-runoff routing program. The URBS model was simulated for 50%, 20%, 10%, 5%, 2%, 1% 0.1% AEPs and probable maximum flood (PMF) with a range of storm durations between 1 hour to 48 hours and ten temporal patterns for each duration accordance with the ARR guideline.

Hydraulic models covering Parrot, Roper, Carlo, Cockatoo and Oaky Creek catchments were developed using flow hydrographs produced by the hydrologic models and the hydrodynamic modelling software TUFLOW (build 2020-10-AC). A range of design storm events was simulated in the hydraulic models for a range of AEPs, which include 1% 0.1% and the PMF. Further details on the hydrologic and hydraulic model set ups and calibration/validation are contained in **Appendix H**.

Flood Levels and Rehabilitation Domains

Maps of the flood levels for each of the modelled creeks and AEPs against the final landform and flood protection landforms are included **Appendix H**.

Roper Creek modelled peak flood levels indicate that flood extents interact with the south-west section.

of the Eagles Nest residual void from the 1% AEP modelled flood. A flood protection landform is proposed to provide adequate protection of the residual void from ingress of flood waters. Table 3-40 below provides a summary of the water level range along the length of the proposed flood protection landforms for the 1%, 0.1% and PMF flood events.

The western sections WC pit and Far South residual voids do not interact with Roper Creek (and Oaky Creek) flows for events up to and including the PMF.

Flood waters within Roper Creek will also potentially interact with the western side of the adjacent Eagle Nest Pit and WC Pit spoil dumps. The maximum predicted depth of flood waters against the spoil dumps

adjacent to Roper Creek is 4 to 5m in a 0.1% AEP flood event. The velocities of the flood waters against the spoil dumps are low (less than 2m/s) with higher velocities concentrated within the watercourse channel.

Cockatoo Creek peak flood levels indicate that flood extents interact with the Pipeline (northern side), WC pit (eastern side) and Far South (eastern side) residual voids from the 1% AEP modelled flood. The south-east section of Foxleigh Plains Pit residual void do not interact with Roper Creek (and Oaky Creek) flows for events up to the PMF event. Flood protection landforms are proposed to provide adequate protection of the residual voids from ingress of flood waters. Table 3-40 below provides a summary of the water level range along the length of the proposed flood protection landforms for the 1%, 0.1% and PMF flood events.

Flood waters within Cockatoo Creek will also potentially interact with the eastern side of the adjacent Foxleigh Plains Pit and WC Pit spoil dumps and the western side of the One Tree Pit / Pipeline and Carlo spoil dumps. The maximum predicted depth of flood waters against the spoil dumps adjacent to Cockatoo Creek is 5 to 6m in a 0.1% AEP flood event. The velocities of the flood waters against the spoil dumps are low (less than 2m/s) with higher velocities concentrated within the watercourse channel.

Carlo Creek modelled peak flood levels indicate that flood extents interact with the eastern section of the Carlo Pit residual void from the 1% AEP modelled flood. A flood protection landform is proposed to provide adequate protection of the residual void from ingress of flood waters. Table 3-40 below provides a summary of the water level range along the length of the proposed flood protection landforms for the 1%, 0.1% and PMF flood events.

Flood waters within Cockatoo Creek will also potentially interact with the eastern side of the adjacent Carlo Pit spoil dump. The maximum predicted depth of flood waters against the spoil dumps adjacent to Cockatoo Creek is 3 to 4 m in a 0.1% AEP flood event. The velocities of the flood waters against the spoil dumps are low (less than 2 m/s) with higher velocities concentrated within the watercourse channel.

Table 3-40: Flood Protection Landform Water Surface Levels

NUMA	Water Surface Level (m AHD)		
	1% AEP	0.1% AEP	PMF
Foxleigh Plains Pit	-	-	140.26 - 140.96
Eagles Nest Pit	141.54 - 141.95	141.60 - 142.05	142.53 - 142.9
One Tree Pit	-	132.27 - 133.03	132.31 - 134.45
Pipeline	132.96 - 133.06	133.56 - 133.69	135.32 - 135.60
WC Pit	125.48 - 127.32	125.85 - 127.73	129.67 - 129.99
Carlo Pit	124.94 - 128.06	125.49 - 130.42	129.64 - 133.07
Far South	124.33 - 124.92	125.37 - 125.91	129.53 - 129.88

Alteration of Flow Upstream and Downstream

The hydraulic modelling undertaken to support this PRCP included the comparison of flows within the pre-mining landform to those within the final rehabilitated landform.

The downstream comparison of pre-mining and rehabilitation flows are presented in Table 3-41. The results indicate a fluctuation of flows less than ±1 % for both Roper Creek DS and at the Roper and Oaky Creek confluence. This indicates that the proposed final landform is consistent with returning the confluence to a pre-mining environment.

Table 3-41: Rehabilitation Flood Model Results Changes between Downstream Pre-Mining Scenario Versus Final Rehabilitated Landform Scenario

Location	AEP (%)	Rehabilitation scenario flow (m^3/s)	Pre-mining scenario flow (m^3/s)	Change (m^3/s)	Change (%)
Roper Creek DS (inc. Roper Creek US, Cockatoo Creek and Carlo Creek)	0.1%	3,404	3,409	- 5	-0.2
Confluence of Roper Creek DS and Oaky Creek	0.1%	6,422	6,413	+9	+ 0.1

Flood Risk Profile

The flooding risk profile identified the risks to the final rehabilitated landforms from flooding to be low.

3.5.3. Waste Characterisation

Background

Geochemical characterisation of waste and a risk assessment of mineral waste was undertaken to support this PRCP (RGS Environmental Pty Ltd, 2021). It is provided in **Appendix K**, with a summary of key findings provided in this section.

Mining waste materials on site at Fox include (RGS Environmental Pty Ltd, 2021):

- Overburden, with lithology types of clay, silt, sand, claystone, mudstone, siltstone, carbonaceous siltstone and sandstone.
- Interburden, with lithology types including carbonaceous mudstone, siltstone, carbonaceous siltstone, sandstone and coal.

Other material waste types include:

- Potential coal rejects, including:
  - Roof rejects, with lithology types including carbonaceous mudstone, mixed carbonaceous mudstone, siltstone, mixed siltstone/sandstone, carbonaceous siltstone, sandstone, carbonaceous sandstone, mixed carbonaceous sandstone.
  - Floor rejects, comprising of lithology types of claystone, carbonaceous mudstone, mixed carbonaceous mudstone, siltstone, carbonaceous siltstone, mixed carbonaceous siltstone, sandstone, carbonaceous sandstone and mixed carbonaceous sandstone.
  - Partings, including lithologies of tuff/carbonaceous siltstone and dolerite.
- Process residue, including:
  - Coarse rejects (carbonaceous)
  - Tailings (carbonaceous)
  - Coal Feed reserve (coal)
- Soil, including:
  - Topsoil
  - Subsoil, and;
  - Weathered waste rock

Water Quality and Static Tests

Based on the results of static testing, it is expected that the risk of potential impact on the quality of surface runoff and groundwater from bulk mining materials represented by the samples tested will be low. The following findings were obtained from static testing and compared to Australian water quality guideline values for livestock, drinking water and freshwater ecosystems ((ANZECC & ARMCANZ, 2000) (RGS Environmental Pty Ltd, 2021).

- The pH of water extracts from samples ranged from pH values of 7.8 to 9.6 and is considered to be slightly alkaline for all sample types except for the mixed overburden sample. The pH results for 8 of the 12 composite samples are slightly greater than the recommended range (pH 6 to 9) for 95 % species protection in freshwater aquatic ecosystems set out in ANZG (2018).
- Water extracts have moderate EC values ranging from 417 to 2,230 uS/cm. Roof and tailings samples had higher EC values than the floor and course reject samples.
- Alkalinity in water extracts from water samples was of the samples was moderate to elevated (442 to 4,480mg/L) and mainly present in the bicarbonate form. Acidity was generally low, ranging from 0.2 to 19 mg $CaCO_3$/L, leading to positive net alkalinity for all sample values.
- Concentration of major ions in solution extractions were bicarbonate, sodium, chloride, and sulphate to a lesser extent. Sulphate concentrations in water samples ranged from 28 to 316mg/L.
- Concentrations of trace metals and metalloids in water extracts from the composite samples were typically low and below the laboratory LoR and below the applied water quality guideline criteria. The main exceptions were aluminium, arsenic, selenium which had concentrations in some water extracts above the freshwater aquatic ecosystem water quality guideline value for 95% species protection but are below livestock drinking water (ANZECC & ARMCANZ, 2000). None of the dissolved metal/metalloid concentrations were elevated compared to applied water quality guideline values in the water extracts from tailing, coarse reject and coal materials.

Water Quality and Kinetic Testing

Leachate results from the testing program were compared to the Australian water quality guideline values for livestock drinking water quality. The following findings were obtained:

- Leachate from the tests has a pH in the range of 3.79 to 8.23 and is typically neutral to alkaline. Apart from coarse reject and coal samples, the pH of the leachate was similar to greater than the pH of dionised water used in the tests. This indicates that pH values in contact with water from most materials over time are likely to be located in the pH neutral or slightly alkaline range. The exception is the contact water from the coarse reject materials, which has the potential to become acidic overtime if left unmanaged.
- Leachate from the tests had EC values ranging from 179 to 2,870uS/cm. The EC values are generally low to moderate and are highest in leachate from the coal reject. Results indicate that the EC values from most mining waste is exposed to oxidising conditions will be in the low to moderate range but should be monitored as a precaution to avoid any saline drainage issues.
- The acidity value in initial leachate from the tests is generally low, with the exception of coarse reject, which has acidity that ranges from 3 to 151 mg/L. In general, alkalinity values in leachate from most the tests are elevated and more than sufficient to produce net alkalinity values.

- The concentration of major ions in leachate from the KLC tests is typically dominated by variable concentrations of sodium, chloride and sulfate. Lower concentrations of other major ions (e.g., calcium, magnesium and potassium) are also present in leachate from these materials.
- Sulphate concentrations of leachate range from 16 to 1,160 mg/L and is generally less than the applied livestock drinking water quality guideline of 1,000 mg/L/. The exception is coarse reject which has a sulphate concentration in the leachate that exceeds the guideline value.
- The concentration of trace metals/metalloids in the leachate from the KLC test materials is generally low and typically below the laboratory LoR. Most trace metals/metalloids are therefore sparingly soluble at the neutral to slightly alkaline pH of the leachate. Concentrations of most metals are below the water quality guideline criteria for livestock drinking water. The main exceptions are molybdenum and selenium in the leachate from the roof and floor materials. Acidic coarse reject leachate contains elevated concentrations of aluminium, iron, manganese, nickel and zinc compared to background concentrations.

AMD Potential of Mineral Waste and Coal Rejects

Results from the static and kinetic geochemical test programs indicate that the majority of overburden and interburden materials have low oxidisable (sulfide) sulfur content, excess ANC and are classified as non-acid formatting (NAF) (RGS Environmental Pty Ltd, 2021).

A portion of the coal reject (roof, parting and floor) materials may have an elevated sulfide concentration compared to median crustal abundance in unmineralized soils. However, overall bulk potential coal reject materials will have excess ANC and be classified as NAF. Given the small amount of the potential coal reject materials compared to bulk overburden and interburden materials, the risk of any significant generation of acid mine drainage (AMD) and neutral metalliferous draining (NMD) is low (RGS Environmental Pty Ltd, 2021). Coarse rejects and tailings materials may also have elevated sulphide concentrations compared to the crustal abundance in unmineralized soils. Tailings materials are classified as NAF, and a portion of course rejects are classified as PAF. As a bulk material, it is not expected to generate significant AMD and NMD. Coarse materials and potential coal reject materials should not report to the outer surfaces of the final landform.

Coal materials have similar geochemical characteristics to tailings and are classified as NAF.

Salinity, Sodicity and Dispersion Potential of Mineral Waste and Coal

Bulk mining waste materials at Fox are classified are likely to be pH neutral to alkaline and have low to moderate levels of salinity. Most mining waste materials are sodic and may be susceptible to erosion and dispersion. (RGS Environmental Pty Ltd, 2021).

Management and Rehabilitation Measures

Material characteristics, such as erosion and dispersion, can be improved to some extent through the addition of gypsum (RGS Environmental Pty Ltd, 2021). In addition, fertiliser, organic matter and seeded topsoil should be considered for mining waste materials at the surface of final landforms for the purpose of providing a reasonable growth medium for revegetation and rehabilitation (RGS Environmental Pty Ltd, 2021). Rock mulch (armouring) materials could be used on the top of topsoil to help stabilise revegetated surfaces on final landforms. (RGS Environmental Pty Ltd, 2021).

In some circumstances, it may be possible to re-grade and lower the slope of the final landform batters to reduce dispersion and erosion. The reshaping of spoil dumps also provides an opportunity to install water drainage infrastructure, which should be lined with NAF, non-sodic, competent rock material that is resistant to weathering (RGS Environmental Pty Ltd, 2021).

Co-disposal of coarse reject and tailings materials are recommended because coal reject materials typically remain moist, and oxidation will only occur at the surface. Fine reject will fill the gaps between the coarse reject particles and generally limit oxygen ingress. The coarse reject will provide geotechnical stability to the mixed reject material assisting in a future covering and rehabilitation process (RGS Environmental Pty Ltd, 2021).

The results indicate that these materials represented by these samples are not significantly enriched with metals/metalloids compared to applied guideline values and median crustal abundance in unmineralized soils. As such, these materials are not expected to present environmental issues associated with metal/metalloid concentrations for revegetation and rehabilitation (RGS Environmental Pty Ltd, 2021).

Material management over the life of mine is presented in Table 3-42.

Table 3-42: Material Management over Mine Life (RGS Environmental Pty Ltd, 2021)

Project Phase	Overburden and Interburden	Potential Coal Reject and Coal Reject	Coal
Operations	Stored out-of-pit spoil dumps and/or backfilled in-pit.	Co-disposed within larger volumes of spoil at spoil dumps or in-pit. Contact water monitored for quality and managed in the mine water management system as part of Water Management Plan	Temporarily stockpiled at ROM. Contact water monitored for quality and managed in the mine water management system as part of Water Management Plan
Rehabilitation	Final landforms rehabilitated/ revegetated, and performance monitored for success	Final landforms rehabilitated/ revegetated and performance monitored for success	ROM removed and footprint rehabilitated/revegetated
Decommissioning	Final landform performance monitoring moving towards lease relinquishment	Final landform performance monitoring moving towards lease relinquishment	None

3.5.4. Soil and Capping Material

PRCP Guideline (Section 3.6.1)

The rehabilitation and management methodology should include that soil assessment activities are supplemented by additional surveys conducted at appropriate intervals to assess soil resources in planned disturbance areas. In addition to the assessment of soils, the proposed rehabilitation methodologies in the rehabilitation planning part must also address topsoil management. Topsoil management must ensure sufficient topsoil quantity and quality is available in those instances that waste rock or tailings cannot support the proposed PMLU. Integrated soil and waste rock characterisation and mapping should form the foundation of the rehabilitation strategies. The available soil resources and capping material should be assessed prior to the commencement of operations.

An assessment of the available resources at Fox for use in rehabilitation was undertaken to inform this PRCP. Soil surveys have been conducted for the mining footprint (refer to Section 3.5.4). The location of topsoil stockpiles are displayed in Figure 3-27, with details provided in Table 3-44. Results demonstrate that the most abundant topsoil stockpile soil type is chromosols, followed by sodosols (RGS Environmental Pty Ltd, 2021).

Quality of Available Resources

An assessment of on-site soil materials and their physiochemical properties for rehabilitation were identified in baseline studies (RGS Environmental Pty Ltd, 2021). Properties of each identified soil resource (prior to disturbance) are listed in Table 3-43. Location of topsoil stockpiles at Fox are displayed in Figure 3-27. All soil

types present at Fox are capable of supporting native vegetation, however there is a general hierarchy or sourcing topsoil covers:

Vertosols > *Arenosols* > *Chromosols* > *Sodosols* (RGS Environmental Pty Ltd, 2021)

Table 3-43: Key Physiochemical Properties of Rehabilitation Resources (RGS Environmental Pty Ltd, 2021)

Rehabilitation Resource	Properties
Vertosols	***General Comments:*** • High moisture content. • Dark grey-brown colour. • High proportion of clay. • Thick, massive structure without horizons. • Slightly alkaline and moderately saline. • Rich in organic carbon and nutrients. • High Cation Exchange Capacity (22 meq/100g).
Sodosols	***Subsoil:*** • Thick, moist, yellowish -brown subsoil. • Mottled texture. • High plasticity. • High salinity. • Sodic. • Alkaline. • Salt crusts (calcareous concentrations). ***Topsoil:*** • Dry. • Crumbly. • Moderate salinity. • Neutral to alkaline pH. • If used as a cover, likely to only be able to support resilient native grasses and adapted salt-tolerant species.
Chromosols	***Subsoil:*** • Orange to bright red orange in colour. • Relatively moist. • Large, soft, crumbly peds. • Low plasticity. ***Topsoil:*** • Dry. • Brown to reddish-brown in colour. ***General comments:*** • Prone to instability and dispersion when exposed. • Generally low in nutrients. • Able to support native vegetation if erosion risks are managed.

Rehabilitation Resource	Properties
Arenosols	***General comments:*** • Fine, powdery texture. • Dry. • No soil horizons. • Low to moderate salinity. • Stable, non-sodic. • Sand-sized particles. • Low moisture retention. • Low in nutrients. • Able to support both grasses and trees – may constitute a good growth medium for rehabilitation.
Anthroposols (Waste Rock)	***General comments:*** • Vary from fresh to weathered. • Intercepting coal rejects and ore. ***Subsoil:*** • Moderate to high salinity. • Strongly sodic. • Alkaline. • Hard. • Compacted. • Hostile profile for root penetration. ***Topsoil:*** • Thin topsoil cover of chromosol or sodosol. • Surface water runoff on slopes has reduced thickness. • Resilient grasses have colonised the topsoil cover when the thickness is 20 cm or more.

The rehabilitation at Fox requires growth media to support vegetation, plus rock for erosional stability of the steeper dump slopes. Available topsoil is displayed in Table 3-44, while required volumes are displayed in Table 3-45, as taken from the Estimated Rehabilitation Calculator 2023.

Table 3-44: Fox Available Topsoil/Growth Medium

	Volume (m^3)
Current topsoil available based on existing stockpiles and future operations	3,568,538
Topsoil estimated required for closure (based on current final landform)	3,069,321

Table 3-45: Fox Growth Media and Capping Required Volumes

Topsoil Balance	Volume (m^3)
Current topsoil available based on existing stockpiles and future operations	3,568,538
Topsoil estimated required for closure (based on current final landform)	3,069,321
Estimated surplus/deficit	499,217

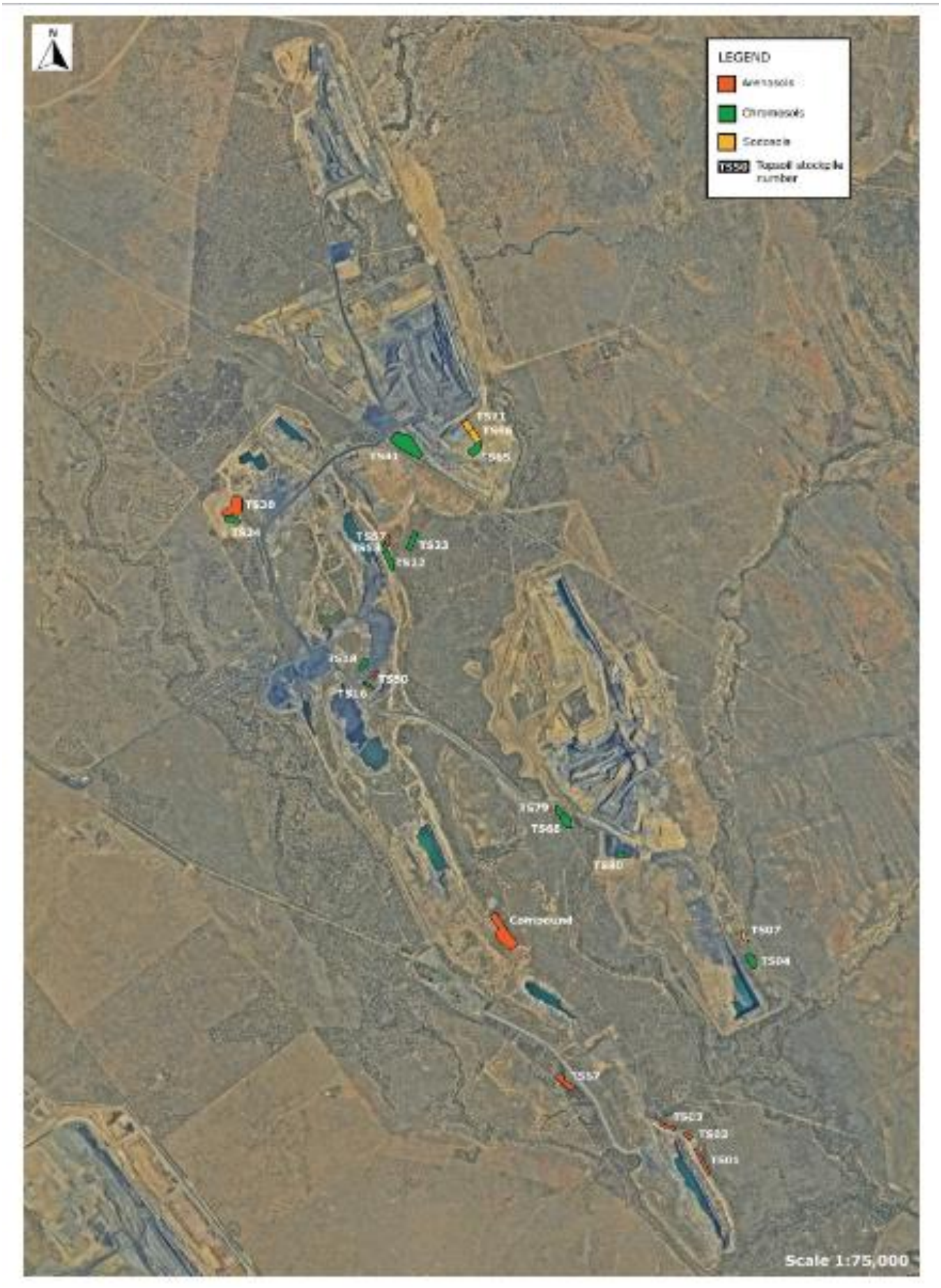


Figure 3-27: Location of Topsoil Stockpiles and Soil Type Classifications (RGS Environmental Pty Ltd, 2021)

Growth Media Management

Generally, land rehabilitation should consider the following factors that determine the success of rehabilitation:

- Geomorphology of the slope
- Texture (particle size) of topsoil cover materials
- Geochemistry of the topsoil and underlying spoil material.

Fertilizer, organic matter, and seeded topsoil should be considered for covering mining waste materials at the surface of final landforms for the purpose of providing a reasonable growth medium for revegetation and rehabilitation. Rock mulching could also be used on the top of the topsoil on slopes greater than 15% to help stabilise revegetated surface slopes at final landforms (RGS Environmental Pty Ltd, 2021).

Geochemistry of soil or spoil materials could be changed by covering with less sodic material or reduce dispersity by adding gypsum. Addition of fertiliser and organic materials may also provide better rehabilitation outcomes. Most spoil materials are expected to be sodic at Fox, therefore will impact rehabilitation for final landform outer slopes (RGS Environmental Pty Ltd, 2021).

3.5.5. Landform design

PRCP Guideline (Section 3.6.1)

The final landform design must be based on the proposed PMLUs and NUMAs and demonstrate that the land will be safe and structurally stable.

Landform design considers the landform development and reshape of all relevant activity areas after the removal of infrastructure, and prior to placement of growth media and seed.

The final landform design has been refined based on the outcomes of the studies undertaken to support this PRCP (see **Appendix J**). The refinements included changes to the mining limits, residual void extents, spoil dump extents and slope angles.

3D Design

The conceptual 3D closure landform design for Fox is provided in Figure 3-28.

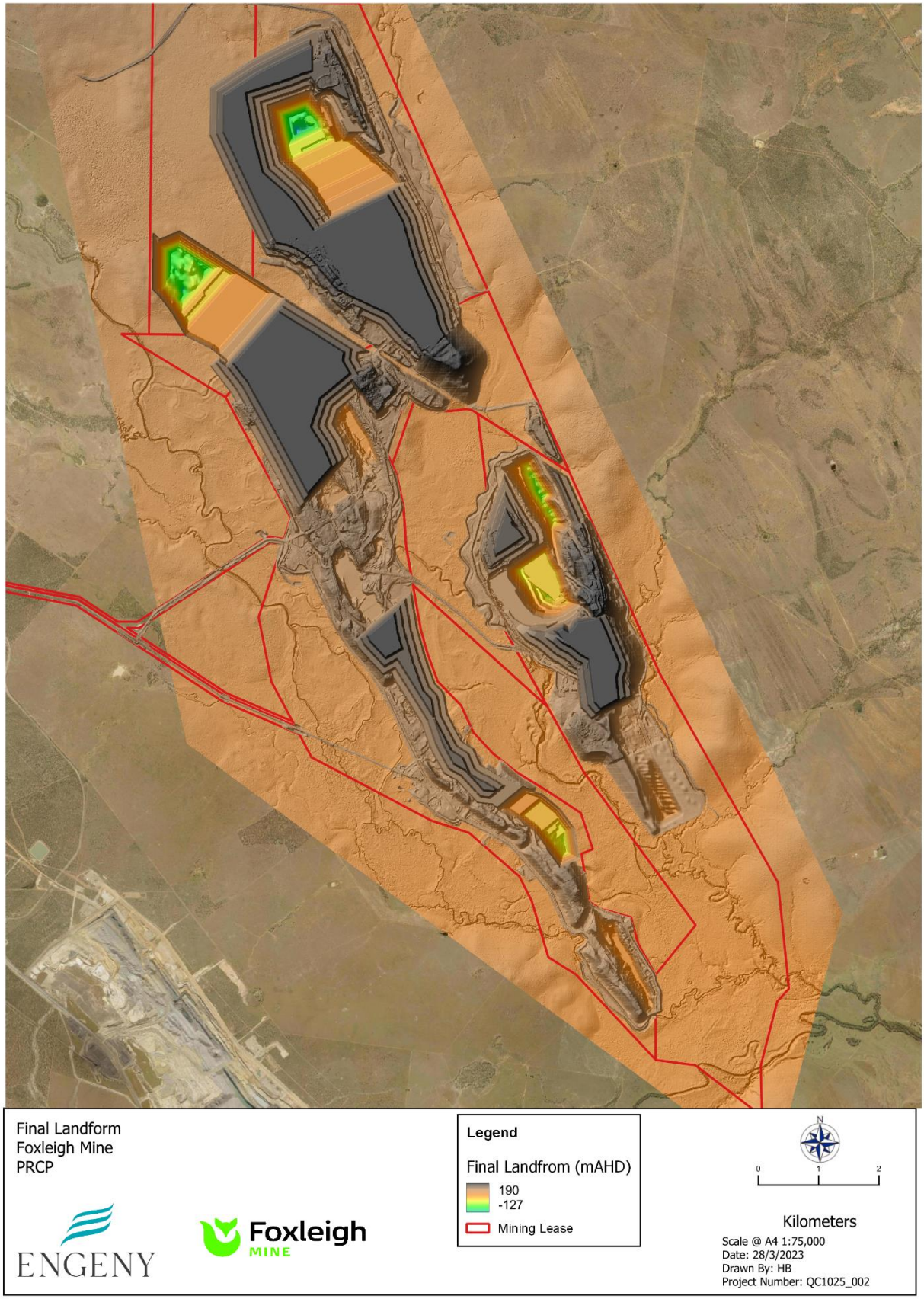


Figure 3-28: 3D post-mining landform design

Method of Determining Landform Design

The relevant activities and areas considered when determining the landform design are detailed in Table 3-46.

Table 3-46: Landform Structures at Fox and Proposed Design

Landform structure	Landform design
Infrastructure and general areas – CHPP and associated infrastructure administration, workshop, laydown areas, roads, drains.	• Area will be reshaped to be free-draining with lower-gradient slopes of maximum 10% and blended in with surrounding area.
Topsoil stockpiles	• After topsoil stockpiles have been depleted, area will be reshaped to be free-draining and blended in with surrounding area if required.
Water dams	• After dam water and sediment is removed, the dam walls will be dozed back over the dam footprint and additional backfill from the coal stockpile base or haul road base will be placed in the area to make free draining. • Area will be reshaped and blended in with surrounding area.
Spoil dumps	• Area will be re-shaped to be a free draining with maximum gradient slopes of 17% and blended in with surrounding area.
Tailings facility	• After drying of the cells, the area will be covered with competent material to create a designed capping layer. • Area will be reshaped to be free-draining with lower-gradient slopes of maximum 10% and blended in with surrounding area.
Watercourse diversion	• Area will be re-shaped to be blended in with surrounding area.
ROM	• After removal of visible coal (no more than 10% visible coaly and carbonaceous mineral waste on surface), the remaining footprint area will be reshaped to be free-draining with lower-gradient slopes of maximum 10% and blended in with surrounding area.

Long-term Landform Stability

A technical study was conducted (Engeny, 2023) to determine whether the post mining landform at Fox is likely to be stable in the long-term. The successful long-term stability of Fox's landforms will be heavily influenced the by soil and water interaction, in particular the landform shape, the chemical and physical characteristics of the topsoil and spoil, the final surface treatment outcomes, and the landforms watershed catchments and resultant potential for the concentration of runoff causing erosion.

WEPP Erosion Model

The Water Erosion Prediction Project (WEPP) erosion model has been utilised to determine long-term landform stability. WEPP is a two-dimensional hillslope analysis model developed by the United States Department of Agriculture (USDA), initially for agricultural land to predict runoff, erosion, deposition for hillslopes and catchments. The model has been previously applied to Australian waste rock dumps to validate

the model against measures erosion observations. After the USLE and RUSLE equations, WEPP is the most widely applied erosion model to assess soil loss from water[3].

WEPP requires inputs in six main categories for computation: climate generation, hydrology, plant growth, hillslope, soils, and management. These elements are assessed over a timestep (typically daily) are used to determine erodibility, with multiple iterations of the model run back-to-back to predict long term change. During model simulations rainfall is evaluated against plant and soil characteristics, to determine the presence of runoff, sediment detachment, and transport. The WEPP model's evaluates soil erodibility, using the following analytical processes:

- Interrill erodibility (Ki) – describes the detachment of sediment in interrill areas of the landform slope.
- Rill erodibility (Kr) – describes the detachment from rills and rill formations down landform the slope.
- Critical shear stress (Tc) – describes the critical shear stress required for rill initiation.
- Hydraulic conductivity (Ke) – critical in determining losses, and subsequent runoff.

The Fox LEM WEPP model was run over a simulation period of 100-years, to enable assessment of long-term stability of each final landform. To enable complete assessment of long-term stability of the landforms (in particular during high-risk periods such as vegetation establishment), model was run with scenarios of increasing vegetation cover.

WEPP provides a range of outputs dependent to the model parameters being investigated, which align with the selected measures within the basis of assessment and are compared against the selected Target Erosion Rates.

Model Output - Average Slope Stability

To assess average slope stability, the annual average soil loss rate was reviewed for landforms.

The WEPP model output showed that at 60% vegetation cover, erosional stability was achieved for all soils on all slopes (Table 3-47).

Table 3-47: WEPP Annual Average Mean Soil Loss Rate Outputs (t/ha/yr.) for 60% Vegetation Cover

Landform	Sodosol	Vertosol	Chromosol
17% 55m high	2.9	4.2	2.4
17% 17m high	2.0	2.3	1.9
14% 55m high	2.5	3.8	2.0
14% 14m high	1.6	1.8	1.5
10% 10m high	1.2	1.1	1.1

Table 3-48: WEPP Annual Average Mean Soil Loss Rate Outputs (t/ha/yr.) for 60% Vegetation Cover with Maximum Erosion Rates shown in Brackets

Landform	Sodosol	Vertosol	Chromosol
17% 55m high	2.9 (5.2)	4.2 (8.1)	2.4 (4.2)
17% 17m high	2.0 (3.4)	2.3 (4.2)	1.9 (3.1)
14% 55m high	2.5 (4.5)	3.8 (7.4)	2.0 (3.4)
14% 14m high	1.6 (2.7)	1.8 (3.4)	1.5 (2.5)
10% 10m high	1.2 (1.9)	1.1 (2.2)	1.1 (1.7)

It is worthy to note that this assessment uses the average (or mean) annual soil loss to compare slopes and material, as defined in a previous section. As stability is indicated at the 60% level of vegetation, further interrogation of the results was warranted to examine the peak or maximum erosion rates for each scenario. Figure 3-29 shows an example WEPP output for the Chromosol for the 14% gradient slope that is 55m high and approximately 400m in horizontal footprint. The results show the annual average erosion rate is 2t/ha/yr. In Figure 3-29 the slope can be seen in profile (green line) and the corresponding erosion rate down the slope in grey. The pattern of erosion shows that the Chromosol is a detachment limited material and that for the first 50m down the slope that the material is very stable and that rills would most likely not be evident in this part of the slope (orange arrow). Further down the slope this is where the material is starting to be detached and this increases down the slope, albeit at very low rates (blue line). All of the results shown in Table 3-48 have very low maximum rates as well as average rates, and this will further decrease with vegetation establishment above the indicated 60%.

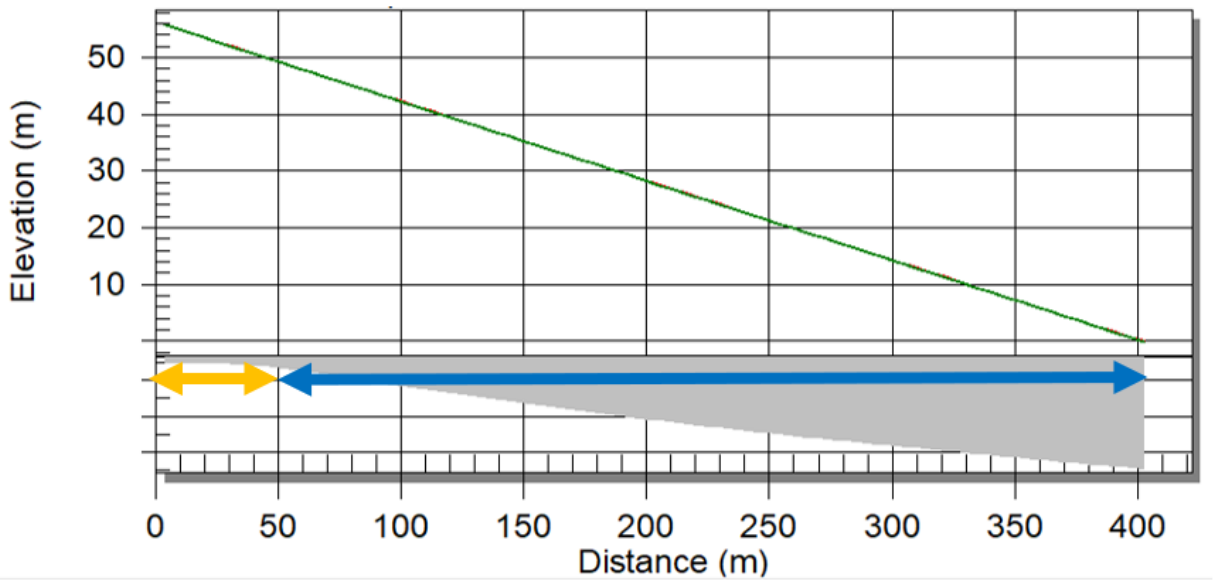


Figure 3-29: Maximum Erosion Rate for the Chromosol Soil on a 14% Gradient 55m High Slope

Vegetation Establishment

The modelling results show that when a vegetation cover is established to provide 60% coverage, rehabilitation stability is achieved at the Fox site. Note that this is for the 'worst case' sections of the landform

with the greatest heights and slope lengths. While extensive and healthy vegetation cover is encouraged, the 60% level will not be required for stability for lower gradient/shorter slope length areas.

Until the 60% level of vegetation cover is established, the soil surface will remain vulnerable to erosion, especially in the summer storm dominant climate. The concept is known as controlling the window of erosion. As shown in Figure 3-30, high sediment losses are more likely to occur over the wet season before cover levels of over 50% are established[2]. The risk increases the steeper the slope gradient, reporting erosion rates of 100t/ha/yr. can result if vegetation is not established.

The process is a vicious circle where vegetation is required to control erosion, but vegetation requires suitable rainfall to grow, and the principal agent of erosion is flowing water from storm events where >50mm/hr is not unusual. This problem is further compounded if the erosion in the first couple of years cuts a rill network into the rehabilitated slope. This rill network will then continue to concentrate flows despite high rates of vegetative surface cover[3]. An example of this is shown in Figure 3-30.

Stability Assessment Conclusion

The Landform Evolution Modelling assessment (Engeny, 2023) was run for a number of scenarios for the landforms provided by Fox. The slopes were selected to represent the 'worst case' in terms of slope height and length, along with soil conditions likely to be encountered both during establishment and at fully established closure landform phases.

Of the slope combinations modelled, it was identified that each will achieve the defined average slope erosional stability with a cover vegetation of 60%. This level of vegetation cover will allow the tested landform slopes to meet both average and maximum erosion target rates on these 'worst case' scenarios. Until this level of cover is established however, the slopes may be at risk during this window of establishment. Several options have been highlighted that include alternative landform configurations and surface treatments. There may also be other opportunities if further landform optimisation takes place.

Once 60% vegetation cover is established however, all other modelled hillslopes will meet requirements of a safe and stable landform, as indicated by this assessment.

Method of Construction

Waste rock dumps (WRD) are dumped in stages/lifts, creating a stepped surface which is then re-profiled, with the objective of reducing overall slope angle of the external faces to 17 degrees.

Some of the original WRD have been rehabilitated prior to purchase of Fox. These were re-profiled to a 17-degree slope, and some areas present with established vegetation coverage.

Methods of construction for all voids is proposed to be consistent with the approved design parameters discussed in Section 3.5.5 and also in accordance with the Standard Geotechnical Design Guidelines (Cartledge, 2022) in **Appendix L**.

The tailings facilities have been constructed as below ground facility and the cover design will be implemented per the AQP approved design.

Quality Assurance / Quality Control

The proposed landform design parameters referenced in Table 3-46 are the key controls that will be put in place to manage the landform risks associated with achieving the PMLUs. Quality assurance and quality control activities are built into all necessary execution and verification activities of these controls. Monitoring and reporting processes will verify controls and ensure that controls are executed effectively (Section 3.7).

[2] Carroll, C. et. al. 2001. Sustainability indicators for coal mine rehabilitation. ACARP C7006, April 2001.

[3] Emmerton. B.R. 2018. Bowen Basin Coal Mine Spoil Classification for Improved Mine Rehabilitation Outcomes. Ph.D. thesis. The University of Queensland. Centre for Mined Land Rehabilitation, Sustainable Minerals Institute.

Trial Methodology

Modelling has indicated the proposed landforms will be stable and monitoring will verify if the landforms are on a trajectory towards achievement of the milestone criteria and eventual certification; or whether corrective actions, maintenance or changes to the rehabilitation methodology is required.

As the landform design is low risk, no trial methodology is proposed.

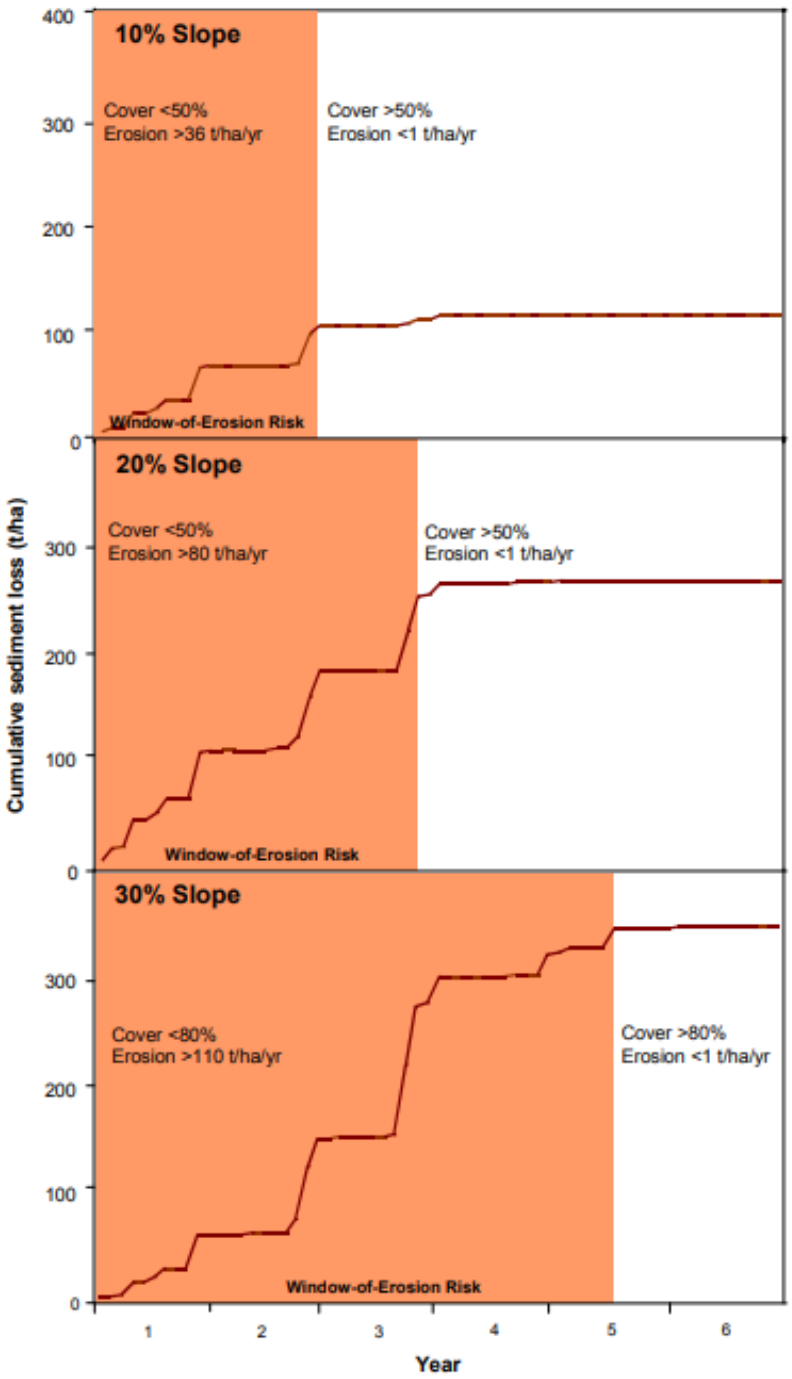


Figure 3-30: The Window of Erosion Risk & Cumulative Sediment Loss for 10, 20, and 30% Slopes Over Time at Curragh Coal Mine

Limitations and Assumptions

Limitations and assumptions made for landform modelling are listed below:

- All cross sections used in the model were assumed to have a grazing end landuse, therefore all cover scenarios used in the modelling are representative of a pasture vegetation type.

- Modelling inputs have been derived from existing Fox reports, which have diverse sources. A tailored site-specific sampling program could provide experimentally derived results, using actual site materials where an erosional stress is applied by way of flumes and simulated rainfall.
- The WEPP results showing landform stability with the achievement of >60% vegetation cover has been assessed on the 'worst case' sections of the landforms in terms of a uniform slope height and gradient. The assessment, while indicating landform stability, is taken on single slope sections and does not include assessment of all the complexities of the proposed 3-dimensional WRD configurations in their entirety. For example, the concentration points for flow are formed where hinge points are present in the landform such as the eastern section of NT WRD. Final landform surface treatments should consider such details as these concentration points are erosion 'hotspots' over and above what has been assessed by WEPP. Figure 3-31 shows one such example and the increased erosion and resulting sediment fan at the toe of the landform.

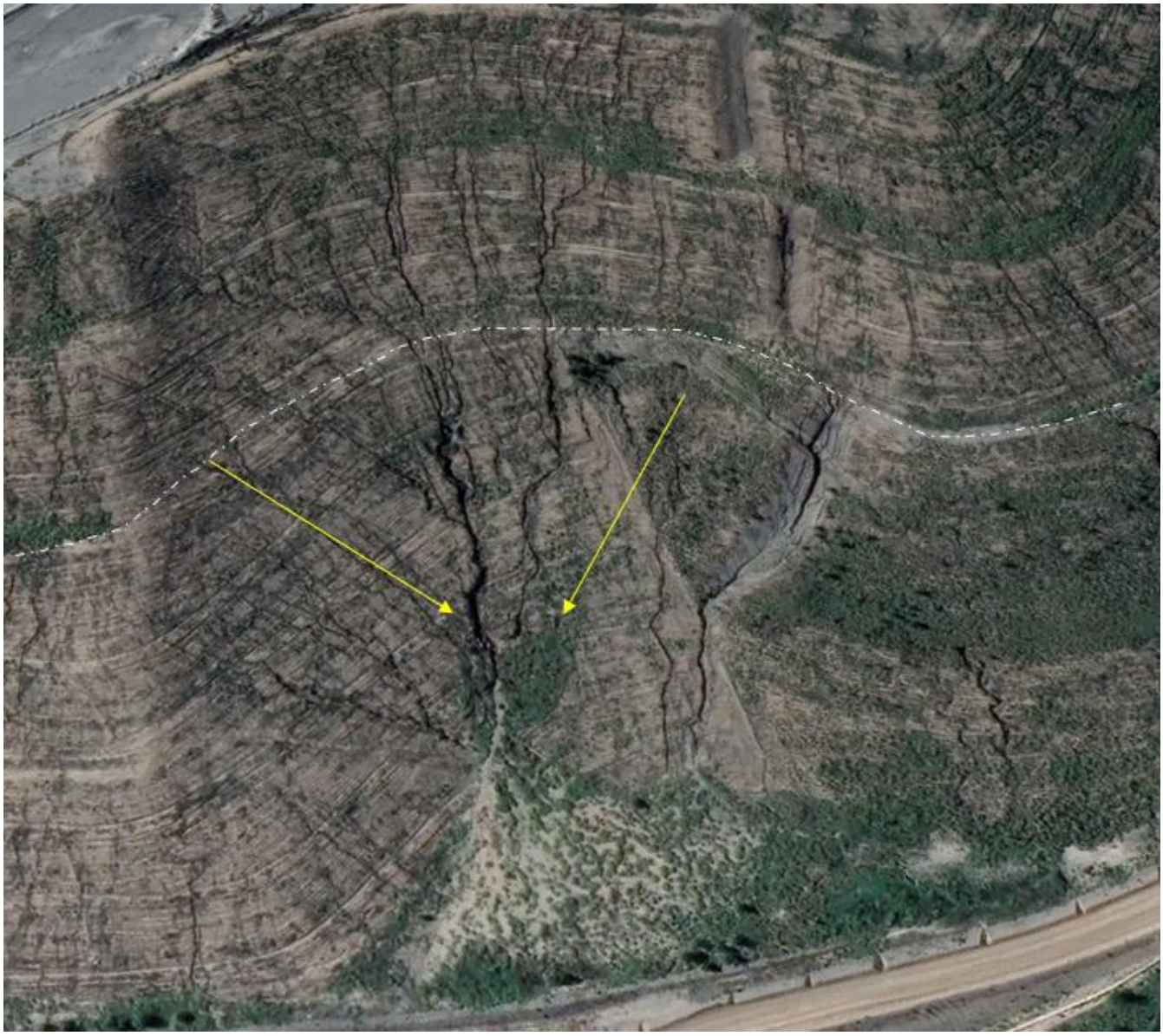


Figure 3-31: Increased Flow Concentration Caused by the Landform Shape

Recommendations

Based on the assumptions and limitations, the assessment concluded with the following recommendations and further works which will be considered in the detailed rehabilitation design:

- Improved characterisation of materials to improve accuracy – the modelling inputs have been derived from existing Fox reports, which have diverse sources. A tailored site-specific sampling program could provide experimentally derived results, using actual site materials where an erosional stress is applied by way of flumes and simulated rainfall.
- Examination of past rehabilitation for what works/what didn't – these areas represent potential knowledge sources as they are in effect long term growth trials, and much could be found from examining the performance of actual site materials in the actual climate.
- Trials – rehabilitation trials are an opportunity to test strategies on a smaller scale to prove the concepts while mining is continuing. Trials can include construction methods, erosion assessment, seed mixes, and grazing trials. The trials are conducted on a smaller scale (and therefore lower risk basis) before site commits to broad acre rehabilitation that may fail. This activity is encouraged to continue at Fox to inform rehabilitation design and continuous improvement.

3.5.6. Cover Design

PRCP Guideline (Section 3.6.1)

A cover design is required for the surface treatment of a mine landform or other waste material. Hence, the cover system design must be appropriate for the type(s) of waste the project will generate and reflect a risk-based approach. Where waste has the potential for AMD, neutral mine drainage or saline mine drainage, an appropriate cover system must be designed.

The cover design should include:

- *identification and specification of the objectives of the cover system*
- *a detailed description of the design including the thickness of each layer*
- *a detailed description of construction methodology including any proposed staging of the cover system*
- *a quantitative assessment that identifies the location and quantity of proposed capping material available on-site*
- *proposed QA/QC for the construction of the cover system including the timely implementation of corrective actions where deviations from the design are identified.*

Henderson Geotech (2023) was commissioned by FoxMan to provide cover designs for emplacements of CHPP waste at Fox to meet the cover design requirements of the PCRP Guideline. The Henderson Geotech report is provided in **Appendix L**.

An assessment was carried out based on review of the completed technical studies (refer **Appendix L**). Subsequently, cover designs were proposed for emplacements of CHPP waste to ensure contaminants are not released to the receiving environment and thereby achieving successful rehabilitation at the Fox.

Spoil at Fox is produced by the excavation of sedimentary strata overlying coal seams within the Rangal Coal Measures and broadly comprises:

- *Unconsolidated sediments* – Quaternary alluvium, mainly clayey soils but with some localised layers of sand and gravel.

- *Partly consolidated sediments* – Tertiary silty and sandy clays, sometimes grading to clayey sands.
- *Weathered Permian* – silty and sandy clays derived from claystone and clay-rich siltstone, with some gravel-sized fragments of weathered rock.
- *Fresh Permian* – predominantly clayey sandy gravel derived from interbedded fine-grained sandstone and siltstone. A proportion of the gravel fragments may break down to sandy clay over time.

The cover system should ideally:

1. Allow shallow rainfall infiltration to support vegetation and reduce erosion from runoff.
2. Prevent infiltration to seep down to the tailings or coarse rejects.
3. Prevent leachate from tailings or coarse rejects to flow upward into the vegetation root zone or into surface waters.

The depth of weathered overburden was reported to be variable but generally at least 30 m thick, whilst the final pit depths are greater than 100 m. Consequently, Henderson Geotech assessed the quantities of both weathered and unweathered spoil to be sufficient to allow selection of suitable cover materials.

The cover system designs for the CHPP waste were proposed by Henderson Geotech by taking into consideration the following information:

- The results from geochemical characterisation
- Type and physical characteristics of the material being covered
- Site conditions
- Availability of suitable cover materials (both quality and quantity)
- Criteria for discharge (protect environmental values)
- Suitable vegetation consistent with the cover design and the proposed PMLU of grazing.

Details of the spoil properties regionally and at Fox along with the above considerations are discussed in Henderson Geotech report in **Appendix L**.

The cover designs for both Tailings and Coarse Rejects materials are provided in the sections below.

Tailings

The key objectives of the cover for the in-pit TSF at Fox are:

1) To minimise recharge of tailings moisture from deep infiltration of rainfall.
2) To avoid upward movement of leachate from tailings into the vegetation rooting zone; and
3) To accommodate long-term consolidation settlement in the tailings, such that the first two objectives and surface erosional stability are not compromised.

Cover Design

The cover designs comprise the following materials (from top of waste to the top)

- Low clay content NAF spoil will be used for at least the initial 2 m thick layer in contact with crusted tailings. It will be thicker as needed to provide a mounded, free-draining subsurface. The spoil will have minimal compaction to limit moisture suction potential.
- A 1 m minimum thickness layer of selected weathered Permian and/or Tertiary spoil, will be spread and worked, such that it is more than ten times less permeable than spoil above and below it. The surface will

be shaped to shed any deep infiltration out of the landform when constructed and after consolidation settlement has occurred. This will require the surface of the layer to be higher than the pit wall crest at the point where any such drainage would exit the landform.

- A 2 m minimum thickness of more permeable material such as gravelly fresh Permian spoil will be placed over the low permeability layer. The thickness may be greater than 2 m as needed to maintain separation between the vegetation rooting zone and the low permeability layer, and to allow a final ground surface that will shed rainfall without ponding with slopes not greater than those on rehabilitated spoil emplacement areas.
- Topsoil and erosion management practices consistent with those on rehabilitated spoil emplacement areas.

Any estimates of the amount and rate of tailings settlement based only on laboratory consolidation testing would have poor reliability and accuracy. Thus, in situ investigation of strength and relative density/moisture profiles should be undertaken after tailings discharge has ceased and the tailings surface has had time to dewater and develop a crust. This data will allow better estimates of consolidation settlement that can then be used to prepare detailed design geometry.

Construction Methodology

The challenge of placing the first layer of cover material over soft fine waste is that the cover needs to be thick enough to spread the weight of the construction equipment (so that the resultant pressure is low enough to avoid bearing failure), and without being so thick that the weight of the cover material causes bearing failure itself. The strength and thickness of the tailings surface crust is critical to being able to meet both constraints.

The filled TSF should be allowed to dewater and desiccate for at least two dry seasons before in situ strength profiles are measured and used to undertake geomechanical design of the construction sequence. Given the inherent variability in tailings due to changes in CHPP feed and product targets, and the effects of beaching and sorting at discharge, it should be expected that the cover design and the construction schedule will be further modified based on monitoring as the initial layers are placed.

Once the first layer has been placed, it may be possible to proceed using normal spoil dumping practices up to the underside of the low permeability layer. The actual dumping strategy should be confirmed by geomechanical analysis, including estimation of consolidation settlement, after the first layer is completed. Topographic (survey) monitoring should continue until an appropriately qualified geotechnical engineer has reviewed the monitoring results and confirmed that predicted remaining differential settlement will not compromise the final mounded shape of the subsequent low permeability layer.

Quality Assurance / Quality Control

It is recommended that quality assurance/ quality control (QC/QA) for the low permeability layer be based on coefficient of permeability, which is the geomechanical property that most directly affects the cover system performance. For QC, a test area could be prepared using the proposed spoil material and construction methodology.

In situ infiltration tests should be undertaken to measure permeability, and the material and/or method modified as necessary, until the design coefficient of saturated permeability (for example, k_v ≤5e-8m/s) is consistently achieved. The resultant material and method can then be used to construct the whole layer, with further infiltration testing as appropriate to provide QA.

To ensure the desired contrast in permeability, the spoil directly above the low permeability layer should be dumped and spread in thicker layers where practicable. As the spoil surface approaches the levels of the

final landform, areas with the greatest predicted remaining consolidation settlement may be over-dumped by a couple of metres to hasten and balance that settlement.

After completion of bulk earthworks, the landform may be left for a period (potentially 2-3 years) while further consolidation settlement occurs. When topographic monitoring indicates that the remaining settlement is within a manageable range (nominally <0.3 m), the surface will be cut-and-filled to final design profile. The area will then be rehabilitated in accordance with normal site practices for spoil dumps, including topsoil placement and construction of erosion control measures. The vegetation species mix must be consistent with roots of mature plants not reaching the low permeability layer.

Coarse Rejects

The key objective of cover over coarse rejects is to minimise water entering the coarse reject from deep infiltration of rainfall. This could be achieved with a single cover layer of low permeability material on a mounded free-draining landform. However, it is expected that the landform will also be required to support vegetation and hence the proposed cover system design comprises:

- Uncompacted subsoil and topsoil shaped to a gently mounded surface, to allow shallow infiltration during rainfall but no surface ponding that would drive deeper seepage; and
- A layer of lower permeability material finished with a mounded top surface so that any seepage that does reach it will tend to move laterally rather than downward.

Cover Design

For the Coarse Rejects, the cover designs comprise the following materials (from top of waste to the top):

- (Optional) Low clay content NAF spoil may be used for an initial layer in contact with coarse rejects to create the bulk landform shape. The spoil will have minimal compaction to limit moisture suction potential.
- A 1m minimum thickness layer of selected weathered Permian and/or Tertiary spoil, will be spread and worked so as to be more than ten times less permeable than spoil above it. The surface will be shaped to shed any deep infiltration out of the landform.
- A 2m minimum thickness of more permeable material such as gravelly fresh Permian spoil will be placed over the low permeability layer. The thickness may be greater than 2m as needed to maintain separation between the vegetation rooting zone and the low permeability layer, and to provide a final ground surface that will shed rainfall without ponding with slopes not greater than those on rehabilitated spoil emplacement areas.
- Topsoil and erosion management practices consistent with those on rehabilitated spoil emplacement areas.

Construction Methodology

Shear strengths of both coarse rejects and spoil are such that 10% slopes will be geotechnically stable, and no special measures will be required to construct the cover.

This section is the same as discussed in construction methodology for Tailings above and further details are provided in Henderson Geotech report in **Appendix L**.

Quality Assurance / Quality Control

This section is the same as discussed in quality assurance for tailings above and further details are provided in Henderson Geotech report in **Appendix L**.

Future Work

The cover systems were presented as preliminary designs based on information available as of July 2023.

As discussed above, the construction design for the TSF cover cannot be finalised until in situ strength profiles are measured and this can only be done after tailings deposition is completed. However, current and future operational procedures will strongly influence those strength profiles, with the two most beneficial measures being:

- Continuously removing as much decant water as possible from the tailings surface, to promote dewatering and densification; and
- Regularly moving the discharge point and the decant pond, to avoid the finest waste accumulating in one area that also has least opportunity for desiccation.

These actions should be included in Tailings Management Plan for the TSF, and compliance should be enforced.

Spoil that may be suitable for the various cover layers should be identified as it is mined, nominally from Eagles Nest Pit and WC North Pit. Ideally, it would be left in dump for a couple of years to observe slaking and other degradation before samples for classification testing including silt/clay fraction and plasticity.

In situ infiltration tests to confirm construction materials and methodology may be undertaken after suitable spoils have been identified and must be completed before the design is finalised.

3.5.7. Water Management

The landform design for Fox is intended to provide rehabilitated landforms that meet the nominated PMLU and NUMA milestone criteria without the need for ongoing water management. The following, which are discussed in more detail in the relevant sections of this PRCP, are key considerations that have been taken into account in the assessment of ongoing water management requirements post-mining:

- With the exception of the catchment of the residual voids, the final landform surfaces will predominately be free draining with runoff allowed to flow to the surrounding creeks (Section 3.5.5)
- All mining-related dams will be decommissioned and removed, and the rehabilitated areas will be free-draining (Table 3-46)
- Final residual voids will remain as NUMAs and will continue to act as groundwater sinks (Section 3.5.13)
- Flood protection landforms have been proposed to prevent flood ingress into the residual voids up to 0.1% AEP (Section 3.5.13)
- The TSF will be covered sufficiently (Section 3.5.6)
- Mineral waste/geochemical risks associated with the geochemical sources, once pit lakes have formed, have identified AMD source hazard scores of Low (Section 3.5.3)
- Modelling of flow paths through particle tracking of groundwaters within and surrounding the mining operations indicate the groundwater within the tenement will migrate toward the residual voids (NUMAs) and not into surrounding environments (Section 3.7.5).
- The assessment of creek diversions at Fox identified they were of suitable design and condition supporting progression to a closure state with ongoing maintenance and monitoring throughout the remaining operational phase (Section 3.5.5).

Contaminants

Description of Contaminants and Risks to Environmental Values

Contaminants present on site at Fox during the operational phase of the mine that could impact on surface water and groundwater quality have been identified and are listed in Table 3-49 (Foxleigh Mine, ND).

Table 3-49: List of Potential Contaminants on site at Fox (Foxleigh Mine, ND).

Possible sources	Potential contaminant
Spoil placement	Unconsolidated material with varying quantities of saline and sediment predisposition – bare areas vulnerable to storm activity
Topsoil stripping area	Unconsolidated materials, bare areas vulnerable to storm activity
Coal stockpiles	Runoff containing dissolved or particulate matter
Hydrocarbon storage	Hydrocarbons
Hazardous and toxic chemical storage	Chemicals
Sewerage	Overflow from storage tanks
CHPP waste (tailings, reject area)	Leakages containing salts and metals to ground or surface waters
Process water storage and reticulation	Sediments, salts and metals released to ground or waters from leaky pumps, burst pipes or drain overflows
Workshop and maintenance activities	Uncontained spills and leaks of oil, diesel fuel, solvent, glycol, thinner and surfactant
Coal preparation	Leakages containing oils, diesel, coal fines, sediments
Machinery washdown	Runoff containing oils, grease and surfactants

Source Contaminants

Source contaminants that are hazards related to water quality and environmental values are listed in Table 3-50, as per the findings of the Contaminated Lands Guidance (refer to **Appendix Q**).

Table 3-50: Source Contaminants Present at Fox (Engeny, 2023)

Potential Source	Potential Contaminants of Concern
Cleared Areas	Heavy metals, pesticides.
Former homestead / cattle dip infrastructure	Asbestos, synthetic mineral fibres (SMF), lead based paint, Polychlorinated biphenyls (PCBs), petroleum hydrocarbons, arsenic, heavy metals, pesticides.
Spoil Dumps, stockpiles, tailings storage	Petroleum hydrocarbons, Methyl Isobutyl Carbinol (MIBC), Per and poly fluorinated substances (PFAS) and, if applicable, acid mine drainage (AMD), polycyclic aromatic hydrocarbons (PAH) and Dioxins are also potentially of concern.
Workshops / Wash Bays / Dangerous Goods Storage	Petroleum hydrocarbons, metals, PFAS, PCBs, phenols, solvents.
Fuel Storage Areas / Mobile refuelling areas	Petroleum hydrocarbons.
Substation	Petroleum hydrocarbons, metals, PFAS, PCBs, phenols, solvents.
Sewage Holding Tank Areas	Metals, PFAS, nitrogen species, microbiological.

Potential Source	Potential Contaminants of Concern
Explosives Storage	Petroleum hydrocarbons, nitrogen species.
Roads and Carparks	Petroleum hydrocarbons, metals.
Voids containing Pit Water	Petroleum hydrocarbons, metals, AMD, PFAS, PCBs, phenols, solvents, nitrogen species, microbiological.
Waste Storage Areas	Petroleum hydrocarbons, metals, PFAS, PCBs, phenols, solvents.
Drainage Lines	Petroleum hydrocarbons, metals, AMD, PFAS, PCBs, phenols, solvents, nitrogen species, microbiological.
Water Storage Areas	Petroleum hydrocarbons, metals, AMD, PFAS, PCBs, phenols, solvents, nitrogen species, microbiological.
Process water	Petroleum hydrocarbons, metals, AMD, PFAS, PCBs, phenols, solvents, nitrogen species, microbiological.
Mine dewatering (Pit water from, direct rainfall and runoff from spoil and seepage.)	Petroleum hydrocarbons, metals, AMD, PFAS, PCBs, phenols, solvents, nitrogen species, microbiological.
Potential Source	Potential Contaminants of Concern

Pathway of Contaminants

During the operational phase of the mine, a variety of water management controls are put in place. These are displayed in Table 3-51.

Mine affected water is released at designated release points. Criteria must be met at upstream monitoring before release, detailed in the EA (**Appendix A**). In most cases, release on non-MAW offsite will occur without any intervention by the mine. FoxMan has a responsibility to minimise the amount of surface water that comes in contact with mine-affected areas. Drains and diversions are used for this purpose (Foxleigh Mine, ND).

ESC water is captured in drains and sedimentation ponds to allow settling of solids. During times of heavy rainfall, sedimentation ponds may overflow into the surrounding environment. Sedimentation ponds are placed as far away from receiving waters as possible. Surrounding vegetation acts as a filter to slow and drop sediment before it reaches receiving waters. Where there is a risk of overflow from a sedimentation dam, rock spillways should be installed to ensure the integrity of the dams and reduce scouring and further sediment mobilisation (Foxleigh Mine, ND) .

CHPP fine rejects (tailings) are pumped into an in-pit tailings storage facility (TSF) within NT pit where solids separate from supernatant water, which is periodically pumped to water storage. NT pit is scheduled to be capped with low permeability mining spoil and rehabilitated to a shedding landform at mine closure (RGS Environmental Pty Ltd, 2021)

Table 3-51: Impacts and Controls on Fox Water Quality and Environmental Values (Foxleigh Mine, ND).

Aspects	Potential Impact	Controls
Dam failure	• Uncontrolled release of contaminants to stream • Downstream flooding	• Dam design and maintenance to standards • Water balance model • Regulated dam specifications

Aspects	Potential Impact	Controls
		• Regular inspections/annual inspection audit
Levee failure	• Uncontrolled ingress of stream water to pit/void • Uncontrolled release of contaminants to stream • Downstream flooding	• Regular inspections, maintenance program and procedures. Designed for use
Mine water discharge to streams	• Release of contaminants to the environment	• Release of water conducted in line with the conditions of the EA
Regional impacts	• Changes to surface and groundwater	• Extensive surface and groundwater monitoring network to detect changes in the environment. • REMP program to define baseline conditions.
Erosion	• Sediment mobilisation to waterways • Degradation of waterway structures	• Diversion monitoring and repair as per Water Licence conditions. • Enhanced bank and riparian vegetation. • Creek restoration works. • Conduct creek restoration works where needed.
Surface water quality	• Contamination of surface water	• Clean water separated from mine affected areas. • Process areas of the mine contained to onsite catchments. • Run-off from ROMs trapped in sediment dams and water transferred to mine water storage voids. • Pipes and pumps regularly inspected and maintained to prevent leaks.
Chemicals and fuels	• Contamination of surface and groundwater	• Chemicals and fuels stored in bunded areas according to Australian Standards. • Plant and vehicles inspected for leaks and repaired. • Waste chemicals retained and disposed of by an approved recycling/disposal company. • Spills cleaned up and reported immediately.
Water usage	• Limited resource	• Recycling of mine water for process operations. • Minimise the use of pipeline water. • Monthly monitoring of water usage.
Tailings storage	• Contaminant release to the environment	Tailings drainage to be contained and recycled.

Fate of Contaminants

At the completion of mining operations, a contaminated land investigation will be undertaken to assess the area for potential contamination. Any contamination remaining post-mining that presents an unacceptable

risk to the nominated PMLUs, or the environment will be subject to investigation and remediation. Therefore, the final landform surface will not contain concentrations of contamination requiring further assessment of contaminant fate.

Where contamination is contained within the subsurface, the strong sinks created by the residual Final voids will continue to collect any potentially contaminated seepage and groundwater. Leakage from any pit lake into groundwater reserves will not occur (RGS Environmental Pty Ltd, 2021).

Infiltration and Seepage Intervention and Collection Controls

Groundwater exchange in the voids is expected to stabilise 450 years after mine closure; each of the voids will operate wholly as a groundwater sink, with inflows occurring from all directions with no water seepage into the natural environment (Groundwater Functions Pty Ltd, 2023).

Dewatering Requirements

There are no associated dewatering requirements with the final proposed landform and associated PMLUs/NUMAs.

Ongoing Water Management and Reduction Requirements

Ongoing water management and reduction requirements will adhere to the site Erosion and Sediment Management Plan (ESMP) (Foxleigh Mine, 2021). Mitigation works relate to the following controls in Table 3-52.

Table 3-52: Mitigation Strategies for ESC

Erosion control	Sediment control	Drainage control
• EC blankets • Mulching • Geocellular containment • Surface roughening • Geo-binders • Rock-lining • Rock mattress • Sealing or hard surfaces • Watering (wind control)	• Vegetative buffers • Sediment fences • Sediment traps • Sediment basins/dams	• Catch drains • Check drains • Energy dissipators

Maintenance and inspections for erosion and sediment control are carried at regularly following heavy storm events (Foxleigh Mine, ND).

Creek Diversions and Long-term Management Requirements

Fox has three (3) licenced creek diversions (shown in Figure 3-8) granted under the *Water Act 2000;* the Roper, Carlo and Cockatoo Creek diversions that are to be retained as part of the final landform. Flood mapping results indicate that these diversions and associated levee maintain flows and prevent flood ingress into One Tree Pit for the 0.1% AEP event plus 1 m freeboard. These results also indicate PMF flood protection to the One Tree Pit final void.

These diversions have been designed and constructed in accordance with the following guidelines:

- Department of Natural Resources, Mines and Energy (DNRME) Guideline “Works that interfere with water in a watercourse for a resource activity – watercourse diversions authorised under the Water Act 2000” (DNRME, 2019); and

- ACARP (Australian Coal Association Research Program) – Criteria for functioning river landscape units in mining and post mining (C20017) (ACARP, 2014)

Operations monitoring of the entire diversion (diversion and levee) occurs on an annual basis. Monitoring is also undertaken following significant flow events to maintain channel condition and reduce risk to mining infrastructure and the environment (Foxleigh Mine, ND). The diversion monitoring package are prescribed by the ACARP monitoring methodology, described in detail in Section 3.7. Baseline operations and monitoring has already taken place for Cockatoo Creek for all of the diversions and reaches upstream and downstream. A monitoring program is an essential component of the design, construction and operational performance evaluation process for creek diversions and required as part of the regulatory process. The ACARP methodology informs management of the diversion in the long term to ensure it is on a trajectory towards timely relinquishment of approvals (Alluvium, 2019).

Operations monitoring of the Cockatoo Creek diversion are displayed in Table 3-53 and Table 3-54, which is undertaken on an annual basis (Foxleigh Mine, ND). Relinquishment monitoring requirements for Cockatoo Creek is described in Table 3-55.

Table 3-53: Operational Monitoring Requirements of Cockatoo Creek Diversion (Alluvium, 2019)

Operational Monitoring Component	Requirements
Survival of works	The survival of any instream structures and works such as riprap and vegetation should be assessed during this phase of monitoring. Early detection of damage is likely to increase the options for remedial action.
Photographs	Photographs should continue to be taken from fixed photo points in the upstream reach and downstream reach set up during the baseline monitoring. The diversion reach fixed photo points established as part of the construction monitoring should also be repeated during IDC assessment.
Aerial Photographs	Aerial photographs of the upstream reach, diversion reach and downstream reach should be taken on an annual basis
Visual Assessment	The upstream reach, diversion reach and downstream reach should be visually assessed using the IDC, which should be repeated on a frequent basis after construction. IDC inspections should include: • Bank condition. • Piping. • Bed condition. • Recovery. • Proximity of spoil piles from bank. • Stability of instream structures. • Structural intactness of vegetation. • Regeneration of vegetation. • Longitudinal continuity of vegetation.

Table 3-54: Diversion Monitoring Package Components (Engeny, 2022)

Monitoring Package Component	Objective
1: Baseline Monitoring	To establish a baseline data set that can be used for comparison when applying for licence renewal and relinquishment.
2: Construction Monitoring	To demonstrate works have been undertaken to specification.
3: Operations Monitoring	To maintain channel condition and reduce risk to mining infrastructure and the environment. Used in licence renewal application.
4: Relinquishment Monitoring	To demonstrate the diversion is operating as a waterway in equilibrium with and not adversely impacting on adjoining reaches.

Table 3-55: Relinquishment Monitoring Requirements of Cockatoo Creek (Alluvium, 2019)

Relinquishment Monitoring Component	Relinquishment Monitoring Requirements
Survey 1	Long-section and cross-section survey should be conducted during the first year of relinquishment monitoring. The survey should include the upstream reach, diversion reach and downstream reach. This survey will then be able to be compared to the 'as built' long-section to assess the change in bed elevation.
Stage 1 Evaluation	Survey data from baseline and operations monitoring should be compared with data from relinquishment monitoring. Rates of change for channel top width, cross-section area, horizontal and vertical displacement can then be calculated.
Vegetation assessment	Detailed vegetation assessment should be conducted during the first year of relinquishment monitoring to determine key species absent from the diversion reach but present in the upstream reach where this is appropriate. However, this must also take into account the fact that the diversion may be constructed in ground higher than the lower lying floodplain, containing larger flows in channel rather than engaging with an adjacent floodplain. The diversion reach may therefore have different geomorphic and ecological characteristics than the reach it will be replacing.
Photography	Photographs should be taken from the fixed photo points in the upstream, diversion and downstream reaches.
Aerial Photographs	Aerial photos of upstream, diversion and downstream reaches should continue to be taken on an annual basis.
Survey 2	A final long-section and cross-section survey should be conducted prior to application for licence relinquishment.
Stage 2 Evaluation	All data should be evaluated, and photographs collated for presentation in a report to regulators
Flow Events	Flow events should be monitored to determine the size of events to which the diversion reach has been subjected.

The creek diversion details, water licences, assessment outcomes and forward work plan commitments for relinquishment are summarised in Table 3-56.

The rehabilitation objectives of the Cockatoo Creek Diversion are (Alluvium, 2019):

1. Ensure rapid early establishment and site stabilisation.
2. Adopt native species capable of accommodating the modified soil condition.
3. Implement rehabilitation delivery systems that comply with mine safety requirements.

4. Construct a safe and stable diversion and associated levee with a self-sustaining ecosystem based on the predominant use of species that are endemic to the region (representative of riparian zone).

Management of the Cockatoo Creek diversion will incorporate the following:

- Subsoil amelioration with gypsum

> *Topsoil stripped to 300 mm and deposited into a 4 m high stockpile. The stockpile detail design volume is approximately 79,00m^3 to 84,000m^3. Actual stockpiled volume exceeds 100,000m^3. There will be an excess volume to demand. The topsoil will be ameliorated with gypsum.*

Table 3-56: Fox Creek Diversion Details and Forward Work Plans (Engeny, 2022) (Engeny, 2022) (Engeny, 2022)

Details	Carlo Creek	Cockatoo Creek	Roper Creek
Water Licence	103298	608515	103298
River Catchment	Mackenzie River	Mackenzie River	Mackenzie River
Upstream Area			450km^2
Year of Construction	2011 - 2012	Stage 1 – Commenced 2014.	2001
Diversion Length	6,285 m	14, 894 m	5,080 m
Diversion Assessment Outcome	Good Condition	Moderate Condition – Stage 4 has been graded as poor condition due to reduced vegetation cover and high bed level.	Good Condition
Operational Phase	Continue to monitor to assess ongoing condition.	Continue to monitor to assess ongoing condition.	Continue to monitor to assess ongoing condition.
Forward Work Plan – Final Landform	Further assessment of these diversions against the ACARP stability criteria is proposed to be undertaken	Further assessment of these diversions against the ACARP stability criteria is proposed to be undertaken	Further assessment of these diversions against the ACARP stability criteria is proposed to be undertaken

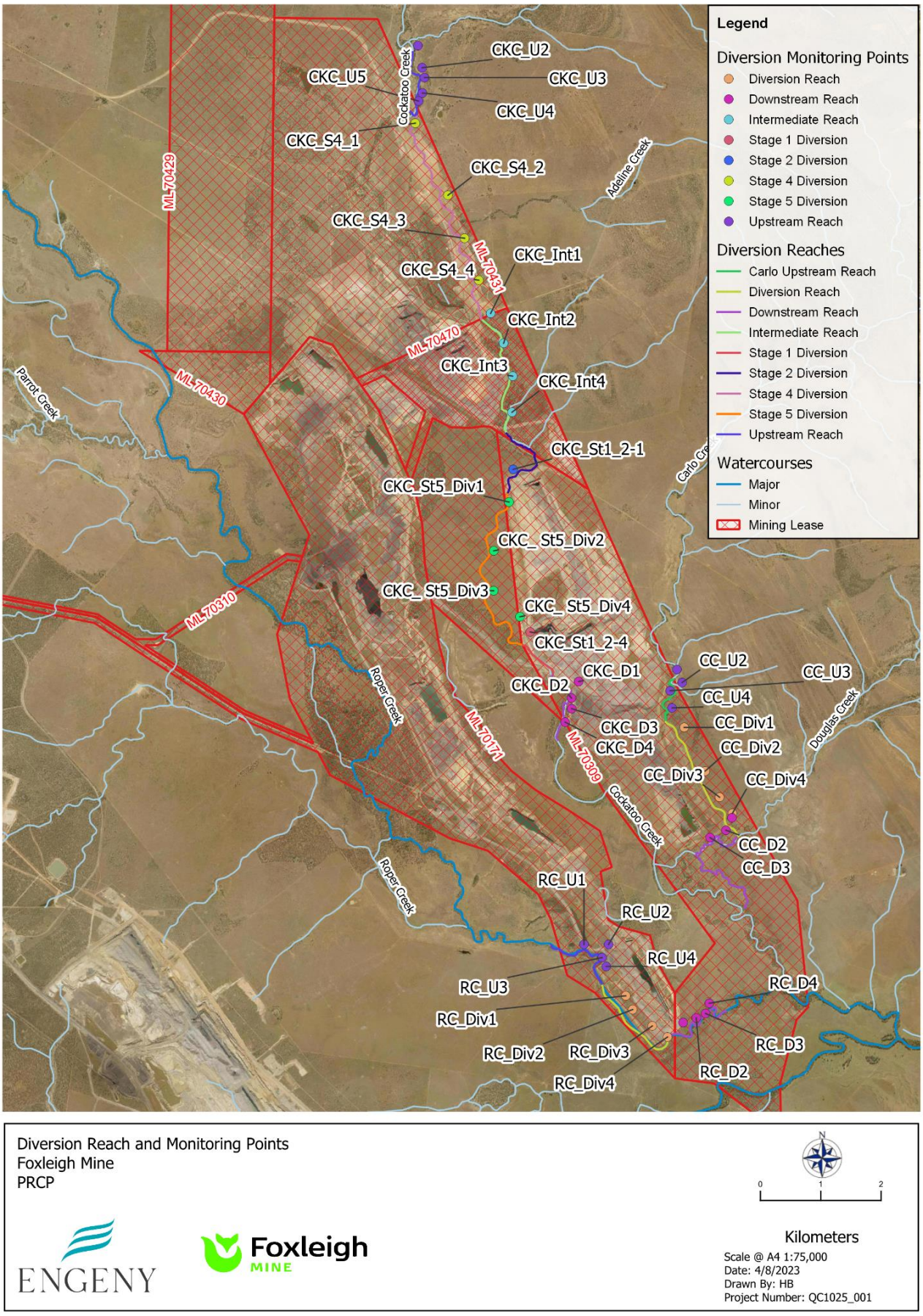


Figure 3-32: Location of Fox Creek Diversions (Foxleigh Mine, ND)

3.5.8. Revegetation

Revegetation Objectives

Condition H1 of the EA EPML00744813 requires all areas disturbed by mining to be rehabilitated in accordance with the Rehabilitation requirements for each defined domain (See Appendix 2 in EA – refer to **Appendix A** of this document).

The revegetation objectives of the planned Post Mining Land Uses (PMLUs) of cattle grazing, and watercourse are consistent with the rehabilitation requirements of the EA as follows:

- To return a self-sustaining landscape based on the proposed PMLUs, grazing, watercourse and native ecosystem corridor.
- Reshape mining surface areas to establish slope ranges of <17%. Existing rehabilitated areas to remain at the approved 17%.
- Infrastructure areas land will be re-shaped to a slope range <10% with adequate erosion controls.
- Implement adequate erosion controls so that no sites displaying significant wind or gully erosion will cause harm to fauna.
- Establish vegetation on slopes with a suitable species mix for the agreed final land use. Areas where cattle grazing land use applies will have pasture grass species present that will provide stock with nutritional requirements, as well as being capable of setting viable seed and flowering similar to reference sites in the Middlemount area and/or with a land suitability class (grazing) of Class 4.
- Watercourse diversions will be rehabilitated in accordance with condition H2- Rehabilitation completion criteria for the Foxleigh Plains Watercourse Diversion (ML70431) must be submitted to the administering authority by way of an amendment to this environmental authority within ten (10) business days of submitting the ''as constructed'' Design Plans to the administering authority, as required by condition G4.
  - Areas where watercourse land use applies will have fast growing pasture grasses to provide adequate erosion coverage and higher banks will support natural germination of woody stem species to provide natural stability and support woodland vegetation.
- The native ecosystem corridor will be rehabilitated to provide a supporting vegetative corridor between Cockatoo creek and Roper creek with species to support a native terrestrial ecosystem of the brigalow belt.

PMLUs

The EA (Appendix 2 of EPML00744813 – refer to **Appendix A** of this document) specifies the following rehabilitation objectives relating to returning lands to:

- Native terrestrial or riparian ecosystem of the brigalow belt; or
- Where agricultural land use applies, to return to self-sustaining grazing land that is sustainably economically viable; and
- Establishment of a native ecosystem connectivity corridor.

Based on the identified surrounding land uses of grazing and the currently managed offset areas, the predominant PMLU proposed for Fox is cattle grazing. Proposed PMLU types for each mine domain is displayed in Table 3-57 and displayed in Figure 3-33.

To support the proposed PMLUs, review of relevant land zones and bioregions within the surrounding area of Fox has been applied (Queensland Herbarium, 2018 & Wilson, P., & Taylor, P. 2012). A PMLU of grazing is

a continued economic support for the region and an appropriate land use based on existing vegetation and surrounding uses.

The proposed PMLU of watercourses is based on achieving a self-sustaining native terrestrial ecosystem, consistent with surrounding watercourse vegetation and work in equilibrium with the adjoining reaches of the watercourse (DES, 2017).

The proposed PMLU of a native ecosystem connectivity corridor is intended to provide a vegetative connectivity corridor between Cockatoo creek and Roper Creek (East to West) in the vicinity of the CHPP infrastructure area.

Table 3-57: Proposed PMLUs for Applicable Mine Domains

Mine Domain	Mine Feature Name	Proposed PMLU
Mine Surface Features	Raw and mine affected water storage dams	Grazing
	Haul roads, roads and tracks	
	Coal stockpile areas	
	MIA (workshops and associated laydown, hardstand, fuel storage, washdown bay areas)	
	CHPP and associated infrastructure	
	Administration offices, crib, office buildings & ablutions	
	General infrastructure and disturbance	
	Explosive magazine	
	Power reticulation network	
	Fencing	
Mining areas	Spoil dumps (inpit and OOPD)	
	Backfilled voids	
	Burrow pit	
	Topsoil stockpiles	
	Mineral residue storage areas	
Watercourse Diversions	Creek Diversions and levees	Watercourse
Native ecosystem connectivity corridor	Undefined	Native ecosystem corridor

Species of Conservation Significance

Baseline ecological surveys were undertaken from 2009 to 2011 as part of the Fox EIS (Ecological Survey and Management, 2012; AECOM, 2012; ALS Global, 2012). Significant vegetation communities under the *Vegetation Management Act 1999 (*VM Act*)* and the Commonwealth *EPBC Act*, including the Endangered Brigalow and Squatter Pigeon.

Fox holds an approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act, Reference Number 2010/5421) to disturb protected matters including Brigalow (*Acacia harpophylla* dominant and co-dominant) threatened ecological community (Brigalow TEC) and Squatter

Pigeon Primary habitat (SPPH). The currently Federally approved Biodiversity Offset Management Plan (BOMP, 2022) outlines defined offset areas and management criteria for the protection of these areas.

Significant impacts to protected matters are limited to the clearing of 83.7 ha of Brigalow, which requires offset under the EPBC Act. Significant Brigalow woodland vegetation and fauna communities were concentrated around Cockatoo Creek, which was a continuous vegetated corridor with substantial hollow bearing trees. The majority of the site was cleared grazing pastures that do not associate with any listed REs (Hansen Bailey & Anglo American, 2012).

Limited aquatic habitat and no stygofauna was identified during the field surveys (Hansen Bailey & Anglo American, 2012).

A State approved Biodiversity Offset Plan (BOS) is currently under review (April 2023) by the Department of Environment and Science (DES). The proposed plan identifies Brigalow TEC and Squatter Pigeon Prime Habitat (SPPH) and a range of endangered regional ecosystems. These areas are proposed to be managed according to the management criteria within the BOS. Protected habitat and use requirements

There are no existing approval requirements to establish fauna habitat and/or fauna use in the rehabilitation areas for the Fox site. Diversion reaches will be rehabilitated to comprise of watercourse habitat PMLU, representative of watercourse habitat present pre-mining.

Revegetation Seed Provenance

It is recommended that proof of provenance (where the seed comes from) is sought for all sourced seed for rehabilitation. Seeds will be sourced as locally as possible from natural populations, ideally from the Brigalow Belt north bioregion. Currently, seeds are sourced from Terralogica. Alternatives for seed supply include Austrahort and Queensland Native Seeds.

Findings from the recent rehabilitation inspection report indicate that there is a significant seed bank for grasses, herbs and small tree species existing in topsoil stockpiles (Engeny, 2021).

Proof of provenance will be sought from the seed supplier(s) for all purchased seeds, alongside germination and viability certificates. The ratio of seed and coating weight (where applicable) will also be requested from seed supplier(s).

Revegetation Site Preparation and Timeframe

Growth Medium

Following vegetation clearing, topsoil will be transported to topsoil stockpiles. Large vegetation will be cleared first and burnt as required. Smaller vegetation and grasses will then be removed from the topsoil and then stockpiled no higher than 4 meters. If required, stockpiles will be ripped and seeded to encourage water infiltration and prevent erosion.

Topsoil stockpiles will provide the growth media for both the cattle grazing and woodland PMLUs. Geochemical characterisation reports indicate that all test-pit soil samples obtained during baseline studies are suitable for supporting native vegetation, however the general hierarchy for growth mediums should be followed:

Vertosols > Arenosols > Chromosols > Sodosols

Topsoil from stockpiles will be respread on surfaces to be rehabilitated in alignment with the PRCP schedule and to maintain the viability of the topsoil seed bank.

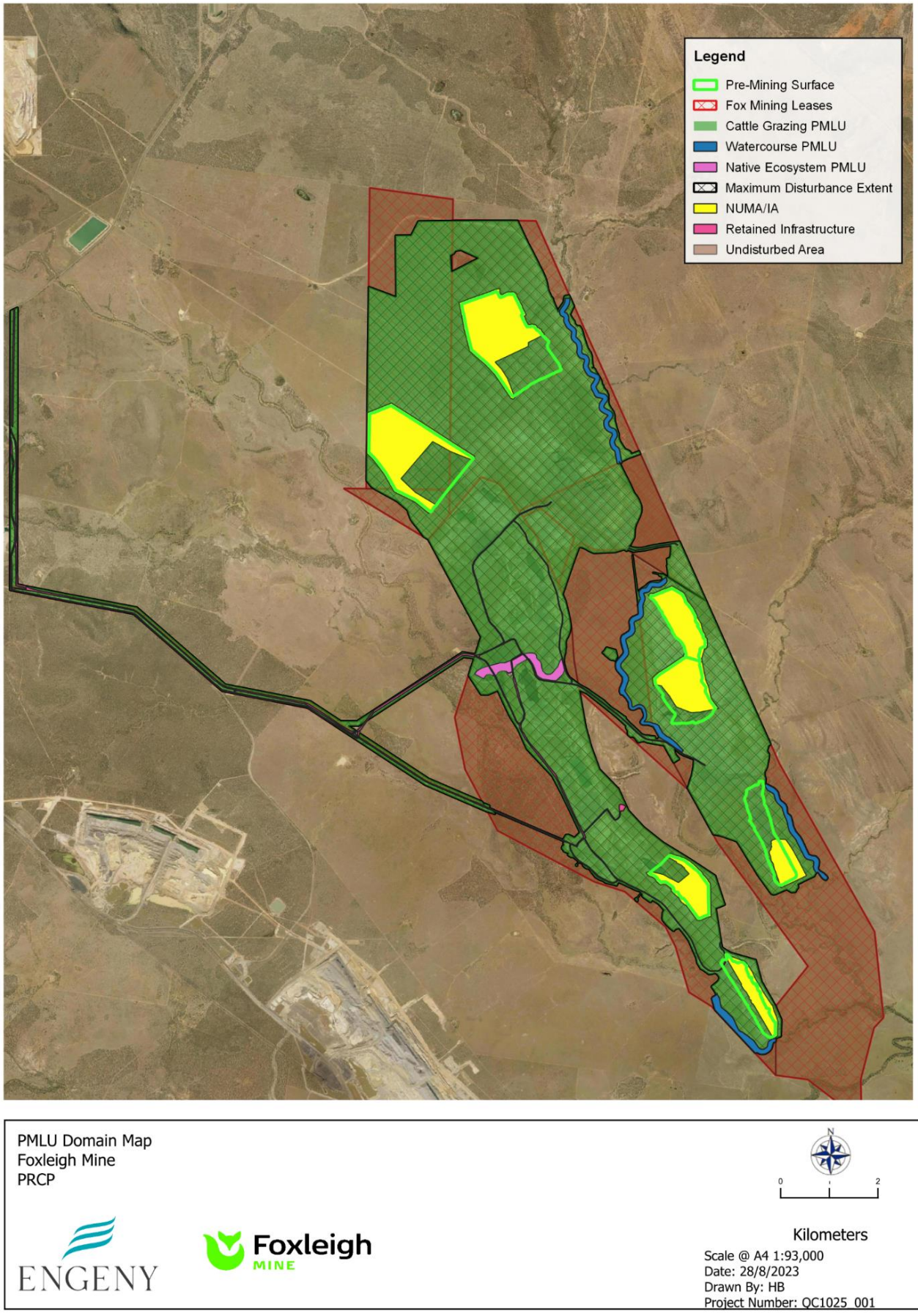


Figure 3-33: PMLU Domain Map

Topsoil Balance

A topsoil balance was completed as part of the Fox Estimated Rehabilitation Calculator submission during 2022. A summary of available topsoil resources is provided in Table 3-58.

Table 3-58: Fox Available Topsoil/Growth Medium

	Volume (m^3)
Current topsoil available based on existing stockpiles and future operations	3,568,538
Topsoil estimated required for closure (based on current final landform)	3,069,321

Amelioration

Topsoil will be ameliorated with gypsum due to the dispersive nature of topsoils available on site to provide greater stability of soil organic matter (Foxleigh Mine, 2021). Areas may also require the addition of fertiliser or organic material. Gypsum will be applied at a rate of no less than 15t/ha and fertiliser at a rate no less than 0.2t/ha unless the area is under a documented rehabilitation trial (Foxleigh Mine, 2021) for slopes of 14%. Gypsum application will be dependent on the rehabilitation slope and is recommended to be defined on a case-by-case basis (Foxleigh Mine, 2022).

For existing rehabilitated areas of 17% slope, a proposed gypsum application rate of no less than 15t/ha and fertiliser at a rate no less than 0.2t/ha. For achieving most effective results, undertaking soil sampling prior to application will provide accurate information on the current soil structure and stability to refine the specific application rates.

Amelioration proposed is based on results from soil sampling conducted as part of the Geochemical characterisation of mining waste, coal and soil (RGS, 2022) in **Appendix K**.

Topsoil Spreading Depths

Topsoil should be spread at depths ranging from 150 mm to 200 mm. A depth of 200 mm is recommended, as it is beneficial to long-term plant establishment, however rehabilitation trials have indicated that a minimum of 150 mm can also generate decent vegetation if adequate topsoil is not available (Foxleigh Mine, 2022). Topsoil will be spread so that there are no bare areas exceeding 100 m^2 on all mine surface features, spoil emplacement areas and watercourse diversions (DEHP, 2017). Ripping to a minimum depth of 50 cm at 1 m spacing is to be implemented across all mine surface features excluding mineral residue domains which is dependent on capping designs (DEHP, 2017).

Seeding

Seeding will be undertaken by specialised contractors with suitable machinery for ensuring even application of seeding rates specified by Fox. Seeding must only take place once all preceding rehabilitation activities, including spreading topsoil, amelioration and ripping (Foxleigh Mine, ND). However, seeding should occur as soon as possible after topsoil placement to prevent bare-soil exposure to the elements and maintain nutrition and microorganisms in the soil (Engeny, 2021).

All equipment will be sterilised of weed material before arriving on site. If seed is not inserted directly to soil and spread, a prickle-chain implement or similar will be used to ensure positive soil contact (Foxleigh Mine, ND).

Seeding should not take place within 48 hours of forecasted heavy rains to prevent seed loss (Foxleigh Mine, ND).

Erosion Control Structures

Erosion control structures that may be implemented on the final landforms include:

- Rock mulching.

- Rock-lined waterway.
- Sediment basins; and
- Contour banks and drains, which will be removed once vegetation is established, if applicable.

These will be applied as required, and consistent with the proposed landform.

3.5.9. Cattle Grazing PMLU

Cattle grazing has been proposed as a primary PMLU for the project area, based on the following factors:

- Consistency with the current approved EA.
- Relevant surrounding land uses as agricultural/cattle grazing.
- Consistency with the Isaac Regional Council regional plan.
- Consistent with land suitability assessments completed during the EIS.

Revegetation Species and Seeding Rates

The standard mix for grazing PMLU is specified in the cattle crazing seed mix composition and seeding rates may be adjusted based on the results of ongoing rehabilitation monitoring, see Table 3-59 (Foxleigh Mine, ND). These species are suitable to support sustained cattle grazing, with a high percentage of 3P grasses and legumes, and a low number of weeds (Queensland Government, 2013). The species are representative of pasture species observed in baseline ecological surveys (Ecological Survey and Management, 2012) and recommended based on a combination of species cognisant of grazing best management practices (Future Beef, 2022).

A seeding rate of 30 kg/ha is recommended for cattle grazing PMLU. Species availability may vary, and unavailable species are to be substituted with other species, including alternative native species consistent with the surrounding landscape.

Pasture seeds are recommended to be sown in the warmer months, from September to March when the probability of rainfall is at its highest to support germination.

Table 3-59: Seed Mix for Grazing PMLU (Foxleigh Mine, ND)

Scientific Name	Common Name	Kg/ha
Grass species – Total seed weight coated (kg/ha)		
Chloris gayana Kunth	Callide Rhodes	2 [c]
Chloris gayana	Katambora Rhodes	2 [c]
Bothriochloa insculpta	Bisset Bluegrass	2 [c]
Bothriochloa pertusa	Keppel Bluegrass	2 [c]
Stylosanthes scabra	Seca Stylo	2 [c]
Stylosanthes hamata	Amiga Stylo	2 [c]
Chamaecrista rotundifolia	Wynn Cassia	1 [c]
Cenchrus ciliaris	Gayndah Buffel	2 [c]
Urochloa mosambicensis	Sabi Grass	2 [c]
Bothriochloa bladhii	Swann Bluegrass	1 [c]
Legume species – Total seed weight uncoated (kg/ha)		
Macroptilium bracteatum	Burgundy Bean	1
Clitoria ternatea	Butterfly Pea	1

Scientific Name	Common Name	Kg/ha
Echinochloa esculenta	Shirohie Millet	10
	Total	**30**

[c] *Assumes seed is coated. If not coated, use half prescribed rate*

Cattle Grazing Reference Sites

Cattle grazing reference sites were chosen based on aerial imagery. The purpose of the reference sites are to provide an indicator for revegetation success on un-disturbed grazing land with the same growth medium and slope conditions.

The EA specifies that cattle grazing sites should be located within the Middlemount area and/or with a land suitability class (grazing) of 4.

Two grazing analogue locations were selected in areas with a land suitability class (grazing) 4 rating across the Fox site. These locations are visually represented in Figure 3-34 and GPS coordinates presented in Table 3-60.

Analogue sites for grazing were located on the Fox mining lease boundary, adjacent to land with a grazing land use. The entire Fox mining lease boundary is surrounded by cattle grazing land use, except for the far western boundary of ML 70171 and ML 70310, which is adjacent to mining land use (German Creek/Oaky East). Situating analogue sites on the mining lease boundary allows for appropriate comparisons to undisturbed cattle grazing areas, whilst providing access for monitoring.

The following factors were considered when selecting the locations of reference sites:

- Not impacted by mining.
- On land with a land class suitability rating of 4 (grazing) (Hansen Bailey & Anglo American, 2012).
- Away from disturbances, such as roads or tracks.
- Outside of mapped rehabilitation areas.
- Within the Fox Mining Lease.
- Outside of the floodplain.
- Within an accessible location, without impact on health and safely access each location.

Table 3-60: GPS Coordinates of PMLU Analogue Monitoring Locations (GDA 94 Zone 55)

Site ID	Analogue Site	Easting	Northing
CG_1	Cattle Grazing	677936	7470089
CG_2	Cattle Grazing	683424	7465730
CKC_U5	Watercourse	682040	7468970
CKC_D4	Watercourse	684468	7458686
CC_U4	Watercourse	686239	7458921
CC_D4	Watercourse	687130	7456894
RC_U3	Watercourse	685079	7454788
RC_D4	Watercourse	686856	7454027
NE_1	Native Ecosystem Corridor	682025	7461682
NE_2	Native Ecosystem Corridor	679923	7460783

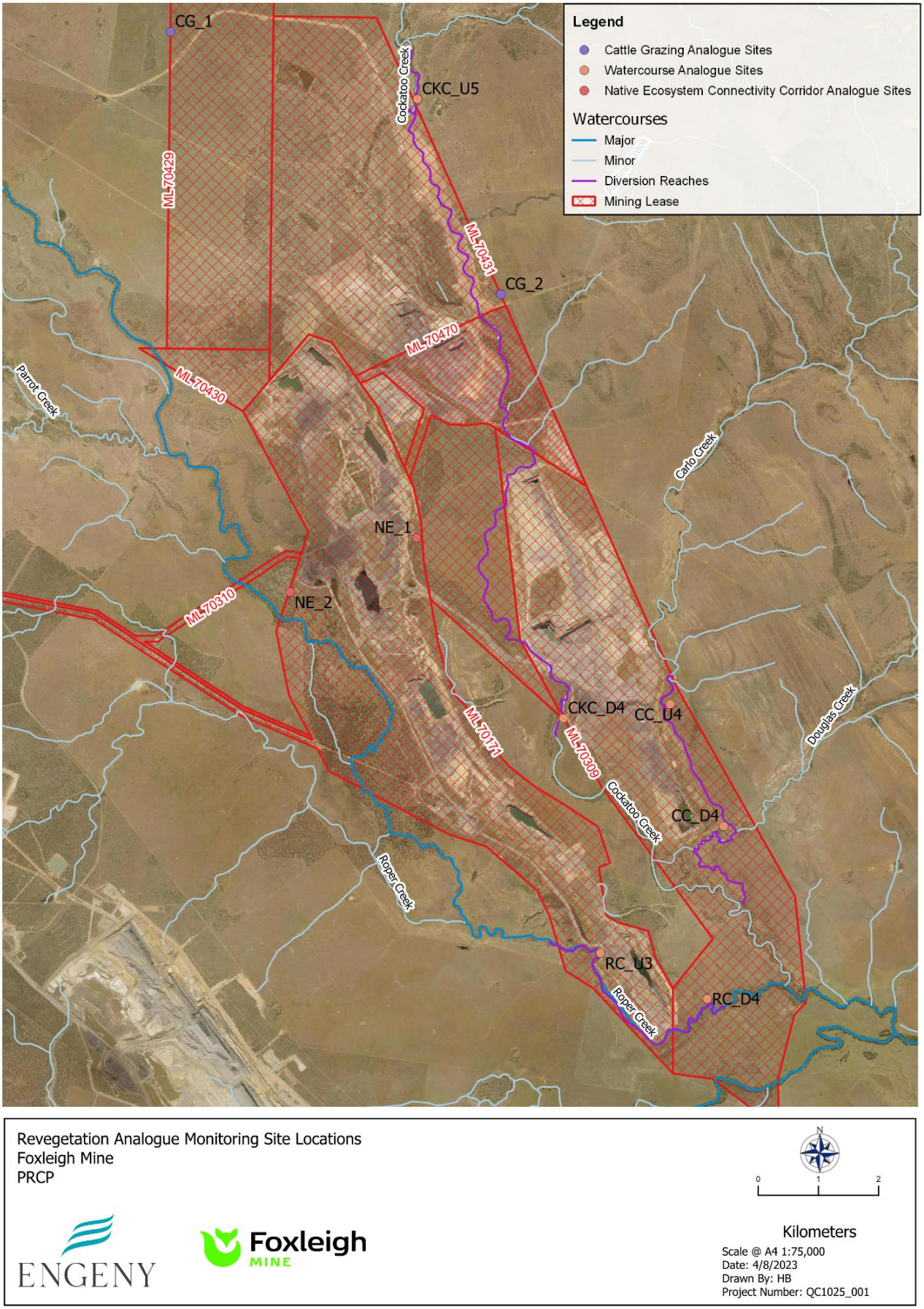


Figure 3-34: Revegetation Analogue Monitoring Site Locations

3.5.10. Watercourse PMLU

There are six (6) creek diversions at Fox that have undergone watercourse habitat revegetation:

- Roper Creek.
- Carlo Creek.
- Cockatoo Creek Stage 4.
- Cockatoo Creek Stage 2.
- Cockatoo Creek Stage 5.
- Cockatoo Creek Stage 1.

These diversions have been revegetated and have a current monitoring program as per the original approved design documents.

The results of the creek diversion monitoring have and will continue to be used to inform ongoing routine maintenance requirements during the operational phase of the mine, with the objective of achieving a self-sustaining riparian vegetation similar to upstream or downstream watercourse areas undisturbed by mining activities.

Where natural watercourses have been disturbed by mining activities, revegetation activities will be implemented to re-establish riparian vegetation associated with a watercourse PMLU.

Revegetation of the watercourses should reflect the typical riparian planting zones, shown in Figure 3.35

. The revegetation zones for natural watercourses are defined as follows and is consistent with the revegetation plan associated with the diversions:

- *Upper bank:* defines the lateral limits of both sides of the watercourse or diversion. It does not include the land adjacent. The upper bank generally extends down the riparian profile and is dominated by taller *Eucalyptus spp*, with a mixed woody and grassy understorey.
- *Mid bank:* occurs between the upper and lower banks and will vary in size depending on the watercourse or diversion. The mid bank may include benches created from high flow events. The vegetation on the mid bank comprises a mix of species including scattered Eucalyptus spp., as well as species that are more adapted to periodic inundation of water and are able to withstand some disturbance from floods.
- *Lower bank (including bank toe):* commences at the edge of the low flow channel or stream bed and extends up the bank to the area affected by more regular lower flows. The vegetation in the lower bank is dominated by species adapted to wetter environments that can provide a high ground cover of grasses, reeds, sedges and rushes.

Topsoils will be ameliorated prior to seeding as recommended by an appropriately qualified person.

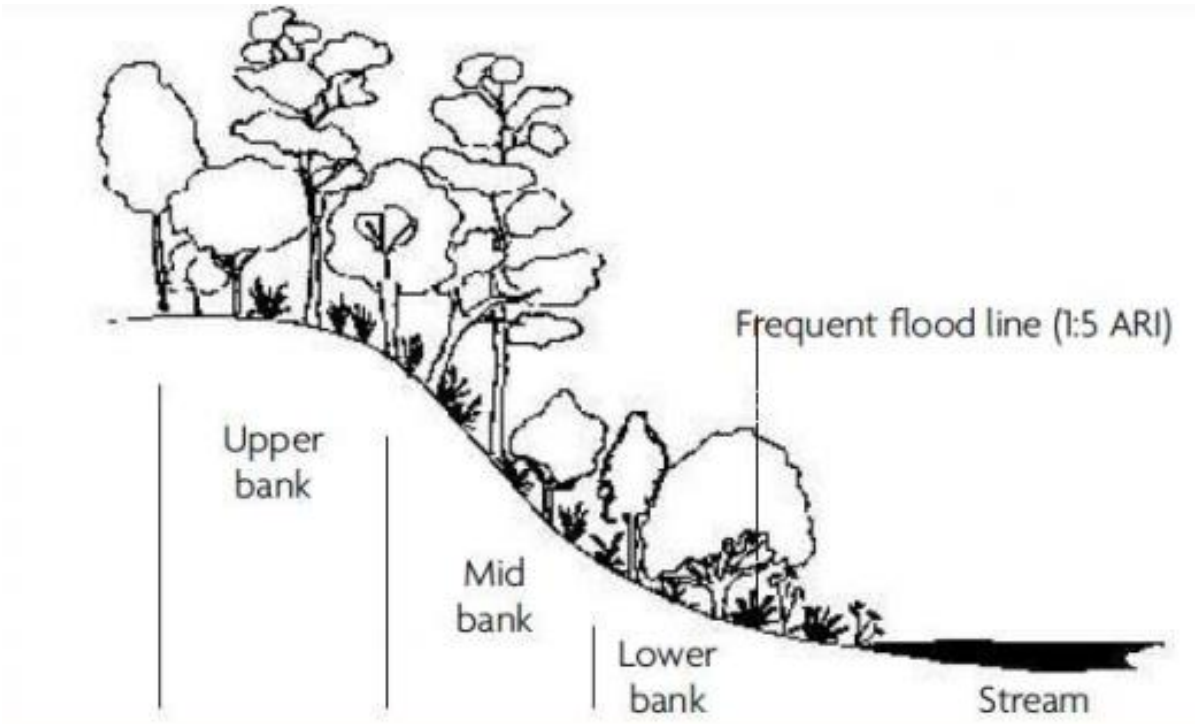


Figure 3-35: Typical Riparian Vegetation Plantings Zone (Vegetation Matters, 2014)

Watercourse Revegetation Species and Seeding Rates

The watercourse revegetation species are based on selecting framework species that are suitable to fit within the riparian and woodland ecosystem. This is primarily riparian tree species, woody understory species and groundcover species associated with the predominant natural watercourse vegetation consistent with the upstream and downstream reaches of each diversion.

The current seeding mix for riparian woodlands are displayed in Table 3-61. These species are representative of riparian woodland species observed in baseline ecological surveys of the mining lease (Ecological Survey and Management, 2012) as well as species common in the Brigalow Belt Northern Bioregion that would best align with rehabilitated watercourses. Key framework trees, woody understorey and grass species that are adapted to the growth media available on site have been selected.

The revegetation on the lower banks has been designed to establish a higher percentage of ground cover species, including grasses and rushes. Competitive pasture species have been excluded from the seed mix and only non-aggressive grass species are recommended. Short lived wattle species have also been excluded in the seed mix. The recommended seeding rate for woodland habitat is 30 kg/ha.

Planting in all revegetation zones will also include the addition of a cover crop (e.g., Japanese millet) seeded at 15 kg/ha. The cover crop will establish quickly on the exposed surfaces and work to provide a root system that will stabilise the surface and prevent erosion until new seedlings have established. The roots will also create pores in the surface to allow water to penetrate the ground, allowing infiltration and reducing overland flow on the surface.

This approach will likely result in woodland habitat revegetation with both characteristics of the representative regional ecosystems surrounding the Fox site as well as species that are better adapted to macro climatic (i.e., drought, fire, flooding rains, climate change) and micro climatic factors (i.e., growth media, physical and chemical variation, variation in slope, aspect, altitude).

The preferred time for seeding of woodland riparian vegetation is August to October; there is a low chance of frost and less likelihood of significant rainfall during this period causing erosion.

Table 3-61: Current Seeding Mix for Riparian Lands (Foxleigh Mine, ND)

Scientific Name	Common Name	Kg/ha
	Upper story native species	
Corymbia tessellaris	Moreton Bay Ash	Minimum (6) species for growth form group at a total (3) kg/ha
Eucalyptus camaldulensis	River Red Gum	
Eucalyptus tereticornis	Forest Red Gum	
Corymbia clarksoniana	Clarkson's Bloodwood	
Eucalyptus populnea	Poplar Box	
Eucalyptus crebra	Narrow Leaved Ironbark	
Eucalyptus orgadophila	Mountain Coolibah	
Eucalyptus cambageana	Dawson river Blackbutt	
Corymbia citriodora	Lemon Scented Gum	
Casuarina cunninghamiana	River She-oak	
Melalueca Leucandendra	Weeping Paperbark	
Casuarina cristata	Belah	
	Mid-stratum native species	
Alphitonia Excelsa	Soap Wattle	Minimum (5) species for growth form group at a total (3) kg/ha
Lysiphyllum caronii	Red flowered Bauhinia	
Melaleuca viminalis	Weeping Bottlebrush	
Acacia leiocalyx	Black Wattle	
Acacia salicina	Sally Wattle	
Acacia macradenia	Zig-zag Wattle	
Alectryon oleifolius	Inland rosewood	
Geijera parviflora	Wilga	
Eremophila mitchellii	False Sandalwood	
	Lower story shrub & grass species	
Carissa ovata	Current Bush	Minimum (5) species for growth form group at a total (8) kg/ha
Dicanthium sericeum	Qld blue grass	
Themeda triandra	Kangaroo Grass	
Heteropogon contortus	Black Speargrass	
Heteropogon triticeus	Giant Speargrass	
Bothriochloa bladhii	Forest Bluegrass	
Bothriochloa erianthoides	Forest Mitchell Grass	
Chloris ventricosa	Tall Windmill Grass	
Cymbopogon refractus	Barb wire grass	
	Cover crop	

Scientific Name	Common Name	Kg/ha
Echinochloa esculenta	Japanese Millet	Minimum (1) species for growth form group at a total (15) kg/ha
Panicum milliaceum	White French Millet	
Lolium rigidum	Annual Rye	
	Legumes	
Stylosanthes hamata	Verano Stylo	Minimum (2) species for growth form group at a total (1) kg/ha
Stylosanthes scabra	Seca Stylo	
Chamaecrista rotundifolia	Wynn Cassia	
Desmanthus progardes	Progardes	

Watercourse Habitat Reference Sites

Watercourse habitat analogue sites were selected based on monitoring points identified in previous diversion monitoring for Carlo Creek, Cockatoo Creek and Roper Creek (Engeny, 2022; Engeny, 2022; Engeny, 2022). During previous monitoring, the upstream and downstream monitoring points for each diversion were classified as being in 'good' condition under the ACARP guidelines (ACARP, 2001). Therefore, these monitoring points would be suitable analogue sites to compare revegetation success along the diversion reaches at Fox.

Three reference sites for watercourse revegetation were chosen based on existing diversion monitoring locations. By utilising existing monitoring locations, it provides a greater range of historical data for referencing success and is consistent with the design plans for each diversion. These locations are displayed in Figure 3-34 correlating GPS coordinates in Table 3-60.

Revegetation Infrastructure

No infrastructure is proposed to support the revegetation.

3.5.11. Native Ecosystem Corridor PMLU

A native ecosystem connectivity corridor has been proposed as a supplementary PMLU to support connectivity between Cockatoo and Roper creek. This is based on:

- Discussions held with DES.
- Consistency with the current approved EA.
- Consistency with the existing conservation area at Fox.

Revegetation Species and Seeding Rates

The standard seeding mix for the native ecosystem PMLU is consistent with seed composition between the grazing PMLU and the watercourse PMLU whilst incorporating species applicable to the relevant RE (Table 3-62); this seeding mix may be adjusted based on the results of ongoing rehabilitation monitoring, see Table 3-59 (Foxleigh Mine, ND).

These species are suitable to support native species consistent with vegetation native to the surrounding Brigalow belt of REs 11.3.1 and 11.3.2.

A seeding rate of 30 kg/ha is recommended for native ecosystem PMLU. Species availability may vary, and unavailable species are to be substituted with other species, including alternative native species consistent with the surrounding landscape.

Seeds are recommended to be sown in the warmer months, from September to March when the probability of rainfall is at its highest to support germination.

Table 3-62: Seed Mix for Native Ecosystem Corridor PMLU (Foxleigh Mine, ND)

Scientific Name	Common Name	Kg/ha
Upper Story Native Species		
Corymbia tessellaris	Moreton Bay Ash	Minimum (6) species for growth form group at a total (3) kg/ha
Eucalyptus melanphloia	Silver-leaved Ironbark	
Eucalyptus largiflorens	Black Box	
Eucalyptus woollsiana		
Corymbia clarksoniana	Clarkson's Bloodwood	
Eucalyptus populnea	Poplar Box	
Eucalyptus crebra	Narrow Leaved Ironbark	
Eucalyptus orgadophila	Mountain Coolibah	
Mid-Stratum Native Species		
Alphitonia Excelsa	Soap Wattle	Minimum (5) species for growth form group at a total (3) kg/ha
Lysiphyllum caronii	Red flowered Bauhinia	
Acacia leiocalyx	Black Wattle	
Acacia salicina	Sally Wattle	
Cassia brewsteri	Brewsters cassia	
Geijera parviflora	Wilga	
Eremophila mitchellii	False Sandalwood	
Lower story shrub & grass species		
Carissa ovata	Current Bush	Minimum (5) species for growth form group at a total (8) kg/ha
Duma florulenta	Tangled lignum	
Dicanthium sericeum	Qld blue grass	
Themeda triandra	Kangaroo Grass	
Heteropogon contortus	Black Speargrass	
Heteropogon triticeus	Giant Speargrass	
Bothriochloa bladhii	Forest Bluegrass	
Bothriochloa erianthoides	Forest Mitchell Grass	
Chloris ventricosa	Tall Windmill Grass	
Cymbopogon refractus	Barb wire grass	
Legumes		
Stylosanthes hamata	Verano Stylo	Minimum (2) species for growth form group at a total (1) kg/ha
Stylosanthes scabra	Seca Stylo	
Chamaecrista rotundifolia	Wynn Cassia	
Desmanthus progardes	Progardes	

Native Ecosystem Corridor Reference Sites

Native Ecosystem corridor reference sites were chosen based on aerial imagery. The purpose of the reference sites are to provide an indicator for revegetation success on un-disturbed brigalow belt ecosystems within the mining lease.

These locations are visually represented in Figure 9-10 and GPS coordinates presented in Table 3-60.

The following factors were considered when selecting the locations of reference sites:

- Not impacted by mining.
- Away from disturbances, such as roads or tracks.
- Outside of mapped rehabilitation areas.
- Within the Fox Mining Lease.
- Outside of the floodplain.
- Within an accessible location, without impact on health and safely access each location.

3.5.12. Tailings Storage Facilities

PRCP Guideline (Section 3.6.2)

The tailings require characterisation to determine the geochemistry, rheology and geotechnical parameters that influence the rehabilitation or management strategies and the capacity of the site to support revegetation.

The design for a TSF must include relevant elements:

- *lining of TSF (i.e., embankments and base of structure)*
- *leak detection systems*
- *cellular design of TSF*
- *seepage collection systems*
- *design storage allowance*
- *spillway location*
- *designing TSF for progressive rehabilitation.*

PRCP Guideline (Section 3.6.3)

The information requirements of this domain are dependent on the nature of the proposed PMLU or NUMA for the void. For mine sites with voids, the rehabilitation planning part must include a void closure plan, which includes options for minimising final void area and volume; final void dimensions; pit wall geotechnical and geochemical stability, final slope angles, void hydrology, groundwater modelling, water balance and predicted long-term water quality.

A geotechnical report should focus on how the void will achieve post-closure slopes that will exhibit stability characteristics consistent with the planning and design of the post-closure my void.

If floodwaters are likely to move over backfilled material, an assessment of the hydraulic properties must be conducted to assess whether instability may occur.

The rehabilitation and management strategies in the plan must include the supervision, verification and auditing of engineering works carried out to achieve the post-closure void landform, to ensure construction is consistent with the geotechnical design.

The rehabilitation and management strategy must also include confirmation that the post-closure landform demonstrates the level of stability as specified by the design.

The tailings storage facilities (TSF) is located within the mined-out NT Pit, which is the northern end situated approximately 500m south-east of the CHPP at Fox. Tailings deposition commenced in October 2006, when the CHPP was commissioned: prior to that, coal was washed under contract at German Creek Mine. The lowest floor level in the northern cell was estimated to be RL 70m; historic pit survey was not available for the southern cell but based on the floor slope observable in 2008, it may have been somewhat higher. Surface spill level is about RL 137m, at the southern end.

Tailings were initially discharged into the southern cell while mine affected water was held at the north. During 2010-2011 coarse reject was paddock dumped in the southern end of the northern cell, while tailings discharge was still occurring in the southern cell. Around the beginning of 2012, tailings in the southern cell was close to the crest level of the internal wall and discharge moved to the north-eastern corner. From that time until the first half of 2022, discharge continued in the northern cell (although at some point the discharge point was moved to the western side). While the tailings were below the internal wall, return water was pumped out of the southern end of the cell but when the wall was overtopped, the decant was allowed to flow to the southern cell. During June 2023, the tailings discharge was relocated to the south end of the cell, at this time the tailings surface graded from RL 128m at the north-eastern corner down to the decant

pond at RL 124m in the former southern cell. As described within the PRCP Guideline, there is no single solution for the safe management of tailings given the variety of site-specific environmental conditions, climate, ore types, geochemistry, topography and other constraints. The tailings at Fox require characterisation to determine the geochemistry, rheology and geotechnical parameters that influence the rehabilitation or management strategies and the capacity of the site to support revegetation. Site-specific tailings management options have been proposed in this PCRP to minimise the interactions between the tailings and the surrounding environment to prevent the release of contaminants to the receiving environment for successful rehabilitation at Fox.

The sections on geotechnical characterisation of tailings, the design of TSF and QA/QC program during construction are discussed below.

Geotechnical Characterisation of Tailings

Particle Size Distribution (PSD) Analysis

Results of physical testing of coarse rejects specifically from Fox were not available but coarse rejects are produced by the CHPP Dense Medium Cyclone circuit, which operates at the 50mm to 1.4mm size range. Noting that gravel is >2.36mm and sand is 2.36mm to 0.075mm, the tailings are described as "*typically equal proportions of sand and silt, with a smaller amount of clay*" based on the PSD analysis. Field observations are also consistent that coarse rejects are a non-cohesive non-plastic material exhibiting frictional strength and high permeability.

Specific Gravity Testing

The average specific gravity testing (also known as soil particle density) of the tailings is 1.98 t/m^3, ranging between 1.82 t/m^3 and 2.36 t/m^3.

Atterberg Limit Testing

The tailings are classified as "*intermediate plasticity Sandy Silty CLAY"* and thus implying that the tailings are expected to be cohesive in behaviour.

Moisture content/dry density profiles and settling testing

As the TSF is still active, no in situ testing has yet been carried out, and thus moisture content and dry density profiles and settling testing are not available at this stage.

Shear Strength Testing

As the TSF is still active, the in-situ testing on tailings samples was not yet carried out. Nonetheless, historic in-situ strength data from coal tailings dams in Bowen Basin were reported and indicates that a stronger surface crust about 2m thick can generally be achieved. This considered the above ground tailings to be dewatered due to seepage and surface water being consistently removed to limit the size of decant pond. A study conducted by Henderson Geotech (2023) expects similar results for the in-pit TSF when the decant pond is managed to similar standard.

Consolidation Testing

Oedometer consolidation tests were conducted on three tailings samples, with average values reported for the following consolidation parameters:

- Compression Index C_c *= 0.20*
- Recompression Index C_r *= 0.026*
- Coefficient of permeability k_{sat} *= 7.4e-9 m/s* for small load increases
- Coefficient of consolidation c_v *= 40m^2/yr.*, but varied over a wide range

These values are within the ranges measured for coal tailings in the Bowen Basin but towards the limits representing lower total consolidation settlement and more rapid consolidation rates. This is consistent with the high proportions of sand and silt.

Soil Water Characteristics Curve Testing

As the TSF is still active, no in situ testing has yet been carried out, and thus soil water characteristics curve testing is not available at this stage.

Instrumented Column Testing

As the TSF is still active, in situ testing column testing cannot be performed at this stage. It is recommended that upon completion of operation of the facility, this sampling be undertaken and where applicable, closure management strategies will be amended within this PRCP.

Design of TSF

The TSF is operated from an inground pit and therefore lining, leak detection systems, cellular design, seepage collection systems are not applicable. There is no present spillway location and design storage allowance does not apply to the facility.

Progressive rehabilitation of the facility is not possible, with the closure strategy to begin upon completion of mining operations.

QA/QC Program during Construction

Given the historical nature of the TSF, a QA/QC program for its construction is not available for inclusion regarding the construction of the pit.

3.5.13. Voids

PRCP Guideline (Section 3.6.3)

For mine sites with voids, the rehabilitation planning part must include a void closure plan that includes, but is not limited to, the following:

- *options available for minimising final void area and volume (where a final void is proposed)*
- *proposed final dimensions of the void (i.e., depth, length and width)*
- *pit wall geotechnical and geochemical stability, considering the effects of long-term erosion and weathering of the pit wall and the effects of significant hydrological events*
- *proposed final slope angles of high wall, low wall and end walls of each final void*
- *void hydrology, addressing the long-term water balance and water level in the voids, stratification connections to groundwater resources and potential for overflow*
- *groundwater modelling to determine whether the void is acting as a sink or a source for groundwater*
- *a water balance study including an assessment of void surface and groundwater interactions such as:*
    - *groundwater lowering/reduction in hydraulic head (from new voids) (e.g., caves/karst systems)*
    - *cones of depression and associated impacts*
    - *the drainage and flooding behaviours of surface waters in the vicinity of the void*
    - *the potential extent of flooding and implications of interactions with the void*
    - *a conceptual model that incorporates all projected inflows, outflows, and recharge rates*
    - *water storage and long-term water balance*
    - *each of the major water fluxes into and out of the void*
    - *the sources of surface water within the mine catchment that are likely to influence the water quality in the void*
- *predicted water quality in the long-term including potential stratification*
- *a 3D void design plan*
- *rehabilitation strategies.*

As per the Fox EA, there are seven (7) residual voids in the final closure landform:

- Eagles Nest
- Fox Plains
- One Tree West
- Pipeline Pit
- WC Pit
- Far South
- Carlo Pit.

These residual voids are pre-approved as NUMAs. Following relevant technical assessments, the NUMA extents achieve an area that is safe and structurally stable. Where required, the conceptual landform includes setback from void crest to achieve suitable geotechnical stability, with the inclusion of a safety bund and fence.

Options for Minimising Final Void

The life of mine (LOM) plan final landform design includes seven residual void areas comprising:

- In-pit water body.
- In-situ pit crest and pit walls above and below the predicted water level; and
- In-pit spoil below the predicted water level plus contingency to provide for changing water level and model uncertainty.

In designing the residual void areas, FoxMan has minimised NUMA extent by maximising areas of in-pit spoil able to be shaped to rehabilitation grade, including areas below the natural ground surface but above the possible water level.

NUMA area has been further minimised through the proposed backfilling of three voids and associated rehabilitation to achieve a post mining land use. Pit 251 and NT Pit will be backfilled with tailings and waste rock. Old NE Pit will be backfilled with coarse rejects and waste rock. Backfilled voids will be constructed as water shedding structures in the final landform, capable of supporting a post-mining land use (grazing).

Foxman's commitment to backfill these voids maximises the area of land returned to a PMLU, consistent with Queensland Government's Mined Land Rehabilitation Policy.

Residual Void Rehabilitation Outcome

Residual voids containing water bodies are defined as an authorised mine feature within Appendix 2 of the EA. There are several rehabilitation objectives defined for residual voids including: Residual void water bodies that are able to be accessed by wildlife, used for water supplies and/or used as recreational facilities according to the final land use. This EA amendment application clarifies the residual voids as NUMAs based on technical studies supporting this outcome as the most relevant outcome. The amendment application also describes the location and area of these residual voids in the final landform.

Appendix 2, of the EA (refer to **Appendix A** of this document) also provides indicators and completion criteria for the pre-approved residual voids. These indicators and criteria refer to stable highwalls left standing, covering of exposed coal in the pit to reduce contaminant release to the residual void water body, drainage works, geotechnical assessment, void wall slope criteria and revegetation of the in-situ spoil dumps (now removed from the void footprint).

Amendments are also proposed to the indicators and completion criteria to better reflect the NUMA outcome.

Consistency with Past Approval Documents

It is clear from past Mine application material that residual voids with pit lakes were described and proposed for approval in the final landform, but at no point was a definitive post mining land use clearly stated for these voids. Although past documentation provides some suggestion of potential terrestrial fauna habitat value for residual voids, this was subject to further detailed investigation. In some instances, it was stated that the land use would be determined at a later stage as part of a residual void study.

The Environmental Impact Study (EIS) and Environmental Management Plan (Anglo American 2011) for the Foxleigh Plains amendment comprises the last major expansion approval for the Mine. The application approved additional mining leases ML 70429, ML 70430 and ML 70431. Three new residual voids were described at the northern end of the site in this approval. The following extracts from the application describe the residual voids (termed final voids):

> *"Final open cut strips (voids) and ramps may not be substantially reshaped. Unless used for CHPP waste disposal, they will be left in a stable condition becoming a part of the landscape, acting as water and sediment containment structures."*
>
> *"Where the final void is located near the crest of the ridge, its use as a water storage structure is limited. However, if the final void is to be located where surface flow can be directed into the void, its use as a water storage structure is possible and will be investigated during the mining operation. Where the final void is to be used for water storage, a research program on final void water quality will be completed during the operation phase to establish its beneficial use for stock or other purposes and appropriate permits and licences obtained."*
>
> *"Final mining voids will exist as part of the post-mining landform. Where possible the area of voids will be minimised by backfilling or used for reject or tailings disposal. People and stock are to be excluded from the remaining final voids, including pits and ramps. The remaining final voids will be made safe by bunding or fencing around the final crest of the pit to inhibit access to the area. The integrity of the bund or fence will be the responsibility of the subsequent landowner."*

In summary, past application material generally describes a final landform containing residual voids with water bodies that will gradually accumulate salt but will remain at water levels that are not a risk to groundwater or surface water values. While past approval documents include references to further investigation and the possibility of alternate beneficial uses for some or all of the residual voids, there is also acknowledgement that this outcome is uncertain and may not be achievable.

Residual Void Design

Fox residual voids, which exclude areas of in-pit spoil returned to a post mining land use, are displayed in Figure 4. The boundary for the NUMA has been developed with a void crest safety buffer of 50 m providing for safety bunds and fencing. The safety buffer has been determined as 50 m from the maximum water level within the residual voids.

Where possible, final landform design has sought to locate residual voids outside the natural floodplain. Otherwise, residual voids will be protected from flooding by permanently rehabilitated landforms. These landforms will provide for a minimum 0.1% AEP flood immunity.

Residual Void Typical Rehabilitation Methods

The residual voids are intended to remain as a NUMA post mining. Bunds and drains will divert water to minimise overland flow inputs into the void post-mining. Final flood protection landforms will be constructed to exclude flooding from all voids up to the 0.1% AEP flood level.

Safe access to the void on the in-situ void wall aspect will not be possible for livestock post-mining. Signage and fencing will be constructed in these areas.

The in-situ void wall slopes will be profiled to meet the EA criteria of <70% for competent material or <45% for non-competent material or as stated in an appropriate risk assessment conducted by a suitability qualified person. Further geotechnical modelling of as-constructed voids will be undertaken as part of final certification to ensure the residual void remains stable and safe.

Spoil slopes will be constructed at < 45% within the NUMA areas and less than 17% elsewhere, where a post-mining land use is targeted (outside the void area).

Final Void Dimensions and Wall Angles

The following residual voids have been assessed and a summary of the engineering dimensions and batter slopes are provided below. Noting that highwall / endwall and low wall batter angles are average overall slopes and generally representative of the current closure design and conceptual landform design.

Table 3-63: Proposed Final Void Dimensions and Overall Wall Angles

Pit Name	Final Pit Depth (mAHD)	Final Pit Length (m)[1]	Final Pit Width (m)[1]	High Wall Batter Overall Angle	Low Wall Pit Floor Overall Angle
Eagle Nest	-65	2,150	1,400	38	6.5
Fox Plains	-130	2,400	1,400	35	6.5
One Tree West	-29	1,250	850	35	21.5
Pipeline Pit	-43	1,550	550	38	30.5
WC Pit	-15	1,450	950	33	6.5
Far South	70	2,050	750	30.5	12.5
Carlo Pit	86	1,100	850	23.5	3.5

Note: [1] Pit length and width dimensions rounded to the nearest 50 m. Measured from FoxMan supplied final landform and bottom pit surveys.

To achieve the closure landform design, the mining pits will be progressively backfilled, based on the mine plan, to minimise the void area and volume. This will be achieved at the completion of mining operations to facilitate the mine plan. Depending on encountered geological conditions and the final mining sequence, which may change throughout the current operational mining period, the final backfilling arrangement of the residual voids may change. Opportunities will be reviewed as the mine plan is executed and be refined to optimise the void area.

Pit Wall Geotechnical and Geochemical Stability

A geotechnical assessment has been undertaken for the Fox NUMAs, as per Figure 7 of the EA, to confirm the residual voids meet the rehabilitation requirements of the EA. The assessment includes analysis of the proposed residual void highwalls, endwalls and low walls. Calculation of geotechnical stability factor of safety was used to determine overall slope stability and to determine any required setbacks within the NUMA extent to ensure stability and potential impacts to any assets or the environment.

Generally, the mine design for the highwalls and endwalls are safe and stable at current operational angles, without modification. Slope modification is required for the weathered Permian and Tertiary units, and this has been incorporated into the conceptual landform design. Where required, setbacks have been included to achieve the required offset. Benches are included where required to meet mining or closure requirements to reduce the overall slope angle of the residual void to meet stability requirements. As the mining pits approach final limits, the final geotechnical design will be developed based on the in situ actual geotechnical data and observed materials and behaviours.

The dump design for the residual void low walls meets the defined minimum factor of safety for all residual voids. Required setbacks have been incorporated into the conceptual landform design.

The detailed assessment is included in **Appendix N**, with a summary of the findings in reference to the PRCP Guideline requirements presented below.

Stability assessment of the pit slopes were analysed considering pit slope geometry, materials and strengths, and groundwater conditions. Three-dimensional geotechnical models were developed for each residual void using topographic LiDAR and definition of base of pits, definition of final landform surface, triangulation of geological surfaces (where known) and production of geological block model. The block model using the final landform, corrected topography, base of tertiary and base of weathering were used to define where material was cut, filled and where the main geological layers were spatially distributed within the final pit arrangements. The development of a site wide geotechnical model allowed for interrogation of each residual void and conceptual landform model. Complete detail and model outputs are included in the geotechnical assessment report (refer **Appendix M**).

The results are summarised below for minimum pit water level after equilibrium. Based on these results and the available information:

- A stable slope (factor of safety > 1) is achieved; and
- A setback distance of 25 - 125 m (depending on pit) is recommended.
- The current pit slope designs (with overall slope angles of 50 degrees or flatter) are deemed to be stable.

The residual voids / NUMA extents achieve overall slope conditions that are safe and structurally stable based on the conceptual landform model. Where required, benching and dumped profiles include additional setbacks from the residual voids to achieve minimum factors of safety.

Landform Design

A three-dimensional conceptual landform model has been developed for the residual voids and includes the following:

- Setback of the void batters (highwall and endwall) to achieve structural stability within the NUMA extents.
- Flood mitigation for all residual voids for all events up to and including the PMF.

The 3D void design was incorporated with the geological model to help the understanding and visualisation of sub-surface conditions for the project. This was used as the basis of the geotechnical stability assessment to confirm all residual voids are structurally stable.

Images from the 3D modelling has been provided in Figure 3-36, Figure 3-37 and Figure 3-38, Figure 3-39 to Figure 3-45 demonstrate the proposed levels of cut and fill for each NUMAs to reach a stable and safe landform.

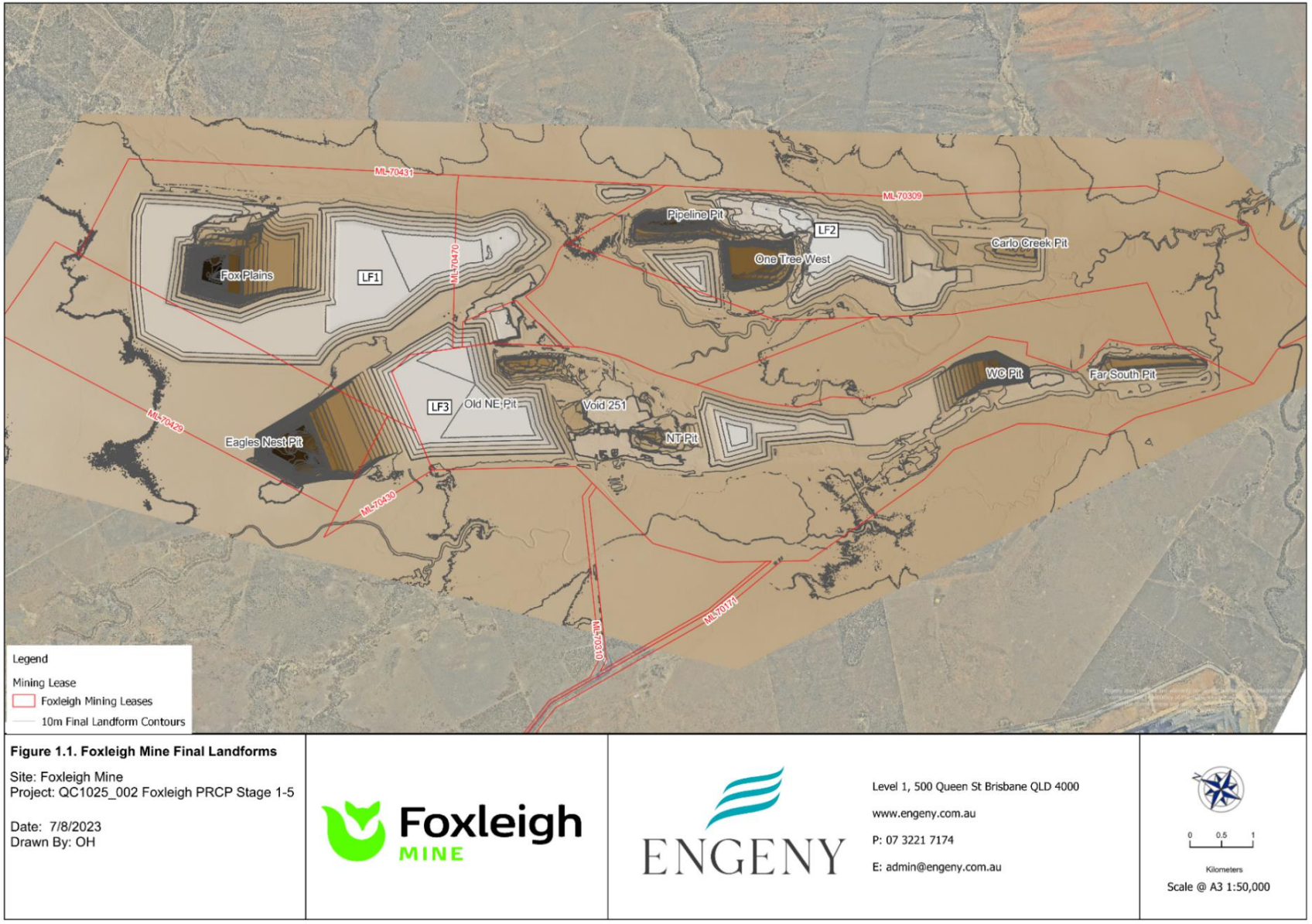


Figure 3-36: Final Landform Design

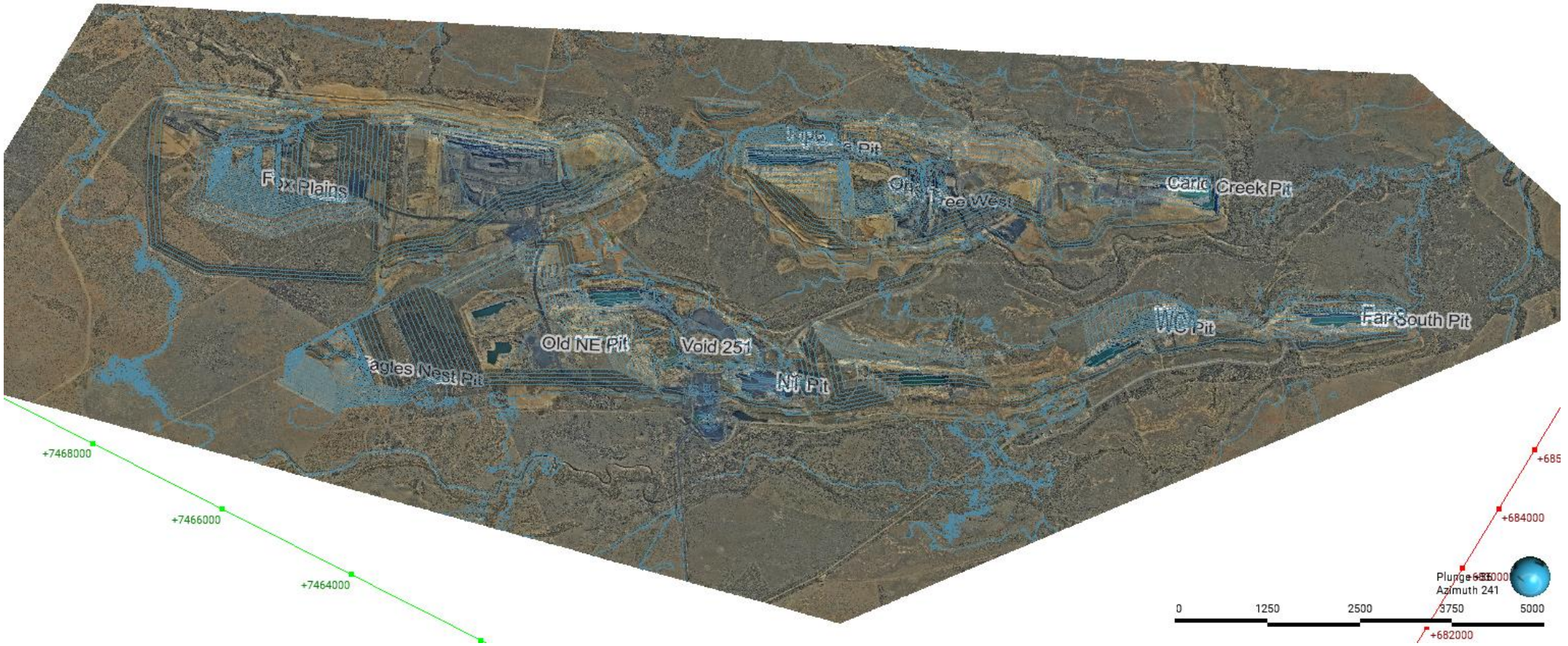


Figure 3-37: 3D Orthographic NUMA Locations and Contours

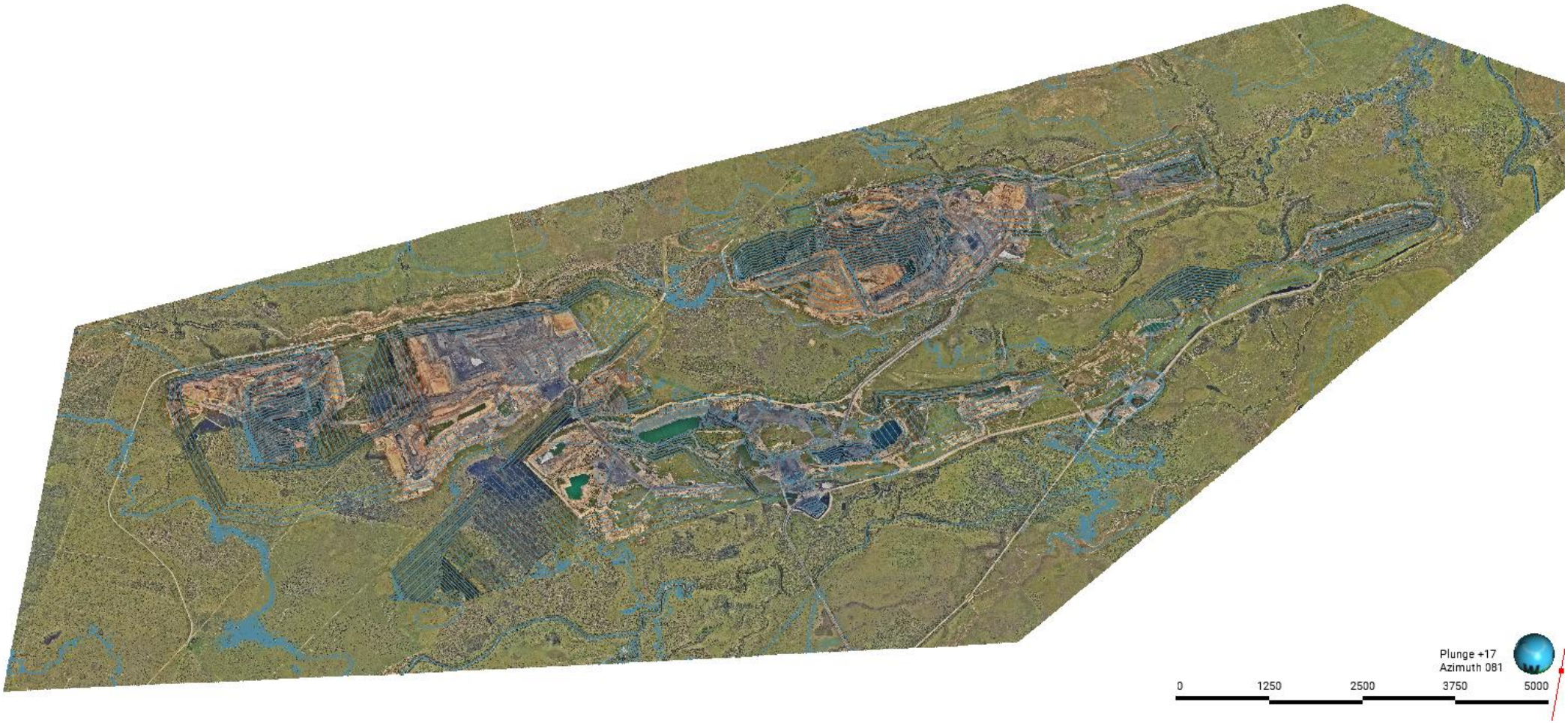


Figure 3-38: 3D Orthographic NUMA Locations and Topographic Overlay

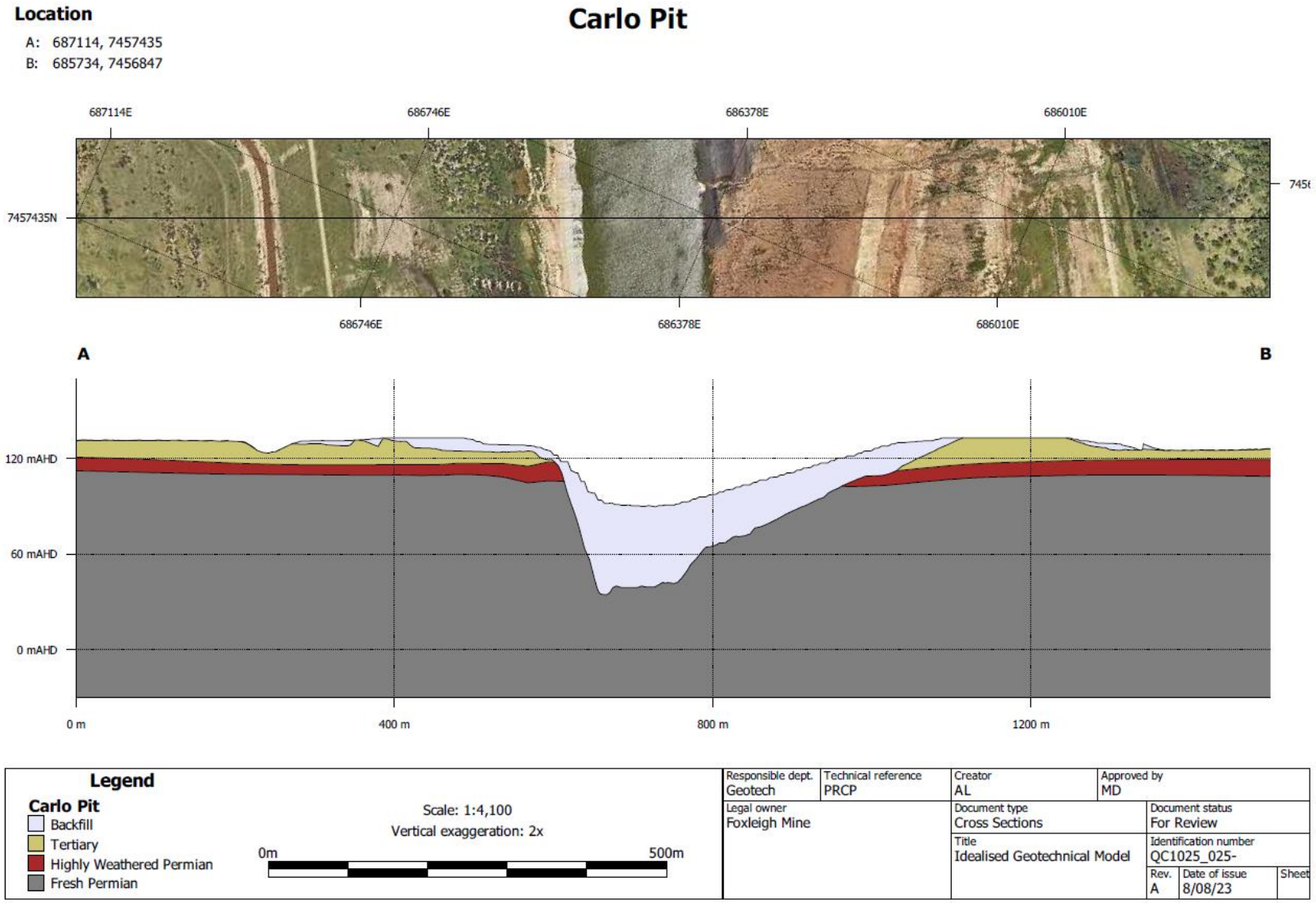
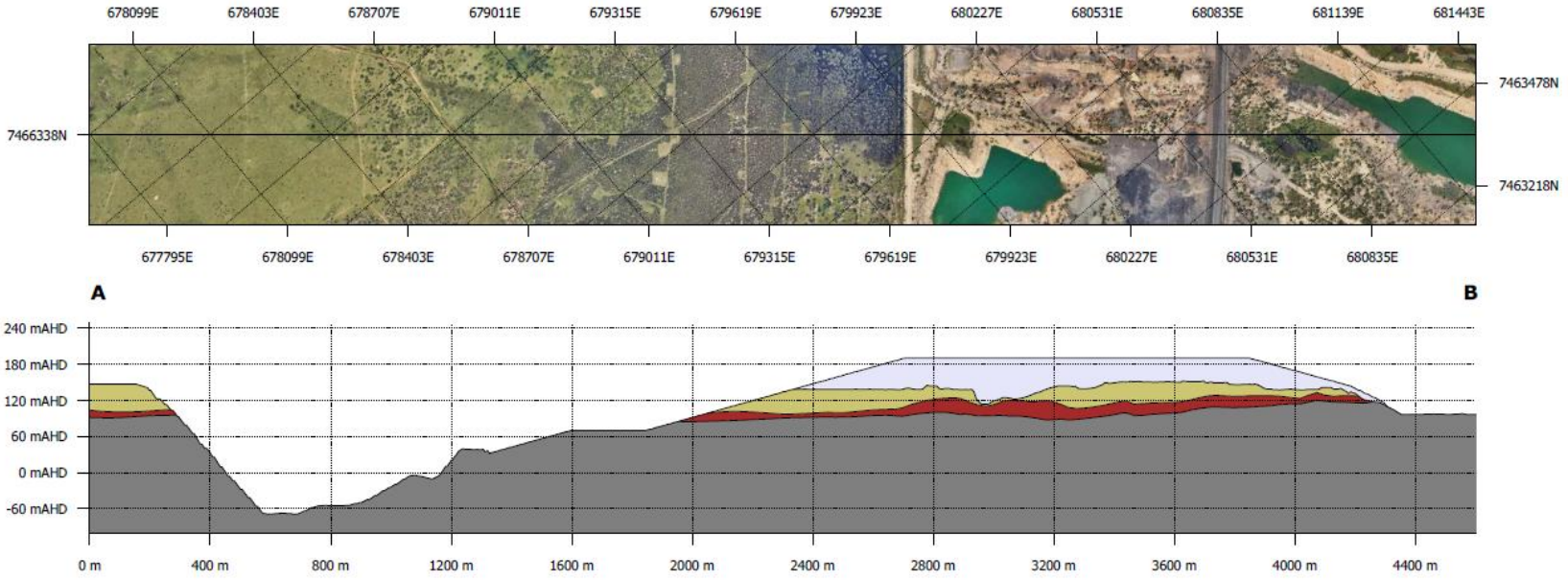


Figure 3-39: Carlo Pit NUMA Cut and Fill Design

Location

A: 677795, 7466338
B: 681291, 7463348

Eagles Nest



Legend

Eagles Nest, Fox Plain North

- Backfill
- Tertiary
- Highly Weathered Permian
- Fresh Permian

Scale: 1:13,000
Vertical exaggeration: 2x
0m 500m

Responsible dept.: Geotech	Technical reference: PRCP	Creator: AL	Approved by: MD
Legal owner: Foxleigh Mine		Document type: Cross Sections	Document status: For Review
		Title: Idealised Geotechnical Model	Identification number: QC1025_025-
		Rev.: A	Date of issue: 8/08/23

Figure 3-40: Eagles Nest NUMA Cut and Fill Design

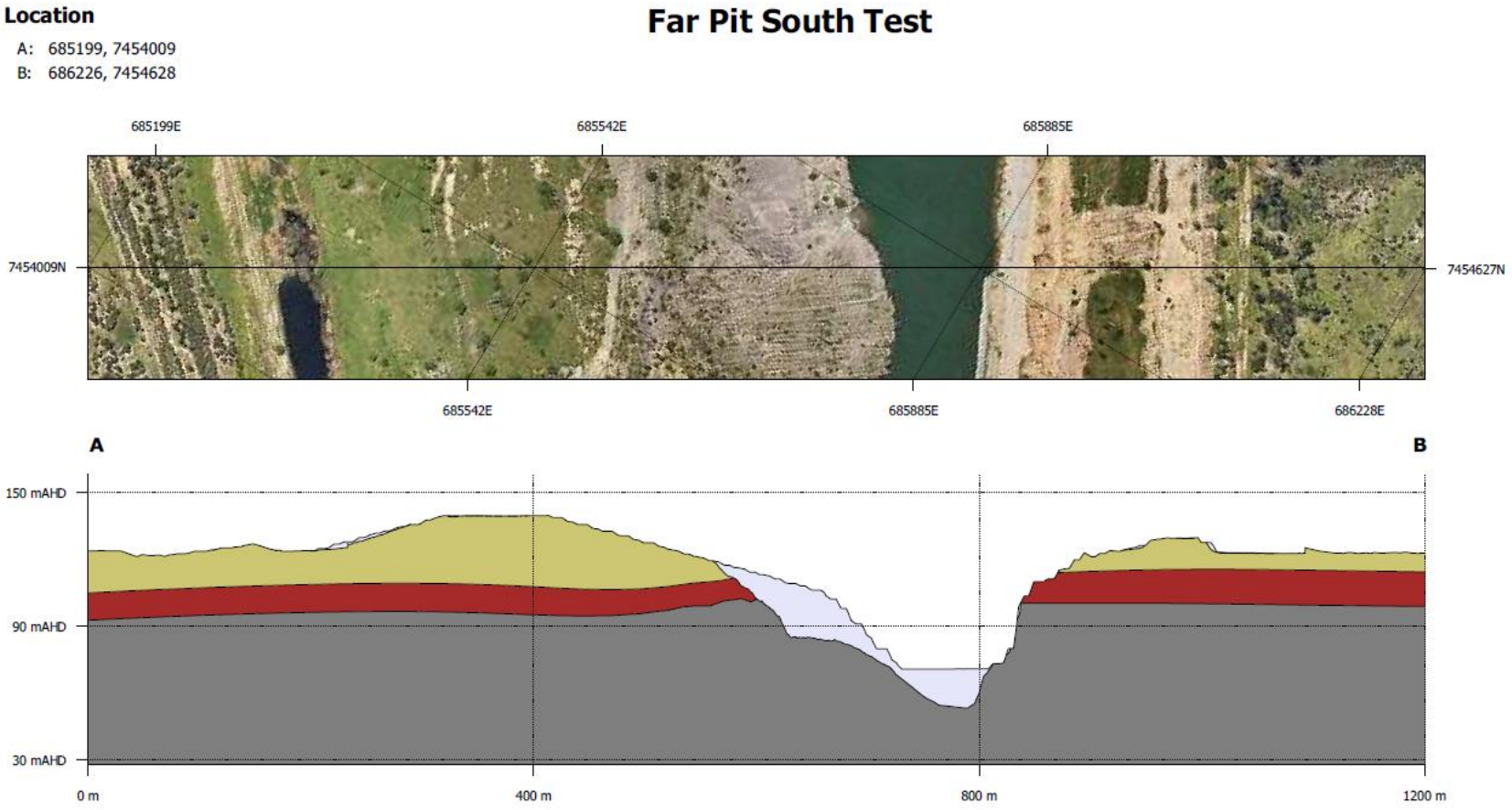
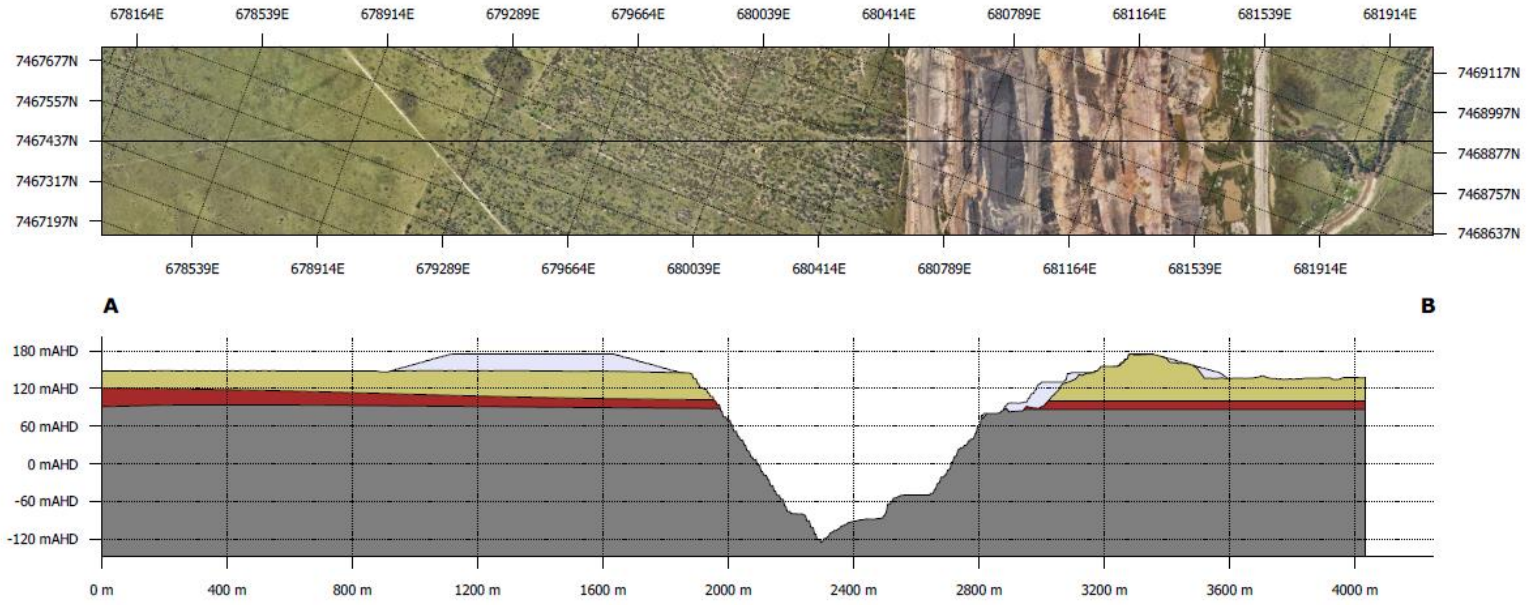


Figure 3-41: Far South NUMA Cut and Fill Design

Location

A: 678164, 7467437
B: 682149, 7468914

Fox Plains (Lag)



Legend

Eagles Nest, Fox Plain North

- Backfill
- Tertiary
- Highly Weathered Permian
- Fresh Permian

Scale: 1:13,000
Vertical exaggeration: 2x
0m 500m

Responsible dept.	Technical reference	Creator	Approved by
Geotech	PRCP	AL	MD

Legal owner	Document type	Document status
Foxleigh Mine	Cross Sections	For Review

Title	Identification number
Idealised Geotechnical Model	QC1025_025-

Rev.	Date of issue	Sheet
A	8/08/23	

Figure 3-42: Fox Plains NUMA Cut and Fill Design

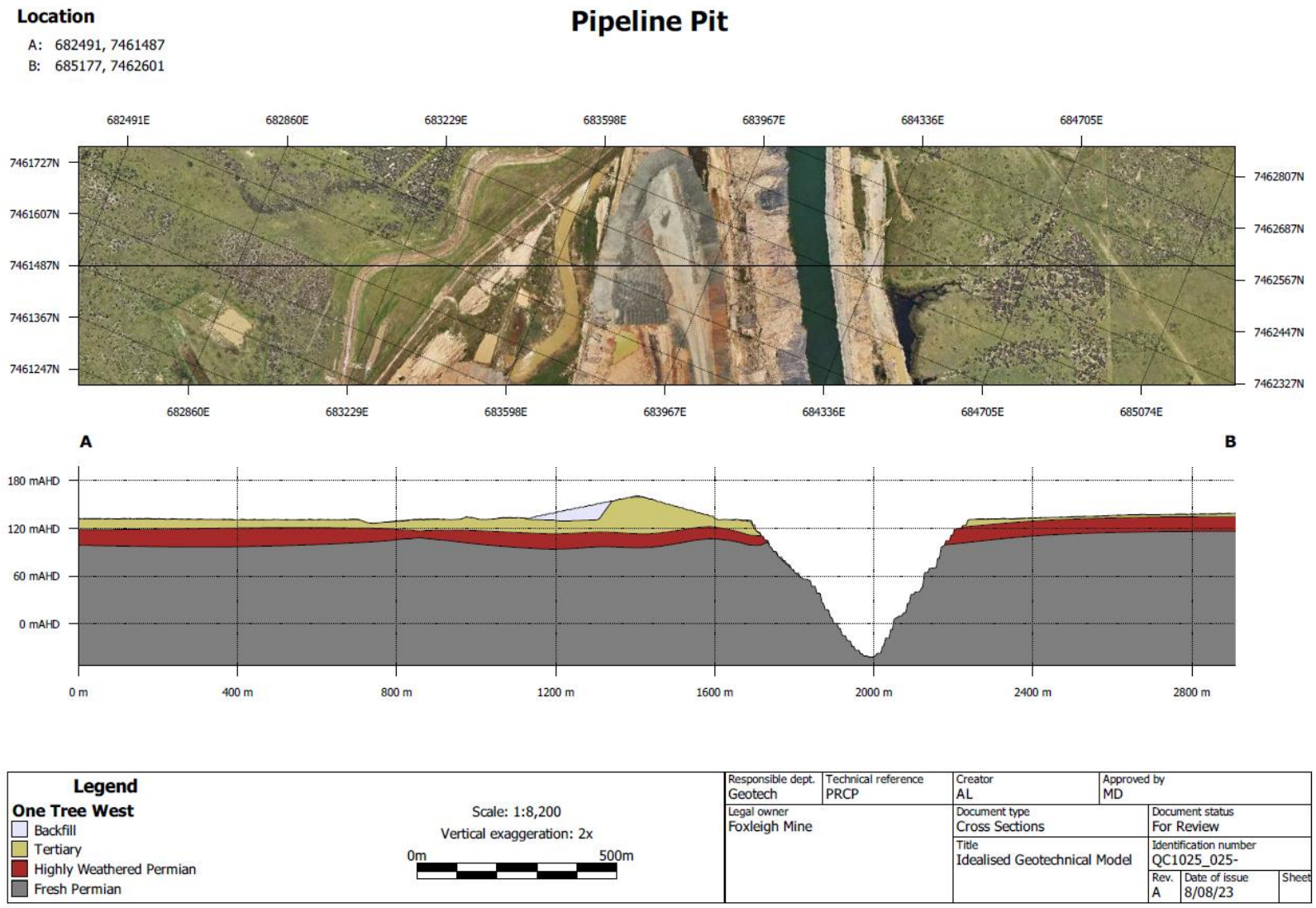
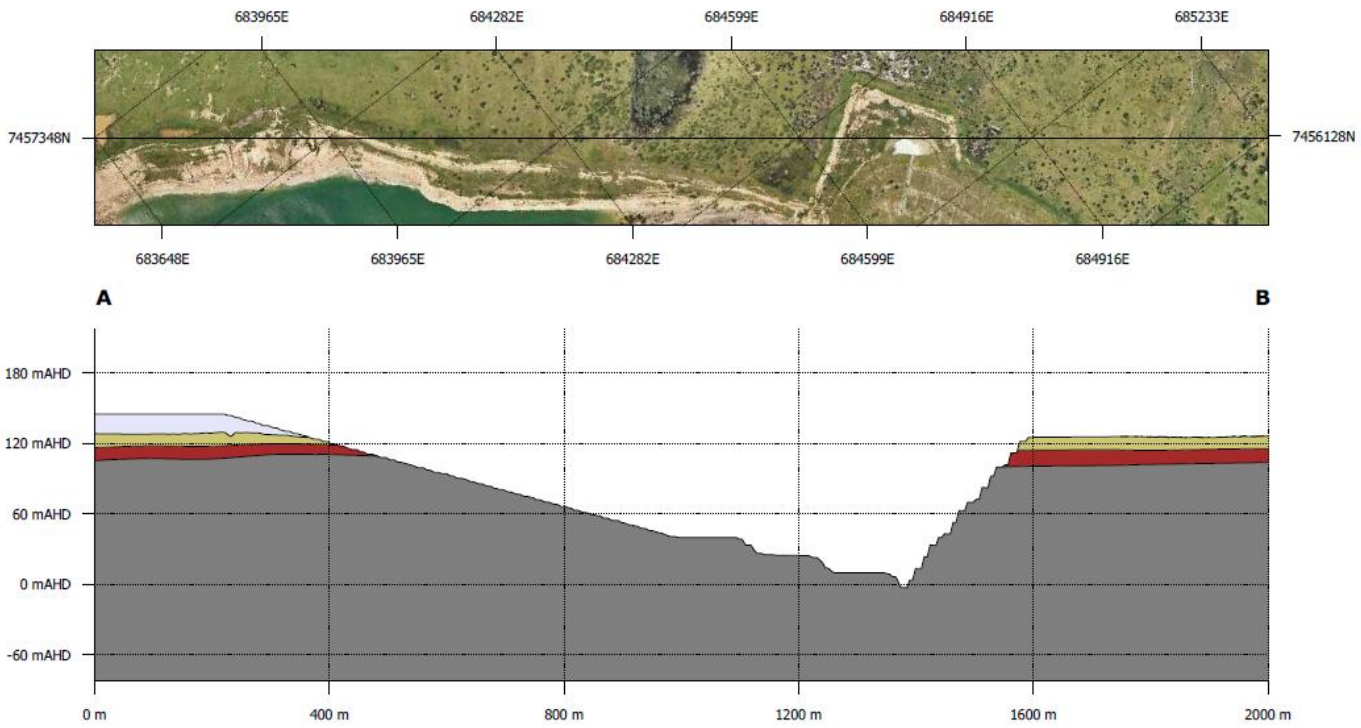


Figure 3-43: Pipeline NUMA Cut and Fill Design

Location

A: 683648, 7457348
B: 685231, 7456126

WC Pit



Legend

WC Pit
- Backfill
- Tertiary
- Highly Weathered Permian
- Fresh Permian

Scale: 1:7,000
Vertical exaggeration: 2x
0m 500m

Responsible dept.	Technical reference	Creator	Approved by
Geotech	PRCP	AL	MD

Legal owner	Document type	Document status
Foxleigh Mine	Cross Sections	For Review

Title	Identification number
Idealised Geotechnical Model	QC1025_025-

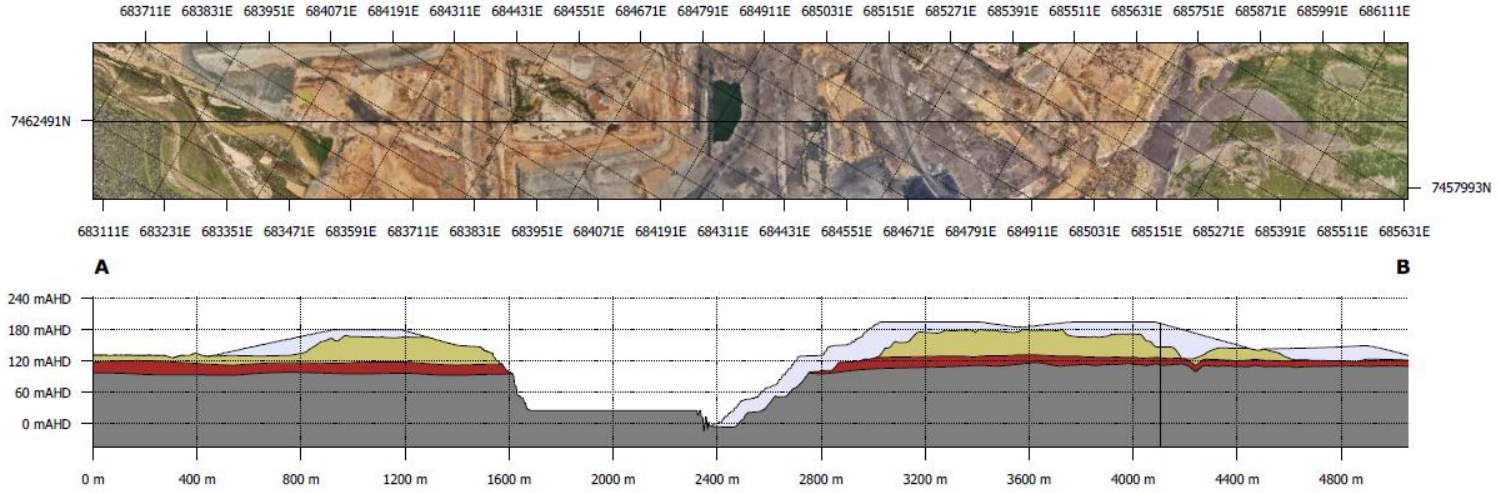
Rev.	Date of issue	Sheet
A	8/08/23	

Figure 3-44: WC NUMA Cut and Fill Design

Location

A: 683351, 7462491
B: 685898, 7458121

One Tree West



Legend

One Tree West

- Backfill
- Tertiary
- Highly Weathered Permian
- Fresh Permian

Scale: 1:15,000
Vertical exaggeration: 2x
0m 500m

Responsible dept.: Geotech	Technical reference: PRCP	Creator: AL	Approved by: MD
Legal owner: Foxleigh Mine		Document type: Cross Sections	Document status: For Review
		Title: Idealised Geotechnical Model	Identification number: QC1025_025-
		Rev.: A	Date of issue: 8/08/23

Figure 3-45: One Tree NUMA Cut and Fill Design

Void Hydrology and Groundwater Modelling

A final void hydrology report (WRM, 2023) has been developed (refer **Appendix O**) to address the long-term water level in the voids, potential for overflow and water quality. WRM (2023) modelled the long-term final void hydrology and water quality behaviour of the of the Fox final voids over a 500-year period post-closure to inform whether the final void would be a non-polluting landform. The modelling indicates that each void will continue to act as a groundwater sink, drawing in groundwater from Permo-Triassic strata. The predicted inflow rate from Permo-Triassic stata is estimated to be 30L/s. Recovery to equilibrium is expected to cease 450 years from the cessation of mining, or in 2505. Predicted water table elevations in 2505 are displayed in Figure 3-46.

The final void water level over a simulated 500-year period and observations are summarised in Table 3-64.

Table 3-64: Modelled Void Water Levels

Void	Observations
Eagles Nest	• The final void reaches equilibrium after about 200 years, with the void oscillating between 40 mAHD and 45 mAHD. • The final void forms a long-term groundwater sink based on the groundwater recharge level of around 122.5 mAHD. • The maximum modelled water level is about 92 m below the pit overflow level.
Fox Plains	• The final void reaches equilibrium after around 200 years, with the void oscillating between 68 mAHD and 75 mAHD. • The final void forms a long-term groundwater sink based on the groundwater recharge level of around 122.5 m AHD. • The maximum modelled water level is about 59 m below the pit overflow level.
One Tree West	• The final void reaches equilibrium after around 200 years, with the void oscillating between 42 mAHD and 52 mAHD. • The final void forms a long-term groundwater sink based on the groundwater recharge level of around 122.5 m AHD. • The maximum modelled water level is about 77 m below the pit overflow level.
Pipeline Pit	• The final void reaches equilibrium after around 200 years, with the void oscillating between 62 mAHD and 71 mAHD. • The final void forms a long-term groundwater sink based on the groundwater recharge level of around 122.5 m AHD. • The maximum modelled water level is about 58 m below the pit overflow level.
WC Pit	• The final void reaches equilibrium after around 50 years, with the void oscillating between 39 mAHD and 46 mAHD. • The final void forms a long-term groundwater sink based on the groundwater recharge level of around 122.5 m AHD. • The maximum modelled water level is about 79 m below the pit overflow level.

Void	Observations
Far South	• The final void reaches equilibrium after around 100 years, with the void oscillating between 76 mAHD and 86 mAHD. • The final void forms a long-term groundwater sink based on the groundwater recharge level of around 122.5 m AHD. • The maximum modelled water level is about 38 m below the pit overflow level.
Carlo Creek	• The final void reaches equilibrium after around 75 years, with the void oscillating between 100 mAHD and 110 mAHD. • The final void forms a long-term groundwater sink based on the groundwater recharge level of around 122.5 m AHD. • The maximum modelled water level is about 15 m below the pit overflow level.

The final void hydrology model results show the following:

- All seven (7) final voids reach their equilibrium levels within a period of 100 to 200 years post-mining. The water balance incorporated all contributing fluxes to and from the pit void, initially including estimates of groundwater inflow. Pit lake levels derived from successive iteration of the water balance model were used in the groundwater model to revise groundwater flux predictions and there were fed back into the water balance model to revise predictions of pit lake level (Groundwater Functions Pty Ltd, 2022).
- Based on an estimated regional groundwater recharge level of 122.5 mAHD (Groundwater Functions Pty Ltd, 2022), in the long-term, all seven voids act as a perpetual sink and do not contribute water or salinity to the surrounding groundwater system. Therefore, forming a non-polluting landform.
- The maximum modelled water levels in all seven voids are well below their respective void overflow levels and therefore the risk of overtopping to the surrounding environment is very low.
- The salinity of all the seven (7) voids progressively increases over the simulation, which is expected in a closed-loop system.

Sensitivity analysis modelling was also undertaken to assess potential impacts of uncertainty in rainfall runoff parameters and groundwater inflows. The modelling predicts that, even with conservatively high estimates of rainfall runoff and groundwater, all seven voids continue to act as a perpetual sink.

Surface Water

The surface water flooding assessment (Engeny, 2023) has been undertaken to determine components of the final landforms with potential flooding interactions. Based on the flooding assessment, no flood ingress into any residual voids is expected for all events up to and including the PMF. Flood protection landforms have been proposed to prevent flood ingress into the NUMAs.

Groundwater

Numerical modelling has been undertaken to assist in the determination of final void water levels and to calculate groundwater flux interactions with the voids in perpetuity (GF, 2022). The detailed technical assessment is included in **Appendix I**.

The results of the groundwater flow modelling indicate that groundwater exchange in the voids will stabilise after around 450 years from mine closure, based on final void lake levels predicted using the surface water balance model and that each of the voids will operate wholly as a groundwater sink.

Groundwater inflows will occur from all directions around each residual void and no water will seep out of any void into the natural environment.

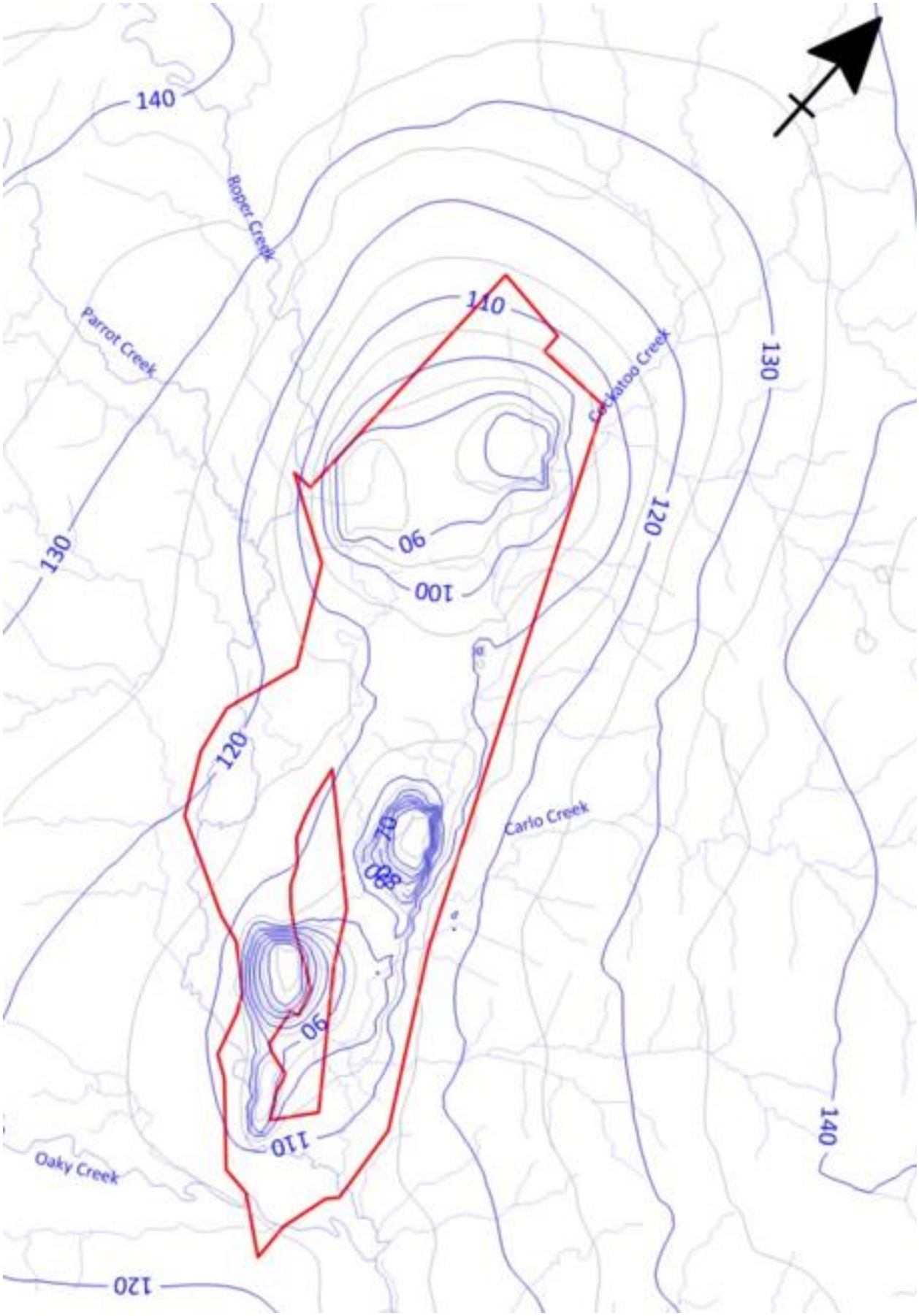


Figure 3-46: Predicted Water Table Elevation at Groundwater and Pit Lake Equilibrium (Groundwater Functions Pty Ltd, 2023)

Void Water Quality

Water is currently stored in a number of former mining pits. These include Far South Pit, WC Pit, WC North pit and NE pit in the south-western quarter of the mine. They also occur in Carlo Creek pit in the south-eastern quarter of the mine (Groundwater Functions Pty Ltd, 2023).

Monitoring of water level and water quality is carried out periodically to maintain site water inventories (Groundwater Functions Pty Ltd, 2023). The most recent monitoring was conducted in June 2022 and indicated that there is negligible stratification of stored waters in any of the five water-filled pits. Electrical conductivity measured at 1 metre intervals of each void are displayed in Table 3-65 (Groundwater Functions Pty Ltd, 2023).

Table 3-65: Void Water Inventory Water Quality

Pit	Mean EC (µS/cm)	Minimum EC (µS/cm)	Maximum EC (µS/cm)
Far South Pit	20,867	20,829	20,919
WC Pit	10,636	10,609	10,819
WC North Pit	14,143	14,118	14,239
NE Pit	13,278	13,193	13,302
Carlo Creek Pit	17,782	17,540	17,848

Particle tracking indicates that the voids are fully acquisitive, meaning that groundwater flows towards the void from all directions, and there is no leakage. This suggests that pit lake water will not seep out of the residual voids and does not represent a risk to groundwater environmental values (Groundwater Functions Pty Ltd, 2023). Groundwater flow directions at post-closure equilibrium are displayed in Figure 3-47 (Groundwater Functions Pty Ltd, 2023).

The principal contaminant of concern present in water accumulating in the voids is predicted to be salinity.

Groundwater quality in the source rocks supplying perpetual seepage to the residual voids is of low quality and the quality of water within the residual pit lakes is likely to deteriorate further through evaporative concentration of dissolved solids. However, no impact on regional groundwater resources or other connected water resources is considered likely to occur in relation to pit lake water quality because no water is predicated to seep from the residual voids (sink). Therefore, irrespective of the evolution of salinity and corresponding pit lake water quality, does not represent a risk to groundwater environmental values.

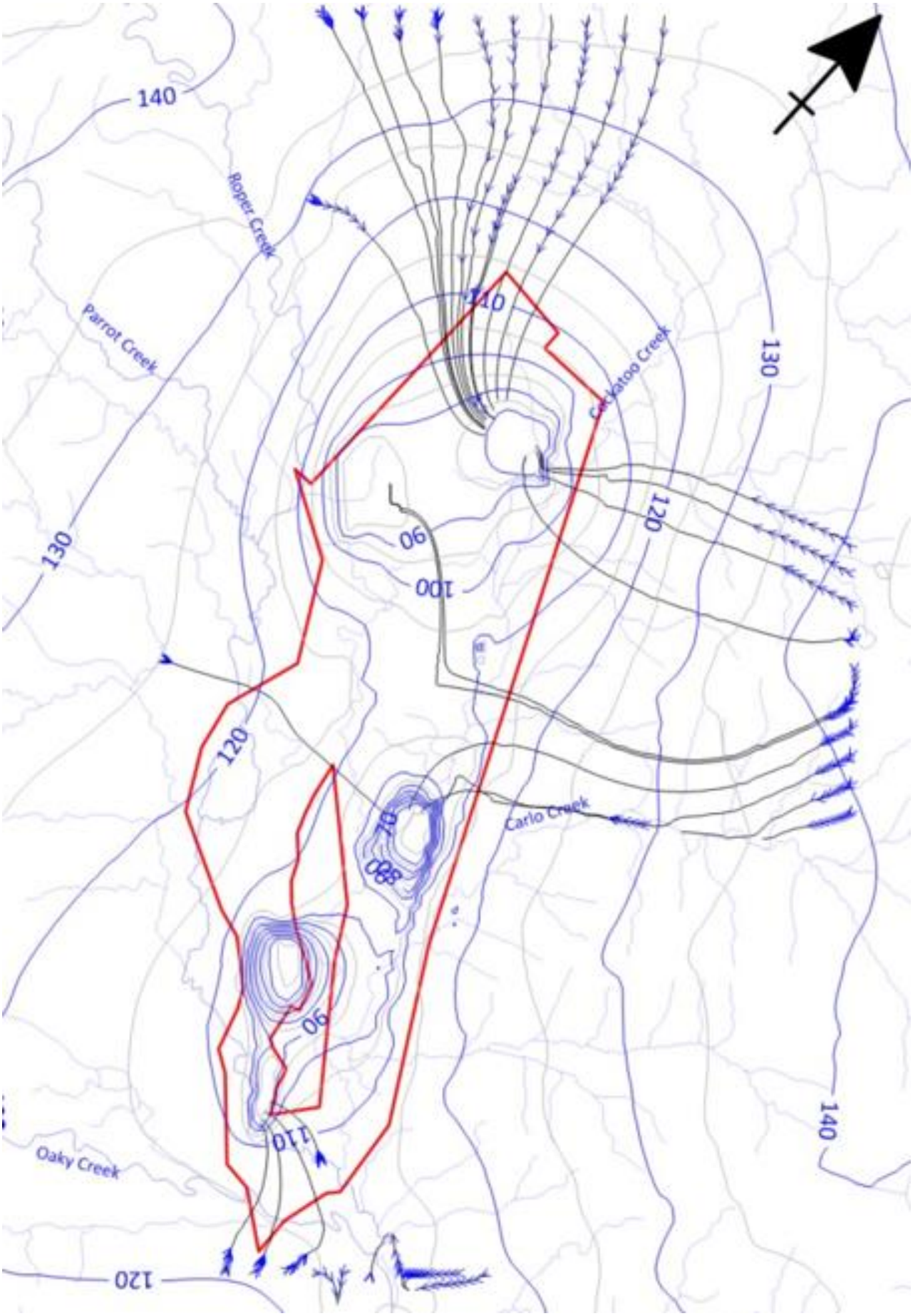


Figure 3-47: Groundwater Flow Directions at Post-Closure Equilibrium (Groundwater Functions Pty Ltd, 2023)

Rehabilitation and Management Strategies

The final NUMA landforms have been modelled and as construction works occur, ongoing review of the landforms will be conducted to ensure consistency with the management milestones.

The rehabilitation strategy to ensure stability for the NUMA landforms is to maximise compactions and settlement during execution. Settlement is expected of the backfill and will be monitored and low spots will be remediated as part of the monitoring and maintenance program as required.

Stability of the final landform will be confirmed through milestone monitoring as well as monitoring of any settlement.

FoxMan has developed a comprehensive suite of milestones for rehabilitation areas and improvement areas for Fox. Table 3-66 and Table 3-67 list these milestones and how they relate to the proposed vegetation scenarios for Fox.

The sections below provide further detail on how Fox will manage the rehabilitation activities to achieve the rehabilitation milestones. The management measures for the rehabilitation areas and improvement areas have been developed in consideration of guidelines and relevant information currently available, including the:

- PRCP Guideline
- DES (2014) Guideline: Rehabilitation requirements for mining resource activities (Historical)
- Australian Government (2016a) Leading Practice Sustainable Development Program for the Mining Industry – Mine Rehabilitation
- Australian Government (2016b) Leading Practice Sustainable Development Program for the Mining Industry – Mine Closure.

The rehabilitation area and improvement area management measures are considered by FoxMan to be consistent with “best practice” measures available as at the time of preparing this PRCP and PRCP Schedule. If further information becomes available or these guidelines are revised, the PRCP and PRCP Schedule would be reviewed, and the proposed management measures updated as required to maintain “best practice” status.

3.5.14. Underground Mining

There are no underground activities occurring at Fox.

Table 3-66: Rehabilitation Milestones

Milestone Reference	Rehabilitation Milestone	Milestone Criteria
RM1	Infrastructure decommissioning and removal	a) All services disconnected. Underground services remain buried and surface points sealed. b) All buildings either demolished and removed or relocated off the mining leases. c) Concrete slabs and footings removed or buried within overburden dump final rehabilitation areas. d) Sumps or dams that do not form part of final landform as sediment control structures dewatered and where applicable contaminated silt removed for licensed disposal. e) Sealed asphalt roads, car parks and hardstand areas will have the asphalt removed for reuse of the mining leases or removed for licensed disposal. f) Mine water dams are decommissioned. g) Watercourse crossings and culverts removed.
RM2	Remediation and/or management of contaminated land	a) Hydrocarbon and chemical storage areas removed and/or remediated by on-site treatment, if required. b) Contaminated Land Investigation Document completed in accordance with the Environmental Protection Act 1994, including: c) Site Suitability Statement confirming the suitability of the property for the PMLUs d) Audit Certification e) Contaminated Land Investigation Document including a Site Investigation Report and, where required, a Validation Report and/or a draft Site Management Plan
RM3	Landform development and reshaping	a) Landforms reshaped maximum 10% slopes (coarse reject) (RA4) b) Landforms requiring reshaping are reshaped to be free-draining with maximum 17% slopes (RA1, RA3; RA5) c) Disturbed natural watercourse bed and banks returned to a profile similar to the pre-disturbance condition (RA2)

Milestone Reference	Rehabilitation Milestone	Milestone Criteria
RM4	Installing Cover Systems/Capping	*if required, removal of residual water from facility Tailing Storage Facility (TSF): a) Low clay content NAF spoil will be used for an initial 2m layer in contact with tailings to create the bulk landform shape. The spoil will have minimal compaction to limit moisture suction potential. Course Reject and Tailing: b) 1m minimum thickness layer of selected weathered Permian and/or Tertiary spoil, will be spread and worked so as to be more than ten times less permeable than spoil above it. The surface will be shaped to shed any deep infiltration out of the landform. c) 2m minimum thickness of more permeable material such as gravelly fresh Permian spoil will be placed over the low permeability layer. The thickness may be greater than 2m as needed to maintain separation between the vegetation rooting zone and the low permeability layer, and to provide a final ground surface that will shed rainfall without ponding with slopes not greater than those on rehabilitated spoil emplacement areas. d) Topsoil and erosion management practices consistent with those on rehabilitated spoil emplacement areas. Noting an additional avoidance of deep-rooted tree species is not to be used within this PMLU. *a minimum of 10 years is required for settlement form the end of use of the TSF to installation of the cover.
RM5	Existing rehabilitation landform remediation	a) Landforms requiring maintenance or remediation that are existing historical rehabilitation landforms are reshaped to maximum 17% slopes. b) Where appropriate, addition of rock and/or natural materials (logs) cover to assist erosion resistance of eventual vegetative ground cover. c) Topsoil placed at minimum depth of 150 mm. d) Addition of growth media and ameliorants to ensure no bare areas greater than 100m2. e) Cultivation and keying of topsoil to subsoil with suitable multi-type ripper and performed parallel to slope contours. f) Where appropriate, addition of rock and/or natural materials (logs) cover to assist erosion resistance of eventual vegetative ground cover.

Milestone Reference	Rehabilitation Milestone	Milestone Criteria
RM6	Surface preparation (cattle grazing)	a) Topsoil placed at minimum depth of 150 mm. b) Addition of growth media and ameliorants to ensure no bare areas greater than 100m2. c) Cultivation and keying of topsoil to subsoil with suitable multi-type ripper and performed parallel to slope contours. d) Where appropriate, addition of rock and/or natural materials (logs) cover to assist erosion resistance of eventual vegetative ground cover.
RM7	Surface preparation (watercourse)	a) Topsoil placed at minimum depth of 150 mm b) Addition of growth media and ameliorants to ensure no bare areas greater than 100m2. c) Where appropriate, cultivation and keying of topsoil to subsoil with suitable multi-type ripper and performed parallel to slope contours. d) Where appropriate, addition of rock and/or natural materials (logs) cover to assist erosion resistance of eventual vegetative ground cover.
RM8	Surface preparation (native ecosystem)	a) Topsoil placed at minimum depth of 150 mm b) Addition of growth media and ameliorants to ensure no bare areas greater than 100m2. c) Where appropriate, cultivation and keying of topsoil to subsoil with suitable multi-type ripper and performed parallel to slope contours. d) Where appropriate, addition of rock and/or natural materials (logs) cover to assist erosion resistance of eventual vegetative ground cover.
RM9	Revegetation (cattle grazing)	a) Completed seeding of target pasture species across areas with a suitable species mix for the agreed final land use of grazing.
RM10	Revegetation (watercourse)	a) Completed seeding of target species across areas with a suitable species mix for the agreed final land use of grazing or native ecosystem.

Milestone Reference	Rehabilitation Milestone	Milestone Criteria
RM11	Revegetation (native ecosystem corridor)	a) Completed seeding of target species across areas with a suitable species mix for the agreed final land use of native ecosystem.
RM12	Achievement of surface requirements (cattle grazing)	a) Vegetation established across areas with a suitable species mix for the agreed final land use of grazing. b) Areas where agricultural land use applies, have pasture grass species present and provide stock with nutritional requirements, as well as being capable of setting viable seed and flowering similar to reference sites in the Middlemount area and/or with a land suitability class (grazing) of 4. c) >60% of the area has a vegetative groundcover[2] achieved. d) No new invasive plants[2] and infestation density of invasive plants within the area are contained or reduced and consistent with reference sites. e) Water control structures are either removed or free of active erosion and integrated into permanent landforms. f) No erosion classifications of 'Severe' or 'Extreme' (>30 rills/gullies and any are >0.3 m deep) and no active erosion present as demonstrated by no increase in erosion over time. [2]Groundcover: anything in contact with the soil surface, for example, live cover, standing dry cover, organic littler (including leaves, hay, coarse woody debris) or rocks
RM13	Achievement of surface requirements (watercourse)	a) Vegetation established across areas with a suitable species mix for the agreed final land use of grazing or native ecosystem. b) Riparian vegetation index score: greater than or equal to upstream or downstream values (RARC method[3]) c) No new invasive plants[3] and infestation density of invasive plants within the area are contained or reduced and consistent with reference sites. d) Water control structures are either removed or free of active erosion and integrated into permanent landforms. e) No erosion classifications of 'Severe' or 'Extreme' (>30 rills/gullies and any are >0.3 m deep) and no active erosion present as demonstrated by no increase in erosion over time. f) Evidence of fauna habitat features for invertebrate and vertebrate species (e.g., logs, rock piles). [3]Rehabilitated watercourse - Modified RARC method with a reduced number of monitoring points within each reach

Milestone Reference	Rehabilitation Milestone	Milestone Criteria
RM14	Achievement of surface requirements (native ecosystem)	a) Vegetation established across areas with a suitable species mix for the agreed final land use of native ecosystem. b) No new invasive plants[2] and infestation density of invasive plants within the area are contained or reduced and consistent with reference sites. c) Water control structures are either removed or free of active erosion and integrated into permanent landforms. d) No erosion classifications of 'Severe' or 'Extreme' (>30 rills/gullies and any are >0.3 m deep) and no active erosion present as demonstrated by no increase in erosion over time. [3]Groundcover: anything in contact with the soil surface, for example, live cover, standing dry cover, organic littler (including leaves, hay, coarse woody debris) or rocks
RM15	Achievement of post-mining land use to a stable condition (cattle grazing)	a) Provide a final rehabilitation report including monitoring records. b) Assessment of carrying capacity by an AQP[1] demonstrates a sustainable grazing outcome has been achieved. c) >75% of groundcover vegetation comprises of species density and diversity consistent with the agreed final land use of grazing. d) If deemed required, either LiDAR or ground survey to confirm settlement levels <10 mm/annum. e) Erosion classification to be comparable with erosion classifications from nearby equivalent land uses with similar landform parameters to be determined by establishing analogue sites at suitable comparable sites. f) No erosion classifications of 'Severe' or 'Extreme' (>30 rills/gullies and any are >0.3 m deep) and no active erosion present as demonstrated by no increase in erosion over time. g) Hazard assessment completed by an AQP[1] to confirm safety hazards in rehabilitation are not significantly different to surrounding unmined landscapes subject to the same land use. h) Water quality in retained structures will meet livestock drinking water criteria as defined in Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018) i) Water quality from direct rainfall runoff or surface seepage from rehabilitated spoil has: i. pH 6.5–9.0; and ii. EC <2,000 µS/cm.

Milestone Reference	Rehabilitation Milestone	Milestone Criteria
RM16	Achievement of post-mining land use to a stable condition (watercourse)	a) Hazard assessment completed by an AQP[1] to confirm safety hazards in rehabilitation are not significantly different to surrounding unmined landscapes subject to the same land use. b) Rainfall runoff from rehabilitated areas is not significantly different to upstream values for the following: pH, EC and turbidity. c) Riparian vegetation index score: greater than or equal to upstream or downstream values (modified RARC method) d) Erosion classification to be comparable with erosion classifications from nearby equivalent land uses with similar landform parameters to be determined by establishing analogue site
RM17	Achievement of post-mining land use to a stable condition (native ecosystem)	a) Provide a final rehabilitation report including monitoring records. b) assessment of carrying capacity by an AQP[1] demonstrates a sustainable grazing outcome has been achieved. c) >75% of groundcover vegetation comprises of species density and diversity consistent with the agreed final land use of native ecosystem. d) If deemed required, either LiDAR or ground survey to confirm settlement levels <10 mm/annum. e) Erosion classification to be comparable with erosion classifications from nearby equivalent land uses with similar landform parameters to be determined by establishing analogue sites at suitable comparable site. f) No erosion classifications of 'Severe' or 'Extreme' (>30 rills/gullies and any are >0.3 m deep) and no active erosion present as demonstrated by no increase in erosion over time. g) Hazard assessment completed by an AQP[1] to confirm safety hazards in rehabilitation are not significantly different to surrounding unmined landscapes subject to the same land use. h) Water quality from direct rainfall runoff or surface seepage from rehabilitated spoil has: iii. pH 6.5–9.0; and iv. EC <2,000 µS/cm.

Table 3-67: Improvement Area Milestones

Milestone reference	Management milestone	Milestone criteria
MM1	Achievement of structural stability	a) Highwall crest battered back where required to achieve a stable slope angle as specified by an AQP[1] (geotechnical engineer)
MM2	Achievement of landform design and surface requirements	a) Highwall as mined weathered average slope angle of 1V and 1.7H (30°) and low wall as backfilled at angle of repose at 1V:0.8H (50°). b) Abandonment safety bund setback distance is in accordance with calculated geotechnical factor of safety determined at MM1. c) Abandonment safety bund constructed of competent rock and to geometry specified (height = 2m, width top = 2m, batters = 1V:3H, width base = 14m) to prevent traversing by vehicles. d) Certification from an AQP[1] that the residual void is sufficiently protected from probable maximum flood levels. e) Abandonment safety bund is revegetated with pasture seed. f) Pit lake water level is stabilize. Safety bund (minimum 2m height and 4m base width) is constructed, where required, at the geotechnical set-back distance. Fencing erected around perimeter of safety bund, where required. Appropriate signage placed to clearly identify and convey the purpose (e.g., EP Act 1994 Non-Use Management Area No Entry).
MM3	Achievement of sufficient improvement not to cause environmental harm and that will be safe and structurally stable	a) Access to highwall, low wall and ramp batter is restricted by physical barriers. Fencing erected on the outside of the abandonment safety bund to specification (five strand barbed stock fencing) b) Safety signage designed in accordance with Australian Standard is erected at 100m intervals along the fence line. c) Certification from an AQP[1] that the residual void will not cause environmental harm outside of the relevant tenure boundary. d) Residual void acts as a groundwater sink to the receiving environment into perpetuity i. Groundwater monitoring confirms modelling of no contamination evidence over five (5) year monitoring program. e) Certification from an AQP[1] that the residual void is safe to humans and livestock. f) Final void walls confirmed to drain internally to the final void

3.5.15. Built Infrastructure.

PRCP Guideline (Section 3.6.5)

The administering authority's expectation of rehabilitation relating to built infrastructure is that it will be decommissioned, demolished, salvaged and/or disposed of unless it is being formally retained by the landholder to achieve an appropriate PMLU.

The rehabilitation planning part must include:

Identification of infrastructure that will be decommissioned and the methods for decommissioning.

A description of infrastructure that will remain post rehabilitation and the identification of ongoing maintenance requirements.

Evidence of agreement for any infrastructure that will have ownership transferred.

The major infrastructure within the EA at the Fox are:

- CHPP
- Private haul road
- Workshop and associated fuel storage and washdown bay
- Administration offices and employee facilities.
- Mine operations and administration building
- First aid, mine rescue and fire services facilities
- Warehousing and storage areas
- Sewage Holding Tanks
- Explosive magazine
- Haul road and stockpile hardstands
- Raw water storage
- Sedimentation dams
- Tailings disposal facilities
- Fuel storage
- Power reticulation/MCC and Transformer at CHPP
- Fencing
- Car parks.

Infrastructure that will remain onsite post-closure include:

- Access tracks
- Creek Diversions and flood protection landforms.

Creek diversions and flood protection landforms will be retained post closure and rehabilitated to achieve closure objectives. Access tracks will be retained for landholders. The landholder agreement for the retainment of access tracks is provided in **Appendix E** & **F.**

The vast majority of infrastructure onsite at Fox is not required for rehabilitation, maintenance, and monitoring, and will be removed from the mine. Infrastructure that will be removed from the mine includes:

- CHPP and associated infrastructure.
- Buildings (Administration area, crib, and general buildings).

- Workshops.
- Fuel, oil and chemical storage.
- Mine dams.
- Roads.
- Laydown areas.
- Coal stockpiles.
- Water management structures when not agreed with landowner to remain.
- Conveyors.

3.5.16. Contaminated Land Assessment

A contaminated land assessment was completed (Engeny 2023) using desktop methods (**Appendix Q**). The study did not incorporate site investigations.

Potential Contaminants

Potential contaminants were identified and displayed in Table 3-68. It is noted that this list is based on limited information provided by Fox and general contaminated land management provisions. It was noted in the contaminated land assessment that all potential sources and contaminants of concern may not be identified. Site investigations must be completed in all high-risk areas prior to rehabilitation. Risk assessment will be used to define locations for intrusive sampling and analysis of soils, sediment, surface water and groundwater in order to determine the actual contamination status of the site.

Table 3-68: Potential Sources and Contaminants at Fox

Potential Source	Potential Contaminants of Concern
Former homestead / cattle dip infrastructure	Asbestos, synthetic mineral fibres (SMF), lead based paint, Polychlorinated biphenyls (PCBs), petroleum hydrocarbons, arsenic, heavy metals, pesticides.
Spoil Dumps, stockpiles, tailings storage	Petroleum hydrocarbons, Methyl Isobutyl Carbinol (MIBC), Per and poly fluorinated substances (PFAS) and, if applicable, acid mine drainage (AMD), polycyclic aromatic hydrocarbons (PAH) and Dioxins are also potentially of concern.
Workshops / Wash Bays / Dangerous Goods Storage	Petroleum hydrocarbons, metals, PFAS, PCBs, phenols, solvents.
Fuel Storage Areas / Mobile refuelling areas	Petroleum hydrocarbons.
CHHP Transformer	Petroleum hydrocarbons, metals, PFAS, PCBs, phenols, solvents.
Sewage Holding Tank Areas	Metals, PFAS, nitrogen species, microbiological.
Explosives Storage	Petroleum hydrocarbons, nitrogen species.
Carparks	Petroleum hydrocarbons, metals.
Voids containing Pit Water	Petroleum hydrocarbons, metals, AMD, PFAS, PCBs, phenols, solvents, nitrogen species, microbiological.
Waste Storage Areas	Petroleum hydrocarbons, metals, PFAS, PCBs, phenols, solvents.

Potential Source	Potential Contaminants of Concern
Drainage Lines	Petroleum hydrocarbons, metals, AMD, PFAS, PCBs, phenols, solvents, nitrogen species, microbiological.
Water Storage Areas	Petroleum hydrocarbons, metals, AMD, PFAS, PCBs, phenols, solvents, nitrogen species, microbiological.
Process water	Petroleum hydrocarbons, metals, AMD, PFAS, PCBs, phenols, solvents, nitrogen species, microbiological.
Mine dewatering (Pit water from groundwater, direct rainfall and runoff from spoil and seepage.)	Petroleum hydrocarbons, metals, AMD, PFAS, PCBs, phenols, solvents, nitrogen species, microbiological.

Potentially Affected Media

Potentially affected media at the site includes all environmental media (Engeny, 2023):

- Soil.
- Soil vapour.
- Sediment.
- Surface Water.
- Groundwater.

Intrusive sampling and analysis will provide further information regarding the contamination status of the various media across the site.

Potential Migration Pathways

Potential contamination migration pathways include a combination of (Engeny, 2023):

- Windblown dust.
- Surface water runoff.
- Surface water infiltration to groundwater.
- Groundwater migration.
- Mine water transfer systems.
- Drainage and diversion channels.
- Discharge points.

Potential Receptors

Potential on-site receptors include workers along with terrestrial and aquatic flora and fauna. Off-site receptors include aquatic and terrestrial flora and fauna (Engeny, 2023).

Management of Residual Contamination

Site Registers

The Fox Regulated Waste Burial Register was reviewed (Engeny, 2023) in preparation of this guidance and includes details of old tyres buried in the PDs and hydrocarbon spill impacted soils disposed to the rejects dump.

Five (5) asbestos registers were provided for review.

- Hygenics Pty Ltd *Asbestos Register Foxleigh Mining Pty Ltd Residential Single-Storey Houses* dated November 2008 identified asbestos as present at twenty (20) of the thirty-one (31) houses inspected. None of the single storey houses are located within the mine site EA.
- Hygenics Pty Ltd *Asbestos Register Foxleigh Mining Pty Ltd Residential Double-Storey Houses* dated November 2008 identified asbestos as present at all six (6) houses inspected. None of the double storey houses are located within the mine site EA.
- Hygenics Pty Ltd *Asbestos Register Foxleigh Mining Pty Ltd Residential Units* dated November 2008 identified asbestos present at all nine (9) units inspected. None of the units are located within the mine site EA.
- Hygenics Pty Ltd *Asbestos Register Foxleigh Mining Pty Ltd Village* dated November 2008 identified no asbestos to be present in the following locations: dining room, rec room, toilet blocks, laundries, office and linen, chemical store, gym and blocks A-P.
- Hygenics Pty Ltd *Asbestos Audit Review of Foxleigh Mining Pty Ltd Mine Site* dated 2011 identified no asbestos in the following locations: training building, safety building, toilets/store, Orica, showers/safety store, first aid, administration, OCE building, technical service building, Carlo creek crib hut, north west crib hut, central crib, pump crew containers, LCR mailbox, orica reload, explosive magazines, CHPP management office, contractor's crib room, lab building, warehouse, administration building, workshop, wash plant, ROM MCC, CPP MCC, TLO Crib room/control room, container, TLO toilets, tunnel, workshop administration, component room, parts store, tool storage container C6, crib room, Pirtek container, CAT container, Hitachi container C3, Service Bay, Container C4 and C5, welding shed, LCR workshop, office/lunchroom, supervisors office/store/toilet and stores office.

Site Management Plans, Systems and Procedures

Various management plans and systems are in place at the Fox (Engeny, 2023). These have been developed to mitigate, manage, and reduce risk and the potential for environmental harm from operations. The following plans have been referenced in the Site Investigation Questionnaire response:

- Environmental Management System.
- Biodiversity Offset Management Plan.
- Erosion and Sediment Management Plan.
- Groundwater Water Monitoring Management Plan.
- Noxious Weed Management Plan.
- Receiving Environment Monitoring Plan.
- Regulated Structures Operational Plan.
- Regulated Waste Management Plan.
- Rehabilitation Management Plan.
- Tailings Management Plan.
- Waste Rock and Spoil Disposal Management Plan.
- Water Management Plan.

Other processes include specific references in Standard Operating Procedures to hydrocarbon or chemical usage that considers the environment, especially with reference to spills and managing / mitigating their effects.

Contamination Remediation Considerations

Milestones for the remediation of contaminated land in accordance with the progressive rehabilitation framework require the following steps to be completed, as appropriate:

- Carry out preliminary and intrusive contaminated land investigations.
- Removal or onsite treatment of contaminated water (e.g., affected by hydrocarbons, metals, etc).
- Removal and appropriate disposal of contaminated materials (PCBs, Dioxins, Mercury).
- On-site remediation of hydrocarbon contaminated soils.
- Removal and disposal of asbestos.
- Conduct validation testing to confirm that contaminated soils have been removed/remediated.

The recommended contamination assessment and remediation considerations, when the site history and site-specific risks are considered include the following (Engeny, 2023):

- Remove any infrastructure.
- Conduct a preliminary site assessment including review of previous activities.
- Develop sampling and analysis plan on a risk basis.
- Determine assessment criteria based on the proposed PMLU.
- Sampling and analysis for potential contaminants of concern.
- Compare sampling results to relevant criteria.
- Determine if remedial works are required to achieve suitability for the proposed PMLU.
- Removal and appropriate disposal of contaminated materials – water, soils, asbestos
- Conduct validation testing.
- Report confirming successful removal of contaminated material and a statement on the contamination status.
- Retain report until mine closure as evidence of remediation works.

3.6. Risk Assessment

Legislative Requirement

In accordance with section 126C(1)(f) of the EP Act, the rehabilitation planning part of the PRC plan must 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 the risks.

PRCP Guideline (Section 3.7)

As per section 126C(1)(j) of the EP Act, the administering authority considers it necessary for the proposed PRC plan to contain a risk assessment of all proposed NUMAs. The risk assessment must be carried out to identify the risks of the NUMA causing environmental harm and not being safe and structurally stable and detail how the applicant intends to manage and minimise the identified risks. The AS ISO 31000:2018 Risk Management – Guidelines (Standards Australia, 2018) describes risk assessment as the overall process of risk identification, risk analysis, risk evaluation and risk treatment. Each of these aspects must be included in the risk assessment in the rehabilitation planning part.

Information requirements in this section apply to all applicants whether or not they are an existing EA holder. Existing holders may have the required information available from previously submitted plans/reports/applications that, if still valid, can be used in the PRC plan.

Risk Methodology

A risk-based approach to the Fox PRCP planning has been undertaken with a risk assessment workshop undertaken to identify the risks of land for a PLMU or NUMA not being achieved. A stable condition for PMLUs is defined as per section 111A of the EP Act, and is listed below:

- The land is safe and structurally stable.
- There is no environmental harm being caused by anything on or in the land; and
- The land can sustain a PMLU.

For Fox, the PMLUs being assessed are cattle grazing, watercourse, and native ecosystem corridor.

As per 126C of the EP Act, NUMAs were assessed to identify the risks of the NUMA's causing environmental harm and not being safe and structurally stable.

The full risk assessment for both PMLUs and NUMAs is included in **Appendix P**.

Completion criteria for rehabilitation at Fox, are presented by domains with a quantifiable/measurable criterion which, once achieved, demonstrates that the rehabilitated landform is stable. The approved PRCP schedule Rehabilitation Milestone criteria is a reflection of the criteria defined in the applicable LOD, the EA.

The physical rehabilitation works undertaken on site in consideration of meeting the criteria (and demonstrating that a stable landform is achieved) are broken up into rehabilitation milestones. Accordingly, this PRCP – Rehabilitation Planning Part, has undertaken the required risk assessment by identifying risks in completing rehabilitation milestones, so as to better relate to actual on-site rehabilitation works. A number of scenarios were identified in the risk identification process related a stable condition for the land described as the PMULs not being achieved:

- Landform failure.
- Environmental factors causing disruption or significant impact to the success of vegetation (e.g., flood, fire, drought).
- Decommissioning challenges leaving contaminated material on the site after conclusion of rehabilitation works.

- Rehabilitation management issues related to insufficient resourcing or inadequate experience/execution of rehabilitation works.

A number of scenarios were identified in the risk identification process related to NUMAs, including the following risks:

- Geotechnical and erosional stability of NUMAs due to steep slopes, rock falls, slope failure, residual void extending beyond permitted EA domain limits and impacts to adjacent PMLUs.
- NUMA design not consistent with criteria due to steep slopes and safety bunds and setbacks not achieved.
- NUMA causing environmental harm due to void switching from sink to source to the groundwater aquifer.

Risk Analysis, Evaluation, and Relevant Treatments

The table included in **Appendix P** provides the full detail of risk analysis, risk evaluation and risk treatment for these scenarios. Worst case outcomes were assessed for each scenario, preventative, and mitigating controls identified and from there a residual risk rating was calculated. The FoxMan likelihood and severity tables is provided in Figure 3-48.

Risk Rating	Risk Level	Guidelines
21 to 25	High	Management objectives may not be achieved. Appropriate mitigation strategy to be devised immediately.
13 to 20	Significant	Management objectives may not be achieved. Appropriate mitigation strategy to be devised as soon as possible.
6 to 12	Medium	Management objectives may not be achieved. Appropriate mitigation strategy to be devised as part of the normal management process.
1 to 5	Low	Management objectives may not be achieved. Monitor risk. No further mitigation required.

		Hazard Effect / Consequence (Where an event has more than one Loss Type, choose the Consequence with the highest rating)				
Loss Type		1 Insignificant	2 Minor	3 Moderate	4 High	5 Major
S Safety and/or health harm to people		First aid case / exposure to minor health risk	Medical treatment case / exposure to major health risk	Lost time injury / reversible impact on health	Single fatality or loss of quality of life / irreversible impact on health	Multiple fatalities / impact on health ultimately fatal
EI Environmental impact		Minimal environmental harm: L1 incident	Material environmental harm: L2 incident remediable short term	Serious environmental harm: L2 incident remediable within LOM	Major environmental harm: L2 incident remediable post LOM	Extreme environmental harm L3 incident irreversible
BI/MD Business interruption, material damage and/or other consequential losses		No disruption to operation / 5% loss of budgeted operating profit	Brief disruption to operation / 10% loss of budgeted operating profit/listed assets	Partial shutdown / 15% loss of budgeted operating profit/listed assets	Partial loss of operation / 20% loss of budgeted operating profit/listed assets	Substantial or total loss of operation / 25% of loss budgeted operating profit/listed assets
LR Legal and/or regulatory		Low level legal issue	Minor legal issue: non-compliance and breaches of the law	Serious breach of law: investigation /report to authority, prosecution and/or moderate penalty possible	Major breach of the law: prosecution and considerable penalties	Very considerable penalties and prosecution. Multiple law suits and jail terms
RSC Impact to reputation, social and/or community		Slight impact: public awareness may exist but no public concern	Limited impact: local public concern	Considerable impact: regional public concern	National impact: national public concern	International impact: international public attention
Likelihood		Risk Rating				
5 Almost Certain	The unwanted event has occurred frequently: occurs one or more times per year and is likely to reoccur within one year	11 (Medium)	16 (Significant)	20 (Significant)	23 (High)	25 (High)
4 Likely	The unwanted event has occurred infrequently: occurs less than once per year and is likely to reoccur within five years	7 (Medium)	12 (Medium)	17 (Significant)	21 (High)	24 (High)
3 Possible	The unwanted event has happened in the business at some time, or could happen within 10 years	4 (Low)	8 (Medium)	13 (Significant)	18 (Significant)	22 (High)
2 Unlikely	The unwanted event has happened in the business at some time; or could happen within 20 years	2 (Low)	5 (Low)	9 (Medium)	14 (Significant)	19 (Significant)
1 Rare	The unwanted event has never occurred in the business or it is highly unlikely to occur within 20 years	1 (Low)	3 (Low)	6 (Medium)	10 (Medium)	15 (Significant)

Figure 3-48: FoxMan Risk Matrix

3.6.1. Rehabilitation Trials.

PRCP Guideline (Section 3.7.1)

In accordance with section 126C(1)(j) of the EP Act, if rehabilitation trials are planned, the rehabilitation planning part must state:

- the objective of the trial(s)
- the trial design including, but not limited to, the location, underlying land characteristics and potential issues
- the details of how the trial(s) will be carried out
- when the trial(s) will commence
- the duration of the trial(s)
- how the trial(s) will be assessed for success
- how the results of the trial(s) will be incorporated into rehabilitation strategies and the development of milestones, and
- where the trials have previously been carried out by the applicant.

The information requirements in this section will apply to all applicants, whether or not they are an existing EA holder, who have planned or commenced rehabilitation trials. Existing EA holders can provide details of any rehabilitation trials that have occurred prior to the submission of the proposed PRC plan.

RGS identified three (3) factors controlling the success the rehabilitation at Fox (RGS Environmental Pty Ltd, 2021):

1. Shape and slope of final landform on which the cover is placed.
2. Texture (particle size) of topsoil cover materials.
3. Geochemistry of the topsoil and underlying spoil material.

Some historical rehabilitation has been successful, whereas others have generated mixed results. The cause of poorly rehabilitated areas in the past has been linked to erosive topsoil placed on steep slopes. The topsoil had likely washed away from high velocity and channelised surface run-off (RGS Environmental Pty Ltd, 2021).

Rehabilitation trials were undertaken in 2021 (Foxleigh Mine, 2022). The objective of the trials was to gain an understanding of what rehabilitation practises could be successful on the mine site (Foxleigh Mine, 2022). The trials were aimed at addressing soil conditions including sodic and erosive soils available for rehabilitation (RGS Environmental Pty Ltd, 2021). Rehabilitation trials were undertaken on WC Pit, Old ML4 OOPD area and Void 251.

Rehabilitation trials in 2022 were focussed on remediation of legacy rehabilitation areas that have either failed in the past or require maintenance to improve vegetation cover. In addition to the legacy rehabilitation areas in 2022, two rehabilitation trial areas were identified, as well as a R&D trial investigated but analysis of proposal recommended trial not to progress. The trials were proposing to make topsoil/ growth medium from coal rejects.

Details for rehabilitation trials are displayed in Table 3-69.

The below detailed trials have not previously been conducted by Fox, and being these are the first trials for rehabilitation conducted and recent completion date, the continued monitoring of these areas will support the future evolution of rehabilitation milestones particularly for grazing PMLUs. Elements of erosion control, slope, seed mix and specific timing of seeding undertaken will provide clear data for improvement of future rehabilitation.

Where ongoing rehabilitation monitoring identifies potential improvements or adjustments to the rehabilitation methodology, those improvements or adjustments will be implemented as part of the continuous improvement of the rehabilitation methodology and the development of milestones.

Table 3-69: Rehabilitation Trials and Details

Trial	Objective	Details	Commencement Date	Success Determination
WC Pit – Rock Chutes	To determine the effectiveness of geofabric in rock chutes and whether it contributes to long-term structural integrity of rock chutes with regards to erosion.	On RC3, geofabric was installed along the entire length of the rock chute. The other two rock chutes had no geofabric installed.	2021	Intactness Erosion Present
Old ML4 Gypsum Application	To identify any major differences in vegetation growth and erosion features between gypsum application rates and application to both subsoil and topsoil as opposed to topsoil only.	Undertaken at Bay 1, 2, 3 and Crest.	2021	Vegetation growth Erosion present
Topsoil Application Rates	This trial was undertaken to better understand topsoil performance criteria with different application thickness.	Topsoil application rates at Void 251 (150 mm) was compared to default topsoil application rate (200 m) of to determine the effect of lowering topsoil application amounts on vegetation establishment and maintenance.	2021	Vegetation establishment Erosion present
Cockatoo Creek Stage 4 Northern Section (20ha) and Southern Section (10 ha)	Implement a 'winter crop' area and show that the area can be remediated within the need to import new topsoil. Comparison of the results of this trial will guide the future remediation of the remainder of the diversion area.	The scope of the trial will include: 1. Soil sampling and analysis, 2. Recommendations on amelioration strategy (by agronomist), 3. Finalise required materials for amelioration and seed (BOQ) 4.Onboarding of people and plant 5.Minor reshaping works to address erosion features 6.Area preparation and amelioration works 7.Seeding works 8.Cross-ripping and seeding of adjacent levee embankment (~3ha)	2022	
Old ML4 – PR2203 (35ha)	Remediate legacy rehab that has struggled on steeper slopes. This area was rehabilitated in 2018-2019. Observation of patchy topsoil depths suggest poor discipline of topsoil application resulted in areas of insufficient topsoil depth to support soil amelioration and seeding. The slope is also steep in some areas which has contributed to excessive erosion due to poor vegetative cover and failure, this may require further alternative stabilisation techniques such as rock mulching.	The scope of the trial will include: 1.Soil sampling and analysis 2.Recommendations for amelioration strategy and if new topsoil required –upcoming stripping may allow fresh topsoil to be placed in this area. 3.Finalise required materials for amelioration and seed (BOQ) 4.Minor reshaping works to address erosion features 5.Area preparation and amelioration works 6.Topsoil placement (if required) 7.Seeding works 8.Install of new rock chutes –anticipate 2 new chutes total length ~500m. 9.Installation of new contour banks and repair existing legacy contour banks. Also repair of any contour banks that broken up for machinery access.	2022	
OT OOPD – PR2206 (34ha	Successfully rehabilitate OT OOPD. This rehabilitated area has had minimal drainage and erosion control installed. Some growth is present, but it is sparse and considered unsuccessful.	Soil testing, analysis and recommendations only.	2022	
Cockatoo Creek ROM Stockpile (4ha)	Rehabilitate the semi-active Cockatoo Creek ROM Stockpile. Successful rehabilitation would Improve water quality running off into the adjacent Cockatoo Creek Rom Sediment Dam.	The scope of the trial will include: 1.Material sampling and analysis 2.Recommendations on amelioration strategy including advice on whether any topsoil will be required to promote successful rehabilitation for the area. 3.Cost analysis and review 4.Recommendations	2022	

3.7. Monitoring and Maintenance

PRCP Guideline (Section 3.8)

Under section 126C(1)(j) of the EP Act, the administering authority considers monitoring and maintenance necessary to decide if the PRC plan is consistent with the requirements of the legislation. The rehabilitation planning part must contain a monitoring and maintenance program that identifies and describes the monitoring systems that will be carried out in order to demonstrate a milestone and milestone criteria have been achieved. The program must include, where relevant to the milestone and milestone criteria (but is not limited to):

- schedule of monitoring, reporting and review for each milestone
- description of methodologies and standards, which could include field-based assessments and the application of new remote sensing, GIS and other relevant emerging technologies.
- monitoring that enables the repeatable collection of relevant statistically valid data
- monitoring using appropriate quality assurance and data management processes and systems
- regular analysis of site data including multi-year comparison trends and benchmarking against analogue/reference sites
- contingency strategies if monitoring data indicates milestone criteria are not being met
- post-closure monitoring to ensure milestone criteria has been demonstrated
- intent of monitoring reports, such as provision of results and key findings

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The information requirements in this section will apply to all applicants whether or not they are an existing EA holder. However, existing holders may already have the required information available from previously submitted plans/reports/applications that, if still valid, could be used in the PRC plan. If there has/is any monitoring or maintenance of areas already rehabilitated, details must be included in the PRC plan.

3.7.1. Rehabilitation Milestone Monitoring

Rehabilitation milestone monitoring will be undertaken at Fox to demonstrate achievement of the RMs, as they relate to achieving the PMLUs of cattle grazing and watercourse. The RMs and associated milestone criteria for Fox are detailed in Section 3.1.6. A combination of monitoring and reporting approaches will be used to demonstrate the achievement of the RMs as detailed in Table 3-70.

The rehabilitation milestones are a series of discrete sequential works which align with rehabilitating the land disturbed during mining to ultimately the pre-approved PMLU of grazing. These discrete rehabilitation works are associated with:

- Removing redundant infrastructure.
- Preparing the landform (i.e., bulk earthworks, placement of capping and growth media layers).
- Revegetation.
- Demonstration of rehabilitation success against criteria.

The overall objective of the rehabilitation works is to achieve a safe, stable, and non-polluting final landform. Rehabilitation milestones and criteria have been developed for all rehabilitation areas that have a PMLU (refer to Section 3.5.9). These milestones are SMART, meaning they are:

- *Specific* – is it clear what must be done.
- *Measurable* - it is possible to know when it is achieved.
- *Achievable* - it is capable of being achieved.
- *Reasonable* – there is a clear connection between the milestone and the desired rehabilitation outcome.
- *Timely* – it is clear when the milestone will be completed.

Monitoring is undertaken as part of each milestone to assess whether the works undertaken have met the milestone criteria or whether rectification works are required. Rehabilitation areas which satisfy the milestone criteria can progress the next rehabilitation milestone (where relevant) as shown in Table 3-70.

Table 3-70: Rehabilitation Milestones with Relevant Reporting Requirements

Milestone reference	Rehabilitation Milestone	Reporting Requirements
RM1	Infrastructure decommissioning and removal	• Undertake and document visual inspections
RM2	Remediation and/or management of contaminated land	• Contaminated Land Investigation Document including a site suitability statement completed by a suitably qualified person confirming the land does not present an unacceptable risk to proposed future land uses or the environment
RM3	Landform development and reshaping	• Survey/LiDAR of landform • Analyse final landform against design
RM4	Installing Cover System/Capping	• Survey/LiDAR of landform • Analyse final landform against design • Document growth media depth • Document growth media assessment • Document ameliorants and physical treatments applied
RM5	Existing rehabilitation landform remediation	• Survey/LiDAR of landform • Detail areas of high risk and provide design specifications for remediation
RM6	Surface preparation (cattle grazing)	• Document growth media depth • Document growth media assessment • Document ameliorants and physical treatments applied
RM7	Surface preparation (watercourse)	• Document growth media depth • Document growth media assessment • Document ameliorants and physical treatments applied
RM8	Surface preparation (native ecosystem corridor)	• Document growth media depth • Document growth media assessment • Document ameliorants and physical treatments applied
RM9	Revegetation (cattle grazing)	• Document seed mix, purity information, planting timing, seed application rates and areas
RM10	Revegetation (watercourse)	• Document seed mix, purity information, planting timing, seed application rates and areas

Milestone reference	Rehabilitation Milestone	Reporting Requirements
RM11	Revegetation (native ecosystem corridor)	• Document seed mix, purity information, planting timing, seed application rates and areas
RM12	Achievement of surface requirements (cattle grazing)	• Undertake rehabilitation monitoring as outlined in Section 3.7
RM13	Achievement of surface requirements (watercourse)	• Undertake rehabilitation monitoring as outlined in Section 3.7
RM14	Achievement of surface requirements (native ecosystem)	• Undertake rehabilitation monitoring as outlined in Section 3.7
RM15	Achievement of post-mining land use to a stable condition (cattle grazing)	• Undertake rehabilitation monitoring as outlined in Section 3.7
RM16	Achievement of post-mining land use to a stable condition (watercourse)	• Undertake rehabilitation monitoring as outlined in Section 3.7
RM17	Achievement of post-mining land use to stable condition (native ecosystem corridor)	• Undertake rehabilitation monitoring as outlined in Section 3.7

3.7.2. Cattle Grazing PMLU Habitat Monitoring Methodology

Monitoring Schedule

The monitoring program follows a phased approach whereby initial monitoring is undertaken on an annual basis for the first three years to assess the performance of rehabilitation as it relates to vegetation establishment and achieving initial surface requirements (Table 3-71). This approach allows a timely assessment of the performance of rehabilitation post initial seeding and provides critical information to determine if rehabilitation is on track towards achieving surface requirements or if maintenance is required (Section 3.7).

Additional rehabilitation parameters are included into the monitoring program in years three, five, ten and five yearly thereafter (Table 3-71), to assess and track the performance of rehabilitation in relation to achievement of surface requirements (RM9-RM10) and achievement of PMLU to a stable condition (RM11-RM12). The phased approach of the monitoring program ensures that there is continual monitoring of rehabilitation parameters against milestone criteria up to the point of EA surrender.

Table 3-71: Cattle Grazing PMLU Monitoring Schedule and Measured Rehabilitation Parameters

Rehabilitation parameter	Monitoring schedule				
	Year 1	Year 2	Year 3	Year 5	Year 10+ (5 yearly thereafter)
Cattle grazing PMLU					
Landform and erosion	✓	✓	✓	✓	✓
Soil and spoil	✓	✓	✓	✓	✓
Groundcover	✓	✓	✓	✓	✓
Invasive plants	✓	✓	✓	✓	✓
Pasture species richness	✓	✓	✓	✓	✓
Pasture condition	-	-	✓	✓	✓
Grazing Land Suitability Assessment	✓	✓	✓	✓	✓

Rehabilitation Monitoring Sites

Permanent rehabilitation monitoring sites will be established and assessed during all phases of rehabilitation monitoring. The following criteria will be used to select cattle grazing monitoring sites:

- Not impacted by mining.
- On land with a land class suitability rating of 4 (grazing) (Hansen Bailey & Anglo American, 2012).
- Away from disturbances, such as roads or tracks.
- Outside of mapped rehabilitation areas.
- Within the FoxMan Mining Lease.
- Outside of the floodplain.
- Within an accessible location, without impact on health and safety to reach location.

The selection of cattle grazing PMLU analogue sites is described in Section 3.2.

Cattle Grazing PMLU Rehabilitation Monitoring Parameters

General Monitoring Information

The following general monitoring information will be collected during each monitoring event:

- Visual records using photographs.
- Climatic variables, including recent rainfall events, intensity, duration, measurement in relation to time of seeding.
- Potential impacts of other climatic events such as intense rainfall events, cyclones, droughts, and floods.
- Other factors that have adversely affected rehabilitation areas, including fire, predation by insects, excessive grazing impact of herbivores, instances of vegetation die-back or soil disturbance caused by feral animals, e.g., pigs or rabbits.

Landform and Erosion

Landform and erosion monitoring should take place annually in the monitoring schedule. Before field monitoring takes place, a desktop assessment using LiDAR can be utilised to generate a DEM. The DEM can be used to assess the rehabilitated slope by comparison to the final landform, as well as ongoing monitoring of the landform and slopes. The desktop analysis will identify progression of erosion features such as developing rills and gullies.

Field based erosion monitoring will be conducted at monitoring sites, as well as new areas identified in the desktop assessment. The survey should involve a 50 m transect run perpendicular to the slope.

The following information is recorded at each site:

- GPS reading of location.
- General description of type of erosion (gully [>30 cm], rill line [<30 cm], circular failure, tunnelling etc.); and possible causes.
- Depth of erosion.
- Width of erosion.
- Length of erosion.
- Where eroded material is being deposited; and
- Whether the erosion line is being stabilised by vegetation.

Erosion severity should be ranked using the criteria displayed in Table 3-72.

Table 3-72: Field Erosion Monitoring Criteria

Erosion Classification	Minor	Moderate	Severe	Extreme
No. of rills/gully	< 15	15 - 30	31 - 50	> 50
Average depth (cm)	< 10	10 - 30	30-60	> 60
Proportion of site affected by disturbance (%)	< 1	1 - 5	>5	-

Soil and Spoil

A soil and spoil assessment should be undertaken analysing the parameters described in Table 3-73 and records kept as part of the topsoil inventory.

Table 3-73: Soil and Spoil Analysis Parameters for Rehabilitation Monitoring

Category	Analyte	Purpose of analyte	Depth	
			Surface	Sub-surface
Acidity / alkalinity	pH	Identify anomalies that may affect plant growth and sustainability.	✓	✓
Salinity	EC	Identify leaching profile. High salinity can lead to poor vegetation germination and establishment, reduced plant growth and vigor.	✓	✓
Exchangeable cations	Cation exchange capacity (CEC)	Major factor in soil fertility. Controls soil stability, nutrient availability and buffers soil's chemical properties.	✓	✓
	Exchangeable Sodium Percentage (ESP)	ESP is a measure of the dominance of sodium ions on the soil's cation exchange complex. Sodicity in soils can lead to slaking and dispersion which impact soil structure and stability.	✓	✓
Organic matter	Organic carbon	An indicator of soil nutrient stores and a contributor to improvements in soil structure. Increases in organic carbon is a key indicator of rehabilitation success?	✓	-
Major elements	Total Nitrogen	Indicator of soil nutrient store and is also a major plant nutrient.	✓	-
	Extractable Phosphorous (Colwell method)	Indicator of phosphorous readily available to plants.	✓	-
	Total Phosphorous	Indicator of total store of phosphorus, some of which is readily available. Key indicator of potential for long-term success or failure of rehabilitation.	✓	-

Groundcover

Groundcover will be assessed at all monitoring sites 1 year after topsoil spreading and seeding has taken place. This will give vegetation sufficient time to establish on rehabilitated surfaces. Groundcover type should be recorded from the following categories with their corresponding percentage of cover:

- Live cover (record species).
- Standing dry cover.
- Litter.
- Rock.
- Fallen woody debris.

- Bare ground.

Invasive Plants

An invasive plant is a prohibited or restricted matter under the *Queensland Biosecurity Act 2014*, and is defined as a species that has, or is likely to have an adverse impact on a biosecurity consideration because of the introduction, spread or increase in population size of the species in an area. A complete list of invasive plant species is listed in schedule 4 of the *Biosecurity Regulation 2016*.

Invasive plants will be assessed at the permanent rehabilitation monitoring sites and reference sites as part of all monitoring phases. The presence of invasive plants and their relative abundance should be recorded at each monitoring site.

Pasture Species Richness

Pasture species richness will be assessed at the permanent rehabilitation monitoring sites for all monitoring events. Species are classified into the number of preferred pasture species (identified as perennial grasses that are productive and palatable to stock (3P)), intermediate pasture species, undesirable species and annual species occurring within the pasture.

Species richness in the lower, upper and midstory will be calculated. A species inventory will also be collected at each monitoring site.

Pasture Condition

Pasture condition will be assessed in Year 3 of rehabilitation monitoring. This allows at least two seasons after seeding for pasture species to establish. Pasture condition includes an assessment of the number of 3P species, as well as an estimate of the percentage dry matter (DM) yield in kg/ha comprised of 3P pasture species versus the percentage DM yield in kg/ha of annual and undesirable grasses.

Grazing Land Suitability Assessment (LSA)

The land suitability assessment (LSA) using the Class 4 Grazing criteria in Section 3.7.2 will be undertaken as required. This will help determine if soil ameliorants are working or if further treatments are required.

3.7.3. Watercourse PMLU Monitoring Methodology

Watercourse monitoring will be conducted at Fox to assess the performance of the creek diversions and rehabilitated watercourses disturbed by mining activities. The purpose of the monitoring is to assess the performance of the rehabilitated watercourses in achieving watercourse surface requirements (G10) and meeting rehabilitation goals of safe, non-polluting, stable and sustaining of the PMLU.

Index Diversion Condition (IDC)

Watercourse monitoring will be undertaken in accordance with the Index of Diversion Condition (IDC) methodology which is outlined in the *Monitoring and Evaluation Program for Bowen Basin River Diversions* (ACARP, 2001). The IDC is a quantitative monitoring method used to measure the geomorphic and riparian condition of diversions; however, it can be utilised for both diverted and rehabilitated reaches of watercourses.

The IDC methodology encompasses:

- Visual inspection of the diversion/rehabilitated watercourse and upstream and downstream reaches (analogue sites)
- Assessment of geomorphic index and riparian index at nominated monitoring points within the diversion/rehabilitated watercourse, upstream and downstream reaches
- Determination of reach-averaged geomorphic index and riparian vegetation index and overall IDC scores for the diversion/rehabilitated watercourse, upstream and downstream reaches

- Comparison of the geomorphic index and riparian vegetation index and overall IDC scores for the diversion/rehabilitated watercourse reaches to the relative upstream and downstream reaches.

The indicators for the geomorphic index and riparian index include:

- Geomorphic index:
  - Width of high flow channel, active channel and low flow channel.
  - Bank condition.
  - Piping of banks.
  - Bed condition.
  - Spoil piles.
  - Recovery.
  - In-stream structures.
- Riparian index:
  - Width of riparian zone.
  - Structural intactness.
  - Regeneration.
  - Longitudinal continuity.

The IDC method is applied to the monitoring sites defined in each of the upstream, diversion and downstream reaches (detailed in Section 3.7.3). Each indicator is assigned a score within each site. The average scores for each indicator from the four sites are then used to calculate the overall score for the geomorphic index (maximum score is 10) and riparian index in each reach (maximum score is 10). The sum of the geomorphic and riparian index is then calculated to determine the overall IDC score (maximum score is 20) for each reach. A low IDC score indicates a poor waterway condition.

The maximum possible score for any reach using the IDC assessment is 20. If a reach were to achieve this score it would be in a stable geomorphic condition with minimal erosion or accelerated rate of sedimentation. It would also have continuous and dense vegetative ground, mid-storey, and over-storey riparian vegetation. Outside of mining areas, this score would be rare, as most streams in central Queensland, as elsewhere, are subject to pressures of human use including grazing, infrastructure and other activities.

The IDC guidelines have defined the condition classification for the IDC scores as follows (ACARP, 2001):

- 4 to 8 is ‘poor’ condition.
- 8 to 12 is ‘moderate’ condition.
- 12 to 16 is ‘good’ condition.
- 16 to 20 is ‘very good’ condition.

These IDC scores will be compared to the performance of the analogue sites. Scores consistent with analogue sites indicate that diversion reaches are on a trajectory towards relinquishment.

Monitoring Schedule

The monitoring schedule for watercourse PMLU is displayed in Table 3-74.

Table 3-74: Monitoring Schedule for Watercourse PMLU

Monitoring Parameters	Monitoring Schedule				
	Monitoring Detail	Year 1	Year 2	Year 5	Year 10+ (5-yearly thereafter)
Geomorphic index parameters					
Stream width	Width of high flow channel (m) Width of active channel (m) Width of low flow channel (m)	✓	✓	✓	✓
Bank condition	Presence of erosion	✓	✓	✓	✓
Piping of banks	Presence of piping on the banks	✓	✓	✓	✓
Bed condition	Presence of aggradation or degradation within the channel bed	✓	✓	✓	✓
Spoil piles	Proximity of spoil dumps in relation to the monitoring point	✓	✓	✓	✓
Recovery	Presence or absence of benches with/without vegetation	✓	✓	✓	✓
Instream structures	Stability of each identified instream structure	✓	✓	✓	✓
Riparian vegetation index parameters					
Riparian zone	Width of riparian zone (m)	✓	✓	✓	✓
Structural intactness	Over-storey, understorey and ground cover (% density)	✓	✓	✓	✓

Monitoring Parameters	Monitoring Schedule				
	Monitoring Detail	Year 1	Year 2	Year 5	Year 10+ (5-yearly thereafter)
Regeneration	Presence or absence of regeneration on banks	-	✓	✓	✓
Longitudinal continuity	Assess the gaps in the riparian vegetation corridor along the banks	✓	✓	✓	✓

Monitoring Sites

The monitoring program for the Carlo (Engeny, 2022), Cockatoo (Alluvium, 2019; Engeny, 2022) and Roper Creek (Engeny, 2022)Diversions have been structured to assess the condition of the diversion reach against the upstream and downstream reaches of each creek. An upstream, downstream and diversion reach has been identified in the baseline studies for each monitoring program.

The monitoring site locations for each diversion are listed in Table 3-75 to Table 3-77. The locations of monitoring points and diversion reaches are displayed in Section 3.5.7.

The selection of analogue sites for IDC methodology is presented in Section 3.7.3.

Table 3-75: Location of Monitoring Points for the Carlo Creek Diversion (Engeny, 2022)

Monitoring Reach	Monitoring Point	Easting	Northing
Upstream	CC_U1	686208	7459376
	CC_U2	686294	7459161
	CC_U3	686095	7459025
	CC_U4	686126	7458741
Diversion	CC_Div1	686327	7458418
	CC_Div2	686675	7457695
	CC_Div3	686913	7457262
	CC_Div4	687126	7456995
Downstream	CC_D1	687118	7456923
	C C_D2	687019	7456716
	CC_D3	686756	7456593
	CC_D4	686636	7456516

Table 3-76: Location of Monitoring Points for the Roper Creek Diversion (Engeny, 2022)

Monitoring Reach	Monitoring Point	Easting	Northing
Upstream	RC_U1	684667	7454825
	RC_U2	685074	7454825
	RC_U3	684967	7454607
	RC_U4	685035	7454460
Diversion	RC_Div1	685361	7453974
	RC_Div2	685474	7453747
	RC_Div3	685799	7453475
	RC_Div4	686051	7453292
Downstream	RC_D1	686310	7453532
	RC_D2	686527	7453608
	RC_D3	686680	7453682
	RC_D4	686744	7453850

Table 3-77: Location of Monitoring Points for the Cockatoo Creek Diversion (Engeny, 2022)

Monitoring Reach	Monitoring Point	Easting	Northing
Upstream Reach	CKC_U1	681916	7469706
	CKC_U2	681986	7469340
	CKC_U3	682025	7469176
	CKC_U4	681991	7468922
	CKC_U5	681927	7468788
Stage 4 Diversion	CKC_S4_1	681872	7468422
	CKC_S4_2	682414	7467229
	CKC_S4_3	682689	7466517
	CKC_S4_4	682925	7465822
Intermediate Reach	CKC_Int1	683121	7465273
	CKC_Int2	683336	7464779
	CKC_Int3	683487	7464234
	CKC_Int4	683475	7463636
Stage 2 Diversion	CKC_St1_2-1	683495	7462690
Stage 5 Diversion	CKC_St5_Div1	683425	7462149
	CKC_ St5_Div2	683172	7461342
	CKC_ St5_Div3	683169	7460681
	CKC_ St5_Div4	683607	7460250
Stage 1 Diversion	CKC_St1_2-4	683776	7459998

Monitoring Reach	Monitoring Point	Easting	Northing
Downstream Reach	CKC_D1	684578	7459177
	CKC_D2	684460	7458905
	CKC_D3	684464	7458728
	CKC_D4	684355	7458505

Receiving Environment Monitoring

Receiving environments monitoring will be undertaken in accordance with the Receiving Environment Monitoring Program Design Document (REMP) (Gauge Industrial and Environmental, 2022) which adheres to the EA surface water monitoring requirements. It is also consistent with Appendix 2 of the EA requiring that creek diversions be rehabilitated to operate in equilibrium with adjoining reaches of the watercourse. Parameters of receiving environments monitoring include and are listed in the monitoring schedule (Table 3-78):

- Flow Monitoring
- Water Quality Monitoring
- Sediment Monitoring
- Biological monitoring

Monitoring results from downstream, impact areas will be compared to monitoring results from upstream areas, identified as reference sites.

Monitoring Schedule

The monitoring schedule for receiving environments is displayed in Table 3-78.

Table 3-78: Receiving Environments Monitoring Schedule

	Monitoring Schedule			
Parameter	Year 1	Year 2	Year 5	**Year 10+ (5-yearly thereafter)**
Flow Monitoring				
Stream height	✓	✓	✓	
Calculated Flow	✓	✓	✓	
Calculated Magnitude	✓	✓	✓	
Stage	✓	✓	✓	
Water Quality Monitoring				
Electrical Conductivity	✓	✓	✓	✓
pH	✓	✓	✓	✓
Dissolved Oxygen	✓	✓	✓	✓
Temperature	✓	✓	✓	✓
Turbidity	✓	✓	✓	✓
Total suspended solids	✓	✓	✓	✓
Sulphate	✓	✓	✓	✓
Sodium	✓	✓	✓	✓
Fluoride	✓	✓	✓	✓

	Monitoring Schedule			
Parameter	Year 1	Year 2	Year 5	**Year 10+ (5-yearly thereafter)**
Nitrate as N	✓	✓	✓	✓
Ammonia as N	✓	✓	✓	✓
Total petroleum hydrocarbons	✓	✓	✓	✓
Total hardness	✓	✓	✓	✓
Silver (Ag)	✓	✓	✓	✓
Aluminium (Al)	✓	✓	✓	✓
Arsenic (As)	✓	✓	✓	✓
Boron (B)	✓	✓	✓	✓
Cadmium (Cd)	✓	✓	✓	✓
Chromium (Cr)	✓	✓	✓	✓
Cobalt (Co)	✓	✓	✓	✓
Copper (Cu)	✓	✓	✓	✓
Iron (Fe)	✓	✓	✓	✓
Manganese (Mn)	✓	✓	✓	✓
Molybdenum (Mo)	✓	✓	✓	✓
Lead (Pb)	✓	✓	✓	✓
Mercury (Hg)	✓	✓	✓	✓
Nickle (Ni)	✓	✓	✓	✓
Selenium (Se)	✓	✓	✓	✓
Uranium (U)	✓	✓	✓	✓
Vanadium (V)	✓	✓	✓	✓
Zinc (Zn)	✓	✓	✓	✓
Sediment Monitoring				
Particle size distribution (PSD)	✓	✓	✓	✓
Biological Monitoring				
Macroinvertebrate identification	✓	✓	✓	✓
Edge and/or pool habitat	✓	✓	✓	✓
Site/habitat physical assessment description	✓	✓	✓	✓

Monitoring Sites

Receiving environment monitoring points (both reference and impact) are displayed in Table 3-79 and Figure 3-49.

Table 3-79: Receiving Environment Water Quality Points

Site Code	Site Name	Type	Latitude	Longitude
CCUS	Cockatoo Creek US	Reference	-22.8904	148.7661
RCUS	Roper Creek US	Reference	-22.87623	148.6719
PCDS	Parrot Creek US	Reference	-22.9218	148.6665
CaCUS	Carlo Creek US	Reference	-22.9241	148.8266
RCDS	Roper Creek DS	Impact	-23.00984	148.84109
CCDS	Cockatoo Creek DS	Impact	-23.0036	148.8326
RCDS @ BP	Roper Creek DS at Barwon Park	Impact	-23.0570	148.8881

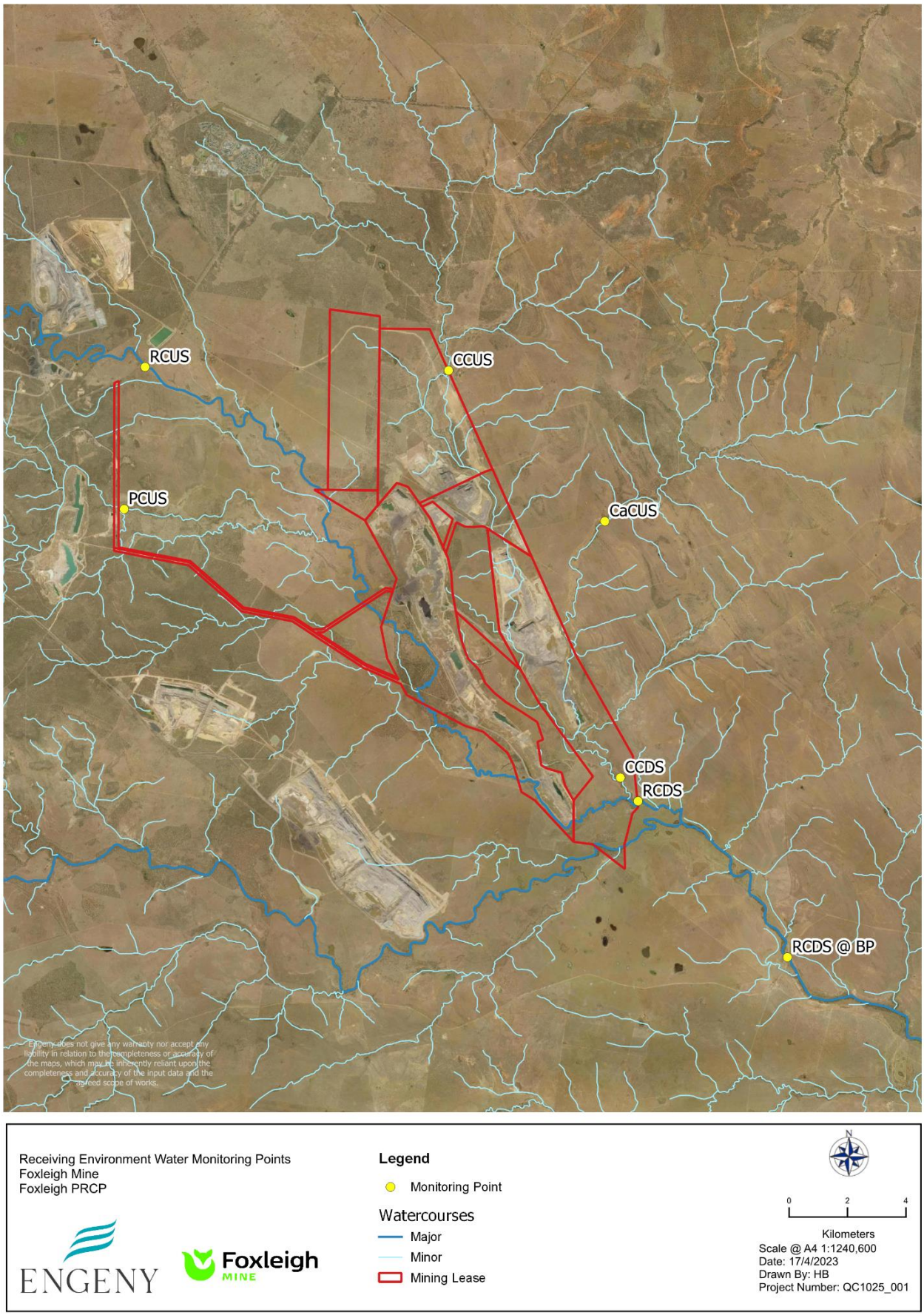

Figure 3-49: Receiving Environment Monitoring Points

3.7.4. Native Ecosystem Corridor PMLU Monitoring Methodology

Monitoring Schedule

The monitoring program follows a phased approach whereby initial monitoring is undertaken on an annual basis for the first three years to assess the performance of rehabilitation as it relates to vegetation establishment and achieving initial surface requirements (Table 3-80). This approach allows a timely assessment of the performance of rehabilitation post initial seeding and provides critical information to determine if rehabilitation is on track towards achieving surface requirements or if maintenance is required (Section 3.7.4).

Additional rehabilitation parameters are included into the monitoring program in years three, five, ten and five yearly thereafter (Table 3-81), to assess and track the performance of rehabilitation in relation to achievement of surface requirements (RM13) and achievement of PMLU to a stable condition (RM17). The phased approach of the monitoring program ensures that there is continual monitoring of rehabilitation parameters against milestone criteria up to the point of EA surrender.

Table 3-80: Native Ecosystem Corridor PMLU Monitoring Schedule and Measured Rehabilitation Parameters

Rehabilitation parameter	Monitoring schedule				
	Year 1	Year 2	Year 3	Year 5	Year 10+ (5 yearly thereafter)
Cattle grazing PMLU					
Landform and erosion	✓	✓	✓	✓	✓
Soil and spoil	✓	✓	✓	✓	✓
Groundcover	✓	✓	✓	✓	✓
Invasive plants	✓	✓	✓	✓	✓
Pasture species richness	✓	✓	✓	✓	✓
Pasture condition	-	-	✓	✓	✓
Grazing Land Suitability Assessment	✓	✓	✓	✓	✓

Monitoring Sites

Monitoring sites for the Native Ecosystem Corridor PMLU are listed in Table 3-81 and displayed in Figure 3-34. The selection of native ecosystem corridor PMLU analogue sites is described in Section 3.7.4.

Table 3-81: Monitoring Locations for the Native Ecosystem Corridor PMLU

Site ID	Analogue Site	Easting	Northing
NE_1	Native Ecosystem Corridor	682025	7461682
NE_2	Native Ecosystem Corridor	679923	7460783

Monitoring Parameters

Native ecosystem corridor monitoring will be conducted at Fox to assess the performance of the corridor in achieving a sustainable connective corridor between Cockatoo creek and Roper creek (east to west). Monitoring will also ensure the corridor meets the rehabilitation goals of safe, non-polluting, stable and sustaining of the PMLU.

The following general monitoring information will be collected during each monitoring event:

- Visual records using photographs.
- Climatic variables, including recent rainfall events, intensity, duration, measurement in relation to time of seeding.
- Potential impacts of other climatic events such as intense rainfall events, cyclones, droughts and floods
- Other factors that have adversely affected rehabilitation areas, including fire, predation by insects, excessive grazing impact of herbivores, instances of vegetation die-back or soil disturbance caused by feral animals, e.g., pigs or rabbits.

Landform and Erosion

Monitoring for landform and erosion will occur within the same parameter outlined in the Section 3.7.2 (See Table 3-72).

Soil and Spoil

A soil and spoil assessment should be undertaken analysing the parameters described in Table 3-73 annually (within Cattle Grazing PMLU Habitat Monitoring Section above).

Groundcover

Groundwater will be assessed at all monitoring events one (1) year after topsoil spreading and seeding has taken place. This will give vegetation sufficient time to establish on rehabilitated surfaces. Groundcover type should be recorded from the following categories with their corresponding percentage of cover:

- Live cover (record species).
- Standing dry cover.
- Litter.
- Rock.
- Fallen woody debris.
- Bare ground.

Invasive Plants

An invasive plant is a prohibited or restricted matter under the *Queensland Biosecurity Act 2014*, and is defined as a species that has, or is likely to have an adverse impact on a biosecurity consideration because of the introduction, spread or increase in population size of the species in an area. A complete list of invasive plant species is listed in schedule 4 of the *Biosecurity Regulation 2016*.

Invasive plants will be assessed at the permanent rehabilitation monitoring sites and reference sites as part of all monitoring phases. The presence of invasive plants and their relative abundance should be recorded at each monitoring site.

Fauna

It is recommended that monitoring be included for fauna movement and presence within the corridor.

Monitoring can be conducted opportunistically during any monitoring within the corridor and includes:

- Incidental fauna sightings e.g., koalas, Squatter Pigeon.
- Evidence of faun presence e.g., scratches on trees, scats.
- Presence of nests, hollows, and other primary fauna retreat areas.

As the PMLU develops vegetation, it would be expected that opportunistic sightings of fauna and presence of fauna will increase. However, it is not mandatory requirement to demonstrate an achieved PMLU.

Opportunistic Fauna Monitoring

Given the premise of the PMLU is to establish a native ecosystem corridor, opportunistic fauna monitoring will be conducted during the above-mentioned scheduled monitoring schedule (Table 3-71). this monitoring includes identifying the following indicators of fauna presence/increase fauna utilisation of both native and introduced/feral species:

- Scats.
- Scratches on trees (e.g., koalas).
- Nests.
- Ground disturbance such as scratching or burrowing.
- Audible presence of fauna.
- Visual presence of fauna.
- Utilisation of hollows or nesting cavities.

These elements are to be recorded as identified. Post completion of year 5 monitoring, a review of the opportunistic data is recommended to be undertaken to identify trends of fauna movement or utilisation of the corridor.

Vegetation Transects

Vegetation transects are to be undertaken in accordance with the monitoring schedule stated in Table 3-71. it is recommended that transect locations are selected at the end sections of the corridor for the purpose of identifying native species migration into the corridor.

Transects are to be conducted in accordance with the Vegetation Assessment Guide (Australian Government, 2013).

3.7.5. Groundwater Monitoring

Groundwater monitoring will be continued in accordance with Schedule E in the EA and updated pending defined trigger limits.

3.7.6. NUMA Milestone Monitoring

Management milestone monitoring will be undertaken at Fox to demonstrate achievement of the MMs, as they relate to achieving sufficient improvement of the NUMA extents. The MMs and associated milestone criteria for Fox are detailed in Section 3.7.6.

The following reporting requirements (Table 3-82) will be undertaken to demonstrate how management activities will support achievement of sufficient improvement of the NUMA extents prior to site relinquishment.

Table 3-82: Proposed Monitoring for Management of NUMAs

Management milestone	Reporting requirements	Frequency					
		Year 1	Year 2	Year 3	Year 4	Year 5	Year 10+ (5 yearly thereafter)
MM1 Achievement of structural stability	Undertake geotechnical monitoring	✓	-	-	-	✓	✓
MM2 Achievement of surface requirements	Undertake and document visual inspections	✓	-	✓	-	✓	✓
MM3 Achievement of sufficient improvement	Undertake and document monitoring of groundwater levels, EC and pH, void water levels and void water quality*	✓	✓	✓	✓	✓	✓

*Aligned to the groundwater monitoring schedule in Section 3.7.5 (in accordance with EA requirements, annually; in 5-year increments as needed)

3.7.7. PMLU Achievement Schedule

As outlined in Section 3.7, RM1 to RM11 will be subject to ongoing reporting requirements to ensure achievement of the associated milestone criteria. The timing of the rehabilitation milestones specific to achievement of surface requirements (RM12 – RM14) and achievement of PMLU to a stable condition (RM15 – RM17), are listed in Table 3-83 and detailed in Sections 3.1.6.

Table 3-83: Time for Achievement of Surface Requirements and PMLUs Rehabilitation Milestones

Rehabilitation Milestone	Rehabilitation Milestone	Milestone Achievement Timeline after Revegetation (In PRCP Schedule)
RM12	Achievement of surface requirements (cattle grazing)	5 years
RM13	Achievement of surface requirements (watercourse)	10 years
RM14	Achievement of surface requirements (native ecosystem corridor)	10 years
RM15	Achievement of post-mining land use to a stable condition (cattle grazing)	Up to 15 years
RM16	Achievement of post-mining land use to a stable condition (watercourse)	Up to 20 years

Rehabilitation Milestone	Rehabilitation Milestone	Milestone Achievement Timeline after Revegetation (In PRCP Schedule)
RM17	Achievement of post-mining land use to a stable condition (native ecosystem corridor)	Up to 15 years

The timing of the management milestones specific to achievement of sufficient improvement (MM3) is listed in Table 3-84.

Table 3-84: Timeline for Achievement of Sufficient Improvement for NUMA Management Milestones

Management Milestone	Management Milestone	Milestone Achievement Timeline (In PRCP Schedule)
MM3	Achievement of sufficient improvement	Aligned with achievement of PMLUs (RM15, RM16 and RM17) to ensure maximum monitoring period

Cattle Grazing

Achievement of surface requirements for cattle grazing RM9 is proposed within a 10-year timeframe commencing upon completion of revegetation activities associated with RM5 including seeding in accordance with recommended pasture mixes and seeding rates in Section 3.7.2 (Table 3-59). There are a number of factors which can influence the successful establishment of pastures on post-mined land including soils and landform, soil management and amelioration, species selection, seeding rates and seeding timing plus rainfall.

Achievement of PMLU to a stable condition for cattle grazing RM11 is proposed within a 15-year timeframe from initial revegetation. This will allow for sufficient time to demonstrate the ongoing sustainability of the PMLU for cattle grazing through additional rehabilitation monitoring data associated with landform, erosion, soils, pastures and surface water (Section 3.7.2).

Watercourse

Achievement of surface requirements for watercourse habitat RM10 is proposed within a 20-year timeframe from revegetation.

Native Ecosystem Corridor

Achievement of surface requirement for a native ecosystem corridor is proposed within a 10-year timeframe commencing upon completion of revegetation activities of surrounding areas.

NUMAs

The achievement schedule of sufficient improvement of the NUMA extents is proposed to be aligned with demonstrable achievement of the site's PMLUs, namely:

- Achievement of PMLU to a stable condition for cattle grazing RM11 is proposed within a 15-year timeframe.
- Achievement of PMLU use to a stable condition for watercourse RM12 is proposed within a 20-year timeframe.

- Achievement of a PMLU use to a stable condition for native ecosystem corridor RM17 is proposed within a 10-year timeframe.

This alignment provides a maximum monitoring period allowance to enable demonstration of sufficient NUMA improvement.

3.7.8. Maintenance

Maintenance will be implemented when monitoring identifies issues with the rehabilitation, or when milestone criteria are not being met. To select the most appropriate corrective actions, the likely cause would be assessed. Contributing factors may be related to:

- Climatic conditions (i.e., droughts and floods).
- Invasive plant presence.
- Invasive or unauthorised fauna access.
- Poor drainage design.
- Insufficient vegetation cover.
- Influence of adjacent land uses.
- Soil type.

3.7.9. Data Analysis and Reporting

Rehabilitation monitoring data will be collected and analysed by an appropriately qualified person and assessed against the milestone criteria. The data will be analysed to identify changes and trends, as well as map the trajectory of rehabilitation to identify whether it is on track to achieve the milestone criteria or requires corrective actions or maintenance.

The rehabilitation data will be stored and processed within internal geospatial and Fox document management systems.

3.7.10. Quality Assurance and Quality Control

Fox follows a quality assurance and quality control (QA/QC) process as part of the Fox ongoing rehabilitation monitoring through the monitoring regime set within the rehabilitation trials. The process provides for initial execution of the rehabilitation in accordance with the rehabilitation measures, followed by verification of how this execution was undertaken. Based on the verification outcomes, allowance is made for interpretation of corrective action and/or maintenance, as needed. The rehabilitated areas as well as corrected and/or maintenance areas then undergo further rehabilitation monitoring and subsequent execution of the rehabilitation measures. This process allows for respective execution, verification, monitoring QA/QC approach, to ensure rehabilitation areas progress on a trajectory towards achievement of milestone criteria and eventual certification.

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4. Appendices

- **Appendix A**: Environmental Authority EPML00744813
- **Appendix B**: Queensland Department of Environment and Science (26 July 2021) Progressive rehabilitation and closure plan Transition Notice. Ref. EPML00744813
- **Appendix C**: Department of Environment and Science (11 May 2021) Meeting minutes Foxleigh Coal Mine – Initial PRCP Transition Meeting.
- **Appendix D**: Hansen Bailey (2 April 2012) Foxleigh Plains Project Socio-economic Impact Assessment
- **Appendix E**: Foxleigh Land (12 September 2018) Infrastructure Written Agreement 1
- **Appendix F**: Rees R & Sydney Jones (15 March 2018) ML70171- Agreement for Sale and Purchase - Small
- **Appendix G**: Foxleigh (2023) Stakeholder Engagement Plan
- **Appendix H:** Engeny (August 2023) PRCP Flood Assessment
- **Appendix I**: Groundwater Functions (November 2022) Report on Groundwater Modelling of Foxleigh Coal Mine. Report reference GWF21/01
- **Appendix J**: Engeny (16 May 2023) Foxleigh Landform PRCP Assessment QC1025_011-REP-001-1
- **Appendix K**: RGS Mine Waste and Water Management (20 October 2021) Geochemical characterisation of mining waste, coal, and soil.
- **Appendix L**: Henderson Geotech Pty Ltd (July 2023) Cover Designs for CHPP Waste
- Cartledge Mining and Geotechnics (May 2022) Standard Geotechnical Design Guidelines. MMS010002-AA_Rev 2
- **Appendix M**: Engeny (August 2023) PRCP Residual Voids Geotechnical Assessment
- **Appendix N**: Cartledge Mining and Geotechnics (May 2022) Standard Geotechnical Design Guidelines. MMS010002-AA_Rev 2
- **Appendix O**: WRM (24 March 2023) Final Void Hydrology Report
- **Appendix P**: PRCP Risk Assessment
- **Appendix Q**: Engeny (3 May 2023) Contaminated Lands Guidance QC1025_005-RPT-001-1
- **Appendix R**: Department of Environment and Heritage Protection (1 July 2013) Environmental Impact Assessment Report under the Environmental Protection Act 1994 for the Foxleigh Plains Project.
- **Appendix S**: Part B – PRCP Schedule

Appendix A: EA EPML00744813

Permit

Environmental Protection Act 1994

Environmental authority EPML00744813 – Foxleigh Mine

This environmental authority is issued by the administering authority under Chapter 5 of the Environmental Protection Act 1994.

Permit number: EPML00744813

Takes Effect From: 11 August 2023

Anniversary date: 21 September

Environmental authority holder(s)

Name	Registered address
CAML Resources Pty Ltd	Level 12 300 Queen Street BRISBANE CITY QLD 4000
Nippon Steel Australia Pty Limited	
Foxleigh Coal Pty Ltd	

Environmentally relevant activity and location details

Environmentally relevant activity(ies)	Location(s)
Environmental Protection Regulation 2019 **, Schedule 3:** ERA13 Mining black coal ***Environmental Protection Regulation 2019*****, Schedule 2:** ERA 31 Mineral processing, Threshold 2 – Processing, in a year, the following quantities of mineral products, other than coke – (b) more than 100,000t. ERA 8 Chemical storage, Threshold 3 – Storing more than 500m^3 total quantity of chemicals of Class 1 or C2 combustible liquids under AS 1940 or dangerous goods class 3 under subsection 1(c). ERA 15 Fuel burning – Using fuel burning equipment that is capable of burning at least 500kg of fuel in an hour. ERA 16 Extractive and screening activities, Threshold 3 – Screening, in a year, the following quantity of material – (c) more than 1,000,000t. ERA 33 Crushing, milling grinding or screening – Crushing, grinding, milling or screening more than 5,000t of material in a year. ERA 56 Regulated waste storage – Receiving and storing regulated waste. ERA 60 Waste disposal, Threshold 1 – Operating a facility for disposing of, in a year, the following quantity of waste mentioned in subsection (1)(a) – (a) less than 50,000t.	ML70171 ML70309 ML70310 ML70429 ML70430 ML70431 ML70470

Additional information for applicants

Environmentally relevant activities

The description of any environmentally relevant activity (ERA) for which an environmental authority is issued is a restatement of the ERA as defined by legislation at the time the approval is issued. Where there is any inconsistency between that description of an ERA and the conditions stated by an environmental authority as to the scale, intensity or manner of carrying out an ERA, then the conditions prevail to the extent of the inconsistency.

An environmental authority authorises the carrying out of an ERA and does not authorise any environmental harm unless a condition stated by the authority 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 if an owner or occupier of land becomes aware a notifiable activity (as defined in Schedule 3 and Schedule 4) is being carried out on the land, or that the land has been, or is being, contaminated by a hazardous contaminant, the owner or occupier must, within twenty-two (22) business days after becoming so aware, give written notice to the chief executive.

Juliana McCosker
Department of Environment and Heritage Protection
Delegate of the administering authority
Environmental Protection Act 1994

Enquiries:
Buisness Centre (Coal)
Department of Environment and Science
PO Box 3028
EMERALD QLD 4720
Phone: (07) 4987 9320
Email: CRMining@des.qld.gov.au

Date issued: 11 August 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

Schedule A - General	
Condition number	**Condition**
A1	This environmental authority authorises environmental harm referred to in the conditions. Where there is no condition or this environmental authority is silent on a matter, the lack of a condition or silence does not authorise environmental harm.
A2	In carrying out the mining activity authorised by this environmental authority, the holder of this environmental authority must comply with *Appendix 1 - Figure 1: Approved Foxleigh Mine Activities* attached to this environmental authority.
Maintenance of measures, plant and equipment	
A3	The holder of this environmental authority must: a) install all measures, plant and equipment necessary to ensure compliance with the conditions of this environmental authority; b) maintain such measures, plant and equipment in a proper and efficient condition; c) operate such measures, plant and equipment in a proper and efficient manner; and d) ensure all instruments and devices used for the measurement or monitoring of any parameter under any condition of this environmental authority are properly calibrated.
Monitoring	
A4	Upon request from the administering authority, copies of monitoring records and reports should be made available and provided to the administering authority's nominated office within 10 business days or an alternative timeframe agreed between the administering authority and the holder.
A5	Any management or monitoring plans, systems or programs required to be developed and implemented by a condition of this environmental authority should be reviewed for effectiveness in minimising the likelihood of environmental harm on an annual basis, and amended promptly if required, unless a particular review date and amendment program is specified in the plan, system or program.
A6	Except where specified otherwise in another condition of this authority, all monitoring records or reports required by this environmental authority must be kept for a period of not less than 5 years.
Risk management	
A7	The holder of this environmental authority must develop and implement a risk management system for mining activities which mirrors the content requirement of the *Standard for Risk Management (ISO31000:2009)*, or the latest edition of an Australian standard for risk management, to the extent relevant to environmental management, by **three (3) months** from the issue of this EA.
Notification of emergencies, incidents and exceptions	
A8	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; and c) proposed actions to prevent a recurrence of the emergency or incident.
Chemicals and flammable or combustible liquids	
A10	All explosives, hazardous chemicals, corrosive substances, toxic substances, gases and dangerous goods must be stored and handled in accordance with the current Australian standard where such is applicable.
A11	Minimise the potential for contamination of land and waters by diverting stormwater around contaminated areas and facilities used for the storage of chemicals and flammable or combustible liquids.
Complaint Response	
A12	The holder of this environmental authority must record all environmental complaints received about the mining activities including: a) name, address and contact number for 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) any person responsible for resolving the complaint.
A13	The holder of this environmental authority 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.
A14	The results of the investigation required by condition **A13** (including an analysis and interpretation of the monitoring results) and abatement measures, where implemented, must be provided to the administering authority: a) within **ten (10) business days** of completion of the investigation; or b) no later than **ten (10) business days** after the end of the timeframe nominated by the administering authority to undertake the investigation.
Third-party reporting	
A15	The holder of this environmental authority must: a) obtain from a suitably qualified and experienced third party a report on compliance with the conditions of this environmental authority at regular intervals not exceeding **three (3) years** from **20 April 2021**; and b) provide each report to the administering authority within **ninety (90) days** of its completion.

A16	Where a condition of this environmental authority requires compliance with a standard, policy or guideline published externally to this environmental authority and the standard is amended or changed subsequent to the issue of this environmental authority the holder of this environmental authority must: a) comply with the amended or changed standard, policy or guideline within **two (2) years** of the amendment or change being made, unless a different period is specified in the amended standard or relevant legislation, or where the amendment or change relates specifically to regulated structures referred to in condition **J37**, the time specified in that condition; and b) until compliance with the amended or changed standard, policy or guideline is achieved, continue to remain in compliance with the corresponding provision that was current immediately prior to the relevant amendment or change.

Schedule B - Air	
Dust nuisance	
B1	The proponent shall ensure that all reasonable and feasible avoidance and mitigation measures are employed so that the dust and particulate matter emissions generated by the mining activities do not cause exceedances of the following levels when measured at any sensitive or commercial place: a) dust deposition of 120 milligrams per square metre per day, averaged over **one (1) month**, when monitored in accordance with the most recent version of *Australian Standard AS3580.10.1 Methods for sampling and analysis of ambient air—Determination of particulate matter—Deposited matter – Gravimetric method*; b) a concentration of particulate matter with an aerodynamic diameter of less than 10 micrometres (PM_{10}) suspended in the atmosphere of 50 micrograms per cubic metre over a 24-hour averaging time, for no more than five (5) exceedances recorded each year, when monitored in accordance with the most recent version of either: i) *Australian Standard AS3580.9.6 Methods for sampling and analysis of ambient air—Determination of suspended particulate matter—PM10 high volume sampler with size-selective inlet – Gravimetric method*, or ii) *Australian Standard AS3580.9.9 Methods for sampling and analysis of ambient air—Determination of suspended particulate matter—PM10 low volume sampler—Gravimetric method;* c) a concentration of particulate matter suspended in the atmosphere of 90 micrograms per cubic metre over a **one (1) year** averaging time, when monitored in accordance with the most recent version of *AS/NZS3580.9.3:2003 Methods for sampling and analysis of ambient air—Determination of suspended particulate matter—Total suspended particulate matter (TSP)—High volume sampler gravimetric method*.
Meteorological monitoring	
B2	The environmental authority holder must establish and maintain a permanent automatic meteorological station to continuously measure and record wind speed, wind direction, temperature, relative humidity and rainfall intensity. *Note: It is possible for environmental authority holders to utilise relevant and available weather monitoring information collected by other parties as reference data for the purposes of this condition.*
Odour nuisance	
B3	The release of noxious or offensive odour(s) or any other noxious of offensive airborne contaminant(s) resulting from the mining activity must not cause an environmental nuisance at any nuisance sensitive or commercial place.
B4	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 complaints (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.

B5	If the administering authority determines the odour released to constitute an environmental nuisance, 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 form the activity do not result in further environmental nuisance.

Schedule C - Waste management	
C1	Unless otherwise permitted by the conditions of this environmental authority or with prior approval from the administering authority and in accordance with a relevant standard operating procedure, waste must not be burnt.
C2	The holder of this environmental authority may burn vegetation cleared in the course of carrying out the extraction activities provided the activities does not cause environmental harm at any environmentally sensitive place and adheres to the following conditions: a) be in accordance with a Permit to Burn issued under the *Fire and Rescue Service Act 1990*; b) ensure retained trees are not damaged by the burn; c) ensure any infrastructure is not damaged or affected by the burn; d) be twenty (20) metres from any watercourse; e) any nearby neighbors must be notified; and, f) fire authorities must be notified.
Tailings disposal	
C3	Tailings must be managed in accordance with procedures contained within the plan of operations. These procedures must include provisions for: a) containment of tailings; b) the management of seepage and leachates both during operation and the foreseeable future; c) the control of fugitive emissions to air; d) a program of progressive sampling and characterisation to identify acid producing potential and metal concentrations of tailings; e) maintaining records of the relative locations of any other waste stored within the tailings; f) rehabilitation strategy; and g) monitoring of rehabilitation, research and/or trials to verify the requirements and methods for decommissioning and final rehabilitation of tailings, including the prevention and management of acid mine drainage, erosion minimisation and establishment of vegetation cover.
Acid sulphate soils	
C4	Treat and manage acid sulphate soils in accordance with the latest edition of the *Queensland Acid Sulfate Soil Technical Manual.*

Waste rock	
C5	A waste rock and spoil disposal plan should be developed and include, where relevant, at least: a) effective characterisation of the waste rock and spoil to predict under the proposed placement and disposal strategy the quality of runoff and seepage generated concerning potentially environmentally significant effects including salinity, acidity, alkalinity and dissolved metals, metalloids and non-metallic inorganic substances; b) a program of progressive sampling and characterisation to identify dispersive and non-dispersive spoil and the salinity, acid and alkali producing potential and metal concentrations of waste rock; c) A materials balance and disposal plan demonstrating how potentially acid forming and acid forming waste rock will be selectively placed and/or encapsulated to minimise the potential generation of acid mine drainage; d) where relevant, a sampling program to verify encapsulation and/or placement of potentially acid-forming and acid-forming waste rock; e) how often the performance of the plan will be assessed; f) the indicators or other criteria on which the performance of the plan will be assessed; and g) rehabilitation strategy.

Schedule D - Noise and vibration	
Noise nuisance	
D1	Subject to condition **D2** noise from the mining activity must not cause an environmental nuisance at any sensitive or commercial place.
D2	When requested by the administering authority, noise 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 **ten (10) business days** to the administering authority following completion of monitoring.
D3	The method of measurement and reporting of noise levels must comply with the latest edition of the administering authority's *Noise Measurement Manual*.
Vibration nuisance	
D4	Subject to condition **D5** vibration from the mining activity must not cause an environmental nuisance at any sensitive or commercial place.
D5	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 **ten (10) business days** to the administering authority following completion of monitoring.
Airblast overpressure nuisance	
D6	The airblast overpressure level from blasting operations must not exceed the limits defined in *Table 1: Airblast overpressure level* at any sensitive or commercial place.

Table 1: Airblast overpressure level

Location	Airblast overpressure measured
Sensitive or commercial place	Air blast overpressure level of 115db (Linear peak) for nine (9) out of ten (10) consecutive blasts initiated and not greater than 120db (Linear peak) at any time.

D7	When requested by the administering authority, airblast overpressure 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 **ten (10) business days** to the administering authority following completion of monitoring.

D8	Airblast overpressure monitoring must include the following descriptors, characteristics and conditions: a) location of the blast(s) within the mining area; b) atmospheric conditions including temperature, relative humidity and wind speed and direction; and c) location, date and time of recording.
D9	If monitoring indicates exceedance of the relevant limits in *Table 1: 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 airblast overpressure abatement measures so that airblast overpressure from the activity does not result in further environmental nuisance.
D10	The method of measurement and reporting of airblast overpressure levels must comply with the current edition of the administering authority's *Noise Measurement Manual.*
Schedule E - Groundwater	
E1	The holder of this environmental authority must not release contaminants to groundwater.
E2	All determinations of groundwater quality and biological monitoring must be performed by an appropriately qualified person.
E3	The holder of the environmental authority must develop and implement a groundwater monitoring program to monitor groundwater quality and levels by **31 August 2016**. Groundwater monitoring locations and frequencies as per *Table 2: Groundwater monitoring locations and frequency*, quality triggers and limits as per *Table 3: Groundwater quality triggers and limits* and level trigger thresholds as per *Table 4: Groundwater Level Monitoring* must be finalised based on background groundwater monitoring program defined in condition **E4** and be submitted to the administering authority by **31 August 2016**.

Table 2: Groundwater monitoring locations and frequency

Monitoring point	Easting (GDA 94)	Northing (GDA 94)	Surface RL (m)[1]	Monitoring frequency
GMP1	678180	7465000	To be supplied to the administering authority in accordance with condition **E3.**	Levels collected from Rewan and underlying coal measure formations and analysed monthly for the initial twelve (12) months of baseline data collection and following that, quarterly.
GMP2	678370	7470200	To be supplied to the administering authority in accordance with condition **E3.**	Levels collected from Rewan and underlying coal measure formations and analysed monthly for the initial twelve (12) months of baseline data collection and following that, quarterly.
GMP3	681400	7470100	To be supplied to the administering authority in accordance with condition **E3.**	Levels collected from underlying coal measure formations and analysed monthly for the initial twelve (12) months of baseline data collection and following that, quarterly.
GMP4	681400	7470100	To be supplied to the administering authority in accordance with condition **E3.**	Samples collected from alluvium and analysed monthly for the initial twelve (12) months of baseline data collection and following that, quarterly. Standing water levels to be measured monthly.

Table 3: Groundwater quality triggers and limits

Water quality indicator	Unit	Contaminant triggers	Contaminant limit
Aluminium	µg/L	To be supplied to the administering authority as required by condition **E3**	To be supplied to the administering authority as required by condition **E3.**
Antimony	µg/L	To be supplied to the administering authority as required by condition **E3**	To be supplied to the administering authority as required by condition **E3.**
Arsenic	µg/L	To be supplied to the administering authority as required by condition **E3**	To be supplied to the administering authority as required by condition **E3.**
Calcium	µg/L	To be supplied to the administering authority as required by condition **E3**	To be supplied to the administering authority as required by condition **E3.**
Chlorine	µg/L	To be supplied to the administering authority as required by condition **E3**	To be supplied to the administering authority as required by condition **E3.**
CO_3	µg/L	To be supplied to the administering authority as required by condition **E3**	To be supplied to the administering authority as required by condition **E3.**
Dissolved Solids (Total)	µg/L	To be supplied to the administering authority as required by condition **E3**	To be supplied to the administering authority as required by condition **E3.**
Electrical Conductivity	µS/cm	To be supplied to the administering authority as required by condition **E3**	To be supplied to the administering authority as required by condition **E3.**
HCO_3	µg/L	To be supplied to the administering authority as required by condition **E3**	To be supplied to the administering authority as required by condition **E3.**
Iron	µg/L	To be supplied to the administering authority as required by condition **E3**	To be supplied to the administering authority as required by condition **E3.**
Magnesium	µg/L	To be supplied to the administering authority as required by condition **E3**	To be supplied to the administering authority as required by condition **E3.**
Mercury	µg/L	To be supplied to the administering authority as required by condition **E3**	To be supplied to the administering authority as required by condition **E3**
Molybdenum	µg/L	To be supplied to the administering authority as required by condition **E3**	To be supplied to the administering authority as required by condition **E3**
pH	pH Units	To be supplied to the administering authority as required by condition **E3**	To be supplied to the administering authority as required by condition **E3**
Potassium	µg/L	To be supplied to the administering authority as required by condition **E3**	To be supplied to the administering authority as required by condition **E3**
Selenium	µg/L	To be supplied to the administering authority as required by condition **E3**	To be supplied to the administering authority as required by condition **E3**
Silver	µg/L	To be supplied to the administering authority as required by condition **E3**	To be supplied to the administering authority as required by condition **E3**
SO_4	µg/L	To be supplied to the administering authority as required by condition **E3**	To be supplied to the administering authority as required by condition **E3**
Sodium	µg/L	To be supplied to the administering authority as required by condition **E3**	To be supplied to the administering authority as required by condition **E3**

Table 4: Groundwater level monitoring

Monitoring point	Level trigger threshold
GMP1	To be supplied to the administering authority as required by condition E3
GMP2	To be supplied to the administering authority as required by condition **E3**
GMP3	To be supplied to the administering authority as required by condition **E3**
GMP4	To be supplied to the administering authority as required by condition **E3**

E4	A background groundwater monitoring program must be developed to include the following: a) groundwater monitoring locations (bore(s)) that are located an appropriate distance from potential sources of impact from mining activities and are representative of the aquifers potentially affected by mining activities b) representative groundwater samples from each of the bores; c) containment parameters, background groundwater levels, quality triggers and contaminant limits must be determined; d) sampling at a frequency of not less than monthly must be undertaken to determine groundwater levels and quality; e) finalise the required information relating to groundwater under *Table 3: Groundwater quality triggers and limits*, *Table 2: Groundwater monitoring locations and frequencies* and *Table 5: Mine affected water release points, sources and receiving waters* of this environmental authority; Review of the results from the groundwater monitoring program must occur to determine if further assessment on the following aspects below would be warranted: a) groundwater interactions with surface waters of Cockatoo Creek; b) impacts on potential shallow alluvial stygofauna; c) impacts on potential groundwater dependent ecosystems across the site; and d) the role of the Rewan formation and groundwater storage in associated sediments. Note*: If a review of the results indicate deficiencies in data recorded, or, warrants that further assessment is required, the holder of the environmental authority must undertake a more detailed assessment and present a report to the department outlining associated risks within the time period specified by the department.*
E5	The groundwater level and the water quality indicators specified in *Table 3: Groundwater quality triggers and limits* must be monitored for at the locations in *Table 2: Groundwater monitoring locations and frequency* and *Appendix 1, Figure 2*: *Groundwater monitoring locations (bores)* at the frequencies in *Table 2: Groundwater monitoring locations and frequency*.
E6	Groundwater levels when measured at the monitoring locations specified in *Table 2: Groundwater monitoring locations and frequency* and *Appendix 1, Figure 2: Groundwater monitoring locations (bores)* must not exceed the groundwater level trigger thresholds specified in *Table 4: Groundwater level monitoring*.

E7	If water quality indicators listed in *Table 3*: *Groundwater quality triggers and limits* are found to exceed any of the contaminant limits stated in *Table 3: Groundwater quality triggers and limits*, or, groundwater levels stated in *Table 4: Groundwater level monitoring* are found to exceed any of the level trigger thresholds, the holder of this environmental authority must complete an investigation in accordance with the ANZG (2018).
E8	Results of monitoring groundwater from compliance bores identified in *Table 2: Groundwater monitoring locations and frequency* must not exceed any of the contaminant limits defined in *Table 3: Groundwater quality triggers and limits*.
Bore construction and maintenance and decommissioning	
E9	The construction, maintenance, management and decommissioning of groundwater bores (including groundwater monitoring bores) must be undertaken in a manner that prevents or minimises impacts to the environment and ensures the integrity of the bores to obtain accurate monitoring.

Schedule F - Water	
Contaminant release	
F1	Contaminants that will or have the potential to cause environmental harm must not be released directly or indirectly to any waters as a result of the authorised mining activities, except as permitted under the conditions of this environmental authority.
F2	Unless otherwise permitted under the conditions of this environmental authority, the release of mine affected water to waters must only occur from the release points specified in *Table 5*: *Mine affected water release point, sources and receiving waters* and depicted in *Appendix 1, Figure 3: Release Points and Monitoring Point Locations* attached to this environmental authority.

Table 5: Mine affected water release points, sources and receiving waters

Release point (RP)	Latitude (decimal degree, GDA94)	Longitude (decimal degree, GDA94)	Mine affected water source and location	Monitoring point		Receiving waters description
				Water flow	Water quality	
RP 1	-22.9180	148.7890	ML4 Pits, Foxleigh and Foxleigh Plains mining areas	Cockatoo Creek US	Roper Creek DS2	Cockatoo Creek
RP 2	-22.9679	148.7992	Foxleigh and Foxleigh Plains mining areas	Cockatoo Creek US	Roper Creek DS2	Cockatoo Creek
RP 3	-23.0164	148.8196	Far South, Foxleigh and Foxleigh Plains mining areas	Roper Creek US	Roper Creek DS2	Roper Creek

F3	The release of mine affected water to internal water management infrastructure installed and operated in accordance with a water management plan that complies with conditions **F30** and **F31** is permitted.
F4	The release of mine affected water to waters in accordance with condition **F2** must not exceed the release limits stated in *Table 6: Mine affected water release limits* when measured at the monitoring points specified in *Table 5: Mine affected water release points, sources and receiving waters*, *Table 8a: Flow triggers to start mine affected water release* and *Table 8b: Flow triggers to cease mine affected water release* for each quality characteristic.

Table 6: Mine affected water release limits

Quality characteristic	Release limits	Monitoring frequency
Electrical Conductivity (µS/cm)	Electrical conductivity (µS/cm) <10,000	Daily during release (the first sample must be taken within two (2) hours of commencement of release)
pH (pH Unit)	6.5 (minimum) 9.0 (maximum)	Daily during release (the first sample must be taken within two (2) hours of commencement of release)
Turbidity (NTU)	Current limit or limit derived from suspended solids limit and demonstrated correlation between turbidity to suspended solids historical monitoring data for dam water*	Daily during release* (first sample within two hours of commencement of release) Note: *Turbidity is required to assess ecosystems impacts and can provide instantaneous results.*
Suspended solids (mg/L)	650* Limit to be determined based on receiving water reference data and achievable best practice sedimentation control and treatment*	Daily during release* (first sample within two hours of commencement of release)
Sulfate ($SO4_{2-}$) (mg/L)	Sulfate (SO_4^{2-}) (mg/L) < 3,000	Daily during release* (first sample within two hours of commencement of release)

Note: **Limit for suspended solids can be omitted if turbidity limit is included. Limit for turbidity not required if suspended solids limit included. Both indicators should be measured in all cases.*

F5	The release of mine affected water to waters from the release points must be monitored at the locations specified in *Table 5: Mine affected water release points, sources and receiving waters* for each quality characteristics and at the frequency specified in *Table 6: Mine affected water release limits* and *Table 8a: Flow triggers to start mine affected water release* and *Table 8b: Flow Triggers to cease mine affected water release*. Note: *The administering authority will take into consideration any extenuating circumstances prior to determining an appropriate enforcement response, in the event condition **F5** is contravened due to a temporary lack of safe or practical access. The administering authority expects the environmental authority holder to take all reasonable and practicable measures to maintain safe and practical access to designated monitoring locations.*

Table 7: Release contaminant trigger investigation levels, potential contaminants

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	For aquatic ecosystem protection, based on SMD guideline	
Copper	2	For aquatic ecosystem protection, based on SMD guideline	
Iron	300	For aquatic ecosystem protection, based on low reliability guideline	
Lead	4	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	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	For aquatic ecosystem protection, based on LOR for ICPMS	
Uranium	1	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 LOR for ICPMS	
Nitrate	1100	For aquatic ecosystem protection, based on ambient Qld WQ Guidelines (2006) for TN	
Sodium*	TBA – to be provided to the administering authority by **30 June 2017.**		
Petroleum hydrocarbons (C6-C9)	20		
Petroleum hydrocarbons (C10-C36)	100		
Fluoride (total)	2000	Protection of livestock and short term irrigation guideline	
Suspended Solids*	Limit to be determined based on receiving water reference data and achievable best practice sedimentation control and treatment and provided to the administering authority by **30 June 2017.**		
Sulfate ($SO4^{2-}$) (mg/L)*	Limit to be determined based on receiving water reference data and achievable best practice sedimentation control and treatment and provided to the administering authority by **30 June 2017.**	*Drinking water environmental values from NHMRC 2006 guidelines OR ANZG*	

Notes:

1. *All metals and metalloids must be measured as total (unfiltered) and dissolved (filtered). Trigger levels for metal/metalloids apply if dissolved results exceed trigger.*
2. *The quality characteristics required to be monitored as per Table 3 can be reviewed once the results of two years monitoring data is available, or if sufficient data is available to adequately demonstrate negligible environmental risk. It may be determined that a reduced monitoring frequency is appropriate or certain quality characteristics can be removed from Table 3 by amendment.*
3. *SMD—slightly moderately disturbed level of protection, guideline refers ANZG (2018).*
4. *LOR—typical reporting for method stated. ICPMS/CV FIMS—analytical method required to achieve LOR.*

Table 8a: Flow triggers to start mine affected water release

Receiving waters / stream	Release point	Monitoring point	Monitoring point latitude (decimal degree, GDA94)	Monitoring point longitude (decimal degree, GDA94)	Receiving water flow recording frequency	Receiving water flow criteria to start discharge (m^3/s)	Maximum release rate for all combined RP flows
Cockatoo Creek	RP 1	Cockatoo Creek US	-22.8904	148.7661	Continuous (minimum daily)	0.66	$2m^3/s$
Cockatoo Creek	RP 2	Cockatoo Creek US	-22.8904	148.7661	Continuous (minimum daily)	0.66	
Roper Creek	RP 3	Roper Creek US	-22.8762	148.6719	Continuous (minimum daily)	0.95	

Table 8b: Flow triggers to cease mine affected water release

Receiving waters / stream	Release point (RP)	Monitoring point	Monitoring point latitude (decimal degree, GDA94)	Monitoring point longitude (decimal degree, GDA94)	Receiving water flow recording frequency	Receiving water flow criteria to cease discharge (m^3/s)
Cockatoo Creek	RP 1	Roper Creek DS2	-23.0105	148.8415	Continuous (minimum daily)	<0.5
Cockatoo Creek	RP 2	Roper Creek DS2	-23.0105	148.8415	Continuous (minimum daily)	<0.5
Roper Creek	RP 3	Ropers Creek DS2	-23.0105	148.8415	Continuous (minimum daily)	<0.5

F6	If quality characteristics of the release exceed any of the trigger levels specified in *Table 7*: *Release contaminant trigger investigation levels, potential contaminants* during a release event, the environmental authority holder must compare the downstream results in the receiving waters to the trigger values specified in *Table 7: Release contaminant trigger investigation levels, potential contaminants* and: 1) where the trigger values are not exceeded then no action is to be taken; or 2) where the downstream results exceed the trigger values specified *Table 7: Release contaminant trigger investigation levels, potential contaminants* for any quality characteristic, compare the results of the downstream site to the data from background monitoring sites and; a) if the result is less than the background monitoring site data, then no action is to be taken; or b) 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 within ninety (90) days of receiving the result, outlining: i) details of the investigations carried out; and ii) actions taken to prevent environmental harm. Note: *Where an exceedance of a trigger level has occurred and is being investigated, in accordance with F6 2) b) of this condition, no further reporting is required for subsequent trigger events for that quality characteristic.*
F7	If an exceedance in accordance with condition **F6 (2) (b)** is identified, the holder of the authority must notify the administering authority in writing within **twenty-four (24) hours** of receiving the result.
Mine affected water release events	
F8	The holder must ensure a stream flow gauging station(s) is installed, operated and maintained to determine and record stream flows at the locations and flow recording frequency specified in *Table 8a -Flow triggers to start mine affected water release and 8b – Flow triggers to cease mine affected water release.*
F9	Notwithstanding any other condition of this environmental authority, the release of mine affected water to waters in accordance with condition **F2** must only start when natural flow in the receiving environment meets the trigger values specified in *Table 8a: Flow triggers to start mine affected water release* for the release point(s) specified in *Table 5: Mine affected water release points, sources and receiving waters*.
F10	The releases of mine affected water to waters in accordance with conditions **F6** must not exceed a maximum release rate for all combined release points flows of $2m^3/s$
F11	The electrical conductivity (EC) values recorded at the downstream monitoring point on Roper Creek (Roper Creek DS2) must not exceed 2000µS/cm at any time during the release influence period.
F12	The electrical conductivity (EC) values recorded at the Barwon Park monitoring station on Roper Creek (Roper Creek Barwon Park) must not exceed 1500µS/cm at any time during the release influence period.
F13	If electrical conductivity (EC) recorded at Bingegang Weir exceeds 650µS/cm during a release event, the environmental authority holder must immediately notify the administering authority and seek written approval to continue releasing mine affected water.
F14	The daily quantity of mine affected water released from each release point must be measured and recorded.

F15	Releases to waters must be undertaken so as not to cause erosion of the bed and banks of the receiving waters, or cause a material build-up of sediment in such waters.
Notification of release event	
F16	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 Schedule F - Water of this environmental authority (that is, contaminant limits, natural flow, discharge volume) c) release point(s); d) release rate e) release salinity; and f) receiving water(s) including the natural flow rate.
F17	The environmental authority holder must notify the administering authority via WaTERS, as soon as practicable and no later than **twenty-four (24) hours** after the cessation of a release event, of the cessation of a release notified under condition **F16.** The cessation notification must include the following information: release cessation date/time; a) natural flow volume in receiving water; b) volume of water released; c) details regarding the compliance of the release with the conditions of Schedule F - Water of this environmental authority (i.e. contamination limits, natural flow, discharge volume); 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 **F16** and **F17**, provided the relevant details of the release are included within the notification provided in accordance with conditions **F16** and **F17**.*
F18	The holder of this environmental authority must within **twenty eight (28) days** after cessation of a release event notified under condition **F16** provide a report to the administering authority via WaTERS, which must include the following information: a) all in-situ water quality monitoring results; and b) any other matters pertinent to the water release event.
Notification of release event exceedance	
F19	If the release limits defined in *Table 6*: *Mine affected water release limits*, *Table 8a: Flow triggers to start mine affected water release* and *Table 8b: Flow triggers to cease mine affected water release* are exceeded, the holder of the environmental authority must notify the administering authority within twenty-four (24) hours of receiving the results.

F20	The environmental authority holder must, within twenty-eight (28) days of a release that exceeds the conditions of this authority, provide a report to the administering authority detailing: a) the reason for the release; b) the location of the release; c) the total volume of the release 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) all water quality monitoring results (including all laboratory analyses); f) identification of any environmental harm as a result of the non-compliance; g) all calculations; and h) any other matters pertinent to the water release event.
F21	In the event that water storages defined in *Table 9: On-site water storage contaminant limits* exceed the contaminant limits defined in *Table 9: On-site water storage contaminant limits*, the holder of the environmental authority must implement measures, where practicable, to prevent access to waters by all livestock.

Table 9: On-site water storage contaminant limits

Quality characteristic	Test value	Contaminant limit
pH (pH unit)	Range	4 - 9^
EC (µS/cm)	Maximum	5970*
Sulphate (mg/L)	Maximum	1000*
Fluoride (mg/L)	Maximum	2*
Aluminium (mg/L)	Maximum	5*
Arsenic (mg/L)	Maximum	0.5*
Cadmium (mg/L)	Maximum	0.01*
Cobalt (mg/L)	Maximum	1*
Copper (mg/L)	Maximum	1*
Lead (mg/L)	Maximum	0.1*
Nickel (mg/L)	Maximum	1*
Zinc (mg/L)	Maximum	20*

** Contaminant limit based on ANZECC & ARMCANZ (2000) stock water quality guidelines.*

^ Page 4.2-15 of ANZECC & ARMCANZ (2000) "Soil and animal health will not generally be affected by water with pH in the range of 4–9".

Note*: Total measurements (unfiltered) must be taken and analysed.*

Receiving environment monitoring and contaminant trigger levels	
F22	The quality of the receiving waters must be monitored at the locations specified in *Table 11: Receiving water upstream background sites and downstream monitoring points* for each quality characteristic and at the monitoring frequency stated in *Table 10: Receiving waters contaminant trigger levels*.

Table 10: Receiving waters contaminant trigger levels

Quality characteristic	Trigger level	Monitoring frequency
pH	6.5 – 8.0	Daily during the release
Suspended solids (mg/L)	650	
Sulphate (SO_4^{2-}) (mg/L)	250 (Protection of drinking water environmental value)	
Sodium (mg/L)	To be supplied to the administering authority by **30 June 2017.**	

Table 11: Receiving water upstream background sites and downstream monitoring points

Monitoring points and receiving waters location description	Site Reference	Latitude (Decimal degree, GDA94)	Longitude (Decimal degree, GDA94)
Upstream background monitoring points			
Roper Creek US	Located 200m downstream of Dysart Middlemount Road	-22.8778	148.6729
Cockatoo Creek US	Located 1.5km upstream of homestead parallel to Foxleigh Road	-22.8778	148.7742
Carlo Creek US	Located 50m upstream of the Barwon Park Middlemount Road and Carlo Creek Crossing	22.9238	148.8269
Parrot Creek DS (Downstream of Capcoal Mine and Upstream of Foxleigh Mine)	Located 200m downstream of haul rod	- 22.9218	148.6665
Downstream monitoring points			
Roper Creek DS2	Located at the confluence of Roper Creek and Cockatoo Creek	-23.0101	148.8392
Roper Creek at Barwon Park	Located 50m downstream of the Mackenzie River Capella Road, Roper Creek Crossing	-23.0577	148.8897
Cockatoo Creek DS	Located 50m upstream of the Lake Lindsay road and Cockatoo Creek Crossing	-23.0029	148.8331

F23	If quality characteristics of the receiving water at the downstream monitoring points exceed any of the trigger levels specified in *Table 10: 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; or 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 in the next annual return, outlining: i) details of the investigations carried out; and ii) actions taken to prevent environmental harm. Note: *Where an exceedance of a trigger level has occurred and is being investigated, in accordance with **F22 b)** of this condition, no further reporting is required for subsequent trigger events for that quality characteristic.*
F24	All determinations of water quality and biological monitoring must be performed by an appropriately qualified person.
Receiving environment monitoring program (REMP)	
F25	The environmental authority holder must develop and implement a Receiving Environment Monitoring Program (REMP) to monitor, identify and describe any adverse impacts to surface water environmental values, quality and flows due to the authorised mining activity. This must include monitoring the effects of the mine on the receiving environment periodically (under natural flow conditions) and while mine affected water is being discharged from the site. For the purposes of the REMP, the receiving environment is the waters of Roper Creek and connected or surrounding waterways within 10km downstream of the release. The REMP should encompass any sensitive receiving waters or environmental values downstream of the authorised mining activity that will potentially be directly affected by an authorised release of mine affected water.
F26	A REMP design document that addresses the requirements of the REMP must be prepared and made available to the administrating authority upon request.
F27	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 must include an assessment of background reference water quality, the condition of downstream water quality compared against water quality objectives, and the suitability of current discharge limits to protect downstream environmental values.
Water reuse	
F28	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).

Annual water monitoring reporting	
F29	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: 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 mine affected water 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 exceedances of the conditions of this environmental authority; and g) water quality monitoring data must be provided to the administering authority in the specified electronic format upon request.
Temporary interference with waterways	
F30	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.*
Water management plan	
F31	A Water Management Plan must be developed by an appropriately qualified person and implemented.
Stormwater and water sediment controls	
F32	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.
F33	Stormwater, other than mine affected water, is permitted to be released to waters from: a) erosion and sediment control structures that are installed and operated in accordance with the Erosion and Sediment Control Plan required by condition **F32**; and b) water management infrastructure that is installed and operated, in accordance with a Water Management Plan that complies with condition **F31**, for the purpose of ensuring water does not become mine affected water.
F34	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.

Schedule G - Watercourse diversions	
Permanent watercourse diversions (Foxleigh Plains ML70431)	
G1	Permanent watercourse diversions, or the re-establishment of a pre-existing watercourse where a temporary watercourse diversion is being replaced, must be designed, constructed and operated to: a) incorporate natural features (including geomorphic and vegetation) present at the location of the diversion; and b) maintain the pre-existing hydrologic characteristics of surface water and groundwater systems for the area in which the watercourse diversion is located; and c) maintain the hydraulic characteristics of the permanent watercourse diversion that are equivalent to other local watercourses and are suitable for the area in which the diversion is located without using artificial structures that require on-going maintenance; and d) maintain sediment transport and water quality regimes that allow the diversion to be self-sustaining, while minimising any adverse impacts to upstream and downstream water quality, geomorphology, fauna and vegetation; and e) maintain equilibrium and functionality in all substrate conditions at the location of the diversion.
Design plan	
G2	A certified Design Plan that achieves condition **G1** for a permanent watercourse diversion, must be submitted to the administering authority at least **ten (10) business days** before commencing construction of the diversion.
G3	The certified Design Plan for any temporary or permanent watercourse diversion must be consistent with the functional design/s (B. Phillips - Hatch Hydrobiology, 14 March 2016, *Technical Report – Foxleigh Plains Diversion – Functional Design Report*, Revision 1) that formed a part of the application documents for this environmental authority.
Construction and operation	
G4	A certified set of 'as constructed' drawings and specifications must be submitted to the administering authority within **sixty (60) business days** from the completion of construction of any temporary or permanent watercourse diversions, and/or re-establishment of the pre-existing watercourse.
G5	The certified set of 'as constructed' drawings and specifications must state: a) that the 'as constructed' drawings and specifications meet the original intent of the design plan for the watercourse diversion; and b) construction of the watercourse diversion is in accordance with the design plan.

Register	
G6	The details of watercourse diversions planned and constructed under this environmental authority must be accurately recorded in a Register of Watercourse Diversions, required to be kept by the holder of this environmental authority.
G7	An electronic copy of the Register of Watercourse Diversions required under condition **G6** must be provided to the administering authority on request.
Annual inspection report	
G8	Each permanent watercourse diversion must be inspected each calendar year by a suitably qualified and experienced person.
G9	At each annual inspection, the condition and adequacy of all components of the permanent watercourse diversion must be assessed and a suitably qualified and experienced person must prepare an annual inspection report containing details of the assessment, and include a recommendations section, with any recommended actions to ensure the integrity of the permanent watercourse diversion, or a positive statement that no recommendations are required.
G10	The annual inspection report specified in condition **G9** must assess: a) if the permanent watercourse diversion is functioning as intended in the design plan and *Appendix 2 – Rehabilitation requirements* of this environmental authority; and b) if the permanent watercourse diversion meets the outcomes for the operation and monitoring of permanent diversions as per the Department of Natural Resources and Mines *Guideline: Works that interfere with water in a watercourse – watercourse diversions.*
G11	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.
G12	If, following receipt of the recommendations and (if applicable) recommended actions, as per condition **G11**, the administering authority requests a copy of the annual inspection report from the holder, the holder must provide this to the administering authority within **ten (10) business days** of receipt of the request.

Schedule H – Land	
Rehabilitation	
H1	Land disturbed by mining must be rehabilitated in accordance with *Appendix 2: Rehabilitation requirements* and *Appendix 4: Approved residual voids* of this environmental authority.
H2	Rehabilitation completion criteria for the Foxleigh Plains watercourse diversion (ML70431) must be submitted to the administering authority by way of an amendment to this environmental authority within **ten (10) business days** of submitting the 'as constructed' Design Plans to the administering authority, as required by condition G4.
Contaminated land	
H3	Before applying for surrender of a mining lease, the holder must (if applicable) provide to the administering authority a site investigation report under the Act, in relation to any part of the mining lease which has been used for notifiable activities or which the holder is aware is likely to be contaminated land, and also carry out any further work that is required as a result of that report to ensure that the land is suitable for its final land use.
H4	Before applying for progressive rehabilitation certification for an area, the holder must (if applicable) provide to the administering authority a site investigation report under the Act, in relation to any part of the area the subject of the application which has been used for notifiable activities or which the holder is aware is likely to be contaminated land, and also carry out any further work that is required as a result of that report to ensure that the land is suitable for its final land use under condition **H1**.
H5	Minimise the potential for contamination of land by hazardous contaminants.
Infrastructure	
H6	All bunding for coal stockpiles must be a minimum of 30m from the lease boundary.
Biodiversity offsets	
H7	**Offsets under the *Environmental Offsets Act 2014*** Significant residual impacts to prescribed environmental matters are not authorised under this environmental authority or the *Environmental Offsets Act 2014*, unless: a) the impacts are specified in *Table 12 – Authorised significant residual impacts to prescribed environmental matters under the Environmental Offsets Act 2014*; or b) the impacts are covered by the offset requirements of EPBC Approval No 2010/5421, issued under the *Environment Protection and Biodiversity Conservation Act 1999* (as specified in *Table 13: Authorised significant residual impacts to prescribed environmental matters under the Environmental Protection and Biodiversity Conservation Act 1999 (EPBC approval 2010/5421)*; or c) the impacts are specified in *Table 14: Authorised significant residual impacts to MSES that are not covered under the Environmental Offsets Act 2014 or the Environmental Protection and Biodiversity Conservation Act 1999 (covered under the Conservation Area),* relating to the Conservation Area required under condition **H12.**
H8	Records demonstrating that each impact to a prescribed environmental matter 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.

H9	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 12 – Authorised significant residual impacts to prescribed environmental matters.*
H10	For proposed offsets relating to significant residual impacts listed in *Table 12 – Authorised significant residual impacts to prescribed environmental matters under the Environmental Offsets Act 2014,* a notice of election under section 18 of the *Environmental Offsets Act 2014* must be provided to the administering authority by **31 August 2023**.
H11	Immediately following provision of the notice of election required under condition **H10** to the administering authority**,** the environmental authority holder must do all things reasonably necessary to enter into an agreed delivery arrangement with the administering authority under section 19 of the *Environmental Offsets Act 2014*.
H12	**Conservation Area** The environmental authority holder must obtain legal security of the Conservation Area shown in **Figure 4: Conservation area reference map** by **30 June 2024** and maintain legal security for the life of the EA.
H13	The environmental authority holder must manage the Conservation Area to achieve, at minimum, the BioCondition scores listed as "Final BioCondition score" in *Table 15: Conservation Area BioCondition Scores*.
H14	The BioCondition scores required under condition **H13** must be determined by an appropriately qualified person according to the latest version of the Queensland BioCondition Assessment Manual.
H15	The BioCondition scores required under condition **H13** must be achieved by **30 June 2043**.
H16	Once the BioCondition scores required under condition **H13** are achieved, including if they are achieved before **30 June 2043**, they must be maintained as a minimum standard for the life of the environmental authority.
H17	The environmental authority holder must develop and implement a Conservation Area Improvement Plan by **31 December 2023.**
H18	The Conservation Area Improvement Plan required by condition **H17** must include the following: a) A description of the vegetation communities and environmental values within the Conservation Area b) A description of how the final BioCondition scores will be achieved, including: i) Identification of the risks that may result in failure to achieve the final BioCondition scores ii) How the identified risks will be managed and mitigated iii) Any actions that will or may be taken to improve the starting BioCondition score c) A statement that specifies the chosen method of legal security d) Any other information that the environmental authority holder considers necessary to achieve the requirements of condition **H13.**
H19	Mining activity or any related disturbance is not authorised to occur within the Conservation Area.

Table 12: Authorised significant residual impacts to prescribed environmental matters under the *Environmental Offsets Act 2014*

Prescribed environmental matters	RE ID	Maximum Extent of Impact (ha)
REGULATED VEGETATION		
Endangered regional ecosystems	11.3.1	20.08
Regional ecosystems within the defined distance from the defining banks of a relevant watercourse on the vegetation management watercourse map	NA	59.99

Table 13: Authorised significant residual impacts to prescribed environmental matters under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC approval 2010/5421)

Protected Matter	Maximum Extent of Impact (ha)
Brigalow (Acacia harpophylla dominant and co-dominant) threatened ecological community	96.2
Squatter Pigeon (Geophaps scripta scripta) primary habitat	202.5

***** For location reference map, see Appendix 3, *Figure 5: Authorised significant residual impacts to prescribed environmental matters under the Environmental Protection and Biodiversity Conservation Act 1999 (EPBC approval 2010/5421).*

Table 14: Authorised significant residual impacts to prescribed environmental matters that are not covered under the *Environmental Offsets Act 2014* or the *Environmental Protection and Biodiversity Conservation Act 1999* (covered under the Conservation Area).

Prescribed environmental matters	RE ID	Location of impact (Polygon ID)*	Maximum Extent of Impact (ha)
REGULATED VEGETATION			
Of concern regional ecosystems	11.3.2	23	9.5
	11.3.3	17, 18	1.36
Regional ecosystems within the defined distance from the defining banks of a relevant watercourse on the vegetation management watercourse map	11.3.3	17	0.23
	11.3.25	6	0.47

***** For polygon ID reference map, see Appendix 3, *Figure 6: Authorised significant residual impacts to prescribed environmental matters that are not covered under the Environmental Offsets Act 2014 or the Environmental Protection and Biodiversity Conservation Act 1999 (covered under the Conservation Area).*

Table 15: Conservation Area BioCondition Scores

Regional Ecosystem	Area (ha)	Starting BioCondition score	Final BioCondition score	Location (Polygon ID)*
11.3.1 – Acacia harpophylla and/or Casuarina cristata open forest on alluvial plains	3.04	4	6	102
11.3.2 – Eucalyptus populnea woodland on alluvial plains	46.35	7	7	99, 104
		5	7	100, 108
		2	4	110
11.3.3 – Eucalyptus coolabah woodland on alluvial plains	23.45	7	7	98
		6	7	103, 109
11.3.25 – Eucalyptus tereticornis or E. camaldulensis woodland fringing drainage lines	13.34	7	7	97

***** For polygon ID reference map of the Conservation Area, see *Figure 4: Conservation area reference map*.

Schedule J - Regulated structures	
J1	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 structures (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.
J2	A consequence assessment report and certification must be prepared for each structure assessed and the report may include a consequence assessment for more than one structure.
J3	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).*
Design and construction of a regulated structure	
J4	Conditions **J5** to **J9** inclusive do not apply to existing structures.
J5	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).*
J6	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.
J7	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.
J8	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.
J9	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.

Notification of affected persons	
J10	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 **ten (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 **five (5) business days** of it being amended.
Operation of a regulated structure	
J11	Operation of a regulated structure, except for an existing structure, is prohibited unless the holder has submitted to the administering authority in respect of regulated structure, all of the following: a) one paper copy and one electronic copy of the design plan and certification of the 'design plan' in accordance with condition **J6**; b) a set of 'as constructed' drawings and specifications; c) certification of the 'as constructed drawings and specifications' in accordance with condition **J9**; 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 structure
J12	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.
J13	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.
Mandatory reporting level	
J14	Conditions **J15** to **J16** inclusive only apply to regulated structures which have not been certified as low consequence category for 'failure to contain – overtopping'.
J15	The Mandatory Reporting Level (MRL) must be marked on a regulated dam in such a way that during routine inspections of that dam, it is clearly observable.

J16	The holder must, as soon as practicable but 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.
J17	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.
J18	The holder must record any changes to the MRL in the Register of Regulated Structures.
Design storage allowance	
J19	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.
J20	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).
J21	The holder must, as soon as practicable but 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.
J22	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.
Annual inspection report	
J23	Each regulated structure must be inspected each calendar year by a suitably qualified and experienced person.
J24	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 a recommendations section, with any recommended actions to ensure the integrity of the regulated structure or a positive statement that no recommendations are required.
J25	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).*
J26	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 receipt of the recommendations and (if applicable) recommended actions, the administering authority requests a 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.
Transfer arrangements	

J27	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.
Decommissioning and rehabilitation	
J28	Regulated structures must not be abandoned but be either: a) decommissioned and rehabilitated to achieve compliance with condition **J29**; or b) be left in-situ for a use by the landholder 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 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.
J29	Before surrendering this environmental authority the site must be rehabilitated to achieve a safe, stable and non-polluting landform in accordance with *Appendix 2: Rehabilitation requirements* of this environmental authority.
Register of regulated structures	
J30	A Register of Regulated Structures must be established and maintained by the holder for each regulated structure.
J31	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.
J32	The holder must make a final entry of the required information in the Register of Regulated Structures once compliance with condition **J11** and **J12** has been achieved.
J33	The holder must ensure that the information contained in the Register of Regulated Structures is current and complete on any given day.
J34	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
J35	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.
Transitional arrangements	
J36	All existing structures that have not been assessed in accordance with either the *Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933)* or the former *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams* must be assessed and certified in accordance with the *Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933)* by **6 November 2016**.
J37	All existing structures must subsequently comply with the timetable for any further assessments in accordance with the Manual specified in *Table 16: Transitional hydraulic performance requirements for existing structures*, depending on the consequence category for each existing structure assessed in the most recent previous certification for that structure.

J38	*Table 16: Transitional hydraulic performance requirements for existing structures* ceases to apply for a structure once any of the following events has occurred: a) it has been brought into compliance with the hydraulic performance criteria applicable to the structure under the Manual; or b) it has been decommissioned; or c) it has been certified as no longer being assessed as a regulated structure..
J39	Certification of the transitional assessment required by **J36** and **J37** (as applicable) must be provided to the administering authority within 6 months of amendment of the authority adopting this schedule, being **6 November 2016**.

Table 16: Transitional hydraulic performance requirements for existing structures

Transitional period required for existing structures to achieve the requirements of the *Manual for Assessing Consequence Categories and Hydraulic Performance of Dams*			
Compliance with criteria	**High consequence**	**Significant consequence**	**Low consequence**
>90% and a history of good compliance performance in last 5 years.	No transition required.	No transition required.	No transitional conditions apply. Review consequence assessment every 7 years.
>70%-≤90%	Within 7 years, unless otherwise agreed with the administering authority, based on no history of unauthorised releases.	Within 10 years, unless otherwise agreed with the administering authority, based on no history of unauthorised releases.	No transitional conditions apply. Review consequence assessment every 7 years.
>50-≤70%	Within 5 years unless otherwise agreed with the administering authority, based on no history of unauthorised releases.	Within 7 years unless otherwise agreed with the administering authority, based on no history of unauthorised releases.	Review consequence assessment every 7 years.
≤50%	Within 5 years or as per compliance requirements (e.g. TEP timing).	Within 5 years or as per compliance requirements (e.g. TEP timing).	Review consequence assessment every 5 years.
Regulated levee designed to prevent the ingress of clean flood water <100% Compliant.*	Within 5 years unless otherwise agreed with the administering authority.		

**Note: Levees designed for the diversion of contaminated waters or protection of the structural integrity of a dam are not to be considered as part of this provision. These levees are considered a key design element of the relevant dam and transitional periods should as such align to that relevant compliance criteria and consequence category*.

Definitions

Words and phrases used throughout this environmental authority are defined below. Where a definition for a term used in this environmental authority is sought and the term is not defined within this environmental authority, the definitions in the *Environmental Protection Act 1994*, its regulations, subordinate legislation and environmental protection policies must be used.

'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' means the Department of Environment and Heritage Protection or its successor.

'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).

'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.

'annual exceedance probability' or 'AEP' means the probability that at least one event in excess of a particular magnitude will occur in any given year.

'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.

'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 relating to the subject matter using the relevant protocols, standards, methods or literature.

'assessed' or **'assessment'** by a suitably qualified and experienced person in relation to a consequence assessment of a dam, 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 of the assessment:

a) exactly what has been assessed and the precise nature of that determination;

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' means in relation to a dam,
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 departmental approval.

'background', with reference to the water schedule means the average of samples taken prior to the commencement of mining from the same waterway that the current sample has been taken.

'BioCondition score' has the meaning given in the latest version of the BioCondition Assessment Manual published by the Queensland Herbarium.

'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' means assessment and approval must be undertaken by a suitably qualified and experienced person in relation to any assessment or documentation required by this Manual, 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 RPEQs (ID: 1.4 (2A))

'certifying', 'certify' or 'certified' have a corresponding meaning as 'certification'.

'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 Australian Code for the Transport of Dangerous Goods by Road and Rail approved by the Australian Transport Council; or
c) a lead hazardous substance within the meaning of the Workplace Health and Safety Regulation 1997;
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
    v) a substance used for, or intended for use for mineral processing or treatment of metal, pulp and paper, textile, timber, water or wastewater; or
    vi) manufacture of plastic or synthetic rubber.

'commercial place' means a workplace 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.

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 (ESR/2016/1933).*

'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.

'construction' or **'constructed'** in relation to a **regulated structure** includes building a new regulated structure and lifting or otherwise modifying an existing regulated structure, but does not include investigations and testing necessary for the purpose of preparing a design plan.

'construction' or **'constructed',** in relation to **watercourse diversions**, is the process of building, or modifying an existing diversion, but does not include investigations and testing necessary for the purpose of preparing a design plan

'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**.

'dam crest volume' means the volume of material (liquids and/or solids) that could be within the walls of a dam at any time when the upper level of that material is at the crest level of that dam. That is, the instantaneous maximum volume within the walls, without regard to flows entering or leaving (eg via spillway).

'designer' for the purposes of a regulated dam, means the certifier of the design plan for the regulated dam.

'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 plan' is a document that contains the design, operation, monitoring and revegetation criteria of a **watercourse diversion** that addresses the outcomes stated in conditions on the environmental authority relating to the diversion. The document should include, but not be limited to:

a) required information under a functional design;
b) the location, function and description of geomorphic and riparian vegetation features within the proposed watercourse diversion;
c) results from hydrologic, hydraulic and sediment transportation modelling used in the design of the diversion;
d) a revegetation and vegetation management plan (a revegetation plan) for the diversion;
e) engineering drawings depicting the physical attributes and dimensions of the diversion;
f) (if relevant) the staged development of a permanent watercourse diversion including the proposed use of temporary watercourse diversions with identified lifespans;
g) all investigation and other reports relied on by the design;
h) plans and specifications sufficient to complete construction and revegetation in accordance with the design.

'design storage allowance' or 'DSA' means an available volume, estimated in accordance with the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (EM635)* 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 (AEP) specified in that manual.

'development approval' means a development approval under the *Integrated Planning Act 1997* or the *Sustainable Planning Act 2009* in relation to a matter that involves an environmentally relevant activity under the *Environmental Protection Act 1994*

'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; or
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.

'EC' means electrical conductivity.

'effluent' means treated waste water released 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 dam owners to annually review and update contact information where required

'**Environmental authority'** means environmental authority granted in relation to an environmentally relevant activity under the *Environmental Protection Act 1994*.

'Environmental authority holder' means the holder of this environmental authority.

'**environmental offset'** has the meaning in section 7 of the *Environmental Offsets Act 2014*.

'existing authority' has the meaning in section 94 of the *Environmental Offsets Act 2014*.

'existing structure' means a structure that prior to <<TBA insert date when EA is issued with new dam manual conditions>> meets any or both of the following, a structure:

a) with a design that is in accordance with the March 2016, Version 5.00 *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* and that is considerably in progress;
b) that is under considerable construction or that is constructed.

'extreme storm storage' – means a storm storage allowance determined in accordance with the criteria in the *Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933)* published by the administering authority.

'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.

'functional design' is a document that contains 'conceptual' information about the design, operation and revegetation criteria of a watercourse diversion that addresses the outcomes stated in the conditions on the environmental authority relating to the diversion. The document should include, but not be limited to:

a) geomorphic and vegetation assessment of the existing watercourse;
b) hydrologic conditions of the existing watercourse;
c) the proposed watercourse diversion route;
d) results from hydrologic, hydraulic and sediment transportation modelling used in the design of the diversion.

'hazard' means in relation to a dam as defined, means the potential for environmental harm resulting from the collapse or failure of the dam to perform its primary purpose of containing, diverting or controlling flowable substances.

'hazard 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 'Manual for Assessing Hazard Categories and Hydraulic Performance of Dams'.

'Holder' means any person who is the holder of, or is acting under, that environmental authority.

'hydraulic performance' means the capacity of a regulated dam to contain or safely pass flowable substances based on the design criteria specified for the relevant consequence category in the *Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933).*

'infrastructure' means water storage dams, levees,, roads and tracks, buildings and other structures built for the purpose of the mining activity.

'in-situ pit walls' means unexcavated faces of exposed overburden or coal (highwalls).

'in-pit backfill spoil' means overburden that has been backfilled in the mining void (low-walls).

'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 use' –means the selected post mining use of the land, which is planned to occur after the cessation of mining operations.

'leachate' means a liquid that has passed through or emerged from, or is likely to have passed through or emerged from, a material stored, processed or disposed of at the operational land which contains soluble, suspended or miscible contaminants likely to have been derived from the said material.

'legal security' for the Conservation Area means that an area of land is legally secured through one of the following mechanisms:

- a voluntary declaration as an area of high nature conservation value under the *Vegetation Management Act 1999*; or
- a statutory covenant for environmental purposes under the *Land Act 1994* or *Land Title Act 1994*

'levee' means an embankment that only provides for the containment and diversion of stormwater or flood flows from a contributing catchment, or containment and diversion of flowable materials resulting from releases from other works, during the progress of those stormwater or flood flows or those releases; and does not store any significant volume of **water** or **flowable substances** at any other times.

'licensed place' means the mining activities carried out at the mining tenements detailed in Table # (page #) of this environmental authority.

'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 (ESR/2016/1933)*

'm' means metres.

'mandatory reporting level' or 'MRL' means a warning and reporting level determined in accordance with the criteria in the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (EM635)* published by the administering authority.

'manual' means the *Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933)* published by the administering authority, as amended from time to time.

'maximum extent of impact' means the total, cumulative, residual extent and duration of impact to a prescribed environmental matter that will occur over a project's life after all reasonable avoidance and reasonable on-site mitigation measures have been, or will be, undertaken.

'mineral residue material' means material described as coal waste produced from Coal Handling an Preparation Plant (CHPP).

'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 2008 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;
   vi) a mix of mine affected water (under any of paragraphs i)-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:
      1) areas that are been capped and have monitoring data demonstrating hazardous material adequately contained with the site;
      2) 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.

'measures' includes any measures to prevent or minimise environmental impacts of the mining activity such as bunds, silt fences, diversion drains, capping, and containment systems.

'modification or modifying' (see definition of 'construction')

'NATA' means National Association of Testing Authorities, Australia.

'natural flow' means the flow of water through waters caused by nature.

'non-polluting' means having no adverse impacts upon the receiving environment.

'operational plan' for a **dam** means a document that amongst other things sets out procedures and criteria to be used for operating a dam during a particular time period. The operational plan as defined herein may form part of a plan of operations or plan otherwise required in legislation.

'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 (mm/s).

'Permanent watercourse diversion' is a man-made structure that incorporates the geomorphologic, hydraulic, hydrologic and ecological components of a local watercourse and is designed, constructed, operated and maintained according to an engineering standard that ultimately achieves a self-sustaining watercourse able to function without features or characteristics that rely on ongoing maintenance or that impose a financial or other burden on the proponent, government or the community.

'prescribed environmental matters' has the meaning in section 10 of the *Environmental Offsets Act 2014*, limited to the matters of State environmental significant listed in schedule 2 of the Environmental Offsets Regulation 2014.

'Pre-existing watercourse' is the section of watercourse from which the flow of water will be diverted as a result of the construction and operation of a watercourse diversion.

'Probable Maximum Flood (PMF)' means the flood that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in a particular drainage area.

'protected area' means – a protected area under the *Nature Conservation Act 1992*; or

a) a marine park under the *Marine Parks Act 1992*; or
b) a World Heritage Area.

'receiving environment' in relation to an activity that causes or may cause environmental harm, means the part of the environment to which the harm is, or may be, caused. The receiving environment includes (but is not limited to):

a) a watercourse;
b) groundwater; and
c) an area of land that is not specified in Figure 1 of this environmental authority.

'receiving waters' means the waters into which this environmental authority authorises releases of mine affected water.

'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 (ESR/2016/1933);*
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. Maximum operating level (metres AHD);
    vi. Storage rating table of stored volume versus level (metres AHD);
    vii. Design storage allowance (megalitres) and associated level of the dam (metres AHD);
    viii. 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 an 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 dam' means any dam in the significant or high hazard category as assessed using the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (EM635)* published by the administering authority.

'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 (ESR/2016/1933)* 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.

'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.

'RL' means reduced level, relative to mean sea level as distinct from depths to water.

'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.

'revegetation' is the re-establishment of vegetation[1] of a species and density of cover similar to surrounding undisturbed areas or the landform that existed before mining activities on soil surfaces associated with the construction or rehabilitation of a watercourse diversion.

'saline drainage' The movement of waters, contaminated with salts, 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; or
b) a motel, hotel or hostel; or
c) an educational institution; or
d) a medical centre or hospital; or
e) a protected area under the *Nature Conservation Act 1992*, the *Marine Parks Act 1992* 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 EPP Noise. That is, a sensitive place is inside or outside on a dwelling, library & educational institution, childcare or kindergarten, school or playground, hospital, surgery or other medical institution, commercial & retail activity, protected area or an area identified under a conservation plan under Nature Conservation Act 1992 as a critical habitat or an area of major interest, marine park under Marine Parks Act 2004, park or garden that is outside of the mining lease and open to the public for the use other than for sport or organised entertainment. A commercial place is inside or outside a commercial or retail activity.*

A mining camp (i.e., accommodation and ancillary facilities for mine employees or contractors or both, associated with the mine the subject of the environmental authority) is not a sensitive place for that mine or mining project, whether or not the mining camp is located within a mining tenement that is part of the mining project the subject of the environmental authority. For example, the mining camp might be located on neighbouring land owned or leased by the same company as one of the holders of the environmental authority for the mining project, or a related company. Accommodation for mine employees or contractors is a sensitive place if the land is held by a mining company or related company, and if occupation is restricted to the employees, contractors and their families for the particular mine or mines which are held by the same company or a related company.

For example, a township (occupied by the mine employees, contractors and their families for multiple mines that are held by different companies) would be a sensitive place, even if part or all of the township is constructed on land owned by one or more of the companies.

'significant residual impact' has the meaning in section 8 *Environmental Offsets Act 2014*.

'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.

'suitably qualified and experienced person' means a person who is a Registered Professional Engineer of Queensland under the provisions of the *Professional Engineers Act 2002*, who has an **appropriate level of**

[1]Not including a species declared under the Land Protection (Pest and Stock Route Management) Regulation 2003 as a category class 1 pest, category class 2 pest or category class 3 pest.

expertise in the structures, geomechanics, hydrology, hydraulics and environmental impact of watercourse diversions.

An ***appropriate level of expertise*** includes:

- demonstrable competency, experience and expertise in:
    - investigation, design or construction of watercourses diversions
    - operation and maintenance of watercourse diversions
    - geomechanics with particular emphasis on channel equilibrium, geology and geochemistry
    - hydrology with particular reference to flooding, estimation of extreme storms, water management or meteorology
    - hydraulics with particular reference to sediment transport and deposition and erosion control
    - hydrogeology with particular reference to seepage and groundwater
    - solute transport processes and monitoring thereof, or
- sufficient knowledge and experience to certify that where the **suitably qualified and experienced person** has relied on advice and information provided by other **persons with relevant expertise***:
    - they consider it reasonable to rely on that advice and information
    - the expert providing the advice and information has knowledge, competency, suitable experience and demonstrated expertise in the matters related to watercourse diversions.

Persons with relevant expertise include:

- Geomorphologist: person who has demonstrated competency and relevant experience in stream geomorphology and watercourse diversions.
- Geotechnical Expert: person who has demonstrated competency and relevant experience in geotechnical assessment of soil characteristics suitable for watercourse diversions.
- Vegetation Expert: person who has demonstrated competency and relevant experience in the identification, role and function of vegetation with watercourses and adjoining floodplains, and has demonstrated competency and relevant experience in revegetation of watercourse diversions and adjoining floodplains. .
- Groundwater Expert: person who has demonstrated competency and relevant experience in groundwater systems.
- Surface Water Expert: person who has demonstrated competency and relevant experience in hydrology.
- Engineer: person who is a Registered Professional Engineer of Queensland (RPEQ) under the provisions of the *Professional Persons Act 2002* or has similar qualifications under a respected professional registration association, and has demonstrated competency and relevant experience in design and construction of watercourse diversions.
- Soils Expert: person who has demonstrated competency and relevant experience in soil classification including the physical, chemical and hydrologic analysis of soil.

'structure' in relation to **regulated structures** means dam or levee.

'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. .

'the Act' means the *Environmental Protection Act 1994*.

'µS/cm' means micro siemens per centimetre.

'void' means any constructed, open excavation in the ground.

'watercourse' has the meaning in Schedule 4 of the *Environmental Protection Act 1994* and means:

a) a river, creek or stream in which water flows permanently or intermittently—

   i. in a natural channel, whether artificially improved or not; or

   ii. in an artificial channel that has changed the course of the watercourse.

b) Watercourse includes the bed and banks and any other element of a river, creek or stream confining or containing 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 water in natural or artificial watercourses, bed and banks of a watercourse, dams, non-tidal or tidal waters (including the sea), stormwater channel, stormwater drain, roadside gutter, stormwater run-off, and groundwater.

'water year' means the 12-month period from 1 July to 30 June.

'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.

END OF DEFINITIONS

Appendix 1

Figure 1: Approved Foxleigh Mine Activities

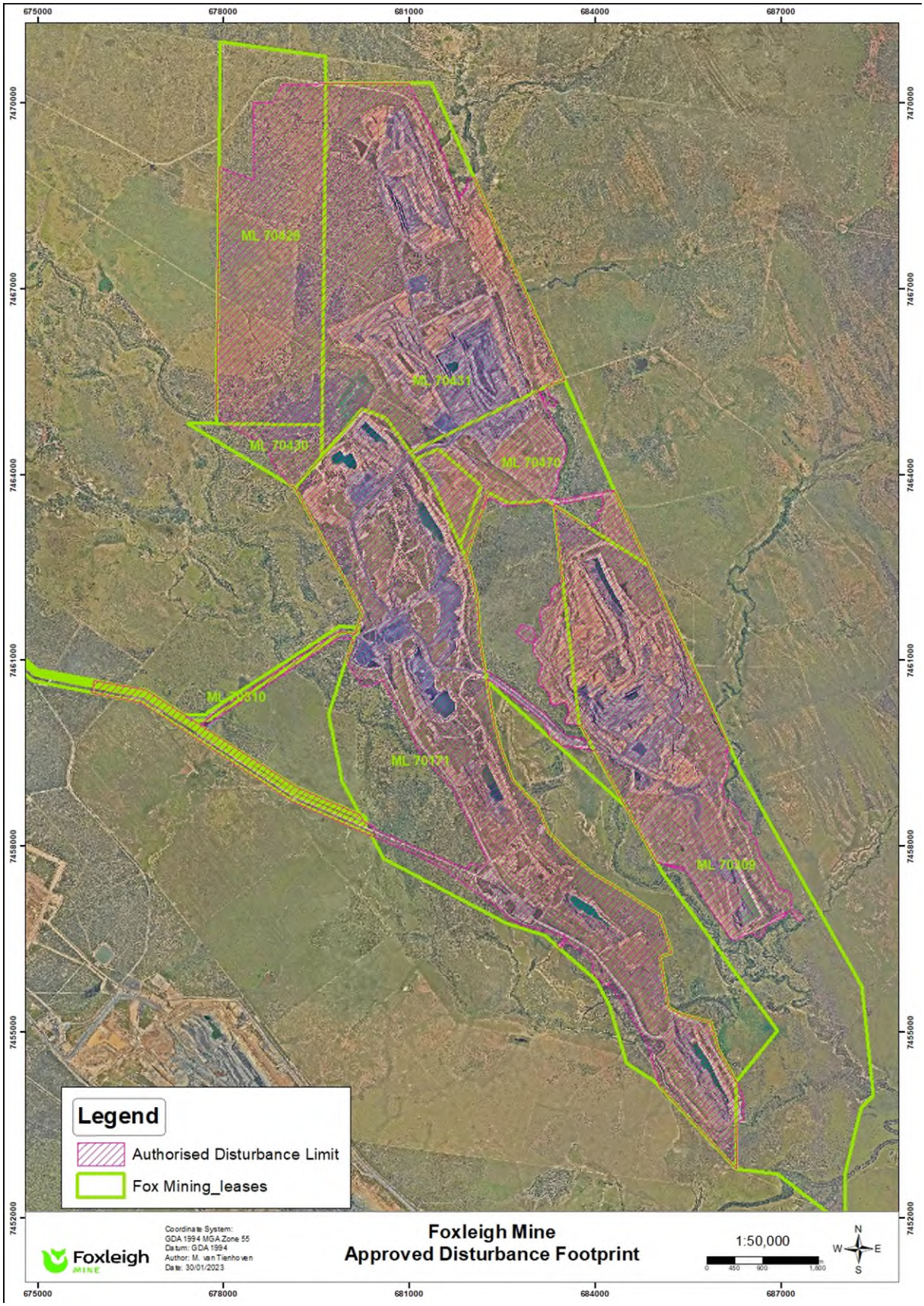
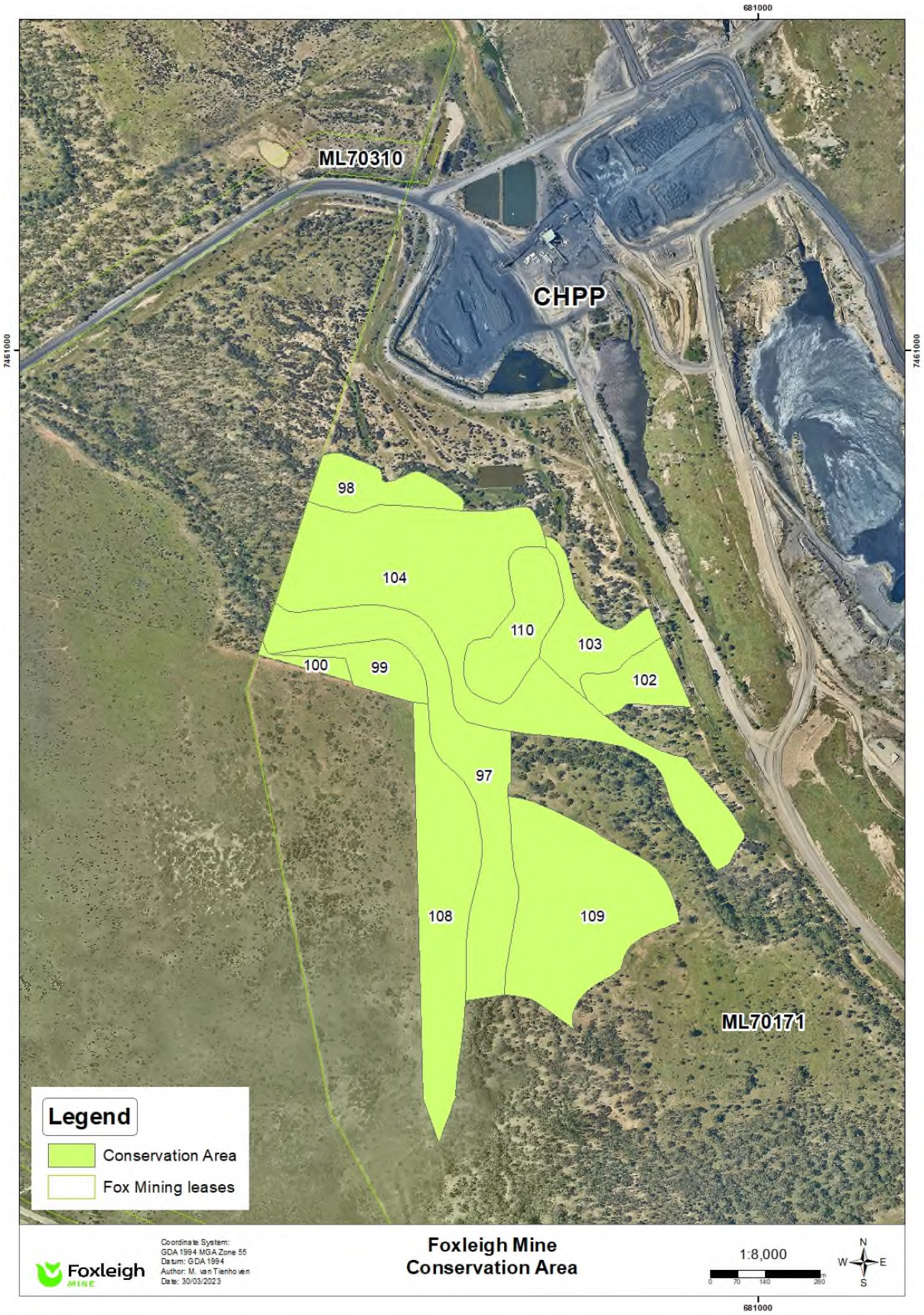


Figure 2: Groundwater monitoring locations (bores)

Figure 3: Release point and monitoring point locations

Figure 4: Conservation area reference map



Appendix 2:

Rehabilitation Requirements

Mine Domain	Mine Feature Name	Rehabilitation Goal	Rehabilitation Objectives	Indicators	Completion Criteria
All mine surface features	Infrastructure areas: • Raw and mine-affected water storage dams • Roads and tracks • ROM stockpile areas • MIA (workshops and associated laydown, hardstand, fuel storage, washdown bay areas) • CHPP • Administration offices • Explosive magazine • Power reticulation network • Fencing Mining areas: • Spoil emplacement areas Mine residue storage areas	1. Safe for humans and wildlife 2. Non polluting 3. Stable 4. Able to sustain agreed post-mining land use	Predominantly a self-sustaining, low maintenance pasture vegetation supporting a grazing post mining land use, or a self-sustaining, low maintenance vegetation state with similar structure, composition and function to that of a native terrestrial or riparian ecosystem of the brigalow belt. Establishment of a native ecosystem connectivity corridor between Cockatoo creek and Roper Creek (East to West) in the vicinity of the CHPP infrastructure area. Where agricultural land use applies, to return self-sustaining grazing land that is sustainable and economically viable.	Infrastructure removed as required and revegetated to a light grazing post mining land use with a mix of pasture and native grass species or revegetated to a native ecosystem. Potential for erosion of waste dump slopes is reduced by correct spoil placement and functional drainage. Adequate access areas used for agriculture that can be maintained into the future. Suitable vegetation is planted for agricultural uses. Adequate shade and water is available for stock use. Topsoil/growth medium spread minimum 150mm depth, with no bare areas greater than 100m^2. Ripping to a minimum depth of 50cm at 1m spacing. Revegetation seed mix complies with final agreed	Any infrastructure that is to remain post closure, shall have a written agreement between the post mining landowner and Foxleigh Management Pty Ltd. Surface water run off quality is similar to the water quality of the surrounding catchment and within the EA conditions. Infrastructure areas land reshaped to slope range <10% (5.71°). Adequate erosion control structures have been installed, with no sites of significant wind or gully erosion that will cause harm to fauna. Vegetation established across areas with a suitable species mix for the agreed final land use of grazing or native ecosystem. Areas where agricultural land use applies, have pasture grass species present and provide stock with nutritional

				land use of grazing or native ecosystem.	requirements, as well as being capable of setting viable seed and flowering similar to reference sites in the Middlemount area and/or with a land suitability class (grazing) of 4.
Mine Domain	**Mine Feature Name**	**Rehabilitation Goal**	**Rehabilitation Objectives**	**Indicators**	**Completion Criteria**
Mining areas	Residual voids as per Appendix 4 and Figure 7 excluding areas of backfill spoil reprofiled to rehabilitation grade.	1. Safe for humans and wildlife 2. Non polluting 3. Stable	Residual voids to remain as water body surrounded by in-situ pit walls and backfilled spoil. Residual voids will be unsuited to any beneficial land use (i.e. Non-Use Management Area). Residual voids will be safe, stable, and non-polluting. Voids will remain as groundwater sinks and will not release contaminants to the downstream receiving waters, including surrounding groundwater aquifers.	Fencing and exclusion zones are established on the in-situ pit walls for exclusion of humans and cattle. Stable in situ pit walls left standing at the slope created by the final blast and a diversion bank provided at the top for safety and drainage. Any exposed coal seam covered with material to minimise highly saline water leaching into void water stores. Drains constructed to redirect surface water from flowing over the in-situ pit walls or in-pit spoil dumps. Geotechnical stability and risk assessments conducted to determine the appropriate treatments prior to closure.	All residual voids protected by permanently rehabilitated stable flood protection landforms providing immunity for a minimum 0.1% AEP event. In-situ pit wall and floor slopes <275% (<70°) and assessed by a suitably qualified person to be long-term stable as per geotechnical stability risk assessment Backfilled spoil walls and floor within the NUMA footprint 70% (<35°) and assessed by a suitably qualified person to be long-term stable as per geotechnical stability risk assessment. A suitability qualified person certifies in-situ pit walls to be stable as per geotechnical stability risk assessment.

					Drainage structures along in-situ pit walls and in-pit spoil dump have been revegetated with native shrub and grass species, with water drainage that flows naturally without pooling or flooding. Modelling confirms voids will remain as groundwater sinks and contaminants will not be released to the receiving environment or groundwater aquifers post-mining. A groundwater monitoring network designed by a suitability qualified person implemented onsite to monitor interaction of residual voids with surrounding aquifers. No groundwater contamination is evidenced by groundwater monitoring over 5 years post mining. Safety fencing and signage erected around pit walls to prevent access to humans and cattle.

Mine Domain	Mine Feature Name	Rehabilitation Goal	Rehabilitation Objectives	Indicators	Completion Criteria
Mining areas	Spoil emplacement areas	1. Safe for humans and wildlife 2. Non polluting 3. Stable 4. Able to sustain agreed post-mining land use	Predominantly a self-sustaining, low maintenance pasture vegetation supporting a grazing post mining land use, or a self-sustaining, low maintenance vegetation state with similar structure, composition and function to that of a native terrestrial or riparian ecosystem of the brigalow belt.	Outer spoil slopes reshaped to 17% (9.65°). Internally draining spoil slopes reshaped to <45% (24.23°) with appropriate spoil placement, functional drainage and erosion control structures to reduce slope erosion potential. Final rehabilitated spoil dumps will be hills with a mix of pasture and native grass species or native vegetation. Topsoil/growth medium spread at minimum 150mm rate with no bare areas greater than 100m^2.	Spoil flat areas (out of pit and in-pit) surfaces have been constructed to a slope range <10% (5.71°). Spoil slopes (out of pit and in-pit) have been constructed to a slope range < 17% (9.65°). Outer spoil slopes are no longer than 100m between benches.
Mining areas	Mineral residue storage areas	1. Safe for humans and wildlife 2. Non polluting 3. Stable 4. Able to sustain agreed post-mining land use	Predominantly a self-sustaining, low maintenance pasture vegetation supporting a grazing post mining land use, or a self-sustaining, low maintenance vegetation state with similar structure, composition and function to that of a native terrestrial or riparian ecosystem of the brigalow belt.	Tailings material will be physically and chemically assessed to determine the appropriate capping required. Mineral residue material capped with coarse reject and/or spoil and revegetated with a mix of pasture and native grass species or native vegetation. Topsoil/growth medium spread at the rate of 150mm with no bare	Tailings and mineral residue material capped with an appropriate capping material. Species mix established to meet the agreed final land use of grazing or native ecosystem. Surface water run off quality is similar to the water quality of the surrounding catchment and within the EA conditions.

				areas greater than 100m2.	A suitability qualified person certifies stability of the capped and rehabilitated landforms. Coarse reject landforms shaped to a slope range <10% (5.71°).
Mine Domain	**Mine Feature Name**	**Rehabilitation Goal**	**Rehabilitation Objectives**	**Indicators**	**Completion Criteria**
Watercourse diversions	Creek diversions and levees	1. Safe for humans and wildlife 2. Non polluting 3. Stable 4. Able to sustain agreed post-mining land use	Creek diversions that operate in equilibrium with adjoining reaches of the watercourse.	Creek diversion must incorporate similar geomorphic and riparian vegetation features to those of the pre-existing watercourse and adjoining landscape. Surface water qualities of flow events through the diversion are similar to the water quality of the surrounding catchment and within the EA conditions. Remediation of the disturbed area within the watercourse diversion and adjoining floodplain is stable with evidence of vegetation achieving a trajectory of self-sustainability. Topsoil/growth medium spread at a minimum rate of 150mm with no bare areas greater than 100m^2. Seed mix includes riparian vegetation.	In accordance with condition **H2**

Appendix 3: Approved significant residual impacts

Figure 5: Authorised significant residual impacts to prescribed environmental matters under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC approval 2010/5421)

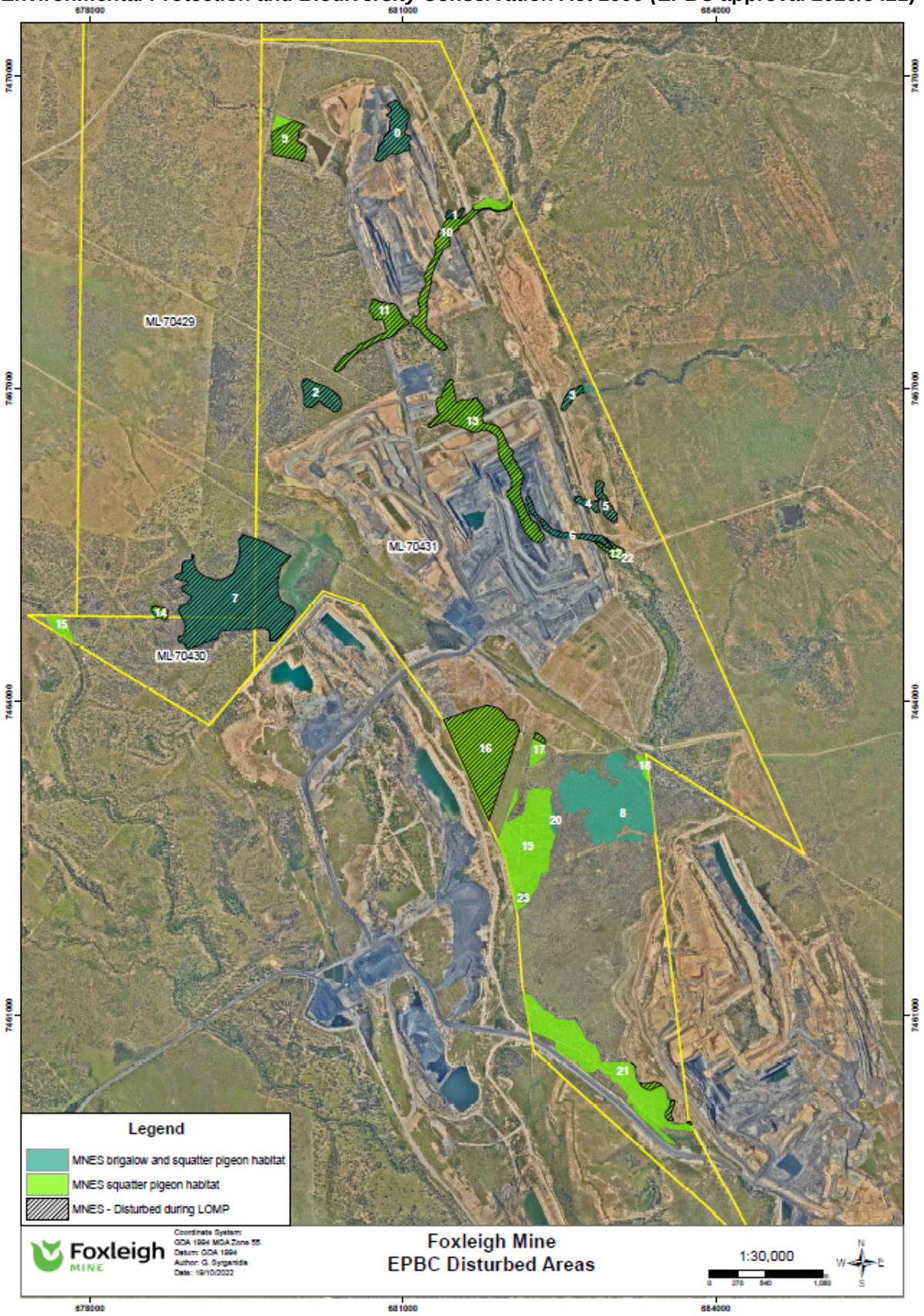
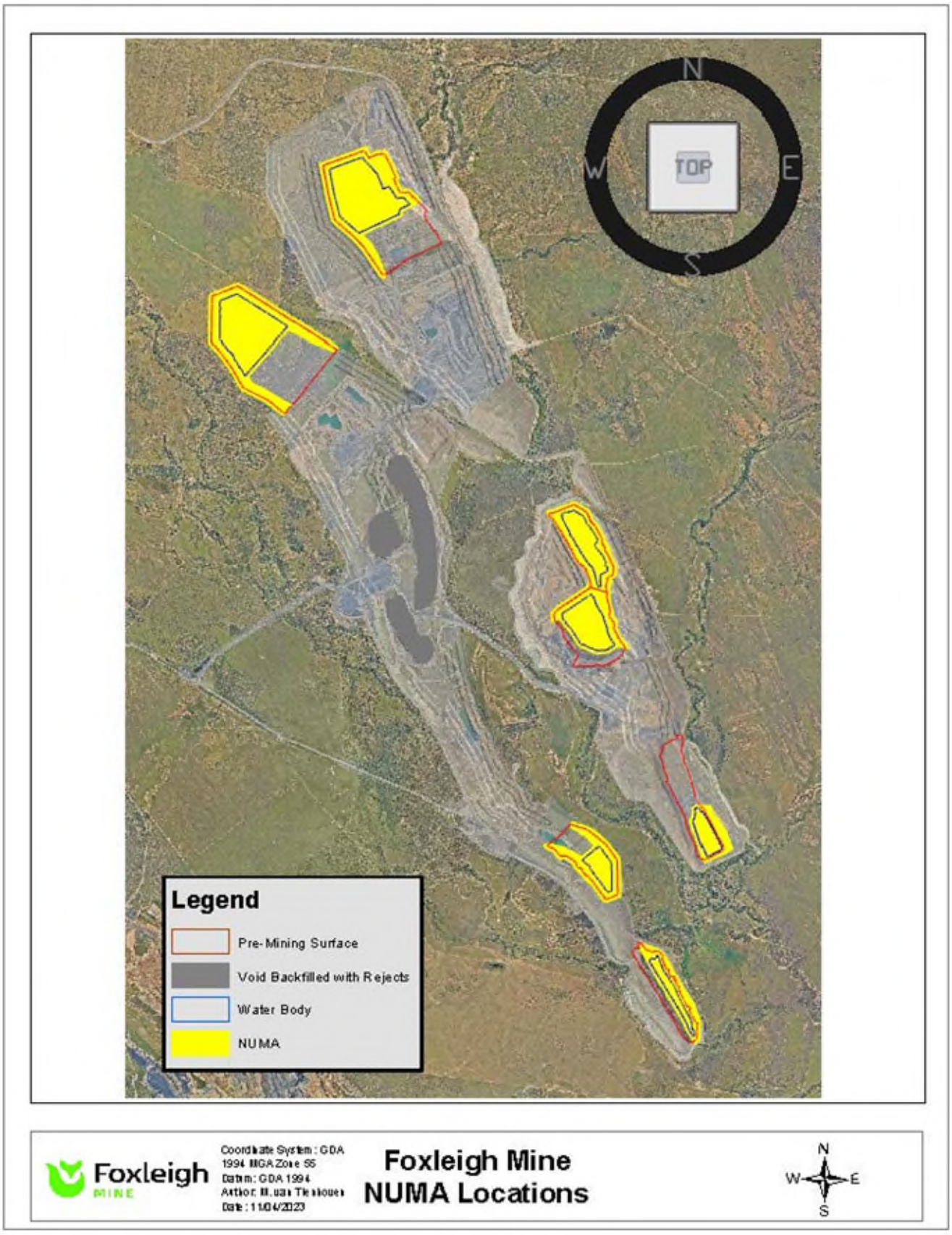


Figure 6: Authorised significant residual impacts to prescribed environmental matters that are not covered under the *Environmental Offsets Act 2014* or the *Environmental Protection and Biodiversity Conservation Act 1999* (covered under the Conservation Area)

Figure 7: NUMA locations at Foxleigh Mine



Appendix 4: Approved Residual Voids

Residual void	Total NUMA Area (Ha)	Void water body surface Area (Ha)
Eagle Nest	187.3	92
Fox Plains	185.5	101.9
One Tree West	93.8	48.9
Pipeline Pit	89.3	37.8
WC Pit	74.6	20.9
Far South	54.0	21.2
Carlo	45.8	23.1

END OF PERMIT

Appendix B: Transitional Notice

Notice

Environmental Protection Act 1994

Progressive rehabilitation and closure plan transition notice

This statutory notice is issued by the administering authority[1] under section 754 of the Environmental Protection Act 1994 *to advise you that you must submit a proposed Progressive rehabilitation and closure plan (PRC plan).*

CAML Resources Pty Ltd,
Nippon Steel Australia Pty Limited,
Foxleigh Coal Pty Ltd.
Level 12, 300 Queen Street
Brisbane City, QLD, 4000

Michael.Rosengren@qmetco.com.au

Attention: Michael Rosengren

Our reference: EPML00744813

Transition Notice for a PRC plan

1 Environmental authority details

Environmental authority EPML00744813 dated 17 February 2017 issued to CAML Resources Pty Ltd. Nippon Steel Australia Pty Limited and Foxleigh Coal Pty Ltd.

Land description: ML70171, ML70309, ML70310, ML70429, ML70430, ML70431, ML70470.

2 Required action

The holder(s) of environmental authority EPML0044813 must submit a proposed PRC plan that meets the requirements in sections 126C and 126D of the *Environmental Protection Act 1994,* pursuant to section 754 of the *Environmental Protection Act 1994*. The holder(s) must submit the proposed PRC plan to the administering authority, by **1 September 2023**.

3 Transitional provisions

Pursuant to the transitional provisions in section 754(3) of the *Environmental Protection Act 1994*, the holder(s) of the environmental authority is/are not required to comply with the requirements under section 126C(1)(g) or (h), or 126D(2) or (3) of the *Environmental Protection Act 1994* if–

(a) an outcome for the land has been identified under a land outcome document; and

[1] The Department of Environment and Science is the administering authority under the *Environmental Protection Act 1994*.

Queensland Government

(b) the outcome for the land is the same as, or substantially similar to, the outcome for the land if it were a non-use management area under a PRCP schedule.

A land outcome document is defined under section 750 of the *Environmental Protection Act 1994*.

Section 126C(1)(g) or (h), or 126D(2) of the *Environmental Protection Act 1994* require reasons and evidence to be provided to support a proposed non-use management area.

Section 126D(3) of the *Environmental Protection Act 1994* provides for any void that is contained wholly or partly in a flood plain to be rehabilitated to a stable condition.

In accordance with section 754(4) of the *Environmental Protection Act 1994*, if a land outcome document does not state sufficient detail to identify either the location or area of the land to which the outcome relates, the proposed PRC plan must state–

(a) if the area is not identified — how the total area of the land to which the outcome relates will be minimised; and

(b) if the location is not identified — how the mining environmental authority holder will ensure the location of the land to which the outcome relates minimises risks to the environment.

4 Supporting information

As detailed in section 2 of this notice, your PRC plan and associated PRCP schedule is required to address the relevant legislative requirements.

Please refer to the guideline Progressive Rehabilitation and Closure Plans (ESR/2019/4964) for more information about the requirements of the PRC plan and associate PRCP schedule, and the assessment process.

5 Consultation

The administering authority recommends that you request a pre-lodgement meeting to discuss the requirements of the proposed PRC plan in more detail. To request a pre-lodgement meeting, please completed and lodge the form ‘Application for pre-lodgement services’ (ESR/2015/1664) to arrange a meeting.

Should you have any questions in relation to this notice, please contact Jessica Edgar on telephone 07 4987 9364.

Signature

26 July 2021

Date

Chris Wake
Department of Environment and Science
Delegate of the administering authority
Environmental Protection Act 1994

Enquiries:
Coal Business Centre
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Appendix C: PRCP Foxleigh Initial Meeting Minutes

Meeting minutes

Foxleigh Coal Mine - Initial PRCP Transition Meeting

Details

Subject	Foxleigh - PRCP Initial Meeting
Chair	Chris Wake
Meeting type	Teams Meeting
Date and location	11/05/2021 (Online)
Timing	10:30 – 11:30am
Distribution	Via email

Present

Name	Job Title	Position/Representation
Michael Rosengren	Managing Director	Qmetco
Mitch Barnes	Technical Services Manager	Middlemount South Pty Ltd
Tod Mathews	General Manager	Middlemount South Pty Ltd
Tegan Ireland	Consultant	Nitro Solutions
Chris Wake	Manager Environmental Services	DES – PRCP team
Lachlan McQuire	Principal Environmental Officer	DES – PRCP team
Alison Sinclair	Manager (Assessment)	DES – BCC
Barbara Van Der Pol	Team Leader (Assessment)	DES – BCC
Jessica Edgar	Senior Environmental Officer (Assessment)	DES – BCC
Kathryn Eller	Senior Environmental Officer (Assessment)	DES – BCC

Items

Item #	Discussion
1.	• Introductions • Site Overview – Foxleigh is in the process of updating and revising legacy documents prepared under the previous site owners.
2.	Established that EPML00744813 is the primary land outcome document (LOD), and Appendix 2 contains land outcomes for the site.
3.	Discussion on interpretation of NUMA pre-approval. Foxleigh have received legal advice that indicates site has pre-approval for pit voids to be transitioned as NUMA's. The department's view is that Appendix 2 prescribes land uses for the residual voids, and that NUMA's have not been pre-approved. Foxleigh are concerns that the water quality within the voids will not be of suitable quality to sustain a use into perpetuity. Foxleigh is to provide a position based on legal advice received to which justifies how Appendix 2 can be considered pre-authorisation of NUMA's and should also provide and identify where information used to populate Appendix 2 (ie Foxleigh Plains EIS) demonstrates that water quality will be unsuitable to achieve PMLU and demonstrates that the inclusion of the uses in Appendix 2 was an error.
4.	Options to resolve NUMA issues include seeking approval for NUMA's during the PRCP assessment process, or seeking an amendment to the EA.
5.	Foxleigh sought clarification on the requirements for a risk assessment of scenic values, given that there are no sensitive reports within 10km. Foxleigh noted that a settlement with a landholder is underway and expected to be finalised in June 2021.
6.	Foxleigh sought clarification on the requirements for community consultation and DES confirmed that they will be required to keep and include a community consultation register and provide a plan for future consultation as per the guideline requirements.
7.	Foxleigh sought clarification on the requirements for floodplain modelling relating to artificial features. DES highlighted that NUMA will not be approved in floodplain and that in order to get a consistent definition of the floodplain artificial features that alter the floodplain should be excluded from modelling to give the closest representation of the pre-mining floodplain. Artificial features existing within the site should be excluded from floodplain modelling, noting that it is recognised that some catchments will be otherwise highly modified by other mining activities.
8.	Foxleigh advised that no analogue sites have been identified for rehabilitation monitoring. DES advised that monitoring will be required and that a reference site/s or other measure (example given: erosion rate) should be nominated, in order to demonstrate rehabilitation success and progress towards PMLU.
9.	Foxleigh noted the following in terms of gap analysis and further studies: • Foxleigh have commissioned several new studies in order to provided updated and contemporary information rather than relying on legacy documents provided by previous site owner. • Phase 1 of the waste and soil characterisation is complete including testing of 200 samples, phase 2 is underway. • An updated Water Balance Model has been prepared • An infrastructure decommissioning report has been prepared

- A Geotechnical Void Study is under preparation
- A Groundwater Model is under preparation as the current model only considers the northern sections of the mine. It is expected that this will take 6+ months to complete
- A geochemical report on tailings is being prepared

Action

Item #	Action	Responsible	Status	Due Date
1.	Set up further meeting: • A further meeting is to be held to resolve the NUMA issue and develop a pathway forward, and to discuss transitional timeframes.	DES	In Progress	30/06/2021
2.	Information to be provided prior to next meeting: • Provide a position on NUMA's with reference to the legal advice received which supports that the EA Appendix 2 can be interpreted as a pre-approval of residual voids as NUMAs. • Provide relevant information that was used to develop Appendix 2, which demonstrates that the water quality of voids was known to be unsuitable to support a use post mining.	Foxleigh	In Progress	Next meeting

Next meeting

Date	TBD
Time	TBD
Location	Teams Meeting

Appendix D: Socio-economic Impact Assessment

L

SOCIO-ECONOMIC IMPACT ASSESSMENT

FOXLEIGH PLAINS PROJECT

SOCIO-ECONOMIC IMPACT ASSESSMENT

Prepared by:

HANSEN BAILEY
Level 15, 215 Adelaide Street
Brisbane QLD 4001

2 April 2012

For:

ANGLO COAL (FOXLEIGH MANAGEMENT) PTY LTD
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LIST OF ABBREVIATIONS

ABS	Australian Bureau of Statistics
ACFM	Anglo Coal (Foxleigh Management) Pty Ltd
CEP	Community Engagement plan
C&K	Crèche and Kindergarten Association
CHC	Community Health Centre
CHPP	Coal Handling and Preparation Plant
CQU	Central Queensland University
CRG	Community Reference Group
CS Act	Census and Statistics Act 1905
DCS	Department of Community Safety
DEEDI	Queensland Department of Employment, Economic Development and Innovation
DERM	Queensland Department of Environment and Resource Management
DET	Queensland Department of Education and Training
DIP	Queensland Department of Infrastructure and Planning
DOC	Queensland Department of Communities
EAP	Employee Assistance Program
EcIA	Economic Impact Assessment
EIS	Environmental Impact Statement
EQ	Education Queensland
ERP	Estimated Resident Population
FIFO/DIDO	Fly-in fly-out/drive-in drive-out
FTE	Full-time Equivalent
GRP	Gross Regional Product
HACC	Home and Community Care
IRC	Isaac Regional Council
LDMG	Local Disaster Management Group
LGA	Local Government Areas
M	million
MCS	Middlemount Community School
MLA	Mining Lease Application
Mtpa	Million tonnes per annum
MRPHP	Major Resource Projects Housing Policy
MRPHP	Mackay Whitsunday Regional Economic Development Corporation
OESR	Office of Economic and Statistical Research
OP	Overall Position Bands
PIFU	Queensland Planning Information and Forecasting Unit
QAS	Queensland Ambulance Service
QFRS	Queensland Fire and Rescue Service
QGAP	Queensland Government Agent Program
QH	Queensland Health

QPS	Queensland Police Service
QSA	Queensland Studies Authority
ROM	Run of Mine
SD	Statistical Division
SEAT	Anglo American Socio-Economic Assessment Toolbox
SEIFA	Socio-Economic Index for Areas
SES	State Emergency Service
SIA	Socio-economic Impact Assessment
SIMP	Social Impact Management Plan
SLA	Statistical Local Area
The project	the Foxleigh Plains Project
TLO	Train load out
TOR	Terms of Reference
UCL	Urban Centre Locality
VET	Vocational Education Training

FOXLEIGH PLAINS PROJECT
SOCIO-ECONOMIC IMPACT ASSESSMENT

for
Anglo Coal (Foxleigh Management) Pty Ltd

1 INTRODUCTION

Hansen Bailey was commissioned by Anglo Coal (Foxleigh Management) Pty Ltd (ACFM) to complete a Socio-economic Impact Assessment (SIA) as part of the Environmental Impact Statement (EIS) for the Foxleigh Plains Project (the project).

1.1 PROJECT OVERVIEW

This section describes the project including the open cut mining activities and associated mine infrastructure. The existing approved Foxleigh Mine operations and the integration of the project with these operations is also discussed.

1.1.1 Project Description

Existing Foxleigh Mine Operations
Foxleigh Mine is an operating open cut coal mine located approximately 12 km south-east of the township of Middlemount in Central Queensland (Figure 1). The mine commenced production in 1999 and currently produces 3.2 million tonnes per annum (Mtpa) of Run of Mine (ROM) coal, yielding 2.4 Mtpa of product coal. It has an anticipated remaining life of two to three years with operations expected to cease by the end of 2014.

Open cut mining is conducted using truck and shovel mining methods. ROM coal is washed on site at a Coal Handling and Preparation Plant (CHPP) before being hauled approximately 28 km by truck on a private haul road to the Foxleigh Mine train load out (TLO) facility. Coal is transported from site by rail to the Dalrymple Bay Coal Terminal for export. Tailings and rejects from the CHPP are stored in in-pit disposal areas. Other Foxleigh Mine infrastructure includes administration and workshop facilities, mine water storages and drainage infrastructure.

The existing Foxleigh Mine infrastructure will be utilised by the Foxleigh Plains Project. This will include the CHPP, private haul road, TLO facility and tailings and coarse reject storage areas. These facilities currently have sufficient capacity to service the project at 4 Mtpa ROM production for the 15 year project life, and no upgrading of infrastructure is required. The existing facilities will therefore continue to operate in accordance with current approvals throughout the development and operation of the project.

Foxleigh Plains Project

The project involves the extension of open cut mining at Foxleigh Mine into the Foxleigh Plains Project site (Figure 2). The Foxleigh Plains Project site is the Foxleigh Plains Mining Lease Application (MLA) area and comprises three MLA areas (MLA 70429, MLA 70430 and MLA 70431) that join the northern end of the existing Foxleigh Mine mining leases (Figure 2).

The project will provide access to an estimated additional coal resource of up to 60 million tonnes and increase ROM coal production from 3.2 to 4.0 Mtpa. This increase in ROM coal production will increase the production of saleable Pulverised Coal Injection coal to approximately 3.2 Mtpa. The project will extend the life of Foxleigh Mine by approximately 15 years.

Coal will be mined in the project site using the same open cut mining method employed at Foxleigh Mine, utilising and expanding upon the current Foxleigh Mine workforce and equipment fleet. The Foxleigh Plains Project will comprise the expansion of the 'Foxleigh Plains' mining area and a new mining area named 'Eagles Nest' (Figure 3).

ROM coal extracted from the project site will be transported via new and existing haul roads to the existing Foxleigh Mine CHPP for washing and processing. The Foxleigh Mine CHPP has a design capacity of 4 Mtpa and therefore no CHPP upgrade will be required as part of the project.

Tailings generated from processing Foxleigh Plains coal at the CHPP will be pumped to the existing Foxleigh Mine in-pit tailings storage facility. Coarse coal reject material will be stored within available mine voids at Foxleigh Mine. The Foxleigh Mine tailings and reject storage areas have sufficient capacity to store the additional life of mine reject material generated by the project.

Product coal will be transported from the CHPP to the Foxleigh Mine train load out facility at German Creek Mine, via the existing privately owned haul road. The Foxleigh Mine train load out facility has sufficient capacity to load product coal from the expanded operations and no upgrading of this facility is required as part of the project.

It is anticipated that project establishment activities will commence in Quarter 2 of 2013 and open cut mining will commence by the end of 2013. Mining operations at the existing Foxleigh Mine are expected to be completed by the end of 2014. From 2014 onward, the Foxleigh Plains MLA will contain the only active mining areas within the expanded Foxleigh Mine operations.

1.1.2 Proponent

The proponent for the project is the Foxleigh Joint Venture. The Foxleigh Joint Venture comprises:

- Anglo Coal (Foxleigh) Pty Ltd (30%);
- CAML Resources Pty Ltd (60%); and
- Nippon Steel Australia Pty Ltd (10%).

Anglo Coal (Foxleigh) Pty Ltd owns 66.7% of CAML Resources Pty Ltd and therefore controls 70% of the Foxleigh Joint Venture.

Anglo Coal (Foxleigh) Pty Ltd is a wholly owned subsidiary of Anglo American Metallurgical Coal Pty Ltd (Met Coal), a member of the Anglo American plc Group (Anglo American). Anglo American is one of the largest diversified mining companies in the world with operations and growth projects located in southern Africa, South America, Australia, North America, and Asia. Anglo American is the second largest exporter of metallurgical coal in Australia. Its current operations include Foxleigh, Capcoal, Dawson, Moranbah North and Callide in Queensland and Drayton in New South Wales.

Anglo Coal (Foxleigh Management) Pty Ltd is the operator of the Foxleigh Joint Venture.

Anglo American's current operations in the vicinity of Middlemount include:

- Foxleigh Mine – open cut mine located 12 km south-east of Middlemount; and
- The Capcoal group of mines (Capcoal) consisting of the German Creek operations (including Grasstree and Aquila), Bundoora, German Creek East, Oak Park and Lake Lindsay.

1.2 PURPOSE OF THE DOCUMENT

This report documents the socio-economic impacts associated with the expansion of the existing Foxleigh Mine, herein termed the Foxleigh Plains Project (the project). The impacts of the project have been analysed with consideration given to its demand for, and effect on, a range of social values present in the study area.

1.3 DOCUMENT STRUCTURE

This report presents the results of the SIA undertaken for the project. The report is structured as follows:

- Section 1 – Introduction.
- Section 2 – Scope and Methodology – provides a detailed explanation of the scope of work and methodology adopted for the SIA.
- Section 3 – Existing Socio-Economic Environment – provides a description of the existing local and regional socio-economic environment within which the project is located.
- Section 4 – Potential Impacts and Mitigation Measures – provides a detailed analysis of the potential impacts of the project including cumulative impacts. Specific strategies for mitigating any adverse impacts are also identified.

1.4 PROJECT ENVIRONMENT

The project site is located approximately 5.3 km south-east of the town of Middlemount within the Isaac Regional Council (IRC) Local Government Area (LGA), a well established coal mining region (Figure 4).

1.4.1 Regional Environment

Middlemount is located within the Mackay Statistical Division (SD) (Figure 4) and in close proximity to the northern boundary of the Fitzroy SD. Mackay is the primary regional centre for the Mackay SD and is located approximately 250 km north-east of Middlemount. Rockhampton, is located approximately 195 km south-east of Middlemount and is the primary regional centre for the Fitzroy SD. Emerald is the closest regional centre to Middlemount, located approximately 150 km south-east of Middlemount. Emerald is located within the Fitzroy SD.

Mackay provides the majority of regional employment in trade, public administration, transport and business and community services (DLGP, 2006). The current resident population of the Mackay SD is 180,000, with approximately 100,000 additional residents anticipated to relocate to the region by 2031 (DLGP, 2011). The estimated resident population of the Fitzroy SD in 2010 was 223,516, with approximately 120,000 additional residents anticipated to relocate to the region by 2031 (OESR, 2011b).

The proximity of Mackay and Rockhampton to the Bowen Basin, and the lifestyle choices offered in these locations means that many employees in the mining industry base themselves and their families in the Mackay and Rockhampton area and commute to work for block shift periods. Mackay, Rockhampton and Emerald have grown rapidly over the

past two decades in line with the major developments in the mining industry and the developing mining services sector. Mackay (and the surrounding coastal areas) not only services the mining industry but is also the centre of transport and port facilities and provides a population base for employment.

The development of the mining industry in the Bowen Basin has provided the region with income, investment, employment and infrastructure. However, the private and public sector continue to experience difficulties in responding to the demand for social infrastructure in a timely manner. This is resulting in mixed social infrastructure and service outcomes for a number of resource communities.

Rapid industry growth has created a number of associated adjustment problems for the region. These include shortages in the skilled and unskilled labour market, congestion of rail and port infrastructure, and management of the environmental and social impacts associated with rapid industry growth.

1.4.2 Local Environment

The project site is located approximately 5.3 km south-east of the town of Middlemount within the IRC (formerly Broadsound Shire) LGA area, a well established coal mining region (Figure 4). Middlemount is a purpose built mining town established by Capcoal in the early 1980's to serve the needs of its employees at the German Creek Mine. The town services the workforces of the Capcoal operations (i.e. including German Creek, German Creek East, Bundoora, Lake Lindsay and Oak Park) and Foxleigh Mine, as well as the local rural industries of grazing and crop production. The proposed Middlemount Coal Project, Stage 2 (an expansion of Middlemount open cut coal mine) is located approximately 4 km to the south-west of the township of Middlemount (Figure 2).

The town of Middlemount is often referred to as a 'Capcoal town', referring to the strong presence of Capcoal in the town and surrounding mines. The history of the town is documented in the *Capcoal Community Engagement Plan SEAT Final Report Middlemount 2007-08* (Capcoal Community Engagement Plan [CEP], 2007). In the early 1980s Middlemount was a thriving town, widely recognised as a 'model mining community' that offered high-quality housing combined with excellent sporting and leisure facilities. Residents would openly promote the town as a good place to live and bring up young children. Middlemount is now almost 30 years old. The Capcoal CEP (2007) describes the Middlemount township in 2007 as 'tired and outdated' with housing and infrastructure that is in need of reinvigoration.

Capcoal is still the main landlord in Middlemount, however the town has evolved into more than a one-company-town. The town currently serves numerous stakeholders including neighbouring Xstrata mines in addition to the Anglo American workforces of the Capcoal operations (including German Creek, German Creek East, Bundoora, Lake Lindsay and Oak

Park) and Foxleigh Mine, and the local rural industries of grazing and crop production. Figure 2 highlights the current and proposed mining operations in the vicinity of Middlemount.

A key feature of Middlemount is the presence of a significant non-resident worker population consisting largely of mine employees and contractors (construction, operations and maintenance) who undertake their jobs on a fly-in fly-out/drive-in drive-out (FIFO/DIDO) basis and who reside permanently for the purposes of census and taxation purposes outside of Middlemount in regional, state and interstate locations. In many cases the non-resident worker population is accommodated in single unit accommodation in large scale accommodation villages located on the perimeter of the Middlemount township.

2 SCOPE AND METHODOLOGY

2.1 SCOPE OF WORK

2.1.1 Overview of Scope

Regulatory Compliance

The scope of work for the SIA was designed to address the relevant requirements of Queensland regulatory guidelines. These requirements are detailed in Table 1.

Table 1
Regulatory Requirements

Name	Description
Terms Of Reference (TOR) for Foxleigh Plains Project EIS - Department of Environment and Resource Management (DERM)	Describes the social and economic issues that are to be addressed in the project EIS. The TOR specifies the requirement to prepare a Social Impact Management Plan (SIMP) which is informed by the findings of the SIA.
Social Impact Assessment - Guideline to preparing a social impact management plan September 2010 (the SIMP Guideline) (former Department of Infrastructure and Planning)	Provides guidelines for the preparation of a SIMP for the project as a component of the EIS.
Major Resource Projects Housing Policy 2011 (MRPHP) - Department of Employment, Economic Development and Innovation (DEEDI)	Provides guidelines for managing workforce accommodation issues in Queensland, against which the SIA Unit of the Department of Local Government and Planning (DLGP) will assess the SIA and SIMP for the project

This SIA has assessed the impacts associated with the establishment, operation and decommissioning phases of the project.

2.1.2 Interactions with Other Technical Assessments

This report has summarised and incorporated the findings of other EIS technical assessments that are applicable to a complete assessment of socio-economic impacts. These studies were undertaken by other specialist consultants, and are provided in the EIS appendices and main EIS document and include:

- Section 4 – Consultation;
- Section 16 - Scenic Values*;*
- *Air Quality Report (Appendix I);*
- *Noise Report (Appendix J);* and
- *Road Impact Assessment (Appendix M).*

2.2 OVERVIEW OF METHODOLOGY

The SIA methodology for the project was developed based on the Fact Sheet – *Social Impact Assessment* published by the former Department of Infrastructure and Planning (DIP) and methodologies adopted for similar mining projects in the Bowen Basin. The SIA methodology included the following key components:

- Identification of the project's socio-economic area of influence (Section 2.3);
- Profiling of the existing socio-economic environment (Section 2.4);
- Identification and assessment of potential social impacts, including cumulative impacts (Section 2.5);
- Identification and assessment of potential economic impacts including cumulative impacts (Section 2.6); and
- Development of appropriate impact mitigation and management measures to address socio-economic impacts and to maximise community benefits (Section 2.7).

Consultation with relevant stakeholders was inherent in each step of the SIA. EIS consultation was conducted to gather information on community perceptions, to better understand the current social setting and to assist in the prediction of potential social impacts. EIS consultation was also conducted to disseminate information about the project and understand key issues of concern to stakeholders.

The following sections document the methodology for the SIA.

2.3 CULTURAL AND SOCIO-ECONOMIC AREA OF INFLUENCE

The cultural and socio-economic area of influence (the SIA study area) focuses predominantly on the town of Middlemount. This is because the project workforce will be

accommodated in the town and the economic and social impacts of the project will be felt foremost in this community.

The project's influences, specifically those related to labour force demand and supply and economic benefits, are likely to extend to other areas of the IRC, the wider Mackay and Fitzroy SDs and the state. For this reason the study area for the assessment of economic impacts includes Queensland.
In determining the cultural and social area of influence it is acknowledged that the impacts associated with any potential non-resident component of the workforce will also be felt at the home base of the workforce. With the presence of airports in Moranbah and Emerald providing direct flights to and from Brisbane, and flights from Mackay and Rockhampton to a suite of state and interstate locations, the potential base locations for the non-resident workers are numerous. Consequently, it is not possible within the scope of this assessment to fully identify the prevalence or magnitude of the project impacts at all the base localities.

For these reasons, the regional study area for the assessment of socio-economic impacts is defined as the Mackay and Fitzroy SDs and the local study area for the assessment of socio-economic impacts is defined as the IRC and principally the town of Middlemount.

2.4 PROFILING OF THE EXISTING SOCIO-ECONOMIC ENVIRONMENT

2.4.1 Approach

Understanding the existing socio-economic environment was central to identifying and analysing the potentially adverse and beneficial project impacts. The socio-economic baseline was determined for the SIA study area and included collection and analysis of a comprehensive data set related to social and economic indicators.

2.4.2 Information Sources

Qualitative and quantitative data was obtained from various sources including desktop research and through a targeted consultation program. Data was collected, collated and reviewed to gain a thorough understanding of the existing social environment, predominantly at the local level. Local data was contextualised by also understanding the broader regional social environment. A description of the information sources reviewed and an overview of the key consultative sources is provided below.

Literature Review
A survey and review of existing studies and available statistical information from government, academic or research institutions was undertaken as part of the SIA. The Bowen Basin has been the subject of several significant studies including but not limited to studies conducted by the CQU Centre for Environmental Management, the Australian Housing and Urban Research Institute, the Queensland Planning Information and

Forecasting Unit (PIFU), the Queensland Department of Housing, the IRC and various consultants who have prepared EIS documents for mineral resource projects in the Bowen Basin.

Regional and Community Planning

Information was drawn from the existing statutory regional and community plans for the three LGAs within the Mackay SD area to inform the baseline profile for the SIA study area. The relevant plans for each are described in Table 2.

Table 2
Regional and Community Plans

Locality	Regional Plan	Community Plan
Isaac Regional Council	*Mackay, Isaac and Whitsunday Regional Plan 2011 – 2031*	*The Isaac Region 2020 Visions 2009 – 2019* (Isaac Region 2020 Vision).
Mackay Regional Council	*Mackay, Isaac and Whitsunday Regional Plan 2011 – 2031*	Community Plan (under SPA 2009) currently under development and due for adoption in 2012.
Whitsunday Regional Council	*Mackay, Isaac and Whitsunday Regional Plan 2011 – 2031*	Community Plan (under SPA 2009) currently under development

Existing Anglo American Documents

The Anglo American documents described in Table 3 were reviewed to inform the baseline profiling of the study area and later the development of management and mitigation strategies.

Table 3
Anglo American Documents Reviewed

Anglo American Documents	Overview
Anglo American Socio Economic Assessment Tool (SEAT)	This is an internal Anglo American performance measurement tool designed to assist Anglo American operations to identify and manage their social and economic impacts (both positive and negative). It also provides guidance on how to improve overall social performance where this is necessary. It is intended through the implementation of the SEAT process, that the long-term economic and social sustainability of the communities around Anglo American operations will be enhanced and the basis for more sustainable partnerships established. The SEAT process is designed to be implemented at least every three years at all Anglo American operations. Stakeholder engagement is a vital part of the SEAT process. The SEAT process was last implemented in 2011 for the combined operations of Capcoal and Foxleigh.
The Capcoal Community Engagement Plan SEAT Final Report Middlemount 2007 – 2008 (2007-2008 Capcoal CEP)	The 2007-2008 Capcoal CEP is the final outcome of the 2007 SEAT community consultation process. The purpose of the CEP is to provide Capcoal with a practical strategy to deliver benefits to the Middlemount community.
The Capcoal/Foxleigh SEAT Report 2011 - 2013 (2011 – 2013 SEAT)	The Capcoal/Foxleigh SEAT Report 2011 - 2013 (2011 – 2013 SEAT) documents the outcomes of the most recent SEAT study conducted for the combined operations of Capcoal and Foxleigh. This study identifies the key issues raised by stakeholders during consultation conducted by Anglo American to inform the preparation of the 2011-2013 SEAT.
2011-2013 Anglo American Middlemount Region Community Engagement Plan (2011 – 2013 CEP)	The 2011-2013 CEP is an internal document prepared by Anglo American based on the findings of the 2011- 2013 SEAT study. The 2011 - 2013 CEP is a strategy designed to assist Anglo American with the delivery of more sustainable, locally focussed and transparent benefits, in partnership with the local Middlemount community. The 2011 - 2013 CEP documents a series of management objectives complete with actions, responsibilities and performance targets responding to the following eight key issues: • Housing and accommodation; • Infrastructure and business; • Community health; • Education and training; • Community engagement and communications; • Community spirit; • Cultural heritage; and • Sponsorship and donations. Where relevant, existing management activities and performance targets documented in the 2011 - 2013 CEP have been incorporated into the Social Impact Management Plan prepared for the project. The 2011-2013 CEP will be updated as part of the next SEAT process.

Quantitative Data

Quantitative data contained within this report has been drawn predominantly from the Australian Bureau of Statistics (ABS) 2006 Census and more recent ABS publications. Additional data has been drawn from the following sources:

- Queensland PIFU Population and Housing facts sheets and annual publications. In particular the Bowen Basin Population Report, 2011 - Full-time equivalent (FTE) population estimates at 31 July 2010.
- Regional profiles prepared by the Office of Economic and Statistical Research (OESR).
- Department of Education and Training (DET) - Education Queensland (EQ) and Queensland Studies Authority (QSA).
- IRC website including IRC publications.

Where possible, data has been sourced for the following census districts within the study area: Mackay SD, Fitzroy SD, the IRC LGA, key towns within the IRC LGA including the town of Middlemount and the city of Emerald within the Central Highlands Regional Council LGA. In most cases census data for the study area has also been compared to Queensland Census data for key towns in the IRC and for the city of Emerald has been included in a number of tables to provide context to the discussion of local issues.

Consultation

Consultation with local and regional stakeholders was a critical component of the EIS. Consultation was conducted for the EIS to inform stakeholders about the project, understand stakeholders' issues in relation to the project and explore the social baseline of the local and regional community.

The findings of the EIS consultation were used to verify data collated through desktop research and to assist in identifying the existing social environment, social impacts and mitigation and management strategies. The following consultation was undertaken specifically to inform the SIA:

- Discussions with relevant local, regional and state government departments including Department of Communities (DOC), Department of Community Safety (DCS), SIA Unit of the Department of Employment Economic Development and Innovation (DEEDI), Queensland Health (QH), DET and IRC.
- Interviews with local service providers including representatives of QH, Middlemount Community School (MCS), Queensland Ambulance Service (QAS) and Queensland Police Service (QPS), childcare organisations and youth centre operators.
- Discussions with various local recreation providers such as the local leisure centre, netball club and rugby clubs.

Indigenous residents of Middlemount were provided with the opportunity to participate in consultation as part of the general community.

A list of all stakeholders consulted for the preparation of the EIS is provided in Appendix A. Further information on the EIS consultation is provided in the main EIS document, Volume 1 Section 4 - *Consultation*.

SEAT Consultation

Consultation for the purposes of informing the preparation of the 2011-2013 SEAT study for the combined operations of Foxleigh and Capcoal was undertaken concurrently with the EIS consultation by representatives of Anglo American. SEAT consultation included:

- Preparation and distribution of a community newsletter to Middlemount community;
- Preparation and distribution of a survey to all parents and staff at MCS and to all Foxleigh Mine and Capcoal employees;
- Letterbox drop of survey to occupied residences in Middlemount;
- Face to face interviews with a range of business and service operators located in the Middlemount; and
- Face to face interviews with a number of Middlemount residents.

A total of 115 direct interviews were conducted and 168 survey responses received as part of the SEAT consultation. The findings of the 2010 SEAT consultation have informed the SIA.

2.5 IDENTIFICATION AND ASSESSMENT OF SOCIAL IMPACTS

2.5.1 Approach

Following the confirmation of the existing social environment of the study area the potential social impacts of each phase of the project were identified and assessed. Social impacts were analysed with consideration given to the local and regional effects on the identified social values within the community. Within this scope, the SIA has addressed impacts on the following affected population groups:

- Resident population of Middlemount;
- Non-resident population of Middlemount;
- Minority groups within the local and regional area including indigenous people, people with disabilities, young people and low income families; and
- Communities outside of Middlemount but within the SIA study area.

In determining the potential socio-economic impacts of the project, consideration was also given to the:

- Existing pressures within the Middlemount community;
- Concerns raised in relation to the project during consultation with community representatives; and
- Cumulative impacts with other mining operations in the local area, notably the proposed Middlemount Coal Project, Stage 2.

The potential impacts identified within the assessment are both positive and negative in nature, as the project has the potential to create both positive and negative socio-economic changes. For example, the project may result in increased employment, induced economic growth and increased resident population, but it also may result in further increase in non-resident workforce, increased demand for social services and changes in community identity.

2.5.2 Identification and Assessment of Cumulative Impacts

Cumulative socio-economic impacts were identified and assessed through the collection and analysis of data relating to employment and other economic contributions, housing, social service provision and residential amenity. Data was provided by the proponent (for example, employment data), other organisations (such as the ABS) and some data was collected directly by the project team through the EIS consultation process.

The existing extent to which Middlemount and the broader study area is subject to cumulative impacts is discussed within Section 3. The potential further contribution of the project to existing cumulative impacts is discussed in Section 4. Measures to manage potential cumulative impacts are also detailed in Section 4.

2.6 IDENTIFICATION AND ASSESSMENT OF ECONOMIC IMPACTS

2.6.1 Approach

An economic impact assessment (EcIA) was completed for the project by the Central Queensland University (CQU). The EcIA quantifies the potential positive and negative economic impacts associated with the establishment and operation of the project.

The identification and assessment of economic impacts included the following three stages:

- Stage 1 – Modelling of economic activity resulting from the project (e.g. employment, workforce and expenditure changes);

- Stage 2 – Identification and assessment of the potential economic impacts; and
- Stage 3 – Project cost-benefit analysis.

Stage 1 – Modelling of Economic Activity

The economic impact assessment generated an estimate of the scale of economic consequences of the project over the area of impacts. Input-Output modelling was used to provide a quantitative approach to estimate how economic impacts can 'ripple' through an economy. Input-Output models are built from national economic data published by the ABS. Models for the national economy are scaled to state and regional level models using employment data or other relevant indicators.

The economic impacts of the establishment and operations phases of the project have been examined separately. Since the establishment phase is expected to last for only 12 months and the effects of the establishment phase are temporary, the economic impacts for the establishment phase are identified only for the Mackay SD and Queensland areas. The underlying assumptions are that all labour for the establishment phase will be drawn from within Queensland, and that the impacts on the state economy are the same as at the national level.

For the operations phase, the smallest economy for which an Input-Output model has been built is the Mackay and Fitzroy SDs, and not the smaller IRC area. CQU considered it inaccurate to extrapolate the structure of the national, state and regional economy to the IRC economy due to the highly specialised nature of the IRC economy.

For the operations phase the economic impacts are identified for the following four areas:

- Fitzroy SD;
- Mackay SD;
- State of Queensland; and
- Australia.

Stage 2 – Economic Impact Assessment

An assessment of the likely economic impacts was undertaken using a mixture of desktop analysis, targeted interviews with key stakeholders and assessment of the economic modelling results. Interviews were conducted with the IRC and local business representatives. Additional data was sourced from a variety of areas, including the Mackay Whitsunday Regional Economic Development Corporation (MWREDC) and the OESR.

Stage 3 – Cost-Benefit Analysis

A cost-benefit analysis of the project was conducted as part of the EcIA. Cost-benefit analysis involves the assessment of the net benefits of a project to society as a whole, and includes the costs and benefits of social and environmental impacts including financial,

infrastructure and other consequences. A positive net result implies that the proposed project produces more benefits than costs and would be beneficial to the local and regional communities. The cost-benefit analysis assigns values to the different impacts and outcomes, and provides a framework where different outcomes may be assessed against each other.

2.7 MANAGEMENT OF SOCIO-ECONOMIC IMPACTS

2.7.1 Approach

The opportunity exists for the proponent to manage predicted impacts to maximise positive impacts and minimise negative impacts through effective socio-economic impact management planning.

The identification of strategies to manage the adverse impacts of the project and enhance the positive benefits of the project was informed through the following processes:

- A review of the 2011-2013 CEP for the combined operations of Foxleigh and Capcoal, and the completion of a gap analysis to identify additional social impact management processes for inclusion in the EIS SIA and SIMP;
- A review of existing and relevant Anglo American management tools including but not limited to those previously described in Table 3 and additional tools described in Table 4;
- A review of the requirements of relevant state government policies and guidelines including the Queensland Government Local Industry Policy and the MRPHP; and
- A review the findings of consultation conducted with key stakeholders for the purposes of the EIS.

Table 4

Existing Corporate Management Tools

Management Tool	Overview
Employee Assistance Program (EAP)	The EAP is provided to support the health and wellbeing of Foxleigh Mine employees and their families, recognising the unique lifestyle requirements associated with employment in the project.
Foxleigh Mine Alcohol and Other Drugs Management System	This management system was developed to eliminate the hazards in the workplace associated with alcohol and drug use in a way that is consistent and fair to all persons who enter the site, and to meet legal and moral obligations.
Anglo American Mine Closure Toolbox (Mine Closure Toolbox)	The Mine Closure Toolbox was developed to expand the focus of mine closure planning from financial provisioning for rehabilitation and physical closure to planning for sustainability beyond mine closure and leaving a positive legacy behind. Includes specific actions for consideration in mine closure planning. The requirements of the Mine Closure Toolbox will be addressed through the Anglo American SEAT process as project operations progress.
Anglo American Capcoal and Foxleigh Community Complaints and Grievance Procedure	This procedure is a new Anglo American (Foxleigh and Capcoal) tool that provides a formal process whereby interested and affected stakeholders can submit a complaint regarding Capcoal and Foxleigh Mine's performance and can, through a defined process, and within a predictable timeframe, receive a response and/or resolution of the complaint.
Anglo American Metallurgical Coal (Met Coal) Equal Employment Opportunities Policy	Anglo American is an equal opportunity employer. The proponent is committed to ensuring equal opportunity for all potential employees to access employment opportunities related to the project, facilitating active inclusion of vulnerable groups in the region including indigenous, women, people with disabilities, mature workers and unskilled.
Anglo American Commitment to Workforce Diversity	Anglo American is an equal opportunity employer. Promoting diversity within its workforces remains an important pillar of the Anglo American human resources principles, as well as a central component of operational human resources strategies at Anglo American operations around the world.
Anglo American Community Officer – Middlemount	This is a new Anglo American role established across Anglo American operations in the Bowen Basin to support communication and engagement between Anglo American and its communities and other stakeholders.

The management and mitigation of each identified socio-economic impact is described in Section 4.

2.7.2 Social Impact Management Plan

A SIMP (EIS Attachment 2) has been prepared for the project. The SIMP documents the proponent's commitments to the:

- Management of social impacts arising from the project; and/or
- Development of strategies to manage social impacts.

The SIMP is designed to be a standalone document. The SIA includes a discussion of the management commitments contained in the SIMP and the related management objectives.

2.8 LIMITATIONS

2.8.1 Council Amalgamation

In 2008 a number of local governments within Queensland were amalgamated to form regional councils. The following regional councils within the SIA study area were formed as a result of these amalgamations:

- Isaac Regional Council (former Broadsound, Belyando and Nebo Shires) (Figure 4);
- Mackay Regional Council (former Mackay City, Mirani and Sarina Shires); and
- Rockhampton Regional Council (former Livingstone, Fitzroy and Mount Morgan Shires).

The SIA recognises the change in local council boundaries. The most accessible and applicable information has been included in the SIA. However, as a result of the 2008 local government amalgamations and boundary realignments, in some cases data for the IRC area has not been available and instead data for the former shire of Belyando has been reported. For some social values, data at the local level was not available.

2.8.2 Australian Bureau of Statistics Introduced Random Error

Under the *Census and Statistics Act 1905* (CS Act) it is an offence to release any information collected under the CS Act that is likely to enable identification of any particular individual or organisation. ABS statistics therefore include an introduced random error designed to ensure that no data is released which could risk the identification of individuals in the statistics.

Random adjustment of the data is considered to be the most satisfactory technique for avoiding the release of identifiable Census data. These adjustments result in small introduced random errors. However, the information value of each data summary table as a whole is not impaired by the adjustments. The totals and subtotals in summary tables are

also subjected to small adjustments. These adjustments include modifications to preserve the ability to total figures within tables. Although each table of this kind is internally consistent, comparisons between tables which contain similar data may show some minor discrepancies. In addition, the tables at different geographic levels are adjusted independently, and tables at the higher geographic level may not be equal to the sum of the tables for the component geographic units.

Minor discrepancies may be evident in the statistics of small populations such as the community of Middlemount and examples are shown in Table 19.

3 EXISTING SOCIO-ECONOMIC ENVIRONMENT

3.1 INTRODUCTION

This section provides a description of the existing socio-economic environment of the SIA study area. The description of the socio-economic environment has been informed by an analysis of relevant statistical data and trends, review of social infrastructure and accessibility and the findings of discussions conducted with representatives of the Middlemount community. The baseline provides an important platform from which to measure social changes arising from the project over the project life.

3.2 ECONOMIC SETTING

3.2.1 Gross Regional Product

Mackay SD

The Mackay SD is a major contributor to the Queensland economy. The Mackay SD accounted for 7.1% of the Queensland Gross Regional Product (GRP) in 2008/09, slightly more than the adjoining Fitzroy and Northern SDs. The Mackay SD produces a substantial amount of Queensland's sugar, approximately half of the state's coal production, and more than half of the state's coal exports. The substantial growth in the Mackay SD economy in 2008/09 was largely driven by an increase in the value of coal exports. While mining dominates the regional economy, the next biggest sectors of manufacturing, transport and storage, construction and wholesale trade are primary input sectors for the mining industry.
Within the Mackay SD, the economy of the IRC area is dominated by the mining sector, with mining representing 77% of the total GRP in the IRC area. The IRC area contributes 52.1% of the GRP of the Mackay SD, and represents 3.7% of the Queensland economy.

IRC LGA

The three largest sectors in the IRC economy in order of contribution to GRP are mining, construction and agriculture. While the IRC area accounts for 80% of the mining income of the Mackay SD economy, it accounts for only 10% of the key industry sectors of manufacturing, transport and storage, construction and wholesale trade in the Mackay SD.

There has been very strong growth in the economy of the IRC area from 2007/08 to 2008/09, largely driven by 28.7% growth in the mining sector. This growth has underpinned its performance in the Mackay SD economy.

The economy of the IRC area has very limited diversity, given the dominance of the mining industry.

Fitzroy SD

The Fitzroy SD is also a major contributor to the Queensland economy. The Fitzroy SD accounted for 6.5% of the Queensland GRP in 2008/2009, slightly less than the Mackay SD and slightly more than the adjoining Northern SD. Mining is the primary industry in the Fitzroy SD followed by transportation and manufacturing. Whilst the substantial growth in the mining sector in the Fitzroy SD economy in 2008/09 was largely driven by an increase in the value of coal exports, some sectors in the Fitzroy SD economy showed declining activity. This is likely to be because the Fitzroy SD area relies heavily on secondary expenditure activity, and declines in expenditure together with a slowing in construction, the agricultural sector and the global economic downturn have caused some sections of the Fitzroy SD economy to contract. On the other hand, the economy of the Mackay SDs has not shown signs of slowing, as it relies primarily on expenditure directly from the mining industry, which has experienced significant growth.

Local Business Turnover

There were 1,635 businesses operating in the IRC area in June 2007, as estimated by the Australian Business Register. This figure excludes major mining operations, as these are registered for business purposes in other locations (e.g. major capital cities in Australia and worldwide). Total estimated business turnover in the IRC area in 2006/07 was $1.5 billion (MWREDC 2010b) based on 1,635 businesses. The sectors with the most businesses operating were agriculture, forestry and fishing, property and business services, construction and retail trade while the sectors with the highest average business turnover were manufacturing, mining, retail trade and finance and insurance.

Within the IRC, business conditions have generally been very favourable since the mining boom began in 2002. However, there have been constraints on business expansion through limited labour markets and higher housing costs (Rolfe *et al.* 2007). This has not been evident in Middlemount, where there has been little growth in businesses supplying directly to the mining sector or servicing the wider community. Business activities in Middlemount are restricted largely to a few small enterprises located in the town centre which focus on servicing the needs of the town community, a number of accommodation centres and the Middlemount Tyre Service.

It is noteworthy that the main business expansion in Middlemount has been in accommodation services, in keeping with the growth in DIDO/FIFO employment patterns

and increased use of contractors. A new motel has been built in Middlemount offering 48 rooms, as well as an extensive expansion of the camp style accommodation.

The economic slowdown of 2008/09 had some impact on Middlemount, with a slight slowdown in spending and some businesses reported having to cut staff numbers. Interviews conducted with the Middlemount business owners in 2010 identified that some retail businesses, such as grocery stores, experienced an additional downturn in sales in 2009-2010.

3.2.2 Labour Markets

Total employment in the Mackay SD in 2008/09 was 72,767 workers, 43.4% of the total estimated population. Total employment in the Fitzroy SD for the same period is not available, however data from 2006 ABS Census indicates during this period there were 87,627 workers, 60.4% of the population (based on place of usual residence). Unemployment in the Mackay and Fitzroy SDs were estimated at 3.8% and 3.3%, respectively, for 2008/09, lower than the state average of 4.4% for the same period. Based on 2006 census data, the employment structure in the economy of the Mackay and Fitzroy SDs are heavily weighted to the mining sector with 11.7% and 6.8% respectively of the labour force employed in mining compared to 1.7% for the state. However, the lower percentage of mining in Fitzroy SD economy is due to the SD also being driven by construction, manufacturing and service sectors. The Mackay SD economy is largely driven by the resources sector, and is very dependent on overseas markets and favourable trading conditions; whilst the Fitzroy SD economy is more diversified.

Table 5 summarises labour utilisation for Middlemount and the wider study area.

Table 5
Labour Force Characteristics in Selected Urban Centre Localities (UCL) 2006

Locality	% Labour force participation	% Unemployed	Employment to population%	Employed in Mining Industry
Middlemount (UCL)	82.4	2.4	79.2	56.8
Dysart (UCL)	82.4	1.9	78.1	49.5
Emerald (UCL)	82.5	1.9	78.6	17.8
Moranbah (UCL)	83.5	1.8	79.6	45.9
IRC				
Total population	80.0	2.1	75.8	38.1
Indigenous	75.2	8	69.2	42.9*
Broadsound				
Population	77.6	2.3	63.5	43.5
Indigenous	75.5	5.4	71.4	58.8*
Mackay SD				
Population	71.2	3.5	66.6	11.3
Indigenous	66.4	11.3	58.9	9.7*
Fitzroy SD				
Population	63.3	4.5	63.2	6.5
Indigenous	57.7	14.4	49.5	5.6*
QLD State				
Population	61.8	4.7	61.5	1.6
Indigenous	56.2	13.1	51.5	2.4*

Source: ABS 2006
Notes:
Persons aged 15 years and over.
The number of unemployed persons is expressed as a percentage of the total labour force.
The number of persons in the labour forced is expressed as a percentage of persons aged 15 years and over, not including labour force not stated.
The number of employed persons is expressed as a percentage of persons aged 15 years and over, not including labour force not stated.
*The number of people employed in mining by the number of people who stated employment in an industry.

Total local employment in the IRC area in 2008/09 was reported by MWREDC (2010b) as 9,934 workers, although a substantial non-resident workforce also commutes into this area (Section 3.3). The percentage of the labour force employed in mining is much higher in Middlemount than in the Mackay SD or the state (56.8% compared to 11.3% and 1.6% respectively). There are also higher rates of employment in the sub-regional area in the agriculture, forestry & fishing sectors, and lower rates in every other sector of the economy. These results confirm that the IRC LGA is very dependent on the resources sector, and has not diversified very strongly away from primary industries.

The indigenous population of the former Broadsound LGA has slightly higher levels of labour force participation and lower levels of unemployment when compared to the total Mackay and Fitzroy SD populations (Table 5). This may be attributed in part to the presence of the mining industry in the IRC LGA and the associated promotion of indigenous participation in mine employment.

3.2.3 Household Income

Residents in Middlemount, Mackay City and the IRC LGA are benefiting from the mining industry with around one quarter of the overall workforce earning more than $1,300 per week. The median household income of Middlemount residents is $2,113 per week compared with $1,027 in Australia.

3.3 POPULATION

3.3.1 Estimated Residential Population

The estimated residential population (ERP) of the SIA study area is documented in Table 6. The ERP of Middlemount in 2010 was 2,238, making it the third largest urban centre in the IRC behind Moranbah and Dysart.

Table 6
Estimated Resident Population 2010

Locality	ERP	Area (km^2)	Population Density Per km^2
Middlemount (UCL)	2,238	4.7	476.1
Dysart (UCL)	3,430	8.3	413.3
Moranbah (UCL)	8,530	8.3	1,027.0
Clermont (UCL)	1,962	7.2	272.5
Isaac Regional Council (LGA)	22,629	58,869	0.4
Emerald (UCL)	13,496	16.8	803.3
Rockhampton (UCL)	67,002	97.8	685.1
Mackay City	78,214	107.1	730.3
Mackay SD	176,236	90,346.5	2.0
Fitzroy SD	223,516	122,966.00	1.8
Queensland	4,513,850	1,734,173.9	2.6

Source: OESR 2011

Estimated resident population growth in the study area from 2005 to 2010 is shown in Table 7. Between 2005 and 2007 the population of Middlemount showed a steady increase. During the same period other localities in the study area showed either consistent or slowing growth. However, in 2007-08 the ERP of Middlemount decreased by 1.0% (Table 8). Although 2008-09 showed return to positive ERP growth, annual average population growth

has generally been lower than reported state and regional levels and in 2009-10 showed a shift to negative growth of -0.5%. The discrepancies evident in the Middlemount (and also Dysart) ERP are likely attributable to fluctuations in the workforce size of existing mining operations in the local areas.

Table 7
Estimated Resident Population Growth

Locality	Total Population by Year					
	2005	2006	2007	2008	2009	2010
Middlemount (UCL)	2,142	2,174	2,262	2,239	2,249	2,238
Dysart (UCL)	3,157	3,340	3,421	3,449	3,444	3,430
Moranbah (UCL)	7,278	7,607	7,847	8,111	8,326	8,530
Emerald (UCL)	11,340	11,748	12,197	12,648	13,118	13,496
IRC (LGA)	19,764	21,113	21,543	22,007	22,417	22,629
Fitzroy SD	201,185	206,204	210,933	215,471	220,714	223,516
Mackay SD	148,502	159,869	16,3629	168,228	172,735	176,236
Queensland	3,994,858	4,090,908	4,195,981	4,308,570	4,425,103	4,513,850

Source: OESR 2011

Table 8
Average Annual Change in Estimated Residential Population

Locality	Average Annual Change (%)				
	2005-06	2006-07	2007-08	2008-09	2009-10
Middlemount (UCL)	1.5	4.0	-1.0	0.4	-0.5%
Dysart (UCL)	5.8	2.4	0.8	-0.1	-0.4%
Moranbah (UCL)	4.5	3.2	3.4	2.7	2.5%
Emerald (UCL)	3.6	3.8	3.7	3.7	2.9%
IRC (LGA)	6.8	2.0	2.2	1.9	0.9%
Fitzroy SD	2.0	2.3	2.2	2.4	1.3%
Mackay SD	7.7	2.4	2.8	2.7	2.0%
Queensland	2.4	2.6	2.7	2.7	2.0%

Source: OESR 2011

3.3.2 Full Time Equivalent Population Estimates

The FTE population estimate is a measure that approximates the total population in an area at a given point in time and includes non-resident workers and resident population.

Since 2007, the OESR has released, on an annual basis, the Bowen Basin Population report. This report contains the FTE population estimates for key localities, statistical local areas (SLAs) and LGAs of the Bowen Basin. The most recent report was released in 2011 and contains data gathered in June 2010.

The OESR (2011) estimated that in 2010 Middlemount had a:

- FTE population of 3,680 persons; and
- Non-resident worker population of 1,431[1] or 39% of the FTE population.

Table 9 details the non-resident worker population as a proportion of the FTE population for Middlemount, surrounding major centres, the former Broadsound Shire and the IRC LGA since 2006. Middlemount has one of the largest non-resident worker populations (as a proportion of FTE) of all communities in the IRC. This has significant implications for the long term sustainability of the town, community vitality and also for the supply of key services and facilities.

Table 9
Non-resident Workers as % of FTE Population

	Percentage					Change in Percentage			
Locality	**2006**	**2007**	**2008**	**2009**	**2010**	**06-07**	**07-08**	**08-09**	**09-10**
Middlemount (UCL)	31.3	38.0	35.2	36.3	39.0	6.7	-2.8	1.1	2.7%
Dysart (UCL)	19.9	24.4	22.9	24.3	30.0	4.5	-1.6	1.4	5.7%
Emerald (UCL)	3.7	4.9	6.6	6.3	5.0	1.3	2.2	-0.8	-1.3%
Moranbah (UCL)	20.1	18.0	18.5	19.0	26.0	-2.1	0.5	0.5	1.9%
IRC (LGA)	25.1	25.0	30.0	27.9	30.0	-0.1	4.9	-2.1	2.1%

Source: OESR 2011

Note: The OESR did not release any FTE and non-resident working population data for 2008 for Middlemount. These values have been calculated based on 2006, 2007 and 2009 trend data.

Table 10 provides an indication of the change in the non-resident worker population of Middlemount, surrounding major centres, the former Broadsound Shire and the IRC since 2006. A significant (34%) increase in the non-resident worker population of Middlemount occurred during the period 2006-07, most likely due to new mines opening within proximity to

[1] Figure extracted from OESR 2011, original source is the OESR survey of accommodation providers.

Middlemount and also an increase in the workforce size at existing operations. The rate of growth in the non-resident population of Middlemount declined between 2007 and 2008, with a decrease in the non-resident worker population experienced between 2008 and 2009. This decrease in is likely attributed to reductions in workforce size which occurred during the global financial crisis. During this time, 30% of the Capcoal workforce were made redundant and the Southern and Central Collieries - both underground mines which had been operating for 30 years - were permanently closed. Between 2009 and 2010 however, the size of the non-resident population in towns of the IRC, and in particular Moranbah and Dysart, experienced a significant increase.

Table 10
Non-resident Workers in the Study Area

	Non-Resident Worker Population					Change in Non-resident Worker Population (%)			
Locality	**2006**	**2007**	**2008**	**2009**	**2010**	**06-07**	**07-08**	**08-09**	**09-10**
Middlemount (UCL)	991	1,331	1,348	1,278	1,431	34.3	1.3	-5.2	12.0
Dysart (UCL)	830	1,117	1,137	1,115	1,480	34.6	1.8	-1.9	32.7
Moranbah	1,915	1,717	1,964	1,933	2931	-10.3	14.4	-1.6	51.6
Emerald (UCL)	450	626	900	862	875	39.1	43.8	-4.2	1.5
Broadsound	1,821	2,448	3,300	2,393	2,911	34.4	34.8	-27.5	21.6
IRC	7,077	7,197	9,379	8,568	9,903	1.7	30.3	-8.6	15.6

Source: OESR 2007, 2010, 2011

Note: The Bowen Basin Population Reports (OESR 2007, 2010, 2011) still reference the former local government areas of Belyando, Nebo and Broadsound for consistency purposes. The OESR did not release any FTE and non-resident working population data for 2008 for Middlemount. These values have been calculated based on 2006, 2007 and 2009 trend data.

A key finding of the OESR (2011) is that the decline in workforce numbers across the Bowen Basin that occurred in 2008-09 was reversed in 2009-10. This can be attributed to the recovery of the Bowen Basins mining industry from the effects of the global economic uncertainty. In 2010 there were an additional 2,385 non-resident workers present in the Bowen Basin since the previous year. Single persons quarters accounted for around 85% of worker accommodation at this time.

3.3.3 Indigenous Population

At the time of the 2006 ABS Census indigenous people, from both Aboriginal and Torres Strait Islander origin, made up 1.9% of the Middlemount population (based on place of usual residence) and 2.1% of the total population in the IRC compared to 3.6% of the Mackay SD population, 4.7% of Fitzroy SD, and 3.3% of Queensland. The indigenous population of Middlemount is much smaller than the state indigenous composition of 3.3%. Table 11

illustrates the age and gender structure of the indigenous population in Middlemount and the IRC compared with the broader regions and state.

Table 11
Indigenous Population Age Group and Gender Composition

Indigenous	Age Cohort					Total Indigenous Population*	Indigenous as % of Total Pop.*
	0–14	15–24	25–44	45–64	65+		
Middlemount							
Males	4	7	3	3	0	17	1.5
Females	12	3	7	0	0	22	2.5
Total	16	10	10	3	0	39	1.9
IRC							
Males	77	54	62	29	3	225	2.1
Females	73	36	62	20	6	197	2.2
Total	150	90	124	49	9	422	2.1
Mackay SD							
Males	1,068	537	656	392	70	2,723	3.5
Females	1,088	470	721	373	105	2,757	3.8
Total	2,156	1,007	1,377	765	175	5,480	3.6
Fitzroy SD							
Males	1,837	874	1,084	541	113	4,449	4.6
Females	1,780	794	1,222	541	135	4,472	4.8
Total	3,617	1,668	2,306	1,082	248	8,921	4.7
Queensland							
Males	25,249	11,900	16,045	7,886	1,609	62,689	3.2
Females	24,377	11,707	17,672	8,914	2,221	64,891	3.3
Total	49,626	23,607	33,717	16,800	3,830	127,580	3.3

Source: ABS 2006
*Note: * Based on place of usual residence*

3.4 POPULATION GROWTH AND PROJECTIONS

Medium series population projections for the study area are shown in Table 12. Projections indicate a 2.0% annual increase in the IRC population across a 25 year period from 2006 to 2031. By 2031, the population of the IRC is estimated to be 34,270. PIFU population projections suggest strong growth in the population of the Mackay SD to 2006 and 2031, with an average annual increase of 1.9% over this period as compared to 1.7% for Queensland. In 2006, the Mackay SD made up 4% of the State ERP, by 2031 this is expected to increase to 4.1% (255,614 persons).

Population trends for Middlemount suggest that the resident population will remain relatively stable in the short term, and maintain a growth rate below that of the IRC and state. These trends do not include the non-resident working population, which based on current OESR figures is likely to experience growth as planned projects proceed and a significant proportion of new mine workers continue to be employed on a FIFO/DIDO basis.

Table 12
Medium Series Project Resident Population

Locality	ERP	Projected Resident Population					Average Annual Growth (06-31)	
	2006	2011	2016	2021	2026	2031	Number	%
IRC	21,113	23,277	28,266	31,418	34,270	37,000	635.48	3.0%
Fitzroy SD	206,204	229,173	256,644	283,931	313,314	344,938	5549.36	2.7%
Mackay SD	159,800	180,417	207,232	233,544	257,802	279,819	4800.76	3.0%
Queensland ('000)	4,091	4,611	5,093	5,589	6,091	6,593	100.08	2.4%

Source: OESR 2011b

3.5 AGE STRUCTURE

Selected demographic trends of the Middlemount population and surrounding communities are illustrated in Table 13.

Table 13
Selected Demographic Characteristics of People

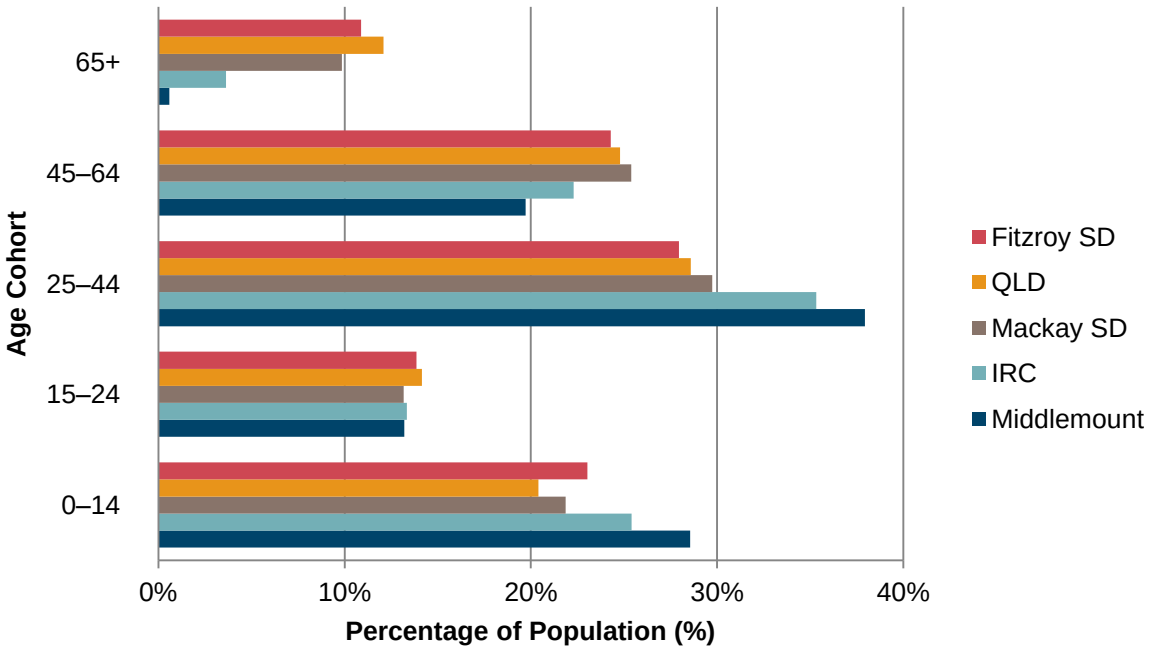
Locality	Median Age		Males per 100 Females	
	2001 (years)	2006 (years)	2001 Ratio	2006 Ratio
Middlemount (UCL)	30	30	130	136
Dysart (UCL)	31	31	143	138
Moranbah (UCL)	31	31	126	158
Emerald (UCL)	29	28	108	108
IRC	Not available	31	137	124
Fitzroy SD	34	35	103	104
Mackay SD	35	35	106	108
Queensland	38	38	98	98

Source: ABS 2008b, ABS 2006, ABS 2001, OESR 2011

The median age of the Middlemount population remained constant at 30 years between 2001 and 2006 and is lower than the median age for the Mackay SD, Fitzroy SD and Queensland (35, 35 and 38 respectively in 2001 and 2006).

The age structure of Middlemount, illustrated in Table 14 is characteristic of resource communities where a high proportion of the community is employed in mining related industries. The 25-44 age cohort is markedly over-represented in Middlemount compared to the Mackay SD and Queensland (Table 14). Similarly, the 0-14 age group is higher than the Mackay SD, Fitzroy SD and Queensland. The population of Middlemount and the Mackay SD in 2006 remains relatively youthful with 29% of Middlemount's population aged 0-14 years, and 21.9% in Mackay SD, compared with 20.4% in Queensland. This youthfulness has implications for the provision of services and facilities and in particular demand for childcare, recreational and educational facilities. Conversely, Middlemount supports a relatively low number of people aged over the primary retirement age of 65. This is not surprising given the majority of housing in Middlemount is provided by Anglo American for its current employees; the minimal support services available in Middlemount for retirees; and the small range of cultural and recreational activities available in the community.

Table 14
Population Age Comparison for the SIA Study Area



Source: ABS 2006 and OESR 2010 (IRC)

3.6 HOUSEHOLD COMPOSITION

At the time of the 2006 ABS Census there were:

- 521 households in Middlemount of which 446 (86.5%) were family households;
- 5,982 households in the IRC of which 4,648 (77.7%) were family households;

- 50,026 households in the Mackay SD of which 37,865 (75.7%) were family households;
- 64,711 households in the Fitzroy SD of which 48,113 (74.4%) were family households; and
- 1,391,634 households in Queensland of which 1,011,979 (72.7%) were family households.

The Mackay and Fitzroy SDs, IRC and Middlemount all have a larger proportion of family households than Queensland (72.7%).

The relative youthfulness of the population of Middlemount is reflected by the number of family households. The number of family households has significant implications for the demand and supply of specific community service and facilities such as child health services, child care, education and recreation. Community identity and vitality in Middlemount is also heavily influenced by the number of families in the community.

In 2006, lone person households represented:

- 10.4% of all households in Middlemount;
- 19% of all households in the IRC;
- 21% of all households in the Mackay SD;
- 25.6% of all households on the Fitzroy SD; and
- 22.8% of all households in Queensland.

The low number of lone person households in Middlemount and the IRC is a reflection of the prevailing employment conditions, i.e. FIFO/DIDO and the associated use of accommodation villages to house employees. Anglo American provided accommodation in Middlemount (the majority of housing) is generally directed at families rather than individuals.

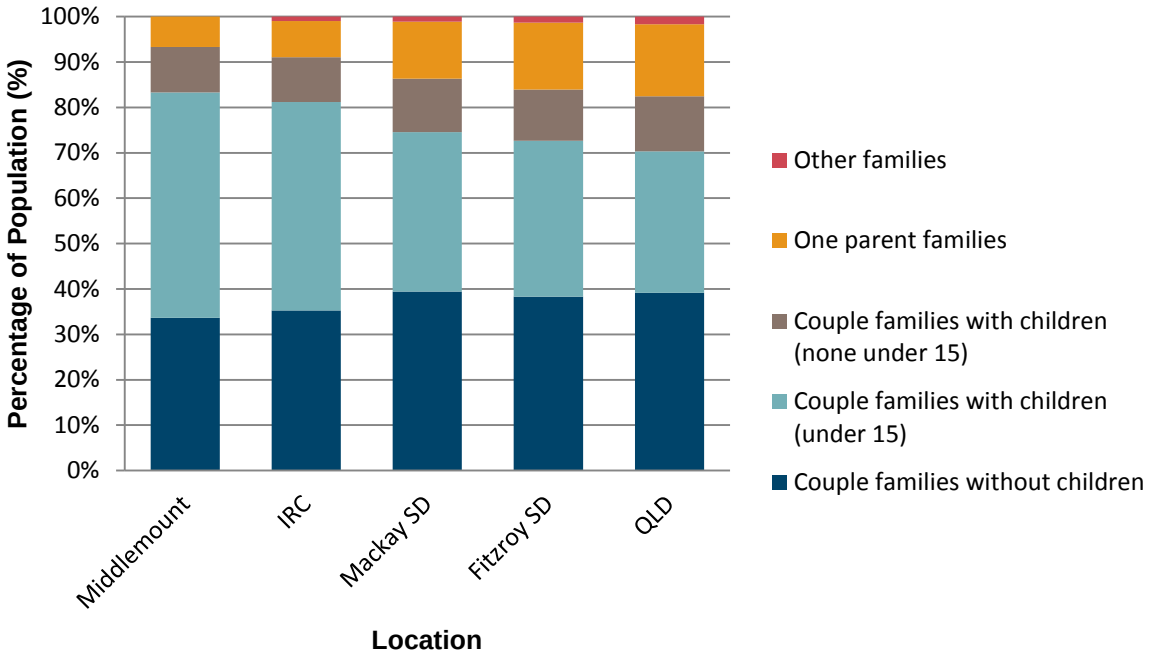
3.7 FAMILY CHARACTERISTICS

At the time of the 2006 ABS Census 38,569 families lived in the Mackay SD of which 4,708 (12.2%) were located in the IRC including 449 (1.16%) in Middlemount. The number of families and the corresponding number of family households in Middlemount (Section 3.6) indicates that in a number of circumstances there is more than one family living in a single dwelling.

Table 15 illustrates the family structure within the study area. Of the families in Middlemount, 59.9% identified themselves as couple families with children, which was greater than regional and state comparisons of 45.5% and 43.3%, respectively. Of the 268 couple families with children in Middlemount, 236 were intact families with no other children

present, 15 were step families, and 16 were blended families (ABS, 2006). In terms of service provision, it is interesting to note the proportion of families with children under 15, with Middlemount (49.7%) being particularly greater than in the Mackay SD (35.1%) and across Queensland (31.1%).

Table 15
Family Structure in the SIA Study Area



Source: ABS 2006

2006 ABS Census data recorded the following number of one parent families in the study area:

- 30 in Middlemount representing 6.7% of families;
- 7,190 in the Fitzroy SD representing 14.7% of families;
- 5,014 in the Mackay SD representing 13% of families; and
- 375 in the IRC representing 8% of families.

Over the last few years there has been an increase in the number of single people and contractors in Middlemount, and a corresponding decline in the number of families. The decline in families is attributed to the block shift patterns which allow for commuting to mainly coastal regional centres of Mackay or Rockhampton.

3.8 RESIDENCY AND MOBILITY

Table 16 highlights the mobility of the population in the study area, with Middlemount experiencing similar mobility to other mining communities in the Bowen Basin. This level of mobility is even more pronounced when compared to the Mackay SD and Queensland. People in Middlemount and the IRC were less likely than other Australians to have been living at the same address one year earlier and five years earlier.

High mobility has implications for community vitality and identity. A community experiencing high mobility can often be more welcoming to newcomers than a less mobile community however, it can also make it more difficult to sustain the community in the long-term and bring about positive social change.

Table 16
Residential Mobility

Location	At Home on Census Night and Usually Lived In Same Home 1 Year Earlier		At home on census night and usually lived in same home 5 years earlier (persons)	
	Persons (%)			
	2001	2006	2001	2006
Middlemount (UCL)^	65	50	35	20
Dysart (UCL)^	67	61	40	32
Moranbah (UCL)^	70	55	40	27
Emerald (UCL)^	57	60	22	26
IRC*	-	61	-	32
Fitzroy SD*	-	72	-	45
Mackay SD*	73	72	47	44
Queensland*	-	70	-	40
Australia	74	78	47	50

Source: ABS 2006, 2001
** Calculated based on basic community profile ABS 2006 data*
^Data extracted from Social Trends; Towns of the Mineral Boom Report

3.9 CULTURAL DIVERSITY

Table 17 provides an indication of the top six countries of birth for residents of Middlemount, as a proportion of the total population, compared to the same countries in neighbouring communities. Of interest is the proportion of Australian-born residents in Middlemount, which is significantly lower than other mining towns in the same region, and is slightly lower than the proportion of Australian born residents across Queensland. Although the top six countries of birth in Middlemount are of similar proportions and origins to other Bowen Basin

towns and their broader regions, the range of cultural diversity in Middlemount is much lower than other towns, with the only other countries of birth being USA (0.34%), Ireland and Netherlands (0.25% each), and Fiji, Indonesia and Malta (0.2% each). Other populations in the same region have greater diversity in terms of population origin.

Table 17
Top Six Countries of Birth for Residents of Middlemount and the SIA Study Area

	Middlemount	Moranbah	Emerald	Dysart	Fitzroy	Qld
Australia	72.51%	83.34%	84.12%	80.99%	84.69%	75.18%
India	0.39%	0.15%	0.15%	0.10%	0.15%	0.28%
New Zealand	1.72%	2.97%	3.25%	2.97%	1.90%	3.81%
Philippines	0.69%	0.69%	0.48%	0.83%	0.35%	0.48%
South Africa	2.16%	0.86%	0.60%	0.83%	0.35%	0.58%
United Kingdom	1.62%	1.53%	1.99%	1.31%	2.51%	4.94%

Source: ABS 2006
NB: These percentages do not include country not stated

3.10 VOLUNTEERISM

During consultation many stakeholders noted a perceived reduction in the level of volunteerism in the community over the preceding years. These stakeholders also commented that it is generally the same people who volunteer for different community events. There is a perception that mining companies' increasing preferences for non-resident workers exacerbated this, as it meant less people permanently connected to the town and therefore less potential volunteers. This is supported by the findings of the consultation conducted to inform the preparation of the 2011-2013 CEP during which residents identified a decreased level of participation in community groups. Contributing factors were identified as block work shifts and improvements in road infrastructure in the region which in turn improved accessibility to the coastal communities of Mackay and Rockhampton.

Table 18 provides an indication of participation in voluntary work in the study area. Despite the perception of reduced volunteerism, participation rates in Middlemount are higher than nearby towns, the broader region and Queensland.

Table 18
Participation in Voluntary Work in the SIA Study Area

Locality	Number of Volunteers (a)	Total Population	% of persons who volunteer
Middlemount (UCL)	587	1,456	40.3%
Dysart (UCL)	883	2,295	38.5%
Moranbah (UCL)	1,733	5,206	33.3%
Emerald (UCL)	2,370	8,108	29.2%
Broadsound (LGA)	1,945	5,054	38.5%
IRC (LGA)*	3,332	14,715	22.6%
Mackay SD	35,435	117,344	30.2%
Fitzroy SD	44,921	145,008	31.0%
Queensland	864,799	3,097,995	27.9%

Source: ABS 2006 and OESR 2010

The 'Voluntary Work for an Organisation or Group' variable records people who spent time doing unpaid voluntary work through an organisation or group, in the 12 months prior to Census Night.
(a) Includes those people who spent time doing unpaid work but did not state name of organisation or group "Voluntary work not stated".
Note: persons aged 15 years and over, based on place of usual residence

3.11 SOCIO ECONOMIC INDEX FOR AREAS

Socio-Economic Indexes for Areas (SEIFA) is a summary measure of the social and economic conditions of geographic areas across Australia. SEIFA consists of four indexes which summarise difference aspects of the socio-economic conditions of people living in an area. The Socio-Economic Index of Disadvantage is one of the four indexes.

In 2006, a Socio-Economic Index of Disadvantage was produced by the ABS, ranking geographical regions to reflect disadvantage of social and economic conditions. The index focuses on low-income earners, relatively lower education attainment, high unemployment and dwellings without motor vehicles. Low index values represent areas of most disadvantage and high values represent areas of least disadvantage.

Table 19 shows the percentage of the population of the study area in each quintile (one-fifth or 20% of the population) according to the Socio-Economic Index of Disadvantage. Quintile 1 represents the most disadvantaged group of persons, while quintile 5 represents the least disadvantaged group of persons.

By definition, Queensland has 20% of the population in each quintile. In comparison, 16.1% of the population of Mackay SD and 5.1% of the population of the IRC area were in the most disadvantaged quintile. Compared with the 20% average across Queensland, 10.5% of the

population of Mackay SD and 17.3% of the population of the IRC area were in the least disadvantaged quintile.

Table 19
Socio-Economic Index of Disadvantage by Local Government Area (2006)

LGA	Quintile 1 (most disadvantaged)	Quintile 2	Quintile 3	Quintile 4	Quintile 5 (least disadvantaged)
	Percentage of Population				
IRC	5.1	7.1	24.5	46.0	17.3
Belyando LGA	4.7	2.5	27.5	36.6	28.7
Broadsound LGA	7.2	4.8	24.1	58.6	5.2
Nebo LGA	0.0	36.3	11.8	51.8	0.0
Mackay RC	14.9	23.4	25.8	25.1	10.9
Whitsunday RC	27.8	29.9	24.4	13.0	4.9
Mackay SD	16.1	22.5	25.4	25.5	10.5
Queensland	20.0	20.0	20.0	20.0	20.0

Source: OESR 2010

3.12 PREVALENCE OF DISABILITY

The prevalence of disability in the IRC and Mackay SD was estimated based on the results of the 2006 ABS census. The ABS census has developed the Core Activity Need for Assistance variable to measure the number of people with a profound or severe disability in a given area. The ABS defines a measure of profound or severe disability population as:

> *"those people needing help or assistance in one or more of the three core activity areas of self-care, mobility and communication, because of a long-term health condition (lasting six-months or more), a disability (lasting six-months or more), or old age."*

In 2006, 3.2% of people in the Mackay SD, 1.3% in the IRC and less than 1% of people in Middlemount had a profound or severe disability and required assistance, compared to 4% in Queensland. In Middlemount, the small prevalence of disability was shared evenly between males and females, and the very low number of cases reflects the relationship of the town to the mining industry and the limited range of services available to support individuals and families with disabilities.

3.13 HOUSING AND ACCOMMODATION

The following sections provide a discussion on housing dynamics in Middlemount and the wider study area. The discussion focuses on an analysis of a number of housing market indicators including:

- Housing affordability;
- Dwelling stock and home ownership; and
- House prices and rental prices.

3.13.1 Housing Affordability

In 2006 the median household income for Middlemount residents was $2,113 per week compared with $1,027 in Australia for the same period, with average housing loan repayments of $515 per month and median rent of $34 per week. The figures for loan repayments and rent in Middlemount are significantly distorted however, by the financial assistance provided by Anglo American to employees permanently based in Middlemount. During consultation no stakeholders raised issues related to housing affordability in Middlemount.

3.13.2 Dwelling Stock and Home Ownership

A summary of housing stock, tenure and ownership in Middlemount is provided in Tables 20 and 21. These figures are drawn from the 2006 ABS Census, however it should be noted there has been some change in the provision and availability of housing stock in Middlemount since the 2006 Census. These changes predominantly include the refurbishment of older Anglo American housing stock, a small quantity of new residential development through private developers and the provision of additional rooms at accommodation villages.

Table 20
Dwelling Structure of Occupied Private Dwellings

Dwelling Structure	Middlemount		IRC	Queensland
	Number of dwelling type	Percentage of total dwellings		
Separate house	472	91	90.4	76.5
Semi-detached, row or terrace house, townhouse etc	0	0	1.2	7.5
Apartment (includes flat, unit or apartment)	20	3.8	3.5	13.0
Other dwellings	27	5.2	4.9	2.8
Not stated	0	0	0.1	0.1
Total occupied private dwellings	519	-	-	90.8

Source: ABS 2006

Table 21
Landlord and Tenure – Occupied Private Dwellings (selected statistics)

Tenure Type	Middlemount[3]		IRC	Queensland
Fully owned	19	3.6%	29.1%	30.4%
Being purchased[1]	14	2.7%	16.2%	31.4%
Rented[2]	476	91.3%	50.3%	30.0%
Other tenure type	8	1.5%	1.7%	1.0%
Not stated	4	0.8%	2.7%	7.3%
Median housing loan repayment (weekly)	$515	-	$,1066	$1,300
Median rent (weekly)	$34	-	$46.3	$200
Average number of persons per household	3.1	-	2.8	2.6
Landlord type – occupied private dwellings being rented[2]				
Real Estate Agent	4	0.8%	9.4%	49.9%
State or Territory Housing Association	14	2.9%	5.7%	10.7%
Person not in same household[(c)]	11	2.3%	8.5%	26.15%
Housing co-operative/community/church group	0	0%	1.0%	2.3%
Other landlord type	433	91.0%	68.7%	36.3%
Landlord type not stated	14	2.9%	6.8%	3.2%

Source: ABS 2006

Notes:

1. Includes being purchased under rent/buy scheme

2. Including rent free accommodation

3. % is based on a total of 521 tenures

In 2006, there were 33 privately owned houses (i.e. fully owned or being purchased) in Middlemount, representing approximately 6.3% of total housing stock. The majority of occupied private dwellings in Middlemount are rented (91.3%), with 91% rented from other landlord type (mining companies, predominantly Anglo American). There are 14 properties in Middlemount rented from the state housing authority. These properties are likely to provide for EQ employees and QH employees.

Household occupancy rates in Middlemount are higher than the IRC and Queensland. The higher occupancy rate in Middlemount is likely to reflect the prevalence of share accommodation in the town for mine employees.

Discussions with representatives of Anglo American in November 2011 provided additional updated information on dwelling stock in Middlemount. Current advice from Anglo American is that there are a total of 761 dwellings (houses and units, not single persons quarters) in Middlemount. Anglo American owns 668 dwellings and rent a further 68 units from MAC Accommodation Services and 25 units through a private developer. There are approximately 25 houses owned by state government for state government services and staff, and a further 30 houses owned by Xstrata.

There are few houses available for purchase or rent by employees of other businesses (non-mining employees) in Middlemount, however, Anglo American allocates 35 dwellings to staff of local businesses who rent shop space or provide essential mine services. These businesses pay nominal rent.

Long Term Social Housing

In Middlemount there are currently nine long-term social housing properties managed by the DOC - Housing and Homelessness Services; two two-bedroom, six three-bedroom and one four-bedroom property. There are no long term social housing options in Middlemount that are managed by other non-government organisations, and there is no crisis or transitional housing option. It is understood that Middlemount has never had a significant need for social housing. Throughout the Bowen Basin, demand for social housing has recently decreased largely due to the limited housing options available (pers comm.). Advice from DOC is that people who require social housing in Middlemount have nowhere to live while waiting for social housing in Middlemount, so they are forced to reside elsewhere.

While DOC allocated four properties at Middlemount last year, they indicated the turnover would normally be much less, more likely one per year and there is longevity in the tenants once approved. The current applicant has only been approved since January this year, the last applicant to receive a tenancy was only on the list for approximately eight months, which the DOC services respondent considered to be a relatively short waiting period. The representative from DOC felt that there is more demand for 'affordable' housing in Middlemount than for social housing. As the majority of private accommodation in Middlemount is mine employer provided there is extremely limited opportunities for non-mine

employees to access housing. This has implications for individuals and their families who may choose to either leave mine employment or who may separate from a mine employer but seek to remain a resident of Middlemount. DOC representatives indicated that the cost of living has increased so much in Bowen Basin housing communities that most people, can ill afford to live in resource communities such as Middlemount, even if they had housing.

Accommodation villages

Accommodation villages form an important component of the housing environment within Middlemount, as the demand from the increasing mining-related workforce, particularly non-resident contractors, currently exceeds available housing levels. There are currently four accommodation villages in Middlemount:

- Vitrinite Village;
- Foxleigh Village;
- Capcoal Village; and
- MAC Middlemount.

The increase in accommodation villages in Middlemount and the associated increase in the non-resident population of the town has received a mixed response from the resident community. The findings of consultation conducted for the EIS and for the 2011-2013 SEAT study highlight the concerns of the community in relation to the increasing non-resident population and the reliance on accommodation villages to house the non-resident population. There is a perception and some dissatisfaction amongst residents that Middlemount is increasingly becoming a contractor town rather than a family town.

With over one in four jobs in the Bowen Basin occupied by non-resident workers (OESR 2011) and the majority of these workers (90%) staying in accommodation villages, the importance of maintaining a sufficient supply of beds in accommodation villages needs to be recognised as a critical component of strategies developed to accommodate a growing workforce within the Bowen Basin.

Short Term Accommodation

There are limited short term accommodation options (outside of accommodation villages) in Middlemount. There is one hotel and one motel; the Middlemount Hotel/Motel and the Swag Motel. The one caravan park in Middlemount was recently purchased by MAC and redeveloped as a MAC accommodation village.

The occupancy rate across all forms of short term accommodation is high, particularly from Monday to Thursday. According to the owner of the 48-room Swag Motel, the motel is generally full from Monday to Thursdays, with a 50% occupancy averaged over seven days. Both motels in Middlemount enjoy positive financial benefits from the mining and related industries.

3.13.3 Status of the Housing and Rental Market

This section describes the current status of the rental and housing market in Middlemount, Emerald and the Mackay and Fitzroy SDs.

House Prices

The limited availability of freehold land for private residential development in Middlemount combined with the current size of the residential property holding of Anglo American means that house prices and rents in Middlemount have shown little movement over the last few years despite the growth in the surrounding mining industry. However, the IRC recently approved Stage 1 of the Milieu Estate development in Middlemount. Based on data from realestate.com.au, there are currently four houses in the Milieu Estate on the market of which three are under contract, one at $430,000 for three bedrooms and three at $465,000 for four bedrooms.

The following discussion of housing dynamics in the study area focuses on the surrounding cities of Mackay, Rockhampton, Emerald and the IRC LGA as this is where the majority of the workforce is likely to be located.

Table 22 provides a summary of the number of sales and median house price for the former LGAs of Belyando, Broadsound, Mackay, Emerald and Rockhampton for the period 2004-2010.

Table 22
Median sale price for housing from 2004 to 2010

Locality	Year	Number of Sales	Median Sale Price	Annual Increase (%)
Belyando (former LGA)	2004/05	472	$226,000	n/a
	2005/06	393	$303,000	34
	2006/07	308	$348,000	15
	2007/08	298	$350,000	1
	2008/09	177	$399,000	14
	2009/10	-	$402,000	5
Broadsound (former LGA)	2004/05	133	$118,000	n/a
	2005/06	159	$235,000	99
	2006/07	92	$303,500	29
	20070/8	145	$330,000	9
	2008/09	64	$400,000	21
	2009/10	-	$335,000	-19
Mackay (city)	2004/05	3,361	$245,000	n/a
	2005/06	2,875	$320,000	31
	2006/07	2,687	$370,000	16
	2007/08	2,315	$380,000	3
	2008/09	1,435	$386,000	2
	2009/10	-	$350,000	-5

Locality	Year	Number of Sales	Median Sale Price	Annual Increase (%)
Emerald (city)	2004/05	668	$215,000	n/a
	2005/06	667	$292,500	36
	2006/07	634	$330,000	13
	2007/08	387	$335,000	2
	2008/09	286	$348,500	4
	2009/10	-	$385,000	4
Rockhampton (city)	2004/05	2,263	$148,500	n/a
	2005/06	2,285	$193,000	30
	2006/07	2,032	$264,750	37
	2007/08	1,412	$295,000	11
	2008/09	858	$285,000	-3
	2009/10	-	$195,000	-31

Source: Property Data Solutions June 2009 and RP Data 2010 (Free Suburb Profile- http://reports.rpdata.com.au, accessed on 6 May 2010).

House prices within the study area have substantially increased from 2004/5 to 2009/10.

Rental Prices

The majority of rental is through 'other landlords' which indicates high levels of housing rented from employers, primarily mining companies but also labour contracting companies, other businesses and government agencies all of which whom are likely to subsidise housing costs in efforts to attract staff. The predominance of subsidised rental is reflected in the 2006 median rent of $34 per week. Over three quarters of all housing in Middlemount is rented from Anglo American.

Table 23 presents the median weekly rents paid for the regional centre of Rockhampton and the cities of Emerald, Mackay and Brisbane. At a regional level, rents reflect the pressures applied by the growth in the mining industry. The regional rental market has experienced strong growth from March 2007 to March 2010.

Median weekly rent data for the IRC is available only for the March Quarter 2010 (DoC, 2010), which shows that the rents for four, three, two and one bed room dwelling unit are $625, $500, $225 and $290, respectively. Comparing these figures with Table 23 it can be concluded that average rent in the IRC is much higher than the other regions in Queensland.

Table 23
Median Weekly Rents

Locality	Type of housing	Median Weekly Rent (March)				% Change 2007- 10
		2007	2008	2009	2010	
Rockhampton RC	4 bedroom house	$280	$330	$350	$350	25%
	3 bedroom house	$250	$270	$280	$290	16%
	3 bedroom unit	$240	$250	$275	$295	23%
	2 bedroom unit	$170	$190	$210	$225	32%
Townsville City	4 bedroom house	$340	$370	$400	$400	18%
	3 bedroom house	$280	$305	$340	$330	18%
	3 bedroom unit	$300	$360	$400	$400	33%
	2 bedroom unit	$220	$260	$280	$275	25%
City of Emerald	4 bedroom house	$480	$450	$495	$485	1%
	3 bedroom house	$360	$360	$380	$380	6%
	3 bedroom unit	$300	$325	$360	$360	20%
	2 bedroom unit	$250	$250	$260	$300	20%
Mackay City	4 bedroom house	$420	$450	$480	$460	10%
	3 bedroom house	$350	$360	$380	$375	7%
	3 bedroom unit	$320	$365	$445	$400	25%
	2 bedroom unit	$240	$250	$290	$280	17%
Brisbane City	4 bedroom house	$370	$420	$450	$450	22%
	3 bedroom house	$310	$350	$370	$380	23%
	3 bedroom unit	$350	$380	$420	$460	31%
	2 bedroom unit	$292	$320	$360	$365	25%

Source: Queensland Rental Tenancy Authority 2009 and Queensland Rental Tenancy Authority 2010

Vacancy Rates

It is difficult to obtain exact figures regarding the number of unoccupied dwellings in Middlemount. However, some insight can be gained from an analysis of existing proponent owned dwellings. There are currently 61 proponent owned houses in Middlemount currently unoccupied. Anecdotal evidence from residents in Middlemount suggests that the unoccupied private dwellings owned by Anglo American are not fit for purpose. This is supported by community feedback received during the preparation of the 2007 Capcoal CEP. It is understood that Anglo American refurbished 26 homes in 2006, before the renovations to housing was discontinued due to the dramatic change in global economic circumstances in late 2008-2009.

Consultation conducted to inform the 2011-2013 Capcoal and Foxleigh SEAT found that existing and potential employees are seeking a commitment from Anglo American to

recommence the refurbishment of company owned housing so as to provide attractive, quality housing for employees and their families who indicate an interest in living in Middlemount rather than DIDO/FIFO. Consultation also identified a perception amongst existing and potential employees that there is limited opportunity to live locally and that some of the housing offered has low appeal and is of poor quality compared to that offered by competitors in the mining industry. There is also a perception in the community that the quality of housing has a detrimental impact on the ability of local businesses to attract and retain their workforce and achieve the desired perception as an "employer of choice."

During recent discussions with Anglo American it was confirmed that 40 houses in Middlemount were refurbished in 2011 with a further 40 marked for refurbishment in 2012. In addition to houses requiring refurbishment, there are a further 24 vacant houses which correspond to vacant positions currently advertised by Anglo American but have not yet been filled.

3.13.4 Summary of Housing Issues in Middlemount

At the time of writing, Middlemount was not subject to the housing pressures evident in other resource communities of the Bowen Basin, such as Moranbah. Middlemount has not experienced the rapid growth in house prices and rental rates associated with resource communities such as Moranbah and Emerald primarily due to the limited stock of private housing and Anglo American monopoly on housing. The lack of freehold land in Middlemount means that there are few opportunities for private investment in housing locally. The housing market is largely controlled by a single landlord – Anglo American.

Housing stock in Middlemount is predominantly 30 years old. The housing stock owned by Anglo American in Middlemount has decreased over the past five years as older houses identified in need of maintenance were removed from the available housing stock. Anglo American has an established and ongoing maintenance program for existing Anglo American accommodation including housing in Middlemount. This program may result in the refurbishment of a sizeable portion of the Anglo American housing stock in Middlemount.

3.14 SOCIAL INFRASTRUCTURE

This section discusses the range of social infrastructure present in Middlemount and the wider SIA study area, potential gaps in infrastructure provision and issues in the demand and supply of social infrastructure. The discussion draws on the findings of a research report prepared by Greer *et al*. (2009) entitled *Family Services in the Mining Sector: A Case Study in the Bowen Basin, Queensland*.

The range of services and facilities provided in Middlemount are generally consistent with the size of the town. This was confirmed during consultation with residents of Middlemount.

The Mackay and Rockhampton urban areas are the primary centres for the Mackay and Fitzroy SD, respectively. Mackay and Rockhampton provide the major regional employment opportunities and a broad range of high level services and functions including transport, public and private health services, and primary, secondary and tertiary education facilities. Physical infrastructure in each city includes university and TAFE campuses, a base hospital in Mackay a major regional public hospital in Rockhampton, and each region's main air, sea and rail ports. Both Mackay and Rockhampton are the key centres of government, administration, retail, commercial and specialised personal and professional services for the city and regional area. They also accommodate cultural, entertainment and education facilities of regional significance that are not available elsewhere in the region (DLGP 2011). In addition, the Shoalwater Bay Military Training Area located in Rockhampton Regional Council LGA is an internationally recognised military training area and offers significant returns and opportunities to the economy of the region.

Social infrastructure provision at the local level is discussed in the following sections.

3.14.1 Retail and Trade

The Middlemount town shopping centre is owned by Anglo American and supports a number of retail and trade outlets including a bakery, IGA, coffee shop, pharmacy, gift shop and a number of fashion boutiques, hair and beauty salon, library, the IRC office and a Queensland Government Agency Provider (QGAP) (co-located with the IRC office).

The QGAP service is permanently based in Middlemount and offers referrals, information, services and advice to the community of Middlemount. Recent consultation conducted with QGAP by Greer *et al*. (2009) indicates that whilst there are several full time positions and voluntary positions within the organisation, one full time position has been vacant for some time and voluntary support is difficult to attract.

QGAP includes access to services such as:

- Queensland Transport
- Workcover Queensland
- DERM
- Public Trustee
- Office of Fair Trading
- Australian Taxation office
- Liquor Licensing Division
- Department of Primary Industries and Fisheries
- Department of Justice and Attorney-General
- Registrar – Births, Deaths and Marriages
- Suncorp Metway/NRMA Insurance
- DoC
- Residential Tenancy Authority
- DoH
- Health insurance Commission

Anglo American has recently undertaken a significant refurbishment of the Middlemount shopping centre to include a new children's playground adjacent to the IGA. A number of other services which support the mining industry are located outside of the town square and include the Middlemount Tyre Service.

3.14.2 Recreational, Cultural, Leisure and Sporting Facilities

There are a range of sports and recreational facilities in Middlemount. Facilities include Middlemount Golf Course (9 holes), Middlemount Leisure Centre, a dam and several rivers for fishing, an aquatic centre (including an Olympic size swimming pool), playgrounds for children, a bike track and a library. The collective sports association runs netball and rugby competitions in Middlemount, however, during consultation stakeholders highlighted the impact of mine shift roster arrangements on patronage and organisation of such facilities and competitions. In particular, many residents interviewed indicated that the sporting groups struggled to retain coaches and management committees due to the transient nature of the community and the prevalent shift patterns. The range of sporting activities in Middlemount is largely aimed at the male sector of the population. Whilst netball is popular, the condition of the courts and grandstands has made it difficult in recent years for Middlemount to host netball competitions necessitating significant travel around the IRC for competitive games.

Community events occur throughout the year in Middlemount, particularly in the cooler months. These events are generally well attended and many residents interviewed during consultation highlighted key events including the Labour Day picnic in May, Race Day in August, Anzac Day parade, a community Treasure Hunt, a community Christmas party sponsored by Capcoal, a Charity Ball held every two years and the QPS charity golf day in October.

There are a number of parks within Middlemount including Blue Mountain Park which provides free barbecue facilities. There are limited dining options in Middlemount. Options include the Chinese Restaurant at the Middlemount Golf Club (open Wednesday to Sunday), the Bowls Club (on Friday nights), the Oasis Bistro and the Swag Hotel. Take-away food options include the Roadhouse, Chino and Burger Bar, the Pizza Shop or the Sports Café at the sports centre.

Greer *et al* (2009) reports that while the Middlemount area has organised sporting and recreation facilities it is difficult to clearly ascertain usage which, in some cases, relates to the block shift working arrangements for mining staff and the off-shift opportunities to engage in leisure activities. The down side of these arrangements for sporting and recreational facilities is that it can give the opportunity for workers to travel to other facilities and thus limit the full patronage of the workforce for sporting clubs and volunteer dependant community organisations.

3.14.3 Youth Services and Facilities

The primary service for young people in Middlemount is the Middlemount Youth Centre, run by the MCS chaplain, whose role is overseen by Middlemount Youth Service, a committee made up of representatives from the various Middlemount Churches, the School Principal, a Middlemount Police Officer and a Council representative.

The Middlemount Youth Service is funded in part by Anglo American who provides part-time wages, housing and fund youth development programs. During consultation for the 2011-2013 SEAT the Middlemount community acknowledged the valuable contribution the Middlemount Youth Service provides to the community and confirmed that the funding of the service by Anglo American was invaluable. Funding from Anglo American has enabled Middlemount community to secure the services of a dedicated worker to work with the MCS and Middlemount Youth Service committee to assist with the development of youth and provide chaplaincy services. The centre is said to attract about 70 young people every Friday night.

Anglo American acknowledges that the volume of organised local and regional activities and events for youth can continue to be enhanced. For example, the cost of hiring bus transport often impedes the school, community, sporting groups and youth from accessing the benefits of education, training and development, sporting and social opportunities available across the Isaac and Central Highlands regions.

The existing partnership of the IRC, Middlemount Community Service and Anglo American has enabled the youth of Middlemount to have a 'place to call theirs'. This initiative is recognised as having had a positive effect on relieving boredom, and in turn reducing incidence of youth involvement in property damage, theft and drug and alcohol abuse.

3.14.4 Children's Services

Playgroup

Middlemount Playgroup operates on Wednesdays or Thursdays during the school term from 9.30am until 11.30am at the Middlemount Sporting Fields where the playgroup uses indoor and outdoor facilities.

Mulligrubs Playgroup caters for all children 0-5 years of age and meets on Tuesday and Friday mornings. In addition, a baby playgroup also operates in Middlemount and is registered with Playgroup Australia.

Pre-Prep

C&K Middlemount Childcare Centre and Kindergarten is a not-for-profit child care centre. It provides kindergarten and before and after school and vacation care services for children 6 weeks to 12 years of age. During consultation the C&K Director identified staffing as a

stressful issue. The centre struggles to secure appropriately trained staff and to retain staff. At the time of writing, the C&K was intending to advertise for a new team leader which would lead to an increase in availability of childcare and reduce the waiting list significantly. There was concern however, that due to the transient nature of the town, finding a suitable applicant, particularly one who would commit to the long term, would be difficult.

At the time of writing, the pricing for childcare ranged from $16 per session for before and after school care, to $70/per day for babies. These prices are not dissimilar to prices paid in Brisbane for child care. The C&K has an extensive waiting list for some age groups, while others had a small number of spaces on some days of the week. A number of community representatives consulted for the project commented that the local businesses of Middlemount depend on the availability of childcare, as most local businesses are run by the spouses of people employed within the mining industry who have young children.

Consultation for the 2011-2013 SEAT confirmed these issues reporting that:

> *"Currently, childcare for families in Middlemount has fundamental issues of access, quality, flexibility and cost. Lack of progress on a much needed renovation has forced Middlemount C&K childcare to reduce centre placements from 65 to 43. This capacity does not satisfy the current level of demand for childcare with the situation likely to be exacerbated with new mining activity planned for Middlemount."*

3.14.5 Aged Care Services

There are few aged care facilities or support services operating in Middlemount primarily because there is limited demand for the services given the small number of people of retirement age or above. There are few opportunities for people to purchase housing in Middlemount for retirement purposes as the vast majority of housing in the town is owned by Anglo American and used to house current employees. Aged care services that are available are provided through Home and Community Care (HACC).

3.14.6 Education Providers

Primary and Secondary Education

Middlemount is serviced by MCS, a co-educational state school that provides education from prep to Year 12. The primary and secondary schools in Middlemount were combined voluntarily in 2000.

There are three other education providers in the region (Mackenzie River State School, Dysart State School and Dysart Sate High School) which have facilities and service children in Middlemount, however they are considerable distance away.

The closest non-state school is St Joseph's at Clermont, a Catholic Education primary school located 145 km from Middlemount. Table 24 presents basic information for the MCS.

Table 24
Selected Characteristics – Middlemount Community School

Characteristic	Middlemount Community School			
Year levels offered	Prep-12			
Enrolment (June 2010)	Primary: 245, Secondary: 103			
% indigenous students[1]	<5%			
% of parents/caregivers satisfied that their child is getting a good education at school[2]	44%			
Staff retention [1]	94%			
NAPLAN results - % of students at or above the national minimum standard for:[1]	**Year Level**			
	3	**5**	**7**	**9**
Reading	86%	91%	92%	81%
Writing	92%	88%	96%	81%
Spelling	81%	85%	92%	77%
Grammar and Punctuation	78%	85%	100%	77%
Numeracy	89%	85%	100%	97%
Additional Services offered	School provides access to participate in Virtual schooling and Distance Education subject delivery.			
Retention Rates Year 10-12 [1]	69%			
Overall Position Bands (OP)[2]	**Number of Yr 12 Students Achieving OP Bands**			
OP1-5	0			
OP 6-10	3			
OP 11-15	2			
OP 16-20	3			
OP 21-25	1			
Vocational Education Training Qualification (VET)[3]	**Number of Yr 12 Students Attaining VET Qualifications**			
Certificate I	13			
Certificate II	5			
Certificate III	1			

1. Data taken from Middlemount Community School 2009 Annual Reports accessed online. Source: Middlemount Community School website- www.middlemountcs.eq.edu/wcmss

2. Based on 2009 year 12 students completing 20 semester units of credit in QLD studies Authority subjects and sitting the QLD Core Skills Test. Source: School Reports on Year 12 Outcomes 2009- All Queensland Schools, www.qsa.qld.edu.au

3. Number of students awarded certificates under the Australian Qualification Framework (AQF)

In 2009 there were 373 students from Prep to Year 12. MCS principal Rob Slater confirmed there were 360 students enrolled at the beginning of 2010, however the school can cater for up to 850. The number of students in Year 12 increased from 14 in 2008 to 25 in 2010.

During consultation with the school principal and the school chaplain the following key issues were raised in relation to MCS:

- While the primary grades are satisfactorily resourced, the secondary school lacks resources which results in limited subject delivery and reliance on virtual and distance education.
- The main challenge faced by the school is attracting staff; most staff leave after three years, and predominantly only less-experienced staff are willing to relocate to take up positions.
- Although the school has a special needs unit and learning support, it lacks the services of other needed specialists such as occupational therapists and speech pathologists.

Tertiary Education

There are no tertiary education providers based in Middlemount. The nearest TAFE is located in Moranbah (145 km from Middlemount), or Emerald (150 km from Middlemount). The nearest university is the CQU, Mackay or Rockhampton campus.

3.14.7 Health Services

Middlemount is located in the Mackay Health Service District and is serviced by a Community Health Centre (CHC), a family general practice and a variety of visiting health services. Hospital facilities are located at Dysart and Emerald, while the main referral hospital(s) are located at Mackay (250 km away) and Rockhampton (280 km away). Table 25 outlines the health services provided by QH in Middlemount.

Table 25
Queensland Health Middlemount Services

Distance to Main referral hospital(s): Mackay Base Hospital 250 km, The Rockhampton Hospital 280 km	
Facility or Service	
Clinics	Well Baby Clinics, Immunisation, Community Nursing, Health Promotion, Triple P Program, Antenatal Classes, School Based Vaccination Program
Allied Health	Counselling, Community Mental Health - Mental Health (adult), Mental Health (child and adolescent), Speech Therapy, Pathology
Visiting Services	School Base Youth Health Nurse, Mobile Women's Health Clinic

Source: http://www.health.qld.gov.au/services/facilities/mackay_midmt_chc.asp accessed 27 January 2011

In addition to QH services, Middlemount also has a family/general practice service. Anglo American pays a retainer to the local doctor to preserve a local medical and dispensing

service. During consultation some residents recalled that there have been times when the centre has not had a doctor, and that at other times it is common for the doctor to not have appointments when required. During such times residents seek medical appointments in other towns, with the next closest General Practitioner located in Tieri, 35 minutes from Middlemount. A QH representative interviewed for the project considered that one doctor in Middlemount was not enough to service the community. The lack of doctors in Middlemount places added pressure on regional QH services such as Dysart hospital particularly in the provision of after-hours service. Depending on the severity of injuries, accidents at any mine site around Middlemount are generally referred to Dysart hospital.

Dysart hospital has nine beds, with one registered nurse and one enrolled nurse staffing the hospital each day. There is no doctor rostered on at the hospital on a 24hr, seven day a week basis. Information from the Director of Nursing at Dysart Hospital indicated that the hospital generally has vacancies due to the rapid turnaround of patients. Dysart hospital has no obstetrics facilities (only deals with obstetric emergencies) and limited community health services. Patients who require treatment beyond those provided at Dysart are transferred to Townsville or Mackay base hospitals.

Middlemount CHC has one full time Community Health nurse and three private physiotherapists all of whom share one room in the CHC. These health service providers operate under a contract with Anglo American and reside in Anglo American housing. These support measures are necessary on order to improve the financially viability of their services and ensure these services are provided locally. Visiting services including a counsellor who also visits Dysart and Teiri, an Alcohol and Other Drugs counsellor who attends on an as needs basis. The nearest mental health services are based in Moranbah and are experiencing ongoing high levels of demand. The 2011-2013 SEAT report confirms the provision of X-Ray facilities locally in early 2011. The provision of this service is a result of a partnership between Anglo American, various levels of government, and the privately owned Middlemount Medical Centre.

Dental services are provided on a needs basis only with Life Time Smiles (Christopher Hart) based in Brisbane, offering service to the Bowen Basin. BMA and Capcoal have teamed up with Lifetime Smiles in a bid to make quality dental treatment more accessible to their employees. With assistance from the mining companies Lifetime Smiles has implemented a FIFO operation to provide dentists to Middlemount and Dysart with further locations to be established in the future, however during consultation, some residents indicated that they seek dental services in Mackay.

3.14.8 Emergency Services

The QAS, State Emergency Services (SES), QPS and Queensland Fire and Rescue Service (QFRS) are all represented in Middlemount. The Middlemount aerodrome is owned by

Anglo American and was recently upgraded to Royal Flying Doctors Service/ Civil Aviation Safety Authority standard.

Queensland Ambulance Service

The QAS is rostered to allow for one single officer response 24/7. The Middlemount QAS also experiences difficulties in recruiting and retaining staff in Middlemount due to housing and salary competition between the QAS and surrounding mines. QAS has recently purchased a residence to overcome the housing situation and enable a permanent second officer.

State Emergency Service

The Middlemount SES group operates within the IRC SES Unit. The Middlemount SES responds to emergency incidents from Middlemount to the Mackenzie River; while they occasionally help out Blackwater, they generally stay within the IRC area.

Response is also coordinated through the IRC Local Disaster Management Group (LDMG). The role of the LDMG is to coordinate emergency services across the IRC, which includes emergency response to significant and predominantly non-mine related incidents such as natural disasters (cyclones/flooding) and road accidents.

Queensland Fire Service

The Middlemount Fire Station is an auxiliary fire station operated by the QFRS. The station services Middlemount and the surrounding area. The Middlemount QFRS has two fire vehicles – one pumper tanker and one light pumper tanker, but is only manned during training nights and during an incident. The station is run by approximately ten auxiliary, volunteer fire fighters who are on call for QFRS 24/7, most of whom are also miners. While QFRS restricts volunteering to people who live and work within a certain distance of the station, the QFRS representative indicated that the high percentage of volunteers who are also miners can sometimes create a delay in response time when they are called upon during a shift, as it can take time to be released from the mine and then reach the fire station before travelling to the emergency. The representative also indicated that recruiting new volunteers is an ongoing challenge.

Queensland Police Service

The Middlemount Police Station is staffed by two full time police officers who share one vehicle. Access to a single police vehicle was identified as a significant limitation to the efficiency of QPS operations in Middlemount given the number of heavy and oversized vehicle escorts QPS is called upon to cover for mine related equipment. During consultation the QPS Officer in Charge indicated that the key policing concerns in Middlemount were driver fatigue and related road accidents. However, demands on QPS to provide escort for large/heavy mine related vehicles was impacting on local servicing capabilities, primarily because the Middlemount QPS only has one vehicle.

QPS representatives indicated that whilst Middlemount has a low reported crime rate, there is a high rate of unreported crimes and assaults, including family violence. QPS respondents attributed the occurrence of family violence to the gender imbalance in the town and consumption of alcohol. QPS also indicated that a number of crimes go unreported because of the perception that jobs and housing might be at stake. Additional concerns raised by the QPS included emerging issues of outlawed organised crime and drugs, and also concerns about absent parents leaving children home without supervision, both to attend work and to travel out of town on weekends.

3.14.9 Local and Regional Transport Connections

Residents of Middlemount travel significant distances to access a number of essential services and facilities. There are no public transport connections between Middlemount and the closest regional centre of Emerald. Within Middlemount there is no public transport service, no school bus service and no bus available for school children to use to go on excursions. A number of stakeholders consulted for the purposes of the SIA highlighted the need for a community bus service that could be accessed by the school and youth groups for extracurricular activities.

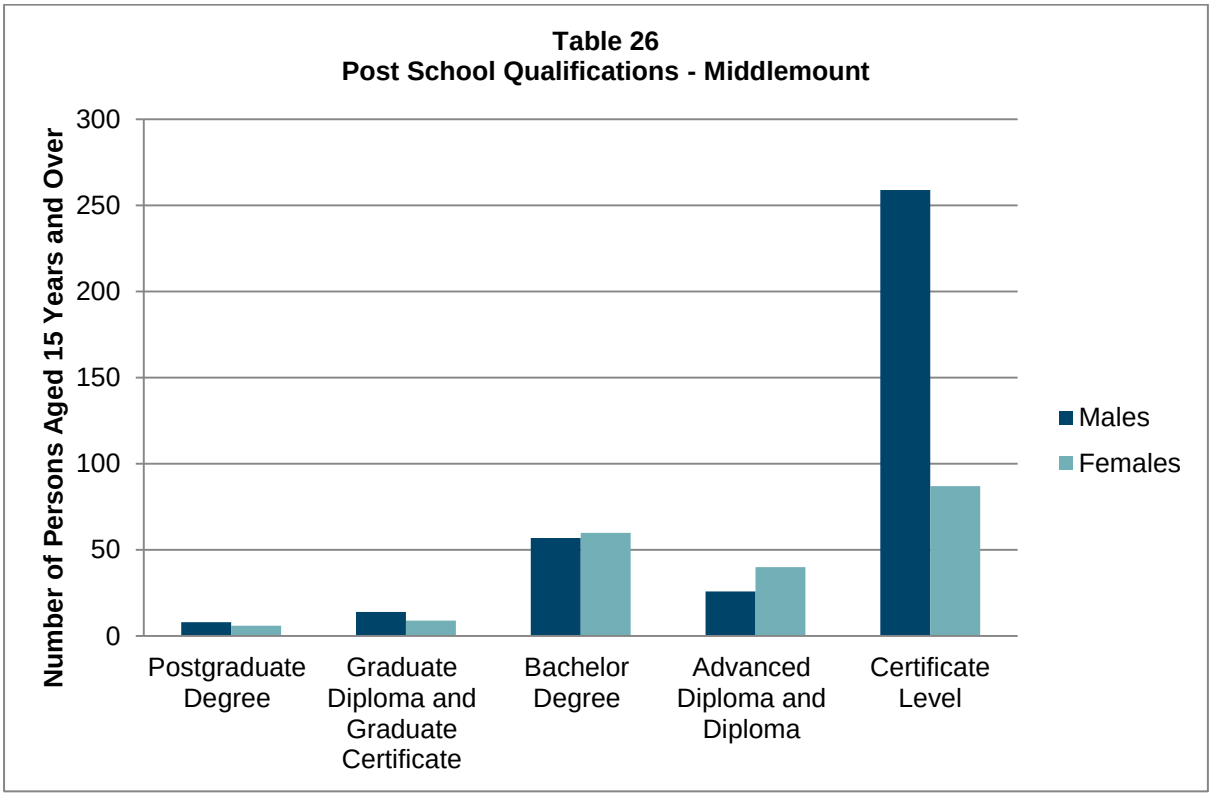
At the time of writing, there was discussion amongst the community and mining stakeholders in relation to the reopening of the Middlemount Airport. At present there is no operating airport in Middlemount. The nearest commercial airport to Middlemount is Emerald, and a full fare return airfare from Brisbane to Emerald costs approximately $1,500, however discounted return airfares at off peak times can be purchased for approximately $400.

The lack of public transport services to regional centres is identified as an existing issue in the Isaac Region 2020 Vision document. During development of Isaac Region 2020 Vision, the community indicated they would like to see rail investigated as a viable public transport option to lessen road traffic around the region and to improve safety.

3.15 EDUCATION AND TRAINING

3.15.1 Post School Qualifications

Of the Middlemount residents who had obtained a post-secondary qualification, 61% (346) had a certificate qualification; most of these were certifications for employment in mining. 20% had qualifications at the bachelor level and 6% had a postgraduate qualification (Table 26).



Source: ABS 2006

Table 27 illustrates the post-school qualifications by level of education for all persons aged 15 years and over, compared with those of similar towns and the regions of which Middlemount is a part.

Table 27
Post-School Qualifications – SIA Study Area

Locality	Level of Education			Persons with a qualification ([a])		Total ([b])
	Bachelor degree or higher	Advanced diploma or diploma	Certificate			
	%			Number	%	Number
Middlemount	17.7	7.6	39.8	869	59.7	1,456
Dysart	16.4	6.8	44.4	1,176	51.2	2,295
Emerald	21.8	9.9	47.9	4,043	49.9	8,108
Moranbah	20.6	7.8	48.3	2,733	52.5	5,206
Broadsound (LGA)	15.5	7.1	42.4	2,545	50.4	5,054
Indigenous	10.3	0.0	48.3	29	29.3	99
Non- Indigenous	20.7	9.3	56.6	1,864	43.6	4,276
Isaac Regional Council	17.2	7.5	43.8	7,317	49.7	14,715
Mackay SD	15.9	9.5	43.7	57,030	48.6	117,344
Fitzroy SD	19.9	9.9	42.2	66,454	45.8	145,008
Queensland	26.0	13.1	35.5	1,560,868	50.4	3,097,995

Source: ABS 2006 (UCL) and OESR 2010 (IRC)

(a) includes "inadequately described" and "not stated" level of education response. In the case of Middlemount 35% of people with a qualification did not state their qualification.

(b) total persons aged 15 years and over.

Middlemount has a significantly higher rate of post-school qualification than neighbouring towns, local and state populations and the Mackay and Fitzroy SDs. Middlemount's history as a purpose-built mining town, and limited employment opportunities outside of mining compared with other towns most likely accounts for this high rate.

Training and skill development opportunities in Middlemount and the wider region are supported by a number of mining companies including Anglo American. At present Anglo American invests approximately $1.4 million per annum in apprenticeships and traineeships in Middlemount. At present there are 29 full time apprentices across proponent owned operations around Middlemount. This is made up of 15 diesel fitters, 11 electrical, two boiler makers and one auto electrician. Anglo American owned operations also have one warehouse trainee, three school based diesel fitting apprentices and three school based administration trainees. MCS students also participate in the Certificate II in Resource and Infrastructure (RIO Program). This program is designed to give predominantly year 10 and year 11 students access to the workplace and provide introductory exposure to the workplace focused on competencies that can be applied both to the trades and production streams.

3.16 SOCIAL ORDER AND COMMUNITY SAFETY

Based on the findings of consultation with residents of Middlemount, social order and community safety is an important value within the community. Feedback during consultation indicates that residents perceive Middlemount to be a relatively safe place to live, with low crime and vandalism rates. This was confirmed during an interview with QPS representatives in Middlemount.

A number of stakeholders interviewed for the project raised concerns in relation to driver fatigue and potential implications for safety both within Middlemount and on the regional road network.

QPS representatives interviewed for the project indicated that traffic infringements (largely speeding and drink driving) were the most common recorded incidents in the local area. Incidents associated with antisocial behaviour (drunk and disorderly) did not have a very high police response rate.

QPS representatives also indicated that whilst QPS response rates to domestic violence incidents in Middlemount were low this did not mean the issue was not significant in the community. There is some concern from the QPS that incidents of domestic violence are not reported because of concerns about potential job losses.

3.17 COMMUNITY AND LIFESTYLE

The following section provides a description of the existing Middlemount community and the elements which contribute to its identity, vitality, lifestyle and amenity.

Middlemount is a small and isolated community, purposely built to support the employees of Anglo American owned mining operations. Whilst smaller than other resource communities in the IRC, its role is similar, that is, to accommodate and provide a lifestyle for employees of the surrounding mining industry. The heart of the community is the small centrally located town square. Formal and informal networking in the community is generally facilitated through a range of sporting facilities, as well as local restaurants/cafés. Stakeholders consulted for the Foxleigh Plains Project EIS identified a number of key annual community events in the town i.e. Anzac Day Ceremony, which draw the community together.

During consultation conducted for the Foxleigh Plains Project EIS, residents of Middlemount raised concerns about the current influence of mine shift arrangements over the sense of community in Middlemount. While many residents highlighted the sense of community as a positive aspect of the town, they felt that the 12 hour shifts and single person accommodation detracted from this. One resident indicated a perception that people only come to Middlemount to make money and then leave, and was concerned that such attitudes result in a town with no heart. During surveys conducted for the 2011-2013 SEAT,

respondents commented on the need to encourage greater community connectivity and involvement. Suggestions included:

- Regular community events utilising the facilities already available in town e.g. town square deck area, lawns, halls and open spaces;
- Re-instate quarterly BBQ and social event to welcome new employees and new community members;
- Proactively engage non-resident population in community events; and
- Promote flexible working hours to encourage longer term participation in community initiatives.

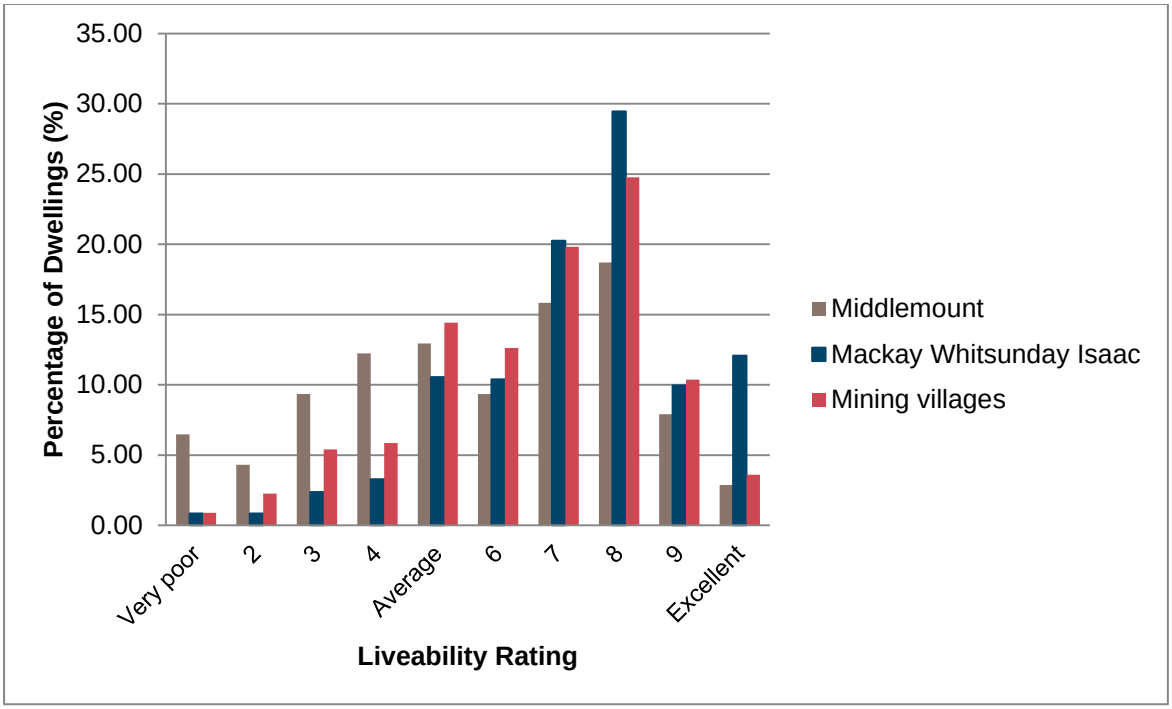
The Middlemount community is heavily supported by Anglo American as the major mining operator in the town. During consultation a number of stakeholders acknowledged the significant efforts of Anglo American to invest in the community. Past investments acknowledged by stakeholders include the upgrade of the town square, the provision of computers to the MCS, provision of various items to a range of clubs and groups, partnering in the mentoring program at MCS, provision of a range of education and training opportunities for school leavers.

Community perceptions of life in Middlemount are captured in the 2007-2008 Capcoal CEP, the report prepared by Greer *et al*. (2009) and more recently in the 2011-2013 SEAT report. These reports draw on the findings of a series of surveys conducted of Anglo American (Middlemount) employees and families residing in Middlemount.

In response to the 2007 Capcoal Community Outlook Survey conducted for the 2007-2008 Capcoal SEAT process, 52% of Middlemount residents gave a positive account of community life in the Middlemount township. While respondents were positive about the friendly, small, close-knit community, one in five made comments about the lack of community connectedness (loss of family unit, impact of the transient population), 23% disliked the lack of services and retail choices, and 22% said there were too many mining villages and the community lacked permanent housing.

Table 28 indicates community perceptions of liveability across the Bowen Basin, as reported in Greer *et al.* (2009). Table 28 compares community perceptions of liveability in Middlemount, with the same across the Mackay/Whitsunday/Isaac regions, and non-resident workers from five MAC Service Group mining villages located in the Bowen Basin.

Table 28
Liveability Rating For Middlemount, MWI and Mining Villages %



Source: Greer et al. 2009

The survey measured the respondents' rating of the overall liveability of the location where they resided while on-shift. Respondents were asked to rate the overall liveability on a scale of 1 to 10 where 1 equals Poor and 10 equals Excellent. Respondents from the Middlemount survey were mostly proponent employees (n=77, 49.3%) or contract workers (n=71, 45.5%), with eight respondents being government or other service workers. The Middlemount respondents were predominantly male (86.5%), and as such the survey provides limited insight into gendered perceptions of liveability in Middlemount.

The general liveability of Middlemount rates lower than the MACs Service Groups mining villages and the larger Mackay/Whitsunday/Isaac regional ratings. A higher percentage of respondents from Middlemount gave the township a less than average rating for liveability. Based on the survey findings, the mean liveability rating for Middlemount was 5.73 compared to the five MACs Service Group mining villages with an averaged rating of 6.59 and the Mackay/Whitsunday/Isaac region with 7.25.

3.17.1 Residential Amenity

Residential amenity in Middlemount remains largely unaffected by the surrounding mining activities. Despite this, during consultation residents raised concern about the potential amenity and health impacts of dust from the existing Foxleigh Mine and the project, and also cumulative impacts as a result of the opening of the Middlemount Mine. A number of

residents interviewed indicated that they could currently hear the reverse beepers of mine vehicles on site at Foxleigh Mine.

3.18 EMERGING ISSUES IN MIDDLEMOUNT AND THE WIDER STUDY AREA

The following section provides a brief account of the emerging issues in Middlemount and the wider study area with implications for the socio-economic characteristics of the Middlemount community. The majority of these issues are drawn from the following sources:

- The findings of the consultation conducted to inform the 2007-2008 Capcoal CEP and more recently the 2011-2013 SEAT Report;
- The findings of Greer *et al.* (2009); and
- The findings of combined consultation conducted with the Middlemount community for the purposes of the project EIS.

3.18.1 Housing and Accommodation

During consultation conducted for the preparation of the 2007-2008 Capcoal CEP, community survey participants and stakeholders were asked '*What is the most important social and economic issue currently facing Middlemount?*' Approximately 22% of stakeholders interviewed and 35% of community survey respondents cited housing or accommodation issues. Stakeholders identified that there is a need to supply housing specifically for families, in order to attract families, to provide a diverse range of housing stock and to provide quality housing and accommodation.

3.18.2 Social and Community

During the same survey, respondents raised a number of issues with regard to community involvement, lifestyle and social behaviour. Key issues raised include:

- Quality of life and lack of community involvement;
- Limited opportunities for social networking;
- Increased violence – not as safe as it used to be, with less-desirable people in town due to transient population;
- Marital problems due to change in roster system;
- Inability of parents to get involved in local sport due to roster system; and
- Maintenance of town spirit and infrastructure.

None of the issues raised above are unique to Middlemount; many resource communities in the Bowen Basin are experiencing similar issues, some at a greater scale.

3.18.3 Alcohol Consumption

Anecdotal evidence together with the findings of consultation undertaken with health and welfare representatives in Middlemount, Moranbah and Dysart, as well as QPS Middlemount, identified growing concerns regarding alcohol consumption amongst mine employees and in some instances school aged children. It appears that there is a strong social norm for all community events in Middlemount to include the consumption of alcohol (pers. comms. 2010). Despite this concern, QPS representative indicated that the Middlemount hotel/motel, which has a licence until 1 am frequently closes at 10 pm.

3.18.4 Demand for Family and Individual Support Services

Both public and private health representatives raised concern during consultation in relation to the growing demand for a range of support services, particularly mental health services across the resource communities of the Bowen Basin. In relation to mental health issues there appears to be concern amongst health representatives about the potential link between the non-resident working population in resource communities and the prevalence of mental health issues (pers. comms. 2010). QH representatives indicated that mental health issues were presented not only by non-resident workers experiencing separation and isolation issues, but also from their partners (located outside the local area) who may be struggling with issues of separation. Stress associated with financial difficulty was also identified by QH representatives as a root cause of a number of mental health cases presented in Middlemount.

The findings of Greer *et al*. (2009) support the concerns of health representatives. The majority of the families surveyed (76%) believed they experienced either the same amount of stress as other families or less stress than other families, with one in four families indicating that they experienced more stress than other families. The most frequent condition cited was anxiety or depression selected by one in four of the respondents, followed by marital/relationship problems by almost one in five of the respondents.

When respondents to the Family Services Survey conducted by Greer *et al.* (2009) were asked to rate on a five point scale which of the 31 factors they thought would create stress/tension within their family, the following six factors had a mean score above three indicating that they are likely or very likely to contribute to stress/tension within the family:

- Employment security;
- Being somewhere that suits the family;
- Having a shift work pattern that suits my lifestyle;
- Access to family and friends including extended family; and
- Mining sector down scaling.

3.18.5 Accessibility to Services and Facilities

Stakeholders consulted for the 2007-2008 Capcoal CEP were concerned about the lack of services in Middlemount, or direct access to them, particularly to health and community services. Issues identified included:

- Lack of services and difficulty in retaining services;
- Lack of sporting and recreational facilities; and
- Lack of medical and dental facilities and no hospital.

Greer *et al.* (2009) confirms the importance of these issues to the community. When respondents to the Family Services Survey were asked which type of family services they would like to see available in Middlemount to support their families, health services were the most frequently cited. This was headed by a number of respondents calling for a hospital to be established in Middlemount and for seven-day-a-week access to a general practitioner. Other services suggested included:

- Better health and specialist services particularly child health services;
- Community based services including youth support services and single parent support group;
- Emergency accommodation services;
- Education, including pre-school and child care facilities along with more sport and recreation facilities to attract more participation from all segments of the community (not just mine workers); and
- Services that could address the isolation issue such as improved transportation services and facilities that increase entertainment for all ages including more shops.

The family service most frequently used by survey respondents in the last five years was the Dysart hospital or general practitioner service followed by accessing a specialist medical practitioner.

In addition to measuring the frequency that services are used by the survey population, the Family Services Survey also measured the level of importance respondents rated for each family service listed. The *local hospital or general practitioner services* rated as important to very important with a mean score of 4.33. Greer *et al*. (2009) also notes the high importance rating given to *women's health services* from a predominately male survey population. *Education and training* as well as *financial services* also rated as very important.

The survey respondents were also given the opportunity to list the community activities which they view as assisting families in the Middlemount area. Responses include:

- Activities for young children and partners such as:
  - Individual music lessons;
  - Underage disco;
  - BMX track for young kids;
  - Arts in the park;
  - Improvements to the gym, late night sports classes and activities; and
  - The opening of the pool during winter and to cater for shift workers.
- Opportunities to increase the pathways available to engage in additional study and training through TAFE oriented courses and improved internet access.

Notably, it was not the lack of community activities in the area but the time available to participate in activities that was a concern, particularly for workers on block shifts who only reside in Middlemount on shift. Greer *et al*. (2009) found that factors such as moderation of shift work and better work-life balance were equally important to respondents as the availability of community activities.

3.18.6 Community and Lifestyle

The presence of a significant non-resident population in Middlemount, the prevailing shift patterns and the continuing reliance of the community on support from Anglo American is a significant limitation to the development of community capacity in Middlemount. Community vitality and identity is slowly being undermined by a lack of community capacity – there are fewer volunteers to help run facilities and services, limited skills to effectively manage community organisations and social networks are restricted to community boundaries, with few partnerships outside of Middlemount.

Greer *et al*. (2009) concluded that there was of a clear opportunity to encourage non-company enterprise and community ownership as mechanisms to build community capacity in Middlemount. The research makes a number of practical recommendations to build community capacity.

3.18.7 Community Engagement and Communications

The majority of stakeholders consulted for the 2011-2013 SEAT and the project EIS highlighted a desire for Anglo American to provide more regular, direct communications to the Middlemount community regarding mining operations surrounding Middlemount and investment strategies for the town. In addition to the current publication of operational statistics, stakeholders are seeking updates on mine strategic direction, promotion of local employment opportunities, clarification on mine donations and sponsorships application process as well as key point(s) of contact for community engagement.

Prior to 2009, Anglo American employed community managers who were responsible for formal communication and consultation with the Middlemount community. Consultation for the 2011-2013 SEAT found that in general, the community perceives the elimination of the community management positions has resulted in limited formal communication and engagement with the Middlemount community. In 2011 Anglo American appointed a Community Officer based in Middlemount to support relationship development with the Middlemount community. The 2011-2013 CEP documents key activities aimed at improving communication with community stakeholders.

3.19 SUMMARY OF THE SOCIAL ENVIRONMENT

The key characteristics of life in Middlemount include:

- Minimal private home ownership as most homes are owned by Anglo American, Xstrata or government agencies.
- The majority of residents are employees of Anglo American.
- Those residents who are not employees of Anglo American are employed in other businesses that either serve Anglo American or the coal mining industry generally.
- A number of proponent owned homes are in poor condition due to their age and require refurbishment.
- The town of Middlemount is part of the IRC which boasts one of the highest average wage and salary incomes in Queensland by virtue of the surrounding mining industry.
- A significant non-resident workforce population with a strong reliance on single persons quarters to accommodate the non-resident workforce.
- A changing social structure fuelled by a reliance on a non-resident workforce and the provision of FIFO/DIDO workforce arrangements which allow families to reside in coastal locations and commute for employment.
- Decreased participation in community groups due to more itinerant nature of residents who by virtue of their employment conditions and accommodation arrangements do not participate in community life.
- Increasing demand for social services in Middlemount fuelled by the increasing non-resident population.

4 POTENTIAL IMPACTS AND MITIGATION MEASURES

The following sections document the potential socio-economic impacts of the project and the mitigation measures that have been developed to address these. The section begins with an overview of the project workforce requirements, followed by a discussion of the associated workforce accommodation strategy. Potential project socio-economic impacts are identified and discussed together with proposed mitigation and management strategies. A summary of potential socio-economic impacts and associated mitigation and management strategies are also documented in the SIMP (EIS Attachment 2).

4.1 PROJECT WORKFORCE

4.1.1 Mine Development Schedule

Mine establishment is scheduled to commence in Quarter 2 of 2013 and be completed within approximately six months. Open cut mining is scheduled to commence in 2013 with the expansion of the Foxleigh Plains pit and cease in 2027 after a 15 year operations phase. Mining operations at the existing Foxleigh Mine are expected to be completed by the end of 2014. From 2014 onward, the project site will contain the only active mining areas within the expanded Foxleigh Mine operations.

The mining operations phase will be followed by a decommissioning and final rehabilitation period from 2028 lasting up to five years. During this phase infrastructure such as the mine industrial area, access and haul roads and dams will be decommissioned and dismantled and final rehabilitation will be undertaken and monitored.

4.1.2 Project Workforce

Table 29 and Table 30 provide a breakdown of the project workforce requirements. These workforce figures are based on current planning and will be refined as more detailed planning is undertaken. Mine establishment would last for approximately six months with the size of the workforce rising and falling during this period to adjust to the requirements of the project. The peak establishment workforce will be approximately 40 persons (Table 29).

Project operations will commence in 2013. The peak operations workforce is anticipated to be 332 persons. This workforce will include the existing Foxleigh Mine workforce of 242, with an additional workforce requirement of 90 employees. The peak total workforce is anticipated to be 372 persons, should the establishment and operations phases overlap in 2013.

A small decommissioning workforce of approximately 9 persons is expected to be required in Project Year 16 (2028). This will reduce to two persons for the remainder of the decommissioning period to undertake and monitor rehabilitation.

Table 29
Workforce Estimates

Project Year	Project Stage	Foxleigh Plains Project Workforce Requirement[1]	Total Workforce for Foxleigh Plains Project and Foxleigh Mine
Current Foxleigh Mine	NA	NA	242
Project Year 1 (2013)	Establishment	40	282
Project Year 1 (2013)	Concurrent Establishment & Operations[2]	130	372
Project Year 1 to Year 15 (2013-2027)	Operations	90	332
Project Year 16 (2028)	Decommissioning	9	9
Project Year 17 (2029) onwards	Decommissioning	2	2

1 Incremental workforce required above the existing Foxleigh Mine level, as a result of the project.

2 Establishment and Operations phases and associated workforces may coincide during Project Year 1 (2013)

Employee Skills Base and Skill Recruitment

The required workforce will be sourced through a range of recruitment processes, including internal and intra-company transfer, local, national and international recruitment, internal succession, apprentice, trainee and graduate programs and contract labour. A summary of the vocational needs for the direct employment workforce are summarised in Table 30.

Table 30
Workforce Vocation

Project Year	Phase	Managerial	Professional	Clerical/Admin	Technical	Operational	Total
		Staff Numbers					
Current Foxleigh Mine (2010)		6	31	8	56	141	242
Project Year 1 (2013)	Establishment	0	0	0	0	40	40
Project Year 1 (2013)	Concurrent Establishment & Operations[1]	6	32	8	69	257	372
Project Year 1 (2013) to Year 15 (2027)	Operations	6	32	8	69	217	332
Project Year 16 (2028)	Decommissioning	0	0	0	0	9	9
Project Year 17 (2029) onwards	Decommissioning	0	0	0	0	2	2

1 Establishment and Operations phases and associated workforces may coincide during Project Year 1 (2013)

Source: ACFM Data

Sources of Available Workforce

A tight labour market in the regional area, proximity to larger coastal centres, and shift patterns contribute to a high likelihood that many employees for the mine will be sourced from outside the local and regional areas. Longer block shift periods make it easier for employees to commute back to a distant home base while off shift. Consultation suggests that most shift workers would like to live in a coastal or regional city during their off shift period because of family reasons, better community facilities, services and lifestyle choice. Most will be based permanently in Mackay and Fitzroy SDs.

Potential Base Locations of the Additional Workforce

Table 31 describes the potential home base locations of the additional workforce required for the expanded operations. The figures contained in Table 31 are estimates only and are based on the residential location of the current Foxleigh Mine workforce. There has been a slight (2%) increase in the prediction for an interstate workforce to allow for future labour force constrains within Queensland. While the shift and roster arrangements for the project operations are still being developed, it is likely they will follow the existing Foxleigh Mine arrangements. The split of employee home base for the project is therefore likely to be similar to the Foxleigh Mine.

Table 31
Employee Home Base - Operations Phase

	Foxleigh Mine		Foxleigh Plains Project		
Base Location	**Employees**	**% of total**	**Employees**	**% of total**	**Source**
Mackay SD	154	63.5	38	42.1	Mixture of existing and new population
Fitzroy SD	47	19.6	28	31.0	Mixture of existing and new population
Rest of QLD	38	15.6	22	24.8	Largely reallocation of existing population
Rest of Australia	3	1.3	2	2.1	Largely reallocation of existing population
Total	**242**	**100.0**	**90**	**100.0**	

Source: Estimated by the CQU from Anglo Coal data

4.1.3 Project Accommodation Requirements

Table 32 summarises the accommodation arrangements for the existing workforce of the Foxleigh Mine and the total workforce over the life of the project. Approximately 65% of the current Foxleigh Mine workforce is accommodated in existing accommodation villages in Middlemount. The remaining 35% reside in predominantly Anglo American provided housing within Middlemount

The total workforce during the project operations phase will be 332. Approximately 26% of this total workforce will reside in predominantly Anglo American provided housing within Middlemount. The remaining 74% will be accommodated in existing accommodation villages in Middlemount.

Table 32
Employee Accommodation Requirements

Project Phase	Accommodation Demand			
	Company Housing[1]	Accommodation Village	Private Housing	Total
Current Foxleigh Mine Operations Workforce				
Foxleigh Mine Current	62	157	23	242
Total Foxleigh Mine and Project Workforce				
Project Year 1 (2013) Establishment Phase	62	197	23	282
Project Year 1 (2013)[2] Concurrent Establishment and Operations Phases	62	287	23	372
Project Year 1 – Year 15 (2013-2027) Operations Phase	62	247	23	332
Project Year 16 (2028) Decommissioning Phase	0	9	0	9
Project Year 17 (2029) onwards[3] Decommissioning Phase	0	2	0	2

1. Includes those accommodated in company housing through partners or family members who also work at the same company
2. Establishment and Operations phases and associated workforces may coincide during Project Year 1 (2013)
3. Final decommissioning workforce 2029 onwards is derived from part of the year 2028 decommissioning workforce

4.2 ECONOMIC IMPACTS AND MANAGEMENT

4.2.1 Local and Regional Economic Development

At a regional (i.e. Mackay and Fitzroy SDs) and state level the project has many positive attributes. Economically, the project offers substantial benefits in the forms of revenue for the state government, employment for an industry sector that has cyclic boom/bust periods and the opportunity to assist in the additional development of the IRC.

The main impacts on the industry sector are expected to occur in the Mackay SD because most services initially flow through Mackay rather than Rockhampton or Gladstone. This is because Mackay has a much more developed mining supply chain sector. The impacts at the Queensland level, outside of the Mackay SD, are likely to vary in different regions. Some impacts, such as income impacts, can be expected to occur mostly in South-East Queensland, while the Fitzroy SD will experience about half of the non-Mackay SD population impacts. Other regions, such as Townsville, will also benefit from the project.

The project is an expansion of the existing Foxleigh Mine. The economic stimulus generated by the project is in addition to the current economic stimulus generated by the Foxleigh Mine. The predicted economic benefits of the project are as follows:

- The value of product coal produced per annum is estimated to be $391 million (M) per annum, an increase of $101M per annum on the current production level at Foxleigh Mine. Coal prices fluctuate considerably and will continue to do so. The estimates of the value of coal production have been based on conservative estimates of long-term prices of $121.17 per tonne of coking coal.
- Total royalty payments to the Queensland Government of approximately $26M to $31M per annum.
- Increased tax receipts to the Australian Government. Increased income tax is estimated at $13.9M based on a 30% average PAYG tax rate on estimated annual salaries of $46.4M per annum in the operational stage (332 operational employees by an average $140,000 annual salary). Increased company tax is estimated at $11.7M based on a 30% tax rate on nominal gross operating profit.
- Increased direct employment in the regional areas of approximately 50 people at Mackay SD and 13 people at Fitzroy SD; and their induced impact will be 157 FTE workers in the Mackay SD, 40 FTE workers in the Fitzroy SD, 451 FTE workers in Queensland and 547 FTE workers in Australia.
- Maintained and increased indirect employment in the regional, state and national economies, with a total of 2,117 jobs maintained and created nationally.

Some level of caution needs to be attached to these estimates, particularly those relating to employment impacts. Firstly, the Input-Output model used to calculate the economic estimates assumes some reliance on the Mackay and Fitzroy SDs to provide additional services and supplies, with others sourced from the state and national economies. As economies become more integrated it becomes easier to source services and supplies from other regions and overseas, suggesting that impacts on the regional area could be lower in some situations. Secondly, the current constraints on the economy in the Mackay SD, in particular, suggest that it would be difficult for this level of economic development and population increase to be accommodated in the short to medium term. Instead, there will be greater development of technology and supply chains which will essentially transmit some of the economic and demographic changes to areas other than Mackay SD. Thus, the estimates that are provided above relate to a model the Mackay SD economy that has available capacity to adjust to a new economic stimulus.

The economic stimulus of the project is likely to put pressure on the local economy (Middlemount and IRC LGA) primarily in relation to labour demand (refer Section 4.3). The positive economic impacts of the project on the Mackay and Fitzroy SDs, state and national economy need to be accompanied with a strategic focus on managing potential labour force impacts.

Household Income and Spending

The expansion of the resource industry in the Bowen Basin has had a significant and beneficial cumulative economic impact on the region, evidenced in increased household income and increased household spending. The economic impacts of the project will further enhance the positive cumulative economic impacts of mining in the region. The economic challenge is to use the increased population and business expenditure flow associated with existing and new developments to develop a stronger and more diversified local economy whilst expanding the business base.

In Middlemount, 79% of households earn weekly incomes of $1,000 or more, in comparison to 49% of the Mackay SD and 46% Australia-wide (ABS 2006). It is anticipated that the increase in workers required for the project will result in growth in the proportion of residents receiving this higher level income. In addition, given the number of mine projects under consideration in the Bowen Basin there is likely to be a continued and expanding demand for skilled labour. This will have the effect of further pushing up anticipated wages for specific skill sets. Consequently, the project is likely to result in an increase in individual, family and household income within the region.

Local Business Development

There are few businesses operating in Middlemount (Section 3.2). The project is unlikely to stimulate the establishment of new businesses in Middlemount, however it will provide economic benefits to those businesses in Middlemount and the wider study area who service the mining industry e.g. Swag Motel. The project also presents the chance to enhance the local and regional share of procurement spend from proponent operations.

Cost Benefit Analysis

CQU conducted a cost-benefit analysis as part of the project EcIA. The development of the project will have financial and employment benefits that will flow through to the local, regional and national economy. The financial benefits of mining, allowing only for mining profits and royalty payments, are much larger than the costs of grazing income that will be foregone. Even when consideration is given to broader environmental and social impacts, the project is likely to deliver significant net benefits to the local and regional area.

With the implementation of mitigation actions aimed at avoiding and minimising any potential negative impacts of the project, the net benefits of the project to society are likely to increase. The potential impacts of the project on the social environment of the study area are discussed in detail in the remainder of the SIA. The potential environmental impacts of the project, including impacts relating to agricultural productivity, groundwater, surface water and terrestrial and aquatic biology are discussed in the relevant sections of the main EIS document.

4.2.2 Mitigation and Management

Anglo American is committed to investing in social infrastructure and capacity building at the local and regional level throughout the life of the project. Besides this social commitment, the proponent has made a commitment to:

- Engage with the Industry Capability Network and, where necessary, prepare a Local Industry Participation Plan;
- Communicate project related supply chain opportunities through established local and regional communication networks;
- Engage with the IRC to provide general business management seminars for small business in the local and regional community;
- Support procurement processes that facilitate increased indigenous business development in the region; and
- Continue to provide low rent base opportunities in Met Coal owned Middlemount Shopping Centre.

In addition, Anglo American proposes to include a key performance indicator for local procurement in the facilities management contract.

4.3 EMPLOYMENT IMPACTS AND MANAGEMENT

4.3.1 Direct and Indirect Employment

The project will require 40 new employees for the 6 month establishment phase in Project Year 1 (2013, Q2 and Q3). For the operational stage (from Project Year 1, 2013 Q3) the project will require an additional 90 employees bringing the peak total operations workforce to 332 employees. This workforce will include the existing Foxleigh Mine workforce of 242. The peak total workforce is anticipated to be 372 persons in Q3 2013 should the establishment and operation phases overlap. From Year 2 the peak project workforce of 372 will reduce to 332 employees for the rest of the mine life. It is estimated that 197 job opportunities will be created in the Mackay and Fitzroy SDs and 451 job opportunities throughout the rest of Queensland and Australia, as a direct and indirect result of the project.

There are significant direct and multiplier impacts from the project outside of the regional area (i.e., outside Mackay and Fitzroy SDs), in part because a significant proportion of the workforce is expected to be based outside of the region. The bulk of economic impacts, including employment, will occur outside of the region. However, the regional impacts are likely to be more concentrated and notable, whereas most impacts outside of the region will be more diffuse given the larger population and land area.

4.3.2 Mitigation and Management

To secure a workforce for the project and to ensure employment opportunities are extended to all potential employment sectors, the proponent proposes to:

- Place job advertisements in local and regional newspapers, and the media (including appropriate and relevant indigenous media), and on the IRC jobs board;
- Implement the Met Coal Equal Employment Opportunity Policies to:
  - Ensure that project recruitment opportunities are available to all potential employees; and
  - Facilitate active inclusion of minority/disadvantaged groups in the region including indigenous, women, people with disabilities, mature workers and the unskilled.
- Continue to support FIFO and DIDO options for employees to extend project employment opportunities;
- Support women in the workforce;
- Support equal employment opportunities; and
- Work with key community groups to create and maintain accessible, quality affordable day-care facilities to remove this significant barrier to participation of women in the project workforce.

The proponent will also continue to support indigenous employment on the project through the establishment of regular communication with Traditional Owners and local indigenous representatives in relation to indigenous education and training.

4.4 EDUCATION AND TRAINING IMPACTS AND MANAGEMENT

4.4.1 Education and Training Impacts

Demand for Education Services

The project will have minimal impact on the permanent resident population of Middlemount and is unlikely to generate any significant additional demand for primary and secondary education services. The MCS does have capacity to accommodate any demand generated directly or indirectly by the project. Maintaining staffing levels and retaining specialist teachers at MCS is directly related to the number of pupils enrolled in the school. MCS is keen to see increased enrolments to facilitate the provision of a more diverse range of subjects and to support ongoing sustainability of the school.

Skill Development

Anglo American currently supports a range of skill development initiatives in Middlemount and across the broader Bowen Basin. These initiatives assist in ensuring adequate skilled labour for proponent owned operations. However, sourcing all skilled workers from the local

and regional areas for the project is likely to drain available skills away from existing businesses, and make labour more expensive.

4.4.2 Mitigation and Management

Anglo American currently supports education and training initiatives in Middlemount through investment from its Foxleigh and Capcoal operations. Anglo American has a budget for apprenticeships and traineeships in Middlemount of approximately $1.4M per annum (Anglo American 2007). Capcoal operations offer school-based traineeship and apprenticeship positions. There are currently no employment and training programs in place at Foxleigh Mine specifically for indigenous employees. However, the two traditional owner groups that have an interest in the Middlemount area are employed to undertake cultural heritage surveys over areas which we are going to be disturbed as part of proponent mining or exploration activities.

Anglo American, through the 2011-2013 CEP has a strategy for education and training initiatives to support the existing workforces of the Foxleigh and Capcoal operations around Middlemount. Current education and training initiatives focus on increasing the employment opportunities for women, who generally have lower rates of participation in mining employment.

The proponent will continue to develop a strong partnership with the MCS to assist in providing and supporting quality education opportunities for local students. Aspects of this partnership may include:

- Provision of school based industry specific projects and apprenticeships and traineeships;
- Providing career and skills information; and
- Participating in education seminars and workshops.

To secure and retain a skilled labour force, the proponent will continue to support the development of Anglo American skills and training programs in the regional area to improve opportunities for regional residents to gain employment. The proponent currently supports the initiatives of regional training authorities such as the Queensland Mines and Energy Academy (QMEA) (Rio Program) and Central Queensland University and other key training and education providers. This support will continue to be provided during the project operations phase.

4.5 POPULATION AND DEMOGRAPHY IMPACTS AND MANAGEMENT

4.5.1 Change in Population and Demography

The size of the construction and operations workforces for the project is unlikely to have a significant impact on size or demographic structure of the Middlemount population. The Mackay and Fitzroy SDs may experience a minor increase in population as a result of the project.

The project will require up to 372 employees during the peak period, including 242 employees in the current operation. After completion of the project establishment in Project Year 1 (2013), 332 employees will be required, 90 more than currently employed in the Foxleigh Mine. The use of block shift arrangements, similar to other mines in the region, will give employees substantial choice about their primary place of residence. Workforce planning currently assumes 74% of the total mine workforce will travel to the mine for block shift periods from their home base in south-east Queensland, the Mackay and the Fitzroy SDs.

Middlemount will experience an increase in the size of the non-resident worker population. The estimated FTE population of Middlemount in 2010 (OESR 2011) was 3,680 of which 39% or 1,431 were non-resident workers. An additional 90 non-resident workers represents a 6% increase in the 2010 non-resident population of Middlemount, and a 3% increase in the FTE population. As mining workforces are male dominated, the project is likely to slightly increase the male to female ratio in Middlemount.

The project will not give rise to any significant indirect population increases in Middlemount associated with expansion in services to support the mining industry e.g. accommodation. The project will have minimal impact on family and household characteristics in Middlemount. This is largely due to project reliance on a FIFO/DIDO workforce and accommodation of the workforce in existing accommodation villages. This increase in the non-resident worker population will impact Middlemount by further decreasing the proportion of permanent families in the town.

There are significant direct and multiplier impacts from the project which occur outside of the study area largely as a result of the significant proportion of the project workforce who are expected to be based outside of the region. The regional impacts are likely to be more concentrated and notable, whereas most impacts outside of the region will be more diffuse. The demographic make-up of any incoming residents to the region is likely to reflect the existing characteristics of the communities in the region.

4.5.2 Mitigation and Management

The proponent will continue to ensure ongoing implementation of the existing Anglo American Housing Policy giving preference, where possible, to families for company housing.

To address the potential for the project to further increase the male to female ratio in Middlemount, Anglo American is currently implementing a targeted recruitment strategy to encourage women and other population groups who have lower participation rates in mining, to take up employment opportunities in their Middlemount mines, particularly, non traditional roles. The targeted recruitment strategy will be supported by the implementation of the Met Coal Equal Employment Opportunities Policy.

Anglo American will continue to invest in strategic landmark projects and community initiatives in Middlemount, consistent with the investment commitments contained in the 2011-2013 CEP. This investment will enhance community capacity and community identity in Middlemount, build resilience in the community to withstand the effects of fluctuations in the resident and non-resident populations, and support economic sustainability in the town.

Whilst new families are likely to move to the wider study area (i.e. not Middlemount) to take up employment in the project on a DIDO basis, the project will have only a minor impact on regional family and household characteristics.

Mitigation strategies for addressing the impacts of increased non-resident worker population on service provision and social order are addressed in Sections 5.10.1 and 5.13, respectively.

4.6 HOUSING AND ACCOMMODATION IMPACTS AND MANAGEMENT

4.6.1 Housing Impacts

The project is unlikely to result in any increased demand for local accommodation which will contribute to further housing shortages in the region (Mackay and Fitzroy SDs). The direct demands on housing in Middlemount and the Mackay and Fitzroy SDs from the project are anticipated to be as follows:

- Establishment phase – accommodation village for mine establishment workforce of 40.
- Operations phase
  - Housing requirements for 77 additional direct and indirect employees in the Mackay and Rockhampton (Fitzroy) SDs and four employees in the rest of Queensland.

- 90 units of accommodation in an accommodation village (Foxleigh Village) in Middlemount.

Local Impacts

Anglo American housing stock in Middlemount is allocated to the proponent and the Capcoal Group of Mines separately. While the quantity of each allocation remains fixed, housing is exchanged between the two groups to ensure that tenants are not required to move houses unnecessarily. The majority of vacant houses in the town are the property of Capcoal. The proponent has limited access to vacant housing in Middlemount, as the majority of the proponent share of Anglo American housing is currently utilised by existing Foxleigh Mine employees. Any existing vacant housing is directly related to the current vacancies in employment positions at the Foxleigh Mine. Given the limited supply of private housing in Middlemount there are few opportunities for the proponent to encourage employees to reside permanently in Middlemount.

The development of new housing in Middlemount by non-mine related entities is constrained by a lack of available freehold land for urban development. In 2010, house and land packages were released in the Milieu Estate in Middlemount but these have been slow to sell.

Regional Impacts

While the pressures from a single development the size of the project are not likely to be problematic, the cumulative impacts of multiple development projects in the broader Mackay SD make them potentially more difficult to address. The project is likely to coincide with other major developments in the area (notably Middlemount Coal Project, Stage 2 and Caval Ridge Mine), with subsequent cumulative impacts. There will also be a number of indirect and induced demands for housing as the downstream effects of the project (and other projects) are realised.

The modelling of housing demands in the Mackay SD shows that significant housing development is needed to address projected population increases (Akbar and Rolfe 2008). However, the time needed to develop new housing means that short term pressures on the housing market in the Mackay SD and surrounding regional areas including in the Fitzroy SD are likely.

The longer term trends in the housing market are driven by the upturn in Central Queensland's industrial and mining industries, the relocation of people to Central Queensland and the spill-over effects from housing demand in South-East Queensland. These factors mean that the project development might coincide with other pressures and demands in the housing market.

There is potential for additional demands on the regional housing market to increase rents and house prices. While those consequences would have some beneficial effects in terms

of increasing wealth and stimulating investment back into the housing market, there may also be some cost-pressure impacts on lower socio-economic groups who are renting, and the potential for a housing 'bubble' to emerge. However, recent data collated by CQU suggests that the recent high-demand experienced for housing in Central Queensland are starting to contract whilst the supply, development and consumption of new residential lots is slowing in response to a slight decline in demand for residential land.

Rents across the Mackay and Fitzroy SD may have to increase further before a stimulus for private investors to increase housing stocks is effective. For example, the average cost of a standard three bedroom house in Middlemount is approximately $400,000 and about $390,000 in Mackay. However, at a median rent of $390 per week for a three bedroom house in Mackay, there is little incentive for investors to purchase new-build housing, which would increase the housing stock of the area. Instead, most of the focus in investment activity is on renovating older housing, which is cheaper than the cost of new housing.

The potential project impacts on the local Middlemount area and the broader Mackay SD region are minimised to a large extent by the use of DIDO/FIFO arrangements for the majority of the workforce. However, Anglo American acknowledges that care will need to be taken to ensure this approach does not have a cumulative impact on community cohesion and social order in Middlemount, and does not simply transfer housing pressures to other communities in the Mackay and Fitzroy SDs.

Long Term Social Housing

The provision of long term social housing in Middlemount is discussed in Section 3.13.2. The project will not impact on the supply of community housing in Middlemount, neither will it directly increase demand for community housing. Middlemount is not experiencing the housing market pressures evident in other resource communities of the Bowen Basin such as Moranbah and subsequently does not have the housing affordability issues prevalent in these communities.

The accommodation strategy for the project workforce places little demand on existing housing resources in Middlemount. The lack of freehold land and Anglo American's ownership of most houses in Middlemount means that there is little opportunity for private housing investment. The accommodation strategy combined with existing levels of private housing investment mean the project is unlikely to result in the displacement of families as investors seek higher rental returns. This is in comparison to the situation in Moranbah where the community is experiencing high rental prices as a result of investors seeking to capitalise on returns from mining tenants or buyers.

The project may indirectly contribute to a minor increase in the demand for low cost and emergency housing in the wider study area as a result of people displaced from increased housing market competition. DOC representatives noted an ongoing demand for emergency housing provision for both mine and non-mine employees in the IRC and wider region. Of

particular concern is the demand for emergency housing and emergency finance for women (and their dependents) following separation from mine employees in Middlemount.

4.6.2 Mitigation and Management

To address the lack of housing choice in workforce accommodation options for the project, the proponent proposes to undertake the following actions:

- Improve the standard of company owned housing and accommodation in Middlemount, through:
  - Continuation of the progressive maintenance program for existing Anglo American accommodation, including houses.
  - Appointment of a facilities management contractor to manage ongoing repairs and maintenance of all Anglo American accommodation in Middlemount, to ensure housing continues to meet Anglo American's housing standards.
- Ongoing implementation of the existing Anglo American Housing Policy giving preference, where possible, to families for company housing.
- Continuation of fortnightly meeting of Anglo American representatives to consider applications for accommodation and review accommodation policies and guidelines.

4.6.3 Short-Term Accommodation Impacts

The project is unlikely to generate any direct demand for hotel and motel accommodation in Middlemount. The relatively small additional establishment workforce and the 90 additional operational employees will be accommodated in the existing Foxleigh Accommodation Village in Middlemount. Some indirect demand may be generated by suppliers and contractors during the establishment phase. Operators of the hotels and motels in town have indicated capacity to accommodate additional demand generated indirectly by the project.

4.6.4 Mitigation and Management

To minimise the impacts of the project on short term accommodation provision in Middlemount, the proponent will encourage non-resident project employees and contractors to reside in identified accommodation villages where possible.

4.7 SOCIAL INFRASTRUCTURE IMPACTS AND MANAGEMENT

4.7.1 Impacts on Social Infrastructure and Services

The community service provision issues currently being experienced in Middlemount (Section 3.14) are likely to be exacerbated by the introduction of the additional non-resident population associated with the project. Facility and service operators have repeatedly expressed concerns regarding the additional demands generated by non-resident workforces. The impact of these demands is exacerbated by the fact that most service and facility providers are planned and funded to service only the permanent resident population, not the non-resident worker population. Without information regarding the size and demographic characteristics of the non-resident worker population, service providers cannot adequately plan for the demand they place on service provision.

Taking into consideration the likely demographic characteristics of the workforce, the project may have a cumulative impact on demand for the following services and facilities in Middlemount:

- Individual and family support services including counselling services;
- Sport and recreational services; and
- Emergency services.

Based on previous analysis of service provision in Middlemount (Section 3.14) and discussions with service providers, the following local community services may experience some difficulties in meeting or managing the demands generated by the additional population:

- Community health services - in particular family support, mental health and counselling services; and
- Emergency services.

The potential impact on these community services are described in detail in the following sections.

Impacts on Health and Welfare Services

During consultation the QH raised concern that the 90 additional employees will lead to increases in demand for acute services beyond the capacities of Middlemount CHC and place strain on Dysart and Moranbah Hospitals. The QH suggested Anglo American contribute to service provision for the Middlemount community, or provide their own treatment services for employees (either in Middlemount or at the base location of the DIDO/FIFO employees). Anglo American continues to pay a retainer to the local doctor to preserve the local medical and dispensing service.

QH also identified an increasing demand for regional mental health services (predominantly counselling services). An increase in regional demand for services can in part be attributed to the non-resident workforce based in resource communities such as Middlemount, Dysart and Moranbah and their families who are based in regional locations such as Mackay.

Emergency Services Impacts

Emergency service representatives all agreed that whilst the overall impact of the project on service delivery in Middlemount is difficult to establish, they cannot guarantee immediate response to a site based incident due to the growth in the number of mines in the area and the rural area covered by the service.

Consultation with representatives of the Middlemount branch of the QPS highlighted the need for the QPS to be made aware of future developments and participate in the planning process so that they can adequately handle any future demands. To ensure adequate service levels the QPS requested advanced notice of the commencement of any major project. The issues raised by the QPS related to size, location and operation of any proposed accommodation villages rather than on QPS service provision.

QPS also raised concern about the increase in oversized vehicle movements in the region and the demands this placed on QPS resources to accompany movements. The Middlemount QPS has one vehicle. When this vehicle is used as an escort vehicle, the QPS in Middlemount does not have access to a second vehicle for responding to other matters.

During consultation, a representative from DCS indicated that the QAS roster in Middlemount allows for one single officer response 24/7. However, due to limited staffing, when two incidents take place at the same time, there is no guarantee that the officer is always available for emergencies, in which case the next closest QAS (Tieri) is called upon to respond. Where mines rely on the community's QAS, this creates potential for QAS to be unavailable for other emergencies in the community and therefore results in delayed response time when back-up from QAS back-up is required from Tieri.

Many operating mine sites have their own paramedical services, provided either directly by the mine or by an external company such as the QAS. This minimises the potential for a local ambulance crew (QAS) to be unavailable to the broader community during an emergency. The DCS representative highlighted the concern that Foxleigh Mine does not have its own paramedic and as such, places an additional strain on the QAS. The respondent also expressed concern that the increased traffic flow generated by the project will lead to increased traffic accidents and therefore put additional pressure on QAS to meet demands in Middlemount and surrounding areas. The respondent also indicated that the intention for the majority of staff to be DIDO will put additional pressures on the QAS service covering the roads between Mackay and Rockhampton. The respondent also indicated the

need for unrestricted, unobstructed and clearly identified access to be provided and maintained to allow QAS and other emergency services to attend the site if necessary.

4.7.2 Mitigation and Management

Health and Welfare Services

Anglo American currently offers to all employees at Foxleigh Mine an Employee Assist Program (EAP). The proponent is committed to the continuing implementation of the Foxleigh/Capcoal EAP. Anglo American recently reviewed the Foxleigh/Capcoal EAP and made the following changes to the scope of service provision:

- More regular site visits and inclusion of outreach model of service provision, resulting in more opportunities for interaction with the EAP provider;
- Provision of accommodation in Middlemount for visiting services offered through the EAP;
- Provision of outreach services from within the Foxleigh/Capcoal accommodation villages in Middlemount;
- Increased site-based training and awareness of mental health issues; and
- National coverage of the EAP to ensure the service is accessible to all employees and their families, regardless of where their FIFO/DIDO/BIBO base location may be, or provision of a managers hotline to coach team leaders to assist their staff when required.

The proponent will implement a comprehensive induction program for all employees including understanding fatigue and fatigue management, relationship management, the EAP and range of services accessible for employees and their families.

The EAP includes access to the existing doctor in Middlemount and to site-based physiotherapy once per week for work related and non-work related injuries, as well as access to an external and confidential counsellor. The EAP alleviates pressure from Anglo American employees on public health services by funding access to private health care and by funding the provision of specialists external to the community. However, the EAP also relies on existing Middlemount health service providers, or providers at employees' base locations, and as such the EAP alone is limited in its capacity to respond to service demand pressure.

To address this demand and to assist in alleviating the cumulative pressures on social infrastructure in the SIA Study Area, Anglo American will also ensure timely provision of information relating to the size and demographic make-up of the projected project construction and operations workforces to service providers. In addition, Anglo will continue to:

- Subsidise the Middlemount General Practitioner to secure the service for the local Middlemount community;
- Subsidise the local physiotherapist to ensure provision of service for employees and the local Middlemount community;
- Subsidise the rent for the local dental surgery to secure a service for the local community; and
- Provide low cost housing in Middlemount for key service industry workers – including health, business owners and childcare providers.

Anglo American is already an active participant in government and inter-agency steering groups across the cultural and social area of influence of the project to ensure they are up to date on issues impacting vulnerable groups and the broader community. This involvement will be ongoing through the life of the project. The proponent will contain to maintain open communication with service providers to monitor and respond to impacts on social infrastructure in a timely manner.

In addition, to support the development of a healthy living and working environment for the project workforce the proponent will design and promote active and healthy lifestyle options in the Middlemount Community. Options may include:

- Continuing to support the 10,000 steps program for employees and community members;
- Continuing to fund gym and pool memberships for employees;
- Providing funding through the Facilities Management Agreement to manage the Middlemount gym;
- Continue current employee and family health programs (influenza vaccinations, skin checks); and
- Explore opportunities to introduce programs such as workplace ergonomic assessments.

Emergency Services

In relation to the concerns of the emergency service providers, information regarding the anticipated movements of over dimensional vehicles is included in the EIS and provides an indication of the frequency and number of movements likely during the establishment and operations phases of the project. In addition, the proponent will maintain regular contact with appropriate representatives to discuss the project and likely impacts including any potential additional requirements to adequately respond to potential emergencies.

Anglo American is bound by the *Coal Mining Safety and Health Act 1999* and *Coal Mining Safety Regulation 2001*. This legislation requires Anglo American to have emergency

capabilities based on site and a fire standard operating procedure, thereby relieving pressures on community emergency services.

Anglo American currently contributes to the capacity of the community to meet demands of emergency situations through resources from their Capcoal operation including, donation of equipment and other emergency response capability.

4.8 COMMUNITY COHESION, VITALITY AND IDENTITY

4.8.1 Community Impacts

In isolation, the project will have little positive or negative impact on community cohesion and vitality in Middlemount. On its own, the project will make a limited contribution to enhancing community capacity primarily due to the relatively small additional workforce. The project will however provide a level of economic certainty for the community and small business providers.

4.8.2 Mitigation and Management

Anglo American acknowledges it has a role to play in supporting community development and securing a vital community with a strong sense of identity. To this end, the proponent has made a number of commitments which target capacity building in the community. These commitments are discussed below.

Anglo American in partnership with the IRC through the *Kicking Goals* strategy funds a community place worker in Middlemount who is responsible for building capacity in community groups and small business in Middlemount. The community place worker is responsible for engaging with the community and other agencies. In the long term and through the efforts of the community place worker it is hoped that the community will participate in and contribute energy to improve the community and increase the liveability for all. Anglo American has also appointed a Community Officer in Middlemount to enhance communications between the Middlemount community and Anglo American.

Promoting the creation of social connections between the incoming workforce and the existing community will strengthen existing levels of community cohesion and assist in the long term in staff retention. The proponent will partner with community bodies to foster community spirit through events, sports clubs and associations.

As discussed under the Section 4.7, an EAP will be made available to employees to support the health and wellbeing of employees and their families. Supporting and responding to the needs of the non-resident workforce and their families in relation to wellbeing will also strengthen the local and regional social fabric and assist in managing the demands placed

on community and government provided support service such as family support and mental health.

Acknowledging the potential increase in the non-resident population of Middlemount, the proponent will also implement the Anglo American Code of Conduct for employee behaviour to protect social order and community safety in Middlemount and enhance community vitality.

In addition, the proponent will discuss with the IRC and other community stakeholders the potential formation of a Middlemount reference group lead by the IRC.

4.9 AMENITY AND LIVEABILITY IMPACTS AND MANAGEMENT

4.9.1 Impacts on Amenity and Liveability

To date Middlemount has experienced infrequent and minor impacts from surrounding mining operations on residential amenity. The potential impacts of the project on residential amenity have been assessed in the EIS. Specifically air quality, noise and vibration modelling has been conducted to determine the extent of potential impacts on residential amenity in Middlemount. Modelling has considered the cumulative impacts of operations with the proposed Middlemount Coal Project, Stage 2 and visual assessment has been completed to define the potential visual impact of the project.

The findings of the assessments indicate that the project is unlikely to adversely impact on the amenity and liveability of Middlemount.

4.9.2 Management and Mitigation

The potential noise, dust and vibration impacts of the mine have been defined in the EIS and suitable management measures identified to meet relevant regulatory requirements. The relevant management and monitoring programs are provided in the Environmental Management Plan (EIS Attachment 1).

4.10 COMMUNITY SAFETY IMPACTS AND MANAGEMENT

4.10.1 Impacts on Community Safety

During consultation, concern was raised about the impact of the project on existing traffic volumes on the Fitzroy Developmental Road, the Middlemount-Dysart Road (Figure 2), and Centenary Drive North. The majority of concerns related to the potential for any increase in fatigue related incidents on the road network.

4.10.2 Mitigation and Management

A detailed road impact assessment has been completed for the project (Appendix M – *Road Impact Assessment*). The findings of the road impact assessment indicate that the project will not adversely impact the safe operation of key intersections on the Dysart-Middlemount Road. The Dysart-Middlemount Road/Barwon Park-Middlemount Road intersection will be upgraded in accordance with the Austroads design standards. Category v5 'flag' lighting will be installed by the proponent at the Dysart-Middlemount Road/Barwon Park-Middlemount Road intersection in accordance with Department of Transport and Main Roads design standards. Any IRC controlled road realignments will be constructed in accordance with relevant IRC standards except where specifically varied by the design guidance presented in Section 8 of Appendix M – *Road Impact Assessment.*

The section of Barwon Park-Middlemount Road between Dysart-Middlemount Road and the project access on Barwon Park-Middlemount Road will be upgraded to safely accommodate project traffic demands. The Barwon Park-Middlemount Road/Foxleigh Plains Project Access intersection will be constructed in accordance with the requirements of the Austroads design standards. Implementation of these commitments is anticipated to fully mitigate all potential significant traffic impacts associated with the Foxleigh Plains Project.

While a certain level of increased traffic is unavoidable, the proponent understands that road safety is an area of particular concern, especially on the Fitzroy Development Road. The proponent is committed to road safety and fatigue management for mine employees. The proponent proposes to:

- Continue to implement the existing *Foxleigh Mine Alcohol and Other Drugs Management System*;
- Implement a comprehensive employee induction program including understanding fatigue and fatigue management;
- Implement the *Anglo American Fatigue Management Policy* in consultation with the QPS and Emergency Services, in addition to the site fatigue management policy;
- Support the implementation of a local Middlemount Community program aimed at raising awareness of fatigue management and the need for the community to support good journey management; and
- Provide bus transport between the Middlemount accommodation village and the mine site for employees.

4.11 MINE CLOSURE IMPACTS AND MANAGEMENT

4.11.1 Mine Closure Impacts

This section discusses the potential socio-economic impacts of closure of the Foxleigh Plains Project. The project has a mine life of approximately 15 years. The closure of the mine may have an impact in the following key areas:

- Local and regional employment and economic development: There is potential for loss of economic stimulus through a loss of procurement opportunities for local and regional businesses, as well as loss of investment in local and regional education and training initiatives.
- Housing and accommodation: The potential housing and accommodation impacts resulting from mine closure include a decrease in demand for accommodation in Middlemount following mine closure leading to lower house prices and higher property vacancy rates.
- Population and demographic structure: Mine closure may result in a departure of permanent residents from Middlemount, with corresponding reduced demand for service provision.
- Social infrastructure provision: As social infrastructure provision is generally determined on population threshold, there is potential for the reduced population to in turn affect service sustainability, with potential loss of some services.

The assessment of mine closure impacts does not consider any cumulative impacts associated with the simultaneous closure of other mining operations in the local area due to the difficulties in obtaining accurate information on the future closure of other mining operations.

4.11.2 Mitigation and Management

Mine closure impacts will be managed through the application of the processes described in the established *Anglo American Mine Closure Toolbox* (the Mine Closure Toolbox), a component of the Anglo American SEAT. The Mine Closure Toolbox is designed to assist operations with strategic long-term mine-closure planning. The Mine Closure Toolbox expands the focus of mine-closure planning from financial provisioning for rehabilitation and physical closure to planning for long-term sustainability through addressing complex socio-economic, physical and bio-physical challenges. It is a requirement of the Mine Closure Toolbox that mine closure planning is conducted through regular engagement processes such as the established triennial Anglo American SEAT process.

4.12 SUMMARY OF PROJECT IMPACTS AND BENEFITS

Table 33 provides a summary of the potential social impacts and benefits associated with the construction and operation of the project, together with a summary of the key management commitments.

Table 33
Summary of Potential Social Impacts and Mitigation

Social Values	E[1]	O[1]	Impacts and Benefits	Mitigation
Employment and Economic Development		✓	Creation of an additional 90 full time positions	• Met Coal *Equal Opportunities Employment Policies*. • Anglo American commitment to workforce diversity. • Continuing to support FIFO and DIDO options for employees to extend project employment opportunities. • Inclusion of local procurement targets in the facilities management contract.
		✓	Direct and indirect creation of 197 full time positions in the region and 451 full time positions in Queensland.	
	✓	✓	Increase in regional, state and national revenue through: • Royalty payments of approximately $26M to $31M per annum; • Increased income tax payments of approximately $13.9M; and • Increased company tax of approximately $11.7M.	
	✓	✓	Stimulate growth in local and regional business supply chain and services industries with increased opportunities for local and regional businesses to supply services during operations.	
		✓	Opportunities to provide for workforce diversity (women, Indigenous, youth, disability) in the project.	
		✓	Increased household incomes at local and regional level.	
		✓	Increase in cost of living at the local and regional level with resultant impacts on individuals and families not employed in the mining sector.	
		✓	Reinforces specialisation of the regional economy in the mining sector.	
		✓	Increased demand on labour force and specific skill sets at the local and regional level.	
		✓	Limited increase in local spend due to project reliance on non-resident workforce.	
Education and Training	✓	✓	Opportunities to build local and regional workforce capacity through training and development strategies specifically targeting young people.	• Continuing to support cleanskin workers and their ongoing education and training.
	✓	✓	Potential to increase regional skill base by providing regional employment opportunities, including for unskilled workers.	

Social Values	E[1]	O[1]	Impacts and Benefits	Mitigation
	✓	✓	Potential to increase training opportunities for disadvantaged groups in the region, particularly Indigenous youth.	• Continuing to develop a strong partnership with Middlemount Community School to assist in providing and supporting quality education opportunities for local students.
Housing and Accommodation	✓	✓	Lack of choice in housing options for the workforce.	• *Anglo American Housing Policy*.
Social Infrastructure	✓	✓	Non-resident workforce does not increase the size of the rateable population base or the population base upon which government service provision is planned.	• Timely provision of employment data to relevant agencies to inform capital investment decisions. • Provision to OESR of necessary data relating to non-resident workforce accommodation. • Employee Assistance Program (EAP).
Workforce Health and Wellbeing	✓	✓	Employment conditions (i.e. long shifts and FIFO/DIDO) increase risk of adverse impacts on employee and family health and wellbeing and employee relationships.	• EAP. • Establish Fatigue Management Policy for the project.
	✓	✓	Increased risk of road accidents resulting from driver fatigue and poor journey management (a result of employment conditions (FIFO/DIDO)).	

Social Values	E[1]	O[1]	Impacts and Benefits	Mitigation
		✓	Potential harm from drug and alcohol abuse associated with employment conditions (FIFO/DIDO).	• Standard contracts will refer to compliance requirements for fatigue management contained within the project Safety and Health Management System. • Fatigue management training for all employees. • Foxleigh Mine Alcohol and Other Drugs Management System.
Community Health and Wellbeing		✓	Increased risk of road incidences due to poor journey management (a result of employment conditions (FIFO/DIDO)) driver fatigue and increased traffic volumes.	• EAP. • *Foxleigh Mine Alcohol and Other Drugs Management System*. • New employee induction process. • Environmental Authority (EA) conditions.
		✓	Cumulative impacts of mining on residential amenity (i.e. dust).	
Amenity and liveability	✓	✓	Potential dust impacts on Middlemount with resulting impacts on residential amenity.	• EA conditions. • Community perceptions survey through Anglo American SEAT process. • *Community Complaints and Grievance Procedure*. • Mine rehabilitation plan.
	✓	✓	Cumulative impacts of mining on residential amenity and increase in rehabilitated area.	
Community cohesion, vitality and identity	✓	✓	Increased non-resident population with potential to intensify existing levels of conflict with permanent residents and adversely impacting on perceptions of community safety and cohesion.	• Monitor baseline demographic indicators.

Social Values	E[1]	O[1]	Impacts and Benefits	Mitigation
	✓	✓	Increase in gender imbalance with potential impacts on community cohesion.	• Community perceptions survey through Anglo American SEAT process.
	✓	✓	Limited focus on attracting a resident workforce with resulting minimal contribution to capacity building for community groups and volunteer organisations.	
	✓	✓	Increased local and regional community development benefits from community investment by Anglo American.	
	✓	✓	Cumulative increase in non-resident workforces into the region.	

[1] *E – Establishment Phase, O – Operations Phase,*

* * *

for
HANSEN BAILEY

Bronwyn Pressland
Principal Social Planner

Peter Hansen
Project Director

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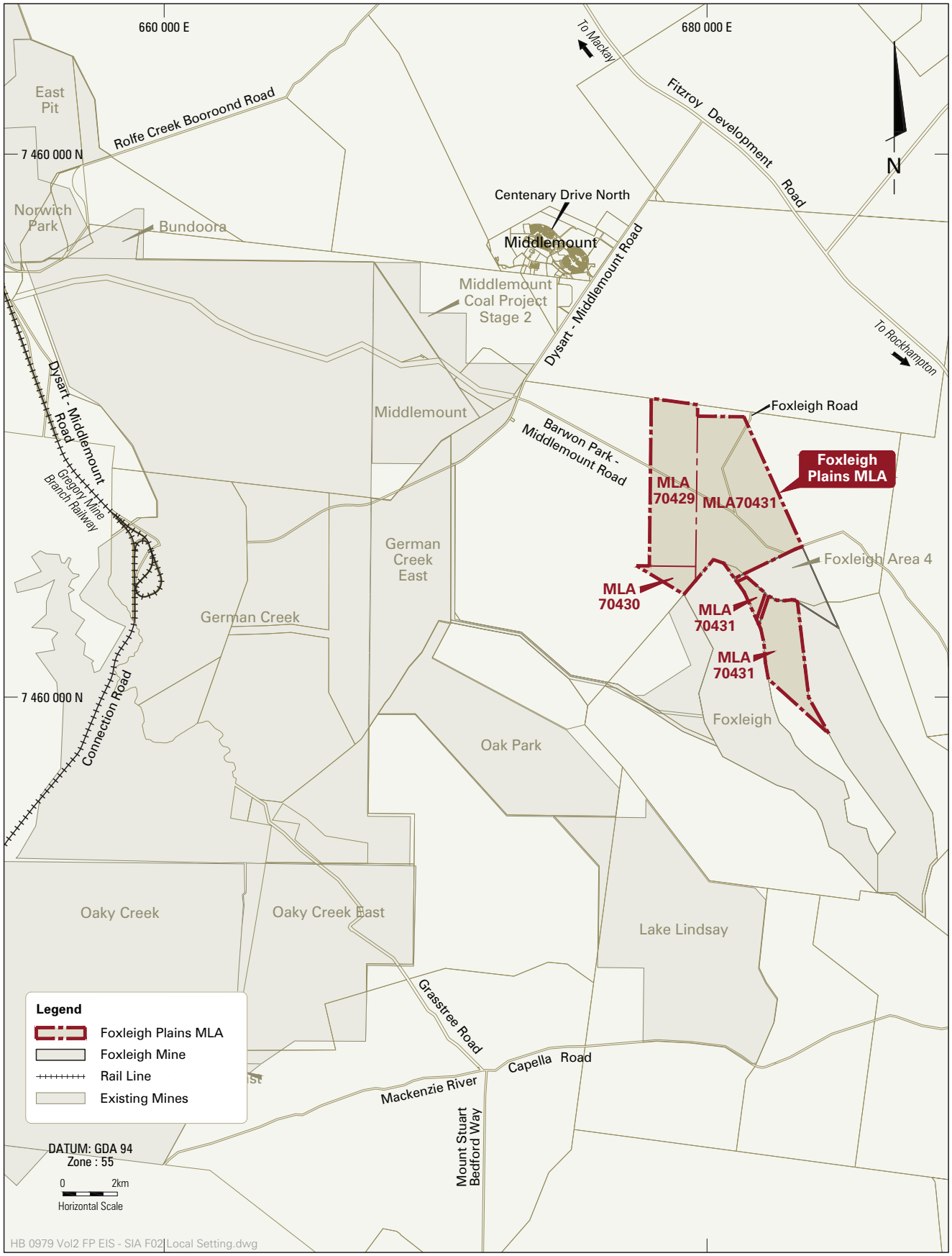
FIGURES

FOXLEIGH PLAINS PROJECT

AngloAmerican | Hansen Bailey ENVIRONMENTAL CONSULTANTS

Project Location

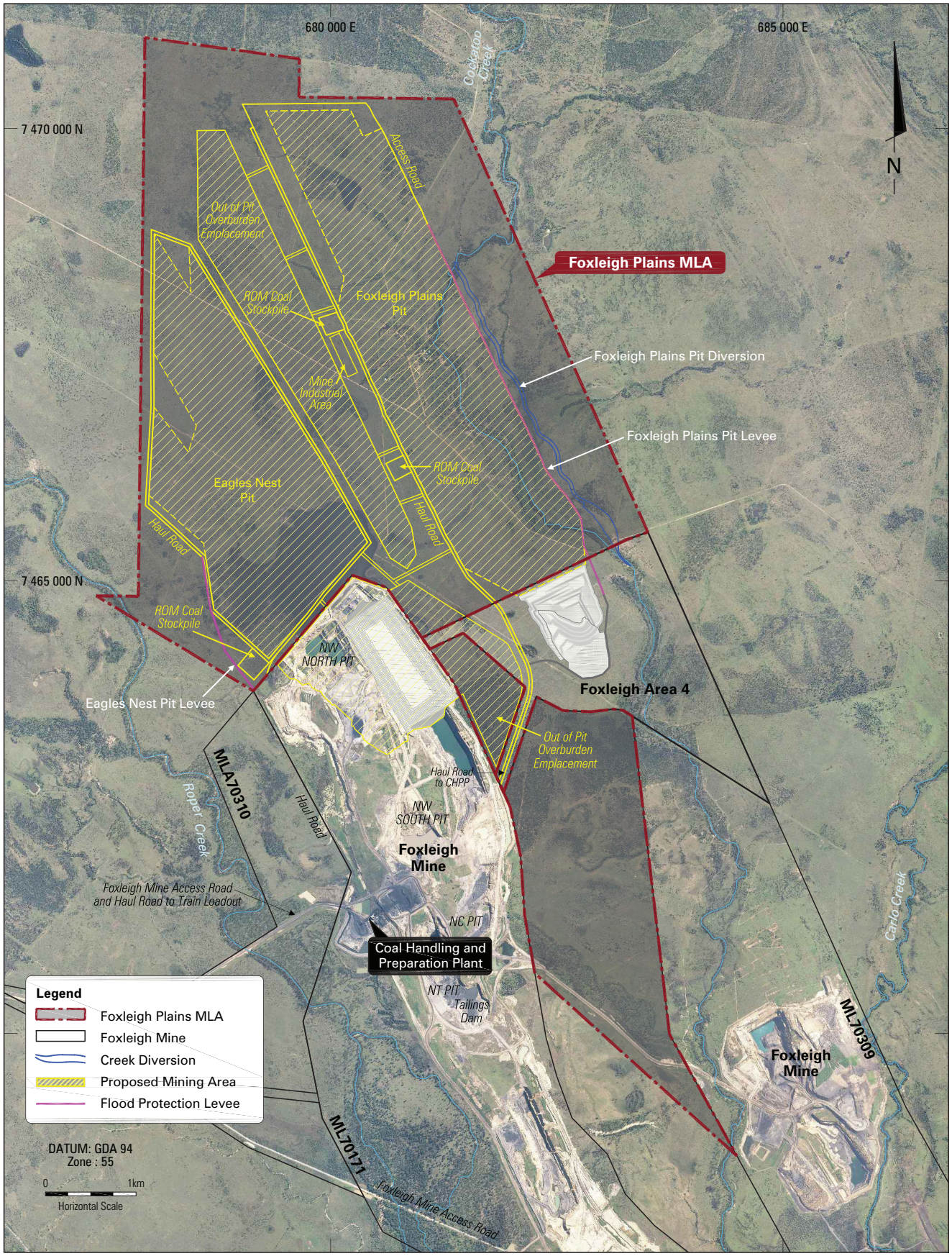
FIGURE 1



FOXLEIGH PLAINS PROJECT

Local Setting

FIGURE 2



FOXLEIGH PLAINS PROJECT

AngloAmerican | Hansen Bailey ENVIRONMENTAL CONSULTANTS

Project Layout

FIGURE 3

FOXLEIGH PLAINS PROJECT

AngloAmerican | Hansen Bailey ENVIRONMENTAL CONSULTANTS

SIA Study Area

FIGURE 4

APPENDIX A

List of Stakeholders Consulted

APPENDIX A

List of Stakeholders Consulted

CATEGORY	STAKEHOLDER
Landowners within the project site	Two landowners with properties within the project site
Landowner adjacent to project site	Single landowner with property adjacent to the project site
Easement Holders/Infrastructure Owners	Four easement holders within the project site
Commonwealth Government	Department of Sustainability, Environment, Water, Population and Communities
State Government	Department of Communities
	Department of Community Safety
	Department of Local Government and Planning – formerly DIP
	Queensland Police Service
	Queensland Health – Rural Services (Dysart, Mackay)
	Department of Environment and Resource Management – Brisbane and Emerald
	Department of Education and Training
	Department of Transport and Main Roads
	Department of Employment, Economic Development and Innovation (DEEDI) – Mining Support Unit/Central Region Mines
	DEEDI – Regional Development Strategies
	DEEDI – Primary Industries and Fishery
Local Government	Isaac Regional Council and local Councillors
Environmental Groups	Mackay Conservation Group
	Capricorn Conservation Group
Facility and Service Providers	Swag Motel
	Queensland Police - Middlemount
	State Emergency Services - Middlemount
	Middlemount Community School
	C&K Kindergarten Middlemount
	Middlemount Leisure Centre
	Middlemount Netball Group
	Middlemount Junior Football Club
	Middlemount Fellowship Church
Endorsed Aboriginal Parties	Southern Barada Barna & Kabalbara People

CATEGORY	STAKEHOLDER
Middlemount Community	Various residents

APPENDIX B

Summary of Community Facilities and Services in Middlemount

Table B-1
Summary of Community Facilities and Services in Middlemount

Services	Service Available
Emergency Services	
Police	Yes
Fire & Rescue Service	Auxiliary Service
Emergency	Yes
Ambulance	Auxiliary Service
Health/Medical	
Hospital	No
Clinics	Well Baby Clinics, Immunisation, Community Nursing, Health Promotion, Triple P Program, Antenatal Classes, School Based Vaccination Program, School Base Youth Health Nurse, Mobile Women's Health Clinic
Allied Health	Counselling, Community Mental Health - Mental Health (adult), Mental Health (child and adolescent), Speech Therapy, Pathology
HACC	Meals on Wheels, Home Medical Aids, Home Help, Day Respite, In Home Respite.
Visiting Services	Flying Obstetrician, Gynaecologist, Flying Surgeon, Psychiatrist, Drug and Alcohol services, Mobile Breast Screening Van, Occupational Therapist, Mobile Oral Health Van, School Based Youth Health Nurse.
General Practitioners	1
Education and Training	
Pre-Prep	Middlemount Community School
Primary	Middlemount Community School
Secondary	Middlemount Community School
Children's Services	
Child Care	Middlemount C&K
Playgroups	Mulligrubs Playgroup
Youth Service	Middlemount Youth Centre and Youth Worker
Housing	
Public/Department of Housing	Yes
Company Owned	Primarily Anglo American
Private Rentals	Minimal
Short-term Accommodation	
Hotels, Motels and Accommodation	SWAG Motel Middlemount Hotel/Motel
Retail Association	No

Services	Service Available
Retail	Middlemount IGA Specialty shops Restaurant and Takeaway food outlets Cafés
Cultural	
Library	Yes with internet access for public.
Churches	Anglican Church Church of the Holy Family FACE Lutheran Church Assemblies of God
Community Centre	No
Cultural Centre	No
Cinema	No
Government	
Local	Isaac Regional Council
State	QGap Services
Commonwealth	No
Access	
Road	Fitzroy Development Road and Capricorn Highway with connections to Mackay, Emerald and Rockhampton
Rail	Freight and coal only
Air	None in operation
Transport	Bus Service Taxi
Sporting Organisations	A large range of sporting facilities and organisations including: Middlemount Aquatics; Middlemount Golf Club; Middlemount Junior Gymnastics; Middlemount Junior Rugby Club; Middlemount Junior Motorcycle Club; Middlemount Sporting Shooters Assoc; Middlemount Tennis Association; Middlemount Touch Assoc; Middlemount Netball; and Middlemount Leisure Centre.

Services	Service Available
Sporting Facilities	Middlemount Aquatic Centre (50 m pool and 25 m heated pool); Sports Fields (basketball, hockey, cricket, tennis, soccer and rugby union/league); Leisure Centre; and Gymnastics Centre.

Source: Middlemount Phone Directory, stakeholder discussions undertaken for the project, and the internet.

Appendix E: Infrastructure Written Agreement

FOXLEIGH LAND

12/09/2018

Mr Tod Mathews
Middlemount South Pty Ltd
PO Box 21
Middlemount QLD 4746

Dear Mr Mathews,

The Department of Environment and Sciences (DES) Financial Assurance Guideline (ESR/2015/1758) requires written agreement for infrastructure to remain on-site and thus not require financial liability for the decommissioning and demolition of site infrastructure.

This letter provides written agreement from the landholder for the following formal land descriptions for the financial assurance calculator from Foxleigh Land Pty Ltd:

- Lot 4 on SP 248577 (Tralee Property)
- Lot 20 on SP 276924 (Foxleigh Mine)

The infrastructure in which this written agreement relates is shown on Attachment A.

Land title searches have been supplied in Attachment B and C for your reference.

This letter has been prepared in relation to the DES Financial Assurance Guideline (ESR/2015/1758) under the *Environmental Protection Act 1994*. The guideline states that the infrastructure can remain onsite if the retention of the infrastructure is consistent with achieving the general rehabilitation goals of a site that is safe to humans and wildlife, non-polluting and stable. Examples of suitable infrastructure provided in the financial assurance guideline is access roads. The infrastructure relating to this letter are access roads which:

- Are bitumen based which require little maintenance and are non-polluting and stable; or
- Are made of benign alluvial materials which are suitably compacted which are also non-polluting and stable.

These roads already contain sediment and erosion controls where applicable. All necessary precautions will be made with the mine operator to ensure compliance with this guideline at life of mine.

Yours sincerely,

M.D. Rosengren

Michael Rosengren
Director
Foxleigh Land Pty Ltd

Attachment A: Infrastructure to be removed from financial assurance calculations

Attachment B: Lot 20 SP 276924

CURRENT TITLE SEARCH
DEPT OF NATURAL RESOURCES AND MINES, QUEENSLAND

Request No: 25185630
Search Date: 23/01/2017 12:18

Title Reference: 51022094
Date Created: 19/01/2016

Previous Title: 50544874
50703346

REGISTERED OWNER

Dealing No: 716980911 24/12/2015

FOXLEIGH LAND PTY LTD A.C.N. 088 327 226

ESTATE AND LAND

Estate in Pee Simple

LOT 20 SURVEY PLAN 276924
Local Government: ISAAC

EASEMENTS, ENCUMBRANCES AND INTERESTS

1. Rights and interests reserved to the Crown by
Deed of Grant No. 40022929 (Lot 5 on CP ROP23)
Deed of Grant No. 40023088 (Lot 4 on CP ROP188)

2. EASEMENT No 602798728 (A1242) 17/09/1981
burdening the land to
UTAH DEVELOPMENT COMPANY
OVER EASEMENT J ON PLAN ROP128

3. EASEMENT No 602798729 (A2221) 18/06/1987
burdening the land to
UTAH DEVELOPMENT COMPANY LIMITED
MITSUBISHI DEVELOPMENT PTY. LTD.
AUSTRALIAN MUTUAL PROVIDENT SOCIETY
UMAL CONSOLIDATED LIMITED
UTAH QUEENSLAND COAL LIMITED
UB MINERALS INC.
BOWEN BASIN MINERALS PROPRIETARY LIMITED
QCT INVESTMENT PTY. LTD.
QCT MINING PTY. LTD.
BELL COAL PTY. LTD.
PANCONTINENTAL MINING LIMITED
CAPRICORN COAL MANAGEMENT PTY. LTD.
OVER EASEMENT J ON PLAN ROP128

4. EASEMENT No 704795162 30/05/2001 at 15:50
burdening the land to
LOT 15 ON SP128608
OVER EASEMENT B ON SP128608

CURRENT TITLE SEARCH
DEPT OF NATURAL RESOURCES AND MINES, QUEENSLAND

Request No: 25195630
Search Date: 23/01/2017 12:18

Title Reference: 51022094
Date Created: 19/01/2016

EASEMENTS, ENCUMBRANCES AND INTERESTS

5. EASEMENT No 704795165 30/05/2001 at 15:51
benefiting
PART OF THE LAND
FORMERLY LOT 16 ON SP128608
OVER EASEMENT A ON SP128608

6. EASEMENT No 704873395 04/07/2001 at 15:51
benefiting part of the land
FORMERLY LOT 16 ON SP128608
EASEMENTS C,D AND E ON SP138787

7. AMENDMENT No 704873402 04/07/2001 at 15:53
EASEMENT: 704873395

8. EASEMENT No 704873398 04/07/2001 at 15:52
benefiting part of the land
FORMERLY LOT 16 ON SP128608
EASEMENT A ON SP138787

9. AMENDMENT No 704873405 04/07/2001 at 15:53
EASEMENT: 704873398

10. EASEMENT No 709480729 30/03/2006 at 11:57
benefiting
PART OF THE LAND
FORMERLY LOT 16 ON SP181611
OVER EASEMENT B ON SP178461

11. EASEMENT No 709965025 26/09/2006 at 09:24
benefiting
PART OF THE LAND
FORMERLY LOT 16 ON SP181611
OVER EASEMENT D ON SP178463

12. EASEMENT No 710747958 25/06/2007 at 16:17
benefiting
PART OF THE LAND FORMERLY
LOT 16 ON SP181611
EASEMENT B ON SP189252

13. EASEMENT No 710747969 25/06/2007 at 16:19
benefiting
PART OF THE LAND FORMERLY
LOT 16 ON SP181611
EASEMENT C ON SP189253

DEPT OF NATURAL RESOURCES AND MINES, QUEENSLAND
Request No: 25185630
Search Date: 23/01/2017 12:18 Title Reference: 51022094
Date Created: 19/01/2016

EASEMENTS, ENCUMBRANCES AND INTERESTS

14. EASEMENT No 710747979 25/06/2007 at 16:21
benefiting
PART OF THE LAND FORMERLY
LOT 16 ON SP181611
EASEMENTS F AND G ON SP189254

15. EASEMENT No 711410608 08/02/2008 at 15:01
benefiting
PART OF THE LAND FORMERLY
LOT 6 ON SP189240
EASEMENT C ON SP193685

16. EASEMENT No 716121516 05/11/2014 at 12:49
burdening the land to
LOT 15 ON SP178417 OVER
EASEMENT Y ON SP256884

17. EASEMENT No 716121517 05/11/2014 at 12:50
burdening the land to
LOT 15 ON SP178417 OVER
EASEMENT S ON SP256884

18. EASEMENT No 716121524 05/11/2014 at 12:50
burdening the land to
LOT 15 ON SP178417 OVER
EASEMENTS U, V, W, X, ON SP256884

ADMINISTRATIVE ADVICES

Dealing	Type	Lodgement Date	Status
709456068	VEG NOTICE VEGETATION MANAGEMENT ACT 1999	22/03/2006 10:13	CURRENT
713748239	VEG NOTICE VEGETATION MANAGEMENT ACT 1999	08/03/2011 12:22	CURRENT

UNREGISTERED DEALINGS - NIL

CERTIFICATE OF TITLE ISSUED - No

Caution - Charges do not necessarily appear in order of priority

** End of Current Title Search **

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Requested By: D-ENQ INFOTRACK PTY LIMITED

FOXLEIGH LAND

Attachment C: Lot on SP 248577

CURRENT TITLE SEARCH
DEPT OF NATURAL RESOURCES AND MINES, QUEENSLAND

Request No: 25185629
Search Date: 23/01/2017 12:18

Title Reference: 50896229
Date Created: 05/11/2012

Previous Title: 50703345

REGISTERED OWNER

Dealing No: 715071777 07/05/2013

FOXLEIGH LAND PTY LTD A.C.N. 088 327 226

ESTATE AND LAND

Estate in Fee Simple

LOT 4 SURVEY PLAN 248577
Local Government: ISAAC

EASEMENTS, ENCUMBRANCES AND INTERESTS

1. Rights and interests reserved to the Crown by
   Deed of Grant No. 40023088 (Lot 4 on CP ROP188)

2. EASEMENT IN GROSS No 602798732 (A1165) 24/07/1978
   burdening the land to
   UTAH DEVELOPMENT COMPANY
   OVER EASEMENT K ON PLAN ROP130

3. EASEMENT IN GROSS No 602798733 (A1698) 27/01/1984
   burdening the land to
   UTAH DEVELOPMENT COMPANY
   CAPRICORN COAL MANAGEMENT PTY. LTD.
   OVER EASEMENT K ON PLAN ROP130

4. EASEMENT No 704795165 30/05/2001 at 15:51
   burdening the land to
   LOT 16 ON SP128608
   OVER EASEMENT A ON SP128608

5. EASEMENT No 709480729 30/03/2006 at 11:57
   burdening the land to
   LOT 16 ON SP181611
   OVER EASEMENT B ON SP178461

6. EASEMENT IN GROSS No 710031652 19/10/2006 at 15:30
   burdening the land
   ERGON ENERGY CORPORATION LIMITED A.C.N. 087 646 062
   over
   EASEMENT E ON SP178460

CURRENT TITLE SEARCH
DEPT OF NATURAL RESOURCES AND MINES, QUEENSLAND

Request No: 25185629
Search Date: 23/01/2017 12:18

Title Reference: 50896229
Date Created: 05/11/2012

ADMINISTRATIVE ADVICES

Dealing	Type	Lodgement Date	Status
711591051	VEG NOTICE VEGETATION MANAGEMENT ACT 1999	21/04/2008 08:46	CURRENT

UNREGISTERED DEALINGS - NIL

CERTIFICATE OF TITLE ISSUED - No

Corrections have occurred - Refer to Historical Search

Caution - Charges do not necessarily appear in order of priority

** End of Current Title Search **

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Requested By: D-ENQ INFOTRACK PTY LIMITED

Appendix F: Landowner Infrastructure Retain Post Mine Agreement

REES R & SYDNEY JONES
SOLICITORS · EST 1864
Serving Central Qld for 150 years

Partners
Gerard Houlihan
Justin Houlihan LLB
George Cowan LLB Acc. Spec. (Pers. Inj.)
Melanie Findlay B.Bus LLB
Kerry Attwill B.Bus LLB

Associates
Shannon Jennings LLB (Hons)

Our Ref: JH 12-16-0036(05)

15 March 2018

The General Manager
Middlemount South Pty Ltd
C/- Foxleigh Management Pty Ltd
GPO Box 2165
BRISBANE QLD 4001

Dear Sirs,

RE: ML70171 - AGREEMENT FOR SALE AND PURCHASE - SMALL

I refer to the above matter and then confirm that I act on behalf of Greg Small, Brian Small and Marie Small.

Enclosed herewith is a copy of your letter dated 8 February, 2018 which has been countersigned by Greg Small to confirm that the Landholders would like the Far South and Mailbox mine access roads located on the land that is to be transferred back to them post mining be retained for their own use.

Yours faithfully,

Justin Houlihan
justinh@reesjones.com.au
Direct Line: (07) 4930 8302

Encl.

FOXLEIGH MANAGEMENT

08/02/2018

Mr Gregory Small
'Lake Lindsay'
Dingo Qld 4072

Dear Mr Small,

2004 Agreement for Sale and Purchase – Confirmation of Retention of Mine Access Road Post Mining

As per our recent discussions, clause 6 of the Agreement for Sale and Purchase of part of Lake Lindsay from 2004 (**2004 Agreement**) states:

> **6. Reconveyance land by the Purchaser to the Vendor**
>
> 6.1 As part of the consideration to be paid by the Purchaser to the Vendor pursuant to this agreement, the Purchaser agrees that:
>
> (a) On the termination of Mining Lease 70171 and any renewal or extension of ML70171 ("ML70171") the Purchaser will transfer to the Vendor the whole of the land described as Lot 16 on SP 128605, County of Roper, Parish of Ternallum ("Lot 16") for the sum of $1.00; and
>
> (b) On the termination of the proposed mining lease to be issued over all or part of the sale land or any renewal or extension of the proposed mining lease ("proposed mining lease"), the Purchaser will transfer to the Vendor the sale land for the sum of $1.00.

Our understanding is that the landholders who now benefit from clause 6 of the 2004 Agreement would like the Far South and Mailbox to Admin mine access roads located on the land that is to be re-transferred to be retained post mining for use by the landholders. Would you please confirm that is the case by countersigning this letter.

Please note that we intend to provide a copy of this letter to the Department of Environment and Heritage Protection so that they understand the arrangements agreed.

FOXLEIGH MANAGEMENT

Yours sincerely

Tod Matthews
General Manager
Middlemount South Pty Ltd
Foxleigh Mine
Dysart – Middlemount Road
Middlemount QLD 4746

On behalf of the persons entitled to the re-transfer of under clause 6 of the 2004 Agreement, I confirm that we would like the Far South and Mailbox to Admin mine access roads located on the land that is to be re-transferred to be retained post mining for use by the landholders.

Signed by Gregory William Small

G W Small

Signature

Appendix G: Foxleigh Stakeholder Engagement Plan

ENV-PLN-0013

Stakeholder Engagement Plan (SEP)

Environmental Protection Act 1994

Sec 126C(1)(c)(iii) and 126C(1)(c)(iv)

Environmental Authority (EA) – EPML00744813

Condition	Description
A12	The holder of this environmental authority must record all environmental complaints received about the mining activities including: a. name, address and contact number for 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. any person responsible for resolving the complaint.
A13	The holder of this environmental authority 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.
A14	The results of the investigation required by condition A13 (including an analysis and interpretation of the monitoring results) and abatement measures, where implemented, must be provided to the administering authority: a. within ten (10) business days of completion of the investigation; or b. no later than ten (10) business days after the end of the timeframe nominated by the administering authority to undertake the investigation.

1 Introduction

The plan defines how community consultation will be carried out in relation to the rehabilitation of land, in accordance with the Mine's Progressive Rehabilitation and Closure Plan (PRCP). The plan assists to demonstrate compliance with the requirements set out in sections 126C(1)(c)(iii) and 126C(1)(c)(iv) of the Environmental Protection Act 1994 (EP Act).

The plan also addresses the licence conditions required under the EA EPML00744813 to record any environmental complaints received about the mining activities.

The objectives of the SEP are to:

- identify community members, including:
  - affected landholders (such as underlying and adjoining land holders, and holders of land necessary for access to the land to which the proposed PRCP relates);
  - traditional owners;
  - local government; and
  - local community groups.
- build awareness and understanding of their needs and objectives, while managing community expectations of how the applicant would operate; to establish and maintain engagement practices that promote ongoing relationships with the community;
- inform the outcomes stated in the PRCP;
- provide the community with appropriate opportunity to express their opinions and concerns in relation to the mine activities; and
- provide a complaint mechanism to affected stakeholders to register complaints/concerns.

2 Community

2.1 Affected and interested persons

The EP Act defines 'affected' and 'interested' persons based on predicted level of impact, perceived level of involvement in site activities, and perceived level of interest in site activities or outcomes of decisions; as:

1) a 'potentially affected' person:
   - a person who is (among others) the registered proprietor/s of any freehold land, the registered holder/s of any land that is held from the state, any holder/s or applicant/s of mining tenures or other resource related tenures, a trustee of any land under the Nature Conservation Act 1992 or Land Act 1994, and a holder of any unallocated State land, State forests or Conservation parks or State Controlled Roads;
   - a registered Native Title body corporate, claimant or representative Aboriginal/Torres Strait Islander body; or
   - a relevant local government.

2) a 'potentially interested' person; may be an unincorporated community or environmental body with a financial or non-financial interest in the local government area that operational land is in.

2.2 Identified stakeholders

The list of community members is intended to be updated with each revision of this plan. Table 1 lists the identified relevant stakeholders in accordance with the definitions above and the stakeholder relationship with the Mine.

Table 1: Mine Community Members

Group	Member	Key Mine Interest / relationship
Affected Persons		
Employees	Foxleigh Mine employees and contractors	• Continuity of employment • Accommodation and services • Workplace Health and Safety.
Local Government	Isaac Regional Council	• Support for community and local business. • Information on significant variations to mine/workforce. • Worker and contractor accommodation Impacts. • Use of local government infrastructure including roads. • Social infrastructure accessibility (schools, Community Health Centre, recreation and sport facilities) • Social impacts and behaviour. • Availability of housing and accommodation in Middlemount (MM). • Future land uses and permitting.
Underlying landholders	Land owner whose property intersect any portion of the mine leases.	• Activities occurring on the land. • Protection of local environmental values. • Rehabilitation methods and outcomes. • Infrastructure retained or removed. • Residual risks.
Landholders adjacent to the mining leases	Land owner whose property borders any portion of the mine leases or borders another property that intersects any portion of the mine leases.	• Protection of local environmental values (including noise, air and water). • Rehabilitation methods and outcomes.
Traditional owners	Barada Kabalbara Yetimarala People (BKY)	• Activities occurring on the land including disturbance footprint and impacts to cultural values. • Protection of local environmental values. • Indigenous employment opportunity. • Rehabilitation methods and outcomes.
Interested Persons		
Local community members	MM residents	• Employment opportunities • Use of local government infrastructure including roads. • Social infrastructure accessibility (schools, Community Health Centre, recreation and sport facilities). • Social impacts and behaviour. • Availability of housing and accommodation in MM. • Future land uses.
Social and public services	Motel/s QPS – MM SES – MM MCS – Principal and Chaplin C&K Kindergarten Middlemount MM Leisure Centre MM Netball Group MM Junior Football Club MM Golf and Country Club Queensland Ambulance Service (QAS) MM Fellowship Church	• Local procurement. • Local residency of workers • Social infrastructure accessibility (schools, Community Health Centre, recreation and sport facilities). • Social impacts and behaviour.
Accommodation providers	Accommodation villages	• Local residency of workers
Conservation Groups	Mackay Conservation Group Capricorn Conservation Group	• Activities occurring on the land. • Protection of local environmental values. • Rehabilitation methods and outcomes.

3 Stakeholder Engagement

3.1 Communication Methods

Consultation and communication will be undertaken at Fox in line with the methods outlined in Table 2.

Table 2: Communication Method

Method	Purpose	Context	Frequency
Face-to-face meetings or phone calls	Communicate the operational and rehabilitation phases of the mine	• Maintain on-going relationships with the community and surrounding landholders; • Provide accurate, relevant and timely information to the community; • Allow an opportunity for the community to express concerns and issues with mine activities; and • Provide feedback to community concerns in a prompt manner.	As required
Site visits	Cater specific community groups and/or members	• Provide opportunity to gain on ground knowledge of mine through visual inspection of activities and rehabilitation, meetings and presentations.	Planned arrangements as organised between parties
External Company Contact	External Contact through Site Management	• QMetco Website: https://www.qmetco.com.au/site/contact-us1/Contact-Us • QMetco Brisbane Office: +61 (07) 3022 9600 • Foxleigh Administration: +61 (07) 4884 8244	Available during Business Hours Monday-Friday
Printed and Electronic materials	General Information and Notice	• Provide information on a project/issues, including project factsheets, newsletter, and internet publications. • Materials may be distributed directly or advertised in the community to raise awareness of the project aspects and opportunities to be involved.	Support planned engagement activities or as required in response to emerging project issues

3.2 Consultation register

Fox has developed and maintains a community consultation register. The register is a record of present and past engagement activities and it provides a starting point to review information about previous consultations that may be able to assist with planning engagement for the mine. The register will also provide information about what was effective and ineffective in different engagement scenarios. Specific information recorded in the register includes:

- Date
- Stakeholder name
- Consultation type
- Information supplied
- Issues addressed
- Response / outcome
- Commitments

The register can be accessed on SharePoint: ENV-REG-0004 Environmental Consultation Register

3.3 Complaints register

Fox has a complaints program which includes consultation with directly affected persons to ensure any potential impacts are adequately managed. Concerns and issues raised by persons will be recorded, investigated and responded to in a timely and consistent manner, and in accordance with regulatory standards. All complaints will be recorded in the Complaints register.

Complaint response will at a minimum comply with the requirements of EA conditions A12 – A14.

The register can be accessed on SharePoint: ENV-REG-0003 Environmental Complaints Register

4 Feedback

Following investigation on complaints, a feedback process will respond to all communications, outlined below.

1. Feedback, comments and submissions received via the website, email, phone or meeting.
2. Feedback distributed to project team, consultants or nominated team responder.
3. Response drafted, peer reviewed and approved.
4. Formal response provided via email, letter, or presentation.
5. Corresponding action determined (if required).
6. Community consultation and complaints registers updated, documenting details of communication.

In some cases, less formal enquires may warrant other forms of response such as email or phone calls.

In instances where an investigation has been requested by the regulator, reporting to the Department of Environment and Science will occur in accordance with EA conditions A12, A13 and A14.

Appendix H: Engeny PRCP Flood Assessment

ENGENY

FOXLEIGH MANAGEMENT PTY LTD

PRCP Flood Assessment

Foxleigh Mine

QC1025_003-001-REP-1

28 AUGUST 2023

DISCLAIMER

This Report has been prepared on behalf of and for the exclusive use of Foxleigh Management Pty Ltd and is subject to and issued in accordance with Foxleigh Management Pty Ltd instruction to Engeny Australia Pty Ltd (Engeny). The content of this Report was based on previous information and studies supplied by Foxleigh Management Pty Ltd.

Engeny accepts no liability or responsibility whatsoever for it in respect of any use of or reliance upon this Report by any third party.

Rev	Date	Description	Author	Reviewer	Project Mgr.	Approver
0	14/07/2023	Client Issue	Tim Shen	Ben Kiernan	Aaron Baldwin	Tegan Ireland
1	28/08/2023	Client Issue	Tim Shen	Ben Kiernan	Aaron Baldwin	Tegan Ireland
Signatures:						

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1. INTRODUCTION

Engeny Australia Pty Ltd (Engeny) completed a floodplain assessment for the Foxleigh Coal Mine (Fox) to assist with the development of the Foxleigh Progressive Rehabilitation and Closure Plan (PRCP). The floodplain assessment has been completed in accordance with the requirements to support the development of a PRCP are outlined in the Progressive Rehabilitation and Closure Plans (PRCP) Guideline (ESR/2019/4964, Version 1.00), and the 'Information sheet: Voids in floodplains' (ESR/2019/4966, Version 1.00).

The PRCP Floodplain assessment includes the following:

- Development and calibration of a hydrologic model
- Development of a two-dimensional hydraulic model of the Fox pre-mining area.
- Simulation of the 0.1% AEP flood event for the Fox pre-mining landform to determine the floodplain extent in accordance with 'Information sheet: Voids in floodplains' (ESR/2019/4966, Version 1.00).
- Simulation of a range of flood events including the Probable Maximum Flood (PMF) using Foxleigh final landform design.
- Assessment of the performance of the final landform in respect to flooding.

1.1 Background

Fox is exposed to flood risk from Parrot, Roper Creek, Cockatoo Creek and Carlo Creek which all flow through the mine lease (ML) in a north south direction. Carlo Creek converges with the Cockatoo Creek, and subsequently, Cockatoo Creek merges with the Roper Creek. Approximately 2 km downstream from this confluence, Oaky Creek joins the Roper Creek, marking the southernmost junction. The Roper River then continues its course for approximately 15 km until it meets the Mackenzie River. Flooding at the northern mining areas occur from flow in the individual creeks while flooding at the southern mining areas occur from the convergence of all the at the southern end of the mine. The mine site and the nearby waterways are shown in Figure 1.1.

1.2 PRCP Criteria

Flood assessment requirements to support the development of a PRCP outline the requirement to complete a flood assessment of the pre-mining 0.1% AEP flood event to define the floodplain extent for waterways with a stream order of 4 or higher to inform final void rehabilitation requirements.

Section 3.6.1 - General rehabilitation practices within the PRCP Guideline (ESR/2019/4964, Version 3.00) outlines specific flooding assessment and documentation requirements to support a PRCP. This includes assessment of a range of flood events for the final landform and assessment of the residual flood risk associated with the proposed final landform long-term stability.

1.3 Landform Configuration

1.3.1 Final Landform Design

The Foxleigh PRCP final landform consists of seven (7) Non-use Management Areas (NUMA) and four (4) clean water diversions.

The Foxleigh final landform design is shown on Figure 1.2 and Figure 1.3 and further described in the following sections.

1.3.2 Non-Use Management Areas

Foxleigh has 7 NUMAs approved. A NUMA is defined in the Environmental Protection Act (EP Act) (Department of Environment and Science, 1994) as an area of land subject of a PRCP that cannot be rehabilitated to a stable condition after all relevant activities for the PRC carried out on the land have ended. Foxleigh has committed to rehabilitating some overburden dump areas that are below the pre-mining surface resulting in the NUMA area often being smaller than the final void surface area.

Final voids for the purpose of this report are calculated by comparing the life of mine plan and pre-mining surface. Any excavation below pre-mining surface is considered final void. A summary of the final void details is provided in Table 1.1.

TABLE 1.1: NUMA SUMMARY

NUMA	Catchment Area (ha)	Surface Area (ha)
Foxleigh Plains Pit	631	276
Eagles Nest Pit	356	283
One Tree Pit	230	142
Pipeline	170	89
WC Pit	136	105
Carlo Pit	167	51
Far South	124	67

1.3.3 Permanent Watercourse Diversions

The Foxleigh final landform design retains the existing watercourse diversions, including:

- Cockatoo Creek Stage 1 Diversion.
- Cockatoo Creek Stage 2 Diversion.
- Cockatoo Creek Stage 4 Diversion.
- Cockatoo Creek Stage 5 Diversion.
- Carlo Creek Diversion.
- Roper Creek Diversion.

Carlo and Cockatoo Creeks have diversion channels directing water flow around the open cut pits and through the lease. Both creeks eventually flow into Roper Creek before entering the Mackenzie River upstream of the Bingegang Weir. The locations of these retained diversion channels are shown in Figure 1.3.

ML 700014
ML 700027
ML 70417
ML 70379
Roper Creek US
Roper Creek
ML 70429
ML 1998
ML 70431
ML 70430
Parrot Creek DS
Parrot Creek
ML 70470
Carlo Creek US
ML 70310
Cockatoo Creek
Carlo Creek
ML 70171
ML 70311
ML 70309
Roper Creek
Cockatoo Creek DS
Roper Creek DS2
Oaky Creek
Roper Creek
ML 70336
Roper Creek @ Barwon Park

Legend

Mining Lease

Monitoring Location

Stream Order

1
2
3
4
5
6

Level 1, 500 Queen Street, Brisbane
PO Box 10183 Brisbane QLD 4000

www.engeny.com.au

P: 07 3221 7174
E: admin@engeny.com.au

ENGENY

Foxleigh MINE

0 1,000 2,000 3,000 m

Scale in metres (1:85,000 @ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Australia Geodetic Datum
Vertical Datum: Australia Geodetic Datum
Grid: Australian Map Grid, Zone 55

Foxleigh Management Pty Ltd

Foxleigh PRCP

Figure 1.1 - Drainage Features

Engeny does not give any warranty nor accept any liability in relation to the completeness or accuracy of the maps, which may be inherently reliant upon the completeness and accuracy of the input data and the agreed scope of works.

Job Number: QC1025_003
Revision: 2
Drawn: TS
Checked: AB
Date: 31/7/2023

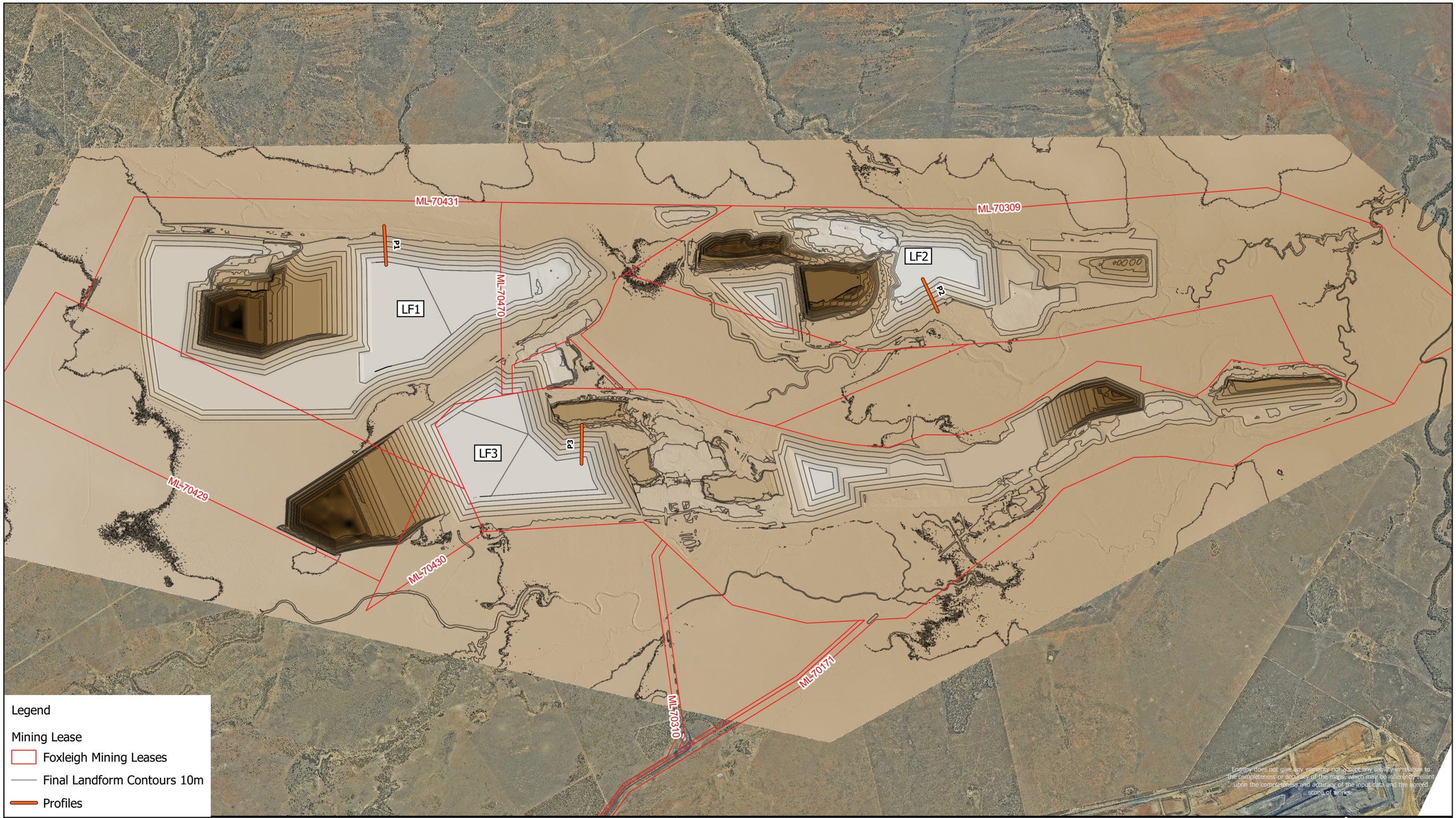

Figure 1.1. Foxleigh Mine Final Landforms

Site: Foxleigh Mine
Project: QC1025_002 Foxleigh PRCP Stage 1-5

Date: 15/5/2023
Drawn By: OH

Foxleigh MINE

ENGENY

Level 1, 500 Queen St Brisbane QLD 4000

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P: 07 3221 7174

E: admin@engeny.com.au

0 0.5 1

Kilometers

Scale @ A3 1:50,000

Foxleigh Plains Pit
Eagles Nest Pit
Cockatoo Creek Diversion - Stage 4
Cockatoo Creek Diversion - Stage 2
Pipeline
Cockatoo Creek Diversion - Stage 5
Cockatoo Creek Diversion - Stage 1
One Tree Pit
Carlo Creek
Carlo Creek Diversion
Carlo Pit
WC Pit
Roper Creek
Far South
Roper Creek Diversion
Roper Creek
Oaky Creek

Legend

- Existing Mine Feature
- Landform Design
- Permanent Creek Diversion
- NUMA
- Capped TSF/Rejects Facility
- Flood Protection Landform
- Final Landform Drainage

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ENGENY

Foxleigh MINE

0 1,000 2,000 3,000 m

Scale in metres (1:72,000 @ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Australia Geodetic Datum
Vertical Datum: Australia Geodetic Datum
Grid: Australian Map Grid, Zone 55

Foxleigh Management Pty Ltd

Foxleigh PRCP

Figure 1.3 - Final Landform and Drainage Features

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Job Number: QC1025_003
Revision: 2
Drawn: TS
Checked: AB
Date: 31/7/2023

2. INPUT DATA

2.1 Previous Studies

The latest Foxleigh flood study was completed by Engeny in November 2021 (*ref. M80100-001-REP-001-1*). This study provided the latest baseline understanding of flood risks to site infrastructure, pits, and levees of Foxleigh. The pre-mining and post mining modelling undertaken for this Foxleigh PRCP will form a continuation of the previous model modelling completed for the Foxleigh flood study. The development and analysis of the flood model are described in the sections below.

2.2 Topography

The Digital Elevation Model (DEM) for Foxleigh and the contributing upstream catchments has been compiled from the following sources in order of priority:

- LiDAR topographic survey of Foxleigh captured on the 28th of December 2020.
- LiDAR topographic survey of the immediate areas surrounding the mine captured during 2009.
- SRTM Survey data of the wider catchment (1 second resolution).

The pre-mining topography was developed by updating the topography data described above with contours underlying current mine disturbance captured prior to mining activities.

The Fox life of mine plan (LOMP) surface was provided to Engeny by FoxMan as a three-dimensional surface (DXF). The landform design considers the landform development and reshape of all relevant activity areas after the removal of infrastructure, and prior to placement of growth media and seed.

2.3 Aerial Imagery

Aerial imagery of Foxleigh extents from December 2020 has been provided. For the area beyond the mine extent, the aerial was sourced from QLD Globe and Google Maps.

2.4 Hydrologic Information

In accordance with Australian Rainfall and Runoff Guidelines 2019 (ARR19) methodology, hydrologic modelling data for Foxleigh has been obtained from the ARR Data Hub (Ball, et al., 2019). A GIS (Geographic Information System) file of the Roper Creek catchment (including Cockatoo Creek and Roper Creek) was used to extract the data.

The hydrologic data sets extracted include:

- Areal Temporal Patterns.
- Area Reduction Factors.
- Rainfall initial and continuing losses.
- Intensity Frequency Duration (IFD) data.

3. INPUT DATA

3.1 Overview

An URBS (Unified River Basin Simulator) hydrologic model of the entire Roper Creek catchments including Oaky Creek, Carlo Creek and Cockatoo Creek was developed and calibrated to the January 2013 flood event. The URBS hydrologic model was used to derive the design flow estimates for Foxleigh for events ranging from the 50% Annual Exceedance Probability (AEP) flood event up to the 0.1% AEP flood events.

3.2 URBS Model Development

3.2.1 Overview

An URBS hydrologic model was developed for the Roper, Carlo, Cockatoo and Oaky Creek catchments. The 2016 version of the URBS software was used. The Split Model version of URBS was used which separates catchment and channel routing in each sub-catchment.

3.2.2 Sub-Catchments and Channel Reaches

The URBS model structure was generated automatically using the CatchmentSIM software. The sub-catchment and channel parameters were determined based on the 28 m cell size Shuttle Radar Topographic Mission (SRTM) Digital Elevation Model (DEM) of the Roper Creek catchment surface. Catchment areas were then refined around Foxleigh using site survey captured in December 2020.

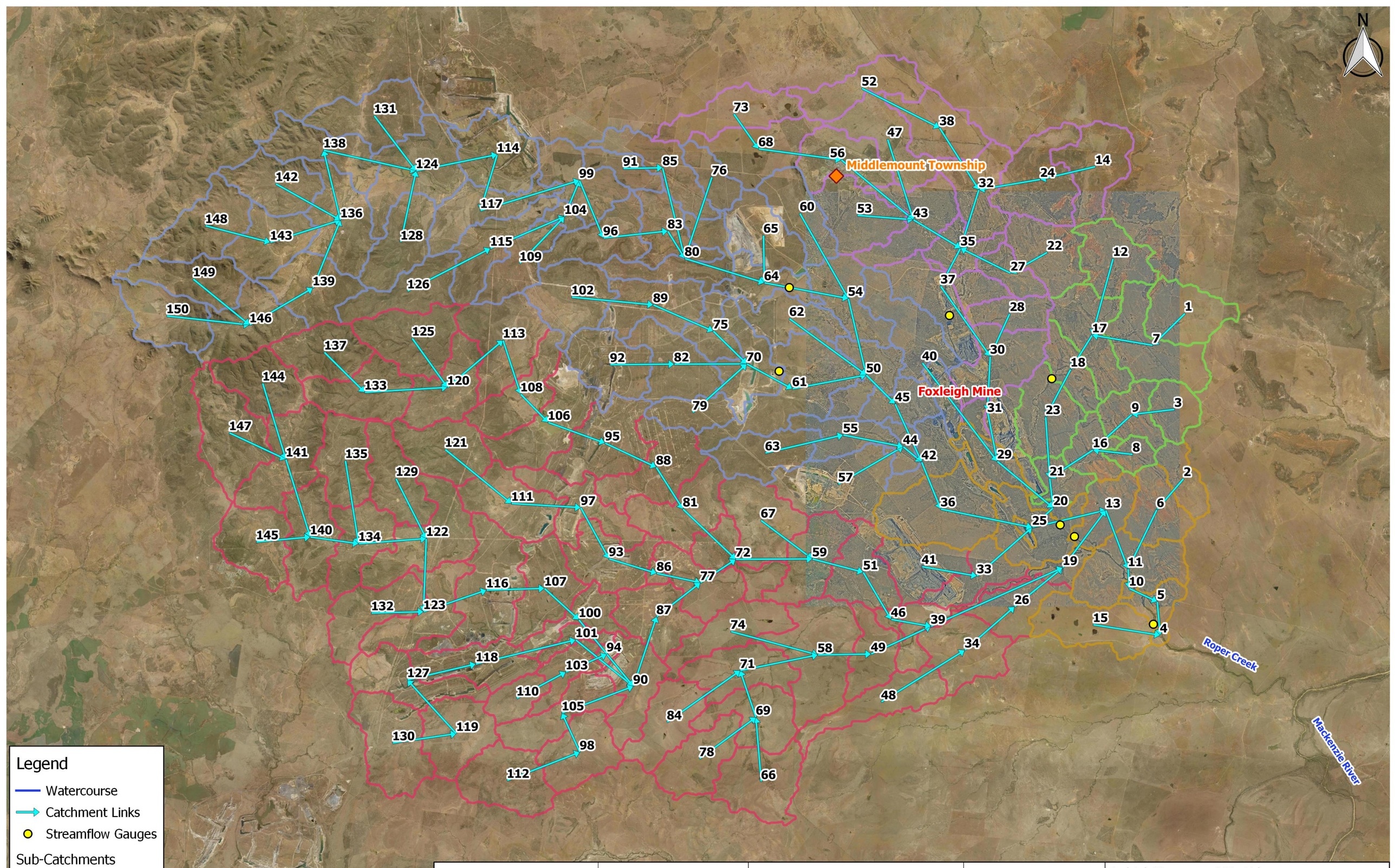
The catchment was subdivided into 150 sub-catchments as follows:

- 46 sub-catchments for the Roper Creek catchment to the mine site (total area 661 km^2).
- 11 sub-catchments for the Carlo Creek catchment to the mine site (total area 131 km^2).
- 18 sub-catchments for the Cockatoo Creek catchment to the mine site (total area 248 km^2).
- 63 sub-catchments for Oaky Creek (total Area 949 km^2).
- 12 sub catchments for Roper Creek downstream of Foxleigh (total area 131 km^2).

Routing in the URBS model was calculated based on the following parameters:

- Sub-catchment routing:
  - Catchment area.
  - Catchment slope.
- Reach Routing:
  - Channel Length.

The sub-catchment layout for Foxleigh URBS model is shown in Figure 3.1.



ENGENY WATER MANAGEMENT

Foxleigh MINE

		Foxleigh Management Pty Ltd
DATE	13/10/2021	Foxleigh Mine Flood Study
DRAWN	AH	URBS Model Set Up
JOB NO.	M80100_001	
		A3 | Figure 3.1 | A

3.3 URBS Model Calibration

The URBS model was calibrated against rainfall and stream flow gauging data within the Roper Creek catchment. The 2013 flood event was adopted for the URBS model calibration as it is the only significant flood event captured by the site gauging network. The calibration process involved the selection of rainfall loss parameters (initial and continuing rainfall losses) and catchment and channel routing parameters (α, β and m) to achieve a reasonable comparison between modelled and recorded flow hydrographs at the stream gauging station locations.

The January 2013 flood event was an intense storm event that occurred from 23 January 2013 to 27 January 2013 with the majority of rainfall occurring on the 24th of January 2013.

3.3.1 Historical Rainfall

Pluviometer and daily rainfall stations in the vicinity of the Roper Creek catchment which were operational during the calibration flood events are listed in Table 3.1. The locations of the rainfall stations are provided in Figure 3.3. Rainfall totals for the calibration event are summarised in Table 3.1.. The time distribution of rainfall recorded at the available pluviometer stations is displayed in Figure 3.2. The spatial variation of rainfall total for the calibration event was estimated from the rainfall gauging data and is displayed in Figure 3.3

The 24-hour rainfall total captured by the Parrot Creek downstream gauging station was 313 mm which corresponds to a 0.2% (1:500) AEP rainfall event based on BoM (Bureau of Meteorology) Intensity Frequency Duration (IFD) rainfall at the gauging station location.

TABLE 3.1: RAINFALL STATIONS USED FOR URBS MODEL CALIBRATION

Station Number	Station Name	Station Type	Agency	Latitude (Degrees)	Longitude (Degrees)	January 2013 Rainfall Total
1304P002	Middlemount Standalone Pluvio	Pluvio	DNRME	-22.816	148.690	324
331306	Parrot Creek Downstream	Pluvio	Foxleigh	-22.921	148.667	310
331360	Foxleigh AWS	Pluvio	Foxleigh	-22.956	148.769	350
34027	Essex	Daily	BoM	-22.774	148.810	368
34059	Warwick Park	Daily	BoM	-22.721	148.663	360
34061	Junee Stn	Daily	BoM	-22.937	149.139	264
35082	Demipique	Daily	BoM	-22.948	148.275	237
35109	Booroondarra	Daily	BoM	-22.818	148.490	267
35131	Talagai	Daily	BoM	-23.133	148.527	224
35195	Maywin Park	Daily	BoM	-23.029	148.469	231
35221	Lucknow	Daily	BoM	-23.304	148.106	112
35295	Bingegang Weir Alert	Daily	BoM	-23.070	149.040	220

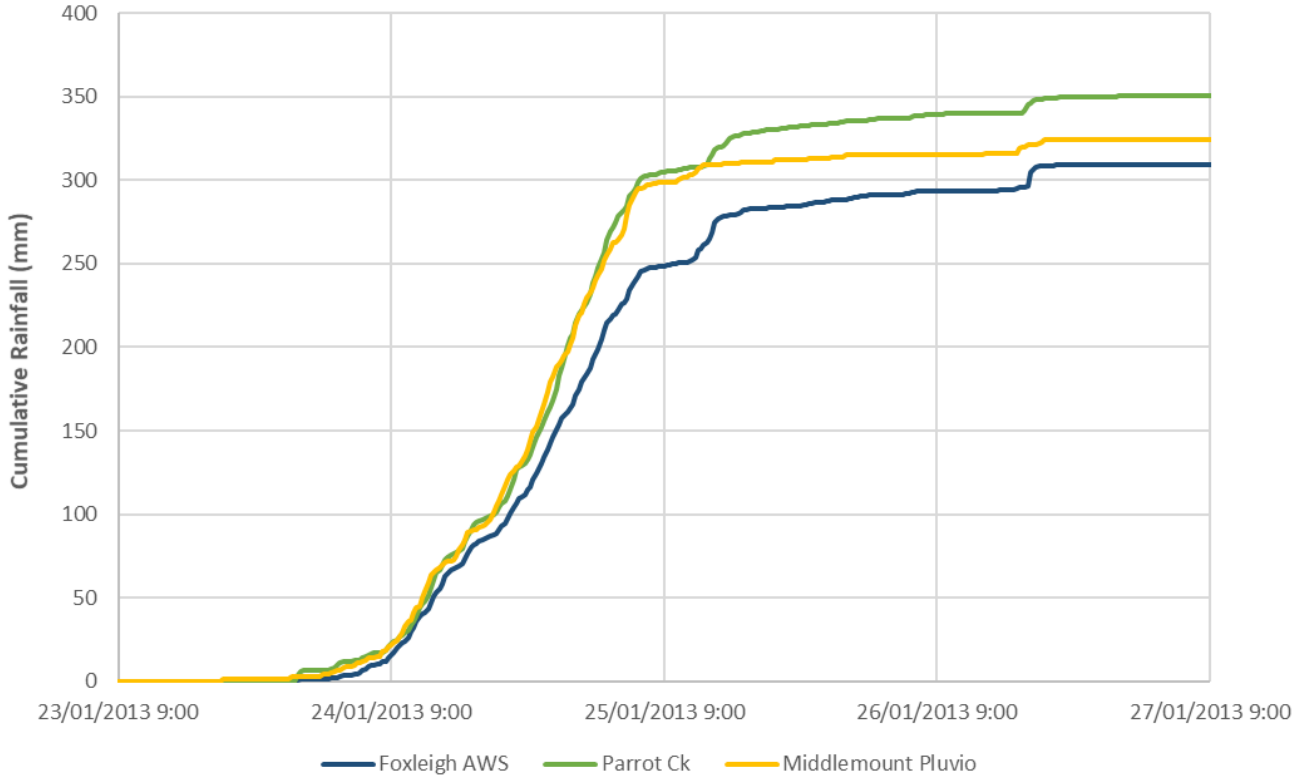


Figure 3.2: Time Distribution of Rainfall – January 2013 Rainfall Event

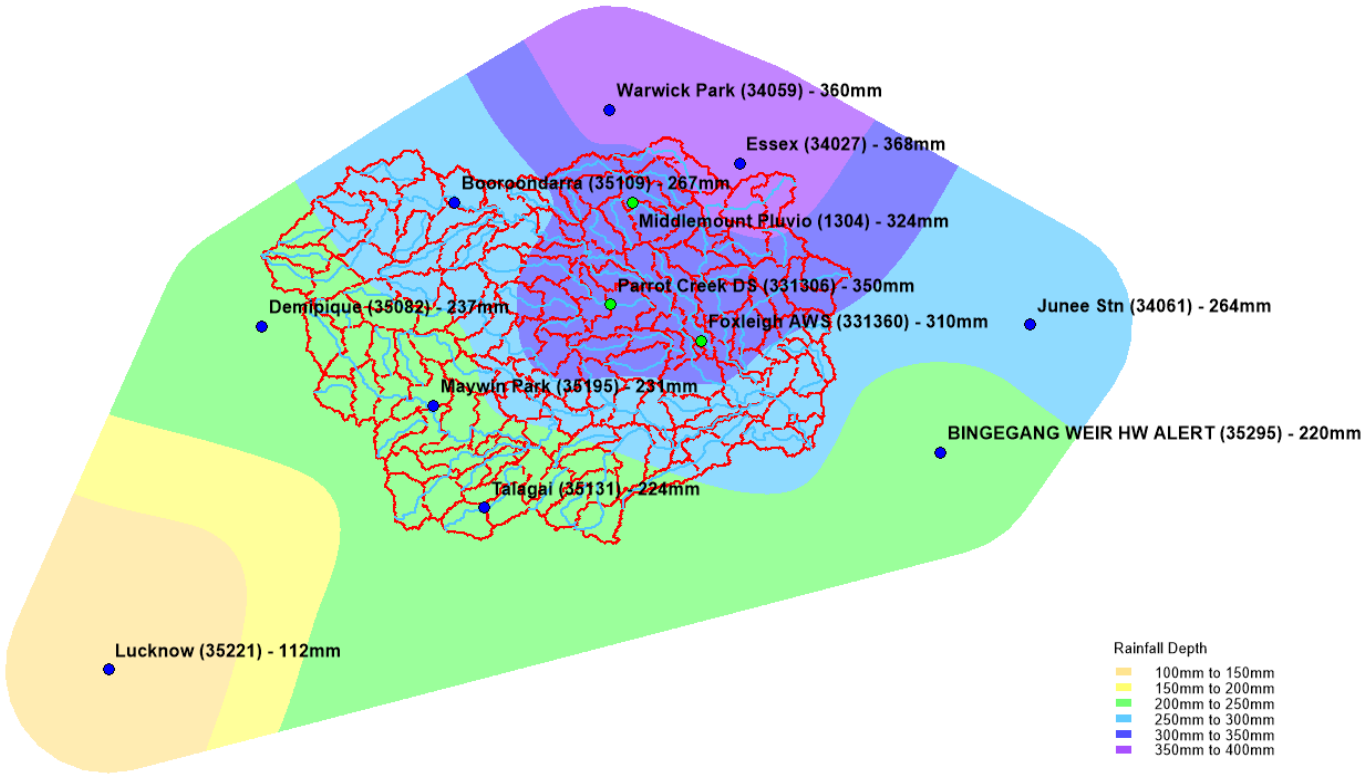


Figure 3.3: January 2013 Flood Event Rainfall Distribution

3.3.2 Stream Gauging Data

Stream flow gauging stations within the Foxleigh catchment which were operational during the calibration event are summarised in Table 3.4. The locations of the stream flow gauging stations are shown in Figure 1.1. All the stream gauging station rating tables do not extrapolate high enough to provide flow estimates for the January 2013 event. The Upstream Roper Creek gauge has the highest rated rating curve, and it was used to calibrate the peak flow rate, while the other gauges were used to calibrate the timing of flow. Stream gauging data captured by the available flow monitoring stations for the January 2013 flood event is shown in Appendix A:.

TABLE 3.2: STREAM FLOW GAUGING STATIONS WITHIN ROPER CREEK CATCHMENT

Station Number	Station Name	Owner	Catchment Area ($km^{2)}$	Cease to Flow Level (m ARL)	Limit of Rating Table (m RL)	Limit of Rating Table (m^3/s)	January 2013 Recorded Peak Flood Level (m RL)
331354	US Roper Creek @ Foxleigh	Foxleigh	395	10	17.1	392	17.50
331358	US Carlo Creek @ Foxleigh	Foxleigh	77	10	11.5	54	12.46
331356	US Cockatoo Creek @ Foxleigh	Foxleigh	230	10	12.7	6	12.28
331355	DS Cockatoo Creek @ Foxleigh	Foxleigh	441	10	14.7	129	16.47
331306	D/S Parrot Creek @ German Ck	Foxleigh	98	10	13.4	29	13.65
331357	Roper Creek Barwon Park @ Foxleigh	Foxleigh	2,126	10	14.2	337	17.76

3.3.3 Calibration Event Simulation

The calibration event was simulated using the URBS model as follows:

- Average event rainfall totals for each sub-catchment were obtained from the gridded rainfall gauging data presented in Figure 3.3.
- The temporal pattern of rainfall was determined for each sub-catchment by assigning the temporal pattern from the nearest pluviometer station (distance from pluviometer station to sub-catchment centroid).

The URBS model was calibrated by varying model parameters to achieve the best possible comparison between the modelled flood hydrographs and recorded flood hydrographs at the stream gauging stations listed in Table 3.1.

The following URBS model parameters were varied for the calibration:

- Initial rainfall loss.
- Continuing rainfall loss.
- Channel lag parameter, α.
- Catchment lag parameter, β.
- Catchment non-linearity parameter, m.

Figure 3.4 shows the modelled and recorded flood hydrographs at the stream gauging station locations. Model parameters determined for the 2013 flood event are provided in Table 3.1. The model calibration shows:

- The model appears to accurately reproduce the shape of the hydrograph with closely matched timings of the rising and falling limbs.
- The modelled peak flow for the upstream Roper Creek gauging station is considered reasonable compared to where the recorded data is unavailable due to the limit of the rating curve.
- A high initial loss was required to achieve the recorded storm volume as well as the timing of the rising limb of the hydrograph.
- The Roper Creek at Barwon Park and Downstream Cockatoo Creek gauging stations have a poor match for the falling limb of the hydrograph. This is due to these stations being affected by flooding from the combined flow of all creeks which has significant floodplain attenuation around the southern end of the model which is not captured in the hydrology model (captured in the hydraulic model).

TABLE 3.3: CALIBRATION MODEL PARAMETERS

Parameter	Value
Initial Loss (mm)	110
Continuing Loss (mm/hr)	5
Channel lag parameter, α	0.2
Catchment lag parameter, β	4
Catchment non-linearity parameter, m.	0.8

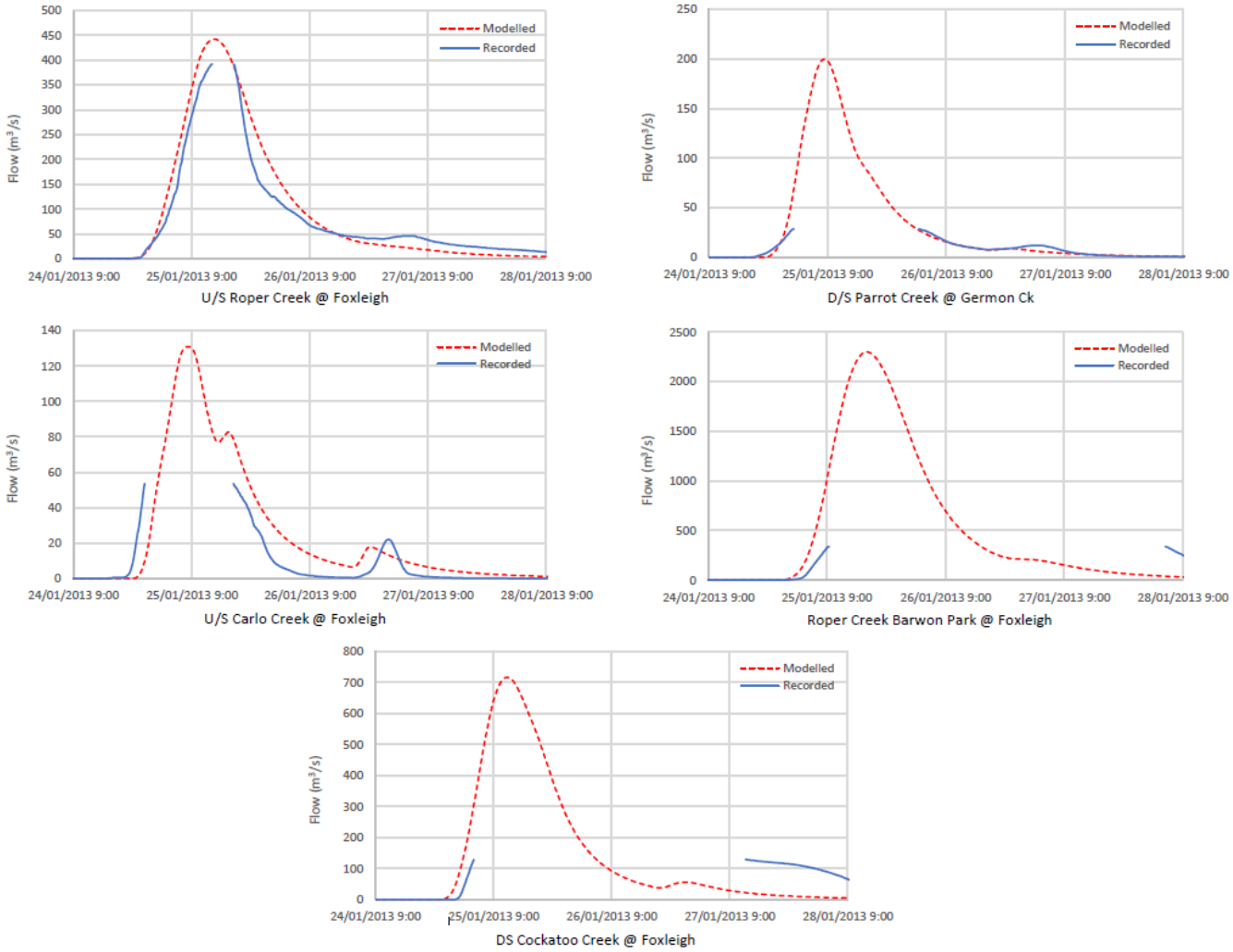


Figure 3.4: Calibration Results

3.3.4 Calibration Sensitivity

A sensitivity of the calibration was undertaken to provide further confidence in the adopted URBS model parameters due to the limited number of events available for calibration. The sensitivity was undertaken by running the URBS model in the BASIC model configuration using regionally validated routing parameters (Weeks equation for Queensland) (Weeks & Steward, 1978). The BASIC model uses a simplified non-linear storage-discharge routing equation with a single routing parameter which can be related to the Kc parameter adopted by RORB. This parameter has equations available to calculate suitable values based on catchment area. The URBS model calibration sensitivity is shown in Figure 3.5 for the U/S Roper Creek gauging station. The sensitivity shows the BASIC modelling approach with regionally derived routing parameters produces similar results to the adopted calibration although has a quicker response to rainfall and a larger peak flow. This provides more confidence in the model calibration accuracy and suitability of the selected parameters.

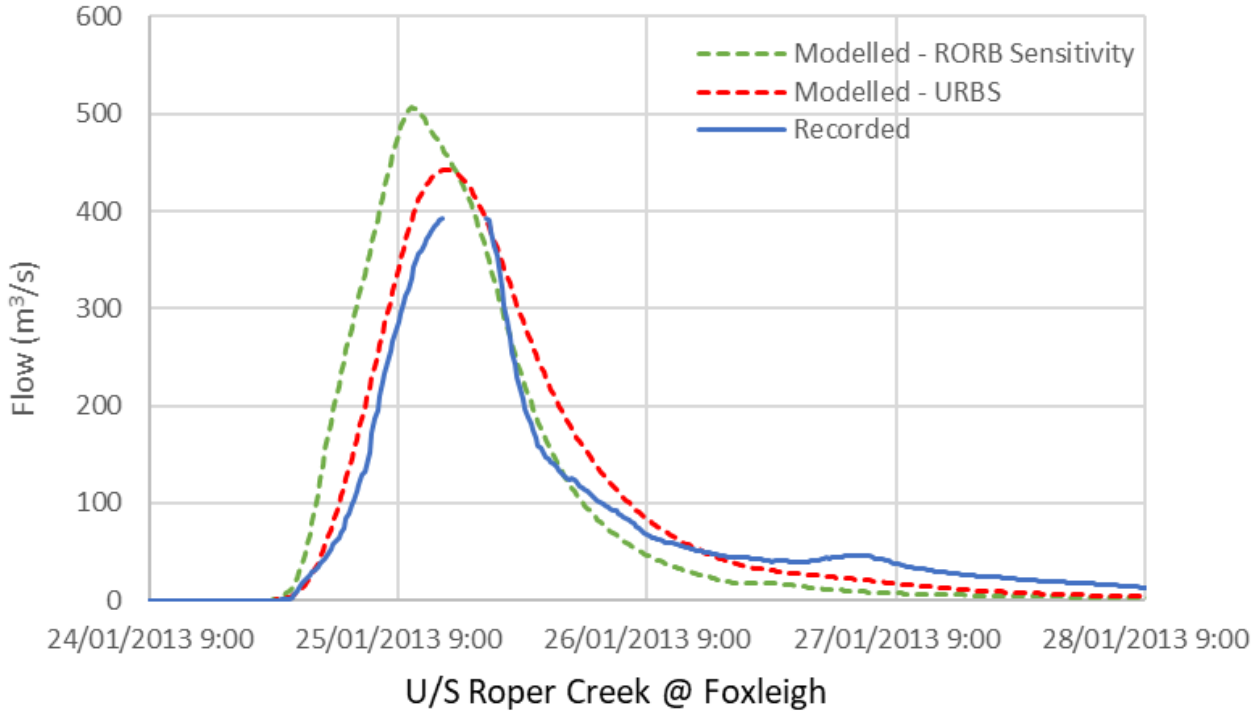


Figure 3.5: Calibration Sensitivity

3.3.5 Calibration Summary

The URBS model calibration accuracy is limited by the accuracy of the streamflow gauging data and the limited number of historical flood events available for calibration. The model however did provide a good fit to the 2013 flood event and the calibrated parameters produced similar results to regionally developed parameters (Weeks equation) with a simplified non-linear storage-discharge hydrology model (RORB). Based on the calibration performance the URBS model is considered suitably calibrated to assess the design flood hydrology for Foxleigh.

3.4 Design Event Simulation

3.4.1 Overview

The calibrated URBS model was used to derive the design flood hydrology for Roper Creek, Cockatoo Creek, Carlo Creek and Oaky Creek to estimate flooding for events ranging from the 50% AEP flood event up to the 0.1% AEP.

3.4.2 Design Rainfall

Design rainfall data for the Foxleigh hydrology was derived for rainfall events between the 50% and 0.1% AEP event. Rainfall totals in the AEP range 50% to 0.1% were generated for all sub-catchment centroids using the BoM IFD tool (www.bom.gov.au/water/designRainfalls/revised-ifd/). Each sub-catchment has been assigned an individual Intensity Frequency Duration (IFD) table.

Aerial Reduction Factors (ARFs) have been used to convert point rainfall estimates to areal rainfall estimates. ARFs for all the creeks have been calculated using the methodology for catchments between 10 km^2 and 30,000 km^2 for the Semi-Arid Inland QLD Zone (Ball, et al., 2019). ARF's are calculated based on the total catchment area (lower rainfall for larger catchments) and therefore depending on the focal point (reporting location of peak flow) the ARF changes. ARF's have been calculated for each of the four (4) creeks independently.

An ensemble of 10 temporal patterns was simulated for each design storm AEP and storm duration as recommended by ARR 19 (Ball, et al., 2019). Temporal patterns for the 50% AEP to 0.1% AEP design storms were adopted from the ensemble temporal patterns for "East Coast North" sourced from ARR Data Hub (http://data.arr-software.org/) were applied. The ensemble result closest to the average of all ensemble results was adopted as the design flood estimate.

3.4.3 Probable Maximum Precipitation

Probable Maximum Precipitation (PMP) rainfall was used to determine the Probable Maximum Flood (PMF) event for the Foxleigh final landform. The PMP estimates were calculated using the Revised Generalised Tropical Storm Method, GTSM-R (BOM, 2003b) for durations 24 hours and longer and the Generalised Short Duration Method (BOM, 2003a) for durations of 6 hours and less. The AEP of the PMP was assigned a value of 1:5,000,000 for Cockatoo Creek and Carlo Creek and 1:2,000,000 for Roper Creek in accordance with ARR (Ball, et al., 2016).

The PMP rainfall depths were simulated using an ensemble of 10 historical event temporal patterns provided with the GTSM-R (BOM, 2003b). The historical temporal pattern that produced the highest peak flow at the site location for each of the waterways was considered the PMF flow event.

3.4.4 Design Rainfall Losses

Design rainfall losses were sourced from the ARR Data Hub (http://data.arr-software.org) for the Roper Creek catchment (includes Cockatoo and Creek Carlo Creek). The median pre-burst rainfall depths sourced from the ARR Data Hub (http://data.arr-software.org) were then subtracted from the initial storm loss to produce the design storm burst loss. The adopted design rainfall losses were then validated to regional point flow estimation techniques and scaled FFA estimates from a nearby catchment.

The PMF was simulated with no initial loss and a continuing loss of 1 mm/hr.

3.4.5 URBS Model Parameters

Table 3.4 provides the URBS model parameters adopted for the design event hydrology. The adopted parameters and design losses have been determined from the model calibration to the January 2013 flood event and the validation of the design flow estimates.

TABLE 3.4: DESIGN HYDROLOGY - URBS MODEL PARAMETERS

Parameter	Value	Justification
Initial Loss (mm)	Design events – 41 PMF - 0	Validation of design flow estimates (Section 3.5)
Continuing Loss (mm/hr)	Design events - 1.3 PMF - 1	Validation of design flow estimates (Section 3.5)
Channel lag parameter, α	0.2	Hydrology model calibration (section 3.3)
Catchment lag parameter, β	4	Hydrology model calibration (section 3.3)
Catchment non-linearity parameter, m.	0.8	Hydrology model calibration (section 3.3)

3.4.6 Design Event Simulation

Design event simulations were undertaken using the calibrated URBS model for AEPs ranging from 50% to the 0.1% AEP event, and for a large range of design storm durations. The design hydrology results are provided in Table 3.5 and the location of the reported flows is shown in Figure 3.1

The critical duration is the storm duration which produced the highest average peak flow for the catchment. The reported peak flow and ensemble number in the table represents result for the next highest peak flow from the average of all ensembles for the critical duration.

TABLE 3.5: DESIGN HYDROLOGY RESULTS

AEP (%)	Roper Creek at Foxleigh			Cockatoo Creek			Carlo Creek			Downstream Roper Creek (D/S of Mine)		
	Peak Flow (m^3/s)	Critical Duration (h)	Ensemble Number	Peak Flow (m^3/s)	Critical Duration (h)	Ensemble Number	Peak Flow (m^3/s)	Critical Duration (h)	Ensemble Number	Peak Flow (m^3/s)	Critical Duration (h)	Ensemble Number
50	166	24	9	90	24	4	60	24	5	452	24	10
20	400	24	9	201	18	9	129	24	1	1,123	24	10
10	568	24	3	286	18	4	186	24	1	1,611	24	3
5	748	24	3	379	18	4	233	24	4	2,145	24	3
2	1,064	24	3	535	18	6	330	18	4	3,115	24	8
1	1,316	24	3	658	18	5	408	18	2	3,799	24	3
0.1	2,326	24	5	1,172	18	5	719	18	6	6,742	24	3
PMF	8,598	36	4	4,205	36	4	2,412	36	4	28,463	36	4

3.5 Design Event Hydrology Validation

The 10% and 1% AEP peak flows estimated from the hydrology model were validated using the following methods:

- Regional Flood Frequency Estimation Model (RFFE).
- Quantile Regression Technique (QRT).
- Scaled Flood Frequency Analysis (FFA).

The RFFE is a recommended peak flow validation method from the ARR19 guidelines (Ball, et al., 2019). The RFFE provides peak flow estimations based on the catchment area and a catchment shaping factor, determined using the catchment centroid and outlet coordinates. The RFFE peak flow estimates were calculated using the AR&R RFFE Model online tool (http://rffe.arr-software.org/).

Validation was also undertaken using the Department of Main Roads Quantile Regression Technique (QRT) (Palmen & Weeks, 2008) which is a method for peak flow estimation for rural catchments up to 1,000 km^2 in area. Like the RFFE, the QRT provides a peak flow estimate using a rainfall intensity and the total catchment area.

The FFA provides peak flow estimates for different AEPs by developing a fitted distribution from recorded peak flows from historical flood events. There are currently no long-term stream flow gauging stations on any of the waterways in this study. The Department of Regional Development, Manufacturing and Water (DRDMW) operates a stream flow gauging station on Crinum Creek at Lilyvale. Although there are several additional flow gauging stations located on the Mackenzie River further downstream of the site (Roper Creek at Barwon Park - 2126 km^2), Crinum Creek was adopted as the most suitable for use due the length of data record available and similar catchment area to the waterways at Foxleigh (Crinum Creek - 252 km^2).

A flood frequency analysis was undertaken on the Crinum Creek gauge (130407A) with the results summarised in Figure 3.6. The Log Pearson Type 3 (LPIII) distribution was fitted to the annual peak flows recorded at the gauging station as per Book 4 of ARR19.

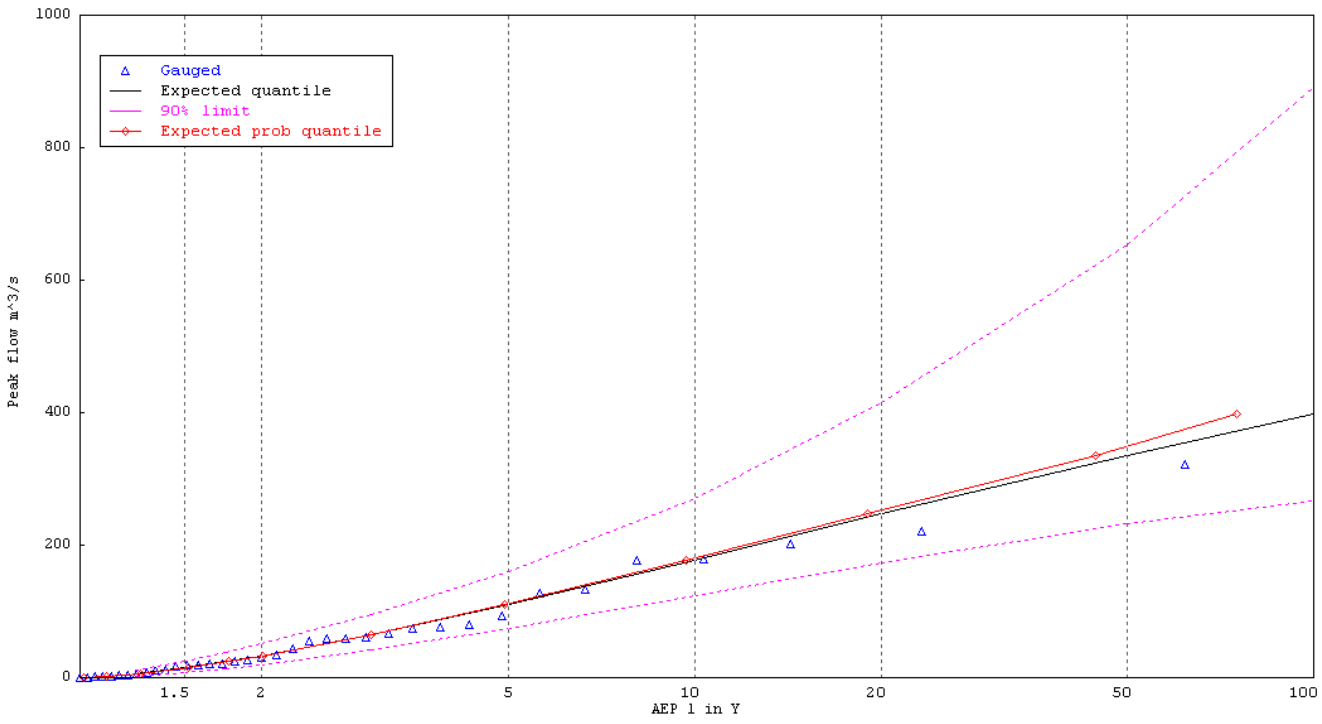


Figure 3.6: Crinum Creek at Lilyvale LPIII Annual Series Flood Frequency Plot

The Crinum Creek Flood Frequency Analysis has been used to validate the Foxleigh hydrology models by scaling of the flood frequency peak flow estimates using the following equation:

$$Q_u = \left(\frac{A_u}{A_g}\right)^n Q_g$$

Where Q_u is the estimated peak flow for the ungauged catchment, A_u is the area for the ungauged catchment, A_g is the catchment area for the stream gauging station and Q_g is the peak flow for the gauging station determined from the flood frequency analysis. The exponent n has been determined from the regional flood frequency regression analysis undertaken by the Queensland Department of Transport and Main Roads (Palmen & Weeks, 2008).

The peak flow validation is summarised in Table 3.6. The peak flows calculated from the URBS hydrology model for each of the waterways generally lay in the middle of the estimates from the three validation methods. Therefore, the runoff hydrographs calculated from the hydrology model were considered suitable for assessing flood risk for Foxleigh.

TABLE 3.6: DESIGN HYDROLOGY VALIDATION SUMMARY

Catchment	Area (km²)	AEP (%)	Peak Flow Estimate (m³/s)			
			URBS	RFFE	QRT	Scaled Crinum Creek FFA
Carlo Creek	132	10	186	149	202	114
		1	424	358	568	262
Roper Creek at Foxleigh	663	10	575	525	608	343
		1	1,313	1,040	1,607	742
Cockatoo Creek at Foxleigh	249	10	286	256	312	176
		1	658	587	855	395
Downstream Roper Creek (D/S of mine)	2159	10	1,612	1,550	1,362	768
		1	3,799	3,050	3,439	1,589

4. HYDRAULICS

4.1 Modelling Software

This study has used the two-dimensional modelling software TUFLOW to quantify the flood behaviour and characteristics of each of the creek systems. Two dimensional models are best suited to scenarios where flow direction and water surface are not uniform across a section (i.e., floodplain and overbank areas).

4.2 Model Development

4.2.1 Model Topography and Extent

The DEM detailed in Section 2.2 was utilised for the hydraulic model topography.

The final landform was developed by overlaying a digital elevation surface of the post mining landform on the pre-mining topography. Figure 4.1 and Figure 4.2 show the model topography and extent for the pre-mining and post landform scenarios.

4.2.2 Boundary Conditions

Boundary conditions are required in the model to define hydrology inflows, flow leaving the model domain and interfaces between the one dimensional and two-dimensional model domains. The following boundary conditions were used in the models:

- Upstream: The upstream boundary condition used a combination of 'SA' and 'BC' type boundaries, allocating flow to the defined model grid cells based on the design hydrograph from the hydrologic model (flow per unit of time) input. Total inflow hydrographs were applied for the following creeks:
  - Roper Creek.
  - Carlo Creek.
  - Cockatoo Creek.
  - Parrot Creek.
  - Oaky Creek.
- Downstream: The outflow boundary conditions of all models have been represented as a normal depth based on low flow channel grades at the downstream extent of the models. These boundaries are located a sufficient distance downstream in all models to not influence the flood behaviour onsite.
- Dimensional boundaries: Interfaces between the one-dimensional (culverts) and two-dimensional (drains) elements used a 'SX' boundary.

4.2.3 Hydraulic Roughness

The Manning's roughness coefficients used in the model are based on visual observation of aerial photography of the site. Roughness values have been tabulated in Table 4.1.

TABLE 4.1:TUFLOW HYDRAULIC ROUGHNESS VALUES

Land Use Category	Manning's "n"
Waterbody	0.035
Mine Roads	0.03
Mine Area	0.05
Low Density Vegetation – Sparse Shrubs / Trees	0.04
Medium Density Vegetation	0.055
High Density Vegetation	0.08
Diversions / Watercourses Without Veg	0.035
Watercourse - Vegetated	0.065

4.3 Model Simulation

The flood model includes multiple creeks with varying catchment sizes, therefore multiple flood scenarios were simulated to ensure the maximum flooding conditions were captured across the mine site. The model was simulated with three varying model focal points where hydrological inputs were changed (ARFs and temporal patterns) based on the focal catchment area. The following scenarios were simulated:

- Upstream creek flooding – flooding based on flows in Roper Creek (upstream), Cockatoo Creek and Carlo Creek.
- Downstream Roper Creek flooding 1 – flooding dominated by Roper Creek downstream of the confluence with Carlo Creek and upstream of Oaky Creek.
- Downstream Roper Creek flooding 2 – flooding dominated by Roper Creek located downstream of the confluence with Oaky Creek.

The flood results from the three scenarios were processed to produce a max-max flood grid across the site which represents the maximum flood level result for the corresponding AEP.

Cockatoo Creek

Carlon Creek

Roper Creek

Oaky Creek

Roper Creek

Legend

- Watercourse
- Model Extent
- Model Outflow Boundary
- Model Inflow Boundary
- Model Inflow

Topography (m AHD)

- 110.00
- 124.00
- 138.00
- 152.00
- 166.00
- 180.00

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Foxleigh MINE

0 1,000 2,000 3,000 m

Scale in metres (1:72,000 @ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Australia Geodetic Datum
Vertical Datum: Australia Geodetic Datum
Grid: Australian Map Grid, Zone 55

Foxleigh Management Pty Ltd

Foxleigh Pre-mine Floodplain Modelling

Figure 4.1 - Pre-mining Scenario Model Configuration

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Checked: AB
Date: 3/7/2023

Foxleigh Plains Pit

Eagles Nest Pit

Pipeline

One Tree Pit

Carlo Pit

WC Pit

Far South

Legend

- Flood Protection Landform
- Model Extent
- Model Outflow Boundary
- Model Inflow Boundary
- Model Inflow

Topography (m AHD)

180

110

0 1,000 2,000 3,000 m

Scale in metres (1:72,000 @ A3)

Map Projection: Tranverse Mercator
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Figure 4.2 - Post-mining Scenario Model Configuration

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5. FLOOD ASSESSMENT RESULTS

5.1 Overview

The flood model was simulated for the following:

- Pre-mining scenario – Simulated for the 0.1% AEP flood event to determine the floodplain extent for waterways with a stream order 4 or greater; and
- Final Landform – Simulated for the 1% AEP and 0.1% AEP flood events and the PMF to assess flood risks and long-term stability of the Foxleigh PRCP final landform.

5.2 Pre-Mining Flood Assessment

A requirement of the guideline for PRCP state that voids must not be situated wholly or partly in a floodplain unless the void will be rehabilitated to a stable condition. The guideline defines the floodplain as the 0.1% AEP magnitude flood extent.

The results of the pre-mining Foxleigh TUFLOW flood depth (with water surface level contours) for the 0.1% AEP event are illustrated in Figure 5.1. Figure 5.2 demonstrates further post processing of these results to classify the floodplain extents with areas with a stream order of 3 or less and areas with a stream order of 4 or greater. A summary of voids situated wholly or partly in the floodplain have been summarised in Table 5.1 below:

TABLE 5.1: SUMMARY OF FINAL VOIDS IN THE FLOODPLAIN

Final Void	Located wholly or partly within the floodplain (YES/NO)
Foxleigh Plains Pit	NO
Eagles Nest Pit	YES
One Tree Pit	YES
Pipeline	YES
WC Pit	YES
Carlo Pit	YES
Far South	YES

Cockatoo Creek
Carlon Creek
Roper Creek
Oaky Creek
Roper Creek

Legend

- Model Extent
- Model Outflow Boundary
- 2m Contours

Flood Depth (m)

- <= 0.05
- 0.05 - 1.00
- 1.00 - 2.00
- 2.00 - 3.00
- > 3.00

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0 1,000 2,000 3,000 m

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Foxleigh Pre-mine Floodplain Modelling

Figure 5.1 - Pre-mining Scenario - 0.01% Flood Depth

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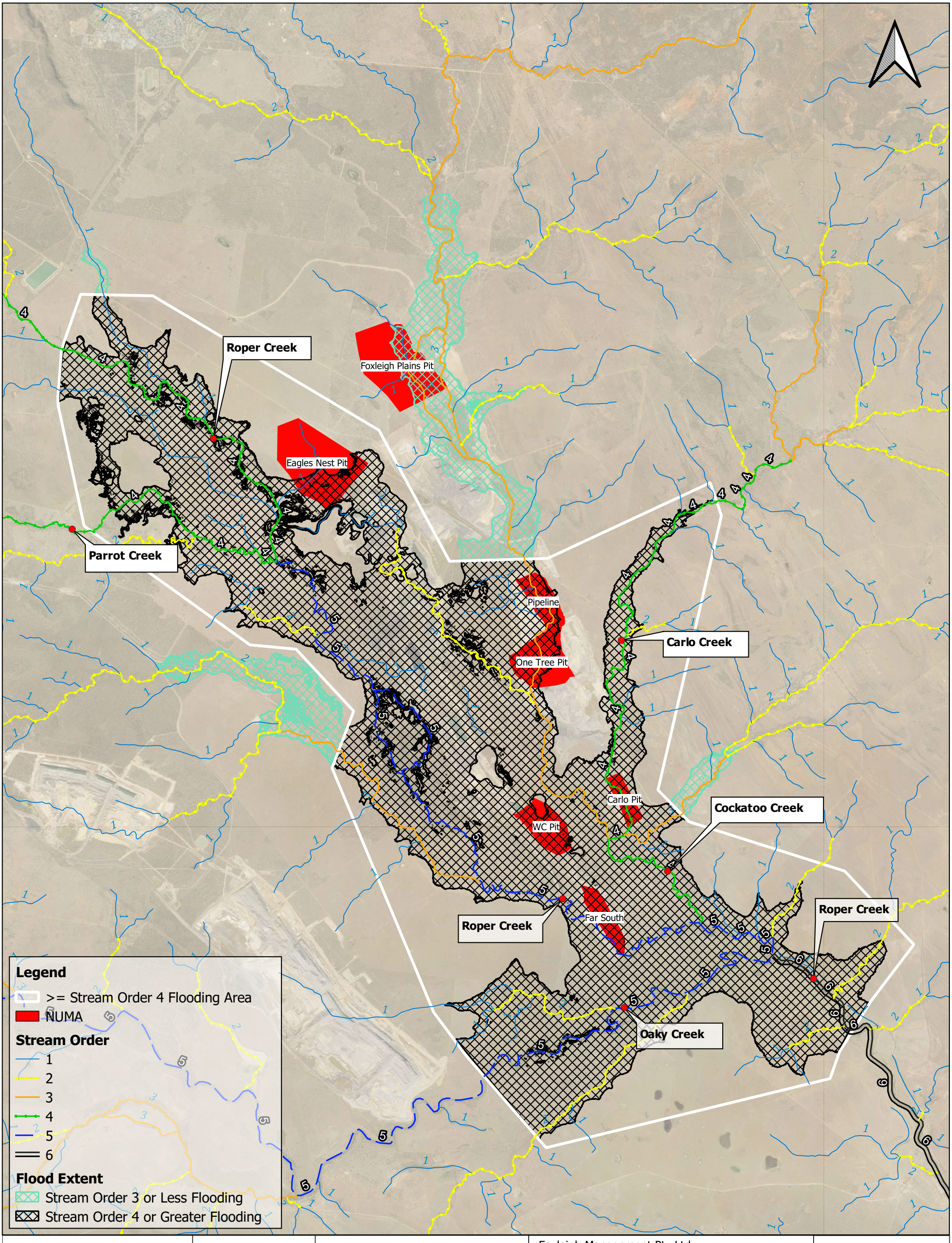

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Figure 5.2 - 0.1% AEP Flood Extent and Stream Order

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5.3 Final Landform Flood Assessment

5.3.1 Landform Flood Interactions

The flood modelling results have been used to identify locations where the 1%, 0.1% AEP and PMF flood events interact with the landform design. Flood depth results have been presented in Figure 5.3 to Figure 5.5. Fox flooding assessment peak velocity results for the 0.1% AEP flood event and the PMF to assess the risk of landform erosion are presented in Appendix B:

Key locations of interest include areas with notable ponding against the final rehabilitated Pipeline pit and WC pit spoil dump and where high velocities are predicted to occur.

5.3.2 Diversions

Permanent watercourse diversions to be retained as part of the final landform are the Cockatoo Creek Stage 1, 2, 4, and 5, Carlo Creek and Roper Creek as shown in Figure 1.3. The detailed design report for the Cockatoo Creek Diversion (Stage 1) (Alluvium, 2019) states that the diversion and associated levee, was proposed to maintain flows and prevent flood ingress into One Tree Pit for the 0.1% AEP event plus 1m freeboard. This is in accordance with the flood mapping results shown in Figure 5.4. The flooding results also indicate PMF flood protection to the One Tree Pit final void shown in Figure 5.5.

These diversions have been designed and constructed in accordance with the following guidelines:

- Department of Natural Resources, Mines and Energy (DNRME) Guideline “Works that interfere with water in a watercourse for a resource activity – watercourse diversions authorised under the Water Act 2000” (DNRME, 2019); and
- ACARP (Australian Coal Association Research Program) – Criteria for functioning river landscape units in mining and post mining (C20017) (ACARP, 2014)

As the Cockatoo, Carlo and Roper Creek diversion are proposed to be permanent structure retained after mine closure, further assessment of these diversions against the ACARP stability criteria is proposed to be undertaken as mining operations progress, prior to endo of operations in the relevant voids.

Foxleigh Plains Pit
Eagles Nest Pit
Pipeline
One Tree Pit
Carlo Pit
WC Pit
Far South

Legend

- Model Extent
- Model Outflow Boundary
- NUMA
- Flood Protection Landform
- 2m Contours

Flood Depth (m)

- <= 0.05
- 0.05 - 1.00
- 1.00 - 2.00
- 2.00 - 3.00
- > 3.00

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Foxleigh Post-mine Floodplain Modelling

Figure 5.3 - Post-mining Scenario -1% AEP Flood Depth

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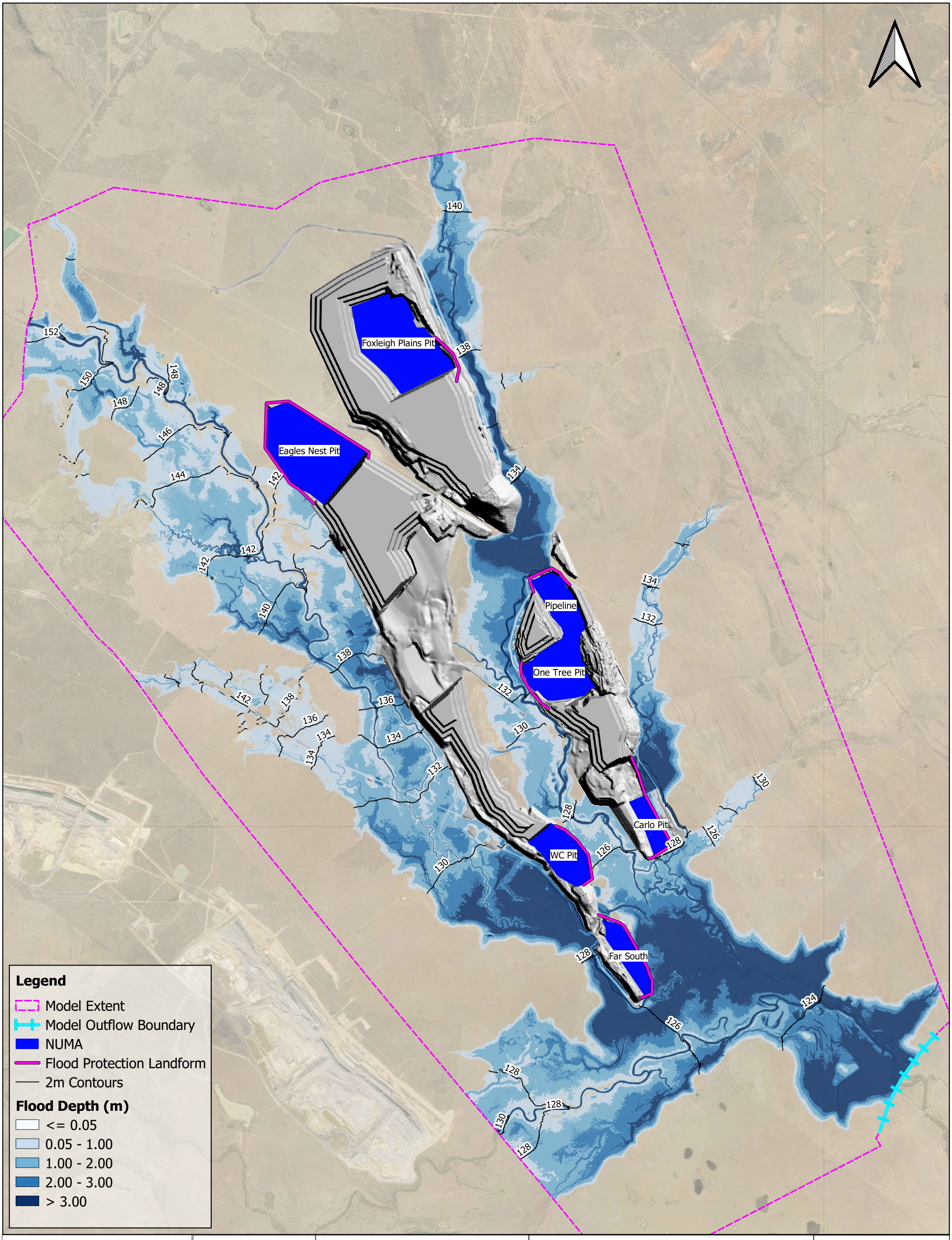

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Figure 5.4 - Post-mining Scenario - 0.1% AEP Flood Depth

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Foxleigh Plains Pit
Eagles Nest Pit
Pipeline
One Tree Pit
WC Pit
Far South

Legend

- Model Extent
- Model Outflow Boundary
- NUMA
- Flood Protection Landform
- 2m Contours

Flood Depth (m)

- <= 0.05
- 0.05 - 1.00
- 1.00 - 2.00
- 2.00 - 3.00
- > 3.00

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0 1,000 2,000 3,000 m

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Foxleigh Post-mine Floodplain Modelling

Figure 5.5 - Post-mining Scenario - PMF Flood Depth

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6. CONCLUSION

Components of the final landforms with potential flooding interactions have been reviewed against the Foxleigh flooding assessment peak velocity results for the 0.1% AEP flood event and the PMF to assess the risk of landform erosion under very rare and extreme flooding. The assessment of landform erosion risk from regional flooding can be summarised as:

- Seven NUMAs are located in a floodplain storage area of Roper and Cockatoo Creek.
- Flooding against the rehabilitated final landform on the western side of the Far South void is expected to have moderate flow velocities up to 4.5 m/s in the PMF only, indicating a low risk of erosion to the rehabilitated landforms.
- No flood ingress into all residual pits is expected for all events up to and including the PMF.
- Isolated locations within Carlo Creek Diversion channel are expected to have 0.1% AEP and PMF flow velocities up to 3.5 and 5 m/s, respectively, with the potential to cause localised erosion with poor vegetation establishment.
- The overall risk of erosion from flooding is low considering the very low likelihood of a PMF event and long-term well-established vegetation will provide suitable erosion protection.
- Flood protection landforms have been proposed to prevent flood ingress to the NUMAs (see Figure 1.3). Table 6.1 below provides a summary of the water level range along the length of the proposed flood protection landforms for the 1%, 0.1% and PMF flood events.

TABLE 6.1: FLOOD PROTECTION LANDFORM WATER SURFACE LEVELS

NUMA	Water Surface Level (m AHD)		
	1% AEP	0.1% AEP	PMF
Foxleigh Plains Pit	-	-	140.26 - 140.96
Eagles Nest Pit	141.54 - 141.95	141.60 - 142.05	142.53 - 142.9
One Tree Pit	-	132.27 - 133.03	132.31 - 134.45
Pipeline	132.96 - 133.06	133.56 - 133.69	135.32 - 135.60
WC Pit	125.48 - 127.32	125.85 - 127.73	129.67 - 129.99
Carlo Pit	124.94 - 128.06	125.49 - 130.42	129.64 - 133.07
Far South	124.33 - 124.92	125.37 - 125.91	129.53 - 129.88

7. QUALIFICATIONS

(a) In preparing this document, including all relevant calculations, and modelling, Engeny Australia Pty Ltd (Engeny) has exercised the degree of skill, care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering principles.

(b) Engeny has used reasonable endeavours to inform itself of the parameters and requirements of the project and has taken reasonable steps to ensure that the works and document is as accurate and comprehensive as possible given the information upon which it has been based including information that may have been provided or obtained by any third party or external sources which has not been independently verified.

(c) Engeny reserves the right to review and amend any aspect of the works performed including any opinions and recommendations from the works included or referred to in the works if:

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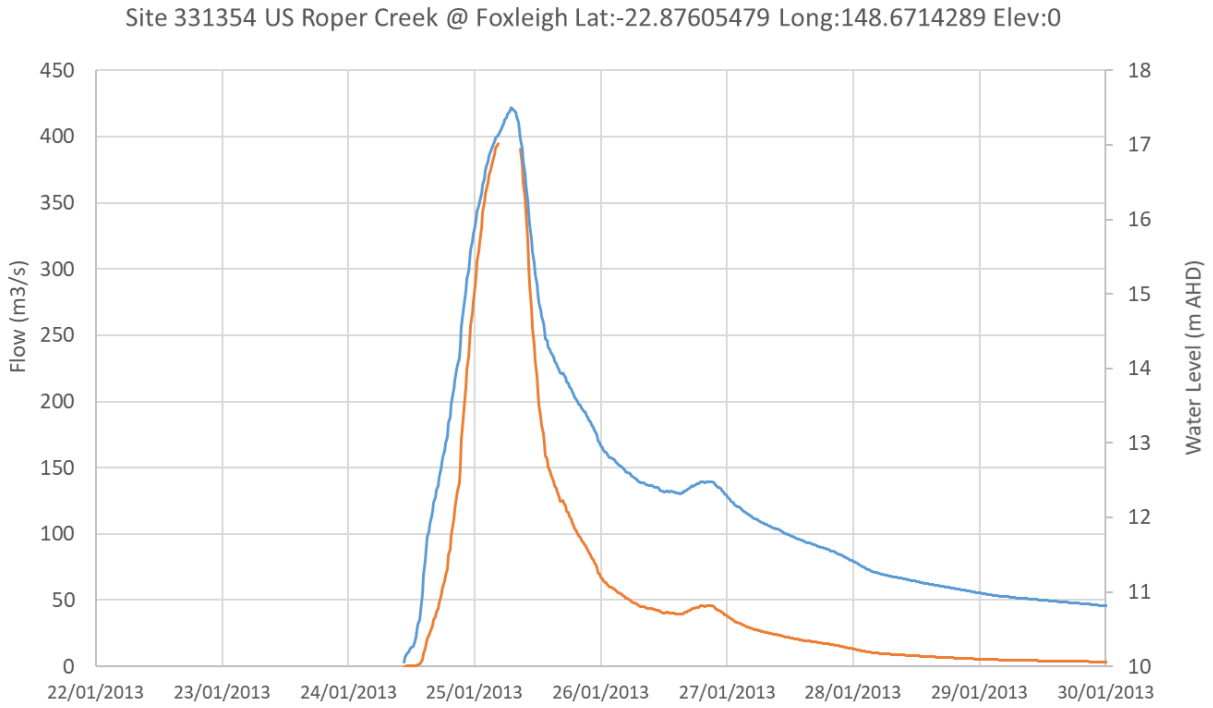
APPENDIX A: FLOW MONITORING DATA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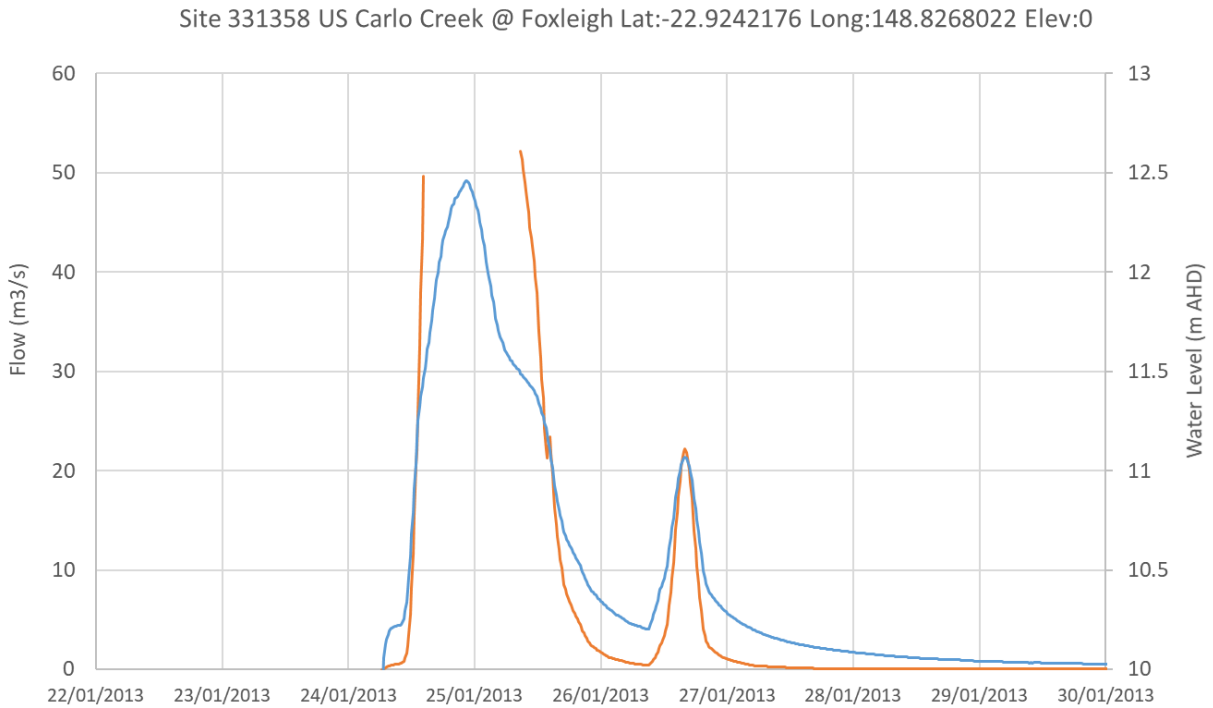
Flow (m3/s)
Water Level (m AHD)
450
400
350
300
250
200
150
100
50
0
18
17
16
15
14
13
12
11
10
22/01/2013
23/01/2013
24/01/2013
25/01/2013
26/01/2013
27/01/2013
28/01/2013
29/01/2013
30/01/2013


Site 331358 US Carlo Creek @ Foxleigh Lat:-22.9242176 Long:148.8268022 Elev:0
Flow (m3/s)
Water Level (m AHD)
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50
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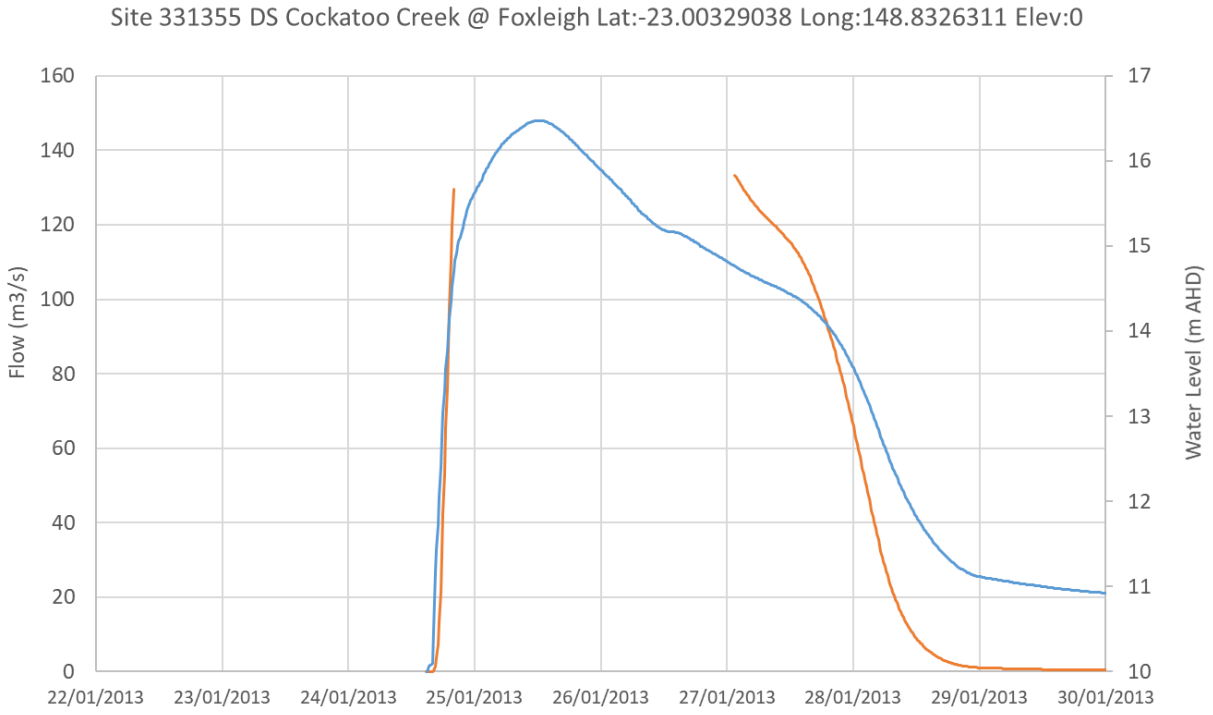
30
20
10
0
13
12.5
12
11.5
11
10.5
10
22/01/2013
23/01/2013
24/01/2013
25/01/2013
26/01/2013
27/01/2013
28/01/2013
29/01/2013
30/01/2013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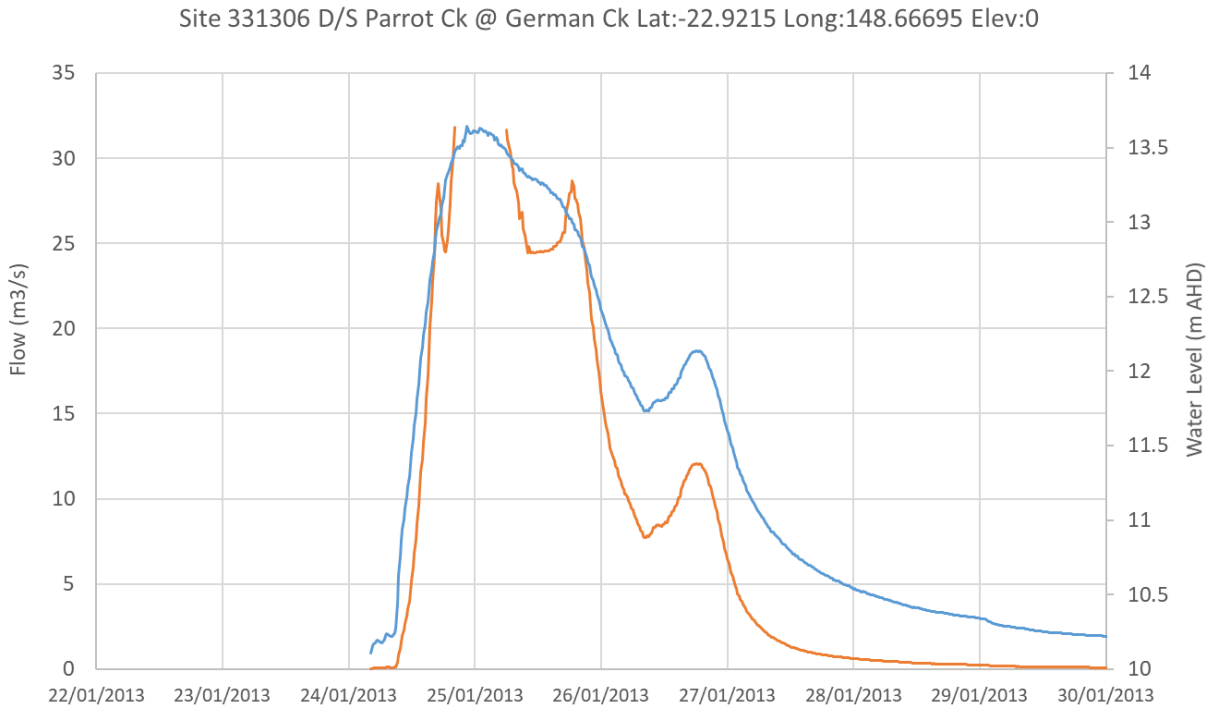
100
80
60
40
20
0
17
16
15
14
13
12
11
10
22/01/2013
23/01/2013
24/01/2013
25/01/2013
26/01/2013
27/01/2013
28/01/2013
29/01/2013
30/01/2013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Flow (m3/s)
Water Level (m AHD)
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30
25
20
15
10
5
0
14
13.5
13
12.5
12
11.5
11
10.5
10
22/01/2013
23/01/2013
24/01/2013
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26/01/2013
27/01/2013
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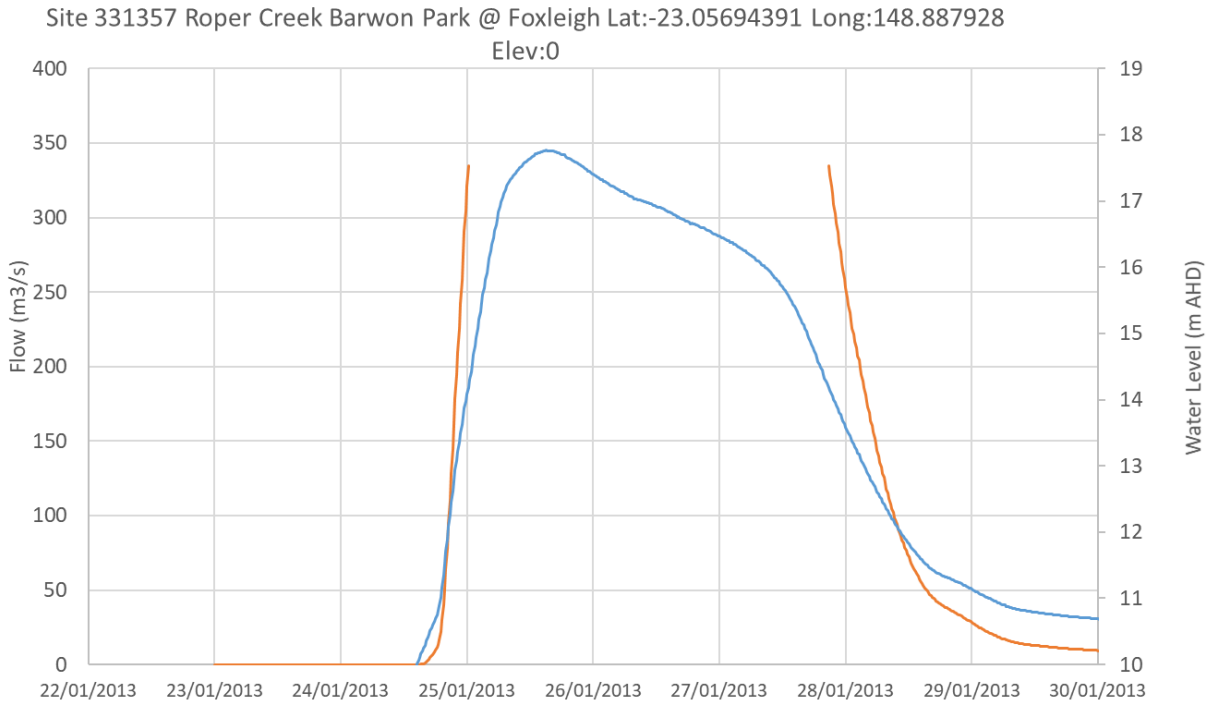
30/01/2013


Site 331357 Roper Creek Barwon Park @ Foxleigh Lat:-23.05694391 Long:148.887928
Elev:0
Flow (m3/s)
Water Level (m AHD)
400
350
300
250
200
150
100
50
0
19
18
17
16
15
14
13
12
11
10
22/01/2013
23/01/2013
24/01/2013
25/01/2013
26/01/2013
27/01/2013
28/01/2013
29/01/2013
30/01/2013

APPENDIX B: FLOOD VELOCITY MAPPING

Foxleigh Plains Pit
Eagles Nest Pit
Pipeline
One Tree Pit
Carlo Pit
WC Pit
Far South

Legend

- Model Extent
- Model Outflow Boundary
- NUMA
- Flood Protection Landform
- 2m Contours

Flood Velocity (m/s)

- <= 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- 3.00 - 4.00
- 4.00 - 5.00
- 5.00 - 6.00
- > 6.00

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Foxleigh MINE

0 1,000 2,000 3,000 m

Scale in metres (1:72,000 @ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Australia Geodetic Datum
Vertical Datum: Australia Geodetic Datum
Grid: Australian Map Grid, Zone 55

Foxleigh Management Pty Ltd

Foxleigh Post-mine Floodplain Modelling

Post-mining Scenario 1% AEP Flood Velocity

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Job Number: QC1025_003
Revision: 2
Drawn: TS
Checked: AB
Date: 28/8/2023

Foxleigh Plains Pit
Eagles Nest Pit
Pipeline
One Tree Pit
Carlo Pit
WC Pit
Far South

Legend

- Model Extent
- Model Outflow Boundary
- NUMA
- Flood Protection Landform
- 2m Contours

Flood Velocity (m/s)

- <= 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- 3.00 - 4.00
- 4.00 - 5.00
- 5.00 - 6.00
- > 6.00

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ENGENY

Foxleigh MINE

0 1,000 2,000 3,000 m

Scale in metres (1:72,000 @ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Australia Geodetic Datum
Vertical Datum: Australia Geodetic Datum
Grid: Australian Map Grid, Zone 55

Foxleigh Management Pty Ltd

Foxleigh Post-mine Floodplain Modelling

Post-mining Scenario - 0.1% AEP Flood Velocity

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Job Number: QC1025_003
Revision: 2
Drawn: TS
Checked: AB
Date: 28/8/2023

Foxleigh Plains Pit

Eagles Nest Pit

Pipeline

One Tree Pit

Carlo Pit

WC Pit

Far South

Legend

- Model Extent
- Model Outflow Boundary
- NUMA
- Flood Protection Landform
- 2m Contours

Flood Velocity (m/s)

- <= 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- 3.00 - 4.00
- 4.00 - 5.00
- 5.00 - 6.00
- > 6.00

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ENGENY

Foxleigh MINE

0 1,000 2,000 3,000 m

Scale in metres (1:72,000 @ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Australia Geodetic Datum
Vertical Datum: Australia Geodetic Datum
Grid: Australian Map Grid, Zone 55

Foxleigh Management Pty Ltd

Foxleigh Post-mine Floodplain Modelling

Post-mining Scenario - PMF Flood Velocity

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Job Number: QC1025_003
Revision: 2
Drawn: TS
Checked: AB
Date: 28/8/2023

Appendix I: PRCP GW Modelling Report

Report on Groundwater Modelling of Foxleigh Coal Mine

for

Foxleigh Management Pty Ltd

Report reference GWF21/01

November 2022

DOCUMENT INFORMATION

GWF Project Reference: GWF21/01

Document Title: Report on Groundwater Modelling of Foxleigh Coal Mine

File name: GWF21_01 PRCP GW Modelling Report v0.docx

Document Version Control

Version	Description	Prepared by	Reviewed by	Issue date
A	Initial draft of HCM	TN	PH	7-Aug-22
B	Draft for numerical modelling	TN	TN	14-Oct-22
0	Issued for client review	TN	WH	4-Nov-22

Groundwater Functions Pty Ltd (ABN 80 651 302 484) ("GWF") has prepared this report for the exclusive use of its client and for the specific purpose or purposes outlined in the commencement of this report. The report cannot be relied upon by any other party or for any other purpose without the prior written consent of GWF which may be withheld in GWF's sole discretion. The report is intended only for the client and its professional advisors and must not be copied or otherwise published or distributed, in whole or in part, to any other person or through any form of media unless permitted in writing by GWF. GWF does not accept any responsibility or liability in any way whatsoever for the use of or reliance upon the report by third parties or for any purpose other than the intended purpose.

In preparing this report, GWF has endeavoured to comply with all generally accepted professional practices common to the international consulting profession, and with regard to the scope of work agreed with the client. Where information or data has been provided by the client, GWF has not independently verified such information or data and has relied on the accuracy of this information or data.

Geological and hydrometric data vary spatially and measurements made at discrete locations represent samples of a wider distribution of data and may depend on the method and scale of measurement. Hydrometric data vary with time and measurements made at discrete moments in time may exhibit influences of physical properties and temporal processes which may not be apparent at the time of measurement or subsequent times but which may influence interpretation of these data.

Document Distribution Record

Version	Date	Distribution
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B	14/10/22	Michael Rosengren, QMetco; MvT, Foxleigh
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Citation

Groundwater Functions Pty. Ltd., 2022. Report on Groundwater Modelling of Foxleigh Coal Mine for Foxleigh Management Pty. Ltd.

Table of Acronyms & Abbreviations

AHD	Australian Height Datum
CHPP	Coal Handling & Preparation Plant
DAWE	Australian Federal Department of Agriculture, Water and the Environment
DCCEEW	Australian Federal Department of Climate Change, Energy, the Environment and Water
DEWS	(former) Queensland Government Department of Energy & Water Supply
DNRM	(former) Queensland Government Department of Natural Resources & Mining
EA	Environmental Authority
EIS	Environmental Impact Statement
EPBC	Environmental Protection & Biodiversity Conservation
GMMP	Groundwater Monitoring & Management Plan
GMP	Groundwater Monitoring Program
GWF	Groundwater Functions Pty Ltd
km	Kilometre
mbgl	Metres below ground level
MAW	Mine affected water
ML	Mining Lease
MLA	Mineral Lease Area
PRCP	Progressive Rehabilitation & Closure Plan
RCM	Rangal Coal Measures
VWP	Vibrating Wire Piezometer

EXECUTIVE SUMMARY

Foxleigh Mine (Foxleigh) is operated by Foxleigh Management Pty Ltd (FoxMan), on behalf of a joint venture between Nippon Steel Australia Pty Ltd, POSCO Australia Pty Ltd and Foxleigh Coal Pty Ltd to extract metallurgical coal.

The QLD Government's Mined Land Rehabilitation Policy (QLD Govt, 2019) states that land disturbed by mining activities will be rehabilitated progressively. To implement the QLD Govt Mined Land Rehabilitation Policy, all mines with a site-specific environmental authority (EA) granted prior to 1 November 2019 are required to submit a Progressive Rehabilitation and Closure Plan (PRCP). The requirements of a PRCP are set out under the Environment Protection Act 1994 (EP Act) (QLD Govt, 1994) and described in the Progressive Rehabilitation and Closure Plans Guideline (QLD Govt, 2021). Section 3.6.1 of the PRCP Guideline identifies the hydrogeological requirements for general rehabilitation practices whilst Section 3.6.3 identifies additional considerations for mine sites with voids.

This document provides the required information, data and predictions to satisfy the groundwater and hydrogeological requirements for Foxleigh's PRCP.

The objectives of this work consist of the preparation of a report that addresses two outcomes. The outcomes are:

1. Prediction of the final water level in open pits to determine whether backfilling of pits is required to avoid groundwater ponding; and,
2. Prediction of the interaction between water in the pits and groundwater, including rates and flow directions.

These outcomes are required to satisfy the PRCP guidelines for groundwater.

Numerical modelling has been conducted to assist in the determination of final void water levels and to calculate groundwater flux interactions with the voids in perpetuity. The modelling has included the development of simulations of the groundwater environment prior to and during mining to the year 2054, closure in 2055 and post-closure for 1000 years to the year 3055. The model domain covers an area of approximately 578 km^2 centred on Foxleigh and incorporates parts of the Roper Creek and Cockatoo Creek catchments.

The results of the modelling indicate that the water level in the voids will stabilise after around 450 years from mine closure and that each of the voids will operate wholly as a groundwater sink.

Maximum and perpetual groundwater fluxes to the residual voids have been calculated for the periods immediately following the cessation of mining in 2054 and after 1000 years, respectively. Maximum fluxes are observed at the point of cessation of mining in 2054 at approximately 40 l/s. These decline over approximately 450 years from the cessation of mining, around the year 2505, to approximately 30 l/s and remain at this rate in perpetuity.

No impact on regional groundwater resources or other connected water resources is considered likely to occur in relation to pit lake water quality because no water is predicted to be able to seep from the residual voids.

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1 INTRODUCTION

1.1 Background

Foxleigh Mine (Foxleigh) is a jointly owned open cut coal mine producing low volatile PCI coal for export. Foxleigh is operated by Foxleigh Management Pty Ltd (FoxMan), on behalf of a joint venture between Nippon Steel Australia Pty Ltd, POSCO Australia Pty Ltd and Foxleigh Coal Pty Ltd.

The site is located in Queensland's eastern Bowen Basin, covering an area of 8,500 ha, approximately 12 km south of Middlemount (Figure 1). The site operates on mining leases ML70171, ML70309, ML70470, ML70310, ML70429, ML70430 and ML70431 (Figure 2).

The mining operation was established in 1999 and comprises a number of open pits accessing the Rangal Coal Measures. Coal is excavated using truck and shovel methods and processed at an on-site CHPP before being trucked to a dedicated rail loadout facility for transport to Dalrymple Bay Coal Terminal (Figure 1).

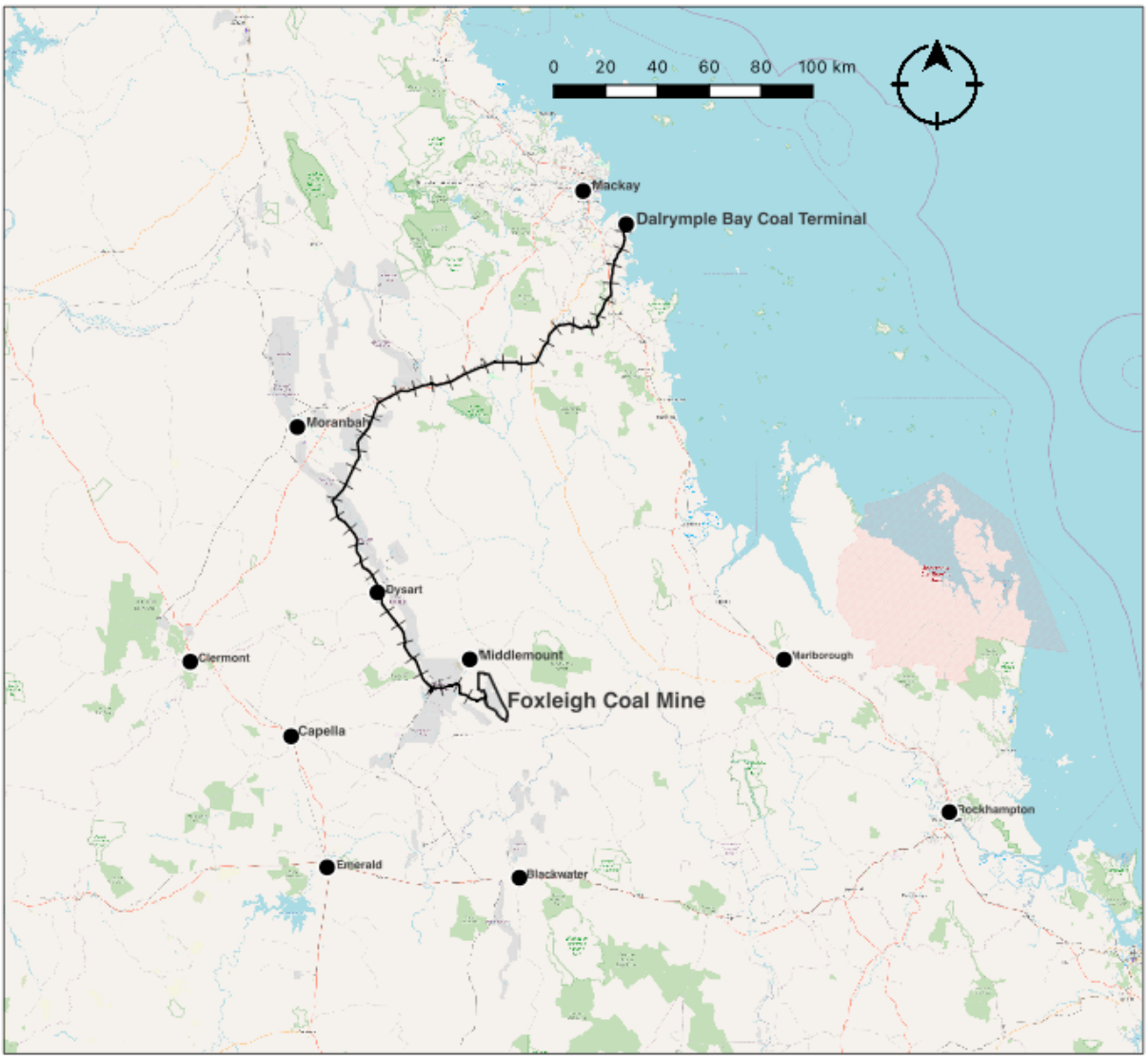

Figure 1: Site location

1.2 Commission

Groundwater Functions Pty Ltd was commissioned by Atkins Global on behalf of FoxMan to provide groundwater advice to satisfy requirements set out in FoxMan-supplied "Groundwater Modelling Scoping" document.

1.3 Objectives

The objectives of this work, as described in the Groundwater Modelling Scoping document, consist of the preparation of a report that addresses two outcomes. The outcomes are specified as (paraphrasing):

3. Prediction of the final water level in open pits to determine whether backfilling of pits is required to avoid groundwater ponding; and,
4. Prediction of the interaction between water in the pits and groundwater, including rates and flow directions.

These outcomes are required to satisfy the PRCP guidelines for groundwater.

1.4 Scope of Work

The scope of work as described in Atkins Global's proposal comprises:

1. Collation of fresh data from a newly installed groundwater monitoring system;
2. Update of a hydrogeological conceptual model described in the existing GMMP;
3. Construction and calibration of a numerical groundwater flow model
4. Prediction of groundwater levels within and beneath former pits & groundwater fluxes; and,
5. Preparation of a report presenting the updated hydrogeological conceptual model, numerical model and groundwater level/flux predictions.

Figure 2: Foxleigh mining leases

2 LEGISLATIVE CONTEXT

The QLD Government's Mined Land Rehabilitation Policy (QLD Govt, 2019) states that land disturbed by mining activities will be rehabilitated progressively as it becomes available, to minimise the risks of environmental impacts and reduce cumulative areas of disturbed land.

To implement key elements of the Mined Land Rehabilitation Policy and provide certainty about the outcomes and timing of rehabilitation, all mines with a site-specific environmental authority (EA) granted prior to 1 November 2019 are required to submit a Progressive Rehabilitation and Closure Plan (PRCP) by 1 September 2023. A PRCP requires the EA holder to plan for progressive rehabilitation of the land to a stable condition.

The requirements of a PRCP are set out under the Environment Protection Act 1994 (EP Act) (QLD Govt, 1994) and described in the Progressive Rehabilitation and Closure Plans Guideline (QLD Govt, 2021). Section 3.6.1 of the PRCP Guideline identifies the hydrogeological requirements for general rehabilitation practices whilst Section 3.6.3 identifies additional considerations for mine sites with voids.

This document provides the required information, data and predictions to satisfy the groundwater and hydrogeological requirements for Foxleigh's PRCP. Table 1 sets out the specific requirements described in the PRCP Guideline relating to groundwater and maps where in this document, and how, these matters have been addressed.

Table 1: PRCP requirements reconciliation

PRCP Guideline		This document		
Section	**Requirement**	**Section**	**Reconciliation**	
3.6.1	Determine groundwater occurrence including the existence of, and depth to, aquifers and aquitards	6.1 6.2	Occurrence Classification	Yes
3.6.1	Locate groundwater recharge and discharge locations locally and regionally	8.4 8.6	Recharge Discharge	Yes
3.6.1	Determine groundwater quality within each of the aquifers and from surface expressions	6.3	Groundwater quality	Yes
3.6.1	Determine current a potential future uses of groundwater including existing groundwater extraction bores	6.4	Groundwater use	Yes
3.6.1	Describe the groundwater flow direction & velocity, including field tests determine hydraulic conductivity	8.5 6.2	Flow directions Hydrogeological characteristics	Yes
3.6.1	Present potentiometric mapping and … … hydrostratigraphic cross-sections	8.5 8.8	Inferred gw flow directions Conceptualisation	Yes
3.6.1	Conduct groundwater modelling to determine contaminant transport	9.7.3 11.4.2	Contaminant transport Post-closure	Yes
3.6.1	Conduct groundwater modelling to determine potential changes to groundwater level from dewatering or waste storage	11 11.4	Operational simulation Post-closure simulation	Yes
3.6.3	Describe void stratigraphic connections to groundwater resources	8.8.2	Conceptual model	Yes
3.6.3	Conduct groundwater modelling to determine whether voids act as sinks or sources for groundwater	9.7 11.4.2	Flow & Mass Transport Post-closure	Yes
3.6.3	Assess void surface/groundwater interactions such as groundwater lowering / reduction in hydraulic head; cones of depression and associated impacts	11.3 11.4 11.5	Operational simulation Post-closure simulation Discussion	Yes

Foxleigh holds a QLD Environmental Authority permit, EPML00744813, which was granted in 2017 and regulates activities in seven mining leases (Figure 2).

The site is also governed by EPBC Referral 2010/5421 issued and administered by the Australian Federal Department of Climate Change, Energy, the Environment and Water (DCCEEW).

3 WORK FLOW

This document is intended to fulfil the requirements of the PRCP guideline in determining the relationship between residual mining voids proposed to remain on the site and the water environment in which the mine exists. The scope of work requires the gathering and interpretation of factual data and the development of a numerical model to provide predictions of future conditions. To provide confidence in the predictions and conclusions, current best practice, as set out in the Australian Groundwater Modelling Guidelines (AGMG, Barnet et al, 2012), prescribes a methodology that has been adopted in the following document. Figure 3 presents a summary of the groundwater modelling process taken from AGMG. Table 2 provides a cross-reference to identify how the individual elements of the groundwater modelling process have been addressed in this study and where they are presented in this report.

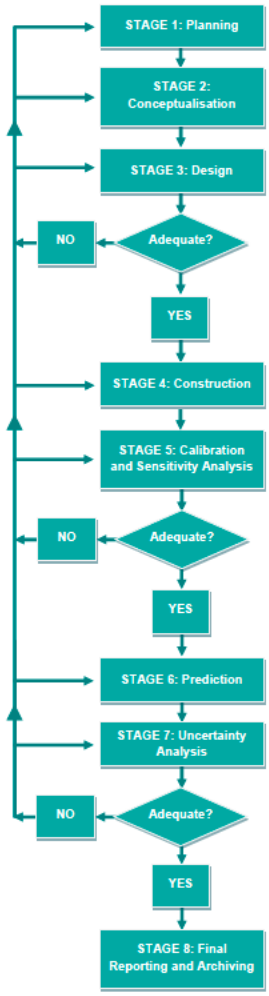

Figure 3: AGMG Groundwater Modelling Methodology Flowchart

Table 2: AGMG Groundwater Modelling Process Reconciliation

Australian Groundwater Modelling Guidelines		This document	
Stage	**Requirement**	**Section**	**Reconciliation**
1	Planning: (incl data gap analysis and subsequent data gathering)	1.4, 13	Yes
2	Conceptualisation	8	Yes
3	Design	9	Yes
4	Construction:	9	Yes
5	Calibration and Sensitivity Analysis:	10	Yes
6	Prediction:	11	Yes
7	Uncertainty Analysis:	12	Yes
8	Reporting:	14	Yes

4 CLIMATE & HYDROLOGY

4.1 Climate

Weather records have been maintained on the site since March 2012. Longer term rainfall and evaporation data have been obtained from the Queensland Climate Change Centre of Excellence (QCCCE) SILO Data Drill Service (https://www.longpaddock.qld.gov.au/silo/point-data/). Days with missing data are in-filled with synthetic data that has been interpolated from recorded data at nearby regional stations as described by Jeffrey et al. (2001). The SILO Data Drill Service provides a continuous daily data set between 1889 and the present day, including derived daily pan evaporation, lake evaporation and actual evapotranspiration rates. Climate data was obtained from the SILO grid point at Lat -22.95, Long 148.75 at an elevation of 138.8 mAHD.

Table 3 shows the mean and maximum monthly and annual rainfall at Foxleigh based on 121 years of data since 1 January 1900. Figure 4 shows the long-term average monthly and maximum monthly rainfall at Foxleigh based on these SILO data.

The average monthly rainfall at Foxleigh exhibits distinct wet (November to March) and dry (April to October) seasons during the year, with a dry season low of 16 mm in August to a wet season high of 103 mm in January. Foxleigh has a mean annual rainfall of approximately 586 mm.

Table 3: SILO Climate Data

Month	Monthly Rainfall (mm)			Monthly Evaporation* (mm)		
	Min	**Mean**	Max	**Min**	Mean	Max
January	0	102.5	486	148.6	223.1	280.6
February	0	95.41	350.7	132	182.5	237.7
March	0	63.96	323.3	129.1	181.5	240.2
April	0	29.69	166.2	107.6	150.8	193.1
May	0	27.11	214.1	91.9	118.5	146.5
June	0	29.56	180	76.4	94.01	110.6
July	0	22.76	221.4	81.2	103.1	126.1
August	0	16.44	126.6	108.3	133.4	167.9
September	0	17.35	153.2	127.5	169.9	209.3
October	0	34.55	139.9	163.4	210.7	254.1
November	0	55.8	196.7	132.9	224.3	275.1
December	0.7	91.16	446.1	142.7	238.2	300.1
Annual	**220.2**	**586.3**	**1228**	**1561**	**2030**	**2386**

(* = synthetic estimate pre-1970, class A pan 1970 onwards)

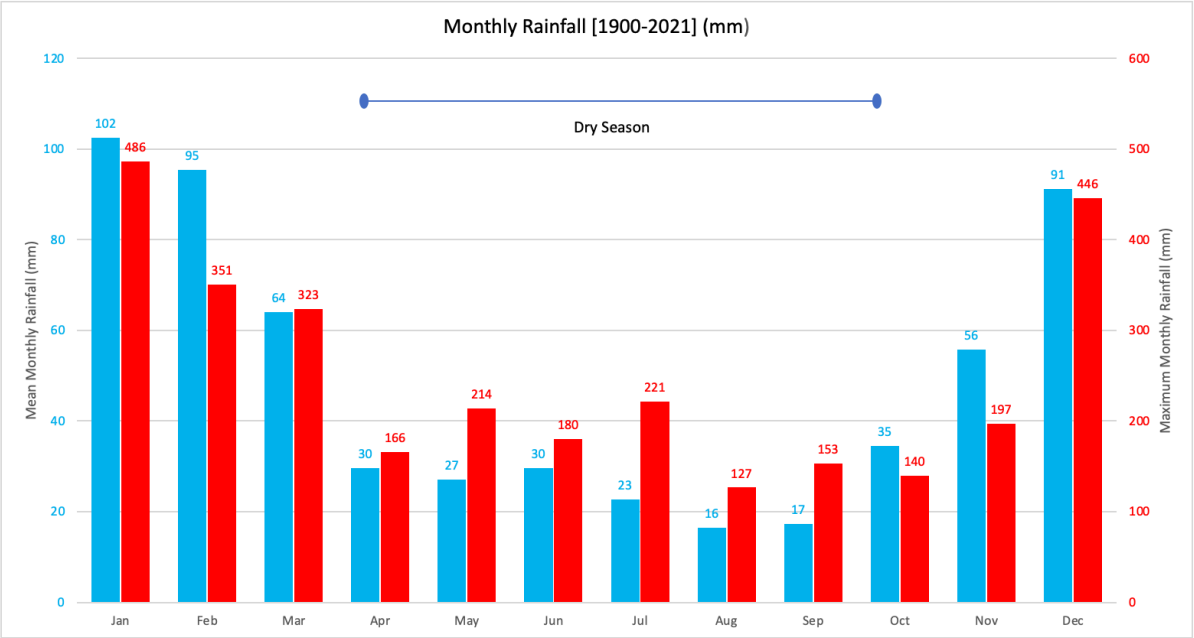

Figure 4: SILO Rainfall

Whilst Figure 4 illustrates the seasonal nature of average monthly rainfall, during recent years, Australia in general and the region in particular, have experienced significant periods of drought interspersed with periods of wetter than average weather.

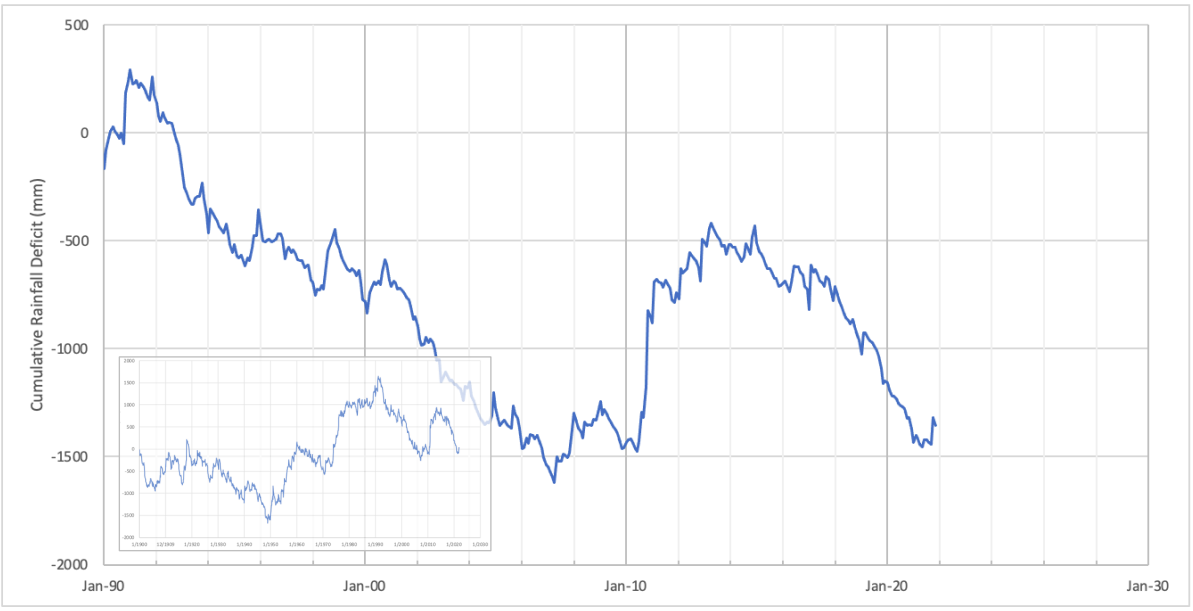

Figure 5: Cumulative Rainfall Departure (1900-present)

Figure 5 illustrates the cumulative rainfall departure from the mean annual rainfall (cumulative rainfall departure, CRD) for the site, calculated from 1900. The CRD accumulates the variance of annual rainfall from the mean annual rainfall. Drier than average years will yield negative values which, year-on-year, will result in a downward trend in the CRD and wetter-than-average years will result in an upward trend. The actual value of CRD at any point in time will

depend on the year that the calculation was initiated and the period of data used to calculate the long-term average rainfall. However, the trend of the CRD is used to indicate multi-year periods of wetter-than-average or drier-than-average climate. Figure 5 indicates that recently the site has experienced drier-than-average conditions since approximately 2015, with a longer period of drought during the preceding two decades. Cumulative rainfall received to date during 2022 has exceeded the long-term annual average.

Mean monthly Potential Evaporation follows a similar seasonal pattern to rainfall (Figure 6), although it typically ranges between 2-times mean monthly rainfall during the wettest month (January) and 8-times to 10-times mean monthly rainfall during the driest months (August and September) with an annual average of 2030 mm. The red bars in Figure 6 represent mean monthly evaporation whilst the blue line indicates evaporation as a multiple of mean monthly rainfall. It is apparent that during the dry season, although evaporation monthly averages are lower than during the summer months of October-March, evaporation reaches up to 10-times monthly average rainfall (September).

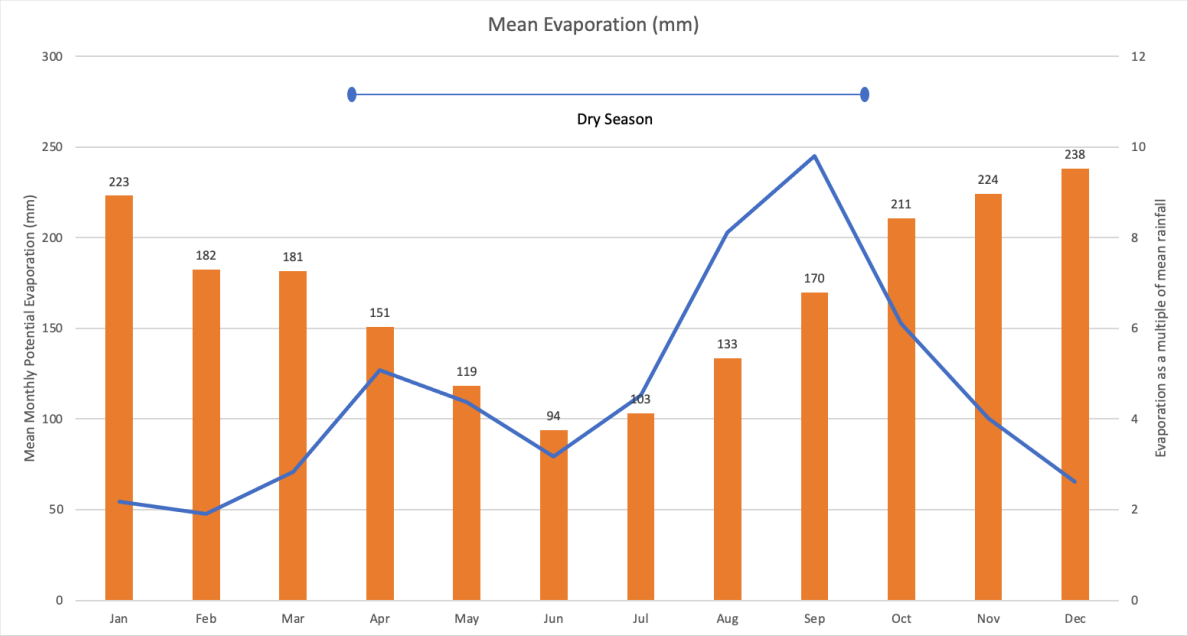

Figure 6: SILO Potential Evaporation (blue line = multiple of rainfall)

4.2 Hydrology

4.2.1 Drainage network

The site lies in Queensland's North East Coast drainage division, within the Mackenzie River sub-basin (1301) of the Fitzroy River, predominantly within the watersheds of Roper Creek and its principal tributary, Cockatoo Creek.

Cockatoo Creek rises 5 km NW of Middlemount entering the site at the northern end of ML 70431 (Figure 7). The creek originally occupied the middle of ML 70431, ML 70470 and ML 70309 with its confluence with Roper Creek in the SE corner of ML 70409, although it is currently diverted along the NE perimeter of Foxleigh Plains/Foxleigh Plains North pits and to the NW of One Tree Pit.

Roper Creek rises 45 km W of the site, flowing eastwards past Norwich Park mine and Middlemount mine before veering SE, passing the western perimeter of the site. Cockatoo Creek converges with Roper Creek immediately south of the mine around Lat -23.009, Long 148.836. Roper Creek continues in a SE direction collecting Oaky Creek at Lat -23.017, Long 148.854 and converging with the Mackenzie River approximately 17 km SE of the mine around Lat -23.097, Long 148.973.

Carlo Creek, draining land to the east of the site, converges with Cockatoo Creek to the south of the mine at Lat -22.991, Long 148.814 although has been diverted around Carlo Creek pit into Douglas Creek before converging with Cockatoo Creek.

Parrot Creek rises to the west of the site around Bundora and German Creek East mines and converges with Roper Creek around Lat -22.930, Long 148.734.

Lucas et al (2011) indicate that the channels of Roper Creek and Cockatoo Creek have anastomosed frequently throughout the Quaternary and possibly Tertiary periods with the highest point of conjunction being identified as Lat -22.8885, Long 148.7654, within the footprint of the current Foxleigh Plains pit. Downstream from this point, there are multiple flood channel features and alluvial deposits.

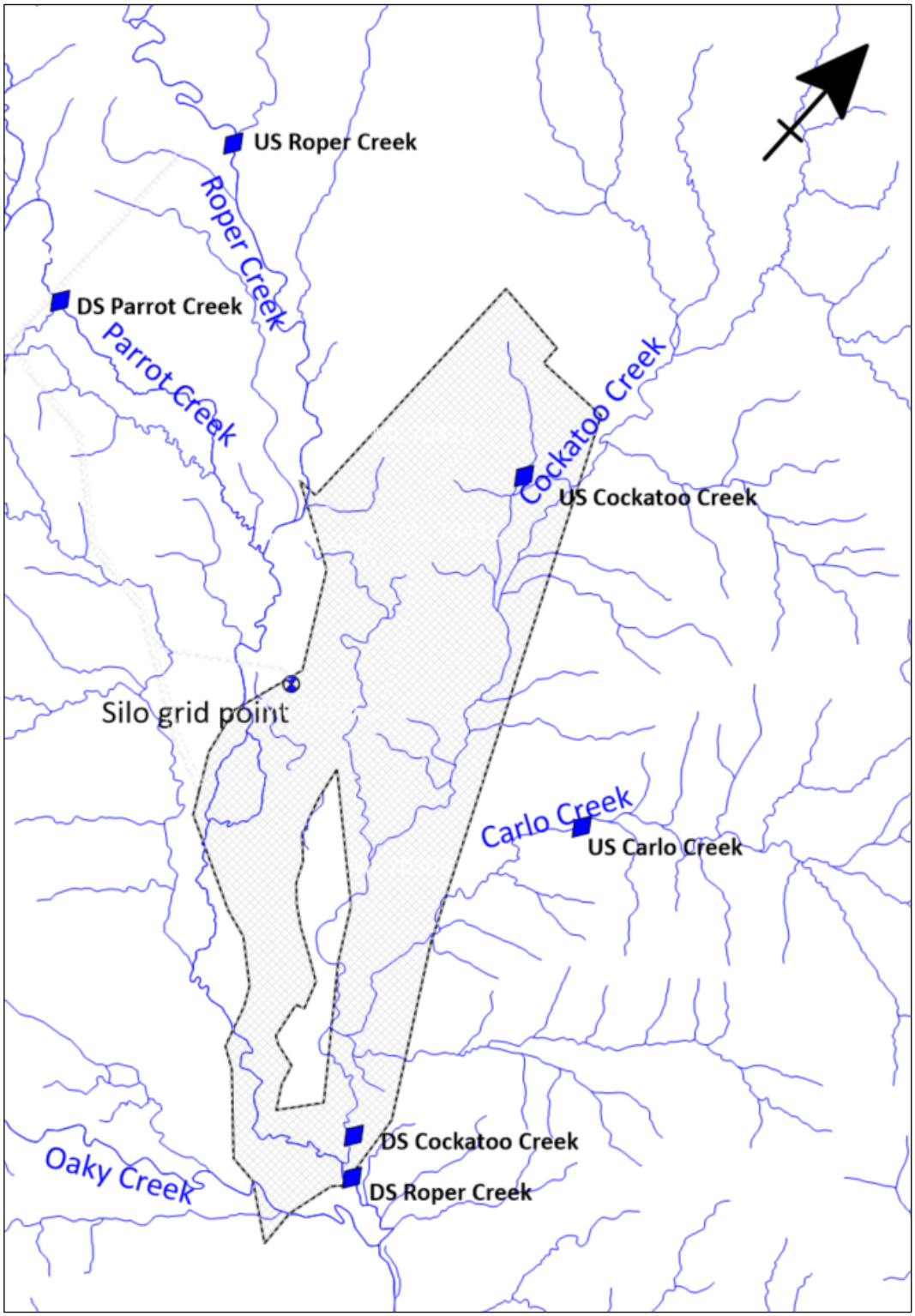

Figure 7: Drainage features

4.2.2 Surface water monitoring

Hydrometric monitoring is carried out by FoxMan with gauges placed on Roper, Parrot, Carlo and Cockatoo creeks. Roper and Cockatoo creeks include gauges at upstream and downstream locations relative to the mining operations (Table 4 and Figure 7).

Table 4: Foxleigh Creek Monitoring Network

Station ID	Lat	Lon	Name ID
331363	-22.8781	148.6727	US Roper Creek
331361	-23.0098	148.8413	DS Roper Creek
331357	-23.0569	148.8879	Roper Creek Barwon Park
331356	-22.8906	148.7660	US Cockatoo Creek
331355	-23.0033	148.8326	DS Cockatoo Creek
331358	-22.9242	148.8268	US Carlo Creek
331306	-22.9215	148.6670	DS Parrot Creek

Hydrometric monitoring is carried out by QLD Government with the nearest gauge on the Mackenzie River at Bingegang weir to the south east of the site (Table 5). The data are available through the Queensland Government's Water Monitoring Information Portal (www.water-monitoring.information.qld.gov.au).

Table 5: Queensland Government Hydrometric Monitoring

Station ID	Lat	Lon	Name ID
130106A	-23.072	149.034	Mackenzie River at Bingegang

4.3 Surface water flow regime

The flow regime of the Roper Creek catchment (including Cockatoo Creek) is ephemeral and highly variable both from season to season and from year to year. Large flows are dominated by rainfall generated by monsoonal low pressure systems.

The ephemeral nature of flow in the gauged creeks local to the mine site is illustrated in Figure 8. Gaps present in the data relate to periods during which equipment recording the flow data was switched off. Rainfall is recorded at the site's weather station and at the Parrot Creek gauging station and is illustrated on the creek flow hydrograph for comparison and correlation with catchment flow events. Creeks may remain dry and terrestrially-vegetated for many consecutive months of the year with smaller rainfall events (<10mm) commonly not eliciting creek flows. Lucas et al (2011) identified semi-permanent pools in some locations along the reaches of Roper and Cockatoo creeks although these were identified as perched features isolated from each other and not in hydraulic continuity with the underlying alluvial deposits.

Flow in the Mackenzie River downstream of the Roper Creek catchment is intermittent (flow >10% of the time), responding more slowly to rain events in the catchment.

Figure 8: Hydrograph of river and creek flow data (01-Aug-2021 to 31-May-2022)

4.4 Surface water quality

Surface water quality is monitored to inform Foxleigh's Receiving Environment Monitoring Plan (REMP) reporting requirements in accordance with the mine's EA, conditions F24-F26.

Four upstream control sites and three downstream impact sites are routinely monitored for physico-chemical and biological water quality.

In-situ testing (pH, turbidity, electrical conductivity and dissolved oxygen) indicated that surface water quality was generally similar downstream to upstream (). There was a slight increase in salinity downstream, which remained well below the stock watering guideline.

Roper Creek downstream which recorded 86.9%. The result is typical of drying pools where warm temperatures and biological action reduce oxygen concentrations. Downstream concentrations were comparable with those upstream of mining.

Electrical Conductivity (EC) showed salinity was above the WQO of 310 µS/cm at all sites except Cockatoo Creek upstream which recorded 208 µS/cm. The salinity gradually increased downstream to a maximum of 698 µS/cm at Roper Creek downstream @ Barwon Park, where desiccation in this small remnant pool may have concentrated salts. All results were well below the ANZECC stock watering guideline of approximately 5,970 µS/cm.

Turbidity was below the WQO of 50 NTU at sites immediately downstream of mining on Roper and Cockatoo creeks. Upstream sites on Cockatoo and Carlo creeks were above the WQO, recording 136 and 308 NTU respectively. The far downstream site on Roper Creek at Barwon Park was also above the guideline, recording 431 NTU, however, turbidity readings at this site were likely increased by the algal bloom present.

pH was slightly alkaline at all sites, with only Carlo Creek upstream (pH 9.0) and Roper Creek downstream at Barwon Park (pH 9.3) above the WQO of pH 6.5-8.5. The higher pH at Roper Creek downstream at Barwon Park may be directly related to the algal bloom, which can raise the pH by consuming carbon dioxide which would normally provide buffering against natural alkalinity.

Table 6: Physico-chemical (in-situ) surface water quality

Analyte	Unit	Mackenzie WQO(W)	Cockatoo Ck upstream	Carlo Ck upstream	Cockatoo Ck downstream	Roper Ck downstream	Roper Ck downstream at BP
Temperature	degC	-	26.2	34.8	30.2	34.3	30.8
Dissolved oxygen	%	85-110	45.4	66.2	52.1	86.9	52.7
pH	Units	6.5-8.5	8.4	9.0	7.6	8.1	9.3
EC	µS/cm	310	208	335	366	518	698
Turbidity	NTU	50	136	308	48.8	48.7	431

(BP: Barwon Park)

In laboratory analysis, most analytes were within guidelines with little difference between upstream and downstream sites. Where analyte concentrations were above guidelines, the concentrations immediately downstream of Foxleigh were similar to, or lower than, the concentrations upstream. The far downstream site (Roper Creek downstream at Barwon Park) recorded concentrations higher than those immediately downstream of the mine, indicating it is subjected to other influences. This site was experiencing an algal bloom at the time of sampling and is immediately downstream of a public road.

In general, higher total metals (for aluminium, iron, and manganese) correlated to higher suspended solids, indicating they are transported in the sediment.

5 GEOLOGY

5.1 Regional setting

Foxleigh is located in the central Bowen Basin at the northern end of the Taroom Trough. The Bowen Basin trends north-south, and extends from central Queensland, south beneath the Surat Basin, into New South Wales where it eventually connects with the Gunnedah and Sydney basins (QLD Government, 2016). It contains Permian to Triassic age sediments with a maximum thickness of about 9,000 metres in the depocenter of the Taroom Trough (URS, 2012).

The basin began forming during the Late Carboniferous during a phase of tectonic extension (Cadman et al., 1998; Elliott, 1989; Draper, 2013). Extensional subsidence during the Early Permian led to the deposition of the earliest known sediments of the basin (Cadman et al., 1998). During this time volcanic rocks were also deposited into the basin. Deposition ceased in the basin during the Late Triassic.

The depositional history of the Bowen Basin is complex and individual formations are not always laterally extensive or easy to correlate across the basin (Draper 2013). Sedimentary deposition in the basin began during the Early Permian, with river and lake sediments and volcanics being deposited in the east, and a thick succession of coals and non-marine sedimentary rocks in the west (Geoscience Australia 2015). These sediments were then overlain by mostly fine-grained sediments such as mudstone and siltstone of marine origin.

In the Late Permian, a thick succession of marine and fluvial sediments, including extensive coal seams, was deposited. This sequence includes the uppermost coal seams in the Bowen Basin—the Rangal Coal Measures. The Rangal Coal Measures comprise calcareous sandstone, shale mudstone coal and concretionary limestone to a thickness of 200 m of late Permian (259-254 Ma) age.

The lowest formation of the Rewan Group, the Sagittarius Sandstone, is absent regionally with the Rewan Formation representing the earliest Triassic strata locally, resting unconformably on the Rangal Coal Measures. The Rewan Formation, a thick sequence of mudstone, siltstone and clayey sandstone, was deposited from rivers and lakes. This was followed by deposition of the Clematis Group sandstones and, finally, more mudstones and siltstones of the Moolayember Formation towards the end of the Triassic Period. Widespread erosion then followed before the deposition of the Surat Basin Jurassic and later sediments (Cadman et al. 1998; URS, 2012).

5.2 Stratigraphy

The stratigraphy relevant to the project is illustrated in the stratigraphic column presented in Figure 9 and surface geological plan presented in Figure 10 and comprises, from youngest to oldest:

- Quaternary age unconsolidated alluvial deposits (Qpa/Qa) associated with the existing creek and river network and colluvial fringing deposits;
- Tertiary age poorly consolidated sediments of the Duaringa Formation (or equivalents) (Tu) sandstone and mudstone and Tertiary intrusive rocks (Ti);
- Early Triassic Rewan Group strata of the Rewan Formation (Rr, subcrop only), consisting of mudstone, siltstone and clayey sandstone resting unconformably atop;

- Late Permian age Blackwater Group (Pw) strata including the Rangal Coal Measures (Pwj, subcrop only), underlying Burngrove Formation (Pwg) and basal Fair Hill Formation (Pwt);

The Burngrove/Fair Hill Formations form the basement of the project area. More widely the Early-Mid Permian age Back Creek Group strata including the Macmillan Formation and underlying German Creek Formation are present underlying the Blackwater Group strata. Elsewhere (beyond the area of influence of the site) the Early to Mid Triassic Clematis Sandstone overlies the Rewan Group and is in turn overlain by the late Triassic Moolayember Formation which forms the uppermost sedimentary unit of the Bowen Basin.

5.3 Quaternary deposits

Quaternary deposits within the study area are associated with the stream channels and flood plains of Roper Creek and Cockatoo Creek (JBT, 2012). The mapped extent of Quaternary alluvium, based on 1:100,000 scale geology, is shown in Figure 10. Cockatoo Creek is a tributary of Roper Creek, which is a substantial tributary of the Fitzroy River system. The floodplains of the two creek systems coalesce at the southern end of the site, resulting in a substantial floodplain with multiple prior channels (Section 4.2.1). Broad deposits of floodplain alluvium are present in the southern part of the study area, and throughout the existing Foxleigh.

5.4 Tertiary sediments

5.4.1 Duaringa Formation

Within the study area, the Tertiary sediments consist of a sub-horizontal blanket of soft, poorly consolidated sandstones and mudstones (Plate 1). The Tertiary sediments are largely confined to the north-west of the study area where there are some indications of a second weathering profile possibly related to Tertiary deposition (JBT, 2012). This stratum occurs as surficial sediments within the study area, incised by alluvial deposits (Figure 10).

5.4.2 Igneous intrusive rocks

Regional geological mapping indicates that Tertiary-age basalts are located approximately 20 km NNW of the site as outliers within the Duaringa Beds (Figure 10).

NE-SW-trending dolerite dykes occur rarely in the northern part of the study area, the largest of which is known as the Grasstree Dyke. Dolerite dykes are also present within the surrounding area. At German Creek mine, the Tieri and Aquila coal seams have been intruded by igneous dykes and sills.

Minor NE-SW-trending dykes are present, notably at the northern end of mining leases, whilst more extensive dykes have been mapped to the east of the site, beyond the extent of Foxleigh mining leases, focussed in the axis of an anticline running parallel to the Foxleigh syncline.

5.5 Triassic strata

Triassic strata are present at the site comprising the Rewan Formation consisting of sandstone, siltstone, and mudstone. The Rewan Formation does not outcrop in the study area but is present beneath Quaternary and Tertiary sediments within the central area of the synclinal structure, as shown in Figure 10 (inset) and Figure 11.

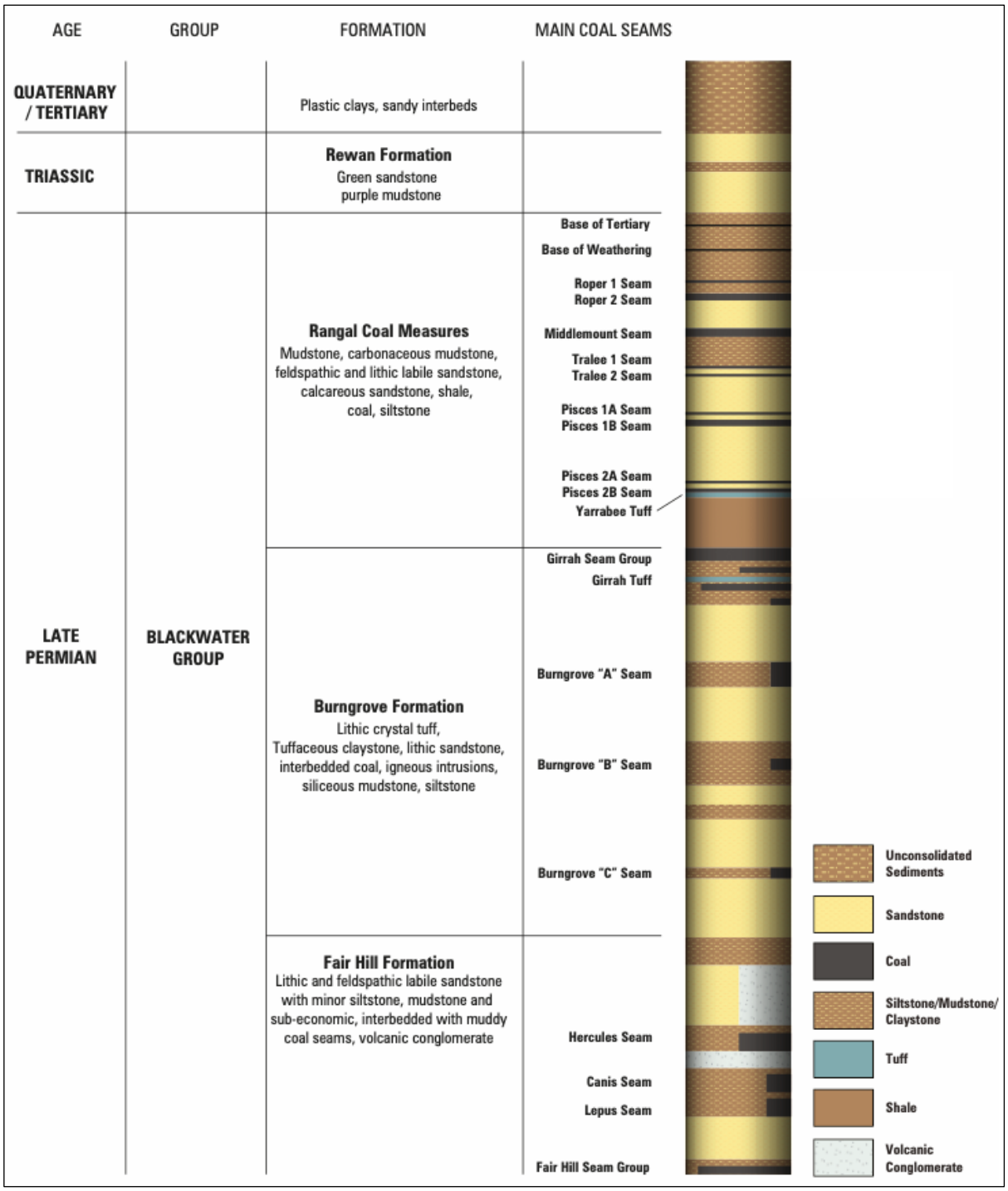

Figure 9: Stratigraphic column (schematic, after JBT, 2013)

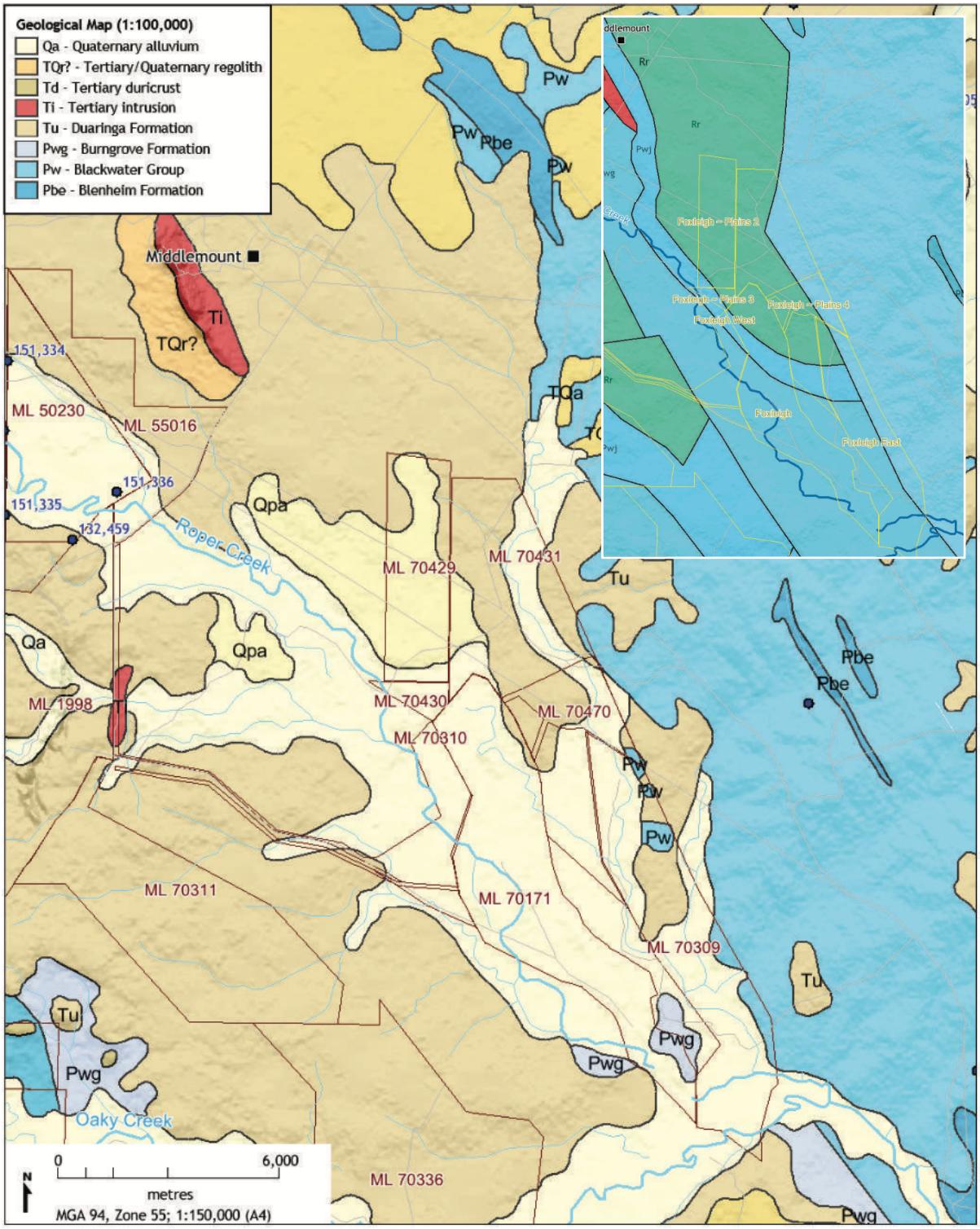

Figure 10: Surface Geology (basement geology inset)

Plate 1: Foxleigh Plains pit showing weak brown Duaringa Formation overlying Rangal Coal Measures strata

5.6 Permian strata

5.6.1 Rangal Coal Measures

The mining operation at Foxleigh targets coal seams of the Rangal Coal Measures, which subcrop in the western and eastern margins of the project site (Figure 11). The Rangal Coal Measures comprise interbedded sandstones, siltstones, mudstones and coal. The Rangal Coal Measures are currently mined at Foxleigh, Lake Lindsay, Oak Park and German Creek East. Regionally the Rangal Coal Measures dip from west to east at an angle of between 1° and 10°, however in the project area the coal measures have been heavily disrupted by faulting and thrusting giving rise to large changes in dip over relatively short distances and near horizontal to near vertical or inverted bedding in places. This relationship is illustrated in Plate 2 and shown schematically in Figure 11 where the coal measures in the Foxleigh and the study area are deformed within a faulted synclinal structure. The dip of the coal seams within the project site is therefore highly variable, depending on localised effects of folding and faulting. As the syncline plunges to the north, the base of the Rangal Coal Measures is deeper within the north of the study area than to the south at Foxleigh.

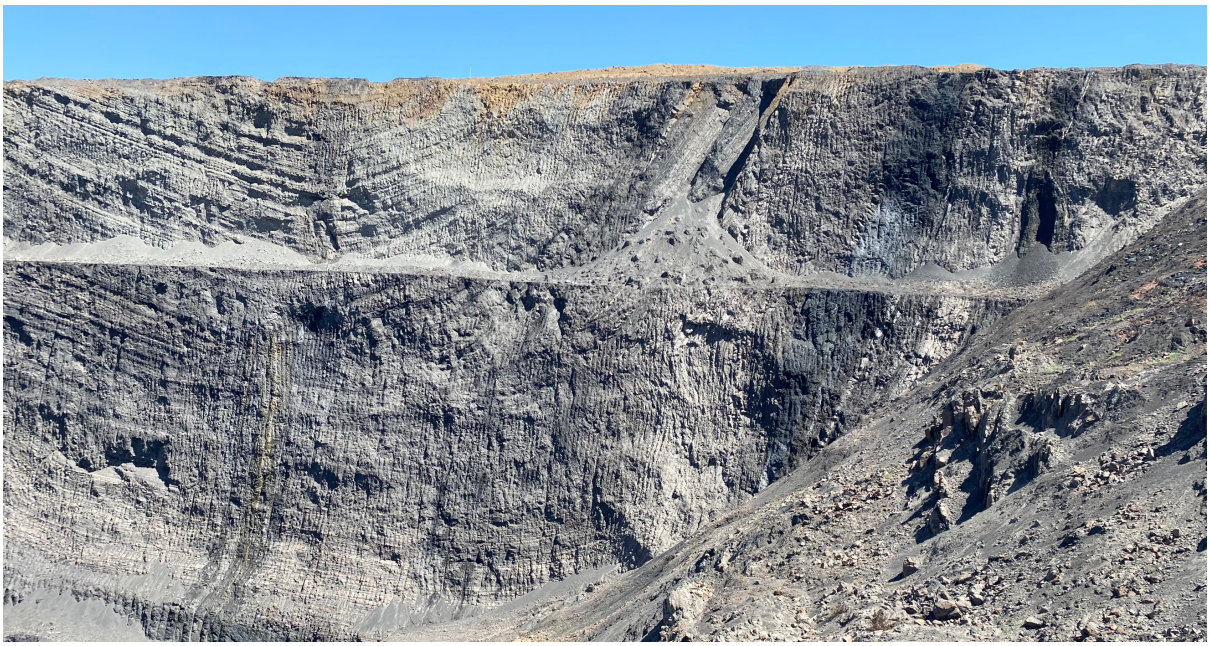

Plate 2: Folded and near-vertical Rangal Coal Measures strata in One Tree West pit (looking North)

The base of the Rangal Coal Measures is marked by the Yarrabee Tuff, a thin but continuous and distinctive tuff band lying a short distance beneath the base of the Pisces seam (Plate 3).

5.6.2 Burngrove Formation

The Burngrove Formation comprises siltstone, claystone, sandstone, mudstone and coal lying conformably beneath the Yarrabee Tuff band (Plate 3) and outcrops or subcrops to the west of the study area. Currently there is no mining of coal seams within the Burngrove Formation or the underlying Fair Hill Formation within the region and hence the Burngrove Formation is effectively the basal formation for this study. The exception to this is the lower of the two Pisces seams, Pisces 2, which lies directly beneath the Yarrabee Tuff and as such is not a part of the Rangal Coal Measures.

5.6.3 Fair Hill Formation

The Fairhill Formation comprises lithic and feldspathic sandstone and minor siltstone and subeconomic coal seams (Hercules, Canis, Lepus and Fair Hill seams). To the east of the study area, the Fair Hill Formation has been upthrust by the Yarrabee Fault 5.7), creating a faulted synclinal structure that effectively hydraulically isolates the Rangal Coal Measures target coal seams (including the Pisces 2 seam of the topmost Burngrove Formation) at Foxleigh and the study area from features to the East of the site.

Plate 3: One Tree West pit showing Rangal Coal Measures overlying Burngrove Formation (inset Yarrabee Tuff)

5.6.4 German Creek Formation

Coal seams within the German Creek Formation are mined to the west of Foxleigh at German Creek southern and central collieries, Grasstree Mine, and Oaky Creek Mine. The German Creek Formation is expected to be present at considerable depth beneath the site, although isolated by the overlying Fairhill and Burngrove Formations.

5.7 Structural geology

5.7.1 Folding

The region is characterised by late/post Triassic compressional regime deformation resulting in the formation of a NNW-plunging syncline, referred to as the Foxleigh syncline.

This structure, with a core of Triassic Rewan strata in the vicinity of Foxleigh (Figure 11) effectively hydraulically isolates groundwater within strata subcropping at the mine because those strata subcropping and outcropping to the west of the mine represent stratigraphically lower formations. Flow of groundwater from west to east on the western side of the mine is effectively prevented by the very low hydraulic conductivity of the Burngrove, Fair Hill and German Creek Formations, the Jellinbah Fault on the western side of the study area and the Yarrabee Fault on the eastern side of the mine.

5.7.2 Faulting and thrusting

The plunging Foxleigh syncline has been further shortened in a NE-SW direction due to compressional movement along major thrust planes including the Yarrabee Fault on the eastern margin of the site and the Jellinbah Fault to the west of the site.

Whilst the Rangal Coal Measures also subcrop in the area of, and are worked at, the German Creek, Oak Park and Lake Lindsay mines west of Foxleigh, the pits in Foxleigh lie in an area where the stratigraphic sequence has been disrupted and effectively isolated by the Yarrabee Fault to the east, and other major faults including the Jellinbah Fault to the west, in addition to the Foxleigh syncline. Further to the West in the vicinity of the German Creek mine, the Grasstree Fault also significantly disrupts the stratigraphy juxtaposing potentially hydraulically conductive coal seams with very low hydraulic conductivity interburden measures.

Faulting at Foxleigh is characterised by thrust faults causing drag and roll structures, rapid changes in bedding dip and near-vertical or inverted bedding in places. The majority of faults are considered to have throws of a few metres to tens of metres whilst the regional-scale thrust faults lying to the East and West sides of the mine are understood to have throws of several hundred metres.

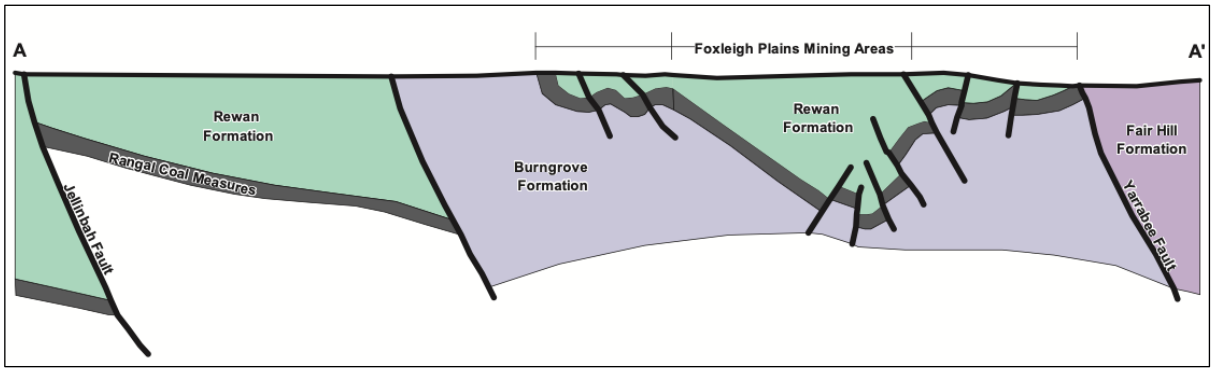

Figure 11: Schematic structural geological section (E-W) (JBT, 2013)

6 HYDROGEOLOGY

6.1 Groundwater occurrence

6.1.1 Regional groundwater monitoring

A number of groundwater monitoring bores are present within the wider region surrounding Foxleigh. Data from these bores is held by QLD Government. Table 7 lists the regional groundwater monitoring bores utilised in this study with which to prepare a regional groundwater level plan.

Table 7: Regional groundwater monitoring bores

Nr	Name/ID	Easting	Northing	Elevation	Depth	Remarks
43461						
43737						
103417						
132459						
136628						
151043						
151334						
151335						
151336						
151658						
161059						
161060						
161061						
161063						
161064						
161065						
161066						
165440						
165442						
165463						
13010005						

6.1.2 Local groundwater monitoring

Historically, groundwater pressure monitoring has been conducted in the northern part of the site using three multi-level vibrating wire piezometer strings installed in 2014 (Golder Associates, 2014), FPVWP01 at the northern end of Foxleigh Plains pit, FPVWP02 on the western side of NE pit and FPVWP03 at the north western corner of the ML, north of the future Eagle's Nest pit (Table 8).

Table 8: Foxleigh VWP network

Bore ID (EA ref)	VWP #	Easting	Northing	Elevation (mAHD)	Sensor		Remarks
					Elevation (mAHD)	Depth (mbgl)	
FPVWP01 (GMP2)	4	681789	7469150	136.8	86.8	50	Burngrove [1]
	3				21.8	115	Burngrove [1]
	2				-3.2	140	Burngrove [1]
	1				-70.2	207	Burngrove
FPVWP02 (GMP3)	4	677853	7464717	142.5	86.5	56	Burngrove [1]
	3				38.5	104	Burngrove [1]
	2				-1.5	144	Burngrove [1]
	1				-59.5	202	Burngrove
FPVWP03 (GMP1)	4	678052	7470201	154.7	76.7	78	Rewan
	3				29.7	125	Rewan [2]
	2				4.7	150	Rewan [2]
	1				-45.3	200	Rewan [2]
FPMB01 (GMP4)		681792	7469139	136.57	121.47	15.1	Alluvium (* 0.57 m)

[1] Re-interpreted from RCM to Burngrove by AGE (AGE, 2021). (*: casing stick-up)

[2] Re-interpreted from RCM to Rewan by AGE (AGE, 2021)

Significant uncertainty has surrounded the data obtained from various of the piezometers in each of these VWP strings and hence they have not been relied on to assess either regional or local groundwater levels or vertical fluxes between strata.

In 2021, FoxMan installed thirteen new groundwater monitoring standpipes, distributed around the site. Table 9 presents details of the standpipe monitoring network infrastructure.

Each standpipe is equipped with a pressure transducer and data logger programmed to record groundwater levels every hour and, weather and access conditions permitting, each datalogger is downloaded approximately every month.

Table 9: Foxleigh groundwater monitoring network

Bore ID	Easting	Northing	Elevation	Total depth (mbgl)	Formation
P1	680902.9	7459872.3	133.6	29.0	Burngrove
P2	679970.8	7460933.4	134.4	25.5	Burngrove
P3	677790.8	7464724.6	143.2	21.0	Alluvium
P4	687058.1	7456993.5	124.5	58.8	Middlemount seam
P5	686679.2	7456663.6	123.5	109.3	Middlemount seam
P6	684167.1	7457430.4	129.0	22.6	Rewan
P7	683905.2	7463055.1	129.3	57.0	Middlemount seam
P8	682487.2	7463531.6	130.9	33.0	Rewan
P9	686071.3	7458763.9	127.0	11.0	Burngrove

Bore ID	Easting	Northing	Elevation	Total depth (mbgl)	Formation
P10	683483.6	7456427.0	127.2	26.0	Burngrove
P11D	686366.4	7453547.2	123.2	93.4	Middlemount seam
P11S	686392.0	7453554.8	122.9	27.2	RCM overburden
P12	687347.3	7455303.0	122.5	12.0	Alluvium / Tertiary

Figure 12 presents an approximation of the distribution (elevation) of the water table across the project area, based on regional and local monitoring assets identified in Table 7, Table 8 and Table 9.

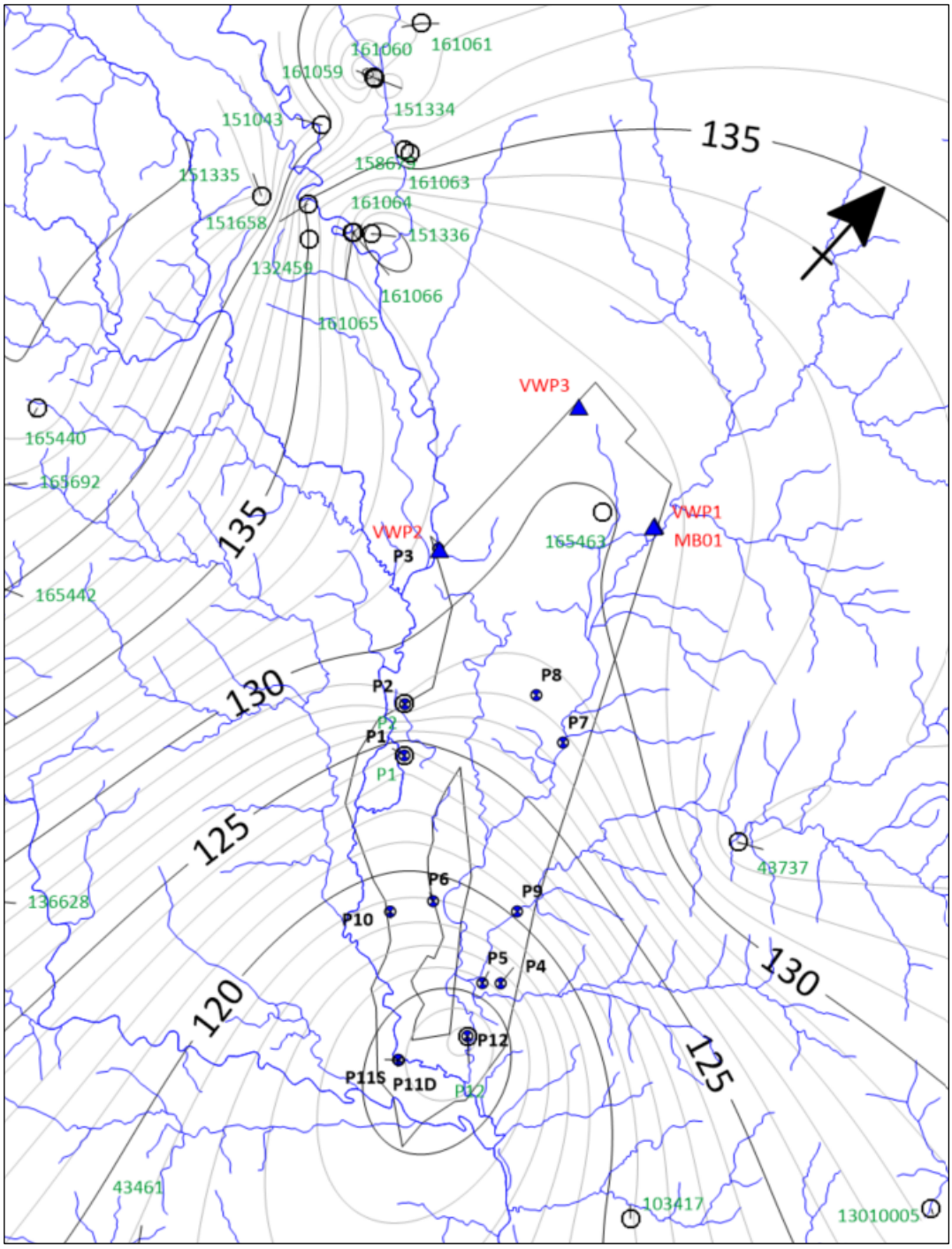

Figure 12: Water table map compiled using regional and local monitoring data

6.1.3 Groundwater occurrence in Quaternary deposits

Quaternary deposits of alluvium and colluvium within the study area are associated with the stream channels and flood plains of Roper Creek and Cockatoo Creek. The floodplains of the two creek systems coalesce in the southern part of the study area, resulting in a substantial floodplain with multiple prior channels. Broad deposits of floodplain alluvium are present in the southern part of the study area, and throughout the existing Foxleigh.

JBT (2013) reported that data available from exploration drilling at Foxleigh Plains indicated an average depth of alluvium of approximately 8 m, with the deposits generally being dry when drilled.

The streams in the area are ephemeral (Section 4.2.2) and it is therefore probable that groundwater occurrence within the alluvium is of relatively short duration (following rainfall recharge or stream flow events) with groundwater levels depleted by either or both evapotranspiration and downward seepage.

Continuous monitoring of groundwater in the alluvium at the site has been conducted in groundwater monitoring standpipes P3 and P12 since August 2021. Hydrogeological logs of these bores are provided in Appendix 2. Groundwater monitoring data have been converted to elevation to assist in comparison and are presented in a composite hydrograph at Figure 14. Neither bore encountered groundwater during drilling.

The hydrograph for P3 and P12 appears to illustrate that the groundwater level in the alluvium has remained very steady throughout the period of monitoring. Closer inspection of the hydrometric data and borehole logs indicates that the groundwater level recorded in the alluvium was typically at or below the elevation of the datalogger transducer which was installed at the base of the slotted section of each standpipe piezometer. Each standpipe piezometer is fitted with a 0.5 m long sump below the bottom of the slotted casing section at the base of the alluvium which may collect and retain groundwater. The dataloggers in P3 and P12 have regularly recorded water levels at or around the level of the top of the sump and only rarely significantly above the transducer. Figure 13 illustrates the events when groundwater has been recorded in P3 and P12 more than 0.02 m[1] above the top of the standpipe sump, implying that groundwater is present in the alluvium surrounding the borehole.

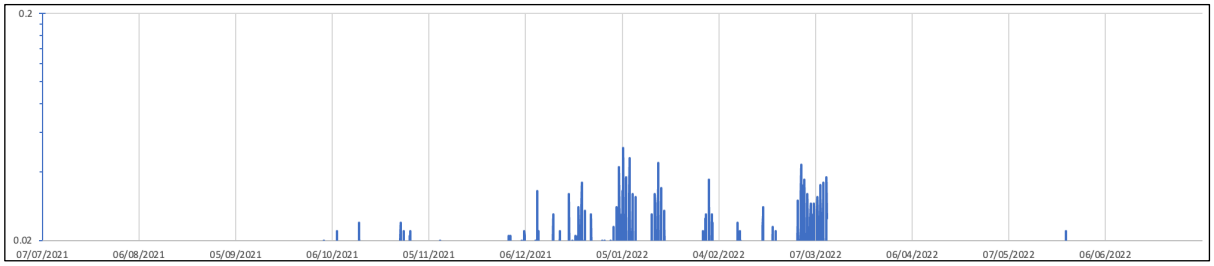

Figure 13: Probable occurrences of groundwater above standpipe sump in P3

This implies that groundwater is typically absent in the alluvium and present only following significant recharge events, or present only close to the base of the sediments.

[1] (0.02 m is equivalent to twice the minimum resolution of the transducer)

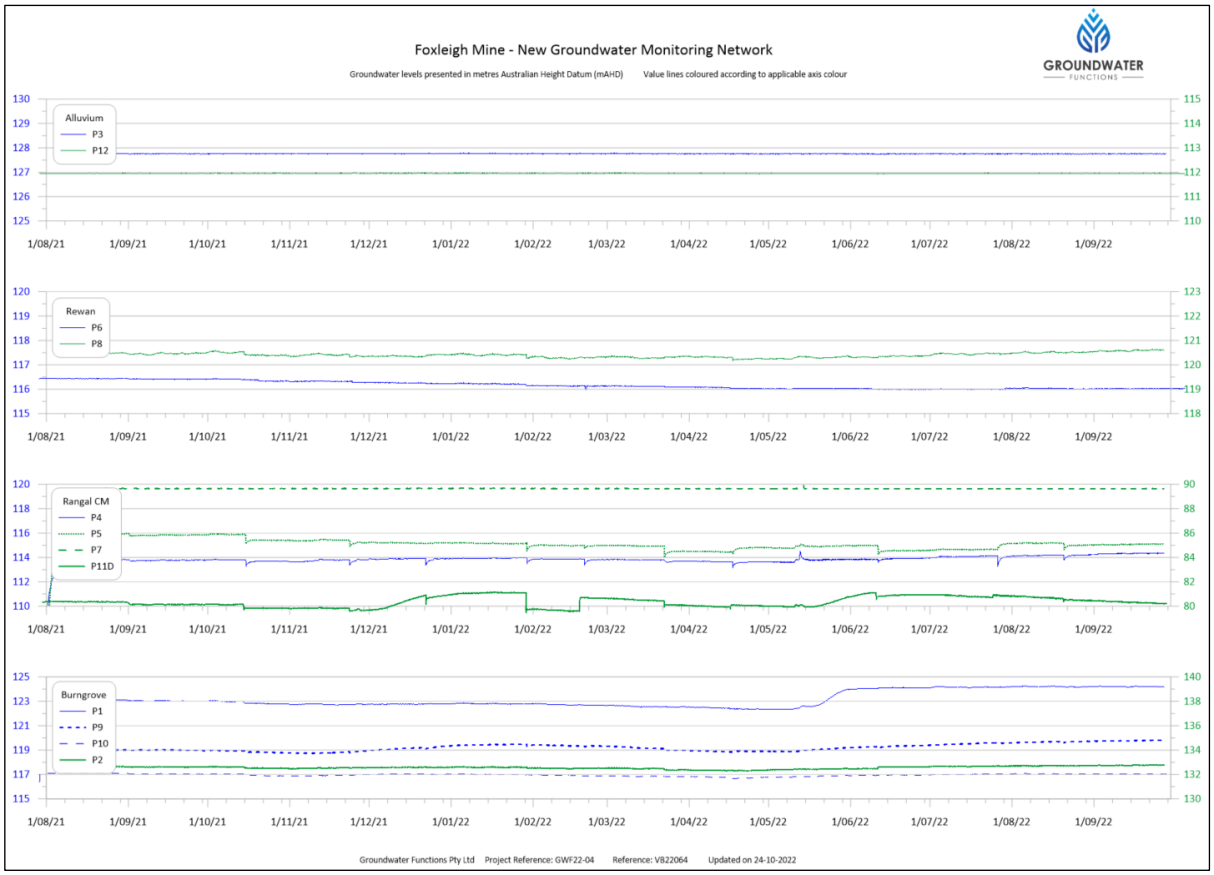

Figure 14: Composite hydrograph of Standpipe Groundwater Monitoring Network

6.1.4 Groundwater occurrence in Tertiary Duaringa Formation

The Tertiary sediments of the Duaringa Formation comprise deposits of soft, poorly consolidated sandstones and mudstones. Currently there is no dedicated monitoring of the presence or absence of groundwater within the Duaringa Formation although historical exploration drilling data from Foxleigh Plains and anecdotal information relating to observations in operating and historical pits indicates that the Tertiary sediments are generally dry at the project site. Standpipe P12, installed in the alluvium may also intersect a thin occurrence of the Duaringa Formation. However, as documented above, it is understood that the borehole was dry at installation.

Tertiary age basalts occur approximately 6 km west of the Foxleigh Plains lease area (Figure 10), however the deposits occur as isolated ridge-cap deposits of limited extent and do not form a regional aquifer system (JBT, 2013).

6.1.5 Groundwater occurrence in Triassic Rewan Formation

Within the study area including Foxleigh, the Rewan Formation is limited to the central core of the faulted northward-plunging syncline. Major thrust faults to the west and east of the Rewan subcrop isolate the occurrence within the vicinity of the mine from occurrences further to the west.

Continuous monitoring of groundwater in the Rewan Formation at the site has been conducted in groundwater monitoring standpipes P6 and P8 since August 2021. Groundwater monitoring

data have been converted to elevation to assist in comparison and are presented in a composite hydrograph at Figure 14.

Groundwater levels in both standpipe piezometers have remained steady between monthly water quality sampling events. During each sampling event, water is purged from the hole and a sample of groundwater collected for field and laboratory analysis. The extraction of water causes a small but sudden drop in the water level in each borehole, with partial short-term recovery. Consequently, groundwater levels in both standpipe piezometers have fallen stepwise very slightly during the period of monitoring from 116.4 mAHD and 120.4 mAHD in August-September 2021 to 116.0 mAHD and 120.2 mAHD in May-June 2022 in P6 and P8 respectively. Given the effect of water extraction for sampling, the groundwater levels reported for the Rewan indicate that there is negligible change in groundwater levels in this formation during the period of monitoring. The hydrograph indicates that there is no apparent response to, nor correlation with, rainfall events or notable surface water flow events. Taken together, the sampling-effected declines and irresponsiveness to recharge events imply that the Rewan Formation is hydraulically isolated from and/or irresponsive to surface recharge events by the nature of its composition and hence can be considered an effective aquitard.

6.1.6 Groundwater occurrence in Permian strata

Inter-seam measures typically comprise mudstones or mudstone-dominated sequences of sandstone, siltstone and mudstone and due to the low permeability of these sequences, groundwater is typically present only in the coal seams. Within the study area groundwater is actively monitored in one bore within Rangal Coal Measures overburden (P11S), four bores within the Middlemount seam of the Rangal Coal Measures (P4, P5, P7, P11D) and four bores within the stratigraphically underlying Burngrove Formation (P1, P2, P9, P10). The Fair Hill Formation, which stratigraphically underlies the Burngrove Formation, is not actively monitored on the site as there is no outcrop or near-surface subcrop within the ML.

Arrow (2016) indicates the regional dip of the Fair Hill Formation directly east of the Yarrabee Fault is likely to be westward towards the centre of the Foxleigh Syncline, likely implying subregional groundwater flow westward towards the mine on its eastern side.

Continuous monitoring of Permian groundwater levels has been conducted since July/August 2021. Hydrogeological logs of these bores are provided in Appendix 2. Groundwater monitoring data have been converted to elevation to assist in comparison and are presented in a composite hydrograph at Figure 14.

Groundwater levels recorded in standpipe piezometers in P4 (Middlemount seam, south end of disused Carlo Creek pit) and P7 (Middlemount seam, north end of Pipeline pit) show negligible variation around 113.8 mAHD and 89.6 mAHD respectively despite being adjacent to active or former open cut pits implying that groundwater within the Middlemount seam at these locations has been reduced to close to the floor of the respective pits which may now be controlling groundwater levels locally in the seam.

The groundwater level in the Middlemount seam at P5, relatively close to P4 at the southern end of Carlo Creek pit (disused) exhibits no level fluctuations except those caused by periodic groundwater extraction for water quality sample collection, which appears to have resulted in the otherwise flat trend falling from approximately 86 mAHD in August 2021 to 85 mAHD by June 2022.

Groundwater is monitored in the Rangal Coal Measures at the southern end of Far South pit (disused) both in the Middlemount seam (P11D) and within the overlying measures (P11S).

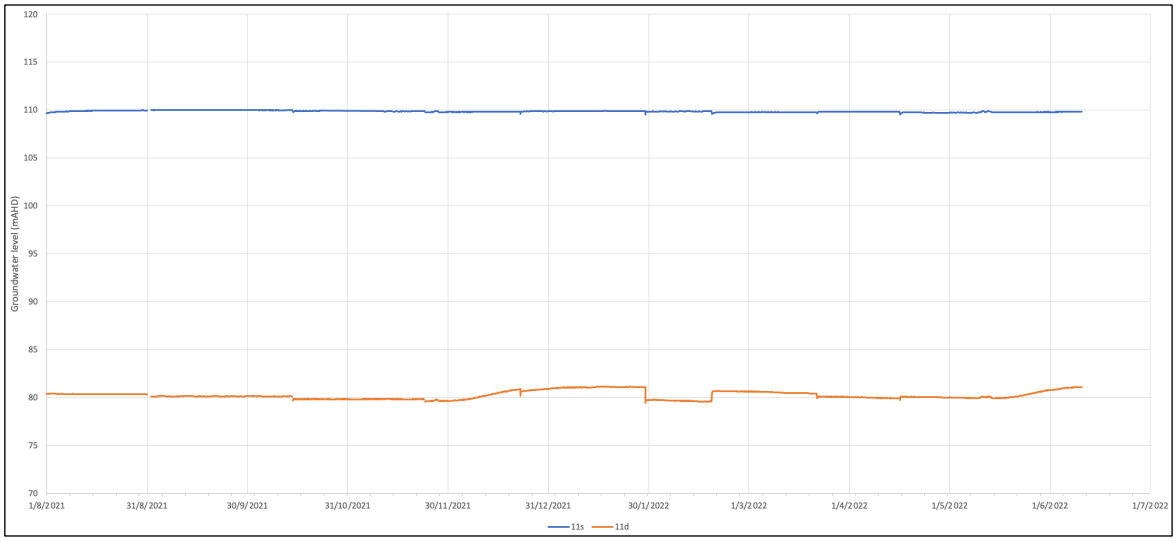

Figure 15: Hydrograph of groundwater in the Middlemount seam and RCM overburden

Figure 15 illustrates that the groundwater level from P11D in the Middlemount seam is approximately 30 m lower than in the overburden (P11S), with groundwater in the overburden reporting consistently close to ground surface throughout the period of monitoring from August 2021 to present.

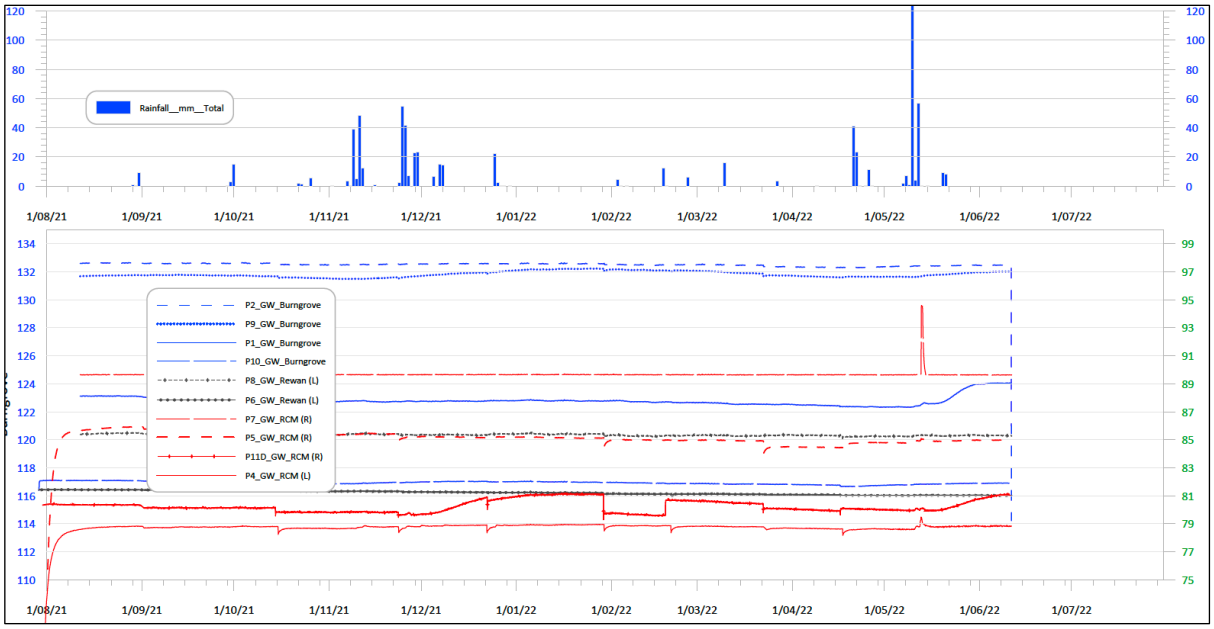

Figure 16: Permian groundwater responses to rainfall

Groundwater within the Middlemount seam beside Far South pit (P11D) appears to reflect the influence of two significant rainfall events experienced at the site in late November 2021 and early May 2022 with a rise of approximately 1.5 m over the six weeks following the November event followed by a recession to pre-event levels and a similar rise following the second event (Figure 16).

Similar but very muted responses are observed in groundwater monitoring standpipes installed in the Burngrove Formation at P9 (southern end of One Tree West pit) and P10 (west side of WC pit), although with fluctuations of approximately 0.1 to 0.2 m only.

6.2 Hydrogeological characteristics of geological units

6.2.1 Alluvium

There are no water supply bores within 10 km of the ML that have been completed in the alluvium on account of the ephemeral presence of groundwater therein and hence no yields reported from registered water bores. JBT (2012) referred to work by Capricorn Coal Management in 1987 for the German Creek mine to determine mine inflow rates. A single test on the German Creek Alluvium (a tributary of Roper Creek) yielded transmissivity in the range 6-15 m^2/day, equating to hydraulic conductivity in the range 0.7-1.5 m/d (8.1E-6 to 1.7E-5 m/s) and a storativity of 1.0E-4 to 1.0E-5 indicating that the unit tested was likely to have been confined.

Other sources referred to by JBT (2013) presented analogous values for alluvium averaging 2.1E-6 m/s. JBT (2013) constructed two 2D models of Foxleigh using a calibrated horizontal hydraulic conductivity (K_h) for the alluvium of 1.74E-5 m/s and a vertical hydraulic conductivity (Kv) of 4.34E-6 m/s. JBT (2013) used Seep/W by GeoStudio to model the mine and based on the volumetric water curve adopted for the alluvium in these calibrated models, the porosity of the alluvium was 0.2 (20%) and the specific yield was 0.12 (12%).

6.2.2 Tertiary Duaringa Formation

The Tertiary sediments of the Duaringa Formation comprise deposits of soft, poorly consolidated sandstones and mudstones. Regionally, the Duaringa Formation contains useable volumes of groundwater, although the distribution and thickness of these deposits is limited within the study area. Data from exploration drilling indicate that the Tertiary sediments tend to be dry when drilled, therefore the Tertiary sediments are not a groundwater source within the study area. JBT (2103) derived values for hydraulic properties for the Duaringa Formation based on information derived from the Lake Lindsay 2005 EIS Groundwater Assessment and German Creek Groundwater Review 1998 and applied horizontal and vertical hydraulic conductivity values of 5.79E-06 and 1.45E-06 m/s (0.5 m/d and 0.125 m/d) respectively and a specific yield of 5%.

6.2.3 Triassic Rewan Formation

The Rewan Formation is a heterogeneous unit of green lithic sandstone, pebble conglomerate and red and green mudstones (Bashari 1998) and is generally regarded as an aquitard (Adani, 2019). It is recognised as the basal confining unit of the Great Artesian Basin (JBT, 2013). A wider search of the Queensland government's registered bore database extending 25 km from the ML boundaries of the site indicates that this formation has recorded a maximum yield of 0.1 l/s confirming that the formation expressed in this locality is not a significant transmissive unit. JBT (2013) cites Arrow Energy (2011) that indicates a hydraulic conductivity for 'Triassic sediments' of 5.79E-08 m/s (0.005 m/d) whilst using values of 1.16E-06 m/s (K_h) and 2.89E-07 m/s (K_v) and a specific yield (S_y) of 0.03 (3%) in the 2D models.

6.2.4 Permian Coal Measures Formations

The mudstone-dominated Permian coal measures strata are typically considered as aquitards interspersed by more hydraulically conductive coal seams. However, the coal seams are typically thin in relation to total formation thickness and hence overall transmissivities are typically low, with commensurately low yields.

JBT (2013) accessed historical air lift data for 129 bores drilled within the Foxleigh Plains mining lease. Analysis of these air lift yield data indicated that 79% recorded yields <1 l/s and only 4% recorded yields >2.5 l/s. JBT (2013) referred to studies by Arrow Energy (2011) which indicated 5.97E-07 m/s (K_h) for the Rangal Coal Measures and by Capricorn Coal Management (1987) which indicated 1.4E-04 m/s to 7.0E-4 m/s (K_h) for the Tieri seam and adopted K_h and K_v of 1.16E-07 m/s and 2.89E-08 m/s for Rangal Coal Measures interburden and Burngrove Formation floor measures and 1.39E-06 m/s and 3.47E-07 m/s respectively for the coal seams.

6.2.5 Summary of hydrogeological characteristics

Review of relevant literature on previous site investigation and modelling studies has yielded the following characteristic values for hydraulic conductivity (Table 10) and storage (Table 11).

Table 10: Characteristic hydraulic conductivity values

Unit	Hydraulic Conductivity (m/s)					
	Review from Literature				Initial Estimate	
	Lower-Kh	Upper-Kh	JBT_Kh (2013)	Ratio (Kh/Kv)	Kh	Kv
Alluvium	8.10E-07	2.89E-04	1.74E-05	2 to 10	1.74E-05	4.34E-06
Weathered Tertiary	3.47E-06	1.16E-04	5.79E-06	2 to 5	5.79E-06	1.45E-06
Rewan Formation	1.16E-08	1.16E-04	1.16E-06	5 to 10	1.16E-06	2.89E-07
Roper interbed	1.16E-09	8.10E-07	1.16E-07	5 to 50	1.16E-07	1.16E-08
Roper coal	1.16E-08	5.79E-06	1.39E-06	5 to 10	1.39E-06	3.47E-07
Middlemount interbed	1.16E-09	1.16E-06	1.16E-07	5 to 50	1.16E-07	1.16E-08
Middlemount coal	1.16E-08	5.79E-06	1.39E-06	5 to 10	1.39E-06	3.47E-07
Tralee interbed	1.16E-09	1.16E-06	1.16E-07	5 to 50	1.16E-07	1.16E-08
Tralee coal	1.16E-08	5.79E-06	1.39E-06	5 to 10	1.39E-06	3.47E-07
Pisces interbed	1.16E-09	1.16E-06	1.16E-07	5 to 50	1.16E-07	1.16E-08
Pisces coal	1.16E-08	5.79E-06	1.39E-06	5 to 10	1.39E-06	3.47E-07
Burngrove Fm	1.16E-09	5.79E-07	1.16E-07	5 to 50	1.16E-07	1.16E-08
Fairhill Fm	1.16E-09	5.79E-07	-	5 to 10	1.16E-07	1.16E-08
Lower Back Creek Gp	1.62E-09	5.56E-07	-	10 to 50	1.16E-08	1.16E-09
Spoil	1.16E-06	1.16E-04	2.31E-05	1 to 5	2.31E-05	5.79E-06
Faults	1.16E-10	1.16E-06		1 to 10	1.16E-08	1.16E-09

Table 11: Characteristic storage values

Unit	Storativity					
	Review from Literature				Initial Estimate	
	Lower-Ss	Upper-Ss	JBT Ss (2013)	JBT Sy (2013)	Ss (m-1)	Sy (-)
Alluvium	1.0E-05	1.0E-02	8.6E-06	0.12	1.0E-4	0.12
Weathered Tertiary	1.0E-06	2.2E-03	8.6E-06	0.05	1.0E-4	0.05
Rewan Formation	2.0E-06	1.0E-03	8.6E-06	0.03	1.0E-5	0.03
Roper interbed	1.0E-06	1.0E-04	8.6E-06	0.03	1.0E-05	0.03
Roper coal	1.0E-06	5.0E-04	8.6E-06	0.05	1.0E-05	0.05
Middlemount interbed	1.0E-06	5.0E-05	8.6E-06	0.03	1.0E-05	0.03
Middlemount coal	1.0E-06	1.0E-04	8.6E-06	0.05	1.0E-05	0.05
Tralee interbed	1.0E-06	5.0E-05	8.6E-06	0.03	1.0E-05	0.03
Tralee coal	1.0E-06	1.0E-04	8.6E-06	0.05	1.0E-05	0.05
Pisces interbed	1.0E-06	5.0E-05	8.6E-06	0.03	1.0E-05	0.03
Pisces coal	1.0E-06	1.0E-04	8.6E-06	0.05	1.0E-05	0.05
Burngrove Fm	1.0E-06	1.0E-05	-	-	1.0E-05	0.01
Fairhill Fm	1.0E-06	6.0E-05	8.6E-06	0.03	1.0E-05	0.03

Unit	Storativity					
	Review from Literature				Initial Estimate	
	Lower-Ss	Upper-Ss	JBT Ss (2013)	JBT Sy (2013)	Ss (m-1)	Sy (-)
Lower Back Creek Gp	1.0E-06	1.0E-04	-	-	1.0E-05	0.01
Spoil	5.0E-06	2.0E-02	2.0	0.15	1.0E-04	0.15
Faults	-	-	-	-	1.0E-05	0.01

6.3 Groundwater quality

Groundwater quality is monitored in compliance with the site's EA at FPMB01 (GMP4) in the alluvium. Alluvial groundwater is typically highly saline with an average EC of 55,000 µS/cm dominated by sodium averaging 9638 mg/l, 21,692 mg/l chloride and 764 mg/l sulphate with a close to neutral average (geometric mean) pH of 7.14.

Additionally, monitoring of field water quality has been conducted at each of the 2021-installed standpipe monitoring bores in order to assist in groundwater characterisation. The results are summarised in Table 12.

Table 12: 2021 GWMB field water quality summary

Formation	GWMB ID	pH (Units) *	Specific Conductivity (µS/cm)	Turbidity (NTU)	Temp (deg C)
Alluvium/Tertiary	P12	6.59	42,765	715.3	28.0
Rewan	P6, P8	6.56	34,084	61.7	26.8
RCM coal seam	P4, P5, P11D	6.89	32,073	16.3	26.1
Permian interburden	P1, P2, P9, P10, P11S	6.81	32,286	36.4	26.8

(*: Geometric mean)

6.4 Groundwater use

The Queensland Government's interactive online mapping and data tool, the Queensland Globe, identifies 31 water bores within a 10 km radius of the site MLs (Figure 17). All 31 bores are identified as existing, with 25 bores identified as 'monitoring' or 'mine monitoring' bores (Appendix 1). Of the remaining six registered water bores (Figure 17), five are identified with a 'water supply' purpose and one is not specified but is understood from anecdotal information to be a water supply bore. Table 13 presents a summary of the information available in the individual bore reports, copies of which are provided in Appendix 1.

Table 13 Registered Water Supply Bores

Registered No.	Name	Lat	Long	Distance [1] (m)	Depth (m)	Fmtn.	GWL [2]	GWQ [3]	Yield (l/s)	Comments
43737	CARLO CREEK No 1	-22.919271	148.84609	4750	51.8	BWG	11.7		0.36	
47353	N0.3 HOLE	-23.008436	148.891646	5370	81	BWG		650	3.8	
103417		-23.005858	148.893155	5600	34.8	BWG	13.7	2100	0.5	
103241	UTAH BORE	-23.075102	148.784901	6700	47.2	Burngrove			1.6	
136126		-23.056944	148.903889	7500	85.3		51.8		0.29	"Bit salty"
103242	HOUSE BORE	-23.068215	148.745731	8770	53.4	Burngrove			0.9	

(1: Distance from ML boundary; 2: Historical groundwater level [mbgl]; 3: Groundwater quality as Electrical Conductivity [µS/cm])

FoxMan conducted a preliminary reconnaissance survey of private water bores in 2022. The results of that inspection are captured in Table 14. Information on other registered water bores identified in Table 13 is not currently available.

Table 14: Water supply bore inspection summary

Bore name	Total depth (m)	Casing depth (m)	Standing water level (mbGL)	pH	EC (µS/cm)	Turbidity (NTU)	Temp (°C)	Use
Carlo Ck No 1 (RN43737)	51.8	13.1	5.2[1]	7.9	3929	28.2	24.9	Existing but not used
Kenny East (-22.895756, 148.815126)	40	NK	n/a	n/a	n/a	n/a	n/a	Disused
Kenny West (-22.898371, 148.700379)	120	NK	20	6.86	403	n/a	n/a	Existing but not used

(1: Date of measurement 2-Aug-2022) (NK: not known)

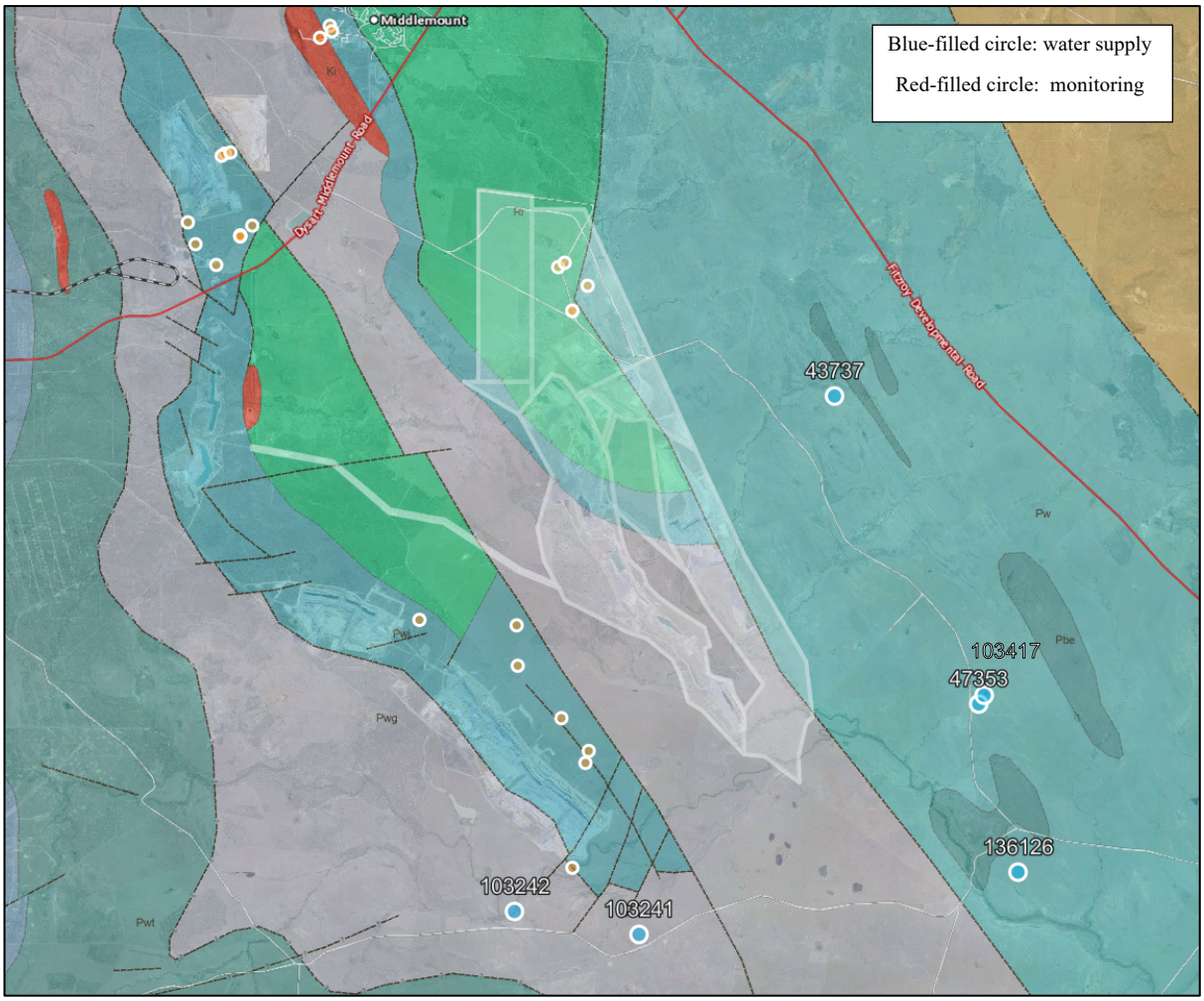

Figure 17: Registered Water Bores

7 MINING

7.1 Mine layout

The mining activities target coal seams within the Rangal Coal Measures including the Pisces, Tralee, Middlemount and Roper seams. These occur as steeply dipping seams sub-cropping on either side of a synclinal structure. The centre of the syncline comprises younger non-coal strata belonging to the Rewan Group and hence pits are opened on either side of the syncline to access the coal. The mine currently comprises thirteen active or former mining pits. The locations and names of each pit are illustrated in Figure 18.

7.2 Development schedule

The evolution of mining at Foxleigh has been compiled by reference to satellite imagery gathered as part of a previous investigation by FoxMan. Table 15 presents a chronology for the development of open-cuts and, where also evident, the presence of water filling residual mining voids.

In broad terms, mining commenced in ML70171 in the south western quarter of the mine starting in WC pit (pre-2000) and spreading first southward into Far South pit (2001) and latterly northward successively into WC North pit (2003), NT pit (2003), Old NE pit (and NW Void 251)(2004), NW pit (2008) and finally NE pit (2011).

Shortly after mining commenced in Old NE pit, mining commenced in the South Eastern quarter of the mine in ML 70309 in One Tree West pit (2005), spreading southward to Carlo Creek pit first (2009) and later northwards to Pipeline pit (2013).

In 2014 mining commenced in the north eastern quarter of the mine in MLs 70470 and 70431 with the opening of Foxleigh Plain pit, working northward. In 2018 Foxleigh Plains North started at the northern end of ML 70431, working southward.

Approved future mining will commence in the north western quarter of the mine in MLs 70429 and 70430 with the opening of the Eagle's Nest pit in 2025.

Table 15: Chronology of mine development from satellite imagery

Year	Operation	Water in voids
Pre-2000	Mining commenced in WC pit	
2001	Mining underway in Far South pit	
2003	Mining commenced in NT pit	
2004	Mining in Old NE pit and NW Void 251	Far South pit
2005	Mining commenced in One Tree West pit	
2006	Mining in NW pit	
2009	Mining commenced in NE pit	
2010	Mining commenced in WC North pit	NW pit
2011	Mining in NE pit	Old NE pit, WC pit
2012	Mining commenced in Carlo pit	Far South pit
2013		WC North pit
2014	Mining commenced in Foxleigh Plains pit	NE pit

Year	Operation	Water in voids
2015		Carlo Creek pit
2016	Mining commenced in Pipeline pit	
2018	Mining commenced in Foxleigh Plains North pit	
2020		Pipeline pit

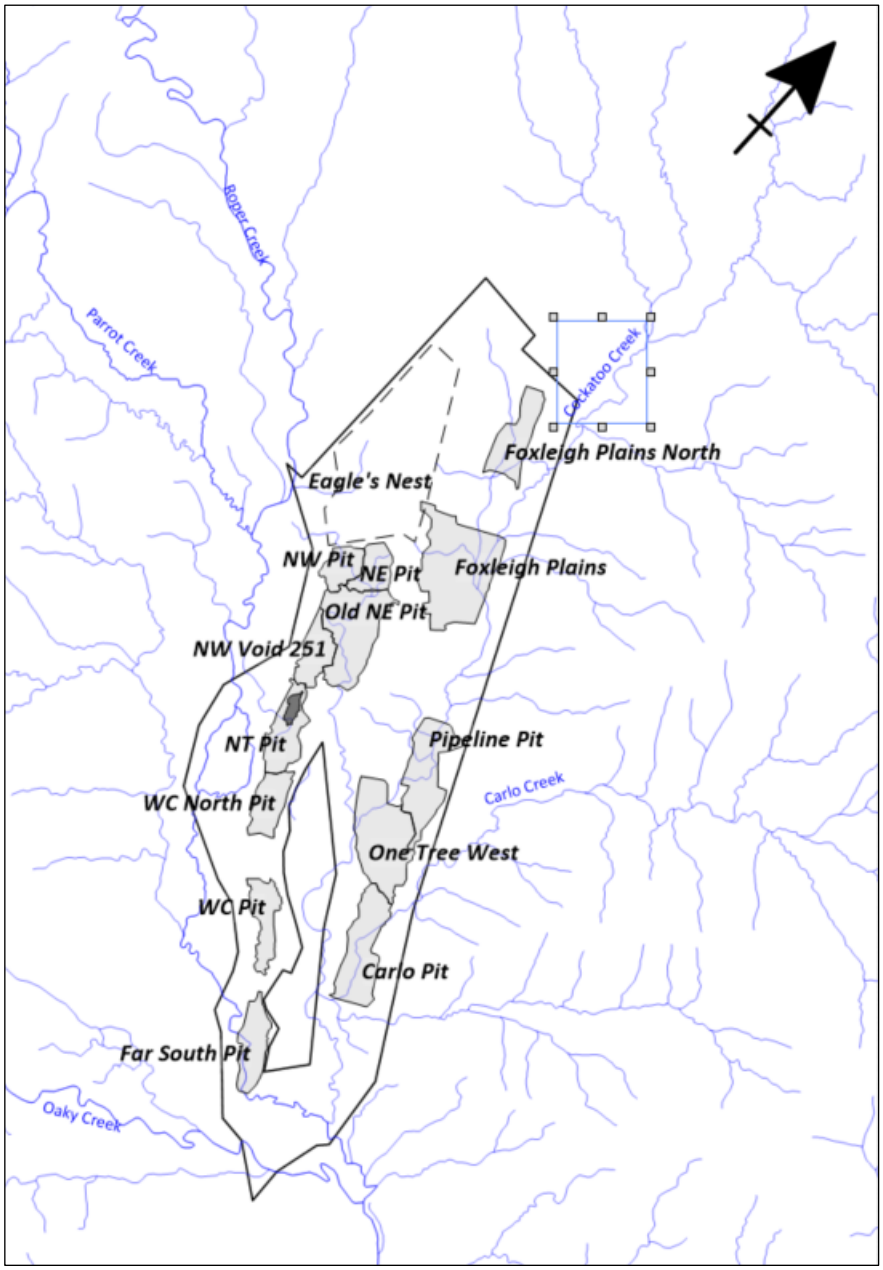

Figure 18: Mine lease illustrating pit names

7.3 Mining method

Subject to the structure and arrangement of seams in each pit, current mining is commenced by developing a box cut to access the coal. Initially, topsoils are stripped and stored for reuse. Tertiary and Quaternary deposits are stripped and stockpiled in out of pit dumps subject to later

reshaping as required for rehabilitation. Permian coal measures overburden is initially excavated and placed in an out of pit dump separate from non-coal measures strata. The box cut is then extended laterally following the strike of the coal seams, with further overburden removal to access the deeper seams. As the deepest seam in the sequence is recovered, so overburden is then replaced behind the mining front to backfill the initial opencut. In this way the opencut void is progressively backfilled and rehabilitated, reducing the extent of opencut void which may be open at any time.

Prior to 2014, mining was conducted by progressive dip mining whereby overburden was stripped and placed in out of pit dumps to access coal. The mine was progressed down dip and overburden was placed in out of pit dumps until the pit was completed.

The former method of mining has resulted in a number of residual mining voids and remnant out of pit dumps in the southern half of the site.

7.4 Characteristics of mining wastes

Mine wastes including coarse rejects and tailings have been the subject of characterisation by RGS in 2021.

7.4.1 Overburden / interburden

RGS (2021) indicates that the overwhelming majority of the overburden and interburden materials have low oxidisable (sulfide) sulfur content, excess acid neutralising capacity (ANC), and are classified as non-acid forming (NAF). These materials have negligible risk of acid generation and a high factor of safety with respect to potential for generation of acid mine drainage (AMD).

7.4.2 Tailings

Coal reject materials have relatively low sulfide content and generally excess ANC. As bulk mixed materials, it is expected that these materials will be classified as NAF and have a relatively low risk of generating AMD (RGS, 2021).

7.4.3 Leachate from mine wastes

Leachate from kinetic leach column (KLC) tests yielded electrical conductivity (EC) values in the range 181 – 2,470 µS/cm, with major ions dominated by sodium, chloride and sulphate. Concentrations of sulphate were typically below the livestock drinking water quality threshold of 1,000 mg/l (ANZG, 2018).

There is no significant metal/metalloid enrichment in leachates derived from KLC tests of mining waste and coal materials compared to applied water quality guideline criteria for livestock drinking water (RGS, 2021). Most metals/metalloids are sparingly soluble at the neutral to alkaline pH of leachate expected from bulk NAF mining waste and coal materials. Hence, dissolved metal/metalloid concentrations in leachate from bulk NAF mining waste materials are generally expected to be low and unlikely to pose a significant risk to the quality of surface and groundwater resources at relevant storage facilities.

7.5 Final voids

The current Life-of-Mine (LOM) plan indicates that voiding below nominally 120 mAHD is likely to remain in Far South pit, One Tree West pit, the far southern ends of Old NE pit and

Carlo Creek pit, the central area between Foxliegh Plains and Foxleigh Plains North pits, and the northern end of the planned Eagle's Nest pit (Figure 19).

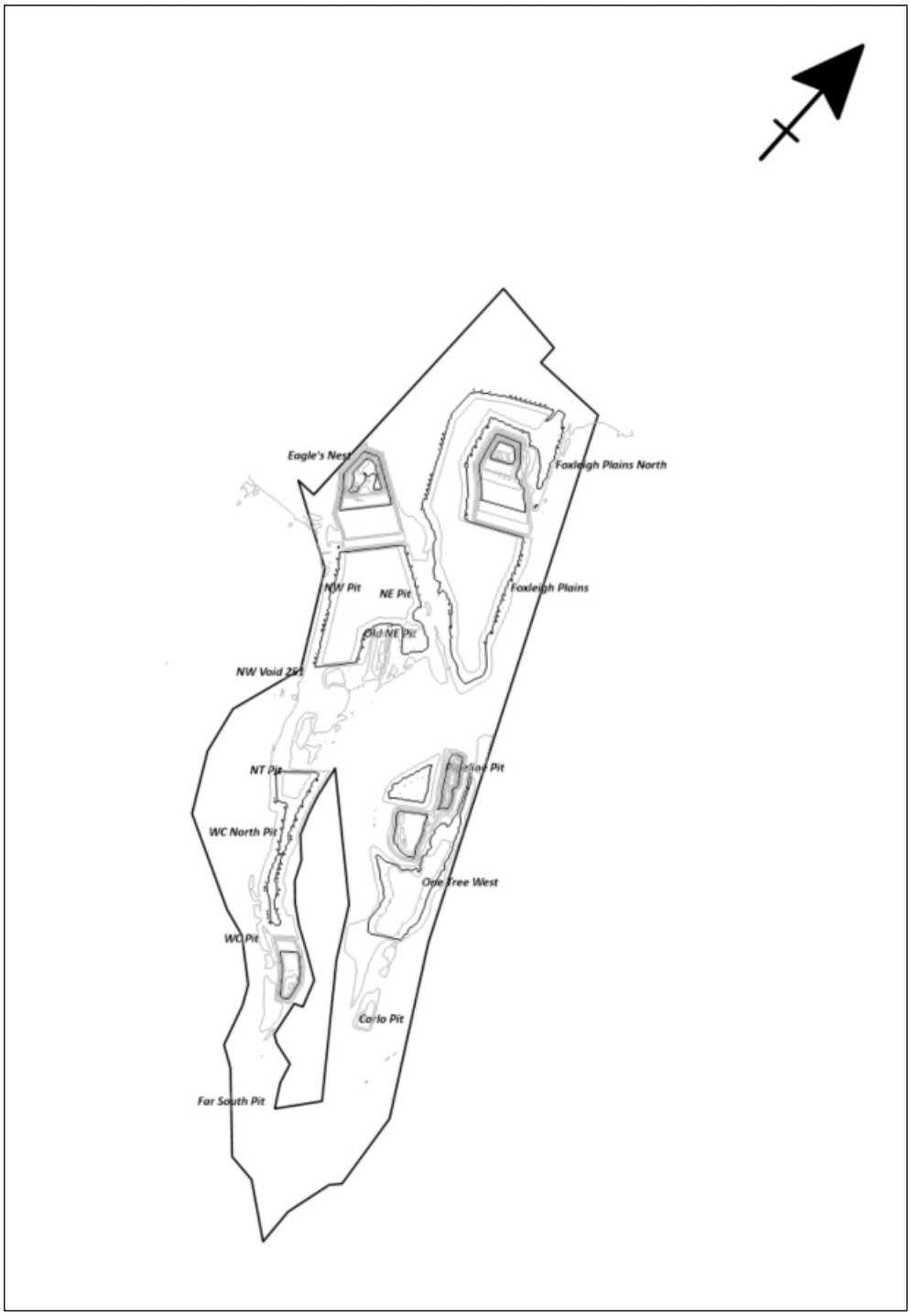

Figure 19: Approximate location of mining voids at end of mining (2054)

7.6 Void water quality

Water is stored a number of former mining pits including Far South pit, WC pit, WC North pit and NE pit in the south western quarter of the mine and in Carlo Creek pit in the south eastern quarter of the mine.

Periodic monitoring of level and water quality is carried out to maintain site water inventories. Recent monitoring carried out in June 2022 indicates that there is negligible stratification of stored waters in any of the five water-filled pits (Appendix 3).

The electrical conductivity was recorded at 1 metre intervals from surface to the base of each water storage; the results are presented in graphical form in Appendix 3 and summarised in Table 16.

Table 16: Void Water Inventory Water Quality

Pit	Mean EC	Min EC	Max EC
Far South pit	20,867	20,829	20,919
WC pit	10,636	10,609	10,819
WC North pit	14,143	14,118	14,239
NE pit	13,278	13,193	13,302
Carlo Creek pit	17,782	17,540	17,848

(Electrical Conductivity, EC, values in µS/cm)

7.7 Tailings Storage Facilities

CHPP fine rejects (tailings) are pumped to an in-pit Tailings Storage Facility (TSF) within NT pit (Figure 18 and Plate 4) where the solids settle out and supernatant water is periodically decanted (Plate 5). NT pit is scheduled to be capped with low permeability mining spoil and rehabilitated to a shedding landform at mine closure.

Plate 4: Discharge of tailings to NT pit

Plate 5: Tailings beach and supernatent in NT pit

8 HYDROGEOLOGICAL CONCEPTUAL MODEL

8.1 Conceptual model domain

The conceptualised domain extents are defined by the fault-bounded Foxleigh syncline with constraints to groundwater flow exchange between Foxleigh and the wider area comprising stratigraphic and structural impediments.

In bedded strata, particularly where the strata contain significant clay contents, horizontal hydraulic conductivity is significantly greater than vertical hydraulic conductivity. Hence groundwater flow normal to bedding is typically very limited. At Foxleigh, the synclinal structure requires lateral groundwater flow to occur normal or sub-normal to the bedded strata and hence impedes horizontal groundwater flow.

Additionally, significant regional thrust faults with substantial tectonic throws extend to either side (East: Yarrabee; and West: Jellinbah) of the mine site, effectively segregating the Foxleigh synclinal Permo-Triassic strata from bedded Permian strata to the East and West.

The Foxleigh syncline plunges to the north, with increasing depth of burial beneath Triassic strata, whilst to the south, the syncline is breached and the target coal seams of the Rangal Coal Measures outcrop.

8.2 Hydrostratigraphic Units

The various geological strata can be classified based on their hydrogeological characteristics into four hydrostratigraphic units (HSUs) (Table 17).

The Quaternary alluvial and colluvial deposits can be grouped with the Tertiary Duaringa Formation based on their relatively similar compositions and low grades of diagenesis as HSU1. There is no evidence of separation of groundwaters within these sediments within the study area.

The Rewan Formation can be considered a single hydrostratigraphic unit, HSU2, whilst the Permian interburden consists of two interleaved hydrostratigraphic units including the coal seams as transmissive units and overburden/interburden and floor measures (including the Burngrove Formation and Fair Hill Formation) as poorly-transmissive units.

There are five principal seams present within the Rangal Coal Measures at the site including, from top down, the Roper, Middlemount, Tralee, Pisces 1 and Pisces 2 seams. Each seam may split or merge but for the purposes of classification, these five seams comprise the coal seams HSU3 with the overlying and intervening measures and the underlying Burngrove Formation comprising the Permian non-coal HSU4.

Table 17: Hydrostratigraphic Unit Designation

HSU	Stratigraphy
1	(Recent) alluvium/colluvium & (Tertiary) Duaringa Formation
2	(Triassic) Rewan Formation
3	(Permian) Rangal Coal Measures overburden and interburden, Burngrove Formation & Fair Hill Formation
4	(Permian) Rangal Coal Measures coal seams (Roper, Middlemount, Tralee & Pisces2) and Burngrove coal seam (Pisces1)

8.3 Surface water – Groundwater interaction

JBT (2013) reported on a groundwater investigation conducted on Cockatoo Creek in 2011 in the vicinity of the future diversion of this creek for Foxleigh Plains pit. The investigation comprised eight shallow bores into the Rangal Coal Measures (FK193, 194, 200, 201, 216, 220, 222 and 223) forming two transects extending westward of, and perpendicular to, the creek (Table 18Table 3).

Table 18: Cockatoo Creek Groundwater Investigation - summary results

Bore ID	Easting (GDA94)	Northing (GDA94)	GWL (mAHD)	EC (µS/cm)
FK193	681277.6	7466490.6	110.3	30,936
FK194	681360.7	7466529.5	103.7	29,387
FK200	681634.2	7466655.4	124.2	39,655
FK201	681678.5	7466673.4	122.6	45,131
FK216	681631.1	7466439.3	121.6	41,941
FK220	681473.8	7466340.9	116.4	36,295
FK222	681387.3	7466290.7	121.9	32,024
FK223	681311.5	7466245.0	118.4	32,987

Piezometric data indicated that the head in the coal measures was highest in bores closest to the creek, although several metres below the top of the Permian strata indicating that ephemeral flow in the creek may yield temporary recharge to the alluvium and ephemeral seepage from the alluvium to the Permian coal measures. The data further indicated that groundwater leakage was not occurring from the coal measures to the alluvium and hence the Permian strata were not contributing groundwater baseflow to the alluvium or surface water baseflow to the alluvium.

Field water quality data reported from the same bores indicated that salinity decreased with increasing distance from the creek, with EC values around 40,000 µS/cm closest to the creek declining to around 30,000 µS/cm distal from the creek. JBT (2013) indicated that historical EC measurements of water from the creek in flow exhibited a median of 179 µS/cm and a maximum of 417 µS/cm, confirming that the creek was not receiving salinity in baseflow from the Permian strata. The EC gradient falling with distance from the creek may indicate that ephemeral flow events which temporarily recharge the alluvium may be drawing salinity from the coal measures by evaporation.

The current standpipe monitoring network includes two bores penetrating alluvium including P3 in the Roper Creek Alluvium and P12 in the alluvium of Cockatoo Creek (and potentially the underlying Tertiary Duaringa Formation). P12 exhibited an average groundwater level of approximately 112 mAHD during the period from August 2021 to September 2022 although this may indicate groundwater is not present in the alluvium at this location as this value represents the base of the borehole. Although potentially influenced by the presence of disused pits, groundwater observations in neighbouring Rangal Coal Measures bores P11D to the south west and P5 to the north have exhibited stable groundwater levels of approximately 80 mAHD and 85 mAHD respectively during the same monitoring period. These measurements indicate that groundwater in the coal measures is approximately 25-30 m below that in the alluvium at the southern extent of the site.

Consequently, it is inferred that groundwater in the alluvium is disconnected from the ephemeral surface water system, likely only occasionally to receive recharge from creeks through bed leakage during times of flood and furthermore that groundwater, when available in the alluvium, is likely to be present above the level of groundwater in the underlying Permian strata and hence lead to ephemeral groundwater recharge by seepage from the alluvium to the coal measures. Discharge of groundwater from the coal measures to alluvium is considered unlikely to occur and hence contributions of saline groundwater from the coal measures to the creeks is considered highly improbable. Pools and waterholes associated with the Roper Creek drainage network are considered likely to be maintained by surface water run-off with no input from groundwater.

8.4 Groundwater recharge

Groundwater recharge is likely to be strongly controlled by the surface expression of hydrostratigraphic units and the extent of weathering of consolidated strata (largely Permo-Triassic strata). Recharge mechanisms to the groundwater system include:

1. Recharge to alluvial channel sediments during creek flow events by bed leakage;
2. Direct infiltration of rainfall to unconsolidated sediments (Quaternary alluvium and Tertiary Duaringa Formation);
3. Indirect infiltration of run-off from the outcrop of less permeable strata at the fringes of permeable alluvium or Tertiary sediments;
4. Direct recharge to Permian coal measures strata where coal seams outcrop, or by downward seepage where coal seams subcrop beneath permeable Quaternary or Tertiary sediments; and
5. Direct recharge to Permian interburden or Triassic strata or by gradual seepage where such strata underly permeable superficial deposits.
6. Following mining activity, a further mechanism of groundwater recharge is identified comprising the direct infiltration of rainfall to replaced/rehabilitated mining spoil.

JBT (2013) initially adopted a rate of recharge across the top surface of their model as 2% of their calculated long-term annual average rainfall, equivalent to approximately 12 mm/year or 3.26e-05 m/day. This was found to result in excessive groundwater mounding in some parts of their models and was subsequently reduced to 1% of long-term annual rainfall.

Initial estimates of recharge for this modelling exercise as proportions of calculated long-term annual average rainfall comprise 1-2% for the alluvium, 0.5-1% for Tertiary sediments and Permian coal seams and 0.1-0.5% for Permian coal measures interburden strata.

JBT (2013) applied recharge to mining spoil in pit backfill at 10% of long-term annual average rainfall, although they applied a very high hydraulic conductivity to mining spoil which would otherwise have resulted in recharge rejection (mounding in the 2D model).

Given the lower conductivity values considered likely to apply to replaced mining spoil, recharge to spoil is here considered to range between 2-5%.

8.5 Groundwater flow directions

Historically, groundwater flow directions have been understood to flow from west to east regionally and locally have been conjectured to flow from the peripheries of the Foxleigh syncline towards its axis, although the direction of axial groundwater flow has not been considered.

Since August 2021 groundwater levels have been monitored in detail, during which time it has been demonstrated that levels are stable throughout the majority of standpipes in the various targeted formations. Whilst there are four standpipes monitoring groundwater in the Burngrove Formation and five in the Rangal Coal Measures (four in the Middlemount seam and one in overlying interburden), the geological compartmentalisation of the site wrought by extensive faulting and the synclinal structure of the Permo-Triassic strata, together with the presence of current and historical pits, has made the determination of groundwater flow directions in the various formations difficult to assess with a high degree of confidence.

8.5.1 Quaternary and Tertiary groundwater flow direction

Monitoring to date indicates that groundwater is not consistently present in the Quaternary Alluvium or Tertiary Duaringa Formation and thus when groundwater is present following significant recharge events, the groundwater flow direction is likely to follow the pathway of the surface drainage network. Hence groundwater in the alluvium associated with Roper Creek and tributaries is expected to flow east towards the site and then southward towards the confluence of Roper Creek and Cockatoo Creek, and from there south eastwards to the confluence with the Mackenzie River Alluvium. Similarly, groundwater in the alluvium associated with Cockatoo Creek and tributaries is expected to flow southward and mix with that within the palaeo-channel of Roper Creek.

Note however that seepage from the alluvium into the underlying unsaturated Permian strata is understood to deplete groundwater within the alluvium between significant recharge events.

8.5.2 Groundwater flow direction in the Rewan

Only two standpipes report groundwater levels within the Rewan and hence conventional triangulation of monitoring data is not applicable. However, the Rewan occupies the centre of Foxleigh syncline and hence lateral flow perpendicular to the axis of the syncline is not expected to be significant. Hence the flow direction is interpreted as south-southeastward based on groundwater levels during 2020-2021 of approximately 120.25 mAHD in the northerly P8 and 116.1 mAHD in the more southerly P6. The inferred groundwater flow gradient is approximately 0.66 m/km (6.58e-4 m/m).

8.5.3 Groundwater flow directions in the Permian

Permian strata are influenced to an uncertain degree by the interaction of groundwater hosted by unmined strata in which the standpipes have been installed and the historic (disused) and currently-operating pits. Given that coal seams are considered to be the predominant transmissive units within the Permian and these coal seams are intersected by the pits, it is inferred that groundwater flow paths within the intersected coal seams will commonly be orientated towards the pits. Hence, whilst a pattern of declining levels in RCM Middlemount seam-intersecting standpipes is evident from P7 (89.9 mAHD) in the north (north side of Pipeline pit) through P5 (85 mAHD) (southern end of Carlo Creek pit) to P11D (80 mAHD) in the south (south of Far South pit), this 7m decline is considered more likely to be controlled by pit floor depths and pit water level management than a reflection of groundwater flow in the coal seam. Comparison of these data with elevation data relating to standing water levels in adjacent flooded voids (Far South pit, WC pit and Carlo Creek pit) may provide further indication of the prevailing groundwater flow direction in the Middlemount and associated RCM seams.

Conversely, groundwater monitoring in standpipes in the Burngrove Formation along the western side of the mine are considered likely to reflect a prevailing groundwater flow direction because they are close to subcrop and occupy a geological position stratigraphically underlying the lowest seams targeted in the adjacent pits. Hence a south-easterly groundwater flow direction is inferred along the western side of the mine in these strata, from P2 (132.5 mAHD) through P1 (122 mAHD) west of NT pit, to P10 (117 mAHD) west of WC pit. P9 (132 mAHD) on the eastern side of Carlo Creek pit may lie in strata on the eastern side of the Yarrabee Fault and hence within the Fair Hill Formation, distinct from the Rangal Coal Measures/Burngrove Formation. Whether or not P9 occupies the same strata as P1, P2 and P10, its position on the eastern side of the syncline renders it unsuitable for correlation with the standpipes on the western limb. The hydraulic gradient indicated by P1, P2 and P10 is approximately 1.2 – 2.7 m/km although considerable uncertainty surrounds how these levels should be interpreted given the sharp change in levels between P1 and P2.

8.6 Groundwater discharge

As discussed in Section 8.5.3, groundwater flow in the Burngrove Formation is inferred to occur in a south easterly direction on the west side of the mine complex. On account of potential historical mining influences and the arrangement of monitoring bores, it is not possible to determine with confidence the groundwater flow in the same strata on the east side of the mine, although the north-south structural alignment of the Foxleigh syncline is likely to encourage a southerly flow direction.

In the absence of mining, it is likely that groundwater flow within the Rangal Coal Measures overlying the Burngrove Formation would have followed a largely similar pattern, although with only limited subcrop, negligible outcrop and only ephemeral recharge from alluvial interfaces, levels would be expected to remain at depth and unlikely to discharge at surface. Closure of the coal measures subcrop at the southern end of the northerly-plunging Foxleigh syncline is further considered likely to prevent flux of coal measures groundwater southward.

However, movement offsite of groundwater from the Burngrove Formation within the footprint of the mine is likely to occur at the southern extent of the mine.

8.7 Role of Faulting

A number of major fault structures occur in the area, including the Grasstree Fault Zone (in the German Creek Mine area), the Jellinbah Fault to the west of the study area, and the Yarrabee Fault, which disrupts the stratigraphic sequence within the study area (Figures 4 and 5). These faults significantly disrupt the stratigraphic sequence and therefore have the potential to significantly impact groundwater occurrence and movement.

The Grasstree Fault Zone in the German Creek Mine area is regarded as a minor aquifer, and pumping tests have been undertaken on bores within, or on either side of, the fault zone. This is discussed further in Section 7.2.

Standpipe monitoring bores P4 (59 m depth) and P5 (109 m depth) may lie on either side of the Yarrabee fault which juxtaposes strata belonging to the Rangal Coal Measures and those of the underlying Fair Hill Formation. It is conjectured that the shallower easterly P4 occupies undrained sediments of the Fair Hill Formation east of the Yarrabee Fault whilst the deeper westerly P5 lies in strata drained / depressurised by mining in the adjacent Carlo Creek pit. This implies that the Yarrabee Fault represents a barrier to groundwater flow, effectively isolating the two groundwater systems.

Numerous small faults have been mapped in the exposed Permian strata within the various pits. Typically these faults are orientated normal to the axis of the syncline and exhibit throws of a few metres or tens of metres at most. Seepages commonly occur on pit faces where these faults intersect coal seams, implying that minor flows, in seams close to but beyond the pit wall, are interrupted by the fault plane and directed toward the open pit.

8.8 Transient Conceptualisation of stresses

Conceptualisation of the study area considers the precursor pre-mining condition, a successively developing mining condition and a post-mining condition.

8.8.1 Pre-mining Conceptual Model

In the pre-mining condition, monsoonal rainfall events leading to ephemeral creek flows deliver groundwater recharge to the alluvium and underlying Tertiary Duaringa Formation. Surface pools remain in places after surface flows have subsided, perched on low hydraulic conductivity creek bed substrates. Groundwater flow in the alluvial sediments occurs in a southerly or south easterly direction within the study area within the palaeochannels in which the sediments have been deposited on a palaeotopography of Permo-Triassic strata. Within weeks following recharging flow events, groundwater present in these superficial sediments is depleted by lateral flow down the palaeochannels and by seepage into the underlying unsaturated Permo-Triassic strata.

In the weeks following the recharge events, minor increases in groundwater levels may be observed in the Permo-Triassic sediments underlying the Quaternary/Tertiary sediments close to the creek channels but these rises are followed by gradual recessions over weeks.

Direct recharge to the majority of the Permo-Triasic strata is minimal due to the low hydraulic conductivities of these materials. However, recharge penetrates the Permo-Triassic rocks at the outcrop or subcrop of more permeable beds or coal seams, percolating down dip within unsaturated strata at the fringes of the syncline towards the axis of the Foxleigh syncline.

The north or north westerly orientated Yarrabee and Jellinbah faults on either side of the mine act as effective barriers to the regional eastward groundwater flow by juxtaposing the thick sequences of low hydraulic conductivity mudstones against the thin occurrences of more hydraulically conductive coal. Therefore, once at the water table, the direction of groundwater flow becomes southerly or south easterly. Groundwater quality data for coal measures within the study area indicates a range of electrical conductivity (EC) values of between 29,000 and 45,000 µS/cm, suggesting long residence times for groundwater within the coal measures.

8.8.2 Conceptual Model during Mining

The principal effects of the mining operation comprise the opening of voids, breaching low hydraulic conductivity cover/overburden and exposing conductive coal seams. Groundwater entering voids is lost through the removal of coal and spoil, evaporation and sump dewatering. This groundwater loss leads to localised groundwater sinks centred on the open pits.

Exposure of coal seams in open-cut pits creates a potential connection along seam to connected groundwater resources, where seams subcrop beneath alluvial or Tertiary sediments along strike from exposure in opencut pits. However, as discussed in Section 6.1.3, monitoring

indicates that groundwater is not perennially present in the alluvium and Section 8.3 identified that groundwater in the Permian beneath or in proximity to the alluvium remained below the top of the Permian strata and hence neither discharging to nor connected with the alluvium.

There are no other potential stratigraphic connections between open pits and groundwater resources at Foxleigh, as although registered water bores have been identified (Table 13) within the study area surrounding the mine, major structural dislocations comprising the Yarrabee and Jellinbah faults and other smaller faults effectively isolate the pits from analogous strata to the east and west of the mine.

8.8.3 Post-mining Conceptual Model

Backfilling of voids reduces evaporative losses and allows groundwater to recover within the voids. Where voids are not backfilled, only partially backfilled or remain open to full depth in parts of their strike length, accumulating groundwater may daylight leading to standing water within the former voids. Subject to rehabilitation and the diversion of incident rainfall into or away from the residual voids, standing water levels in the residual voids may recover above or remain below the original piezometric surface prevalent before mining began.

Where post-mining groundwater levels recover above original groundwater levels due to the influx of rainfall and surface water from the catchment of the individual pit, groundwater mounding will occur beneath and around the residual void, standing water may occupy the void and the void will become a source of groundwater recharge to the intersected coal seams and associated Permian strata. In this circumstance, groundwater recharge potentially containing elevated levels of contaminants (largely limited to salinity, refer Section 7.4.3) released from the broken / weathered spoil will seep into the groundwater system and may potentially follow pre-mining groundwater flow pathways southward beyond the extents of the mine. This surcharging of the Permian groundwater system may lead to elevated groundwater levels that discharge to the alluvium to the south of the site.

Alternatively, where evaporation continues to exceed influxes of incident rainfall and run-off from the void catchment into the residual void, the standing water level in the residual void will remain below that in the surrounding connected strata. Although contaminants from spoil will enter the residual void, the void will remain a groundwater sink and hence accumulate solutes.

9 NUMERICAL MODEL DESIGN

9.1 Modelling Objectives

The modelling objectives are described in Section 1.3 and comprise the prediction of water levels in open pits and the interaction of pit lake waters with groundwater. The prediction of pit lake water levels requires interaction with a surface water balance model, through iteration with which, groundwater fluxes can be quantified. Prediction of pit lake water / groundwater interaction requires simulation of the groundwater flow field within which the pit lakes exist from genesis to post-closure equilibration. Hence a model is required that is capable of calibration to available site data and which can be used to simulate transiently the regional and local groundwater flow field within which mining voids are developed and variously backfilled or allowed to flood with water.

The model is required to predict representative groundwater levels in each hydrogeologic unit that may affect the interaction of groundwater with the mining voids during mining and subsequent backfilling or flooding to the extent that it is possible to assess calibration to available site or regional data. In this way an assessment may be made of the suitability of the model for transient prediction.

Neither fixed calibration metrics nor predictive targets have been quantified for this modelling work. However, industry-accepted metrics for assessing acceptability of calibration have been adopted including achieving, for the steady-state and transient calibration models, Mean Sum of Residuals (MSR) errors less than 1 m, total scaled Root Mean Square Errors (SRMS value) less than 10% and correlation coefficients greater than 95%. In addition, the likeness of fit of individual hydrographs during the transient calibration was adopted as an indicator of model fitness for purpose.

9.2 Code Selection

United States Geological Survey (USGS) MODFLOW-USG version 1.8 was used as the modelling code to simulate groundwater flow at Foxleigh. USG stands for UnStructured Grid and MODFLOW-USG is based on a control volume finite difference code which contains complex simulation capabilities and robust solution methods. This enables the effective representation of hydrogeological features and interaction between groundwater and surface water flow, mass conservation and solute transport within numerical solutions.

Groundwater Vistas version 8.22 was adopted as the graphical user interface (GUI) for building, running and analysing the MODFLOW models.

When building groundwater flow models, it is important to ensure that model runtimes can be achieved with reasonable durations on conventionally-available computing hardware. The hardware on which the current Foxleigh transient predictive models have been built and operated comprises a Lenovo RTX 3080 Ti laptop with a 16-core Intel Core i9-12900HX 2.5GHz CPU. Run times for specific models are listed below:

Steady-state model:	5 mins
Transient historical calibration model:	30 mins
Transient operation prediction model:	75 mins
Transient post-closure prediction model:	90 mins

9.3 Model Extent

The model domain presented in Figure 20 covers an area of approximately 578 km^2 extending 20 km from the SW boundary to the NE boundary and 29 km from the NW boundary to the SE boundary. The model domain is centred on Foxleigh and incorporates parts of the Roper Creek and Cockatoo Creek catchments.

The domain was constrained to a combination of surface, solid and structural geology, as well as consideration of the topography from which groundwater divide boundaries that could be inferred. Furthermore, the model boundaries are considered to be sufficiently distant from existing and future operations that the predicted drawdowns would not be influenced by numerical boundary effects.

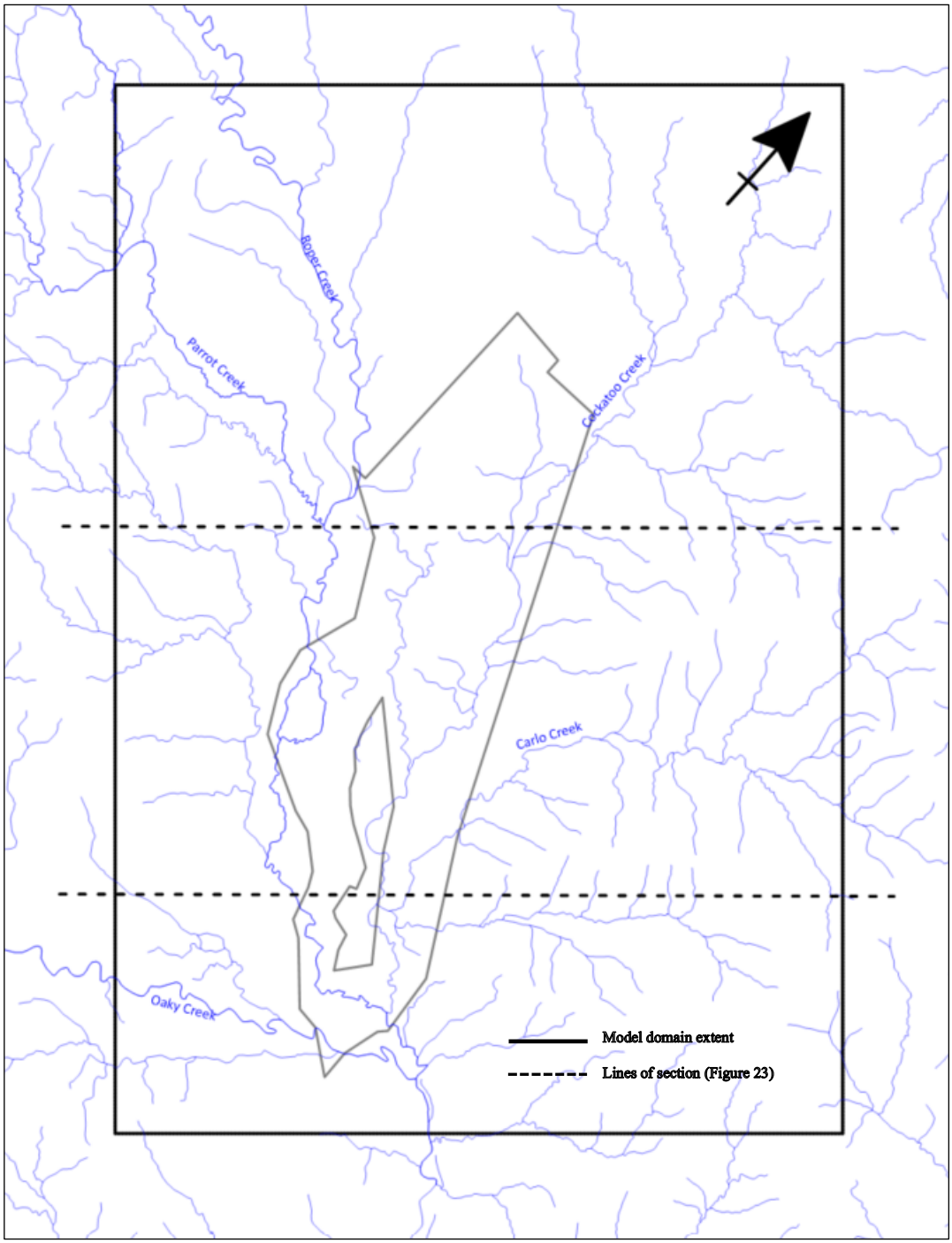

Figure 20: Model Domain Extent

9.4 Spatial discretisation

The numerical model uses a USG quad-tree refinement approach to generate an irregular mesh with 14,337 cells per layer. The cell size varies from 50 m x 50 m, within the vicinity of the mine operation area, waste rock dumps and backfill and major watercourses, to a maximum of 400 m x 400 m at the regional extents of the model domain.

A rotation of 42° was selected for the model grid to align with the extension of open cut layout for the project and the major orientation of the existing Foxleigh mine leases.

The model grid mesh refinement is illustrated in Figure 21.

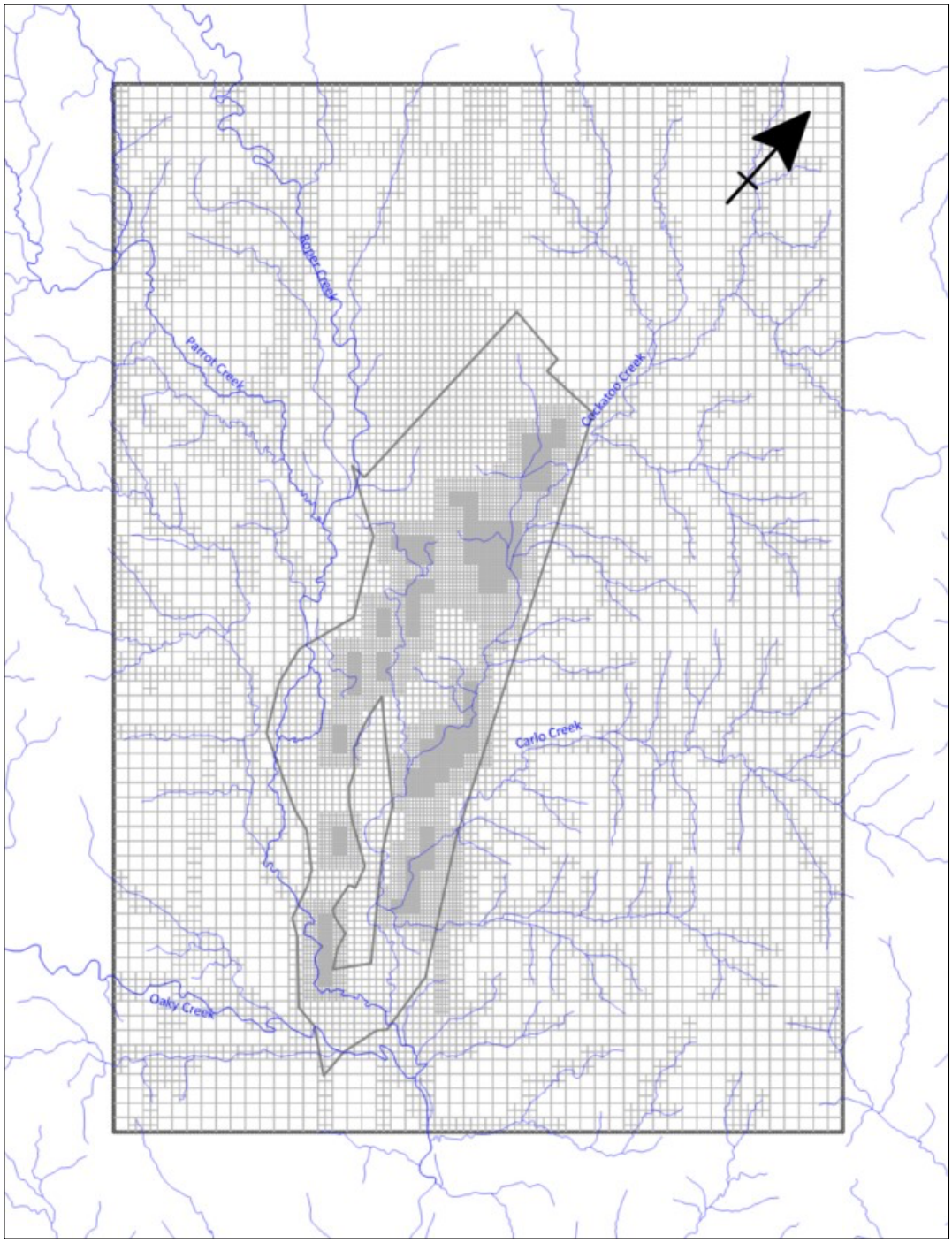

Figure 21: Model grid mesh refinement (Layer 1)

9.5 Boundary Conditions

Boundary conditions are mathematical statements of the constraints necessary for aligning locations in the model where flows occur either into or out of the model domain due to external factors. The following boundary conditions were established in the model:

9.5.1 General Head Boundary

The General Head Boundary (GHB) defines a constant head boundary with a resistance between the model and the constant head. Flow to the GHB can be positive or negative and is unlimited. A negative flow in MODFLOW indicates flow out of the ground-water system. Conceptually, the GHB is a fixed head far from the model where it is assumed to be a fixed head with time (i.e., the river or head will not be affected by the model stresses over time). The purpose of using this boundary condition is to avoid unnecessarily extending the model domain outward to meet the element influencing the head in the model. As a result, the general head condition is usually assigned along the outside edge of the model domain. GHBs were established around the perimeter of the model to simulate regional groundwater flow across the model domain and allow hydraulic exchange beyond the model extents. Establishing GHBs additionally permitted the regional groundwater flow system to be reliably represented at local scale on four sides of the model. Figure 12 illustrates the regional expression of the water table and provides the basis for determining the GHB characteristic heads at the edges of the model domain.

The South eastern boundary is assigned as a GHB to represent the regional flow exchange in the downstream and beyond the riverbed in southern model domain.

The south western boundary was assigned a GHB so that any potential impacts from other mines to the model regime could be considered.

The north western boundary is assigned as a GHB to permit groundwater flow in-and-out of the model because the this boundary does not represent a terminal groundwater flow system boundary for upper stream catchments of Roper Creek and Cockatoo Creek.

The north eastern boundary comprises is predominantly represented by a no-flow boundary for the location where is a catchment divide. The GHB was limited to adapt below the upper stream of Carlo Creek to represent flow beyond the riverbed from upstream outside of the model to downstream inside of model domain.

Mine site voids and water storages are also modelled using GHB to represent the interaction between pit (surface) water and groundwater. The method of managing time-variant properties arising due to mining is addressed in Section 9.7 and Figure 24. Where pit water level data are absent, the pit water levels were assumed to recover linearly to the 2022 site levels from the bottom of the pit at the end of mining.

9.5.2 Creeks

Creeks within the model domain were simulated using drainage (DRN) boundaries since locally they are ephemeral in nature and are not a source of recharge. The DRN boundary allows groundwater to discharge into the drainage line where the water table in the surrounding geological units is above the base of the creek due to rainfall recharge. This boundary condition has been applied to the surface water drainage features within the model domain.

9.5.3 Evapotranspiration

Evapotranspiration was applied with the EVT package and zoned according to the extent of individual surficial units. The evapotranspiration rate for each zone was calibrated with PEST in the range between 20% and 60% of the pan evaporation. This range of values was sourced from the average areal potential evapotranspiration map. Extinction depths (the depth below

which evapotranspiration is negligible) between 3 m and 7 m were calibrated and applied for various EVT zones.

9.5.4 Recharge

Recharge across the model domain was zoned according to the surface expression of different geological units with varying rates across the model surface. The zonation of recharge is shown on 22

Recharge rates are defined and calibrated as a percentage of annual rainfall. A slightly higher recharge rate is assigned to surficial alluvium to account for leakage from drainage during seasonal rainfall events.

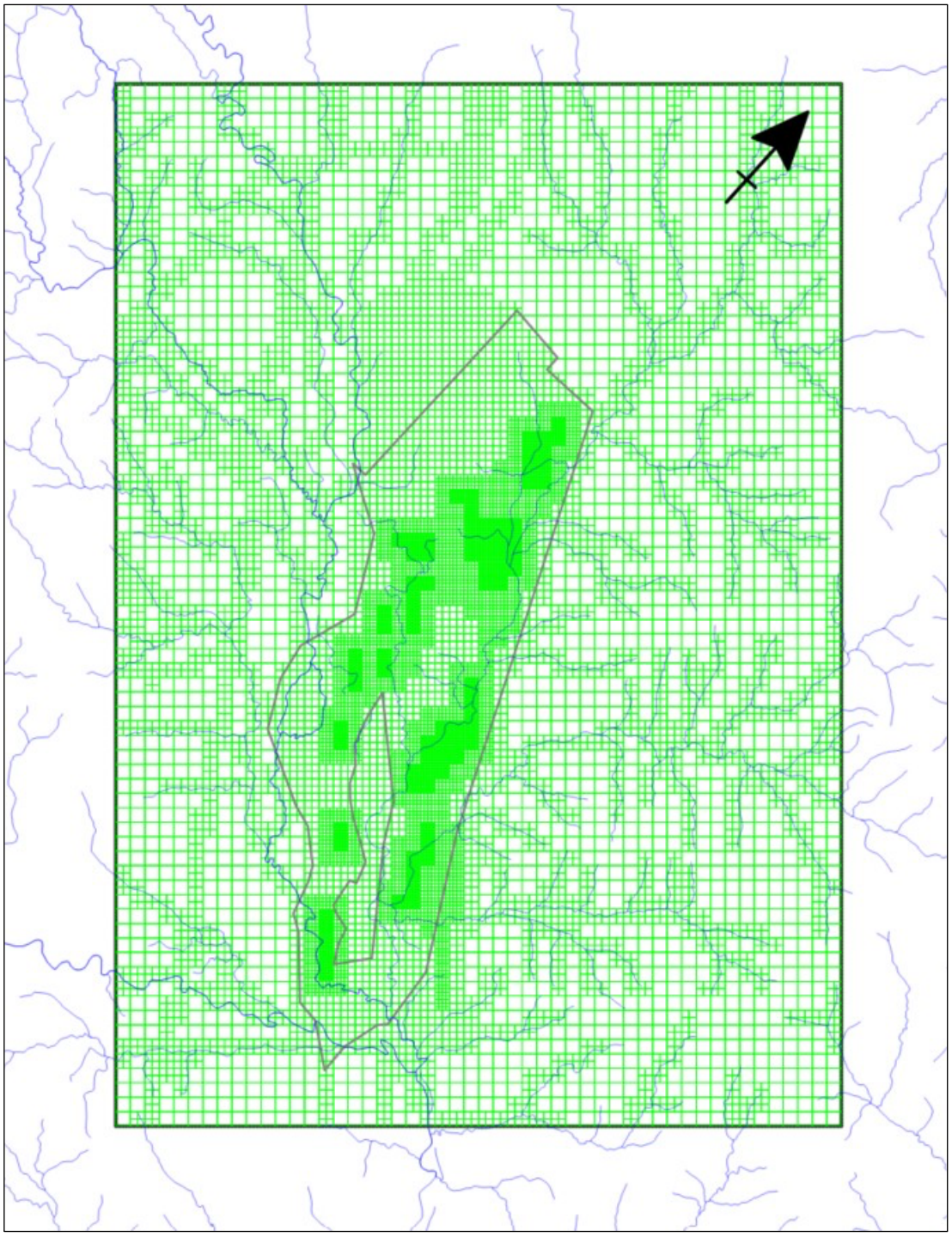

Figure 22: Distribution of recharge across model domain

9.6 Model Layering

Section 8.2 identified four principal hydrostratigraphic units relevant to the hydrogeology of the study area including the Quaternary/Tertiary sediments, the Triassic Rewan Formation, Permian coal seams and Permian non-coal strata. Within the numerical model, these are translated into fifteen model layers (Table 19) to accommodate the interweaving of coal seams with non-coal strata and the spatial distribution at outcrop/subcrop.

Table 19: Model layering

Layer	Zone	Formation	Coal Seam/Material
1	1\2	Alluvium	Alluvium/Tertiary regolith
2	2	Weathered zone	Weathered (Triassic and Permian)
3	3	Rewan / Duaringa	Rewan Formation
4	4	Rangal Coal Measures (Pbj)	Roper overburden
5	5		Roper Coal Seam
6	6		Middlemount overburden
7	7		Middlemount Coal Seam
8	8		Tralee overburden
9	9		Tralee Coal Seam
10	10		Pisces overburden
11	11		Pisces Coal Seam 1
12	12	Burngrove Formation	Yarrabee Tuff / Pisces interburden
13	13		Pisces Coal Seam 2
14	14		Burngrove Formation 1
15	15		Burngrove Formation 2
	16	Blackwater	Fair Hill Formation
	17	Back Creek Group	Blenheim Formation

The top two model layers represent unconfined Quaternary and Weathered Sediments. The surface elevation of Layer 1 (topography) was provided by Foxleigh and augmented with the Queensland Government DEM outside of the mining areas.

All layers extend across the full model domain.

- Layer 1 represents the alluvium, where present, or alternatively tertiary regolith or weathered Permo-Triassic strata;
- Layer 2 represents weathered Permo-Triassic strata present beneath the Tertiary and Alluvium and in areas where these sediments are absent, exhibits identical properties to Layer 1;
- Layer 3 represents the Triassic Rewan Formation, where present;
- Layers 4-13 represent the coal seams extracted at Foxleigh and the overburden/ interburden measures between them;
- Layers 14 and 15 comprise the Burngrove Formation beneath the basal worked seam (Pisces Coal Seam 2) at Foxleigh (The Yarrabee Tuff is identified as marking the floor of the Rangal coal Measures and hence the lower leaf of the Pisces seam, represented in the model as Pisces Coal Seam 2, lies within the Burngrove Formation). These layers can also represent the Fairhill Formation, Back Creek Group and Blackwater Formation, where present due to faulting or outcrop at the edges of the model domain.

Where geologic layers are not present, including to the east where the Fairhill Formation is at outcrop, the layers are assigned a thickness of 0.1m and the properties of the underlying layer applied accordingly.

Figure 23 illustrates the model in cross-section. Section A bisects the model approximately through Foxleigh Plains pit whilst Section B bisects the model through WC and Carlo Creek pits.

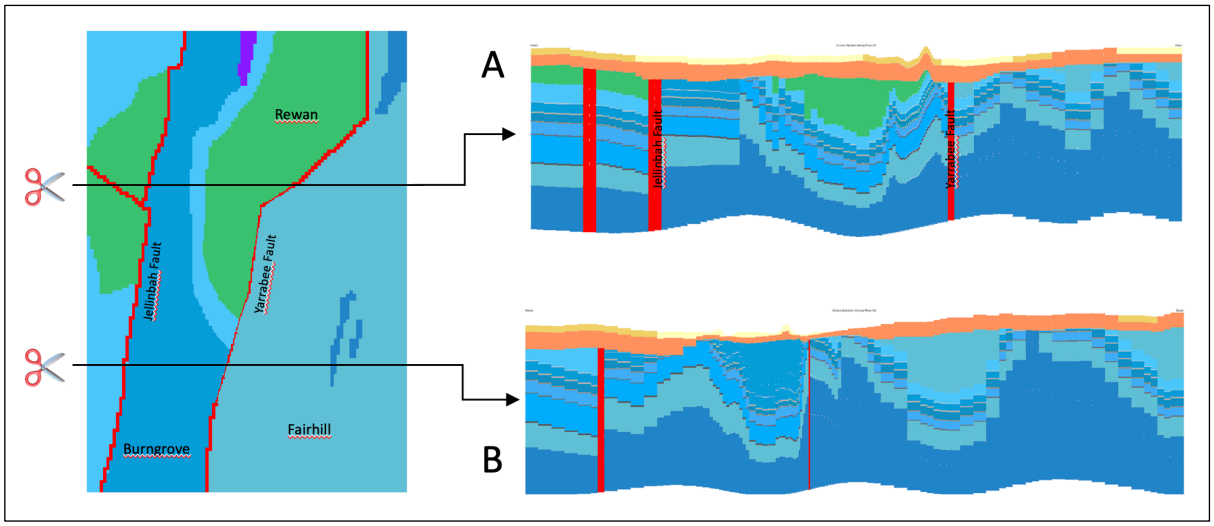

Figure 23: Cross-sections of numerical model

9.7 Flow and Mass Transport Considerations

9.7.1 Initial model properties

Initial model parameters were assessed from previous site investigation and groundwater models as summarized in Table 10. Table 20 presents the hydraulic parameters adopted as the initial model values and adjusted during model calibration.

Table 20: Initial hydraulic characteristics

Unit	Hydraulic Conductivity				Ratio Kh/Kv	Storativity	
	Kh		Kv			Ss	Sy
	(m/d)	(m/s)	(m/d)	(m/s)		(m-1)	(-)
Alluvium		2.01E-10		5.02E-11	4	1.0E-4	0.12
Weathered Tertiary		6.70E-11		1.67E-11	4	1.0E-4	0.05
Rewan Formation		1.34E-11		3.35E-12	4	1.0E-5	0.03
Roper interbed		1.34E-12		1.34E-13	10	1.0E-5	0.03
Roper coal		1.61E-11		4.02E-12	4	1.0E-5	0.05
Middlemount interbed		1.34E-12		1.34E-13	10	1.0E-5	0.03
Middlemount coal		1.61E-11		4.02E-12	4	1.0E-5	0.05
Tralee interbed		1.34E-12		1.34E-13	10	1.0E-5	0.03
Tralee coal		1.61E-11		4.02E-12	4	1.0E-5	0.05
Pisces interbed		1.34E-12		1.34E-13	10	1.0E-5	0.03
Pisces coal		1.61E-11		4.02E-12	4	1.0E-5	0.05
Burngrove Fm		1.34E-12		1.34E-13	10	1.0E-5	0.03
Fairhill Fm		1.34E-12		1.34E-13	10	1.0E-5	0.01
Lower Back Creek Gp		1.34E-13		1.34E-14	10	1.0E-5	0.01
Spoil		2.68E-10		6.70E-11	4	1.0E-4	0.15

Unit	Hydraulic Conductivity				Ratio Kh/Kv	Storativity	
	Kh		Kv			Ss	Sy
	(m/d)	(m/s)	(m/d)	(m/s)		(m-1)	(-)
Faults		1.34E-13		1.34E-14	10	1.0E-5	0.01

9.7.2 Mining development and transient model properties

The MODFLOW Time-Variant Materials (TVM) package was used to represent the time-sensitive variable hydraulic properties of the mine pit/spoil during mining. The TVM Package allows specified hydraulic conductivity and storage values (as indicated in Table 20) to be changed in a time continuous manner. That provides a very convenient approach for setting a step function (factor) between stress periods for changing hydraulic conductivity and storage values through void-spoil zone development.

Figure 24 depicts the development of the mine on an annual basis illustrating the commencement and completion of mining, pit flooding and backfilling. The figure contemplates conditions after 2022 based on the current LOM plan.

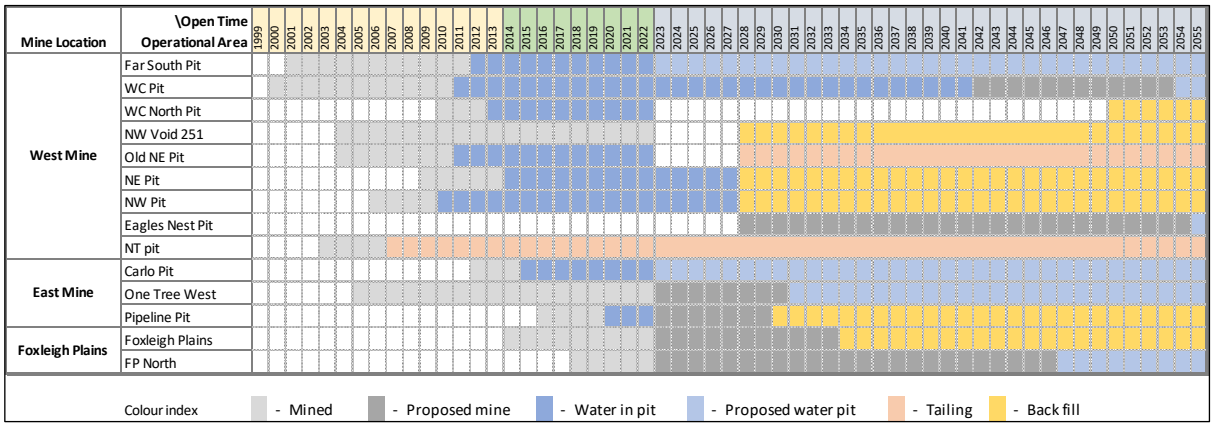

Figure 24: Schedule of TVM assignment

9.7.3 Modelling contaminant transport

The principal contaminant of concern present in water accumulating in the voids is understood from current void water quality monitoring to comprise salinity (Section 4.4). Whilst the evolution of salinity within flooded pit voids is beyond the scope of this work, the impact of accumulating salinity on groundwater environmental values can be assessed semi-quantitatively through the use of particle tracking.

By releasing conservative theoretical particles around individual flooded pits, it is possible to trace the pathway of groundwater with respect to each void. Particles following a pathway away from the pit indicate a potential pathway for salinity (elevated in the pit lake water with respect to natural groundwater) to migrate towards sensitive environmental values for groundwater.

Flooded pit voids may be nett groundwater sinks with evaporation losses exceeding groundwater recharge and may also be both sources and sinks subject to void geometry and hydrogeology. Where particles all converge on the pit voids, this confirms that saline water is

not seeping from the pit void. Conversely, where some particles converge on, and others depart from, the void this indicates that the void is only a partial groundwater sink and the potential risk of escape of water from voids must be considered.

USGS MODPATH v7.2 is a particle tracking code developed to track the trajectory of a set of particles from user-defined starting locations using the MODFLOW solution as the flow field. The particles can be tracked either forward or backward in time.

9.8 Structural Considerations

Major and minor faults are both represented in the model. Major faults including the Yarrabee Fault on the eastern margin of the mine and the Jellinbah Fault on the western margin are represented as vertical cross-cutting features assigned designated hydraulic properties (Figure 23).

Minor faults which have been proved through drilling throughout the mining area are represented by modifying the layer properties on one side of the fault, simulating the juxtaposition of different geological bedding, with the displacement derived from Foxleigh's local geological models.

9.9 Time discretisation

The models and the stress periods were rationalised to the mining sequence which is illustrated in Figure 24. Four preliminary models were developed based on the mine planning and available groundwater data:

Steady-state calibration model	to provide initial conditions for the Transient calibration model.
Transient calibration model	from January 1999 to July 2022– to calibrate groundwater conditions with the existing voids, groundwater levels and measured inpit flow.
Transient operation prediction model	from August 2022 to December 2054 to simulate variation of groundwater conditions with the proposed mine development.
Transient post-closure prediction model	from 2055 to 3055– to simulate mine site groundwater recovering in line with the proposed PRCP.

10 MODEL CALIBRATION

10.1 Data available for model calibration

Limited data was available for the pre-mining period; therefore, data was collected with consideration of: (1) regional bores with a good spatial distribution across the model domain and data as close to 1999 as possible; (2) bores within the mining area and the monitoring data observed before mining; (3) bores within the mining area with relatively static levels over whole monitoring period. Seventeen targets were selected and used in the steady-state calibration. Table 21 presents a summary of the calibration targets.

Table 21: Calibration target sites

ID	Easting	Northing	Comment	ID	Easting	Northing	Comment
FK200	681634.2	7466655		P12	687347.3	7455303	
FK216	681631.1	7466439		P2	679970.8	7460933	
FK222	681387.3	7466291		G161066	670251	7469592	
RDM0709	668027.3	7469757		G165463	680479	7468469	
RDM0711	669328.8	7470562		G43737	689312	7464237	
RDM0681	675353.9	7469307		G103417	693629	7455679	
RDR1123	673975.8	7462003		G151335	667697	7468670	
RDR0800	679492.1	7464166		G151658	668792	7469358	
P1	680902.9	7459872					

For the transient calibration period, the most recent groundwater level data from 13 bores were used as calibration targets with records between 2021 and 2022 (see Figure 12 and Table 9).

Recharge and evapotranspiration rates were based on monthly rainfall data from 1999 to 2022 at Foxleigh Mine based on the SILO data. The initial rates for SS and Tr models were reviewed against previous models (JBT, 2013; AGE, 2016; KCB, 2017) and are presented in Table 22 and Table 23 respectively.

Table 22: Reference Recharge Rates

Unit	Zone	SS Model Recharge			Tr Model Recharge		
		m/d	% of Rainfall	mm/year	AVE(m/d)	% of Rainfall	mm/year
Alluvium	1	1.6%	2.58E-05	9.4	4.55E-05	2.8%	16.6
Weathered Tertiary	2	0.7%	1.10E-05	4.0	1.80E-05	1.1%	6.6
Weathered Permian	3	0.3%	4.80E-06	1.8	3.40E-06	0.2%	1.2
Spoil	4	-	-	-	5.22E-05	3.3%	19.1
Void	5	-	-	-	1.61E-03	100.0%	586.0

Table 23: Reference Evapotranspiration Rates

Unit	Zone	SS Model Evapotranspiration			Tr Model Evapotranspiration		
		% of EVT	Rate (m/d)	depth	% of EVT	Rate (m/d)	depth
Alluvium	1	29.7%	1.65E-03	5	28.0%	1.56E-03	3
Weathered Tertiary	2	22.5%	1.25E-03	3	19.0%	1.06E-03	2
Weathered Permian	3	18.9%	1.05E-03	3	11.8%	6.55E-04	2
Spoil	4	-	-	-	29.8%	1.66E-03	5
Void	5	-	-	-	80.6%	4.48E-03	10

10.2 Calibration approach

10.2.1 Steady-state calibration

A preliminary steady state model simulation, which excluded mining operations, was used to establish the initial groundwater levels for the transient calibration. The steady state calibration was considered appropriate for the broad-scale optimisation of hydraulic parameters and boundary conditions. Calibration was performed by applying both an automated PEST approach and a manual trial-and-error approach. Both approaches assumed that all hydraulic parameter values were able to be modified, within realistic/conceptual bounds, to achieve a better calibration fit.

10.2.2 Transient calibration

A transient calibration was conducted using the manual trial-and-error approach according to the sensitivity results of the steady state PEST model. Transient calibration mainly focussed on the optimisation of hydraulic properties around the mine site that took account of the influence of open cut mining, void conditions, dewatering and recharge/discharge on the current groundwater system.

The calibration model comprised 88 seasonal/quarterly stress periods from January 1999 to December 2020 and 19 monthly stress periods which have site monitoring records in 12 observation bores from 2021 to July 2022. The model stress periods were rationalised based on the mining sequence and the available in-pit levels and groundwater monitoring data.

10.2.3 Calibration metrics

The following performance metrics were used to assess the quality of the model calibration:

- The Root Mean Squared (RMS) and Scaled Root Mean Squared (Scaled RMS) Error for the model-predicted versus observed hydraulic heads for 17 monitoring bore locations in steady state model and 13 time-variant records in transient model.
- A calibration variance scatterplot to show systematic/unsystematic nature and magnitude of over-prediction or under-prediction of hydraulic heads at all the calibration targets. A correlation coefficient is calculated to indicate the strength of relationship between observed and computed heads on the scatterplot.
- Hydrographs show the observed and modelled groundwater level variations over time. Vertical hydraulic gradients between coal measures and various coal seams are also compared in eight pairs of monitoring locations.
- Groundwater flow budget throughout the calibration process to confirm if the groundwater flow system is honouring the conceptual model.

10.3 Calibration results

10.3.1 Steady-state calibration

10.3.1.1 Steady-state calibration objectives

The objectives of the steady state calibration were to optimise the hydraulic boundary and hydraulic parameters across the model domain and reduce model uncertainty. The optimisation included:

- GHBs along the model boundary.
- Hydraulic conductivity for each hydrostratigraphic unit; and
- Preliminary recharge and evapotranspiration rates.

Groundwater levels selected from the 17 bores, including six mine site bores, five bores located within the model domain and measured before 1999 (JBT, 2013) and six regional bores from the Queensland Groundwater Database (GWDB, 2021).

10.3.1.2 Steady-state calibration statistics

A scatter plot of predicted versus observed hydraulic heads is presented in Figure 25. The statistics from the steady state calibration are summarised in Table 24. The table shows the Mean Sum of Residuals (MSR) error for all the monitoring bores is less than 1 m, the total SRMS value is less than 10%, and the correlation coefficients are higher than 97.3%; indicating a reasonable agreement between the modelled and measured groundwater levels was achieved.

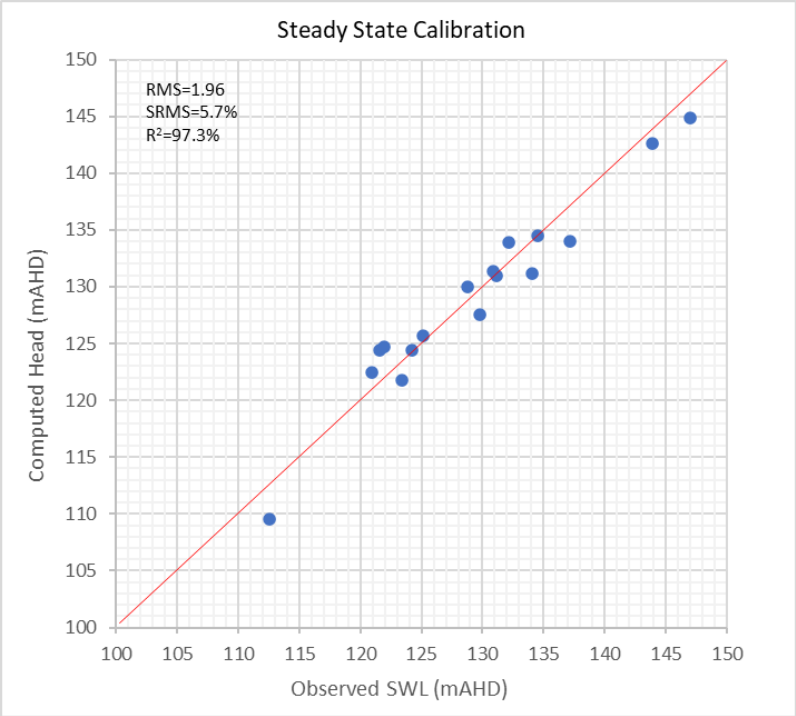

Figure 25: Steady-state calibration - observed vs computed heads

Table 24: Summary statistics of steady-state model calibration

Statistical Metric	Calibration Results
MSR	0.30 (m)
RMS Error	1.96
Scaled RMS	5.7 (%)
Correlation Coefficient	97.3 (%)
Total calibration targets: 21	

10.3.1.3 Steady-state calibrated water balance

The modelled water balance and mass balance error for the steady state calibration simulation defines the difference between model inflows and model outflows. An error of 1%, or less, in a groundwater model water budget is typically considered acceptable for a regional groundwater aquifer system. The water budget and mass balance error for the steady state calibration simulation are outlined in Table 25. The water balance error is less than the target 0.1% indicating that the model is stable and has an adequate level of accuracy for the simulation of groundwater-related fluxes.

Table 25: Steady-state water budget and mass balance error

Boundary	Inflow From Boundary		Outflow From Boundary	
	Inflow (ML/day)	% of Total Inflow	Outflow (ML/day)	% of Total Outflow
River drainage	-	-	0.48	10.4
Recharge	3.02	65.5	-	-

Boundary	Inflow From Boundary		Outflow From Boundary	
	Inflow (ML/day)	% of Total Inflow	Outflow (ML/day)	% of Total Outflow
GHB through boundary	1.59	34.5	1.78	38.5
Evapotranspiration	-	-	2.36	51.1
TOTAL	**4.61**	**-**	**4.61**	**-**
Error	**-1.20E-04**			**0.0**

10.3.1.4 Steady-state sensitivity analysis

Prior to the transient calibration, PEST calibration runs were conducted. The result of a normalized sensitivity coefficient (NSC) calculated for each model parameter from the final PEST calibration is shown in Figure 26. In this figure, hydraulic conductivity (K) values are referenced to specific hydrostratigraphic units, which have consistent values across the applied volume in the model. K_x and K_z indicate horizontal and vertical hydraulic conductivity, respectively. Recharge values (RCH) and evapotranspiration (EV) values reference specific recharge and evapotranspiration in the model. Conductance (C) for DRN and GHBs are specified to each reach number. These results indicate:

Hydraulic conductivities (K_x and K_z) of the alluvium, weathered Tertiary units are the most sensitive parameters. Variation in those values influence head gradients in shallow aquifers and allow recharge to be transmitted into the groundwater system.

Recharge rates for alluvium and DRN boundary conditions for Roper Creek (C2) and Cockatoo Creek (C8) are the next most sensitive parameters, which is consistent with the conceptual understanding of the importance of rainfall recharge and leakage into the groundwater system.

Conductance of GHBs for the South and East boundaries is less sensitive. This is due to the availability of monitoring data close to the boundaries used for PEST calibration.

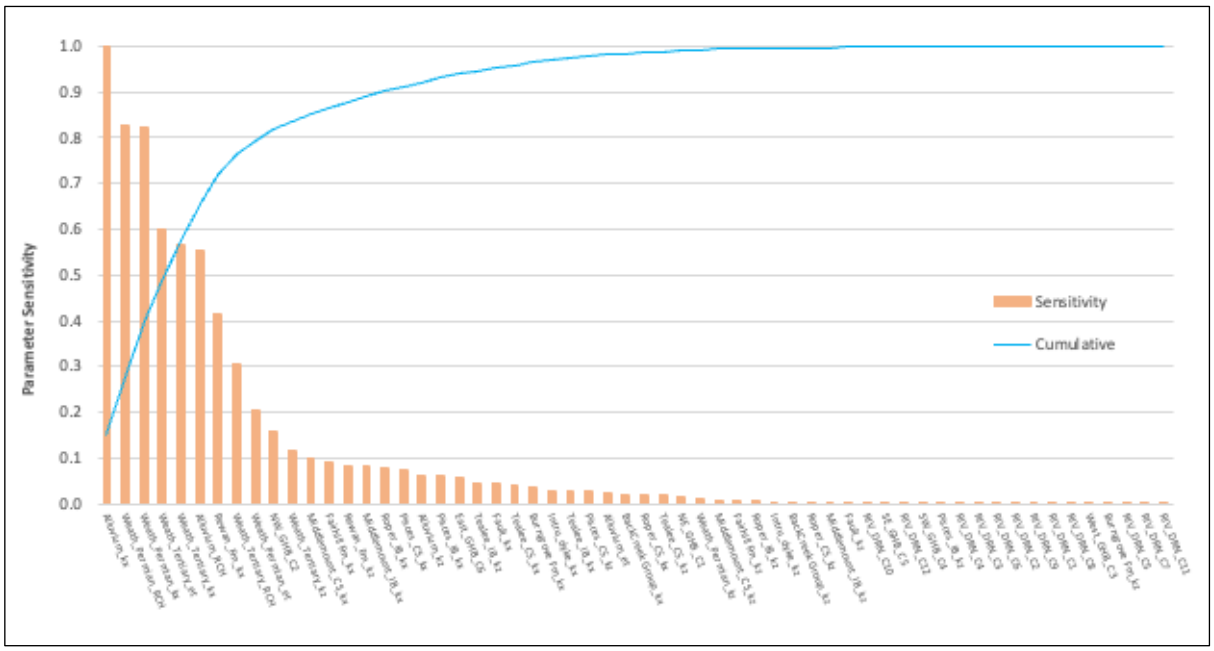

Figure 26: PEST calibration - normalised sensitivity coefficients

10.3.2 Transient calibration

10.3.2.1 Transient calibration objectives

Transient model calibration was performed based on the initial results from the calibrated steady state model. The observed groundwater levels recorded over one year (2021 to 2022) from 12 monitoring bores at Foxleigh and in-pit water levels are used in the calibration. The calibration was conducted using a manual trial-and-error process based on PEST sensitivity analysis.

Model parameters and boundary conditions were adopted from the steady state calibrated model as the starting conditions. The main challenges and then assumptions made for this simulation are:

- Limited and short monitoring record was available in the vicinity of the open pits to verify the groundwater response during mining operations in this regime.
- The open pit mining / backfilling process also had limited information. Google Earth images were used to infer the mining sequence.
- Dewatering data was not available for individual open cut voids, however, a total dewatering rate for open cut voids was available, which was also used in the model calibration.

10.3.2.2 Transient calibration statistics

Table 26 presents the transient calibration metrics. Calibration was considered to be fair to good with a good correlation between observed and simulated heads (Figure 27).

Table 26: Summary statistics of transient model calibration

Statistical Metric	Calibration Results
MSR	0.098 (m)
RMS Error	1.34
Scaled RMS	3.8 (%)
Correlation Coefficient	99.7 (%)
Total calibration targets: 13	

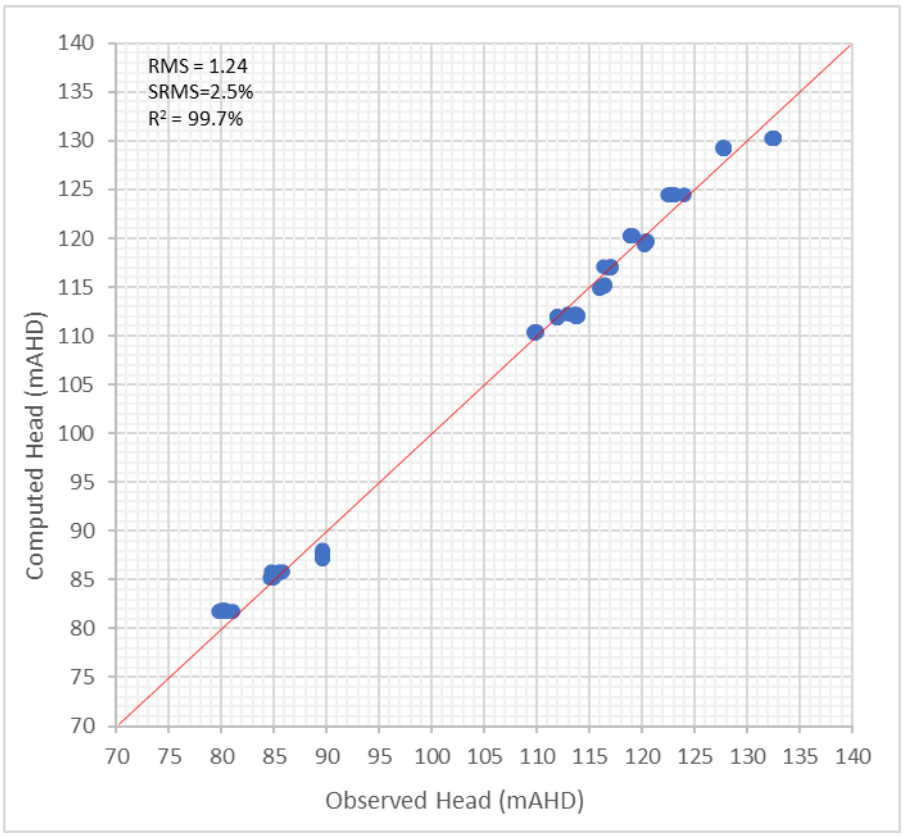

Figure 27: Transient calibration - observed vs computed heads

10.3.2.3 Calibrated hydrographs

Hydrographs showing measured versus modelled groundwater heads are provided in Figure 28 and Figure 29. The following three comments are made related to the transient calibration:

1. Monthly data were selected across two monitoring bores for the alluvium and Tertiary sediments units in model layers 1 and 2 for the calibration. A very good calibration is achieved across the shallow monitoring bore P12, located adjacent to Roper Creek and west of Far South pit.

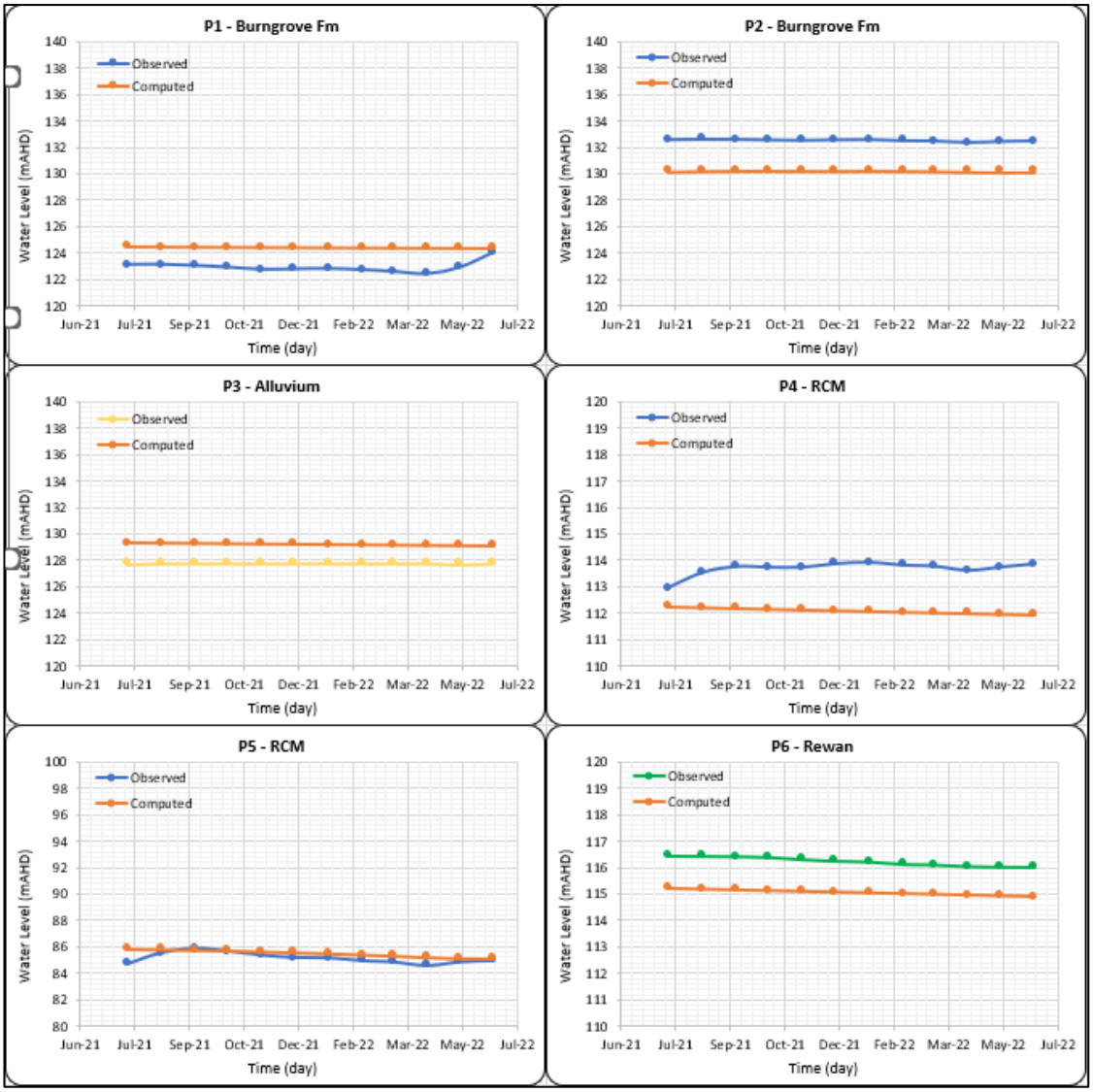

Figure 28: Transient calibration hydrographs – Monitoring bores P1 to P6

2. Nine bores screened within the Permian units were available for calibration. A fair to good calibration was achieved for the Permian units, with over/under-prediction of levels observed in P2 and P4, located near the NW pit and Carlo Creek pit, respectively. This is considered likely to be related to the uncertainty in the mine sequence/backfill timing.

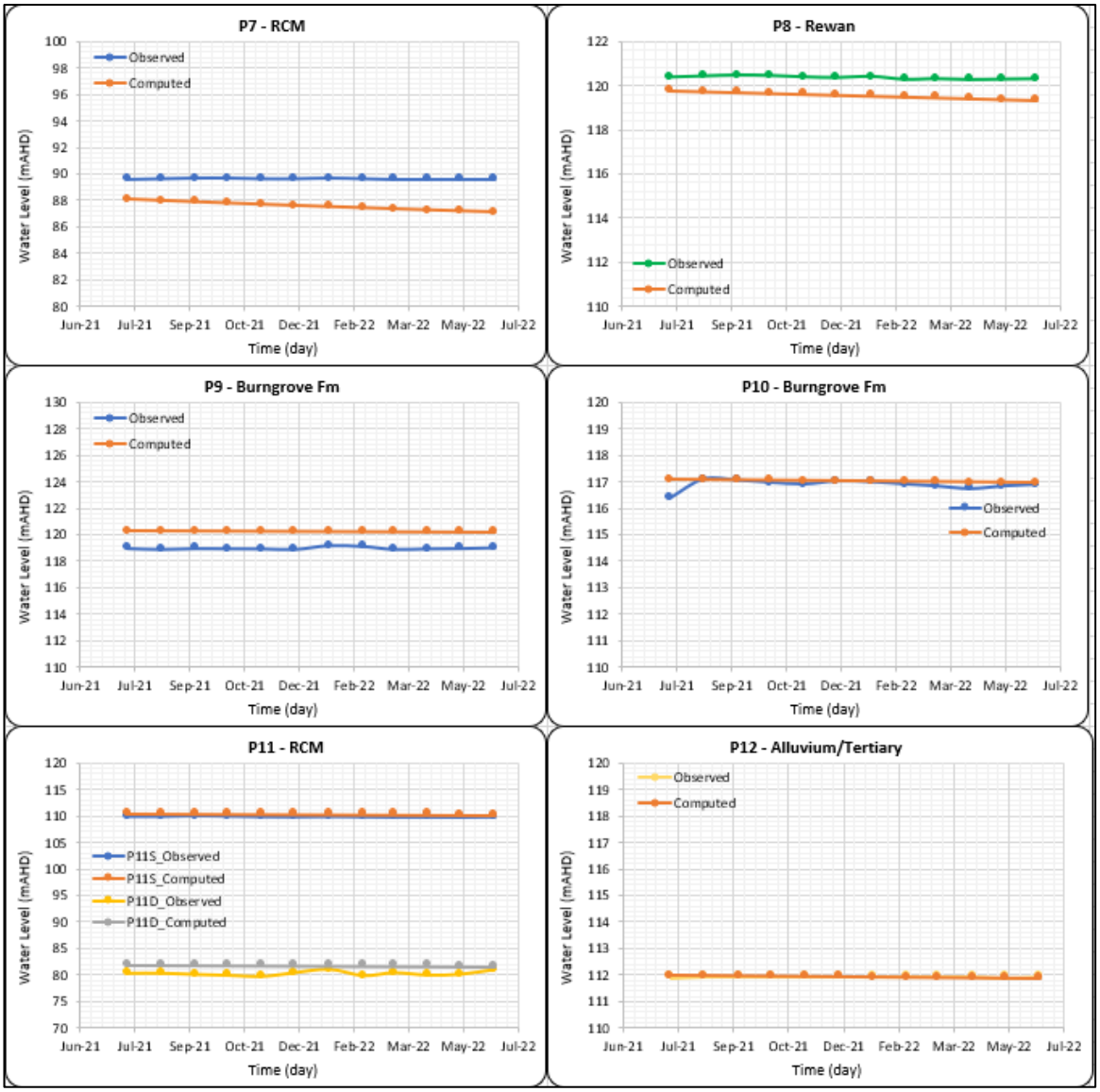

Figure 29: Transient calibration hydrographs – Monitoring bores P7 to P12

3. P11S and P11D monitoring locations comprise two monitoring bores located very close together but screened at different depths. A good calibration was achieved at these bores, with the vertical separation between the coal seams reasonably replicated within the model.

10.3.2.4 Calibrated fluxes

Figure 30 presents the measured inflow rates versus the calibrated model predicted inflow rate for the transient model showing a strong correlation between the measured inflows from 3 pits and the model-simulated seepage rates. Total inflows are shown to be greater, noting that metrics were only available for three pits.

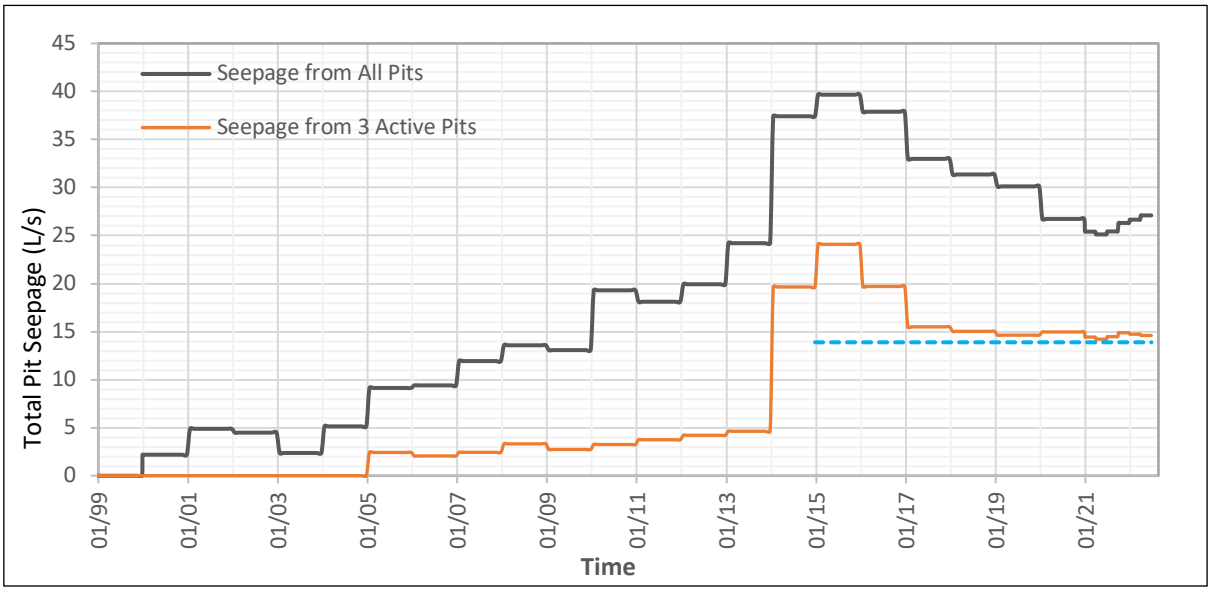

Figure 30: Measured versus modelled seepage (mine inflow) rates

10.3.2.5 Transient calibrated water balance

The transient water balance is summarised in Table 27 and illustrated in Figure 31.

Table 27: Transient water budget and mass balance error

Boundary	Inflow From Boundary		Outflow From Boundary	
	Inflow (ML/day)	**% of Total Inflow**	**Outflow (ML/day)**	**% of Total Outflow**
River drainage	-	-	0.45	5.4
Recharge	4.03	49.2	-	-
Mine drainage	-	-	3.39	41.4
GHB through model boundary	1.64	20.0	1.67	20.4
Evapotranspiration	-	-	2.60	31.8
Storage	2.53	30.9	0.08	1.0%
TOTAL	**8.2**	**-**	**8.2**	**-**
Total Net Flow (Storage Loss)	**1.80E-03**			**0.02%**

Figure 31: Transient water balance

10.3.3 Calibrated model parameters

The calibrated model parameters are presented in Table 28.

Table 28: Calibrated model parameters

Unit	Zone ID	Kh		Kz		Ratio (Kh/Kv)	Ss	Sy	Porosity
		(m/d)	(m/s)	(m/d)	(m/s)				
Alluvium	1	1.2E+00	1.4E-05	5.0E-01	5.8E-06	2	1.0E-04	5.0E-02	0.20
Weathered Tertiary	2	6.9E-01	8.0E-06	1.4E-01	1.6E-06	5	2.0E-05	3.0E-02	0.15
Rewan Formation	3	3.5E-01	4.1E-06	5.8E-02	6.7E-07	6	2.0E-05	2.0E-02	0.20
Roper interbed	4	4.2E-02	4.9E-07	4.6E-03	5.3E-08	9	2.0E-05	2.0E-02	0.10
Roper coal	5	7.0E-02	8.1E-07	1.4E-02	1.6E-07	5	2.0E-05	1.0E-02	0.10
Middlemount interbed	6	3.4E-03	4.0E-08	3.4E-04	4.0E-09	10	2.0E-05	1.0E-02	0.10
Middlemount coal	7	5.1E-02	5.9E-07	1.0E-02	1.2E-07	5	5.0E-05	2.0E-02	0.10
Tralee interbed	8	1.1E-03	1.3E-08	1.1E-04	1.3E-09	10	1.0E-05	1.0E-02	0.05
Tralee coal	9	6.2E-02	7.2E-07	1.2E-02	1.4E-07	5	5.0E-05	2.0E-02	0.10
Pisces interbed	10	1.2E-02	1.3E-07	1.2E-03	1.3E-08	10	1.0E-05	1.0E-02	0.10
Pisces coal	11	1.6E-01	1.8E-06	1.8E-02	2.1E-07	9	5.0E-05	2.0E-02	0.10
Burngrove Fm	13	6.4E-02	7.4E-07	6.4E-03	7.4E-08	10	5.0E-05	2.0E-02	0.05
Fairhill Fm	12	1.0E-02	1.2E-07	1.0E-03	1.2E-08	10	1.0E-05	1.0E-02	0.10
Lower Back Creek Gp	14	1.4E-03	1.6E-08	6.8E-05	7.9E-10	20	1.0E-05	1.0E-03	0.10
Spoil	22	5.0	5.8E-05	2.5	2.9E-05	2	1.0E-04	1.5E-01	0.25
Voids	19	100	1.2E-03	100	1.2E-03	1	0.01	0.99	1.00
Faults	23	100	1.2E-03	100	1.2E-03	1	1.0E-03	9.9E-01	0.99

11 PREDICTIVE MODELLING

11.1 Predictive Simulations

Predictive simulations to support the PRCP included three simulations:

- Nil mining simulation;
- Operational predictive simulation;
- Post-closure predictive simulation.

11.2 Nil mining simulation

The 'Nil mining' simulation was executed to allow for the calculation of drawdowns in each of the other predictive simulations. The Nil mining simulation ran from 2000 to 3055. All drain nodes in the model were switched off to simulate the condition of the groundwater system over the full period from before mining began at Foxleigh to the end of the Post-Closure simulation. Predictions of drawdown in each of the Operation predictive model and the Post-Closure predictive model were calculated by subtracting the respective groundwater heads from the heads predicted with the Nil mining simulation.

11.3 Operational Simulation

A predictive simulation was carried out which extended from the end of the calibration period in 2022 until the end of operations in 2054 according to the LOM plan. This included the remaining mining at Foxleigh including continued operations in Pipeline pit to 2029, One Tree West pit to 2030, Foxleigh Plains pit to 2033 and Foxleigh Plains North pit to 2046, re-opening WC pit from 2042 to 2053 and opening Eagle's Nest pit in 2028 to 2054 (Figure 24). Amongst the fourteen pits worked, or proposed to be worked at the site, most change from active mining to backfilled or water-filled during the operational model simulation.

11.3.1 Simulation Setup and Implementation

The simulation comprised quarterly (three-monthly) stress periods for the transient prediction model. The mine operation sequence was obtained from the LOM (video and WRM data). The future climate (rainfall and evaporation) was applied with recycling the monthly rainfall records from July 1999 to Dec 2021 and then Jan 1999 to Dec 2008 for a total 32.5 years for the simulation period. Water levels in the voids for the remaining operations used the 2022 void water level. All other boundary conditions were carried over from the transient calibration model.

The Time-Variant Materials (TVM) Package was used for representation of variable hydraulic properties of the mine developed over the open cut mining process. The TVM Package allows hydraulic conductivity and storage values specified in the LPF package (USG) to be changed in a continuous manner. That provides a very convenient approach for setting a step function (factor) between stress periods for changing hydraulic conductivity and storage values through void-spoil zone development. As with the proposed mining sequence, the hydraulic conductivity within the zone of continuous mining is inherently uncertain with following assumptions:

- The pit void will be highly permeable (assumed Kh=Kv=100 m/day) and is simulated to intersect the entire thickness of pit location where it is continuously excavated.

- The zone of backfilling is continuously updated following the mine sequence and hydraulic conductivity is switched from void to spoil.

11.3.2 Operational Simulation - Predictive Results

Figure 32 presents the predicted drawdown of the simulated pre-mining water table at the end of operations at Foxleigh in 2054

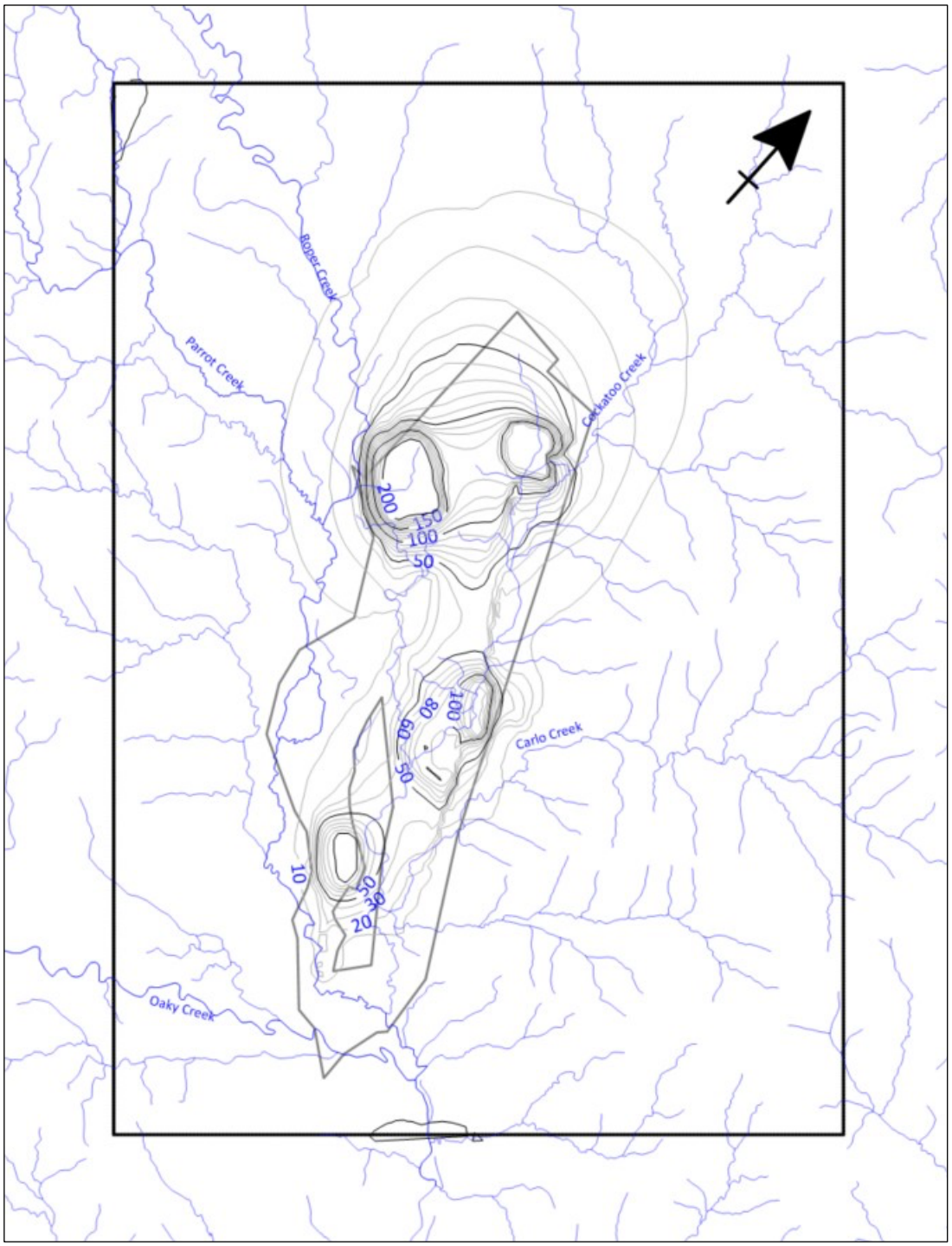

Figure 32: Predicted drawdown at end of mining in 2054

The figure shows areas of the drawdown associated with the mining activities in proximity to the mining areas with the lowest contour illustrated as 10 m drawdown.

11.4 Post-Closure Simulation

The simulation of post-closure groundwater conditions was undertaken to assess the final void water elevations within the proposed post-closure landforms. The simulation was run for 1000 years following mine closure in 2055. Six residual voids are represented in the model including Far South, WC, Eagle's Nest, Carlo Creek, One Tree West and Foxleigh Plains North pits. Remaining pits are represented as backfilled to shedding landforms.

11.4.1 Simulation Setup and Implementation

The top surface of the model was updated to reflect the proposed post-closure landform, provided by WRM, as shown in Figure 19.

Final pit void lake elevations were simulated by WRM using a water balance model, as part of the surface water assessment. This water balance incorporated all contributing fluxes to the pit void, including the groundwater inflow. The future climate was applied as an annual average for the post-closure model since the stress period was yearly. All other boundary conditions were carried over from the transient operational period model.

The post-closure groundwater flux was simulated for a range of pit void lake elevations, from the maximum inflow rate when groundwater levels are at the base of the pit to the pre-mining groundwater level elevation where no groundwater inflow is observed. Table 29 presents the maximum modelled inflow rate at the base of the void, for each of the voids modelled.

Table 29: Simulated maximum groundwater inflow rates

Pit Name	Bottom of Pit (mAHD)	Maximum Flow Rate (L/s)
Far South pit	70.50	0.16
WC pit	119.54	3.60
Eagles Nest pit		10.56
Carlo Creek pit	56.94	0.48
One Tree West pit*	-13.78	5.50
Foxleigh Plains North pit	40.46	18.02
TOTAL	n/a	38.32

(includes Pipeline pit)

11.4.2 Post-Closure Simulation - Predictive Results

Post-closure steady state elevations of the pit voids associated with the final landform were calculated by WRM from the water balance model. The final equilibrium levels are provided in Table 30. The respective elevations for each of the voids were applied to the groundwater model, using GHBs to simulate the post-closure groundwater conditions. Recharge and evaporation were not applied to the voids, as this was captured in the water balance model. This simulation was conducted for a 1000-year duration, using climate data provided by WRM, to allow groundwater levels to recover to equilibrium / steady state conditions.

Table 30: Long-term void water levels and steady-state groundwater fluxes

Void	Long-Term Median Void Water Level (mAHD)	Post-Closure Equilibrated Pit Void Flux	
		Inflow (L/s) (Sink)	Outflow (L/s) (Source)
Far South pit	81.6	0.06	0.00
WC pit	42.6	5.58	0.00
Eagles Nest pit	98.3	10.43	0.00

Void	Long-Term Median Void Water Level (mAHD)	Post-Closure Equilibrated Pit Void Flux	
		Inflow (L/s) (Sink)	Outflow (L/s) (Source)
Carlo Creek pit	44.4	0.25	0.00
One Tree West pit*	71.7	5.30	0.00
Foxleigh Plains North pit	48.3	8.39	0.00
TOTAL	n/a	29.89	0.00

(includes Pipeline pit)

The results confirm that in each of the six final voids, the pit lake water level remains below regional groundwater levels. This indicates that each void will continue to act as a groundwater sink in perpetuity, drawing in groundwater from the connected Permo-Triassic strata.

The predicted groundwater inflow rate following equilibration is predicted to be approximately 30 l/s in perpetuity. This water is sourced from the Permo-Triassic strata.

Recovery to equilibrium occurs in the pits after approximately 450 years from the cessation of mining operations in 2055, or at around the year 2505.

Figure 33 presents the predicted water table elevation following equilibration of pit lake voids and groundwater levels at Foxleigh in 3055 The figure shows areas of the drawdown associated with the persistent seepage of groundwater to the pit lakes.

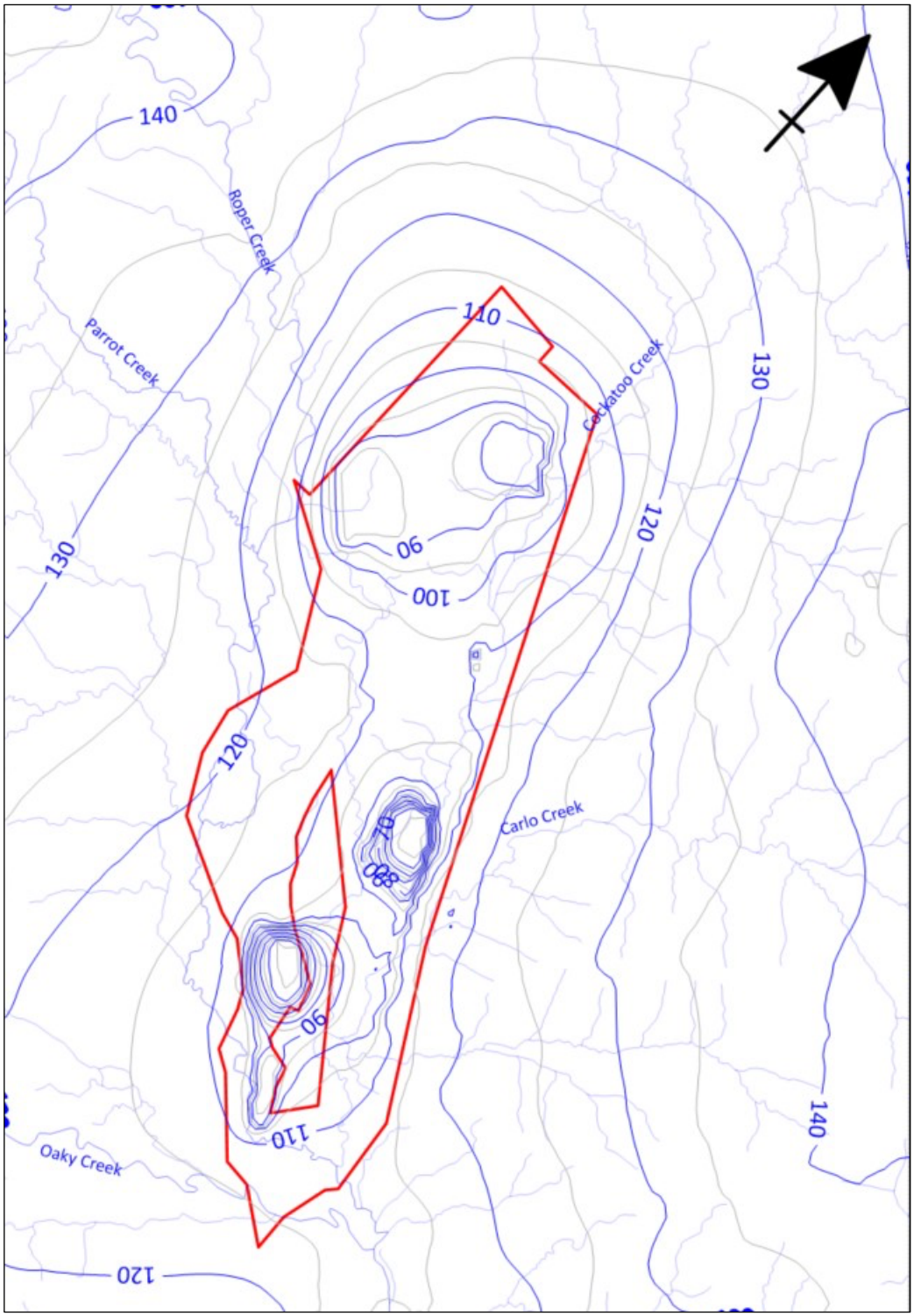

Figure 33: Predicted water table elevation at groundwater and pit lake equilibration

Particle tracking using MODPATH with MODFLOW head data from the final stress period of the Post-Closure model (after all recovery has been completed) indicates that each of the voids is fully acquisitive (Figure 34). This means that groundwater flows towards the void from all directions and there is no leakage from one or other side or end of any pit lake.

This indicates that pit lake water will not seep out of the residual voids and hence, irrespective of the evolution of salinity and corresponding pit lake water quality, does not represent a risk to groundwater environmental values. It also indicates that even following complete equilibration, there is no contribution from pit lake waters to baseflow in local creeks.

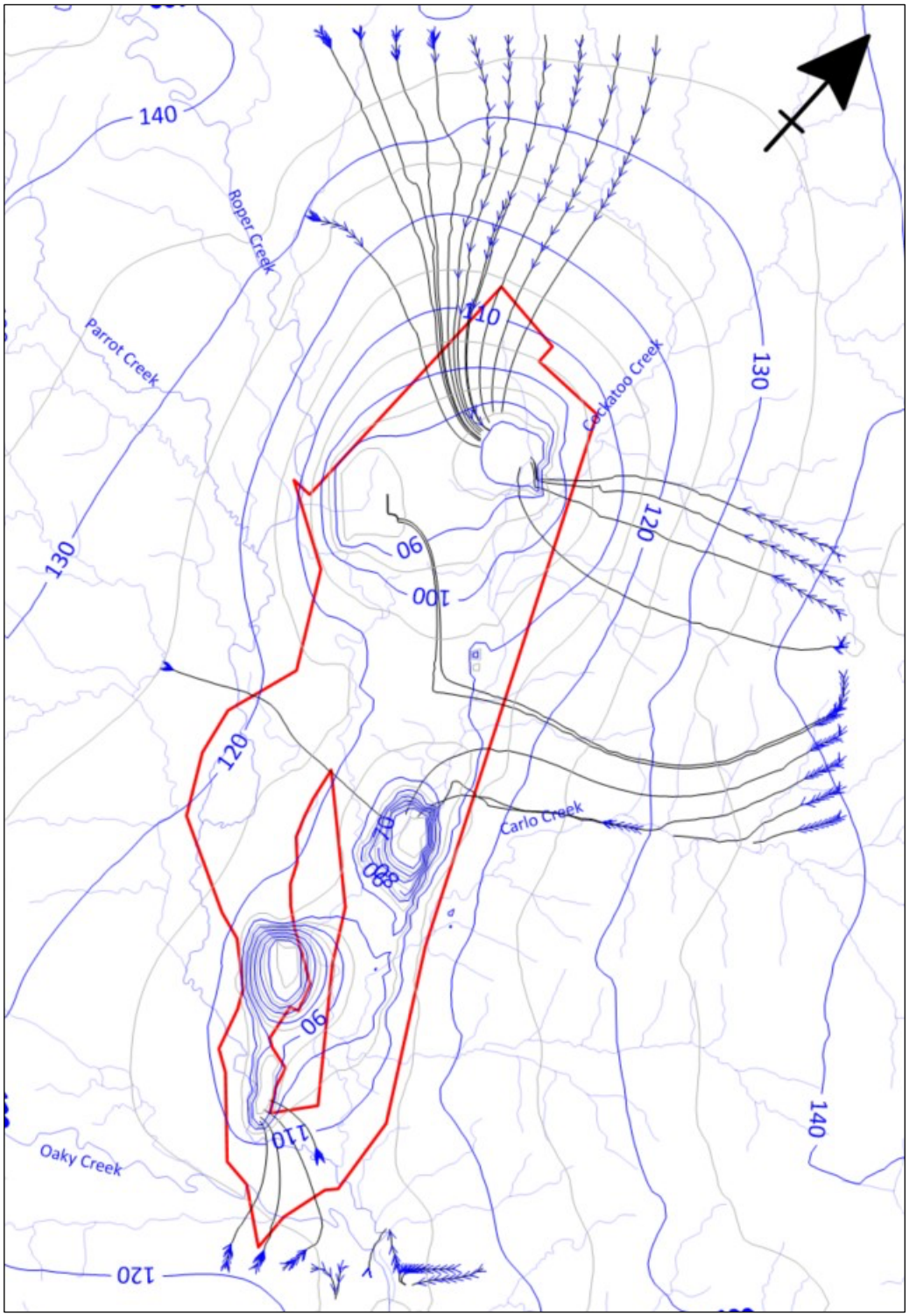

Figure 34: Groundwater flow directions at Post-Closure equilibrium

11.5 Discussion

Numerical modelling has confirmed that each of the six residual pit voids at Foxleigh is predicted to form a pit lake which acts as a groundwater sink in perpetuity. Equilibration of groundwater inflows and pit lake levels is predicted to take approximately 450 years although the majority of pit lake level recovery is likely to occur within the early years of cessation of mining activities.

Analysis of pit void water budgets, supported by particle tracking, has confirmed that each of the residual voids is entirely acquisitive and no pit lake water is predicted to seep from the void into the regional groundwater system. This indicates that the pit lakes, or the quality of water within those lakes, does not present a risk of contamination to regional groundwater systems.

12 UNCERTAINTY ANALYSIS

The calibration model has been assessed to determine the model's sensitivity to parameter values (Section 10.3). Sensitivity analysis is related to uncertainty analysis, the latter which is carried out following the stage of predicting the future behaviour of a system. In uncertainty analysis, sensitivities of predictions to model parameters are combined with a (statistical) description of parameter uncertainty, leading eventually to quantitative estimates of prediction uncertainty.

Whilst quantitative uncertainty analysis has not been conducted at this stage, it may be appropriate following the acquisition of additional data with which to describe more fully the probable range of model parameter values. However, it is possible to assess qualitatively the uncertainty arising in model predictions from variations of parameter values or the incomplete knowledge of a parameter range of variation:

12.1 Predictive time frame

The transient calibration model is calibrated over approximately one year using site-based data. Whilst the predictive operational model is runs for 32 years, the post-closure predictive model was run for 1000 years following mine closure in order to capture the full extent of void water level stabilisation. AGMG recommend where possible limiting predictive time frames to five times the period of calibration. However, this is not possible both due to the relatively short period over which the mining operation has been present and that environmental (groundwater) monitoring has been conducted, and the very long time period over which void water level stabilisation is expected to occur.

12.2 Spatial representation of piezometric head

Calibration data obtained from monitoring of piezometric heads in discrete bores will be subject to uncertainty regarding the distribution of piezometric head predicted by a distributed model where the spatial cell dimensions significantly exceed the dimensions of the asset and there is an imperfect match between the geometry of the asset in its environment and the geometry of the model cell representing the asset. Effort has been made to reduce this uncertainty by ensuring that the grid mesh is suitably refined at the locations of transient calibration points, although it is noted that regional steady-state calibration points may remain in areas of unrefined grid mesh.

12.3 Climatic stresses in prediction

The predictive model aims to predict long into the future for the purpose of quantifying the time required to achieve quasi-steady state void water levels. Current climatic stresses (rainfall and evapotranspiration) have been applied consistently to the predictive model and hence model predictions may be subject to the influence of future climate change not accounted for in the model.

However, the magnitude of change in void water level in the early years of the predictive model is expected to be substantially greater than the change expected at later times in the simulation due to the diminution of driving head as the void water level stabilises. The inclusion or exclusion of alternative future climatic stresses is expected to hasten or defer void water level stabilisation and may result in stabilisation at a level above or below that predicted on the basis of current climatic stresses.

12.4 Scale of observation

The prediction of void water levels in this model is based on the assignment of parameter values, calibrated over a relatively short time period, to relatively large areas. However, the spatial scale of the voids is large and hence predictions are likely to be insensitive to small-scale spatial or temporal variations.

13 MODEL CLASSIFICATION, CAPABILITIES & LIMITATIONS

Barnet et al (2012) describe three classes of models: Class 1, Class 2, and Class 3. A Class 3 model has the greatest confidence level, and a Class 1 model has the least. Factors that are considered when determining model confidence level are:

- Data availability;
- Calibration procedures;
- Consistency between calibration and predictive analyses; and
- Stresses applied on the model and associated simulation results.

The model outlined in this report is considered a Class 2 model based on the following:

- The local geological model used to support development of the groundwater model domain was constructed using site specific geological investigation data. 13 groundwater monitoring bores were used for transient calibration, with all these monitoring bores within Foxleigh.
- Key calibration statistics (SMRS <5%; R^2 > 90%) were acceptable and meet agreed targets in transient model calibration.
- Detailed transient calibration was undertaken over only 1-year period.
- Abstraction data (mine dewatering rates from the previous studies) were used for model calibration.
- Model parameters were calibrated within the ranges identified from previous investigations and studies as part of the conceptualisation.
- Model water balance error is less than 0.1%.
- The predictive model duration is longer than the calibration period.

The calibration model meets the criteria for a Class 1 & 2 model. The calibrated model is therefore deemed to be a suitable tool for assessing the drawdown impacts and recovery into closure from the Foxleigh operations.

14 CONCLUSIONS

Numerical modelling has been conducted to assist in the determination of final void water levels and to calculate groundwater flux interactions with the voids in perpetuity.

The results of the modelling indicate that the water level in the voids will stabilise after around 450 years from mine closure and that each of the voids will operate wholly as a groundwater sink. That is to say, groundwater inflows will occur from all directions around each residual void and no water will seep out of any void into the natural environment.

Maximum and perpetual groundwater fluxes to the residual voids have been calculated for the periods immediately following the cessation of mining in 2054, at intermediate times following the end of mining and after 1000 years, respectively. Maximum fluxes are observed at the point of cessation of mining in 2054 at approximately 40 l/s. These decline over approximately 450 years from the cessation of mining, around the year 2505, to approximately 30 l/s and remain at this rate in perpetuity.

Groundwater drawdown due to mining has been calculated by simulating the groundwater condition in the absence of mining at Foxleigh and subtracting the predicted water tables predicted at the end of mining in 2054 and after 1000 years in 3055 from this surface. Partial groundwater recovery occurs following the cessation of mining and stabilises after approximately 450 years with residual drawdowns focussed at the residual voids.

Groundwater quality in the source rocks supplying perpetual seepage to the residual voids is of low quality and the quality of water within the residual pit lakes is likely to deteriorate further through evaporative concentration of dissolved solids. However, no impact on regional groundwater resources or other connected water resources is considered likely to occur in relation to pit lake water quality because no water is predicted to be able to seep from the residual voids.

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APPENDICES

Appendix 1: Registered Water Bore Reports

Queensland Government
Groundwater Information
Bore Report

Report Date: 17/08/2021 17:52 **Page:** 1 **of** 4 **GWDB8250**

From Year:

Registered Number	Facility Type	Facility Status	Drilled Date	Office	Shire
43737	Sub-Artesian Facility	Existing	07/06/1973	Rockhampton	3980 - ISAAC REGIONAL

Details

Description	P1		
Parish	4499 - TERNALLUM		
Original Name	CARLO CREEK NO 1		
Driller Name	G SHELLEY		
Drill Company	SHELLEY WELLBORING CO		
Const Method	ROTARY		
Bore Line			
D/O File No	50-0986	**Polygon**	
R/O File No	C2917/E409	**Equipment**	HS
H/O File No	L41361B	**RN of Bore Replaced**	
Log Received Date		**Data Owner**	
Roles	Water Supply		

Location

Latitude	22-55-09	**Basin**	1301
Longitude	148-50-46	**Sub-area**	
GIS Latitude	-22.919270876	**Lot**	
GIS Longitude	148.846089653	**Plan**	
Easting	689312		
Northing	7464237	**Map Scale**	104 - 1: 100 000
Zone	55	**Map Series**	M - Metric Series
Accuracy		**Map No**	8652
GPS Accuracy		**Map Name**	WINDEYERS HILL
Checked	No	**Prog Section**	

Casing — **2** *records for RN* 43737

Pipe	Date	Rec	Top (m)	Bottom (m)	Material Description	Mat Size (mm)	Size Desc	Outside Diameter (mm)
A	07/06/1973	1	0.00	13.10	Steel Casing		WT - Wall Thickness	127
A	07/06/1973	2		51.80	Open Hole			

Strata Logs — **12** *records for RN* 43737

Rec	Top (m)	Bottom (m)	Strata Description

Queensland Government
Groundwater Information
Bore Report

Report Date: 17/08/2021 17:55 **Page:** 1 **of** 4 **GWDB8250**

From Year:

Registered Number	Facility Type	Facility Status	Drilled Date	Office	Shire
47353	Sub-Artesian Facility	Existing	28/09/1967	Rockhampton	3980 - ISAAC REGIONAL

Details

Description	P8		
Parish	4499 - TERNALLUM		
Original Name	N0.3 HOLE		
Driller Name			
Drill Company			
Const Method	ROTARY DRILLER R.ALEXANDER (		
Bore Line			
D/O File No	50-0042	**Polygon**	
R/O File No	C1639/E103	**Equipment**	TE
H/O File No	L44660B	**RN of Bore Replaced**	
Log Received Date		**Data Owner**	
Roles			

Location

Latitude	23-00-30	**Basin**	1301
Longitude	148-53-30	**Sub-area**	
GIS Latitude	-23.008435946	**Lot**	
GIS Longitude	148.891646468	**Plan**	
Easting	693880		
Northing	7454293	**Map Scale**	104 - 1: 100 000
Zone	55	**Map Series**	M - Metric Series
Accuracy		**Map No**	8651
GPS Accuracy		**Map Name**	COOROORAH
Checked	No	**Prog Section**	

Casing — **2** *records for RN* 47353

Pipe	Date	Rec	Top (m)	Bottom (m)	Material Description	Mat Size (mm)	Size Desc	Outside Diameter (mm)
A	28/09/1967	1	0.00	45.70	Steel Casing	4.760	WT - Wall Thickness	127
A	28/09/1967	2	45.70	80.80	Open Hole			

Strata Logs — **8** *records for RN* 47353

Rec	Top (m)	Bottom (m)	Strata Description

Report Date: 17/08/2021 17:56

Queensland Government
Groundwater Information
Bore Report

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GWDB8250

From Year:

Registered Number	Facility Type	Facility Status	Drilled Date	Office	Shire
103417	Sub-Artesian Facility	Existing	14/03/1999	Emerald	3980 - ISAAC REGIONAL

Details

Description			
Parish	4499 - TERNALLUM		
Original Name			
Driller Name	RIDDELL W		
Drill Company	DEPCO		
Const Method	ROTARY		
Bore Line			
D/O File No	50-0042	Polygon	
R/O File No		Equipment	
H/O File No		RN of Bore Replaced	
Log Received Date		Data Owner	
Roles	Water Supply		

Location

Latitude	23-00-21	Basin	1301
Longitude	148-53-35	Sub-area	
GIS Latitude	-23.005858101	Lot	15
GIS Longitude	148.893154904	Plan	ROP172
Easting	694029		
Northing	7454579	Map Scale	104 - 1: 100 000
Zone	55	Map Series	M - Metric Series
Accuracy	SKET	Map No	8651
GPS Accuracy		Map Name	COOROORAH
Checked	Yes	Prog Section	

Casing

3 *records for RN* 103417

Pipe	Date	Rec	Top (m)	Bottom (m)	Material Description	Mat Size (mm)	Size Desc	Outside Diameter (mm)
A	14/03/1999	1	0.00	34.75	Polyvinyl Chloride	5.900	WT - Wall Thickness	141
A	14/03/1999	2	9.14	34.75	Perforated or Slotted Casing		AP - Aperture Size	141
A	14/03/1999	3	9.14	34.75	Gravel Pack			

Strata Logs

5 *records for RN* 103417

Queensland Government
Groundwater Information
Bore Report

Report Date: 17/08/2021 17:56 Page: 1 of 3 GWDB8250

From Year:

Registered Number	Facility Type	Facility Status	Drilled Date	Office	Shire
103241	Sub-Artesian Facility	Existing	01/01/1900	Emerald	3980 - ISAAC REGIONAL

Details

Description			
Parish	2006 - GIRRAH		
Original Name	UTAH BORE		
Driller Name			
Drill Company			
Const Method			
Bore Line			
D/O File No	50-1958	Polygon	
R/O File No		Equipment	
H/O File No		RN of Bore Replaced	
Log Received Date		Data Owner	
Roles	Water Supply		

Location

Latitude	23-04-30	Basin	1301
Longitude	148-47-06	Sub-area	
GIS Latitude	-23.075102309	Lot	2
GIS Longitude	148.784900709	Plan	TT299
Easting	682839		
Northing	7447050	Map Scale	104 - 1: 100 000
Zone	55	Map Series	M - Metric Series
Accuracy	SKET	Map No	8651
GPS Accuracy		Map Name	COOROORAH
Checked	Yes	Prog Section	

Casing 1 *records for RN* 103241

Pipe	Date	Rec	Top (m)	Bottom (m)	Material Description	Mat Size (mm)	Size Desc	Outside Diameter (mm)
A	01/01/1900	1	0.00	25.70	Steel Casing			

Strata Logs 1 *records for RN* 103241

Rec	Top (m)	Bottom (m)	Strata Description
1	0.00	47.24	NO DETAILS

Queensland Government
Groundwater Information
Bore Report

Report Date: 17/08/2021 17:57 Page: 1 of 4 GWDB8250

From Year:

Registered Number	Facility Type	Facility Status	Drilled Date	Office	Shire
136126	Sub-Artesian Facility	Existing	29/06/2002	Rockhampton	3980 - ISAAC REGIONAL

Details

Description			
Parish	4499 - TERNALLUM		
Original Name			
Driller Name	JACKMAN, RONALD HARVEY		
Drill Company	R. JACKMAN		
Const Method	ROTARY		
Bore Line			
D/O File No		Polygon	
R/O File No		Equipment	
H/O File No		RN of Bore Replaced	
Log Received Date	25/03/2004	Data Owner	
Roles	Water Supply		

Location

Latitude	23-03-25	Basin	1301
Longitude	148-54-14	Sub-area	
GIS Latitude	-23.0569444	Lot	15
GIS Longitude	148.9038889	Plan	ROP172
Easting	695057		
Northing	7448907	Map Scale	
Zone	55	Map Series	
Accuracy	GPS	Map No	
GPS Accuracy	20	Map Name	
Checked	Yes	Prog Section	

Casing 4 *records for RN* 136126

Pipe	Date	Rec	Top (m)	Bottom (m)	Material Description	Mat Size (mm)	Size Desc	Outside Diameter (mm)
A	28/06/2002	1	0.00	87.17	Polyvinyl Chloride	5.900	WT - Wall Thickness	140
A	28/06/2002	2	0.00	0.30	Grout			
A	28/06/2002	3	44.50	53.64	Perforated or Slotted Casing	3.175	AP - Aperture Size	140
A	28/06/2002	4	79.25	85.34	Perforated or Slotted Casing	3.175	AP - Aperture Size	140

Strata Logs 13 *records for RN* 136126

Report Date: 17/08/2021 17:56

Queensland Government
Groundwater Information
Bore Report

Page: 1 of 3
GWDB8250

From Year:

Registered Number	Facility Type	Facility Status	Drilled Date	Office	Shire
103242	Sub-Artesian Facility	Existing	07/06/1993	Emerald	3980 - ISAAC REGIONAL

Details

Description			
Parish	2006 - GIRRAH		
Original Name	HOUSE BORE		
Driller Name			
Drill Company			
Const Method	ROTARY		
Bore Line			
D/O File No	50-1958	Polygon	
R/O File No		Equipment	
H/O File No		RN of Bore Replaced	
Log Received Date		Data Owner	
Roles	Water Supply		

Location

Latitude	23-04-05	Basin	1301
Longitude	148-44-45	Sub-area	
GIS Latitude	-23.068214941	Lot	1
GIS Longitude	148.745730741	Plan	TT299
Easting	678835		
Northing	7447861	Map Scale	104 - 1: 100 000
Zone	55	Map Series	M - Metric Series
Accuracy	SKET	Map No	8651
GPS Accuracy		Map Name	COOROORAH
Checked	Yes	Prog Section	

Casing

1 *records for RN* 103242

Pipe	Date	Rec	Top (m)	Bottom (m)	Material Description	Mat Size (mm)	Size Desc	Outside Diameter (mm)
A	07/06/1993	1	0.00		Plastic Casing	5.900	WT - Wall Thickness	141

Strata Logs

1 *records for RN* 103242

Rec	Top (m)	Bottom (m)	Strata Description
1	0.00	54.30	NO DETAILS

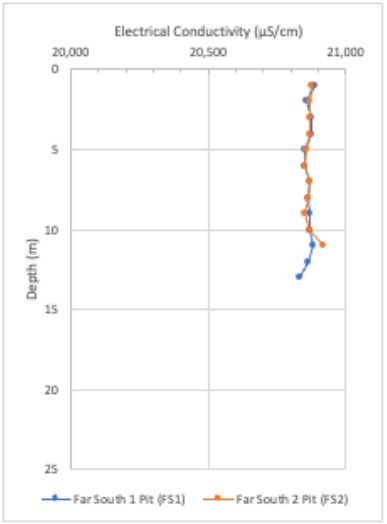
Appendix 2: Hydrogeological logs of monitoring standpipes

Proposed bore No	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11S	P11D	P12
Stratigraphic Target	Burngrove Formation	Burngrove Formation	Alluvium	RCM - Middlemount CS	RCM - Middlemount CS	Rewan	RCM - Middlemount CS	Rewan Formation	Burngrove Formation	Burngrove Formation	RCM Overburden	RCM - Middlemount CS	Tertiary/Alluvium
Rationale qualifier	1,3,4,5	1,3,4,5	1,2,3,4,6,	1,3,4,5,7	1,3,4,5,7	1,3,4,5	1,3,4,7	1,3,4,7	1,3,4,6	1,3,4,5	1,2,3,4,6	1,2,3,4,6	1,3,4,8
Location	h Pit (In-pit tailings disposal 1 (w	West of CHPP	nt Roper Ck upstream from oper	(In-pit tailings disposal 2) - near o	Pit (In-pit tailings disposal 2) - (	(In-pit tailings disposal 3) near C	South of Foxleigh Plains Pit	Southwest of Foxleigh Plains Pit	One Tree West Pit adjacent Carl	t of WC Pit (In-pit tailings dispos	t of "Far South Pit" adjacent Rop	uth of "Carlo Pit" adjacent Cockat	
Access	Adjacent track	On abandoned track	95 m west of multilevel piezome	urbed ground near diversion chai	Adjacent Track	Fence line	Adjacent track	Adjacent Track	Adjacent Track	Adjacent track/cleared area	Near pit perimeter track	Near pit perimeter track	Located on existing track
Bore ID			P3	P4	P5	P6	P7	P8		P10	P11S	P11D	
Date			25/6/2021	1/7/2021	1/7/2021	1/7/2021	26/6/2021	27/6/2021		29/6/2021	30/6/2021	29/6/2021	
Groundwater Level (mbGL)			Dry	9.1	17.4	17	50.2	9		19.2	26.6	22.22	
Date		30/6/2021		1/7/2021		1/7/2021						29/6/2021	
Yield (L/s)		0.04		9.1		0.8						0.37	
Investigation Bore No	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11S	P11D	P12
Easting (GDA94, z55)	680,928	679,984	677,774	687,136	686,670	684,199	683,372	681,822	685,880	683,435	686,295	686,370	687,302
Northing (GDA94, z55)	7,459,866	7,460,976	7,464,684	7,456,960	7,456,688	7,457,432	7,463,137	7,463,697	7,460,174	7,456,349	7,453,583	7,453,540	7,455,371
Stratigraphic target	Burngrove Formation	Burngrove Formation	Alluvium	RCM (Middlemount seam)	RCM (Middlemount seam)	Rewan Formation	RCM (Middlemount seam)	Rewan Formation	Burngrove Formation	Burngrove Formation	RCM Overburden	RCM (Middlemount seam)	Tertiary/Alluvium
Interpolated base of Tertiary sedir	18.8	21.3	37.3	6.2	8	11.5	8.4	11.3	11.8	13	3.5	3.5	13.6
Estimated elevation MML coal sea	NA	NA	NA	65	10	NA	85	NA	NA	NA	NA	40	NA
Proposed drill depth (m bgl)	31	36	19	58	120	31	45	36	25	31	31	85	15
Proposed drill depth (m RL)	102.4	102.2	125.8	65	4	98.1	84.2	94.5	114.8	96.3	92.3	38.3	107.6
Screen depth (m bgl)	24 - 30	29 - 35	12 - 18	51 - 57	113 - 119	24 - 30	38 - 44	29-35	18 - 24	24 - 30	24 - 30	78 - 84	9 - 15
Easting	680902.895	679970.753	677790.768	687058.082	686679.213	684167.131	683905.157	682487.183	686071.349	683483.602	686392.036	686366.398	687347.329
Northing	7459872.299	7460933.407	7464724.578	7456993.452	7456663.56	7457430.433	7463055.086	7463531.576	7458763.869	7456426.969	7453554.817	7453547.207	7455302.98
Elevation	133.572	134.42	143.198	124.481	123.526	128.981	129.287	130.875	127.043	127.154	122.875	123.165	122.522
Date	11/8/2021	11/8/2021	11/8/2021	28/7/2021	28/7/2021	29/7/2021	11/8/2021	11/8/2021	11/8/2021	27/7/2021	29/7/2021	28/7/2021	29/7/2021
SWL (mbRP)	10.93	6.36	-	9.57	38.80	22.94	-	9.82	8.96	11.14	14.41	42.81	11.66
RP Height (m)	0.80	0.73	0.93	0.87	0.82	1.09	1.04	0.90	0.83	0.78	0.77	0.82	0.89
SWL (mbGL)	10.13	5.63	-	8.70	37.98	21.85	-	8.92	8.13	10.36	13.64	41.99	10.77
SWL (RL)	123.44	128.79	-	115.78	85.55	107.13	-	121.96	118.91	116.79	109.24	81.18	111.75
BHTD (mbRP)	22.20	26.02	18.78	59.83	110.18	22.94	41.85	30.09	10.35	25.09	28.19	94.14	12.06
BHTD (mbGL)	21.40	25.29	17.85	58.96	109.36	21.85	40.81	29.19	9.52	24.31	27.42	93.32	11.17
DT Depth (mbRP)	22.00	24.73	17.98	57.83	107.18	20.94	40.65	29.89	9.15	23.59	26.19	91.74	11.56
DT Depth (mbGL)	21.20	24.00	17.05	56.96	106.36	19.85	39.61	28.99	8.32	22.81	25.42	90.92	10.67
Barometer SN						828668							
SN	831506	831462	826448	829325	829502	831523	829326	828178	831487	831533	828203	826746	828205
DT Type (m)	30	30	30	76	76	30	76	30	30	30	30	76	30
HoleID	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11S	P11D	P12
Easting	680903	679971	677791	687058	686679	684167	683905	682487	686071	683484	686392	686366	687347
Northing	7459872	7460933	7464725	7456993	7456664	7457430	7463055	7463532	7458764	7456427	7453555	7453547	7455303
Elevation	133.57	134.42	143.20	124.48	123.53	128.98	129.29	130.88	127.04	127.15	122.88	123.17	122.52
TD	29m	25.5m	21m	58.8m	109.3m	22.6m	57.0m	33.0m	11.0m	26.0m	27.2m	93.4m	12.0m
Sump	24.3m - 24.9m	24.0m - 25.0m	17.0m - 17.5m	57.8m - 58.8m	108.0m - 109.0m	21.3m - 22.3m	39.0m - 40.0m	28.0m - 29.0m	8.4m - 9.4m	22.0m - 23.0m	25.0m - 26.2m	91.0m - 92.4m	-
Slotted PVC	18.3m - 24.3m	18.0m - 24.0m	11.0m - 17.0m	51.8m - 57.8m	102.0m - 108.0m	15.3m - 21.3m	33.0m - 39.0m	22.0m - 28.0m	5.4m - 8.4m	16.0m - 22.0m	19.0m - 25.0m	85.0m - 91.0m	8.3m - 11.3m
PVC	0m - 24.3m	0m - 18.0m	0m - 11.0m	0m - 51.8m	0m - 102.0m	0m - 15.3m	0m - 33.0m	0m - 22.0m	0m - 5.4m	0m - 16.0m	0m - 19.0m	0m - 85.0m	0m - 8.3m
Backfill	26.5m - 29.0m	-	17.8m - 21.0m	-	-	-	41.0m - 57.0m	30.0m - 33.0m	10.0m - 11.0m	24.0m - 26.0m	-	-	-
Bentonite	25.5m - 26.5m	25.0m - 25.5m	17.5m - 17.8m	58.0m - 58.8m	109.0m - 109.3m	22.3m - 22.6m	40.0m - 41.0m	29.0m - 30.0m	9.4m - 10.0m	23.0m - 24.0m	26.2m - 27.2m	92.4m - 93.4m	11.3m - 12.0m
Gravel	12.9m - 25.5m	16.0m - 25.0m	10.0m - 17.5m	45.0m - 58.0m	100.0m - 109.0m	14.3m - 22.3m	32.0m - 40.0m	18.0m - 29.0m	4.6m - 9.4m	10.0m - 23.0m	18.0m - 26.2m	83.4m - 92.4m	6.8m - 11.3m
Bentonite	11.0m - 12.9m	15.0m - 16.0m	8.0m - 10.0m	43.0m - 45.0m	98.0m - 100.0m	13.0m - 14.3m	30.0m - 32.0m	16.0m - 18.0m	3.6m - 4.6m	8.0m - 10.0m	16.0m - 18.0m	81.4m - 83.4m	5.8m - 6.8m
Grout	0m - 11.0m	0m - 15.0m	0m - 8.0m	0m - 43.0m	0m - 98.0m	0m - 13.0m	0m - 30.0m	0m - 16.0m	0m - 3.6m	0m - 8.0m	0m - 16.0m	0m - 81.4m	0m - 5.8m

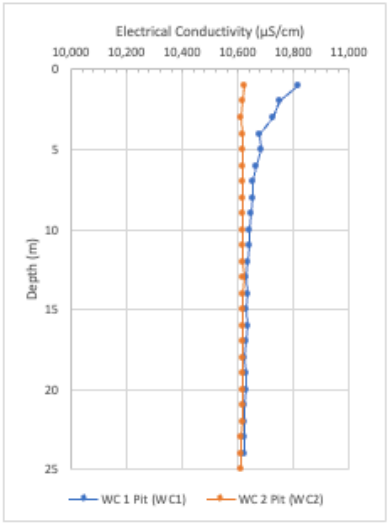
Appendix 3: Void Water Quality

Monitoring carried out on 22 June 2022

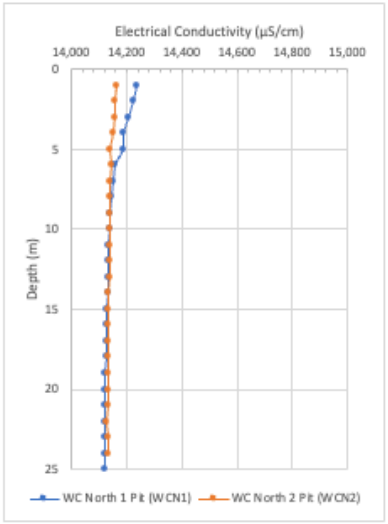
Far South pit



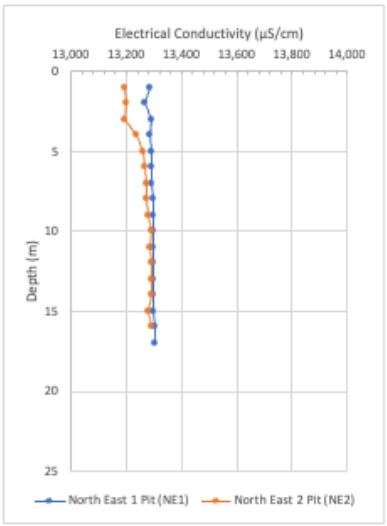
WC pit



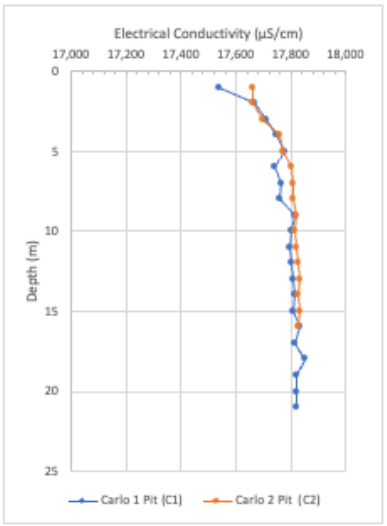
WC North pit



NE pit



Carlo Creek pit



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AUSTRALIA

Appendix J: Engeny PRCP Landform Assessment

ENGENY

FOXLEIGH
LANDFORM

PRCP ASSESSMENT

QC1025_011-REP-001-1

16 MAY 2023

DISCLAIMER

This Report has been prepared on behalf of and for the exclusive use of FOXLEIGH and is subject to and issued in accordance with FOXLEIGH instruction to Engeny Australia Pty Ltd (Engeny). The content of this Report was based on previous information and studies supplied by FOXLEIGH.

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Rev	Date	Description	Author	Reviewer	Project Mgr.	Approver
0	5/04/2023	Client Issue	Brendan Roddy	Matthew Curtis	Brendan Roddy	Tegan Ireland
1	16/05/2023	Client Issue	Brendan Roddy	Matthew Curtis	Brendan Roddy	Tegan Ireland
Signatures:						

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1. INTRODUCTION

1.1 Background

The focus of this report is to assess the landforms in line with the PRCP assessment criteria to gauge the validity of the plans to produce safe, stable, and sustainable rehabilitation of the WRD areas into the long term for Foxleigh Coal Pty. Ltd. (Fox). Background information on the project area can be found in Engeny 2023[1].

1.2 PRCP Criteria

Any organisation carrying out mining activities in Queensland is obligated to rehabilitate the land. A key element in meeting this obligation is the progressive rehabilitation and closure plan (PRCP), which details how the proponent will achieve the closure commitments in the site environmental authority (EA). This assessment has been developed to act as supporting information for the PRCP submission as it relates to the **landform** component. The goal of the landform is that it is fundamentally safe and stable into the long term (Table 1.1). The PRCP submission must include all supporting information required by the Department of Environment and Science (DES) to reach a decision on the soundness of the rehabilitation strategies planned to meet the approved Post Mining Land Use (PMLU) outcomes and agreed non-use management areas (NUMA).

TABLE 1.1: PRCP LANDFORM ASSESSMENT CRITERIA

Assessment Criteria	Example of Satisfactory Outcomes
Safe	The landform is geotechnically safe and not at risk of mass movement or slumping failure
Stable	The landform is erosionally stable and does not have active rill or gully features
Non-polluting	The landform is not contributing pollutants (e.g., acid/saline drainage, metals, sediment)
Self-sustaining	The landform can sustain the PMLU from a vegetation perspective without ongoing maintenance

To comply with the PRCP guideline requirements for final landform assessment shown in Table 1.1, the guideline states that the assessment must include:

- 3D design plans developed for the final landform.
- method of determining landform design.
- modelling predicting the long-term stability of the final landform design.
- method of construction.
- Quality Assurance / Quality Control (QA/QC) requirements.
- trial methodology to verify the predicted success of the final landform design.
- limitations and assumptions of the landform design.

[1] Engeny. 2023. Foxleigh Progressive Rehabilitation Closure Plan. QC1025_002-REP-001-G.

This report captures the requirements of step 3 (modelling predicting the long-term stability of the final landform design) on the proposed Foxleigh WRD excluding any pits or voids. A summary of the past works (Steps 1 and 2) is provided below. To meet the requirements of Step 3, the method of evaluation selected for Landform Evolution Modelling (LEM) assessment. Inputs to the assessment are based on information supplied in the form of 3D final landform configuration developed by Fox.

1.3 Landform Configuration & Rehabilitation Requirements

It is understood that upon completion of mining, the majority of the Foxleigh WRD landforms will be reshaped and rehabilitated in anticipation of a post mining land use with similar vegetation structure and function to that of either native ecosystem, or cattle grazing[2]. The current proposed closure WRD landforms are shown in Figure 1.1. The landforms are comprised of various smaller dumps, so for simplicity in this report they are referred to as:

- Landform 1 (LF1) consisting of Foxleigh Plains North and Foxleigh Plains dumps.
- Landform 2 (LF2) consisting of Pipeline, One Tree, and Carlo dumps.
- Landform 3 (LF3) consisting of NE, NW, Old NE, Void 251, NT, WC North, and WC dumps.

[2] DEHP. 2017. Environmental Authority EPML00744813 – Foxleigh Mine. 17 February 2017.

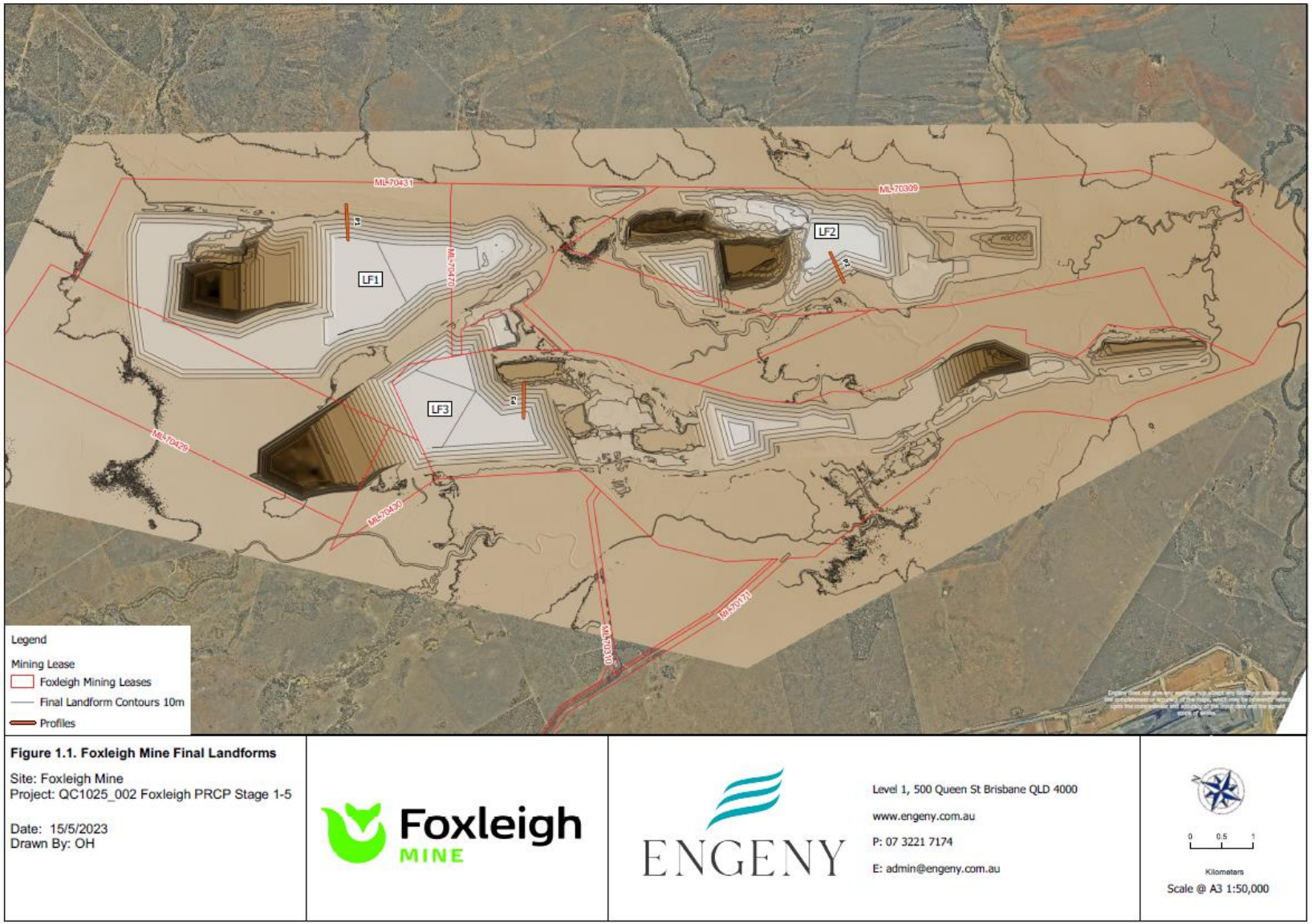

Figure 1.1: Foxleigh Mine Landform Configuration

2. BASIS OF ASSESSMENT

The successful long-term stability of the site's landforms will be heavily influenced the by soil and water interaction, in particular the landform shape, the chemical and physical characteristics of the topsoil and spoil, the final surface treatment outcomes, and the landforms watershed catchments and resultant potential for the concentration of runoff causing erosion. Typically, landform erosional stability is measured as sediment loss t/ha/yr (i.e., the amount of sediment expected to detach from the landform). The assessment methodology has therefore been developed to enable evaluation of these factors. The measure of sediment loss used for the assessment methodology is Average Slope Stability. This is the annual average mean soil loss rate t/ha/yr expected over the total length of the slope. The average slope stability (mean) has been used as the primary assessment tool, to enable evaluation of failure which may occur on a constant grade slope.

2.1 Landform Evaluation Model (LEM) Selection

The Water Erosion Prediction Project (WEPP) erosion model has been utilised to determine long-term landform stability. WEPP is a two-dimensional hillslope analysis model developed by the United States Department of Agriculture (USDA), initially for agricultural land to predict runoff, erosion, deposition for hillslopes and catchments. The model has been previously applied to Australian waste rock dumps to validate the model against measures erosion observations. After the USLE and RUSLE equations, WEPP is the most widely applied erosion model to assess soil loss from water3.

WEPP requires inputs in six main categories for computation: climate generation, hydrology, plant growth, hillslope, soils, and management. These elements are assessed over a timestep (typically daily) are used to determine erodibility, with multiple iterations of the model run back-to-back to predict long term change. During model simulations rainfall is evaluated against plant and soil characteristics, to determine the presence of runoff, sediment detachment, and transport. The WEPP model's evaluates soil erodibility, using the following analytical processes:

- Interrill erodibility (Ki) – describes the detachment of sediment in interrill areas of the landform slope.
- Rill erodibility (Kr) – describes the detachment from rills and rill formations down landform the slope.
- Critical shear stress (Tc) – describes the critical shear stress required for rill initiation.
- Hydraulic conductivity (Ke) – critical in determining losses, and subsequent runoff.

The Foxleigh LEM WEPP model was run over a simulation period of 100-years, to enable assessment of long-term stability of each final landform. To enable complete assessment of long-term stability of the landforms (in particular during high-risk periods such as vegetation establishment), model was run with scenarios of increasing vegetation cover.

WEPP provides a range of outputs dependent to the model parameters being investigated, which align with the selected measures within the basis of assessment and are compared against the selected Target Erosion Rates.

2.2 Target Erosion Rate Selection

Any assessment of mining landform erosion requires a determination of an acceptable erosion rate so as to set the goal of the landform design. There are many definitions of what is an acceptable or tolerable soil loss rate[4] of which the most environmentally sound would be that soil loss would match soil creation for an equilibrium state. This is impractical from a mine site perspective as the equilibrium assumes an undisturbed soil profile where pedological and biological processes are functioning and not a newly created soil cover on a highly disturbed waste landform.

Reviewing regularly refenced industry targets determined that a range of values has typically been adopted, such as:

[3] Borrelli, P. et. al. 2021. Soil erosion modelling: A global review and statistical analysis. Science of the Total Environment. v780, pp146-194.
[4] Verheijen, F.G.A., et. al. 2009. Tolerable versus actual soil erosion rates in Europe. Earth Science Reviews. v94, n1-4, pp23–38.

- Historically, Mining industry Environmental Management Overview Strategies (EMOS) often included conditions requiring sites to target soil erosion loss rates for post mining land use. Typical ranges identified within these studies ranged between 12 t/ha/yr and 40 t/ha/yr[5]. Environmental Management Plans (EMPlans) which replaced the EMOS frameworks and then Environmental Authorities have remained silent on providing guidance to sites on acceptable soil loss rates, favouring general conditions to achieve 'stable' landforms.
- An Australia wide study undertaken in 2001 *The Prediction of Sheet and Rill Erosion Over the Australian Continent, Incorporating Monthly Soil Loss Distribution* used remote sensing to determine erosion rates on a national scale [6]. Erosions rates were then broken down into land uses, with the relevant rates identified as residual / native pastures (7.96 t/ha/yr) and national parks (10.30 t/ha/yr).
- Similarly, the *Leading Practice Sustainable Development Program for the Mining Industry*, published by the Department of Industry, Sciences and Resources references the work of early erosional models, suggesting a loss rate of 12.6 t/ha/yr for maintenance of the fertility of cropland is an applicable target[7].
- The Soil Conservation Measures Design Manual for Queensland (2004) states that a historically accepted limit, roughly representing 1mm of soil loss nominates, would result in approximately 12.5 t/ha/yr as an acceptable soil loss rate.
- Actual studies of erosion rates using rainfall simulators on Central Queensland mine sites estimated topsoil losses under pasture at 10% gradients as 6.7, 2.2, 8.3, and 3.5t/ha/yr. The same study estimated soil loss for 20% gradient pasture as 10.8, 50.7, 15.7, 18.7, 27.1t/ha/yr[8].
- Erosion rate estimates for cultivated Vertosols in Theresa Creek catchment (south of Clermont) on low relief gradients (<3%) at 4t/ha/yr[9].
- The author is aware of a long-term rehabilitation trial (~20 years) in Central Queensland on a WRD between 25-40% gradient. There was no topsoil used on the WRD, nor berms or rock spine drains. The current state of the trial is that there is no visible erosion, and the area is self-sustaining a woodland habitat without maintenance or inputs of fertiliser or soil amendments. The erosion rates during the early establishment as measured by direct sediment measurement were 44.5t/ha/yr in the first two years, and then 89t/ha/yr in the following 3 years.
- The USDA undertook a study that suggested tolerable soil loss rates for agricultural soil were between 4.5 and 11.2t/ha/yr[10].

CSIRO have conducted a national assessment of soil erosion using the revised universal soil loss equation (RUSLE). The grid is an estimate of the six RUSLE inputs for rainfall erosivity factor (R), soil erodibility (K), slope length and steepness (LS), cover management (C), and conservation practice (P), and the grid for the Foxleigh mine site area is shown in Figure 2.1. The grid shows erosion rates between 1-2t/ha/yr and this is due to the low relief of less than 2% of the surrounding area, of which the RUSLE is particularly sensitive to the LS factor and the anticipated Foxleigh landform will be around 50m above the surrounding natural surface. For this reason, these rates are not applicable. Looking at areas approximately 25km further to the northeast of the mine site (Figure 2.2), the same data set was examined for the 14-17% topography. This yielded erosion rate ranges from 2-8t/ha/yr. As this topography is similar to the expected Foxleigh landform ranges, thus a midpoint of **5t/ha/yr** is selected which is also a conservative value in light of the above conversations.

[5] Welsh, D., et. al. 1994. Coal mining on target with environmental planning. Queensland Government Mining Journal. v2, pp19-22.
[6] Lu, Hua. 2001. Prediction of sheet and rill erosion over the Australian continent, incorporating monthly soil loss distribution. CSIRO Land and Water, http://nla.gov.au/nla.arc-13482
[7] Wischmeier, W.H., and Smith, D.D. 1978. Predicting rainfall erosion losses: a guide to conservation planning, US Department of Agriculture handbook no. 537, US Government Printing Office, Washington DC.
[8] So HB, et. al. 2018. MINErosion 3: Using measurements on a tilting flume-rainfall simulator facility to predict erosion rates from post-mining landscapes in Central Queensland, Australia. PLoS One. v28, n13. Pp1-21.
[9] Hughes, A.O., et. al. 2009. Sediment source changes over the last 250 years in a dry-tropical catchment, central Queensland, Australia. Geomorphology. V104, n3-4, pp262-275.
[10] McCormack, D.E., et. al. 1982. Current criteria for determining soil loss tolerance, in: Determinants of Soil Loss Tolerance. ASA Special Publication No. 45. American Society of Agronomy, Madison, WI, pp. 95–111.

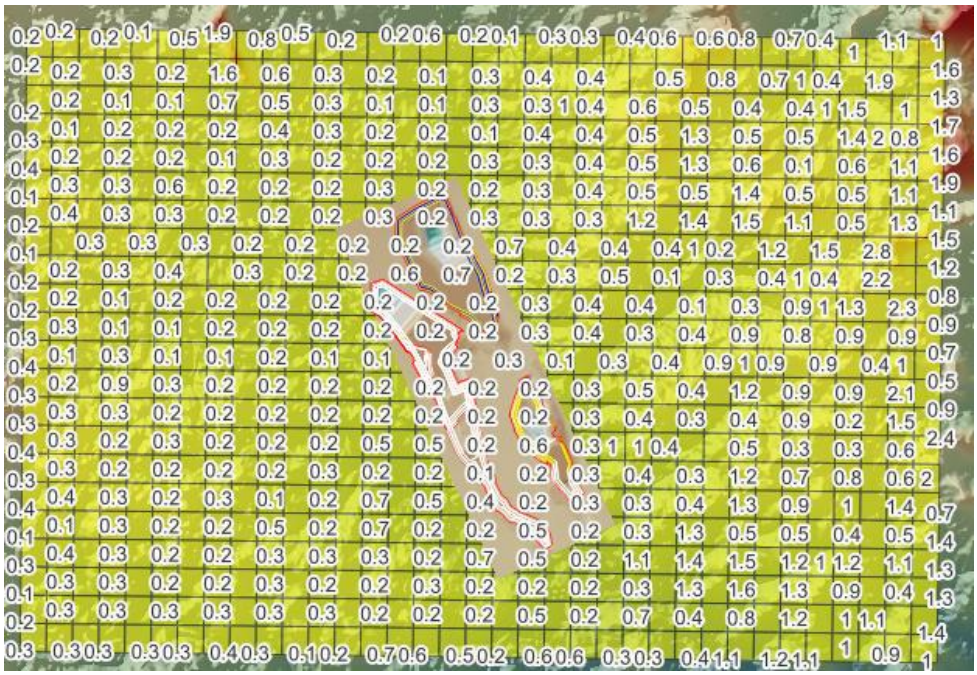

Figure 2.1: National Assessment Grid of Annual Erosion Rate for the Surrounding Area of Foxleigh Mine

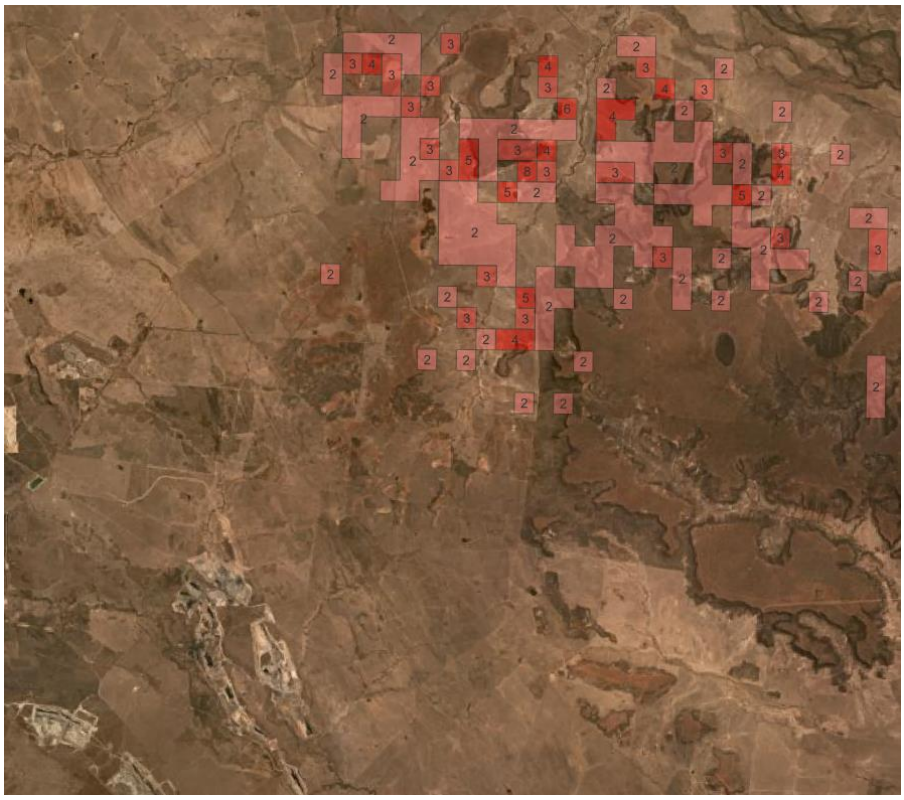

Figure 2.2: National Assessment Grid of Annual Erosion Rate for the Steeper Topography to the Northeast Area of the Foxleigh Mine

3. WEPP INPUT FILES

To enable evaluation of landform stability in the establishment phase, the WEPP model allows for inputs to define conditions expected post construction. A typical landform erodibility potential is particularly high during the establishment period, as the residual ground conditions encountered (i.e., where vegetation coverage on landform slopes is limited). In the context of a reshaped mine WRD, key factors affecting residual ground conditions would include:

- Climatic conditions.
- Landform topography.
- Quality and quantity of growth media, and preparation of the surface (e.g., tillage, deep ripping, crop rill lines).
- Landform establishment (vegetation species selection and success).

3.1 Climate

WEPP generates a climate file using an internal stochastic weather generator, CLIGEN (version 5.1). CLIGEN has previously been validated for Australian climates, including western Queensland. For each CLIGEN simulation, ten daily parameters are required.

- Precipitation.
- Precipitation duration.
- Peak storm intensity.
- Time to storm peak.
- Average maximum temperature.
- Average minimum temperature.
- Dew point.
- Solar radiation.
- Wind speed.
- Wind direction.

To generate the appropriate climate file, the SILO[11] data set was used. The SILO data drill contains information on the Foxleigh mine site for daily rainfall, solar radiation, and temperature.

Using the data set above, the following WEPP parameter values were calculated:

- Mean daily precipitation on wet days for each month.
- Standard deviation and skewness of daily precipitation for each month.
- Probability of a wet day following a dry day for each month.
- Probability of a wet day following a dry day for each month.
- Mean daily maximum temperature for each month.
- Mean daily minimum temperature for each month.
- Standard deviation of maximum daily temperature for each month.
- Standard deviation of minimum daily temperature for each month.
- Mean maximum 30-min rainfall intensity for each month.

[11] Qld. Government. 2022. SILO – Australian climate data from 1889 to yesterday. Queensland Government. Accessed 13/12/2022. URL: https://www.longpaddock.qld.gov.au/silo/

- Mean dew point for each month.

Using the calculated parameters, a CLIGEN parameter file was created for the site and a subsequent 100-year climate file was generated using CLIGEN (5.1). The standard WEPP approach of using Priestley-Taylor's method for estimating the potential evaporation was also adopted.

3.2 CLIGEN Validation

For validation of the CLIGEN climate file, statistical comparison was undertaken against the SILO drill data set. The annual average annual rainfall for the SILO Drill data set was approximately 584 mm, while the CILGEN model produced an annual average of 547mm. Figure 3.1 compares the monthly average rainfall for the both the SILO data drill and CLIGEN 100-year climate data sets.

The frequency of occurrence of the maximum daily rainfall was compared using a Log Pearson III distribution for both data sets. Figure 3.2 displays the corresponding daily rainfall to recurrence interval for the data sets. Given the variability in the region's rainfall, the recurrence interval for daily rainfall matches well for both data sets.

The 100-year synthetic CLIGEN generated data set, correlates closely with the SILO Drill data set for the Foxleigh mine region. This correlation validates the use of the CLIGEN climate file within the WEPP program to simulate runoff conditions expected on the landform.

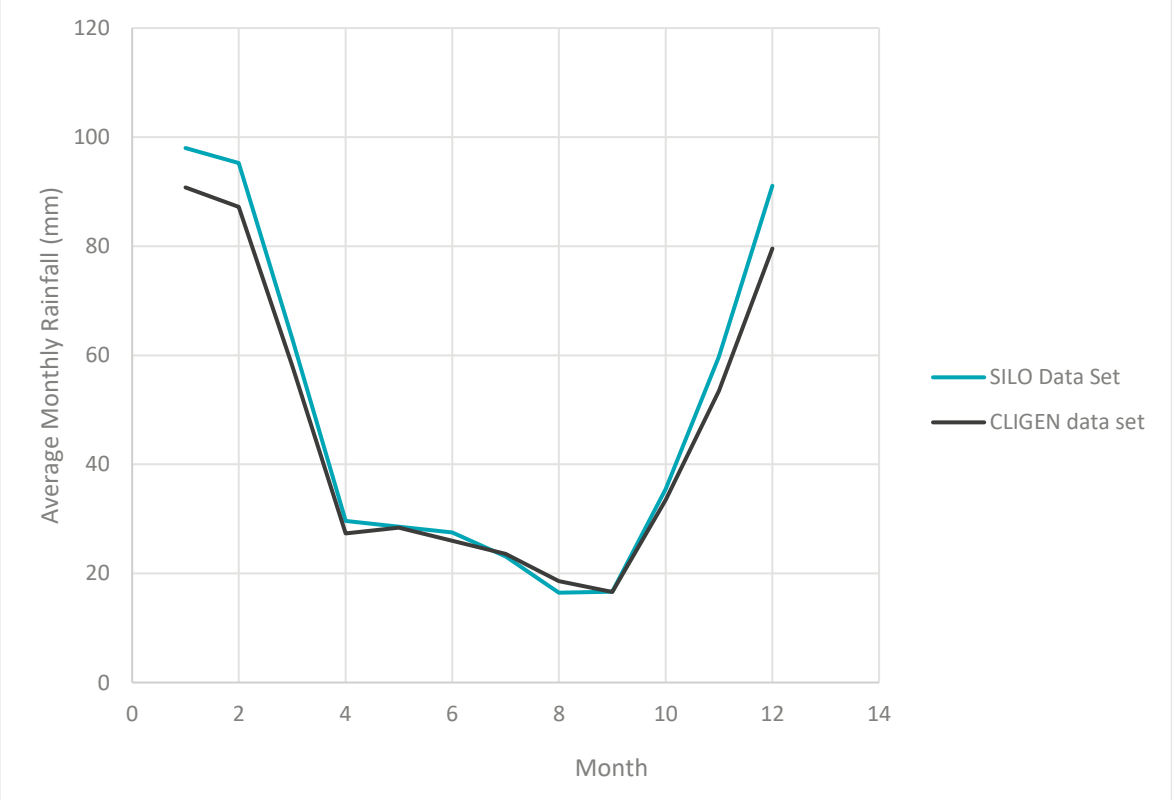

Figure 3.1: CLIGEN and SILO Data Drill Monthly Rainfall Comparison

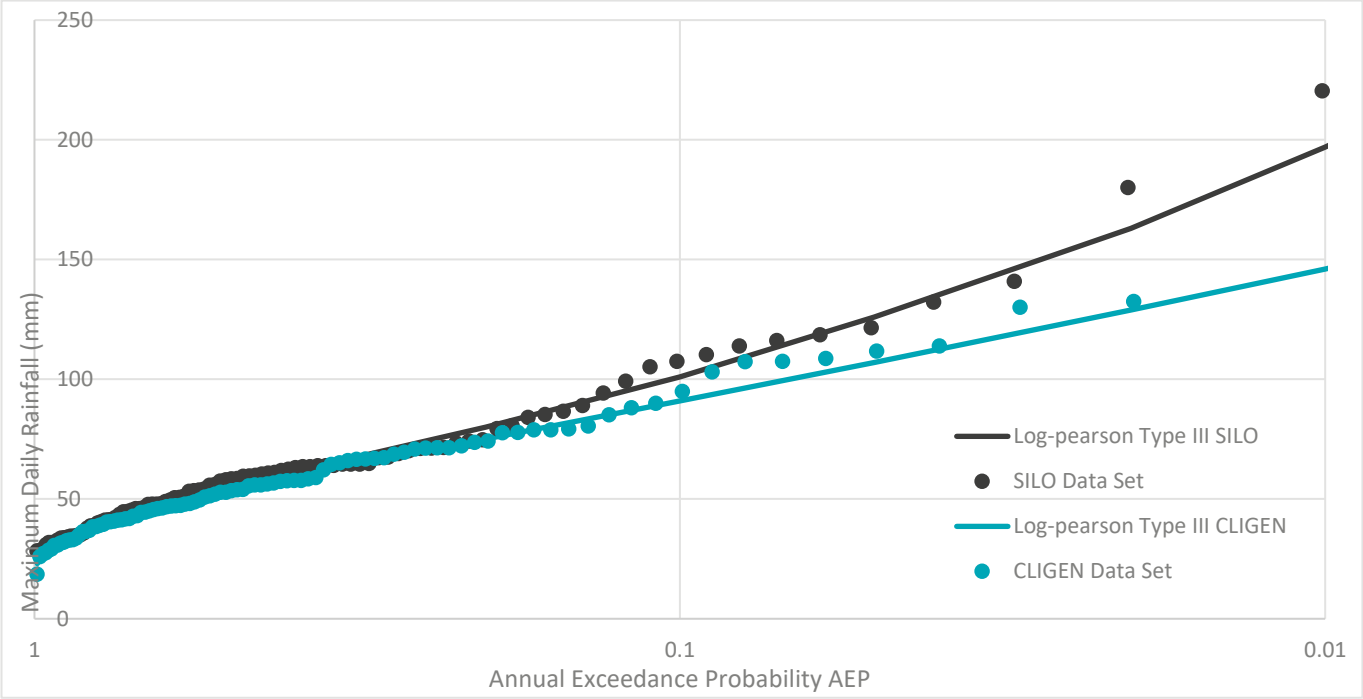

Figure 3.2: CLIGEN and SILO Data Drill Frequency of Occurrence Comparison

3.3 Landform Topsoil

WEPP requires a material file of the proposed landform growth media/topsoil. The main input requirements for the material file are:

- Particle size distribution (%) (clay, sand, rock).
- Organic matter (%).
- Catio Exchange Capacity (CEC) (meq/100g).

The soil parameters represented in the WEPP model for the site landforms, is based on the nominated soil depth of 300mm. Engeny acknowledges that this soil depth is larger than that proposed by Foxleigh (150-200mm) but achieving target erosion rates for this thicker layer add conservancy to the model results. No assessment of the underlying spoil material is undertaken. This is because a) the underlying spoil is highly heterogeneous and a representative type would be hard to define without extensive field work, and b) the aim is to assess if a growth medium cover can be erosionally stable over the long term and thus avoid any rilling or gullying into the underlying spoil.

No direct soil testing was undertaken for this assessment. The soil/spoil input parameters have been taken from previous site studies. The site was soil mapped in 2011[12]. The survey found the area was dominated (43%) by brown/yellow sodosols and other smaller areas of different coloured duplex soils and cracking clay vertosols. The survey was limited as the southernmost extent was on ML70470 in line with WC North. A more recent study[13] characterised and mapped soils over the entire Foxleigh site. This study showed the site was dominated by sodosols in the north and vertosols in the south with minor areas of minor areas of chromosols near the ML boundary (Figure 3.3). Sampling of the topsoil stockpiles and a subjective assessment determined that the most abundant topsoil stockpile type was chromosols, followed by sodosols[13]. It is for this reason that the three materials considered in this report was sodosols, vertosols, and chromosols.

[12] GSS Environmental. 2011. Soil and Land Suitability Assessment: The Foxleigh Plains Project. HAN19-001. March 2011.

[13] RGS. 2021. Geochemical characterisation of mining waste, coal, and soil. 2021011. 20th October 2021.

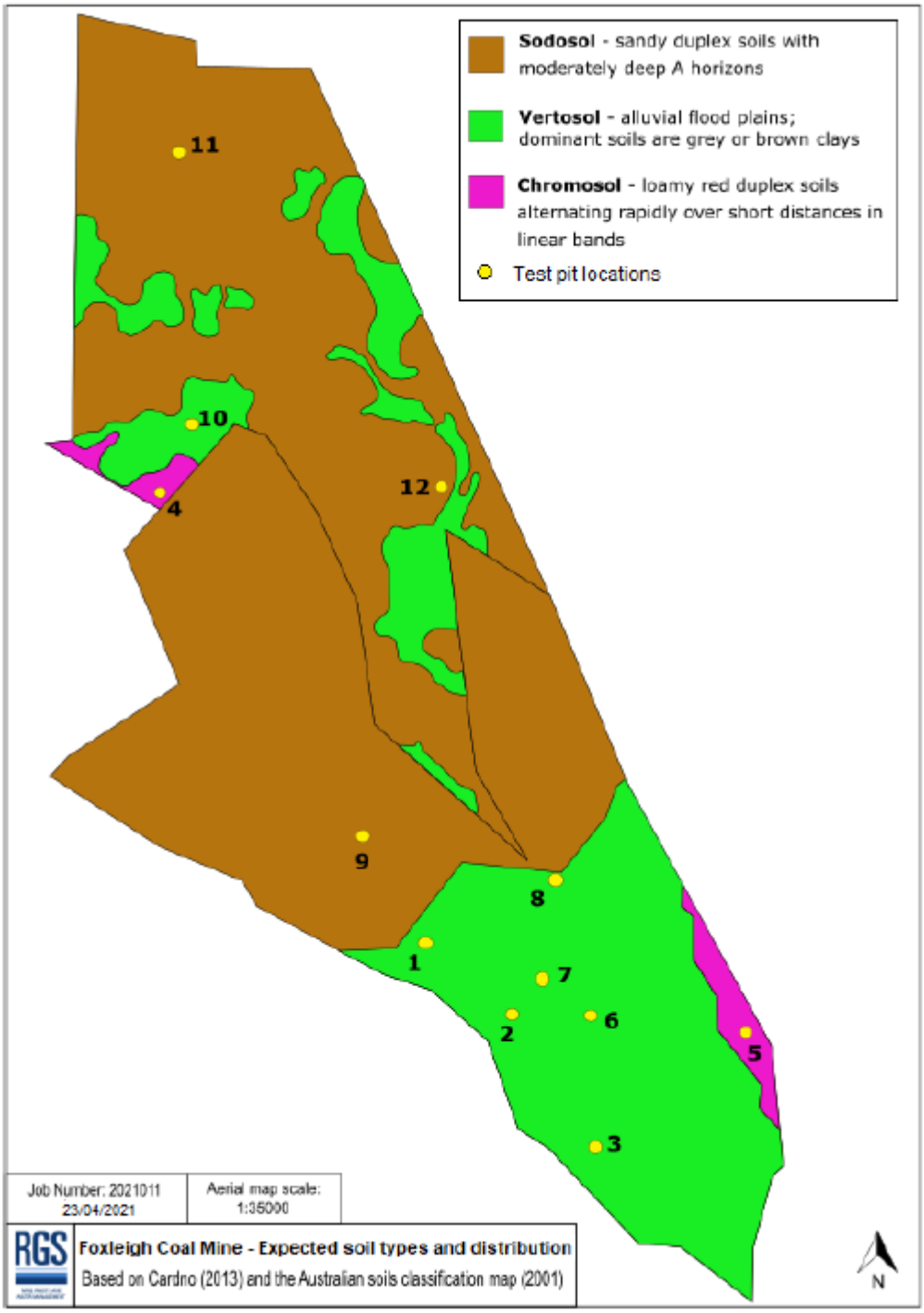

Figure 3.3: Main Soil Types Found at the Foxleigh Mine Site

Vertosols (soil association Bluchers): this soil type is a shrink-swell (or cracking clay) that is associated with site drainage lines. The typical soil on site is a deep grey clay with other areas of black or brown clays. These clay rich soils are slightly alkaline and saline but has a higher CEC than the other soil types.

Chromosols (soil association Roper): they are associated with shallow valley and are brightly coloured (orange/reds) loams or sandy clay loams soil with texture contrasted B horizons. They are low in salinity and sodicity, but also low in nutrients.

Sodosols (soil association Foxleigh, Racetrack, Emoh): these are soils influenced by sodium and are a texture contrast soil with thick mottled B horizons. The topsoils are clay loams or silty clays of moderate alkalinity and salinity, but low nutrients and saturated hydraulic conductivity means they are susceptible to erosion. A summary matrix is shown in Figure 3.4.

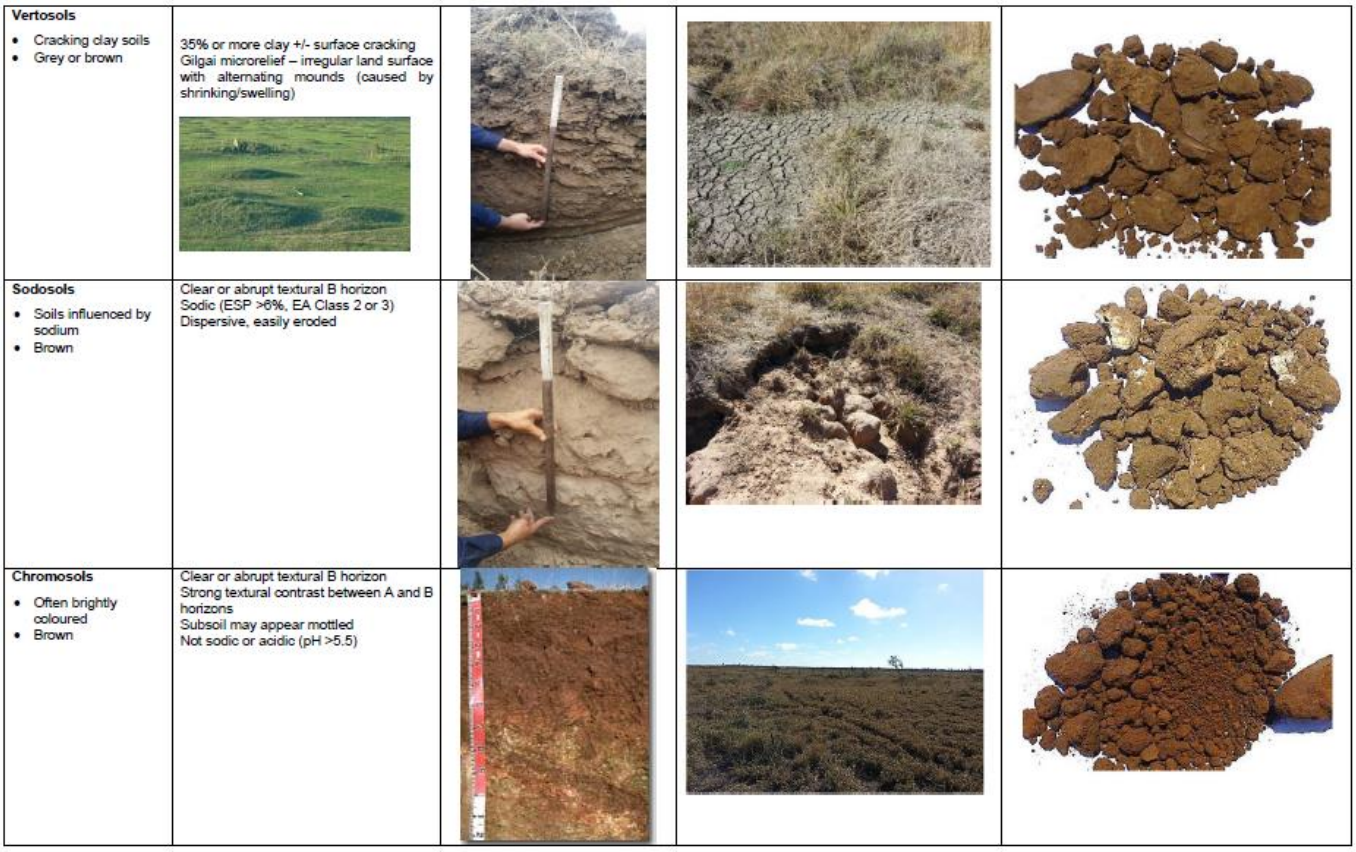

Figure 3.4: Details of Vertosols, Sodosols, & Chromosols Found at the Foxleigh Mine

The information in the RGS report was cross checked with that in the GSS report and from nationally available soils data from the SLGA[14] layer, a study on Central Queensland mine soils and spoils[15], and from Central Queensland mine site soil data that Engeny has access to check ranges of texture, CEC, organic carbon, etc. These parameters were then used to compile the material file for WEPP and the results are shown in Table 3.1. The reports also showed that these materials were of an alluvial/colluvial origin, and therefor had a very low rock content. The self-mulching nature of the vertosols shows up in the slightly higher organic content and higher CEC. The reports also contained a moisture percent which was used to input the initial saturation within the material file.

[14] Searle, R. 2021. Australian Soil Classification Map. Version 1.0.0. Terrestrial Ecosystem Research Network. (Dataset). https://doi.org/10.25901/edyr-wg85

[15] Sheridan, G.J, *et. al*. 2000. Estimation of erosion model erodibility parameters from media properties. Australian Journal of Soil Research. v38. pp265-284.

TABLE 3.1: SOIL ATTRIBUTES USED FOR THE WEPP MATERIAL FILE

Attribute	Sodosol	Vertosol	Chromosol
Sand %	37	20	43
Silt %	33	35	32
Clay %	30	45	25
Texture	Clay Loam	Clay	Loam
Organic content %	1	2	1
CEC	10	22	6
Rock content %	0	0	0
Moisture %	4.7	6.6	4.0
pH*	8.1	8.2	7.8

* Not a WEPP input

To enable representation of landform surface preparation, the following inputs were utilised, which are values considered standard in the construction of WRD's:

- 5 cm – initial ridge height and roughness.
- 5 m – rill spacing.

3.4 Rehabilitation Requirements & Topography

The rehabilitation requirements for the landforms are set out in the Foxleigh Rehabilitation Management Plan[16] (RMP) for spoil emplacement areas:

- Top of dump <10%.
- Outer slopes 17%.
- Topsoil 150mm.
- Functional drainage.
- Outer spoil slopes are no longer than 100m without being broken by a contour bank (0.3 – 1% fall to a spine drain).

The landform data supplied to Engeny was an XYZ file (PRCP_2054) and a DXF drawings (OT PL Dump Shell Stage 5_PRCP). The two sets of drawings were used to interrogate the surface to find the 'worst case' (i.e., the most difficult areas in terms of highest dump elevation and

[16] Foxleigh Mine. 2021. Rehabilitation Management Plan. ENV-PLN-0010. 16/08/2021.

longest slope length) for landform design. The most challenging sections on all three Final Landform WRD configurations consisted of four lifts at the highest point. Each lift was approximately 15m high with a 50% gradient. The lifts are separated by benches of approximately 85m in width (Figure 3.5). This bench and batter configuration is optimised to a 14% cut/fill balanced single linear slope 55m in height (Figure 3.6).

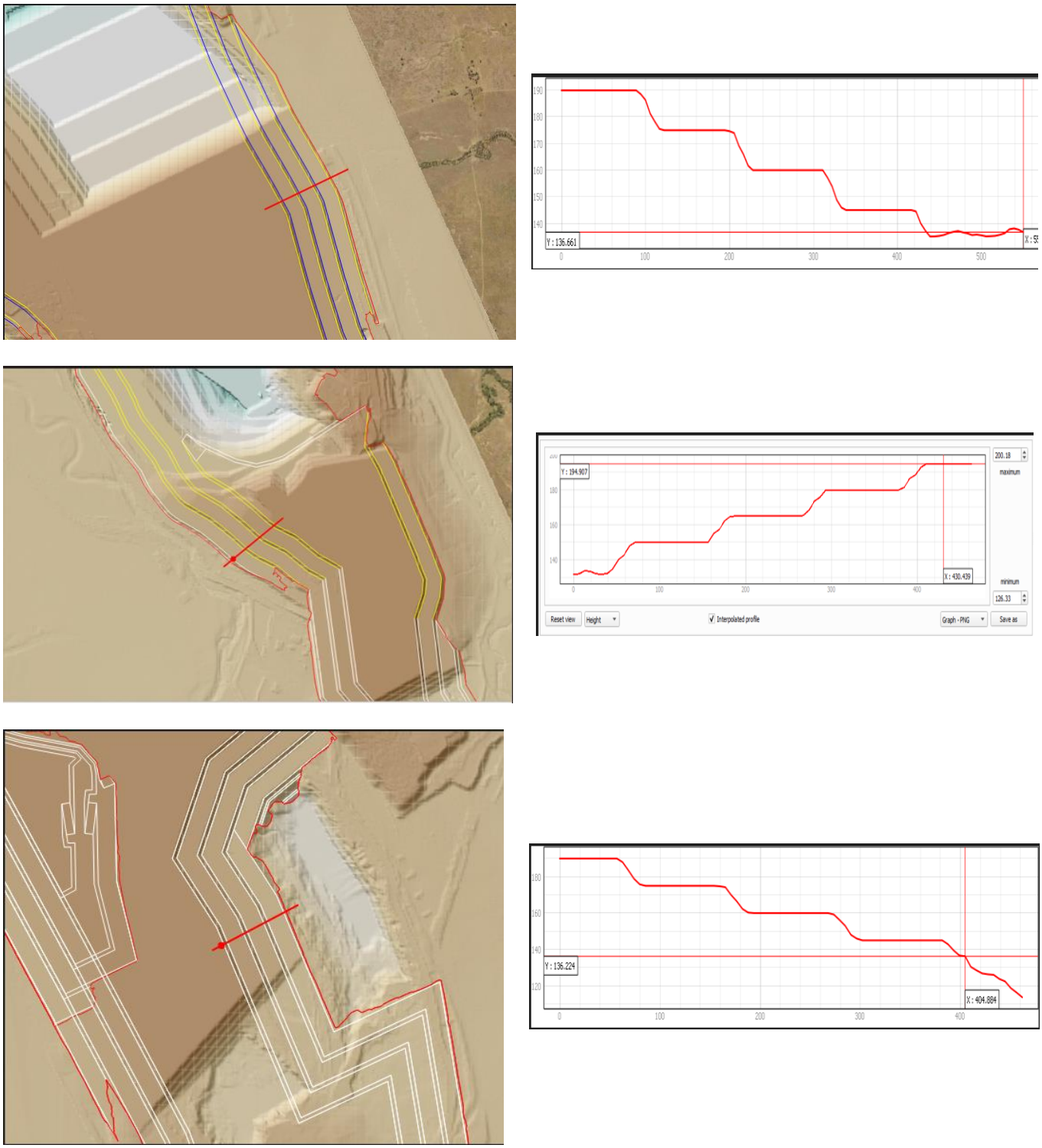

Figure 3.5: Landforms Cross Sections & Profile of LF1 (Top), LF2 (Middle), and LF3 (Bottom)

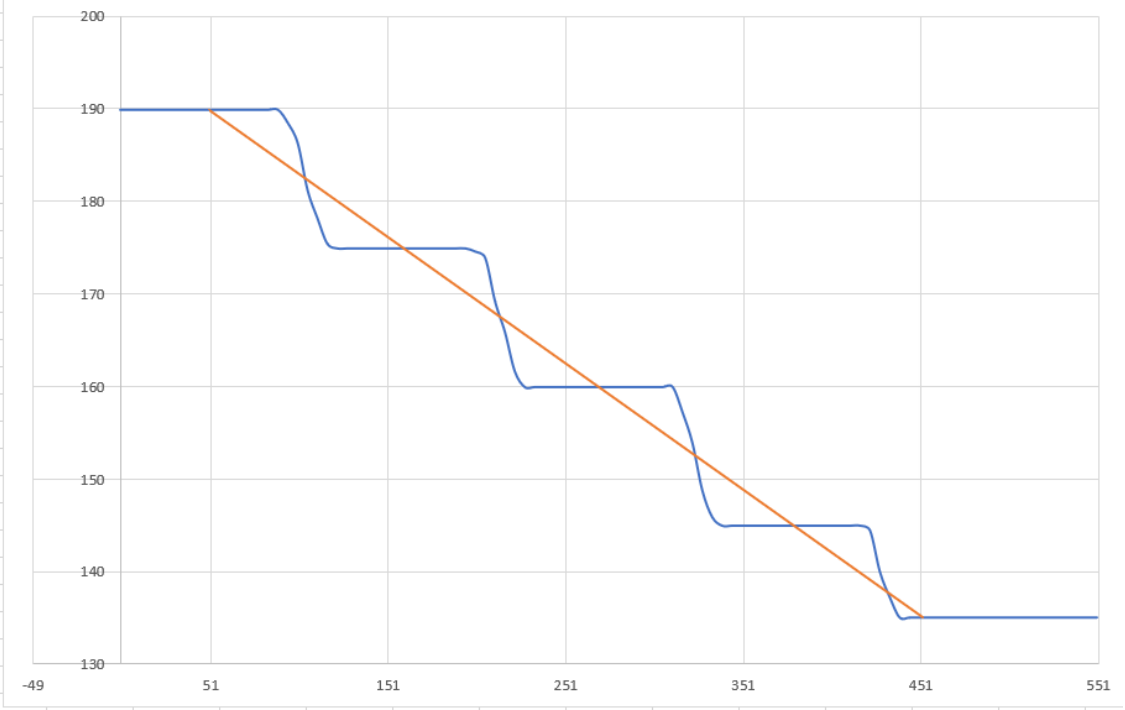

Figure 3.6: Cut/Fill Balanced 14% Slope for Four Lifts of the Foxleigh Plans WRD

Based on the rehabilitation requirements and the supplied landforms, the following landform scenarios were modelled to gauge erosional stability:

- Cut/fill balanced (or optimised) single lineal slope: 14% gradient and 55m high (Figure 3.6).
- Cut/fill balanced single lineal slope 100m long: 14% gradient and 14m high.
- Single lineal slope 100m long: 10% gradient and 10m high.
- Single lineal slope: 17% gradient and 55m high.
- Single lineal slope 100m long: 17% gradient and 17m high.

The 14% slope is derived from the optimised landform gradient, and 17% slope from the Foxleigh RMP. The 55m height comes from the highest elevation locations on the planned landform, and the 10m (10%), 14m (14%), and 17m (17%) heights are a slope partitioned with a contour bank as per the Foxleigh RMP.

The WEPP model was run on the above five slope scenarios (for each of the three main soil types) and the results assessed against the target erosion rate. The scenarios were also modelled using varying rates of vegetation cover.

3.5 Vegetation Cover

The presence of vegetation provides resilience to erosion on all landform slopes. All cross sections used in the model were assumed to have a grazing end land use, therefore all cover scenarios used in the modelling are representative of a pasture vegetation type. Each cover scenario was run as a standalone model simulation for the duration of the model (i.e., 100 years) at that cover value. It is expected however that the cover scenario will not be achieved immediately at the start of the simulation, so the results should be read in light of those caveats.

4. LANDFORM EVOLUTION MODEL RESULTS

Analysis has been undertaken for the long-term erosion rates (100 years) in the prevailing climate to meet the average acceptable soil loss rate of 5t/ha/yr. Long term average erosion rates that do not meet these criteria are shown in red in the following tables. The landform scenarios modelled for the three soil types were:

- Single lineal slope: 17% gradient and 55m high.
- Single lineal slope 100m long: 17% gradient and 17m high.
- Cut/fill balanced (or optimised) single lineal slope: 14% gradient and 55m high.
- Cut/fill balanced single lineal slope 100m long: 14% gradient and 14m high.
- Single lineal slope 100m long: 10% gradient and 10m high.

Comparison of model results for target rates of slope average provides an indication of future stability.

4.1 Average Slope Stability

To assess average slope stability, the annual average soil loss rate was reviewed for landforms. The results show that for all of the slopes scenarios for all of the soils, long term stability will not be achieved without vegetation. The most erodible material was the clay rich Vertosol for the 17% slope 55m high at 121t/ha/yr (Table 4.1).

TABLE 4.1: WEPP ANNUAL AVERAGE MEAN SOIL LOSS RATE OUTPUTS (T/HA/YR) FOR 0% VEGETATION COVER

*Rates above the target erosion rates are shown in red.

Landform	Sodosol	Vertosol	Chromosol
17% 55m high	87.7	121.0	80.9
17% 17m high	43.9	55.7	41.1
14% 55m high	81.3	116.7	75.3
14% 14m high	37.5	47.8	35.1
10% 10m high	27.8	36.3	26.0

A vegetation cover of 30% was next applied and the scenarios were rerun. A perennial grass cover was used to represent the pasture species likely to be used for Foxleigh grazing areas. While the vegetation made a substantial difference, the 14% 55m high slope was still above the acceptable soil loss limits for the sodosol and vertosol soils (Table 4.2).

TABLE 4.2: WEPP ANNUAL AVERAGE MEAN SOIL LOSS RATE OUTPUTS (T/HA/YR) FOR 30% VEGETATION COVER

*Rates above the target erosion rates are shown in red.

Landform	Sodosol	Vertosol	Chromosol
17% 55m high	6.5	8.9	5.4
17% 17m high	3.8	4.4	3.5
14% 55m high	5.8	8.4	4.7
14% 14m high	3.2	3.6	2.9
10% 10m high	2.2	2.5	2.0

The vegetation cover was increased from 30% to 60% for the next run. At this level of vegetation cover erosional stability was achieved for all soils on all slopes (Table 4.3).

TABLE 4.3: WEPP ANNUAL AVERAGE MEAN SOIL LOSS RATE OUTPUTS (T/HA/YR) FOR 60% VEGETATION COVER

Landform	Sodosol	Vertosol	Chromosol
17% 55m high	2.9	4.2	2.4
17% 17m high	2.0	2.3	1.9
14% 55m high	2.5	3.8	2.0
14% 14m high	1.6	1.8	1.5
10% 10m high	1.2	1.1	1.1

4.2 Maximum Erosion Rates

At this point it is worthy to note that this assessment uses the average (or mean) annual soil loss to compare slopes and material, as defined in a previous section. As stability is indicated at the 60% level of vegetation, further interrogation of the results was warranted to examine the peak or maximum erosion rates for each scenario. Figure 4.1 shows an example WEPP output for the Chromosol for the 14% gradient slope that is 55m high and approximately 400m in horizontal footprint. The results show the annual average erosion rate is 2t/ha/yr. In Figure 4.1 the slope can be seen in profile (green line) and the corresponding erosion rate down the slope in grey. The pattern of erosion shows that the Chromosol is a detachment limited material and that for the first 50m down the slope that the material is very stable and that rills would most likely not be evident in this part of the slope (orange arrow). Further down the slope this is where the material is starting to be detached and this increases down the slope, albeit at very low rates (blue line). All of the results shown in Table 4.4 have very low maximum rates as well as average rates, and this will further decrease with vegetation establishment above the indicated 60%.

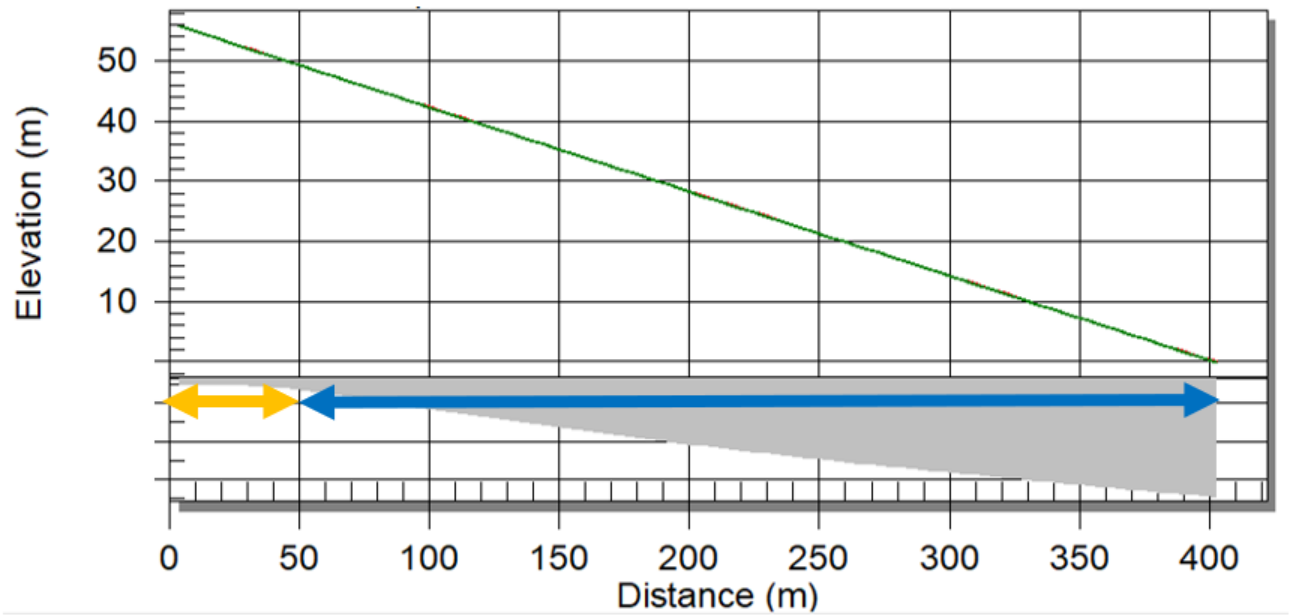

Figure 4.1: Maximum Erosion Rate for the Chromosol Soil on a 14% Gradient 55m High Slope

TABLE 4.4: WEPP ANNUAL AVERAGE MEAN SOIL LOSS RATE OUTPUTS (T/HA/YR) FOR 60% VEGETATION COVER

*with maximum erosion rates shown in brackets

Landform	Sodosol	Vertosol	Chromosol
17% 55m high	2.9 (5.2)	4.2 (8.1)	2.4 (4.2)
17% 17m high	2.0 (3.4)	2.3 (4.2)	1.9 (3.1)
14% 55m high	2.5 (4.5)	3.8 (7.4)	2.0 (3.4)
14% 14m high	1.6 (2.7)	1.8 (3.4)	1.5 (2.5)
10% 10m high	1.2 (1.9)	1.1 (2.2)	1.1 (1.7)

5. DISCUSSION

5.1 Introduction of Vegetation

It should be noted that the erosion rate assessment indicates that a large reduction in the erosion rate was identified through the introduction of 30% vegetation cover when compared to the bare soil scenario. The relationship between erosion rate and vegetation cover is well established, and there are studies in Central Queensland using experimentally derived input parameters for WEPP showing the same relationship[17]. Figure 5.1 shows the reduction in sediment concentration from a Central Queensland and South-East Queensland mine topsoil. At the 30% level of vegetation cover, the resultant reduction in sediment was 60% and 80% in comparison to a bare surface, which supports the findings in this assessment. The slopes for the study were 15% at Tarong and 25% at Callide.

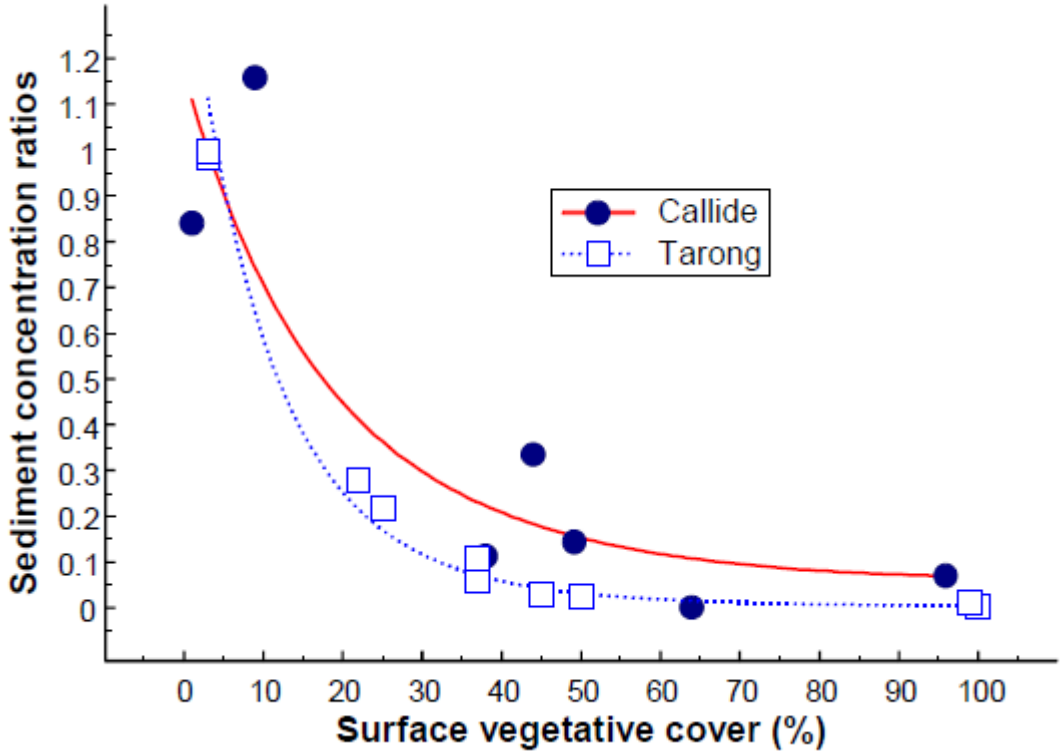

Figure 5.1: Reduction in Sediment Concentration with Increasing Levels of Vegetation Cover

The sediment concentration rations were calculated as a percentage of the bare surface erosion relative to the vegetated plot for the same event.

The inclusion of established vegetation of landforms has the effect on reducing erosion by:

- Reducing runoff amount through increased infiltration via root channels and improving the soil condition.
- Protection of the soil surface from raindrop impact and stopping splash detachment and material saltation down the slope.
- Increased soil cohesion via the root mass and improving the soil condition.
- Impedance of overland flow velocities, and consequently rill development.

[17] So, H.B. et. al. 1998. Post Mining Landscape Parameters for Erosion and Water Quality Control. ACARP C4011 and C5009, November 1998.

5.2 Established Vegetation

The modelling results show that when a vegetation cover is established to provide 60% coverage, rehabilitation stability is achieved at the Foxleigh mine site. Note that this is for the 'worst case' sections of the landform with the greatest heights and slope lengths. While extensive and healthy vegetation cover is encouraged, the 60% level will not be required for stability for lower gradient/shorter slope length areas.

Until the 60% level of vegetation cover is established, the soil surface will remain vulnerable to erosion, especially in the summer storm dominant climate. The concept is known as controlling the window of erosion. As shown in Figure 5.2, high sediment losses are more likely to occur over the wet season before cover levels of over 50% are established[18]. The risk increases the steeper the slope gradient. The authors report that erosion rates of 100t/ha/yr can result if vegetation is not established (Table 4.1).

The process is a vicious circle where vegetation is required to control erosion ➔ vegetation requires suitable rainfall to grow ➔ the principal agent of erosion is flowing water from storm events where >50mm/hr is not unusual. This problem is further compounded if the erosion in the first couple of years cuts a rill network into the rehabilitated slope. This rill network will then continue to concentrate flows despite high rates of vegetative surface cover[19]. An example of this is shown in Figure 5.3.

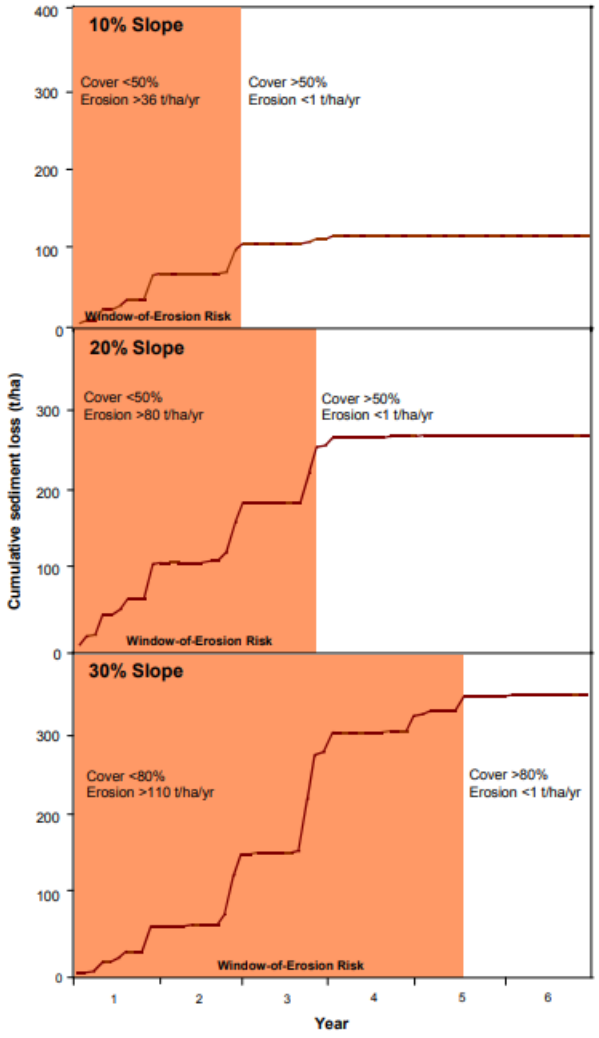

Figure 5.2: The Window of Erosion Risk & Cumulative Sediment Loss for 10, 20, and 30% Slopes Over Time at Curragh Coal Mine

[18] Carroll, C. et. al. 2001. Sustainability indicators for coal mine rehabilitation. ACARP C7006, April 2001.

[19] Emmerton. B.R. 2018. Bowen Basin Coal Mine Spoil Classification for Improved Mine Rehabilitation Outcomes. Ph.D. thesis. The University of Queensland. Centre for Mined Land Rehabilitation, Sustainable Minerals Institute.

Figure 5.3: Example of a Rill Network Established into a Topsoil Rehabilitation Slope of 3% in Central Queensland After One Wet Season

5.3 Landform Design Options

It is noted that in the Rehabilitation Management Plan[20] (RMP) that the landform design calls for slopes of 10% to a maximum of 17%. The RMP also calls for a slope length no longer than 100m where the flow length is controlled by the installation of contour banks. As the supplied drawings are a batter/berm configuration, this provides an opportunity to review some landform design options.

5.3.1 Whole of Dump Assessment

The WEPP results showing landform stability with the achievement of >60% vegetation cover has been assessed on the 'worst case' sections of the landforms in terms of a uniform slope height and gradient. The assessment, while indicating landform stability, is taken on single slope sections and does not include assessment of all the complexities of the proposed 3-dimensional WRD configurations in their entirety. For example, the concentration points for flow are formed where hinge points are present in the landform such as the eastern section of NT WRD. Final landform surface treatments should consider such details as these concentration points are erosion 'hotspots' over and above what has been assessed by WEPP. Figure 5.4 shows one such example and the increased erosion and resulting sediment fan at the toe of the landform.

[20] Foxleigh Mine. 2021. Rehabilitation Management Plan. ENV-PLN-0010. 16/08/2021.

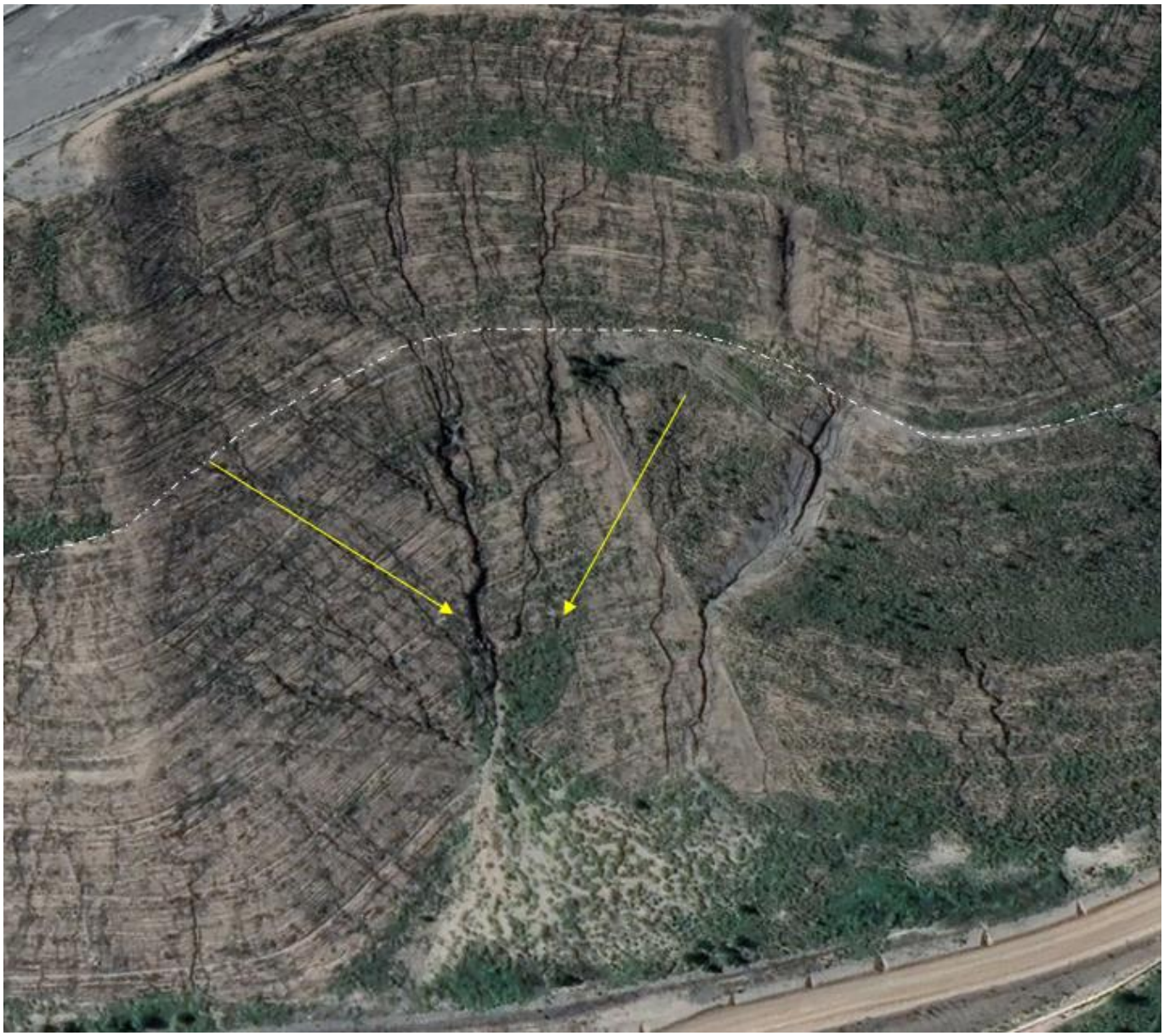

Figure 5.4: Increased Flow Concentration Caused by the Landform Shape

5.3.2 Additional Surface Resilience

The relationship between increased rock cover and reduced erosion rates is well established[21] (Figure 5.5). The tactical use of rock would be of great benefit for landform areas steeper than considered in this report, or in areas of flow concentration such as drains or landform depressions/valleys.

[21] Avala, L.M. and Jordan, A. 2010. Relationships between rock fragment cover and soil hydrological response in a Mediterranean environment. Soil Science and Plant Nutrition. v56, n1. pp 95-104.

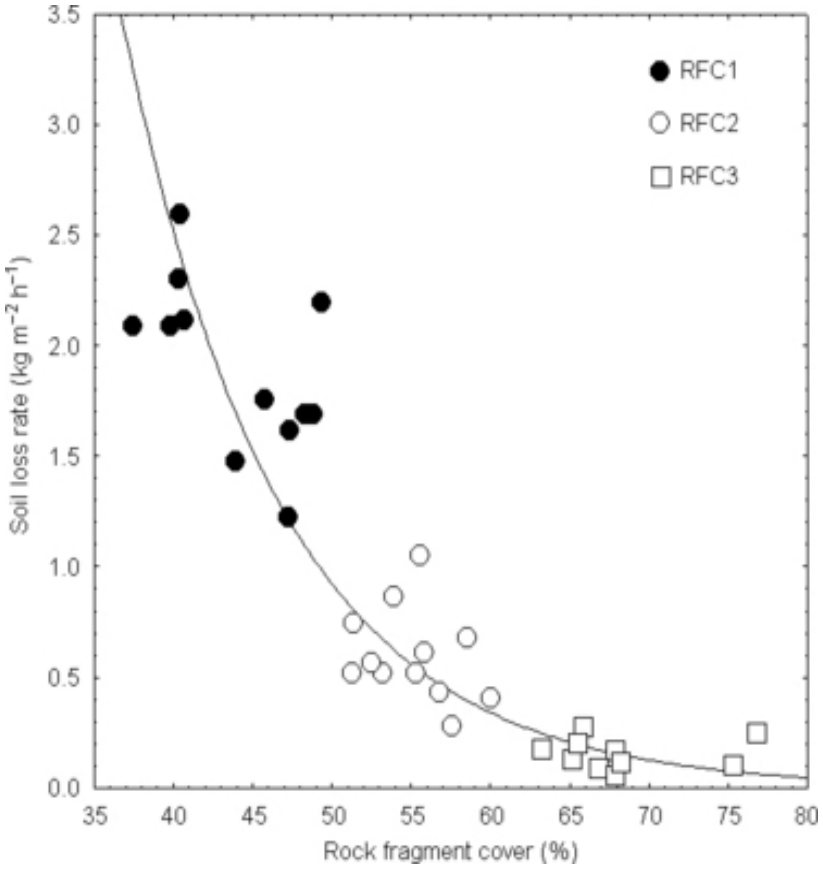

Figure 5.5: Relationship Between Increasing Rock Cover & Decreased Soil Loss

5.3.3 Concave slopes

Concave (or curvilinear) slopes are an alternative landform design option. They can provide a more aesthetically pleasing closure landform shape as concave shapes can arise from natural fluvial evolutionary processes. Concave slopes also have the advantage of potentially reducing erosion rates. A study from Western Australia showed that concave slopes can reduce sediment loss by a factor of five in comparison to linear slopes[22].

The key to designing concave slopes is well characterised materials which can be used to calibrate erosion models to aid in the landform design process. The example in Figure 5.6 shows the erosion patterns of a bare soil material with 10% and 20% contact cover using WEPP. The concave design is informed by the modelling results showing where peak erosion rates are above target erosion rates and this becomes the point at which to insert slope break points[23]. This type of design process negates the risk of blindly copying nearby undisturbed concave slopes without appreciating the difference in material properties.

The disadvantage of such a design is that a concave design generally needs more footprint than a conventional linear design. Figure 5.7 shows the comparison of 20-year SIBERIA erosion output for a Kalgoorlie soil material for a 20m high batter berm lineal slope versus a concave design. The designed concave is clearly more erosionally stable but has a horizontal footprint of 120m compared to 60m for the batter berm slope[24].

[22] Hancock, G.R., Loch, R.J., and Willgoose, G.R. 2003. The Design of Post-Mining Landscapes Using Geomorphic Principles. Earth Surface Processes & Landforms. v28, pp1097-1110.

[23] Howard, E.J., and Roddy, B.P. 2012. Evaluation of the water erosion prediction project model – validation data from sites in Western Australia. Mine Closure Conference, Brisbane 2012. Australian Centre for Geomechanics.

[24] Roddy, B., and Howard, E. 2016. Hydrological function of berms within a waste landform design. Mine Closure Conference, Perth 2016. Australian Centre for Geomechanics.

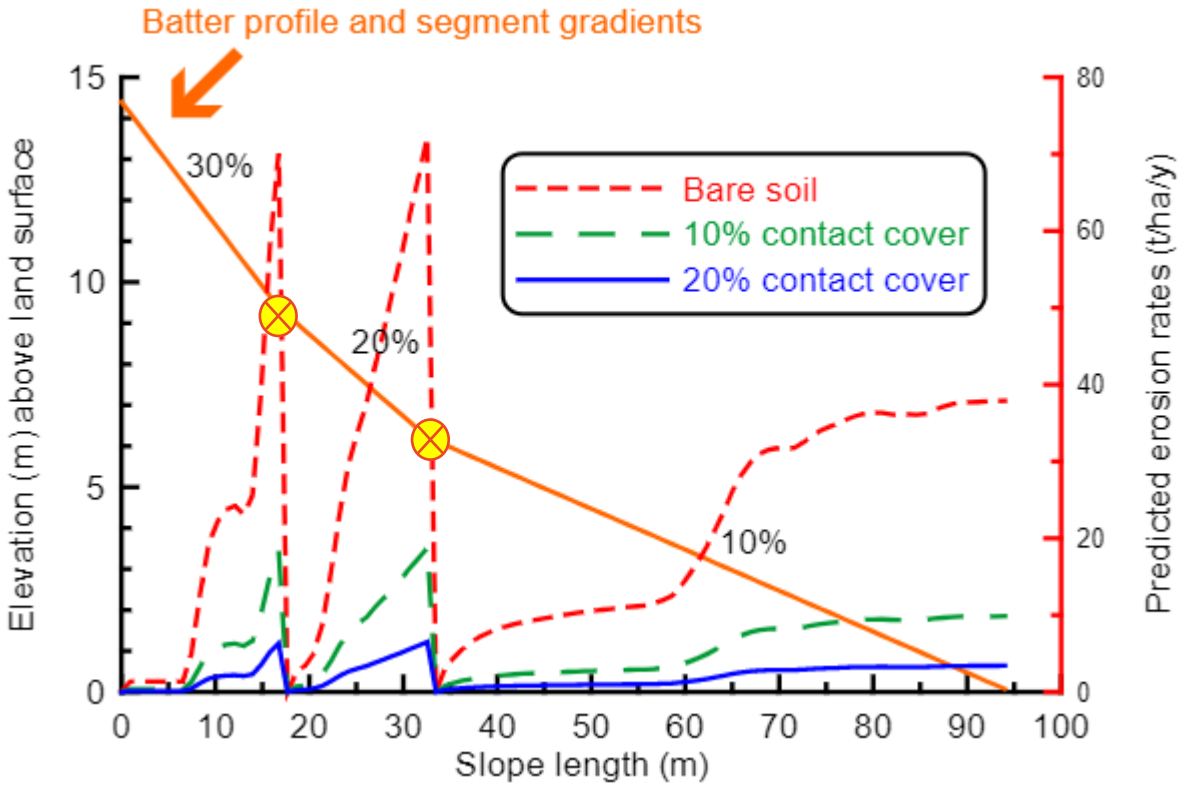

Figure 5.6: WEPP Characterised Bare Soil with 10% and 20% Contact Cover and the Resultant Erosion Rates.

*The Corresponding Concave Designed 30/20/10% Profile is Shown with Break Points

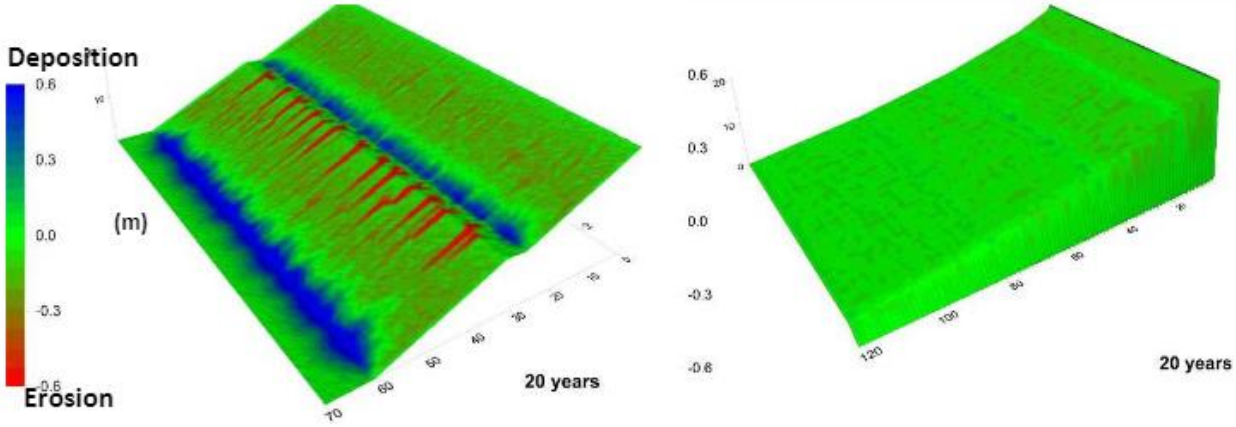

Figure 5.7: 20-year SIBERIA Erosion Results for a 20m High Batter/Berm Configuration (Left) and Concave Design

5.4 Further Work

To further support landform stability outcomes during the future phases of Foxleigh WRD landform development, Engeny suggests the following future works:

- Improved characterisation of materials to improve accuracy – the modelling inputs have been derived from existing Fox reports, which have diverse sources. A tailored site-specific sampling program could provide experimentally derived results, using actual site materials where an erosional stress is applied by way of flumes and simulated rainfall.
- Examination of past rehabilitation for what works/what didn't – these areas represent potential knowledge sources as they are in effect long term growth trials, and much could be found from examining the performance of actual site materials in the actual climate.
- Trials – rehabilitation trials are an opportunity to test strategies on a smaller scale to prove the concepts while mining is continuing. Trials can include construction methods, erosion assessment, seed mixes, and grazing trials. The trials are conducted on a smaller scale (and therefore lower risk basis) before site commits to broad acre rehabilitation that may fail. This activity is encouraged to continue at Fox to inform rehabilitation design and continuous improvement.

6. CONCLUSIONS

The Landform Evolution Modelling assessment was run for a number of scenarios for the landforms provided by Fox. The slopes were selected to represent the 'worst case' in terms of slope height and length, along with soil conditions likely to be encountered both during establishment and at fully established closure landform phases.

Of the slope combinations modelled, it was identified that each will achieve the defined average slope erosional stability with a cover vegetation of 60%. This level of vegetation cover will allow the tested landform slopes to meet both average and maximum erosion target rates on these 'worst case' scenarios. Until this level of cover is established however, the slopes may be at risk during this window of establishment. Several options have been highlighted that include alternative landform configurations and surface treatments. There may also be other opportunities if further landform optimisation takes place.

Once 60% vegetation cover is established however, all other modelled hillslopes will meet requirements PRCP guidelines as indicated by this assessment.

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Appendix K: Geochemical Characterisation of Waste Assessment

TECHNICAL REPORT

Geochemical characterisation of mining waste, coal, and soil

Foxleigh Coal Mine

Prepared for: **Foxleigh Management Pty Ltd**

RGS

MINE WASTE AND
WATER MANAGEMENT

TECHNICAL REPORT

Geochemical characterisation of mining waste, coal, and soil

Foxleigh Coal Mine

Prepared for: **Foxleigh Management Pty Ltd**

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Glossary of Terms and Acronyms

Acidity	A measure of hydrogen ion (H+) concentration; generally expressed as pH.
Alkalinity	A measure of the capacity of a water to neutralise acids.
ABA	Acid Base Account, an evaluation of the balance between acid generation and acid neutralisation processes. Generally, determines the MPA and the inherent ANC, as defined below, and is commonly used in assessing the potential for AMD associated with mining.
AMD	Acid and metalliferous drainage caused by exposure of sulfide minerals in mine waste materials to oxygen and water. Typically characterised by low pH and elevated concentrations of salts, sulfate and metals.
ANC	Acid neutralising capacity of a sample as kg H_2SO_4 per tonne of sample. Commonly referred to as the buffering capacity.
ANC:MPA Ratio	Ratio of the acid neutralising capacity and maximum potential acidity of a sample. Used to assess the risk of a sample generating acid conditions.
Coarse Reject	A form of process residue generated as a result of processing the ore at the concentrator. Represents the coarser size fraction of the coal reject produced.
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.
DTPA	Diethylenetriamine pentaacetic acid
EC	Electrical Conductivity, expressed as µS/cm, is a measure of electrical conductance.
eCEC	Effective cation exchange capacity provides a measure of the amount of exchangeable cations (Ca, Mg, Na and K) in a sample.
ESP	Exchangeable sodium percentage provides a measure of the sodicity of a materials and propensity to erode.
GIS	Geographic Information Systems
Interburden	The waste rock material found in between coal seams.
KLC test	Kinetic leach column tests are procedures used to measure the geochemical/ weathering behaviour of a sample of mine material over time.
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 content of a sample by 30.625 (stoichiometric factor) and expressed as kg H_2SO_4 per tonne.
NAG test	Net acid generation test. Hydrogen peroxide solution is used to oxidise sulfides in a sample, then any acid generated through oxidation may be consumed by neutralising components in the sample. Any remaining acidity is expressed as kg H_2SO_4 per tonne. The more elaborate extended boil NAG test can be used if a sample has a high organic carbon content to attempt to eliminate interference and false positive results (Stewart et al, 2003).
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 0.07% sulfur). Geochemical classification criterion for a sample that will not generate acid conditions.

NAPP	Net acid producing potential expressed as kg H_2SO_4 per tonne. NAPP is the balance between the capacity of a sample to generate acidity (MPA) minus its capacity to neutralise acidity (ANC).
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.
Ore	Material that is been mined with sufficient value to warrant processing. Low-grade ore may be left as waste.
Overburden	Material that overlays a coal resource and must be removed to mine the coal.
PAF	Potentially acid forming. Geochemical classification criterion for a sample that has the potential to generate acid conditions.
pH	Measure of the hydrogen ion (H+) activity in a sample solution, expressed in pH units.
PSD	Particle size distribution of a sample material measured by hydrometer.
%S	Percent sulfur. A measurement unit for the sulfur content of a sample material.
Scr	Chromium reducible sulfur test measures the sulfide sulfur content of a sample material.
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.
Static test	Procedure for characterising the geochemical nature of a sample at one point in time. Static tests may include measurements of mineral and chemical composition of a sample and the Acid Base Account.
Tailing	A form of process residue generated as a result of washing coal at the CHPP. Represents the finer size fraction of the coal reject produced.
Total Sulfur	Total sulfur content of a sample generally measured using a ‘Leco’ analyser expressed as % S.
TSS	Total suspended solids is a measurement of the suspended solids concentration in a water sample.
Uncertain	Geochemical classification criterion for a sample where the potential to generate acid conditions remains uncertain and may require further analysis.

1 Introduction

RGS Environmental Pty Ltd (RGS) was commissioned by Foxleigh Management Pty Ltd (Foxleigh) to complete a geochemical characterisation of mining waste, coal, and soil materials to meet the conditions of the Environmental Authority (EA) EPML 00744813 for Foxleigh Coal Mine (the Project). The aim was to evaluate the use of these materials for rehabilitation purposes based on their nutrient, geochemical, and physical properties.

This geochemical characterisation report has been developed in line with Australian guidelines that are routinely used in the mining sector (COA, 2016a,b,c) as well as agricultural industries (Isbell, 2020, MacDonald et. al., 1998). It is focused on filling geochemical, physical and nutrient, information gaps required to optimise the Rehabilitation Management Plan for the Project, which is required to be completed as part of the EA.

RGS has utilised existing exploration drill hole data and topsoil survey data and as background information to inform the Geochemical Sampling and Analysis Plan (GSaAP) and Soil Sampling and Analysis Plan (SSaAP), which are appended at the end of this document (**Attachment F**). RGS has relied upon information provided by RPM Global and Foxleigh, relevant soil and mining guidelines and previous knowledge of the Project to produce this document.

1.1 Background

1.1.1 Location and ownership

The Project is located on mining leases ML70171, ML70309, ML70470, ML70310, ML70429, ML70430 and ML70431 in Queensland's eastern Bowen Basin, covering an area of 8,499 ha, approximately 12 km south of Middlemount, 250 km southwest of Mackay and 280 km northwest of Rockhampton **(Figure 1-1)**.

The Project is a jointly owned open cut coal mine producing low volatile PCI coal for export. Foxleigh Mine is operated by Foxleigh Management Pty Ltd, on behalf of a joint venture between CAML Resources, Foxleigh Coal Pty Ltd and Nippon Steel.

1.1.2 Open cut mining activities

The mining operation accesses the Rangal Coal Measures using an open cut method to approximately 150 m depth, depending on current economics and market demand. Coal is excavated using truck and shovel methods and processed at an on-site coal handling and preparation plant (CHPP) before being trucked to a dedicated rail loadout facility for transport to Dalrymple Bay Coal Terminal.

Foxleigh's coal presents in the shape of a bowl in most places and is mined utilising a terrace approach to mining. Initial waste is placed in out-of-pit dumps or when in-pit dumps have insufficient room. The in-pit dumps are filled progressively as the terrace face progresses.

Within the mining lease there are 12 open pits which have an open pit void surface area as detailed below:

- Foxleigh Plains Pit (260.8 ha)
- Foxleigh Plains North Pit (50.1 ha)
- Pipeline Pit (55.8 ha)
- Carlo Creek Pit (23.2 ha)
- One Tree Pit (124.5 ha)
- Far South Pit (56.2 ha)
- WC Pit (14.7 ha)
- North WC Pit (25.5 ha)
- Old NE Pit (36.2 ha)
- NW Pit (17.9 ha)
- NE Pit (16.9 ha)
- Void 251 (9.1 ha)

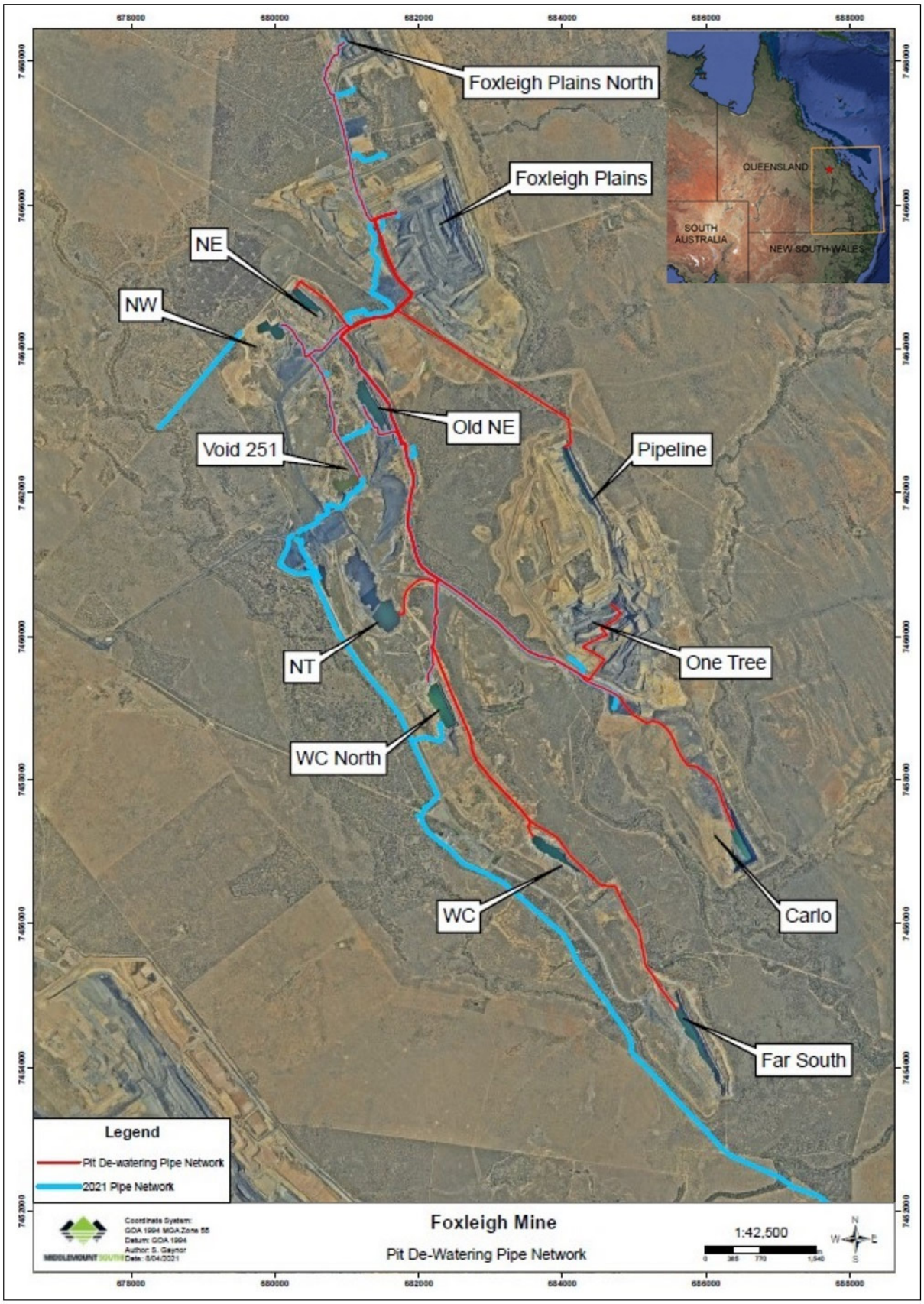

Figure 1-1: Foxleigh Project location and pits

1.1.3 Progressive rehabilitation

Overburden dumps are progressively rehabilitated when they reach their final limits and results have been variable over preceding years. Progressive geochemical characterisation of available on-site mining waste, coal, and soil materials will assist these planned rehabilitation activities. The identification of suitable source materials for overburden dump covers and topsoil growth medium will help to rehabilitate disturbed areas and result in a favourable outcome for end of mine closure.

1.2 Scope of work

The RGS scope of work was developed based on discussions with RPM Global and Foxleigh personnel and was driven by the requirement for further development of a long-term rehabilitation plan for mine closure. It is intended that the findings of the scope of work be used as a key input into the long-term rehabilitation plan for mine closure.

The initial phase of work involved the identification and collection of representative samples of mining waste (overburden, interburden, potential coal reject and coal reject), coal, and soil materials. The second phase of work was to characterise the collected samples for their geochemical, physical and nutrient properties and provide an interpretation of the results.

The geochemical test program was designed to assess the degree of risk from AMD, oxidation of pyrite, leachability of metals/metalloids, and characterisation of standard soil parameters including salinity, cation exchange capacity and major metal/metalloid compositions. The results were used to assess any potential for acid and metalliferous drainage (AMD), neutral metalliferous drainage (NMD) salinity or sodicity issues related to the Project. The work program was completed in accordance with relevant industry guidelines (DME, 1995; DEHP 2013; COA, 2016a,b,c; and INAP, 2009).

1.2.1 Sampling program

The GSaAP details the sampling plan for mining waste (overburden, interburden, potential coal reject and coal reject) and coal samples. The SSaAP details the sampling plan for soil samples. These reports are attached in **Attachment F**. Each document comprises:

- A review of existing data against the relevant guidelines and identification of data gaps.
- Instructions for selected sample locations or drill holes that represent the range of materials that are likely to be encountered during the mining process.
- Recommendations for sampling frequency and quantities (mass and volume) to facilitate testing.
- Advice regarding sample containers, storage, and transport to appropriate laboratories.
- Assistance on site in executing the GSaAP and SSaAP.

1.2.2 Analysis report

After obtaining the mining waste, coal, and soil samples, RGS developed the testing and interpretation phase, and produced this technical report, which details:

- The design of an analytical testing program to determine the properties of the mining waste, coal, and soil samples and coordination with suitable laboratories to undertake the work.
- Collection and organisation of results and data, and the construction of tables and graphs to assist in the interpretation of the results.
- The preparation of a draft and final technical report (this report), including conclusions and recommendations, for review and comment by Foxleigh and RPM Global Solutions.

2 Geology and soils overview

2.1 Geology and stratigraphy

The regional surface geology for the Project area is shown in **Figure 2-1**. The area comprises predominantly sedimentary sequences that range from Permian to Quaternary in age (**Table 2-1**). The surface geology of the active mine area is generally classified as Quaternary sediments, most of which are underlain by Tertiary Rewan Formation. There are also small outcrops of older Permian Burngrove Formation and Blackwater Group at the southern end of the mine lease area. Lithologies range from gravel, sandstone, siltstone and claystone, with minor igneous basalt and tuff.

When excavated, these geological materials are mixed together and constitute the spoil or waste rock (overburden, interburden) that will be referred to in this report as 'mining waste'. The geological units present at Foxleigh are expected to be relatively benign, with the exception of any carbonaceous lithologies, which tend to be higher in pyrite (and sulfur).

Table 2-1: Geology and lithology of the Foxleigh Project area

Age	Code	Formation	Lithology[1]
Quaternary	Qa-QLD	Quaternary sediments	Clay, silt, sand and gravel; flood plain alluvium
Quaternary	Qf-QLD	Quaternary sediments	Clay, silt, sand and clayey to sandy gravel; alluvial fans, sheetwash and floodout sheets
Quaternary	Qpa-QLD	Quaternary sediments	Clay, silt, sand and gravel; flood-plain alluvium on high terraces
Quaternary	Qr-QLD	Quaternary sediments	Clay, silt, sand, gravel and soil; colluvial and residual deposits
Late Tertiary	TQa-QLD	Tertiary sediments	Locally red-brown mottled, poorly consolidated sand, silt, clay, minor gravel; high-level alluvial deposits (generally related to present stream valleys but commonly dissected)
Tertiary	Td	Tertiary sediments	Duricrusted palaeosols at the top of deep weathering profiles, including ferricrete and silcrete; duricrusted old land surfaces
Tertiary	Rr	Rewan Formation	Sandstone, siltstone, and claystone
Tertiary	Tu	Duaringa Formation	Mudstone, sandstone, conglomerate, siltstone, oil shale, lignite, basalt
Late Permian	Pbe	Blenheim Formation	Carbonaceous and micaceous labile sandstone, siltstone, shale, coquinite, minor conglomerate
Late Permian	Pw	Blackwater Group	Feldspathic and lithic sandstone, silty sandstone, calcareous sandstone, ashstone and cherty mudstone, carbonaceous mudstone and coal; commonly abundant plant fossils and fossil wood
Permian	Pwg	Burngrove Formation	Sandstone, claystone, siltstone, coal, and tuff
Permian	Pwj	Rangal Coal Measures	Lithic sandstone, siltstone, claystone and carbonaceous mudstone and coal.

[1]Classifications are based on Queensland geology detailed surface GIS files, June 2018.

2.2 Mining activities

2.2.1 Waste rock removal and placement

The open pits at Foxleigh have been mined progressively after the mine began production in 2000. Some of the pits have been backfilled and rehabilitated (**Section 1.1.3**), while others are still operational. Topsoil from each pit has been stockpiled prior to excavation. Initial waste rock extracted during the early stages of each open pit has been placed in out-of-pit dumps near the open pits. Following this initial out-of-pit placement and once sufficient pit space has been established, waste rock is placed back in-pit, providing the waste fill material does not impede further mining progress. This process continues for the life of each pit as it develops. When completely filled, in-pit dumps usually extend above the surrounding ground level, with batters shaped to a minimum slope to allow rehabilitation.

2.2.2 Coal extraction and reject

Once overburden, interburden and potential coal reject has been removed to expose the coal seam, coal is extracted via truck and shovel. The coal is hauled to the Run of Mine (ROM) pad and crushing and screening is completed as part of the Coal Handling and Processing Plant (CHPP) circuit. Coal processing includes the production of several products, such as:

- A raw coal handling circuit to size ROM coal for further processing;
- A raw coal bypass conveyor to provide the option to direct appropriate quality raw coal to the product stockpile;
- Three CHPP circuits (coarse, secondary coarse and mid-sized) for coal beneficiation, producing a single product stream; and,
- A tailings thickener to thicken ultrafine reject material that is pumped to the tailings dam.

Solid process residue from coal processing (coarse reject), as well as roof, parting and floor materials (potential coal reject) may be placed within spoil dumps, and therefore it is important to assess the characteristics of these materials.

Compared to overburden and interburden materials, coal reject may have some potential to produce AMD, NMD and salinity. The placement of coal reject is generally managed to minimise its interaction with water and potential oxidation, which otherwise may result in seepage and runoff issues.

Coal tailing (fine coal reject) material produced at Foxleigh is placed within a tailings storage facility (TSF), which is slowly infilling an excavated open pit. This management option helps to control any tailings seepage, although tailing materials will generally have to become sufficiently dry to enable the TSF to be covered and rehabilitated.

2.3 Soil materials

Regolith is weathered rock material that develops into soil through a process called pedogenesis. Over time, extremely weathered soil becomes structured into layers or 'horizons' which vary in fertility, due to properties such as nutrients, organic matter, and texture (particle size distribution). By contrast, human-made soils, or anthroposols, have under-developed or no structure, depending on (a) the complexity of the artificially made cover, and (b) the duration of time since the soil was disturbed.

Figure 2-2 shows the expected distribution of soil types present in the Project area, based on available survey data and previous studies. The soils may be classified as vertosols, chromosols, or sodosols, and have a diverse range of properties. The twelve proposed test pit locations that will be utilised by RGS for obtaining soil samples is also shown on the **Figure 2-2**.

According to the Australian Atlas of Soil Classifications (2016), the soil types at Foxleigh may be described as follows:

Vertosols – shrink-swell clays

Level alluvial flood-plains associated with major streams, often dissected by numerous braided channels and mostly subject to irregular flooding: dominant soils are deep grey clays with smaller areas of black or brown clays.

Chromosols – often brightly coloured

Moderate to gently undulating lands with widely spaced shallow valleys: dominant are thin-surfaced loamy duplex soils, and often of shallow depth and with some rock outcrop.

Sodosols – influenced by sodium

Gently undulating plains: dominant are sandy duplex soils with moderately deep A horizons.

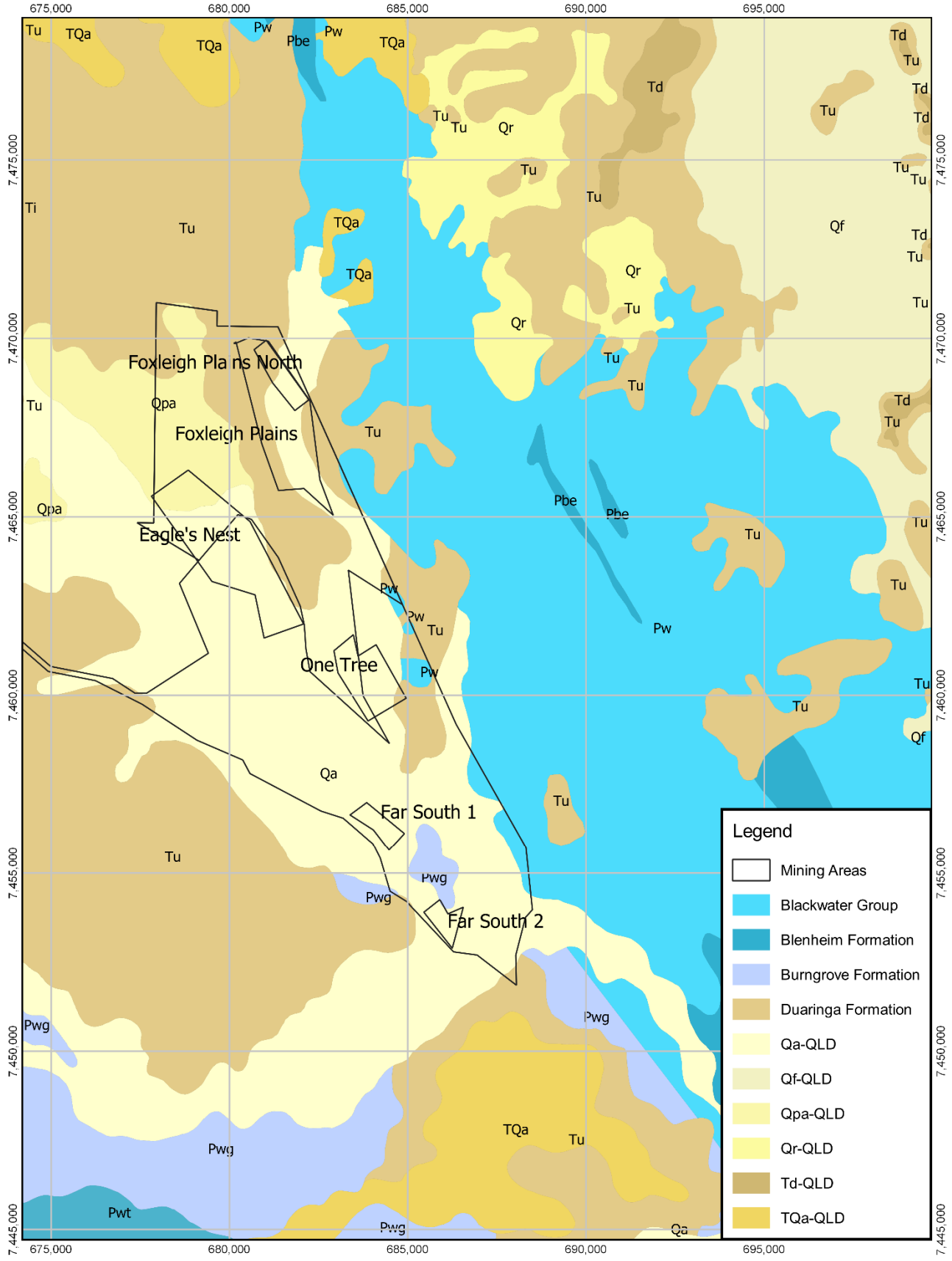

Figure 2-1: Surface geology of Foxleigh Project area

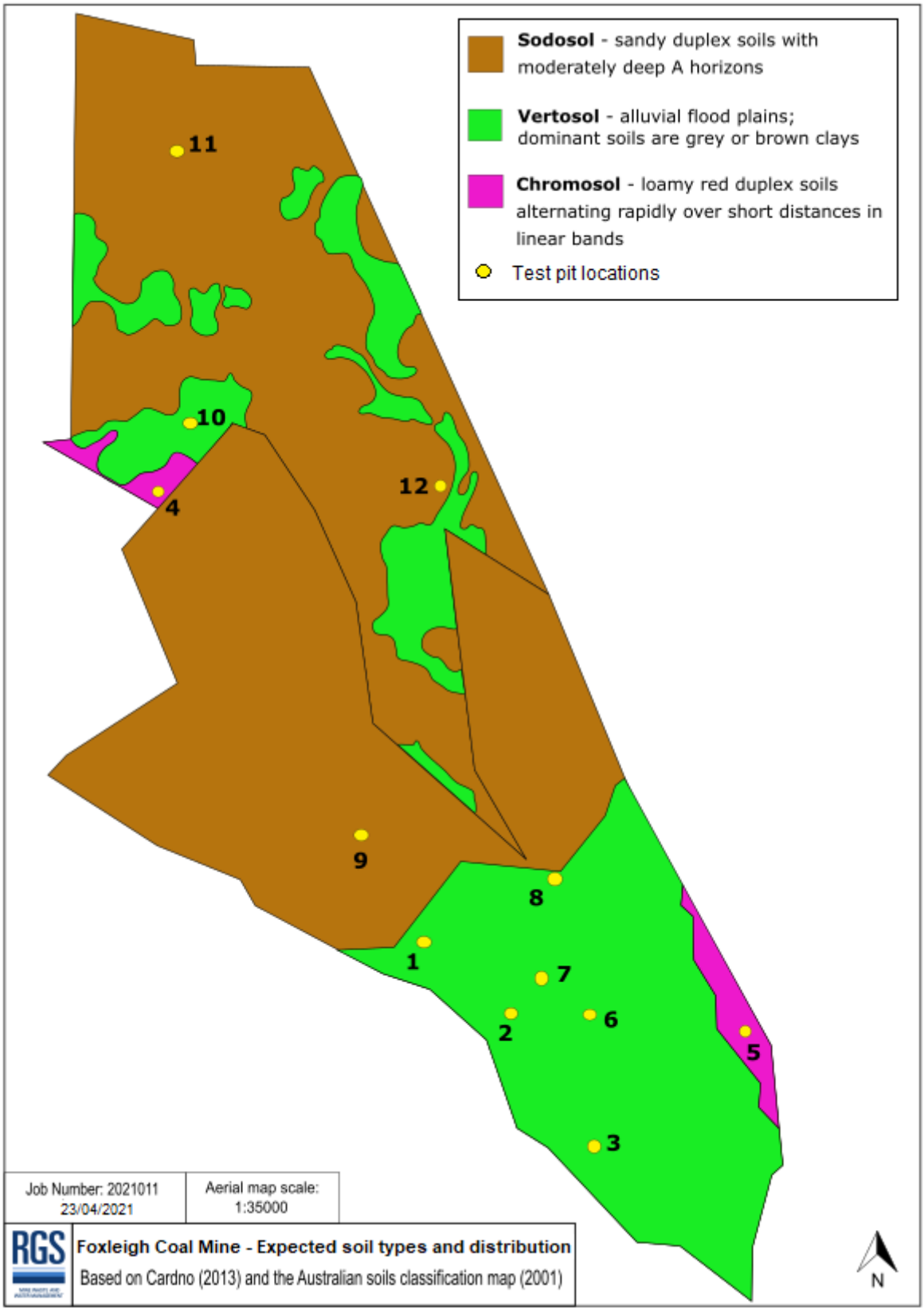

Figure 2-2: Expected Foxleigh soil types and distribution

3 Methodology

3.1 Sampling program

3.1.1 Overburden and interburden

The methodology for sampling mining waste (overburden and interburden) has been detailed in the GSaAP in **Attachment F**. A summary of mining waste samples collected is provided in **Table 3-1**. A total of 103 mining waste samples were collected from four drill holes, which were 49% overburden, and 51% interburden. The most common lithology was sandstone, followed by siltstone. The location of the four selected drill holes is shown in **Figure 3-1**.

- DDE0958C (45 samples) – north of Eagle's Nest pit
- DDF1157C (10 samples) – north of Foxleigh Plains pit
- DDO0018C (29 samples) – north of One Tree pit
- DDO0019C (19 samples) – northwest of One Tree pit

Table 3-1: Summary of mining waste samples

Material type	Lithology	Number of samples
Overburden	Clay	3
Overburden	Silt	2
Overburden	Sand	5
Overburden	Claystone/Mudstone	4
Overburden	Siltstone	11
Overburden	Carbonaceous siltstone	6
Overburden	Sandstone	19
Interburden	Carbonaceous mudstone	1
Interburden	Siltstone	12
Interburden	Carbonaceous siltstone	11
Interburden	Sandstone	28
Interburden	Coal	1
	TOTAL	**103**

3.1.2 Potential coal rejects

The methodology for sampling potential coal reject materials (roof, floor, and parting) has been detailed in the GSaAP in **Attachment F**. For the purpose of interpreting the geochemical test results, any parting materials (three samples) have been classified as roof samples. A summary of potential coal reject samples is provided in **Table 3-2**. A total of 68 potential coal reject samples were collected from 9 drill holes, the locations of which are shown in **Figure 3-1**. The samples are collected near coal seams MMT (22%), PI1 (19%), PI2 (6%), ROP1 (22%), and TRA (25%). Roof materials constitute 47% of samples, floor materials 49% and partings 4%.

- LDE0901C (6 samples) – north of Eagle's Nest pit
- LDE0910C (8 samples) – north of Eagle's Nest pit
- LDE0912C (8 samples) – north of Eagle's Nest pit
- LDF0995C (6 samples) – north of Foxleigh Plains pit
- LDF1043C (9 samples) – north of Foxleigh Plains pit
- LDF1062C (8 samples) – north of Foxleigh Plains pit

- LDF1094C (6 samples) – north of Foxleigh Plains pit
- LDF1148C (7 samples) – Foxleigh Plains pit
- LDF1174C (10 samples) – north of Foxleigh Plains pit

Table 3-2: Summary of potential coal reject samples

Material type	Lithology	Number of samples
Roof	Carbonaceous mudstone	6
Roof	Mixed carbonaceous mudstone	2
Roof	Siltstone	4
Roof	Mixed siltstone/sandstone	3
Roof	Carbonaceous siltstone	3
Roof	Mixed carbonaceous siltstone	6
Roof	Sandstone	5
Roof	Carbonaceous sandstone	2
Roof	Mixed carbonaceous sandstone	1
Floor	Claystone	2
Floor	Carbonaceous mudstone	6
Floor	Mixed carbonaceous mudstone	2
Floor	Siltstone	3
Floor	Carbonaceous siltstone	5
Floor	Mixed carbonaceous siltstone	12
Floor	Sandstone	1
Floor	Carbonaceous sandstone	1
Floor	Mixed carbonaceous sandstone	1
Parting	Tuff/carbonaceous siltstone	2
Parting	Dolerite	1
	Total	**68**

3.1.3 Coal Reject and Coal

The methodology for sampling process residue (coarse coal rejects, tailings, and coal) has been detailed in the GSaAP in **Section 7**. A summary of the process residue samples (n=25) is provided in **Table 3-3**. Tailings were collected in buckets from the CHPP and TSF. Coal reject samples were collected in buckets from various stockpiles at the CHPP. Coal samples were collected from coal feed reserve at the CHPP.

Table 3-3: Summary of coal reject and coal samples

Material type	Lithology	Number of samples
Coarse reject	Carbonaceous	10
Tailing	Carbonaceous	10
Coal Feed Reserve	Coal	5
	Total	**25**

3.1.4 Soil materials

The methodology for sampling soil (topsoil, subsoil, and weathered waste rock), as well as topsoil stockpile locations, has been detailed in the SSaAP in **Section 7**. Complete soil logs are included in **Section 7**. The test pit locations are shown in **Figure 2-2** and **Figure 8-1**. A summary of soil samples is provided in **Table 3-4**. A total of 89 soil samples were collected from 12 test pits (40 samples), 23 topsoil stockpiles (46 samples), and 3 surface grab samples. Overall, vertosols constitute 1% of samples, chromosols 45%, sodosols 20%, arenosols 20%, and waste rocks (anthroposols) 12%.

Table 3-4: Summary of soil samples

Source	Material	Soil type	Colour	Number of samples
Test pit	Topsoil	Vertosol	Dark brown/black	1
Test pit	Topsoil	Chromosol	Brown	3
Test pit	Topsoil	Chromosol	Dull orange	4
Grab sample	Topsoil	Chromosol - eroded	Yellow orange	1
Test pit	Subsoil	Chromosol	Brown	2
Test pit	Subsoil	Chromosol	Bright orange	4
Test pit	Subsoil (subsample)	Chromosol – carbonaceous layer	Dark brown/black	1
Test pit	Subsoil (subsample)	Chromosol - clay lens	Dark brown	1
Test pit	Topsoil	Arenosol	Light brown	2
Test pit/grab sample	Topsoil	Sodosol	Brown	7
Test pit	Topsoil	Sodosol – cover	Brown	4
Test pit	Subsoil	Sodosol	Brown	1
Test pit	Subsoil (subsample)	Sodosol – salt crust	White/brown	1
Test pit/grab sample	Topsoil	Anthroposol - cover	Dark grey/orange	2
Test pit	Weathered waste rock	Anthroposol	Dark grey/black	4
	Weathered waste rock	Anthroposol	Grey	5
Topsoil stockpile	Topsoil	Chromosol	Dull orange	22
Topsoil stockpile	Topsoil	Sodosol	Dark brown	6
Topsoil stockpile	Topsoil	Arenosol	Brown	18
			Total	**89**

3.1.5 Summary of mining waste, coal, and soil samples

A summary compilation of the 285 total samples from **Section 3.1.1** to **3.1.4** is provided in **Table 3-5**.

Table 3-5: Summary of mining waste, coal, and soil samples

Material Type	Number of samples
Mining waste (overburden and interburden)	103
Potential coal rejects (roof, floor, and partings)	68
Process residue (coarse coal rejects, tailings, and coal)	25
Soil (topsoil, subsoil, and weathered waste rock)	89
Total	**285**

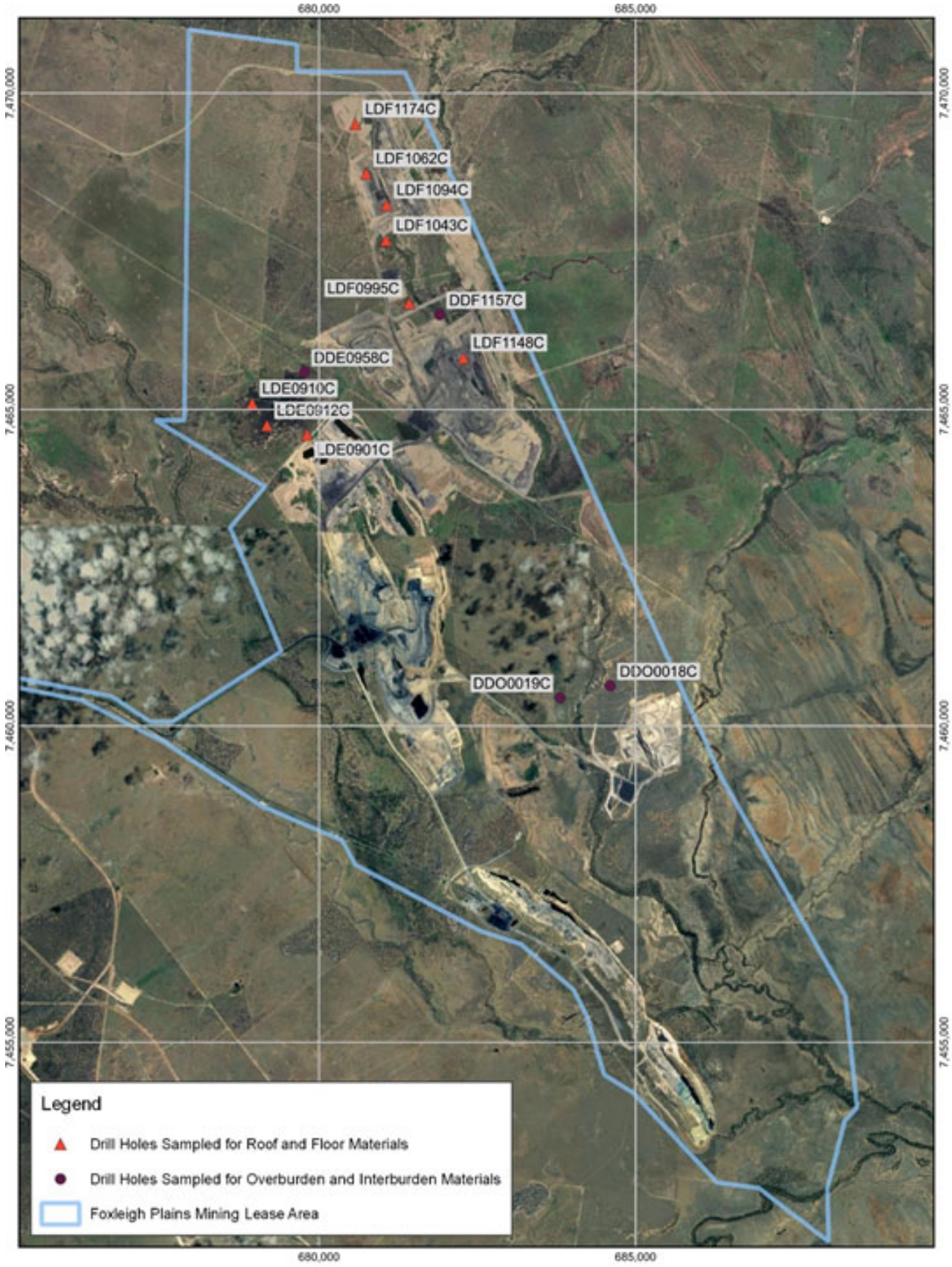

Figure 3-1: Location of drill holes for geochemical characterisation

3.2 Geochemical test program

An overview of a typical static and kinetic geochemical test procedure for mining waste materials is provided in **Attachment A.**

3.2.1 Static tests

Static geochemical tests provide a 'snapshot' of the characteristics of a sample material at a single point in time. These tests were staged to screen individual samples before selecting either individual and/or composite samples for more detailed static test work.

The Acid Base Account method was used as a screening procedure whereby the acid-neutralising and acid-generating characteristics of a material were assessed. **Table 3-7** shows that a total of 196 samples of mining waste and coal were screened using the Acid Base Account method, which included static geochemical testing for the following parameters:

- pH [1:5 w:v. sample:deionised water];
- Electrical conductivity (EC) [1:5 w:v. sample:deionised water];
- Total sulfur [LECO analyser]; and
- Acid neutralising capacity (ANC) [AMIRA, 2002 method].

The results of the ABA screening tests are discussed in **Section 4.1**. After the results of the screening tests were received and interpreted, selected samples were also tested for sulfide sulfur, using the chromium reducible sulfur (Scr), Australian Standard (AS 4969.7, 2008) method.

From the total sulfur value (or Scr value, where available), maximum potential acidity (MPA) values were calculated. Scr data was preferentially used where available, as it provides a more accurate representation of the potential MPA, as acid generation forms from the oxidation of reactive sulfide measured by this method.

After the results of the initial static geochemical tests were received and reviewed, all 196 samples were used to create 12 composite samples for more detailed static geochemical testing. These 12 composite samples were sent for whole rock and soluble multi-element analysis at ALS Stafford laboratory. The composite samples were tested for:

- pH and EC [1:5 w:v. sample: deionised water];
- Major cations (Ca, Mg, K, Na) [HCl and HNO_3 acid digest followed by ICP-AES/MS];
- Major anions (Cl, SO_4, F) [ICP-AES/MS and PC Titrator (1:5 w:v water extracts)];
- Acidity and alkalinity as $CaCO_3$ mg/L [PC Titrator (1:5 w:v water extracts)];
- Total metals (Al, As, B, Ba, Be, Cd, Cr, Co, Cu, F, Fe, Hg, Pb, Mn, Mo, Ni, Sb, Se, Th, U and Zn) [HCl and HNO_3 acid digest followed by FIMS and/or ICP-AES/MS]; and
- Soluble metals (Al, As, B, Ba, Be, Cd, Cr, Co, Cu, F, Fe, Hg, Pb, Mn, Mo, Ni, Sb, Se, Th, U, V and Zn) [ICPAES/MS and FIMS (1:5 w:v water extracts)].

To analyse potential soil fertility and sodicity, 11 of the 12 composite samples, as well as 12 test pit soil composite samples were tested for:

- Exchangeable cations [ICP-AES] [Rayment and Lyons, 2011.

The exchangeable cation results were then used to calculate:

- Effective Cation Exchange Capacity (eCEC); and
- Exchangeable Sodium Percentage (ESP).

ESP is used in the classification of saline and alkali soils or to indicate whether a sodium hazard exists. Generally, 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, 2020; and Northcote and Skene, 1972). Soil classifications are discussed in **Section 4.4.5**.

To assess the available soil nutrients, the 12 test pit soil composites were also tested for:

- 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];

Summary geochemical results tables for the static geochemical test program are provided in **Attachment B**. The ALS laboratory certificates of analysis for the static geochemical tests are provided in **Attachment D**.

3.2.2 Kinetic tests

Following receipt and interpretation of the static geochemical test results, seven kinetic leach column (KLC) tests were set up at the RGS 'in-house' laboratory using composite sample materials from the Project. The KLC tests underwent their first leach event in March 2021 and were subjected to ongoing monthly leach events until September 2021. A summarised description of the material represented by each KLC test is provide in **Table 3-6**. The identities of the specific individual samples included in composite samples used for the KLC test program are detailed in **Table B1** (**Attachment B)**.

Table 3-6: KLC material description

KLC Sample #	Description
KLC 1	Overburden
KLC 2	Interburden
KLC 3	Roof
KLC 4	Floor
KLC 5	Tailing
KLC 6	Coarse reject
KLC 7	Coal feed reserve

Approximately 2 kg of each composite sample was accurately weighed and used in each of the KLC tests. Heat lamps were used daily to simulate sunshine and ensure that the KLC test materials were unsaturated and subject to oxidising conditions between leaching events (this is essentially an assumed "worst case" scenario for sulfide oxidation and potential acid/salt generation). Further details and a schematic of the KLC test arrangement are provided in **Attachment A**.

All leachate samples collected from the KLC tests were assayed at ALS Stafford laboratory for:

- pH and EC;
- Acidity and alkalinity [PC Titrator];
- Dissolved metals/metalloids (Al, As, B, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Sb, Se, V and Zn) [ICP-AES/MS];
- Dissolved major cations (Ca, Mg, Na and K) [ICP-AES/MS]; and
- Dissolved major anions (Cl, SO_4) and F [ICP-AES/MS].

Summary results tables and trends for the KLC tests are provided in **Attachment C**. The ALS laboratory certificates of analysis for the KLC test program are provided in **Attachment D**.

3.3 Physical test program for soil

3.3.1 Emerson Class test

The objective of the Emerson Class test is to classify the behaviour of immersed soil aggregates for their coherence in water. Emerson Class is a physical test to check for dispersiveness and is often preferred for reliability over the geochemical ESP test. The Emerson Class test is usually performed on mudstones and siltstones, as sands and gravels are usually unsuitable (Craze et al., 2003).

Twelve (12) test pit composite soil samples and 8 topsoil stockpile composite soil samples underwent Emerson class testing. The identities of the specific individual samples included in composite samples used for the soil test program are detailed in **Attachment E**.

3.3.2 Particle size distribution

The objective of the particle size distribution (PSD) analysis is to group an assembly of soil 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 employs dry sieving for coarse particles and sedimentation of a soil/water/dispersant suspension in a hydrometer to separate the fine 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).

Seven test pit composite soil samples and 4 topsoil stockpile composite soil samples underwent coarse and fine PSD analysis. This test is also referred to as grading with hydrometer.

3.3.3 Particle density (specific gravity)

The objective of the particle density test is used as the basis of a broad classification of aggregates into a ‘normal’, ‘lightweight’ or ‘heavy’ category. The particle density of aggregates is the ratio of the mass of a given volume of material to the mass of the same volume of water. Three types of value are generally recognised: oven dry, saturated surface-dried and apparent particle densities, in order of increasing numerical magnitude. Particle size distribution analyses that employ sedimentation rate usually require information on particle density (Blake et al., 1986).

Seven (7) test pit composite soil samples and 4 topsoil stockpile composite soil samples underwent particle density analysis.

.

Table 3-7: Geochemical and physical testing suite

Static geochemical analyses	ALS Code	Method Code	Overburden & Interburden	Potential coal reject	Coal Reject and Coal	Soil materials
pH plus EC (1:5)	EA02 and EA010	APHA 4500 H+ - B and APHA 2510 B	103	68	25	59
NAPP (includes ANC, Total S)	ASS1	III. Coastech Research (Canada)	103	68	25	-
Chromium Reducible Sulfur (22B)	EA026	Ahern et al (2004)	5	32	25	-
Major, minor and trace elemental analysis (Total) (48 elements)	ME-MS41 - 2 acid aqua regia digest		**5**	**4**	**3**	-
Mercury (Total)	EG035T	APHA 3112 Hg-B CV/FIMS	**5**	**4**	**3**	-
Agricultural Soil Suite (pH plus EC (1:5), Exchangeable Cations and ECEC plus ESP)	AG-1	Rayment and Lyons (2011)	**5**	**4**	**3**	-
Agricultural Soil Suite (pH plus EC (1:5), pH plus EC (Saturated Paste), Colwell P and K, Exchangeable Cations and ECEC plus ESP, TN, TP, TKN, NO_2, NO_3, NH_3 and NO_x. Chloride (1:5), pH ($CaCl_2$), DTPA Extractable Cu, Fe, Mn and Zn, Organic Matter and Organic Carbon.	AG-3	Rayment and Lyons (2011)	-	-	-	**12**
Shake Flask Extraction 1:5 and 16 hr leach for water soluble elements	**ALS Code**	**Method Code**	**Overburden & Interburden**	**Potential coal reject**	**Coal Reject and Coal**	**Soil materials**
Leach method	EN35		**5**	**4**	**3**	-
Alkalinity: including Bicarbonate, Carbonate, Hydroxide & Total as CaCO3	ED037	APHA 2320 B	**5**	**4**	**3**	-
Acidity as CaCO3	ED038	APHA 2310 B	**5**	**4**	**3**	-
Cations - Dissolved: Calcium, Magnesium, Sodium, Potassium + Anions: Major (Cl, SO_4, Alkalinity), Fluoride	NT-1 & NT-2	APHA 3120B, APHA 3125B	**5**	**4**	**3**	-
Trace metals by ICP/MS (including digestion)	EG020F (ME-02)	USEPA 6020 ICP/MS	**5**	**4**	**3**	-
Kinetic Leach Cell Testing (AMIRA, 2002)	**ALS Code**	**Method Code**	**Overburden & Interburden**	**Potential coal reject**	**Coal Reject and Coal**	**Soil materials**
pH by PC titrator	EA005P	APHA 4500 H^+ – B	**2**	**2**	**3**	-
EC by PC titrator	EA010P	APHA 2510 B	**2**	**2**	**3**	-
Alkalinity as $CaCO_3$ (PC Titrator)	ED037	APHA 2320 B	**2**	**2**	**3**	-
Acidity as CaCO3 mg/L	ED038	APHA 2310 B	**2**	**2**	**3**	-
Major Cations (Ca, Mg, Na, K) and Major Anions (CL, SO4, Alkalinity), Fluoride	NT-1 & NT-2	APHA 3120B, APHA 3125B	**2**	**2**	**3**	-
Water Leachable Metals - ICP-MS Full scan (dissolved)	EG020F (ME-02)	USEPA 6020 ICP/MS	**2**	**2**	**3**	-
Physical Testing	**ALS Code**	**Method Code**	**Overburden & Interburden**	**Potential coal reject**	**Coal Reject and Coal**	**Soil materials**
Emerson Aggregate Class	-	AS1289.3.8.1	-	-	-	**20**
Grading with Hydrometer (coarse and fine PSD)	-	AS 1289.3.6.1 , AS 1289.3.6.3	-	-	-	**11**
Particle density (specific gravity)	-	AS 1141.3.1	-	-	-	**11**

Note: Samples in bold text are composite samples.

4 Geochemical and physical characterisation results

4.1 Acid Base Account

4.1.1 Overburden/interburden

Acid Base Account results for the 103 overburden and interburden samples (50 overburden and 53 interburden) from the Project are presented in **Table B1** (**Attachment B**) and summarised below. The results are shown by lithology to facilitate interpretation.

- **pH:** The $pH_{(1:5)}$ of the 103 samples ranges from 6.4 to 10.2, with a median pH value of 9.6 (**Figure 4-1**). The lowest pH values tend to be associated with weathered overburden materials located at shallower depth in the stratigraphic profile. The pH results indicate that materials represented by the samples tested will add some alkalinity to any contact water as the pH of deionised water used in the pH tests was 5.5.

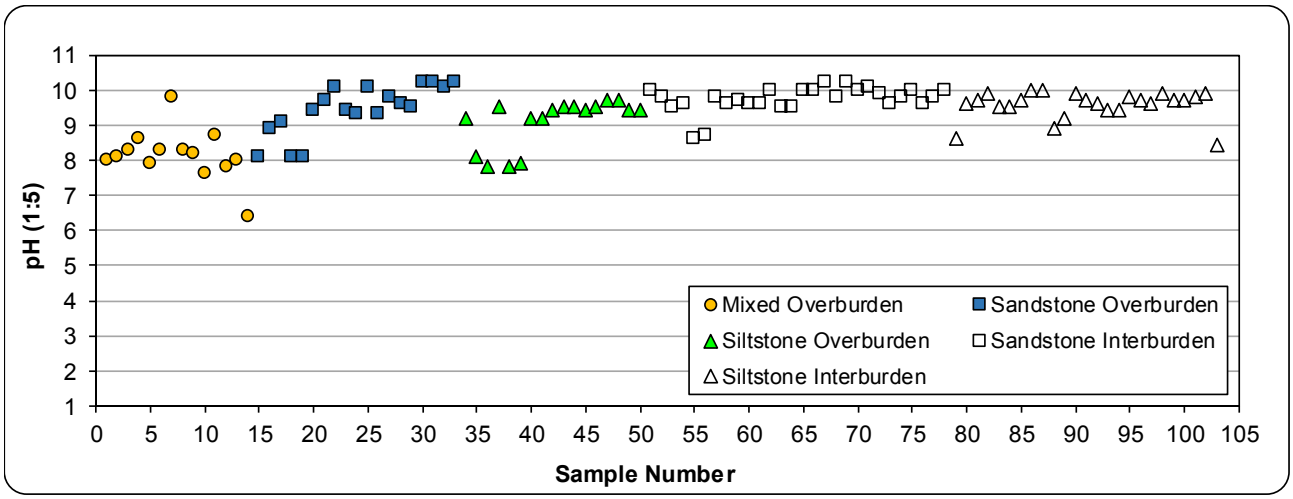

Figure 4-1: pH for overburden and interburden

- **EC:** The $EC_{(1:5)}$ of the 103 samples ranges from 98 to 2,010 µS/cm, with a median value of 373 µS/cm (**Figure 4-2**). The highest EC values tend to be associated with weathered overburden materials located at shallower depth in the stratigraphic profile.

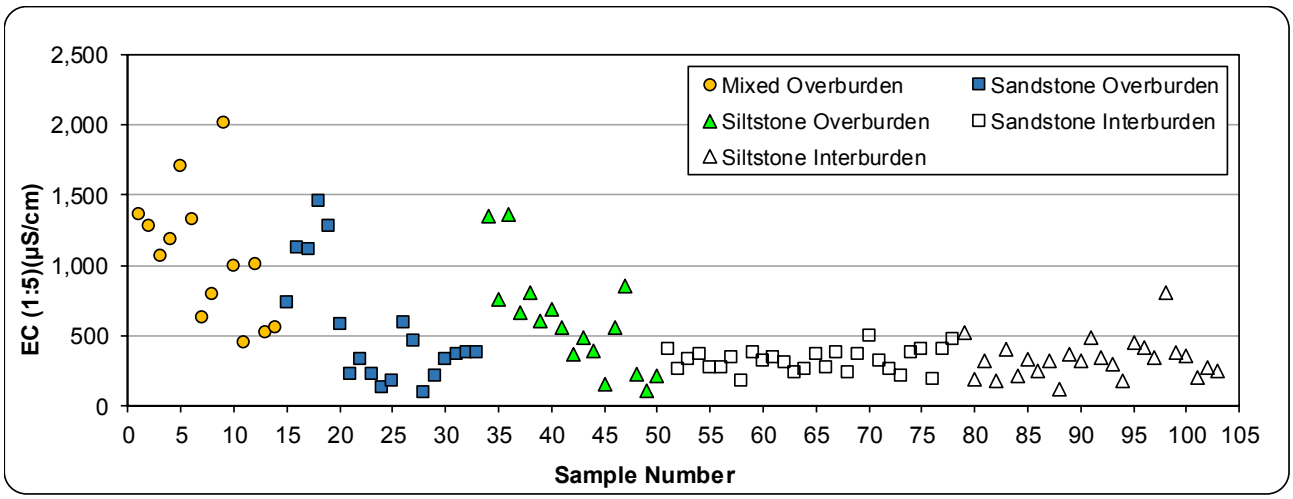

Figure 4-2: EC for overburden and interburden

To provide additional context, the $pH_{(1:5)}$ and $EC_{(1:5)}$ results for the overburden and interburden are classified against pH and salinity criteria for mining waste materials, as defined by as defined by technical guidelines for the environmental management of exploration and mining in Queensland DME (1995) (**Table 4-1**).

Based on the median pH and EC values, the overburden and interburden samples tested are generally regarded as having a 'Very High' soil pH and 'Low' to 'Medium' salinity characteristics, as indicated by the distribution of samples corresponding to each pH and salinity class. Overburden samples tend to have a lower pH and higher EC value than interburden samples.

Table 4-1: Salinity and pH criteria for assessment of overburden and interburden

Overburden	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	450 – 900 (Median 588)	900 – 2,000	> 2,000
Interburden	**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 9.7)
$EC_{1:5}$ (µS/cm)	< 150	150 – 450 (Median – 326)	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 for the samples.

The pH and EC tests 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 rock 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.

- **Sulfur:** The total sulfur content of the overburden and interburden samples ranges from below the laboratory limit of reporting (LoR) (i.e., 0.01 %S) to 0.38 %S and has a very low median value of 0.02 %S, compared with the median crustal abundance value of 0.07 %S in unmineralised soils (Bowen, 1979; INAP, 2009). 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[1]. **Figure 4-3** shows the total sulfur content of the 103 samples by material type and illustrates that all but five samples (three overburden and two interburden) have total sulfur values less than 0.1 %S.

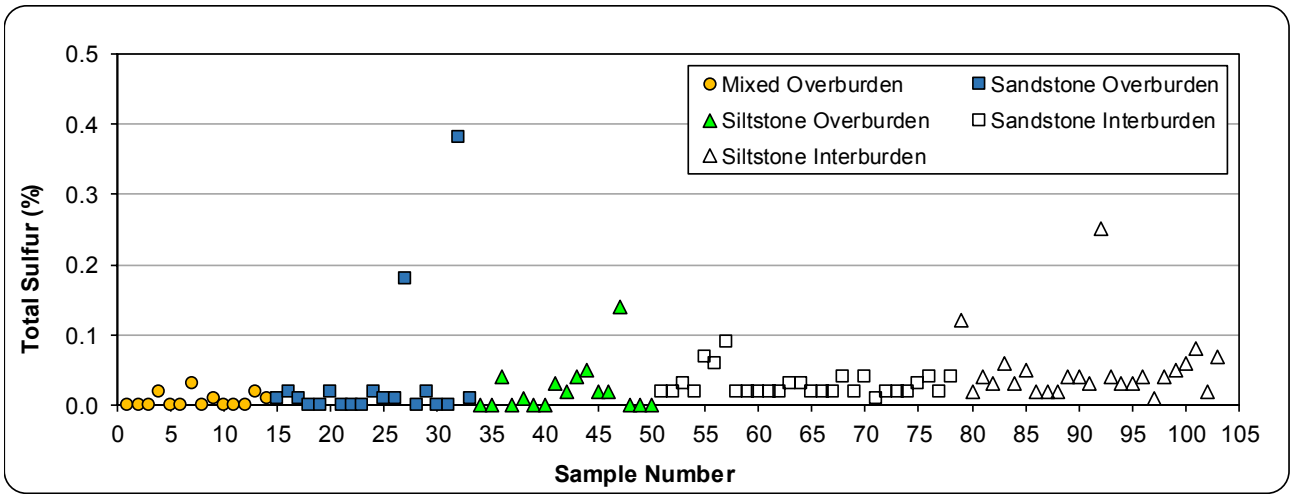

Figure 4-3: Total sulfur for overburden and interburden

[1] The median crustal abundance of sulfur (0.07 %S) has been rounded up to 0.1 % (INAP, 2009).

- **Sulfide sulfur:** Due to the very low total sulfur content of most of the overburden and interburden samples, only five samples were tested for sulfide sulfur using the Scr method. The test results indicate that the total sulfur in the three overburden samples is likely to be in the sulfide form whereas the total sulfur in the two interburden samples is mainly present as organic sulfur which does not generate acidity.
- **MPA:** Based on the total sulfur content (and sulfide sulfur content, where available), the (MPA that could be generated by the overburden and interburden samples ranges from 0.2 (i.e., below the laboratory LoR) to 13.7 kg H_2SO_4/t, and has a very low median value of 0.6 kg H_2SO_4/t.
- **ANC:** The ANC for the 103 overburden and interburden samples ranges from 3.6 to 125.0 kg H_2SO_4/t and has a median value of 22.5 kg H_2SO_4/t, which is more than 30 times the median MPA.
- **ANC:MPA ratio:** The ANC:MPA ratio of the 103 samples ranges from 0.2 to 1,423.7, with a median value of 36.1. In simplistic terms, this means that on average, the overburden and interburden sample materials have more than an order of magnitude excess ANC over MPA.
- **NAPP:** The calculated Net Acid Producing Potential (NAPP) values range from -124.8 to -3.0 kg H_2SO_4/t, with a negative median value of -21.6 kg H_2SO_4/t. The NAPP data is presented overleaf in **Figure 4-5**.

Given the very low sulfur content of the overburden and interburden samples tested and the negative NAPP values, the risk of generating any significant amounts of acidity from these materials is low.

Figure 4-4 (below) shows a plot of ANC versus MPA for the overburden and interburden samples tested by material type and lithology. ANC:MPA ratio lines have been plotted on the figure to illustrate the factor of safety associated with the samples in terms of potential for generation of acidity. Generally, those samples with an ANC:MPA ratio of greater than 2 and a sulfide content of <0.1 %S are considered to represent material with a high factor of safety and a very low risk of generating acidity (COA, 2016c; INAP, 2009).

The ANC:MPA results in **Figure 4-4** show that all overburden and interburden samples plot in the negligible risk domain and therefore the all of the samples tested represent materials that have a high factor of safety and a very low risk of generating acidity.

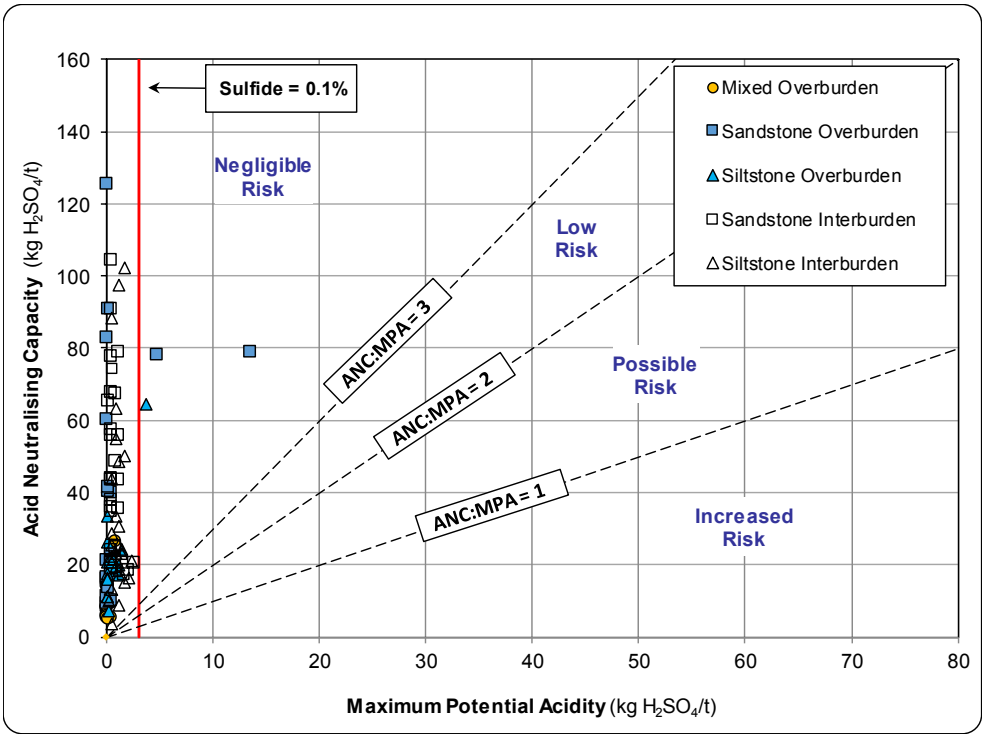

Figure 4-4: ANC:MPA ratio for overburden and interburden

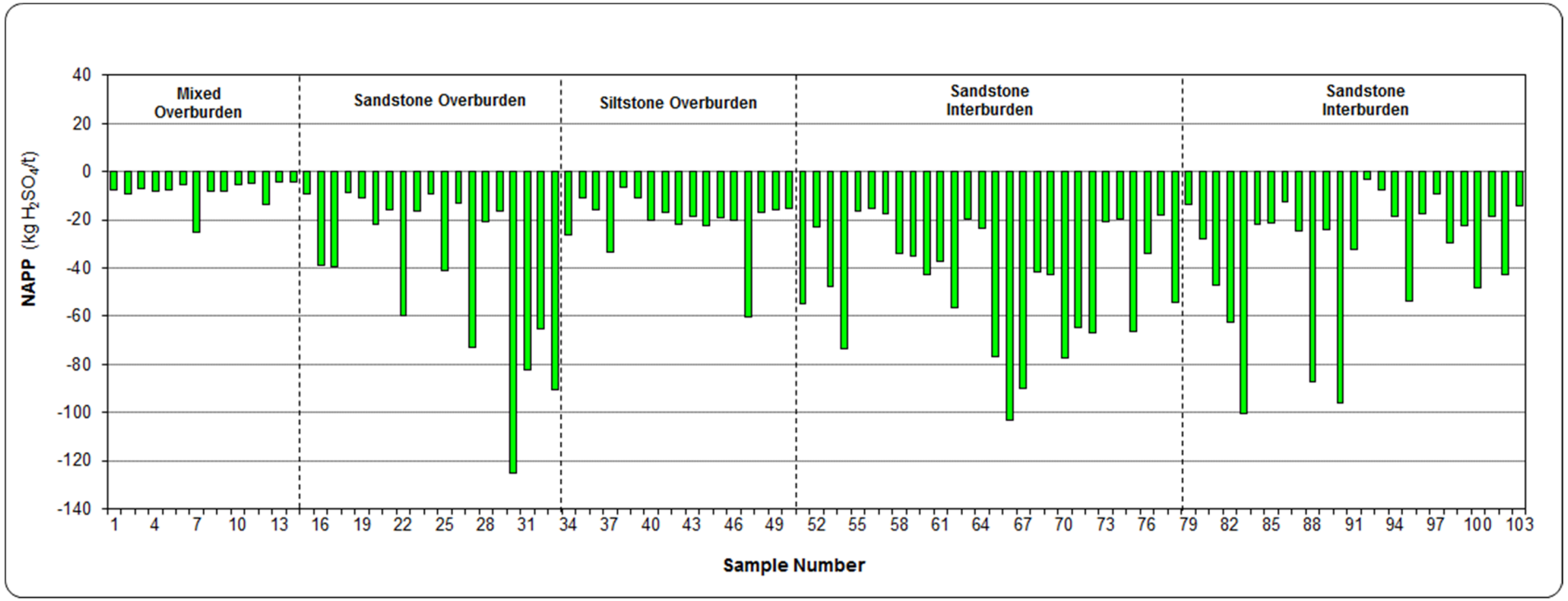

Figure 4-5: Total sulfur for overburden and interburden

Table 4-2 provides a summary of the geochemical classification criteria used by RGS to classify the acid forming nature of the waste rock and a breakdown of the number of samples in each classification category. The classification criteria reflect Australian (COA, 2016c) and international (INAP, 2009) guidelines for the classification of mining waste materials.

The Acid Base Account test data presented in **Table B2 (Attachment B)** and discussed in this section have been used to classify the acid forming nature of the 103 overburden and interburden samples. The results in **Table 4-2** demonstrate that materials represented by all of the samples tested are classified as Non-Acid Forming (NAF) (Barren) or NAF.

Table 4-2: Geochemical classification criteria for overburden and interburden

Geochemical Classification	Total Sulfur[1] (%)	NAPP (kg H_2SO_4/t)	ANC:MPA Ratio	No. Samples (n = 103)
Non-Acid Forming (Barren)[2]	≤ 0.1	-	-	100
Non-Acid Forming	> 0.1	≤ -5	≥ 2	3
Uncertain	> 0.1	> -5 and ≤ +5	< 2	1
Potentially Acid Forming	> 0.1	> +5	< 2	0

Notes:
1. If total sulfur is less than or equal to 0.1 %S, 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 %S, as the sample essentially has negligible acid generating capacity.

Overall, the Acid Base Account results demonstrate that the overwhelming majority of the overburden and interburden materials represented by the samples tested have very low sulfur content, excess ANC, and are classified as NAF. These materials have a high factor of safety and a very low risk of generating acidic drainage.

4.1.2 Potential coal reject, coal reject and coal

Acid Base Account results for the 68 samples of potential coal reject (roof and floor), 20 samples of coal reject (coarse reject and tailing), and five samples of coal feed reserve materials (total of 93 samples) from the Project are presented in **Table B1** (**Attachment B**) and summarised below. The results are shown by material type to facilitate interpretation.

- **pH:** The $pH_{(1:5)}$ of the 93 samples ranges from 5.7 to 9.8, with a median pH value of 9.0 (**Figure 4-6**). Only one sample (a roof sample from the ROP1 seam) has a pH value less than 7.0. The pH results indicate that materials represented by the samples tested will generally add some alkalinity to any contact water as the pH of deionised water used in the pH tests was 5.5.

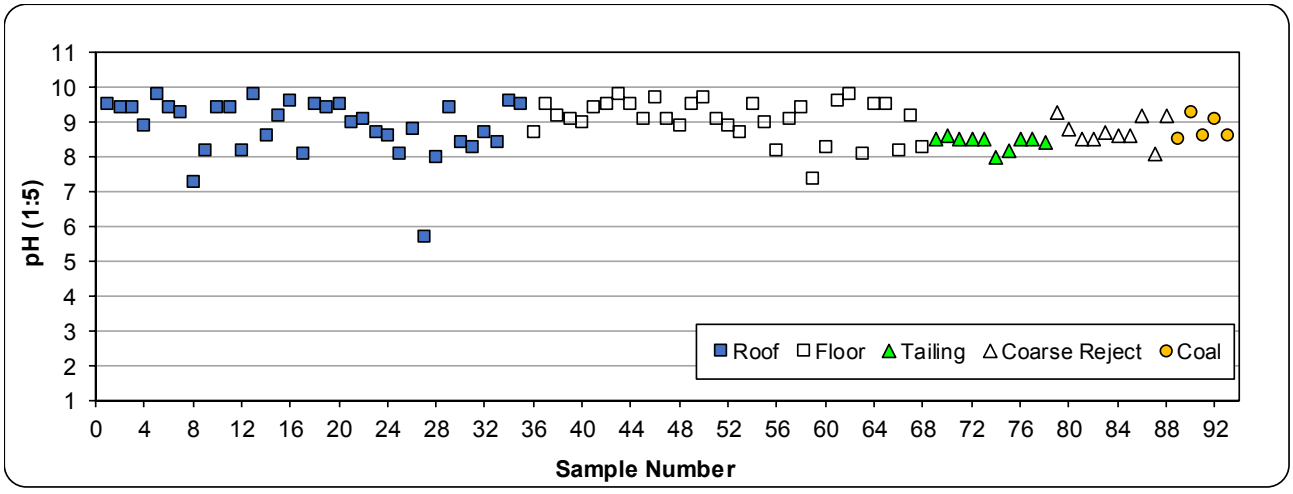

Figure 4-6: pH for potential coal reject, coal reject and coal

- **EC:** The $EC_{(1:5)}$ of the 93 samples ranges from 180 to 3,390 µS/cm, with a median value of 506 µS/cm (**Figure 4-7**). The highest EC values tend to be associated with material represented by the tailing samples.

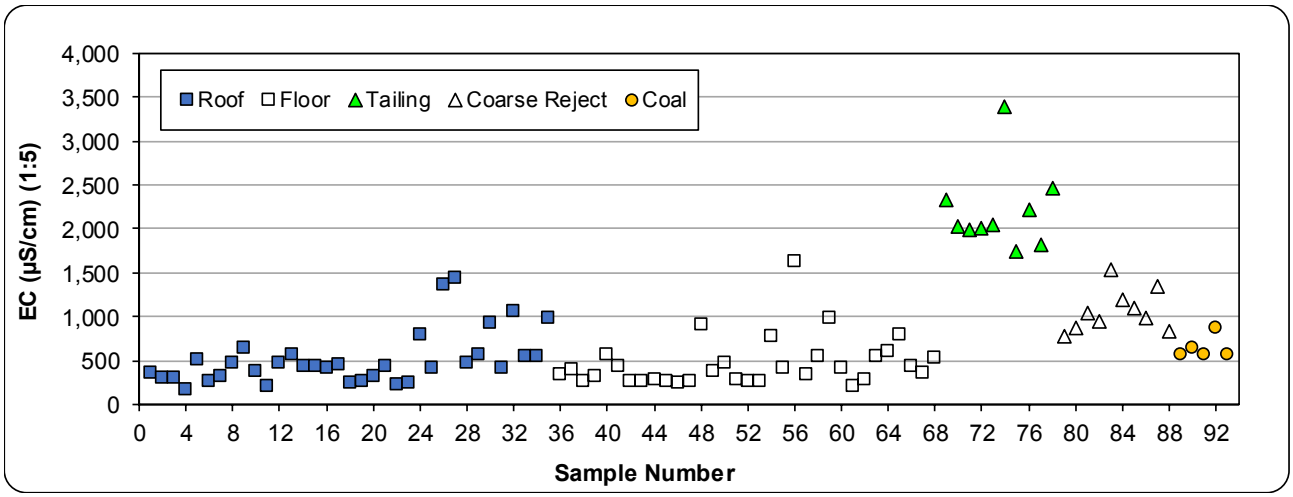

Figure 4-7: EC for potential coal reject, coal reject and coal

To provide additional context, the $pH_{(1:5)}$ and $EC_{(1:5)}$ results for the potential coal reject, coal reject and coal samples are classified against pH and salinity criteria for mining wastes, as defined by technical guidelines for the environmental management of exploration and mining in Queensland DME (1995) (**Table 4-3**).

Table 4-3: Salinity and pH criteria for assessment of potential coal reject, coal reject and coal

Roof	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 9.1)
$EC_{1:5}$ (µS/cm)	< 150	150 – 450 (Median 437)	450 – 900	900 – 2,000	> 2,000
Floor	**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 9.1)
$EC_{1:5}$ (µS/cm)	< 150	150 – 450 (Median – 348)	450 – 900	900 – 2,000	> 2,000
Tailing	**Very Low**	**Low**	**Medium**	**High**	**Very High**
$pH_{1:5}$	< 4.5	4.5 – 5.5	5.5 – 7.0	7.0 – 9.0 (Median 8.5)	> 9.0
$EC_{1:5}$ (µS/cm)	< 150	150 – 450	450 – 900	900 – 2,000	> 2,000 (Median 2,030)
Coarse Reject	**Very Low**	**Low**	**Medium**	**High**	**Very High**
$pH_{1:5}$	< 4.5	4.5 – 5.5	5.5 – 7.0	7.0 – 9.0 (Median 8.7)	> 9.0
$EC_{1:5}$ (µS/cm)	< 150	150 – 450	450 – 900	900 – 2,000 (Median 1,012)	> 2,000
Coal	**Very Low**	**Low**	**Medium**	**High**	**Very High**
$pH_{1:5}$	< 4.5	4.5 – 5.5	5.5 – 7.0	7.0 – 9.0 (Median 8.6)	> 9.0
$EC_{1:5}$ (µS/cm)	< 150	150 – 450	450 – 900 (Median 578)	900 – 2,000	> 2,000

Note: Adapted from DME, 1995. Highlighted cells show the category corresponding to the median pH and EC values for the samples.

Based on the median pH and EC values, the material types tested have soil pH characteristics ranging from 'Medium' for coal to 'Very High' for potential coal reject (roof and floor). Salinity characteristics range from "Low" for potential coal reject (roof and floor) to 'Very high' for tailing materials.

The pH and EC tests 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 rock 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.

- **Sulfur:** The total sulfur content of the potential coal reject, coal reject and coal samples ranges from below the laboratory LoR to 2.60 %S and has a slightly elevated median value of 0.19 %S, compared with the median crustal abundance value of 0.07 %S in unmineralised soils (Bowen, 1979; INAP, 2009). 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[1]. **Figure 4-8** shows the total sulfur content of the 93 sample materials and illustrates that some of the roof, tailing and coarse reject samples have total sulfur values less than 1 %S.

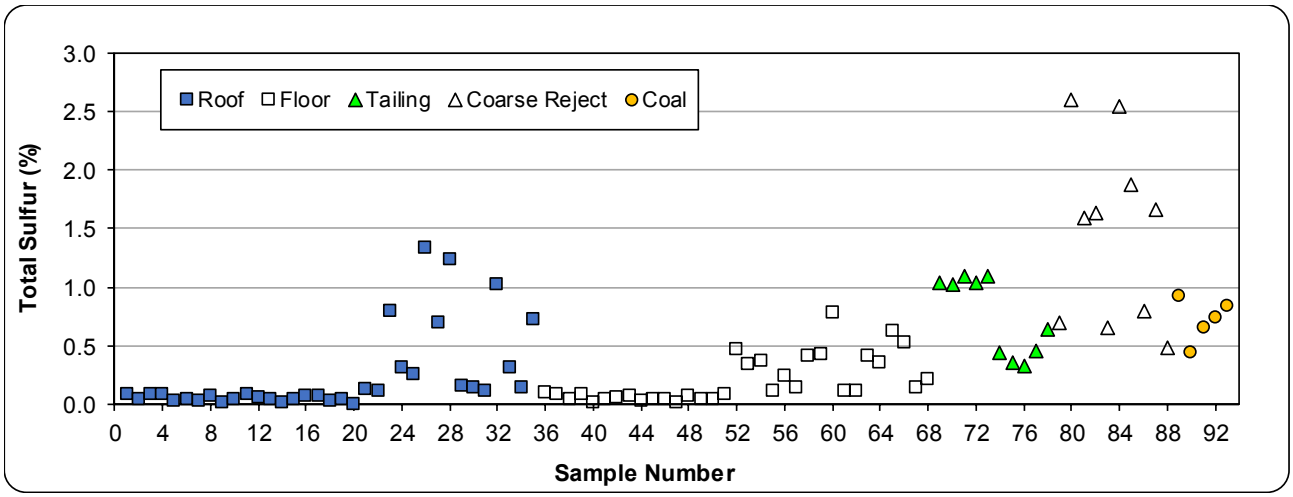

Figure 4-8: Total sulfur for potential coal reject, coal reject and coal

- **Sulfide sulfur:** A total of 57 of the 93 potential coal reject, coal reject and coal samples with a total sulfur content greater than 1 % S were tested for sulfide sulfur using the Scr method. The test results indicate that for 45 of the 57 samples at least half of the total sulfur in the three overburden samples is likely to be in the sulfide form whereas the total sulfur in 12 of the 57 samples is mainly present as organic sulfur which does not generate acidity.
- **MPA:** Based on the total sulfur content (and sulfide sulfur content, where available), the (MPA that could be generated by the 93 samples ranges from 0.2 (i.e., below the laboratory LoR) to 66.5 kg H_2SO_4/t, and has a low median value of 3.1 kg H_2SO_4/t.
- **ANC:** The ANC for the 93 samples ranges from 7.5 to 234.0 kg H_2SO_4/t and has a median value of 17.6 kg H_2SO_4/t, which is more than 5 times the median MPA.
- **ANC:MPA ratio:** The ANC:MPA ratio of the 93 samples ranges from 0.2 to 150.0, with a median value of 5.2. In simplistic terms, this means that on average, materials represented by the sample materials have more than five times excess ANC over MPA.
- **NAPP:** The calculated NAPP values range from -203.8 to +51.6 kg H_2SO_4/t, with a negative median value of -13.4 kg H_2SO_4/t. The NAPP data is presented overleaf in **Figure 4-9**.

Given the relatively low sulfur content of most of the samples tested and the negative NAPP values, the risk of generating any significant amounts of acidity from bulk materials is low.

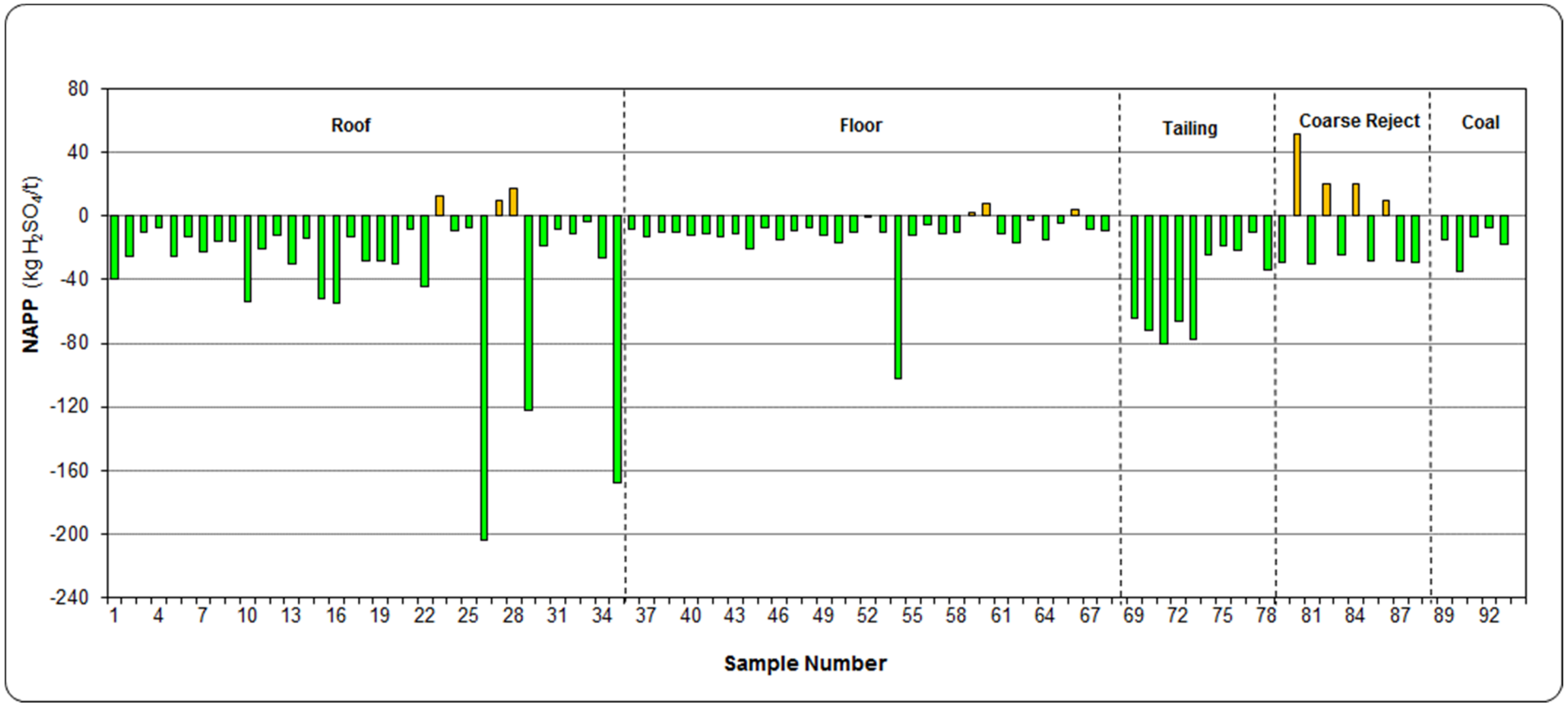

Figure 4-9: Total sulfur for potential coal reject, coal reject and coal

Figure 4-10 shows a plot of ANC versus MPA for the 93 samples tested by material type. ANC:MPA ratio lines have been plotted on the figure to illustrate the factor of safety associated with the samples in terms of potential for generation of acidity. Generally, those samples with an ANC:MPA ratio of greater than 2 and a sulfide content of <0.1 %S are considered to represent material with a high factor of safety and a very low risk of generating acidity (COA, 2016c; INAP, 2009).

The ANC:MPA results in **Figure 4-10** show that most samples plot in the negligible to low risk domains and therefore these samples represent materials that have a high factor of safety and a low risk of generating acidity. A portion of the roof, floor and coarse reject samples plot in the possible risk and increased risk domains and material represented by these samples has a reduced factor of safety and if taken in isolation and allowed to freely oxidise may have some potential to generate acidity.

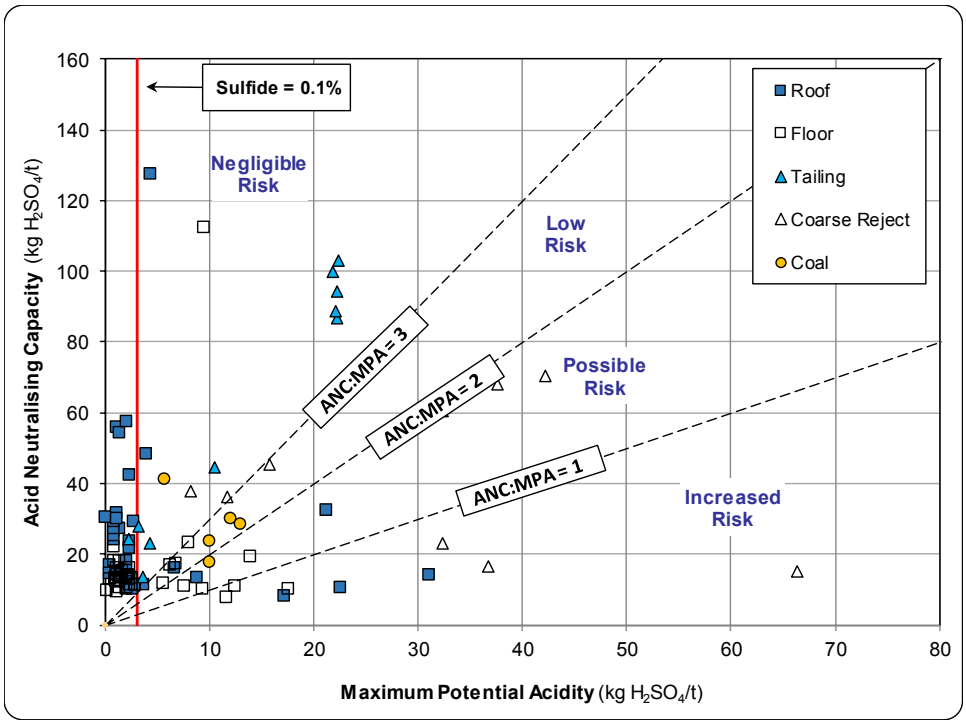

Figure 4-10: ANC:MPA ratio for potential coal reject, coal reject and coal

Table 4-4 provides a summary of the geochemical classification criteria used by RGS to classify the acid forming nature of the potential coal reject, coal reject and coal and a breakdown of the number of samples in each classification category. The classification criteria reflect Australian (COA, 2016c) and international (INAP, 2009) guidelines for the classification of mining waste materials.

The Acid Base Account test data presented in **Table B2 (Attachment B)** and discussed in this section have been used to classify the acid forming nature of the 93 samples. The results in **Table 4-4** demonstrate that materials represented by most of the samples tested are classified as NAF (Barren) or NAF. Six samples are classified as Uncertain and eight samples are classified as Potentially Acid Forming (PAF).

Table 4-4: Geochemical classification criteria for potential coal reject, coal reject and coal

Geochemical Classification	Total Sulfur[1] (%)	NAPP (kg H_2SO_4/t)	ANC:MPA Ratio	No. Samples (n = 93)
Non-Acid Forming (Barren)[2]	≤ 0.1	-	-	48
Non-Acid Forming	> 0.1	≤ -5	≥ 2	31
Uncertain	> 0.1	> -5 and ≤ +5	< 2	6
Potentially Acid Forming	> 0.1	> +5	< 2	8

Notes:
1. If total sulfur is less than or equal to 0.1 %S, 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 %S, as the sample essentially has negligible acid generating capacity.

Overall, the Acid Base Account results demonstrate that most of the potential coal reject, coal reject and coal materials represented by the samples tested have relatively low sulfur content, excess ANC, and are classified as NAF. These materials have a high factor of safety and a very low risk of generating acidic drainage. However, some of the roof and coarse reject samples have elevated sulfur content, lower ANC and if taken in isolation and allowed to freely oxidise may have some potential to generate acidity.

4.2 Multi-element concentration in solids

Multi-element scans were carried out on 12 composite samples (i.e., 3 overburden, 2 interburden, 4 potential coal reject, 2 coal reject and 1 coal) as described in **Section 3.2.1** to identify any elements (metals/metalloids) present at concentrations that may be of environmental concern with respect to materials handling, storage, revegetation and water quality.

To provide some context, RGS has compared the total metal/metalloid concentration in the composite 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 12 composite samples are presented in **Table B2 (Attachment B)**. The results indicate that the sample materials have low total metal and metalloid concentrations in solids below the applied NEPC (HIL(C)) guideline for soils.

The results from multi-element testing (total metals/metalloids) of the 12 composite samples are discussed with respect to median crustal abundance in un-mineralised soils in **Section 4.2.1**.

4.2.1 Geochemical Abundance Index

Total metal/metalloid concentrations in mining waste materials can be compared to the median crustal abundance for un-mineralised soils (Bowen, 1979, COA, 2016c and INAP, 2009). The extent of enrichment is reported as the Geochemical Abundance Index (GAI), which relates the actual concentration in a sample with the median (or average) 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 (see **Table 4-5**).

Table 4-5: Geochemical abundance index values and 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, such as arsenic, chromium, cadmium, copper, lead, selenium and zinc, more so than with major rock-forming elements, such as aluminium, calcium, iron, manganese and sodium.

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. While the GAI provides an indication of metals/metalloids that may be enriched relative to the global average crustal abundance, the following points should also be considered:

- The median crustal abundance varies between different literature sources, thereby affecting the calculated GAI values.
- Samples that are enriched relative to the median crustal abundance, do not necessarily leach metals/metalloids at elevated concentrations. The mobility of metals/metalloids is dependent on mineralogy, adsorption/desorption and the environment in which it occurs.

Similarly, because an element is not enriched does not mean it will never be a concern, as under some conditions (e.g., low pH) the solubility of common environmentally important elements such as aluminium, copper, cadmium, iron and zinc increase significantly.

Table B2 (**Attachment B**) provides total metal/metalloid concentrations for the 12 composite samples described in **Section 3.2.1**. The relative enrichment of metals/metalloids in the samples compared to median crustal abundance (the Geochemical Abundance Index - GAI) is presented in **Table B3** (**Attachment B**).

The GAI results indicate that of the metals/metalloids measured, none of the 12 composite samples are enriched compared to median crustal abundance (i.e., all samples have a GAI < 3). While the concentration of selenium appears slightly elevated relative to median crustal abundance (GAI = 2) this is generally an artefact of the concentrations used in the GAI calculation (i.e., half the laboratory LoR of 5 mg/kg).

The potential solubility of any metals/metalloids in the sample materials was investigated further through water extract and KLC tests as presented in **Sections 4.4** and **4.5**, respectively.

4.3 Exchangeable cations and sodicity

A total of 11 composite overburden, interburden, potential coal reject and coal reject samples were selected for additional characterisation tests, as some of these materials could potentially report to the outer surfaces of final landforms and could also be earmarked for use in other site infrastructure and rehabilitation works. The tests focussed on exchangeable cations and allowed calculation of the effective cation exchange capacity and exchangeable sodium percentage values. The test results and calculated values are provided in **Table B2** (**Attachment B**) and summarised below.

4.3.1 Exchangeable cations

The effective cation exchange capacity (eCEC) measures the capacity of a mining waste material to hold and exchange cations, which provides a buffering effect to changes in pH and available nutrient levels (Hazelton and Murphy, 2016).

The eCEC and individual exchangeable cation values for the 11 composite samples presented in **Table B2** (**Attachment B**) show that the eCEC of the samples ranges from 8.5 to 13.7 meq/100g and is typically in the low to moderate range as described in **Table 4-6** (Hazelton and Murphy, 2016). The individual exchangeable cation values are summarised in **Table 4-7**. The calcium:magnesium ratio is low and less than or equal to unity in all samples tested and the samples range from calcium deficient to low in calcium.

Table 4-6: Ratings for cation exchange capacity

eCEC Rating	CEC (meq/100g)
Very low	<6
Low	6 – 12
Moderate	12 – 25
High	25 – 40
Very high	>40

Table 4-7: Summary of exchangeable cation levels

Cation	Minimum (meq/100g)	Maximum (meq/100g)	Average (meq/100g)
Na^+	4.5	9.3	6.3
K^+	<0.2	0.3	<0.2
Ca^{2+}	<0.2	2.5	1.6
Mg^{2+}	1.5	6.0	3.7

[1] Ratings are based on Hazelton and Murphy (2016)

For materials with a low to moderate eCEC value and low calcium:magnesium ratio, fertiliser and gypsum addition may be required to provide a reasonable growth medium for vegetation roots as part of revegetation and rehabilitation activities. The most appropriate application rates for fertiliser and gypsum should be determined as part of rehabilitation field trials.

4.3.2 Sodicity

Sodicity occurs when the exchangeable sodium on the cation-exchange complex leads to clay dispersion in the soil (Hazelton and Murphy, 2016). Sodicity is of interest as it can result in surface crusting and low infiltration and hydraulic conductivity within affected soils. Sodicity is generally measured by calculating the Exchangeable Sodium Percentage (ESP) from the exchangeable cation results. ESP ratings for Australian soils established by Isbell (2020) and Northcote and Skene (1972) shown in **Table 4.8**.

Table 4-8: Ratings for exchangeable sodium percentage

ESP Rating[1]	ESP Percentage
Non-sodic	< 6
Moderate	6 – 14
Strong	> 14%

[1] Ratings are based on Isbell (2020) and Northcote and Skene (1972).

The ESP results for the 11 composite mining waste samples are presented in **Table B2** (**Attachment B**). The ESP results range from 43.0 to 76.6 % and are typically elevated as would be expected for mining waste materials found in this part of the Bowen Basin. Generally, 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, 2020; and Northcote and Skene, 1972).

Overall, the ESP results indicate that the mining waste materials are likely to be strongly sodic; and consequently, may be susceptible to dispersion and erosion and should be managed appropriately. The addition of gypsum and organic matter to sodic mining waste materials has the potential to reduce the sodicity and reduce the potential for dispersion and erosion. The most appropriate application rates for organic matter and gypsum should be determined as part of rehabilitation field trials.

4.4 Soil Characteristics

In order to supplement the geochemical characterisation of mining waste and coal materials, RGS coordinated a soil test pit program aimed at characterising soils at the southern end of the mine disturbance footprint. An earlier soil survey (Cardno, 2013) across the northern end of the Project was validated as part of the work program and used as a comparison to assess the soil properties. The test pit sampling was undertaken by RGS personnel with assistance from Foxleigh. The soil profiles of the test pits were logged by RGS and these are provided in **Attachment E**.

Laboratory data (**Attachment D**) for individual and composite soil samples has been analysed by RGS and aligns well with the soil survey completed by Cardno. RGS has maintained similar soil mapping units, although classifications have been simplified to orders rather than suborders for ease of use by Foxleigh. Based on the Atlas of Australian Soil Classifications (Isbell, 2020), vertosols and sodosols were expected to be the most encountered soil types in the southern area. However, later on site it was observed that several test pits were located in historical mining areas that had been backfilled with waste rock and covered with topsoil. These units have been classified as ‘anthroposols’ or human-made soils. In addition, chromosols were more prevalent than anticipated, and turned out to be the most common soil type in this study.

4.4.1 Arenosols (new soil classification)

Soils classified as ‘Arenosols’ or sandy soils were observed for the first time at southern end of the mine. Arenosols are a new Australian Soil Classification (introduced in 2019), and therefore would not have been available as a soil type when the Cardno (2013) soil survey was conducted. Arenosols have a distinctive apedal texture (i.e., does not form clumps), but must also be deep sands (at least 1 m thick). Key factors in distinguishing between different soil orders include colour, texture, moisture, particle size distribution, pH and EC, and have been summarised in **Table 4-9**. Australian Soil classification criteria are listed in **Table 4-10**.

Table 4-9: Foxleigh soil descriptions and characteristics

Soil Type	Examples	Horizons (where available)	Particle Size Distribution	Moisture	Peds/Texture	pH	EC	Colour	Emerson Class	Photograph
Vertosols	Test Pit 5	Thin surface A horizon, massive B horizon	>35% clay	Moist to wet (6.6%)	Lenticular peds	8	Low - Moderate (300 – 700 μS/cm)	Dark Grey	1	
Sodosols	Test Pits 7, 11, 12	Bleached A horizon, abrupt mottled B horizon	Mostly clay and silt	Moist (4.7%)	Strongly plastic B horizon	7-9	Moderate – Very High (400 – 2000 μS/cm)	Yellowish Brown	2	
Chromosols	Test Pits 4, 6, 10	Strong texture contrast between A, B, and C horizons	Mostly silt and sand	Moist (4.0%)	Large, rounded peds up to 5 cm	7-9	Very Low - Moderate (20 – 500 μS/cm)	Orange Red	2	
Arenosols	Test Pit 9	No distinct horizons	Mostly sand	Very dry (2.3%)	Apedal, powdery	6-7	Very Low to Low (5 – 300 μS/cm)	Brown	3	
Anthroposols	Test Pits 1, 2, 3, 8	No distinct horizons	Mostly gravel	Dry (3.7%)	No soil aggregation	9-10	Moderate – High (400 – 1000 μS/cm)	Grey	1	

Table 4-10: Summary of Australian Soil Classification Criteria

Soil Order	Australian Soil Classification Criteria
Vertosols "Shrink-swell clays"	• Contains > 35% clay • May contain thin, surface crusty horizons • Exhibits cracking when dry at surface (>5 mm wide) • May contain lenticular peds and/or slickensides
Sodosols "Influenced by sodium"	• Abrupt textural B horizon • Upper B2 horizon is sodic (ESP > 14%) • Upper B2 horizon is ≥ pH 6 and not strongly acidic • Moderate to strong plasticity • Low saturated hydraulic conductivity • Emerson Class 1 or 2 • Large, weak peds 5 – 20 mm in size • May contain hard calcareous horizons
Chromosols "Often bright coloured"	• Abrupt textural B horizon • Upper B2 horizon is not sodic (ESP < 14%) • Upper B2 horizon is ≥ pH 6 and not strongly acidic • Low to moderate plasticity (i.e., sub-plastic) • Commonly red or brown in colour • May contain petroferric horizon i.e., rich in iron (Fe) • May contain hard calcareous horizons
Arenosols "Sandy soils"	• Predominantly sand-sized particles • Soil texture is sand, loamy sand, or clayey sand • Deep sand profile - minimum 1 m thick • Poor or absent horizon development • Few coarse fragments (≤ 10 % gravel) • No clay layers exceeding 15% clay • No hard layers or cemented pans • May contain calcite concretions or shells
Anthroposols "Human-made soils"	• Soils resulting from human activities • Profound modification, mixing, truncation, or burial of original soil horizons • Rudimentary horizons may be forming from pedogenic processes

Note: Criteria based on Isbell et al., (2020).

4.4.2 Soil types and descriptions

A more detailed soil survey will be required to confirm and map the full extent of these soil units at the southern end of the mine lease. An overview of key test pit soil types and their characteristic geochemistry is provided in **Figure 4-11**.

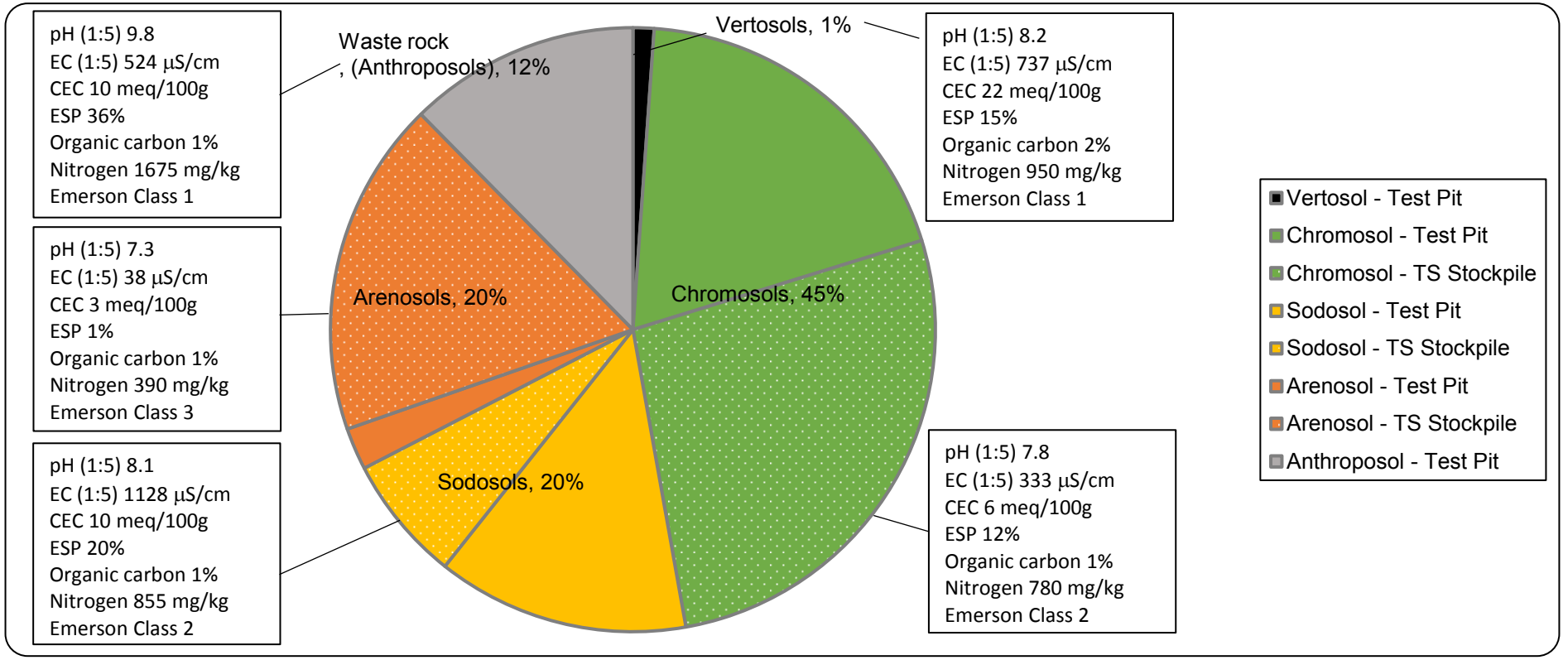

Figure 4-11: Summary of 2021 test pit soil and topsoil stockpile results

The key properties and occurrence of the soil units in the 2021 RGS test pit and topsoil stockpile survey have been summarised below. Soil type units refer to similar undisturbed soils mapped in the northern section that were described in the Cardno (2013) report.

Vertosols

Soil Type Unit: Bluchers

Encountered only in Test Pit 5, this unit is characterised by its high moisture content, dark grey-brown colour, high proportion of clay, and thick, massive structure without horizons. Vertosols are slightly alkaline and moderately saline but compared to other soils are rich in organic carbon and nutrients and have a high cation exchange capacity (22 meq/100g). Vertosols are rare in the southern section, but most likely to be found near the eastern boundary of the mine lease.

Sodosols

Soil Type Unit: Foxleigh, Racetrack, and Emoh

Sodosols are characterised by thick, moist, yellowish-brown subsoil (B horizons) with a mottled texture and very high plasticity. Subsoil units have high salinity (up to 2000 μS/cm) and are sodic and alkaline. Salt crusts (calcareous concretions) have been observed in some test pits. In undisturbed profiles, sodosol topsoils (A horizons) are dry and crumbly, with moderate salinity and neutral to alkaline pH. However, samples collected from placed sodosol topsoil covers (e.g., Test Pit 8) demonstrate that when disturbed, these soils are likely to form surface salt crusts that severely limit root penetration. If used as a cover, it is likely that sodosols will only be able to support resilient native grasses and adapted salt-tolerant species.

Chromosols

Soil Type Unit: Roper

Chromosol subsoils (B horizons) are orange to bright red-orange in colour, making them easy to identify in the field. Subsoil units are relatively moist with large, soft crumbly peds, and low plasticity. By contrast, chromosol topsoils (A horizons) are dry, brown to reddish-brown in colour and similar in appearance to sodosol topsoils. As both chromosols and sodosols have an abrupt textural change at the B horizon, samplers should dig to at least 1 m depth to characterise the distinctive subsoil layers in these soil types. Chromosols are generally lower in salinity and sodicity compared to sodosols, but disturbed areas show that when exposed, chromosols are prone to instability and dispersion. Chromosols are generally low in nutrients, but able to support native vegetation if erosion risks are managed.

Arenosols

Soil type Unit: N/A

Arenosols were observed only in Test Pit 9, which is a historically rehabilitated area with excellent vegetation regrowth. The soils have a fine, powdery texture, but are very dry. The placed soil cover is at least 3 m thick and has no soil horizons. Salinity is very low to moderate, and the soils are stable and non-sodic. As the soil particles are predominantly sand-sized, arenosols have low moisture retention and are low in nutrients yet are fertile and able to support both grasses and trees. While RGS did not observe any undisturbed arenosol profiles, the characteristics shared by Test Pit 9 and many of the topsoil stockpiles demonstrates that arenosols are abundant and may constitute a good growth medium for rehabilitation.

Waste rock (anthroposols)

Soil type Unit: N/A

Backfilled waste rocks (anthroposols) vary from fresh to weathered and sometimes have a thin (20 – 30 cm) topsoil cover of chromosol or sodosol. Coal rejects and coal ore fragments are interspersed within these units, which increases the organic carbon and nutrient content. Subsoil waste rocks at Test Pit 1 and 8 are moderate to highly saline, strongly sodic, alkaline, hard, and compacted, making this a difficult and hostile profile for roots to penetrate, although resilient grasses have colonised the topsoil cover when the thickness is 20 cm or more. Surface water runoff on slopes has reduced the thickness of the topsoil cover. On flat terrain, waste rocks at Test Pit 2 and 3 have significantly weathered and are able to support sparse vegetation despite a lack of topsoil. Anthroposols created by weathering through natural pedogenic processes will vary depending on the parent materials but are likely to be highly alkaline (pH 9-10) and, on their own, generally unsuitable as a growth medium.

4.4.3 Topsoil stockpile soil classifications

The Australian Soil Classification is intended for use on undisturbed 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. Technically speaking, when the soil is disturbed and re-deposited it becomes an anthroposol, or "human-made soil" and therefore all of the Foxleigh topsoil stockpiles are "anthroposols" based on the guideline.

However, RGS understands that a universal anthroposol topsoil stockpile classification is neither useful nor practical to Foxleigh. Therefore, RGS have attempted to classify the soils based on what they were, prior to disturbance. This adds a degree of subjectiveness, as the guideline was not intended for this purpose. As the key indicators of soil classification (the structure of the soil profile) has been removed, the only way to attempt to classify these disturbed soils is through their geochemical and physical properties. Soil scientists classify in-situ (undisturbed) soil profiles by using visual indicators, for example, a field texture test, or the colour of each horizon, but do not generally perform laboratory tests. The analytical program conducted by RGS to analyse the topsoil stockpiles is more comprehensive so as to infill the data gaps that are missing due to disturbance. While RGS specialises in mine waste materials and has the knowledge and experience to classify disturbed materials, it should be noted that all soil classifications are subjective interpretations.

Topsoil stockpile soil types have been mapped in **Figure 4-12**. Total areas and volumes of each topsoil stockpile soil type, based on data provided by Foxleigh, have been calculated in **Table 4-11**. Results demonstrate that the most abundant topsoil stockpile soil type is chromosols (480,156 m^3), followed by sodosols (126,831 m^3), and finally arenosols (123, 876 m^3). Measures for rehabilitation and revegetation are discussed in **Section 5.4**.

Table 4-11: Area and volumes of topsoil stockpile soil types

Stockpile	Location	Rehab (Y/N)	Centroid_X	Centroid_Y	Area (m^2)	Volume (m^3)	Soil Classification	Total Area (m^2)	Total Volume (m^3)
TS01	Far South	Yes	685912.155	7454803.259	3197.592	8281	**Arenosol**	**57,288**	**123,876**
TS02	Far South	Yes	685750.411	7455141.873	2289.129	5356	**Arenosol**		
TS03	Far South	Yes	685527.636	7455242.797	2096.645	5273	**Arenosol**		
TS30	Eagles Nest	Yes	679672.705	7463617.189	44588.88	99037	**Arenosol**		
TS50	Rejects	No	681515.930	7461319.714	2147.075	1630	**Arenosol**		
TS57	Fox Plains	Yes	681703.096	7463201.092	1537.979	2296	**Arenosol**		
TS58	Fox Plains	Yes	681745.630	7463106.383	1430.421	2003	**Arenosol**		
TS04	Carlo	Yes	686649.465	7457323.765	7621.783	17625	**Chromosol**	**229,533**	**480,156**
TS16	Rejects	No	681465.851	7461202.538	5339.458	11822	**Chromosol**		
TS18	Rejects	No	681411.562	7461517.096	11713.48	27956	**Chromosol**		
TS22	Fox Plains	No	681729.235	7462990.573	23748.25	26673	**Chromosol**		
TS23	Fox Plains	Yes	681888.606	7463099.106	28758.96	52098	**Chromosol**		
TS24	Eagles Nest	Yes	679658.399	7463435.886	7262.594	15372	**Chromosol**		
TS41	Fox Plains	No	681998.733	7464462.109	86976.76	200059	**Chromosol**		
TS65	Fox Plains	Yes	682918.912	7464411.578	18769.05	65550	**Chromosol**		
TS67	Far South	Yes	684116.518	7455883.802	21232.87	27000	**Chromosol**		
TS68	One Tree	Yes	684159.740	7459326.449	8666.84	17138	**Chromosol**		
TS79	One Tree	No	684189.473	7459413.691	5410.132	8648	**Chromosol**		
TS80	One Tree	Yes	684802.630	7458934.196	4032.321	10215	**Chromosol**		
TS66	Fox Plains	Yes	682894.445	7464595.786	13064.7	46820	**Sodosol**	**52,835**	**126,831**
TS71E	Fox Plains	Yes	682718.624	7464658.970	26469.91	44300	**Sodosol**		
TS71W	Fox Plains	Yes	682590.151	7464509.316	11092.8	21600	**Sodosol**		
TS07	Carlo	Yes	686482.438	7457873.163	2207.935	14111	**Sodosol**		

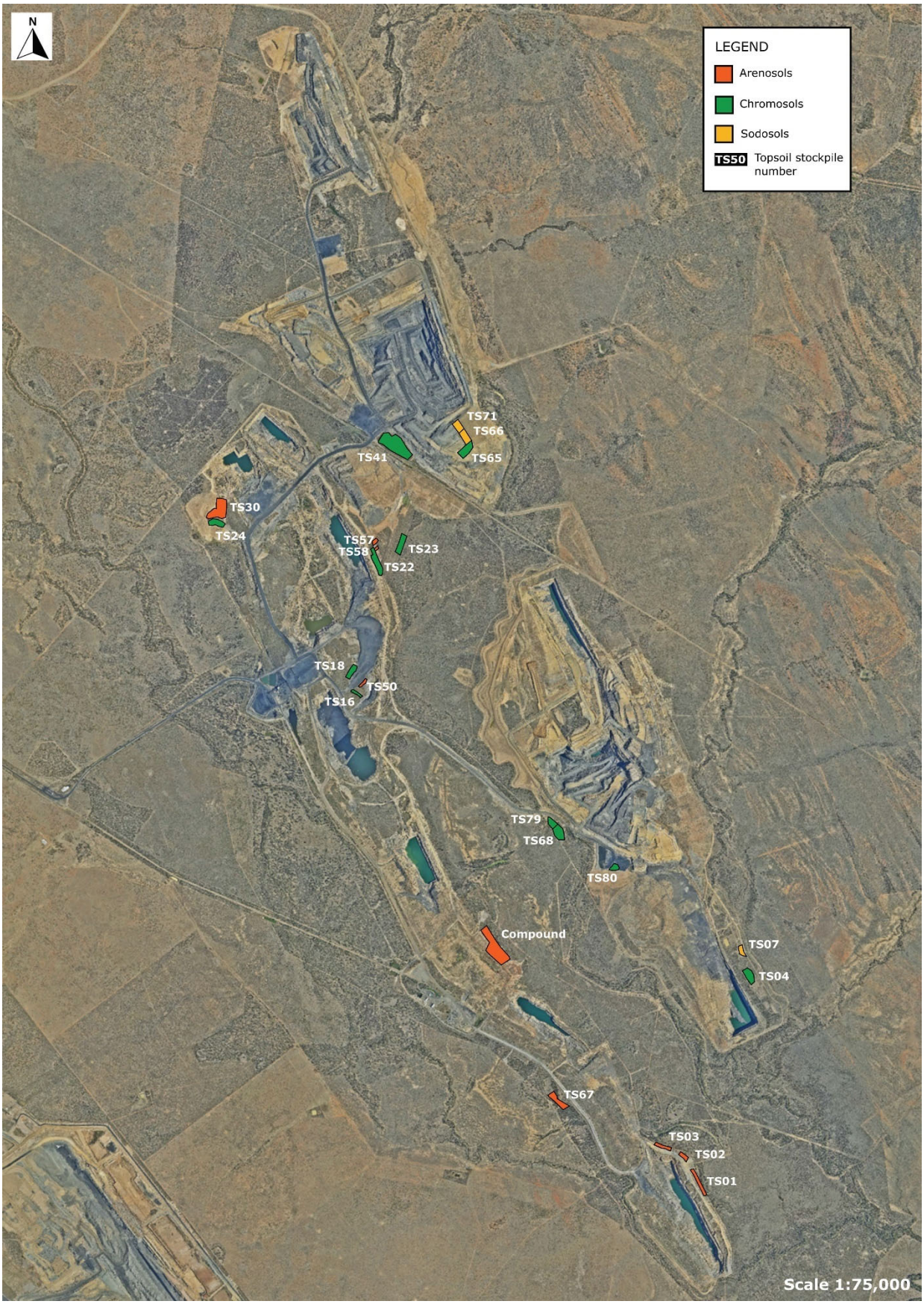

Figure 4-12: Topsoil stockpile soil type classifications

4.4.4 Nutrients

A brief summary of the geochemical results is provided in following points:

- Soil pH (1:5) for the test pit and topsoil stockpile samples (n=89) ranges from 6.3 to 10.2 (median 8.1) and is alkaline. Samples that had relatively low pH were usually arenosols or chromosols. Waste rocks (anthroposols) measured the highest pH (**Figure 4-13**).
- Soil EC (1:5) (n=89) ranges from 9 to 2,081 µS/cm (median 250 µS/cm) and is generally low across the test pits and soil horizons. Arenosols and chromosols had relatively low EC and sodosol subsoils were the most saline (**Figure 4-14**).
- pH ($CaCl_2$) for the test pit and topsoil stockpile soil composites (n=19) ranges from 6.0 to 8.4 (median 7.2). This pH method is generally preferred for soil samples in agricultural suites. Trends here are similar to those obtained for the standard pH (1:5), but about 1 pH unit lower.
- Soil moisture for the soil composites (n=19) ranges from 0.5 to 6.6% (median 4.1%) and is generally low. The grey vertosol sample has the highest moisture, and an arenosol topsoil stockpile sample is the driest.
- The concentrations of exchangeable cations in the soil composites (n=19) are summarised in **Table 4-12**. By agricultural standards (Hazelton and Murphy, 2016), Exchangeable Ca and K are low, Mg are moderate, and Na is high across the test pit and topsoil stockpile samples.

Table 4-12: Summary of soil chemistry results

Parameter	Analysis	Min	Max	Median	Classification
Exchangeable Ca	Exchangeable Cations	1.1	13.9	2.5	Low
Exchangeable Mg	Exchangeable Cations	0.1	7.7	1.9	Moderate
Exchangeable K	Exchangeable Cations	0.1	0.5	0.3	Low
Exchangeable Na	Exchangeable Cations	0.1	5.3	1.1	High
Cation exchange capacity (CEC) (meq/100g)	Soil fertility	2.6	27.3	6.9	Low
Exchangeable Sodium Percentage (ESP) (%)	Sodicity	0.1	39.7	13	Sodic
Calcium/Magnesium Ratio	Soil stability	0.4	3.5	1.8	Ca (low)

- The effective cation exchange capacity (eCEC) of the soil composites (n=19) is generally low. This is a measure of the ability of the soil to hold and exchange nutrients, which then become available to plants and microorganisms. Soils with a high clay content (such as vertosols and sodosols) will have a higher eCEC. A comparison between the 2021 test pit samples and 2013 soil survey results is shown in **Figure 4-15**.
- The exchangeable sodium percent (ESP) of the soil composites (n=19) is generally sodic. ESP values <6% are non-sodic, 6-14% are sodic and >14 are strongly sodic This measurement expresses the proportion of exchangeable Na compared to other cations and is used to determine whether the soil is flocculated or dispersive. Waste rocks (anthroposols) and sodosols are highest in sodicity (**Figure 4-16**).
- The Ca/Mg ratio is also a measure of dispersion. The soil composites (n=19) are slightly Mg deficient and Ca low, which means that soils are more dispersive than those that are Ca balanced.
- **Table 4-13** shows the DTPA extractable metal results (n=19) against critical nutrient levels required for corn pastures in near-neutral and calcareous soils based on Lindsay and Norvell (1978). It should be noted that the LoR of 0.5 mg/kg is above the critical level required for Cu, making it difficult to detect any Cu deficiencies. Results show that the soils are likely to contain sufficient Cu, Fe, and Mn, but the median concentration of Zn is less than the critical level, inferring that Zn deficiencies may be present. Waste rocks (anthroposols) are the exception and are relatively high in Zn.

Table 4-13: Critical nutrient levels of corn for DTPA extractable metals

Parameter	Min	Max	Median	Critical levels (mg/kg)
DTPA Extractable Cu	0.5	2.0	0.5	0.2
DTPA Extractable Fe	5.3	51.4	11.0	4.5
DTPA Extractable Mg	2.6	47.2	10.6	1.0
DTPA Extractable Zn	0.5	2.2	0.5	0.8

- Total Nitrogen (N) results for the composite samples (n=19) were 260 mg/kg to 2000 mg/kg with a median of 780 mg/kg. These results indicate that the soils are classified as low in total N by agricultural standards (Hazelton and Murphy, 2016) but nevertheless support native vegetation. Waste rock (anthroposols) samples are also relatively high in Nitrogen (**Figure 4-17**).
- Organic matter in the soil composite samples (n=19) has a median value of 1.6% and total organic carbon has a median value of 1%. Organic matter is calculated from total organic carbon and represents plant and animal derived material that supports microorganisms in the soil. The results show that organic matter and total organic carbon are generally low by agricultural standards.
- Bicarbonate extractable K (median 301 mg/kg) for the soil composite samples (n=19) are generally high by agricultural standards, indicating that K fertiliser will not be required (Marx et al., 1996). Bicarbonate extractable P (median 8.5 mg/kg) is low, but still able to support native vegetation. Plant-available P and K are nutrients that are essential constituents of biochemical soil processes, such as photosynthesis and respiration.
- When compared to EC, the chloride concentration can be used to determine if the salt is predominantly halite (NaCl) or gypsum ($CaSO_4 \cdot 2H_2O$). A higher proportion of chloride infers that the soil is likely to be sodic and/or dispersive. The chloride concentration for the soil composites (n=19) ranges from 5 to 2580 mg/kg (median 290 mg/kg) and is highest in the sodosol subsoil samples (**Figure 4-18**).

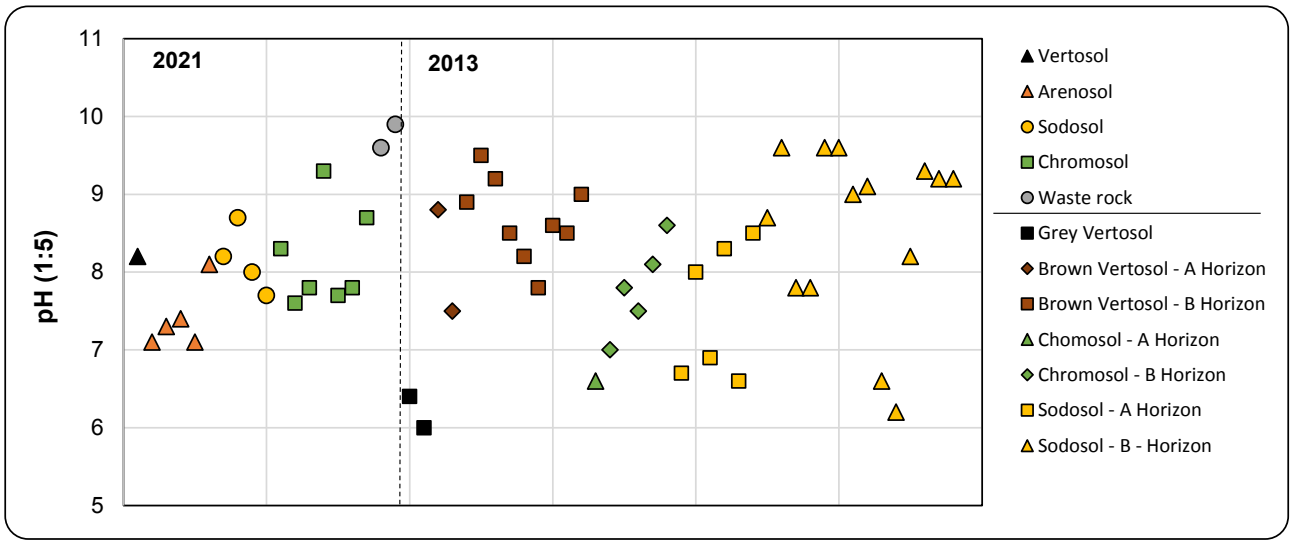

Figure 4-13: pH for test pit and topsoil stockpile soil composites

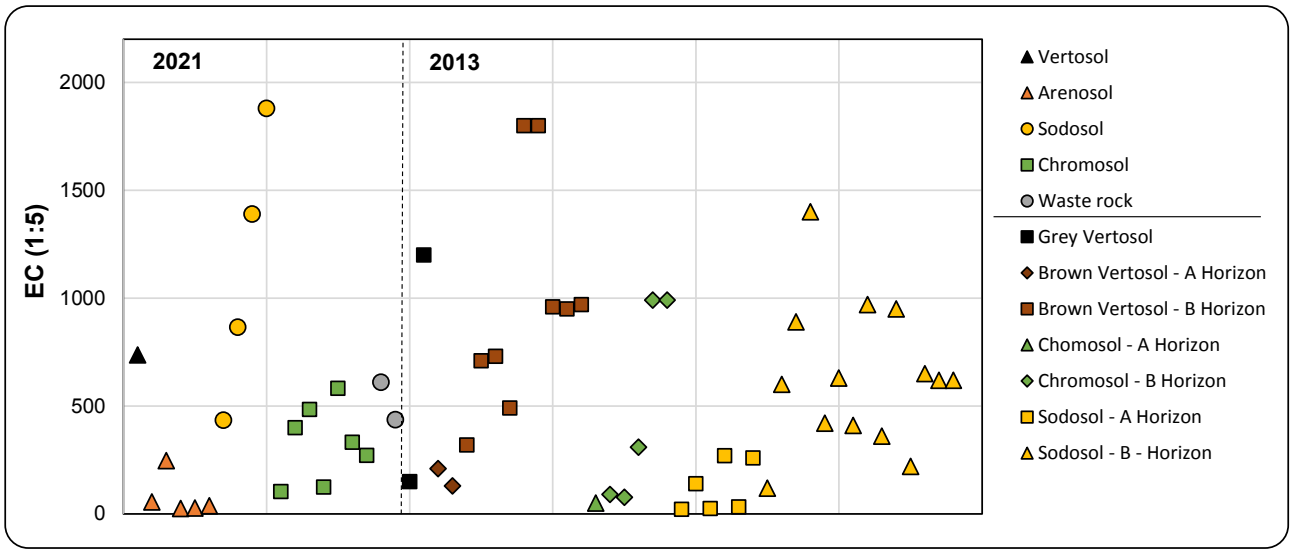

Figure 4-14: Electrical conductivity for test pit and stockpile soil composites

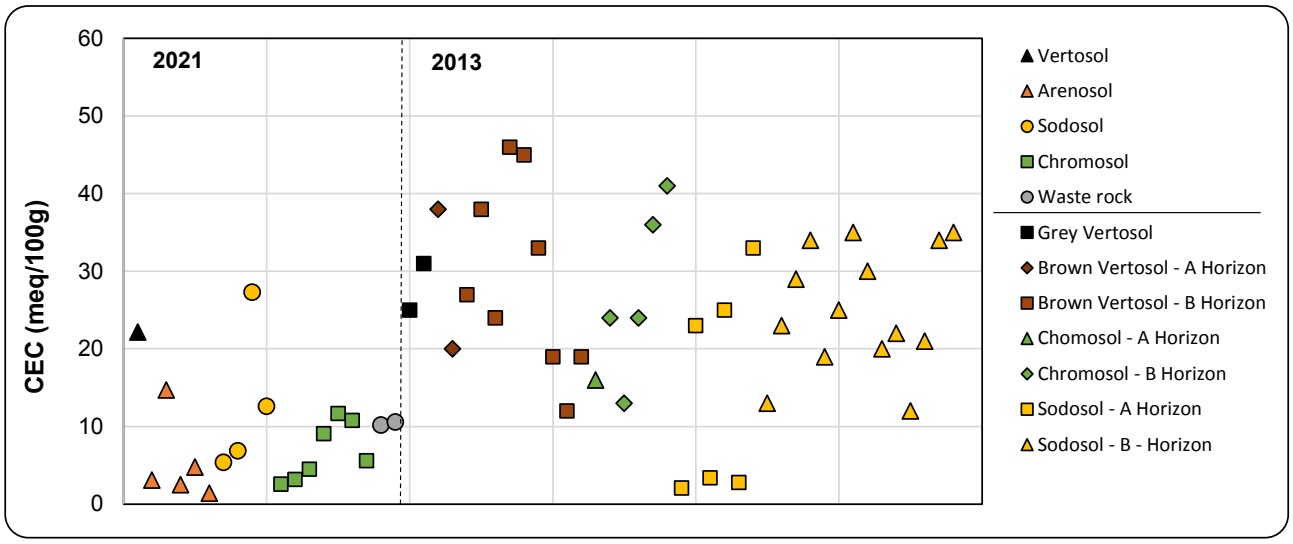

Figure 4-15: Cation exchange capacity test pit and stockpile soil composites

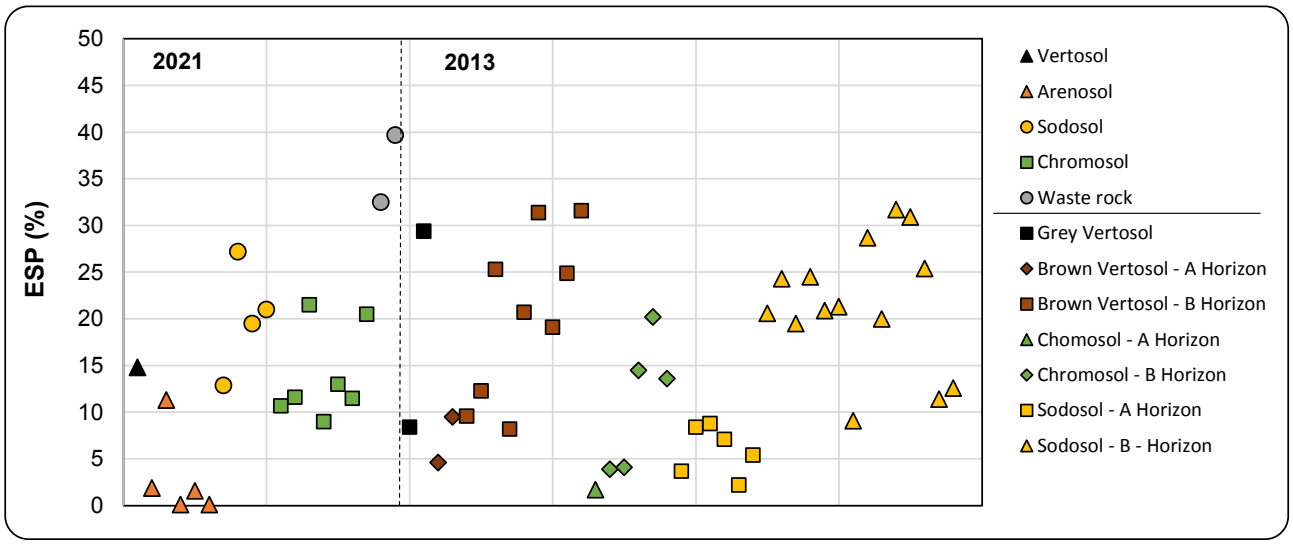

Figure 4-16: Exchangeable sodium percentage for test pit and stockpile soil composites

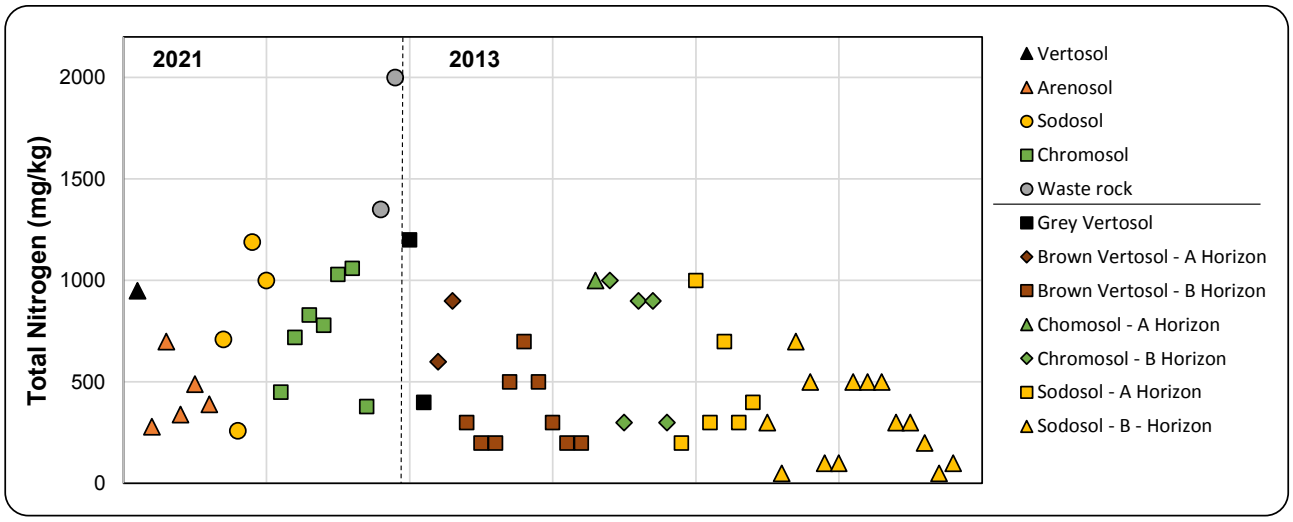

Figure 4-17: Total Nitrogen for test pit and stockpile soil composites

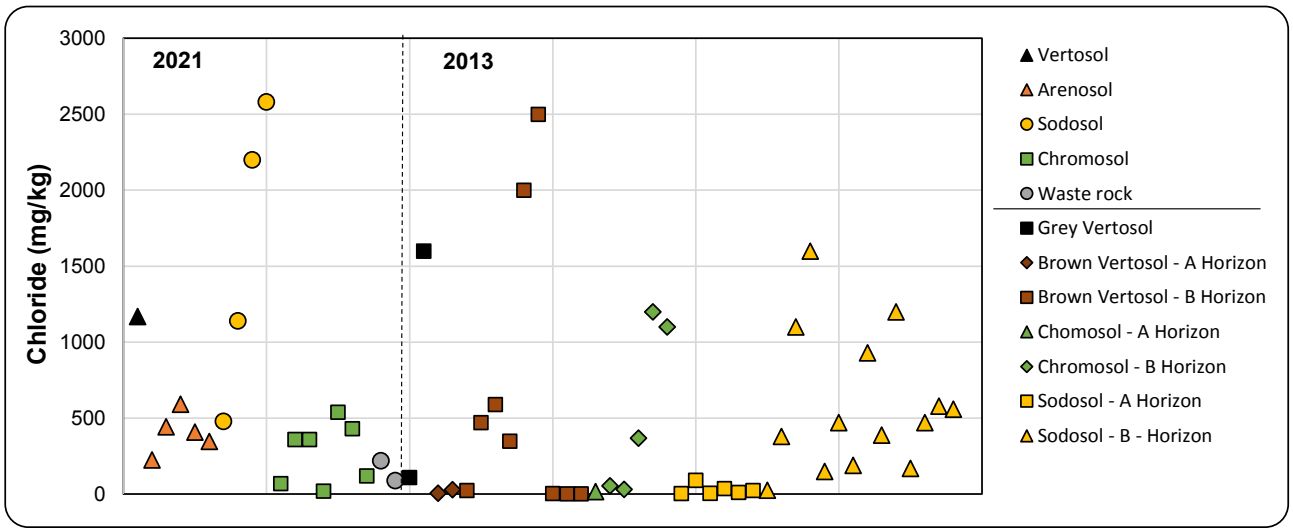

Figure 4-18: Chloride for test pit and stockpile soil composites

4.4.5 Soil class classification

The likelihood of whether dispersion occurs in soil can be predicted from the relationship between ESP and EC and was derived by Rengasamy et. al (1984). Soils at Foxleigh (n=52) are mostly Class 2B (n=35) which are potentially dispersive. Waste rock (anthroposols), as well as some chromosols and sodosols (n=7) were classified as Class 1 (dispersive). A small number of soils (n=10) including most arenosols were Class 2A soils, which have few structural problems (**Figure 4-19**).

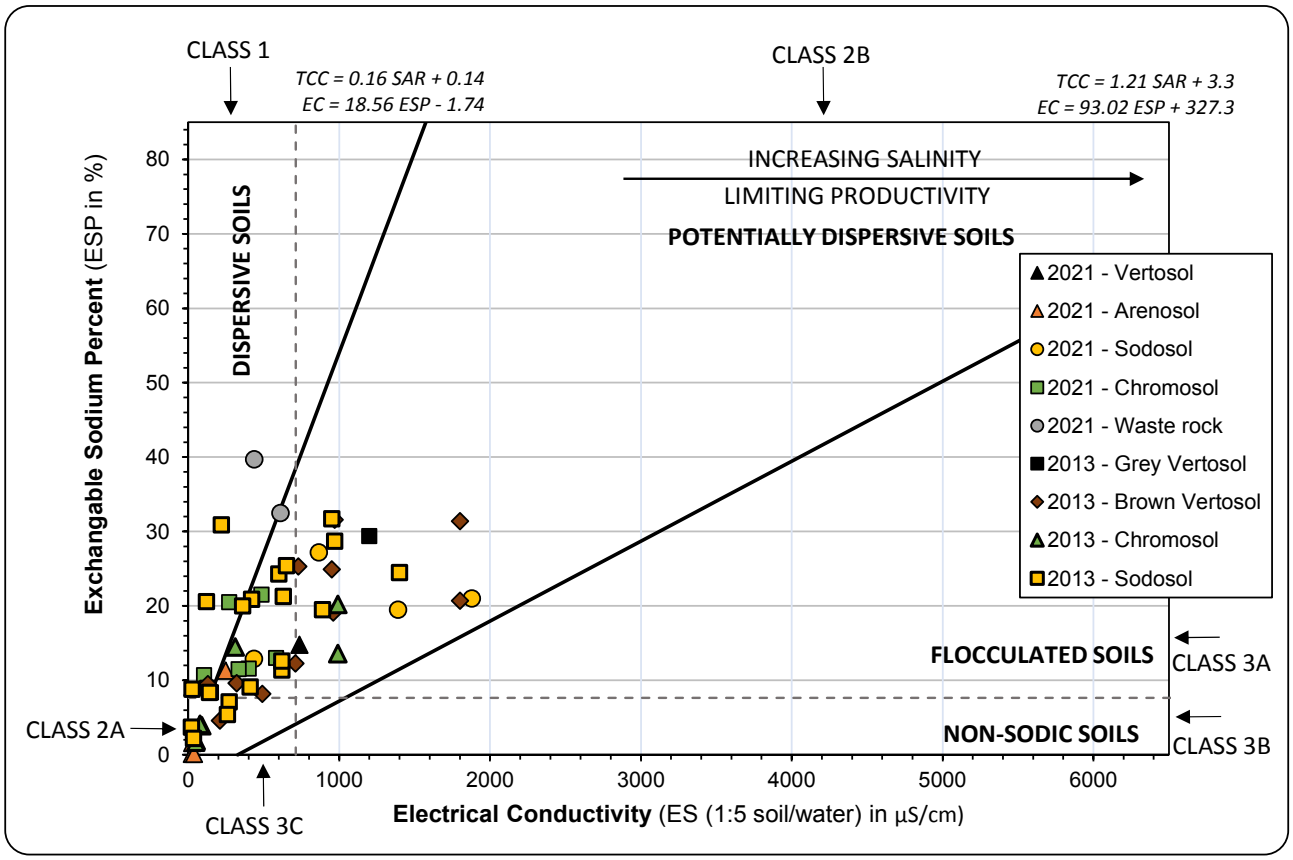

Figure 4-19: Soil classifications of 2021 test pits and stockpiles and 2013 soil survey

4.4.6 Soil physical results

A brief summary of the physical results is provided in following points:

- Emerson Class is a physical test that can be used to predict sodicity. Soil composite samples (n=32) ranged from Class 3 (n=10) that are unlikely to be sodic; Class 2 (n=14) that are likely to be sodic; and Class 1 (n=8) that are almost certainly sodic. Waste rocks (anthroposols) and vertosols are unstable Class 1 soils that have dispersive characteristics. Chromosols and sodosols are generally Class 2 which are potentially dispersive, although some subsoils are Class 1 and some chromosol topsoils are Class 3. Arenosols are generally stable Class 3 soils and have the lowest dispersion risk.
- Particle density for the soil composites (n=19) ranges from 2.36 to 2.61 t/m^3 (median 2.49 t/m^3). This value is the density of solid particles that collectively make up a soil sample and provides information about the amount void space between particles. Arenosols had the highest particle density, and vertosols had the lowest.
- Particle size distribution (PSD) is a measure of the proportions of clay, silt, sand, and gravel in a soil sample and is used to develop information about soil texture. In general, a soil with a high proportion of clay will hold moisture, while a sandy soil will be more free draining. **Figure 4-20** shows that the test pit vertosol is comprised of predominantly clay-sized particles, while the waste rocks are mainly sand and gravel. Chromosols and sodosols are mostly silt, but topsoils are generally finer than subsoils.

- The PSD of the topsoil stockpiles are shown in **Figure 4-21**. Sodosols are richer in clay compared to chromosols and arenosols. Chromosols have a balance of clay, silt, and sand. Arenosols are very low in clay but have a high proportion of sand-sized particles.
- The proportions of clay, silt, and sand for the soil composites (n=19) have been plotted in a soil texture triangle in **Figure 4-22**. Sodosols classify as silty clays or clay loams; chromosols are loams or sandy clay loams; and arenosols are generally sandy loams or loamy sands.

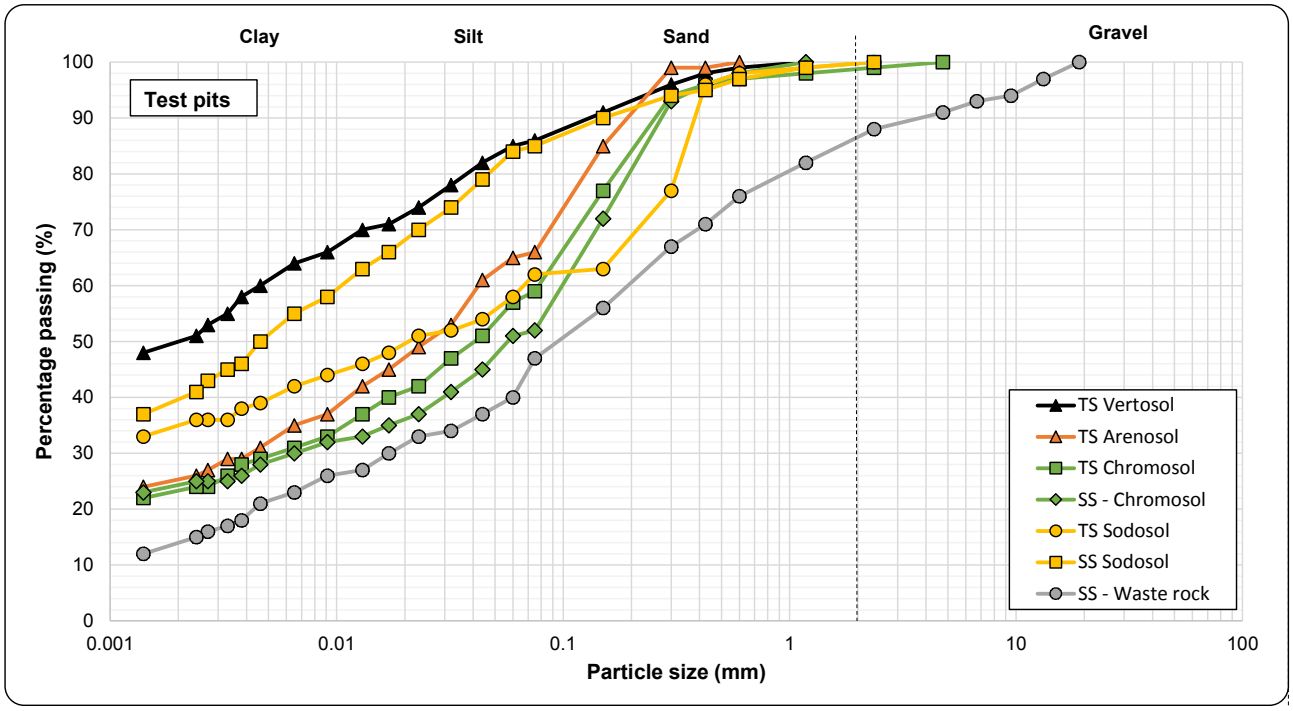

Figure 4-20: Particle size distribution of test pit soil samples

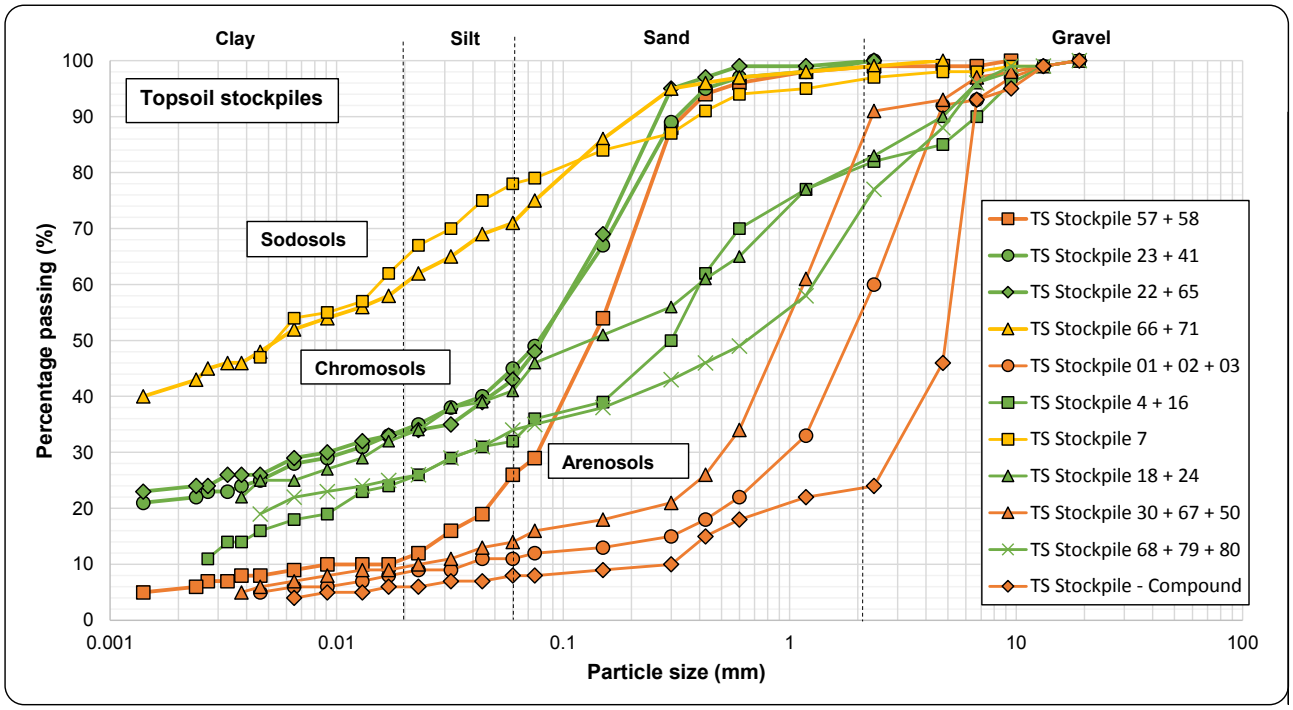

Figure 4-21: Particle size distribution of topsoil stockpile samples

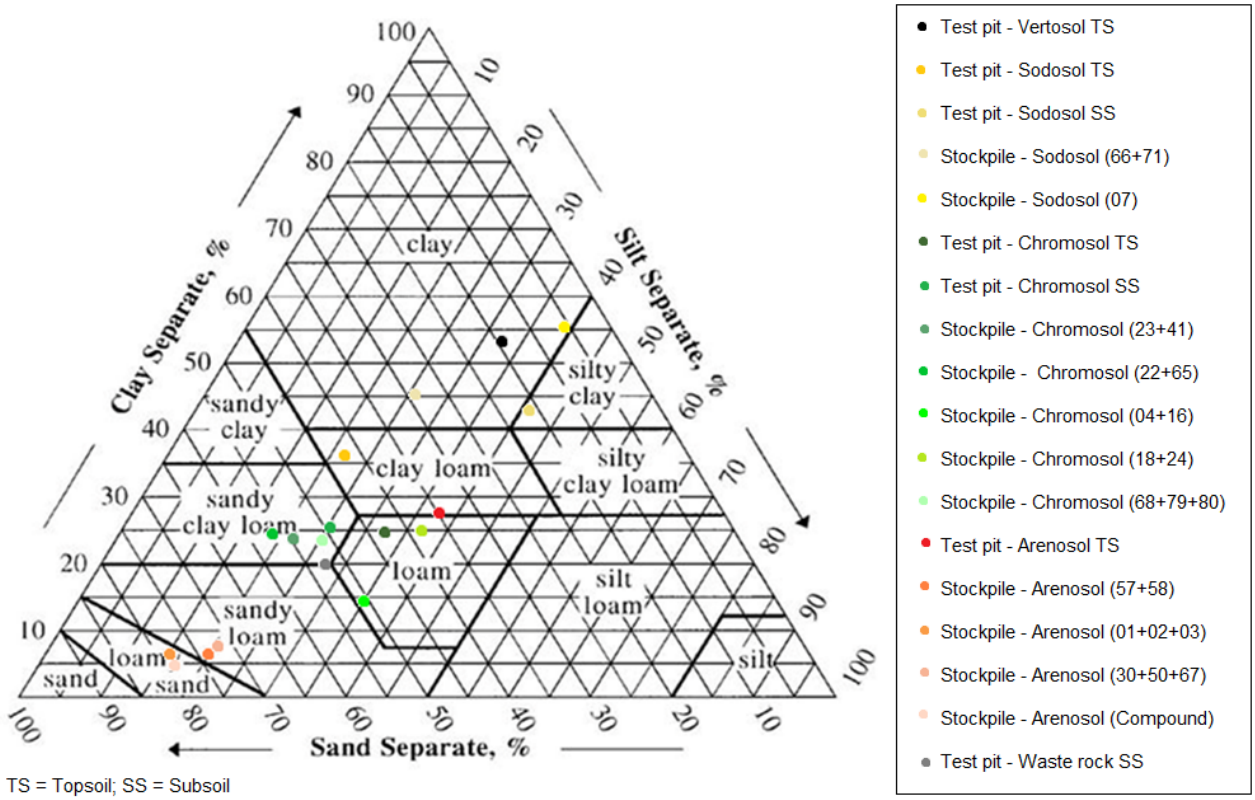

Figure 4-22: Soil texture triangle

4.5 Water quality static tests

There are no specific regulatory criteria for metal/metalloid concentrations in leachate from mining waste materials on mine sites in Queensland. As such, RGS has compared the multi-element results in water extracts from the 12 composite samples from the Project, described in **Section 4.2**, with Australian guidelines for livestock drinking water and aquatic freshwater ecosystems guideline values (ANZECC & ARMCANZ, 2000; superseded by 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 also be recognised that direct comparison of geochemical data with guideline values can be misleading. For the purpose of this study, guideline values are only provided for broad context and should not be interpreted as arbitrary "maximum" values or "trigger" values. 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. Therefore, the results of screening tests on water extract solutions are assumed to represent an assumed 'worst case' scenario for initial surface runoff and seepage from mining waste materials.

The results from multi-element testing of water extracts (1:5 solid:water) from the 12 composite samples are presented in **Table B4** (**Attachment B**). The pH of the water extracts for the composite samples ranges from pH 7.8 to 9.6 and is considered to be slightly alkaline for all but the (shallow weathered) mixed overburden sample. In all cases it is expected that some alkalinity will be added to contact water from these materials as the deionised water used in the tests was pH 5.4. The pH results for 8 of the 12 composite samples are slightly greater than the recommended range (pH 6 to 9) for 95 % species protection in freshwater aquatic ecosystems set out in ANZG (2018).

The water extracts from the 12 composite samples have moderate EC values ranging from 417 to 2,230 µS/cm, indicating a range of concentrations of dissolved solids and salinity. While there are no firm

trends within this limited dataset, the roof samples and tailings samples tend to have higher EC values than the floor and coarse reject samples, respectively.

The total alkalinity in the water extracts from the 12 composite samples ranges from moderate to elevated (442 to 4,480 mg $CaCO_3$/L) and is mainly present in the bicarbonate form. The acidity in the water extracts from the waste rock samples is generally low, ranging from less than 0.2 to 19 mg $CaCO_3$/L, leading to a positive net alkalinity value for all samples.

The total concentration of major ions in the water extracts is dominated by bicarbonate, sodium, chloride and to a lesser extent, sulfate. The concentration of sulfate in the water extracts from the 12 composite samples ranges from 28 to 316 mg/L (median 29 mg/L), and is below the applied (ANZG, 2018) water quality guideline criterion (1,000 mg/L) for livestock drinking water for this anion.

The concentration of trace metals/metalloids tested in the water extracts from the 12 composite samples is typically low and predominantly below the laboratory LoR. Most metal/metalloid concentrations tested in the water extracts are below the applied water quality guideline criteria. The main exceptions are aluminium (8 samples), arsenic (8 samples) and selenium (6 samples), which have concentrations in some of the water extracts above the applied freshwater aquatic ecosystem water quality guideline value for 95 % species protection but are below the applied guideline values for livestock drinking water (ANZG, 2018). The only exceptions are four composite samples which have a slightly elevated selenium concentration; and one composite sample, which has slightly elevated molybdenum concentration compared to the livestock drinking water guideline values for these elements (0.02 and 0.15 mg/L, respectively). None of the dissolved metal/metalloid concentrations were elevated compared to applied water quality guideline values in the water extracts from tailing, coarse reject and coal materials.

Given that the pH values in the relevant water extracts are slightly alkaline, the slightly elevated dissolved metal/metalloid concentrations in these water extracts could be accurate. However, the concentrations may also be in part due to the formation of colloidal materials in the water extracts, which can pass through the (0.45 µm filter) filtration stage used in the standard laboratory preparation procedure. This can occur due to the physical preparation of the sample at the laboratory to pass a 75 µm particle size.

On the basis of these results, it is expected that the risk of potential impact on the quality of surface runoff and groundwater from bulk mining materials represented by the samples tested will be low. The dynamic quality of contact water (if these materials are left exposed to atmospheric i.e., oxidising conditions) and any potential risk to water resources at the site is investigated further using KLC tests as described in **Section 4.6.**

4.6 Water quality kinetic tests

As described in **Section 3.2.2, Table 3-6** and **Attachment A**, a KLC test program was completed for seven representative composite samples of overburden, interburden, roof, floor, tailing, coarse reject and coal material for a period of six months under a monthly watering and leaching regime. The seven KLC tests cover the range of material types likely to be generated by the Project. The KLC test program has been completed using methodology that aligns with relevant mining industry guidelines for such tests (AMIRA, 2002; COA, 2016c).

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 relatively high surface area for potential geochemical reaction. The ratio of sample to water in the KLC tests was generally between 2:1 and 4:1 (w/v) (i.e., concentrated), whereas the ratio of sample to water generally used in tests where results can (arbitrarily) be compared against guideline concentrations to provide relevant context is two orders of magnitude more dilute at 1:5 (w/v). Whilst arbitrary comparisons against guideline concentrations can be helpful in some situations to provide relevant context, such comparisons cannot be directly extrapolated to the field situation at the Project.

The monthly test results for the composite KLC test samples available to date are shown in **Attachment C**. Tables **KLC1** to **KLC7** provide the test data for initial KLC leaching event. The KLC test results indicate that:

- Leachate from the KLC tests has a pH in the range of 3.79 to 8.23 and is typically pH neutral to slightly alkaline. It should be noted that the pH of the deionised water used in the KLC tests has a pH value

ranging from 6.27 to 7.64. Apart from KLC6 (coarse reject) and to a lesser extent KLC7 (coal), the pH of the collected KLC leachate is similar to or greater than the pH of the deionised water used in the KLC tests. These results indicate that pH values in contact water from most materials over time are likely to be located in the pH neutral to slightly alkaline range. The exception is the contact water from the coarse reject materials, which has the potential to become acidic over time if left unmanaged.

- Leachate from the KLC tests has an EC value in the range of 179 to 2,870 µS/cm. The EC values are generally low to moderate and are highest in leachate from the coal reject KLC test (KLC6). Given that the ratio of sample to water in the KLC tests is concentrated (i.e., generally between 2:1 or 4:1 (w/v)) these results indicate that EC values from most bulk mining waste materials exposed to oxidising conditions will be in the low to moderate range but should be monitored as a precaution to avoid any saline drainage issues.
- The acidity value in initial leachate from the KLC tests is generally low (≤10 mg/L, as $CaCO_3$). The exception is coarse reject (KLC 6) which has acidity that ranges from 3 to 151 mg/L (median 66 mg/L). In general, the alkalinity values in leachate from most of the KLC tests are elevated, and more than sufficient to create positive net alkalinity values (i.e., the alkalinity is greater than the acidity). The main exception is the course reject material (KLC6) and to a lesser extent the coal feed reserve material (KLC7).
- The concentration of major ions in leachate from the KLC tests is typically dominated by variable concentrations of sodium, chloride and sulfate. Lower concentrations of other major ions (e.g., calcium, magnesium and potassium) are also present in leachate from these materials.
- The sulfate concentration in leachate from the KLC tests ranges from 16 to 1,160 mg/L (median 216 mg/L) and is generally less than the applied livestock drinking water quality guideline value of 1,000 mg/L (ANZG, 2018). The exception is the coarse reject sample (KLC6) which has a sulfate concentration in leachate that can marginally exceed this guideline value.
- The concentration of trace metals/metalloids in the leachate from the KLC test materials is generally low and typically below the laboratory LoR. Most trace metals/metalloids are therefore sparingly soluble at the neutral to slightly alkaline pH of the KLC leachate. The concentrations of most metals/metalloids in KLC leachate are typically below the applied water quality guideline criteria for livestock drinking water (AZNG, 2018). The main exceptions are molybdenum and selenium in leachate from roof (KLC3) and floor (KLC4) materials. In addition the acidic course reject leachate from KLC6 contains elevated concentrations of aluminium, iron, manganese, nickel and zinc compared to background concentrations. Overall, the results indicate that dissolved metal/metalloid concentrations in leachate from managed bulk mine waste materials will be relatively low.

Potential implications of these results with respect to the management of the overburden, interburden, potential coal reject, coal reject and coal materials at the Project are discussed further in **Section 5**.

5 Discussion

5.1 AMD/NMD potential and management

The results of the static and kinetic geochemical test program demonstrate that the overwhelming majority of the overburden and interburden materials have low oxidisable (sulfide) sulfur content, excess ANC, and are classified as NAF. These samples represent materials with a very low risk of acid generation and a high factor of safety with respect to generating AMD and NMD. These results align well with the results of previous investigations at the Project (RGS, 2012). Therefore, no specific management measures are required for overburden and interburden materials to manage the risk of AMD and NMD.

A portion of the potential coal reject (roof, parting and floor) materials may have an elevated sulfide concentration compared to median crustal abundance in unmineralised soils. However, overall, bulk potential coal reject materials will have excess ANC and be classified as NAF. Given the small amount of the potential coal reject materials compared to bulk overburden and interburden materials, the risk of any significant generation of AMD and NMD is low. Notwithstanding, potential coal reject materials should not report to the outer surfaces of final landforms.

Coal reject (coarse reject and tailing) materials may also have an elevated sulfide concentration compared to median crustal abundance in unmineralised soils. Based on the currently available sample data set, tailing materials are classified as NAF and a portion of the coarse reject materials are classified as PAF. As a bulk material, it is expected that coarse reject materials may have a low capacity to generate acidity. However, given the small amount of the coarse reject materials compared to bulk overburden and interburden materials, the risk of any significant generation of AMD and NMD is low. Notwithstanding, coarse materials should not report to the outer surfaces of final landforms. It is worth noting that at the nearby Middlemount Coal Mine, where mining occurs within similar strata and coal seams, both coarse reject and tailing materials are managed by placement within bulk spoil (overburden and interburden) materials well away from final landform surfaces (RGS, 2013).

Coal materials have similar geochemical characteristics to tailing materials, are classified as NAF, and are also unlikely to be a significant source of AMD and NMD.

Based on the water extract and KLC test results presented in **Section 4.5** and **Section 4.6,** apart from slightly elevated sulfate, it is expected that the quality of leachate from any coal reject materials co-disposed with spoil materials would be similar to leachate at areas where co-disposal was not used.

From a geochemistry viewpoint, co-disposal of coarse reject and tailing materials in-pit would be beneficial. This is because coal reject materials typically remain moist and any oxidation will only occur at surface (i.e., the fine reject will fill the gaps between the coarse reject particles and generally limit oxygen ingress). The coarse reject also would also provide some geotechnical stability to the mixed reject material assisting in a future covering and rehabilitation process. The in-pit disposal of mixed coarse and tailing materials within general spoil is also a low risk strategy as the much larger volume of spoil typically has negligible oxidisable sulfur content and excess ANC. This mining waste management strategy is currently used at a number of coal mines in the Bowen Basin.

5.2 Multi-element composition and enrichment

The multi-element concentrations of overburden, interburden, potential coal reject, coal reject and coal samples are presented in **Section 4.2**, along with a comparison against applied guideline values and median crustal abundance in unmineralised soils. The results indicate that these materials represented by these samples are not significantly enriched with metals/metalloids compared to applied guideline values and median crustal abundance in unmineralised soils. As such, these materials are not expected to present environmental issues associated with metal/metalloid concentrations for revegetation and rehabilitation.

5.3 Water quality

The static and kinetic geochemical test results presented in this report indicate that the surface runoff and seepage from NAF mining waste materials are likely to be slightly alkaline to alkaline in pH and have low salinity values. However, roof, floor, tailing, coal reject and coal may have low to moderate EC values indicating

low to moderate salinity levels (and moderate concentrations of dissolved solids such as sodium, chloride, and sulfate). Surface runoff and seepage from bulk mining waste materials is likely to pH neutral to slightly alkaline and towards the upper end of the range (pH 6 to 9) recommended for 95 % species protection in freshwater aquatic ecosystems as set out in Australian Water Quality Guidelines (ANZG, 2018).

The major ion concentrations in leachate from mining waste materials are relatively low and dominated by sodium, chloride, sulfate and bicarbonate. Lower concentrations of other major ions are also likely to be present in leachate from the materials. The sulfate concentration in leachate from most mining waste samples is well below the applied ANZG (2018) livestock water quality guideline criterion (1,000 mg/L) but may be slightly elevated over time in leachate from coarse reject materials if exposed to oxidising conditions.

Static and kinetic test results suggest that the only dissolved metal/metalloid concentrations that may be elevated compared to the applied livestock drinking water guideline values are molybdenum and selenium in roof and floor materials (ANZG, 2018). If coarse reject material are left exposed to oxidising conditions and become acidic, some acid soluble metals may become more mobile in contact water.

It is therefore expected that the potential risk to the quality of surface water and groundwater resources from surface water and groundwater in contact with mining waste materials at the Project will be relatively low.

5.4 Revegetation and Rehabilitation

5.4.1 General land rehabilitation

During the mining process, topsoil is usually stripped from the regolith so that it can later be replaced as a cover over disturbed areas and initiate the land rehabilitation process. There are generally three controlling factors that determine whether rehabilitation is successful or otherwise. These are:

1. The geomorphology (shape and slope) of the final landform on which the cover is placed;
2. The texture (particle size) of the topsoil cover materials; and
3. The geochemistry of the topsoil and underlying spoil material.

If the geochemistry of the topsoil is too acidic, alkaline, saline, or has elevated metal concentrations, rehabilitation outcomes may be affected. Another common issue is the geochemistry of the spoil materials directly underneath the topsoil. The thickness of the topsoil must be sufficient to protect plants from underlying spoil material, or there may be limited deep root penetration, and larger vegetation, such as trees, may be unable to grow. A thin topsoil cover will generally only provide a suitable growth medium for sparse grasses that are tolerant to a wide range of conditions.

Dispersion and erosion can be a significant hindrance to rehabilitation objectives. A good coverage of vegetation serves to stabilise the soil as plant roots trap moisture and prevent fine particles from being washed away. Before such a vegetative cover can be established, the rate of erosion will be determined by both the texture of the soil and the angle at which the soil is placed i.e., the slope of the landform. Although fine soil particles are better for providing plant nutrients and storing moisture, on a slope they are very unstable when wet compared to larger rocks and cobbles. A heavy rainfall event creates surface water runoff that can wash away fine soil particles if there are limited engineering controls in place, such as drainage channels.

5.4.2 Project mining waste materials

From a soil chemistry viewpoint, bulk mining waste materials at the Project are classified as NAF and are likely to be pH neutral to alkaline and have low to moderate levels of salinity. Most mining waste materials are sodic and may be susceptible to dispersion and erosion, although these material characteristics may be improved to some extent by the addition of gypsum. In addition, fertiliser, organic matter and seeded topsoil should be considered for mining waste materials at the surface of final landforms for the purpose of providing a reasonable growth medium for revegetation and rehabilitation.

If a source of rock mulch (armouring) materials is available, this could also be used on top of the topsoil to help to stabilise revegetated surface slopes at final landforms. However, rock mulch would only be required on specific final landform areas where slopes are greater than 15 %.

The rock mulch should generally only be a nominal 10 to 20 cm depth and be ripped into the topsoil layer along the contour following placement. This approach encourages seed germination and sustainable growth along with self-healing and limits surface water runoff down surface slopes thereby discouraging topsoil erosion.

The optimum rehabilitation strategy should be based on successful strategies used at the Project, nearby mines dealing with sodic materials, and/or based on rehabilitation field trials.

Additional confirmatory sampling and testing of the field trials should be completed on bulk mining waste materials at the Project to optimise the progressive rehabilitation of these materials during operations and at mine closure. Sampling should focus on collecting representative samples of any spoil materials planned to be used at the surface of final landforms to supplement any existing subsoil and topsoil salvaged and re-used in revegetation and rehabilitation activities. Testing should include typical soil parameters including pH, EC, exchangeable cations, organic matter, total organic carbon, Emerson Aggregate, particle size distribution, and nutrients (including available K, P, S, as well as Nitrogen (N) species (TKN, TN, Nitrite and Nitrate).

5.4.3 Project soils and existing rehabilitation

The fundamental factors controlling the success or otherwise of rehabilitation described in **Section 5.4.1** appear to influence the success of rehabilitation at the Project. Some areas have been successfully rehabilitated whereas other areas have generated mixed results.

For example, at poorly rehabilitated final landform slopes near Test Pit 8 (**Figure 5-1**) (left hand picture), a thin layer (5-10 cm) of dispersive soil (sodosol) (pH (7.91, EC 1,832 µS/cm) covers a historical spoil dump. The deeper materials excavated at Test Pit 8 and are generally highly alkaline (pH 9.3 to 10), have low to moderate salinity (EC 370 to 872 µS/cm) and are sodic (ESP 32.5 to 39.7%). It is assumed that the soil cover was thicker when it was originally placed (e.g., 15-20 cm) but has partially washed away as the eroded water channels from surface runoff are clearly visible. A contributing factor is the steeper slopes of the hill, which has increased the water velocity, and without any plants or rocks to stabilise the soil, a loss of soil thickness due to erosion is inevitable.

Figure 5-1: Poorly rehabilitated hillslopes from historical mining

The right hand picture in **Figure 5-1** (situated adjacent on the opposite side of the road) appears to be a similar spoil with no soil cover. The top few centimetres of spoil have weathered into finer particles, providing a rudimentary soil material that resembles the geochemistry of the parent rocks. This gravelly soil is alkaline (pH 10.2 with relatively low salinity (EC 259 µS/cm). In comparison to the slope in the left hand picture, there is a sparse covering of specially adapted vegetation despite the strong alkalinity of the spoil. Plants have been able to colonise the hill because it has a gentler slope, allowing roots to establish in the more stable islands between the water channels, as the surface runoff has less velocity in these zones.

To achieve a more successful rehabilitation outcome for these spoil slopes, it is recommended that the three factors controlling rehabilitation success described in **Section 5.4.1** be addressed and evaluated.

The geochemistry of the soil or spoil materials could be changed by covering with less sodic material, for example. The properties of sodic or dispersive materials are also often improved by adding gypsum ($CaSO_4$),

which displaces some of the sodium ions for calcium ions on the surface of soil particles, creating a better soil structure that allows sodium ions to leach out. Addition of fertiliser and organic materials may also provide an improved rehabilitation outcome. The quantities of spoil material on final landform slopes requiring some form of amelioration should be evaluated for rehabilitation planning purposes. At Foxleigh, most spoil materials are expected to be sodic and therefore this will impact rehabilitation costs allowed for final landform outer slopes.

Another method of improving rehabilitation outcomes in more steeply sloping outer batters of final landforms at the Project (> 15 %) could be to place a nominal 20 cm topsoil cover on the surface of the spoil dumps, and then rip the soil on the contour with a nominal thickness of rocky mulch (particle sizes approximately 10-20 cm). This rocky mulch material does not need to be a thick cover, instead it can be interspersed sparingly through the topsoil to provide stability and texture. The variation in soil texture provides pockets of shelter where seeds can germinate, and over time, the slope will be self-healing as the rock mulch weathers into a more a soil-like material. It may be possible to source the rocky mulch from materials on site, provided their geochemical properties have been characterised and they are amenable for use in this purpose.

Alternatively, in some circumstances, it may be possible to re-grade and lower the slope of the final landform batters to reduce dispersion and erosion. Changing the slope angle of a spoil dump may not be practical or economic but could be a viable option where sufficient land area is available. If the angle of the outer batters could be reduced, the environment for vegetation establishment and sustainability is more favourable. Slopes of 20 % or more will generally be barren, whereas slopes of 10% or less will usually rehabilitate quite readily (RGS, 2012; LRS, 2010). Ideally, Foxleigh should aim for outer batter slopes of 15 % or less at final landforms, where practical. The reshaping of spoil dumps also provides an opportunity to install water drainage infrastructure. Drainage channels should be lined with NAF, non-sodic, competent rock material that is resistant to weathering. As it is unlikely that these materials will be readily available on site and may need to be sourced from elsewhere, for example, from the nearby basalt quarry.

The test pit soil sampling program has verified that all of the soil types present at Foxleigh are capable of supporting native vegetation. There is, however, a wide variance in soil fertility and moisture retention. Where possible, the following general hierarchy for sourcing topsoil covers should be followed:

Vertosols > Arenosols > Chromosols > Sodosols

Topsoil covers on steeper slopes of outer batters at final landforms should be a nominal thickness of 20 cm, provided they are mixed and contour ripped with rocky mulch. For soils with less favourable fertility characteristics, a thicker cover may be required as determined in rehabilitation field trials.

It should be noted that Emerson Class 1 and 2 soils present at Foxleigh may be subject to dispersion. These characteristics can be seen in the heavily eroded soil profile visible near Far South Pit (**Figure 5-2**). These soils can support vegetation, but they are geotechnically unstable. The addition of nominal (10 to 20 cm) rocky soil mulch ripped on the contour on slopes greater than 15 % may provide an economically viable way to improve the soil structure for these materials although this should be the subject of rehabilitation field trials. All soil materials are otherwise expected to be suitable for use in rehabilitation.

Figure 5-2: Eroded soils near Far South Pit (non-rehabilitated)

5.5 Management Measures

Table 5-1 provides a summary how the mining waste, coal reject and coal materials will be managed through all stages of the mine life including operations, rehabilitation and decommissioning.

Table 5-1: Material management over mine life

Project Phase	Overburden and Interburden	Potential Coal Reject and Coal Reject	Coal
Operations	Stored out-of-pit spoil dumps and/or backfilled in-pit.	Co-disposed within larger volumes of spoil at spoil dumps or in-pit. Contact water monitored for quality and managed in the mine water management system as part of Water Management Plan	Temporarily stockpiled at ROM. Contact water monitored for quality and managed in the mine water management system as part of Water Management Plan
Rehabilitation	Final landforms rehabilitated/ revegetated and performance monitored for success	Final landforms rehabilitated/ revegetated and performance monitored for success	ROM removed and footprint rehabilitated/revegetated
Decommissioning	Final landform performance monitoring moving towards lease relinquishment	Final landform performance monitoring moving towards lease relinquishment	None

6 Conclusions and recommendations

6.1 Conclusions

RGS has completed a geochemistry assessment of representative samples of mining waste (overburden, interburden, potential coal rejects and coal rejects), coal and soil materials at the Project. The main findings of the assessment are as follows:

- The overwhelming majority of the overburden and interburden materials have low oxidisable (sulfide) sulfur content, excess ANC, and are classified as NAF. These materials have negligible risk of acid generation and a high factor of safety with respect to potential for generation of AMD and/or NMD.
- Potential coal reject and coal reject materials can have higher sulfide content but only some of the coarse reject material is expected to have any significant capacity to generate acidity. As bulk mixed materials with overburden/interburden spoil, it is expected that these materials will be classified as NAF and have a relatively low risk of generating AMD and/or NMD
- Coal is likely to have similar geochemical characteristics to potential coal reject and coal reject materials and will be temporarily stockpiled at the ROM area prior to transport for sale off-site. As is standard practice at coal mining operations in the Bowen Basin, any surface runoff and seepage from the temporary ROM coal stockpile will be monitored for quality and managed in the mine water management system as part of the Water Management Plan.
- Initial and ongoing surface runoff and seepage from bulk mining waste and coal reject materials is expected to be pH neutral to alkaline and have a low to moderate level of salinity.
- There is no significant metal/metalloid enrichment in mining waste and coal materials compared to applied guideline values and median crustal abundance in un-mineralised soils.
- Most metals/metalloids are sparingly soluble at the neutral to alkaline pH of leachate expected from bulk NAF mining waste and coal materials. Dissolved metal/metalloid concentrations in surface runoff and leachate from bulk NAF mining waste materials are generally expected to be low and unlikely to pose a significant risk to the quality of surface and groundwater resources at relevant storage facilities.
- NAF overburden and interburden materials should be amenable to revegetation as part of rehabilitation activities although addition of gypsum, fertiliser and organic matter, and/or addition of a nominal 20 cm topsoil layer and 10 to 20 cm rock mulch (armouring) layer ripped on the contour may need to be considered for sodic materials on outer batters of final landforms (with slopes greater than 15 %) to limit dispersion and erosion and to provide a reasonable growth medium for sustainable revegetation and rehabilitation.

6.2 Recommendations

As a result of the geochemical assessment work completed on mining waste, coal and soil materials at the Project, several recommendations are provided to minimise the risk of any significant environmental harm to the immediate and downstream environment:

- A supplementary geochemical and physical testing program for the Project should be completed on representative samples of existing drill core materials currently stored at RGS.
- Confirmatory sampling, testing and rehabilitation field trials should be completed on Project materials to confirm the most appropriate management methodology for progressive rehabilitation of these materials during mine operations and at mine closure.
- Consideration should be given to the merits of adding addition of gypsum, fertiliser and organic matter to poorly performing rehabilitation on final batters of final landforms. The most appropriate application rates for gypsum, fertiliser and organic matter should be determined as part of rehabilitation field trials. Where practical, regrading and reducing the slopes of these batters and/or adding a nominal 10-20 cm rock mulch (armouring) layer contour ripped into a nominal 20 cm topsoil layer on slopes greater than 15 % should also be considered in specific areas where warranted, to enhance rehabilitation outcomes in these areas.

- Surface water and seepage from the open pit, ROM coal and mining waste storage areas should be monitored to ensure that key water quality parameters remain within appropriate criteria. Whilst significantly elevated metal/metalloid concentrations in contact water are not expected at the Project, it is recommended that the suite of metals/metalloids described in the static and KLC test in this report be included from time to time, where appropriate, in the site water quality monitoring program.

6.3 Forward works

RGS recommends design of an additional geochemical and physical sampling and testing program for the Project to supplement the existing geochemical assessment program currently being completed for mining waste, coal and soil at the Project described in **Section 3.3** of this report.

The focus of the supplementary geochemical and physical sampling and testing program would be overburden and interburden sample materials that could be used as near-surface materials in final landforms. The additional test program would be completed on remnant samples from existing drill core materials utilised in the current RGS test program.

RGS could also assist with confirmatory sampling, testing and rehabilitation field trials for Project materials to confirm the most appropriate and sustainable management methodology for progressive rehabilitation of these materials during mine operations and at mine closure.

The results from the additional geochemical and physical sampling and testing program and confirmatory sampling, testing and rehabilitation field trials could be used to further verify the ongoing geochemical and physical characteristics of the Project materials and increase confidence in the likely success of planned rehabilitation activities during operations and moving towards closure.

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8 Attachments

Attachment A: Geochemical Assessment Methodology for Mining Waste Materials

Geochemical Assessment of Mining Waste 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 (S) 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 S 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:

$$FeS_2 + 15/4\ O_2 + 7/2\ H_2O \rightarrow Fe(OH)_3 + 2\ H_2SO_4$$

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

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 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 is based on the assumption 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 through 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 that have resulted 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 (e.g. 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.

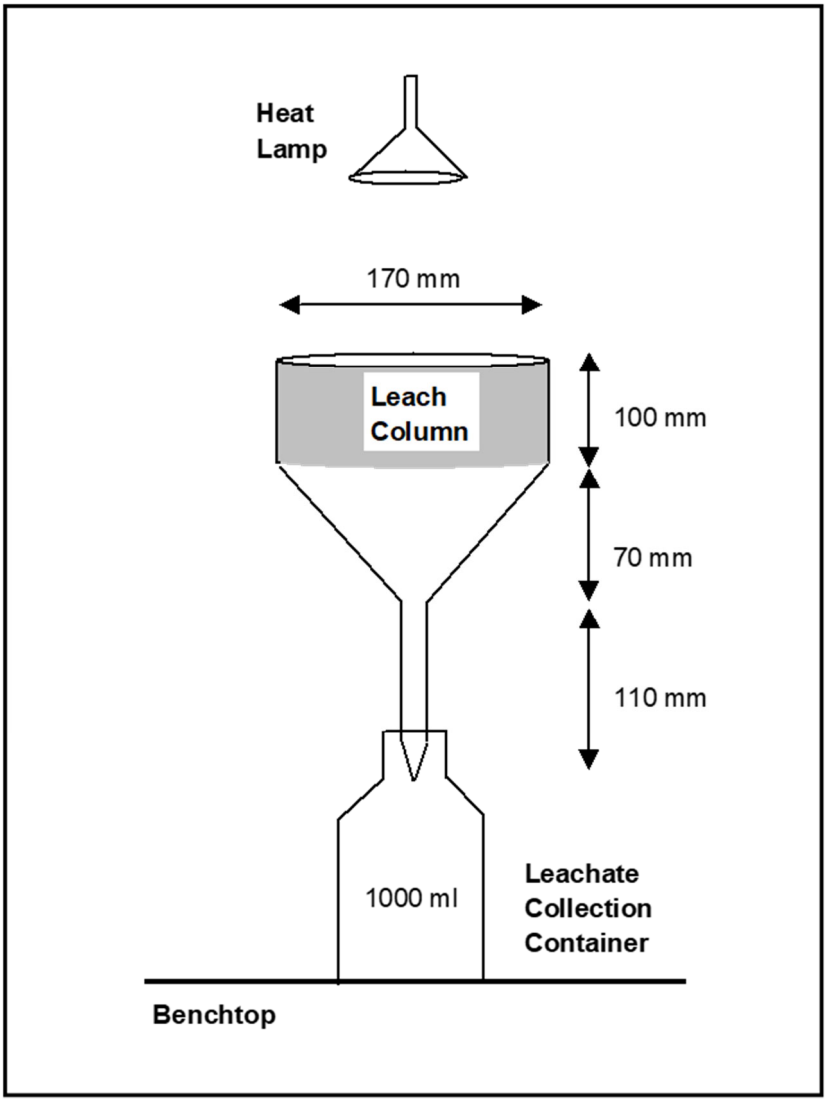
Figure A1 shows the kinetic leach column set up used by RGS adapted from *AMIRA, 2002*. The columns are placed under heat lamps to allow the sample to dry between water additions to ensure adequate oxygen ingress into the sample material.

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 is generally used above the sample during daylight hours to maintain the leach column surface temperature at about 30°C.

Figure A1

Kinetic Leach Column Setup



Attachment B: Static Geochemical Test Results

Table B1: Acid Base Account test results

Table B2: Multi-element test results

Table B3: Geochemical Abundance Index results

Table B4: Multi-element test results for water extracts

Table B1: Acid Base Account Results for Overburden, Interburden, Potential Coal Reject, Coal Reject and Coal

RGS Sample ID	RGS Sample ID	ALS Sample ID	Field ID	Hole No.	Site sample number	Sample Lithology/Description	Sample Type	From (m)	To (m)	Interval (m)	pH[1]	EC[1] (µS/cm)	Total S (%)	Scr (%)	MPA[2] (kgH_2SO_4/t)	ANC[2] (kgH_2SO_4/t)	NAPP[2] (kgH_2SO_4/t)	ANC:MPA Ratio	Sample Classification[3]	ME	CEC	KLC
Overburden and Interburden																						
1	2021011 1064	EB2106557064	58	DDO0018C	113307	Clay	Overburden	2.01	3.00	0.99	8.0	1,360	<0.01		0.2	7.7	-7.5	50.3	Non-Acid Forming (Barren)			
2	2021011 1062	EB2106557062	3	DDE0958C	113157	Clay	Overburden	13.24	14.24	1.00	8.1	1,280	<0.01		0.2	9.1	-8.9	59.4	Non-Acid Forming (Barren)			
3	2021011 1063	EB2106557063	5	DDE0958C	113197	Clay	Overburden	24.01	25.00	0.99	8.3	1,060	<0.01		0.2	7.1	-6.9	46.4	Non-Acid Forming (Barren)			
4	2021011 1067	EB2106557067	92	DDO0019C	113271	Claystone	Overburden	25.45	26.00	0.55	8.6	1,180	0.02		0.6	8.8	-8.2	14.4	Non-Acid Forming (Barren)			
5	2021011 1065	EB2106557065	6	DDE0958C	113161	Claystone	Overburden	26.10	26.60	0.50	7.9	1,700	<0.01		0.2	7.8	-7.6	50.9	Non-Acid Forming (Barren)			
6	2021011 1066	EB2106557066	8	DDE0958C	113196	Claystone	Overburden	30.15	30.65	0.50	8.3	1,330	<0.01		0.2	5.7	-5.5	37.2	Non-Acid Forming (Barren)			
7	2021011 1068	EB2106557068	64	DDO0018C	113309	Mudstone	Overburden	37.50	38.00	0.50	9.8	629	0.03		0.9	25.9	-25.0	28.2	Non-Acid Forming (Barren)			
8	2021011 1069	EB2106557069	1	DDE0958C	113160	Sand	Overburden	1.50	2.51	1.01	8.3	796	<0.01		0.2	8.2	-8.0	53.6	Non-Acid Forming (Barren)	√	√	
9	2021011 1070	EB2106557070	2	DDE0958C	113156	Sand	Overburden	7.00	8.00	1.00	8.2	2,010	0.01		0.2	8.0	-7.8	52.2	Non-Acid Forming (Barren)			
10	2021011 1072	EB2106557072	89	DDO0019C	113268	Sand	Overburden	11.01	11.51	0.50	7.6	999	<0.01		0.2	5.4	-5.2	35.3	Non-Acid Forming (Barren)			
11	2021011 1071	EB2106557071	4	DDE0958C	113155	Sand	Overburden	16.91	17.91	1.00	8.7	451	<0.01		0.2	4.9	-4.7	32.0	Non-Acid Forming (Barren)			
12	2021011 1073	EB2106557073	90	DDO0019C	113269	Sand	Overburden	18.00	19.00	1.00	7.8	1,010	<0.01		0.2	13.9	-13.7	90.8	Non-Acid Forming (Barren)			
13	2021011 1093	EB2106561005	87	DDO0019C	113266	Silt	Overburden	1.40	2.40	1.00	8.0	516	0.02		0.6	4.9	-4.3	8.0	Non-Acid Forming (Barren)			
14	2021011 1094	EB2106561006	88	DDO0019C	113267	Silt	Overburden	3.10	4.03	0.93	6.4	552	0.01		0.3	4.7	-4.4	15.3	Non-Acid Forming (Barren)			
15	2021011 1089	EB2106561001	61	DDO0018C	113308	Sandstone	Overburden	15.53	16.00	0.47	8.1	734	0.01		0.3	9.6	-9.3	31.3	Non-Acid Forming (Barren)			
16	2021011 1092	EB2106561004	91	DDO0019C	113270	Sandstone	Overburden	22.00	22.50	0.50	8.9	1,120	0.02		0.6	39.6	-39.0	64.7	Non-Acid Forming (Barren)			
17	2021011 1090	EB2106561002	62	DDO0018C	113291	Sandstone	Overburden	22.50	23.00	0.50	9.1	1,110	0.01		0.3	39.9	-39.6	130.3	Non-Acid Forming (Barren)			
18	2021011 1074	EB2106557074	7	DDE0958C	113162	Sandstone	Overburden	29.66	30.15	0.49	8.1	1,450	<0.01		0.2	9.0	-8.8	58.8	Non-Acid Forming (Barren)			
19	2021011 1075	EB2106557075	9	DDE0958C	113158	Sandstone	Overburden	32.72	33.20	0.48	8.1	1,280	<0.01		0.2	10.9	-10.7	71.2	Non-Acid Forming (Barren)			
20	2021011 1091	EB2106561003	65	DDO0018C	113292	Sandstone	Overburden	46.52	47.00	0.48	9.4	585	0.02		0.6	22.5	-21.9	36.7	Non-Acid Forming (Barren)			
21	2021011 1076	EB2106557076	14	DDE0958C	113163	Sandstone	Overburden	55.53	56.03	0.50	9.7	229	<0.01		0.2	15.7	-15.5	102.5	Non-Acid Forming (Barren)			
22	2021011 1077	EB2106557077	15	DDE0958C	113187	Sandstone	Overburden	59.65	60.15	0.50	10.1	330	<0.01		0.2	59.8	-59.6	390.5	Non-Acid Forming (Barren)			
23	2021011 1078	EB2106557078	16	DDE0958C	113164	Sandstone	Overburden	64.87	65.38	0.51	9.4	231	<0.01		0.2	16.3	-16.1	106.4	Non-Acid Forming (Barren)			
24	2021011 1079	EB2106557079	17	DDE0958C	113165	Sandstone	Overburden	66.13	66.67	0.54	9.3	137	0.02		0.6	9.6	-9.0	15.7	Non-Acid Forming (Barren)	√	√	
25	2021011 1088	EB2106557088	47	DDF1157C	113200	Sandstone	Overburden	67.33	67.83	0.50	10.1	181	0.01		0.3	41.4	-41.1	135.2	Non-Acid Forming (Barren)			
26	2021011 1080	EB2106557080	18	DDE0958C	113188	Sandstone	Overburden	70.00	70.50	0.50	9.3	591	0.01		0.3	13.2	-12.9	43.1	Non-Acid Forming (Barren)			KLC1
27	2021011 1081	EB2106557081	22	DDE0958C	113190	Sandstone	Overburden	82.50	83.02	0.52	9.8	464	0.18	0.16	4.9	77.8	-72.9	16.0	Non-Acid Forming			
28	2021011 1082	EB2106557082	23	DDE0958C	113167	Sandstone	Overburden	92.41	92.89	0.48	9.6	98	<0.01		0.2	20.8	-20.6	135.8	Non-Acid Forming (Barren)			
29	2021011 1083	EB2106557083	24	DDE0958C	113191	Sandstone	Overburden	96.13	96.63	0.50	9.5	214	0.02		0.6	16.9	-16.3	27.6	Non-Acid Forming (Barren)			
30	2021011 1084	EB2106557084	28	DDE0958C	113180	Sandstone	Overburden	114.13	114.63	0.50	10.2	338	<0.01		0.2	125.0	-124.8	816.3	Non-Acid Forming (Barren)			
31	2021011 1085	EB2106557085	29	DDE0958C	113169	Sandstone	Overburden	120.36	120.86	0.50	10.2	369	<0.01		0.2	82.4	-82.2	538.1	Non-Acid Forming (Barren)			
32	2021011 1086	EB2106557086	30	DDE0958C	113181	Sandstone	Overburden	125.28	125.75	0.47	10.1	381	0.38	0.45	13.7	78.8	-65.1	5.8	Non-Acid Forming			
33	2021011 1087	EB2106557087	31	DDE0958C	113182	Sandstone	Overburden	127.38	127.88	0.50	10.2	375	0.01		0.3	90.6	-90.3	295.8	Non-Acid Forming (Barren)			
34	2021011 1102	EB2106561014	59	DDO0018C	113301	Siltstone	Overburden	4.23	7.03	2.80	9.2	1,350	<0.01		0.2	26.1	-25.9	170.4	Non-Acid Forming (Barren)			
35	2021011 1103	EB2106561015	60	DDO0018C	113290	Siltstone	Overburden	10.25	10.75	0.50	8.1	759	<0.01		0.2	10.8	-10.6	70.5	Non-Acid Forming (Barren)			
36	2021011 1105	EB2106561017	93	DDO0019C	113272	Siltstone	Overburden	27.38	27.92	0.54	7.8	1,360	0.04		1.2	17.1	-15.9	14.0	Non-Acid Forming (Barren)			
37	2021011 1104	EB2106561016	63	DDO0018C	113302	Siltstone	Overburden	29.50	30.00	0.50	9.5	666	<0.01		0.2	33.4	-33.2	218.1	Non-Acid Forming (Barren)			
38	2021011 1095	EB2106561007	10	DDE0958C	113159	Siltstone	Overburden	38.18	38.68	0.50	7.8	800	0.01		0.3	7.0	-6.7	22.9	Non-Acid Forming (Barren)			
39	2021011 1096	EB2106561008	11	DDE0958C	113154	Siltstone	Overburden	42.62	43.12	0.50	7.9	602	<0.01		0.2	11.1	-10.9	72.5	Non-Acid Forming (Barren)			
40	2021011 1097	EB2106561009	12	DDE0958C	113153	Siltstone	Overburden	47.45	47.95	0.50	9.2	688	<0.01		0.2	20.4	-20.2	133.2	Non-Acid Forming (Barren)			
41	2021011 1098	EB2106561010	13	DDE0958C	113177	Siltstone	Overburden	50.29	50.77	0.48	9.2	559	0.03		0.9	18.0	-17.1	19.6	Non-Acid Forming (Barren)			
42	2021011 1099	EB2106561011	19	DDE0958C	113189	Siltstone	Overburden	73.27	73.83	0.56	9.4	369	0.02		0.6	22.2	-21.6	36.2	Non-Acid Forming (Barren)	√	√	
43	2021011 1100	EB2106561012	20	DDE0958C	113178	Siltstone	Overburden	75.51	75.99	0.48	9.5	486	0.04		1.2	19.8	-18.6	16.2	Non-Acid Forming (Barren)			
44	2021011 1101	EB2106561013	21	DDE0958C	113166	Siltstone	Overburden	78.64	79.14	0.50	9.5	386	0.05		1.5	23.8	-22.3	15.5	Non-Acid Forming (Barren)			
45	2021011 1059	EB2106557059	66	DDO0018C	113303	Carbonaceous Siltstone	Overburden	52.05	52.60	0.55	9.4	150	0.02		0.6	19.5	-18.9	31.8	Non-Acid Forming (Barren)			
46	2021011 1060	EB2106557060	67	DDO0018C	113296	Carbonaceous Siltstone	Overburden	59.50	60.00	0.50	9.5	556	0.02		0.6	20.7	-20.1	33.8	Non-Acid Forming (Barren)			
47	2021011 1061	EB2106557061	68	DDO0018C	113304	Carbonaceous Siltstone	Overburden	65.00	65.50	0.50	9.7	852	0.14	0.13	3.9	64.3	-60.4	16.7	Non-Acid Forming			
48	2021011 1056	EB2106557056	25	DDE0958C	113179	Carbonaceous Siltstone	Overburden	100.59	101.09	0.50	9.7	220	<0.01		0.2	17.2	-17.0	112.3	Non-Acid Forming (Barren)			
49	2021011 1057	EB2106557057	26	DDE0958C	113168	Carbonaceous Siltstone	Overburden	104.54	105.04	0.50	9.4	103	<0.01		0.2	16.2	-16.0	105.8	Non-Acid Forming (Barren)			
50	2021011 1058	EB2106557058	27	DDE0958C	113192	Carbonaceous Siltstone	Overburden	111.55	112.00	0.45	9.4	211	<0.01		0.2	15.6	-15.4	101.9	Non-Acid Forming (Barren)			

Table B1: Acid Base Account Results for Overburden, Interburden, Potential Coal Reject, Coal Reject and Coal

RGS Sample ID	RGS Sample ID	ALS Sample ID	Field ID	Hole No.	Site sample number	Sample Lithology/Description	Sample Type	From	To	Interval	pH[1]	EC[1]	Total S	Scr	MPA[2]	ANC[2]	NAPP[2]	ANC:MPA Ratio	Sample Classification[3]	ME	CEC	KLC
								(m)				(µS/cm)	(%)		(kgH_2SO_4/t)							
51	2021011_1040	EB2106557040	96	DDO0019C	113275	Sandstone	Interburden	38.00	38.50	0.50	10.0	399	0.02		0.6	55.6	-55.0	90.8	Non-Acid Forming (Barren)			
52	2021011_1041	EB2106557041	97	DDO0019C	113276	Sandstone	Interburden	43.24	43.74	0.50	9.8	257	0.02		0.6	23.7	-23.1	38.7	Non-Acid Forming (Barren)			
53	2021011_1042	EB2106557042	100	DDO0019C	113263	Sandstone	Interburden	66.00	66.50	0.50	9.5	331	0.03		0.9	48.4	-47.5	52.7	Non-Acid Forming (Barren)			
54	2021011_1027	EB2106557027	70	DDO0018C	113297	Sandstone	Interburden	73.00	73.50	0.50	9.6	364	0.02		0.6	74.3	-73.7	121.3	Non-Acid Forming (Barren)			
55	2021011_1043	EB2106557043	102	DDO0019C	113262	Sandstone	Interburden	78.44	79.00	0.56	8.6	269	0.07		2.1	18.3	-16.2	8.5	Non-Acid Forming (Barren)			
56	2021011_1028	EB2106557028	71	DDO0018C	113305	Sandstone	Interburden	79.50	80.00	0.50	8.7	273	0.06		1.8	16.8	-15.0	9.1	Non-Acid Forming (Barren)			
57	2021011_1029	EB2106557029	72	DDO0018C	113294	Sandstone	Interburden	85.00	85.50	0.50	9.8	344	0.09		2.8	20.1	-17.3	7.3	Non-Acid Forming (Barren)			
58	2021011_1030	EB2106557030	73	DDO0018C	113306	Sandstone	Interburden	90.00	90.50	0.50	9.6	178	0.02		0.6	34.5	-33.9	56.3	Non-Acid Forming (Barren)			
59	2021011_1031	EB2106557031	74	DDO0018C	113295	Sandstone	Interburden	96.00	96.50	0.50	9.7	385	0.02		0.6	35.8	-35.2	58.4	Non-Acid Forming (Barren)			
60	2021011_1032	EB2106557032	75	DDO0018C	113298	Sandstone	Interburden	99.50	100.00	0.50	9.6	315	0.02		0.6	43.5	-42.9	71.0	Non-Acid Forming (Barren)			
61	2021011_1033	EB2106557033	76	DDO0018C	113299	Sandstone	Interburden	108.00	108.50	0.50	9.6	342	0.02		0.6	37.8	-37.2	61.7	Non-Acid Forming (Barren)			
62	2021011_1034	EB2106557034	77	DDO0018C	113300	Sandstone	Interburden	119.52	120.00	0.48	10.0	310	0.02		0.6	57.3	-56.7	93.6	Non-Acid Forming (Barren)			
63	2021011_1021	EB2106557021	48	DDF1157C	113277	Sandstone	Interburden	121.53	122.00	0.47	9.5	234	0.03		0.9	20.8	-19.9	22.6	Non-Acid Forming (Barren)			
64	2021011_1022	EB2106557022	49	DDF1157C	113199	Sandstone	Interburden	127.16	127.66	0.50	9.5	265	0.03		0.9	24.6	-23.7	26.8	Non-Acid Forming (Barren)	√	√	
65	2021011_1035	EB2106557035	78	DDO0018C	113310	Sandstone	Interburden	128.00	128.50	0.50	10.0	363	0.02		0.6	77.4	-76.8	126.4	Non-Acid Forming (Barren)			
66	2021011_1015	EB2106557015	34	DDE0958C	113183	Sandstone	Interburden	138.13	138.63	0.50	10.0	274	0.02		0.6	104.0	-103.4	169.8	Non-Acid Forming (Barren)			
67	2021011_1036	EB2106557036	80	DDO0018C	113289	Sandstone	Interburden	144.00	144.50	0.50	10.2	374	0.02		0.6	90.6	-90.0	147.9	Non-Acid Forming (Barren)			
68	2021011_1037	EB2106557037	81	DDO0018C	113282	Sandstone	Interburden	150.00	150.50	0.50	9.8	237	0.04		1.2	43.0	-41.8	35.1	Non-Acid Forming (Barren)			
69	2021011_1016	EB2106557016	37	DDE0958C	113174	Sandstone	Interburden	152.35	152.93	0.58	10.2	373	0.02		0.6	43.3	-42.7	70.7	Non-Acid Forming (Barren)			
70	2021011_1023	EB2106557023	50	DDF1157C	113278	Sandstone	Interburden	153.00	153.50	0.50	10.0	502	0.04		1.2	78.7	-77.5	64.2	Non-Acid Forming (Barren)			
71	2021011_1017	EB2106557017	38	DDE0958C	113184	Sandstone	Interburden	156.19	156.69	0.50	10.1	326	0.01		0.3	65.2	-64.9	212.9	Non-Acid Forming (Barren)			
72	2021011_1024	EB2106557024	51	DDF1157C	113254	Sandstone	Interburden	156.59	157.09	0.50	9.9	257	0.02		0.6	67.4	-66.8	110.0	Non-Acid Forming (Barren)			
73	2021011_1038	EB2106557038	82	DDO0018C	113286	Sandstone	Interburden	160.50	161.00	0.50	9.6	216	0.02		0.6	21.1	-20.5	34.4	Non-Acid Forming (Barren)			
74	2021011_1018	EB2106557018	43	DDE0958C	113176	Sandstone	Interburden	173.82	174.32	0.50	9.8	376	0.02		0.6	20.1	-19.5	32.8	Non-Acid Forming (Barren)			
75	2021011_1020	EB2106557020	46	DDE0958C	113198	Sandstone	Interburden	183.09	183.59	0.50	10.0	404	0.03		0.9	67.0	-66.1	72.9	Non-Acid Forming (Barren)			
76	2021011_1039	EB2106557039	86	DDO0018C	113283	Sandstone	Interburden	185.43	186.00	0.57	9.6	186	0.04		1.2	35.2	-34.0	28.7	Non-Acid Forming (Barren)			
77	2021011_1025	EB2106557025	55	DDF1157C	113280	Sandstone	Interburden	202.46	203.00	0.54	9.8	403	0.02		0.6	18.7	-18.1	30.5	Non-Acid Forming (Barren)			KLC2
78	2021011_1026	EB2106557026	57	DDF1157C	113256	Sandstone	Interburden	208.03	208.53	0.50	10.0	473	0.04		1.2	55.4	-54.2	45.2	Non-Acid Forming (Barren)			
79	2021011_1050	EB2106557050	94	DDO0019C	113273	Siltstone	Interburden	30.39	30.85	0.46	8.6	518	0.12	0.058	1.8	15.1	-13.3	8.5	Non-Acid Forming (Barren)			
80	2021011_1051	EB2106557051	98	DDO0019C	113265	Siltstone	Interburden	53.03	53.53	0.50	9.6	188	0.02		0.6	28.5	-27.9	46.5	Non-Acid Forming (Barren)			
81	2021011_1052	EB2106557052	99	DDO0019C	113264	Siltstone	Interburden	59.00	59.50	0.50	9.7	318	0.04		1.2	48.3	-47.1	39.4	Non-Acid Forming (Barren)			
82	2021011_1053	EB2106557053	101	DDO0019C	113261	Siltstone	Interburden	69.01	69.71	0.70	9.9	183	0.03		0.9	63.2	-62.3	68.8	Non-Acid Forming (Barren)			
83	2021011_1046	EB2106557046	69	DDO0018C	113293	Siltstone	Interburden	72.00	72.51	0.51	9.5	403	0.06		1.8	102.0	-100.2	55.5	Non-Acid Forming (Barren)			
84	2021011_1054	EB2106557054	103	DDO0019C	113260	Siltstone	Interburden	84.19	84.69	0.50	9.5	211	0.03		0.9	22.8	-21.9	24.8	Non-Acid Forming (Barren)			
85	2021011_1055	EB2106557055	104	DDO0019C	113259	Siltstone	Interburden	87.00	87.50	0.50	9.7	327	0.05		1.5	22.9	-21.4	15.0	Non-Acid Forming (Barren)			
86	2021011_1047	EB2106557047	79	DDO0018C	113287	Siltstone	Interburden	136.00	136.50	0.50	10.0	248	0.02		0.6	13.1	-12.5	21.4	Non-Acid Forming (Barren)			
87	2021011_1044	EB2106557044	52	DDF1157C	113252	Siltstone	Interburden	157.74	158.24	0.50	10.0	320	0.02		0.6	25.3	-24.7	41.3	Non-Acid Forming (Barren)			
88	2021011_1048	EB2106557048	83	DDO0018C	113288	Siltstone	Interburden	167.69	168.26	0.57	8.9	118	0.02		0.6	88.0	-87.4	143.7	Non-Acid Forming (Barren)			
89	2021011_1049	EB2106557049	84	DDO0018C	113284	Siltstone	Interburden	177.50	178.00	0.50	9.2	364	0.04		1.2	25.4	-24.2	20.7	Non-Acid Forming (Barren)			
90	2021011_1045	EB2106557045	56	DDF1157C	113281	Siltstone	Interburden	204.23	204.73	0.50	9.9	320	0.04		1.2	97.2	-96.0	79.3	Non-Acid Forming (Barren)			
91	2021011_1014	EB2106557014	95	DDO0019C	113274	Carbonaceous Siltstone	Interburden	34.00	34.56	0.56	9.7	491	0.03		0.9	33.2	-32.3	36.1	Non-Acid Forming (Barren)	√	√	
92	2021011_1002	EB2106557002	105	DDO0019C	113257	Carbonaceous Mudstone	Interburden	88.50	89.00	0.50	9.6	350	0.25	0.018	0.6	3.6	-3.0	6.5	Non-Acid Forming (Barren)			
93	2021011_1003	EB2106557003	32	DDE0958C	113170	Carbonaceous Siltstone	Interburden	130.72	131.22	0.50	9.4	297	0.04		1.2	8.7	-7.5	7.1	Non-Acid Forming (Barren)			
94	2021011_1004	EB2106557004	33	DDE0958C	113171	Carbonaceous Siltstone	Interburden	132.71	133.22	0.51	9.4	181	0.03		0.9	19.2	-18.3	20.9	Non-Acid Forming (Barren)			
95	2021011_1005	EB2106557005	35	DDE0958C	113172	Carbonaceous Siltstone	Interburden	142.46	143.00	0.54	9.8	454	0.03		0.9	54.8	-53.9	59.6	Non-Acid Forming (Barren)			
96	2021011_1001	EB2106557001	106	DDE0958C	113173	Coal	Coal	144.10	144.80	0.70	9.7	410	0.04		1.2	18.7	-17.5	15.3	Non-Acid Forming (Barren)			
97	2021011_1006	EB2106557006	36	DDE0958C	113193	Carbonaceous Siltstone	Interburden	148.50	149.00	0.50	9.6	341	0.01		0.3	9.6	-9.3	31.3	Non-Acid Forming (Barren)			
98	2021011_1007	EB2106557007	39	DDE0958C	113194	Carbonaceous Siltstone	Interburden	161.06	161.61	0.55	9.9	807	0.04		1.2	30.6	-29.4	25.0	Non-Acid Forming (Barren)			
99	2021011_1008	EB2106557008	40	DDE0958C	113195	Carbonaceous Siltstone	Interburden	163.70	164.22	0.52	9.7	385	0.05		1.5	24.0	-22.5	15.7	Non-Acid Forming (Barren)			
100	2021011_1009	EB2106557009	41	DDE0958C	113186	Carbonaceous Siltstone	Interburden	167.38	167.86	0.48	9.7	354	0.06		1.8	49.8	-48.0	27.1	Non-Acid Forming (Barren)			
101	2021011_1010	EB2106557010	42	DDE0958C	113175	Carbonaceous Siltstone	Interburden	170.36	170.85	0.49	9.8	207	0.08		2.5	20.8	-18.4	8.5	Non-Acid Forming (Barren)			
102	2021011_1012	EB2106557012	53	DDF1157C	113279	Carbonaceous Siltstone	Interburden	180.32	181.32	1.00	9.9	268	0.02		0.6	43.5	-42.9	71.0	Non-Acid Forming (Barren)			
103	2021011_1013	EB2106557013	85	DDO0018C	113285	Carbonaceous Siltstone	Interburden	180.65	181.19	0.54	8.4	248	0.07		2.1	16.2	-14.1	7.6	Non-Acid Forming (Barren)			

Table B1: Acid Base Account Results for Overburden, Interburden, Potential Coal Reject, Coal Reject and Coal

RGS Sample ID	RGS Sample ID	ALS Sample ID	Field ID	Hole No.	Site sample number	Sample Lithology/Description	Sample Type	From (m)	To (m)	Interval (m)	pH[1]	EC[1] (µS/cm)	Total S (%)	Scr (%)	MPA[2] (kgH2SO4/t)	ANC[2] (kgH2SO4/t)	NAPP[2] (kgH2SO4/t)	ANC:MPA Ratio	Sample Classification[3]	ME	CEC	KLC
Potential Coal Reject (Roof and Floor)																						
1	2021011_3002	EB2106297002	-	LDF1043C	401023	Carbonaceous Mudstone	PI1B-Roof	-	-	-	9.5	367	0.08		2.5	42.0	-39.6	17.1	Non-Acid Forming (Barren)			
2	2021011_3005	EB2106297005	-	LDE0901C	400957	Carbonaceous Mudstone	TRA2-Roof	-	-	-	9.4	297	0.05		1.5	26.8	-25.3	17.5	Non-Acid Forming (Barren)			
3	2021011_3012	EB2106297012	-	LDF1148C	383594	Carbonaceous Mudstone	TRA2_Roof	-	-	-	9.4	302	0.09		2.8	12.6	-9.8	4.6	Non-Acid Forming (Barren)			
4	2021011_3006	EB2106297006	-	LDF1043C	401016	Carbonaceous Sandstone	TRA2-Roof	-	-	-	8.9	180	0.09		2.8	9.8	-7.0	3.6	Non-Acid Forming (Barren)			
5	2021011_3008	EB2106297008	-	LDF1062C	383305	Carbonaceous Siltstone	PI2A_Roof	-	-	-	9.8	506	0.03		0.9	25.9	-25.0	28.2	Non-Acid Forming (Barren)			
6	2021011_3009	EB2106297009	-	LDF0995C	383566	Carbonaceous Siltstone	TRA2_Roof	-	-	-	9.4	260	0.04		1.2	14.6	-13.4	11.9	Non-Acid Forming (Barren)			
7	2021011_3010	EB2106297010	-	LDF1148C	383593	Carbonaceous Siltstone	TRA2_Roof	-	-	-	9.3	320	0.03		0.9	23.5	-22.6	25.6	Non-Acid Forming (Barren)			
8	2021011_3016	EB2106297016	-	LDE0912C	383130	Sandstone	ROP1_Roof	-	-	-	7.3	473	0.07		2.1	17.6	-15.5	8.2	Non-Acid Forming (Barren)			
9	2021011_3017	EB2106297017	-	LDF1148C	383574	Sandstone	ROP1_Roof	-	-	-	8.2	650	0.02		0.6	16.7	-16.1	27.3	Non-Acid Forming (Barren)			
10	2021011_3020	EB2106297020	-	LDF1174C	113030	Sandstone/Siltstone	PI1B_Roof	-	-	-	9.4	376	0.04		1.2	55.5	-54.3	45.3	Non-Acid Forming (Barren)	√	√	
11	2021011_3022	EB2106297022	-	LDE0910C	383162	Siltstone	TRA2_Roof	-	-	-	9.4	210	0.08		2.5	23.4	-21.0	9.6	Non-Acid Forming (Barren)			
12	2021011_3023	EB2106297023	-	LDF0995C	383551	Siltstone	ROP1_Roof	-	-	-	8.2	471	0.06		1.8	14.0	-12.2	7.6	Non-Acid Forming (Barren)			
13	2021011_3024	EB2106297024	-	LDF0995C	383555	Siltstone	MMT1_Roof	-	-	-	9.8	566	0.04		1.2	31.4	-30.2	25.6	Non-Acid Forming (Barren)			
14	2021011_3025	EB2106297025	-	LDF1174C	113022	Siltstone	IN_Roof	-	-	-	8.6	442	0.02		0.6	14.2	-13.6	23.2	Non-Acid Forming (Barren)			
15	2021011_3026	EB2106297026	-	LDE0912C	383139	Siltstone/Carbonaceous Siltstone	TRA2_Roof	-	-	-	9.2	430	0.05		1.5	53.8	-52.3	35.1	Non-Acid Forming (Barren)			
16	2021011_3028	EB2106297028	-	LDE0910C	383154	Siltstone/Carbonaceous Siltstone	MMT1_Roof	-	-	-	9.6	417	0.07		2.1	57.0	-54.9	26.6	Non-Acid Forming (Barren)			
17	2021011_3031	EB2106297031	-	LDF1174C	113010	Siltstone/Carbonaceous Siltstone	ROP1_Roof	-	-	-	8.1	447	0.07		2.1	15.0	-12.9	7.0	Non-Acid Forming (Barren)			
18	2021011_3014	EB2106297014	-	LDE0910C	383166	Siltstone/Sandstone	PI1B_Roof	-	-	-	9.5	243	0.03		0.9	28.8	-27.9	31.3	Non-Acid Forming (Barren)			
19	2021011_3019	EB2106297019	-	LDE0912C	383143	Siltstone/Sandstone	PI1B_Roof	-	-	-	9.4	265	0.04		1.2	29.6	-28.4	24.2	Non-Acid Forming (Barren)			
20	2021011_3035	EB2106297035	-	LDF1062C	383307	Tuff/Carbonaceous Siltstone	Parting	-	-	-	9.5	324	<0.01		0.2	30.0	-29.8	150.0	Non-Acid Forming (Barren)			KLC3
21	2021011_3001	EB2106297001	-	LDF1043C	401004	Carbonaceous Mudstone	MMT1-Roof	-	-	-	9.0	437	0.13	0.072	2.2	10.2	-8.0	4.6	Non-Acid Forming (Barren)			
22	2021011_3003	EB2106297003	-	LDE0901C	401046	Carbonaceous Mudstone	ROP1-Roof	-	-	-	9.1	228	0.11	0.134	4.1	48.1	-44.0	11.7	Non-Acid Forming			
23	2021011_3004	EB2106297004	-	LDE0901C	401049	Carbonaceous Mudstone	MMTU-Roof	-	-	-	8.7	240	0.80	0.741	22.7	10.2	12.5	0.4	Potentially Acid Forming			
24	2021011_3011	EB2106297011	-	LDF1062C	383301	Carbonaceous Mudstone/Claystone	PI1B_Roof	-	-	-	8.6	800	0.32	0.220	6.7	15.7	-9.0	2.3	Non-Acid Forming			
25	2021011_3007	EB2106297007	-	LDF1174C	113020	Carbonaceous Mudstone/Siltstone	TRA_Roof	-	-	-	8.1	417	0.25	0.124	3.8	11.1	-7.3	2.9	Non-Acid Forming			
26	2021011_3021	EB2106297021	-	LDF1062C	378138	Carbonaceous Sandstone	TRA2_Roof	-	-	-	8.8	1,370	1.33	0.985	30.2	234.0	-203.8	7.8	Non-Acid Forming			
27	2021011_3013	EB2106297013	-	LDF1043C	401001	Sandstone	ROP1-Roof	-	-	-	5.7	1,440	0.70	0.563	17.2	7.7	9.5	0.4	Potentially Acid Forming			
28	2021011_3015	EB2106297015	-	LDE0910C	383149	Sandstone	ROP1_Roof	-	-	-	8.0	466	1.24	1.020	31.2	13.9	17.3	0.4	Potentially Acid Forming	√	√	
29	2021011_3018	EB2106297018	-	LDF1174C	113013	Sandstone	MMTU_Roof	-	-	-	9.4	572	0.16	0.146	4.5	127.0	-122.5	28.4	Non-Acid Forming			
30	2021011_3032	EB2106297032	-	LDF1094C	383510	Siltstone/Carbonaceous Sandstone	PI1B_Roof	-	-	-	8.4	931	0.14	0.082	2.5	21.2	-18.7	8.4	Non-Acid Forming (Barren)			
31	2021011_3027	EB2106297027	-	LDE0912C	383133	Siltstone/Carbonaceous Siltstone	MMT1_Roof	-	-	-	8.3	421	0.11	0.082	2.5	11.1	-8.6	4.4	Non-Acid Forming (Barren)			
32	2021011_3029	EB2106297029	-	LDF1094C	383514	Siltstone/Carbonaceous Siltstone	PI2A_Roof	-	-	-	8.7	1,070	1.03	0.698	21.4	32.0	-10.6	1.5	Non-Acid Forming			
33	2021011_3030	EB2106297030	-	LDF1174C	113016	Siltstone/Carbonaceous Siltstone	MMT1_Roof	-	-	-	8.4	560	0.31	0.292	8.9	12.8	-3.9	1.4	Uncertain			
34	2021011_3033	EB2106297033	-	LDF1094C	383516	Tuff/Carbonaceous Siltstone	Parting	-	-	-	9.6	545	0.15	0.095	2.9	29.0	-26.1	10.0	Non-Acid Forming (Barren)			
35	2021011_3034	EB2106297034	-	LDF1062C	978150	Dolerite	Parting	-	-	-	9.5	979	0.73	0.742	22.7	190.0	-167.3	8.4	Non-Acid Forming			
36	2021011_3036	EB2106297036	-	LDF1043C	401013	Carbonaceous Mudstone	MMT1-Floor	-	-	-	8.7	345	0.10		3.1	11.0	-7.9	3.6	Non-Acid Forming (Barren)			
37	2021011_3037	EB2106297037	-	LDF1043C	401028	Carbonaceous Mudstone	PI1B-Floor	-	-	-	9.5	393	0.08		2.5	15.8	-13.4	6.4	Non-Acid Forming (Barren)			
38	2021011_3044	EB2106297044	-	LDF0995C	383572	Carbonaceous Siltstone	TRA2_Floor	-	-	-	9.2	258	0.04		1.2	11.8	-10.6	9.6	Non-Acid Forming (Barren)			
39	2021011_3045	EB2106297045	-	LDF1174C	113012	Carbonaceous Siltstone	ROP1_Floor	-	-	-	9.1	331	0.09		2.8	12.9	-10.1	4.7	Non-Acid Forming (Barren)			
40	2021011_3047	EB2106297047	-	LDF1174C	113029	Carbonaceous Siltstone	TR2I_Floor	-	-	-	9.0	567	0.02		0.6	12.4	-11.8	20.2	Non-Acid Forming (Barren)			
41	2021011_3049	EB2106297049	-	LDF1043C	401015	Claystone	MMTL-Floor	-	-	-	9.4	446	0.05		1.5	13.0	-11.5	8.5	Non-Acid Forming (Barren)			
42	2021011_3050	EB2106297050	-	LDF1148C	383591	Siltstone/Carbonaceous Siltstone	MMT1_Floor	-	-	-	9.5	264	0.06		1.8	15.1	-13.3	8.2	Non-Acid Forming (Barren)			
43	2021011_3051	EB2106297051	-	LDE0912C	383148	Siltstone/Carbonaceous Siltstone	PI1B_Floor	-	-	-	9.8	270	0.07		2.1	13.5	-11.4	6.3	Non-Acid Forming (Barren)			
44	2021011_3053	EB2106297053	-	LDE0901C	400959	Sandstone	TRA2-Floor	-	-	-	9.5	282	0.03		0.9	21.9	-21.0	23.8	Non-Acid Forming (Barren)	√	√	
45	2021011_3056	EB2106297056	-	LDF1043C	401022	Siltstone	TRA2-Floor	-	-	-	9.1	272	0.04		1.2	8.8	-7.6	7.2	Non-Acid Forming (Barren)			
46	2021011_3057	EB2106297057	-	LDF0995C	383565	Siltstone	MMT1_Floor	-	-	-	9.7	256	0.04		1.2	15.9	-14.7	13.0	Non-Acid Forming (Barren)			
47	2021011_3058	EB2106297058	-	LDF1148C	383592	Siltstone	MMT1_Floor	-	-	-	9.1	262	0.01		0.3	9.3	-9.0	30.4	Non-Acid Forming (Barren)			
48	2021011_3065	EB2106297065	-	LDF1094C	383513	Siltstone/Carbonaceous Sandstone	PI1B_Floor	-	-	-	8.9	918	0.07		2.1	9.6	-7.5	4.5	Non-Acid Forming (Barren)			
49	2021011_3066	EB2106297066	-	LDF1148C	383434	Siltstone/Carbonaceous Siltstone	PI1B_Floor	-	-	-	9.5	388	0.04		1.2	13.7	-12.5	11.2	Non-Acid Forming (Barren)			
50	2021011_3067	EB2106297067	-	LDF1062C	383309	Siltstone/Carbonaceous Siltstone	PI2B_Floor	-	-	-	9.7	471	0.05		1.5	17.9	-16.4	11.7	Non-Acid Forming (Barren)			
51	2021011_3068	EB2106297068	-	LDF1174C	113033	Siltstone/Carbonaceous Mudstone	PI1B_Floor	-	-	-	9.1	277	0.08		2.5	12.7	-10.3	5.2	Non-Acid Forming (Barren)			
52	2021011_3038	EB2106297038	-	LDE0901C	401048	Carbonaceous Mudstone	ROP1-Floor	-	-	-	8.9	274	0.47	0.308	9.4	9.7	-0.3	1.0	Uncertain			
53	2021011_3039	EB2106297039	-	LDE0901C	400956	Carbonaceous Mudstone	MMT1-Floor	-	-	-	8.7	260	0.34	0.206	6.3	16.5	-10.2	2.6	Non-Acid Forming			
54	2021011_3040	EB2106297040	-	LDF1062C	378149	Carbonaceous Mudstone	TRA2_Floor	-	-	-	9.5	771	0.37	0.313	9.6	112.0	-102.4	11.7	Non-Acid Forming			
55	2021011_3041	EB2106297041	-	LDF1062C	383304	Carbonaceous Mudstone	PI1B_Floor	-	-	-	9.0	414	0.12	0.037	1.1	13.0	-11.9	11.5	Non-Acid Forming (Barren)			
56	2021011_3042	EB2106297042	-	LDF1094C	383509	Carbonaceous Sandstone	TRA2_Floor	-	-	-	8.2	1,620	0.24	0.186	5.7	11.4	-5.7	2.0	Non-Acid Forming			
57	2021011_3043	EB2106297043	-	LDE0912C	383132	Carbonaceous Siltstone	ROP1_Floor	-	-	-	9.1	350	0.14	0.075	2.3	13.7	-11.4	6.0	Non-Acid Forming (Barren)			
58	2021011_3046	EB2106297046	-	LDF1174C	113019	Carbonaceous Siltstone	MMT1_Floor	-	-	-	9.4	552	0.42	0.224	6.9	16.9	-10.0	2.5	Non-Acid Forming			
59	2021011_3048	EB2106297048	-	LDF1043C	401003	Claystone	ROP1-Floor	-	-	-	7.4	990	0.43	0.409	12.5	10.5	2.0	0.8	Uncertain			
60	2021011_3052	EB2106297052	-	LDE0910C	383153	Siltstone/Carbonaceous Siltstone	ROP1R_Floor	-	-	-	8.3	427	0.78	0.579	17.7	9.9	7.8	0.6	Potentially Acid Forming	√	√	
61	2021011_3054	EB2106297054	-	LDE0910C	383173	Siltstone/Carbonaceous Siltstone	PI1B_Floor	-	-	-	9.6	214	0.11	0.035	1.1	12.3	-11.2	11.5	Non-Acid Forming (Barren)			
62	2021011_3055	EB2106297055	-	LDE0910C	383165	Siltstone/Carbonaceous Siltstone	TRA2_Floor	-	-	-	9.8	280	0.12	0.031	0.9	17.8	-16.9	18.7	Non-Acid Forming (Barren)			
63	2021011_3059	EB2106297059	-	LDF0995C	383554	Siltstone/Carbonaceous Siltstone	ROP1_Floor	-	-	-	8.1	552	0.41	0.252	7.7	10.6	-2.9	1.4	Uncertain			
64	2021011_3060	EB2106297060	-	LDE0912C	383142	Siltstone/Carbonaceous Siltstone	TRA2_Floor	-	-	-	9.5	609	0.36	0.267	8.2	23.0	-14.8	2.8	Non-Acid Forming			
65	2021011_3061	EB2106297061	-	LDF1094C	383518	Siltstone/Carbonaceous Siltstone	PI2B_Floor	-	-	-	9.5	803	0.62	0.461	14.1	19.0	-4.9	1.3	Uncertain			
66	2021011_3062	EB2106297062	-	LDE0910C	383151	Siltstone/Carbonaceous Siltstone	ROP1_Floor	-	-	-	8.2	442	0.52	0.383	11.7	7.5	4.2	0.6	Uncertain			
67	2021011_3063	EB2106297063	-	LDE0912C	383138	Siltstone/Carbonaceous Siltstone	MMT1_Floor	-	-	-	9.2	356	0.15	0.096	2.9	10.8	-7.9	3.7	Non-Acid Forming (Barren)			
68	2021011_3064	EB2106297064	-	LDF1148C	383577	Siltstone/Carbonaceous Mudstone	ROP1_Floor	-	-	-	8.3	526	0.21	0.048	1.5	10.3	-8.8	7.0	Non-Acid Forming (Barren)			KLC4

Table B1: Acid Base Account Results for Overburden, Interburden, Potential Coal Reject, Coal Reject and Coal

RGS Sample ID	RGS Sample ID	ALS Sample ID	Field ID	Hole No.	Site sample number	Sample Lithology/Description	Sample Type	From (m)	To (m)	Interval (m)	pH[1]	EC[1] (µS/cm)	Total S (%)	Scr (%)	MPA[2] (kgH_2SO_4/t)	ANC[2] (kgH_2SO_4/t)	NAPP[2] (kgH_2SO_4/t)	ANC:MPA Ratio	Sample Classification[3]	ME	CEC	KLC
Coal Reject (Coarse Reject and Tailing)																						
69	2021011 2001	EB2106551001	-	-	T1	Tailing	Tailing	-	-	-	8.5	2,330	1.04	0.730	22.4	86.6	-64.2	3.9	Non-Acid Forming			
70	2021011 2002	EB2106551002	-	-	T2	Tailing	Tailing	-	-	-	8.6	2,020	1.02	0.728	22.3	94.0	-71.7	4.2	Non-Acid Forming			
71	2021011 2003	EB2106551003	-	-	T3	Tailing	Tailing	-	-	-	8.5	1,990	1.10	0.734	22.5	103.0	-80.5	4.6	Non-Acid Forming			
72	2021011 2004	EB2106551004	-	-	T4	Tailing	Tailing	-	-	-	8.5	2,010	1.04	0.723	22.1	88.5	-66.4	4.0	Non-Acid Forming			
73	2021011 2005	EB2106551005	-	-	T5	Tailing	Tailing	-	-	-	8.5	2,040	1.10	0.713	21.8	99.8	-78.0	4.6	Non-Acid Forming			
74	2021011 2006	EB2106551006	-	-	T6	Tailing	Tailing	-	-	-	8.0	3,390	0.44	0.106	3.2	27.5	-24.3	8.5	Non-Acid Forming (Barren)	√	√	KLC5
75	2021011 2007	EB2106551007	-	-	T7	Tailing	Tailing	-	-	-	8.2	1,740	0.36	0.143	4.4	23.1	-18.7	5.3	Non-Acid Forming			
76	2021011 2008	EB2106551008	-	-	T8	Tailing	Tailing	-	-	-	8.5	2,220	0.33	0.078	2.4	24.0	-21.6	10.0	Non-Acid Forming (Barren)			
77	2021011 2009	EB2106551009	-	-	T9	Tailing	Tailing	-	-	-	8.5	1,820	0.46	0.118	3.6	13.3	-9.7	3.7	Non-Acid Forming			
78	2021011 2010	EB2106551010	-	-	T10	Tailing	Tailing	-	-	-	8.4	2,470	0.64	0.344	10.5	44.4	-33.9	4.2	Non-Acid Forming			
79	2021011 2011	EB2106551011	-	-	CR1	Coarse Reject	Coarse Reject	-	-	-	9.3	777	0.69	0.517	15.8	45.0	-29.2	2.8	Non-Acid Forming			
80	2021011 2012	EB2106551012	-	-	CR2	Coarse Reject	Coarse Reject	-	-	-	8.8	863	2.60	2.170	66.5	14.9	51.6	0.2	Potentially Acid Forming			
81	2021011 2013	EB2106551013	-	-	CR3	Coarse Reject	Coarse Reject	-	-	-	8.5	1,040	1.59	1.230	37.7	67.7	-30.0	1.8	Non-Acid Forming			
82	2021011 2014	EB2106551014	-	-	CR4	Coarse Reject	Coarse Reject	-	-	-	8.5	947	1.64	1.200	36.8	16.5	20.3	0.4	Potentially Acid Forming			
83	2021011 2015	EB2106551015	-	-	CR5	Coarse Reject	Coarse Reject	-	-	-	8.7	1,530	0.65	0.386	11.8	36.1	-24.3	3.1	Non-Acid Forming			
84	2021011 2016	EB2106551016	-	-	CR6	Coarse Reject	Coarse Reject	-	-	-	8.6	1,190	2.54	1.920	58.8	38.4	20.4	0.7	Potentially Acid Forming	√	√	KLC6
85	2021011 2017	EB2106551017	-	-	CR7	Coarse Reject	Coarse Reject	-	-	-	8.6	1,090	1.88	1.380	42.3	70.3	-28.0	1.7	Non-Acid Forming			
86	2021011 2018	EB2106551018	-	-	CR8	Coarse Reject	Coarse Reject	-	-	-	9.2	983	0.79	1.060	32.5	22.9	9.6	0.7	Potentially Acid Forming			
87	2021011 2019	EB2106551019	-	-	CR9	Coarse Reject	Coarse Reject	-	-	-	8.1	1,350	1.66	1.060	32.5	60.3	-27.8	1.9	Non-Acid Forming			
88	2021011 2020	EB2106551020	-	-	CR10	Coarse Reject	Coarse Reject	-	-	-	9.2	832	0.49	0.269	8.2	37.7	-29.5	4.6	Non-Acid Forming			
Coal																						
89	2021011 2021	EB2106551021	-	-	Coal 1	Coal Feed Reserve	FPPI1B	-	-	-	8.5	578	0.92	0.427	13.1	27.9	-14.8	2.1	Non-Acid Forming			
90	2021011 2022	EB2106551022	-	-	Coal 2	Coal Feed Reserve	FPPI2A	-	-	-	9.3	644	0.44	0.189	5.8	40.9	-35.1	7.1	Non-Acid Forming			
91	2021011 2023	EB2106551023	-	-	Coal 3	Coal Feed Reserve	FPMMT1	-	-	-	8.6	577	0.65	0.331	10.1	23.4	-13.3	2.3	Non-Acid Forming	√	No	KLC7
92	2021011 2024	EB2106551024	-	-	Coal 4	Coal Feed Reserve	FNTI22	-	-	-	9.1	867	0.74	0.330	10.1	17.2	-7.1	1.7	Non-Acid Forming			
93	2021011 2025	EB2106551025	-	-	Coal 5	Coal Feed Reserve	FPTRA2	-	-	-	8.6	568	0.84	0.397	12.2	29.5	-17.3	2.4	Non-Acid Forming			
																			Number of Samples	12	11	7

1. Current pH, EC, Alkalinity and Acidity provided for 1:5 sample:water extracts
2. Scr = Chromium Reducible Sulfur; MPA = Maximum Potential Acidity; ANC = Acid Neutralising Capacity; and NAPP = Net Acid Producing Potential.
3. Sample classification criteria detail provided in report text.

* Where total sulfur or ANC results are less than the laboratory LoR a value of half of the LoR is used in Table B1.

Table B2: Multi-Element Test Results for Overburden, Interburden, Potential Coal Reject, Coal Reject and Coal

	RGS Sample Number →		2021011_C1001	2021011_C1002	2021011_C1003	2021011_C1004	2021011_C1005	2021011_C3001	2021011_C3002	2021011_C3003	2021011_C3004	2021011_C2001	2021011_C2002	2021011_C2003
	ALS Laboratory ID →		EB2108504001	EB2108504002	EB2108504003	EB2108504004	EB2108504005	EB2108504009	EB2108504010	EB2108504011	EB2108504012	EB2108504006	EB2108504007	EB2108504008
	Sample description →													
Parameters	Limit of Reporting	NEPC[1] Health-Based Investigation Level (HILs)-C	Mixed Overburden	Sandstone Overburden	Siltstone Overburden	Sandstone Interburden	Siltstone Interburden	Roof	Roof	Floor	Floor	Tailing	Coarse Reject	Coal
Major Cations			All units mg/kg											
Calcium (Ca)	50	-	7,520	14,200	19,400	19,300	9,690	4,860	3,580	8,410	12,400	2,230	1,360	1,990
Magnesium (Mg)	50	-	3,520	6,050	5,510	4,810	4,010	2,860	2,500	3,850	4,580	3,730	3,970	2,250
Potassium (K)	50	-	1,200	940	1,160	1,170	1,330	1,100	1,220	1,180	1,160	1,400	1,600	1,070
Sodium (Na)	50	-	650	280	510	920	1,320	430	1,080	1,070	450	710	2,400	770
Major, Minor & Trace Elements	All units mg/kg													
Silver (Ag)	2	-	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Aluminium (Al)	50	-	7,170	10,600	11,000	7,870	8,140	8,160	5,910	4,800	4,180	3,260	3,610	2,360
Antimony (Sb)	0.1	-	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Arsenic (As)	0.1	300	<5	7	7	8	7	7	14	<5	<5	<5	<5	<5
Boron (B)	50	20,000	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Barium (Ba)	1	-	190	100	130	130	170	140	100	200	360	300	100	80
Beryllium (Be)	1	-	2	<1	1.0	<1	<1	<1	<1	1.0	<1	<1	<1	<1
Cadmium (Cd)	0.1	90	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chromium (Cr)	0.1	300 **	21	21	16	7	6	7	14	4	3	3	3	<2
Cobalt (Co)	0.1	300	30	14	12	11	13	8	10	6	11	4	4	<2
Copper (Cu)	0.1	17,000	23	29	41	45	55	41	36	48	51	31	43	16
Iron (Fe)	50	-	36,800	37,800	29,800	27,200	26,800	33,600	22,600	8,400	6,660	14,000	27,500	12,400
Lead (Pb)	0.1	600	9	12	15	14	15	19	15	18	18	10	11	6
Manganese (Mn)	0.1	19,000	887	623	396	434	488	573	353	75	44	216	261	178
Mercury (Hg)	0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum (Mo)	2		<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Nickel (Ni)	0.1	1,200	43	35	34	18	20	17	26	13	20	8	9	3
Reactive Phosphorous	0.1		0.1	0.8	0.4	0.4	0.5	0.5	0.3	0.4	0.5	<0.1	<0.1	<0.1
Selenium (Se)	1	700	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Thorium (Th)	1		2.0	2.0	1.6	2.3	2.1	3.2	3.2	1.3	1.1	1.0	1.0	1.1
Uranium (U)	0.1		0.6	0.4	0.4	0.3	0.3	0.5	0.6	0.3	0.3	0.6	0.3	0.3
Zinc (Zn)	0.5	30,000	66	59	70	75	82	64	75	73	85	40	47	34
Exchangable Cations	All units meq/100g (except Exchangable Sodium Percentage (%))													
Exch. Calcium	0.1	-	0.4	0.4	0.5	0.4	1.1	2.5	2.1	2.5	2.2	<0.2	<0.2	-
Exch. Magnesium	0.1	-	5.5	3.6	5.00	1.8	1.5	2.9	4.4	2.5	4.0	6.0	3.6	-
Exch. Potassium	0.1	-	<0.2	<0.2	<0.2	<0.2	0.2	0.3	<0.2	0.2	0.2	<0.2	<0.2	-
Exch. Sodium	0.1	-	4.5	5.3	8.1	8.6	9.3	6.0	5.1	6.6	5.5	5.8	4.9	-
Cation Exchange Capacity	0.1	-	10.4	9.3	13.7	11.0	12.1	11.7	11.8	11.8	11.9	11.7	8.5	-
Calcium:Magnesium Ratio	-	-	<0.2	<0.2	<0.2	<0.2	0.7	0.9	0.5	1.0	0.6	<0.2	<0.2	-
Magnesium:Potassium Ratio	-	-	----	----	----	----	6.7	10.3	----	11.0	19.1	----	----	-
Exchangable Sodium Percentage	0.1%	-	43.0	57.0	59.3	78.4	76.6	51.5	43.7	55.7	46.1	49.3	57.6	-

Notes:

< indicates less than the laboratory limit of reporting. Shaded cells exceed applied guideline limit. ** Guideline level for Cr(VI) = 300 mg/kg. Guideline level for Cr(III) = 24% of total Cr.

1. NEPC (2013). National Environmental Protection Council (NEPC). *National Environmental Protection (Assessment of Site Contamination) Measure (NEPM)*, Amendment of Schedule B1-B7 of 1999 version. Guideline on Investigation Levels for Soil and Groundwater. Health-Based Investigation Level - HIL(C); public open spaces - recreational use.

Table B3: Geochemical Abundance Index (GAI) Results for Overburden, Interburden, Potential Coal Reject, Coal Reject and Coal

	RGS Sample Number →		2021011_C1001	2021011_C1002	2021011_C1003	2021011_C1004	2021011_C1005	2021011_C3001	2021011_C3002	2021011_C3003	2021011_C3004	2021011_C2001	2021011_C2002	2021011_C2003
	ALS Laboratory ID →		EB2108504001	EB2108504002	EB2108504003	EB2108504004	EB2108504005	EB2108504009	EB2108504010	EB2108504011	EB2108504012	EB2108504006	EB2108504007	EB2108504008
	Sample description →		Mixed Overburden	Sandstone Overburden	Siltstone Overburden	Sandstone Interburden	Siltstone Interburden	Roof	Roof	Floor	Floor	Tailing	Coarse Reject	Coal
Parameters	Limit of Reporting	Median Crustal Abundance[1]												
Major Elements	All units mg/kg		Geochemical Abundance Index											
Calcium (Ca)	50	15,000	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium (Mg)	50	5,000	0	0	0	0	0	0	0	0	0	0	0	0
Potassium (K)	50	14,000	0	0	0	0	0	0	0	0	0	0	0	0
Sodium (Na)	50	5,000	0	0	0	0	0	0	0	0	0	0	0	0
Major, Minor & Trace Elements	All units mg/kg		Geochemical Abundance Index											
Aluminium (Al)	50	71,000	0	0	0	0	0	0	0	0	0	0	0	0
Antimony (Sb)	0.1	5	0	0	0	0	0	0	0	0	0	0	0	0
Arsenic (As)	0.1	6	0	0	0	0	0	0	1	0	0	0	0	0
Boron (B)	50	100	0	0	0	0	0	0	0	0	0	0	0	0
Barium (Ba)	10	500	0	0	0	0	0	0	0	0	0	0	0	0
Beryllium (Be)	1	6	0	0	0	0	0	0	0	0	0	0	0	0
Cadmium (Cd)	0.1	0.35	0	0	0	0	0	0	0	0	0	0	0	0
Chromium (Cr)	0.1	70	0	0	0	0	0	0	0	0	0	0	0	0
Cobalt (Co)	0.1	8	1	0	0	0	0	0	0	0	0	0	0	0
Copper (Cu)	0.1	30	0	0	0	0	0	0	0	0	0	0	0	0
Iron (Fe)	50	40,000	0	0	0	0	0	0	0	0	0	0	0	0
Lead (Pb)	0.1	35	0	0	0	0	0	0	0	0	0	0	0	0
Manganese (Mn)	0.1	1000	0	0	0	0	0	0	0	0	0	0	0	0
Mercury (Hg)	0.1	0.06	0	0	0	0	0	0	0	0	0	0	0	0
Molybdenum (Mo)	2	2	0	0	0	0	0	0	0	0	0	0	0	0
Nickel (Ni)	0.1	50	0	0	0	0	0	0	0	0	0	0	0	0
Reactive Phosphorous	0.1	800	0	0	0	0	0	0	0	0	0	0	0	0
Selenium (Se)	1	0.4	2	2	2	2	2	2	2	2	2	2	2	2
Thorium (Th)	1	9	0	0	0	0	0	0	0	0	0	0	0	0
Uranium (U)	0.1	2	0	0	0	0	0	0	0	0	0	0	0	0
Zinc (Zn)	0.5	90	0	0	0	0	0	0	0	0	0	0	0	0

Notes: GAI's greater than or equal to 3 are highlighted.

1. Media Crustal Abundance values sourced from the "GARD Guide", Chapter 5 (INAP, 2009). When no GARD Guide value is available, values are taken from Bowen H.J.M.(1979) Environmental Chemistry of the Elements, pages 60-61.

Table B4: Multi-Element Test Results for Water Extracts from Overburden, Interburden, Potential Coal Reject, Coal Reject and Coal

		RGS Sample Number →		2021011_C1001	2021011_C1002	2021011_C1003	2021011_C1004	2021011_C1005	2021011_C3001	2021011_C3002	2021011_C3003	2021011_C3004	2021011_C2001	2021011_C2002	2021011_C2003
		ALS Laboratory ID →		EB2108504001	EB2108504002	EB2108504003	EB2108504004	EB2108504005	EB2108504009	EB2108504010	EB2108504011	EB2108504012	EB2108504006	EB2108504007	EB2108504008
		Sample description →													
		Water Quality Guidelines:													
Parameters	Limit of Reporting	Aquatic Ecosystems (freshwater)[1]	Livestock Drinking Water[2]	Mixed Overburden	Sandstone Overburden	Siltstone Overburden	Sandstone Interburden	Siltstone Interburden	Roof	Roof	Floor	Floor	Tailings	Coarse Reject	Coal
pH	0.01 pH unit	6 to 9	-	7.8	9.3	9.3	9.6	9.5	8.4	8.8	9.0	9.5	9.2	9.3	9.4
Electrical Conductivity	1 µS/cm	-	3,580^	1,080	650	634	550	582	2,230	1,080	417	509	810	379	733
Carbonate Alkalinity ($mgCaCO_3/L$)	0.2 mg/L	-	-	<0.2	191	104	173	156	156	69	35	87	17	35	17
Bicarbonate Alkalinity ($mgCaCO_3/L$)	0.2 mg/L	-	-	442	2,660	694	814	814	564	2,220	486	658	4,060	1,292	736
Total Alkalinity ($mgCaCO_3/L$)	0.2 mg/L	-	-	442	2,840	798	988	970	720	2,300	520	746	4,080	1,326	754
Total Acidity ($mgCaCO_3/L$)	0.2 mg/L	-	-	19	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Net Alkalinity ($mgCaCO_3/L$)	0.2 mg/L	-	-	347	2,840	798	988	970	720	2,300	520	746	4,080	1,326	754
Major Ions (1:5 w:v extract)	All units mg/L			All units mg/L											
Calcium (Ca)	2	-	1,000	<2	<2	<2	<2	<2	<2	<2	<2	<2	24	6	8
Magnesium (Mg)	2	-	-	2	<2	<2	<2	<2	<2	<2	<2	<2	28	4	6
Potassium (K)	2	-	-	4	4	4	4	4	4	6	<2	4	8	4	2
Sodium (Na)	2	-	-	194	124	122	112	118	104	162	82	144	414	208	132
Chloride (Cl)	2	-	-	320	98	90	20	28	42	120	56	96	586	170	98
Fluoride (F)	0.2	-	2	0.6	<0.2	0.4	<0.2	<0.2	<0.2	0.4	0.2	0.6	0.4	0.6	0.2
Sulfate (SO_4)	2	-	1,000	48	32	28	36	44	38	124	32	90	316	226	164
Trace Metals/Metalloids (1:5 w:v extract)	All units mg/L			All units mg/L											
Aluminium (Al)	0.02	0.055	5	<0.02	0.20	0.20	0.50	0.46	0.34	0.10	0.32	0.18	<0.02	0.04	0.02
Antimony (Sb)	0.002	-	-	<0.002	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.01	<0.002	<0.002	<0.002
Arsenic (As) - trivalent	0.002	0.024 *	0.5	<0.002	0.056	0.066	0.174	0.168	0.212	0.218	0.166	0.100	<0.002	0.006	0.002
Boron (B)	0.2	0.37	5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Barium (Ba)	0.002	-	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.02	0.03	0.02	0.02
Beryllium (Be)	0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cadmium (Cd)	0.002	0.0002	0.01	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium (Cr) - total	0.002	-	1 (total)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cobalt (Co)	0.002	-	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Copper (Cu)	0.002	0.0014	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Iron (Fe)	0.2	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Lead (Pb)	0.002	0.0034	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Manganese (Mn)	0.002	1.90	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Mercury (Hg)	0.0001	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum (Mo)	0.002	-	0.15	0.004	0.012	0.036	0.068	0.094	0.094	0.106	0.114	0.156	0.016	0.012	0.006
Nickel (Ni)	0.002	0.011	1	<0.002	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.008	<0.002	<0.002	<0.002	<0.002
Selenium (Se)	0.02	0.011	0.02	<0.02	<0.02	<0.02	0.02	0.04	0.04	0.02	0.04	0.04	<0.02	<0.02	<0.02
Thorium (Th)	0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Uranium (U)	0.002	-	0.2	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Vanadium (V)	0.02	-	-	<0.02	<0.02	<0.02	0.06	0.06	0.04	0.02	0.04	0.06	<0.02	<0.02	<0.02
Zinc (Zn)	0.01	0.008	20	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes:

< indicates concentration less than the detection limit. Shaded cells are above applied guideline values. * 0.013 mg/L for pentavalent Arsenic (V).

^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC. TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water.

ANZECC & ARMCANZ (2000). 1. Trigger values for aquatic ecosystems (95% species protection level). 2. Recommended guideline limits for Livestock Drinking Water.

Attachment C: KLC Results and Trends

KLC 1 Overburden

Weight (kg)	2.00	Total S (%)	0.02	ANC	16.6	
pH (1:5)	9.30	Scr (%)	0.020	NAPP	-16.0	
EC (µS/cm)	588	MPA	0.6	ANC:MPA	27.1	

			WQ Guidelines[a]							
Date				01-Apr-21	29-Apr-21	27-May-21	24-Jun-21	22-Jul-21	19-Aug-21	16-Sep-21
Number of Weeks				0	4	8	12	16	20	24
Leach Number				1	2	3	4	5	6	7
ALS Laboratory Number				EB2108916001	EB2111591001	EB2114626001	EB2117744001	EB2120541001	EB2123329001	EB2126256001
Volume On (L)				1.0	1.0	1.0	1.0	1.0	1.0	1.0
Volume Off (L)				0.487	0.591	0.668	0.673	0.681	0.702	0.701
Cum. Volume (L)				0.49	1.08	1.75	2.42	3.10	3.80	4.50
Pore Volumes				0.4	0.8	1.3	1.8	2.3	2.8	3.3
pH (RGS Measurement)				6.76	6.97	7.11	7.25	7.21	6.49	6.68
pH (ALS Measurement)				7.07	7.22	7.05	7.08	7.00	6.99	7.17
pH (deionised water used in test)				6.89	6.27	7.04	7.06	7.02	6.30	7.64
EC (RGS Measurement) (µS/cm)				1,968	625	323	501	236	222	242
EC (ALS Measurement) (µS/cm)				2,040	651	326	414	200	237	241
Acidity (mg/L as $CaCO_3$)*				4	2	2	3	2	3	3
Hydroxide Alkalinity (mg/L as $CaCO_3$)*				<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity (mg/L as $CaCO_3$)*				<1	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity (mg/L as $CaCO_3$)*				23	10	10	12	8	12	10
Total Alkalinity (mg/L as $CaCO_3$)*				23	10	10	12	8	12	10
Net Alkalinity (mg/L as $CaCO_3$)*				19	8	8	9	6	9	7
Major Ions (mg/L)	Elements	LoR	WQ Guidelines[a]							
Calcium	(Ca)	1	1,000	12	2	2	3	<1	1	2
Potassium	(K)	1	-	2	1	<1	3	<1	<1	<1
Magnesium	(Mg)	1	-	14	2	2	2	<1	1	1
Sodium	(Na)	1	-	381	124	58	66	35	39	46
Chloride	(Cl)	1	-	640	188	85	107	47	48	57
Fluoride	(F)	0.1	2	0.6	0.2	0.1	0.1	<0.1	<0.1	<0.1
Sulfate	(SO_4)	1	1,000	101	26	18	21	16	16	16
Trace metals/ metalloids (mg/L)	Elements	LoR	WQ Guidelines[a]							
Aluminium	(Al)	0.01	5	<0.01	0.27	0.35	0.20	0.40	0.52	0.29
Antimony	(Sb)	0.001	-	0.003	<0.001	0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	(As)	0.001	0.5	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	(B)	0.05	5	0.07	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	(Cd)	0.0001	0.01	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	(Cr)	0.001	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	(Co)	0.001	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	(Cu)	0.001	1	0.002	<0.001	0.002	<0.001	<0.001	<0.001	<0.001
Iron	(Fe)	0.05	-	<0.05	0.09	0.13	0.10	0.16	0.20	0.10
Lead	(Pb)	0.001	0.1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	(Mn)	0.001	-	0.012	0.002	0.001	0.002	0.002	0.002	0.002
Mercury	(Hg)	0.0001	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	(Mo)	0.001	0.15	0.007	0.003	0.002	0.002	0.001	0.002	0.002
Nickel	(Ni)	0.001	1	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001
Selenium	(Se)	0.01	0.02	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	(V)	0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	(Zn)	0.005	20	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005

< indicates less than the analytical limit of reporting (LoR)

* Acidity and alkalinity data calculated in mg CaCO3/L.

** SO_4, Ca and Mg release rates calculated in mg/kg/flush.

Residual ANC assumes all leached Mg and Ca is dissolution of calcite or dolomite

Total S = Total Sulfur; Scr = Chromium Reducible Sulfur; and ANC = Acid Neutralising Capacity.

MPA = Maximum Potential Acidity, and NAPP = Net Acid Producing Potential.

a. AWQG (2018). Recommended Guideline Values for Livestock Drinking Water

KLC 2 Interburden

Weight (kg)	2.01	Total S (%)	0.03	ANC	34.5	
pH (1:5)	9.70	Scr (%)	0.030	NAPP	-33.6	
EC (µS/cm)	326	MPA	0.9	ANC:MPA	37.6	

		WQ Guidelines[a]							
Date			01-Apr-21	29-Apr-21	27-May-21	24-Jun-21	22-Jul-21	19-Aug-21	16-Sep-21
Number of Weeks			0	4	8	12	16	20	24
Leach Number			1	2	3	4	5	6	7
ALS Laboratory Number			EB2108916002	EB2111591002	EB2114626002	EB2117744002	EB2120541002	EB2123329002	EB2126256002
Volume On (L)			1.0	1.0	1.0	1.0	1.0	1.0	1.0
Volume Off (L)			0.624	0.643	0.610	0.637	0.598	0.642	0.606
Cum. Volume (L)			0.62	1.27	1.88	2.51	3.11	3.75	4.36
Pore Volumes			0.5	0.9	1.4	1.9	2.3	2.8	3.2
pH (RGS Measurement)			8.57	7.69	8.45	8.59	9.22	8.37	7.86
pH (ALS Measurement)			8.23	7.47	7.17	8.07	8.18	8.07	8.05
pH (deionised water used in test)			6.89	6.27	7.04	7.06	7.02	6.30	7.64
EC (RGS Measurement) (µS/cm)			181	246	311	396	406	352	401
EC (ALS Measurement) (µS/cm)			179	243	298	342	361	373	389
Acidity (mg/L as $CaCO_3$)*			1	2	1	2	<1	<1	<1
Hydroxide Alkalinity (mg/L as $CaCO_3$)*			<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity (mg/L as $CaCO_3$)*			<1	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity (mg/L as $CaCO_3$)*			27	16	22	31	32	34	45
Total Alkalinity (mg/L as $CaCO_3$)*			27	16	22	31	32	34	45
Net Alkalinity (mg/L as $CaCO_3$)*			26	14	21	29	32	34	45
Major Ions (mg/L)	Elements	LoR	WQ Guidelines[a]						
Calcium	(Ca)	1	1,000	0.5	<1	<1	<1	<1	<1	<1
Potassium	(K)	1	-	1	1	<1	<1	<1	9	1
Magnesium	(Mg)	1	-	0.5	<1	<1	<1	<1	<1	<1
Sodium	(Na)	1	-	35	48	59	62	72	75	86
Chloride	(Cl)	1	-	20	32	37	37	44	31	38
Fluoride	(F)	0.1	2	0.1	0.2	0.2	0.2	0.2	0.2	0.3
Sulfate	(SO_4)	1	1,000	26	40	48	46	56	68	70
Trace metals/ metalloids (mg/L)	Elements	LoR	WQ Guidelines[a]						
Aluminium	(Al)	0.01	5	1.99	1.80	0.71	1.12	1.44	0.58	1.80
Antimony	(Sb)	0.001	-	0.002	<0.001	0.001	0.001	0.001	<0.001	<0.001
Arsenic	(As)	0.001	0.5	0.024	0.012	0.012	0.011	0.012	0.009	0.01
Boron	(B)	0.05	5	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	(Cd)	0.0001	0.01	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	(Cr)	0.001	1	0.001	0.001	<0.001	<0.001	0.001	<0.001	0.002
Cobalt	(Co)	0.001	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	(Cu)	0.001	1	0.004	0.003	0.002	0.003	0.004	0.002	0.005
Iron	(Fe)	0.05	-	0.15	0.13	0.07	0.15	0.12	0.06	0.13
Lead	(Pb)	0.001	0.1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	(Mn)	0.001	-	0.002	0.002	0.002	0.002	0.001	0.001	0.002
Mercury	(Hg)	0.0001	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	(Mo)	0.001	0.15	0.014	0.016	0.025	0.032	0.034	0.044	0.050
Nickel	(Ni)	0.001	1	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	<0.001
Selenium	(Se)	0.01	0.02	0.01	0.02	0.02	0.02	0.03	0.03	0.03
Vanadium	(V)	0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	(Zn)	0.005	20	<0.005	<0.005	<0.005	0.006	0.005	0.008	0.009

< indicates less than the analytical limit of reporting (LoR)

* Acidity and alkalinity data calculated in mg CaCO3/L.

** SO_4, Ca and Mg release rates calculated in mg/kg/flush.

Residual ANC assumes all leached Mg and Ca is dissolution of calcite or dolomite

Total S = Total Sulfur; Scr = Chromium Reducible Sulfur; and ANC = Acid Neutralising Capacity.

MPA = Maximum Potential Acidity, and NAPP = Net Acid Producing Potential.

a. AWQG (2018). Recommended Guideline Values for Livestock Drinking Water

KLC 3 Roof

Weight (kg)	2.00	Total S (%)	0.09	ANC	23.4	
pH (1:5)	9.10	Scr (%)	0.085	NAPP	-20.8	
EC (µS/cm)	437	MPA	2.6	ANC:MPA	9.0	

	WQ Guidelines[a]							
Date		13-Apr-21	11-May-21	08-Jun-21	06-Jul-21	03-Aug-21	31-Aug-21	28-Sep-21
Number of Weeks		0	4	8	12	16	20	24
Leach Number		1	2	3	4	5	6	7
ALS Laboratory Number		EB2109870001	EB2112795001	EB2115898001	EB2118810001	EB2121733001	EB2124585001	EB2127422001
Volume On (L)		1.0	1.0	1.0	1.0	1.0	1.0	1.0
Volume Off (L)		0.457	0.533	0.532	0.557	0.562	0.442	0.485
Cum. Volume (L)		0.46	0.99	1.52	2.08	2.64	3.08	3.57
Pore Volumes		0.3	0.7	1.1	1.5	2.0	2.3	2.6
pH (RGS Measurement)		7.40	6.69	7.27	6.87	7.52	7.40	6.66
pH (ALS Measurement)		7.42	7.39	6.43	7.33	7.4	7.61	7.38
pH (deionised water used in test)		7.15	7.44	6.94	6.73	7.23	7.96	7.15
EC (RGS Measurement) (µS/cm)		647	912	1,485	950	674	937	869
EC (ALS Measurement) (µS/cm)		706	1000	1400	918	683	899	1,050
Acidity (mg/L as $CaCO_3$)*		2	2	6	3	4	1	2
Hydroxide Alkalinity (mg/L as $CaCO_3$)*		<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity (mg/L as $CaCO_3$)*		<1	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity (mg/L as $CaCO_3$)*		28	14	17	16	10	25	29
Total Alkalinity (mg/L as $CaCO_3$)*		28	14	17	16	10	25	29
Net Alkalinity (mg/L as $CaCO_3$)*		26	12	11	13	6	24	27
Major Ions (mg/L)	**Elements**	**LoR**	**WQ Guidelines[a]**					
Calcium	(Ca)	1	1,000	3	5	8	6	3	7	7
Potassium	(K)	1	-	1	1	2	1	1	1	2
Magnesium	(Mg)	1	-	2	4	8	4	2	5	6
Sodium	(Na)	1	-	133	193	257	172	118	186	206
Chloride	(Cl)	1	-	135	164	221	111	87	92	116
Fluoride	(F)	0.1	2	0.3	0.2	0.3	0.3	0.2	0.3	0.4
Sulfate	(SO_4)	1	1,000	86	205	364	263	160	234	283
Trace metals/ metalloids (mg/L)	**Elements**	**LoR**	**WQ Guidelines[a]**							
Aluminium	(Al)	0.01	5	0.54	0.10	0.02	0.09	0.99	0.11	0.04
Antimony	(Sb)	0.001	-	<0.001	0.001	<0.001	<0.001	<0.001	0.002	<0.001
Arsenic	(As)	0.001	0.5	0.054	0.019	0.013	0.012	0.011	0.012	0.014
Boron	(B)	0.05	5	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	(Cd)	0.0001	0.01	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	(Cr)	0.001	1	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001
Cobalt	(Co)	0.001	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	(Cu)	0.001	1	0.002	<0.001	<0.001	<0.001	0.002	0.001	0.001
Iron	(Fe)	0.05	-	<0.05	<0.05	<0.05	<0.05	0.07	<0.05	<0.05
Lead	(Pb)	0.001	0.1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	(Mn)	0.001	-	0.005	0.007	0.008	0.006	0.003	0.006	0.003
Mercury	(Hg)	0.0001	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	(Mo)	0.001	0.15	0.044	0.046	0.055	0.041	0.017	0.031	0.034
Nickel	(Ni)	0.001	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	(Se)	0.01	0.02	0.03	0.06	0.08	0.05	0.03	0.03	0.04
Vanadium	(V)	0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	(Zn)	0.005	20	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005

< indicates less than the analytical limit of reporting (LoR)

* Acidity and alkalinity data calculated in mg CaCO3/L.

** SO_4, Ca and Mg release rates calculated in mg/kg/flush.

Residual ANC assumes all leached Mg and Ca is dissolution of calcite or dolomite

Total S = Total Sulfur; Scr = Chromium Reducible Sulfur; and ANC = Acid Neutralising Capacity.

MPA = Maximum Potential Acidity, and NAPP = Net Acid Producing Potential.

a. AWQG (2018). Recommended Guideline Values for Livestock Drinking Water

KLC 4 Floor

Weight (kg)	2.00	Total S (%)	0.08	ANC	13.0	
pH (1:5)	9.10	Scr (%)	0.080	NAPP	-10.6	
EC (µS/cm)	348	MPA	2.5	ANC:MPA	5.3	

		WQ Guidelines[a]							
Date			13-Apr-21	11-May-21	08-Jun-21	06-Jul-21	03-Aug-21	31-Aug-21	28-Sep-21
Number of Weeks			0	4	8	12	16	20	24
Leach Number			1	2	3	4	5	6	7
ALS Laboratory Number			EB2109870002	EB2112795002	EB2115898002	EB2118810002	EB2121733002	EB2124585002	EB2127422002
Volume On (L)			1.0	1.0	1.0	1.0	1.0	1.0	1.0
Volume Off (L)			0.411	0.517	0.524	0.539	0.562	0.431	0.360
Cum. Volume (L)			0.41	0.93	1.45	1.99	2.55	2.98	3.34
Pore Volumes			0.3	0.7	1.1	1.5	1.9	2.2	2.5
pH (RGS Measurement)			7.71	7.04	7.34	7.05	7.52	7.62	7.35
pH (ALS Measurement)			7.59	7.29	6.63	7.48	7.98	8.02	8.17
pH (deionised water used in test)			7.15	7.44	6.94	6.73	7.23	7.96	7.15
EC (RGS Measurement) (µS/cm)			843	808	1,385	970	674	1,189	1,900
EC (ALS Measurement) (µS/cm)			906	866	1290	942	1470	1,140	2,320
Acidity (mg/L as $CaCO_3$)*			2	1	3	3	3	1	<1
Hydroxide Alkalinity (mg/L as $CaCO_3$)*			<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity (mg/L as $CaCO_3$)*			<1	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity (mg/L as $CaCO_3$)*			42	15	22	21	66	79	114
Total Alkalinity (mg/L as $CaCO_3$)*			42	15	22	21	66	79	114
Net Alkalinity (mg/L as $CaCO_3$)*			40	14	19	18	63	78	114
Major Ions (mg/L)	Elements	LoR	WQ Guidelines[a]						
Calcium	(Ca)	1	1,000	2	2	4	2	5	4	10
Potassium	(K)	1	-	2	1	2	1	2	2	3
Magnesium	(Mg)	1	-	1	1	3	2	3	3	10
Sodium	(Na)	1	-	175	172	243	184	275	250	506
Chloride	(Cl)	1	-	199	186	280	150	221	154	357
Fluoride	(F)	0.1	2	0.5	0.3	0.4	0.4	0.9	0.7	1.2
Sulfate	(SO_4)	1	1,000	113	110	223	216	334	228	499
Trace metals/ metalloids (mg/L)	Elements	LoR	WQ Guidelines[a]						
Aluminium	(Al)	0.01	5	0.55	0.70	0.07	0.46	1.16	0.37	0.02
Antimony	(Sb)	0.001	-	0.002	0.001	<0.001	0.001	0.004	0.008	0.006
Arsenic	(As)	0.001	0.5	0.047	0.014	0.012	0.018	0.037	0.038	0.037
Boron	(B)	0.05	5	<0.05	<0.05	<0.05	<0.05	0.06	0.05	0.05
Cadmium	(Cd)	0.0001	0.01	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001
Chromium	(Cr)	0.001	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	(Co)	0.001	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	(Cu)	0.001	1	0.002	0.001	0.001	0.003	0.003	0.003	0.004
Iron	(Fe)	0.05	-	<0.05	<0.05	<0.05	<0.05	0.07	<0.05	<0.05
Lead	(Pb)	0.001	0.1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	(Mn)	0.001	-	0.001	0.001	0.001	<0.001	<0.001	<0.001	0.002
Mercury	(Hg)	0.0001	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	(Mo)	0.001	0.15	0.104	0.146	0.193	0.148	0.195	0.141	0.287
Nickel	(Ni)	0.001	1	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	(Se)	0.01	0.02	0.05	0.07	0.11	0.08	0.12	0.10	0.22
Vanadium	(V)	0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	(Zn)	0.005	20	<0.005	<0.005	<0.005	0.005	<0.005	<0.005	<0.005

< indicates less than the analytical limit of reporting (LoR)

* Acidity and alkalinity data calculated in mg CaCO3/L.

** SO_4, Ca and Mg release rates calculated in mg/kg/flush.

Residual ANC assumes all leached Mg and Ca is dissolution of calcite or dolomite

Total S = Total Sulfur; Scr = Chromium Reducible Sulfur; and ANC = Acid Neutralising Capacity.

MPA = Maximum Potential Acidity, and NAPP = Net Acid Producing Potential.

a. AWQG (2018). Recommended Guideline Values for Livestock Drinking Water

KLC 5 Tailings

Weight (kg)	2.10	Total S (%)	0.83	ANC	65.5	
pH (1:5)	8.50	Scr (%)	0.529	NAPP	-49.3	
EC (µS/cm)	2,030	MPA	16.2	ANC:MPA	4.0	

			WQ Guidelines[a]							
Date				01-Apr-21	29-Apr-21	27-May-21	24-Jun-21	22-Jul-21	19-Aug-21	16-Sep-21
Number of Weeks				0	4	8	12	16	20	24
Leach Number				1	2	3	4	5	6	7
ALS Laboratory Number				EB2108916003	EB2111591003	EB2114626003	EB2117744003	EB2120541003	EB2123329003	EB2126256003
Volume On (L)				1.0	1.0	1.0	1.0	1.0	1.0	1.0
Volume Off (L)				0.988	0.869	0.818	0.772	0.769	0.797	0.849
Cum. Volume (L)				0.99	1.86	2.68	3.45	4.22	5.01	5.86
Pore Volumes				0.9	1.4	2.0	2.6	3.1	3.7	4.3
pH (RGS Measurement)				7.57	7.36	7.30	7.66	7.73	7.16	7.45
pH (ALS Measurement)				7.31	7.11	6.63	7.10	7.2	7.19	7.39
pH (deionised water used in test)				6.89	6.27	7.04	7.06	7.02	6.30	7.64
EC (RGS Measurement) (µS/cm)				2,055	1,912	1,254	1,394	1,109	1,507	1,099
EC (ALS Measurement) (µS/cm)				1,660	2,000	1,260	1,230	1,070	1,800	1,020
Acidity (mg/L as $CaCO_3$)*				3	2	1	2	1	2	4
Hydroxide Alkalinity (mg/L as $CaCO_3$)*				<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity (mg/L as $CaCO_3$)*				<1	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity (mg/L as $CaCO_3$)*				16	8	7	11	9	12	14
Total Alkalinity (mg/L as $CaCO_3$)*				16	8	7	11	9	12	14
Net Alkalinity (mg/L as $CaCO_3$)*				13	6	6	9	8	10	10
Major Ions (mg/L)	Elements	LoR	WQ Guidelines[a]							
Calcium	(Ca)	1	1,000	12	18	12	14	8	10	9
Potassium	(K)	1	-	<1	<1	<1	<1	<1	<1	<1
Magnesium	(Mg)	1	-	20	47	28	26	15	43	22
Sodium	(Na)	1	-	238	328	193	177	168	267	164
Chloride	(Cl)	1	-	480	471	296	307	284	448	250
Fluoride	(F)	0.1	2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2
Sulfate	(SO_4)	1	1,000	164	345	195	162	126	230	121
Trace metals/ metalloids (mg/L)	Elements	LoR	WQ Guidelines[a]							
Aluminium	(Al)	0.01	5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Antimony	(Sb)	0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	(As)	0.001	0.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	(B)	0.05	5	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	(Cd)	0.0001	0.01	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	(Cr)	0.001	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	(Co)	0.001	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	(Cu)	0.001	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Iron	(Fe)	0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Lead	(Pb)	0.001	0.1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	(Mn)	0.001	-	0.003	0.002	0.002	0.002	<0.001	0.002	0.001
Mercury	(Hg)	0.0001	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	(Mo)	0.001	0.15	0.002	0.002	0.001	0.002	0.002	0.002	0.003
Nickel	(Ni)	0.001	1	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	<0.001
Selenium	(Se)	0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	(V)	0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	(Zn)	0.005	20	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005

< indicates less than the analytical limit of reporting (LoR)

* Acidity and alkalinity data calculated in mg CaCO3/L.

** SO_4, Ca and Mg release rates calculated in mg/kg/flush.

Residual ANC assumes all leached Mg and Ca is dissolution of calcite or dolomite

Total S = Total Sulfur; Scr = Chromium Reducible Sulfur; and ANC = Acid Neutralising Capacity.

MPA = Maximum Potential Acidity, and NAPP = Net Acid Producing Potential.

a. AWQG (2018). Recommended Guideline Values for Livestock Drinking Water

KLC 6 Coarse Reject

Weight (kg)	1.73	Total S (%)	1.62	ANC	38.1	
pH (1:5)	8.70	Scr (%)	1.130	NAPP	-3.5	
EC (µS/cm)	1,012	MPA	34.6	ANC:MPA	1.1	

		WQ Guidelines[a]							
Date			01-Apr-21	29-Apr-21	27-May-21	24-Jun-21	22-Jul-21	19-Aug-21	16-Sep-21
Number of Weeks			0	4	8	12	16	20	24
Leach Number			1	2	3	4	5	6	7
ALS Laboratory Number			EB2108916004	EB2111591004	EB2114626004	EB2117744004	EB2120541004	EB2123329004	EB2126256004
Volume On (L)			1.0	1.0	1.0	1.0	1.0	1.0	1.0
Volume Off (L)			0.687	0.720	0.735	0.692	0.684	0.717	0.661
Cum. Volume (L)			0.69	1.41	2.14	2.83	3.52	4.24	4.90
Pore Volumes			0.5	1.0	1.6	2.1	2.6	3.1	3.6
pH (RGS Measurement)			7.06	5.20	3.82	4.00	3.84	3.71	4.01
pH (ALS Measurement)			6.96	4.93	3.93	3.79	3.83	3.85	3.92
pH (deionised water used in test)			6.89	6.27	7.04	7.06	7.02	6.30	7.64
EC (RGS Measurement) (µS/cm)			2,470	2,084	2,554	2,848	2,147	1,847	2,111
EC (ALS Measurement) (µS/cm)			2,770	2,260	2,820	2,870	2,300	2,400	1,970
Acidity (mg/L as $CaCO_3$)*			3	34	151	114	72	60	50
Hydroxide Alkalinity (mg/L as $CaCO_3$)*			<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity (mg/L as $CaCO_3$)*			<1	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity (mg/L as $CaCO_3$)*			8	<1	<1	<1	<1	<1	<1
Total Alkalinity (mg/L as $CaCO_3$)*			8	<1	<1	<1	<1	<1	<1
Net Alkalinity (mg/L as $CaCO_3$)*			5	-34	-151	-114	-72	-60	-50
Major Ions (mg/L)	Elements	LoR	WQ Guidelines[a]						
Calcium	(Ca)	1	1,000	46	45	62	56	70	71	82
Potassium	(K)	1	-	2	2	2	2	1	2	2
Magnesium	(Mg)	1	-	35	42	72	78	69	94	83
Sodium	(Na)	1	-	500	387	419	372	305	306	232
Chloride	(Cl)	1	-	560	275	247	223	131	101	62
Fluoride	(F)	0.1	2	0.2	<0.1	0.1	0.1	0.1	0.1	0.1
Sulfate	(SO_4)	1	1,000	696	791	1,080	1,160	981	1,020	924
Trace metals/ metalloids (mg/L)	Elements	LoR	WQ Guidelines[a]							
Aluminium	(Al)	0.01	5	<0.01	0.17	1.27	0.92	0.98	1.16	0.97
Antimony	(Sb)	0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	(As)	0.001	0.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	(B)	0.05	5	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	(Cd)	0.0001	0.01	0.0001	0.0006	0.0013	0.0011	0.001	0.0011	0.0011
Chromium	(Cr)	0.001	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	(Co)	0.001	1	0.005	0.019	0.032	0.025	0.028	0.03	0.03
Copper	(Cu)	0.001	1	<0.001	0.017	0.061	0.051	0.055	0.065	0.082
Iron	(Fe)	0.05	-	<0.05	13.1	74.8	36.1	23.8	14.2	7.4
Lead	(Pb)	0.001	0.1	<0.001	<0.001	0.004	0.002	0.002	0.002	0.002
Manganese	(Mn)	0.001	-	0.180	0.972	3.180	1.950	3.120	3.620	3.460
Mercury	(Hg)	0.0001	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	(Mo)	0.001	0.15	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	(Ni)	0.001	1	0.006	0.024	0.042	0.038	0.04	0.048	0.049
Selenium	(Se)	0.01	0.02	<0.01	<0.01	0.01	0.01	0.01	0.01	<0.01
Vanadium	(V)	0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	(Zn)	0.005	20	0.012	0.076	0.149	0.131	0.174	0.202	0.214

< indicates less than the analytical limit of reporting (LoR)

* Acidity and alkalinity data calculated in mg CaCO3/L.

** SO_4, Ca and Mg release rates calculated in mg/kg/flush.

Residual ANC assumes all leached Mg and Ca is dissolution of calcite or dolomite

Total S = Total Sulfur; Scr = Chromium Reducible Sulfur; and ANC = Acid Neutralising Capacity.

MPA = Maximum Potential Acidity, and NAPP = Net Acid Producing Potential.

a. AWQG (2018). Recommended Guideline Values for Livestock Drinking Water

KLC 7 Coal Feed Reserve

Weight (kg)	1.43	Total S (%)	0.74	ANC	27.9	
pH (1:5)	8.60	Scr (%)	0.331	NAPP	-6.3	
EC (µS/cm)	578	MPA	10.1	ANC:MPA	2.8	

			WQ Guidelines[a]							
Date				01-Apr-21	29-Apr-21	27-May-21	24-Jun-21	22-Jul-21	19-Aug-21	16-Sep-21
Number of Weeks				0	4	8	12	16	20	24
Leach Number				1	2	3	4	5	6	7
ALS Laboratory Number				EB2108916005	EB2111591005	EB2114626005	EB2117744005	EB2120541005	EB2123329005	EB2126256005
Volume On (L)				1.0	1.0	1.0	1.0	1.0	1.0	1.0
Volume Off (L)				0.614	0.738	0.714	0.710	0.715	0.717	0.706
Cum. Volume (L)				0.61	1.35	2.07	2.78	3.49	4.21	4.91
Pore Volumes				0.5	1.0	1.5	2.1	2.6	3.1	3.6
pH (RGS Measurement)				7.44	6.32	5.89	5.92	5.85	5.54	5.49
pH (ALS Measurement)				7.26	6.48	5.16	6.13	5.76	5.69	6.08
pH (deionised water used in test)				6.89	6.27	7.04	7.06	7.02	6.30	7.64
EC (RGS Measurement) (µS/cm)				1,155	1,654	2,264	1,557	1,305	1,253	1,536
EC (ALS Measurement) (µS/cm)				1,210	1730	2440	1480	1290	1,550	1,430
Acidity (mg/L as $CaCO_3$)*				3	3	4	6	6	7	10
Hydroxide Alkalinity (mg/L as $CaCO_3$)*				<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity (mg/L as $CaCO_3$)*				<1	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity (mg/L as $CaCO_3$)*				15	3	<1	3	<1	1	4
Total Alkalinity (mg/L as $CaCO_3$)*				15	3	<1	3	<1	1	4
Net Alkalinity (mg/L as $CaCO_3$)*				12	0	-4	-3	-6	-6	-6
Major Ions (mg/L)	Elements	LoR	WQ Guidelines[a]							
Calcium	(Ca)	1	1,000	30	39	79	48	62	82	99
Potassium	(K)	1	-	<1	1	2	1	<1	2	2
Magnesium	(Mg)	1	-	16	38	68	44	41	58	60
Sodium	(Na)	1	-	196	279	373	195	145	164	139
Chloride	(Cl)	1	-	205	192	248	103	69	58	48
Fluoride	(F)	0.1	2	0.2	<0.1	0.1	0.1	<0.1	<0.1	0.1
Sulfate	(SO_4)	1	1,000	320	623	937	614	587	708	700
Trace metals/ metalloids (mg/L)	Elements	LoR	WQ Guidelines[a]							
Aluminium	(Al)	0.01	5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Antimony	(Sb)	0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	(As)	0.001	0.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	(B)	0.05	5	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	(Cd)	0.0001	0.01	<0.0001	<0.0001	0.0003	0.0002	0.0001	0.0002	0.0002
Chromium	(Cr)	0.001	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	(Co)	0.001	1	<0.001	0.004	0.007	0.005	0.004	0.006	0.006
Copper	(Cu)	0.001	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Iron	(Fe)	0.05	-	<0.05	0.10	0.97	0.78	1.18	1.74	1.55
Lead	(Pb)	0.001	0.1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	(Mn)	0.001	-	0.104	0.410	0.906	0.482	0.715	1.060	1.160
Mercury	(Hg)	0.0001	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	(Mo)	0.001	0.15	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	(Ni)	0.001	1	<0.001	0.003	0.005	0.005	0.003	0.005	0.006
Selenium	(Se)	0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	(V)	0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	(Zn)	0.005	20	<0.005	0.006	0.018	0.014	0.016	0.023	0.027

< indicates less than the analytical limit of reporting (LoR)

* Acidity and alkalinity data calculated in mg CaCO3/L.

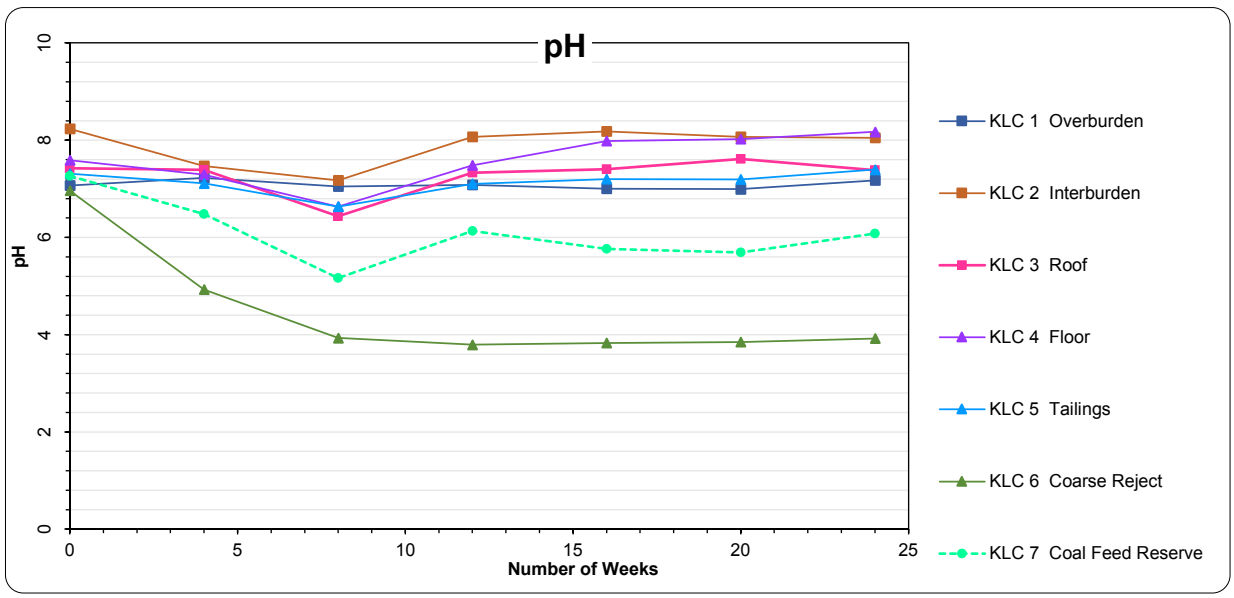
** SO_4, Ca and Mg release rates calculated in mg/kg/flush.

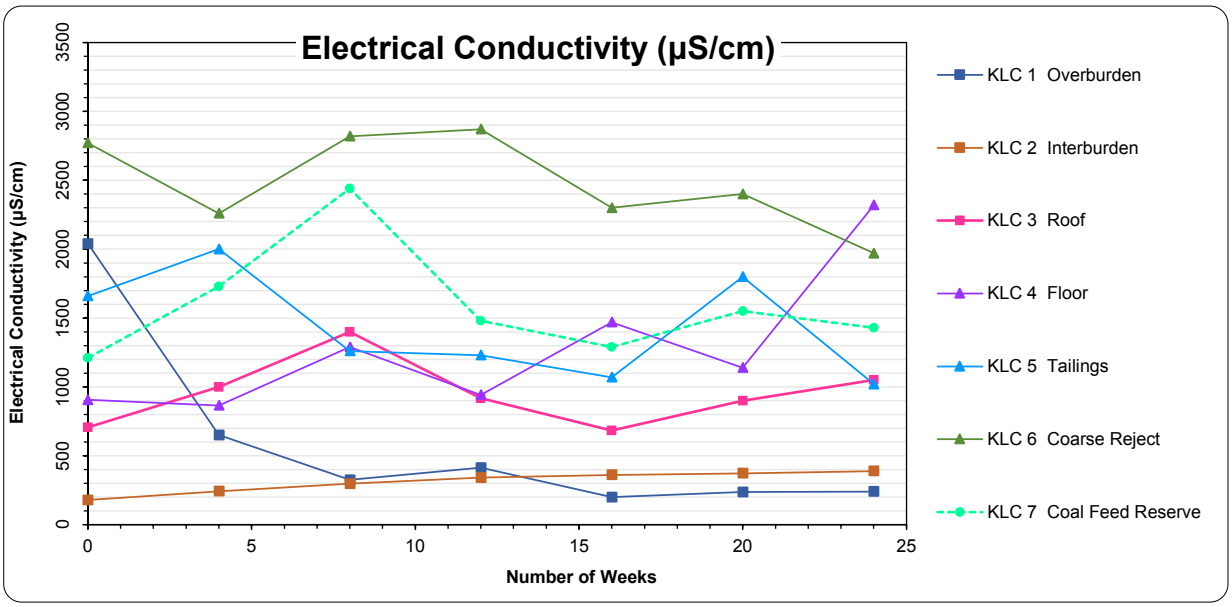
Residual ANC assumes all leached Mg and Ca is dissolution of calcite or dolomite

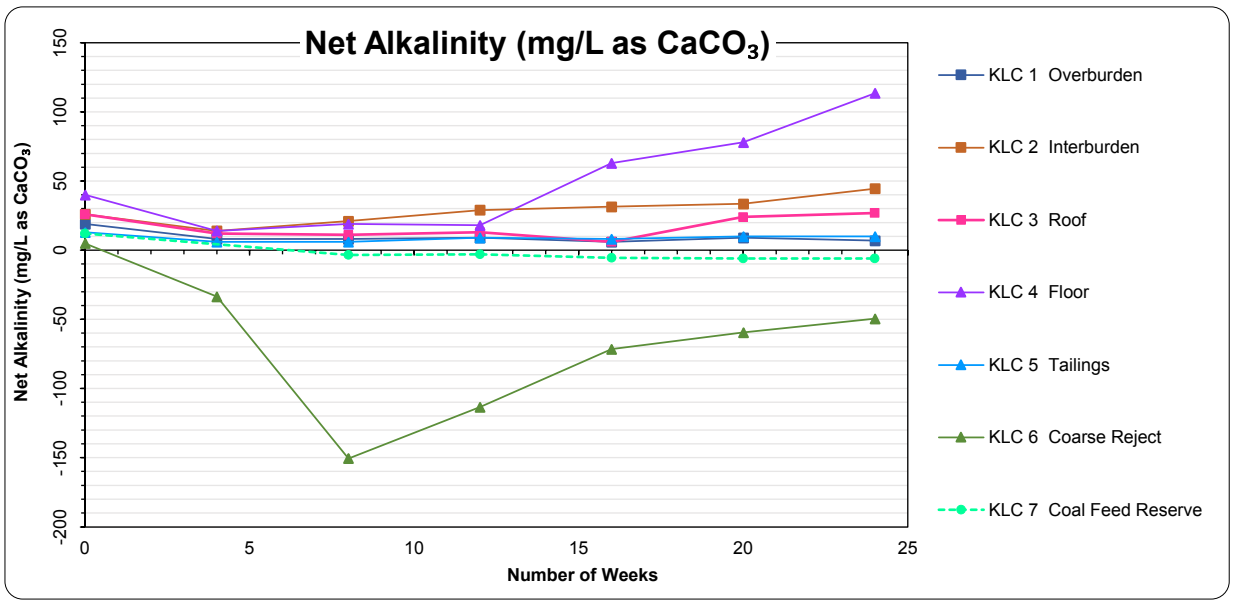
Total S = Total Sulfur; Scr = Chromium Reducible Sulfur; and ANC = Acid Neutralising Capacity.

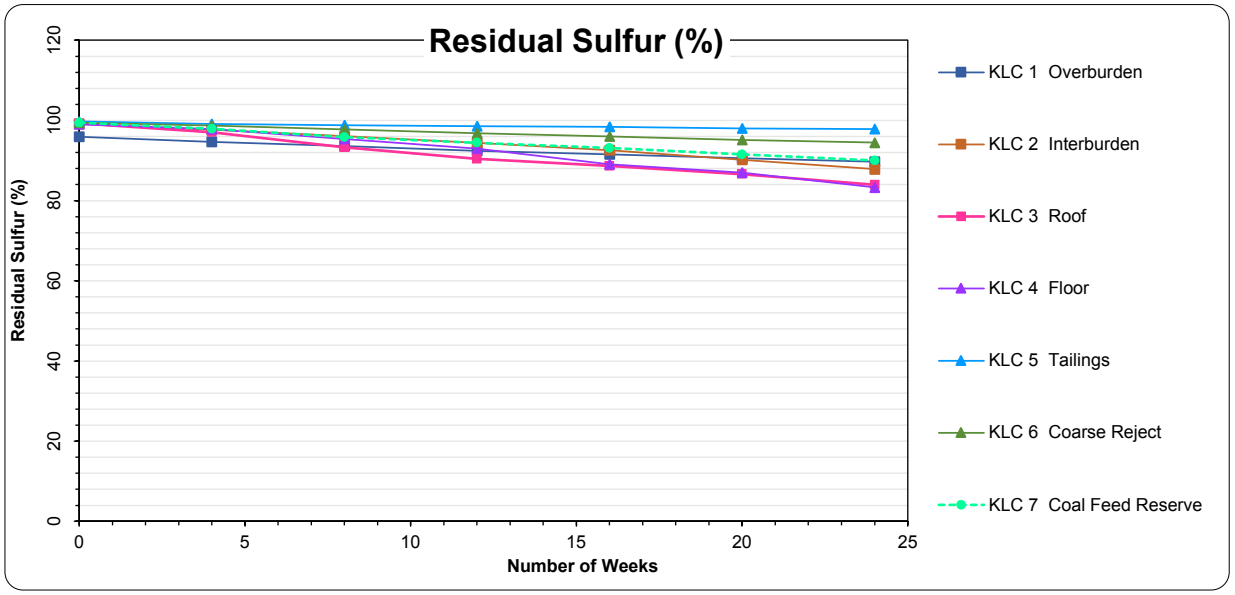
MPA = Maximum Potential Acidity, and NAPP = Net Acid Producing Potential.

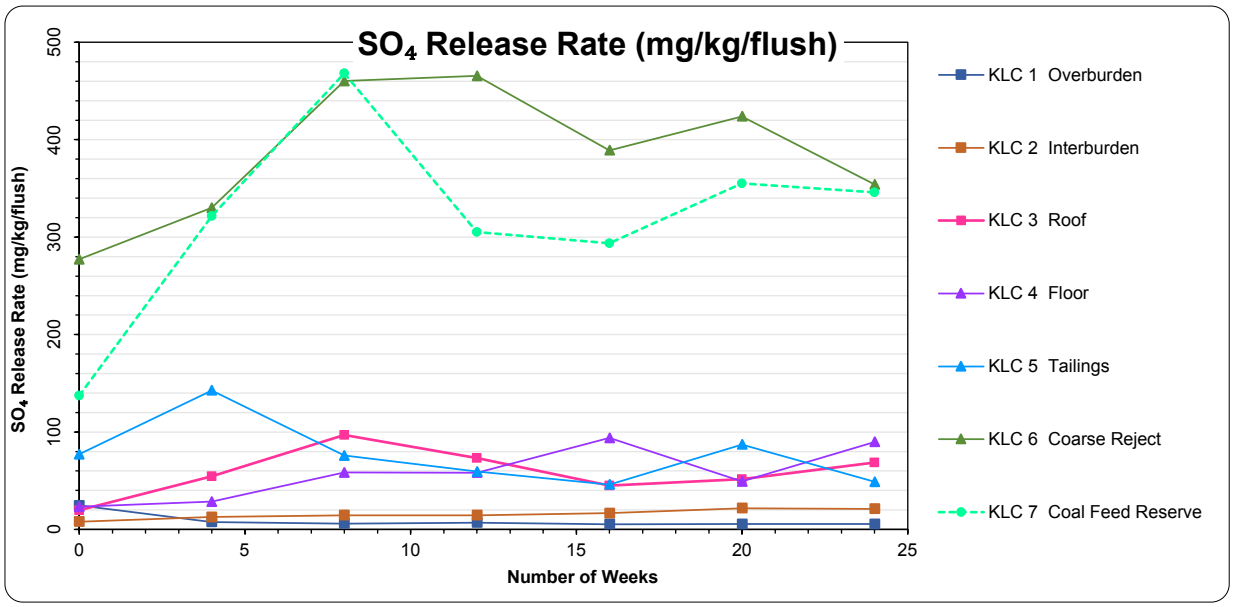
a. AWQG (2018). Recommended Guideline Values for Livestock Drinking Water

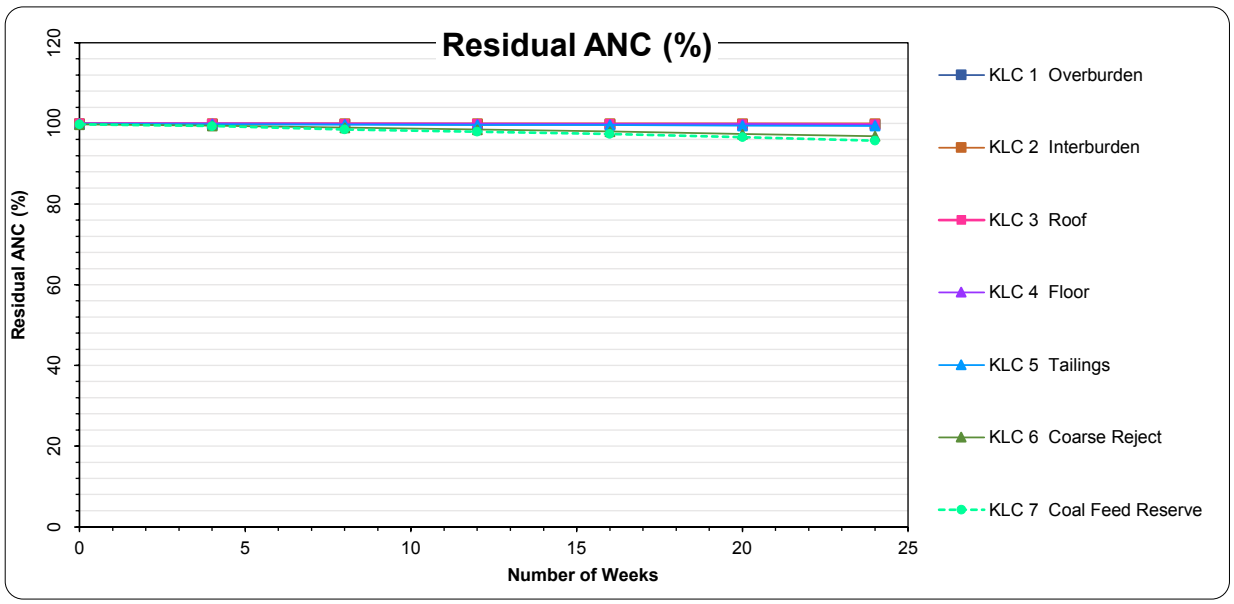

pH
pH
Number of Weeks
KLC 1 Overburden
KLC 2 Interburden
KLC 3 Roof
KLC 4 Floor
KLC 5 Tailings
KLC 6 Coarse Reject
KLC 7 Coal Feed Reserve

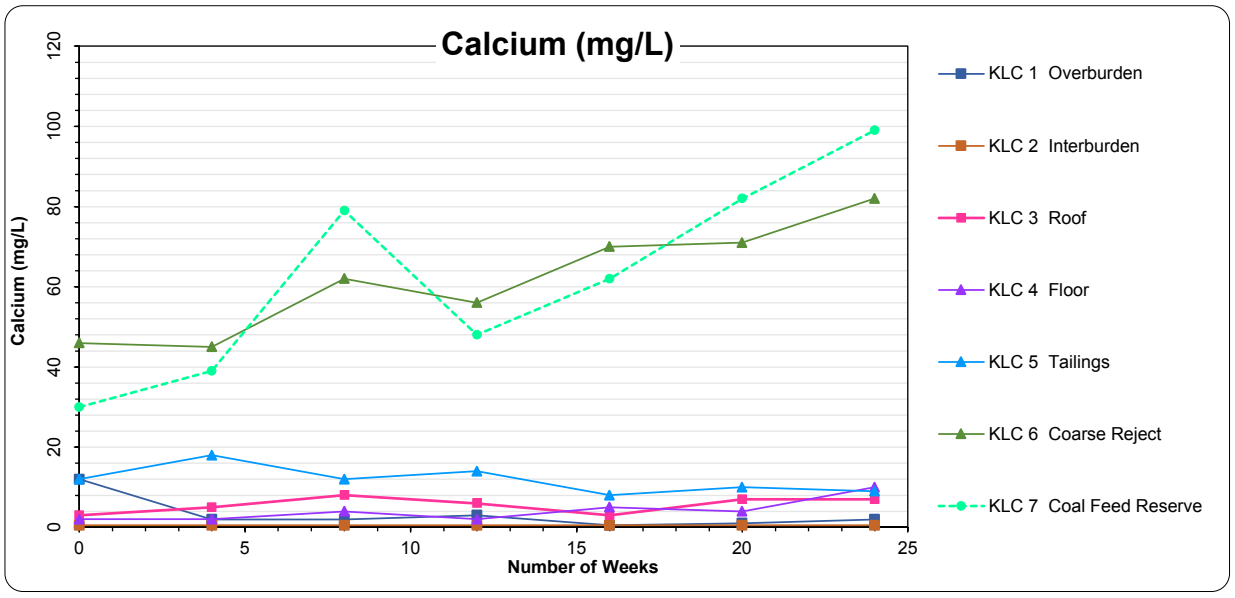

Electrical Conductivity (µS/cm)
Electrical Conductivity (µS/cm)
Number of Weeks
KLC 1 Overburden
KLC 2 Interburden
KLC 3 Roof
KLC 4 Floor
KLC 5 Tailings
KLC 6 Coarse Reject
KLC 7 Coal Feed Reserve

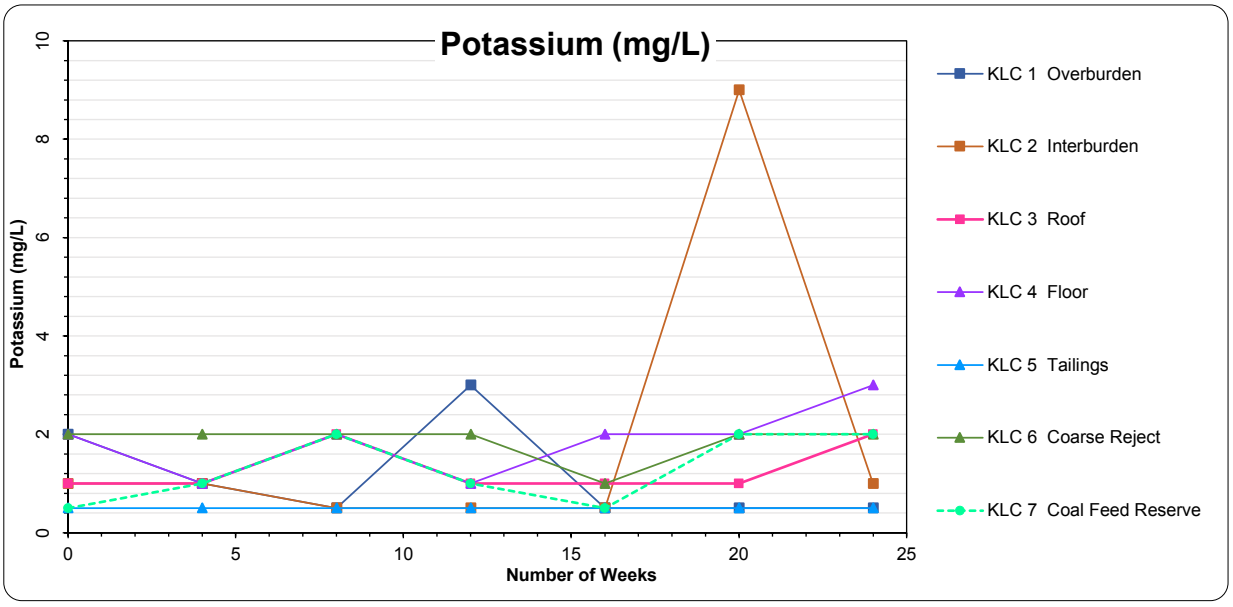

Net Alkalinity (mg/L as CaCO3)
Net Alkalinity (mg/L as CaCO3)
Number of Weeks
KLC 1 Overburden
KLC 2 Interburden
KLC 3 Roof
KLC 4 Floor
KLC 5 Tailings
KLC 6 Coarse Reject
KLC 7 Coal Feed Reserve

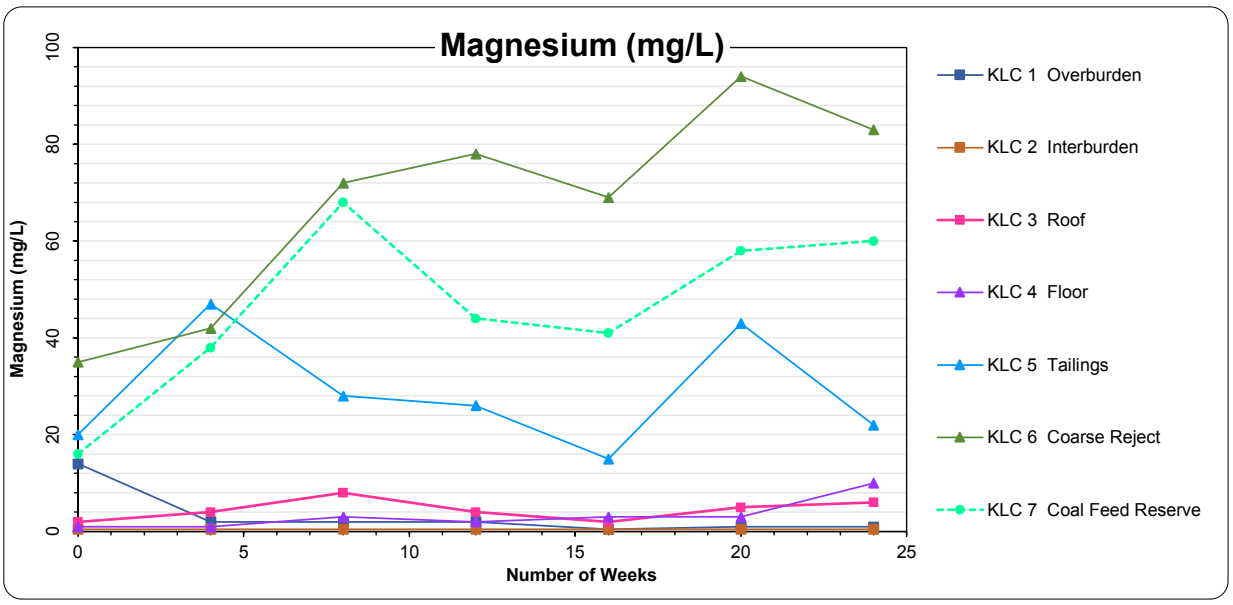

Residual Sulfur (%)
Residual Sulfur (%)
Number of Weeks
0
20
40
60
80
100
120
0
5
10
15
20
25
KLC 1 Overburden
KLC 2 Interburden
KLC 3 Roof
KLC 4 Floor
KLC 5 Tailings
KLC 6 Coarse Reject
KLC 7 Coal Feed Reserve

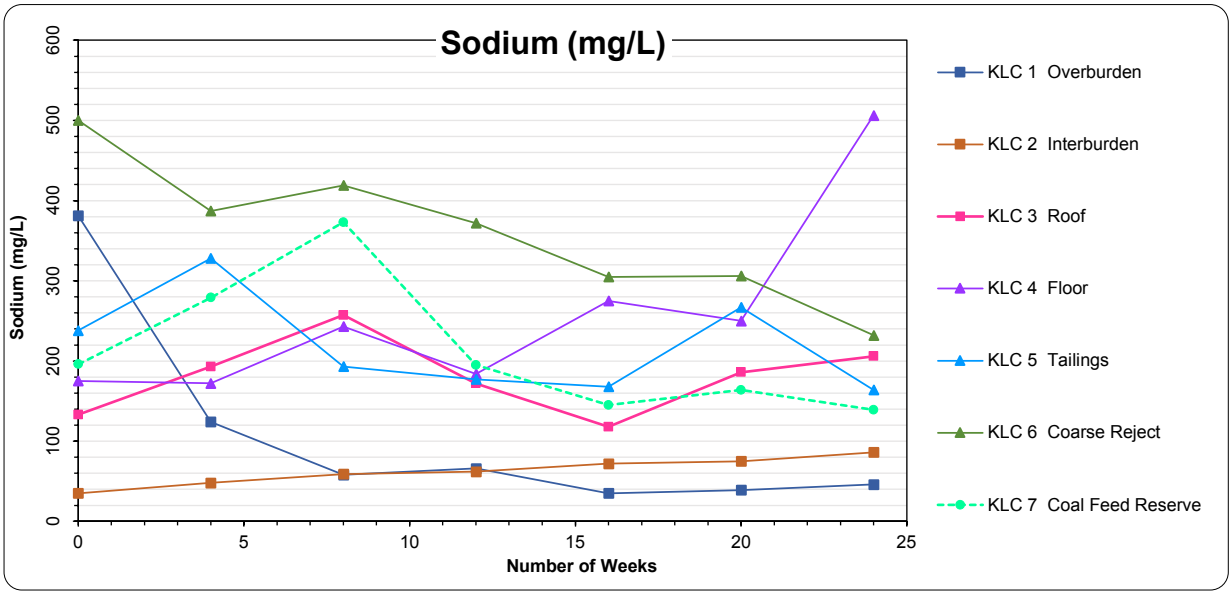

SO4 Release Rate (mg/kg/flush)
SO4 Release Rate (mg/kg/flush)
Number of Weeks
0
100
200
300
400
500
0
5
10
15
20
25
KLC 1 Overburden
KLC 2 Interburden
KLC 3 Roof
KLC 4 Floor
KLC 5 Tailings
KLC 6 Coarse Reject
KLC 7 Coal Feed Reserve

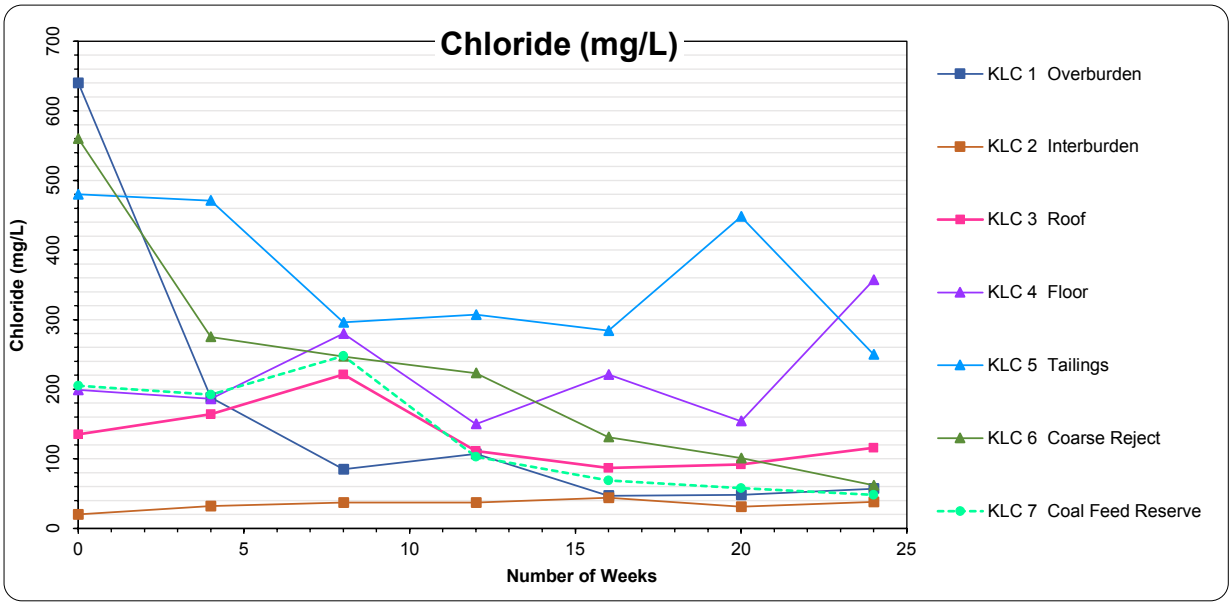

Residual ANC (%)
Residual ANC (%)
Number of Weeks
0
20
40
60
80
100
120
0
5
10
15
20
25
KLC 1 Overburden
KLC 2 Interburden
KLC 3 Roof
KLC 4 Floor
KLC 5 Tailings
KLC 6 Coarse Reject
KLC 7 Coal Feed Reserve

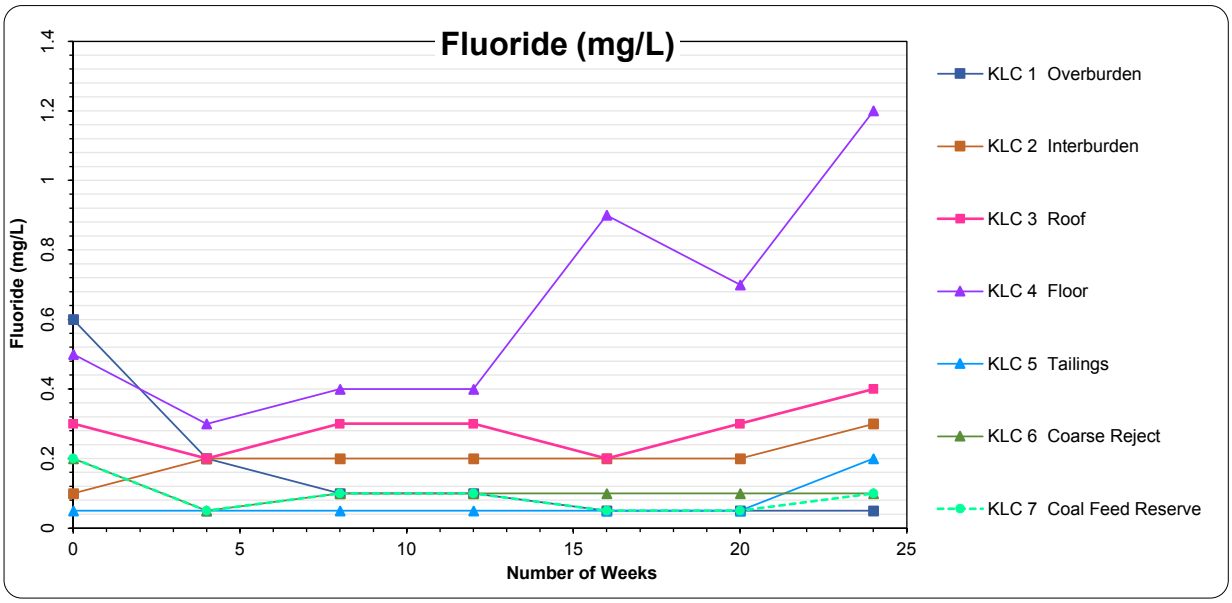

Calcium (mg/L)
Calcium (mg/L)
0
20
40
60
80
100
120
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Interburden
KLC 3 Roof
KLC 4 Floor
KLC 5 Tailings
KLC 6 Coarse Reject
KLC 7 Coal Feed Reserve

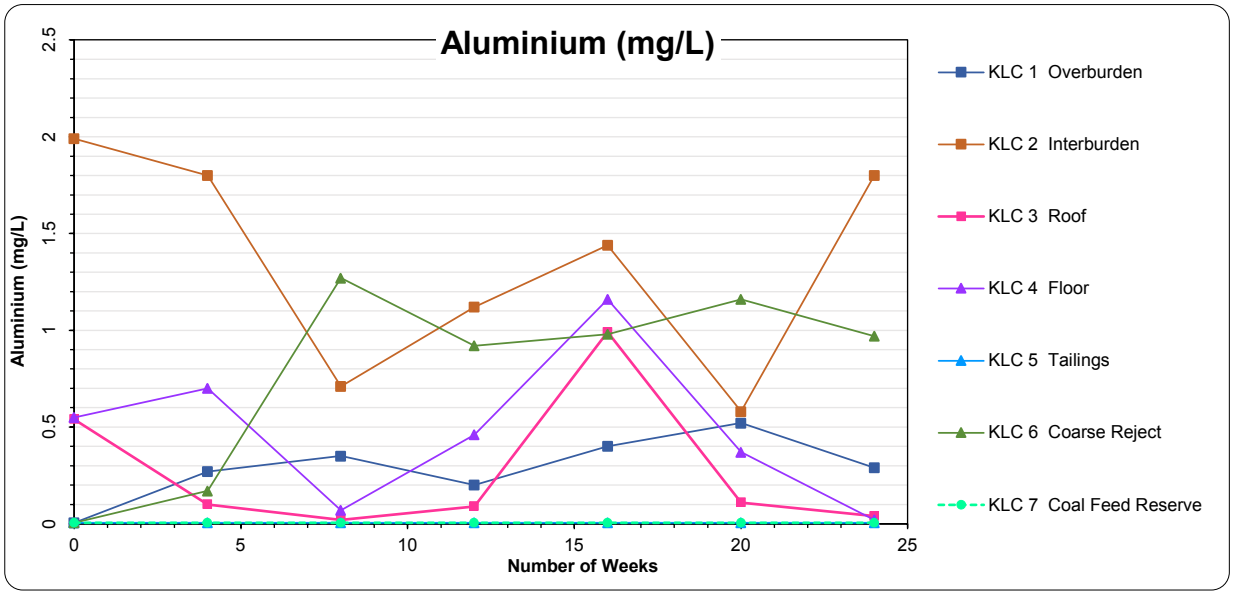

Potassium (mg/L)
Potassium (mg/L)
0
2
4
6
8
10
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Interburden
KLC 3 Roof
KLC 4 Floor
KLC 5 Tailings
KLC 6 Coarse Reject
KLC 7 Coal Feed Reserve

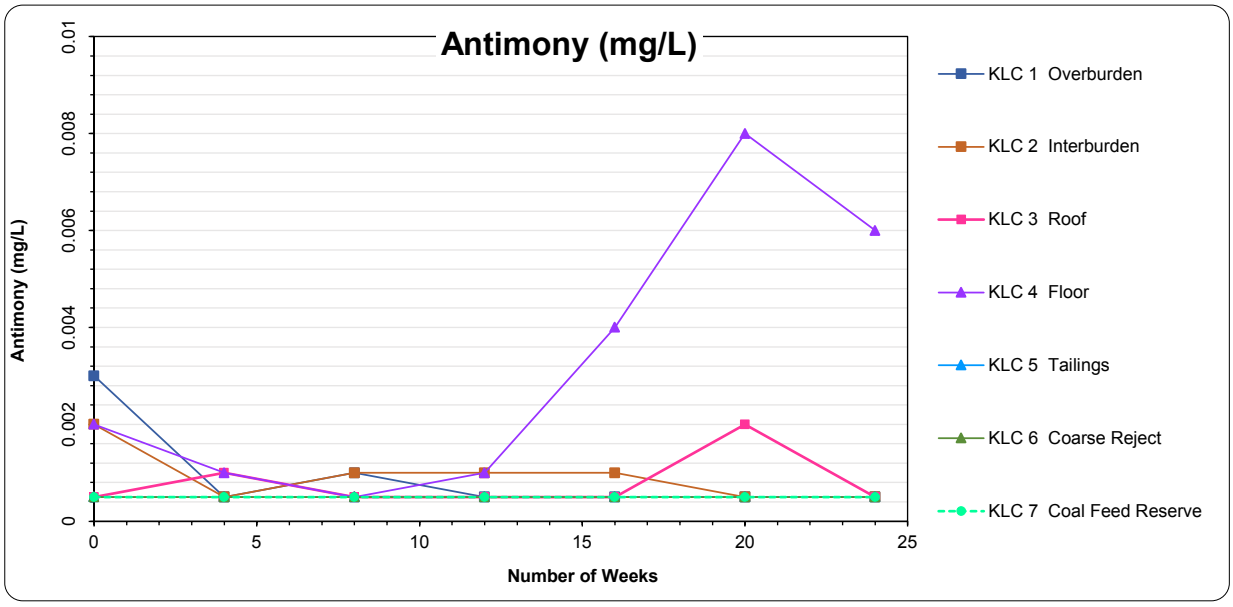

Magnesium (mg/L)
Magnesium (mg/L)
0
20
40
60
80
100
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Interburden
KLC 3 Roof
KLC 4 Floor
KLC 5 Tailings
KLC 6 Coarse Reject
KLC 7 Coal Feed Reserve

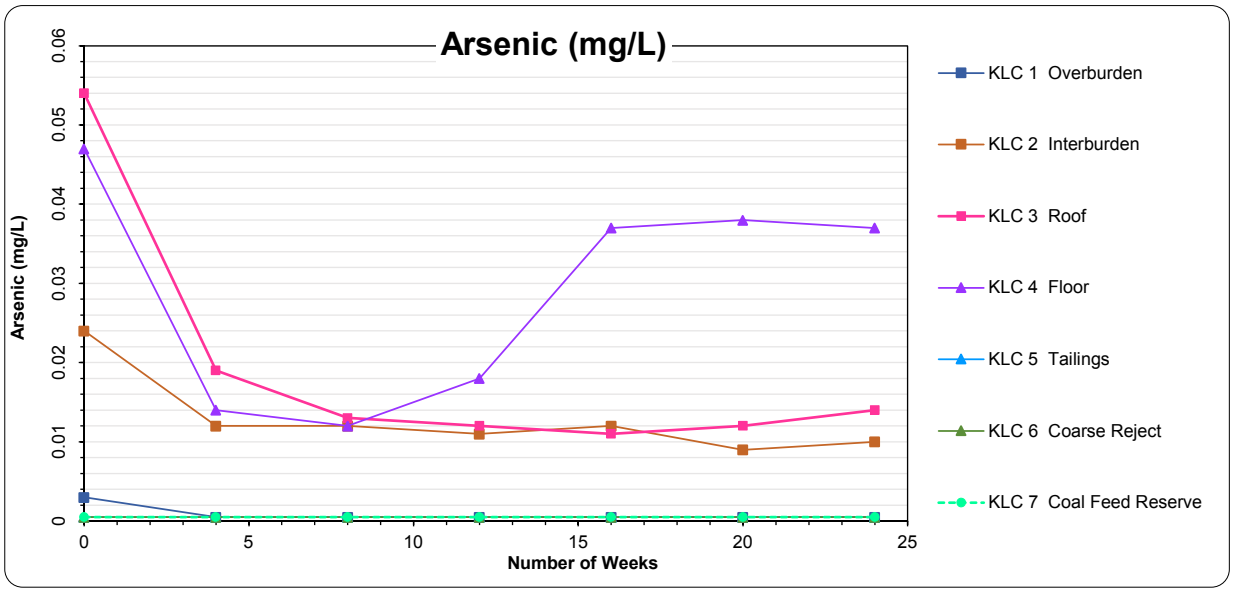

Sodium (mg/L)
Sodium (mg/L)
0
100
200
300
400
500
600
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Interburden
KLC 3 Roof
KLC 4 Floor
KLC 5 Tailings
KLC 6 Coarse Reject
KLC 7 Coal Feed Reserve

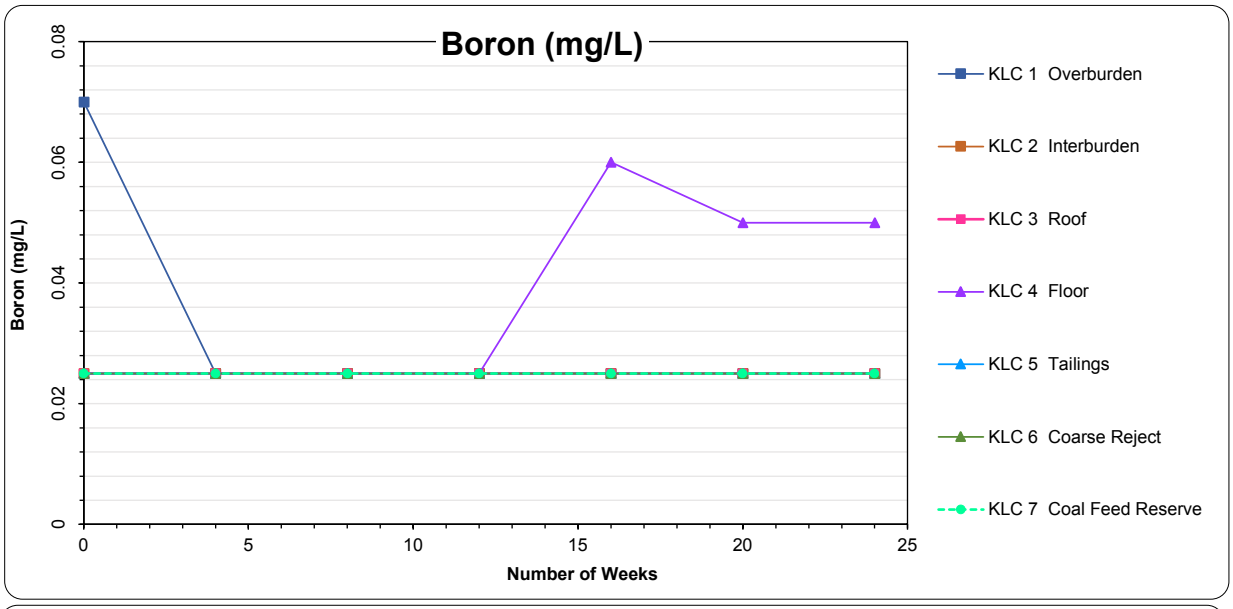

Chloride (mg/L)
Chloride (mg/L)
0
100
200
300
400
500
600
700
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Interburden
KLC 3 Roof
KLC 4 Floor
KLC 5 Tailings
KLC 6 Coarse Reject
KLC 7 Coal Feed Reserve

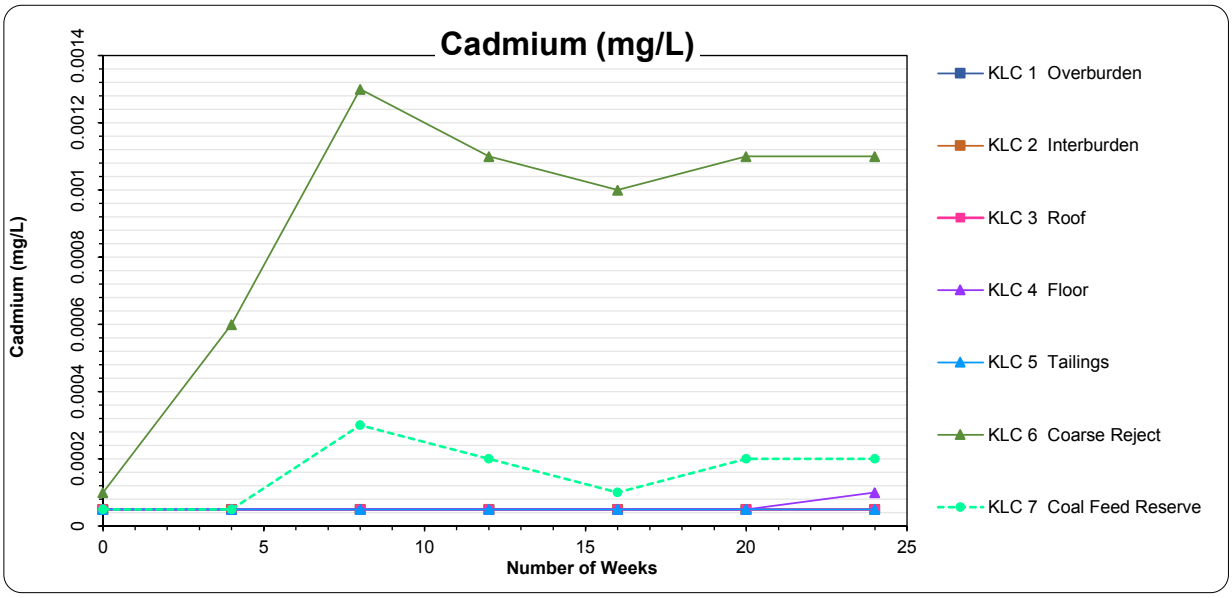

Fluoride (mg/L)
Fluoride (mg/L)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Interburden
KLC 3 Roof
KLC 4 Floor
KLC 5 Tailings
KLC 6 Coarse Reject
KLC 7 Coal Feed Reserve

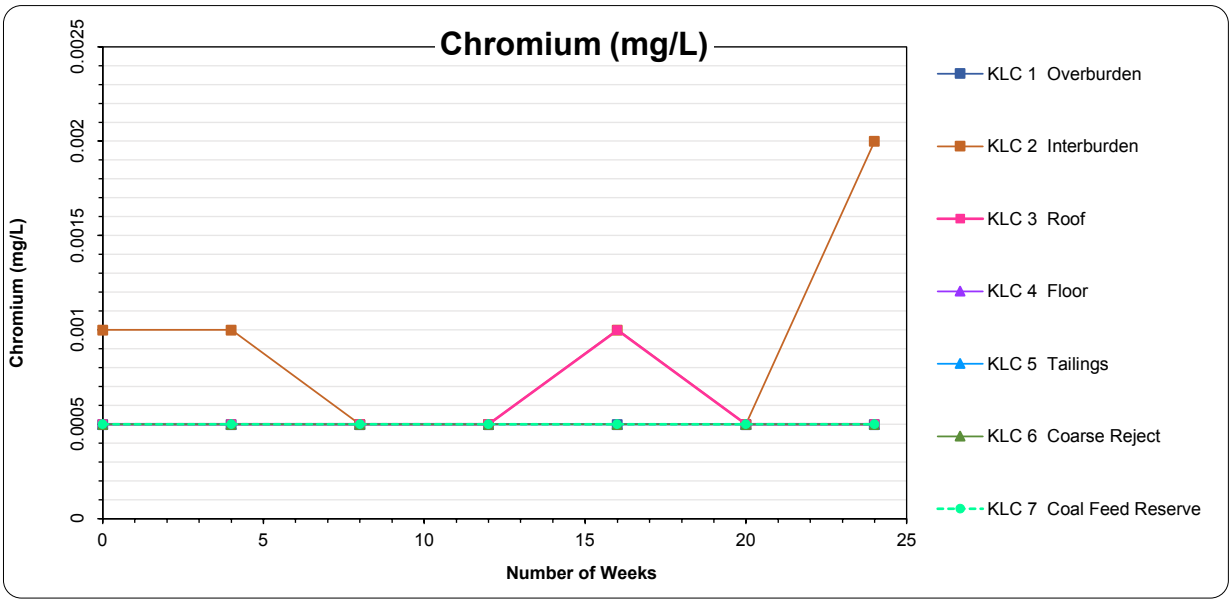

Aluminium (mg/L)
Aluminium (mg/L)
0
0.5
1
1.5
2
2.5
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Interburden
KLC 3 Roof
KLC 4 Floor
KLC 5 Tailings
KLC 6 Coarse Reject
KLC 7 Coal Feed Reserve

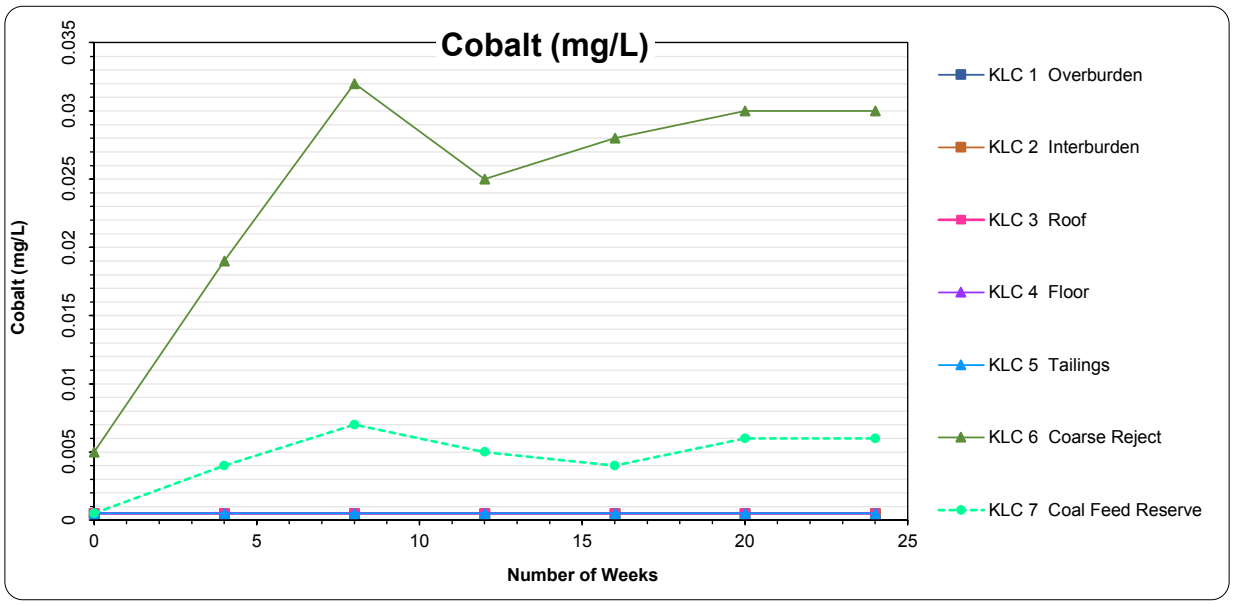

Antimony (mg/L)
Antimony (mg/L)
0
0.002
0.004
0.006
0.008
0.01
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Interburden
KLC 3 Roof
KLC 4 Floor
KLC 5 Tailings
KLC 6 Coarse Reject
KLC 7 Coal Feed Reserve

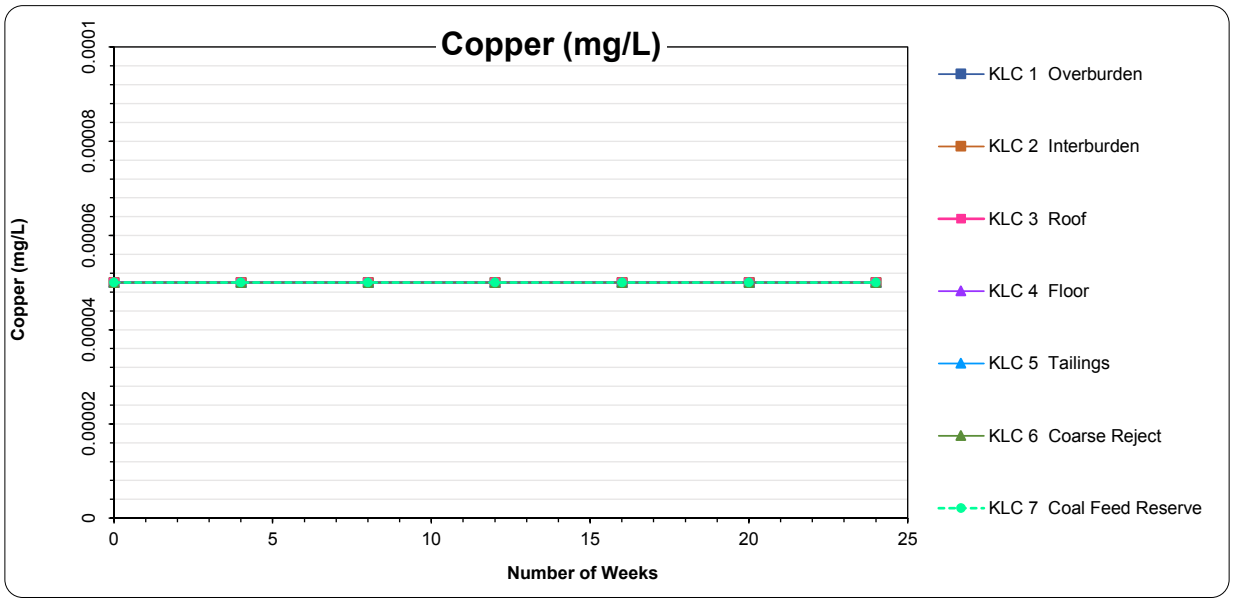

Arsenic (mg/L)
Arsenic (mg/L)
0
0.01
0.02
0.03
0.04
0.05
0.06
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Interburden
KLC 3 Roof
KLC 4 Floor
KLC 5 Tailings
KLC 6 Coarse Reject
KLC 7 Coal Feed Reserve

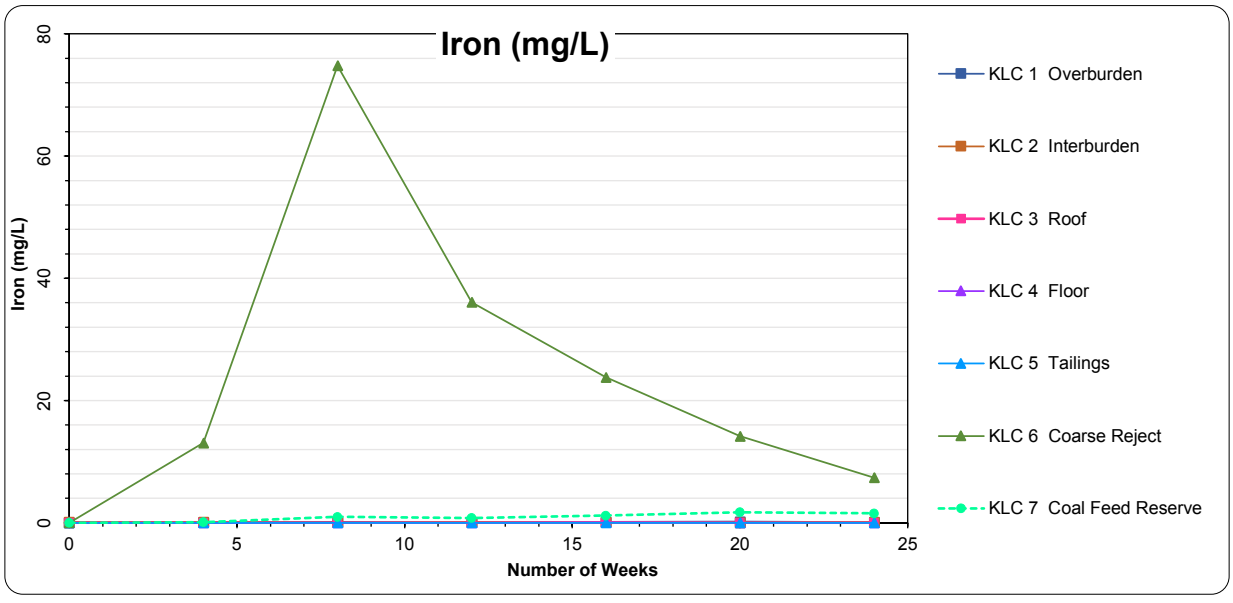

Boron (mg/L)
Boron (mg/L)
0
0.02
0.04
0.06
0.08
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Interburden
KLC 3 Roof
KLC 4 Floor
KLC 5 Tailings
KLC 6 Coarse Reject
KLC 7 Coal Feed Reserve

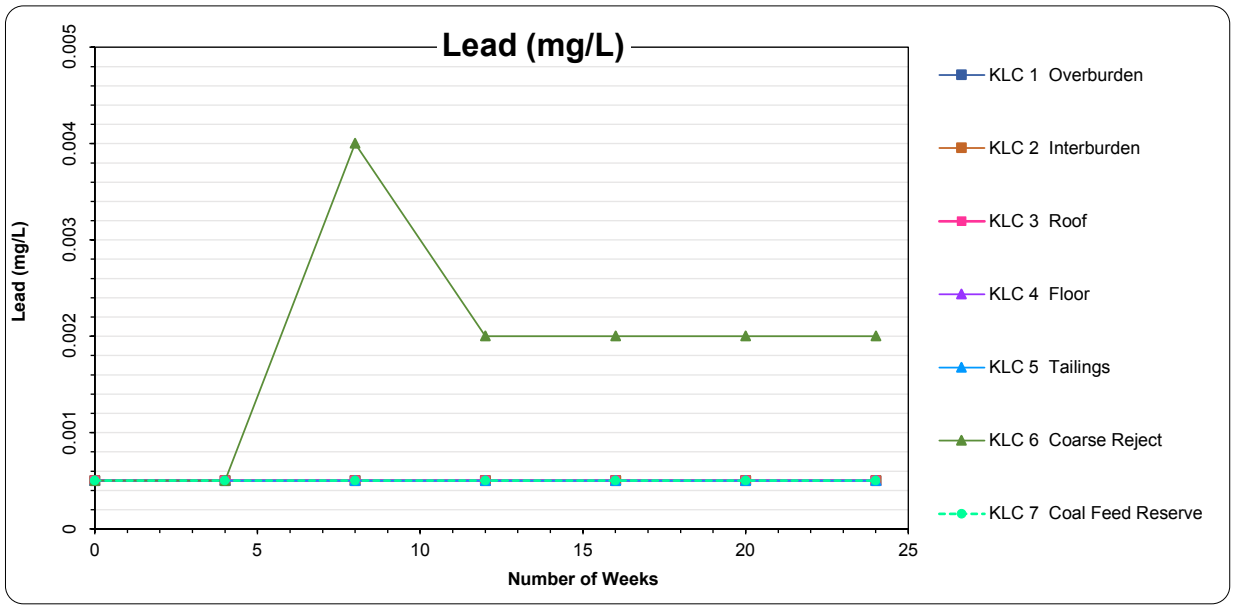

Cadmium (mg/L)
Cadmium (mg/L)
0
0.0002
0.0004
0.0006
0.0008
0.001
0.0012
0.0014
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Interburden
KLC 3 Roof
KLC 4 Floor
KLC 5 Tailings
KLC 6 Coarse Reject
KLC 7 Coal Feed Reserve

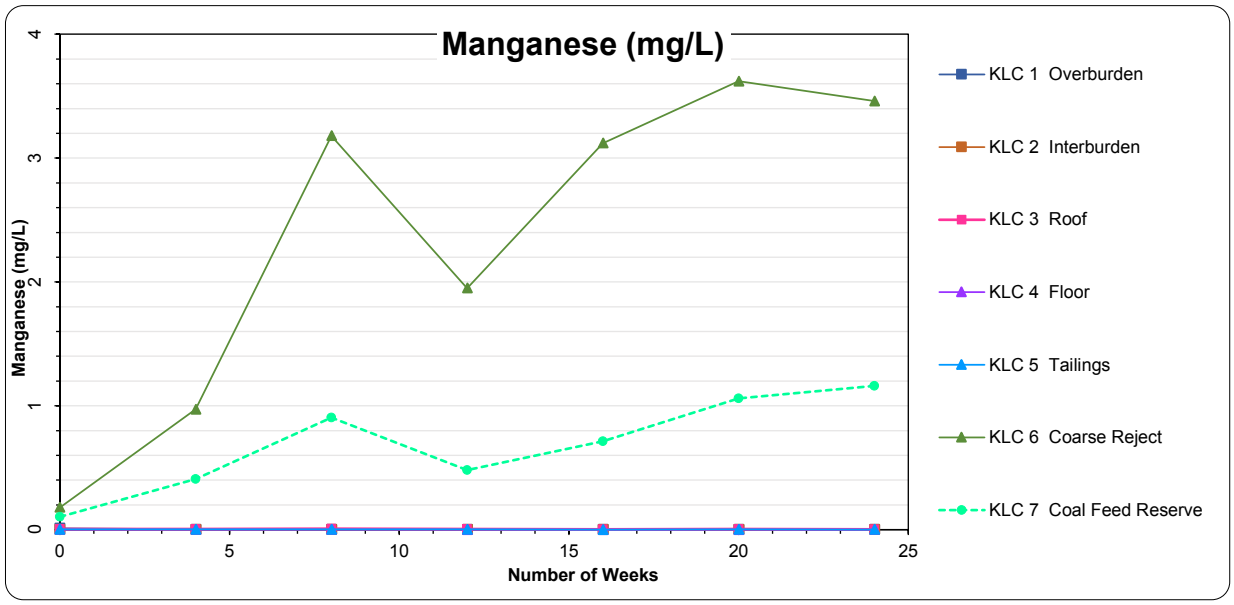

Chromium (mg/L)
Chromium (mg/L)
0
0.0005
0.001
0.0015
0.002
0.0025
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Interburden
KLC 3 Roof
KLC 4 Floor
KLC 5 Tailings
KLC 6 Coarse Reject
KLC 7 Coal Feed Reserve

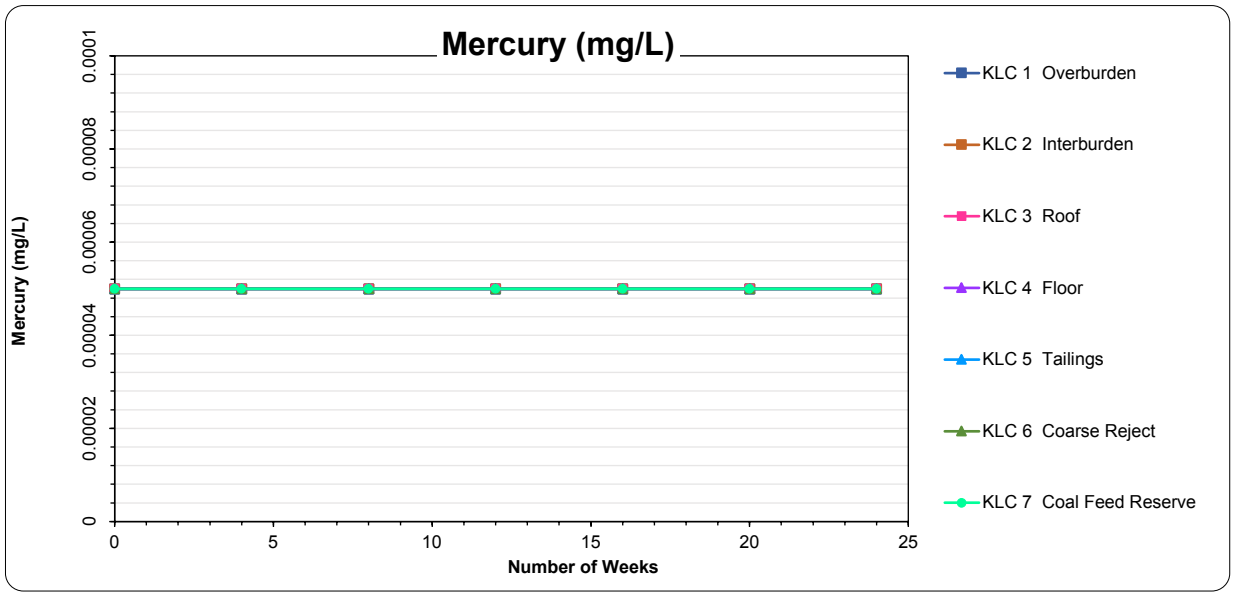

Cobalt (mg/L)
Cobalt (mg/L)
0
0.005
0.01
0.015
0.02
0.025
0.03
0.035
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Interburden
KLC 3 Roof
KLC 4 Floor
KLC 5 Tailings
KLC 6 Coarse Reject
KLC 7 Coal Feed Reserve

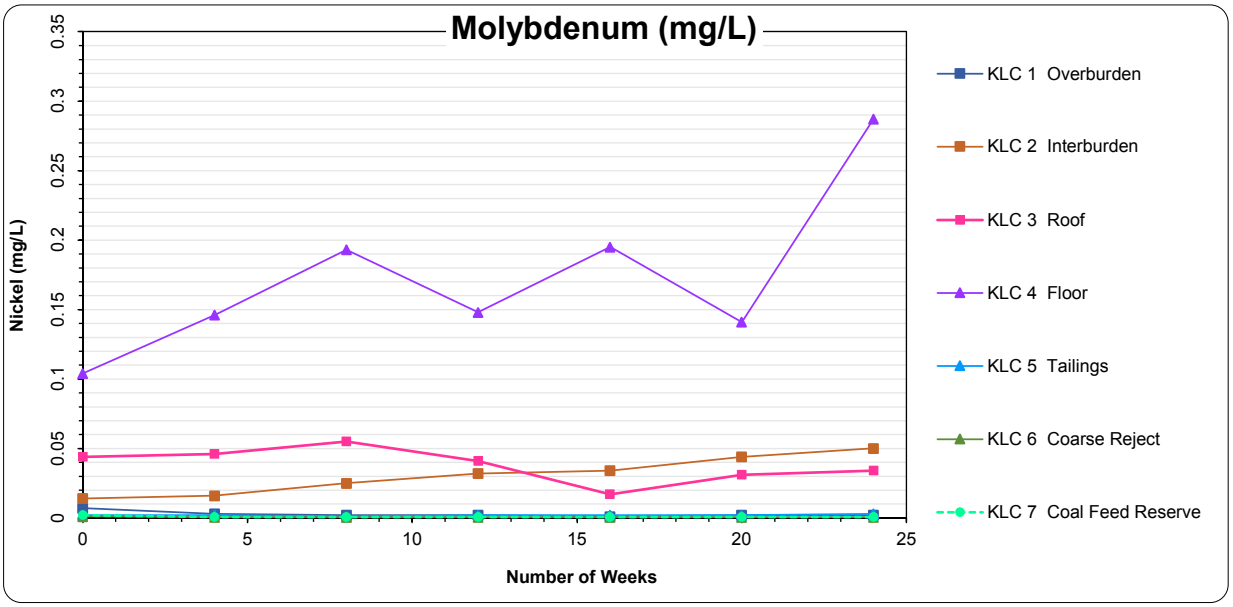

Copper (mg/L)
Copper (mg/L)
0
0.00002
0.00004
0.00006
0.00008
0.0001
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Interburden
KLC 3 Roof
KLC 4 Floor
KLC 5 Tailings
KLC 6 Coarse Reject
KLC 7 Coal Feed Reserve

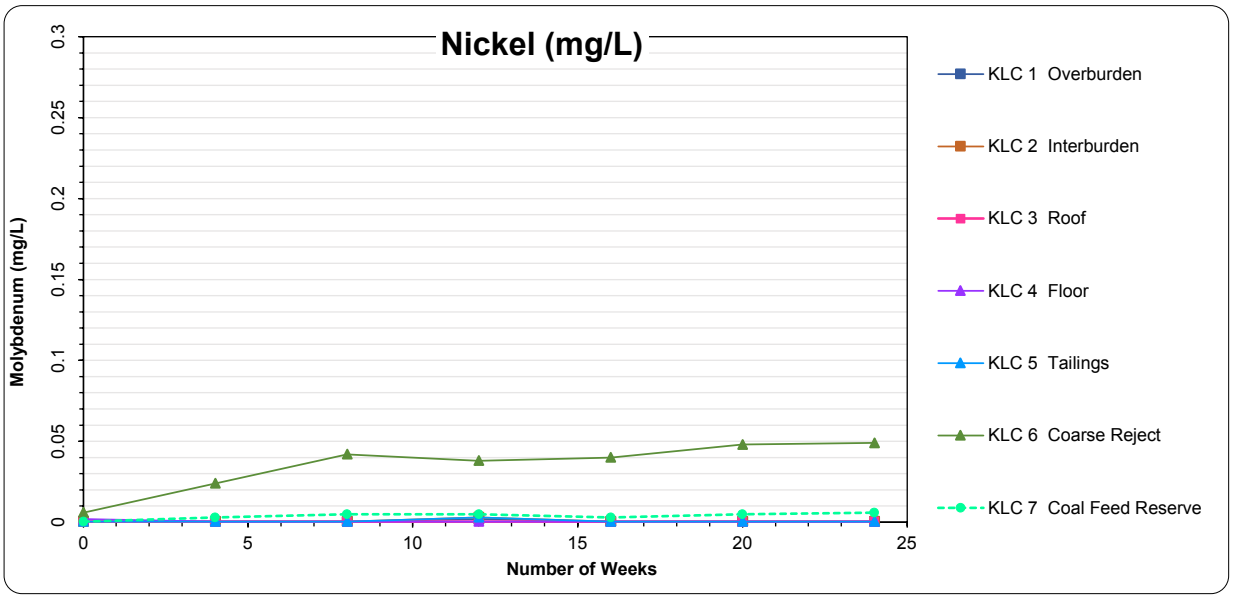

Iron (mg/L)
Iron (mg/L)
0
20
40
60
80
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Interburden
KLC 3 Roof
KLC 4 Floor
KLC 5 Tailings
KLC 6 Coarse Reject
KLC 7 Coal Feed Reserve

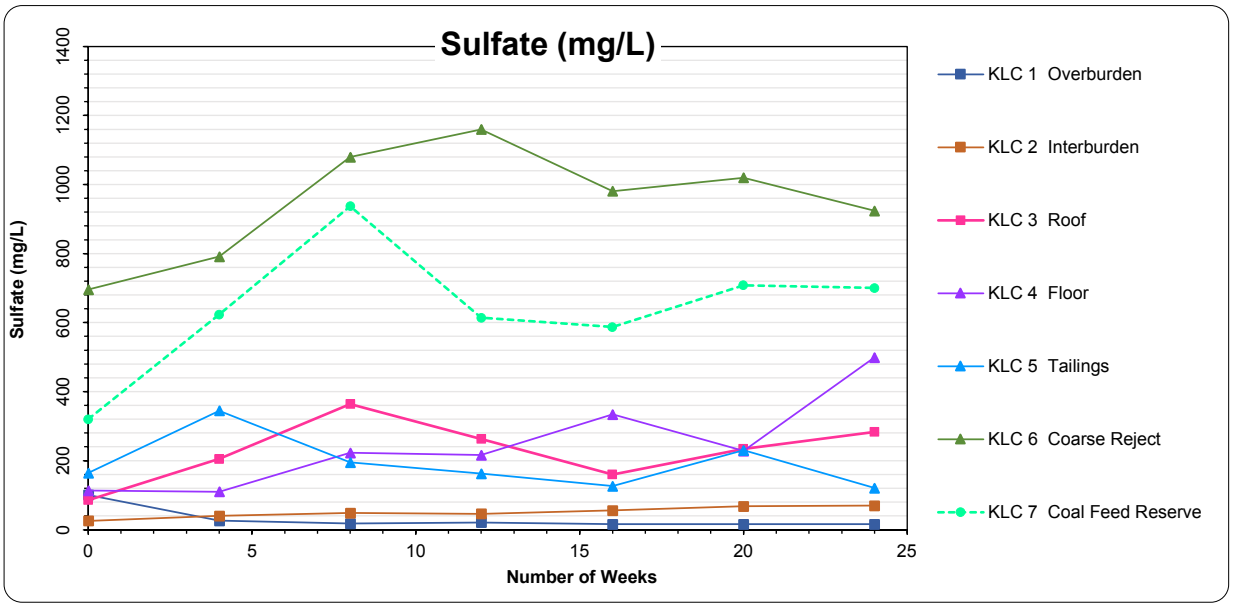

Lead (mg/L)
Lead (mg/L)
0
0.001
0.002
0.003
0.004
0.005
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Interburden
KLC 3 Roof
KLC 4 Floor
KLC 5 Tailings
KLC 6 Coarse Reject
KLC 7 Coal Feed Reserve

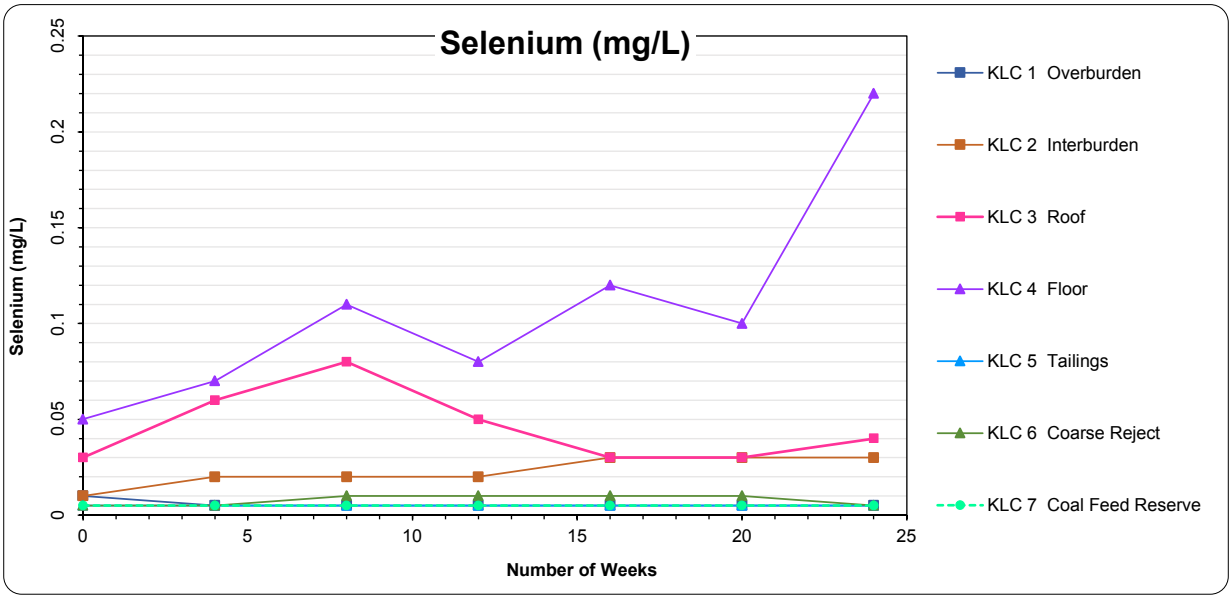

Manganese (mg/L)
Manganese (mg/L)
0
1
2
3
4
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Interburden
KLC 3 Roof
KLC 4 Floor
KLC 5 Tailings
KLC 6 Coarse Reject
KLC 7 Coal Feed Reserve

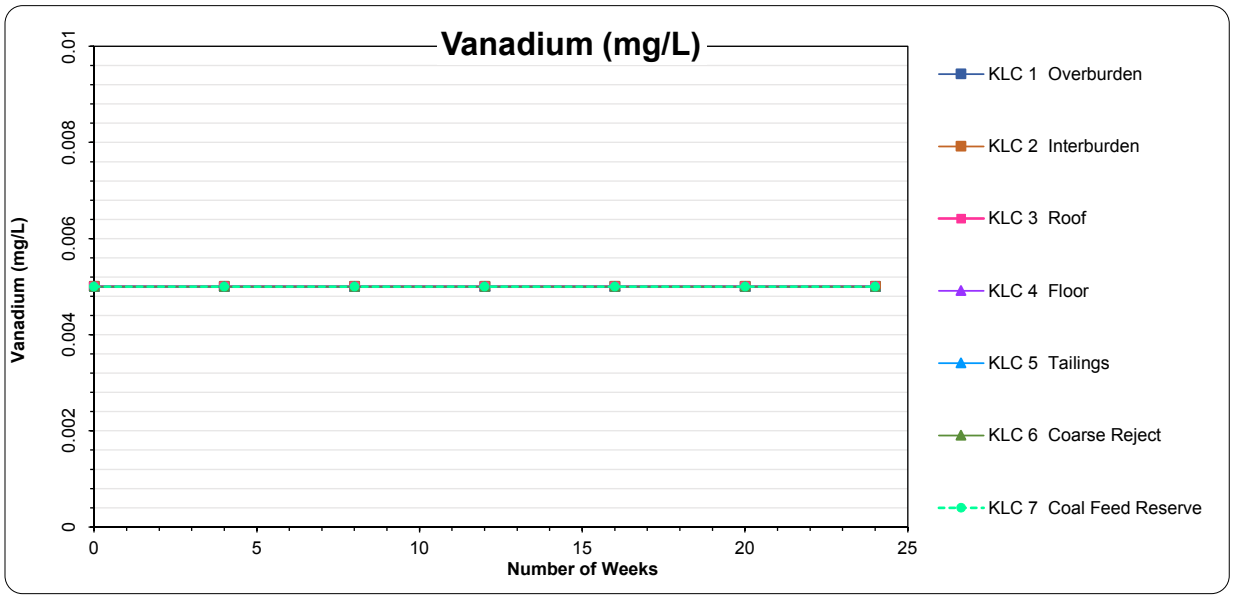

Mercury (mg/L)
Mercury (mg/L)
0
0.00002
0.00004
0.00006
0.00008
0.0001
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Interburden
KLC 3 Roof
KLC 4 Floor
KLC 5 Tailings
KLC 6 Coarse Reject
KLC 7 Coal Feed Reserve

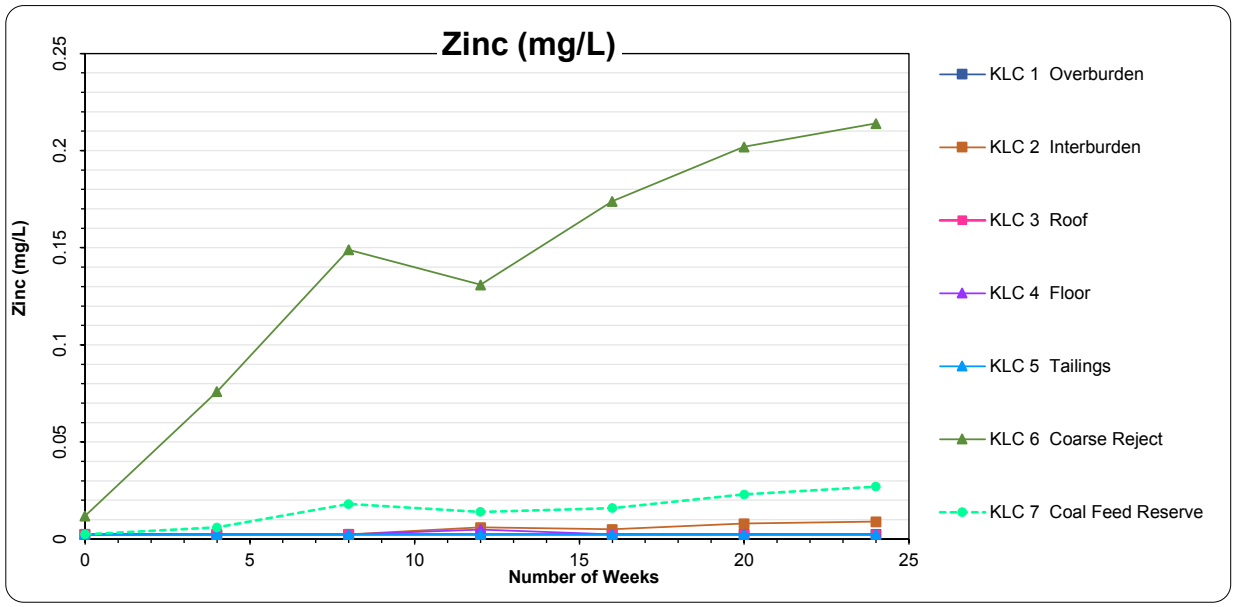

Molybdenum (mg/L)
Nickel (mg/L)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Interburden
KLC 3 Roof
KLC 4 Floor
KLC 5 Tailings
KLC 6 Coarse Reject
KLC 7 Coal Feed Reserve


Nickel (mg/L)
Molybdenum (mg/L)
0
0.05
0.1
0.15
0.2
0.25
0.3
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Interburden
KLC 3 Roof
KLC 4 Floor
KLC 5 Tailings
KLC 6 Coarse Reject
KLC 7 Coal Feed Reserve


Sulfate (mg/L)
Sulfate (mg/L)
0
200
400
600
800
1000
1200
1400
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Interburden
KLC 3 Roof
KLC 4 Floor
KLC 5 Tailings
KLC 6 Coarse Reject
KLC 7 Coal Feed Reserve


Selenium (mg/L)
Selenium (mg/L)
0
0.05
0.1
0.15
0.2
0.25
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Interburden
KLC 3 Roof
KLC 4 Floor
KLC 5 Tailings
KLC 6 Coarse Reject
KLC 7 Coal Feed Reserve


Vanadium (mg/L)
Vanadium (mg/L)
0
0.002
0.004
0.006
0.008
0.01
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Interburden
KLC 3 Roof
KLC 4 Floor
KLC 5 Tailings
KLC 6 Coarse Reject
KLC 7 Coal Feed Reserve


Zinc (mg/L)
Zinc (mg/L)
0
0.05
0.1
0.15
0.2
0.25
0
5
10
15
20
25
Number of Weeks
KLC 1 Overburden
KLC 2 Interburden
KLC 3 Roof
KLC 4 Floor
KLC 5 Tailings
KLC 6 Coarse Reject
KLC 7 Coal Feed Reserve

Attachment D: ALS and Trilab Results

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2106297**	Page	: 1 of 17
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ALAN ROBERTSON	Contact	: Carsten Emrich
Address	: PO BOX 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2021011 Nitro Foxleigh	Date Samples Received	: 08-Mar-2021 17:02
Order number	: ----	Date Analysis Commenced	: 22-Mar-2021
C-O-C number	: ----	Issue Date	: 23-Mar-2021 15:17
Sampler	: ALAN ROBERTSON		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 69		
No. of samples analysed	: 69		

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.

- Sample/s xxx has been crushed by ALS prior to preparation and analysis. This procedure is not part of the ALS NATA accreditation.
- 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)			Sample ID	2021011_3001	2021011_3002	2021011_3003	2021011_3004	2021011_3005
			Sampling date / time	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106297-001	EB2106297-002	EB2106297-003	EB2106297-004	EB2106297-005
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.0	9.5	9.1	8.7	9.4
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-6.2	-39.6	-44.7	14.3	-25.3
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	437	367	228	240	297
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	10.2	42.0	48.1	10.2	26.8
ANC as CaCO3	----	0.1	% CaCO3	1.0	4.3	4.9	1.0	2.7
Fizz Rating	----	0	Fizz Unit	1	2	2	1	1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.13	0.08	0.11	0.80	0.05

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_3006	2021011_3007	2021011_3008	2021011_3009	2021011_3010
			Sampling date / time	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106297-006	EB2106297-007	EB2106297-008	EB2106297-009	EB2106297-010
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.9	8.1	9.8	9.4	9.3
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-7.0	-3.4	-25.0	-13.4	-22.6
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	180	417	506	260	320
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	9.8	11.1	25.9	14.6	23.5
ANC as CaCO3	----	0.1	% CaCO3	1.0	1.1	2.6	1.5	2.4
Fizz Rating	----	0	Fizz Unit	1	1	1	1	1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.09	0.25	0.03	0.04	0.03

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_3011	2021011_3012	2021011_3013	2021011_3014	2021011_3015
			Sampling date / time	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106297-011	EB2106297-012	EB2106297-013	EB2106297-014	EB2106297-015
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.6	9.4	5.7	9.5	8.0
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-5.9	-9.8	13.7	-27.9	24.0
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	800	302	1440	243	466
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	15.7	12.6	7.7	28.8	13.9
ANC as CaCO3	----	0.1	% CaCO3	1.6	1.3	0.8	2.9	1.4
Fizz Rating	----	0	Fizz Unit	1	1	1	1	1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.32	0.09	0.70	0.03	1.24

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_3016	2021011_3017	2021011_3018	2021011_3019	2021011_3020
			Sampling date / time	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106297-016	EB2106297-017	EB2106297-018	EB2106297-019	EB2106297-020
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	7.3	8.2	9.4	9.4	9.4
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-15.4	-16.1	-122	-28.4	-54.3
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	473	650	572	265	376
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	17.6	16.7	127	29.6	55.5
ANC as CaCO3	----	0.1	% CaCO3	1.8	1.7	13.0	3.0	5.7
Fizz Rating	----	0	Fizz Unit	1	1	2	1	2
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.07	0.02	0.16	0.04	0.04

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_3021	2021011_3022	2021011_3023	2021011_3024	2021011_3025
			Sampling date / time	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106297-021	EB2106297-022	EB2106297-023	EB2106297-024	EB2106297-025
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.8	9.4	8.2	9.8	8.6
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-193	-21.0	-12.2	-30.2	-13.6
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	1370	210	471	566	442
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	234	23.4	14.0	31.4	14.2
ANC as CaCO3	----	0.1	% CaCO3	23.8	2.4	1.4	3.2	1.4
Fizz Rating	----	0	Fizz Unit	3	1	1	1	1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	1.33	0.08	0.06	0.04	0.02

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_3026	2021011_3027	2021011_3028	2021011_3029	2021011_3030
			Sampling date / time	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106297-026	EB2106297-027	EB2106297-028	EB2106297-029	EB2106297-030
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.2	8.3	9.6	8.7	8.4
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-52.3	-7.7	-54.8	-0.5	-3.3
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	430	421	417	1070	560
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	53.8	11.1	57.0	32.0	12.8
ANC as CaCO3	----	0.1	% CaCO3	5.5	1.1	5.8	3.3	1.3
Fizz Rating	----	0	Fizz Unit	2	1	2	2	1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.05	0.11	0.07	1.03	0.31

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_3031	2021011_3032	2021011_3033	2021011_3034	2021011_3035
			Sampling date / time	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106297-031	EB2106297-032	EB2106297-033	EB2106297-034	EB2106297-035
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.1	8.4	9.6	9.5	9.5
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-12.8	-16.9	-24.4	-168	-30.0
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	447	931	545	979	324
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	15.0	21.2	29.0	190	30.0
ANC as CaCO3	----	0.1	% CaCO3	1.5	2.2	3.0	19.4	3.1
Fizz Rating	----	0	Fizz Unit	1	1	1	3	1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.07	0.14	0.15	0.73	<0.01

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_3036	2021011_3037	2021011_3038	2021011_3039	2021011_3040
			Sampling date / time	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106297-036	EB2106297-037	EB2106297-038	EB2106297-039	EB2106297-040
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.7	9.5	8.9	8.7	9.5
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-7.9	-13.4	4.7	-6.1	-101
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	345	393	274	260	771
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	11.0	15.8	9.7	16.5	112
ANC as CaCO3	----	0.1	% CaCO3	1.1	1.6	1.0	1.7	11.4
Fizz Rating	----	0	Fizz Unit	1	1	1	1	3
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.10	0.08	0.47	0.34	0.37

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_3041	2021011_3042	2021011_3043	2021011_3044	2021011_3045
			Sampling date / time	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106297-041	EB2106297-042	EB2106297-043	EB2106297-044	EB2106297-045
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.0	8.2	9.1	9.2	9.1
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-9.3	-4.0	-9.4	-10.6	-10.1
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	414	1620	350	258	331
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	13.0	11.4	13.7	11.8	12.9
ANC as CaCO3	----	0.1	% CaCO3	1.3	1.2	1.4	1.2	1.3
Fizz Rating	----	0	Fizz Unit	1	1	1	1	1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.12	0.24	0.14	0.04	0.09

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_3046	2021011_3047	2021011_3048	2021011_3049	2021011_3050
			Sampling date / time	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106297-046	EB2106297-047	EB2106297-048	EB2106297-049	EB2106297-050
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.4	9.0	7.4	9.4	9.5
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-4.0	-11.8	2.6	-11.5	-13.3
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	552	567	990	446	264
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	16.9	12.4	10.5	13.0	15.1
ANC as CaCO3	----	0.1	% CaCO3	1.7	1.3	1.1	1.3	1.5
Fizz Rating	----	0	Fizz Unit	1	1	1	1	1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.42	0.02	0.43	0.05	0.06

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_3051	2021011_3052	2021011_3053	2021011_3054	2021011_3055
			Sampling date / time	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106297-051	EB2106297-052	EB2106297-053	EB2106297-054	EB2106297-055
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.8	8.3	9.5	9.6	9.8
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-11.4	14.0	-21.0	-8.9	-14.1
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	270	427	282	214	280
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	13.5	9.9	21.9	12.3	17.8
ANC as CaCO3	----	0.1	% CaCO3	1.4	1.0	2.2	1.2	1.8
Fizz Rating	----	0	Fizz Unit	1	1	1	1	1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.07	0.78	0.03	0.11	0.12

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_3056	2021011_3057	2021011_3058	2021011_3059	2021011_3060
			Sampling date / time	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106297-056	EB2106297-057	EB2106297-058	EB2106297-059	EB2106297-060
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.1	9.7	9.1	8.1	9.5
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-7.6	-14.7	-9.0	1.9	-12.0
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	272	256	262	552	609
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	8.8	15.9	9.3	10.6	23.0
ANC as CaCO3	----	0.1	% CaCO3	0.9	1.6	1.0	1.1	2.3
Fizz Rating	----	0	Fizz Unit	1	1	1	1	1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.04	0.04	0.01	0.41	0.36

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_3061	2021011_3062	2021011_3063	2021011_3064	2021011_3065
			Sampling date / time	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106297-061	EB2106297-062	EB2106297-063	EB2106297-064	EB2106297-065
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.5	8.2	9.2	8.3	8.9
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-0.03	8.4	-6.2	-3.9	-7.4
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	803	442	356	526	918
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	19.0	7.5	10.8	10.3	9.6
ANC as CaCO3	----	0.1	% CaCO3	1.9	0.8	1.1	1.0	1.0
Fizz Rating	----	0	Fizz Unit	1	1	1	1	1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.62	0.52	0.15	0.21	0.07

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_3066	2021011_3067	2021011_3068	----	----
			Sampling date / time	08-Mar-2021 00:00	08-Mar-2021 00:00	08-Mar-2021 00:00	----	----
Compound	CAS Number	LOR	Unit	EB2106297-066	EB2106297-067	EB2106297-068	--------	--------
				Result	Result	Result	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**9.5**	**9.7**	**9.1**	**----**	**----**
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-12.5**	**-16.4**	**-10.2**	**----**	**----**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**388**	**471**	**277**	**----**	**----**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**13.7**	**17.9**	**12.7**	**----**	**----**
ANC as CaCO3	----	0.1	% CaCO3	**1.4**	**1.8**	**1.3**	**----**	**----**
Fizz Rating	----	0	Fizz Unit	**1**	**1**	**1**	**----**	**----**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.04**	**0.05**	**0.08**	**----**	**----**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **SOIL**)				Sample ID	**pH and EC of DI water**	**----**	**----**	**----**	**----**
				Sampling date / time	09-Mar-2021 00:00	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*		**EB2106297-069**	**--------**	**--------**	**--------**	**--------**
					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	: **EB2106551**	Page	: 1 of 8
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ALAN ROBERTSON	Contact	: Carsten Emrich
Address	: PO BOX 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2021011 Nitro Foxleigh	Date Samples Received	: 10-Mar-2021 15:45
Order number	: ----	Date Analysis Commenced	: 22-Mar-2021
C-O-C number	: ----	Issue Date	: 24-Mar-2021 15:26
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
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.

- 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)			Sample ID	2021011_2001	2021011_2002	2021011_2003	2021011_2004	2021011_2005
			Sampling date / time	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106551-001	EB2106551-002	EB2106551-003	EB2106551-004	EB2106551-005
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.5	8.6	8.5	8.5	8.5
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-54.8	-62.8	-69.3	-56.7	-66.1
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	2330	2020	1990	2010	2040
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	86.6	94.0	103	88.5	99.8
ANC as CaCO3	----	0.1	% CaCO3	8.8	9.6	10.5	9.0	10.2
Fizz Rating	----	0	Fizz Unit	2	2	2	2	2
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	1.04	1.02	1.10	1.04	1.10

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_2006	2021011_2007	2021011_2008	2021011_2009	2021011_2010
			Sampling date / time	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106551-006	EB2106551-007	EB2106551-008	EB2106551-009	EB2106551-010
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.0	8.2	8.5	8.5	8.4
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-14.0	-12.1	-13.9	0.8	-24.8
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	3390	1740	2220	1820	2470
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	27.5	23.1	24.0	13.3	44.4
ANC as CaCO3	----	0.1	% CaCO3	2.8	2.4	2.4	1.4	4.5
Fizz Rating	----	0	Fizz Unit	1	1	1	1	2
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.44	0.36	0.33	0.46	0.64

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_2011	2021011_2012	2021011_2013	2021011_2014	2021011_2015
			Sampling date / time	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106551-011	EB2106551-012	EB2106551-013	EB2106551-014	EB2106551-015
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.3	8.8	8.5	8.5	8.7
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-23.9	64.7	-19.0	33.7	-16.2
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	777	863	1040	947	1530
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	45.0	14.9	67.7	16.5	36.1
ANC as CaCO3	----	0.1	% CaCO3	4.6	1.5	6.9	1.7	3.7
Fizz Rating	----	0	Fizz Unit	2	1	2	1	2
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.69	2.60	1.59	1.64	0.65

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_2016	2021011_2017	2021011_2018	2021011_2019	2021011_2020
			Sampling date / time	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106551-016	EB2106551-017	EB2106551-018	EB2106551-019	EB2106551-020
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.6	8.6	9.2	8.1	9.2
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	39.3	-12.8	1.3	-9.5	-22.7
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	1190	1090	983	1350	832
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	38.4	70.3	22.9	60.3	37.7
ANC as CaCO3	----	0.1	% CaCO3	3.9	7.2	2.3	6.2	3.8
Fizz Rating	----	0	Fizz Unit	2	2	1	2	2
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	2.54	1.88	0.79	1.66	0.49

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_2021	2021011_2022	2021011_2023	2021011_2024	2021011_2025
			Sampling date / time	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106551-021	EB2106551-022	EB2106551-023	EB2106551-024	EB2106551-025
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.5	9.3	8.6	9.1	8.6
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	<0.5	-27.4	-3.5	5.4	-3.8
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	578	644	577	867	568
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	27.9	40.9	23.4	17.2	29.5
ANC as CaCO3	----	0.1	% CaCO3	2.8	4.2	2.4	1.7	3.0
Fizz Rating	----	0	Fizz Unit	1	2	1	1	1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.92	0.44	0.65	0.74	0.84

Analytical Results

Sub-Matrix: **WATER** (Matrix: **SOIL**)				Sample ID	**pH and EC of DI Water**	**----**	**----**	**----**	**----**
				Sampling date / time	09-Mar-2021 00:00	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*		**EB2106551-026**	**--------**	**--------**	**--------**	**--------**
					Result	----	----	----	----
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		**5.5**	**----**	**----**	**----**	**----**
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		<1	**----**	**----**	**----**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2106557**	Page	: 1 of 21
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ALAN ROBERTSON	Contact	: Carsten Emrich
Address	: PO BOX 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2021011 Nitro Foxleigh	Date Samples Received	: 10-Mar-2021 15:45
Order number	: ----	Date Analysis Commenced	: 13-Mar-2021
C-O-C number	: ----	Issue Date	: 17-Mar-2021 16:32
Sampler	: PRIYA RAJENDRAN		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 87		
No. of samples analysed	: 87		

ilac-MRA NATA
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.

- **SPLIT WORK ORDER: It should be noted that ALS has split this work order over the following work orders EB2106557/ EB2106561 due to the size of the sample numbers. For any further information regarding this processing of samples please contact ALS client services division on ALSEnviro.Brisbane@alsglobal.com**
- Sample/s xxx has been crushed by ALS prior to preparation and analysis. This procedure is not part of the ALS NATA accreditation.
- 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)			Sample ID	2021011_1001	2021011_1002	2021011_1003	2021011_1004	2021011_1005
			Sampling date / time	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106557-001	EB2106557-002	EB2106557-003	EB2106557-004	EB2106557-005
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.7	9.6	9.4	9.4	9.8
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-17.5	4.0	-7.5	-18.3	-53.9
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	410	350	297	181	454
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	18.7	3.6	8.7	19.2	54.8
ANC as CaCO3	----	0.1	% CaCO3	1.9	0.4	0.9	2.0	5.6
Fizz Rating	----	0	Fizz Unit	1	0	0	1	2
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.04	0.25	0.04	0.03	0.03

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_1006	2021011_1007	2021011_1008	2021011_1009	2021011_1010
			Sampling date / time	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106557-006	EB2106557-007	EB2106557-008	EB2106557-009	EB2106557-010
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.6	9.9	9.7	9.7	9.8
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-9.3	-29.4	-22.5	-48.0	-18.4
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	341	807	385	354	207
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	9.6	30.6	24.0	49.8	20.8
ANC as CaCO3	----	0.1	% CaCO3	1.0	3.1	2.4	5.1	2.1
Fizz Rating	----	0	Fizz Unit	0	2	1	2	1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.01	0.04	0.05	0.06	0.08

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_1012	2021011_1013	2021011_1014	2021011_1015	2021011_1016
			Sampling date / time	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106557-012	EB2106557-013	EB2106557-014	EB2106557-015	EB2106557-016
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.9	8.4	9.7	10.0	10.2
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-42.9	-14.0	-32.3	-103	-42.7
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	268	248	491	274	373
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	43.5	16.2	33.2	104	43.3
ANC as CaCO3	----	0.1	% CaCO3	4.4	1.6	3.4	10.6	4.4
Fizz Rating	----	0	Fizz Unit	2	1	2	2	2
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.07	0.03	0.02	0.02

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_1017	2021011_1018	2021011_1020	2021011_1021	2021011_1022
			Sampling date / time	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106557-017	EB2106557-018	EB2106557-020	EB2106557-021	EB2106557-022
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	10.1	9.8	10.0	9.5	9.5
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-64.9	-19.5	-66.1	-19.9	-23.7
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	326	376	404	234	265
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	65.2	20.1	67.0	20.8	24.6
ANC as CaCO3	----	0.1	% CaCO3	6.6	2.0	6.8	2.1	2.5
Fizz Rating	----	0	Fizz Unit	2	1	2	1	1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.01	0.02	0.03	0.03	0.03

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_1023	2021011_1024	2021011_1025	2021011_1026	2021011_1027
			Sampling date / time	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106557-023	EB2106557-024	EB2106557-025	EB2106557-026	EB2106557-027
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	10.0	9.9	9.8	10.0	9.6
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-77.5	-66.8	-18.1	-54.2	-73.7
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	502	257	403	473	364
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	78.7	67.4	18.7	55.4	74.3
ANC as CaCO3	----	0.1	% CaCO3	8.0	6.9	1.9	5.6	7.6
Fizz Rating	----	0	Fizz Unit	2	2	1	2	2
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.04	0.02	0.02	0.04	0.02

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_1028	2021011_1029	2021011_1030	2021011_1031	2021011_1032
			Sampling date / time	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106557-028	EB2106557-029	EB2106557-030	EB2106557-031	EB2106557-032
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.7	9.8	9.6	9.7	9.6
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-15.0	-17.3	-33.9	-35.2	-42.9
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	273	344	178	385	315
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	16.8	20.1	34.5	35.8	43.5
ANC as CaCO3	----	0.1	% CaCO3	1.7	2.0	3.5	3.6	4.4
Fizz Rating	----	0	Fizz Unit	1	1	1	2	2
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.06	0.09	0.02	0.02	0.02

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_1033	2021011_1034	2021011_1035	2021011_1036	2021011_1037
			Sampling date / time	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106557-033	EB2106557-034	EB2106557-035	EB2106557-036	EB2106557-037
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.6	10.0	10.0	10.2	9.8
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-37.2	-56.7	-76.8	-90.0	-41.8
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	342	310	363	374	237
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	37.8	57.3	77.4	90.6	43.0
ANC as CaCO3	----	0.1	% CaCO3	3.8	5.8	7.9	9.2	4.4
Fizz Rating	----	0	Fizz Unit	2	2	2	2	2
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.02	0.02	0.02	0.04

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_1038	2021011_1039	2021011_1040	2021011_1041	2021011_1042
			Sampling date / time	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106557-038	EB2106557-039	EB2106557-040	EB2106557-041	EB2106557-042
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.6	9.6	10.0	9.8	9.5
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-20.5	-34.0	-55.0	-23.1	-47.5
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	216	186	399	257	331
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	21.1	35.2	55.6	23.7	48.4
ANC as CaCO3	----	0.1	% CaCO3	2.2	3.6	5.7	2.4	4.9
Fizz Rating	----	0	Fizz Unit	1	2	2	1	2
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.04	0.02	0.02	0.03

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_1043	2021011_1044	2021011_1045	2021011_1046	2021011_1047
			Sampling date / time	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106557-043	EB2106557-044	EB2106557-045	EB2106557-046	EB2106557-047
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.6	10.0	9.9	9.5	10.0
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-16.2	-24.7	-96.0	-100	-12.5
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	269	320	320	403	248
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	18.3	25.3	97.2	102	13.1
ANC as CaCO3	----	0.1	% CaCO3	1.9	2.6	9.9	10.4	1.3
Fizz Rating	----	0	Fizz Unit	1	1	2	2	1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.07	0.02	0.04	0.06	0.02

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_1048	2021011_1049	2021011_1050	2021011_1051	2021011_1052
			Sampling date / time	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106557-048	EB2106557-049	EB2106557-050	EB2106557-051	EB2106557-052
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.9	9.2	8.6	9.6	9.7
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-87.4	-24.2	-11.4	-27.9	-47.1
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	118	364	518	188	318
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	88.0	25.4	15.1	28.5	48.3
ANC as CaCO3	----	0.1	% CaCO3	9.0	2.6	1.5	2.9	4.9
Fizz Rating	----	0	Fizz Unit	2	1	1	1	2
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.04	0.12	0.02	0.04

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_1053	2021011_1054	2021011_1055	2021011_1056	2021011_1057
			Sampling date / time	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106557-053	EB2106557-054	EB2106557-055	EB2106557-056	EB2106557-057
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**9.9**	**9.5**	**9.7**	**9.7**	**9.4**
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-62.3**	**-21.9**	**-21.4**	**-17.2**	**-16.2**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**183**	**211**	**327**	**220**	**103**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**63.2**	**22.8**	**22.9**	**17.2**	**16.2**
ANC as CaCO3	----	0.1	% CaCO3	**6.4**	**2.3**	**2.3**	**1.8**	**1.6**
Fizz Rating	----	0	Fizz Unit	**2**	**1**	**1**	**1**	**1**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.03**	**0.03**	**0.05**	<0.01	<0.01

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_1058	2021011_1059	2021011_1060	2021011_1061	2021011_1062
			Sampling date / time	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106557-058	EB2106557-059	EB2106557-060	EB2106557-061	EB2106557-062
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.4	9.4	9.5	9.7	8.1
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-15.6	-18.9	-20.1	-60.0	-9.1
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	211	150	556	852	1280
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	15.6	19.5	20.7	64.3	9.1
ANC as CaCO3	----	0.1	% CaCO3	1.6	2.0	2.1	6.6	0.9
Fizz Rating	----	0	Fizz Unit	1	1	1	2	1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	0.02	0.02	0.14	<0.01

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_1063	2021011_1064	2021011_1065	2021011_1066	2021011_1067
			Sampling date / time	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106557-063	EB2106557-064	EB2106557-065	EB2106557-066	EB2106557-067
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**8.3**	**8.0**	**7.9**	**8.3**	**8.6**
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-7.1**	**-7.7**	**-7.8**	**-5.7**	**-8.2**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**1060**	**1360**	**1700**	**1330**	**1180**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**7.1**	**7.7**	**7.8**	**5.7**	**8.8**
ANC as CaCO3	----	0.1	% CaCO3	**0.7**	**0.8**	**0.8**	**0.6**	**0.9**
Fizz Rating	----	0	Fizz Unit	**1**	**0**	**0**	**0**	**0**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	<0.01	<0.01	<0.01	**0.02**

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_1068	2021011_1069	2021011_1070	2021011_1071	2021011_1072
			Sampling date / time	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106557-068	EB2106557-069	EB2106557-070	EB2106557-071	EB2106557-072
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**9.8**	**8.3**	**8.2**	**8.7**	**7.6**
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-25.0**	**-8.2**	**-7.7**	**-4.9**	**-5.4**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**629**	**796**	**2010**	**451**	**999**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**25.9**	**8.2**	**8.0**	**4.9**	**5.4**
ANC as CaCO3	----	0.1	% CaCO3	**2.6**	**0.8**	**0.8**	**0.5**	**0.5**
Fizz Rating	----	0	Fizz Unit	**1**	**0**	**1**	**0**	**0**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.03**	<0.01	**0.01**	<0.01	<0.01

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_1073	2021011_1074	2021011_1075	2021011_1076	2021011_1077
			Sampling date / time	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106557-073	EB2106557-074	EB2106557-075	EB2106557-076	EB2106557-077
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**7.8**	**8.1**	**8.1**	**9.7**	**10.1**
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-13.9**	**-9.0**	**-10.9**	**-15.7**	**-59.8**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**1010**	**1450**	**1280**	**229**	**330**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**13.9**	**9.0**	**10.9**	**15.7**	**59.8**
ANC as CaCO3	----	0.1	% CaCO3	**1.4**	**0.9**	**1.1**	**1.6**	**6.1**
Fizz Rating	----	0	Fizz Unit	**1**	**1**	**1**	**1**	**2**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_1078	2021011_1079	2021011_1080	2021011_1081	2021011_1082
			Sampling date / time	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106557-078	EB2106557-079	EB2106557-080	EB2106557-081	EB2106557-082
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**9.4**	**9.3**	**9.3**	**9.8**	**9.6**
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-16.3**	**-9.0**	**-12.9**	**-72.3**	**-20.8**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**231**	**137**	**591**	**464**	**98**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**16.3**	**9.6**	**13.2**	**77.8**	**20.8**
ANC as CaCO3	----	0.1	% CaCO3	**1.7**	**1.0**	**1.4**	**7.9**	**2.1**
Fizz Rating	----	0	Fizz Unit	**1**	**0**	**1**	**2**	**1**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	**0.02**	**0.01**	**0.18**	<0.01

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_1083	2021011_1084	2021011_1085	2021011_1086	2021011_1087
			Sampling date / time	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106557-083	EB2106557-084	EB2106557-085	EB2106557-086	EB2106557-087
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**9.5**	**10.2**	**10.2**	**10.1**	**10.2**
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-16.3**	**-125**	**-82.4**	**-67.2**	**-90.3**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**214**	**338**	**369**	**381**	**375**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**16.9**	**125**	**82.4**	**78.8**	**90.6**
ANC as CaCO3	----	0.1	% CaCO3	**1.7**	**12.8**	**8.4**	**8.0**	**9.2**
Fizz Rating	----	0	Fizz Unit	**1**	**2**	**2**	**2**	**2**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.02**	<0.01	<0.01	**0.38**	**0.01**

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_1088	----	----	----	----
			Sampling date / time	09-Mar-2021 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EB2106557-088	--------	--------	--------	--------
				Result	----	----	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**10.1**	----	----	----	----
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-41.1**	----	----	----	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**181**	----	----	----	----
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**41.4**	----	----	----	----
ANC as CaCO3	----	0.1	% CaCO3	**4.2**	----	----	----	----
Fizz Rating	----	0	Fizz Unit	**2**	----	----	----	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.01**	----	----	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **SOIL**)				Sample ID	**pH and EC of DI Water**	**----**	**----**	**----**	**----**
				Sampling date / time	09-Mar-2021 00:00	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*		**EB2106557-089**	**--------**	**--------**	**--------**	**--------**
					Result	----	----	----	----
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		**4.7**	**----**	**----**	**----**	**----**
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		<1	**----**	**----**	**----**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2106561**	Page	: 1 of 7
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ALAN ROBERTSON	Contact	: Carsten Emrich
Address	: PO BOX 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2021011 Nitro Foxleigh	Date Samples Received	: 10-Mar-2021 15:45
Order number	: ----	Date Analysis Commenced	: 12-Mar-2021
C-O-C number	: ----	Issue Date	: 18-Mar-2021 16:42
Sampler	: PRIYA RAJENDRAN		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 18		
No. of samples analysed	: 18		

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.

- **SPLIT WORK ORDER: It should be noted that ALS has split this work order over the following work orders EB2106557/ EB2106561 due to the size of the sample numbers. For any further information regarding this processing of samples please contact ALS client services division on ALSEnviro.Brisbane@alsglobal.com**
- Sample/s xxx has been crushed by ALS prior to preparation and analysis. This procedure is not part of the ALS NATA accreditation.
- 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)			Sample ID	2021011_089	2021011_090	2021011_091	2021011_092	2021011_093
			Sampling date / time	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106561-001	EB2106561-002	EB2106561-003	EB2106561-004	EB2106561-005
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.1	9.1	9.4	8.9	8.0
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-9.3	-39.6	-21.9	-39.0	-4.3
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	734	1110	585	1120	516
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	9.6	39.9	22.5	39.6	4.9
ANC as CaCO3	----	0.1	% CaCO3	1.0	4.1	2.3	4.0	0.5
Fizz Rating	----	0	Fizz Unit	0	2	1	2	0
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.01	0.01	0.02	0.02	0.02

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_094	2021011_095	2021011_096	2021011_097	2021011_098
			Sampling date / time	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106561-006	EB2106561-007	EB2106561-008	EB2106561-009	EB2106561-010
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**6.4**	**7.8**	**7.9**	**9.2**	**9.2**
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-4.4**	**-6.7**	**-11.1**	**-20.4**	**-17.1**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**552**	**800**	**602**	**688**	**559**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**4.7**	**7.0**	**11.1**	**20.4**	**18.0**
ANC as CaCO3	----	0.1	% CaCO3	**0.5**	**0.7**	**1.1**	**2.1**	**1.8**
Fizz Rating	----	0	Fizz Unit	**0**	**0**	**1**	**1**	**1**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.01**	**0.01**	<0.01	<0.01	**0.03**

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_099	2021011_1100	2021011_1101	2021011_1102	2021011_1103
			Sampling date / time	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00	09-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106561-011	EB2106561-012	EB2106561-013	EB2106561-014	EB2106561-015
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**9.4**	**9.5**	**9.5**	**9.2**	**8.1**
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-21.6**	**-18.6**	**-22.3**	**-26.1**	**-10.8**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**369**	**486**	**386**	**1350**	**759**
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**22.2**	**19.8**	**23.8**	**26.1**	**10.8**
ANC as CaCO3	----	0.1	% CaCO3	**2.2**	**2.0**	**2.4**	**2.6**	**1.1**
Fizz Rating	----	0	Fizz Unit	**1**	**1**	**1**	**1**	**1**
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	**0.02**	**0.04**	**0.05**	<0.01	<0.01

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	2021011_1104	2021011_1105	----	----	----
			Sampling date / time	09-Mar-2021 00:00	09-Mar-2021 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2106561-016	EB2106561-017	--------	--------	--------
				Result	Result	----	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**9.5**	**7.8**	----	----	----
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	**-33.4**	**-15.9**	----	----	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**666**	**1360**	----	----	----
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	**33.4**	**17.1**	----	----	----
ANC as CaCO3	----	0.1	% CaCO3	**3.4**	**1.7**	----	----	----
Fizz Rating	----	0	Fizz Unit	**2**	**1**	----	----	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	**0.04**	----	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **SOIL**)			Sample ID	**pH and EC of DI Water**	**----**	**----**	**----**	**----**
			Sampling date / time	09-Mar-2021 00:00	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB2106561-018**	**--------**	**--------**	**--------**	**--------**
				Result	----	----	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**5.5**	**----**	**----**	**----**	**----**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	<1	**----**	**----**	**----**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2106911**	Page	: 1 of 8
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ALAN ROBERTSON	Contact	: Rebecca Kleinschmidt
Address	: PO BOX 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61 7 3552 8660
Project	: 2021011 Nitro Foxleigh	Date Samples Received	: 12-Mar-2021 15:45
Order number	: ----	Date Analysis Commenced	: 19-Mar-2021
C-O-C number	: ----	Issue Date	: 06-Apr-2021 14:21
Sampler	: MELINDA HILTON		
Site	: ----		
Quote number	: BN/025/21		
No. of samples received	: 64		
No. of samples analysed	: 12		

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 Acid Sulphate Soils, Stafford, QLD
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.

- 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.
- Sample/s xxx has been crushed by ALS prior to preparation and analysis. This procedure is not part of the ALS NATA accreditation.
- EK061G (Total Kjeldahl Nitrogen as N): Sample EB2106911_063 (Composite 11) shows poor duplicate results due to sample heterogeneity. Confirmed by visual inspection.
- ED006 (Exchangeable Cations on Alkaline Soils): Unable to calculate Magnesium/Potassium Ratio result for some samples as required Exchangeable Magnesium and/or Potassium results are less than the limit of reporting.
- 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: **SOLID**
(Matrix: **SOIL**)

			Sample ID	Composite 1 Composite 1, 2, 3	Composite 2 Composite 4, 5, 6, 7, 8, 9	Composite 3 Composite 10	Composite 4 Composite 11, 12	Composite 5 Composite 13, 14, 15, 16, 17, 18, 19
			Sampling date / time	11-Mar-2021 00:00	11-Mar-2021 00:00	11-Mar-2021 00:00	11-Mar-2021 00:00	11-Mar-2021 00:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB2106911-053**	**EB2106911-054**	**EB2106911-055**	**EB2106911-056**	**EB2106911-057**
				Result	Result	Result	Result	Result
EA001: pH in soil using 0.01M CaCl extract								
pH (CaCl2)	----	0.1	pH Unit	**7.2**	**7.9**	**7.5**	**6.6**	**7.1**
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**7.7**	**8.7**	**8.2**	**7.3**	**7.8**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**1880**	**865**	**737**	**247**	**484**
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	**4.9**	**3.8**	**6.6**	**5.0**	**3.6**
ED006: Exchangeable Cations on Alkaline Soils								
ø **Exchangeable Calcium**	----	0.2	meq/100g	**5.5**	**2.3**	**13.1**	**----**	**1.9**
ø **Exchangeable Magnesium**	----	0.2	meq/100g	**4.2**	**2.7**	**5.6**	**----**	**1.5**
ø **Exchangeable Potassium**	----	0.2	meq/100g	**0.3**	<0.2	**0.3**	**----**	<0.2
ø **Exchangeable Sodium**	----	0.2	meq/100g	**2.6**	**1.9**	**3.3**	**----**	**1.0**
ø **Cation Exchange Capacity**	----	0.2	meq/100g	**12.6**	**6.9**	**22.2**	**----**	**4.5**
ø **Exchangeable Sodium Percent**	----	0.2	%	**21.0**	**27.2**	**14.8**	**----**	**21.5**
ø **Calcium/Magnesium Ratio**	----	0.2	-	**1.3**	**0.8**	**2.3**	**----**	**1.3**
ø **Magnesium/Potassium Ratio**	----	0.2	-	**15.3**	**----**	**19.8**	**----**	**----**
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	**----**	**----**	**----**	**8.1**	**----**
Exchangeable Magnesium	----	0.1	meq/100g	**----**	**----**	**----**	**4.4**	**----**
Exchangeable Potassium	----	0.1	meq/100g	**----**	**----**	**----**	**0.4**	**----**
Exchangeable Sodium	----	0.1	meq/100g	**----**	**----**	**----**	**1.6**	**----**
Cation Exchange Capacity	----	0.1	meq/100g	**----**	**----**	**----**	**14.7**	**----**
Exchangeable Sodium Percent	----	0.1	%	**----**	**----**	**----**	**11.3**	**----**
Calcium/Magnesium Ratio	----	0.1	-	**----**	**----**	**----**	**1.8**	**----**
Magnesium/Potassium Ratio	----	0.1	-	**----**	**----**	**----**	**9.5**	**----**
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	100	mg/kg	**330**	**182**	**264**	**443**	**319**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	**2580**	**1140**	**1170**	**190**	**360**
ED092: DTPA Extractable Metals								
ø **Copper**	7440-50-8	1.00	mg/kg	**1.56**	<1.00	**1.53**	<1.00	<1.00
ø **Iron**	7439-89-6	1.00	mg/kg	**18.7**	**10.6**	**10.9**	**18.8**	**21.6**

Analytical Results

Sub-Matrix: **SOLID**
(Matrix: **SOIL**)

				Sample ID	Composite 1 Composite 1, 2, 3	Composite 2 Composite 4, 5, 6, 7, 8, 9	Composite 3 Composite 10	Composite 4 Composite 11, 12	Composite 5 Composite 13, 14, 15, 16, 17, 18, 19
				Sampling date / time	11-Mar-2021 00:00	11-Mar-2021 00:00	11-Mar-2021 00:00	11-Mar-2021 00:00	11-Mar-2021 00:00
Compound	*CAS Number*	*LOR*	*Unit*		**EB2106911-053**	**EB2106911-054**	**EB2106911-055**	**EB2106911-056**	**EB2106911-057**
					Result	Result	Result	Result	Result
ED092: DTPA Extractable Metals - Continued									
ø **Manganese**	7439-96-5	1.00	mg/kg		**23.6**	**3.98**	**6.49**	**8.43**	**10.6**
ø **Zinc**	7440-66-6	1.00	mg/kg		<1.00	<1.00	<1.00	<1.00	<1.00
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**	<0.1	<0.1	<0.1	**0.1**
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg		**79.8**	**0.7**	**0.5**	**35.6**	**1.6**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		**79.9**	**0.7**	**0.5**	**35.6**	**1.7**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		**920**	**260**	**950**	**660**	**830**
EK062: Total Nitrogen as N (TKN + NOx)									
^ **Total Nitrogen as N**	----	20	mg/kg		**1000**	**260**	**950**	**700**	**830**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		**349**	**126**	**145**	**326**	**246**
EK080: Bicarbonate Extractable Phosphorus (Colwell)									
Bicarbonate Ext. P (Colwell)	----	5	mg/kg		**26**	<5	<5	**32**	**19**
EP004: Organic Matter									
Organic Matter	----	0.5	%		**1.6**	<0.5	**3.6**	**1.7**	**1.7**
Total Organic Carbon	----	0.5	%		**1.0**	<0.5	**2.1**	**1.0**	**1.0**

Analytical Results

Sub-Matrix: **SOLID**
(Matrix: **SOIL**)

			Sample ID	Composite 6 Composite 20, 21, 22, 23, 24, 25, 26, 27	Composite 7 Composite 28, 29, 30, 31, 32, 33, 34, 35	Composite 8 Composite 36	Composite 9 Composite 37, 38, 39, 40	Composite 10 Composite 41, 42, 43, 44
			Sampling date / time	11-Mar-2021 00:00	11-Mar-2021 00:00	11-Mar-2021 00:00	11-Mar-2021 00:00	11-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2106911-058	EB2106911-059	EB2106911-060	EB2106911-061	EB2106911-062
				Result	Result	Result	Result	Result
EA001: pH in soil using 0.01M CaCl extract								
pH (CaCl2)	----	0.1	pH Unit	**7.5**	**8.3**	**8.4**	**6.4**	**7.0**
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**8.7**	**9.6**	**9.9**	**7.1**	**8.3**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**271**	**610**	**437**	**56**	**104**
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	**4.0**	**6.1**	**1.4**	**1.2**	**2.4**
ED006: Exchangeable Cations on Alkaline Soils								
ø **Exchangeable Calcium**	----	0.2	meq/100g	**2.4**	**2.1**	**2.8**	**----**	**1.7**
ø **Exchangeable Magnesium**	----	0.2	meq/100g	**1.9**	**4.7**	**3.3**	**----**	**0.6**
ø **Exchangeable Potassium**	----	0.2	meq/100g	<0.2	<0.2	**0.3**	**----**	<0.2
ø **Exchangeable Sodium**	----	0.2	meq/100g	**1.1**	**3.3**	**4.2**	**----**	**0.3**
ø **Cation Exchange Capacity**	----	0.2	meq/100g	**5.6**	**10.2**	**10.6**	**----**	**2.6**
ø **Exchangeable Sodium Percent**	----	0.2	%	**20.5**	**32.5**	**39.7**	**----**	**10.7**
ø **Calcium/Magnesium Ratio**	----	0.2	-	**1.2**	**0.4**	**0.8**	**----**	**2.7**
ø **Magnesium/Potassium Ratio**	----	0.2	-	**----**	**----**	**12.6**	**----**	**----**
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	**----**	**----**	**----**	**2.1**	**----**
Exchangeable Magnesium	----	0.1	meq/100g	**----**	**----**	**----**	**0.6**	**----**
Exchangeable Potassium	----	0.1	meq/100g	**----**	**----**	**----**	**0.2**	**----**
Exchangeable Sodium	----	0.1	meq/100g	**----**	**----**	**----**	<0.1	**----**
Cation Exchange Capacity	----	0.1	meq/100g	**----**	**----**	**----**	**3.1**	**----**
Exchangeable Sodium Percent	----	0.1	%	**----**	**----**	**----**	**1.9**	**----**
Calcium/Magnesium Ratio	----	0.1	-	**----**	**----**	**----**	**3.5**	**----**
Magnesium/Potassium Ratio	----	0.1	-	**----**	**----**	**----**	**2.6**	**----**
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	100	mg/kg	**268**	**273**	**354**	**226**	**134**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	**120**	**220**	**90**	**20**	**70**
ED092: DTPA Extractable Metals								
ø **Copper**	7440-50-8	1.00	mg/kg	<1.00	**1.64**	**1.33**	<1.00	<1.00
ø **Iron**	7439-89-6	1.00	mg/kg	**10.3**	**11.0**	**10.9**	**9.78**	**10.9**

Analytical Results

Sub-Matrix: **SOLID** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Sample ID	Composite 6 Composite 20, 21, 22, 23, 24, 25, 26, 27	Composite 7 Composite 28, 29, 30, 31, 32, 33, 34, 35	Composite 8 Composite 36	Composite 9 Composite 37, 38, 39, 40	Composite 10 Composite 41, 42, 43, 44
				Sampling date / time	11-Mar-2021 00:00	11-Mar-2021 00:00	11-Mar-2021 00:00	11-Mar-2021 00:00	11-Mar-2021 00:00
					EB2106911-058	EB2106911-059	EB2106911-060	EB2106911-061	EB2106911-062
					Result	Result	Result	Result	Result
ED092: DTPA Extractable Metals - Continued									
ø **Manganese**	7439-96-5	1.00	mg/kg		**6.28**	**5.22**	**2.56**	**13.6**	**16.3**
ø **Zinc**	7440-66-6	1.00	mg/kg		<1.00	**2.02**	**2.21**	<1.00	<1.00
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	<0.1	<0.1	<0.1	**0.1**
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg		**0.8**	**1.6**	**5.5**	**15.1**	**10.9**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		**0.8**	**1.6**	**5.5**	**15.1**	**11.0**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		**380**	**1350**	**2000**	**270**	**440**
EK062: Total Nitrogen as N (TKN + NOx)									
^ **Total Nitrogen as N**	----	20	mg/kg		**380**	**1350**	**2000**	**280**	**450**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		**201**	**485**	**532**	**77**	**119**
EK080: Bicarbonate Extractable Phosphorus (Colwell)									
Bicarbonate Ext. P (Colwell)	----	5	mg/kg		**8**	<5	<5	<5	<5
EP004: Organic Matter									
Organic Matter	----	0.5	%		**0.9**	**2.5**	**2.2**	**0.8**	**1.3**
Total Organic Carbon	----	0.5	%		**0.5**	**1.4**	**1.2**	<0.5	**0.8**

Analytical Results

Sub-Matrix: SOLID (Matrix: SOIL)			Sample ID	Composite 11 Composite 45, 46, 47, 48	Composite 12 Composite 49, 50, 51, 52	----	----	----
			Sampling date / time	11-Mar-2021 00:00	11-Mar-2021 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2106911-063	EB2106911-064	--------	--------	--------
				Result	Result	----	----	----
EA001: pH in soil using 0.01M CaCl extract								
pH (CaCl2)	----	0.1	pH Unit	7.0	7.4	----	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	7.6	8.2	----	----	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	400	435	----	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	4.1	5.4	----	----	----
ED006: Exchangeable Cations on Alkaline Soils								
ø Exchangeable Calcium	----	0.2	meq/100g	1.6	2.9	----	----	----
ø Exchangeable Magnesium	----	0.2	meq/100g	0.8	1.8	----	----	----
ø Exchangeable Potassium	----	0.2	meq/100g	0.4	<0.2	----	----	----
ø Exchangeable Sodium	----	0.2	meq/100g	0.4	0.7	----	----	----
ø Cation Exchange Capacity	----	0.2	meq/100g	3.2	5.4	----	----	----
ø Exchangeable Sodium Percent	----	0.2	%	11.6	12.9	----	----	----
ø Calcium/Magnesium Ratio	----	0.2	-	1.8	1.6	----	----	----
ø Magnesium/Potassium Ratio	----	0.2	-	2.3	----	----	----	----
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	100	mg/kg	267	211	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	360	480	----	----	----
ED092: DTPA Extractable Metals								
ø Copper	7440-50-8	1.00	mg/kg	<1.00	1.05	----	----	----
ø Iron	7439-89-6	1.00	mg/kg	21.4	14.5	----	----	----
ø Manganese	7439-96-5	1.00	mg/kg	17.3	25.4	----	----	----
ø Zinc	7440-66-6	1.00	mg/kg	<1.00	<1.00	----	----	----
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	<0.1	<0.1	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	45.9	8.0	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								

Analytical Results

Sub-Matrix: SOLID (Matrix: SOIL)				Sample ID	Composite 11 Composite 45, 46, 47, 48	Composite 12 Composite 49, 50, 51, 52	----	----	----
				Sampling date / time	11-Mar-2021 00:00	11-Mar-2021 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EB2106911-063	EB2106911-064	--------	--------	--------
					Result	Result	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser - Continued									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		**45.9**	**8.0**	**----**	**----**	**----**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		**670**	**700**	**----**	**----**	**----**
EK062: Total Nitrogen as N (TKN + NOx)									
^ Total Nitrogen as N	----	20	mg/kg		**720**	**710**	**----**	**----**	**----**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		**146**	**135**	**----**	**----**	**----**
EK080: Bicarbonate Extractable Phosphorus (Colwell)									
Bicarbonate Ext. P (Colwell)	----	5	mg/kg		**14**	**7**	**----**	**----**	**----**
EP004: Organic Matter									
Organic Matter	----	0.5	%		**1.3**	**1.6**	**----**	**----**	**----**
Total Organic Carbon	----	0.5	%		**0.8**	**1.0**	**----**	**----**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2108500**	Page	: 1 of 15
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ALAN ROBERTSON	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4107	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2021011 Nitro Foxleigh	Date Samples Received	: 29-Mar-2021 17:32
Order number	: ----	Date Analysis Commenced	: 30-Mar-2021
C-O-C number	: ----	Issue Date	: 31-Mar-2021 10:58
Sampler	: ALAN ROBERTSON		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 62		
No. of samples analysed	: 62		

ilac-MRA NATA
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

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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.

Analytical Results

Sub-Matrix: **PULP** (Matrix: **SOIL**)			Sample ID	2021011_1081	2021011_1086	2021011_1061	2021011_1050	2021011_1002
			Sampling date / time	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB2108500-001**	**EB2108500-002**	**EB2108500-003**	**EB2108500-004**	**EB2108500-005**
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.159**	**0.446**	**0.126**	**0.058**	**0.018**

Analytical Results

Sub-Matrix: **PULP** (Matrix: **SOIL**)			Sample ID	2021011_3001	2021011_3003	2021011_3004	2021011_3011	2021011_3007
			Sampling date / time	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB2108500-006**	**EB2108500-007**	**EB2108500-008**	**EB2108500-009**	**EB2108500-010**
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.072**	**0.134**	**0.741**	**0.220**	**0.124**

Analytical Results

Sub-Matrix: **PULP** (Matrix: **SOIL**)			Sample ID	2021011_3021	2021011_3013	2021011_3015	2021011_3018	2021011_3032
			Sampling date / time	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB2108500-011**	**EB2108500-012**	**EB2108500-013**	**EB2108500-014**	**EB2108500-015**
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.985**	**0.563**	**1.02**	**0.146**	**0.082**

Analytical Results

Sub-Matrix: **PULP** (Matrix: **SOIL**)			Sample ID	2021011_3027	2021011_3029	2021011_3030	2021011_3033	2021011_3034
			Sampling date / time	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB2108500-016**	**EB2108500-017**	**EB2108500-018**	**EB2108500-019**	**EB2108500-020**
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.082**	**0.698**	**0.292**	**0.095**	**0.742**

Analytical Results

Sub-Matrix: **PULP** (Matrix: **SOIL**)			Sample ID	2021011_3038	2021011_3039	2021011_3040	2021011_3041	2021011_3042
			Sampling date / time	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB2108500-021**	**EB2108500-022**	**EB2108500-023**	**EB2108500-024**	**EB2108500-025**
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.308**	**0.206**	**0.313**	**0.037**	**0.186**

Analytical Results

Sub-Matrix: **PULP** (Matrix: **SOIL**)			Sample ID	2021011_3043	2021011_3046	2021011_3048	2021011_3052	2021011_3054
			Sampling date / time	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB2108500-026**	**EB2108500-027**	**EB2108500-028**	**EB2108500-029**	**EB2108500-030**
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.075**	**0.224**	**0.409**	**0.579**	**0.035**

Analytical Results

Sub-Matrix: **PULP** (Matrix: **SOIL**)			Sample ID	2021011_3055	2021011_3059	2021011_3060	2021011_3061	2021011_3062
			Sampling date / time	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB2108500-031**	**EB2108500-032**	**EB2108500-033**	**EB2108500-034**	**EB2108500-035**
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.031**	**0.252**	**0.267**	**0.461**	**0.383**

Analytical Results

Sub-Matrix: **PULP** (Matrix: **SOIL**)			Sample ID	2021011_3063	2021011_3064	2021011_2001	2021011_2002	2021011_2003
			Sampling date / time	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB2108500-036**	**EB2108500-037**	**EB2108500-038**	**EB2108500-039**	**EB2108500-040**
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.096**	**0.048**	**0.730**	**0.728**	**0.734**

Analytical Results

Sub-Matrix: **PULP** (Matrix: **SOIL**)			Sample ID	2021011_2004	2021011_2005	2021011_2006	2021011_2007	2021011_2008
			Sampling date / time	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB2108500-041**	**EB2108500-042**	**EB2108500-043**	**EB2108500-044**	**EB2108500-045**
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.723**	**0.713**	**0.106**	**0.143**	**0.078**

Analytical Results

Sub-Matrix: **PULP** (Matrix: **SOIL**)			Sample ID	2021011_2009	2021011_2010	2021011_2011	2021011_2012	2021011_2013
			Sampling date / time	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB2108500-046**	**EB2108500-047**	**EB2108500-048**	**EB2108500-049**	**EB2108500-050**
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.118**	**0.344**	**0.517**	**2.17**	**1.23**

Analytical Results

Sub-Matrix: **PULP** (Matrix: **SOIL**)			Sample ID	2021011_2014	2021011_2015	2021011_2016	2021011_2017	2021011_2018
			Sampling date / time	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB2108500-051**	**EB2108500-052**	**EB2108500-053**	**EB2108500-054**	**EB2108500-055**
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**1.20**	**0.386**	**1.92**	**1.38**	**0.543**

Analytical Results

Sub-Matrix: **PULP** (Matrix: **SOIL**)			Sample ID	2021011_2019	2021011_2020	2021011_2021	2021011_2022	2021011_2023
			Sampling date / time	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB2108500-056**	**EB2108500-057**	**EB2108500-058**	**EB2108500-059**	**EB2108500-060**
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**1.06**	**0.269**	**0.427**	**0.189**	**0.331**

Analytical Results

Sub-Matrix: **PULP** (Matrix: **SOIL**)			Sample ID	**2021011_2024**	**2021011_2025**	**----**	**----**	**----**
			Sampling date / time	29-Mar-2021 00:00	29-Mar-2021 00:00	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB2108500-061**	**EB2108500-062**	**--------**	**--------**	**--------**
				Result	Result	----	----	----
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.330**	**0.397**	**----**	**----**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2108504**	Page	: 1 of 12
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ALAN ROBERTSON	Contact	: Carsten Emrich
Address	: 3/30 LENSWORTH STREET COOPERS PLAINS 4107	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2021011 Foxleigh	Date Samples Received	: 29-Mar-2021 17:32
Order number	: ----	Date Analysis Commenced	: 31-Mar-2021
C-O-C number	: ----	Issue Date	: 06-Apr-2021 16:32
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*
Kim McCabe	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
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.

- ED037 (Alkalinity): NATA accreditation does not cover the performance of this service.
- ED038 (Acidity): NATA accreditation does not cover the performance of this service.

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Sample ID	2021011_C1001	2021011_C1002	2021011_C1003	2021011_C1004	2021011_C1005
			Sampling date / time	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2108504-001	EB2108504-002	EB2108504-003	EB2108504-004	EB2108504-005
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	7.8	9.3	9.3	9.6	9.5
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	1080	650	634	550	582
ED037: Alkalinity								
ø Total Alkalinity as CaCO3	----	1	mg/kg	2210	14200	3990	4940	4850
ø Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/kg	2210	13300	3470	4070	4070
ø Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/kg	<5	953	520	867	780
ED038A: Acidity								
Acidity	----	1	mg/kg	95	<5	<5	<5	<5
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	240	160	140	180	220
Silica	7631-86-9	1	mg/kg	79	42	45	45	45
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	1600	490	450	100	140
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	<10	<10	<10	<10	<10
Magnesium	7439-95-4	10	mg/kg	10	<10	<10	<10	<10
Sodium	7440-23-5	10	mg/kg	970	620	610	560	590
Potassium	7440-09-7	10	mg/kg	20	20	20	20	20
ED093T: Total Major Cations								
Calcium	7440-70-2	50	mg/kg	1320	11900	4310	10800	8790
Magnesium	7439-95-4	50	mg/kg	2350	4340	4110	5530	4630
Sodium	7440-23-5	50	mg/kg	2140	1710	2040	2240	2300
Potassium	7440-09-7	50	mg/kg	670	960	1090	1220	1220
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	7170	10600	11000	7870	8140
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	<5	<5
Barium	7440-39-3	10	mg/kg	190	100	130	130	170
Beryllium	7440-41-7	1	mg/kg	2	<1	1	<1	<1
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Cobalt	7440-48-4	2	mg/kg	30	14	12	11	13

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)				Sample ID	2021011_C1001	2021011_C1002	2021011_C1003	2021011_C1004	2021011_C1005
				Sampling date / time	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00
Compound	CAS Number	LOR	Unit		EB2108504-001	EB2108504-002	EB2108504-003	EB2108504-004	EB2108504-005
					Result	Result	Result	Result	Result
EG005(ED093)T: Total Metals by ICP-AES - Continued									
Iron	7439-89-6	50	mg/kg		36800	37800	29800	27200	26800
Manganese	7439-96-5	5	mg/kg		887	623	396	434	488
Molybdenum	7439-98-7	2	mg/kg		<2	<2	<2	<2	<2
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Silver	7440-22-4	2	mg/kg		<2	<2	<2	<2	<2
Arsenic	7440-38-2	5	mg/kg		<5	7	7	8	7
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg		21	21	16	7	6
Copper	7440-50-8	5	mg/kg		23	29	41	45	55
Lead	7439-92-1	5	mg/kg		9	12	15	14	15
Nickel	7440-02-0	2	mg/kg		43	35	34	18	20
Zinc	7440-66-6	5	mg/kg		66	59	70	75	82
EG020S: Soluble Metals by ICPMS									
Arsenic	7440-38-2	0.01	mg/kg		<0.01	0.28	0.33	0.87	0.84
Selenium	7782-49-2	0.1	mg/kg		<0.1	<0.1	<0.1	0.1	0.2
Barium	7440-39-3	0.01	mg/kg		0.06	0.03	0.03	0.04	0.06
Beryllium	7440-41-7	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
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		0.02	0.06	0.18	0.34	0.47
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	0.02	0.02	0.03	0.04
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	0.3	0.3
Aluminium	7429-90-5	0.1	mg/kg		<0.1	1.0	1.0	2.5	2.3
EG020T: Total Metals by ICP-MS									
Thorium	7440-29-1	0.1	mg/kg		2.0	2.0	1.6	2.3	2.1
Uranium	7440-61-1	0.1	mg/kg		0.6	0.4	0.4	0.3	0.3

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Sample ID	2021011_C1001	2021011_C1002	2021011_C1003	2021011_C1004	2021011_C1005
			Sampling date / time	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2108504-001	EB2108504-002	EB2108504-003	EB2108504-004	EB2108504-005
				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
EK040S: Fluoride Soluble								
Fluoride	16984-48-8	1	mg/kg	**3**	<1	**2**	<1	<1
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.1	mg/kg	**0.1**	**0.8**	**0.4**	**0.4**	**0.5**

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Sample ID	2021011_C2001	2021011_C2002	2021011_C2003	2021011_C3001	2021011_C3002
			Sampling date / time	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2108504-006	EB2108504-007	EB2108504-008	EB2108504-009	EB2108504-010
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.4	8.8	9.0	9.5	9.2
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	2230	1080	417	509	810
ED037: Alkalinity								
ø Total Alkalinity as CaCO3	----	1	mg/kg	20400	6630	3770	3600	11500
ø Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/kg	20300	6460	3680	2820	11100
ø Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/kg	87	173	87	780	347
ED038A: Acidity								
Acidity	----	1	mg/kg	<5	<5	<5	<5	<5
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	1580	1130	820	190	620
Silica	7631-86-9	1	mg/kg	26	26	15	46	41
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	2930	850	490	210	600
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	120	30	40	<10	<10
Magnesium	7439-95-4	10	mg/kg	140	20	30	<10	<10
Sodium	7440-23-5	10	mg/kg	2070	1040	660	520	810
Potassium	7440-09-7	10	mg/kg	40	20	10	20	30
ED093T: Total Major Cations								
Calcium	7440-70-2	50	mg/kg	18600	12000	8210	6140	15600
Magnesium	7439-95-4	50	mg/kg	4650	3120	2130	4260	6800
Sodium	7440-23-5	50	mg/kg	2880	1950	1020	1890	1920
Potassium	7440-09-7	50	mg/kg	600	780	360	1220	1020
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	3260	3610	2360	8160	5910
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	<5	<5
Barium	7440-39-3	10	mg/kg	300	100	80	140	100
Beryllium	7440-41-7	1	mg/kg	<1	<1	<1	<1	<1
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Cobalt	7440-48-4	2	mg/kg	4	4	<2	8	10

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)				Sample ID	2021011_C2001	2021011_C2002	2021011_C2003	2021011_C3001	2021011_C3002
				Sampling date / time	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00
Compound	CAS Number	LOR	Unit		EB2108504-006	EB2108504-007	EB2108504-008	EB2108504-009	EB2108504-010
					Result	Result	Result	Result	Result
EG005(ED093)T: Total Metals by ICP-AES - Continued									
Iron	7439-89-6	50	mg/kg		14000	27500	12400	33600	22600
Manganese	7439-96-5	5	mg/kg		216	261	178	573	353
Molybdenum	7439-98-7	2	mg/kg		<2	<2	<2	<2	<2
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Silver	7440-22-4	2	mg/kg		<2	<2	<2	<2	<2
Arsenic	7440-38-2	5	mg/kg		<5	<5	<5	7	14
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg		3	3	<2	7	14
Copper	7440-50-8	5	mg/kg		31	43	16	41	36
Lead	7439-92-1	5	mg/kg		10	11	6	19	15
Nickel	7440-02-0	2	mg/kg		8	9	3	17	26
Zinc	7440-66-6	5	mg/kg		40	47	34	64	75
EG020S: Soluble Metals by ICPMS									
Arsenic	7440-38-2	0.01	mg/kg		<0.01	0.03	0.01	1.06	1.09
Selenium	7782-49-2	0.1	mg/kg		<0.1	<0.1	<0.1	0.2	0.1
Barium	7440-39-3	0.01	mg/kg		0.13	0.09	0.12	0.04	0.07
Beryllium	7440-41-7	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
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		0.05	0.02	0.04	<0.01	<0.01
Molybdenum	7439-98-7	0.01	mg/kg		0.08	0.06	0.03	0.47	0.53
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	0.03	0.02
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	0.2	0.1
Aluminium	7429-90-5	0.1	mg/kg		<0.1	0.2	0.1	1.7	0.5
EG020T: Total Metals by ICP-MS									
Thorium	7440-29-1	0.1	mg/kg		1.0	1.0	1.1	3.2	3.2
Uranium	7440-61-1	0.1	mg/kg		0.6	0.3	0.3	0.5	0.6

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)				Sample ID	2021011_C2001	2021011_C2002	2021011_C2003	2021011_C3001	2021011_C3002
				Sampling date / time	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00	29-Mar-2021 00:00
Compound	CAS Number	LOR	Unit		EB2108504-006	EB2108504-007	EB2108504-008	EB2108504-009	EB2108504-010
					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**
EK040S: Fluoride Soluble									
Fluoride	16984-48-8	1	mg/kg		**2**	**3**	**1**	<1	**2**
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	**0.5**	**0.3**

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Sample ID	2021011_C3003	2021011_C3004	----	----	----
			Sampling date / time	29-Mar-2021 00:00	29-Mar-2021 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2108504-011	EB2108504-012	--------	--------	--------
				Result	Result	----	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.3	9.4	----	----	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	379	733	----	----	----
ED037: Alkalinity								
ø Total Alkalinity as CaCO3	----	1	mg/kg	2600	3730	----	----	----
ø Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/kg	2430	3290	----	----	----
ø Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/kg	173	433	----	----	----
ED038A: Acidity								
Acidity	----	1	mg/kg	<5	<5	----	----	----
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	160	450	----	----	----
Silica	7631-86-9	1	mg/kg	47	46	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	280	480	----	----	----
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	<10	<10	----	----	----
Magnesium	7439-95-4	10	mg/kg	<10	<10	----	----	----
Sodium	7440-23-5	10	mg/kg	410	720	----	----	----
Potassium	7440-09-7	10	mg/kg	<10	20	----	----	----
ED093T: Total Major Cations								
Calcium	7440-70-2	50	mg/kg	1960	3310	----	----	----
Magnesium	7439-95-4	50	mg/kg	2060	1880	----	----	----
Sodium	7440-23-5	50	mg/kg	2280	2130	----	----	----
Potassium	7440-09-7	50	mg/kg	910	1020	----	----	----
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	4800	4180	----	----	----
Antimony	7440-36-0	5	mg/kg	<5	<5	----	----	----
Barium	7440-39-3	10	mg/kg	200	360	----	----	----
Beryllium	7440-41-7	1	mg/kg	1	<1	----	----	----
Boron	7440-42-8	50	mg/kg	<50	<50	----	----	----
Cobalt	7440-48-4	2	mg/kg	6	11	----	----	----

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Sample ID	2021011_C3003	2021011_C3004	----	----	----
			Sampling date / time	29-Mar-2021 00:00	29-Mar-2021 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2108504-011	EB2108504-012	--------	--------	--------
				Result	Result	----	----	----
EG005(ED093)T: Total Metals by ICP-AES - Continued								
Iron	7439-89-6	50	mg/kg	**8400**	**6660**	----	----	----
Manganese	7439-96-5	5	mg/kg	**75**	**44**	----	----	----
Molybdenum	7439-98-7	2	mg/kg	<2	<2	----	----	----
Selenium	7782-49-2	5	mg/kg	<5	<5	----	----	----
Silver	7440-22-4	2	mg/kg	<2	<2	----	----	----
Arsenic	7440-38-2	5	mg/kg	<5	<5	----	----	----
Cadmium	7440-43-9	1	mg/kg	<1	<1	----	----	----
Chromium	7440-47-3	2	mg/kg	**4**	**3**	----	----	----
Copper	7440-50-8	5	mg/kg	**48**	**51**	----	----	----
Lead	7439-92-1	5	mg/kg	**18**	**18**	----	----	----
Nickel	7440-02-0	2	mg/kg	**13**	**20**	----	----	----
Zinc	7440-66-6	5	mg/kg	**73**	**85**	----	----	----
EG020S: Soluble Metals by ICPMS								
Arsenic	7440-38-2	0.01	mg/kg	**0.83**	**0.50**	----	----	----
Selenium	7782-49-2	0.1	mg/kg	**0.2**	**0.2**	----	----	----
Barium	7440-39-3	0.01	mg/kg	**0.02**	**0.11**	----	----	----
Beryllium	7440-41-7	0.01	mg/kg	<0.01	<0.01	----	----	----
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	**0.57**	**0.78**	----	----	----
Nickel	7440-02-0	0.01	mg/kg	**0.04**	<0.01	----	----	----
Lead	7439-92-1	0.01	mg/kg	<0.01	<0.01	----	----	----
Antimony	7440-36-0	0.01	mg/kg	**0.02**	**0.03**	----	----	----
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	**0.2**	**0.3**	----	----	----
Aluminium	7429-90-5	0.1	mg/kg	**1.6**	**0.9**	----	----	----
EG020T: Total Metals by ICP-MS								
Thorium	7440-29-1	0.1	mg/kg	**1.3**	**1.1**	----	----	----
Uranium	7440-61-1	0.1	mg/kg	**0.3**	**0.3**	----	----	----

Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Sample ID	2021011_C3003	2021011_C3004	----	----	----
			Sampling date / time	29-Mar-2021 00:00	29-Mar-2021 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2108504-011	EB2108504-012	--------	--------	--------
				Result	Result	----	----	----
EG035S: Soluble Mercury by FIMS								
Mercury	7439-97-6	0.0005	mg/kg	<0.0005	<0.0005	----	----	----
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	**1**	**3**	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.1	mg/kg	**0.4**	**0.5**	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	pH and EC of DI Water	----	----	----	----
				Sampling date / time	29-Mar-2021 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2108504-013	--------	--------	--------	--------
					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	: **EB2108658**	Page	: 1 of 4
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ALAN ROBERTSON	Contact	: Carsten Emrich
Address	: PO BOX 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2021011 Foxleigh	Date Samples Received	: 30-Mar-2021 15:53
Order number	: ----	Date Analysis Commenced	: 01-Apr-2021
C-O-C number	: ----	Issue Date	: 07-Apr-2021 10:27
Sampler	: PRIYA RAJENDRAN		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 7		
No. of samples analysed	: 7		

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 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 for some samples as required Exchangeable Magnesium and/or Potassium results are less than the limit of reporting.
- 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	2021011_C1001	2021011_C1002	2021011_C1003	2021011_C1004	2021011_C1005
			Sampling date / time	30-Mar-2021 00:00	30-Mar-2021 00:00	30-Mar-2021 00:00	30-Mar-2021 00:00	30-Mar-2021 00:00
Compound	CAS Number	LOR	Unit	EB2108658-001	EB2108658-002	EB2108658-003	EB2108658-004	EB2108658-005
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**9.1**	**9.9**	**9.6**	**9.9**	**9.9**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**1180**	**479**	**625**	**329**	**366**
ED006: Exchangeable Cations on Alkaline Soils								
ø **Exchangeable Calcium**	----	0.2	meq/100g	**0.4**	**0.4**	**0.5**	**0.4**	**1.1**
ø **Exchangeable Magnesium**	----	0.2	meq/100g	**5.5**	**3.6**	**5.0**	**1.8**	**1.5**
ø **Exchangeable Potassium**	----	0.2	meq/100g	<0.2	<0.2	<0.2	<0.2	**0.2**
ø **Exchangeable Sodium**	----	0.2	meq/100g	**4.5**	**5.3**	**8.1**	**8.6**	**9.3**
ø **Cation Exchange Capacity**	----	0.2	meq/100g	**10.4**	**9.3**	**13.7**	**11.0**	**12.1**
ø **Exchangeable Sodium Percent**	----	0.2	%	**43.0**	**57.0**	**59.3**	**78.4**	**76.6**
ø **Calcium/Magnesium Ratio**	----	0.2	-	<0.2	<0.2	<0.2	<0.2	**0.7**
ø **Magnesium/Potassium Ratio**	----	0.2	-	**----**	**----**	**----**	**----**	**6.7**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	2021011_C2001	2021011_C2002	----	----	----
			Sampling date / time	30-Mar-2021 00:00	30-Mar-2021 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2108658-006	EB2108658-007	--------	--------	--------
				Result	Result	----	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**8.8**	**9.1**	----	----	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**2820**	**877**	----	----	----
ED006: Exchangeable Cations on Alkaline Soils								
ø **Exchangeable Calcium**	----	0.2	meq/100g	<0.2	<0.2	----	----	----
ø **Exchangeable Magnesium**	----	0.2	meq/100g	**6.0**	**3.6**	----	----	----
ø **Exchangeable Potassium**	----	0.2	meq/100g	<0.2	<0.2	----	----	----
ø **Exchangeable Sodium**	----	0.2	meq/100g	**5.8**	**4.9**	----	----	----
ø **Cation Exchange Capacity**	----	0.2	meq/100g	**11.7**	**8.5**	----	----	----
ø **Exchangeable Sodium Percent**	----	0.2	%	**49.3**	**57.6**	----	----	----
ø **Calcium/Magnesium Ratio**	----	0.2	-	<0.2	<0.2	----	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2108916**	Page	: 1 of 4
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ALAN ROBERTSON	Contact	: Carsten Emrich
Address	: PO BOX 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2021011_Foxleigh	Date Samples Received	: 01-Apr-2021 17:27
Order number	:	Date Analysis Commenced	: 07-Apr-2021
C-O-C number	: 20944	Issue Date	: 12-Apr-2021 13:49
Sampler	: ALAN ROBERTSON		
Site	: 2021011_Foxleigh L1		
Quote number	: BN/1234/19		
No. of samples received	: 5		
No. of samples analysed	: 5		

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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*
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.

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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.

- Ionic Balance out of acceptable limits 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	KLC-1	KLC-2	KLC-5	KLC-6	KLC-7
			Sampling date / time	01-Apr-2021 12:01	01-Apr-2021 12:01	01-Apr-2021 12:02	01-Apr-2021 12:02	01-Apr-2021 12:03
Compound	CAS Number	LOR	Unit	EB2108916-001	EB2108916-002	EB2108916-003	EB2108916-004	EB2108916-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	7.07	8.23	7.31	6.96	7.26
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	2040	179	1660	2770	1210
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	23	27	16	8	15
Total Alkalinity as CaCO3	----	1	mg/L	23	27	16	8	15
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	4	1	3	3	3
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	101	26	164	696	320
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	640	20	480	560	205
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	12	<1	12	46	30
Magnesium	7439-95-4	1	mg/L	14	<1	20	35	16
Sodium	7440-23-5	1	mg/L	381	35	238	500	196
Potassium	7440-09-7	1	mg/L	2	1	<1	2	<1
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	1.99	<0.01	<0.01	<0.01
Antimony	7440-36-0	0.001	mg/L	0.003	0.002	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	0.003	0.024	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	0.002	0.004	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	0.005	<0.001
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	0.006	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	0.012	<0.005
Manganese	7439-96-5	0.001	mg/L	0.012	0.002	0.003	0.180	0.104
Molybdenum	7439-98-7	0.001	mg/L	0.007	0.014	0.002	0.001	0.002
Selenium	7782-49-2	0.01	mg/L	0.01	0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Sample ID	KLC-1	KLC-2	KLC-5	KLC-6	KLC-7
				Sampling date / time	01-Apr-2021 12:01	01-Apr-2021 12:01	01-Apr-2021 12:02	01-Apr-2021 12:02	01-Apr-2021 12:03
					EB2108916-001	EB2108916-002	EB2108916-003	EB2108916-004	EB2108916-005
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Boron	7440-42-8	0.05	mg/L		**0.07**	<0.05	<0.05	<0.05	<0.05
Iron	7439-89-6	0.05	mg/L		<0.05	**0.15**	<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	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.6**	**0.1**	<0.1	**0.2**	**0.2**
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**20.6**	**1.64**	**17.3**	**30.4**	**12.7**
ø Total Cations	----	0.01	meq/L		**18.4**	**1.55**	**12.6**	**27.0**	**11.3**
ø Ionic Balance	----	0.01	%		**5.75**	**----**	**15.6**	**6.05**	**5.84**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2109870**	Page	: 1 of 4
Client	: **RGS ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ALAN ROBERTSON	Contact	: Carsten Emrich
Address	: PO BOX 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2021011_Foxleigh	Date Samples Received	: 13-Apr-2021 17:55
Order number	:	Date Analysis Commenced	: 16-Apr-2021
C-O-C number	: 21362	Issue Date	: 20-Apr-2021 17:36
Sampler	: ALAN ROBERTSON		
Site	: 2021011_Foxleigh L1		
Quote number	: BN/1234/19		
No. of samples received	: 2		
No. of samples analysed	: 2		

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 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.

- Ionic Balance out of acceptable limits 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	KLC-3	KLC-4	----	----	----
			Sampling date / time	13-Apr-2021 14:20	13-Apr-2021 14:20	----	----	----
Compound	CAS Number	LOR	Unit	EB2109870-001	EB2109870-002	--------	--------	--------
				Result	Result	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.42**	**7.59**	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**706**	**906**	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**28**	**42**	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**28**	**42**	----	----	----
ED038: Acidity								
Acidity as CaCO3	----	1	mg/L	**2**	**2**	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**86**	**113**	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**135**	**199**	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**3**	**2**	----	----	----
Magnesium	7439-95-4	1	mg/L	**2**	**1**	----	----	----
Sodium	7440-23-5	1	mg/L	**133**	**175**	----	----	----
Potassium	7440-09-7	1	mg/L	**1**	**2**	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.54**	**0.55**	----	----	----
Antimony	7440-36-0	0.001	mg/L	<0.001	**0.002**	----	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.054**	**0.047**	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.002**	**0.002**	----	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	----	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	**0.002**	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	----	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.005**	**0.001**	----	----	----
Molybdenum	7439-98-7	0.001	mg/L	**0.044**	**0.104**	----	----	----
Selenium	7782-49-2	0.01	mg/L	**0.03**	**0.05**	----	----	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	KLC-3	KLC-4	----	----	----
				Sampling date / time	13-Apr-2021 14:20	13-Apr-2021 14:20	----	----	----
Compound	CAS Number	LOR	Unit		EB2109870-001	EB2109870-002	--------	--------	--------
					Result	Result	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Boron	7440-42-8	0.05	mg/L		<0.05	<0.05	----	----	----
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	----	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.3**	**0.5**	----	----	----
EN055: Ionic Balance									
ø **Total Anions**	----	0.01	meq/L		**6.16**	**8.80**	----	----	----
ø **Total Cations**	----	0.01	meq/L		**6.12**	**7.84**	----	----	----
ø **Ionic Balance**	----	0.01	%		**0.27**	**5.77**	----	----	----

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EMERSON CLASS NUMBER TEST REPORT

Test Method: AS 1289 3.8.1

Client	RGS Environmental Pty Ltd	**Report No.**	21031098-EM
		Workorder No.	8399
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	23/3/21-1/4/21
		Report Date	01/04/2021
Project	2021011 - Nitro Foxleigh		

Sample No.	21031098	21031099	21031100	21031101	21031102	21031103	21031104
Client ID	Composite 1	Composite 2	Composite 3	Composite 4	Composite 5	Composite 6	Composite 7
Depth (m)	Not Supplied	Not Supplied	Not Supplied	Not Supplied	Not Supplied	Not Supplied	Not Supplied
Description	Gravelly Sandy CLAY - brown	CLAY - brown	Sandy CLAY - brown	CLAY - dark brown	Silty Sandy CLAY - brown	Sandy CLAY - brown	Sandy Silty CLAY - brown/black
Emerson Class Number	**2**	**1**	**1**	**1**	**2**	**3**	**1**

Sample No.	21031105	21031106	21031107	21031108	21031109	21031110	21031111
Client ID	Composite 8	Composite 9	Composite 10	Composite 11	Composite 12	Composite 13	Composite 14
Depth (m)	Not Supplied	Not Supplied	Not Supplied	Not Supplied	Not Supplied	Not Supplied	Not Supplied
Description	Sandy CLAY - brown	Sandy Silty CLAY - brown	Clayey Sandy GRAVEL - grey	Sandy Clayey GRAVEL - grey/black	Clayey SAND - dark grey	Clayey Silty SAND - brown	Clayey Silty SAND - brown
Emerson Class Number	**1**	**1**	**2**	**1**	**1**	**3**	**3**

Sample No.	21031112	21031113	21031114	21031115	21031116	21031117	-
Client ID	Composite 15	Composite 16	Composite 17	Composite 18	Composite 19	Composite 20	-
Depth (m)	Not Supplied	Not Supplied	Not Supplied	Not Supplied	Not Supplied	Not Supplied	-
Description	Sandy Silty CLAY - brown	Silty Sandy CLAY - brown	Silty Sandy CLAY - brown	Sandy CLAY - brown	Silty CLAY - brown	Sandy CLAY - brown	-
Emerson Class Number	**3**	**2**	**2**	**2**	**2**	**2**	**-**

NOTES/REMARKS:

Sample/s supplied by the client

Tested with Distilled water at 22°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

C. Park

NATA ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

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Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

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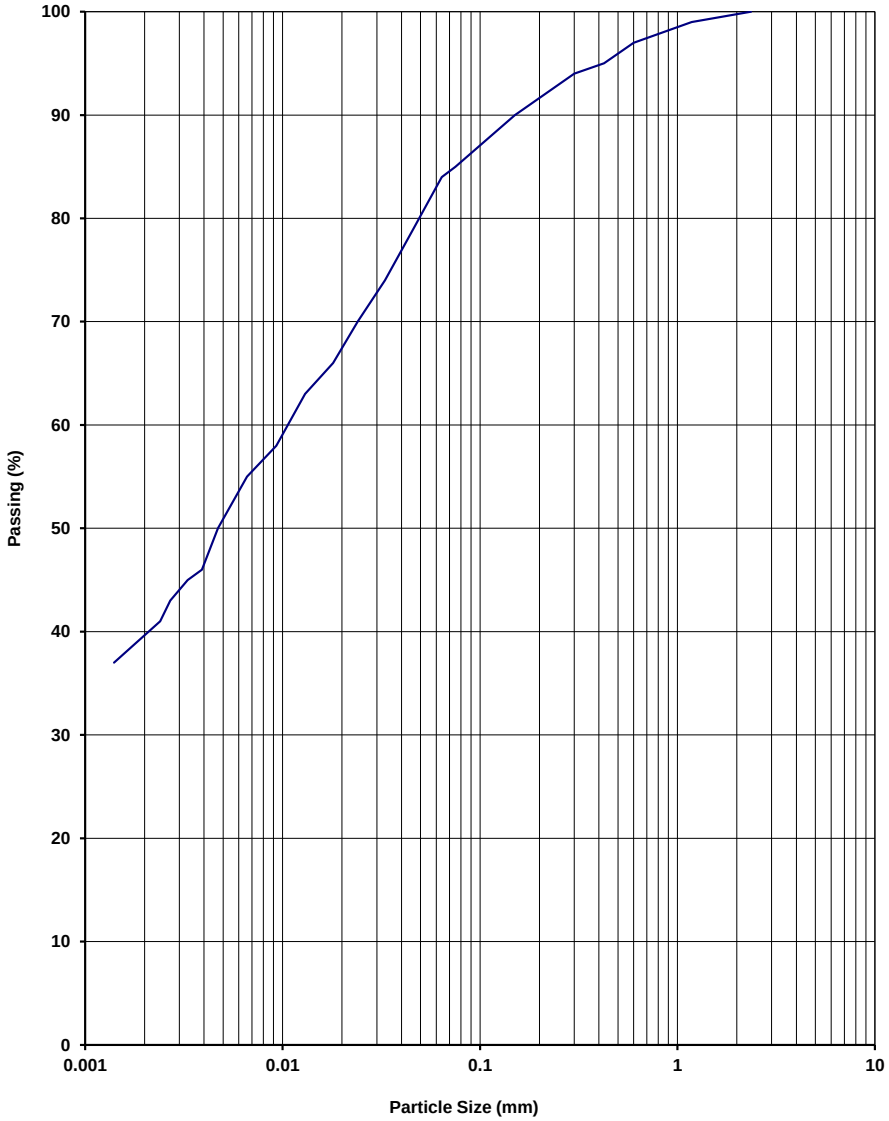
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	21031118-G
		Workorder No.	0008399
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	23/3/21-7/4/21
		Report Date	7/4/2021
Project	2021011 - Nitro Foxleigh		
Client ID	Composite 21	**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	97
0.425	95
0.300	94
0.150	90
0.075	85
0.064	84
0.046	79
0.033	74
0.024	70
0.018	66
0.013	63
0.0093	58
0.0066	55
0.0047	50
0.0039	46
0.0033	45
0.0027	43
0.0024	41
0.0014	37



NOTES/REMARKS: -

Moisture Content 3.5% -2.36mm Soil Particle Density(t/m^3) 2.41

Sample/s supplied by the client

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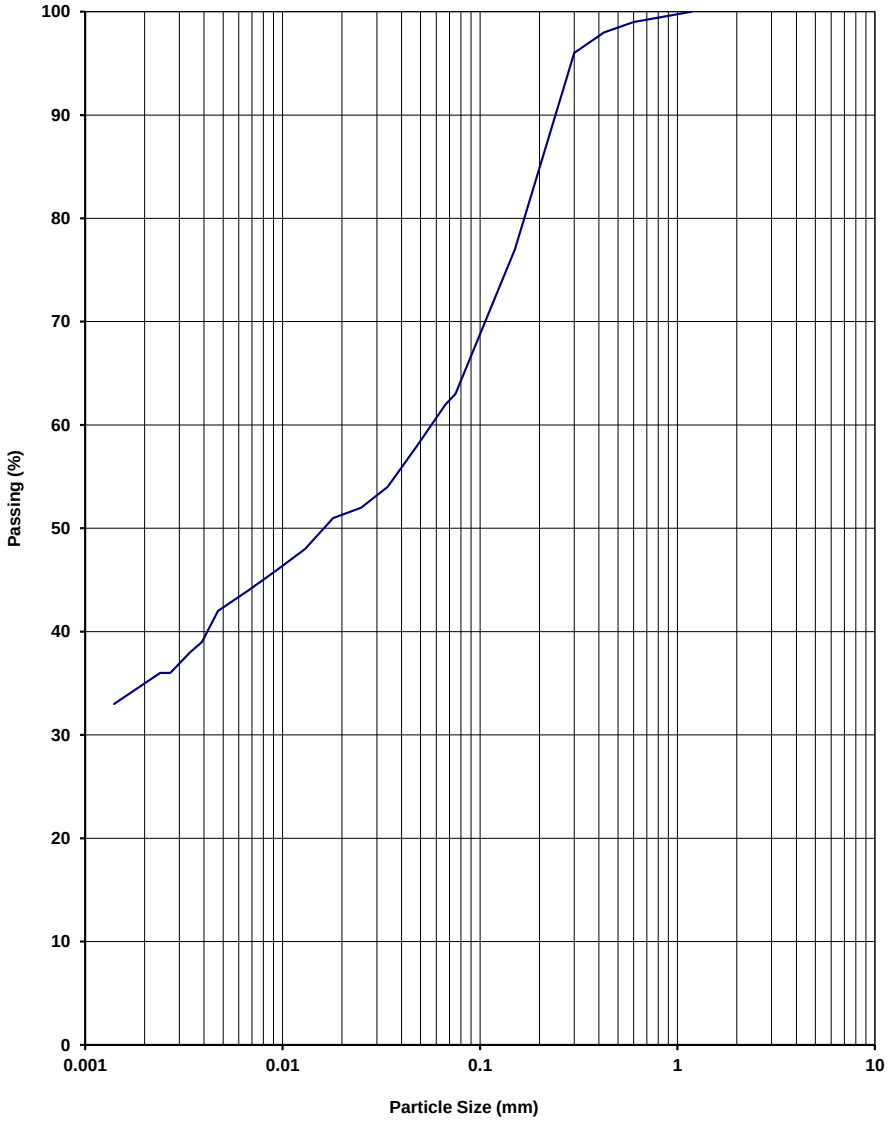
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	21031119-G
		Workorder No.	0008399
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	23/3/21-7/4/21
		Report Date	7/4/2021
Project	2021011 - Nitro Foxleigh		
Client ID	Composite 22	**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
0.150	77
0.075	63
0.067	62
0.048	58
0.034	54
0.025	52
0.018	51
0.013	48
0.0094	46
0.0067	44
0.0047	42
0.0039	39
0.0034	38
0.0027	36
0.0024	36
0.0014	33



NOTES/REMARKS: -

Moisture Content 9.7% -2.36mm Soil Particle Density(t/m^3) 2.45

Sample/s supplied by the client

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The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Tested at Trilab Brisbane Laboratory

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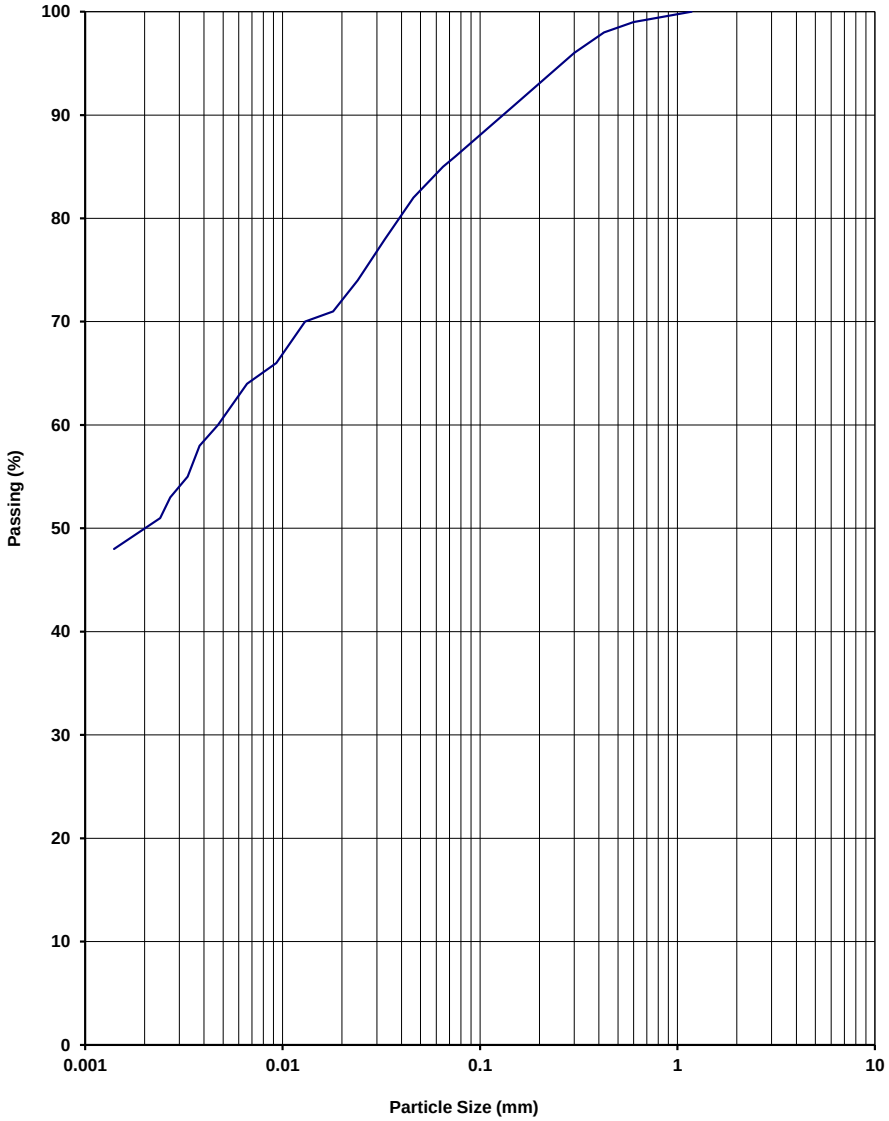
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	21031120-G
		Workorder No.	0008399
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	23/3/21-7/4/21
		Report Date	7/4/2021
Project	2021011 - Nitro Foxleigh		
Client ID	Composite 23	**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
0.150	91
0.075	86
0.065	85
0.046	82
0.033	78
0.024	74
0.018	71
0.013	70
0.0093	66
0.0066	64
0.0047	60
0.0038	58
0.0033	55
0.0027	53
0.0024	51
0.0014	48



NOTES/REMARKS: -

Moisture Content 16.1% -2.36mm Soil Particle Density(t/m^3) 2.36

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 Australian/National Standards.

Tested at Trilab Brisbane Laboratory

Authorised Signatory

C. Park

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.
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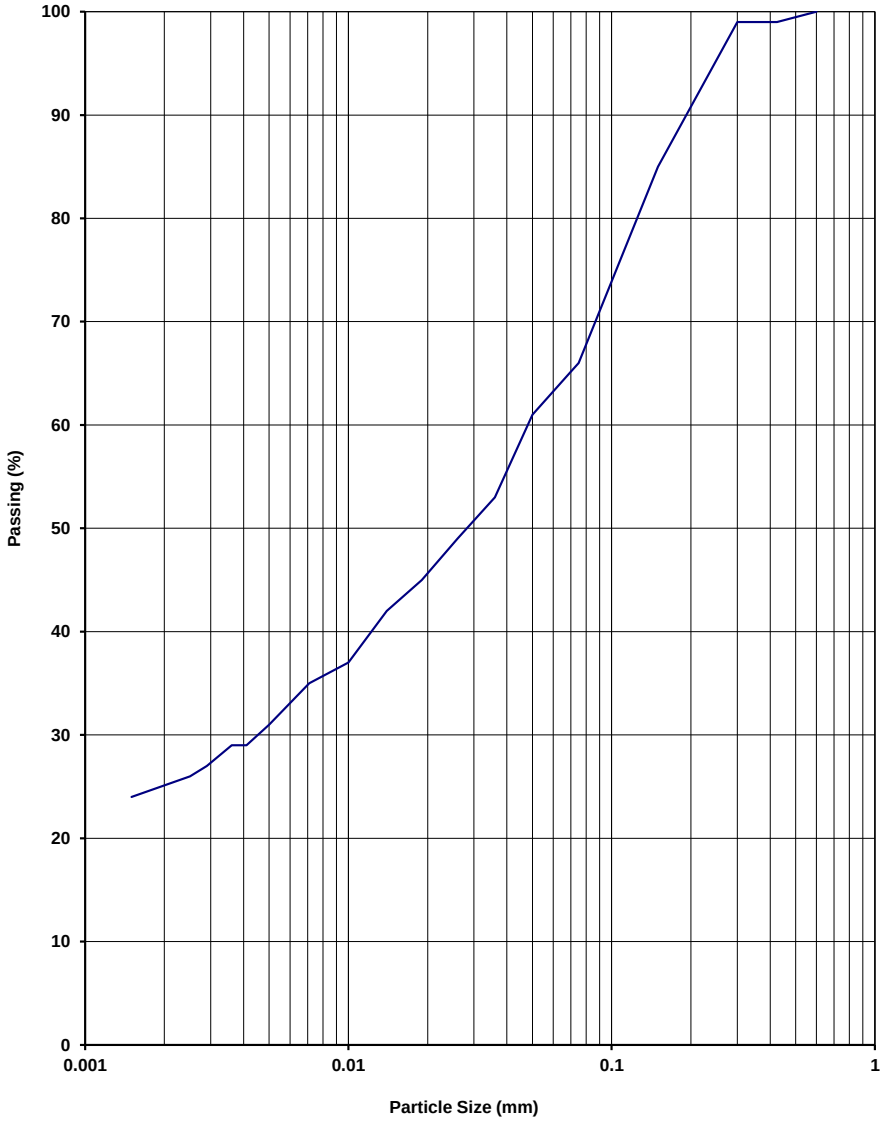
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	21031121-G
		Workorder No.	0008399
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	23/3/21-7/4/21
		Report Date	7/4/2021
Project	2021011 - Nitro Foxleigh		
Client ID	Composite 24	**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	
0.600	100
0.425	99
0.300	99
0.150	85
0.075	66
0.069	65
0.05	61
0.036	53
0.026	49
0.019	45
0.014	42
0.01	37
0.0071	35
0.005	31
0.0041	29
0.0036	29
0.0029	27
0.0025	26
0.0015	24



NOTES/REMARKS: -

Moisture Content 5.4% -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

Trilab
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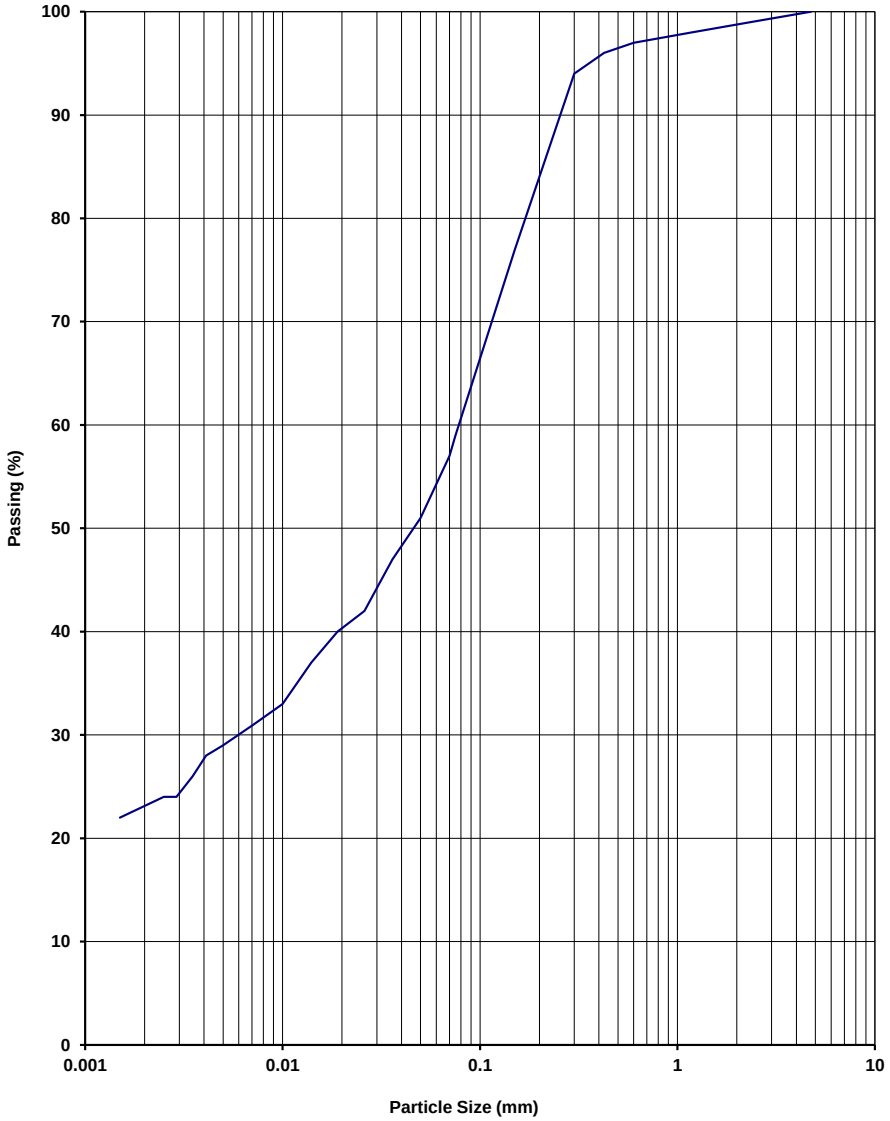
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	21031122-G
		Workorder No.	0008399
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	23/3/21-7/4/21
		Report Date	7/4/2021
Project	2021011 - Nitro Foxleigh		
Client ID	Composite 25	**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	94
0.150	77
0.075	59
0.07	57
0.05	51
0.036	47
0.026	42
0.019	40
0.014	37
0.01	33
0.0071	31
0.005	29
0.0041	28
0.0035	26
0.0029	24
0.0025	24
0.0015	22



NOTES/REMARKS: -

Moisture Content 6.3% -2.36mm Soil Particle Density(t/m^3) 2.39

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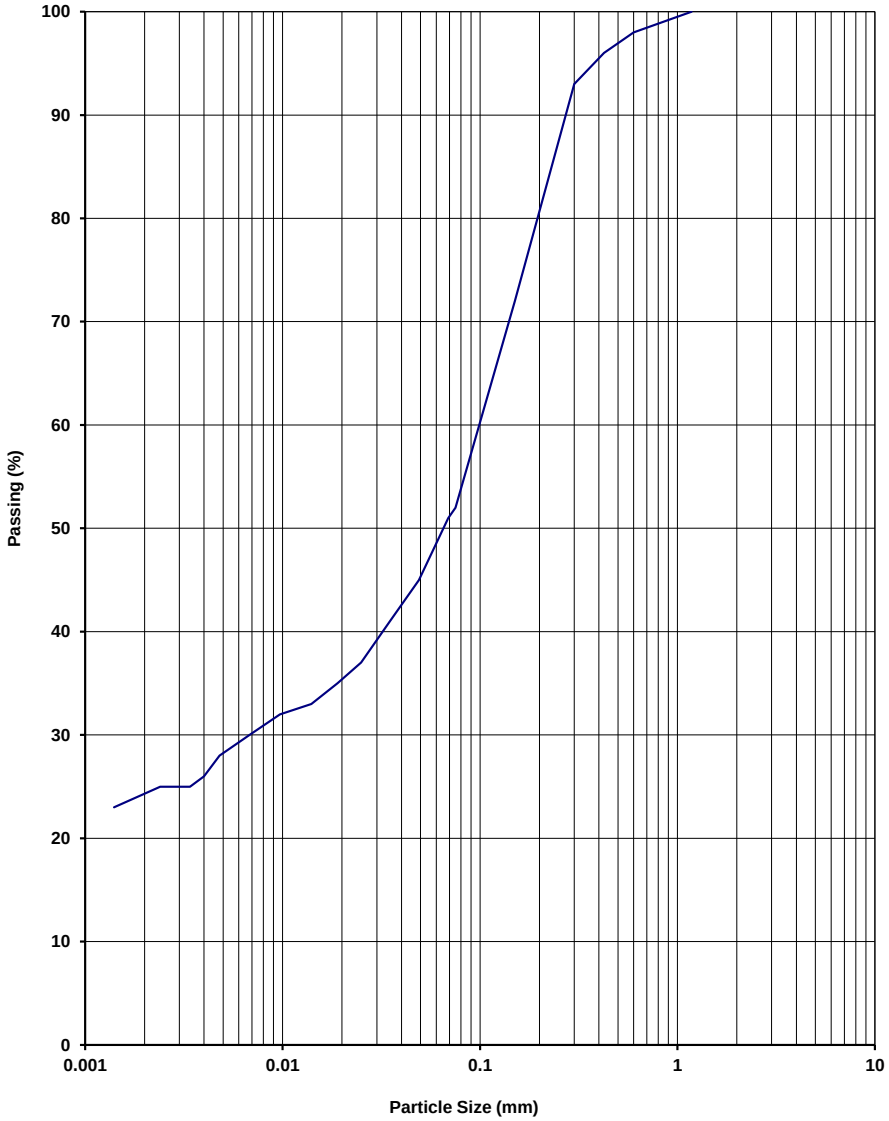
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	21031123-G
		Workorder No.	0008399
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	23/3/21-7/4/21
		Report Date	7/4/2021
Project	2021011 - Nitro Foxleigh		
Client ID	Composite 26	**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	98
0.425	96
0.300	93
0.150	72
0.075	52
0.069	51
0.049	45
0.035	41
0.025	37
0.019	35
0.014	33
0.0097	32
0.0068	30
0.0048	28
0.004	26
0.0034	25
0.0028	25
0.0024	25
0.0014	23



NOTES/REMARKS: -

Moisture Content 7% -2.36mm Soil Particle Density(t/m^3) 2.49

Sample/s supplied by the client

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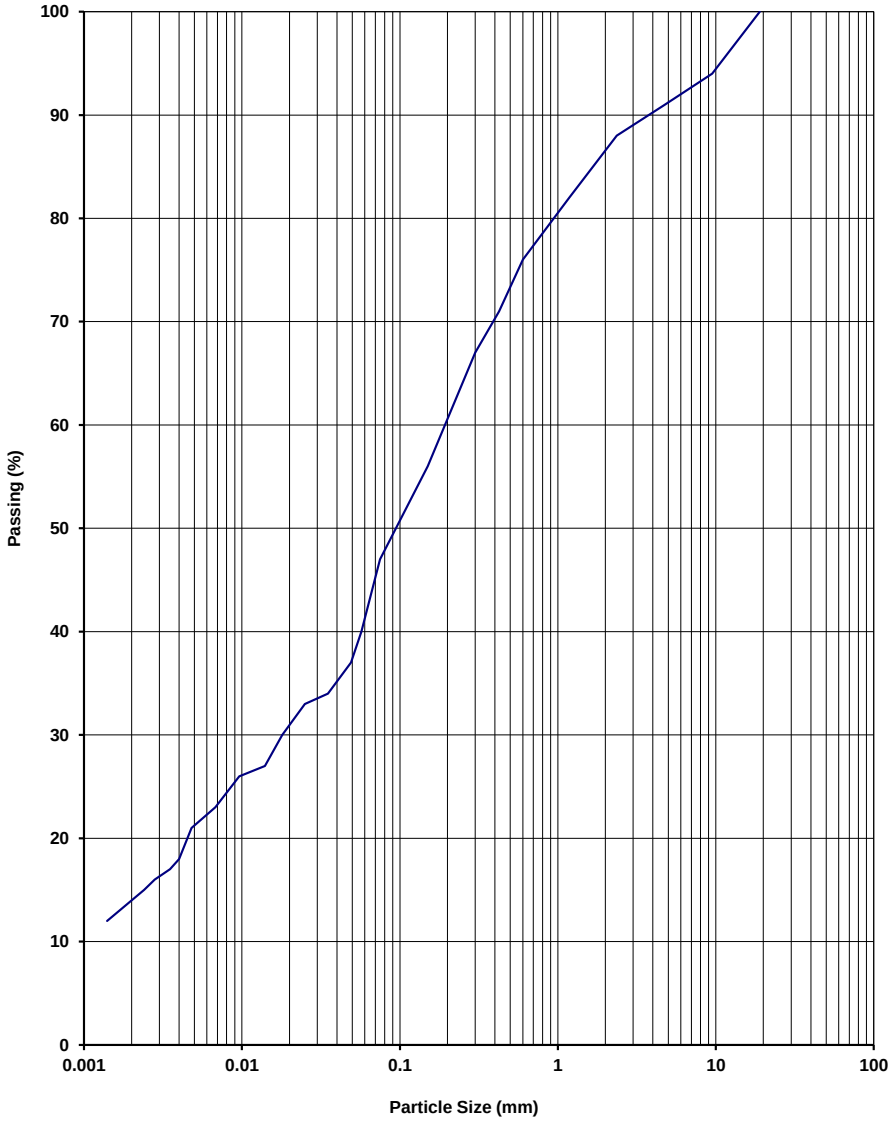
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	21031124-G
		Workorder No.	0008399
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	23/3/21-7/4/21
		Report Date	7/4/2020
Project	2021011 - Nitro Foxleigh		
Client ID	Composite 27	**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	97
9.5	94
6.7	93
4.75	91
2.36	88
1.18	82
0.600	76
0.425	71
0.300	67
0.150	56
0.075	47
0.057	40
0.049	37
0.035	34
0.025	33
0.018	30
0.014	27
0.0096	26
0.0068	23
0.0048	21
0.004	18
0.0035	17
0.0028	16
0.0024	15
0.0014	12



NOTES/REMARKS: -

Moisture Content 6%

-2.36mm Soil Particle Density(t/m^3) 2.49

Sample/s supplied by the client

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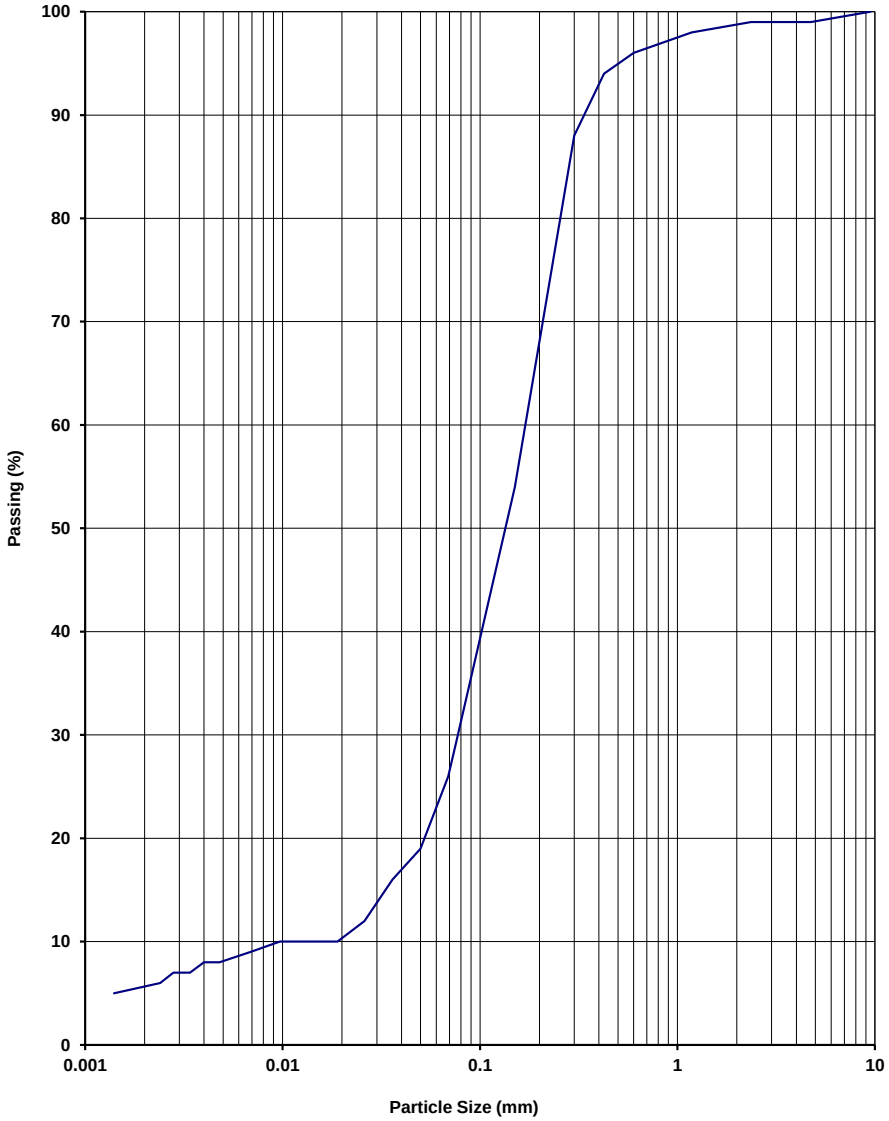
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	21031125-G
		Workorder No.	0008399
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	23/3/21-7/4/21
		Report Date	7/4/2021
Project	2021011 - Nitro Foxleigh		
Client ID	Composite 28	**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	98
0.600	96
0.425	94
0.300	88
0.150	54
0.075	29
0.069	26
0.05	19
0.036	16
0.026	12
0.019	10
0.014	10
0.0097	10
0.0069	9
0.0048	8
0.004	8
0.0034	7
0.0028	7
0.0024	6
0.0014	5



NOTES/REMARKS: -

Moisture Content 1.2% -2.36mm Soil Particle Density(t/m^3) 2.61

Sample/s supplied by the client

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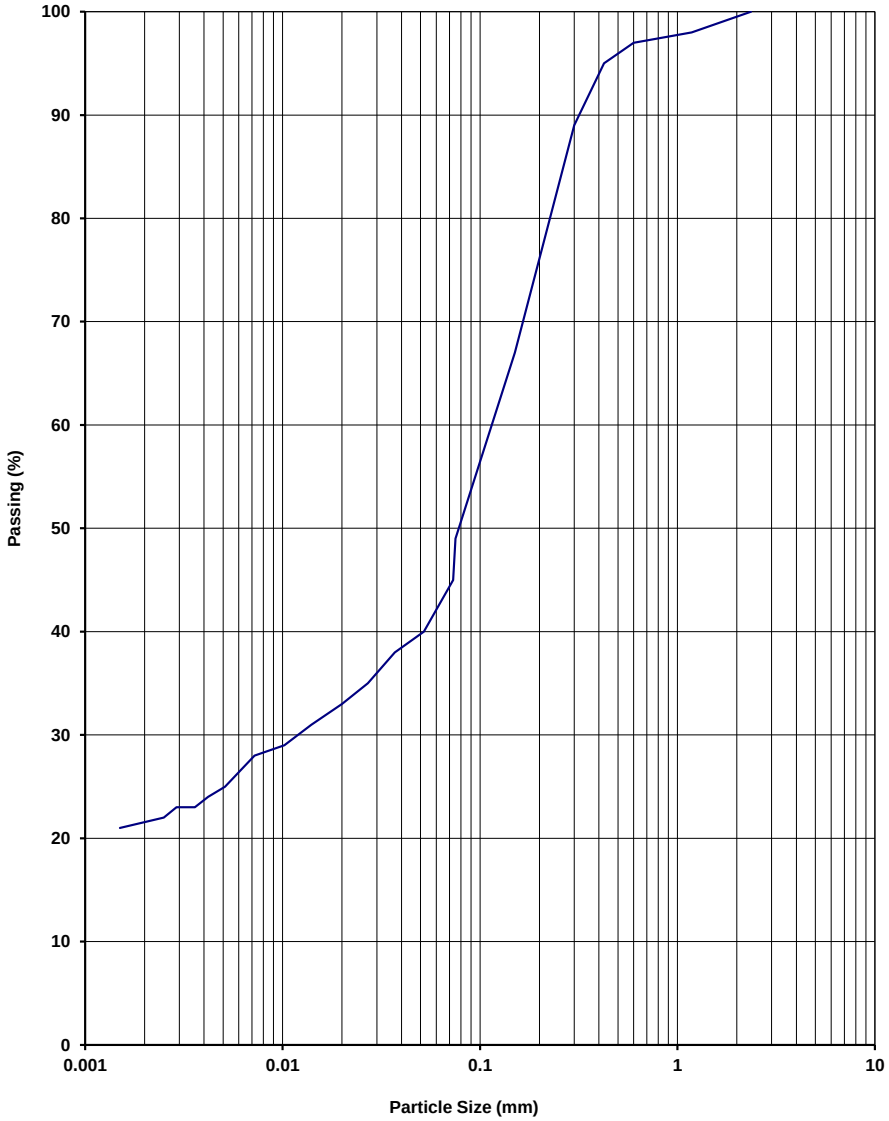
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	21031126-G
		Workorder No.	0008399
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	23/3/21-7/4/21
		Report Date	7/4/2021
Project	2021011 - Nitro Foxleigh		
Client ID	Composite 29	**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	98
0.600	97
0.425	95
0.300	89
0.150	67
0.075	49
0.073	45
0.052	40
0.037	38
0.027	35
0.02	33
0.014	31
0.0102	29
0.0072	28
0.0051	25
0.0042	24
0.0036	23
0.0029	23
0.0025	22
0.0015	21



NOTES/REMARKS: -

Moisture Content 4.5% -2.36mm Soil Particle Density(t/m^3) 2.38

Sample/s supplied by the client

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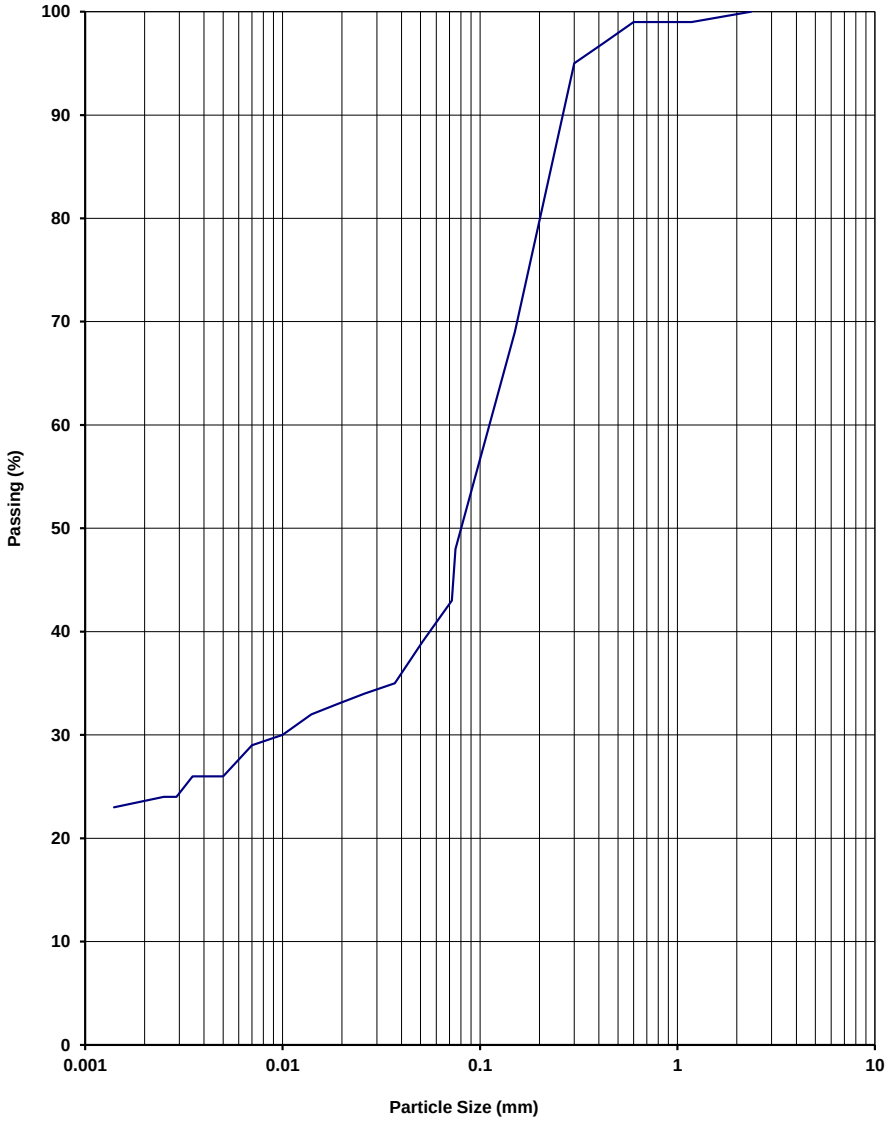
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	21031127-G
		Workorder No.	0008399
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	23/3/21-7/4/21
		Report Date	7/4/2021
Project	2021011 - Nitro Foxleigh		
Client ID	Composite 30	**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	99
0.425	97
0.300	95
0.150	69
0.075	48
0.072	43
0.051	39
0.037	35
0.026	34
0.019	33
0.014	32
0.01	30
0.007	29
0.005	26
0.0041	26
0.0035	26
0.0029	24
0.0025	24
0.0014	23



NOTES/REMARKS: -

Moisture Content 4.8% -2.36mm Soil Particle Density(t/m^3) 2.44

Sample/s supplied by the client

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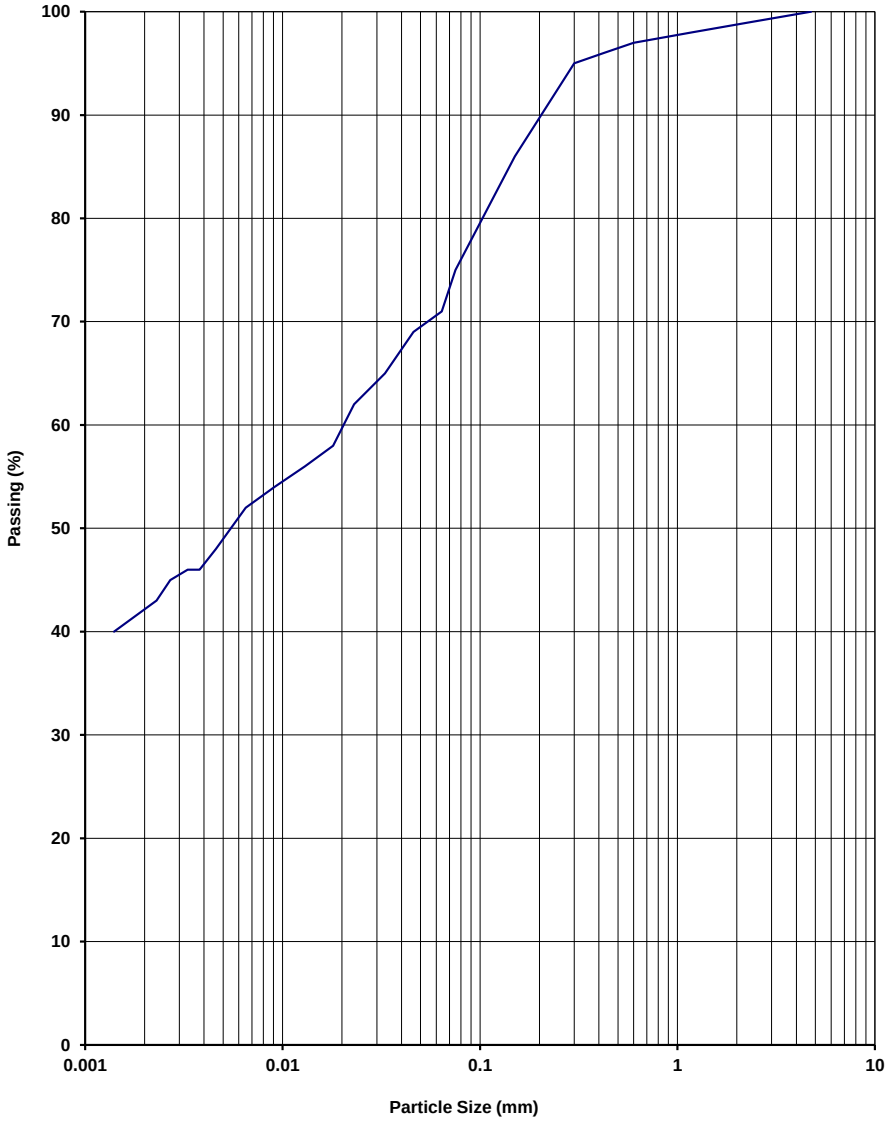
Ph: +61 8 9258 8323

PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	RGS Environmental Pty Ltd	**Report No.**	21031128-G
		Workorder No.	0008399
Address	PO Box 3091, Sunnybank South QLD 4109	**Test Date**	23/3/21-7/4/21
		Report Date	7/4/2021
Project	2021011 - Nitro Foxleigh		
Client ID	Composite 31	**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
0.150	86
0.075	75
0.064	71
0.046	69
0.033	65
0.023	62
0.018	58
0.013	56
0.0091	54
0.0065	52
0.0046	48
0.0038	46
0.0033	46
0.0027	45
0.0023	43
0.0014	40



NOTES/REMARKS: -

Moisture Content 7.2% -2.36mm Soil Particle Density(t/m^3) 2.48

Sample/s supplied by the client

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

Attachment E: Soil Logs

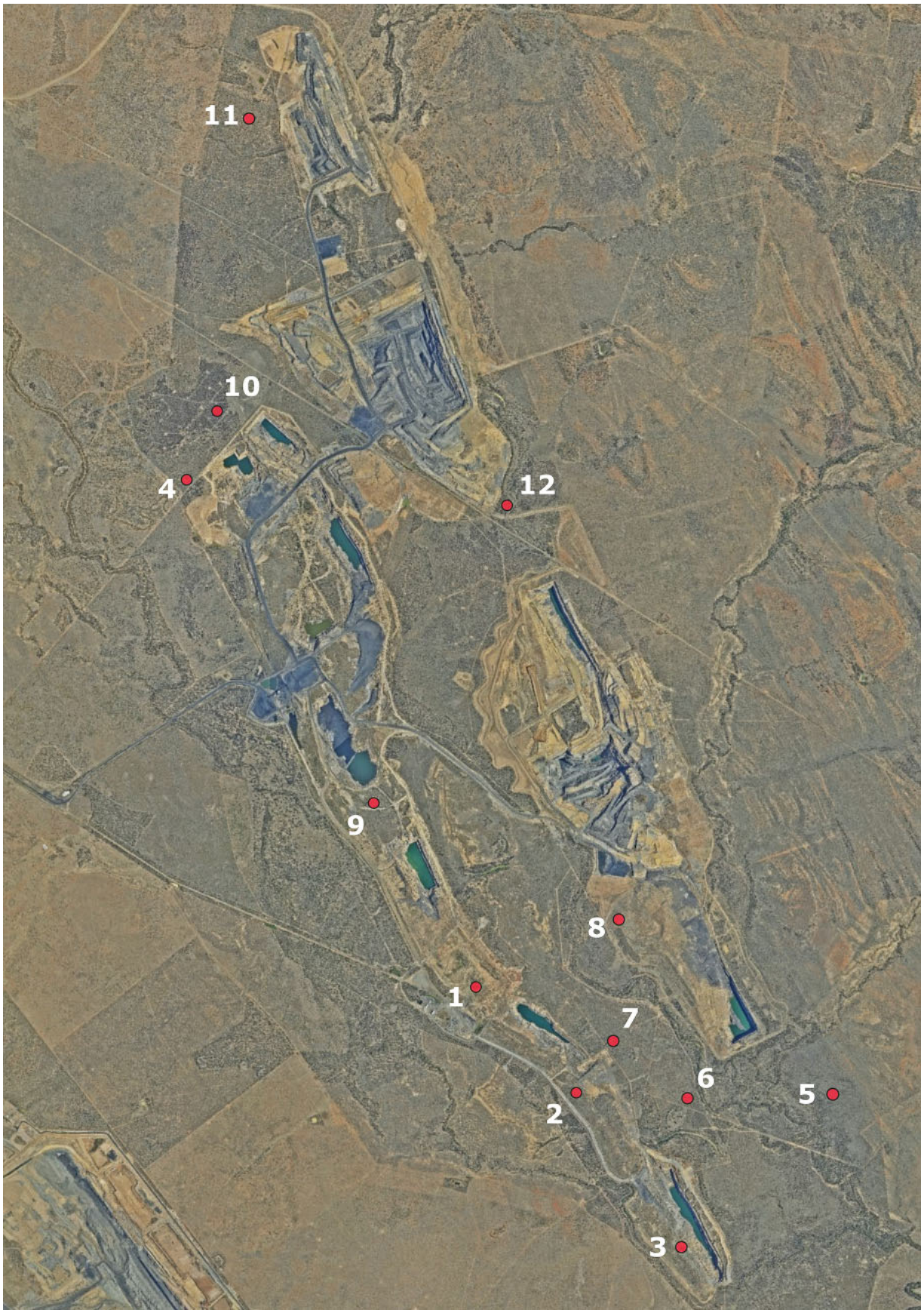


Figure 8-1: Test pit locations

TEST PIT LOG

Client:	Nitro Solutions Pty Ltd	Easting:	148°46998
Project:	Foxleigh	Northing:	22°59023
Site:	Foxleigh Coal Mine	GCS:	
Method:	30T Backhoe Excavator	Logged Datum:	WGS84
Contractor:	Middlemount South	Page:	1/1
Log Date:	23 February 2021		

TEST PIT: Test Pit 1

Backfilled open pit

Atlas of Australian Soils Description: N/A - Disturbed soil profile

Atlas of Australian Soils Major Unit:	Anthroposol
ASC DSM Unit:	
Logged Unit:	
Regional Geology:	Qa-QLD

Hole ID:	TP0001
Top of Hole:	0.0 m
End of Hole:	1.4 m
Logged by:	Melinda Hilton
Checked by:	Greg Maddocks
Compiled by:	Melinda Hilton
Reviewed by:	Alan Robertson
Approved by:	Alan Roberston

Depth	Unit	Graphic	Material	Moisture	Strength	Density	Notes	Samples	Photos	Soil Type	Emerson Test	$pH_{1:5}$ & $EC_{1:5}$	% Clay, Silt, Sand, Gravel
	TS		Brown, poorly sorted, subrounded sandy CLAY **A1 Horizon**	D	S	VL	Loose and powdery, like ash Contains plant roots Fertile Probably a cover	2021011_0001	Topsoil	Sodosol	2	6.98 1053 µS/cm	43 41 16 0
	WR1		Dark grey/black, carbonaceous, very poorly sorted, subrounded GRAVEL **B2 Horizon**	M	St	L	Contains coal rejects and plant roots Fertile	2021011_0002		Anthroposol	1	6.77 1154 µS/cm	16 24 48 12
0.5	WR2		Reddish brown, very poorly sorted, subangular GRAVEL **C1 Horizon**	D	VSt	L	No roots Highly alkaline Rocks compacted into horizontal layers Dumped overburden	2021011_0003	Waste rock	Anthroposol	2	9.56 416 µS/cm	--- --- --- ---
1.0	WR3		Reddish brown, very poorly sorted, subangular GRAVEL **TOTAL DEPTH = 1.4 m** Test pit profile **C2 Horizon**	D	St	L	No roots Highly alkaline Less compaction and structure Smaller rock fragments Higher proportion of fines Dumped overburden	2021011_0004	Waste rock Waste rock	Anthroposol	2	9.53 491 µS/cm	--- --- --- ---
1.5													
2.0													
2.5			Rehabilitation: Fair - grasses only but moderately thick										
3.0													

Moisture: D - dry; M - moist; W - wet | Strength: H - hard; VSt - very stiff; St - stiff; F - firm; S - soft; VS - very soft | Density: VD - very dense; MD - medium dense; L - loose; VL - very loose

Figure 8-2: Test Pit 1 soil log

TEST PIT LOG

TEST PIT: Test Pit 2 — Backfilled open pit

Atlas of Australian Soils Description: N/A - Disturbed soil profile

Client:	Nitro Solutions Pty Ltd	Easting:	148°47747
Project:	Foxleigh	Northing:	22°59511
Site:	Foxleigh Coal Mine	GCS:	
Method:	30T Backhoe Excavator	Logged Datum:	WGS84
Contractor:	Middlemount South	Page:	1/1
Log Date:	23 February 2021		

Atlas of Australian Soils Major Unit:	Anthroposol
ASC DSM Unit:	
Logged Unit:	
Regional Geology:	Qa-QLD

Hole ID:	TP0002
Top of Hole:	0.0 m
End of Hole:	2.0 m
Logged by:	Melinda Hilton
Checked by:	Greg Maddocks
Compiled by:	Melinda Hilton
Reviewed by:	Alan Robertson
Approved by:	Alan Roberston

Depth	Unit	Graphic	Material	Moisture	Strength	Density	Notes	Samples	Photos	Soil Type	Emerson Test	$pH_{1:5}$ & $EC_{1:5}$	% Clay	% Silt	% Sand	% Gravel
	TS		Orange-brown, poorly sorted, subangular gravelly sandy SILT **A1 Horizon**	D	F	VL	Loose and powdery Contains plant roots Fertile Probably a cover	2021011_0005	Topsoil	Chromosol	3	8.76 70 µS/cm	25	26	49	0
0.5	WR1		Reddish brown, very poorly sorted, subangular GRAVEL **B/C Horizon**	D	St	L	No roots Highly alkaline Low compaction Very thick and no structure Same unit as WR3, TP1 Dumped overburden	2021011_0006	Waste rock	Anthroposol	2	9.45 143 µS/cm	16	24	48	12
1.0																
1.5			**TOTAL DEPTH = 2.0 m**						Test pit profile							
2.0																
2.5			**Rehabilitation: Poor to fair - sparse grasses only**													
3.0																

Moisture: D - dry; M - moist; W - wet | Strength: H - hard; VSt - very stiff, St - stiff, F - firm; S - soft; VS - very soft | Density: VD - very dense; MD - medium dense; L - loose; VL - very loose

Figure 8-3: Test Pit 2 soil log

TEST PIT LOG — **TEST PIT: Test Pit 3 — Backfilled open pit**

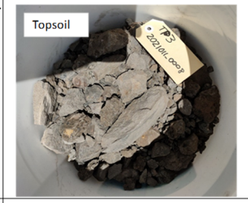
Client:	Nitro Solutions Pty Ltd	Easting:	148°48580	Atlas of Australian Soils Description:	N/A - Disturbed soil profile
Project:	Foxleigh	Northing:	23°00486	Atlas of Australian Soils Major Unit:	Anthroposol
Site:	Foxleigh Coal Mine	GCS:		ASC DSM Unit:	
Method:	30T Backhoe Excavator	Logged Datum:	WGS84	Logged Unit:	
Contractor:	Middlemount South	Page:	1/1	Regional Geology:	Qa-QLD
Log Date:	23 February 2021				

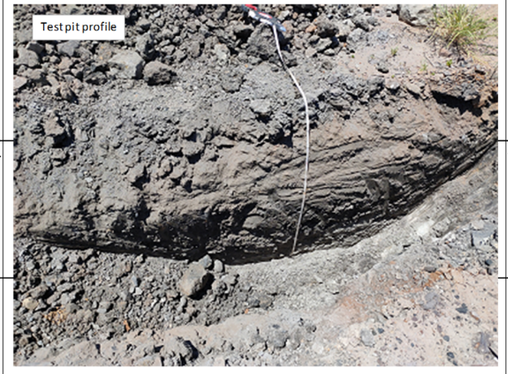
Hole ID:	TP0003	
Top of Hole:	0.0 m	
End of Hole:	2.3 m	
Logged by:	Melinda Hilton	
Checked by:	Greg Maddocks	
Compiled by:	Melinda Hilton	
Reviewed by:	Alan Robertson	
Approved by:	Alan Roberston	

Depth	Unit	Graphic	Material	Moisture	Strength	Density	Notes	Samples	Soil Type	Emerson Test	$pH_{1:5}$ & $EC_{1:5}$	% Clay, Silt, Sand, Gravel
0.5	WR1		Brown, very poorly sorted, subangular GRAVEL with orange lithic fragments **A1 Horizon**	D	St	L	Weathered waste rock Few fine particles Fertile No apparent cover	2021011_0008	Anthroposol	2	7.77 1513 µS/cm	--- --- --- ---
1.0	WR2		Brown, very poorly sorted, subrounded gravelly GRVAEL with orange lithic fragments **B2 Horizon**	D	F	VL	Weathered waste rock Unconsolidated Contains fine particles Fertile	2021011_0009	Anthroposol	2	8.3 767 µS/cm	24 33 42 1
1.5	WR3		Brown, very poorly sorted, subrounded gravelly GRAVEL **C1 Horizon**	D	F	VL	No roots Alkaline Low compaction No structure Similar to TP1 & TP2 but older Dumped overburden	2021011_0010	Anthroposol	2	9.11 451 µS/cm	16 24 48 12
2.0	WR4		Brown, very poorly sorted, subrounded sandy GRAVEL with coal fragments **C2 Horizon**	M	F	VL	No roots Alkaline Low compaction Somewhat moist Contains coal ore Dumped overburden/interburden	2021011_0011	Anthroposol	1	9.27 234 µS/cm	--- --- --- ---
2.5			**TOTAL DEPTH = 2.3 m**									
3.0												

Moisture: D - dry; M - moist; W - wet | Strength: H - hard; VSt - very stiff; St - stiff; F - firm; S - soft; VS - very soft | Density: VD - very dense; MD - medium dense; L - loose; VL - very loose

Photos





Rehabilitation: Good - sparse native trees and grasses

Figure 8-4: Test Pit 3 soil log

TEST PIT LOG — **TEST PIT: Test Pit 4 — Undisturbed soil profile**

Atlas of Australian Soils Description: Moderate to gently undulating lands with widely spaced shallow valleys: dominant are thin-surfaced loamy duplex soils, and often of shallow depth and with some rock outcrop.

Client:	Nitro Solutions Pty Ltd	Easting:	148°44654	Atlas of Australian Soils Major Unit:	Chromosol
Project:	Foxleigh	Northing:	22°55239	ASC DSM Unit:	
Site:	Foxleigh Coal Mine	GCS:		Logged Unit:	
Method:	30T Backhoe Excavator	Logged Datum:	WGS84	Regional Geology:	Qa-QLD
Contractor:	Middlemount South	Page:	1/1		
Log Date:	24 February 2021				

Hole ID:	TP0004
Top of Hole:	0.0 m
End of Hole:	3.1 m
Logged by:	Melinda Hilton
Checked by:	Greg Maddocks
Compiled by:	Melinda Hilton
Reviewed by:	Alan Robertson
Approved by:	Alan Roberston

Depth	Unit	Graphic	Material	Moisture	Strength	Density	Notes	Samples	Photos	Soil Type	Emerson Test	$pH_{1:5}$ & $EC_{1:5}$	% Clay	% Silt	% Sand	% Gravel
	TS		Brown, poorly sorted, subrounded clayey SAND **A1 Horizon**	D	S	VL	Loose and powdery Contains plant roots Fertile Bedding thickness dips from 40 cm to 80 cm	2021011_0021	Topsoil	Chromosol	3	7.83 63 µS/cm	24	33	42	1
0.5																
	SS1		Orange-brown, poorly sorted, subrounded clayey SAND **B21 Horizon**	D	S	L	Transitional material Fertile	2021011_0022	Subsoil; Carbonaceous fragments; 2021011_0024	Chromosol	1	7.91 765 µS/cm	25	26	49	0
			B22 Horizon	D	S	MD	Carbonaceous fragments are thin layer at ~0.5 m Possibly 5-10 cm thick	2021011_0024				8.02 874µS/cm				
1.0			**B23 Horizon**						Subsoil							
	SS2		Orange, poorly sorted, subangular gravelly clayey SAND **B3 Horizon**	M	VS	VL	Somewhat stony Relatively moist No plant roots Bright red-orange colour	2021011_0023	Subsoil; Subsoil; Clay lenses; 2021011_0026	Chromosol	1	8.3 689 µS/cm	---	---	---	---
1.5																
	SS3		Orange, poorly sorted, subrounded clayey SAND **B41 Horizon**	M	VS	VL	Softer, more crumbly soil Relatively moist No plant roots Bright orange colour	2021011_0025		Chromosol	1	8.55 480 µS/cm	---	---	---	---
2.0																
2.5									Test pit profile							
			B42 Horizon	M	S	VL	Clay lenses are dark brown/grey About 10 cm thick	2021011_0026				8.39 940 µS/cm	---	---	---	---
			TOTAL DEPTH = 3.1 m				Occur at a depth of 2.8 m near the base of the pit			Rehabilitation: Undisturbed native trees and grasses						
3.0			**B43 Horizon**													

Moisture: D - dry; M - moist; W - wet | Strength: H - hard; VSt - very stiff; St - stiff; F - firm; S - soft; VS - very soft | Density: VD - very dense; MD - medium dense; L - loose; VL - very loose

Figure 8-5: Test Pit 4 soil log

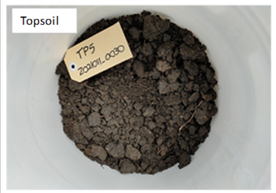
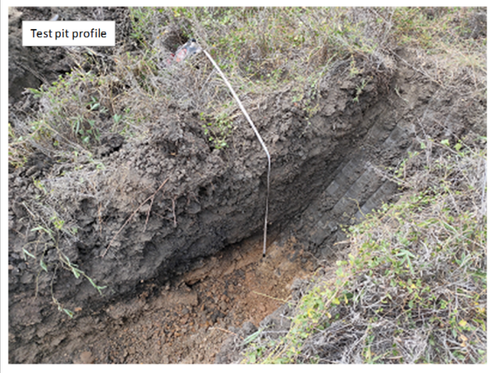
RGS	**TEST PIT LOG**			**TEST PIT:**		**Test Pit 5** **Undisturbed soil profile**			Atlas of Australian Soils Description: Moderate to gently undulating lands with widely spaced shallow valleys: dominant are thin-surfaced loamy duplex soils, and often of shallow depth and with some rock outcrop.			Hole ID: Top of Hole: End of Hole: Logged by: Checked by: Compiled by: Reviewed by: Approved by:	TP0005 0.0 m 2.7 m Melinda Hilton Greg Maddocks Melinda Hilton Alan Robertson Alan Roberston							
Client: Project: Site: Method: Contractor: Log Date:	Nitro Solutions Pty Ltd Foxleigh Foxleigh Coal Mine 30T Backhoe Excavator Middlemount South 24 February 2021			Easting: Northing: GCS: Logged Datum: Page:	148°494888 22°59665 WGS84 1/1				Atlas of Australian Soils Major Unit: ASC DSM Unit: Logged Unit: Regional Geology:	Chromosol Blackwater group											
Depth	Unit	Graphic	Material	Moisture	Strength	Density	Notes	Samples	Photos			Soil Type	Emerson Test	$pH_{1:5}$ & $EC_{1:5}$	% Clay, Silt, Sand, Gravel									
0.0	TS		Dark brown-black, poorly sorted, subangular CLAY	W	F	VL	Very moist dark brown soil Contains plant roots Fertile	2021011_0030				Vertosol	1	8.44 524 µS/cm	53	32	15	0				
0.5			**A1 Horizon**																		
1.0	SS1		Red-orange, very poorly sorted, subangular clayey SAND	D	St	L	Hard and rocky regolith No roots Highly alkaline Much drier than other chromosols Hardness increases with depth Material is saprolite (rock) at base	2021011_0031				Chromosol	1	9.68 338 µS/cm	25	26	49	0				
1.5			**C2 Horizon**																					
2.0																								
2.5			**TOTAL DEPTH = 2.7 m** **Rehabilitation: Undisturbed scrub and grasses**																					
3.0																								
Moisture: D - dry; M - moist; W - wet | Strength: H - hard; VSt - very stiff; St - stiff; F - firm; S - soft; VS - very soft | Density: VD - very dense; MD - medium dense; L - loose; VL - very loose																								

Figure 8-6: Test Pit 5 soil log

TEST PIT LOG — **TEST PIT: Test Pit 6 — Undisturbed soil profile**

Client:	Nitro Solutions Pty Ltd	Easting:	148°48862	Atlas of Australian Soils Description:	Moderate to gently undulating lands with widely spaced shallow valleys: dominant are thin-surfaced loamy duplex soils, and often of shallow depth and with some rock outcrop.
Project:	Foxleigh	Northing:	22°59651	Hole ID:	TP0006
Site:	Foxleigh Coal Mine	GCS:		Top of Hole:	0.0 m
Method:	30T Backhoe Excavator	Logged		End of Hole:	3.0 m
Contractor:	Middlemount South	Datum:	WGS84	Logged by:	Melinda Hilton
Log Date:	25 February 2021	Page:	1/1	Checked by:	Greg Maddocks
				Compiled by:	Melinda Hilton
				Reviewed by:	Alan Robertson
				Approved by:	Alan Roberston
				Atlas of Australian Soils Major Unit:	Chromosol
				ASC DSM Unit:	
				Logged Unit:	
				Regional Geology:	Qa-QLD

Depth	Unit	Graphic	Material	Moisture	Strength	Density	Notes	Samples	Photos	Soil Type	Emerson Test	$pH_{1:5}$ & $EC_{1:5}$	% Clay, Silt, Sand, Gravel
	TS		Brown, poorly sorted, subangular sandy CLAY **A1 Horizon**	D	F	VL	Loose and powdery Contains plant roots Very low salinity Fertile	2021011_0032	Topsoil	Chromosol	1	8.11 37 µS/cm	27, 38, 35, 0
0.5	SS1		Reddish brown, very poorly sorted, subangular sandy CLAY **B2 Horizon**	D	S	L	Transitional material Few plant roots Very low salinity Fertile	2021011_0033	Subsoil	Chromosol	1	8.33 33 µS/cm	25, 26, 49, 0
1.0	SS2		Orange brown, very poorly sorted, subangular CLAY **B3 Horizon**	M	VS	L	Dull orange colour Softer, more crumbly soil Relatively moist No plant roots	2021011_0034	Subsoil Subsoil	Chromosol	1	8.92 109 µS/cm	---
1.5													
2.0	SS3		Red-orange, very poorly sorted, subrounded CLAY **TOTAL DEPTH = 3.0 m** **B4 Horizon**	M	VS	L	Bright red-orange colour Soft and crumbly Relatively moist No plant roots Similar to SS3, TP4	2021011_0035	Test pit profile	Chromosol	1	9.33 209 µS/cm	---
2.5													
3.0													

Moisture: D - dry; M - moist; W - wet | Strength: H - hard; VSt - very stiff; St - stiff; F - firm; S - soft; VS - very soft | Density: VD - very dense; MD - medium dense; L - loose; VL - very loose

Rehabilitation: Undisturbed native trees and grasses

Figure 8-7: Test Pit 6 soil log

TEST PIT LOG — **TEST PIT: Test Pit 7 — Undisturbed soil profile**

Atlas of Australian Soils Description: Gently undulating plains: dominant are sandy duplex soils with moderately deep A horizons.

Client:	Nitro Solutions Pty Ltd	Easting:	148°48170	Atlas of Australian Soils Major Unit:	Sodosol
Project:	Foxleigh	Northing:	22°59324	ASC DSM Unit:	
Site:	Foxleigh Coal Mine	GCS:		Logged Unit:	
Method:	30T Backhoe Excavator	Logged Datum:	WGS84	Regional Geology:	Qa-QLD
Contractor:	Middlemount South	Page:	1/1		
Log Date:	25 February 2021				

Hole ID:	TP0007
Top of Hole:	0.0 m
End of Hole:	3.4 m
Logged by:	Melinda Hilton
Checked by:	Greg Maddocks
Compiled by:	Melinda Hilton
Reviewed by:	Alan Robertson
Approved by:	Alan Roberston

Depth	Unit	Graphic	Material	Moisture	Strength	Density	Notes	Samples	Photos	Soil Type	Emerson Test	$pH_{1:5}$ & $EC_{1:5}$	% Clay	% Silt	% Sand	% Gravel
0.5	TS		Light brown, very poorly sorted, prismatic clayey SAND **A1 Horizon**	D	S	L	Clumpy, lots of peds Contains plant roots Fertile	2021011_0036		Sodosol	1	8.69 598 µS/cm	36	22	42	0
1.0	SS1		Light brown, very poorly sorted, lenticular CLAY **B2 Horizon**	M	VS	MD	Clumpy and very sticky Like plasticine Mottled brown texture Relatively moist Very thick and uniform unit	2021011_0037		Sodosol	1	7.05 2081 µS/cm	43	41	16	0
1.5			**TOTAL DEPTH = 3.4 m**													
2.0																
2.5																
3.0			**Rehabilitation: Good coverage of salt-tolerant trees and scrub**													

Moisture: D - dry, M - moist, W - wet | Strength: H - hard; VSt - very stiff, St - stiff, F - firm; S - soft; VS - very soft | Density: VD - very dense; MD - medium dense; L - loose; VL - very loose

Figure 8-8: Test Pit 7 soil log

TEST PIT LOG — **TEST PIT: Test Pit 8** — **Backfilled open pit**

Atlas of Australian Soils Description: N/A - Disturbed soil profile

Client:	Nitro Solutions Pty Ltd	Easting:	148°48490
Project:	Foxleigh	Northing:	22°58262
Site:	Foxleigh Coal Mine	GCS:	
Method:	30T Backhoe Excavator	Logged	
Contractor:	Middlemount South	Datum:	WGS84
Log Date:	23 February 2021	Page:	1/1

Atlas of Australian Soils Major Unit:	Anthroposol
ASC DSM Unit:	
Logged Unit:	
Regional Geology:	Duaringa Formation

Hole ID:	TP0008
Top of Hole:	0.0 m
End of Hole:	3.05 m
Logged by:	Melinda Hilton
Checked by:	Greg Maddocks
Compiled by:	Melinda Hilton
Reviewed by:	Alan Robertson
Approved by:	Alan Roberston

Depth	Unit	Graphic	Material	Moisture	Strength	Density	Notes	Samples	Soil Type	Emerson Test*	$pH_{1:5}$ & $EC_{1:5}$	% Clay	% Silt	% Sand	% Gravel
	TS		Light brown, poorly sorted, subangular gravelly clayey SAND **A1 Horizon**	D	S	VL	Very dry sodosol Thinly placed cover Sparse roots	2021011_0005	Sodosol	2	7.72 1196 µS/cm	36	22	42	0
	WR1		Reddish brown-grey, very poorly sorted, angular GRAVEL **B2 Horizon**	D	St	MD	Alkaline waste rock Possibly thin rocky mulch layer Moderately compacted Weathered, breaks apart easily		Anthroposol	2	9.28 872 µS/cm	16	24	48	12
0.5	WR2		Brown to dark grey, very poorly sorted, angular GRAVEL **C1 Horizon**	D	H	VD	Highly alkaline waste rock Unweathered Contains carbonaceous rocks and coal Angular, very rocky and hard Brown to dark grey		Anthroposol	2	9.76 434 µS/cm	---	---	---	---
1.0															
1.5															
2.0	WR3		Dark grey to black, very poorly sorted, angular sandy GRAVEL **C2 Horizon**	D	VSt	MD	Highly alkaline waste rock Unweathered Contains carbonaceous rocks and coal Dark grey to black More fine material and rejects Rocky and moderately hard		Anthroposol	2	9.94 370 µS/cm	---	---	---	---
2.5															
3.0			**TOTAL DEPTH = 3.05 m**												

Moisture: D - dry; M - moist; W - wet | Strength: H - hard; VSt - very stiff; St - stiff; F - firm; S - soft; VS - very soft | Density: VD - very dense; MD - medium dense; L - loose; VL - very loose

Rehabilitation: Poor - Sparse monoculture grasses only

Figure 8-9: Test Pit 8 soil log

TEST PIT LOG — **TEST PIT:** **Test Pit 9** — **Disturbed soil profile**

Atlas of Australian Soils Description: Level alluvial flood-plains associated with major streams, often dissected by numerous braided channels and mostly subject to irregular flooding: dominant soils are deep grey clays with smaller areas of black or brown clays.

Client:	Nitro Solutions Pty Ltd	Easting:	148°46182	Atlas of Australian Soils Major Unit:	Vertosol
Project:	Foxleigh	Northing:	22°57727	ASC DSM Unit:	
Site:	Foxleigh Coal Mine	GCS:		Logged Unit:	
Method:	30T Backhoe Excavator	Logged Datum:	WGS84	Regional Geology:	Qa-QLD
Contractor:	Middlemount South	Page:	1/1		
Log Date:	23 February 2021				

Hole ID:	TP0009
Top of Hole:	0.0 m
End of Hole:	3.4 m (did not reach base)
Logged by:	Melinda Hilton
Checked by:	Greg Maddocks
Compiled by:	Melinda Hilton
Reviewed by:	Alan Robertson
Approved by:	Alan Roberston

Depth	Unit	Graphic	Material	Moisture	Strength	Density	Notes	Samples	Soil Type	Emerson Test	$pH_{1:5}$ & $EC_{1:5}$	% Clay	% Silt	% Sand	% Gravel
0.5	TS		Brown, well sorted, massive, silty LOAM **A1 Horizon**	D	VS	VL	Soil unit very thick and uniform Powdery and soft at surface Moisture increases with depth Fertile Probably a very thick cover No distinct horizons (diffuse)	2021011_0012	Arenosol	2	8.18 250 µS/cm	27	38	35	0
2.5			Brown, well sorted, massive, silty LOAM **A2 Horizon** **TOTAL DEPTH = 3.4 m**	M	VS	VL		2021011_0013	Arenosol	2	7.9 284 µS/cm	---	---	---	---

Photos

Rehabilitation: Very good - diverse native trees and grasses

Moisture: D - dry; M - moist; W - wet | Strength: H - hard; VSt - very stiff; St - stiff; F - firm; S - soft; VS - very soft | Density: VD - very dense; MD - medium dense; L - loose; VL - very loose

Figure 8-10: Test Pit 9 soil log

TEST PIT LOG — **TEST PIT:** **Test Pit 10** — **Undisturbed soil profile**

Atlas of Australian Soils Description: Moderate to gently undulating lands with widely spaced shallow valleys: dominant are thin-surfaced loamy duplex soils, and often of shallow depth and with some rock outcrop.

Client:	Nitro Solutions Pty Ltd	Easting:	148°45076
Project:	Foxleigh	Northing:	22°55057
Site:	Foxleigh Coal Mine	GCS:	
Method:	30T Backhoe Excavator	Logged	
Contractor:	Middlemount South	Datum:	WGS84
Log Date:	24 February 2021	Page:	1/1

Atlas of Australian	Chromosol
Soils Major Unit:	
ASC DSM Unit:	
Logged Unit:	
Regional Geology:	Qa-QLD

Hole ID:	TP0010
Top of Hole:	0.0 m
End of Hole:	2.9 m
Logged by:	Melinda Hilton
Checked by:	Greg Maddocks
Compiled by:	Melinda Hilton
Reviewed by:	Alan Robertson
Approved by:	Alan Roberston

Depth	Unit	Graphic	Material	Moisture	Strength	Density	Notes	Samples	Photos	Soil Type	Emerson Test	$pH_{1:5}$ & $EC_{1:5}$	% Clay, Silt, Sand, Gravel			
0.5	TS		Brown, poorly sorted, columnar clayey SAND **A1 Horizon**	D	S	VL	Loose and powdery Contains plant roots Fertile	2021011_0018	Topsoil: TP10 2021011_0018	Chromosol	3	8.54 72 µS/cm	25	26	49	0
1.0	SS1		Orange brown, very poorly sorted, subangular clayey SAND	M	S	L	Dull orange colour Soft soil with peds, no fines Relatively moist No plant roots	2021011_0019	Subsoil: TP10 2021011_0020 Subsoil: TP10 2021011_0019	Chromosol	1	9.04 74 µS/cm	---	---	---	---
1.5			**B2 Horizon**													
2.0	SS2		Orange brown, very poorly sorted, subangular clayey SAND	D	S	L	Slightly brighter colour Drier than previous unit Contains fine material No plant roots	2021011_0020	Test pit profile	Chromosol	1	9.19 81 µS/cm	---	---	---	---
2.5			**B3 Horizon** **TOTAL DEPTH = 2.9 m**						**Rehabilitation: Undisturbed native trees and grasses**							
3.0																

Moisture: D - dry; M - moist; W - wet | Strength: H - hard; VSt - very stiff; St - stiff; F - firm; S - soft; VS - very soft | Density: VD - very dense; MD - medium dense; L - loose; VL - very loose

Figure 8-11: Test Pit 10 soil log

TEST PIT LOG — **TEST PIT: Test Pit 11** — **Undisturbed soil profile**

Atlas of Australian Soils Description: Gently undulating plains: dominant are sandy duplex soils with moderately deep A horizons.

Client:	Nitro Solutions Pty Ltd	Easting:	148°45526
Project:	Foxleigh	Northing:	22°53021
Site:	Foxleigh Coal Mine	GCS:	
Method:	30T Backhoe Excavator	Logged	
Contractor:	Middlemount South	Datum:	WGS84
Log Date:	24 February 2021	Page:	1/1

Atlas of Australian Soils Major Unit:	Sodosol
ASC DSM Unit:	
Logged Unit:	
Regional Geology:	Duaringa Formation

Hole ID:	TP00011
Top of Hole:	0.0 m
End of Hole:	3.2 m
Logged by:	Melinda Hilton
Checked by:	Greg Maddocks
Compiled by:	Melinda Hilton
Reviewed by:	Alan Robertson
Approved by:	Alan Roberston

Depth	Unit	Graphic	Material	Moisture	Strength	Density	Notes	Samples	Photos	Soil Type	Emerson Test	$pH_{1:5}$ & $EC_{1:5}$	% Clay, Silt, Sand, Gravel			
0.5	TS		Reddish brown, poorly sorted, prismatic silty LOAM **A1 Horizon**	D	S	VL	Loose and powdery Contains plant roots Fertile	2021011_0027	Topsoil	Sodosol	3	8.49 38 µS/cm	27	38	35	0
1.0	SS1		Yellowish brown, very poorly sorted, subangular CLAY **B21 Horizon**	D	S	L	Highly alkaline Mottled brown texture Thick and uniform unit	2021011_0028	Subsoil	Sodosol	1	9.58 438 µS/cm	43	41	16	0
1.5									Salt crust							
2.0			**B22 Horizon**	D	St	MD	White salt crust visible at 2 m Likely calcium carbonate (calcite)	2021011_0029				10.09 633 µS/cm	---	---	---	---
2.5			**B23 Horizon** **Rehabilitation: Undisturbed native trees and grasses**				Several salt crusts visible at different depths probably from fluctuating water table		Test pit profile							
3.0			**TOTAL DEPTH = 3.2 m**													

Moisture: D - dry; M - moist; W - wet | Strength: H - hard; VSt - very stiff; St - stiff; F - firm; S - soft; VS - very soft | Density: VD - very dense; MD - medium dense; L - loose; VL - very loose

Figure 8-12: Test Pit 11 soil log

TEST PIT LOG — **TEST PIT:** Test Pit 12 — Undisturbed soil profile

Atlas of Australian Soils Description: Gently undulating plains: dominant are sandy duplex soils with moderately deep A horizons.

Client:	Nitro Solutions Pty Ltd	Easting:	148°47248
Project:	Foxleigh	Northing:	22°55506
Site:	Foxleigh Coal Mine	GCS:	
Method:	30T Backhoe Excavator	Logged Datum:	WGS84
Contractor:	Middlemount South	Page:	1/1
Log Date:	24 February 2021		

Atlas of Australian Soils Major Unit:	Sodosol
ASC DSM Unit:	
Logged Unit:	
Regional Geology:	Duaringa Formation

Hole ID:	TP00012
Top of Hole:	0.0 m
End of Hole:	3.0 m
Logged by:	Melinda Hilton
Checked by:	Greg Maddocks
Compiled by:	Melinda Hilton
Reviewed by:	Alan Robertson
Approved by:	Alan Roberston

Depth	Unit	Graphic	Material	Moisture	Strength	Density	Notes	Samples	Photos	Soil Type	Emerson Test	$pH_{1:5}$ & $EC_{1:5}$	% Clay	% Silt	% Sand	% Gravel
0.5	TS		Brown, very poorly sorted, subangular LOAM **A1 Horizon**	M	S	L	Crumbly and moist Numerous peds Fertile Contains roots	2021011_0014	Topsoil	Sodosol	1	7.83 948 µS/cm	27	38	35	0
1.0	SS1		Greyish brown, very poorly sorted, granular clayey SAND **B2 Horizon**	W	S	L	Colour darker than topsoil Very moist No fine material Clumpy	2021011_0015	Subsoil	Sodosol	1	7.82 698 µS/cm	24	33	42	1
1.5	SS2		Yellowish brown, very poorly sorted, subangular silty CLAY **B31 Horizon**	M	S	L	Transitional material More fine particles Change in colour Mottled texture	2021011_0016	Subsoil Subsoil	Sodosol	1	8.87 577 µS/cm	43	41	16	0
2.0	SS3		Yellowish brown, very poorly sorted, lenticular silty CLAY **TOTAL DEPTH = 3.0 m** **B32 Horizon** **Rehabilitation: Undisturbed native trees and grasses**	M	S	MD	Very sticky High in clay content Like plasticine	2021011_0017	Test pit profile	Sodosol	1	9.12 656 µS/cm	---	---	---	---
2.5																
3.0																

Moisture: D - dry; M - moist; W - wet | Strength: H - hard; VSt - very stiff; St - stiff; F - firm; S - soft; VS - very soft | Density: VD - very dense; MD - medium dense; L - loose; VL - very loose

Figure 8-13: Test Pit 12 soil log

Attachment F: Geochemical Sampling and Analysis Plan and Soil Sampling and Analysis Plan

Geochemical Sampling and Analysis Plan

Foxleigh Coal Mine

Prepared for: Foxleigh Management Pty Ltd

RGS

MINE WASTE AND WATER MANAGEMENT

Geochemical Sampling and Analysis Plan

Foxleigh Coal Mine

Prepared for: Foxleigh Management Pty Ltd

DOCUMENT CONTROL	
Title	**Geochemical Sampling and Analysis Plan**
Project number	**2021011**

DOCUMENT DISTRIBUTION			
Document File Name	**Document Status**	**Distributed to**	**Date distributed**
2021011_001_Nitro Foxleigh GSaAP_RevA_24042021.docx	**Revision no. A**	**Foxleigh Management Pty Ltd**	**24/04/2021**

Limitations and disclaimer:

This report documents the work undertaken by RGS Environmental Pty Ltd (RGS).

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This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

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1 Background information relevant to the GSaAP

RGS Environmental Pty Ltd (RGS) was commissioned by Foxleigh Management Pty Ltd (Foxleigh) to develop a Geochemical Sampling and Analysis Plan (GSaAP) to meet the conditions of the Environmental Authority (EA) EPML 00744813 for Foxleigh Coal Mine (the Project). The aim of the GSaAP is to characterise mining waste, coal and soil materials based on their geochemical properties.

This GSaAP has been developed in line with Australian and Queensland State guidelines that are routinely used in the mining sector. This GSaAP is focused on filling data gaps needed to inform the Rehabilitation Management Plan for the Project, which is required to be completed as part of the EA, and will ultimately inform the development of a future Progressive Rehabilitation and Closure Plan (PRCP).

RGS has utilised existing geochemical data as background information to inform the current sampling and analysis program, which is detailed in this GSaAP. RGS has relied upon information provided by Nitro Solution Pty Ltd (Nitro) and Foxleigh, relevant technical guidelines and previous knowledge of the Project to produce this document.

1.1 Background

1.1.1 Location and ownership

The Project is located on mining leases ML70171, ML70309, ML70470, ML70310, ML70429, ML70430 and ML70431 in Queensland's eastern Bowen Basin, covering an area of 8,499 ha, approximately 12 km south of Middlemount, 250 km southwest of Mackay and 280 km northwest of Rockhampton **(Figure 1-1)**.

The Project is a jointly owned open cut coal mine producing low volatile PCI coal for export. Foxleigh Mine (Foxleigh) is operated by Foxleigh Management Pty Ltd, on behalf of a joint venture between CAML Resources, Foxleigh Coal Pty Ltd and Nippon Steel.

1.1.2 Open cut mining activities

The mining operation accesses the Rangal Coal Measures using an open cut method to approximately 150 m depth, depending on current economics and market demand. Coal is excavated using truck and shovel methods and processed at an on-site coal handling and preparation plant (CHPP) before being trucked to a dedicated rail loadout facility for transport to Dalrymple Bay Coal Terminal.

Foxleigh's coal presents in the shape of a bowl in most places and is mined utilising a terrace approach to mining. Initial waste is placed in out-of-pit dumps or when in-pit dumps have insufficient room. The in-pit dumps are filled progressively as the terrace face progresses.

Within the mining lease there are 12 open pits which have an open pit void surface area as detailed below:

- Foxleigh Plains Pit (260.8 ha)
- Foxleigh Plains North Pit (50.1 ha)
- Pipeline Pit (55.8 ha)
- Carlo Creek Pit (23.2 ha)
- One Tree Pit (124.5 ha)
- Far South Pit (56.2 ha)
- WC Pit (14.7 ha)
- North WC Pit (25.5 ha)
- Old NE Pit (36.2 ha)
- NW Pit (17.9 ha)
- NE Pit (16.9 ha)
- Void 251 (9.1 ha)

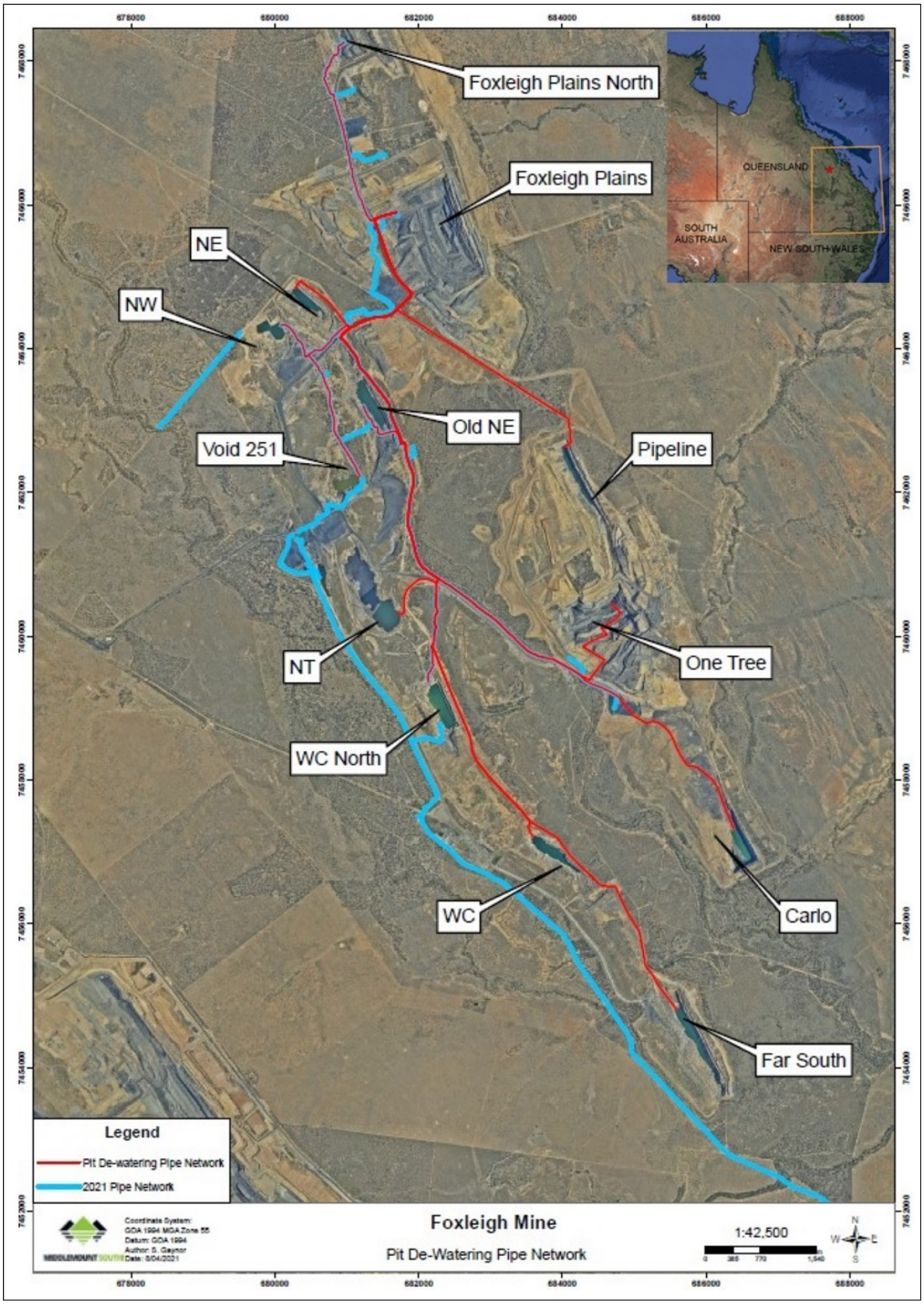


Figure 1-1: Foxleigh Project location and pits

1.2 What is the purpose of the GSaAP

The purpose of the GSaAP is to obtain samples of all major mine waste materials, from highly weathered near-surface materials to the deepest mined surface, to assist Foxleigh in meeting the conditions of its EA.

The GSaAP provides details on the forms of analyses used to determine the chemical properties of the potentially mine impacted material at Foxleigh.

These chemical data are used to characterise the major lithological units to assist Foxleigh in developing a Waste Rock and Spoil Disposal Plan (WRSDP) addressing Condition C5 of the mine's EA, i.e.:

- To effectively characterise the waste rock and spoil generated by mining activities.
- To predict the quality of runoff and seepage generated by the materials.
- To develop an ongoing program of sampling and characterisation for future spoil materials.
- To develop a materials balance and disposal plan detailing the emplacement strategies for minimising the formation of acidic and/or metalliferous drainage (AMD) from mine materials and a sampling program to monitor the effectiveness of the disposal method/s employed.
- Describing the criteria used to assess the effectiveness of the WRSDP and how often assessments will be undertaken.
- Describing the rehabilitation strategy at Foxleigh.

There is potential for the findings from this GSaAP to be used as part of a future works program to inform a 3D model that defines the surfaces or solids for each of the material types identified at Foxleigh, i.e., in addition to a 3D model of the coal seams there would also be a model for the topsoil, subsoil, regolith, and major rock types in the overburden and interburden.

The geoenvironmental model is then used by mine planners to ensure the mined material are placed into the best position over the life of the mine. Reducing the potential for unnecessary double handling costs and adverse effects on the receiving environment.

This general process is an objective of the Progressive Rehabilitation and Closure Planning (PRCP) process in Queensland.

1.3 What is acid and metalliferous drainage

In Australia, the term acid and metalliferous drainage (AMD) is used and addresses all mine water issues that can include acid, neutral or alkaline pH, saline drainage, and metalliferous drainage. In North America, the terms acid rock drainage and Metal Leaching are used. AMD is not just about acid.

1.3.1 AMD classification

Terms used to **classify mined materials** can include the following:

- **AF** (Acid Forming) – sample is producing acid (< pH 5), contains no available Acid Neutralising Capacity (ANC) and may have additional sulfide content that will oxidise and produce additional acid.
- **PAF** (Potentially Acid Forming) –has sufficient reactive sulfide minerals to potentially produce acid when all available ANC is consumed.
- **PAF-LC** (Low Capacity – Potentially Acid Forming) - has the potential to produce relatively minor acidity.
- **NAF-Barren** (Non-Acid Forming - Barren) - is geochemically inert in respect to total sulfur and will produce circum-neutral drainage generally in the range pH 6 to 9 with low sulfate concentrations.
- **NAF** (Non-Acid Forming) - will not produce acid but may leach salts and some metals/metalloids due to the presence of low concentrations of sulfide minerals.
- **AC** (Acid Consuming) - has significant available ANC that will contribute to ongoing acid neutralisation e.g., calcite.

Other terminology used to classify geological materials include the following:

- Saline - material may leach salts dominated by sodium chloride (NaCl) and/or calcium (Ca), magnesium (Mg) and sulfate (SO_4).
- Sodic – this material has a proportionally high concentration of exchangeable Na and has the potential to disperse and tunnel.

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 Drainage,
- Saline Drainage, and
- Mine Impacted Water.

Mine water that is in contact with mining materials is classified as having the follow geochemical characteristics;

- acid, neutral, or alkaline pH,
- variable concentrations of major ions (salts e.g., Ca, Mg, potassium (K), Na, Cl, SO_4, boron (B), fluoride (F), phosphate (P)),
- variable concentrations of metals (e.g., aluminium (Al), iron (Fe), manganese (Mn) and zinc (Zn)) or metalloids (e.g., arsenic (As), selenium (Se) and antimony (Sb)) with specific concentrations often linked to pH.

Potential sources of acid in contact water at mine sites can include;

- oxidation of sulfide minerals such as pyrite that produce sulfuric acid (INAP, 2009),
- oxidation of coal that can produce humic acid-like materials and organic acids,
- rainfall and leaching of cations such as Ca, Mg, K and Na that reduce soil acidification by atmospheric carbonic, nitric, or sulfuric acid,
- organic matter decay, and
- use of ammonium-based nitrogen fertilisers.

Potential sources of salts in contact water at mine sites can include;

- oxidation of sulfide minerals, the production of sulfuric acid and subsequent neutralisation reactions that mobilise major ions such as SO_4 and Ca,
- chemical weathering of adjacent soil and rock by sulfuric acid that releases major ions such as Na, K, Mg and Cl, and
- the mobilisation of NaCl or sodium bi-carbonate ($NaHCO_3$) that are present within geological units and groundwater which is then released in fluxes as mined materials are extracted (blasted), processed (crushed) and placed into mine landforms.

Potential sources of metal ions (e.g. Al^{3+}, Fe^{2+},Fe^{3+}, Mn^{2+} and Zn^{2+}) and oxyanions (e.g., MoO_4^{2-}, and $[H_2VO_4]^-$) in water at mine sites that can include elements present:

- as ancillary minerals that weather very slowly within primary sulfide minerals,
- a range of minerals in geological units with increasing environmental mobility that include immobile oxide minerals which are less mobile than carbonate minerals which are less mobile than exchangeable minerals which are less mobile than water soluble minerals, and
- in pore water.

1.4 Quality, standards, regulation, legislation, and guidelines

Foxleigh requires the deliverables for the development of the mine to comply with applicable legislation, regulation, guidelines, standards, and best industry practice and be of high quality.

By necessity, the Project should also consider the implications of the need for a future Progressive Rehabilitation and Closure Plan (PRCP) and the evaluation of Residual Risk that has been implemented by the Queensland Government.

The purpose of this GSaAP is to complete targeted sampling and analysis of specific mine waste materials to gain the appropriate information to verify adherence to applicable legislation, regulation, guidelines, and standards which may include:

- Environmental Protection Act (1994).
- Environmental Protection (Water) Policy 2009 (EPP (Water)). The EPP (Water) achieves the object of the Environmental Protection Act 1994 (EP Act) to protect Queensland's waters while supporting ecologically sustainable development.
- National Environment Protection Council (Queensland) Act 1994 (Qld). National Environment Protection (Assessment of Site Contamination) Measure.
- Australian and New Zealand Water Quality Guidelines 2018 that supersede the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000) (ANZECC).
- DSITI (2017). Using monitoring data to assess groundwater quality and potential environmental impacts. Version 1. Department of Science, Information Technology and Innovation (DSITI), Queensland Government, Brisbane.
- INAP Global Acid Rock Drainage Guide (2009).
- DME (1995). Draft Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland, Technical Guideline – Assessment and Management of Acid Drainage and Saline/Sodic Wastes. Queensland Department of Minerals and Energy (DME).
- DEHP (2013). Application Requirements for Activities with Impacts to Land Guideline. Queensland Department of Environment and Heritage Protection.
- Commonwealth of Australia Leading Practice Sustainable Development Program (LPSDP) for the Mining Industry: Rehabilitation (2016).
- The *Mineral and Energy Resources (Financial Provisioning) Act 2018* (MERFP Act) came into force on 1 April 2019 and establishes the Financial Provisioning Scheme (FPS) administered by the Scheme Manager. The FPS will hold all scheme assurance provided by the resource sector under the *Environmental Protection Act 1994*.
- Financial assurance under the Environmental Protection Act 1994 (ESR/2015/1758).
- 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 (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 (2013). Department of Environment and Science. Application for the certification of progressive rehabilitation: ESR/2015/1563 • Version 2.01 • Effective 23 May 2013.

There are a number of considerations that need to be worked through in regard to the legislation, regulation and guidelines that are, or may become, applicable to the Project. Some of these considerations are outlined below.

1.4.1 Department of Environment and Science Guidelines

The 2018 Department of Environment and Science Rehabilitation requirements guideline provides a very useful framework to document final landform goals, objectives, performance criteria and indicators for success.

1.4.2 Australian and New Zealand Water Quality Guidelines 2018

The ANZECC & ARMCANZ (2000) Guideline has been superseded by the Australian New Zealand Water Quality Guideline (2018). The application of the ANZG (2018) water quality guidelines will become one of the over-riding regulatory tools for Foxleigh if the WRDs have the potential to release water as;

- surface runoff to receiving land,
- surface runoff to the final void,
- resurgent seepage to receiving land,
- seepage to the regolith and from there to receiving groundwater impacted by mining, and/or
- seepage to the regolith and from there to receiving groundwater in the receiving environment.

For example, RGS completed a water quality compliance report relating to the derivation of trigger values for Glencore McArthur River Mine (MRM) in the Norther Territory in 2019. The report provided by RGS enabled

MRM to continue using its existing trigger values for another two-year period. The additional time allowed MRM to implement a number of recommendations made by RGS to update its water quality compliance framework and align it with the ANZG (2018) Guideline. RGS is assisting Glencore with a Bauxite Project to use the ANZG (2018) framework to derive water quality objectives for compliance monitoring that will be based on site specific conditions, rather than on default ANZECC & ARMCANZ (2000) guideline values.

The ANZG (2018) water quality framework can be used to provide beneficial outcomes for mine sites and ultimately derive site specific water quality compliance targets that could be used at Foxleigh for the management of site water and the release of water from the mine site (should this be required).

1.4.3 INAP Global Acid Rock Drainage Guide

The International Network for Acid Prevention (INAP) is an organization of international mining companies dedicated to reducing liabilities associated with sulfide mine materials and AMD. INAP exists to fill the need for an international body which mobilizes AMD information and experience. The network was founded in 1998. Since then INAP has become a proactive, global leader in this field.

The development of the Global Acid Rock Drainage (GARD) Guide is sponsored by INAP with the support of the Global Alliance. The GARD Guide was created through the contributions of many individuals and organizations. The GARD Guide deals with the prediction, prevention and management of drainage produced from sulfide mineral oxidation).

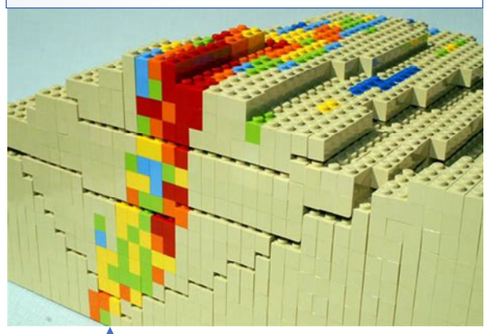
The GARD Guide is intended as a state-of-the-art summary of the best practices and technology to assist mine operators and regulators to address issues related to sulphide mineral oxidation.

1.4.4 Leading Practice Sustainable Development Program (LPSDP) for the Mining Industry

The mining industry guidelines within the LPSDP have been developed by a select group of industry and consulting professionals on behalf of the Commonwealth Government of Australia. RGS was the Peer Reviewer of the AMD Prevention and Management Guideline (2016).

Drill and log deposit

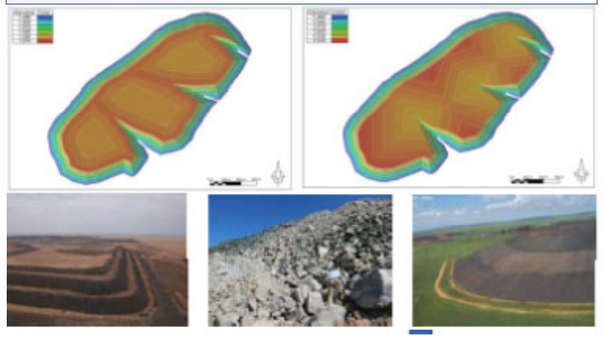
Develop numerical block model – chemical and physical attributes



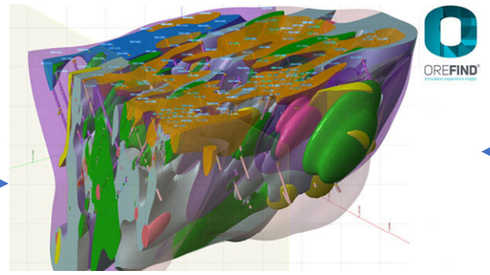
Work out what you need to achieve e.g. stop oxygen or water getting into PAF

Criteria	Groundwater depth	Urban centers	Villages	Rivers	Elevation	Slope	Roads	Soils types	Gas pipelines	Oil pipelines	Power lines	Land use	Agricultural land use	Archaeological sites	Railways	Weighted average
Groundwater depth	1	2	3	2	4	5	5	4	8	8	7	6	5	6	9	0.2004
Urban centers	0.50	1	2	1	3	4	4	3	7	7	6	5	4	5	8	0.1473
Villages	0.33	0.50	1	0.5	2	3	3	2	6	6	5	4	3	4	7	0.1050
Rivers	0.50	1.00	2.00	1	3	4	4	3	7	7	6	5	4	5	8	0.1472
Elevation	0.25	0.33	0.50	0.33	1	2	2	1	5	5	4	3	2	3	6	0.0709
Slope	0.20	0.25	0.33	0.25	0.50	1	1	0.5	4	4	3	2	1	2	5	0.0465
Roads	0.20	0.25	0.33	0.25	0.50	1.00	1	0.5	4	4	3	2	1	2	5	0.0465
Soils types	0.25	0.33	0.50	0.33	1.00	2.00	2.00	1	5	5	4	3	2	3	6	0.0709
Gas pipelines	0.13	0.14	0.17	0.14	0.20	0.25	0.25	0.20	1	1	0.5	0.34	0.25	0.34	2	0.0146
Oil pipelines	0.13	0.14	0.17	0.14	0.20	0.25	0.25	0.20	1.00	1	0.5	0.34	0.25	0.34	2	0.0146
Power lines	0.14	0.17	0.20	0.17	0.25	0.33	0.33	0.25	2.00	2.00	1	0.5	0.34	0.5	3	0.0207
Land use	0.17	0.20	0.25	0.20	0.33	0.50	0.50	0.33	2.94	2.94	2.00	1	0.5	1	4	0.0292
Agricultural land use	0.20	0.25	0.33	0.25	0.50	1.00	1.00	0.50	4.00	4.00	2.94	2.00	1	2	5	0.0462
Archaeological sites	0.17	0.20	0.25	0.20	0.33	0.50	0.50	0.33	2.94	2.94	2.00	1.00	0.50	1	4	0.0292
Railways	0.11	0.13	0.14	0.13	0.17	0.20	0.20	0.17	0.50	0.50	0.33	0.25	0.20	0.25	1	0.0107

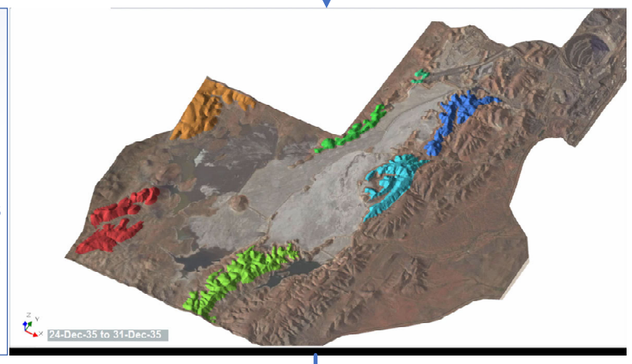
Work out what you can achieve with the material balance that is available for all mined materials

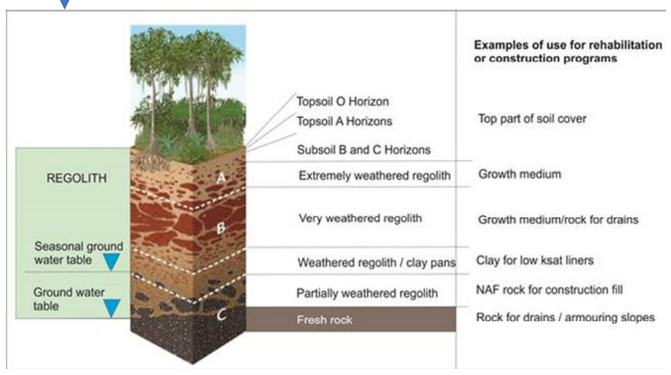


Build the geology model with data from the drill holes and drill logs



Use mine landform and haulage schedules to verify how the work can be done using various fleet options and use the schedule to cost the work





Characterise all material that will be mined from topsoil to the deepest mined surface.

Classify the soil, regolith and drill core from fresh rock into mine waste units e.g. NAF and PAF, Saline or Non-saline

Environmental assessment process using conceptual and numerical models

Use a range of conceptual and numerical modelling methods and environmental data for air, soil, sediment, surface water ground water to determine if the proposed management plan will work.

Figure 1-2: **Conceptual model of how to implement a GSaAP**

2 Geochemical data review and gap analysis

RGS reviewed existing information on mining (overburden, interburden, coal reject, and tailing materials), coal and soil materials. RGS received the following documents:

- Foxleigh 2018 - Foxleigh Tailings Management Plan
- Foxleigh 2019 - Foxleigh Mine 2020 Plan of Operations
- Foxleigh 2020a - Foxleigh Mine Life of Mine Plan CY2020
- Foxleigh 2020b - Xenith Coal Handling and Processing Plant (CHPP) waste tonnages
- Foxleigh 2021a - Waste Rock and Spoil Disposal Plan
- JBT 2012 - Foxleigh Plains Project Environmental Impact Statement Groundwater Report
- RGS 2012 - Foxleigh Plains Project: Geochemical Assessment of Overburden and Coal Reject Materials

Foxleigh 2018 – The Tailings Management Plan (TMP) describes the strategy for the emplacement of tailings and coal reject materials over the life of mine. It also describes the surface water management and progressive rehabilitation practices of the tailings storage facilities and reject emplacements.

Tailings are described as comprising both coal rejects with a particle size of less than 0.25 mm, and the tailings removed by the floatation process. The tailings are thickened and dewatered to a slurry 30% solids by mass before being pumped to the tailings storage facility (TSF).

Coal rejects are described as both coarse and fine high ash material removed from the input stream by cyclones and teeter beds respectively. Coal rejects range in particle size from 0.25 mm to 50 mm and are conveyed from the coal handling and preparation plant CHPP to a stockpile before being hauled to the reject emplacements.

The TMP states that a program of material characterisation and sampling to assess the likelihood of the tailings generating acid and/or metalliferous drainage will be developed during the life of the TSF. It is noted that at the time of writing there had been no indication of potentially acid forming material and metal concentrations of the tailings are described as atypical relative to the tailings of similar and nearby mines.

Water sampling was to be employed, with analysis recommended to occur at a NATA laboratory. No recommendations are made regarding the frequency of water sampling and which water is to be sampled is not described clearly, i.e., it is not clearly stated if water reclaimed for reuse in the CHPP is to be sampled or water which has accumulated in the earthen material surrounding the tailings cell facility.

Foxleigh 2019 – The Foxleigh Mine 2020 Plan of Operations describes the mining and associated activities that will occur during 2019 and 2020. In addressing Schedule C of the Environmental Authority Condition the Tailings Management Procedures are referenced however, Foxleigh (2019) does not describe a “program of progressive sampling and characterisation to identify acid producing potential and metal concentrations of tailings”. The characterisation of tailings is addressed in Hatch (2020). To address the obligations of Foxleigh in managing waste rock (EA Condition Schedule C5) Foxleigh (2019) refers to the development of the Foxleigh Waste Rock and Spoil Disposal Plan (Foxleigh 2021a).

Foxleigh 2020a – The Foxleigh Life of Mine Plan is a model updated every 1 - 2 years which attempts to model the mining activities of Foxleigh over the longer-term. The plan models the volume of waste that is expected to be excavated from 2020 to 2023 and then every 5 years afterwards. Appendix 5 of the Life of Mine Plan describes Foxleigh Plains spoil as having been characterised as acid consuming with salinity levels decreasing over time and highlights the need for the characterisation of spoil from other pits at Foxleigh.

Foxleigh 2020b – Xenith CHPP waste tonnages are provided on a worksheet of a Microsoft Excel spreadsheet titled *3_5_Base 200113 Physicals for Financial Modelling.xlsx.* The worksheet provides monthly tonnage values for the feed from the run of mine to the CHPP and tonnages of saleable coal produced. This allows calculation of monthly coal reject and tailings tonnages. The data also is divided by pit, seam, and oxidation state.

Foxleigh 2021a – The Foxleigh Waste Rock and Spoil Disposal Plan was developed to provide guidance on the characterisation and management of waste rock and spoil at Foxleigh. The plan refers to the 2013 Environmental Impact Statement when describing overburden and interburden at the site. The plan describes overburden and

interburden as generally alkaline, non-acid forming, strongly sodic and prone to dispersion, with low salinity, and unbalanced nutrient ratios. The section of the plan discussing waste rock and spoil sampling, and characterisation (Section 1.4) does not provide clear guidance on a progressive sampling and characterisation program, a materials balance for non-acid and potentially acid forming materials, the need for a sampling program to verify the encapsulation of potentially acid forming material, the criteria to assess the effectiveness of the Waste Rock and Spoil Disposal Plan, how often the plan should be assess and rehabilitation strategies for waste rock emplacements.

JBT 2012 – The Foxleigh Plains Project Environmental Impact Statement Groundwater Report prepared by JBT Consulting on behalf of Hansen Bailey. The report discussed the results of an assessment of groundwater impacts of the project on the existing groundwater environment at Foxleigh. The report was prepared as part of the Environmental Impact Statement for the Foxleigh Plains Project.

The report describes the groundwater at the project as separated from the local surface water and regional groundwater systems and influenced by the presence of coal seams. It also describes the groundwater hosted in the coal bearing strata at the project as naturally relatively saline, i.e., 70% of 129 samples had salinity exceeding 30,000 µS/cm.

RGS 2012 – RGS completed a geochemical assessment of overburden and coal reject materials for the Foxleigh Plains Project. The report is a component of the Environmental Impact Statement for the project.

Forty-two samples of overburden and interburden, including coal seam roof and floor samples, were collected from six drill holes as well as three samples of coal rejects and analysed at ALS Environmental Laboratory Brisbane. The report found:

- Initial and ongoing surface runoff and leachate from overburden stored within overburden emplacement areas would be alkaline and have a low salinity value.
- The risk of saline surface runoff and leachate from overburden material (including sulfate) was predicted to be low in the short term and to diminish with time as soluble salts are flushed from these materials.
- Overburden material generated by the project could be regarded as an acid consuming and/or non-acid forming unit with significant excess acid neutralising capacity. The material had a high factor of safety and a low to negligible risk of acid generation.
- The concentration of total metals in overburden was below applied guideline criteria for soils and was unlikely to present any environmental issues associated with rehabilitation and final land use.
- The concentration of soluble metals and major ions in runoff and seepage from overburden was likely to remain within applied water quality guideline criteria and was unlikely to present any significant environmental risks for on-site or downstream water quality.
- Overburden material was expected to be sodic with some nutrient imbalance and poor physical characteristics. To address any potential erosion and dispersion issues this material would be managed in a similar manner to the existing Foxleigh Mine overburden material.
- Initial and ongoing runoff/seepage from coal reject emplacement areas was likely to be pH neutral and have a high salinity value.
- It was expected that the risk of saline surface runoff and leachate from exposed coal reject material would diminish in the longer term as soluble salts were flushed from these materials over time, although ongoing monitoring of surface runoff and leachate from the exposed emplacement areas would be completed to confirm the salinity level over the life of mine.
- Coal rejects generated by the project were likely to be NAF with excess ANC. Material represented by the test samples had an elevated factor of safety and low to negligible risk of acid generation.
- The concentration of total metals in coal rejects was below applied guideline criteria for soils and was unlikely to present any environmental issues associated with rehabilitation and final land use.
- The concentration of soluble metals and major ions (except sulfate) in runoff and seepage from coal rejects were likely to remain within applied water quality guideline criteria and were unlikely to present any significant environmental risks for on-site or downstream water quality.

3 GIS requirements for the Foxleigh GSaAP

In developing this GSaAP, RGS has used drill hole collar coordinates provided by Foxleigh. To assist in the development of the Materials Characterisation Report RGS requests the following GIS data:

- Georeferenced image of the site,
- Polygons and polylines delineating:
  - Mine domains.
  - Existing hydraulic data (e.g., perennial creeks, ephemeral creeks, major, minor creeks),
  - Proposed dams and drainage paths,
  - Open pit(s), and
  - Ex-pit and in-pit maximum footprints for waste dumps.
- Proposed diamond hole drill hole locations that will be drilled in 2021, including drill hole specifications and corrected drill logs.

The purpose of receiving this data is to enable RGS to produce quality figures depicting data relevant to the GSaAP.

4 Sampling program

In RGS discussions with Foxleigh in early 2021, it was determined that the most practical way to fulfill the objectives of the GSaAP would be to initially collect geochemical samples from pre-existing drill core stored on site, from drill core stored at various laboratories, and from the coal handling and processing plant (CHPP) and TSF at site.

This approach was considered likely to provide sufficient data to confirm the geochemical characteristics of mining waste, coal and soil materials. Notwithstanding, future sampling may be required to address unforeseen data gaps identified at the conclusion of the sampling and analysis program.

The samples selected for analysis are tabulated in **Attachment A**.

Overburden and interburden sampling

Two methods were used to guide the selection of overburden and interburden geochemical samples. Most of the samples (105 samples from four drill holes) were selected based on their lithology (**Table A-1**), with a smaller number of samples (68 samples from nine drill holes) selected based on their proximity to target coal seams (**Table A-2**), i.e., coal seam roof and floor samples.

The drill hole logs for holes selected for sampling (**Figure 4-1**) were analysed to determine the relative proportions of the lengths of lithologies logged across the four drill holes. Intervals of a single lithology above the base of weathering approximately 1.0 m in length were selected. Below the base of weathering, intervals of a consistent lithology approximately 0.5 m in length were selected. To generate a set of samples that are as representative as possible, samples were selected down the full length of the drill holes and the lithologies of selected samples were chosen in proportions relatively similar to the proportions of the lengths of the major lithologies of all four drill holes combined (**Table 4-1**).

Table 4-1: Relative proportions of overburden and interburden lithology sampled

Lithology	Sampled Length (m)	Proportion of Sampled Length	Available Length (m)	Proportion of Total Length
Sand	4.51	7%	11.83	2%
Clay	2.98	5%	11.86	2%
Claystone	1.55	3%	6.42	1%
Sandstone	24.15	40%	329.20	52%
Siltstone	14.10	23%	155.67	25%
Carbonaceous Siltstone	9.69	16%	64.09	10%
Tuff	0.50	1%	0.89	1%
Mudstone	0.50	1%	4.06	1%
Silt	1.93	3%	6.06	1%
Carbonaceous Mudstone	0.50	1%	2.40	0%
Coal	0.70	1%	37.97	6%
Total	**61.12**		**630.44**	

When sampling from pre-existing drill core it is recommended that selected samples showing excessive weathering post-drilling (i.e., heavily weathered rock that was originally below the base of weathering) are omitted and another similarly representative sample is selected in its place. Samples should only be collected from the same lithological unit or material type e.g., if sampling a sandstone unit that becomes conglomerate there should not be a sample containing both material types.

Roof and floor samples should be selected based on their proximity to both potentially economic and uneconomic coal seams that have been/will be excavated. These sample materials could be sourced directly from the coal quality laboratory where they have been maintained in cold storage (i.e., frozen).

If there is no requirement for Foxleigh to retain drill core, then the sampled intervals can be freighted to the RGS warehouse where the samples will be registered and dispatched to ALS Environmental Laboratory Brisbane (ALS) to be crushed to sub-20 mm diameter. A representative 0.5 kg sample of the crushed material will be riffle split at ALS to be pulped and used in conjunction with the crushed core by ALS for a suite of static geochemical analyses. The portion of crushed core not used for static geochemical analyses will be sent to RGS's in-house laboratory for the establishment of the kinetic leach column (KLC) program.

Coal reject sampling

Representative samples of the coal reject (coarse reject and tailing) materials tailing generated at Foxleigh should be collected from the waste streams at the on-site CHPP and/or in storage locations (e.g., the TSF). 10 coal reject and 10 tailings samples (**Table A-3**) should be collected in 20L plastic buckets and sealed for transport with water-tight lids. The samples will be sent to RGS to have sub-samples taken for static geochemical analyses. The sub-samples will be sent to ALS Environmental Laboratory Brisbane for analysis.

At the conclusion of the static analyses, Foxleigh may elect for the unused pulped, crushed, and coal reject and tailings samples to be disposed of, returned to Foxleigh, or stored by RGS for use in future works.

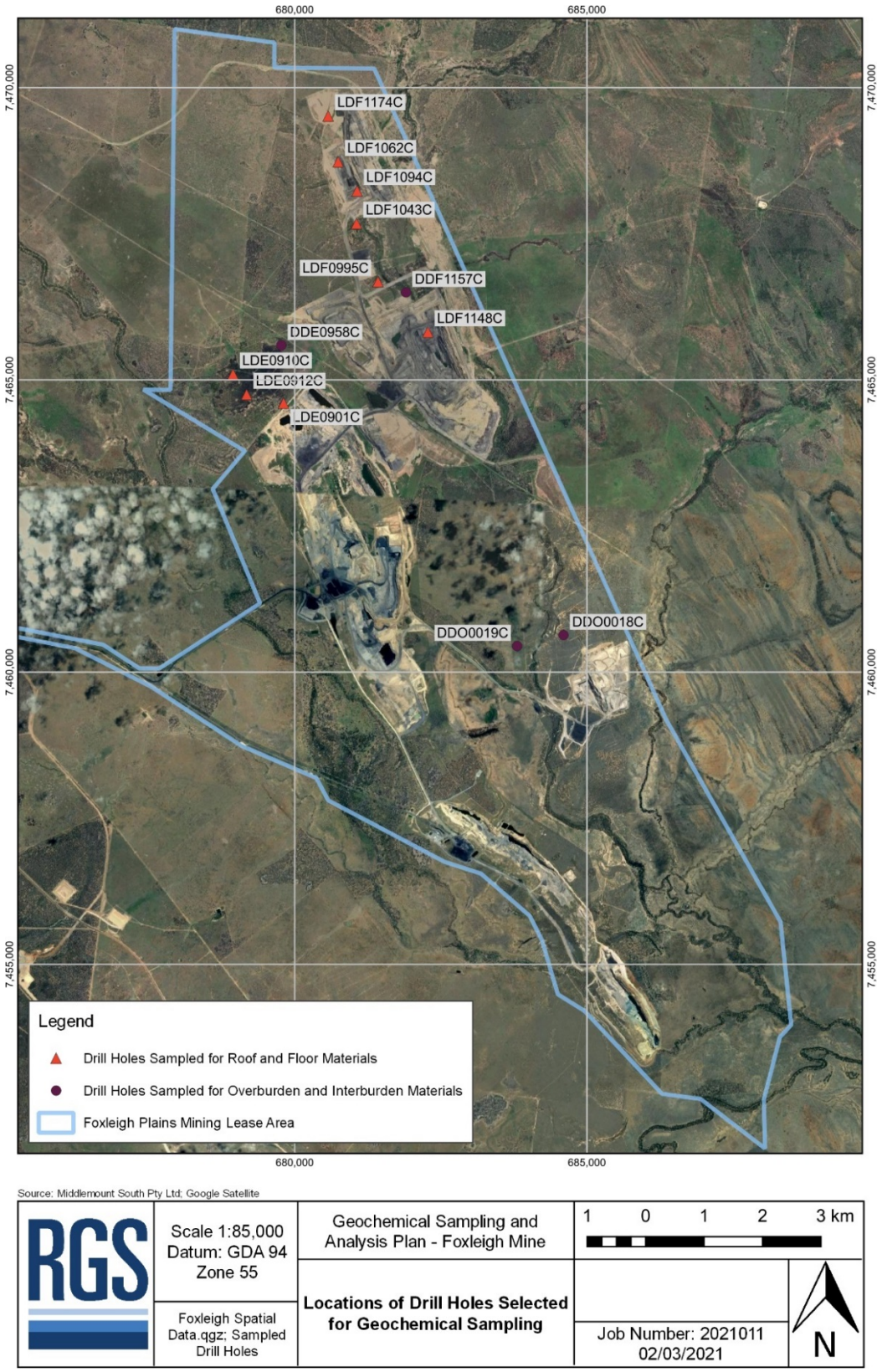


Figure 4-1: Locations of drill holes selected for geochemical sampling

5 Analysis program

The geochemical analysis program has three main objectives:

1. Quantify the total sulfur content and sulfate mobility of mining waste and coal materials to evaluate the potential for sulfate drainage issues.
2. Quantify the sulfide content and potential neutralising capacity in all material types to verify the potential for the generation of AMD/NMD/SD.
3. Assess the impacts of the mining waste and coal waste materials on water quality over time using a series of analyses on leachates from kinetic leaching columns.

5.1 Analytical methods for AMD

To characterise the acid producing potential of a sample a range of analyses are generally undertaken including determination of total sulfur, sulfide sulfur measured using the chromium reducible sulfur method (Scr), sulfate (that can be measured in a range of fractions and species using various methods), the hydrogen ion concentration (pH), electrical conductivity (EC), acid neutralising capacity (ANC), available ANC using the acid buffering characteristic curve (ABCC) method, mineralogy, and the single peroxide addition net acid generation (NAG) method (MEND, 2009). However, it is often cost prohibitive and unnecessary to undertake all these analyses on every sample.

RGS undertakes pH, EC, TS and ANC on all coal mining waste samples to screen them and undertake supplementary analyses on specific samples to understand anomalies or to verify assumptions. This approach results in a balance between sample coverage and cost and is an effective strategy for geochemical assessment.

5.1.1 Maximum potential acidity

Actual acidity

Actual acidity can be divided into soluble acidity and retained acidity. Soluble acidity is defined here as acidity measured using a 1:5 (soil:water) extract whereas retained acidity is defined as the acidity that is not recorded in such an extraction however, there is no clear-cut distinction between soluble acidity and retained acidity because part of the retained forms of acidity can be released during successive extractions with water. Soluble acidity can be subdivided into active soluble acidity and buffered acidity. Active soluble acidity accounts for the activity of hydrogen ions (H^+) whereas buffered soluble acidity accounts for other soluble acidic cations (mainly Fe^{2+}, $AlSO_4^+$ and Al^{3+}) that can produce hydrogen ions when they hydrolyse[1].

Retained acidity can be sub-divided into (a) exchangeable acidity, (b) acidity carried by protonated variably charged particles, such as clays, and (c) acidity carried by basic sulfate minerals. These retained forms of acidity are temporarily immobilised by soils and are subject to re-mobilisation if geochemical conditions change, e.g. during liming, or re-flooding with brackish tidal water. Exchangeable acidity is acidity that is retained through cation exchange reactions[1]. An example of exchangeable acidity is found in the sulfate mineral Jarosite; One mole of jarosite carries three moles of acidity that can be released by hydrolysis:

$$KFe_3(OH)_6(SO_4)_2 + 3OH^- \rightarrow 3Fe(OH)_3 + 2SO_4^{2-} + K^+$$

Acidity that is buffered through protonation of variably charged particles can be released through their de-protonation, e.g.:

$$[Al(OH)]SO_4 + 2OH^- \rightarrow Al(OH)_3 + SO_4^{2-}$$

[1] Lin, C. Lancaster, L.A. Sullivan, D. McConchie, D. and Saenger, P. (2002). Actual Acidity in Acid Sulfate Soils: Chemical Processes and Analytical Methods. Acid Sulfate Soils in Australia and China.

Potential acidity

Total sulfur is measured by combustion of the sample in a furnace at 1,350ºC in the presence of strong oxidants/catalysts. This method measures the total concentration of sulfur, including elemental sulfur, sulfur present in sulfide and sulfate minerals as well as organic sulfur. The most environmentally conservative approach to calculate maximum potential acidity (MPA) is to assume that all sulfur in a sample is potentially reactive sulfide and therefore capable of generating acid. By convention in acid base accounting studies, 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 expressed in kg H_2SO_4 / tonne. However, this ignores the fact that not all sulfur will contribute to the generation of acidity (e.g. sulfate sulfur in gypsum and barite). As a result, the total sulfur concentration may overestimate the acid generation potential of a sample.

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 a large number of non-acid producing secondary minerals such as alunite ($KAl_3(SO_4)_2(OH)_6$), gypsum ($CaSO_4 \bullet 2H_2O$) through to minerals such as jarosite ($KFe^{3+}{}_3(OH)_6(SO4)_2$) that can store and release acid and trace, minor and major elements.

To differentiate between total sulfur and sulfide sulfur the Scr method was used to measure the sulfide sulfur. The Scr method provides a direct measure of reduced inorganic sulfur over the wide range of values encountered in acid sulfate soils and mineral waste in geological materials. The selectivity of the Scr test in samples containing residual organic sulfur makes it an ideal choice analytically to measure sulfide within primary sulfide minerals. While this method excludes sulfur present as sulfate, or organic sulfur it does not differentiate between acid producing (e.g. pyrite) and non-acid producing (e.g. sphalerite) minerals.

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 acid that could be generated by the sample by either directly determining 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:

$$4FeS_2 + 15O_2 + 14H_2O \rightarrow 4Fe(OH)_3 + 8SO_4^{2-} + 16\ H^+$$

According to this reaction, the MPA of a sample containing 1% sulfur 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.

5.1.2 Acid neutralising capacity (ANC)

The ANC can be measured by the peroxide siderite correction for the Sobek method that utilises digestion of a pulp sample with 0.5 M hydrochloric acid (HCl), 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, as it represents the capacity of the solids to neutralise acid but not necessarily implying that calcite ($CaCO_3$) is present.

The primary minerals in geological materials that are readily able to neutralise acidity are calcium and magnesium carbonates. Secondary neutralising minerals accounted for in 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 small 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 do not report to the ANC measurement. The relative reactivity of acid consuming minerals at pH 5 is provided in **Table 5-1**.

Table 5-1: Relative Mineral Reactivity

Mineral Group	Typical Minerals	Relative Reactivity at pH 5
Dissolving	Calcite, aragonite, dolomite, magnesite, brucite	1.0
Fast weathering	Anorthite, nepheline, olivine, jadeite, leucite, spodumene, diopside, wollastonite	0.6
Intermediate weathering	Epidote, zoisite, enstatite, hypersthene, augite, hedenbergite, hornblende, glaucophane, tremolite, actinolite, anthophyllite, serpentine, chrysotile, talc, chlorite, biotite	0.4
Slow weathering	Albite, oligoclase, labradorite, montmorillonite, vermiculite, gibbsite, kaolinite	0.02
Very slow weathering	K-feldspars, muscovite	0.01
Inert	Quartz, rutile, zircon	0.004

(Source http://technology.infomine.com/enviromine/ard/acid-base%20accounting/ABAdiscussion.htm)

5.1.3 Reactive acid neutralising capacity

The reactive (available) ANC is determined using the ABCC (AMIRA, 2002) method that was derived from the British Columbia Research Incorporated Initial Neutralisation Potential method[2]. The measurements of reactive (available) acid neutralising capacity involves slow titration of a sample with the addition of hydrochloric or sulfuric acid over set time intervals while continuously measuring the pH. The method is used to estimate the ANC of the material and the buffering capacity available at a pre-determined pH value. When acid is added to finely ground particles or aggregates the material will react with the acid neutralising components and reduce the pH of the solution. The amount of acid required to reach each pH interval is dependent on the amount of neutralisation present. 'Buffering' occurs where a significant amount of acid is added before the pH drops, thereby producing a 'step-like' curve in a plot of pH versus volume of acid added.

5.1.4 Net acid producing potential (NAPP) and neutralisation potential ratio (NPR)

Geochemical classification is achieved using the net acid producing potential (NAPP) of a sample, which is calculated from acid base accounting (ABA) procedures (COA, 2016). The NAPP value is derived as the difference between the MPA and ANC of a sample.

The ANC:MPA ratio (or Neutralising Potential Ratio) is also used as a means of assessing the risk of acid generation from mine waste materials. The purpose of the ANC:MPA ratio is to provide an indication of the relative margin of safety within a material. As a general rule, an ANC:MPA ratio of 2 or more can signify that a material will remain circum-neutral in pH (AMIRA, 2002; INAP, 2009).

5.1.5 Net acid generation (NAG)

The single addition standard NAG test involves a single addition of 250 mL of 15 % H_2O_2 to a 2.5 g of pulverised (less than 75 µm) sample. The sample is then allowed to react and the entire sample is heated until gently bubbling for approximately 1-2 h to remove excess H_2O_2, encouraging the release of inherent ANC. Once the sample has cooled to room temperature, the pH and titrated acidity to pH 4.5 and 7.0 (in kg H_2SO_4/t of sample) of the solution are measured. A NAG_{pH} of less than 4.5 may indicate the sample is PAF.

A NAG_{pH} value can be used in combination with NAPP values to classify the geochemical nature of samples. The Australian Government Leading Practice Handbook on Acid and Metalliferous Drainage (COA, 2016) states

[2] Duncan, D.W., Bruynesteyn, A. (1979) Determination of acid production potential of waste material. Met. Soc AIME

that, “the risks of misclassifying Non-Acid Forming (NAF) material as Potentially Acid Forming (PAF) and PAF material as NAF, are substantially reduced by conducting both NAPP and NAG tests.”

The standard NAG method is also known to have several limitations, especially for highly carbonaceous materials) that should be considered in the interpretation of data (MEND, 2009; COA, 2016).

5.1.6 Metalliferous drainage potential

The potential of a geological material to leach trace, minor or major elements (salts, metals, and metalloids) is a function of the fractionation and speciation of the elements and the way the mine waste materials will be managed. The static methods used in this assessment will measure the “total” and “water soluble” fractions of these elements.

The geochemical abundance index (GAI) quantifies a “total” 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 5-2**.

Table 5-2: Geochemical Abundance Index values and Enrichment Factor

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		

Generally, a GAI greater than or equal to three indicates element enrichment to a level that may warrant further investigation (INAP, 2009). This is the case with some environmentally important ‘trace’ elements, such as As, Cd, Cu and Zn, rather than with major rock-forming elements, such as Ca, Mg, K and Na. 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. 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.

A 1:5 (solid:solute) or more concentrated deionised water leach test can be used to measure the pH, EC, and the concentration of major ions and trace metals/metalloids in water extracts. It should be recognised that direct comparison of geochemical data from water extracts with guideline values can be misleading.

RGS prefers to evaluate the solubility of metals/metalloids and major ions in leachate from mining wastes and coal materials using kinetic leach column testing that generally provides an indication of the rate of weathering and associated concentration/release rate of elements in the leachate over time under controlled laboratory conditions.

5.1.7 Saline drainage potential

Saline drainage is of concern to regulators in Queensland and other states and territories. Saline drainage can come from the release of major cations and anions from geological units due to weathering of the host rock, or from the accumulation of elements over time e.g., accumulation of NaCl in soil from leaching by rain. Saline drainage can also be attributed to sulfide oxidation process that release sulfate and or the weathering of sulfate minerals such as gypsum. Sulfate and other major ions such as NaCl can be present under both acid and neutral pH conditions.

5.1.8 Kinetic leach columns

Kinetic leach columns (KLCs) will be established to assess the impacts of mining waste materials and coal on surface water or seepage over time. The data from multiple leach events over time may assist in predicting the longer-term geochemical properties of the selected materials.

To establish KLCs, representative composites of mining waste and coal materials with a particle size of less than 20 mm are combined. These composites are then placed into columns established using the AMIRA method (AMIRA 2002). The AMIRA method for leach column tests aligns with the following:

"Leach columns are normally loaded with 2-3 kg of crushed (not pulverised) waste rock or tailing materials and subjected to wetting and drying cycles to encourage oxidation and flushing of oxidation products. Water flushed through the column sample is collected and analysed for a variety of parameters to provide information on a range of issues including sulfide reactivity, oxidation kinetics, metal solubility and the leaching behaviour of the test material.

Leach columns are run under the assumption that oxygen is freely available throughout the sample. Results of leachate analysis therefore give a measure of the relative reactivity of a given sample under atmospheric oxygen concentrations. If a column sample is too wet, then the assumption that oxygen is freely available is not valid. If a sample is too dry, secondary mineral solubility comes into effect, so that leachate collected can significantly underestimate sulfide reaction rates. The leach column operation is designed to achieve a weekly wet-dry cycle and a monthly flushing cycle. The sample is wetted by applying water to the surface of the column and leachate is collected through the funnel at the base of the column. Heat lamps are used to ensure drying of the sample between water applications."

For the selected Foxleigh materials, after the collection of an initial leachate on the establishment of the leach columns, leachates should be collected monthly for six months. The leachates will be sent to ALS Environmental Brisbane to undergo the range of analyses detailed in **Table 5-3**.

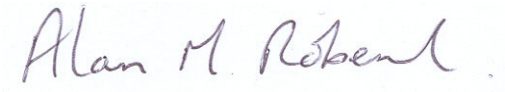
Table 5-3: 2021 GSaAP analytical program

Static geochemical analyses	ALS Code	Method Code	Number of samples
pH plus EC (1:5)	EA02 and EA010	APHA 4500 H+ - B and APHA 2510 B	150
NAPP (includes ANC, Total S)	ASS1	III. Coastech Research (Canada)	150
Chromium Reducible Sulfur (22B)	EA026	Ahern et al (2004)	30
Major, minor and trace elemental analysis (Total) (48 elements)	ME-MS41 - 2 acid aqua regia digest		15
Mercury (Total)	EG035T	APHA 3112 Hg-B CV/FIMS	15
Fluoride (Total)	EK040T	EK040T In-house Fusion	15
Shale Flask Extraction (1:5 sample:water) and 16 hr leach for water soluble elements	**ALS Code**	**Method Code**	**Number of samples**
Leach method	EN35		15
Alkalinity: including Bicarbonate, Carbonate, Hydroxide & Total as CaCO3	ED037	APHA 2320 B	15
Acidity as CaCO3	ED038	APHA 2310 B	15
Cations - Dissolved: Calcium, Magnesium, Sodium, Potassium + Anions: Major (Cl, SO_4, Alkalinity), Fluoride	NT-1 & NT-2	APHA 3120B, APHA 3125B	15
Trace metals by ICP/MS (including digestion)	EG020F (ME-02)	USEPA 6020 ICP/MS	15
Kinetic Leach Column Testing	**ALS Code**	**Method Code**	**Number of samples**
pH by PC titrator	EA005P	APHA 4500 H^+ – B	49
EC by PC titrator	EA010P	APHA 2510 B	49
Alkalinity as $CaCO_3$ (PC Titrator)	ED037	APHA 2320 B	49
Acidity as CaCO3 mg/L	ED038	APHA 2310 B	49
Major Cations (Ca, Mg, Na, K) and Major Anions (CL, SO4, Alkalinity), Fluoride	NT-1 & NT-2	APHA 3120B, APHA 3125B	49
Water Leachable Metals - ICP-MS Full scan (dissolved)	EG020F (ME-02)	USEPA 6020 ICP/MS	49

6 Closing

Please contact Alan Robertson or Greg Maddocks on 07 3344 1222 (office) or 0431 620 623 (mobile) with any queries or if you require further information.

Yours sincerely,
RGS ENVIRONMENTAL PTY LTD



Dr. Alan M. Robertson
Managing Director/Principal Geochemist

Attachment A: Samples Selected for Geochemical Assessment

Table A-1: Foxleigh Overburden and Interburden Samples

Sample ID	Hole No.	From (m bgl)	To (m bgl)	Length (m)	Lithology
113160	DDE0958C	1.50	2.51	1.01	Sand
113156	DDE0958C	7.00	8.00	1.00	Sand
113157	DDE0958C	13.24	14.24	1.00	Clay
113155	DDE0958C	16.91	17.91	1.00	Sand
113197	DDE0958C	24.01	25.00	0.99	Clay
113161	DDE0958C	26.10	26.60	0.50	Claystone
113162	DDE0958C	29.66	30.15	0.49	Sandstone
113196	DDE0958C	30.15	30.65	0.50	Claystone
113158	DDE0958C	32.72	33.20	0.48	Sandstone
113159	DDE0958C	38.18	38.68	0.50	Siltstone
113154	DDE0958C	42.62	43.12	0.50	Siltstone
113153	DDE0958C	47.45	47.95	0.50	Siltstone
113177	DDE0958C	50.29	50.77	0.48	Siltstone
113163	DDE0958C	55.53	56.03	0.50	Sandstone
113187	DDE0958C	59.65	60.15	0.50	Sandstone
113164	DDE0958C	64.87	65.38	0.51	Sandstone
113165	DDE0958C	66.13	66.67	0.54	Sandstone
113188	DDE0958C	70.00	70.50	0.50	Sandstone
113189	DDE0958C	73.27	73.83	0.56	Siltstone
113178	DDE0958C	75.51	75.99	0.48	Siltstone
113166	DDE0958C	78.64	79.14	0.50	Siltstone
113190	DDE0958C	82.50	83.02	0.52	Sandstone
113167	DDE0958C	92.41	92.89	0.48	Sandstone
113191	DDE0958C	96.13	96.63	0.50	Sandstone
113179	DDE0958C	100.59	101.09	0.50	Carbonaceous Siltstone
113168	DDE0958C	104.54	105.04	0.50	Carbonaceous Siltstone
113192	DDE0958C	111.55	112.00	0.45	Carbonaceous Siltstone
113180	DDE0958C	114.13	114.63	0.50	Sandstone
113169	DDE0958C	120.36	120.86	0.50	Sandstone
113181	DDE0958C	125.28	125.75	0.47	Sandstone
113182	DDE0958C	127.38	127.88	0.50	Sandstone
113170	DDE0958C	130.72	131.22	0.50	Carbonaceous Siltstone
113171	DDE0958C	132.71	133.22	0.51	Carbonaceous Siltstone
113183	DDE0958C	138.13	138.63	0.50	Sandstone
113172	DDE0958C	142.46	143.00	0.54	Carbonaceous Siltstone
113193	DDE0958C	148.50	149.00	0.50	Carbonaceous Siltstone
113174	DDE0958C	152.35	152.93	0.58	Sandstone
113184	DDE0958C	156.19	156.69	0.50	Sandstone

Sample ID	Hole No.	From (m bgl)	To (m bgl)	Length (m)	Lithology
113194	DDE0958C	161.06	161.61	0.55	Carbonaceous Siltstone
113195	DDE0958C	163.70	164.22	0.52	Carbonaceous Siltstone
113186	DDE0958C	167.38	167.86	0.48	Carbonaceous Siltstone
113175	DDE0958C	170.36	170.85	0.49	Carbonaceous Siltstone
113176	DDE0958C	173.82	174.32	0.50	Sandstone
113253	DDE0958C	176.74	177.24	0.50	Sandstone
113255	DDE0958C	180.08	180.58	0.50	Carbonaceous Siltstone
113198	DDE0958C	183.09	183.59	0.50	Sandstone
113200	DDF1157C	67.33	67.83	0.50	Sandstone
113277	DDF1157C	121.53	122.00	0.47	Sandstone
113199	DDF1157C	127.16	127.66	0.50	Sandstone
113278	DDF1157C	153.00	153.50	0.50	Sandstone
113254	DDF1157C	156.59	157.09	0.50	Sandstone
113252	DDF1157C	157.74	158.24	0.50	Siltstone
113279	DDF1157C	180.32	181.32	1.00	Carbonaceous Siltstone
113280	DDF1157C	202.46	203.00	0.54	Sandstone
113281	DDF1157C	204.23	204.73	0.50	Siltstone
113256	DDF1157C	208.03	208.53	0.50	Sandstone
113307	DDO0018C	2.01	3.00	0.99	Clay
113301	DDO0018C	4.23	7.03	2.80	Siltstone
113290	DDO0018C	10.25	10.75	0.50	Siltstone
113308	DDO0018C	15.53	16.00	0.47	Sandstone
113291	DDO0018C	22.50	23.00	0.50	Sandstone
113302	DDO0018C	29.50	30.00	0.50	Siltstone
113309	DDO0018C	37.50	38.00	0.50	Mudstone
113292	DDO0018C	46.52	47.00	0.48	Sandstone
113303	DDO0018C	52.05	52.60	0.55	Carbonaceous Siltstone
113296	DDO0018C	59.50	60.00	0.50	Carbonaceous Siltstone
113304	DDO0018C	65.00	65.50	0.50	Carbonaceous Siltstone
113293	DDO0018C	72.00	72.51	0.51	Siltstone
113297	DDO0018C	73.00	73.50	0.50	Sandstone
113305	DDO0018C	79.50	80.00	0.50	Sandstone
113294	DDO0018C	85.00	85.50	0.50	Sandstone
113306	DDO0018C	90.00	90.50	0.50	Sandstone
113295	DDO0018C	96.00	96.50	0.50	Sandstone
113298	DDO0018C	99.50	100.00	0.50	Sandstone
113299	DDO0018C	108.00	108.50	0.50	Sandstone
113300	DDO0018C	119.52	120.00	0.48	Sandstone
113310	DDO0018C	128.00	128.50	0.50	Sandstone
113287	DDO0018C	136.00	136.50	0.50	Siltstone
113289	DDO0018C	144.00	144.50	0.50	Sandstone

Sample ID	Hole No.	From (m bgl)	To (m bgl)	Length (m)	Lithology
113282	DDO0018C	150.00	150.50	0.50	Sandstone
113286	DDO0018C	160.50	161.00	0.50	Sandstone
113288	DDO0018C	167.69	168.26	0.57	Siltstone
113284	DDO0018C	177.50	178.00	0.50	Siltstone
113285	DDO0018C	180.65	181.19	0.54	Carbonaceous Siltstone
113283	DDO0018C	185.43	186.00	0.57	Sandstone
113266	DDO0019C	1.40	2.40	1.00	Silt
113267	DDO0019C	3.10	4.03	0.93	Silt
113268	DDO0019C	11.01	11.51	0.50	Sand
113269	DDO0019C	18.00	19.00	1.00	Sand
113270	DDO0019C	22.00	22.50	0.50	Sandstone
113271	DDO0019C	25.45	26.00	0.55	Claystone
113272	DDO0019C	27.38	27.92	0.54	Siltstone
113273	DDO0019C	30.39	30.85	0.46	Siltstone
113274	DDO0019C	34.00	34.56	0.56	Carbonaceous Siltstone
113275	DDO0019C	38.00	38.50	0.50	Sandstone
113276	DDO0019C	43.24	43.74	0.50	Sandstone
113265	DDO0019C	53.03	53.53	0.50	Siltstone
113264	DDO0019C	59.00	59.50	0.50	Siltstone
113263	DDO0019C	66.00	66.50	0.50	Sandstone
113261	DDO0019C	69.01	69.71	0.70	Siltstone
113262	DDO0019C	78.44	79.00	0.56	Sandstone
113260	DDO0019C	84.19	84.69	0.50	Siltstone
113259	DDO0019C	87.00	87.50	0.50	Siltstone
113257	DDO0019C	88.50	89.00	0.50	Carbonaceous Mudstone
113173	DDE0958C	144.10	144.80	0.70	Coal

Table A-2: Foxleigh Roof and Floor Samples for Geochemical Assessment

Sample ID	ALS Sample No	Labsys Job No	Labsys Sample No	Hole No.	Seam Name	Rock Type
401001	1	21017720	RH858839	LDF1043C	ROP1-Roof	Sandstone
401003	3	21017720	RH858841	LDF1043C	ROP1-Floor	Claystone
401004	4	21017720	RH858842	LDF1043C	MMT1-Roof	Carb Mudstone
401013	13	21017720	RH858891	LDF1043C	MMT1-Floor	Carb Mudstone
401015	15	21017720	RH858893	LDF1043C	MMTL-Floor	Claystone
401016	16	21017720	RH858894	LDF1043C	TRA2-Roof	Carb Sandstone
401022	22	21017720	RH858900	LDF1043C	TRA2-Floor	Siltstone
401023	23	21017720	RH858901	LDF1043C	PI1B-Roof	Carb Mudstone
401028	28	21017720	RH858906	LDF1043C	PI1B-Floor	Carb Mudstone
401046	1	21017770	RH866323	LDE0901C	ROP1-Roof	Carb Mudstone
401048	3	21017770	RH866325	LDE0901C	ROP1-Floor	Carb Mudstone
401049	4	21017770	RH866326	LDE0901C	MMTU-Roof	Carb Mudstone
400956	11	21017770	RH866365	LDE0901C	MMT1-Floor	Carb Mudstone
400957	12	21017770	RH866366	LDE0901C	TRA2-Roof	Carb Mudstone
400959	14	21017770	RH866368	LDE0901C	TRA2-Floor	Sandstone
383149	1	21017801	RH875168	LDE0910C	ROP1_RF	Sandstone 100%
383151	3	21017801	RH875170	LDE0910C	ROP1_FLR	Siltstone 45%, Carbonaceous Siltstone 55%
383153	5	21017801	RH875172	LDE0910C	ROP1R_FLR	COAL 7%, Siltstone 35%, Carbonaceous Siltstone 58%
383154	6	21017801	RH875173	LDE0910C	MMT1_RF	Siltstone 64%, Carbonaceous Siltstone 36%
383162	14	21017801	RH875181	LDE0910C	TRA2_RF	Siltstone 100%
383165	17	21017801	RH875184	LDE0910C	TRA2_FLR	Sandstone 36%, Siltstone 37%, Carbonaceous Mudstone 27%
383166	18	21017801	RH875185	LDE0910C	PI1B_RF	Sandstone 10%, Siltstone 90%
383173	25	21017801	RH875192	LDE0910C	PI1B_FLR	Sandstone 26%, Carbonaceous Siltstone 74%
383130	1	21017802	RH875193	LDE0912C	ROP1_RF	Sandstone 100%
383132	3	21017802	RH875195	LDE0912C	ROP1_FLR	Carbonaceous Siltstone 100%
383133	4	21017802	RH875196	LDE0912C	MMT1_RF	Siltstone 50%, Carbonaceous Siltstone 50%
383138	9	21017802	RH875201	LDE0912C	MMT1_FLR	Siltstone 50%, Carbonaceous Siltstone 50%
383139	10	21017802	RH875202	LDE0912C	TRA2_RF	Siltstone 47%, Carbonaceous Siltstone 53%
383142	13	21017802	RH875205	LDE0912C	TRA2_FLR	Siltstone 36%, Carbonaceous Mudstone 28%, Carbonaceous Siltstone 36%
383143	14	21017802	RH875206	LDE0912C	PI1B_RF	Sandstone 12%, Siltstone 88%
383148	19	21017802	RH875211	LDE0912C	PI1B_FLR	COAL 12%, Siltstone 43%, Carbonaceous Siltstone 45%
378138	1	21018005	RH907899	LDF1062C	TRA2_RF	Sandstone 81%, Carbonaceous Sandstone 19%
378149	12	21018005	RH907910	LDF1062C	TRA2_FLR	Carbonaceous Mudstone 100%
978150	13	21018005	RH907911	LDF1062C		Dolerite 100%

Sample ID	ALS Sample No	Labsys Job No	Labsys Sample No	Hole No.	Seam Name	Rock Type
383301	14	21018005	RH907912	LDF1062C	PI1B_RF	Claystone 45%, Carbonaceous Mudstone 55%
383304	17	21018005	RH907915	LDF1062C	PI1B_FLR	Carbonaceous Mudstone 76%, Carbonaceous Siltstone 24%
383305	18	21018005	RH907916	LDF1062C	PI2A_RF	Carbonaceous Siltstone 100%
383307	20	21018005	RH907918	LDF1062C	YT	Tuff 88%, Carbonaceous Mudstone 4%, Carbonaceous Siltstone 8%
383309	22	21018005	RH907990	LDF1062C	PI2B_FLR	Siltstone 73%, Carbonaceous Siltstone 20%, Coaly Mudstone 7%
383509	6	21018119	RH922483	LDF1094C	TRA2_FLR	Carbonaceous Sandstone 100%
383510	7	21018119	RH922484	LDF1094C	PI1B_RF	Siltstone 90%, Carbonaceous Sandstone 10%
383513	11	21018119	RH922487	LDF1094C	PI1B_FLR	Siltstone 53%, Carbonaceous Sandstone 47%
383514	12	21018119	RH922488	LDF1094C	PI2A_RF	Siltstone 67%, Carbonaceous Siltstone 33%
383516	14	21018119	RH922490	LDF1094C	YT	Clay 6%, Tuff 70%, Carbonaceous Siltstone 24%
383518	16	21018119	RH922492	LDF1094C	PI2B_FLR	Siltstone 43%, Carbonaceous Siltstone 57%
383551	1	21018357	RH987462	LDF0995C	ROP1_RF	Siltstone 100%
383554	4	21018357	RH987465	LDF0995C	ROP1_FLR	Siltstone 22%, Carbonaceous Mudstone 26%, Carbonaceous Siltstone 52%
383555	5	21018357	RH987466	LDF0995C	MMT1_RF	Siltstone 100%
383565	15	21018357	RH987476	LDF0995C	MMT1_FLR	Siltstone 100%
383566	16	21018357	RH987477	LDF0995C	TRA2_RF	Carbonaceous Siltstone 100%
383572	22	21018357	RH987483	LDF0995C	TRA2_FLR	Carbonaceous Siltstone 100%
383574	1	21018420	RA003102	LDF1148C	ROP1_RF	Sandstone 100%
383577	4	21018420	RA003105	LDF1148C	ROP1_FLR	Siltstone 52%, Carbonaceous Mudstone 48%
383591	18	21018420	RA003119	LDF1148C	MMT1_FLR	Claystone 23%, Siltstone 21%, Carbonaceous Mudstone 12%, Carbonaceous Siltstone 25%, Coaly Mudstone 19%
383592	19	21018420	RA003120	LDF1148C	MMT1_FLR	Siltstone 100%
383593	20	21018420	RA003121	LDF1148C	TRA2_RF	Carbonaceous Siltstone 100%
383594	21	21018420	RA003122	LDF1148C	TRA2_RF	Coaly Mudstone 100%
383434	25	21018420	RA003126	LDF1148C	PI1B_FLR	Siltstone 8%, Carbonaceous Siltstone 92%
113010	1	21019025	RA106932	LDF1174C	ROP1_RF	Siltstone 80%, Carbonaceous Siltstone 20%
113012	3	21019025	RA106934	LDF1174C	ROP1_FLR	Carbonaceous Siltstone 100%
113013	4	21019025	RA106935	LDF1174C	MMTU_RF	Sandstone 100%
113016	7	21019025	RA106938	LDF1174C	MMT1_RF	Siltstone 70%, Carbonaceous Mudstone 11%, Carbonaceous Siltstone 19%
113019	10	21019025	RA106941	LDF1174C	MMT1_FLR	Carbonaceous Siltstone 100%
113020	11	21019025	RA106942	LDF1174C	TRA_RF	Carbonaceous Mudstone 67%, Carbonaceous Siltstone 33%
113022	13	21019025	RA106944	LDF1174C	IN_RF	Siltstone 100%
113029	20	21019025	RA106951	LDF1174C	TR2I_FLR	Carbonaceous Siltstone 100%
113030	21	21019025	RA106952	LDF1174C	PI1B_RF	Sandstone 66%, Siltstone 34%
113033	24	21019025	RA106955	LDF1174C	PI1B_FLR	Siltstone 83%, Carbonaceous Mudstone 17%

Table A-3: Foxleigh Tailings and Coarse Reject Samples for Geochemical Assessment

Sample ID	Sample Date	Sample Source
Foxleigh Tailings 1	23/02/2021	CHPP
Foxleigh Tailings 2	23/02/2021	CHPP
Foxleigh Tailings 3	23/02/2021	CHPP
Foxleigh Tailings 4	23/02/2021	CHPP
Foxleigh Tailings 5	23/02/2021	CHPP
Foxleigh Tailings 6	23/02/2021	TSF
Foxleigh Tailings 7	23/02/2021	TSF
Foxleigh Tailings 8	23/02/2021	TSF
Foxleigh Tailings 9	23/02/2021	TSF
Foxleigh Tailings 10	23/02/2021	TSF
Foxleigh Rejects 1	23/02/2021	CHPP Stockpile
Foxleigh Rejects 2	23/02/2021	CHPP Stockpile
Foxleigh Rejects 3	23/02/2021	CHPP Stockpile
Foxleigh Rejects 4	23/02/2021	CHPP Stockpile
Foxleigh Rejects 5	23/02/2021	CHPP Stockpile
Foxleigh Rejects 6	23/02/2021	CHPP Stockpile
Foxleigh Rejects 7	23/02/2021	CHPP Stockpile
Foxleigh Rejects 8	23/02/2021	CHPP Stockpile
Foxleigh Rejects 9	23/02/2021	CHPP Stockpile
Foxleigh Rejects 10	23/02/2021	CHPP Stockpile

Soils Sampling and Analysis Plan (SSaAP)

Foxleigh Coal Mine

Prepared for: **Foxleigh Management Pty Ltd**

RGS

MINE WASTE AND WATER MANAGEMENT

Soils Sampling and Analysis Plan (SSaAP)

Foxleigh Coal Mine

Prepared for: Foxleigh Management Pty Ltd

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Glossary of Terms and Acronyms

ALS	Australian Laboratory Services Pty Ltd
AMD	Acid, saline, and metalliferous drainage
EA	Environmental Authority
EC	Electrical Conductivity, expressed as µS/cm, is a measure of electrical conductance.
ERC	Estimated Rehabilitation Cost
CEC	Cation exchange capacity provides a measure of the amount of exchangeable cations (Ca, Mg, Na and K) in a sample.
CHPP	Coal handling and preparation plant
CoC	Chain of custody
GIS	Geographic Information Systems
LCM	Loose cubic meters
ML	Mining Lease
NAF	Non-acid forming
pH	Measure of the hydrogen ion (H+) activity in a sample solution, expressed in pH units.
PLN	Pipeline North
PoO	Plan of Operations
PSD	Particle size distribution of a sample material measured by hydrometer.
RGS	RGS Environmental Pty Ltd
ROM	Run of Mine
QA	Quality Assurance
QC	Quality Control
SSaAP	Soil Sampling and Analysis Plan
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.
TP	Test pit
TS	Topsoil stockpile
TSF	Tailings Storage Facility

1 Introduction

RGS Environmental Pty Ltd (RGS) was commissioned by Foxleigh Management Pty Ltd (Foxleigh) to develop a Soil Sampling and Analysis Plan (SSaAP) to meet the conditions of the Environmental Authority (EA) EPML 00744813 for Foxleigh Coal Mine (the Project). The aim of the SSaAP is to characterise soil materials based on their nutrient and physical properties.

This SSaAP 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). This SSaAP is focused on filling nutrient and physical data gaps needed to inform the Rehabilitation Management Plan for the Project, which is required to be completed as part of the EA.

RGS has endeavoured to utilise existing topsoil survey data as background information to inform the current test pitting program, which is detailed in this SSaAP. RGS has relied upon information provided by Nitro Solution Pty Ltd and Foxleigh, relevant soil guidelines and previous knowledge of the Project to produce this document.

1.1 Background

1.1.1 Location and ownership

The Project is located on mining leases ML70171, ML70309, ML70470, ML70310, ML70429, ML70430 and ML70431 in Queensland's eastern Bowen Basin, covering an area of 8,499 ha, approximately 12 km south of Middlemount, 250 km southwest of Mackay and 280 km northwest of Rockhampton **(Figure 1-1)**.

The Project is a jointly owned open cut coal mine producing low volatile PCI coal for export. Foxleigh Mine (Foxleigh) is operated by Foxleigh Management Pty Ltd, on behalf of a joint venture between CAML Resources, Foxleigh Coal Pty Ltd and Nippon Steel.

1.1.2 Open cut mining activities

The mining operation accesses the Rangal Coal Measures using an open cut method to approximately 150 m depth, depending on current economics and market demand. Coal is excavated using truck and shovel methods and processed at an on-site coal handling and preparation plant (CHPP) before being trucked to a dedicated rail loadout facility for transport to Dalrymple Bay Coal Terminal.

Foxleigh's coal presents in the shape of a bowl in most places and is mined utilising a terrace approach to mining. Initial waste is placed in out-of-pit dumps or when in-pit dumps have insufficient room. The in-pit dumps are filled progressively as the terrace face progresses.

Within the mining lease there are 12 open pits which have an open pit void surface area as detailed below:

- Foxleigh Plains Pit (260.8 ha)
- Foxleigh Plains North Pit (50.1 ha)
- Pipeline Pit (55.8 ha)
- Carlo Creek Pit (23.2 ha)
- One Tree Pit (124.5 ha)
- Far South Pit (56.2 ha)
- WC Pit (14.7 ha)
- North WC Pit (25.5 ha)
- Old NE Pit (36.2 ha)
- NW Pit (17.9 ha)
- NE Pit (16.9 ha)
- Void 251 (9.1 ha)

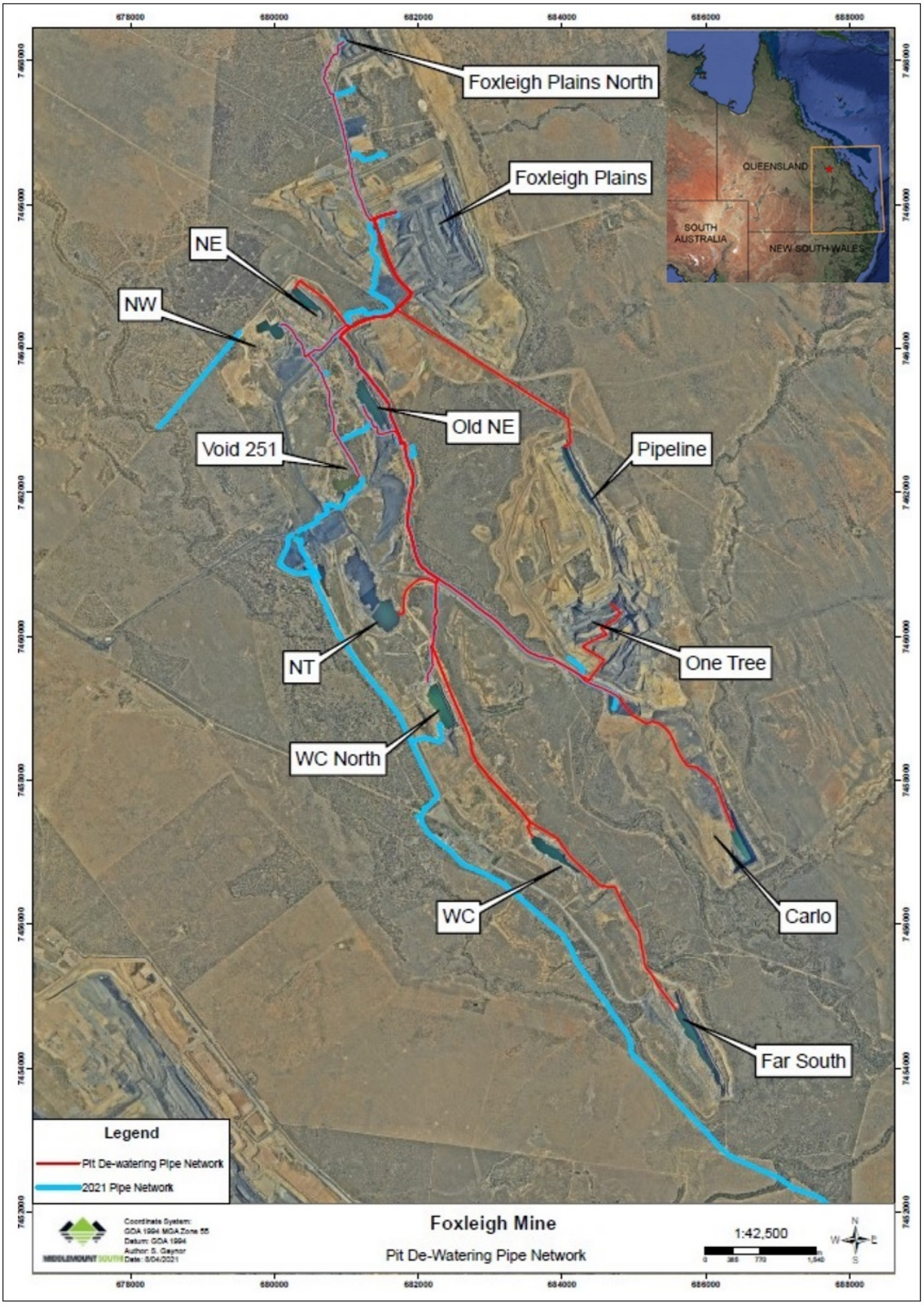

Figure 1-1: Foxleigh Project location and pits

1.1.3 Progressive rehabilitation

Overburden dumps are progressively rehabilitated when they reach their final limits and results have been variable over preceding years. Progressive geochemical characterisation of available on-site mining waste, coal, and soil materials will assist these planned rehabilitation activities. The identification of suitable source materials for overburden dump covers and topsoil growth medium will help to rehabilitate disturbed areas and result in a favourable outcome for end of mine closure.

1.2 Scope of work

1.2.1 Rehabilitation objectives

RGS has developed the scope of work based on discussions with Nitro and Foxleigh personnel. The need for a SSaAP is driven by the requirement for further development of a long-term rehabilitation plan for mine closure. The initial phase of work involved the identification and collection of representative samples of mining waste (overburden, interburden, potential coal reject and coal reject), coal, and soil materials. The second phase of work was to characterise the collected samples for their geochemical, physical and nutrient properties and provide an interpretation of the results.

At Foxleigh mine, the design of an appropriate cover system will depend strongly on the quantity and quality of available soil and waste rock rehabilitation materials. A detailed study is required to investigate the type of soils present and their nutrient and physical characteristics, as well as their locations and thickness in the soil profile. This soil data information, coupled with the geochemical investigation of the waste rock material, coal rejects and tailings, are key contributions that will inform the general rehabilitation plan.

1.2.2 Sampling program

The SSaAP details the sampling plan for soil samples and provides:

- A review of existing data against the relevant guidelines and identification of data gaps.
- Instructions for selected sample locations or test pits that represent the range of soil materials that are likely to be encountered during the mining process.
- Recommendations for sampling frequency and quantities (mass and volume) to facilitate testing.
- Advice regarding sample containers, storage, and transport to appropriate laboratories.
- Assistance on site in executing the SSaAP.

1.2.3 Analysis report

After obtaining the mining waste, coal, and soil samples, RGS will complete the testing and interpretation phase, and produce a technical report, which details:

- The design of an analytical testing program to determine the properties of the soil samples and coordination with suitable laboratories to undertake the work.
- Collection and organisation of results and data, and the construction of tables and graphs to assist in the interpretation of the results.
- The preparation of a draft and final technical report, including conclusions and recommendations, for review and comment by Foxleigh and Nitro Solutions.

1.2.4 Future scope

RGS will provide recommendations for managing the soil characteristics and the quantity and type of ameliorants that may be required. This information will be provided after the completion of the characterisation, which will be completed following the collection of relevant samples.

This SSaAP is limited to planning how the soil samples will be obtained and which tests will be performed. The results of laboratory testing and recommendations for improving soil quality and rehabilitation strategies will be included in the combined technical report on mining wastes and soils.

2 Approach

2.1 Guidelines

RGS has developed this SSaAP 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:

- 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.
- ACARP (2008). *Development of ARD Assessment for Coal Process Wastes*. ACARP Project C15034. Report prepared by Environmental Geochemistry International and Levay and Co. Environmental Services, ACeSSS University of South Australia, July.
- Commonwealth of Australia (2016). *Leading Practice Sustainable Development Program for the Mining Industry. Preventing Acid and Metalliferous Drainage*. September, Canberra ACT.
- DME (1995). *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland*. Queensland Department of Mines and Energy.

2.2 Develop Soil Sampling and Analysis Plan

The basic steps required to develop the SSaAP plan include:

1. Determining the objectives of the program.
2. Reviewing available historical data and relevant information from previous studies.
3. Selecting nutrient and physical indicators which are relevant to the objectives of the program.
4. Selecting the appropriate sampling equipment.
5. Mapping out the location and site to determine the number and type of samples needed.
6. Obtaining a representative sample or samples.
7. Accurately recording site observations and measurements.
8. Appropriate labelling, preserving, storing, and transporting of samples for analysis.
9. Reporting results accurately and completely.
10. Providing informed interpretation.

2.2.1 SSaAP plan of tasks

Task 1 – Soil data review and gap analysis

RGS will complete a review of existing information pertaining to topsoil surveys, dated 2007 – 2020. It has been observed that while previous studies have been comprehensive for selected areas of interest, there are some data gaps, particularly if mining operations are expanded over time. The character and availability of potential rehabilitation materials will be included to assist with an ERC submission.

RGS will develop a stand-alone SSaAP (this document) to better define (and fill) knowledge gaps and to verify baseline information related to soil materials identified by the desktop review.

Task 2 – Produce SSaAP document

This SSaAP is aimed at characterising soil materials on site that have not previously been characterised as part of a separate investigation. It includes details of the sampling methodology, storage and sample transport. A member of RGS staff will undertake a site visit to collect test pit samples. The SSaAP also describes the number of samples to be analysed at NATA accredited laboratories (ALS Environmental Pty Ltd (ALS) and Trilab), which will include a selection of nutrient and physical testing suites. These sample numbers and analyses may be subject to change depending on the outcomes of the site visit and sampling.

Task 3 – Soil materials characterisation report (future Stage 2)

The results and interpretation of the soil materials nutrient and physical testing will be contained in a separate technical report, which will be completed after the analytical testing has been completed.

2.2.2 Desktop review

2.2.2.1 *Topsoil Register (2007 – 2020)*

Foxleigh has provided RGS with numerous images and GIS files which indicated the locations of topsoil stockpiles around the site. These have increased in number as new mining areas have been accessed. There is also detailed information showing the depth to which topsoil has been stripped in the northern area of the mine. Volumes of topsoil, and the location coordinates of each stockpile were included with this data set, which will be useful for future material balance calculations. The most recent topsoil stockpile location maps and the priority order for their characterisation are included in **Attachment A - Section 7.1.**

2.2.2.2 *Foxleigh Topsoil Survey (2013) - Cardno*

The 2013 Cardno soil survey included a preliminary desktop review, soil mapping at a scale of 1:25,000 over the study area and laboratory testing program. The soil mapping consisted of an assessment of 526 descriptive sites, of which 394 sites were evaluated as minor field observations, 132 sites were logged in detail and sampled at a **maximum depth of 1.5 m** below ground using a skid steer loader and 100 mm **auger drill**.

- The undated Map of Soil Mapping Activities **(Attachment B – Section 7.2**) showing the location of 96 soil sampling sites is assumed to be connected to this report. It may be a preliminary plan.

The samples were sent to Cardno laboratory in Mackay for storage. 54 of the 132 sampled sites were chosen for subsequent laboratory testing at SGS Laboratories in Cairns. The samples were analysed for the following parameters:

- Bicarbonate Extractable (Colwell) Potassium, K
- Calcium Chloride Extractable Boron
- Chloride (water extractable)
- Colwell Phosphorus
- Conductivity and TDS by Calculation - Soil
- DTPA Extractable Metals in Soil
- Emerson Class Number
- Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR)
- Moisture Content
- Nitrate Nitrogen and Nitrite Nitrogen (NOx) by Auto Analyser in Soil

- Particle sizing of soils <75µm by hydrometer
- Particle sizing of soils by sieving
- pH in soil (1:5)
- Potassium Chloride Extractable Sulphur
- Total Kjeldahl Nitrogen and Total Nitrogen in Soil/Sludges
- Total Organic Carbon by Heanes Oxidation
- Total Phosphorus by Kjeldahl Digestion DA in Soil

The objectives of the soil survey were to classify and determine the soil profile types within the study area and to assess the suitability of the current topsoil for future rehabilitation including the identification of unfavourable materials within the study area.

The results of the soil survey identified **thirteen (13) soil units** identified in the Foxleigh Plains project area, most of which are brown sodosols with some gilgaied microrelief **(Table 2-1** and **Attachment B – Section 7.2**). With the exception of the Thirteen-mile soil unit, all remaining soils units within the project area are found to be suitable for stripping and subsequent rehabilitation. The most suitable layers for topsoil stripping are in the top A1 and B21 horizon intervals, approximately 0.3-0.5 metres below ground level. **Beyond this average depth range (in tertiary materials), the soils tend to be increasingly sodic with elevated chloride levels**, rendering them unsuitable for topsoil rehabilitation programs.

Table 2-1: Foxleigh Plains Project soil units

Soil Unit	Soil Classification (ASC)	Representative Sites	Area (Ha) MLA	Area (Ha) ML4
Turon	Brown Vertosol (Gilgaied Brigalow clay)	64, 66, 71, 73, 76 and 78	129	0
Langley	Brown Vertosol (Non-gilgaied Brigalowclay)	17 and 18	126.2	0.8
Thirteenmile	Grey / Brown Sodosol	37, 40 and 68	45.8	6.2
Tralee	Brown Vertosol (Non-gilgaied Brigalowclay)	3, 8, 13, 15, 16, 28, 30, 54, 62, 69, 79, 90, 97 and 104	427.98	0.02
Roper	Brown Chromosol	1, 2, 6, 7, 10, 23, 29 and 31	199	0
Emoh	Brown Sodosol	110 and 116	56	70
Stateschool	Brown Sodosol	44 and 45	20.3	3.7
Bluchers	Grey Vertosol	20	19.6	56.4
Parrot	Brown Chromosol	14, 26, 43 and 53	49	0
Racetrack	Brown Sodosol	55, 58, 63, 65, 70, 72, 83, 85, 88, 91, 93, 96, 99, 100, 106, 107, 111, 115, 123, 128, 129, 131 and 132	445	0
Honeycomb	Brown Sodosol	4, 5, 9, 11, 12, 49, 75, 81, 92, 105, and 113	378.1	60.9
Foxleigh	Brown Sodosol	Soil sites 19, 21, 22, 25, 32, 33, 35, 36, 39, 41, 47, 50, 52, 59, 61, 67, 74, 77, 84, 86, 89, 94, 95, 98, 101, 102, 103, 108, 109, 111, 114, 117, 118, 119, 120, 122, 124, 125 and 126	942.6	227.4
Foxleigh Clay Loam Phase	Brown Sodosol	24, 27, 34, 38, 42, 46, 48, 51, 56, 57, 60, 80, 82, 87, 96, 99, 112, 121 and 127	523.5	9.5

2.2.2.3 *Foxleigh Topsoil Survey, Pipeline North (July 2015) – Anglo American*

A topsoil field survey was completed within the Pipeline North (PLN) area at Foxleigh on July 23, 2015 for the purpose of determining the depth of topsoil and suitable subsoil that could be stripped and stockpiled for use in rehabilitation at a later date. Due to the deficit of stockpiled topsoil at Foxleigh, opportunities for topsoil stripping at depths greater than 300mm were explored.

Five sampling sites were selected PLN area, encompassing the proposed west dump and pit, as well as the area east of the pit but within the total PLN extent (**Attachment B – Section 7.2**).

At each site, a soil **test pit** was excavated to a depth of approximately **1 – 1.5 m** using a backhoe. The depth of the topsoil and subsoil profiles were measured, soil samples were collected from each and analysed in field to determine salinity levels. Soil samples were also taken from the subsoil profile and sent to SGS Laboratories for further analysis. Results are summarised in **Table 2-2** below.

Table 2-2: Foxleigh Topsoil Survey 2015 findings

Site	Type	Topsoil	EC (mS/cm)	Subsoil	EC (mS/cm)	pH	CEC cmol (+)/kg
PLN1	Brown vertosol	0-300 mm	1,219	300-600 mm	2,100	8.4	47
PLN2	Brown vertosol	0-300 mm	1,589	300-600 mm	2,500	8.2	41
PLN3	Yellow sodosol	0-500 mm	Not tested	500 mm+	Not tested	NA	NA
PLN4	Grey vertosol	0-300 mm	1,525	300-600 mm	2,100	7.2	42
PLN5	Yellow vertosol	0-300 mm	155	300-600 mm	590	8.6	18

2.2.2.4 *Foxleigh Topsoil resurvey, Pipeline North (Jan 2016) – Anglo American*

Block 5 was resurveyed in January 2016 after initial topsoil stripping activities indicated topsoil could be stripped at greater depths. Six sampling sites were selected in Block 5, Pipeline North (**Attachment B – Section 7.2**).

At each site, a soil **test pit** was excavated to depths ranging between **1.4 m and 2.4 m** using a backhoe. The depth of the topsoil and subsoil profiles were measured, soil samples were collected from each and analysed in field to determine salinity and pH levels. Soil samples were also taken from the subsoil profile at Sites 5 and 6 and sent to SGS Laboratories for further analysis. Results are summarised in **Table 2-3** below.

Table 2-3: Foxleigh Topsoil Resurvey 2016 findings

	Type	Pit Depth	Topsoil	Subsoil	EC (mS/cm)	pH	CEC cmol (+)/kg
Site 1	Grey vertosol	1.4 m	1.2 m	0.2 m	1,261	7.4	-
Site 2	Yellow vertosol	1.8 m	1.5 m	0.3 m	1,690	8.2	-
Site 3	Grey vertosol	2.0 m	1.3 m	0.7 m	2,030	7.8	-
Site 4	Yellow vertosol	2.0 m	0.5 m	1.5 m	1,767	7.2	-
Site 5	Grey vertosol	2.4 m	1.5 m	0.9 m	1,998	7.3	44
Site 6	Grey vertosol	Unknown	-	-	4,600	6.2	38

2.2.2.5 *Australian Soil Classification map (CSIRO, 2001)*

The Atlas of Australian Soils **Figure 2-1** shows the distribution of soil classifications across Australia.

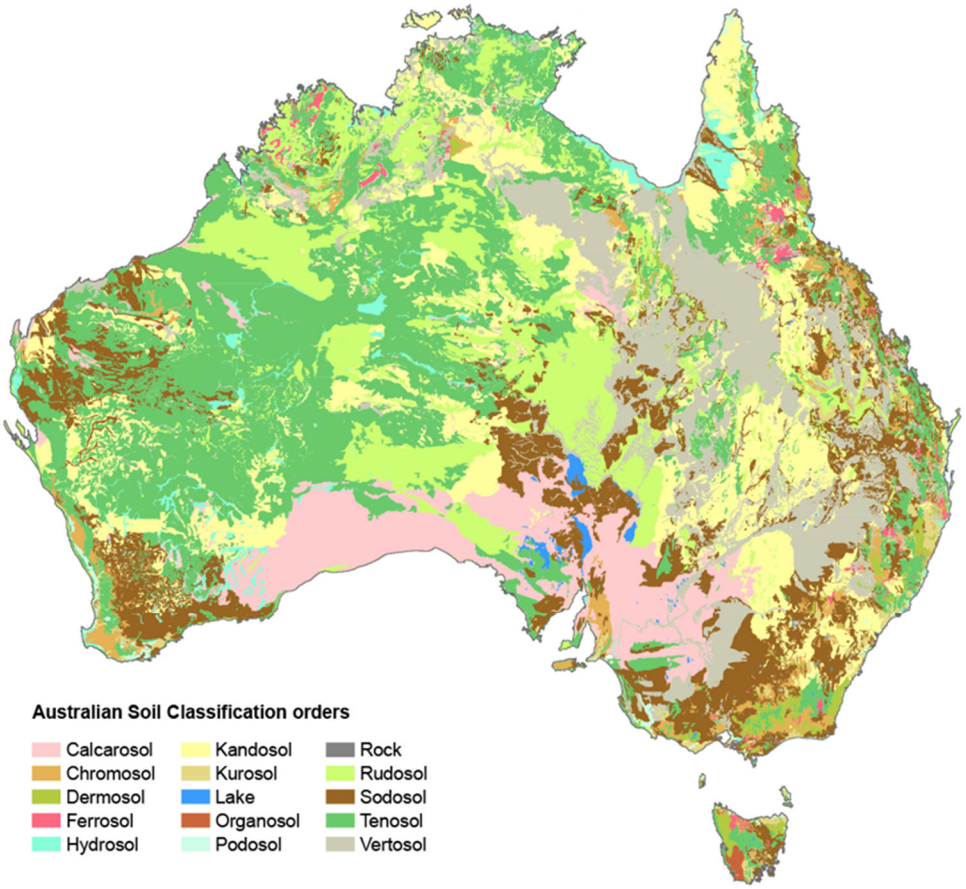

Figure 2-1: Atlas of Australian Soils (Northcote, 1979)

The Atlas of Australian Soils (Northcote et al, 1960-68) was compiled by CSIRO in the 1960's to provide a consistent national description of Australia's soils. Mapped units in the Atlas are soil landscapes, usually comprising a number of soil types. The explanatory notes include descriptions of soils landscapes and component soils. Soil classification for the Atlas is based on the Factual Key. The Factual Key (Northcote 1979) was the most widely used soil classification scheme prior to the Australian Soil Classification (Isbell 2002). In 2001, The Atlas of Australian Soils was converted to the Australian Soil Classification and is now available as a GIS file.

RGS used the Australian Soil Classification GIS map to predict, at a regional level, the soil types most likely to be encountered in the unexplored areas of the Foxleigh mine lease.

2.2.3 RGS interpretation of available data

After performing a desktop review, RGS has reached the following conclusions:

- Foxleigh has a large number of topsoil stockpiles (47), which are from stripping depths of up to 1.5 m and are expected to be variable in character.
- The Cardno (2013) soil survey is a comprehensive drilling program (132 soil sampling locations and 54 samples analytically tested) but only includes samples from the northern part of the mine.
- Extensive sampling of the southern mine area will be necessary to gain a better understanding of the range of soil materials available and their properties. This has been identified as a knowledge gap.
- The classification of 13 soil different units is too detailed for practical use. RGS proposes that these soil units be simplified to: (1) vertosols; (2) sodosols; and (3) chromosols.
- Test pitting programs in 2015-2016 has revealed moderately thick soil profiles up to 2.4 m in depth. As a backhoe can only dig 2-3 m, the depth of the test pits may have been limited by equipment.

- Test pitting was skewed towards vertosols, which had moderate to high EC (590 – 4600 μS/cm), moderate to very high CEC (18 – 47 cmol (+)/kg) and were neutral to alkaline (pH 6.2 – 8.6).
- The clay-rich vertosols were targeted due to their thick soil profiles. It was hoped this would maximise the potential soil volume that could be used for rehabilitation.
- One test pit was performed on a sodosol in 2015, but geochemical analyses were not performed on the topsoil and subsoil samples of the sodosol.
- Cardno (2013) and Anglo American (2015) both recommended that stripping beyond 0.5 m would be unfavourable due to the sodic and dispersive nature of the sodosols.
- In the experience of RGS, sodic and dispersive sodosols can be used as beneficial rehabilitation materials, provided they are adequately ameliorated and placed appropriately.
- Test pitting has not yet been performed in areas where chromosols are present.
- The lack of variance of soil types in the test pitting programs presents a second knowledge gap. RGS will ensure that a range of all soil types are included in the new test pit program.
- By extending viable soils to include vertosols, sodosols, and chromosols, the Project will be in a more favourable position to provide enough rehabilitation soil to meet its material balance needs.
- Based on the Australian Soil Classification (**Figure 2-2**) it is expected that the southern mine area will be dominated by vertsosols and sosodols, with a lower occurrence of chromosols.
- Proposed test pit locations have been marked in **Figure 2-2**, based on existing soil survey data and to fill the knowledge gaps in the southern mine area.
- Soil samples will also be collected from the northern area to confirm previous findings.

2.2.4 Summary of SSaAP knowledge gaps

The following knowledge gaps from the desktop review will be addressed in the SSaAP:

- There is a paucity of soil sampling data from the southern mine area, which will form part of the current and future mine operations.
- Test pitting on sodosol and chromosol soils has been overlooked, and therefore their suitability as rehabilitation materials has not yet been adequately addressed.

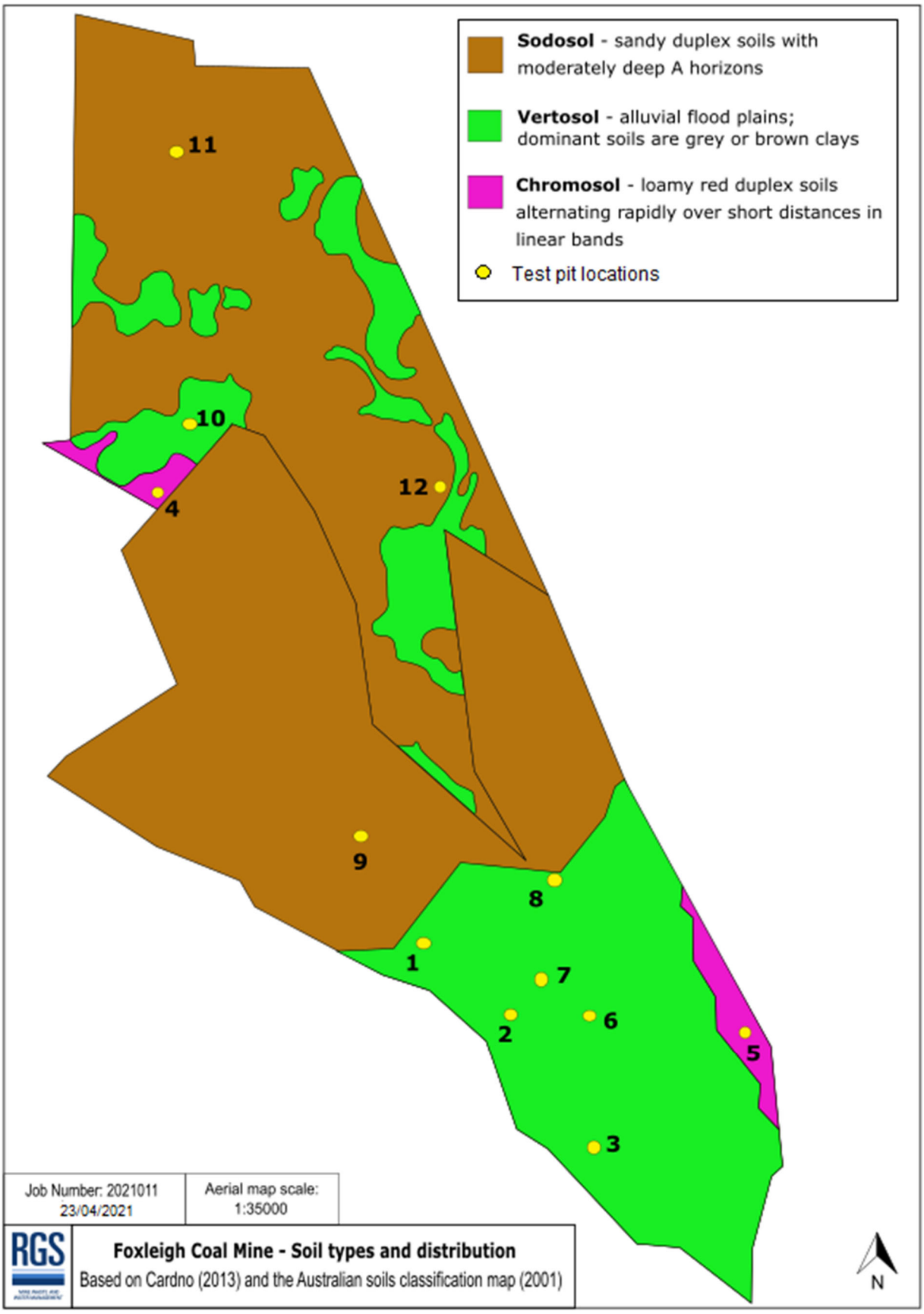

Figure 2-2: Foxleigh soil types and distribution (based on Cardno, 2013 and CSIRO, 2001)

2.3 Proposed test pit locations

Twelve (12) proposed test pit (TP) locations have been marked in **Figure 2-5**, which have been chosen to fill knowledge gaps outlined in **Section 2.2.4**.

These test pits will consist of:

- 8 test pits (TP 1-8) in the southern mine area, not previously investigated; and,
- 4 test pits (TP 9-12) in the northern area, to confirm existing soil survey data.

2.3.1 Test pit excavation method

The test pits will be excavated by an excavator or backhoe provided by Foxleigh, under the supervision of RGS staff member (Melinda Hilton). The procedure for excavating a test pit is as follows:

1. Ensure access is available (e.g. via track or road) to the proposed test pit location. Generally, it is better to move the test pit location to be convenient, rather than to clear excess vegetation to access the exact spot that has been pinpointed.
2. Preferably, the test pit should be dug on a flat surface, facing away from the sun. This is to ensure that photographs of the test pit walls are not obscured by shadows.
3. Carefully remove any obstructing vegetation. Test pit dimensions will be about 1 m wide x 2 m long x 1-3 m deep. The excavator will also need room to swing the arm and to turn around (**Figure 2-3**).

Figure 2-3: Illustration of a test pit excavation

4. Excavate the test pit, placing the regolith materials into a bulk pile on the right side (**Figure 2-4**). Stop excavating at a depth of approximately 1.5 m (or until a hard base is reached). Place the arm on the ground to signal the sampler that it is safe to approach.
5. At depths of up to 1.5 m, the sampler will climb into the pit and remove soil samples from the fresh wall face (the sides) of the test pit using a chisel or scoop. The sample will be collected in a bucket.
6. Up to 5 samples may be collected, which will take approximately 15-30 minutes. The sampler will then climb out of the test pit.
7. The excavator operator and the sampler must then communicate whether to continue digging the test pit deeper (i.e. there is more soil in the profile), or to stop (a hard base has been reached).
8. If the test pitting is to continue to a deeper depth, the sampler will retreat to a safe distance for excavation to recommence. Continue to excavate to 2-3 m (depending on the size and reach of the exacavator), or until a hard base is reached.
9. The material from the deeper excavation should be placed in bulk piles on the left side of the pit (**Figure 2-4**). Where possible, try to separate the piles into different soil materials (e.g. on the basis of colour or texture).

10. For the deeper depths, the sampler will not climb into the pit, but will sample from the bulk piles.
11. After all of the samples have been collected, the sampler should move away and signal the operator to infill the test pit. Care should be taken to ensure that the soil placed back in the test pit is:
    - As flat as possible (i.e. not a concave depression or mound); and,
    - Moderately compacted by stamping the bucket over the disturbed area.

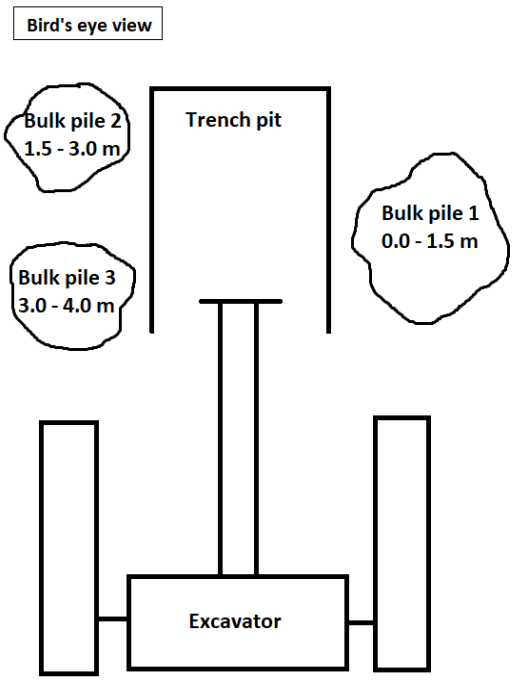

Figure 2-4: Diagram showing placement of excavated material from a test pit

2.4 Topsoil stockpiles

Due to the large number of topsoil stockpiles, it would be wise to individually characterise them before they are used as rehabilitation materials. Nutrient and physical testing of the soils will ensure that a suitable type and quantity of ameliorant is used when required. RGS recommends:

- At least one sample from each topsoil stockpile (depending on stockpile volume); and,
- The sample is obtained from a depth of approximately 1.5 m.

Sampling from depth ensures that the soil is 'fresh', as opposed to sampling shallow weathered soil, which may produce misleading results. Excavation to this depth is usually performed by an excavator or backhoe. However, if suitable equipment is not available, the sampler may instead use a shovel to dig at least 0.5 m beneath the surface.

RGS will not have time to sample all 54 topsoil stockpiles during the site visit (**Attachment B – Section 7.2**). Instead, RGS will sample from approximately 2-5 stockpiles and demonstrate the procedure to Foxleigh staff. The rest of the stockpile samples can then be collected by mine personal and sent directly to ALS for analysis using a Chain of Custody (CoC) template provided by RGS.

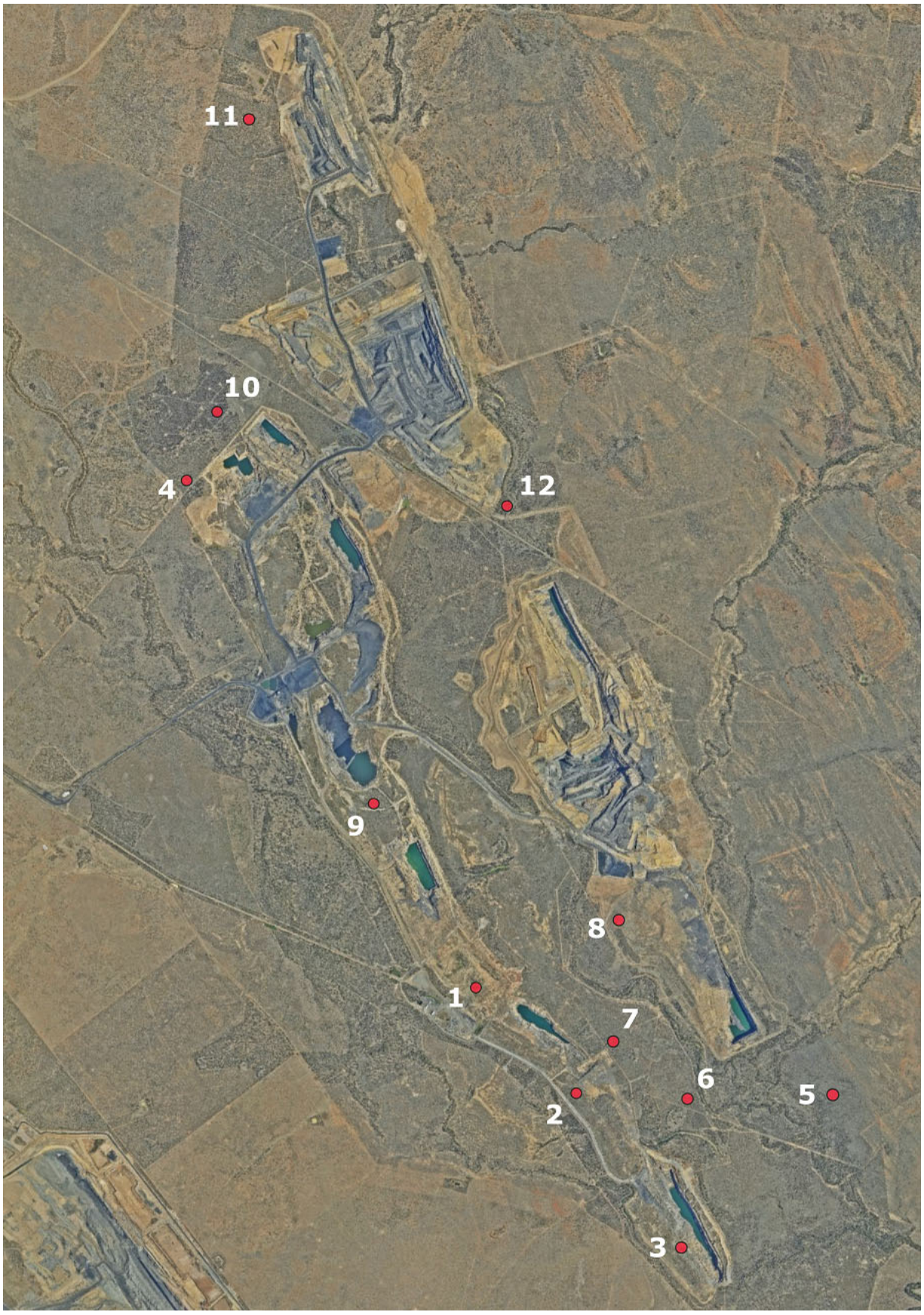

Figure 2-5: Proposed test pit locations

2.5 Examples of good and poor rehabilitation

Nitro and Foxleigh have advised RGS that there are some areas of rehabilitated land within the mine lease that have not performed as well as expected. As it is not possible to define these areas from aerial photographs, RGS will engage with mine personnel to locate these areas to ascertain the problems with the nutrient and physical characteristics of the soil and compare them with other sites that have been more successful. As part of the Stage 2 scope, RGS will provide recommendations for ameliorants, re-structure, or re-shaping of the soil for these areas.

RGS will not have time to sample every example of good and poor rehabilitation during the site visit. Instead, RGS will sample from approximately 4 - 8 locations, which will follow the same generic procedure as the topsoil stockpile sampling described in **Section 2.4**. The procedure will be demonstrated to Foxleigh staff, so that any further sampling can be performed by mine personal and sent directly to ALS for analysis using the CoC template provided by RGS.

2.6 Sampling frequency

2.6.1 Test pit sampling

RGS believes that a suitable approach for rehabilitation soil sampling frequency is to adopt overburden sampling requirements suggested by several guidance documents which are endorsed by the mining industry worldwide. According to the guidance documents, the actual number of samples are project specific. A sufficient number of samples should be taken to represent the nature, distribution and variability of critical parameters in each soil type.

To ensure adequate sampling of each in-situ soil profile, RGS will collect approximately 10 – 15 kg of bulk soil materials from each soil horizon. This material will initially be tested for particle size distribution and a portion will be retained and crushed for physical characterisation. Additionally, a 1 – 2 kg sample of -2 mm sieved soil material will be collected at each test pit for soil nutrient testing. It is recommended that these analyses are subjected to sieved samples, as crushing changes the physical properties of the soil.

The number of samples collected from each test pit will depend on:

- The number of soil horizons present in the in-situ soil profile;
- The extent to which the saprolite has been weathered (if it is soft enough to be excavated); and,
- The size of the excavator or backhoe and depth to which it is able to reach.

Table 2-4 summaries the expected number of samples that will be generated from the test pit sampling. Based on the desktop review, it is likely that 3-4 soil horizons will be encountered in each test pit. Additional samples will be collected if there is any geological variability or complexity within each horizon. The minimum number of samples that will be collected from the test pits is 24 and the maximum number is 60. The expected number of samples is approximately 45.

Table 2-4: Expected soil sample quantities from RGS field investigation

	Quantity of test pits	Number of horizons	Total samples generated
Test pit sampling	12	2	24
	12	3	36
	12	4	48
	12	5	60

Examples of soil horizons are summarised in **Figure 2-6**. In technical terms, all material excavated from a test pit is classified as regolith, but there is a scale of weathering that decreases from topsoil (extremely weathered) down to fresh rock (least weathered). The extent of weathering is dependent on the groundwater table level, as interaction between water and rock is required for weathering to occur and for the rock to break down into soil-like materials – a process referred to as pedogenesis.

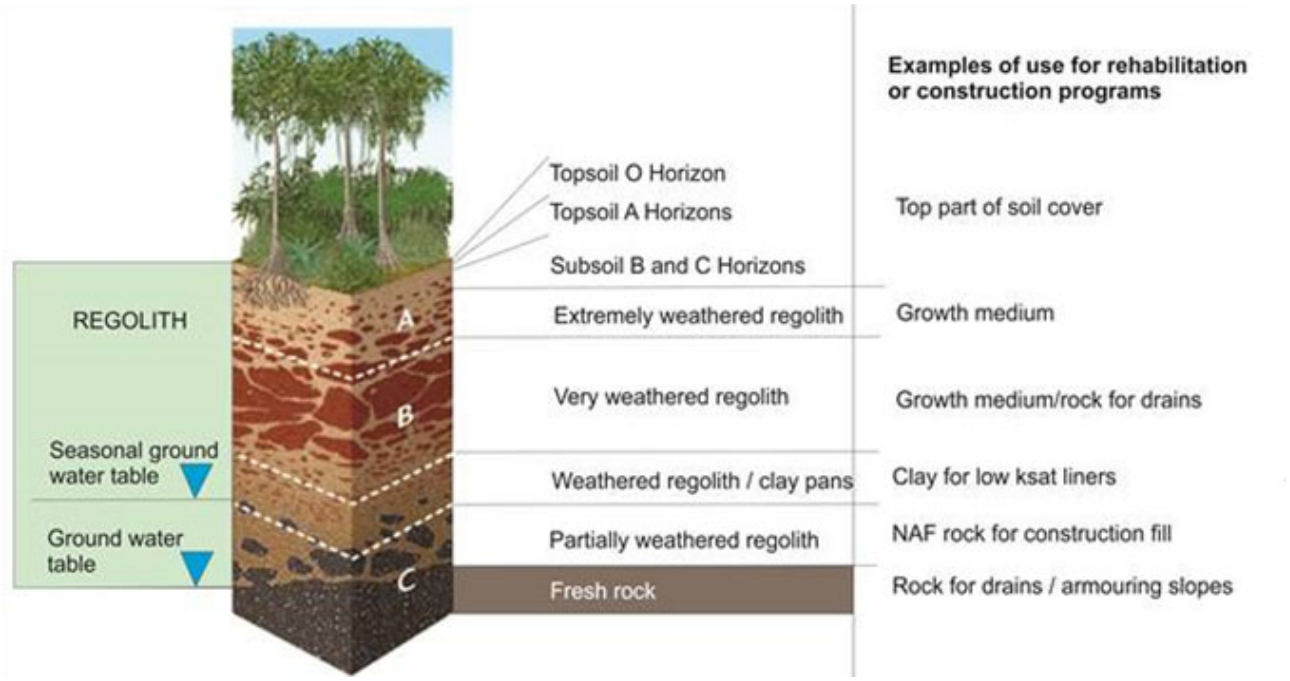

Figure 2-6: Illustrations of soil horizons

Table 2-5 defines the terms that RGS will use in the report and are preferred for clarity and simplicity (from Taylor and Eggleton 1988).

Table 2-5: Soil horizons and equivalent terminology

Horizon (s)	Equivalent terminology
O horizon and A horizon	Topsoil
B horizon and C horizon	Subsoil
Extremely to very weathered regolith	Saprolite
Weathered to partially weathered regolith	Saprock
Fresh rock	Bedrock

2.6.2 Topsoil stockpile volumes

The number of samples that should be collected from each topsoil stockpile (TS) will vary according to the size or volume of the resource. In order to accurately represent the material, the number of samples will increase with the volume of the stockpile. As most of the topsoil stockpile are small (<50,000 m^3 loose cubic meters (LCM)), one sample should suffice. For the largest stockpile, TS 25, RGS recommends that at least five samples are collected. The volume of the stockpiles and suggested sample numbers are summarised in **Figure 2-7.**

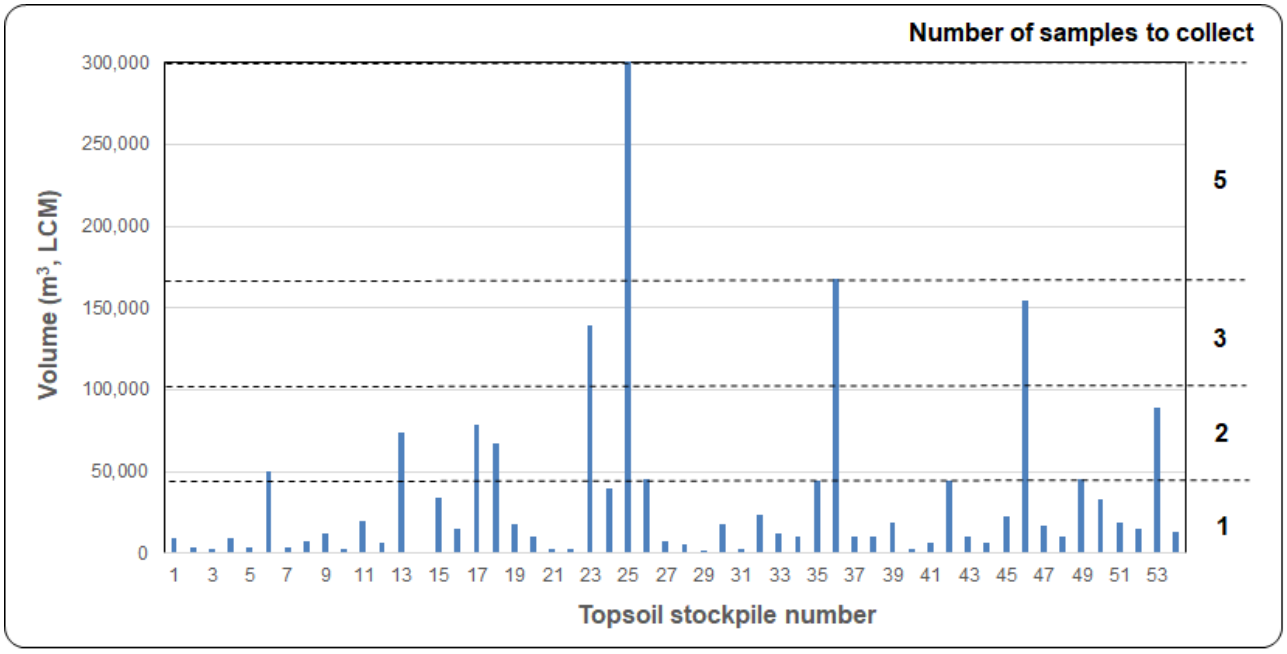

Figure 2-7: Topsoil stockpile volumes and recommended sample numbers

In order to be representative, the sampling of the topsoil stockpile should be spaced evenly across the entire area of the stockpile, as illustrated in **Figure 2-8.** The same principles also apply to sampling examples of good and poor rehabilitation – for a larger area, collect more samples.

Figure 2-8: Example of laterally distributed sampling for TS 25

2.7 Field guide to soil types present at Foxleigh

If mine personnel are to perform soil sampling, it would be beneficial to be able to recognise the three basic soil types present at Foxleigh. **Figure 2-9** provides a visual dictionary and descriptive text to be able to classify most soils that will be encountered.

Vertosols • Cracking clay soils • Grey or brown	35% or more clay +/- surface cracking Gilgai microrelief – irregular land surface with alternating mounds (caused by shrinking/swelling) 			
Sodosols • Soils influenced by sodium • Brown	Clear or abrupt textural B horizon Sodic (ESP >6%, EA Class 2 or 3) Dispersive, easily eroded			
Chromosols • Often brightly coloured • Brown	Clear or abrupt textural B horizon Strong textural contrast between A and B horizons Subsoil may appear mottled Not sodic or acidic (pH >5.5)			

Figure 2-9: Foxleigh Soil types

2.8 Other field tasks

2.8.1 Logging and photographs

RGS will the log the test pit in-situ profiles manually with pen and paper to detail information such as:

- The depth of each test pit;
- The thickness of each soil horizon;
- Colour, texture, and clay content of each sample;
- Presence of any biological material such as roots;
- Bedding plane angles; and,
- Extent of weathering, hardness, and density.

RGS will also take photographs of the area surrounding the test pit, the visual appearance of the wall face, and the appearance of the sample collected in each bucket.

After the site investigation, the field logs will be converted to an electronic format and will be used to help interpret the analytical results.

2.8.2 GPS Coordinates

Coordinates of the sampling locations will be recorded at the time of sampling using a hand-held GPS and the specific coordinate system used noted (e.g. WGS84). The sampling points will be overlayed on a site aerial photograph to ensure adequate sample distribution is obtained over the extent of the mine lease area. The coordinates of the sampling locations will later be uploaded into GIS files to show the spatial distribution of the soil types and their properties.

2.8.3 pH and electrical conductivity (EC)

Field-based assessments, also referred to as screening tests, will be undertaken off-site in the RGS in-house laboratory. This is to reduce the amount of equipment that is required to be brought to the field, and also to provide a more controlled environment in which to produce an accurate and reliable result. pH and EC measurements will be performed using a 5 g sample of – 2 mm material, which is placed in a centrifuge with 25 mL of de-ionised (DI) water. The contents are shaken for 10-30 s and then left to stand for approximately 1 hour before the measurement is taken with a pH/EC meter.

2.8.4 Soil sample handling and storage

The soil samples will be contained in 20L white plastic buckets with a metal handle and sealable lid. The lids will be hammered with a rubber mallet to ensure they are not loose. The buckets will be stacked in 3 x 3 rows on a pallet and may be stacked to 2 layers. Each bucket is 10-15 kg and a pallet of 18 buckets will weigh approximately 250 kg. It is not necessary to refrigerate the buckets and they can be left in the sun or outside. The main precaution to be followed is proper manual handling of each bucket as they can be quite heavy. Gloves are recommended if moving a large number of buckets.

2.8.5 Responsibility

The sampling program for the SSaAP will be supervised by an appropriately trained RGS staff member who will be responsible for sampling, labelling, field logging, site descriptions, and handling and storage of the samples. RGS is responsible for delivering suitably durable and sealed buckets to Foxleigh staff, who will provide equipment for RGS to pack the containers onto pallets and wrap them in straps and plastic cling. RGS will provide delivery details and labels for each pallet, and Foxleigh staff will organise the collection and freight.

3 Analytical Program

3.1 Sample Preparation

Unlike rock samples, soil samples are usually fine and require minimal sample preparation.

The soil nutrient tests (AG-3 suite) performed by ALS require that the samples are -2 mm. For these tests, RGS will provide -2 mm samples in ziplock bags (contained in buckets) that were sieved in the field and do not require further crushing.

Sample preparation for the physical tests at Trilab will involve weighing the samples, prior to performing the particle size distribution (PSD) and bulk density analyses. A portion of the bulk soil sample will be crushed to -2 mm to perform the Emerson Aggregate and water repellence tests.

3.2 Analysis Suites

Table 3-1 and **Table 3-2** summarise the analytical suites. The soil nutrient analyses will be performed by ALS, and the physical tests will be done by Trilab. Technique and methods are included for reference where applicable if further details are required.

Table 3-1: Soil nutrient analysis suite (ALS)

Soil nutrient analyses	ALS Code	Method Code	Number of analyses
Exchangeable Soil Acids	ED002	Baumann Gully DIN 4030 Part 2	10
Exchangeable Cations (Ca, Mg, Na, K) plus ECEC & ESP on Alkaline Soils (pH > 7.3)	ED006	Soil Survey Test Method C5	10
Exchangeable Cations (Ca, Mg, Na, K) plus ECEC & ESP on Soils (pH < 7.3 and EC <300µm) NOTE: If pH < 6.0 ECEC includes ED005 - Exchange Acidity (includes Exchangeable Aluminium)	ED007	Rayment & Lyons 2011 15A1ED005: Rayment & Lyons 2011 15G10.1	10
Exchangeable Cations (Ca, Mg, Na, K) plus ECEC & ESP with pre-treatment on Soils (pH <7.3 and EC >300µm) NOTE: If pH < 6.0 ECEC includes ED005 - Exchange Acidity (includes Exchangeable	ED008	Rayment & Lyons 2011 15A1 ED005 - Rayment & Lyons 2011 15G1	10
Total Phosphorus as P by Discrete Analyser	EK067G	APHA 4500-P	10
Fluoride Extractable Phosphorus (Bray)	EK074	Rayment & Lyons 2011 9E1	10
Organic Matter Content plus Organic Carbon by Calc' (Walkley Black)	EP004	AS 1289.4.1.1-1997/ NEPM	10
ED008+EN34+EA02 and EA010 + NT8S Nutrients (TN, TP, TKN, NO_2, NO_3, NH_3 and NO_x)	AG-2	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,	10
AG2 + Chloride (1:5), pH ($CaCl_2$) Colwell P and K, DTPA extractable Fe, Cu, Zn and Mn, Organic Matter and Organic Carbon by Walkley Black	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,	10

Table 3-2: Physical testing suite (Trilab)

Physical testing parameter	Code	Method Code	Number of analyses
Emerson Class No.	Based on method	AS1289.3.8.1	20
Grading - Coarse (75mm to 0.075mm)	Based on method	AS 1289.3.6.1	10
Separation of fraction <2.0 mm	Based on method		10
Grading with Hydrometer (includes Particle Density)	Based on method	AS 1289.3.6.1 AS 1289.3.6.3	10
Particle Density (Specific Gravity)	Based on method		10
Water repellence	Based on method		10

Approximately 45 soil samples will be collected and subjected to field screening, but only some will be selected for further nutrient and physical testing. To reduce the number of samples, the soils may be composited together, by combining materials with similar properties (such as colour, texture, pH and EC). Alternatively, some samples may be selected for specific properties and others put aside as similar materials are already represented. Either method is valid and will be decided once the samples have been collected and assessed by RGS.

The soil samples will be stored at the RGS laboratory warehouse for approximately 12 months after testing and are available for further analyses if required for the Stage 2 scope.

3.3 Quality Assurance/ Quality Control

Quality Assurance (QA) and Quality Control (QC) procedures will follow those followed by ALS Laboratories. A laboratory quality assurance system is a requirement of all NATA accreditation. Where results are disputed, a duplicate blank sample will be sent to the laboratory for repeated analysis. All sample analyses will be undertaken within storage times of 1 year.

3.4 Characterisation of Materials

The interpreted results and characterisation of soil materials will be provided in a summary report including all field results and maps, summarised laboratory data and certificates, QA/QC and recommendations for managing the topsoil and the addition of soil ameliorants (if required). This will be used to inform the ERC submission as outlined in the objectives in **Section 1.2.1.**

4 Timeframe

The following estimated schedule is applicable for the soil materials that will be collected from Foxleigh in the site investigation occurring February 23 to February 26, 2021 (**Table 4-1**). The commencement of the schedule begins after samples are received by ALS and Trilab, with the completion being a final standalone soil nutrient and physical testing technical report.

Table 4-1: Estimated project schedule

Proposed Action/Milestone	Timing/Deadline (for completion)
Samples collected from Foxleigh Coal Mine	Week 0
ALS and Trilab sample receipt	Week 1
RGS field screening tests	Week 2
ALS soil nutrient results received	Week 3
Trilab physical testing results received	Week 4
Interpretation and characterisation	Week 5
Preparation of Draft Technical Report for feedback	Week 6
Receipt of report feedback from Nitro/Foxleigh	Week 8
Final Technical Report to Nitro/Foxleigh	Week 10
Total Period of Time Required for Draft Report	**6 weeks (from sample receipt)**

5 Conclusion

RGS has prepared this SSaAP to be robust and fit-for-purpose for characterising soil materials for Foxleigh Coal Mine. The samples will be reviewed after the field program; if it is deemed that the materials are highly heterogeneous, then further sample collection and analysis may be required.

6 References

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7 Attachments

7.1 Attachment A - Topsoil stockpile locations and volumes

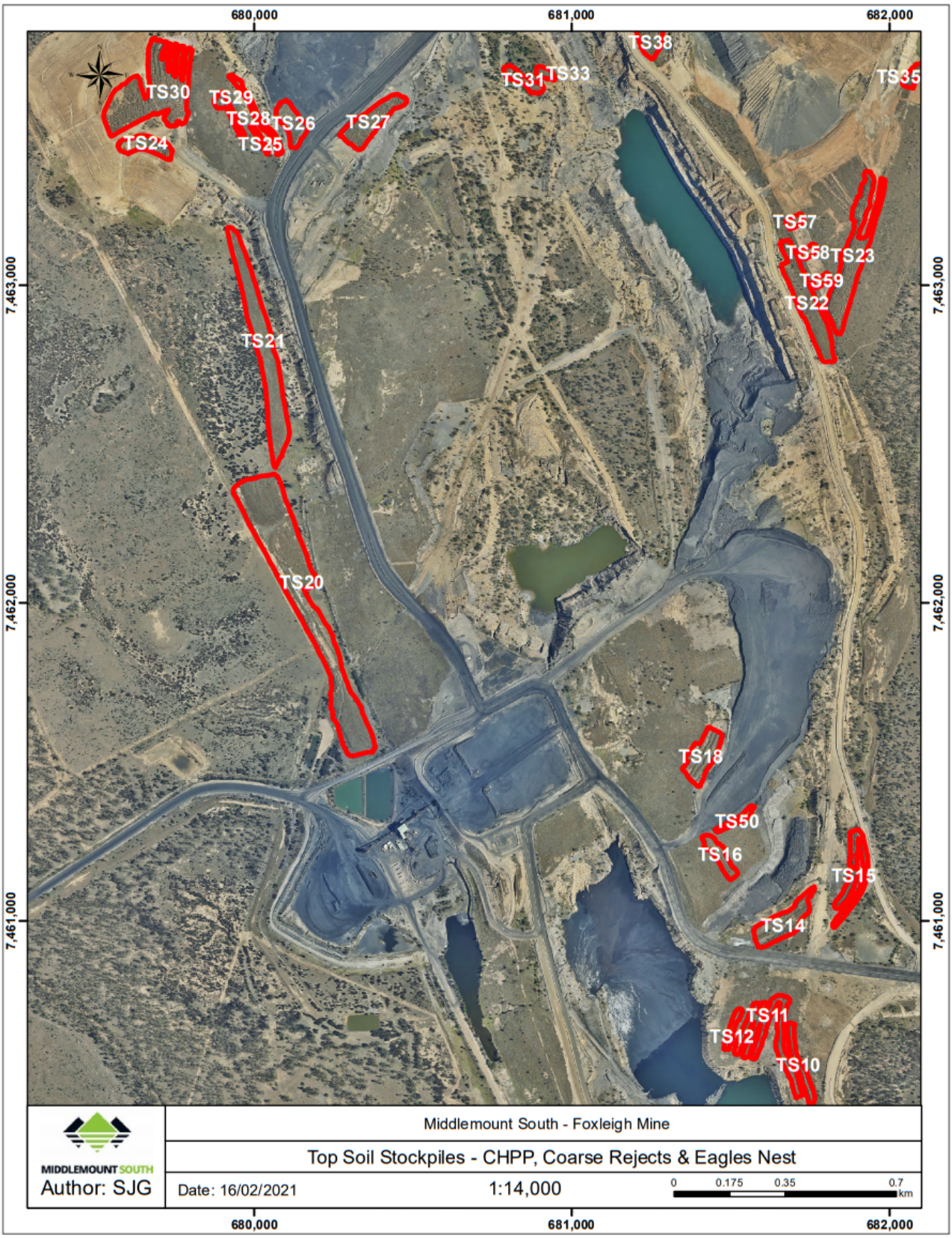

Figure 7-1: 2021 Topsoil stockpile locations – CHPP, Coarse Rejects & Eagles Nest

Figure 7-2: 2021 Topsoil stockpile locations - Far South & Admin

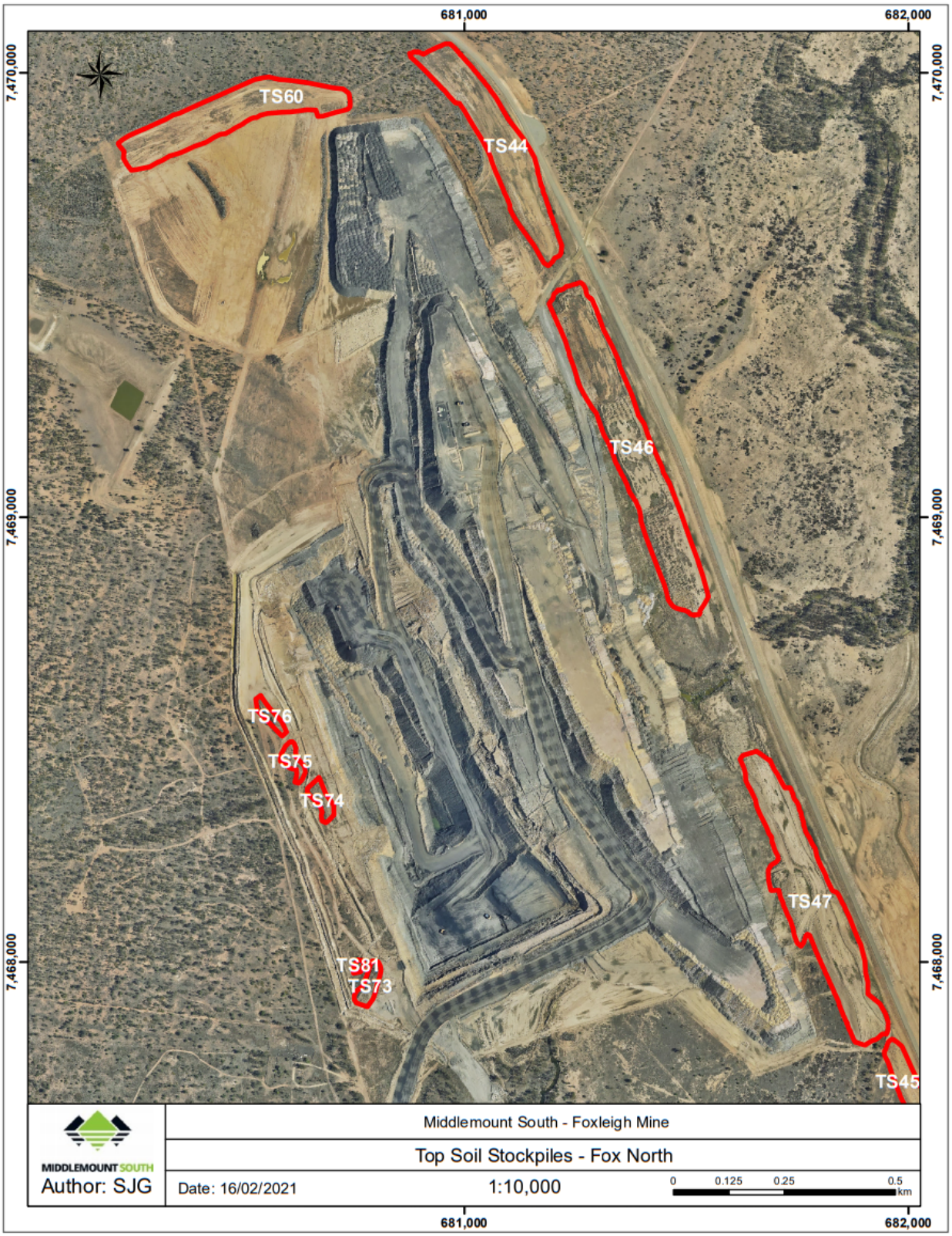

Figure 7-3: 2021 Topsoil stockpile locations – Foxleigh Plains North

Figure 7-4: 2021 Topsoil stockpile locations – Foxleigh Plains

Figure 7-5: 2021 Topsoil stockpile locations – One Tree & Pipeline

FOXLEIGH MINE TOPSOIL REGISTER 2021			
Name	Surface Area (m^2)	Location	Volume (m^3)
TS01	3,198	Far South	8,281
TS02	2,289	Far South	5,356
TS03	2,097	Far South	5,273
TS04	7,622	Carlo	17,625
TS05	20,469	Far South	41,491
TS06	817	Admin	1,743
TS08	6,031	One Tree Pipeline	14,317
TS09	80,798	One Tree Pipeline	195,084
TS10	5,744	Tailings	12,273
TS11	18,950	Tailings	48,076
TS12	2,501	Tailings	5,744
TS13	14,974	One Tree Pipeline	38,257
TS14	13,239	Coarse Rejects	32,777
TS15	10,992	Coarse Rejects	24,879
TS16	5,339	Coarse Rejects	11,822
TS17	50,773	One Tree Pipeline	119,162
TS18	11,713	Coarse Rejects	27,956
TS19	43,672	One Tree Pipeline	110,036
TS20	84,291	CHPP	192,059
TS21	36,760	CHPP	90,526
TS22	20,861	Fox Plains	50,122
TS23	28,759	Fox Plains	52,098
TS24	7,263	Eagles Nest	15,372
TS25	1,221	Eagles Nest	2,192
TS26	7,675	Eagles Nest	15,387
TS27	13,406	Eagles Nest	30,579
TS28	4,165	Eagles Nest	9,441
TS29	3,291	Eagles Nest	7,394
TS30	44,589	Eagles Nest	99,037
TS31	3,861	Fox Plains	6,320
TS33	1,658	Fox Plains	5,388
TS35	6,310	Fox Plains	12,774
TS36	2,029	Fox Plains	4,698
TS38	14,412	Fox Plains	36,562
TS39	6,449	Fox Plains	8,496
TS40	5,744	Eagles Nest	14,542
TS41	86,977	Fox Plains	200,059
TS42	37,416	Fox Plains	85,074
TS43	21,384	Fox Plains	49,511
TS44	43,239	Fox North	93,047
TS45	61,113	Fox North	235,946

FOXLEIGH MINE TOPSOIL REGISTER 2021			
Name	Surface Area (m^2)	Location	Volume (m^3)
TS46	70,618	Fox North	131,294
TS47	64,101	Fox North	154,759
TS48	1,254	One Tree Pipeline	1,178
TS49	589	One Tree Pipeline	345
TS50	2,147	Coarse Rejects	1,630
TS51	6,913	Fox Plains	9,223
TS52	7,720	Fox Plains	8,141
TS53	5,470	Fox Plains	4,643
TS54	41,235	Fox Plains	86,994
TS55	64,296	Fox Plains	179,334
TS56	26,107	Fox Plains	46,470
TS57	1,538	Fox Plains	2,296
TS58	1,430	Fox Plains	2,003
TS59	1,305	Fox Plains	1,821
TS60	40,242	Fox North	59,162
TS61	19,597	One Tree Pipeline	41,717
TS62	9,501	One Tree Pipeline	2,762
TS63	18,805	One Tree Pipeline	39,835
TS65	18,769	Fox Plains	65,550
TS66	13,065	Fox Plains	46,820
TS67	15,631	Far South	23,700
TS68	7,098	One Tree Pipeline	15,442
TS69	2,013	One Tree Pipeline	4,500
TS70	1,830	One Tree Pipeline	3,662
TS71	9,127	Fox Plains	19,303
TS72	9,899	Fox Plains	7,600
TS73	3,152	Fox North	6,463
TS74	2,752	Fox North	4,651
TS75	2,398	Fox North	3,579
TS76	2,141	Fox North	1,411
TS77	16,227	One Tree Pipeline	19,395
TS64	8,860	One Tree Pipeline	9,208
TS78	2,799	One Tree Pipeline	1,189
TS79	5,410	One Tree Pipeline	8,648
TS80	4,032	One Tree Pipeline	10,215
TS07	2,208	Carlo	14,111
TS81	489	Fox North	277
TS82	6,136	Fox North	4,300
TS83	1,793	Fox North	2,500
TS84	7,439	Fox Plains	5,292
TS85	16,485	One Tree Pipeline	33,593
TS86	6,782	Fox Plains	15,162
		Total	**3,136,954**

TOPSOIL VOLUMES BY LOCATION			
LOCATION	Volume (m^3)	LOCATION	Volume (m^3)
Far South	84,101	Coarse Rejects	99,064
Carlo	31,736	CHPP	282,585
Admin	1,743	Eagles Nest	193,944
One Tree Pipeline	668,545	Fox Plains	1,011,754
Tailings	66,093	Fox North	697,389

Figure 7-6: 2021 Topsoil stockpile volumes

7.2 Attachment B – Previous soil survey sampling locations

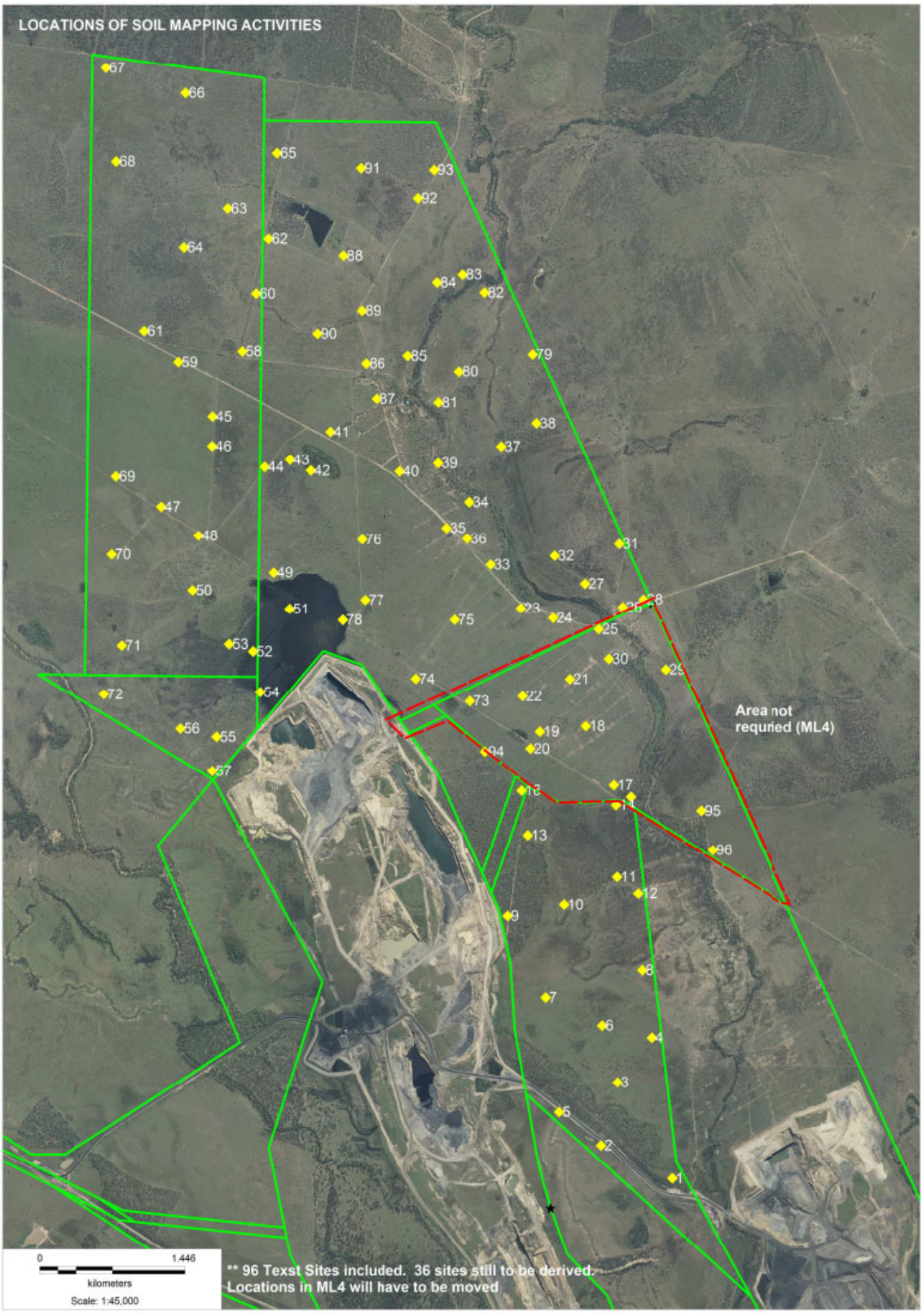

Figure 7-7: 2013 - Soil survey sampling sites

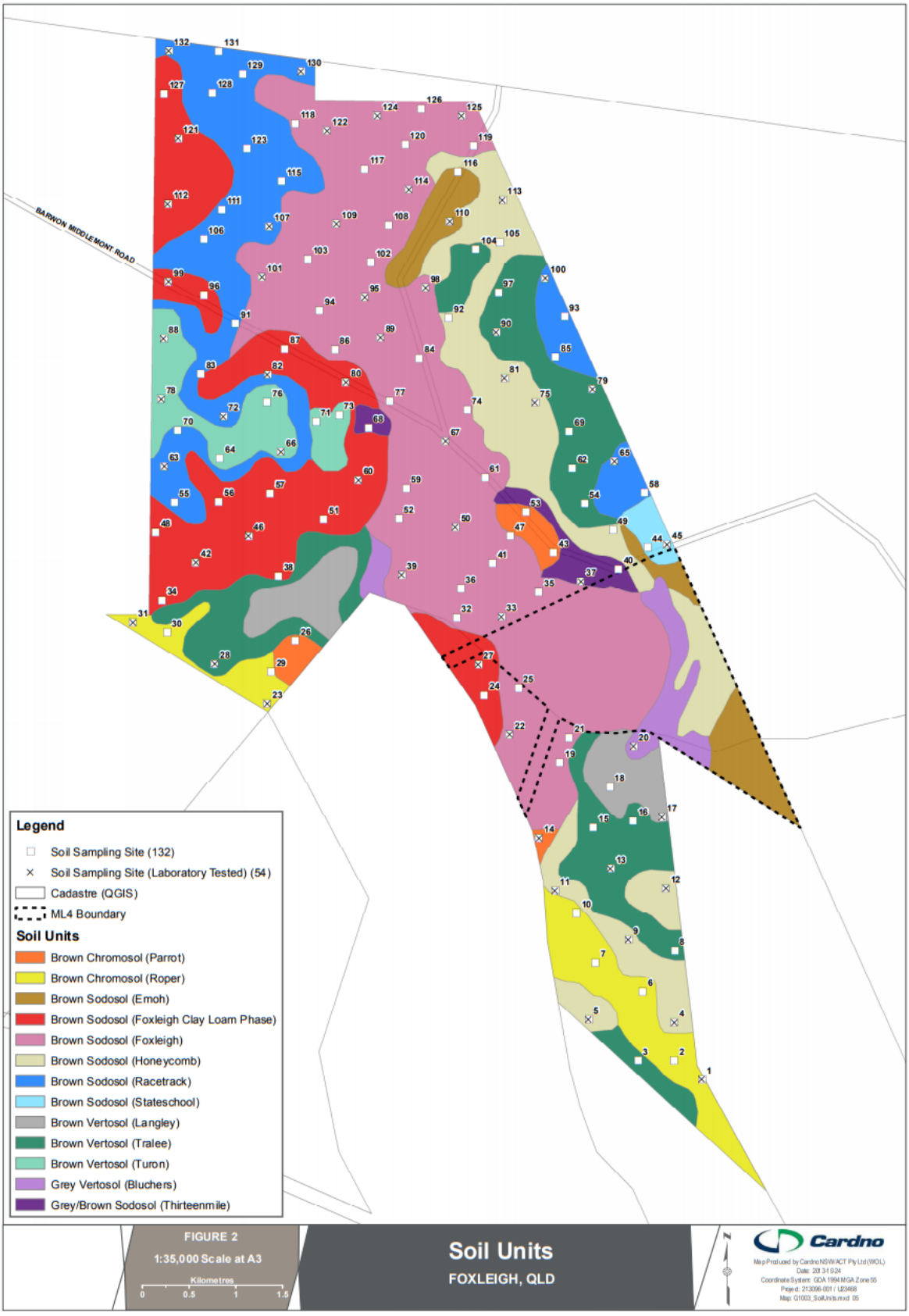

Figure 7-8: 2013 - Soil units from soil survey

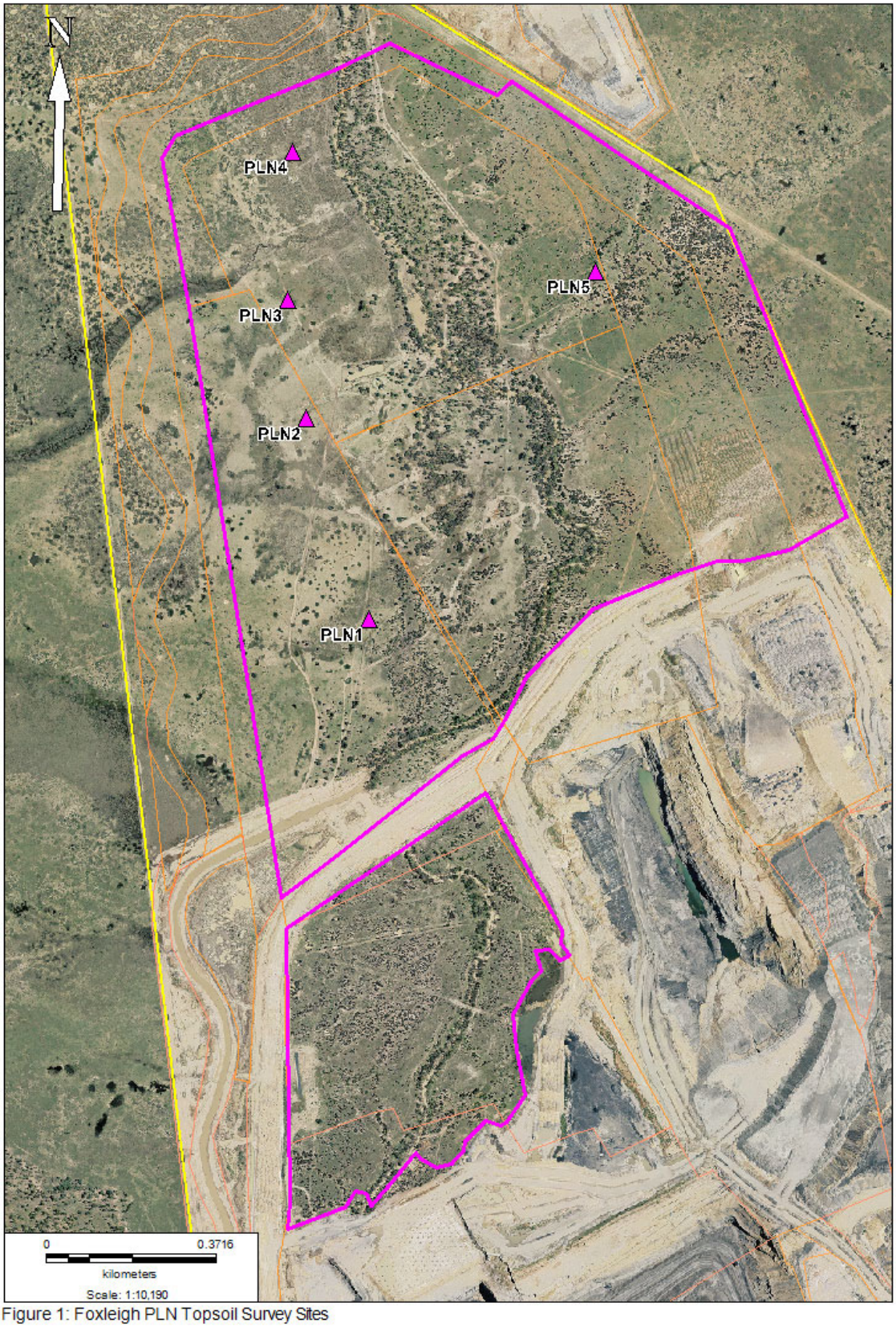

Figure 1: Foxleigh PLN Topsoil Survey Sites

Figure 7-9: 2015 - Soil survey sampling sites

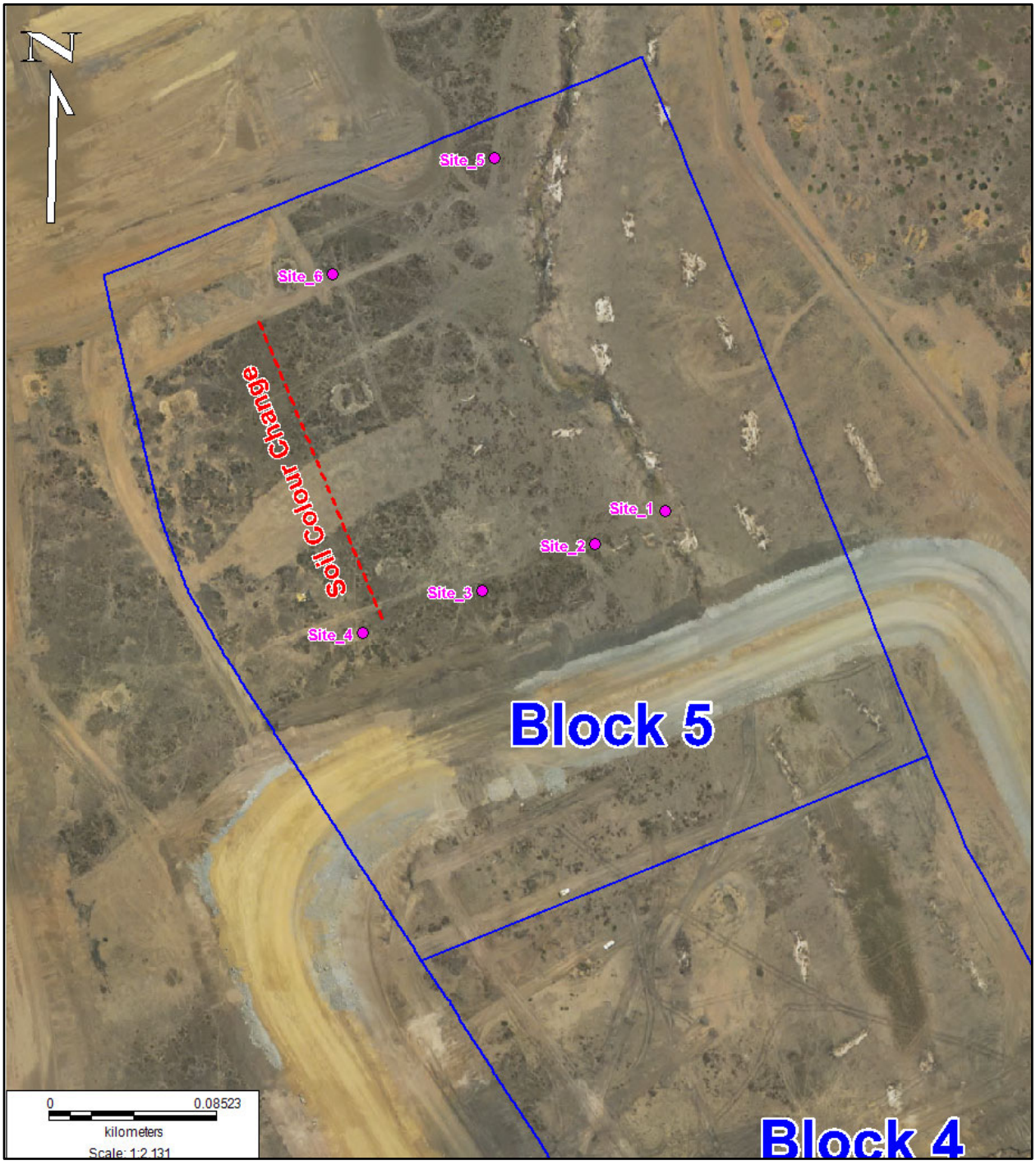

Figure 7-10: Jan 2016 - Soil resurvey: Block 5

MINE WASTE AND
WATER MANAGEMENT

Appendix L: Foxleigh WSF Cover Designs

FOXLEIGH MANAGEMENT PTY LTD

Foxleigh Mine
Cover Designs for CHPP Waste

July 2023

henderson geotech pty ltd

11 Olive St
MORNINGSIDE 4170
ph: 07 3399 5020

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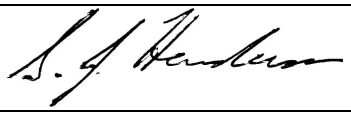
Review	Ivan Wong	3/07/2023	
Revised Draft	S.Henderson, RPEQ 4952	15/08/2023	
Final	S.Henderson, RPEQ 4952	18/08/2023	

1 INTRODUCTION

In June 2023, Foxleigh Management Pty Ltd engaged Henderson Geotech Pty Ltd to provide cover designs for emplacements of CHPP waste at Foxleigh Coal Mine, near Middlemount in Central Queensland. The cover designs are intended to support preparation of the rehabilitation planning part of the progressive rehabilitation and closure plan (PRCP) for the mine.

This report provides an overview of relevant characteristics of potential cover materials (mining spoil) and waste materials (tailings and coarse rejects). It then describes the existing waste emplacements and potential hazards after mining, leading to objectives for earthen covers. Finally cover designs proposed to meet those rehabilitation objectives are detailed.

Note that the cover designs have been developed based on material characteristics and accepted practice as understood at the time of preparing this report (June 2023). In future, additional information on material properties and/or new understanding of the performance of waste covers may become available revision of the cover designs. Further note that this report is subject to the Limitations set out in Section 7.

2 POTENTIAL COVER MATERIALS

Spoil at Foxleigh coal mine is produced by the excavation of sedimentary strata overlying coal seams within the Rangal Coal Measures and broadly comprises:

- Unconsolidated sediments – Quaternary alluvium, mainly clayey soils but with some localised layers of sand and gravel;
- Partly consolidated sediments – Tertiary silty and sandy clays, sometimes grading to clayey sands;
- Weathered Permian – silty and sandy clays derived from claystone and clay-rich siltstone, with some gravel-sized fragments of weathered rock;
- Fresh Permian – predominantly clayey sandy gravel derived from interbedded fine-grained sandstone and siltstone. A proportion of the gravel fragments may break down to sandy clay over time.

2.1 Spoil Properties Regionally

Regionally, Quaternary alluvium is generally very shallow and limited to creek floodplains. Consequently, it is rarely excavated as a discrete stratum but is instead combined with Tertiary spoil. At pit and mine scale, the proportion of Quaternary alluvium is rarely sufficient to effect spoil properties.

Figure 2-1 summarises grading and index properties of Tertiary spoil from test results reported for various mines across the Bowen Basin. It shows that the material is typically sandy or silty clay with little gravel. Experience is that gravel fragments – being weathered rock – often break down with moisture and handling. Basic geochemical properties are summarised in Figure 2-2: using the categories in Hazelton & Murphy (2007), Tertiary spoil

is typically moderately to strongly alkaline, moderately to highly saline, strongly sodic, and dispersive.

Physical and geochemical properties of weathered Permian spoil are usually similar to those of Tertiary spoil. Hence, the two materials are often not differentiated in spoil management practice.

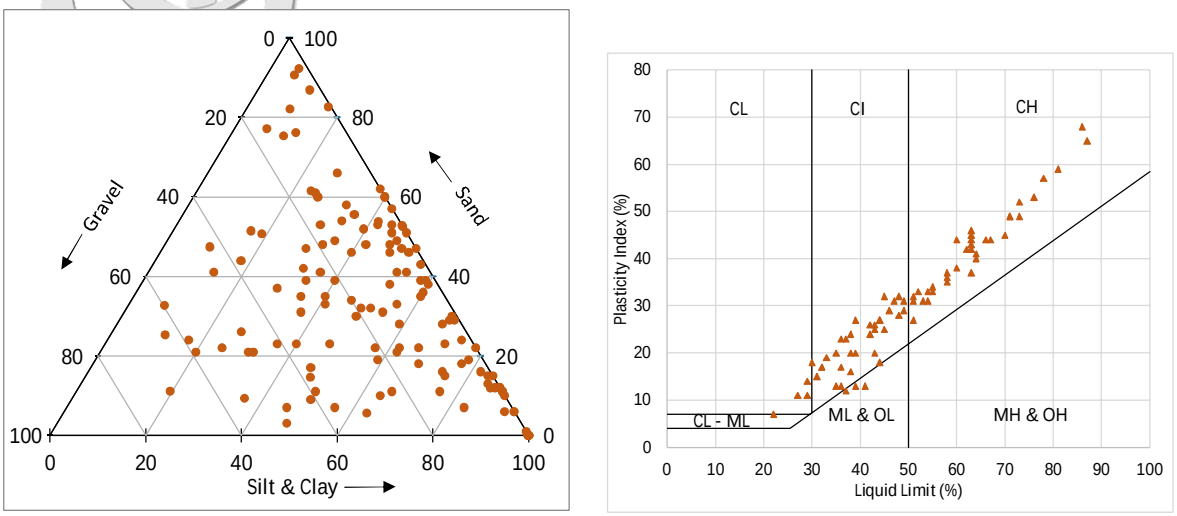


Figure 2-1: Physical Characteristics of Tertiary Spoil

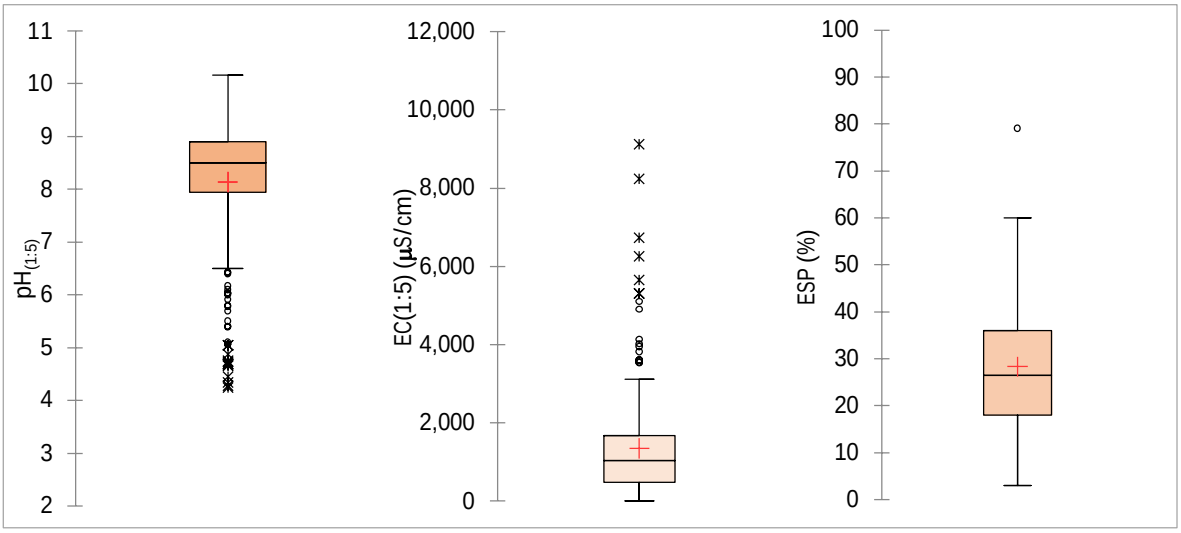


Figure 2-2: Geochemical Characteristics of Tertiary Spoil

In a similar, manner, Figure 2-3 summarises grading and index properties of fresh Permian spoil in the Bowen Basin. The material clearly contains more gravel than spoils from above the base of weathering; however, often the proportion of sand, silt and clay combined is still sufficient for the spoil structure to be 'matrix supported', that is, Category 2 and 2-3 (Simmons & McManus, 2004). Gravel fragments derived from claystone and carbonaceous siltstone still tend to break down when worked or wetted, but a significant gravel fraction usually remains. Note also that the fines do not often exhibit high plasticity.

Geochemically, fresh Permian spoil is typically moderately-strongly alkaline, slightly to moderately saline, moderately to strongly sodic, and potentially dispersive (Figure 2-4).

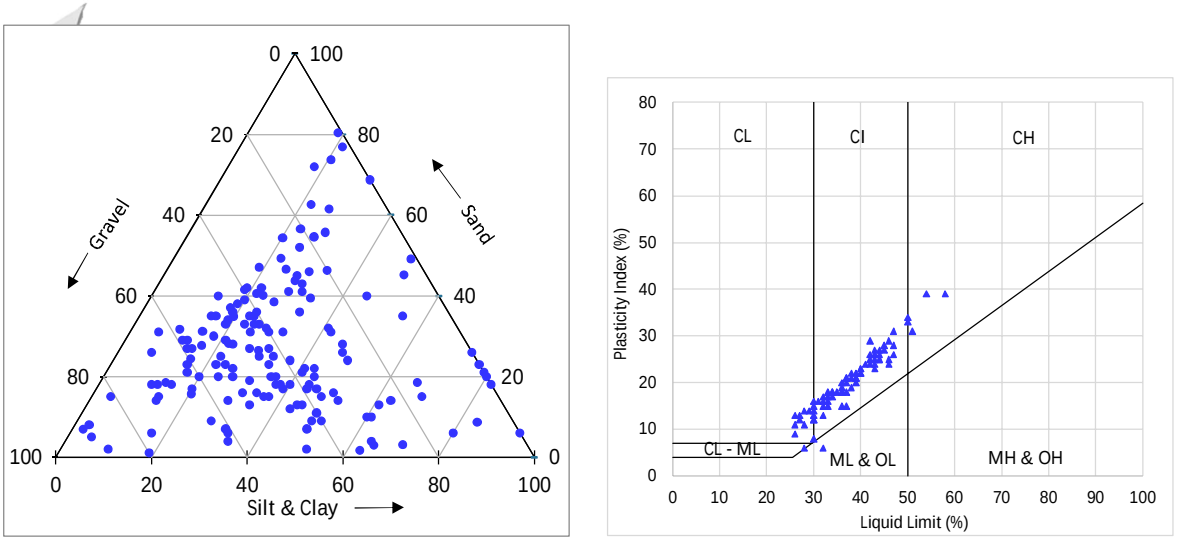


Figure 2-3: Physical Characteristics of Fresh Permian Spoil

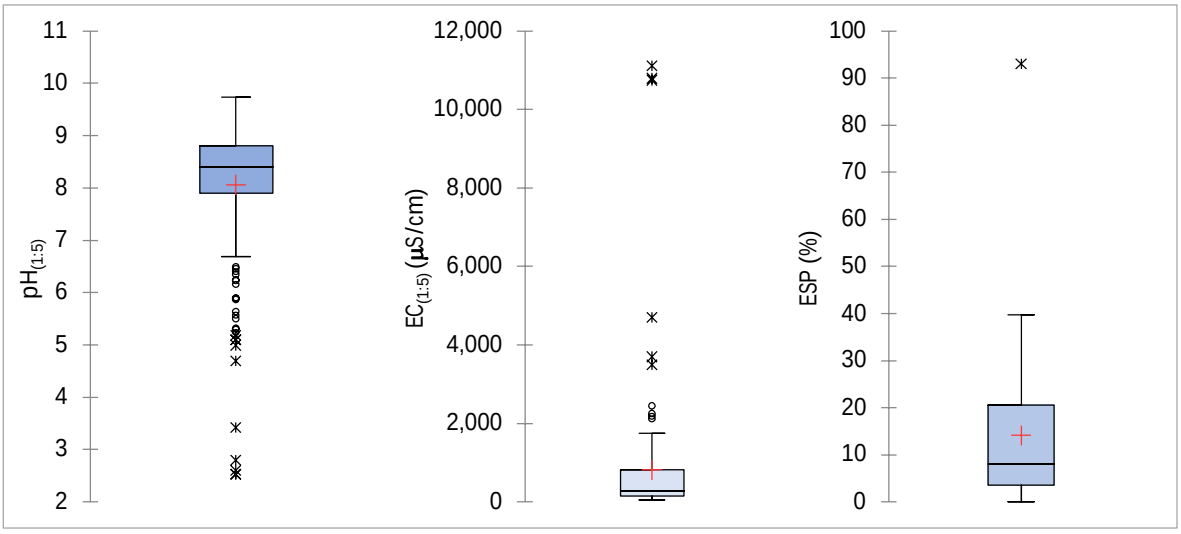


Figure 2-4: Geochemical Characteristics of Fresh Permian Spoil

2.2 Spoil Properties at Foxleigh Mine

Results of physical testing of spoil specifically from Foxleigh Mine were not available but Figure 2-5 presents results collated from foundation investigations undertaken in alluvial and weathered overburden for creek diversions and levees at the mine (Douglas Partners, 2011, Hatch, 2013a, Hatch, 2013b, and Cartledge Mining and Geotechnics, 2019). Size grading was noticeably finer than for the broader Tertiary spoil dataset; samples taken from boreholes and test pits would naturally be finer sized than bulk-excavated spoil but the results suggest that Tertiary and weathered spoil at Foxleigh may be toward the finer end of such spoils across the Bowen Basin. The distribution of plasticity results was similar to that for the regional dataset and confirmed that the spoil would behave more like clay than silt.

Geochemical results for weathered overburden and spoil, extracted from RGS (2021) are presented in Figure 2-6. These indicate that Foxleigh material from above the base of weathering is consistent with the rest of the Bowen Basin. Exchangeable Sodium Percent

(ESP) was only reported for mixed samples but was also within the expected range. All overburden and interburden samples tested in that investigation were assessed as negligible risk for acid generation.

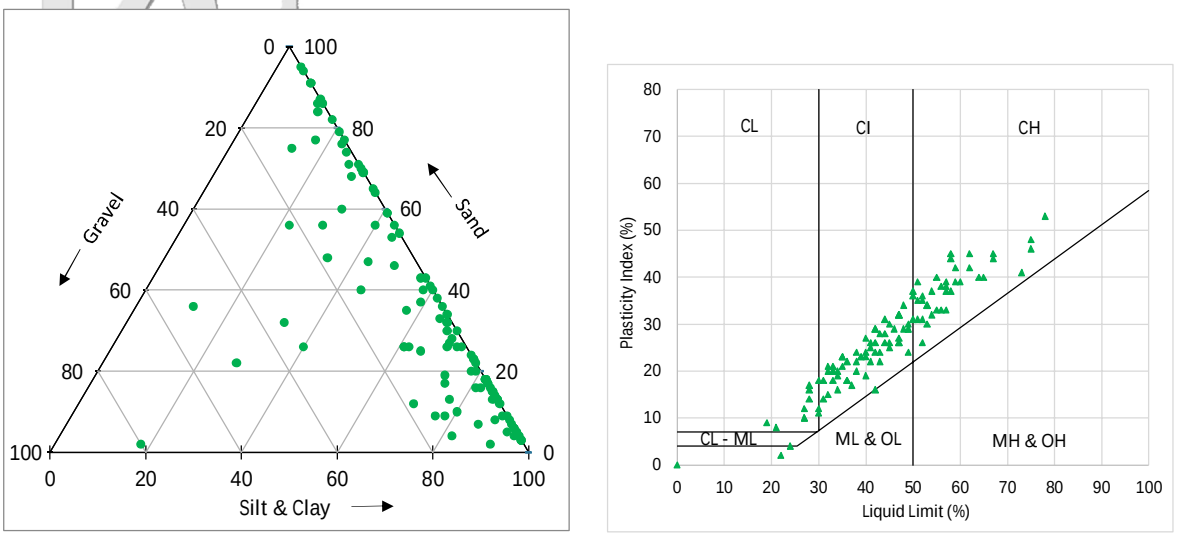


Figure 2-5: Physical Characteristics of Quaternary & Tertiary Overburden at Foxleigh Mine

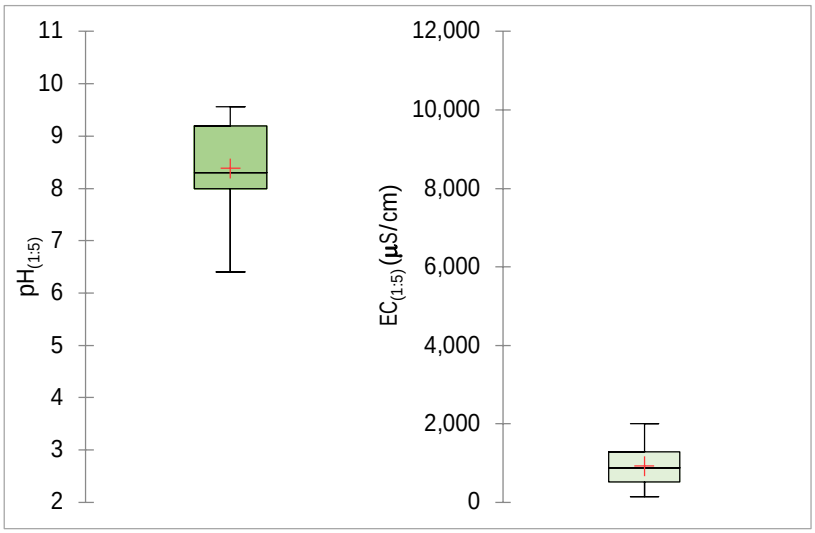


Figure 2-6: Geochemical Characteristics of Quaternary, Tertiary & Weathered Overburden & Spoil at Foxleigh Mine

Results of physical testing of fresh Permian spoil from Foxleigh Mine were not available; however, there was nothing in geotechnical reports or visual observation to suggest that it was different from the corresponding spoil at other coal mines in the Bowen Basin.

Geochemical analyses of overburden and interburden presented in RGS (2021) show: $pH_{(1:5)}$ mainly between 8 and 10; $EC_{(1:5)}$ ranging approximately from 200 to 2,000 (µS/cm); material strongly sodic; and with negligible risk for acid generation. Once again, these are consistent with the regional dataset.

2.3 Desirable Cover Material Properties

A cover system over material that is chemically hostile to vegetation will ideally

- Allow shallow rainfall infiltration to support vegetation and reduce erosion from runoff;
- Not allow infiltration to seep down to the hostile material
- Not allow solute from the hostile material to flow upward into the root zone or into surface waters

These criteria impose conflicting requirements on cover materials: high permeability for initial infiltration but low permeability to limit seepage; more clay to reduce permeability but less clay to reduce matric (capillary) water suction potential. For example, clay-rich spoil from Tertiary and weathered Permian overburden could be placed to achieve low permeability but doing so would increase its tendency to allow upward water movement due to capillary action (matric suction potential). Conversely, gravelly fresh Permian spoil would have less tendency to promote upward water movement but may be too permeable to prevent deep infiltration into the tailings. Consequently, a multi-layer cover system is required, with different spoil types placed to utilise the desirable properties each.

Depth of weathered overburden is variable but generally at least 30m thick, while final pit depths are greater than 100m. Consequently, the quantities of both weathered and unweathered spoil available will be sufficient to allow selection of suitable materials.

A grazing or grassland Post-Mining Land Use is most suited to covered waste storage; a typical mixture of grasses and low shrubby vegetation should provide uptake of much of the infiltrated moisture. Planting of deep-rooted vegetation is not recommended, unless the

3 TAILINGS

3.1 Characterisation

3.1.1 Physical Properties

Figure 3-1 summarises grading and plasticity index properties for tailings sampled from the in-pit TSF at Foxleigh Mine. Based on particle size, the tailings are typically equal proportions of sand and silt, with a smaller amount of clay; however, plasticity results (Liquid Limit & Plasticity Index) plot above the 'A' line and therefore in accordance with AS 1726:2017 (Standards Australia Limited, 2017), the tailings are classified as *intermediate plasticity Sandy Silty CLAY*. The implication of this classification is that with regard to strength, the tailings are expected to behave cohesively (like clay).

Average solid particle density was 1.98t/m^3, with a range of 1.82-2.36. Considering the different solid particle densities of coal (~1.4t/m^3) and general overburden (~2.5t/m^3), this suggests that the tailings include up 50% coal that would be concentrated in the fine size range (<75μm).

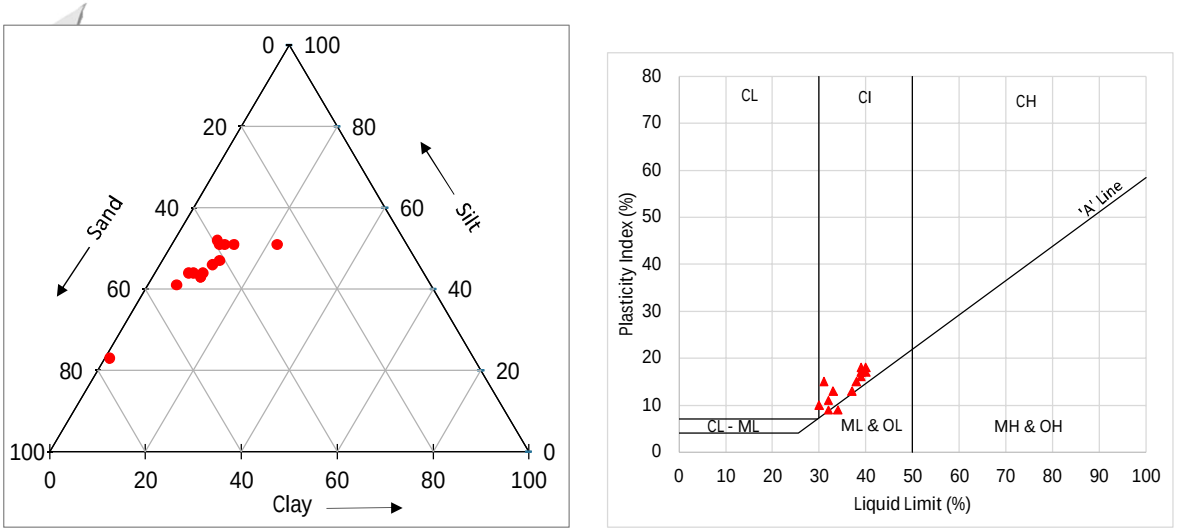


Figure 3-1: Physical Characteristics of Tailings at Foxleigh Mine

Oedometer consolidation tests on three samples prepared to an initial dry density of 1.1t/m^3 provided the following average parameter values:

- Compression Index C_c = *0.20*
- Recompression Index C_r = *0.026*
- Coefficient of permeability k_{sat} = *7.4e-9 m/s* for small load increases
- Coefficient of consolidation c_v = *40m^2/yr*, but varied over a wide range

These values are within ranges measured for coal tailings in the Bowen Basin but towards the limits representing lower total consolidation settlement and more rapid consolidation rates. This is consistent with the high proportions of sand and silt.

3.1.2 Chemical Properties

RGS (2021) reported results of static geochemical testing on ten tailings samples and kinetic testing on one composite tailings sample. Based on these results, tailings at Foxleigh Mine are moderately to strongly alkaline, highly to extremely saline, have negligible risk of generating acidity and show no significant metal/metalloid enrichment. Core samples of roof, floor and coal indicated higher risk of acid generation; however, it appears that the mixing inherent in tailings creation results in overall Acid Neutralising Capacity that outweighs the Maximum Potential Acidity of localised pockets of the CHPP feed.

3.1.3 In Situ Properties

In the context of rehabilitation, the most important properties of tailings are: strength profiles, which constrain safe placement of capping; and moisture-density profiles, which – in combination with consolidation properties - dictate how much water is squeezed out during consolidation, the consequent vertical settlement, and the timeframe over which that consolidation occurs (The Minserve Group et al, 2003).

Because the TSF is still active, no in situ testing has yet been carried out. Tailings has minimal shear strength when initially discharged (being fluid) and strength is only gained

over time as the deposit dewaters, densifies, and develops a drier surface crust. Figure 3-2 presents in situ tailings strength tests results from Bowen Basin Coal mines and shows that a stronger surface crust about 2m thick can generally be achieved; however, these data were from aboveground tailings dams where there may have been some dewatering due to seepage and surface water would typically be consistently removed to limit the size of the decant pond. Similar results are expected for in-pit TSFs if the decant pond is managed to a similar standard.

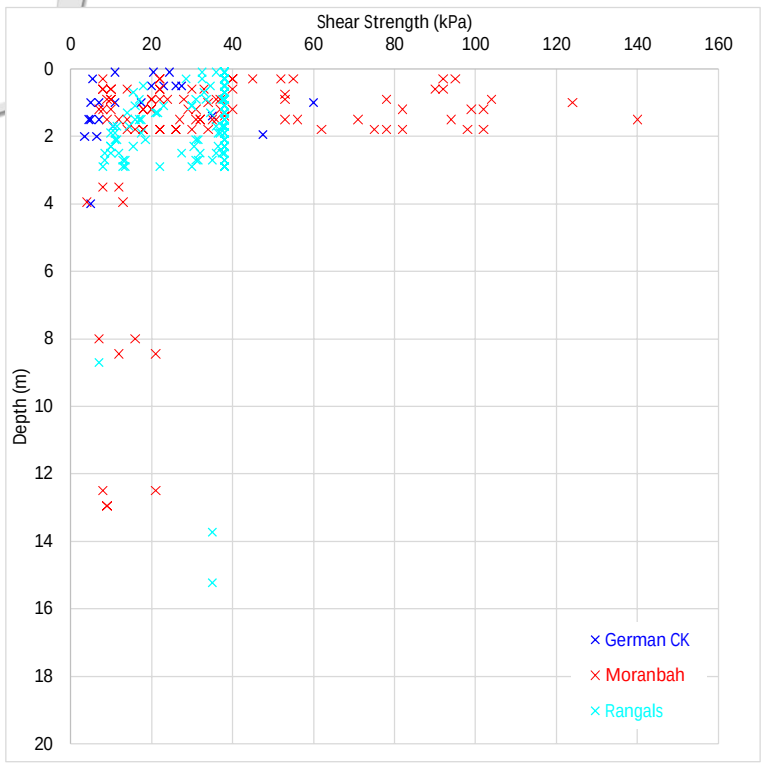


Figure 3-2: Historic In Situ Strength Data from Coal Tailings Dams in the Bowen Basin

3.2 In-Pit TSF

3.2.1 Description

The TSF is located within the mined-out NT Pit, the northern end of which is about 500m south-east of the CHPP. Tailings deposition commenced in October 2006, when the CHPP was commissioned: prior to that, coal was washed under contract at German Creek Mine. At that time, there was a spoil bund roughly east-west across the pit about a third of the distance from the southern end. The lowest floor level in the northern cell was estimated to be RL 70m; historic pit survey was not available for the southern cell but based on the floor slope observable in 2008, it may have been somewhat higher. Surface spill level is about RL 137m, at the southern end.

Tailings were initially discharged into the southern cell while mine affected water was held at the north. During 2010-2011 coarse reject was paddock dumped in the southern end of the northern cell, while tailings discharge was still occurring in the southern cell. Around the beginning of 2012, tailings in the southern cell was close to the crest level of the internal wall and discharge moved to the north-eastern corner. From that time until the first half of

2022, discharge continued in the northern cell (although at some point the discharge point was moved to the western side). While the tailings were below the internal wall, return water was pumped out of the southern end of the cell but when the wall was overtopped, the decant was allow to flow to the southern cell. At June 2022, the tailings surface graded from RL 128m at the north-eastern corner down to the decant pond at RL 124m in the former southern cell.

3.2.2 Surrounding Environment

As previously noted, the CHPP is about 0.5km north-west of the TSF with other mine infrastructure and pits north of that. WC North pit, currently a water storage, is about 0.8km to the south, again with further mining disturbance south of that. Roper Creek is about 0.9km to the east and Cockatoo Creek re-diversion is about 1.5km east of the TSF. The bed of Roper Creek is at about RL 130.5m near the TSF and the bed of Cockatoo Creek diversion is at about RL 125.5m.

The final landform design has the TSF and nearby mining-disturbed areas being rehabilitated to or above pre-mining ground level; residual voids will be more than 3km to the north and south, and on the far side of Cockatoo Creek to the east.

At a broader scale, Cockatoo Creek joins Roper Creek at the southern end of the current mine footprint, Oaky Creek joins Roper Creek 2km further downstream, and Roper Creek enters the MacKenzie River about 17km downstream of that. Those areas contain Of-Concern Regional Ecosystems including regulated vegetation – remnant, regrowth, and riverine regrowth – and essential habitat, all mainly associated with the watercourses.

It is understood that groundwater is present in coal seams within the mined Rangal Formation and in isolated coarse-grained strata within the overlying Rewan Formation. In the Quaternary alluvium, sub-surface water is only present after significant recharge events. Sampling to date suggests that groundwater at Foxleigh Mine is neutral pH but highly saline.

3.2.3 Hazards at Closure

Compared with aboveground tailings dams, in-pit tailings storage has the great advantage that large-scale release of waste due to dam wall failure, and small-scale release of waste due to dam wall erosion, are not possible. With those exceptions, the potential hazards to be considered at closure are similar to those for aboveground TSFs that were identified in The Minserve Group (2003), namely:

a) Seepage of poor-quality water to groundwater;

b) Seepage of poor-quality water to surface water;

c) Spill of poor-quality water to surface water;

d) Contaminants affecting vegetation;

e) Contaminants entering food chain;

f) Interference with natural surface drainage;

g) Consolidation settlement affecting landform surface drainage;

h) Combustion of tailings; and

i) Dust generation.

Essentially any earthen cover would avoid hazards h) and i); as long as tailings deposition stops below spill level (RL 137m) and the final landform does not pond water, hazard c) will also be averted.

All mine excavation and spoil placement interferes with natural surface drainage in some manner, such that overland flow management must be addressed operationally not just at closure. For the TSF, NT Pit was located roughly along the watershed between the two south-flowing creeks, so the impact on surface flow is limited to the pit's own footprint and hazard f) is not significant.

There are other mining pits, and a planned residual void, east of Cockatoo Creek that have interrupted coal seam, and any overlying, aquifers, down-dip of the TSF. Consequently, any deep seepage from the TSF would be captured in those features and would not reach regional groundwaters - hazard a).

Henderson Geotech (2022) recommended investigation for continuous sand layers within the Quaternary alluvium connecting the TSF with Roper Creek, as an unlikely but possible mechanism by which seepage from the TSF might reach surface and base flows in the creek. Addressing this low risk is an operational matter. A cover constructed over the tailings at closure may have conflicting effects on the potential for seepage to surface waters - hazard b): cessation of tailings discharge and removal of the decant pond would reduce seepage; the weight of landform could temporarily increase pore water pressures in the tailings and consequent seepage; and rainfall infiltration through the landform into the tailings could provide water to continue seepage. The second effect would decrease over time as excess pore pressure equilibrates, but the cover system should aim to minimise recharge of tailings moisture from deep infiltration.

High alkalinity and very high salinity are the only significant geochemical issues with the tailings (refer Section 3.1.2). In this context, adverse effects on vegetation – hazard d) – but not on the higher food chain – hazard e) – could be expected, if water from the tailings flowed upward into the rooting zone. The mechanisms that might drive such flow against gravity are: soil suction (e.g. capillary action) drawing moisture from more saturated to less saturated layers; and consolidation settlement pushing water upwards out of the matrix of tailings solids. To mitigate the hazard to vegetation, the cover system should be designed to provide a barrier between solutes in the tailings and the topsoil and subsoil layers.

Consolidation settlement occurs when the loads on the saturated tailings cause excess pore water pressures and water flows out of the material to reduce those pore pressures until equilibrium is achieved. The amount of settlement varies with depth and water content of the tailings and with height of overlying landform; consequently, settlement is unlikely to be constant over the TSF – hazard g). The cover system cannot prevent consolidation settlement but it can be designed to adapt to the settlement such that the cover can continue to function.

3.3 Cover Design

3.3.1 Objectives and Concept

The hazard control requirements arrived at in Section 3.2.3 are essentially the ideal cover system characteristics outlined in Section 2.3, with an additional requirement to consider tailings consolidation. Reiterating, those requirements, the key objectives of the cover for the in-pit TSF at Foxleigh Mine are:

1. To minimise seepage from the TSF by minimising recharge of tailings moisture from deep infiltration of rainfall;
2. To avoid discharge by upward movement of solutes from tailings into the vegetation rooting zone;
3. To establish vegetation cover comprising grasses and shallow rooting shrubs suitable for grazing; and
4. To accommodate long-term consolidation settlement in the tailings, such that the first two objectives and surface erosional stability are not compromised.

These objectives impose conflicting requirements on cover materials: high permeability for initial infiltration but low permeability to limit seepage; more clay to reduce permeability but less clay to reduce matric (capillary) water suction potential.

The previously discussed conflicts between permeability and water suction potential can be reconciled using a multi-layer cover system and topographic features as follows:

- *Uncompacted subsoil and topsoil shaped to a gently mounded surface, to allow shallow infiltration during rainfall but no surface ponding that would drive deeper seepage;*
- *A layer of lower permeability material finished with a mounded top surface so that any seepage that does reach it will tend to move laterally rather than downward; and*
- *Porous, low clay content material placed directly over the waste to limit upward flow;*

Within this context, gravelly fresh Permian spoil would be suitable for the base cover layer and clay-rich spoil from Tertiary and weathered Permian overburden may be used for the lower permeability layer. Fresh Permian spoil is expected to have somewhat lower salinity and sodicity, so it may also be more suitable for the subsoil layer, subject to chemical amelioration if testing suggest that is necessary.

Tailings consolidation settlement will vary with tailings depth and water content profile (or conversely, density profile) and with cover thickness, and is expected to occur over a long timeframe – potentially decades. *Conceptually, this settlement can be accommodated by making the relevant layers of the cover thicker in the areas where greater settlement is predicted so that mounded interfaces and surfaces will remain mounded after the settlement has occurred.*

3.3.2 Design Details

The over-arching objective for rehabilitation of the in-pit TSF is to create a landform that marries into the adjoining topography, integrating surface drainage and post-mining land uses. The layers comprising the cover system will be part of that landform but not

necessarily all of it – additional fill, not essential to cover performance, may be required to create the required ground surface. Consequently, the following specify minimum layer thicknesses, but actual dimensions could be greater, either to create the integrated landform or from considerations of constructability:

- Low clay content NAF spoil will be used for at least the initial 2m thick layer in contact with crusted tailings. It will be thicker as needed to provide a mounded, free-draining subsurface. The spoil will have minimal compaction to limit moisture suction potential;
- A 1m minimum thickness layer of selected weathered Permian and/or Tertiary spoil, will be spread and worked so as to be more than ten times less permeable than spoil above and below it. The surface will be shaped to shed any deep infiltration out of the landform when constructed and after consolidation settlement has occurred. This will require the surface of the layer to be higher than the pit wall crest at the point where any such drainage would exit the landform;
- A 2m minimum thickness of more permeable material such as gravelly fresh Permian spoil will be placed over the low permeability layer. The thickness may be greater than 2m in places to provide a final ground surface that will shed rainfall without ponding with slopes not greater than those on rehabilitated spoil emplacement areas;
- Topsoil, vegetation and erosion management practices consistent with those for other areas being rehabilitated to a grazing Post-Mining Land Use.

Any estimates of the amount and rate of tailings settlement based only on laboratory consolidation testing would have poor reliability and accuracy because a small number of artificially prepared specimens are unlikely to be representative of in situ conditions when the cover is about to be constructed. As discussed in the following Section 3.3.3, in situ investigation of strength and relative density/moisture profiles should be undertaken after tailings discharge has ceased and the tailings surface has had time to dewater and develop a crust. This data will allow better estimates of consolidation settlement that can then be used to prepare detailed design geometry.

3.3.3 Construction Methodology

The challenge in placing a first layer of cover material over soft fine waste, is that the cover needs to be thick enough to spread the weight of the construction equipment (so that the resultant pressure is low enough to avoid bearing failure), without being so thick that the weight of the cover material causes bearing failure itself. The strength and thickness of the tailings surface crust is critical to being able to meet both constraints, but it is obvious from Figure 3-2 that both parameters can vary over significant ranges. For this reason, the filled TSF should be allowed to dewater and desiccate for at least two dry seasons before in situ strength profiles are measured and used to undertake geomechanical design of the construction sequence. Even then, considering the inherent variability in tailings due to changes in CHPP feed and product targets, and the effects of beaching and sorting at discharge, it should be expected that the cover design and the construction schedule will be further modified based on monitoring as the initial layers are placed.

Once the first layer has been placed, it may possible to proceed using normal spoil dumping practices up to the underside of the low permeability player. The actual dumping strategy should be confirmed by geomechanical analysis, including estimation of consolidation settlement, after the first layer is completed. Topographic (survey) monitoring should continue until an appropriately qualified geotechnical engineer has reviewed the monitoring results and confirmed that predicted remaining differential settlement will not compromise the final mounded shape of the subsequent low permeability layer.

it is recommended that QC/QA for the low permeability layer be based on coefficient of permeability, which is the geomechanical property that most directly affects cover system performance. For QC, a test area could be prepared using the proposed spoil material and construction methodology. In situ infiltration tests would be undertaken to measure permeability, and the material and/or method modified as necessary, until the design coefficient of saturated permeability (for example, k_v ≤5e-8m/s) is consistently achieved. The resultant material and method can then be used to construct the whole layer, with further infiltration testing as appropriate to provide QA.

To ensure the desired contrast in permeability, spoil directly above the low permeability layer should be dumped and spread in thicker layers where practicable. As the spoil surface approaches the levels of the final landform, areas with the greatest predicted remaining consolidation settlement may be over-dumped by a couple of metres to hasten and balance that settlement.

After completion of bulk earthworks, the landform may be left for a period (potentially 2-3 years) while further consolidation settlement occurs. When topographic monitoring indicates that the remaining settlement is within a manageable range (nominally <0.3m), the surface will be cut-and-filled to final design profile. The area will then be rehabilitated in accordance with normal site practices for spoil dumps, including topsoil placement and construction of erosion control measures. The vegetation species mix must be consistent with roots of mature plants not reaching the low permeability layer.

4 COARSE REJECTS EMPLACEMENT

4.1 Characterisation

4.1.1 Physical Properties

Size grading data collated from mines in the Bowen Basin and summarised on Figure 4-1 indicates a composition ranging from *GRAVEL with sand* to *Sandy GRAVEL* (Standards Australia Limited, 2017). Results of physical testing of coarse rejects specifically from Foxleigh Mine were not available but coarse rejects are produced by the CHPP Dense Medium Cyclone circuit, which operates at the 50mm to 1.4mm size range. Noting that gravel is >2.36mm and sand is 2.36mm to 0.075mm, it is therefore expected that coarse rejects at Foxleigh Mine are consistent with the collated data.

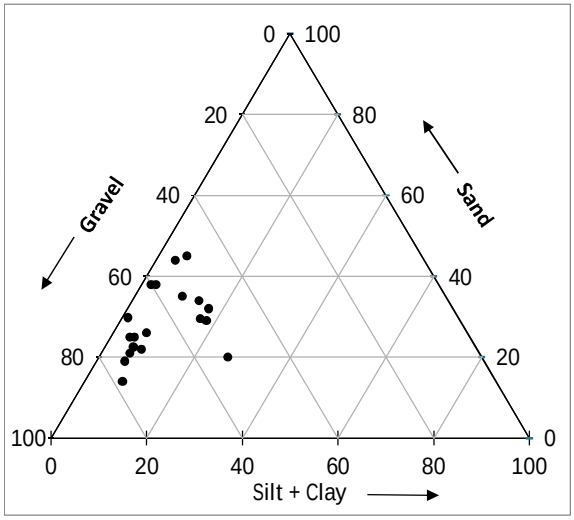


Figure 4-1: Particle Size Distribution of Coarse Rejects in the Bowen Basin

The classification and Sandy GRAVEL is also consistent with field observation that coarse rejects are a non-cohesive non-plastic material exhibiting frictional strength and high permeability.

Solids particle density (specific gravity) will vary with the ratio of fresh Permian spoil (from seam roof and floor) to coal. For example, 20% coal would produce an average solids particle density of about 2.4t/m^3 whereas 40% coal would produce an average of about 2.1t/m^3.

As an unsaturated non-cohesive material, coarse rejects will not experience consolidation settlement overtime. Some settlement is expected as the cover is constructed and imposes vertical load on the rejects and there may be further settlement due to moisture adjustment and particle breakage but significant settlement after the first few years is unlikely.

4.1.2 Chemical Properties

RGS (2021) reported results of static geochemical testing on ten samples of actual coarse rejects from stockpile and 68 samples of potential coarse rejects (roof and floor material from boreholes), and of kinetic testing on one composite rejects sample. Based on the stockpile sample results, coarse rejects at Foxleigh Mine are strongly alkaline, highly saline, have variable risk of generating acidity and show no significant metal/metalloid enrichment. Core samples of roof and floor ranged from moderately to very strongly alkaline but showed the same variability in acid generation potential. Overall, bulk potential coal reject material was classified as Non-Acid Forming (NAF).

4.1.3 In Situ Properties

The gravelly character of coarse rejects makes them difficult to test appropriately in situ. Seventeen laboratory shear test results collated from other mines in the Bowen Basin gave a median friction angle of 34° with two-thirds of the results within the range of 29° to 39°.

Because the waste is free draining (highly permeable) and not subject to consolidation settlement density-moisture profiles are not important for rehabilitation design.

4.2 Coarse Rejects Dumps

4.2.1 Description

The coarse rejects emplacement (CRE) wraps around the eastern side of the spoil dump immediately east of the CHPP, and is currently extending northward to fill Old NE Pit void. The planned final footprint of the CRE covers about 104Ha and is about 2.7km north-to-south and less than 0.5km east-west.

It is understood that the final height of the CRE will be less than 20m above pre-mining ground level, in order to integrate with the adjoining spoil landform, and that the outer slopes will be <10%.

4.2.2 Surrounding Environment

The southern end of the CRE is close to the north-eastern wall of the In-Pit TSF and as previously noted, a spoil dump sits between the CRE and the CHPP. Unmined ground falls gently (<1% slope) from the CRE to Cockatoo Creek Diversion about 1.2km further east.

As described in Section 3.2.2, Cockatoo Creek joins Roper Creek at the southern end of the mine, and Roper Creek joins the MacKenzie River further downstream. There is an area of Of-Concern Regional Ecosystem comprising mainly essential habitat along the pre-diversion path of Cockatoo Creek.

4.2.3 Hazards at Closure

Truck-dumped coarse rejects are unsaturated and geotechnically competent. The former means. With only a small volume of entrained water, seepage to groundwater is highly unlikely and spill to surface water is not feasible. Any settlement will be short-term so disruption of the final landform surface will be minimal, and gravel-sand composition limits dust generation potential. Therefore, the relevant potential hazards to address in closure are:

a) Seepage to surface water;

b) Contaminants affecting vegetation;

c) Contaminants entering food chain;

d) Interference with natural surface drainage; and

e) Combustion of coarse rejects.

Although there is little water initially in the rejects, if enough rainfall infiltrated it could flow through and seep out of the landform toe, carrying soluble contaminants. Hence the cover system once again should minimise flow of rainwater into the CHPP waste. Once again in the context of there being little stored water, significant amounts of soluble contaminants could only reach vegetation and the food chain if rainfall reached the coarse rejects and then flowed up out again.

As noted in Section 3.2.3, all mine excavation and spoil placement affects natural surface drainage. Because it abuts an existing spoil dump and will backfill a void, the incremental impact of the CRE will be relatively minor.

Finally, any occurrence of spontaneous combustion in the coarse rejects would have been identified and treated during mining operations. That leaves only external combustion, for example, from bushfires and a cover system designed to limit deep infiltration will be sufficient to avoid this hazard.

4.3 Cover Design

4.3.1 Objectives and Concept

Without the complications of a large volume of contained water and slow consolidation settlement, the key objective of the cover system for the Coarse Rejects Emplacement is simply:

1. To minimise water entering the coarse reject from deep infiltration of rainfall.

This could be achieved with a single cover layer of low permeability material on a mounded free-draining landform. However, it is expected that the landform will also be required to support vegetation and hence the proposed cover system design comprises:

- *Uncompacted subsoil and topsoil shaped to a gently mounded surface, to allow shallow infiltration during rainfall but no surface ponding that would drive deeper seepage; and*
- *A layer of lower permeability material finished with a mounded top surface so that any seepage that does reach it will tend to move laterally rather than downward.*

As for the TSF cover system, clay-rich spoil from Tertiary and weathered Permian overburden may be used for the low permeability layer with less clayey (and ideally less saline and sodic) spoil selected for the subsoil layer.

4.3.2 Design Details

The following are proposed as minimum layer thicknesses required to meet the design objective. In practice, these may be increased to include construction tolerances and equipment operational limits:

- (Optional) Low clay content NAF spoil may be used for an initial layer in contact with coarse rejects to create the bulk landform shape. The spoil will have minimal compaction to limit moisture suction potential;
- A 1m minimum thickness layer of selected weathered Permian and/or Tertiary spoil, will be spread and worked so as to be more than ten times less permeable than spoil above it. The surface will be shaped to shed any deep infiltration out of the landform;
- A 2m minimum thickness of more permeable material such as gravelly fresh Permian spoil will be placed over the low permeability layer. The thickness may be greater than 2m as needed to maintain separation between the vegetation rooting zone and the low permeability layer, and to provide a final ground surface that will shed rainfall without ponding with slopes not greater than those on rehabilitated spoil emplacement areas;

- Topsoil and erosion management practices consistent with those on rehabilitated spoil emplacement areas.

4.3.3 Construction Methodology

Shear strengths of both coarse rejects and spoil are such that 10% slopes will be geotechnically stable and no special measures will be required to construct the cover.

QC/QA for the low permeability layer should follow the same approach as described for the TSF in Section 3.3.3.

5 FUTURE WORK

The cover systems described herein are preliminary designs based on information available at July 2023.

As emphasised in Section 3.3.3, construction design for the TSF cover cannot be finalised until in situ strength profiles are measured and this can only be done after tailings deposition is completed. However, current and future operational procedures will strongly influence those strength profiles, with the two most beneficial measures being:

- Continuously removing as much decant water as possible from the tailings surface, to promote dewatering and densification; and
- Regularly moving the discharge point and the decant pond, to avoid the finest waste accumulating in one area that also has least opportunity for desiccation.

These actions should be included in standard operating procedures for the TSF and compliance should be enforced.

Spoil that may be suitable for the various cover layers should be identified as it is mined, nominally from Eagles Nest Pit and WC North Pit. Ideally, it would be left in dump for a couple of years to observe slaking and other degradation before samples for classification testing including silt/clay fraction and plasticity. In situ infiltration tests to confirm construction materials and methodology may be undertaken after suitable spoils have been identified and must be completed before the design is finalised.

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Appendix M: Engeny Geotechnical PRCP Assessment

ENGENY

FOXLEIGH MANAGEMENT PTY LTD

Foxleigh Mine Progressive Rehabilitation Closure Plan

Residual Voids Geotechnical Assessment

QC1025_010-REP-001-1

29 AUGUST 2023

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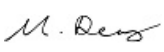
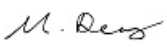
Rev	Date	Description	Author	Reviewer	Project Mgr.	Approver
0	8/08/2023	Uncontrolled Draft Issue for Client Review	Alex Leotta	Matthew Dews	Tegan Ireland	Matthew Dews
1	29/08/2023	Final Issue	Alex Leotta	Matthew Dews	Tegan Ireland	Matthew Dews
Signatures:						

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1. INTRODUCTION

1.1 Background

Engeny is providing consulting services to support the development of the Progressive Rehabilitation and Closure Plan (PRCP) for Foxleigh Mine, operated by Foxleigh Management Pty Ltd (FoxMan).

Justification for voids / Non-Use Management Areas (NUMAs) is a requirement as per the Department of Environment and Science's (DES) Guideline: *Progressive rehabilitation and closure plans (PRC plans)* (ESR/2019/4964). This technical report is specific to the geotechnical technical inputs to the PRCP relating to voids / Non-use Management Areas (NUMAs). This includes geotechnical reviews and assessment of high, end and low walls and out-of-pit dumps.

1.2 Objectives

The objective of this technical study is to support the closure of residual voids (NUMAs) at Foxleigh Mine. The outcomes are specified as:

- Demonstrating safe and sustainable final slope angles of the high wall, low wall and end walls of each final void.
- Pit wall geotechnical stability considering long-term effects.

These outcomes are required to satisfy the PRCP guidelines for geotechnical stability of the proposed NUMAs.

1.3 Scope of Work

To enable development of the technical inputs to the PRCP relating to voids / NUMAs, the following scope of work has been undertaken:

- Review of available data including existing void and pit geometries, materials characterisation, stability assessments, and other relevant geological/geotechnical information.
- Develop a tabulated basis of assessment include sources of survey/geometric data, material strengths, and other assumptions.
- Develop representative cross-sections of the slopes of the final voids including the high wall, end walls, low walls, and ramp slopes.
- Review the available data and undertake conceptual geotechnical stability risk assessments, informed by geometry and host rock properties. Sensitivity modelling will be undertaken to represent all voids across the site.
- The stability assessment will incorporate existing studies (Cartledge Mining and Geotechnics, 2021) and any findings from Engeny's concurrent scopes on landform evolution and void water balance, including any potential long-term steepening/ flattening of slopes from erosion/ weathering, and the critical long-term water level in the final void.
- Preparation of a technical report presenting the geotechnical models and outcomes.

1.4 Legislative Context

1.4.1 PRCP Guideline

In accordance with Version 3 of the PRCP Guideline (2023), Table 1.1 details the specific void requirements relating to geotechnical stability and provides reference to this document in response to each item. Geochemical stability is addressed as part of other specialist studies.

TABLE 1.1: PRCP VOID REQUIREMENTS

PRCP Guideline		Document Reference	
Section	**Void Requirements**	**Section**	**Comment**
3.6.3	Options available for minimising final void area and volume (where a final void is proposed).	Section 2 and 4	Geotechnical assessment.
3.6.3	Proposed final dimensions of the void (i.e. depth, length and width).	Environmental Authority EPML00744813, Appendix 4	Approved residual voids are detailed in the FoxMan EA.
3.6.3	Pit wall geotechnical stability, considering the effects of long-term erosion and weathering of the pit wall and the effects of significant hydrological events.	Section 4	Geotechnical assessment.
3.6.3	Proposed final slope angles of high wall, low wall and end wall of each final void.	Section 2 and 4 Environmental Authority EPML00744813, Appendix 4	Rehabilitation requirements as per the EA used as the basis for the FoxMan landform design and assessed in Section 2 and 4.
3.6.3	How the void(s) will achieve post-closure slopes that will exhibit stability characteristics consistent with the planning and design of the post-closure mine void.	Section 4	Geotechnical assessment.
3.6.3	Demonstrate mechanisms for achieving acceptable geotechnical stability, including methods and techniques for achieving safe slopes.	Section 4	Geotechnical assessment.
3.6.3	Where applicable, methods and techniques for achieving safe slopes must be detailed.	Section 2 and 4	Geotechnical assessment.

1.4.2 Environmental Authority

The Foxleigh Mine Environmental Authority (EA) (EPML00744813) states that the residual voids shall be rehabilitated to achieve a safe and stable outcome. Final voids are to be reshaped to slope ranges:

- <275% (<70 degrees) for in situ pit walls and floor slopes.
- <70% (<35 degrees) for backfilled spoil walls and floor within the NUMA footprint.
- Determined based on appropriate risk assessment conducted by a suitable qualified person.

This technical assessment aims to address this risk assessment by undertaking suitable analysis to determine safe and stable residual voids in accordance with the EA.

2. PROPOSED RESIDUAL VOIDS

2.1 Overview

The final Foxleigh landform was modelled using the supplied data outlined in Table 2.2. The final voids features are illustrated in Figure 2.1 and Table 2.1.

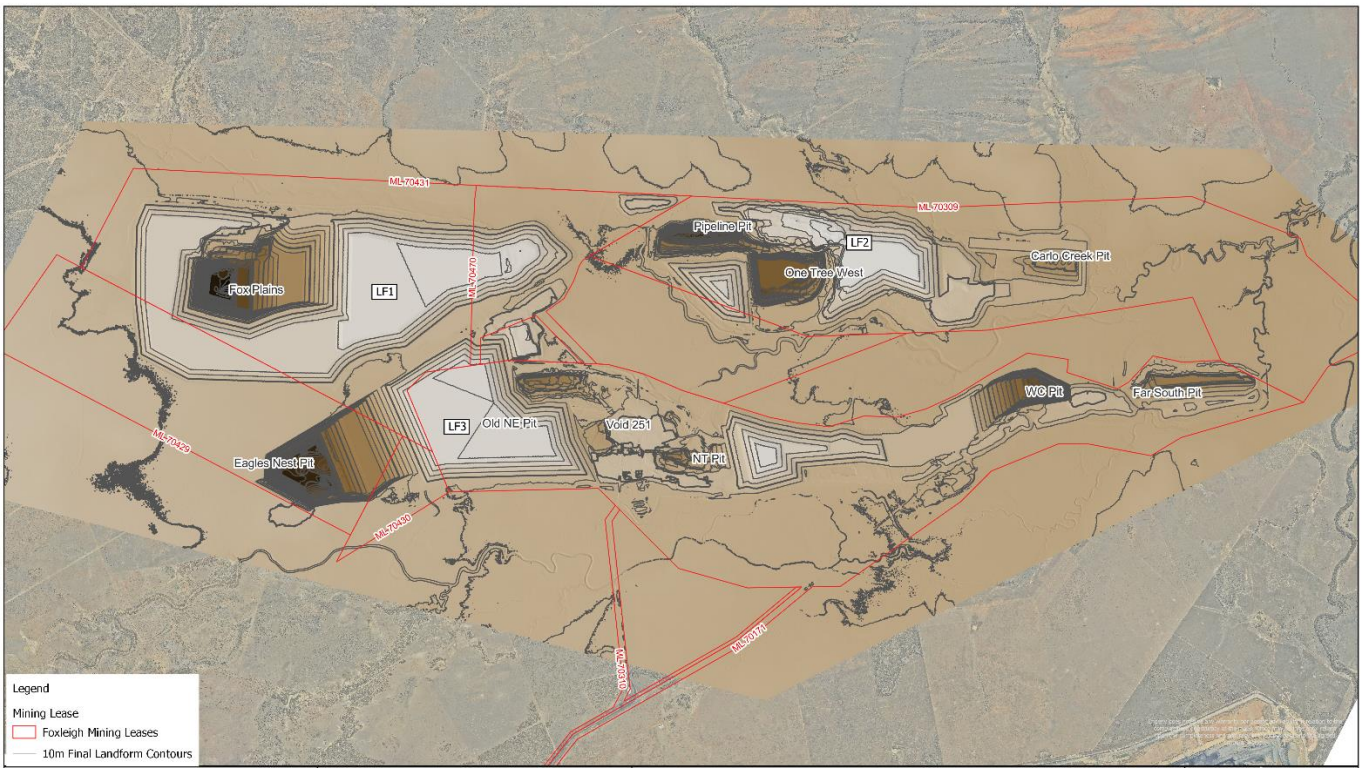


Figure 2.1: Final Landform and Voids

TABLE 2.1: FINAL VOID PRINCIPAL FEATURES

Pit Name	Final Pit Depth (mAHD)	Final Pit Length (m)[1]	Final Pit Width (m)[1]	High Wall Batter Angle (degrees)	Low Wall Pit Floor Angle (degrees)
Eagle Nest	-65	2,150	1,400	38	6.5
Fox Plains	-130	2,400	1,400	35	6.5
One Tree West	-29	1,250	850	35	21.5
Pipeline Pit	-43	1,550	550	38	30.5
WC Pit	-15	1,450	950	33	6.5
Far South	70	2,050	750	30.5	12.5
Carlo Pit	86	1,100	850	23.5	3.5

Note: [1] Pit length and width dimensions rounded to the nearest 50 m. Measured from FoxMan supplied final landform and bottom pit surveys.

2.2 Existing Information and Studies

The following data and input (provided by others) has been used for this assessment.

TABLE 2.2: SUPPLIED DATA AND EXISTING ASSESSMENTS

Data Type	Date	Author	Title
Imagery	25/01/2023	Foxleigh Mine	PRJ42861_Foxleigh_50cm_20230125.ecw
Survey	04/01/2023	Foxleigh Mine	PRJ42861_Foxleigh_MKP_20230104.xyz
Survey	2020	Foxleigh Mine	Carlo Pit Bottom 2020.csv Far South Pit Bottom 2020.csv NE Pit Bottom 2020.csv NT Pit Bottom 2020.csv NW Pit Bottom 2020.csv Old NE Pit Bottom 2020.csv PIPELINE PIT BOTTOM 2021.csv Void 251 Pit Bottom 2020.csv WC North Pit Bottom 2020.csv WC Pit Bottom 2020.csv
Landform Designs	17/07/2023 (date of supply)	Foxleigh Mine	Foxleigh Rehab landforms.dxf
Geological Surfaces	17/07/2023 (date of supply)	Foxleigh Mine	bhw.dat bter.dat mmt1_floor.dat mmt1_roof.dat pi1b_floor.dat pi1b_roof.dat pi2a_floor.dat pi2a_roof.dat rop1_floor.dat rop1_roof.dat tra2_floor.dat tra2_roof.dat
Geotechnical Report	2021	Cartledge Mining and Geotechnics	Final Void Summary Report (Cartledge Mining and Geotechnics, 2021)

2.2.1 Active Highwall Assessment

A probabilistic geotechnical analysis has been undertaken on active highwalls (Cartledge Mining and Geotechnics, 2021) to determine appropriate treatments of highwalls prior to closure (refer Appendix B). The probability of failure (PoF) method of assessment, rather than

traditional factor of safety (FoS), was used to determine safe and sustainable slopes for long-term closure. The PoF considers the variability in the geology and materials, however requires a statistically meaningful dataset.

The PoF assessment was undertaken using unconfined compressive strength (UCS) data for fresh interburden and coal measure rocks only. The PoF is therefore only determined for slope failure surfaces passing through these units, i.e. the active highwall. The FoS method was adopted for failure surfaces passing through the weathered Permian and/or Tertiary units. The assessment did not consider the impacts of the proposed out-of-pit landforms.

A summary of the findings are presented below, with the full report included in Appendix A:

- The PoF is 0% for the highwalls and endwall, indicating that the consolidated rock mass can remain in its current geometry and exhibit long-term stability.

Most of the walls have been standing unsupported for several years already without any indication of global scale instability.

To further improve the robustness of the geotechnical model, it is recommended that geotechnical samples be collected as part of future investigation programs.

The analyses did not address the risk of instability controlled by geological structure. Verification of the adopted assumptions is required through visual inspection and mapping.

Based on the study, recommended slope geometries were provided and presented in Table 2.3.

TABLE 2.3: DESIGN PROFILE RECOMMENDTIONS (CARTLEDGE MINING AND GEOTECHNICS, 2021)

Material Type	Cut Slope Angle	Bench Width*
Tertiary	22 degrees	15 m
Weathered Permian	45 degrees	N/A
Pre-split Highwall	N/A**	N/A
Waste Dumps	Adopt slope recommendations provided in the EA	

* Benches are to be constructed at the base of the unit

** No changes to these profiles is required to satisfy long-term stability requirements

In summary, the long-term stability assessment of active highwalls revealed that the EA criteria for competent walls are conservative and that the current wall exposures for fresh Permian (pit slope angle varies for each void) satisfy the minimum geotechnical requirements. Slope modification is required for the weathered Permian and Tertiary units, which forms the basis of this technical study.

2.3 Geology

The project area is located in the central portion of the roughly north-south trending, Early Permian to Late Triassic Bowen Basin. The basin is part of a larger amalgamation of sedimentary basins consisting of the Surat, Clarence-Moreton and Mulgidie basins, which are located to the south. Geologic formations within the three basins generally comprise various layers of sandstone, siltstone and mudstone that were primarily deposited by rivers and lakes, with occasional marine influences, refer Figure 2.2.

Deposition in the Bowen Basin commenced during an Early Permian extensional phase (back-arc tectonic rifting) with fluvial and lacustrine sediments and volcanics being deposited in a series of half grabens structural controls in the east, while a western succession of coals and non-marine clastics were deposited.

Post tectonic rifting, a thermal subsidence phase extending from the Early to Late Permian, which accommodated a basin transgression and the deposition of deltaic, shallow marine and extensive coal measures. Continued deposition of marine and fluvial clastics and coal was experienced until the late Permian forming the 200 m thick Rangal Coal Measures. This was followed unconformably by further depositions of Middle to Late Triassic fluvial and lacustrine clastics of the Rewan Group and eventually terminated by the middle to late Triassic (Geosciences Australia, 2015).

Although the depositional history of the Bowen Basin can be broadly summarised, the fine elements of basinal geology is complex and individual formations are not always laterally extensive or easy to correlate across the basin. The stratigraphy relevant to the project is presented in the relevant sections below.

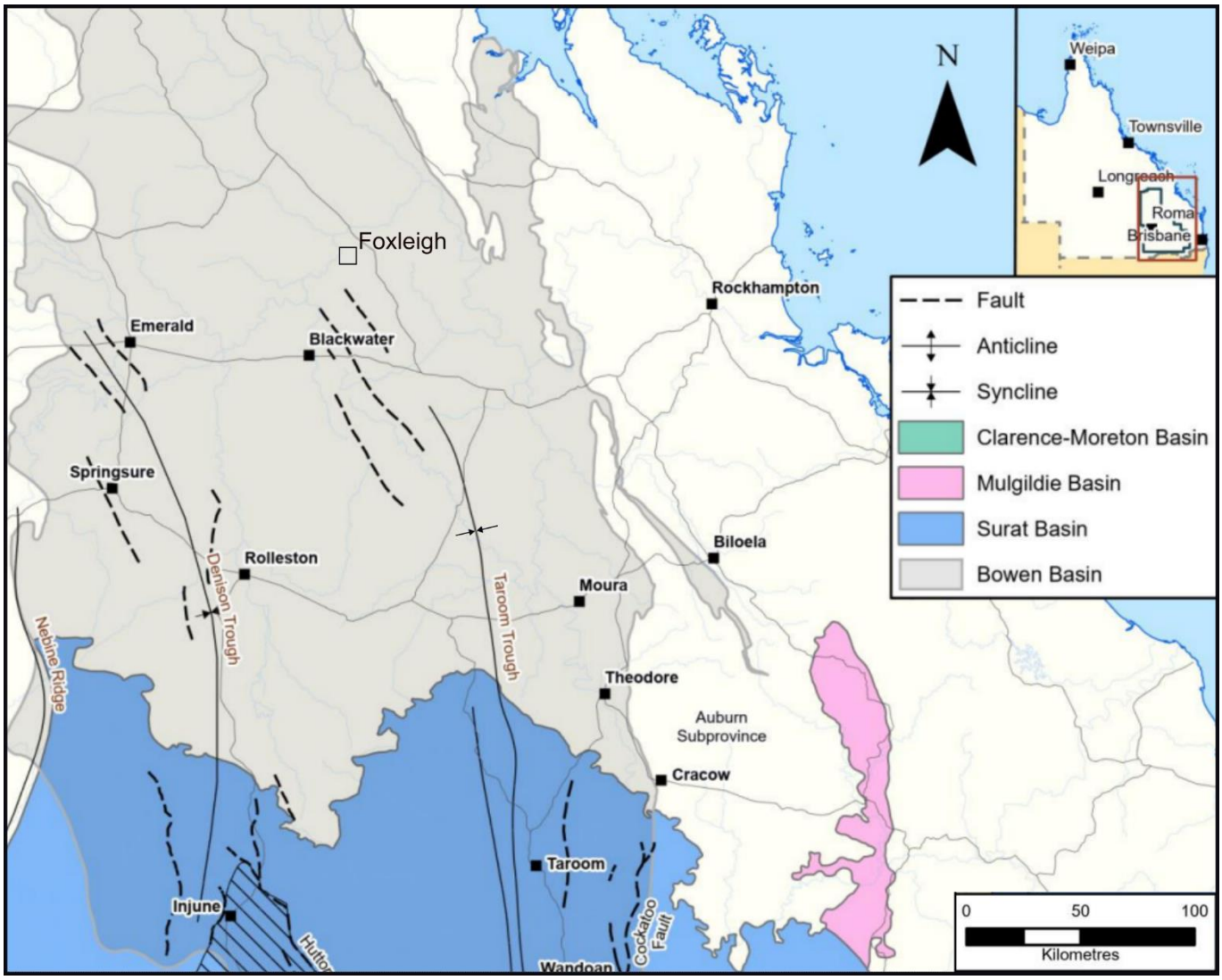


Figure 2.2: Overview of Sedimentary Basins in Central Queensland, after OGIA, 2021.

2.3.1 Stratigraphy

The relevant stratigraphy is illustrated in the stratigraphic column presented in and surface geological plan presented in Figure 9 and comprises, from youngest to oldest:

- Quaternary age unconsolidated alluvial deposits (Qpa/Qa) associated with the existing creek and river network and colluvial fringing deposits.
- Tertiary age poorly consolidated sediments of the Duaringa Formation (or equivalents) (Tu) sandstone and mudstone and Tertiary intrusive rocks (Ti).
- Early Triassic Rewan Group strata of the Rewan Formation (Rr, subcrop only), consisting of mudstone, siltstone and clayey sandstone resting unconformably atop.
- Late Permian age Blackwater Group (Pw) strata including the Rangal Coal Measures (Pwj, subcrop only), underlying Burngrove Formation (Pwg) and basal Fair Hill Formation (Pwt).

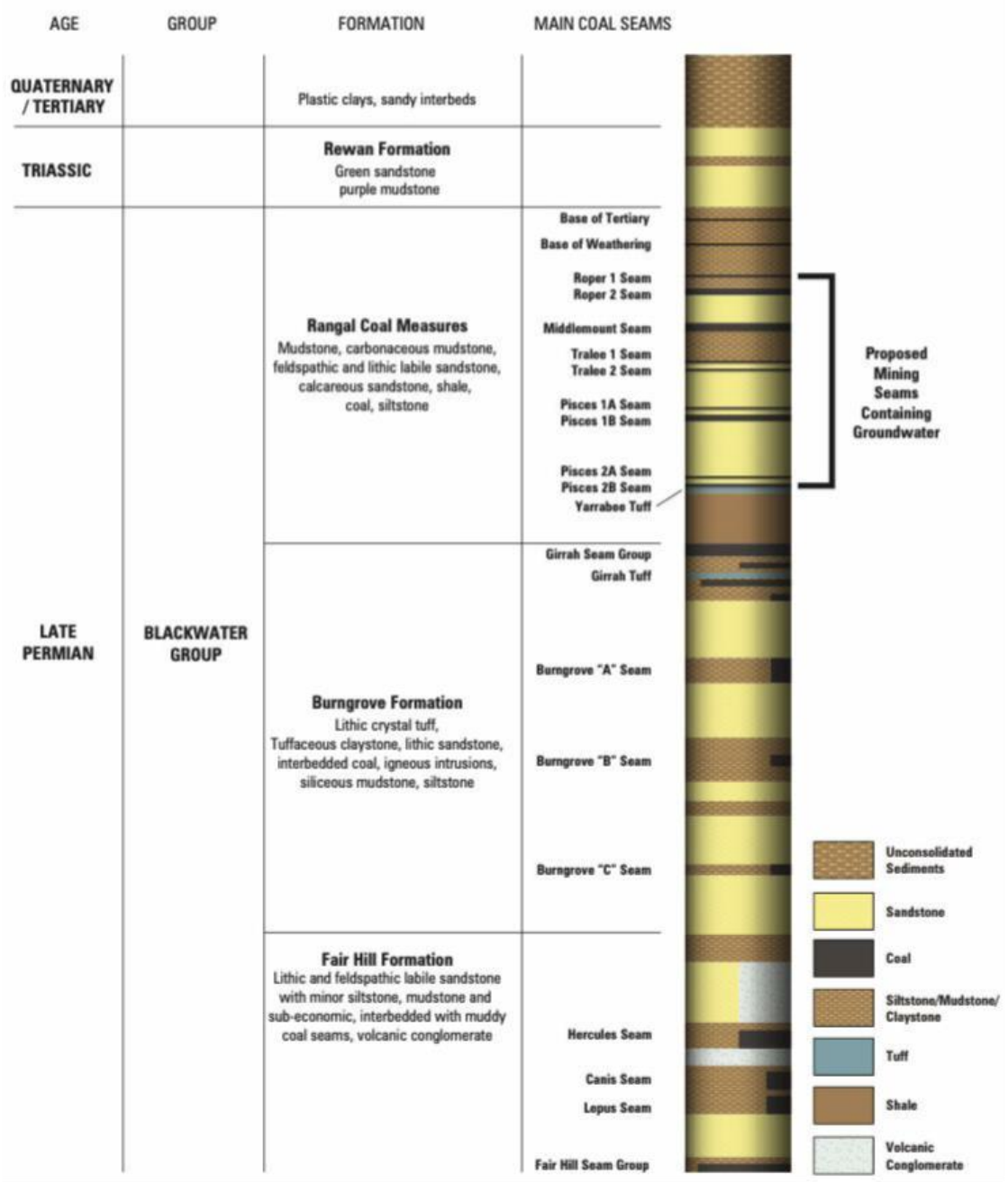


Figure 2.3: Stratigraphic Column (after JBT, 2013)

2.3.1.1 Quarternary Deposits

Quaternary deposits within the study area are associated with the stream channels and flood plains of Roper Creek and Cockatoo Creek. These flood plains deposits appear to become thicker at the southern limit of the site. The expected materials consist of sandy clays/clayey sands and clays.

2.3.1.2 Tertiary deposits

2.3.1.2.1 Duringa Formation

Consists of poorly consolidated sandstones and mudstones. The stratum generally occurs as surficial sediments incised by local alluvial deposits.

2.3.1.2.2 Intrusive Igneous Rocks

A cretaceous volcanic event led to the emplacement of intrusive structures and subsequent Tertiary intrusions as the entire basin was subjected to a long period of deep weathering. These deposits mantle much of the basin with surface basalt and associated intermediate rocks. Regional mapping shows these deposits outcrop approximately 20 km away from the site area. Minor dolerite dykes may be present.

2.3.1.2.3 Triassic Strata

Consists of sandstone, siltstone and mudstones belonging to the Rewan Goup sediments, however, these do not outcrop within the project area.

2.3.1.3 Permian Strata

Permian strata (Blackwater Group sediments) are broken into functional subgroups based on the presence of particular coal seams and volcanic tuffs. Generally, the strata in each of these units consist of relatively well lithified sandstones, siltstones and mudstones. The Rangal coal measures is the principally targeted formations, whereby, the coal seams dip between 1-10 degrees and interrupted by thrust faulting.

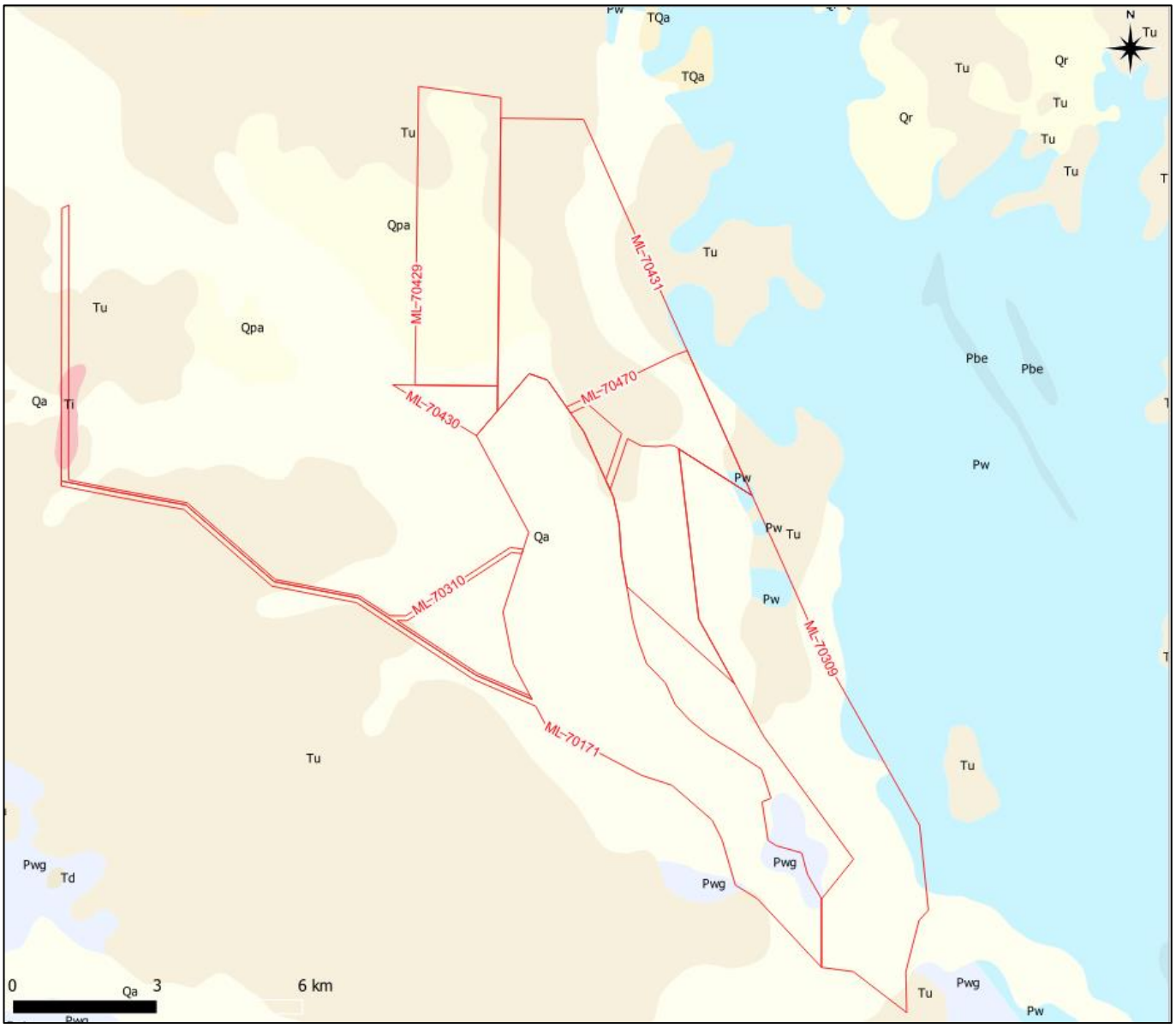


Figure 2.4: Regional Detailed Geology displayed together with the Foxleigh Mining Lease

3. GEOTECHNICAL MODEL

3.1 Summary of the Geotechnical Model

The geotechnical model was built from the following supplied point data sets:

- **Existing Topography –** PRJ42861_Foxleigh_MKP_20230104.xyz
- **Pit Voids –** PIPELINE PIT BOTTOM 2021.csv, NE Pit.csv, etc.
- **Final landform design –** Foxleigh Rehab landforms.dxf
- **Base of tertiary material –** bter.dat
- **Base of highly weathered Permian –** bhw.dat

Based on the above datasets, the site geology can be grouped into geotechnical units. Each of the geotechnical units, together with a brief description of the expected materials are as follows:

- **Backfill** – reshaped overburden and excavated spoil. This material is expected to be extremely heterogeneous spanning from quaternary alluvial soils to boulders of fresh Permian rocks.
- **Tertiary Sediments** – consisting of highly weathered and poorly consolidated sandstones and mudstones and minor alluvial soils. Due to the difficulty of modelling in incised alluvial channels and igneous intrusions at the resolution of this study, all tertiary material has been included as one geotechnical unit.
- **Highly Weathered Permian Sedimentary Sequences** – defined here as highly and moderately weathered, low to moderate strength interbedded sandstone, siltstone, mudstone and coal interbeds. Individual coal units have not been included within the block model.
- **Fresh Permian Sedimentary Sequences** – defined here as slightly weathered or fresh, moderate to high strength interbedded sandstone, siltstone, mudstone and coal interbeds. Individual coal units have not been included within the block model.

3.2 Methodology

Engeny used the 3D Geological Modelling software package Leapfrog Works to help the understanding and visualisation of subsurface conditions for the project. The model was built in three main steps and are described as follows:

1) **Topographic LiDAR resampling and definition of base of pits**

   The provided topographic LiDAR was too large to model in detail, so the data set was resampled at one-eighth of the original point density to allow for the data to be triangulated into a topographic surface. Once this surface was defined the point data sets for the supplied base of pits were triangulated and merged with the LiDAR data set. This was done to define the topographic surface beneath any of the in-pit water storages.

2) **Definition of final landform surface**

   The supplied Foxleigh Mine landform designs were combined with the corrected topographic surface to determine the extents of filling within the pits and cutting of out of pit dumps.

3) **Triangulation of Geological Surfaces**

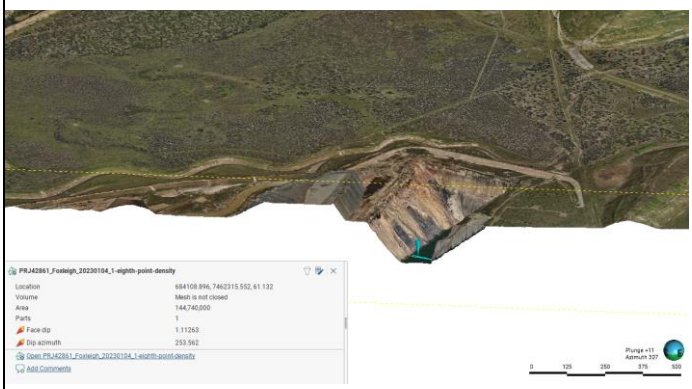
   The geological surfaces representing the base of tertiary (btw.dat) and base of highly weathered Permian (bhw.dat) were imported and triangulated.

4) **Production of geological block model**

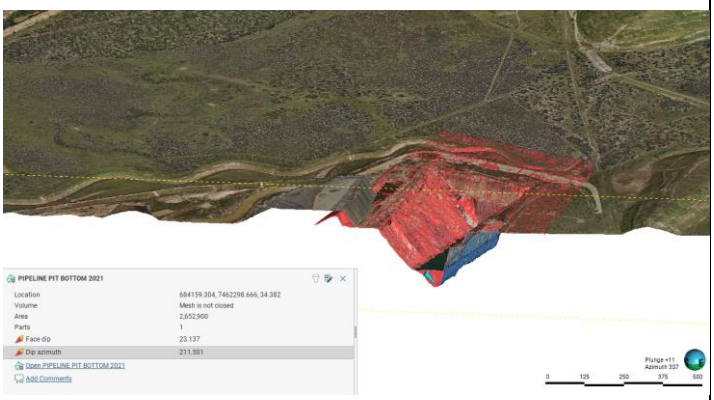
   A simple block model using the final landform, corrected topography, base of tertiary and base of weathering were used to define where material was cut, filled and where the main geological layers were spatially distributed within the final pit arrangements.

Figure 3.1 below illustrates the modelling methodology completed for Pipeline pit.

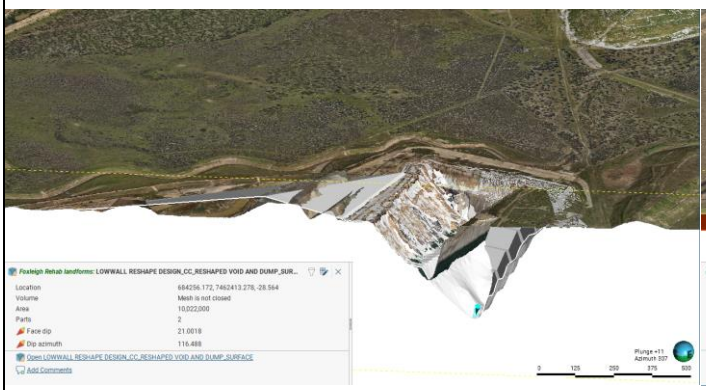
1 a) Resample and triangulate existing LiDAR data.



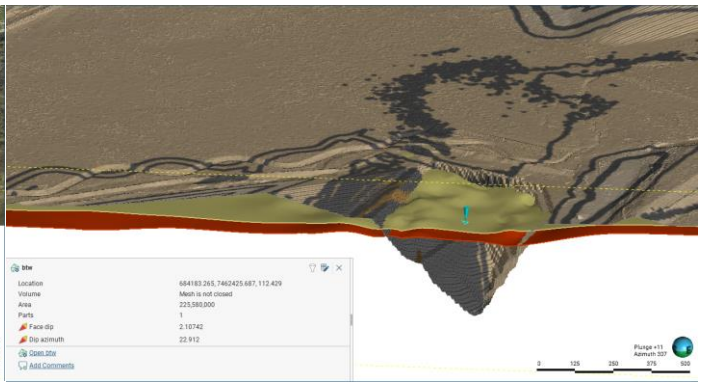
1 b) Correct LiDAR with base of pit survey data.



2) Merge with Foxleigh Mine landform design to define final landform surface to define cut / fill volumes.



3) Triangulation of base of tertiary and base of highly weathered Permian geological surfaces.



4) Production of geological block model

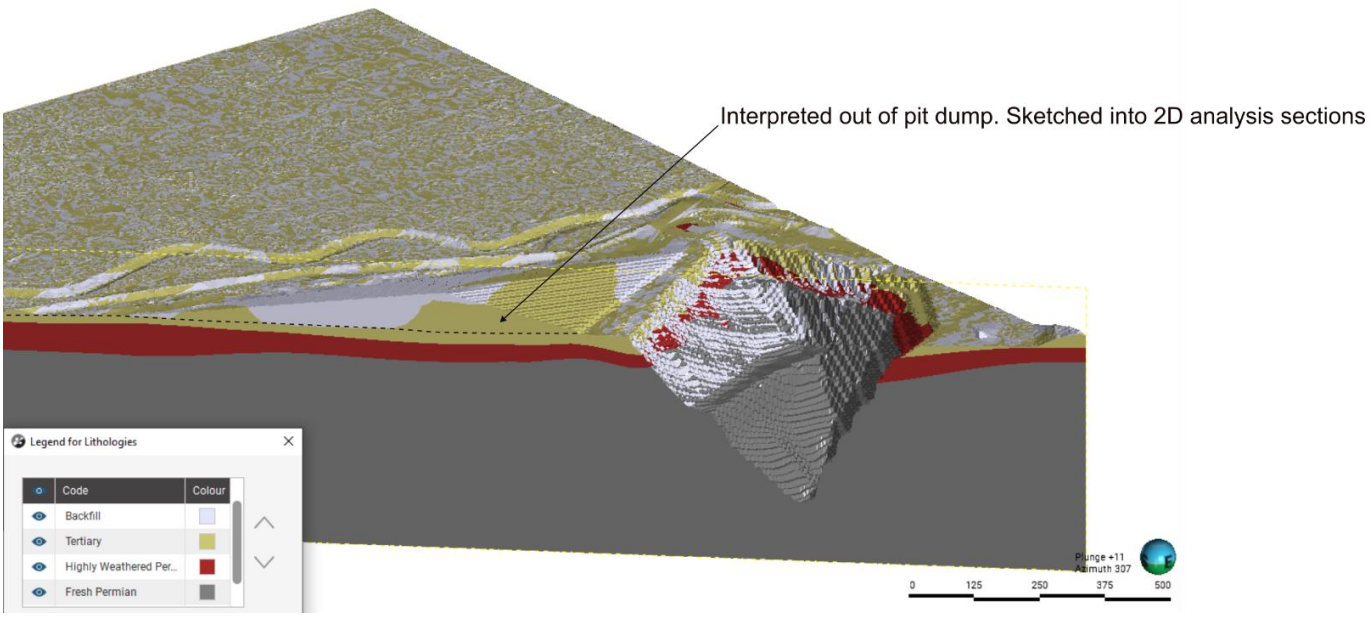


Figure 3.1: Leapfrog 3D Geotechnical Modelling Methodology Steps Completed for the Pipeline Pit Geotechnical Model (typical)

These geological models were exported to 2D sections and formed the basis of the geotechnical stability analyses outlined in Section 4.

3.3 Model Assumptions and Limitations

The following assumptions and limitations have been adopted for the site geotechnical model:

- The geological models are triangulated from points supplied by FoxMan. These points have not been cross-referenced with other data sources including but not limited to borehole data, geological mapping and site photographs.
- The geological models do not include the definition of out-of-pit and in-pit dumps. The modelled tertiary surfaces include out-of-pit dumps within the 3D geological model and the 2D sections are corrected (based off the existing LiDAR) prior to modelling within Geostudio analyses as outlined in Section 4.
- No structural geological elements and kinematic controls have been considered as part of this assessment and geological modelling.
- No coal layers have been included as part of the geological model. Where higher resolution studies are required, coal layers can be modelled upon request.

4. GEOTECHNICAL ASSESSMENT

Geotechnical stability assessments have been completed to demonstrate that post closure conceptual void slopes will exhibit long-term geotechnical stability for the residual voids. The outcomes from this assessment are described below.

4.1 Pit Wall Assessment

4.1.1 Methodology

Stability assessment of the pit slopes were analysed using 2-dimensional limit equilibrium (LE) analyses. LE analyses are a widely accepted practical industry method for assessment of slope stability, including pit slopes. Inputs for the stability assessment include pit slope geometry, materials and strengths, and groundwater conditions.

It is noted that this assessment does not intend to consider small-scale localised slope instabilities including inter-ramp and bench-scale failures such as toppling, planar or wedge failures. Rather, it is large-scale or global slip failures of the pit slopes that have a material impact on the long-term stability and safety of the void, valuable assets or PMLUs around the void. This will define the suitable set-back distanced from the pit. The design of the residual voids has considered the following:

- Slopes designed to be geotechnically stable.
- Catchments diverted to reduce inflows of surface water.
- Design of the void extent to ensure the void acts as a sink for groundwater post closure, with the pit lake equilibrium level below the long-term groundwater level.
- Design of the void extent to ensure no overflows from the void occur post closure, which could release contaminants into the environment.
- Design of surface water diversions / landforms to capture flows up to a Probable Maximum Flood (PMF), ensuring flood waters do not flow into residual voids.

Large-scale or global failures are likely to intersect a significant volume of rock mass and rock structures/defects, and slip failure may not necessarily be controlled by a single or dominant structure. Rockmass strength properties based on back-analyses and observation which, implicitly include the effects of typical rock structure and allow for an approximation of stability for purposes of planning and preliminary design. This is the basis of this technical study.

4.1.2 Inputs and Assumptions

Inputs required for the geotechnical model have been derived from the strength and condition of the expected geology from available information or inferred from published information. The adopted inputs are summarised in Table 4.1.

TABLE 4.1: GEOTECHNICAL ASSESSMENT INPUTS AND ASSUMPTIONS FOR RESIDUAL VOIDS

Input	Eagle Nest	Fox Plains	One Tree West	Pipeline Pit	WC Pit	Far South	Carlo
Final landform / pit shell	Available	Available	Available	Available	Available	Available	Available
Long-term average water level (RL m)	41.5	71.6	47.7	67.4	42.8	81.3	105.6
Long-term peak water level (RL m)	45.1	75.1	52.1	71.3	46.1	86.4	110.8

The following assumptions were made to inform the geotechnical stability assessment:

- Based on the available data, the profile of the in-pit dumps have been inferred from available LiDAR survey, a mixture of mining surfaces and the proposed landform. Detailed definition of the dumps will be confirmed and verified at a later time as mining approaches the final void limits.
- This assessment has not considered any potential effects of surface erosion on the stability of the low wall spoil slopes.
- The adopted minimum factor of safety for any potential slip surfaces is 1.5.
- Final void water equilibrium levels have been adopted from the water balance modelling (WRM, 2023).
- Any spoil material is assumed to be homogeneous.
- Any weak seams that might be present within the sub-floor strata are assumed to have been treated during operations. No weak seams or coal seams have been considered in the stability assessment of the conceptual void slopes.
- It is assumed adequate mitigation measures have been undertaken during the placement of spoil dumps, such as adequate void floor preparation prior to placement, such that no preferential sliding surface is present.
- Three-dimensional stability effects have not been considered in this assessment.

4.1.3 Adopted Material Design Parameters

The site wide geological units have been simplified into the following:

- Tertiary materials – covering residual soils and extremely to moderately weathered sedimentary rocks.
- Highly weathered Permian – weathered coal measure rocks.
- Fresh Permian – fresh and slightly weathered coal measure rocks.

Assumed strength parameters (refer Table 4.2) have been derived from existing site-specific studies and available literature for the region.

TABLE 4.2: GEOTECHNICAL MATERIAL PARAMETERS

Material	Bulk Unit Weight [kN/m3]	Cohesion [kPa]	Friction Angle [degrees]
Tertiary	20	50	30
Weathered Permian	22	70	30
Fresh Permian	24	450	42
Spoil / Fill	18	40	30

4.1.4 Assessment Results

The results of the assessment have been presented as a factor of safety (FoS) value against instability. The calculation of a FoS against instability is useful during planning phases, with a FoS of 1.5 typically targeted to account for uncertainties in the pit slope material properties and unexpected conditions. However, when the pit slope is excavated and constructed, much of the uncertainty disappears. If a slope exists and is not moving, then it can be considered stable under current conditions, regardless of any computed FoS. Given that the pit slope is expected to become increasingly stable following the cessation of mining as groundwater inflows and surface run-off fills the pit, a stable pit during mining is likely to result in a stable pit post-closure. As such, the FoS presented is only illustrative to indicate that, where the FoS is greater than 1, a stable slope is likely.

For the purpose of planning (i.e. to inform any impacts to environmental or third-party assets), the distance of the backscarp to the pit crest (i.e. setback distance) has been identified for the most critical slip failure (where the FoS is above 1.5).

The stability results are presented in Appendix B and summarised in Table 4.3 for minimum pit water level after equilibrium. Based on these results and the available information:

- A stable slope (FoS > 1) is likely; and
- The setback distance of 25-125 m (depending on pit) is recommended.
- The current pit slope designs (with overall slope angles of 50 degrees or flatter) are likely to be stable based on current data.

The level of assessment is considered appropriate for the level of information available and/or at the current project/mining stage.

TABLE 4.3: RESULTS OF STABILITY ANALYSIS

Void/Landform	Factor of Safety (FoS)		
	Groundwater Absent	Long-term Average Water Level	Peak Groundwater Level
Fox Plains (Longitude) – Low Wall	> 2.0	> 2.0	> 2.0
Fox Plains (Longitude) – High Wall	> 2.0	> 2.0	> 2.0
Fox Plains (Latitude) – Low Wall	1.1	1.3	1.3
Fox Plains (Latitude) – High Wall	> 2.0	> 2.0	> 2.0
Fox Plains (Landform)	> 2.0	> 2.0	> 2.0
Pipeline Pit – Low Wall	1.2	1.2	1.2
Pipeline Pit – High Wall	> 2.0	> 2.0	> 2.0
One Tree West – Low Wall	1.7	1.7	1.6
One Tree West – High Wall	> 2.0	> 2.0	> 2.0
Eagles Nest – Low Wall	> 2.0	> 2.0	> 2.0
Eagles Nest – High Wall	> 2.0	> 2.0	> 2.0
WC (Landform)	> 2.0	> 2.0	> 2.0
WC Pit – High Wall	> 2.0	> 2.0	> 2.0
Far Pit South – Low Wall	2.0	1.9	1.9
Far Pit South – High Wall	> 2.0	> 2.0	> 2.0
Carlo Pit – Low Wall	> 2.0	> 2.0	> 2.0
Carlo Pit – High Wall	1.9	1.9	> 2.0

4.1.5 Historical Pit Slope Performance

There has been no record provided by FoxMan of large-scale failures of the pit slopes. Geotechnical hazard monitoring is available and indicate localised geotechnical hazards only. This appears consistent with the estimated large-scale/global stability FoS estimated above.

4.1.6 Effect of Weathering

Weathering of the pit walls generally occur through physical or chemical processes. It is generally the additional effects of weathering that might occur after cessation of mining (i.e. post-closure) would be of relevance. Given the semi-arid to arid environment, it is anticipated the weathering would be slow and as such not considered to have a material impact to pit stability. However, there is a general risk that less-weathering resistant materials exposed at surface may weather quicker than surrounding rock mass and may result in undermining of overlying rock resulting in rock falls.

Rock falls resulting from this situation are considered to be localised and infrequent and are not expected to materially impact on the overall pit stability or present a risk to the environment or people. Further to this, as some of the pits are yet to be excavated to their final depth and extents, with a significant volume of material to be mined, it would be reasonable to expect that any significant weathered zones, should they be present, be addressed/treated as they are exposed in the mining process and at the end of mining (i.e. at the detailed design stage for closure).

4.1.7 Effect of Long-term Erosion

Given the geological context of the pits, long-term erosion will generally have limited material impact on geotechnical stability of the pit slopes. Given any erosion gullies which may form would typically be orientated downslope or down-ramp, severe erosion, should it occur, is not expected to result in undercutting of the base of the pit slopes to extents which would have a material impact of geotechnical stability. Therefore, long-term erosion has not been considered further in this assessment.

4.1.8 Effect of Significant Hydrological Events

Large rainfall events (as a significant hydrological event) are not expected to result in softening and weakening of the materials exposed in the pit walls. However, surface recharge may result in temporary increase in seasonal groundwater levels. Given this is usually accompanied by a rise in-pit water levels (resulting in a reduced overall pit slope height), the net effect on pit stability is expected to be negligible.

A significant hydrological effect which results in a rapid drawdown of pit water level is not considered credible and has not been considered further.

5. QUALIFICATIONS

(a) In preparing this document, including all relevant calculation and modelling, Engeny Australia Pty Ltd (Engeny) has exercised the degree of skill, care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering principles.

(b) Engeny has used reasonable endeavours to inform itself of the parameters and requirements of the project and has taken reasonable steps to ensure that the works and document is as accurate and comprehensive as possible given the information upon which it has been based including information that may have been provided or obtained by any third party or external sources which has not been independently verified.

(c) Engeny reserves the right to review and amend any aspect of the works performed including any opinions and recommendations from the works included or referred to in the works if:

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  (ii) Engeny considers it prudent to revise any aspect of the works in light of any information which becomes known to it after the date of submission.

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(g) This Report does not provide legal advice.

APPENDIX A: EXISTING STUDIES AND ASSESSMENTS

MEMO

To: Michael Rosengren, Mitch Barnes;

From: Davide Pistellato

Re: Final Void Study Summary Report

Date: 21st April 2021

Overview

Cartledge Mining & Geotechnics (CM&G) was asked to assess the long-term stability of active and inactive pits within the Foxleigh mining lease to assist with the formulation of the Estimated Rehabilitation Cost (ERC) for the Foxleigh mining lease following life-of-mine.

These include ten voids that mainly exhibit long-term stability (inactive pits), with many having stood up for 10+ years following the cessation of operations. Active pits are characterised by instabilities with current geometries; however, many failures are mining related. Where instability is predicted, alternate designs are proposed to minimise cost while maintaining an acceptable Probability of Failure (PoF).

Scope of work

The Environmental Authority (EA) for Foxleigh Coal Mine states that "Geotechnical stability and risk assessments must be conducted to determine the appropriate treatments prior to closure". The appropriate treatments must meet the following criteria: "Final voids reshaped to a slope range of <70% (35°) for competent material or <45% (24°) for non-competent material *or as stated in an appropriate risk assessment conducted by a suitably qualified person*".

It is understood that the scope of work is limited to only highwalls as on-site Technical Services will conduct any rehabilitation based on the abovementioned EA recommendations for non-competent materials.

Furthermost, this document provides summary advice, and a detailed report is being drafted and will be made available to Middlemount South Pty Ltd.

Methodology

2D and 3D limit equilibrium modelling was carried out to test the potential for stability analyses returning suitable probabilities of failure, rather than adopting the traditional method of achieving a minimum calculated Factor of Safety (FoS) of 1.5 for long-term stability.

Design assumptions

To further verify the analyses' veracity, input parameters for the rock mass were adjusted following (Duran, 2019) recommendations that state that all geotechnical data for the rock mass can be combined into a single dataset if the dataset itself is representative of the whole population. As only a data population for UCS values was available, CM&G combined this dataset and tested it for robustness. UCS values greater than 45 MPa were excluded, due to them being typically seen only within the Pisces interburden and causing a positive skew of the data distribution. The resulting Confidence Level (CL), a measure of the confidence that the mean of the datasets represents the true mean, for the adjusted dataset equalled 85%. This is greater than the recommended confidence level of >80% for operating mines, as published by (Read & Stacey, 2009).

In addition to the UCS values, CM&G adopted conservative values for the remaining rock mass input parameters for the Generalised Hoek-Brown Criterion. These values were:

- GSI value of 45 was assumed, which is consistent with the recently back-calculated values from the OTW Pit failure,
- m_i was set to 9 to match a fine-grained rock, such as siltstone.
- Standard design values adopt for these parameters at Foxleigh Coal Mine are GSI-55 and $m_i \geq 10$.

Alluvial soils are not well identified across the site, and little is available describing the geomechanical properties of this material. Revised parameters based on (Lynch, 2021) were used for the analyses, along with typical Bowen Basin descriptors for the Weathered Permian (Table 1).

Table 1: Rock strength properties for Tertiary and Weathered Permian materials.

Material Type	Failure Criterion	Cohesion (KPa)	Friction angle (°)
Alluvium	Mohr-Coulomb	0	30
Weathered Permian	Mohr-Coulomb	70	30

Finally, the groundwater table was established at 25 MBGL after (JBT, 2012) and the pits were assumed to be dry. A filled pit will return higher FoS than a dry pit due to the passive support provided by the mass of water to the slope.

Design Acceptance Criteria

As these voids are to remain in perpetuity, CM&G considered that a PoF means test was a more robust methodology than the traditional FoS only means test. FoS only typically does not consider material variability but rather adopts a design value. For a PoF to be meaningful, it requires a statistically meaningful dataset including:

- Median, minimum and maximum values,
- Standard distribution, and,
- Statistical distribution.

As the UCS dataset for fresh interburden and coal measure rocks was the only available dataset to yield statistically acceptable results, PoF could only be determined for failure surfaces passing through

these units. A target PoF was adopted of <0.5% after Read & Stacey (2009), refer to Table 2. Therefore, the acceptance criteria adopted for this study were as follows:

- Global Stability (Failure through fresh Permian rock units) – PoF <1.5%,
- For failure surfaces passing through the Weathered Permain and/or Tertiary units only, a FoS >1.5 was adopted.

Table 2: PoF design acceptance guidelines after Read & Stacey (2009).

	Design criteria			Aspects of natural situation	
PoF (%)	Serviceable life	Public liability	Minimum surveillance required	Frequency of slope failures	Frequency of unstable movements
50–100	None	Public access forbidden	Serves no purpose	Slope failures generally evident	Abundant evidence of creeping valley sides
20–50	Very very short-term	Public access forcibly prevented	Continuous monitoring with intensive sophisticated instruments	Significant number of unstable slopes	Clear evidence of creeping valley sides
10–20	Very short-term	Public access actively prevented	Continuous monitoring with sophisticated instruments	Significant instability evident	Some evidence of slow creeping valley sides
5–10	Short-term	Public access prevented	Continuous monitoring with simple instruments	Odd unstable slope evident	Some evidence of very slow creeping valley sides
1.5–5	Medium-term	Public access discouraged	Conscious superficial monitoring	No ready evidence of unstable slopes	Extremely slow creeping valley sides
0.5–1.5	Long-term	Public access allowed	Incidental superficial monitoring	No unstable slopes evident	No unstable movements evidence
<0.5	Very long-term	Public access free	No monitoring required	Stable slopes	No movements

Source: Kirsten (1983)

Summary of Results

A summary of results for current pit slope geometries is provided in Table 3. The Reliability Index (RI) is a measure of the robustness of the statistical model. RI values >3 indicate a good assurance of a safe slope design.

The results indicate that acceptable PoF was obtained for all scenarios obtained and where available, the RI was >3, indicating safe slope design.

A summary of the recommended slope geometries for all pits and based on the above methodology is provided in Section Final Void Slope Geometry Recommendation.

Table 3: Summary of highwall stability analyses for the current pitwall geometries.

Pit Name	Highwall			
	Dry Pit		Flooded Pit	
	PoF	RI	PoF	RI
NW Pit	0.00	6.42	0.00	10.79
WC North Pit	0.00	10.77	0.00	13.31
WC Pit	0.00	5.71	0.00	4.86
Carlo Pit	0.00	-	0.00	-
NE Pit	0.00	4.14	0.00	40.25
Old NE Pit	0.00	5.72	0.00	4.86
Far South Pit	0.00	-	0.00	-
Pipeline Pit	0.00	-	0.00	-

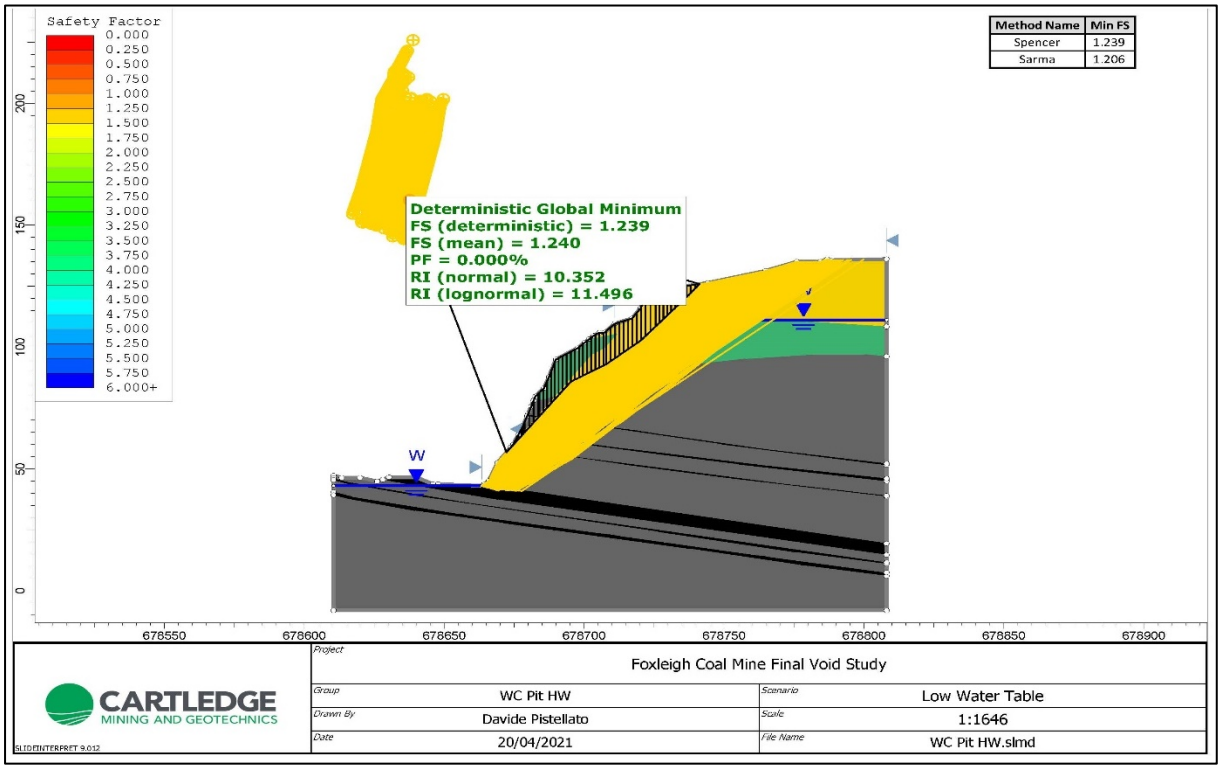


Figure 1: Summary of results for WC Pit current highwall profile.

Discussion and Recommendations

Model Robustness

From the above, PoF values of 0% for the highwalls and endwalls indicates that the consolidated rock mass can remain in its current geometry and exhibit long term stability. It is considered that the model and dataset are reasonably conservative and provide sufficient confidence that the walls will be stable in perpetuity. Most of the walls have been standing unsupported for several years already without any indication of global scale instability. Based on recommendations for slopes with a PoF <1.5% presented in Table 2, these results would allow public access, no monitoring required with stable slopes, and no movement expected.

Geotechnical Site Investigation

To further improve the robustness of the geotechnical model, it is recommended that geotechnical samples be collected as part of the planned 2021 drilling campaign. Following data reduction and parameter selection, it is recommended that the analyses be updated with the new geomechanical dataset.

Visual Pit Inspection

The current analyses does not address the risk of instability controlled by geological structure. To verify the assumptions adopted herein and the accuracy of the ground model, a visual inspection of all the voids by a suitably qualified Engineering Geologist/Geotechnical Engineer is required.

Final Void Slope Geometry Recommendation

Based on the study results, a summary of recommended slope geometries for all pits is provided in Table 4.

Table 4 Summary of Design Profile Recommendations by Material Type

Material Type	Cut Slope Angle	Bench Width*
Tertiary	22°	15 m
Weathered Permian	45°	NA
Pre-Split highwall	NA**	NA
Waste Dumps	Adopt slope recommendations provided in the EA	

* Benches are to be constructed at the base of the unit

**NA – no change to these profiles is required to satisfy long-term stability requirements.

All pits currently satisfy these conditions except for Far South Pit. The geological model for Far South is inferred to be erroneous and that the exposed wall predominantly comprises fresh Permian, consistent with other pits on the lease. It is recommended that site personnel visually inspect Far South Pit to verify the exposed conditions and confirm the suitability of the recommended design.

Pit Crest Access

As pit voids will remain in perpetuity, it is understood that Middlemount South Pty Ltd will construct a bund to restrict access to the void behind the pit crests. To allow for erosion and sloughing (shallow skin failures), it is recommended that the bund be set 25 m back from the modified pit crest.

Risk Assessment

As outlined in the EA, a Risk Assessment is required to identify and ensure all latent geotechnical risks are identified and managed as part of this design process. A Risk Assessment must be carried out that includes a suitably qualified Engineering Geologist/Geotechnical Engineer.

Conclusions

CM&G engineers carried out a long-term stability assessment of the main pit highwalls. Modelling revealed that the Environmental Authority (EA) criteria for Foxleigh Coal Mine competent walls are conservative and that current wall exposures for fresh Permian satisfy the minimum geotechnical requirements. Slope modification is required for the weathered Permian and Tertiary units, and the EA recommended geometry should be adopted for waste dumps.

Localised instability and minor failure mechanisms are still possible due to the high geological variability across the mining lease and confined adverse structures on the wall. Further work, including a visual assessment of the pit walls and Risk Assessment, is required to verify the analysis assumptions and ensure all latent geotechnical risks are identified and appropriately managed.

References

Duran, A. (2019). Probabalistic Stability Analyses for Sedimentary Deposits. In J. Wesseloo (Ed.), *Proceedings of the First International Conference on Mining Geomechanical Risk* (pp. 429-442). Perth: Australian Centre for Geomechanics. doi:https://doi.org/10.36487/ACG_rep/1905_26_Duran

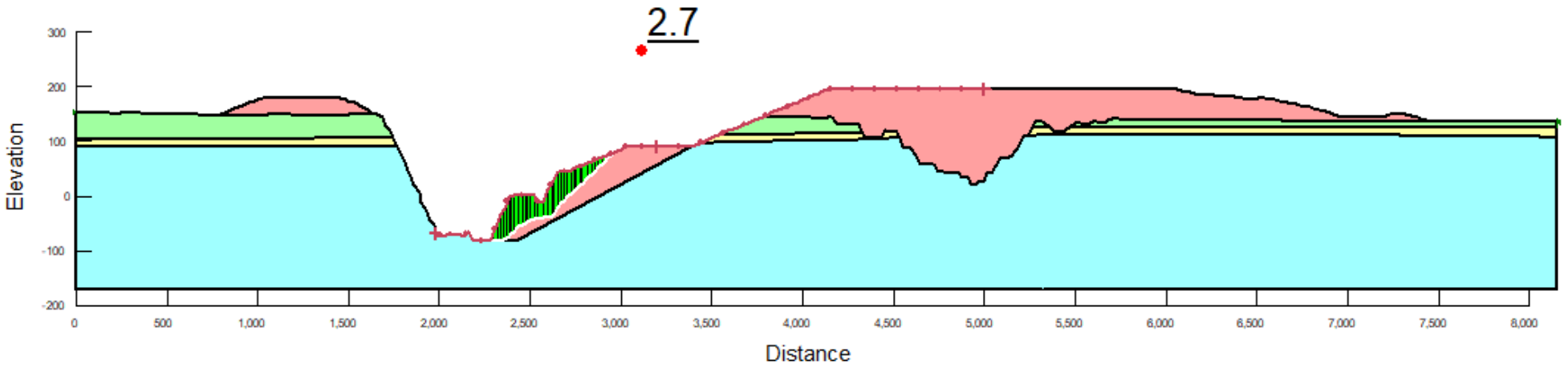
JBT. (2012). *Environmental Impact Statement - Groundwater Report.*

Lynch, T. (2021). *MMS010001-BG_Rev0 Foxleigh Coal Mine Alluvium Material Assessment.* Cartledge Mining & Geotechnics.

Read, J., & Stacey, P. (2009). *Guidelines for Open Pit Slope Design.* CSIRO Publishing. doi:10.1071/9780643101104

APPENDIX B: GEOTECHNICAL STABILITY ASSESSMENT

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1



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Drawn	ML	8-Aug-23	Fox Plains Pit – Longitude Steady State Stability – Low Wall, No Groundwater	
Checked	MD	8-Aug-23		
Job No.	QC1025_010		Figure A.1	Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
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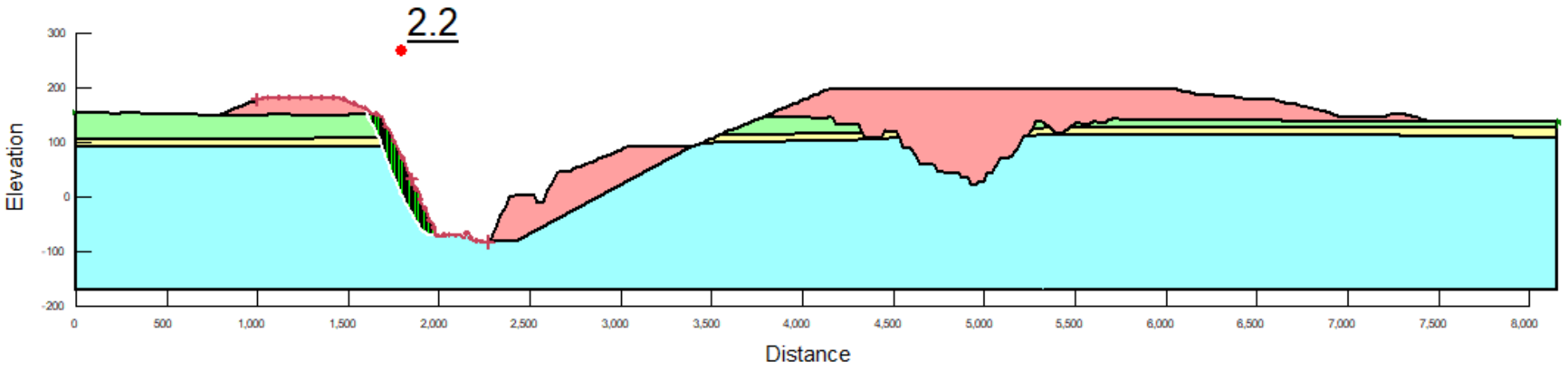
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1



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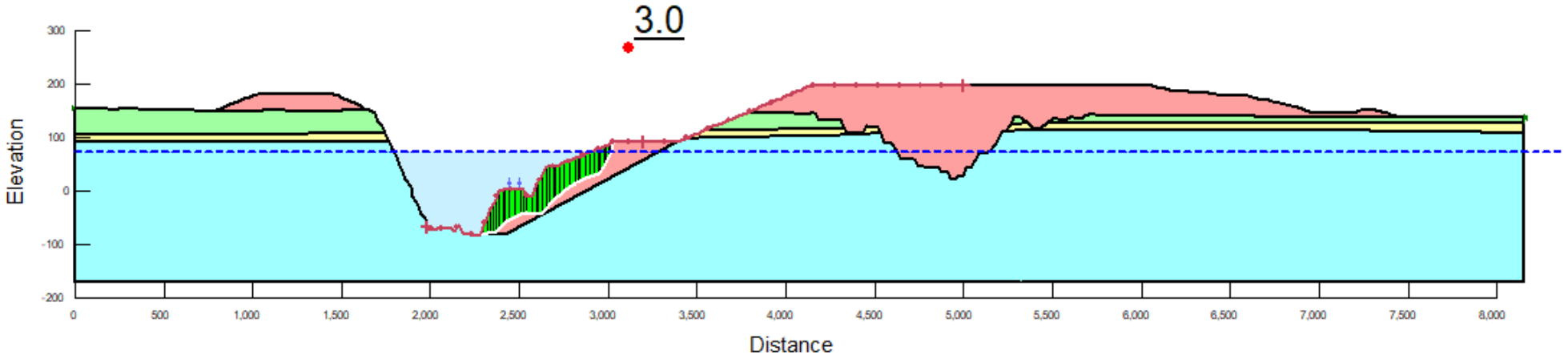
Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1



Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment
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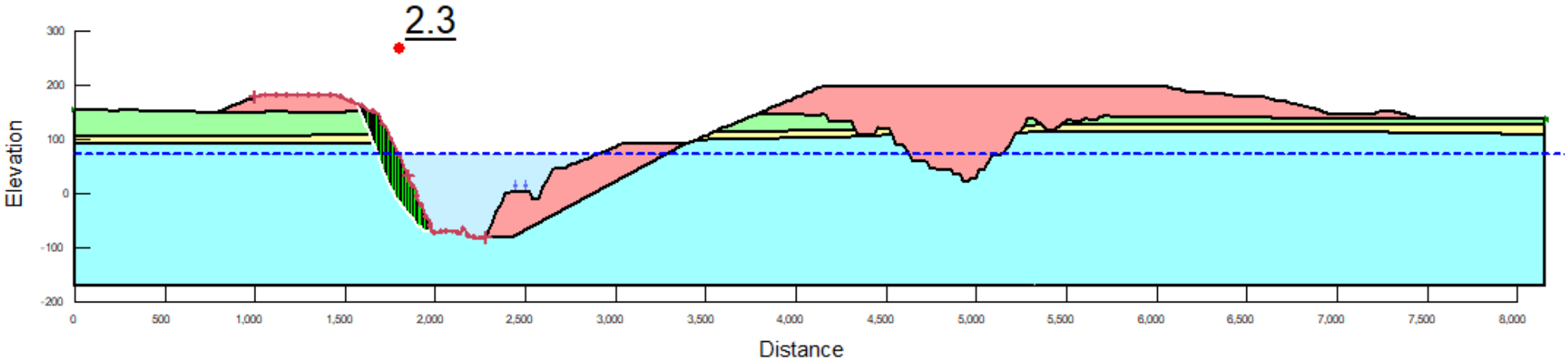
Job No.	QC1025_010		Figure A.3 / Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1



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Job No.	QC1025_010		Figure A.4 / Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
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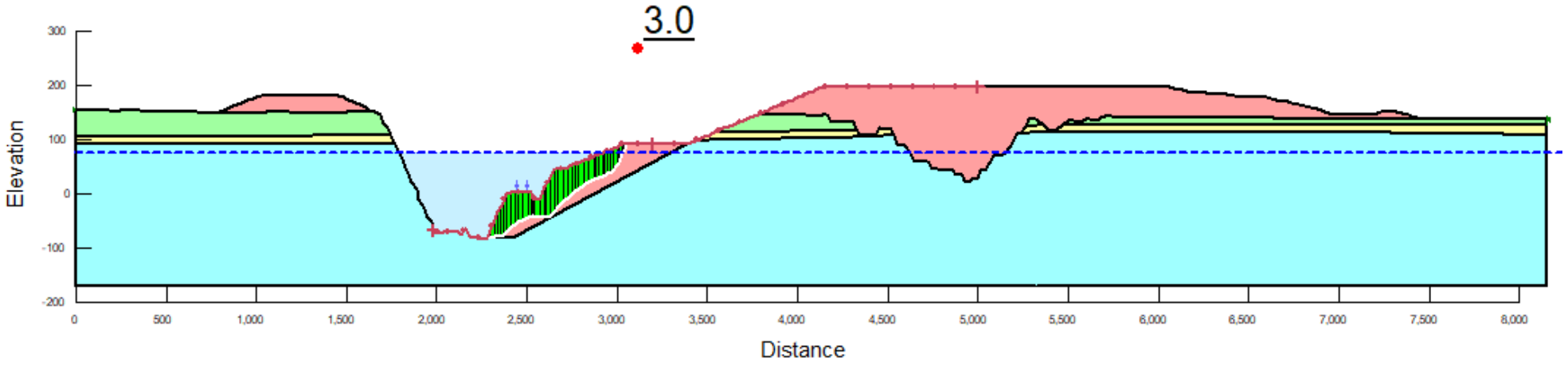
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1



Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment
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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
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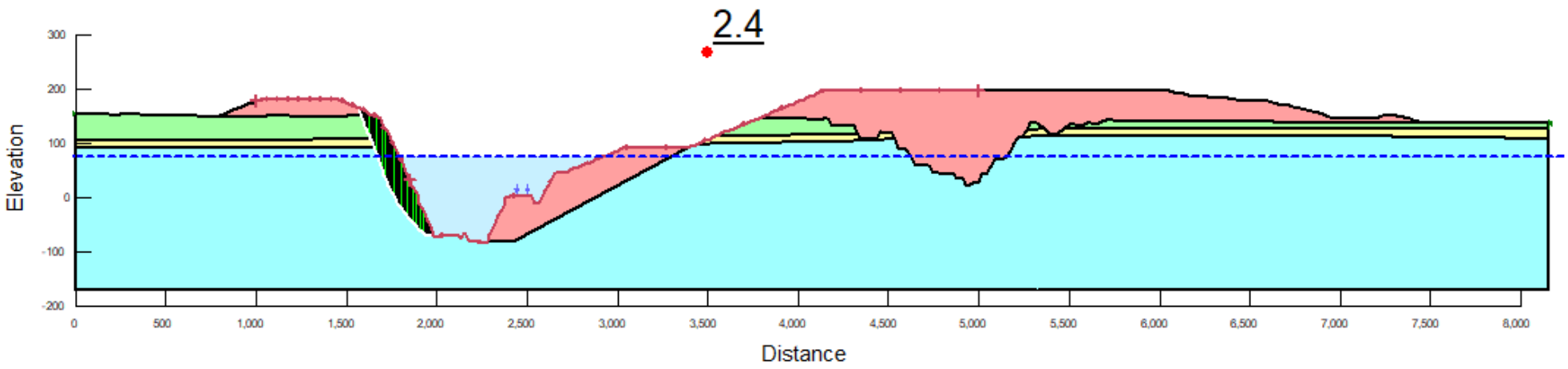
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1



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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
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	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
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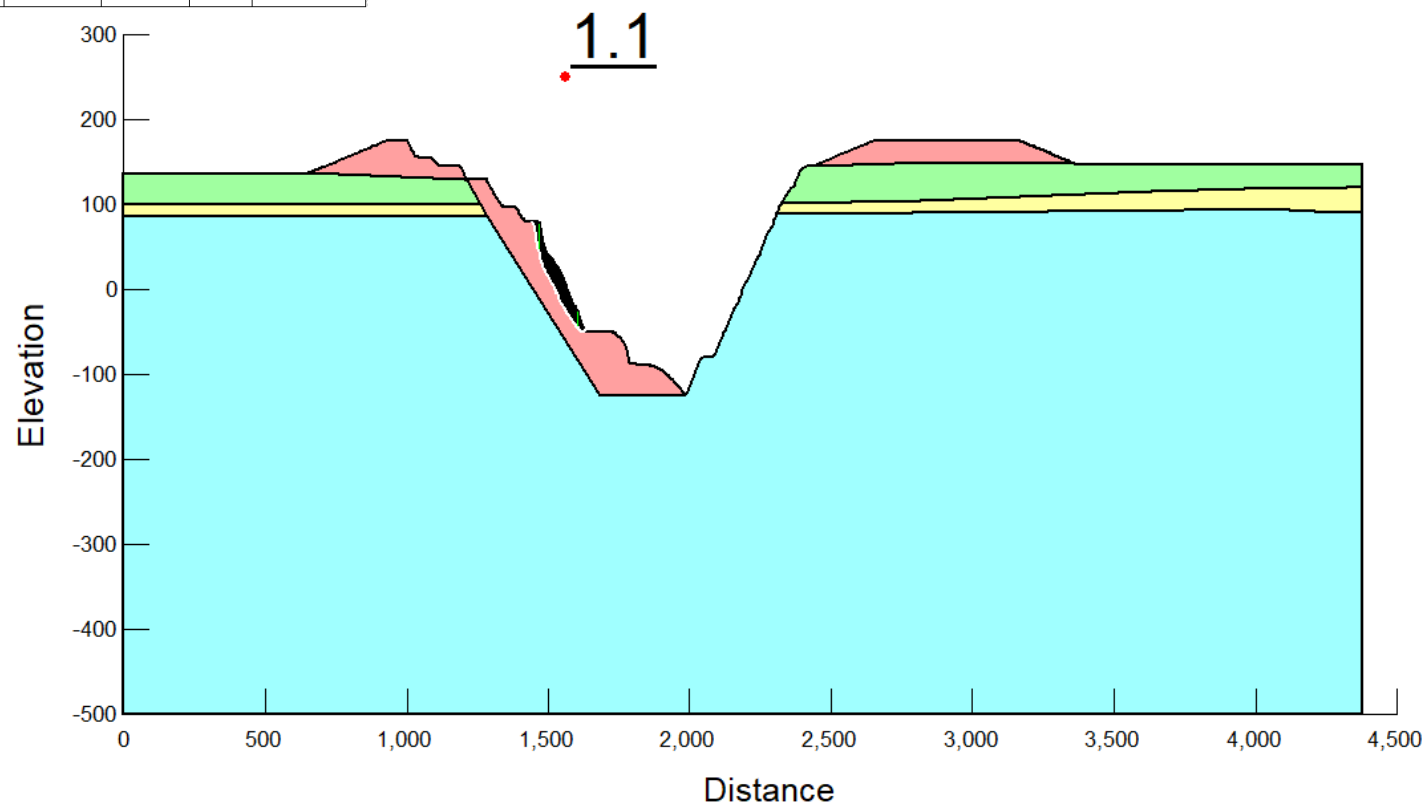

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
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	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
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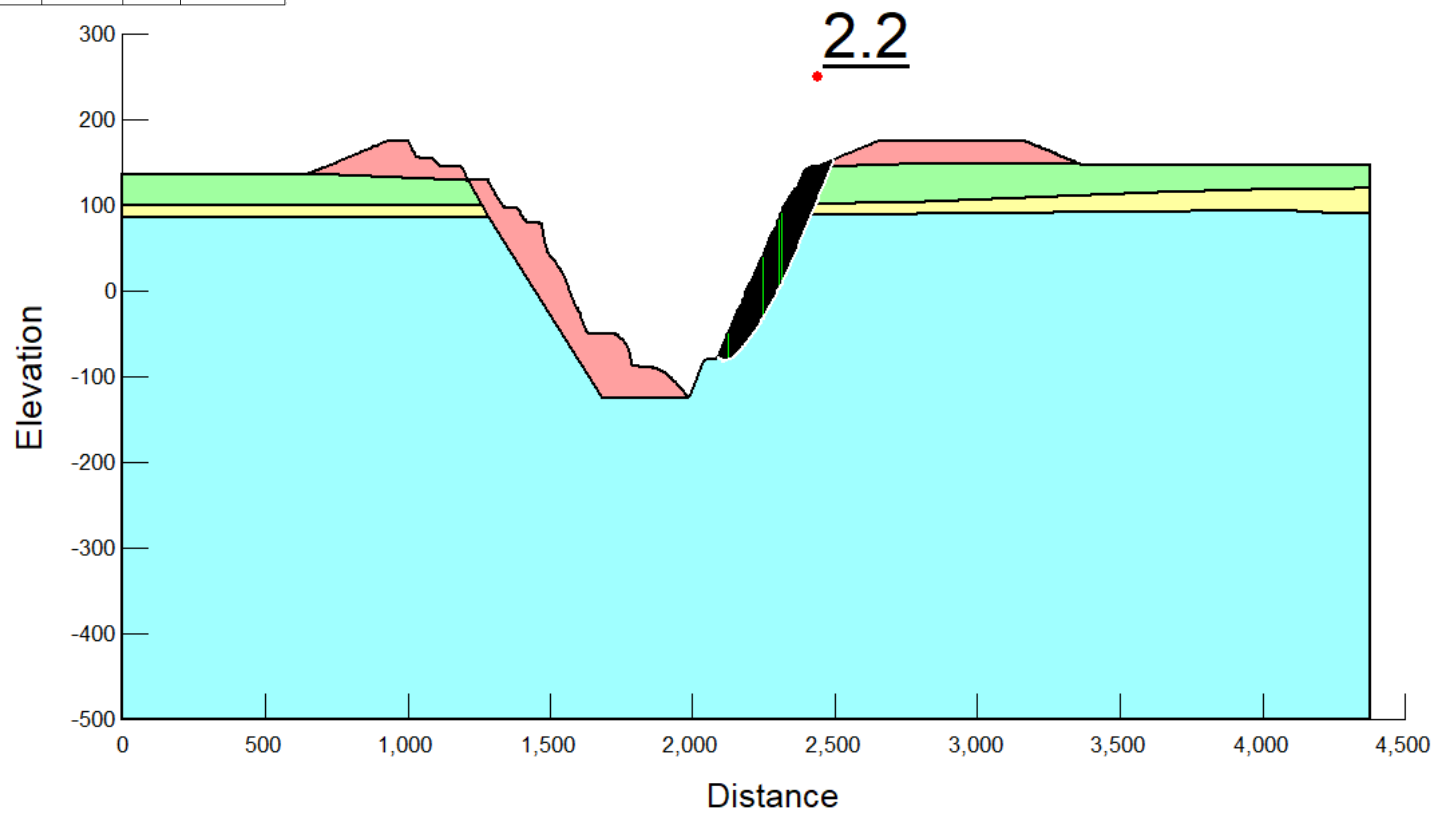

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Job No.	QC1025_010		Figure A.8 | Rev 0

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	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
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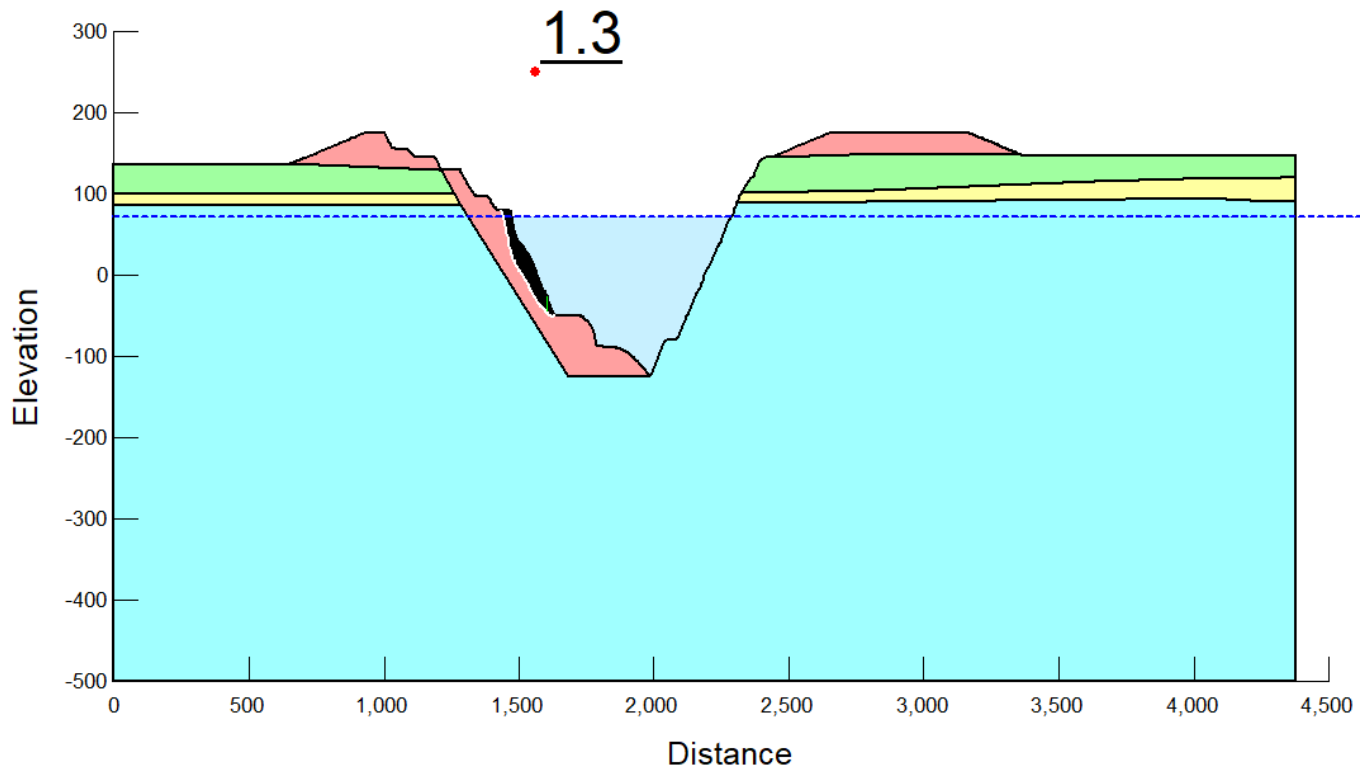

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Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment
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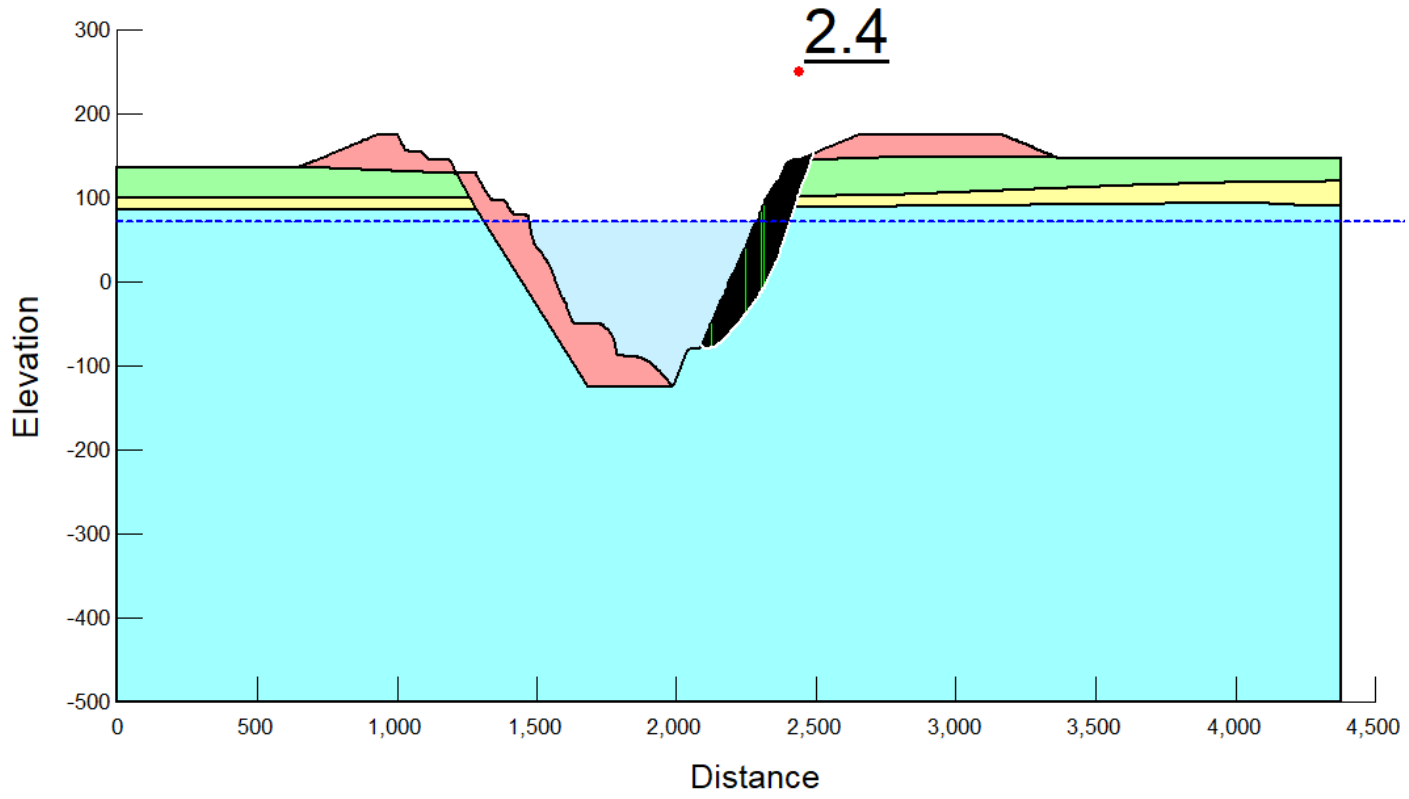
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1



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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
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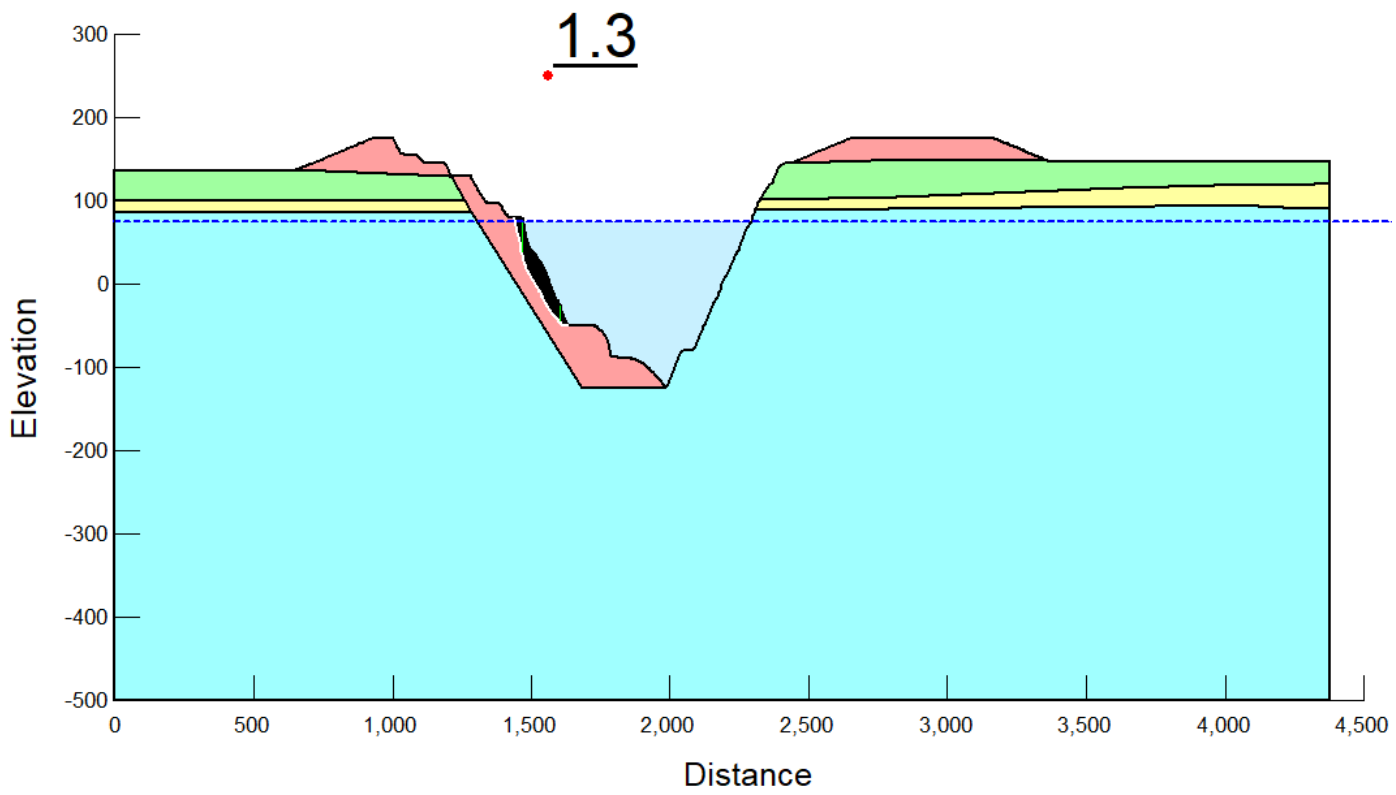
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1

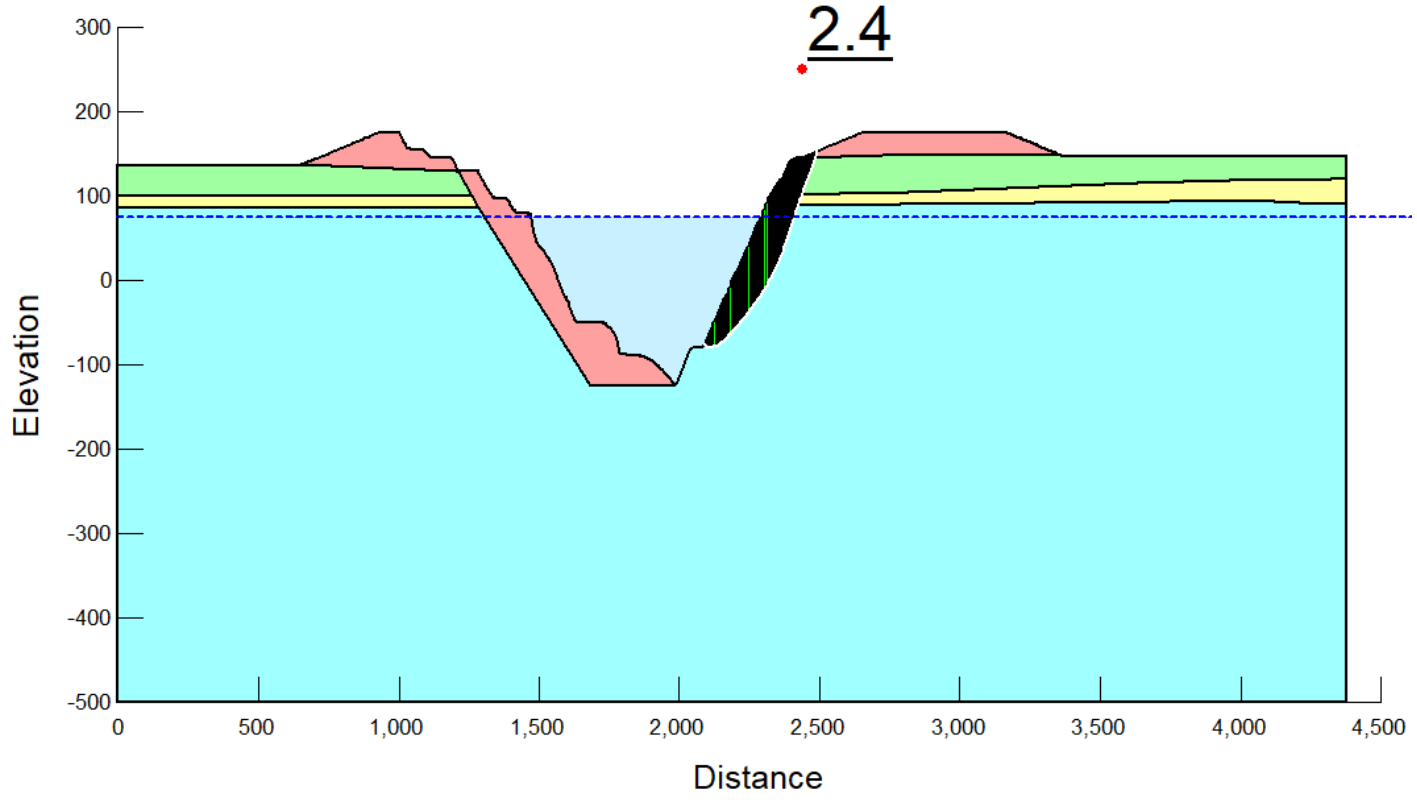


Foxleigh MINE

ENGENY

Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment
Drawn	ML	8-Aug-23	Fox Plains Pit – Latitude Steady State Stability – Low Wall, Peak Groundwater RL75.1m
Checked	MD	8-Aug-23	
Job No.	QC1025_010		Figure A.11 / Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1

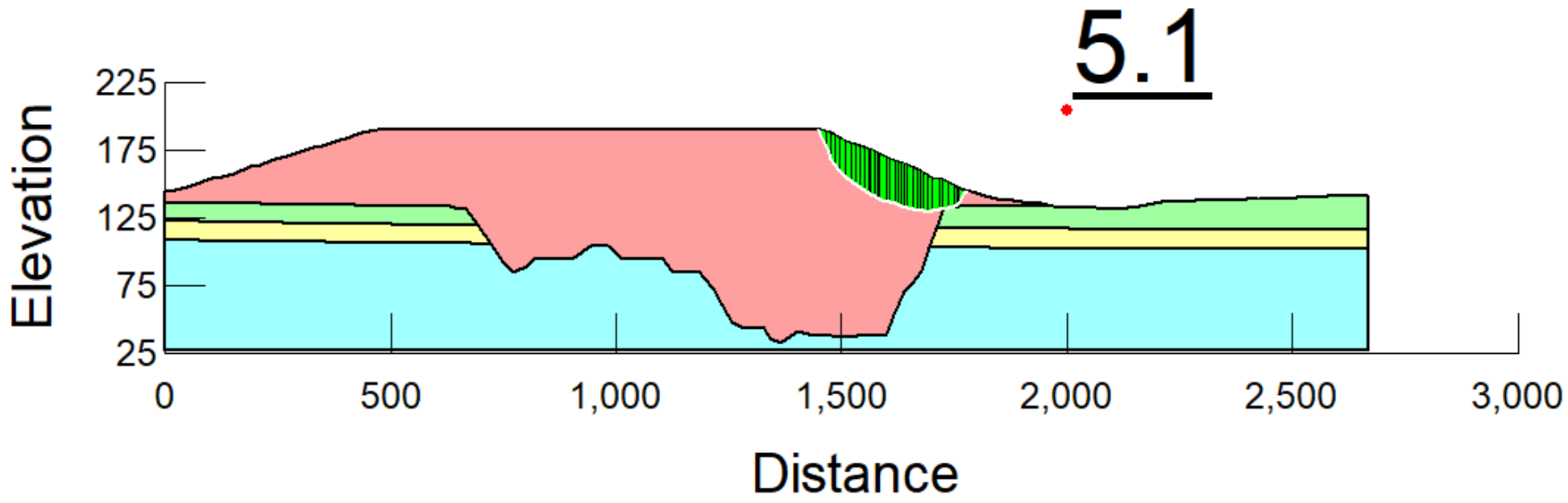


Foxleigh MINE

ENGENY

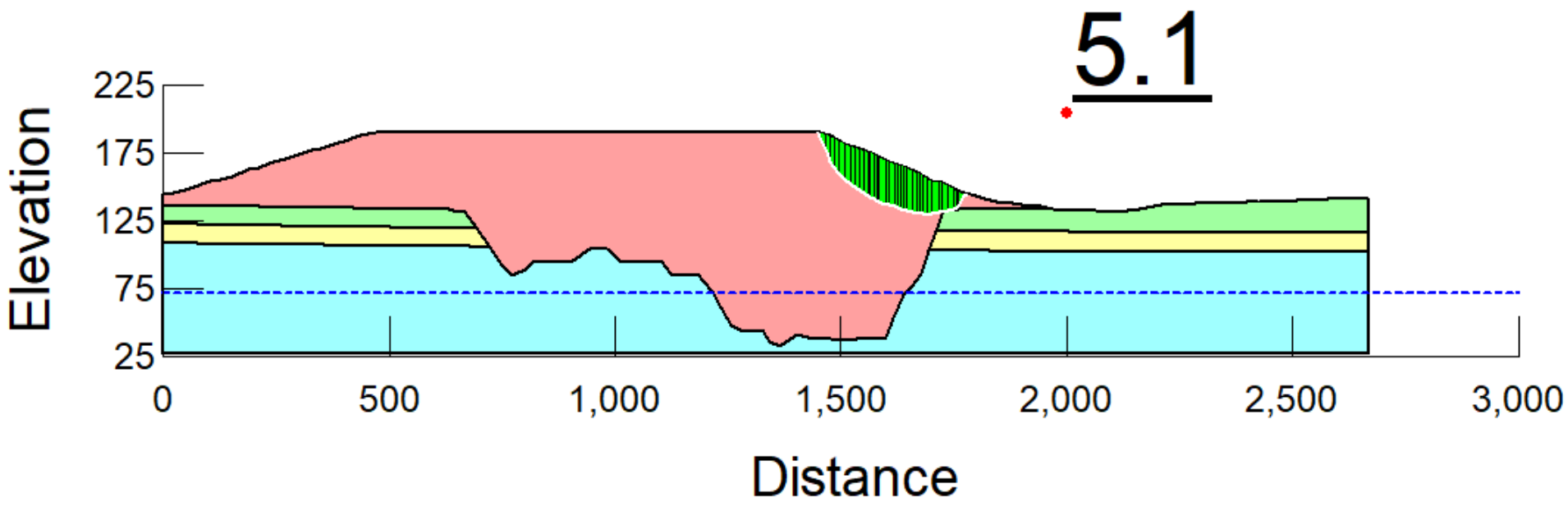
Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment
Drawn	ML	8-Aug-23	Fox Plains Pit – Latitude Steady State Stability – High Wall, Peak Groundwater RL75.1m
Checked	MD	8-Aug-23	
Job No.	QC1025_010		Figure A.12 Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1



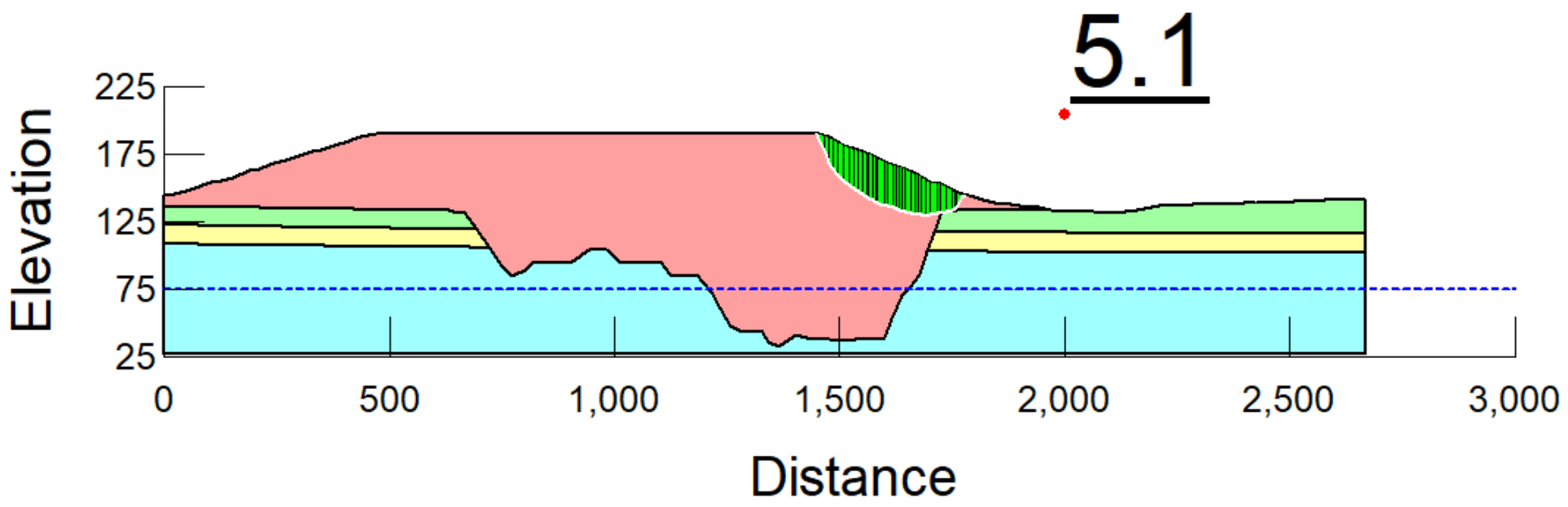
Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment	
Drawn	ML	8-Aug-23	Fox Plains Pit (Landform) Steady State Stability – No Groundwater	
Checked	MD	8-Aug-23		
Job No.	QC1025_010		Figure A.13	Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1



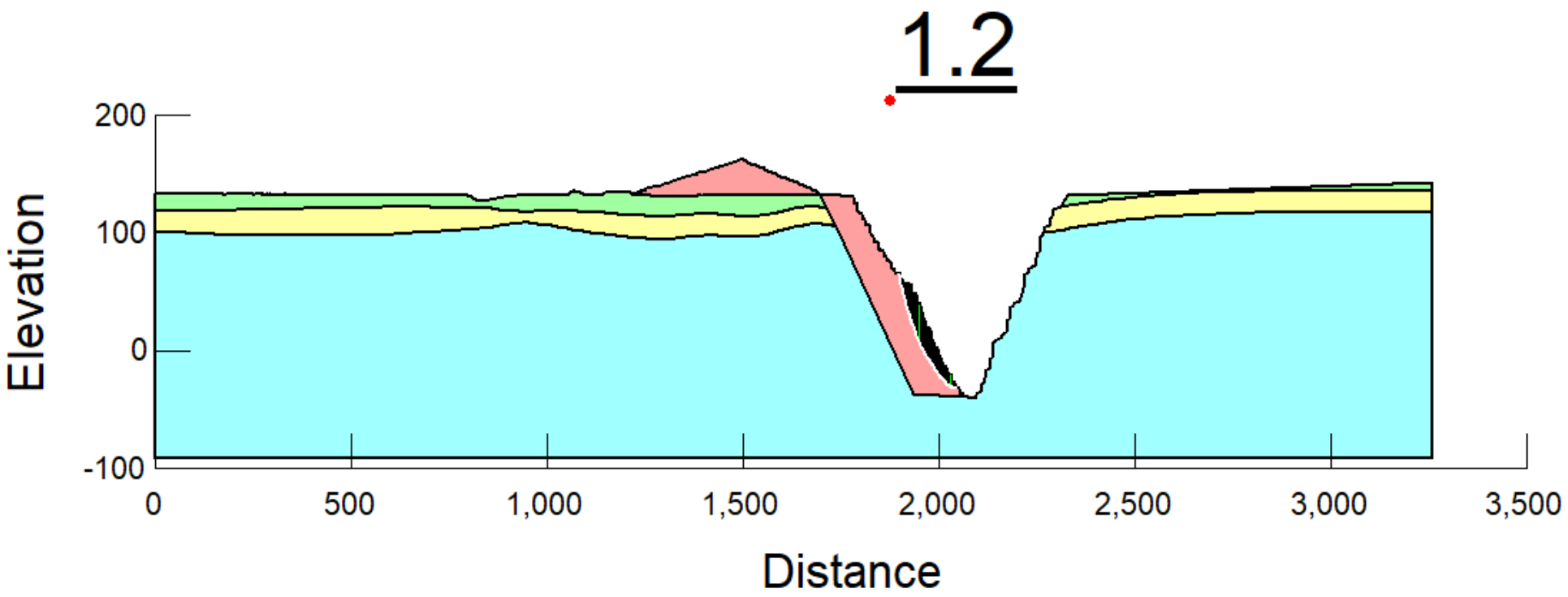
Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment	
Drawn	ML	8-Aug-23	Fox Plains Pit (Landform) Steady State Stability – Average Groundwater RL71.6m	
Checked	MD	8-Aug-23		
Job No.	QC1025_010		Figure A.14	Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1



Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment	
Drawn	ML	8-Aug-23	Fox Plains Pit (Landform) Steady State Stability – Peak Groundwater RL75.1m	
Checked	MD	8-Aug-23		
Job No.	QC1025_010		Figure A.15	Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1

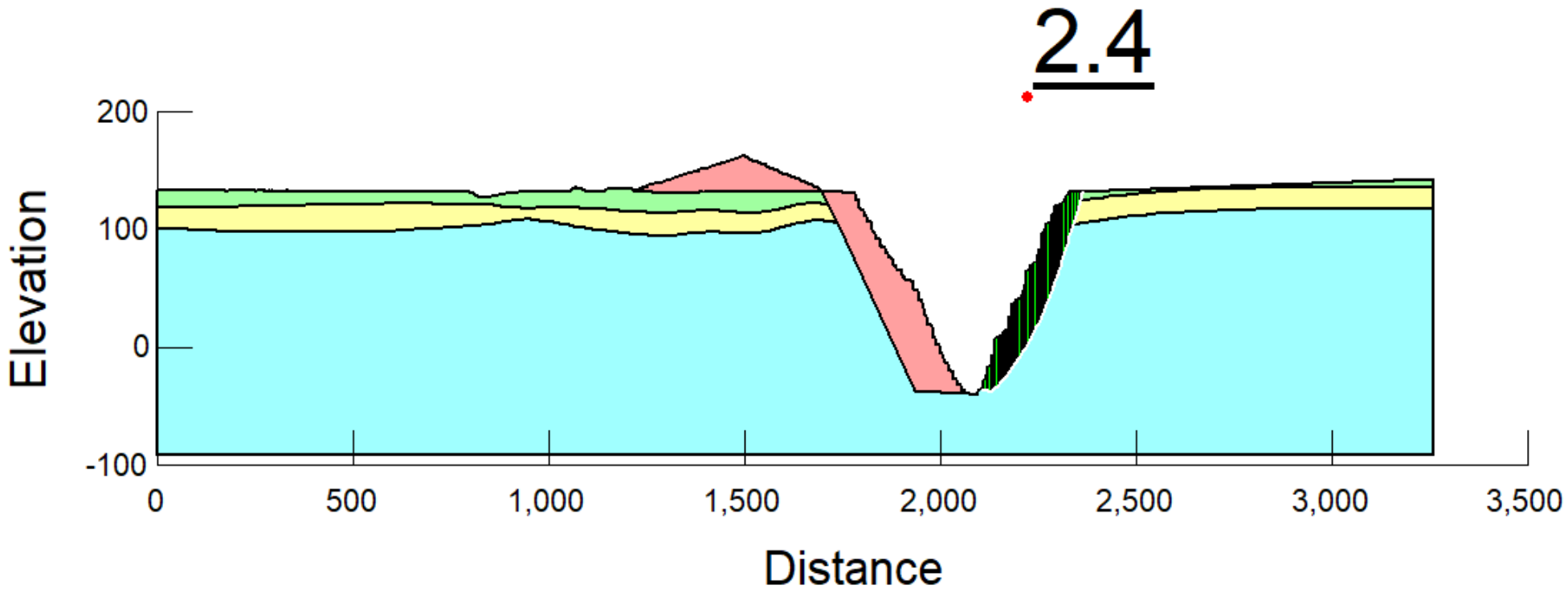


Foxleigh MINE

ENGENY

Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment	
Drawn	ML	8-Aug-23	Pipeline Pit Steady State Stability – Low Wall, No Groundwater	
Checked	MD	8-Aug-23		
Job No.	QC1025_010		Figure A.16	Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1

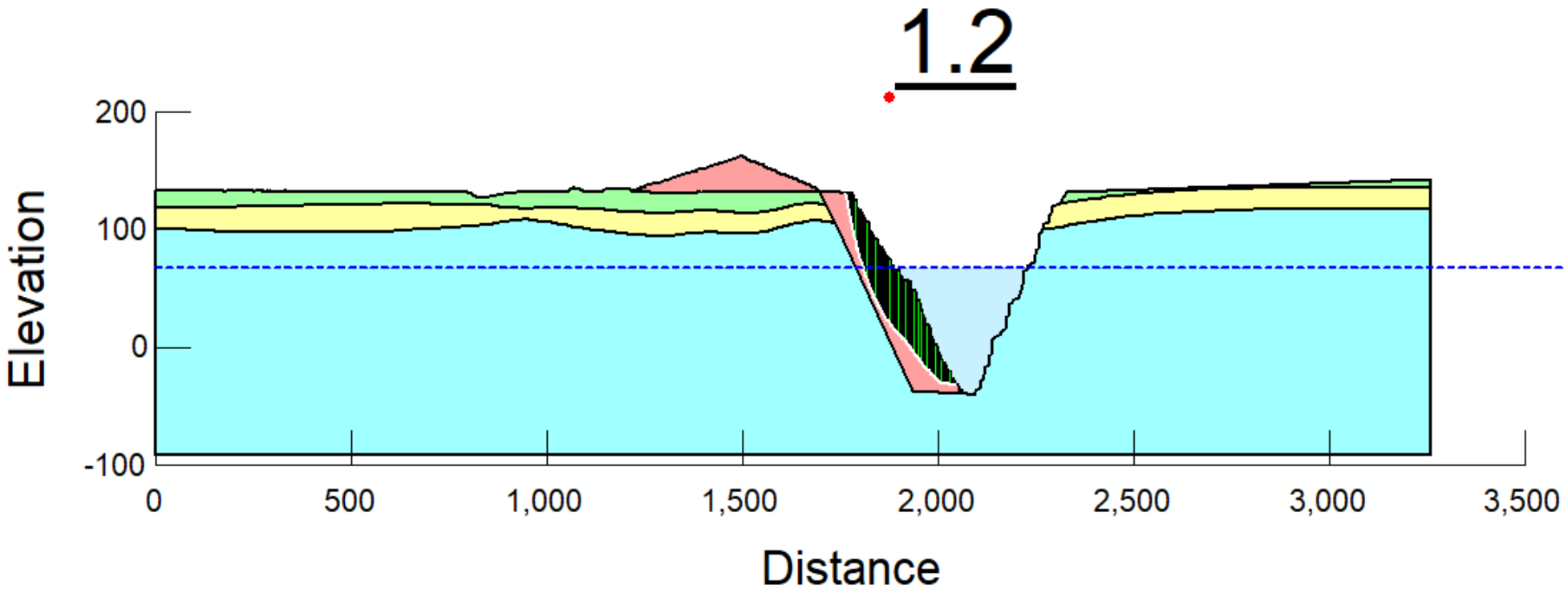


Foxleigh MINE

ENGENY

Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment	
Drawn	ML	8-Aug-23	Pipeline Pit Steady State Stability – High Wall, No Groundwater	
Checked	MD	8-Aug-23		
Job No.	QC1025_010		Figure A.17	Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1

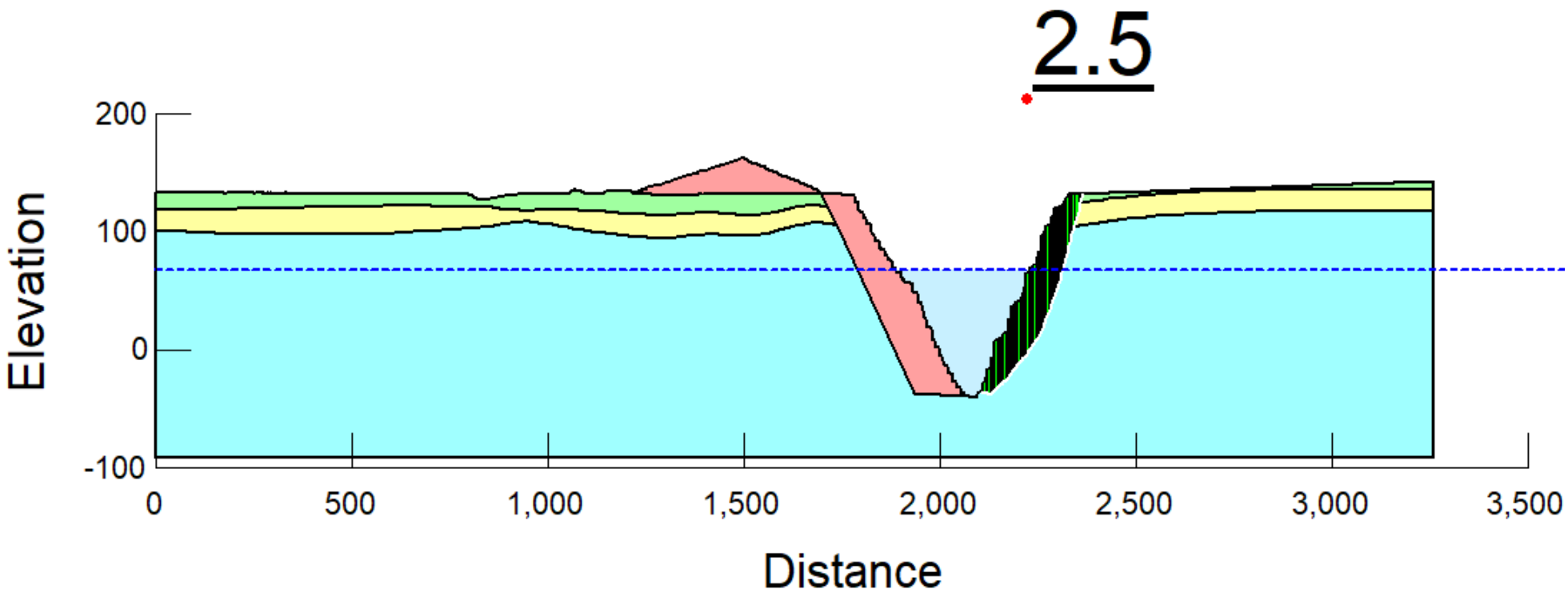


Foxleigh MINE

ENGENY

Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment	
Drawn	ML	8-Aug-23	Pipeline Pit Steady State Stability – Low Wall, Average Groundwater RL67.4m	
Checked	MD	8-Aug-23		
Job No.	QC1025_010		Figure A.18	Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1

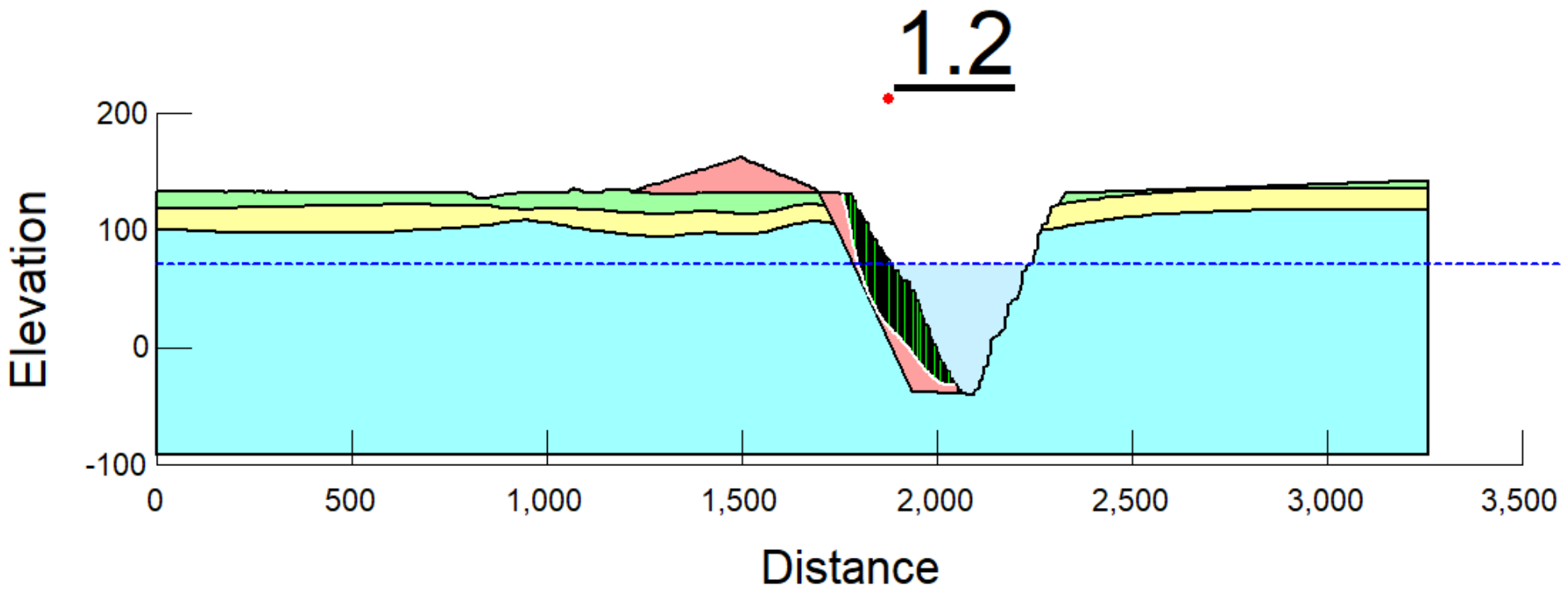


Foxleigh MINE

ENGENY

Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment
Drawn	ML	8-Aug-23	Pipeline Pit Steady State Stability – High Wall, Average Groundwater RL67.4m
Checked	MD	8-Aug-23	
Job No.	QC1025_010		Figure A.19 / Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1

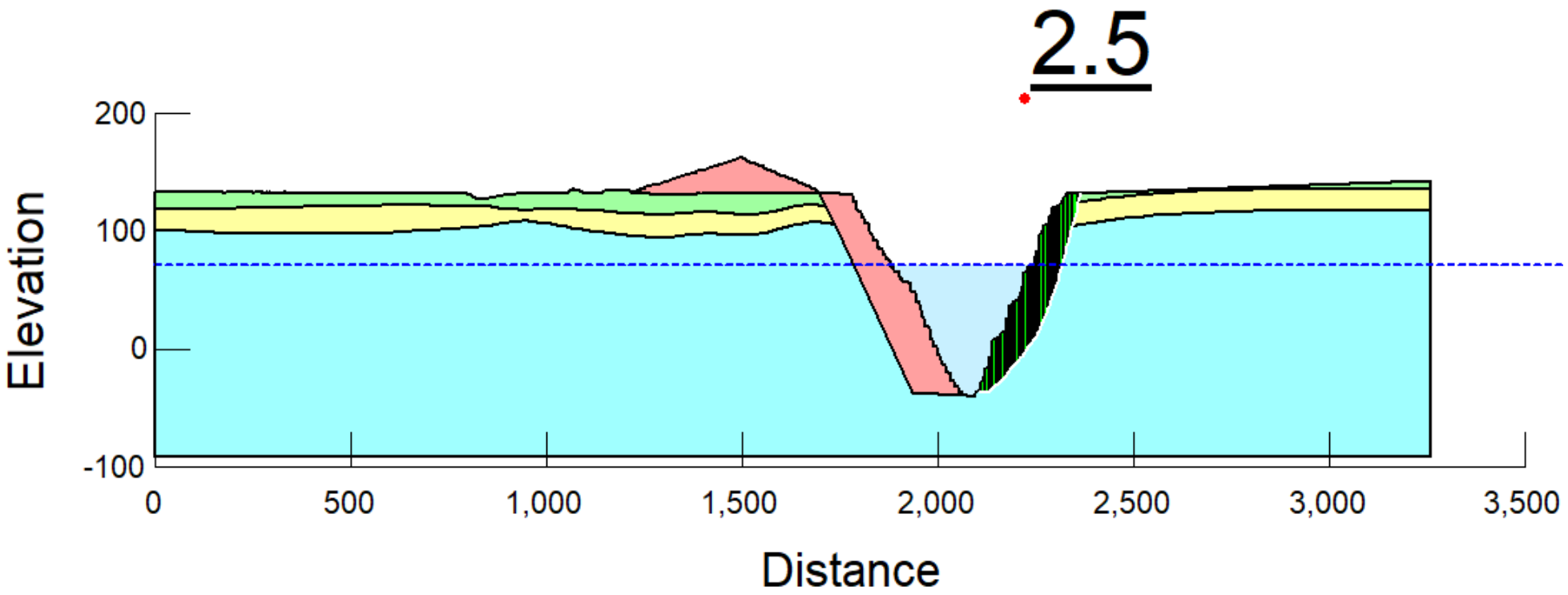


Foxleigh MINE

ENGENY

Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment	
Drawn	ML	8-Aug-23	Pipeline Pit Steady State Stability – Low Wall, Peak Groundwater RL71.3m	
Checked	MD	8-Aug-23		
Job No.	QC1025_010		Figure A.20	Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1

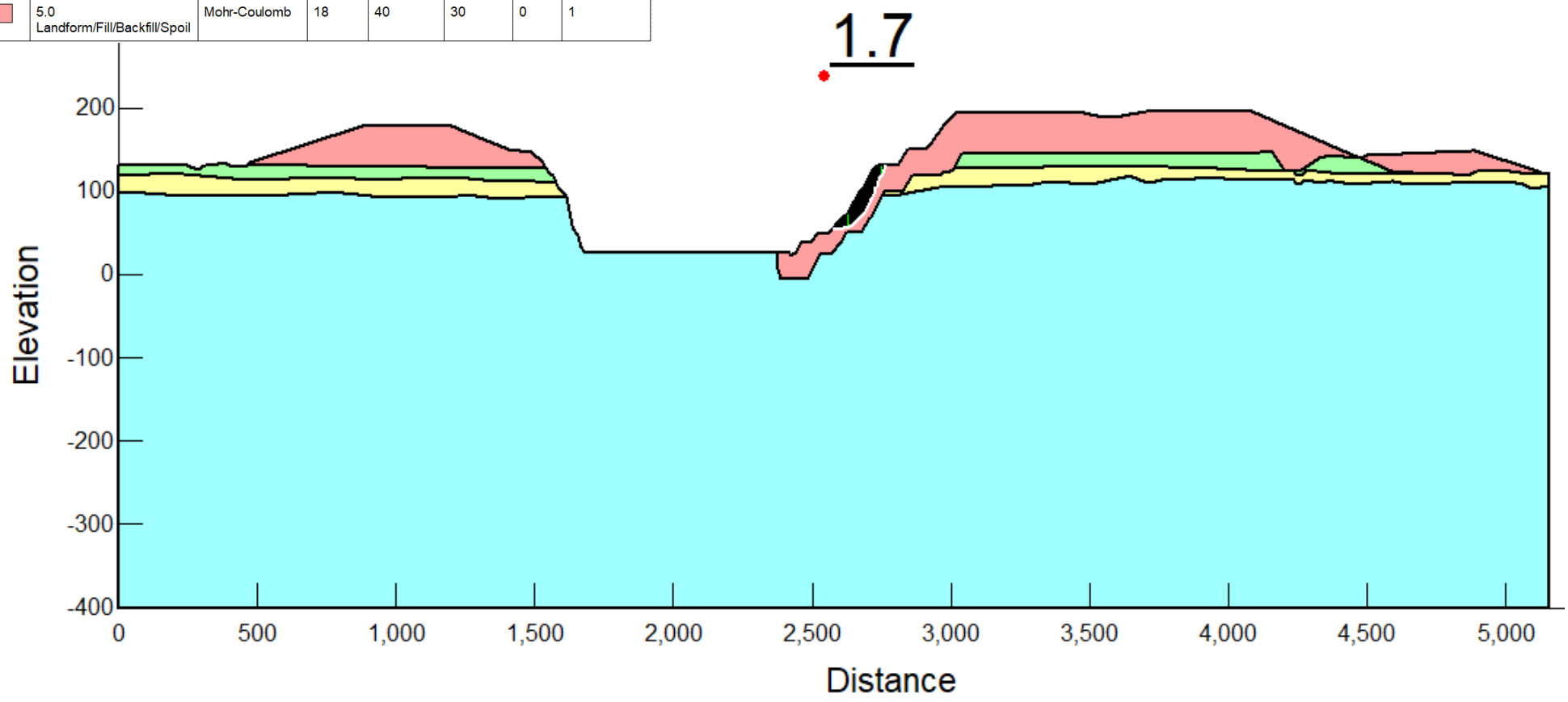


Foxleigh MINE

ENGENY

Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment	
Drawn	ML	8-Aug-23	Pipeline Pit Steady State Stability – High Wall, Peak Groundwater RL71.3m	
Checked	MD	8-Aug-23		
Job No.	QC1025_010		Figure A.21	Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1

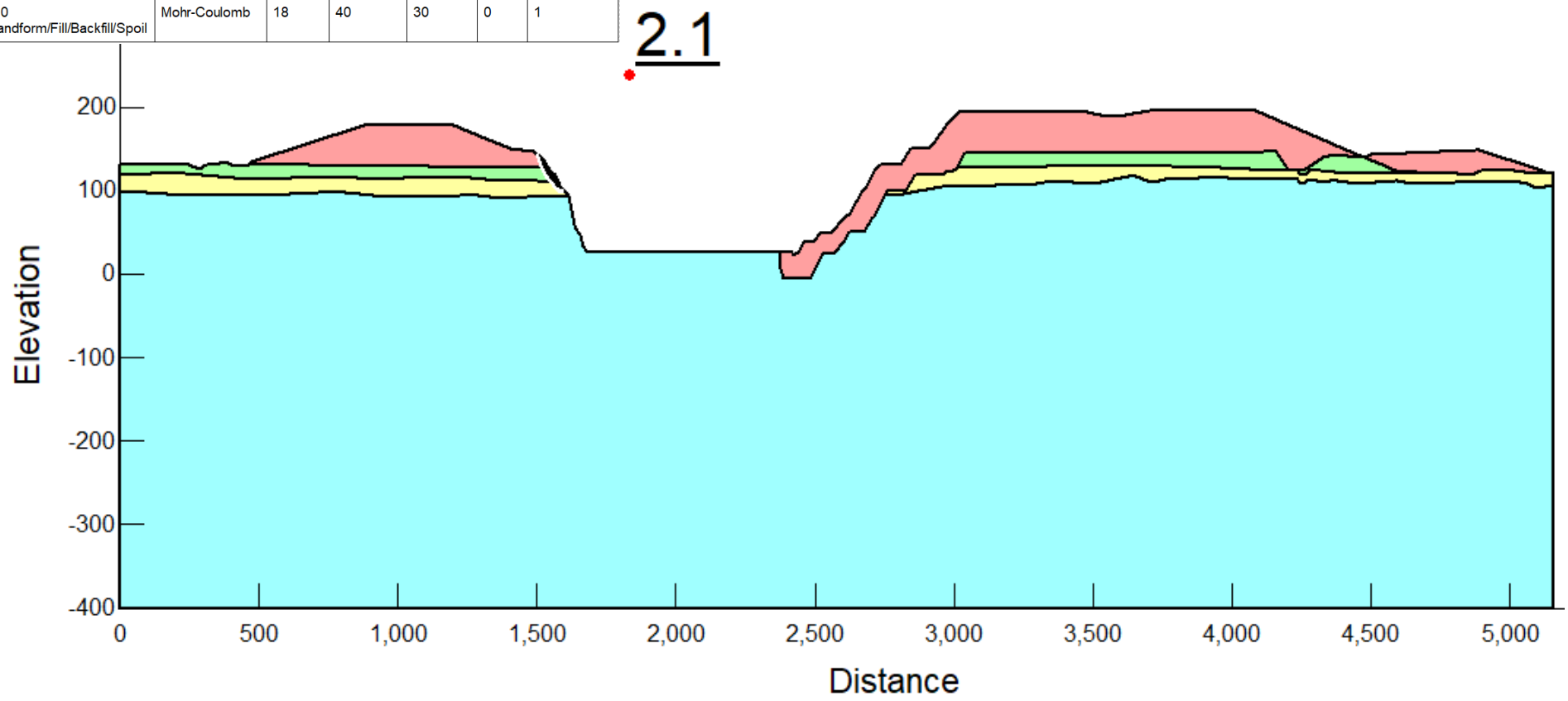


Foxleigh MINE

ENGENY

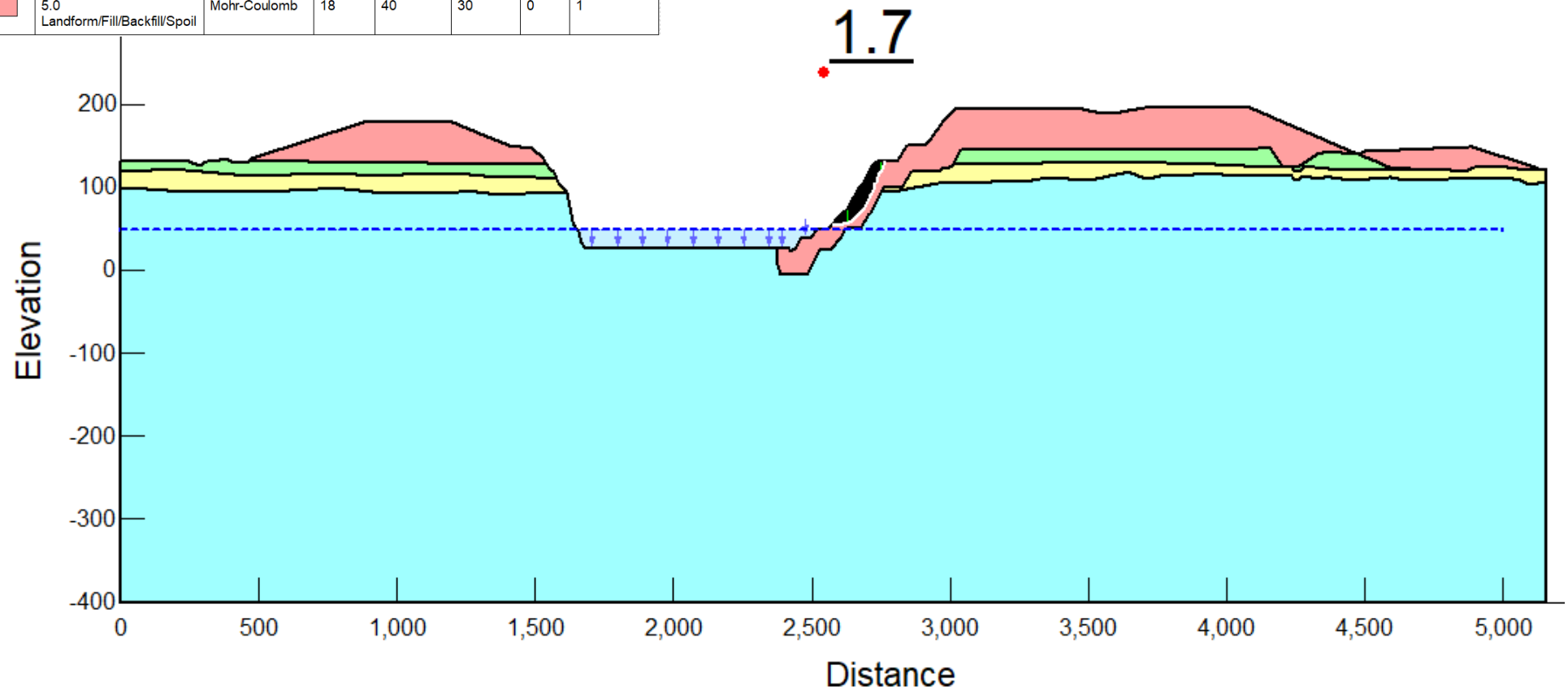
Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment	
Drawn	ML	8-Aug-23	One Tree West Pit Steady State Stability – Low Wall, No Groundwater	
Checked	MD	8-Aug-23		
Job No.	QC1025_010		Figure A.22	Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1



Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment	
Drawn	ML	8-Aug-23	One Tree West Pit Steady State Stability – High Wall, No Groundwater	
Checked	MD	8-Aug-23		
Job No.	QC1025_010		Figure A.23	Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1

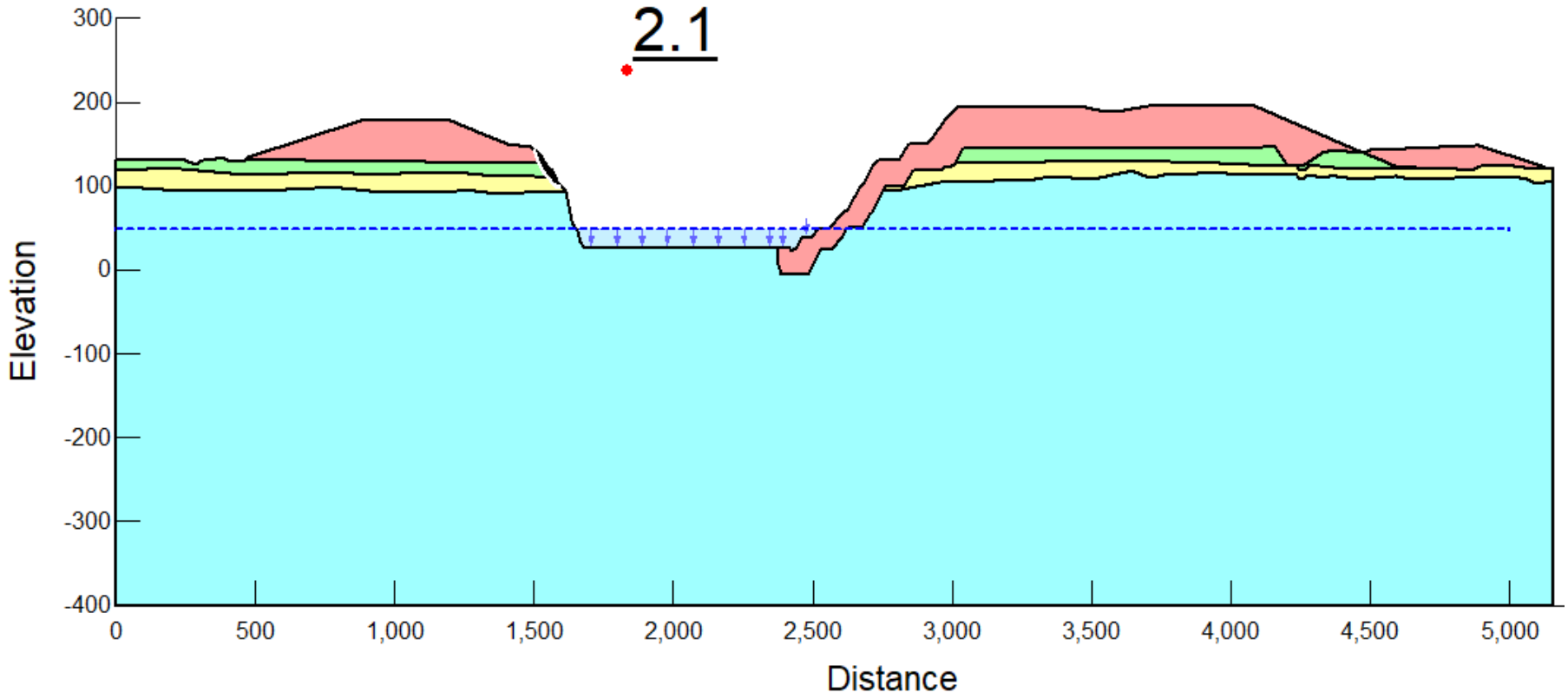


Foxleigh MINE

ENGENY

Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment	
Drawn	ML	8-Aug-23	One Tree West Pit Steady State Stability – Low Wall, Average Groundwater RL47.7m	
Checked	MD	8-Aug-23		
Job No.	QC1025_010		Figure A.24	Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1

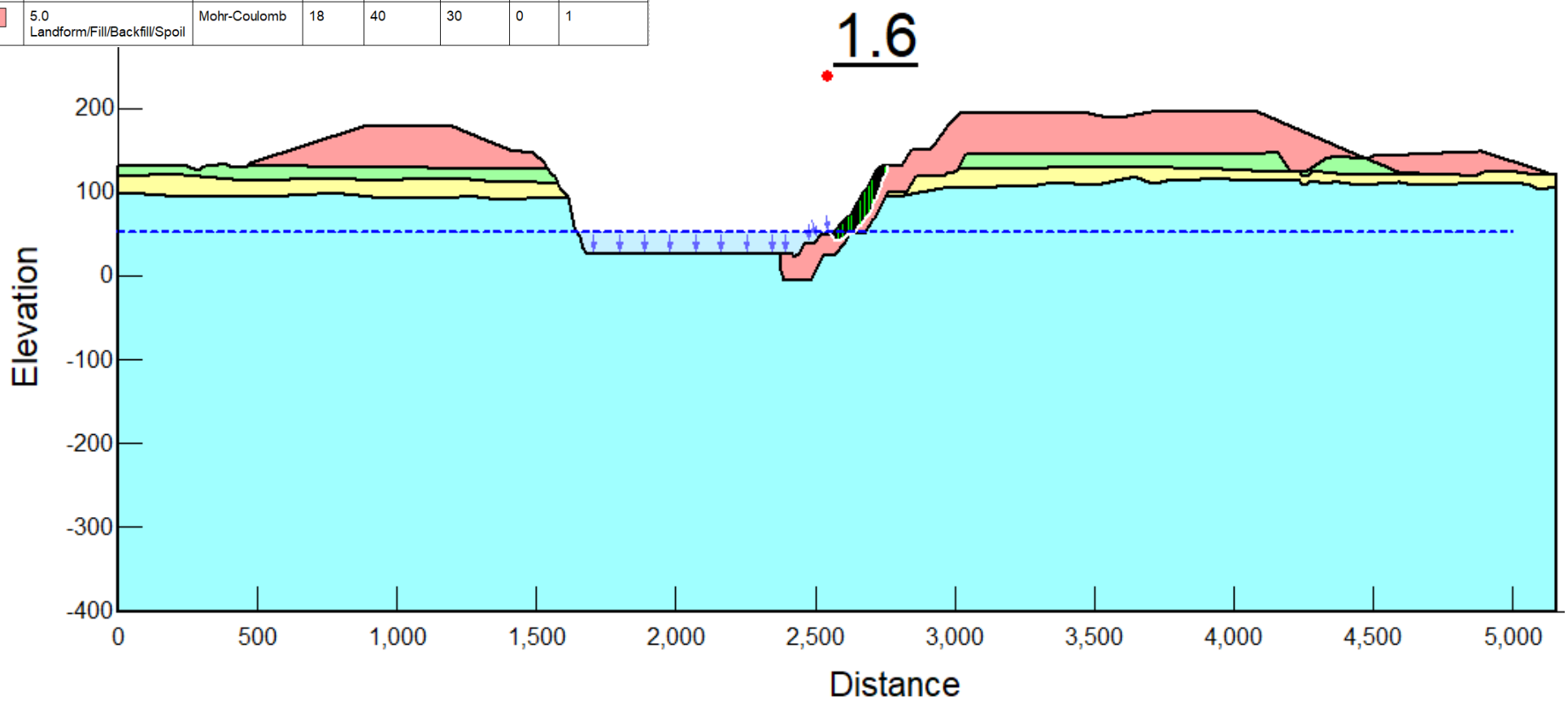


Foxleigh MINE

ENGENY

Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment
Drawn	ML	8-Aug-23	One Tree West Pit Steady State Stability – High Wall, Average Groundwater RL47.7m
Checked	MD	8-Aug-23	
Job No.	QC1025_010		Figure A.25 Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1

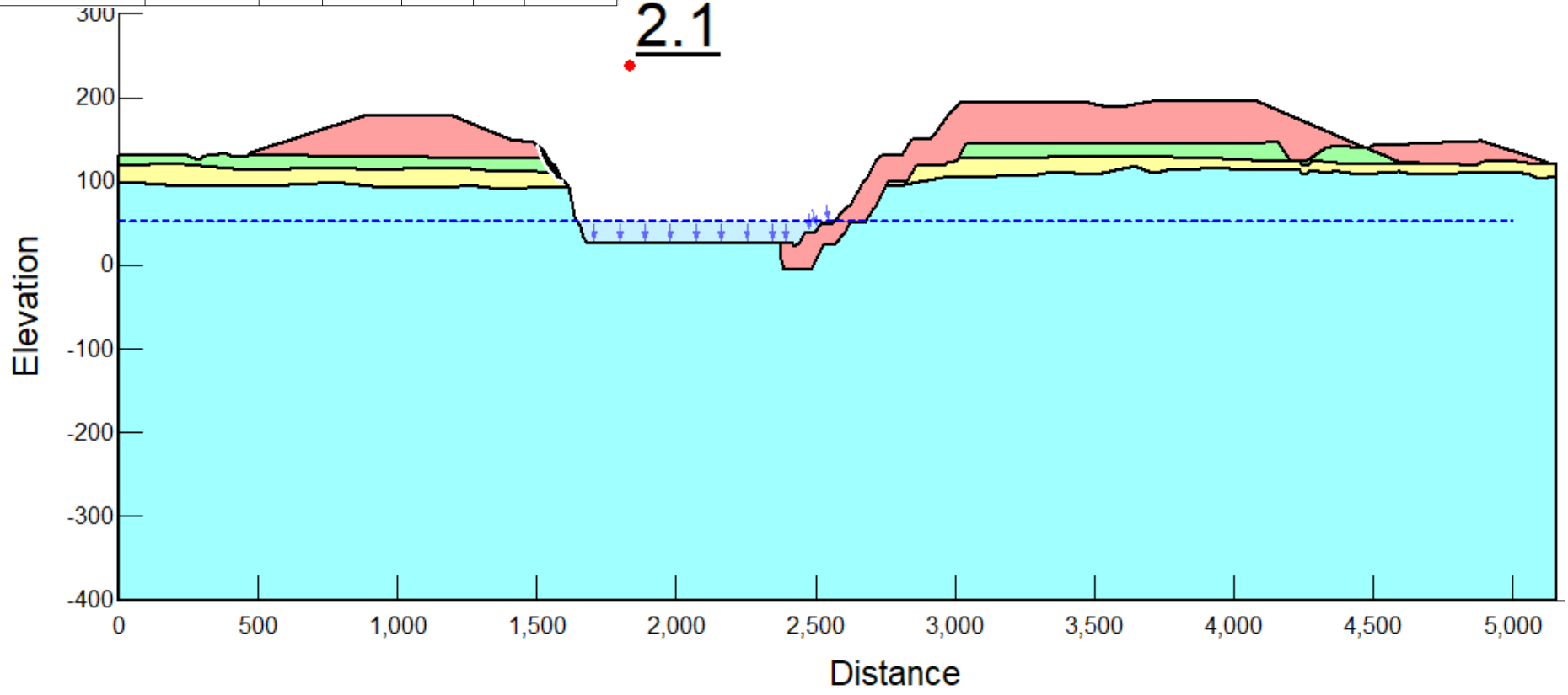


Foxleigh MINE

ENGENY

Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment
Drawn	ML	8-Aug-23	One Tree West Pit Steady State Stability – Low Wall, Peak Groundwater RL52.1m
Checked	MD	8-Aug-23	
Job No.	QC1025_010		Figure A.26 / Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1

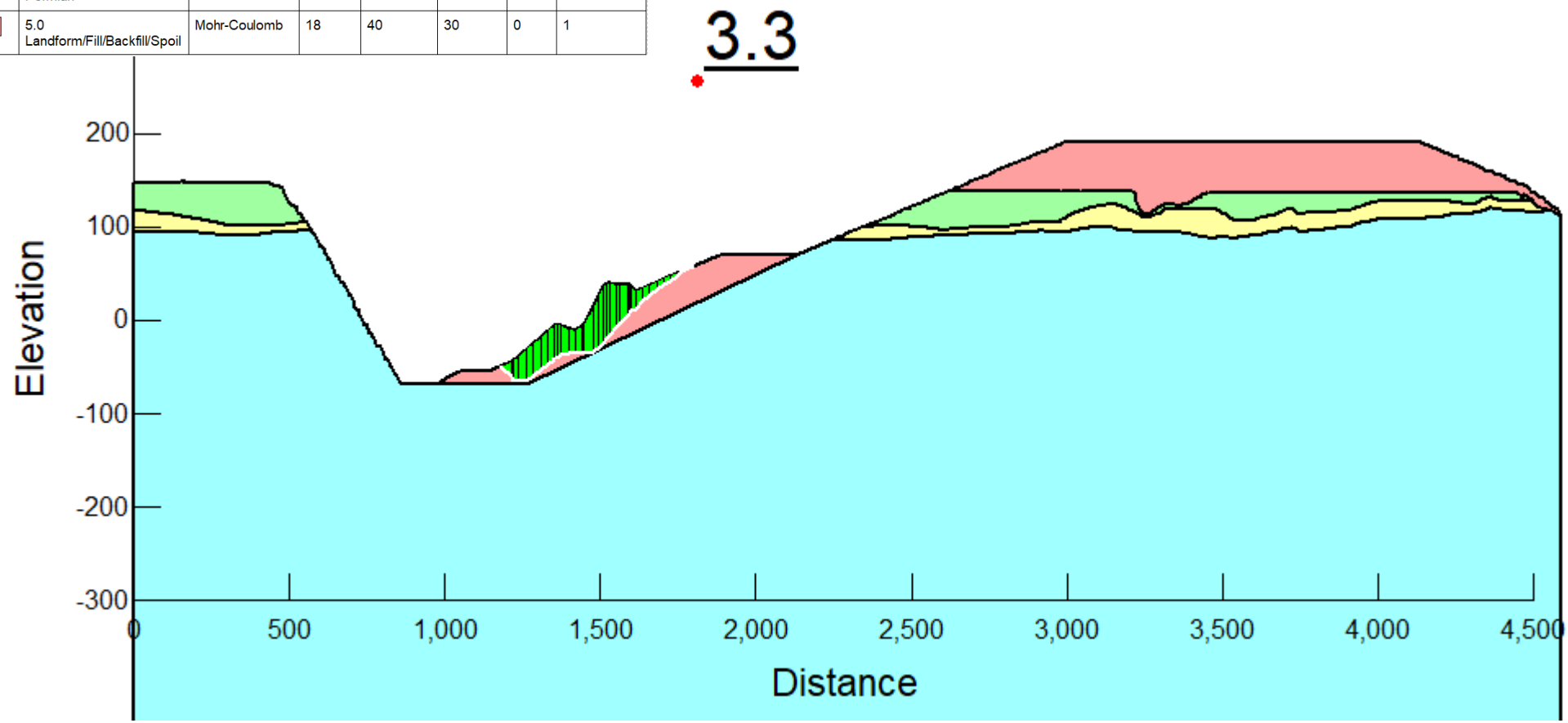


Foxleigh MINE

ENGENY

Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment
Drawn	ML	8-Aug-23	One Tree West Pit Steady State Stability – High Wall, Peak Groundwater RL52.1m
Checked	MD	8-Aug-23	
Job No.	QC1025_010		Figure A.27 Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1

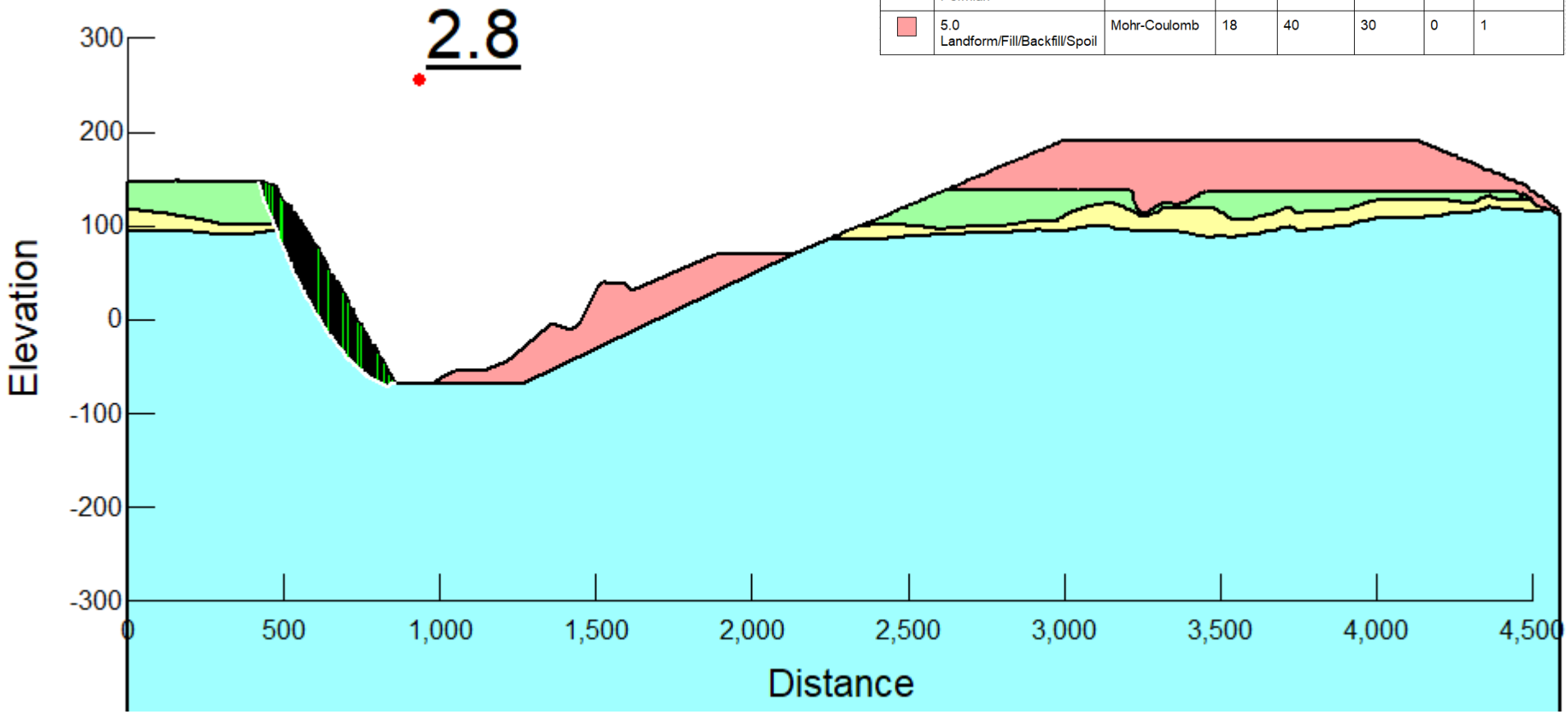


Foxleigh MINE

ENGENY

Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment
Drawn	ML	8-Aug-23	Eagles Nest Pit Steady State Stability – Low Wall, No Groundwater
Checked	MD	8-Aug-23	
Job No.	QC1025_010		Figure A.28 Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1

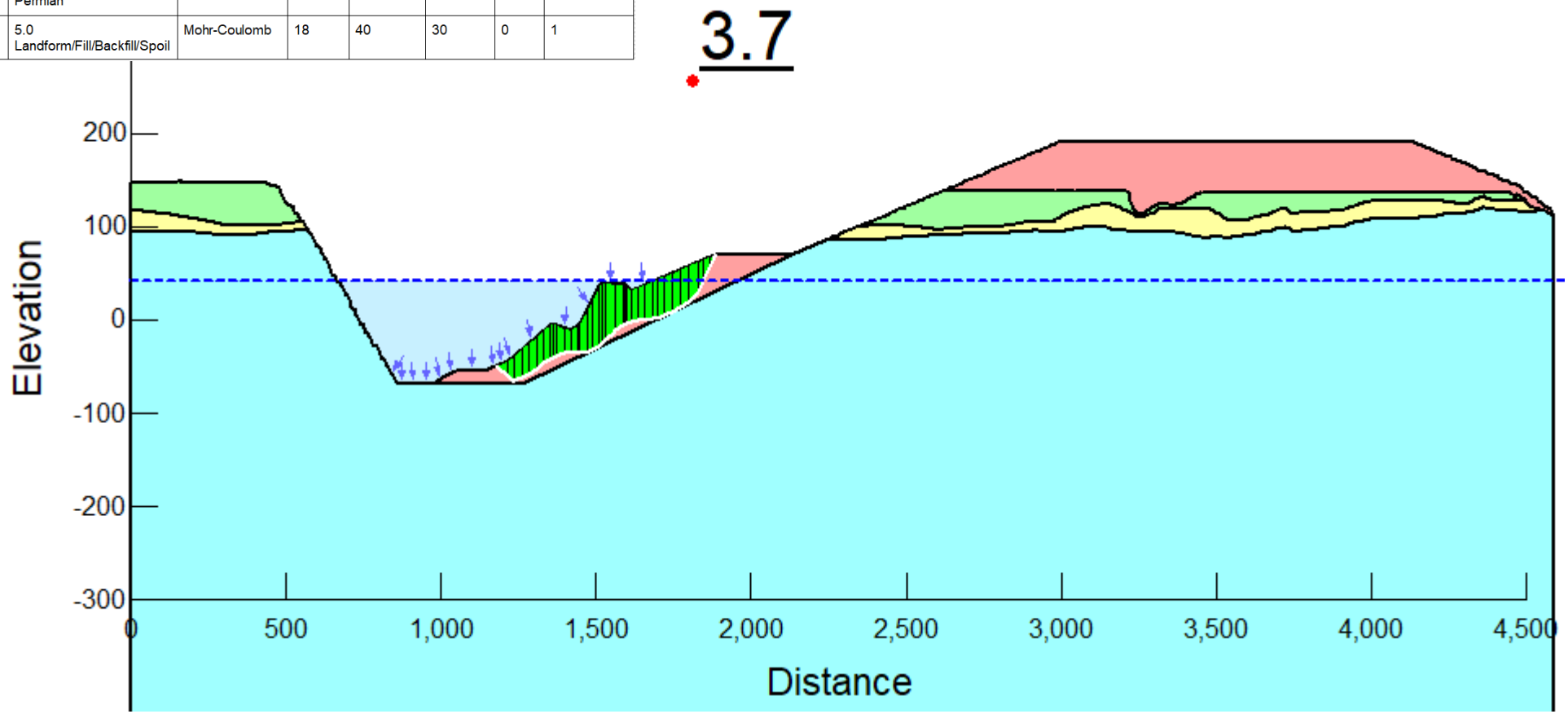


Foxleigh MINE

ENGENY

Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment
Drawn	ML	8-Aug-23	Eagles Nest Pit Steady State Stability – High Wall, No Groundwater
Checked	MD	8-Aug-23	
Job No.	QC1025_010		Figure A.29 Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1

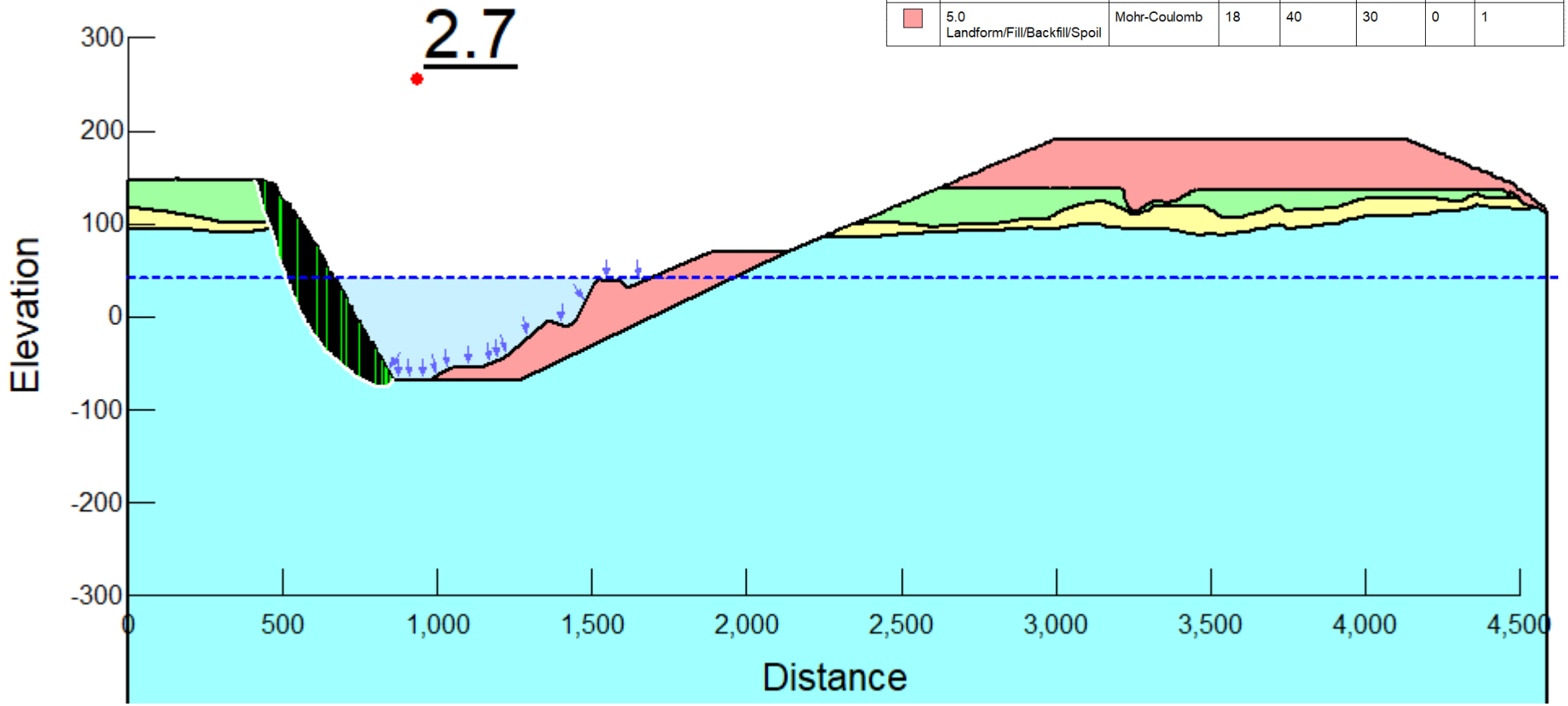


Foxleigh MINE

ENGENY

Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment
Drawn	ML	8-Aug-23	Eagles Nest Pit Steady State Stability – Low Wall, Average Groundwater RL41.5m
Checked	MD	8-Aug-23	
Job No.	QC1025_010		Figure A.30 Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1

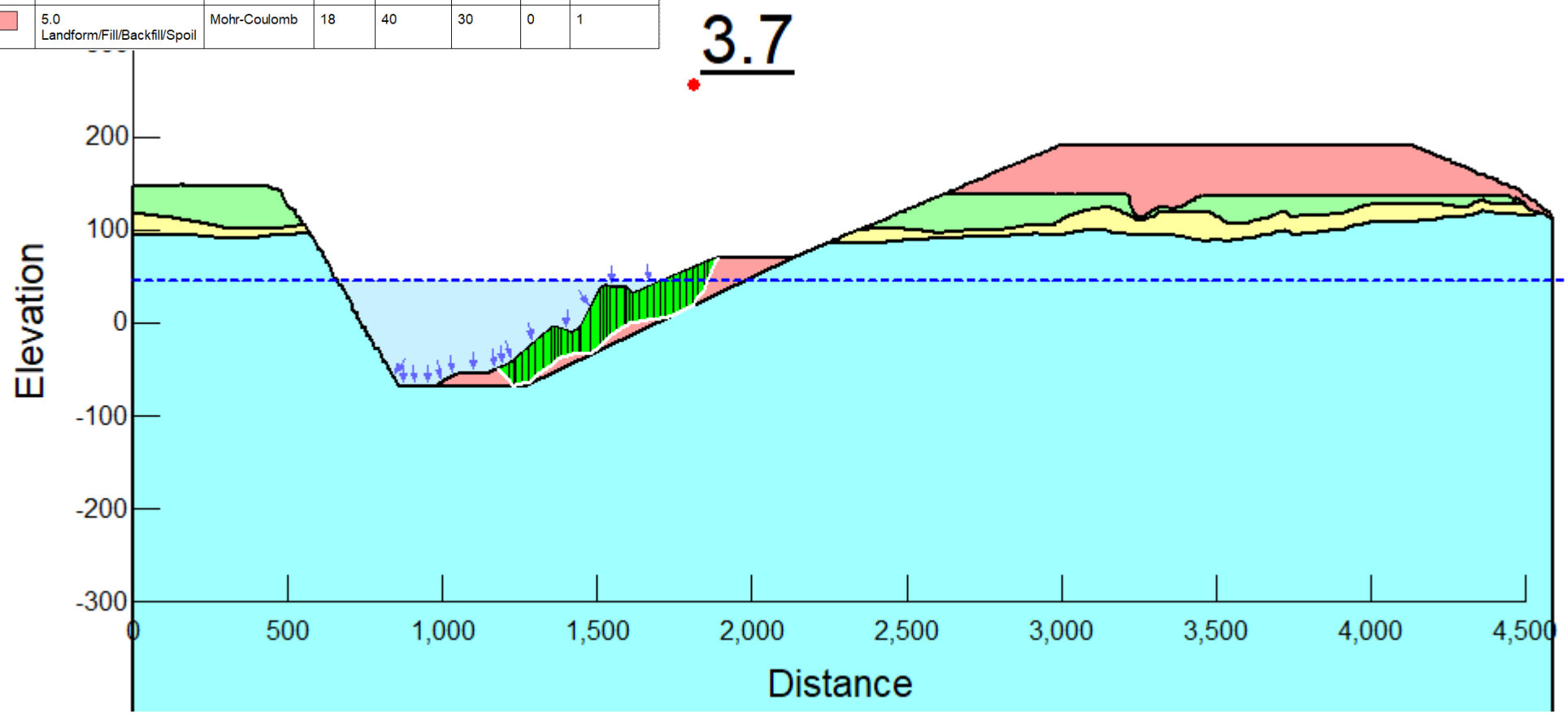


Foxleigh MINE

ENGENY

Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment
Drawn	ML	8-Aug-23	Eagles Nest Pit Steady State Stability – High Wall, Average Groundwater RL41.5m
Checked	MD	8-Aug-23	
Job No.	QC1025_010		Figure A.31 Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1

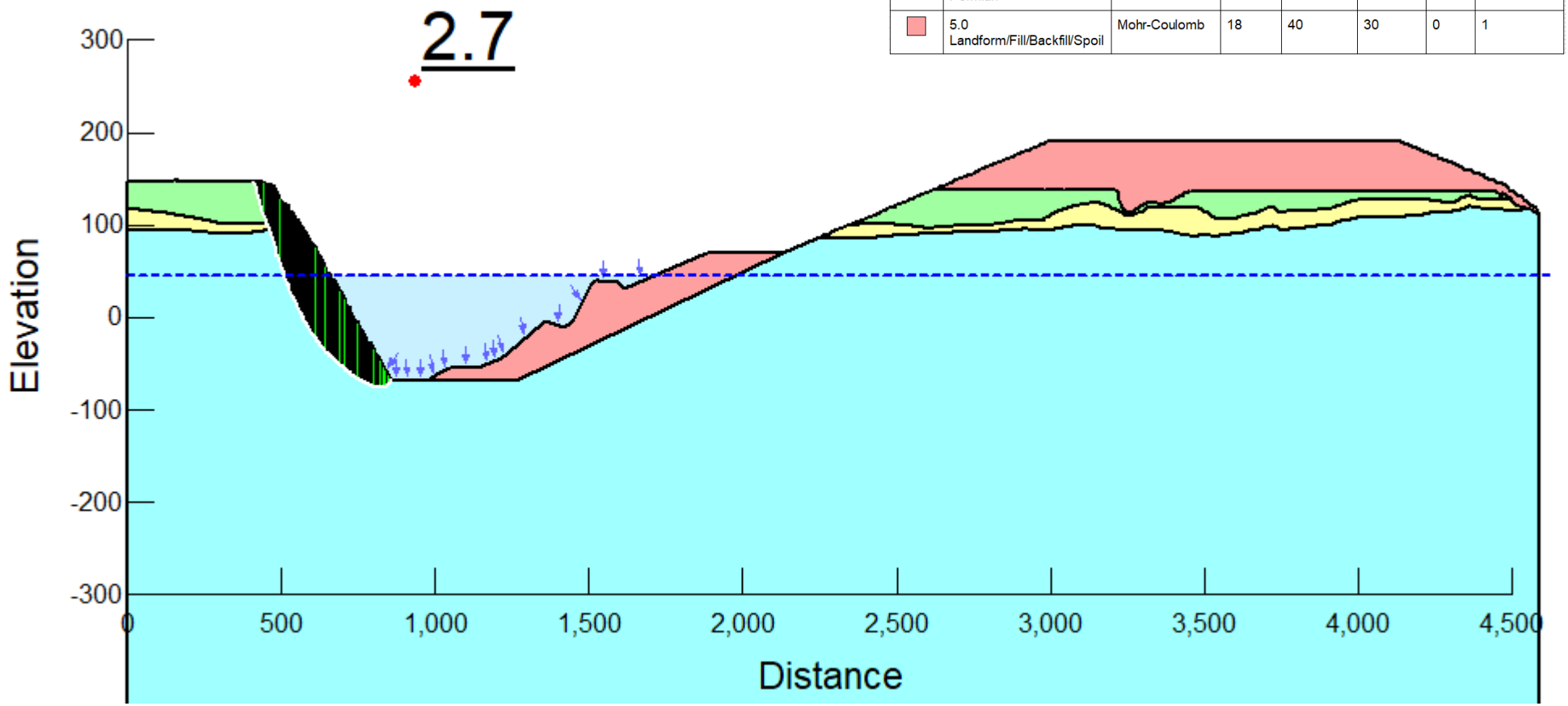


Foxleigh MINE

ENGENY

Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment
Drawn	ML	8-Aug-23	Eagles Nest Pit Steady State Stability – Low Wall, Peak Groundwater RL45.1m
Checked	MD	8-Aug-23	
Job No.	QC1025_010		Figure A.32 Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1

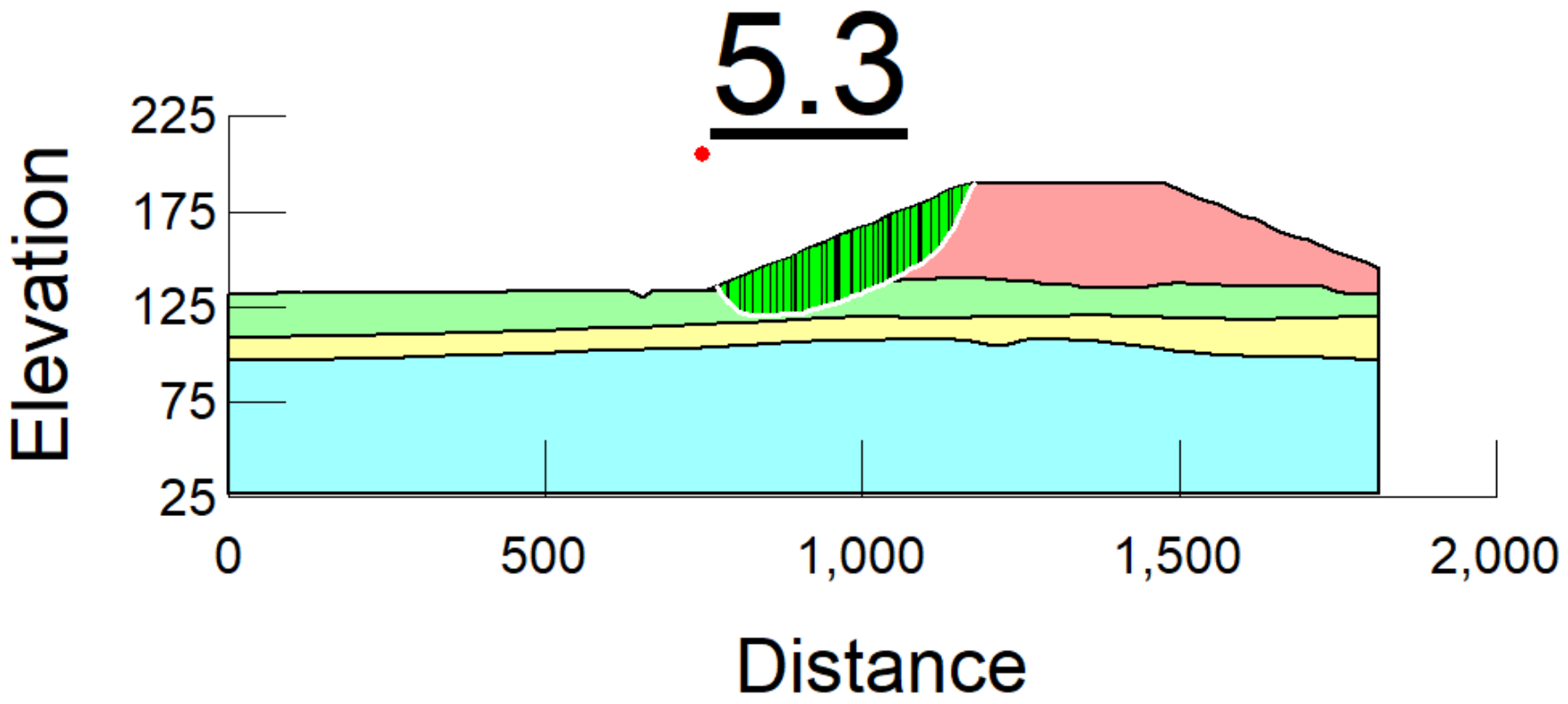


Foxleigh MINE

ENGENY

Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment	
Drawn	ML	8-Aug-23	Eagles Nest Pit Steady State Stability – High Wall, Peak Groundwater RL45.1m	
Checked	MD	8-Aug-23		
Job No.	QC1025_010		Figure A.33	Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1

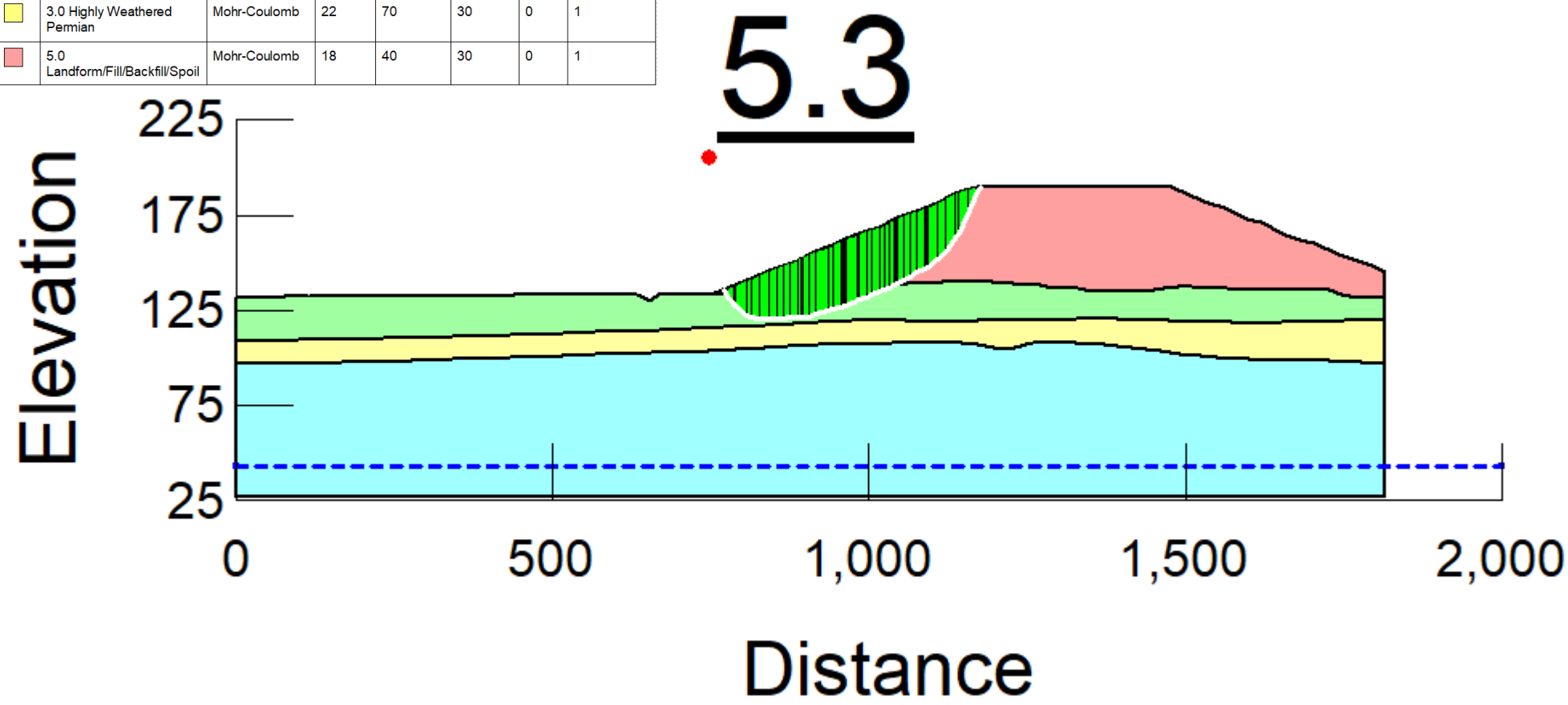


Foxleigh MINE

ENGENY

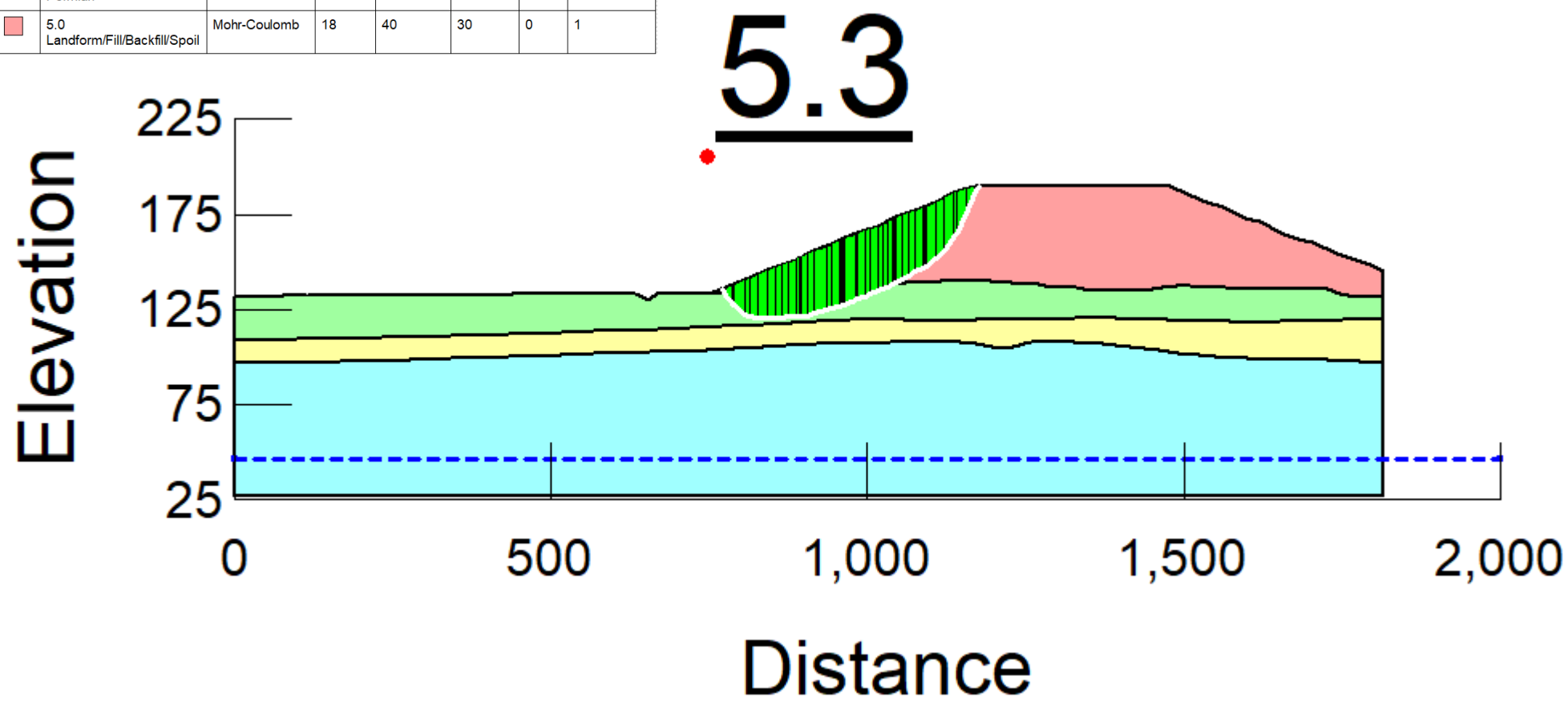
Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment	
Drawn	ML	8-Aug-23	WC Pit (Landform) Steady State Stability – No Groundwater	
Checked	MD	8-Aug-23		
Job No.	QC1025_010		Figure A.34	Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1



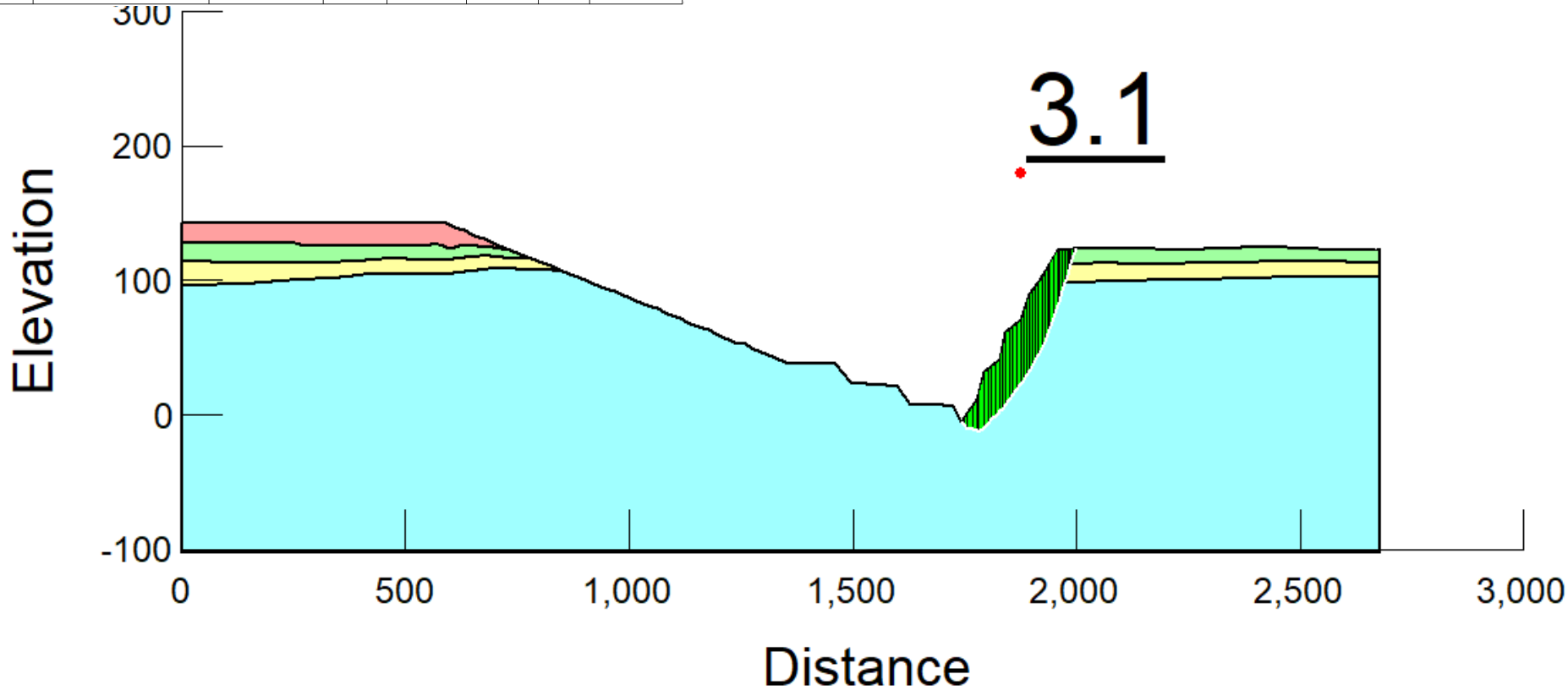
Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment	
Drawn	ML	8-Aug-23	WC Pit (Landform) Steady State Stability – Average Groundwater RL42.8m	
Checked	MD	8-Aug-23		
Job No.	QC1025_010		Figure A.35	Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1



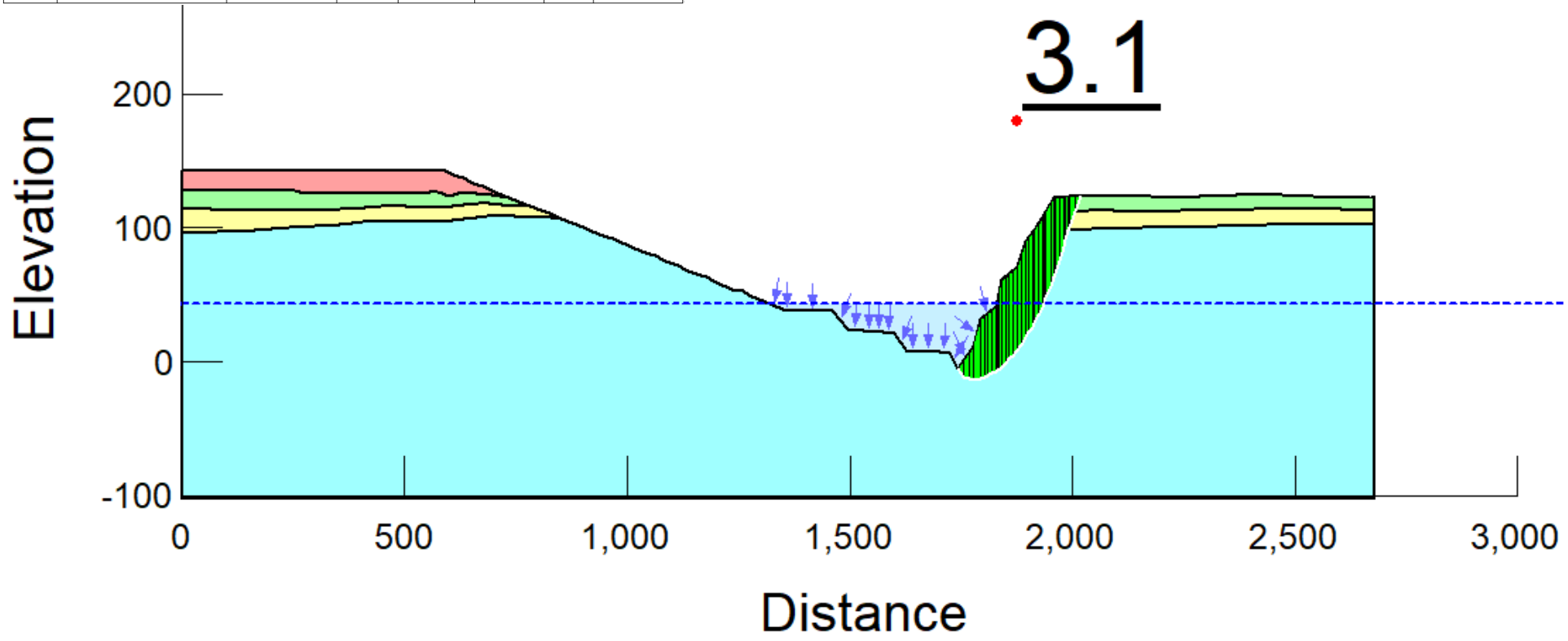
Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment	
Drawn	ML	8-Aug-23	WC Pit (Landform) Steady State Stability – Peak Groundwater RL46.1m	
Checked	MD	8-Aug-23		
Job No.	QC1025_010		Figure A.36	Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1



Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment	
Drawn	ML	8-Aug-23	WC Pit Steady State Stability – Low Wall, No Groundwater	
Checked	MD	8-Aug-23		
Job No.	QC1025_010		Figure A.37	Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1

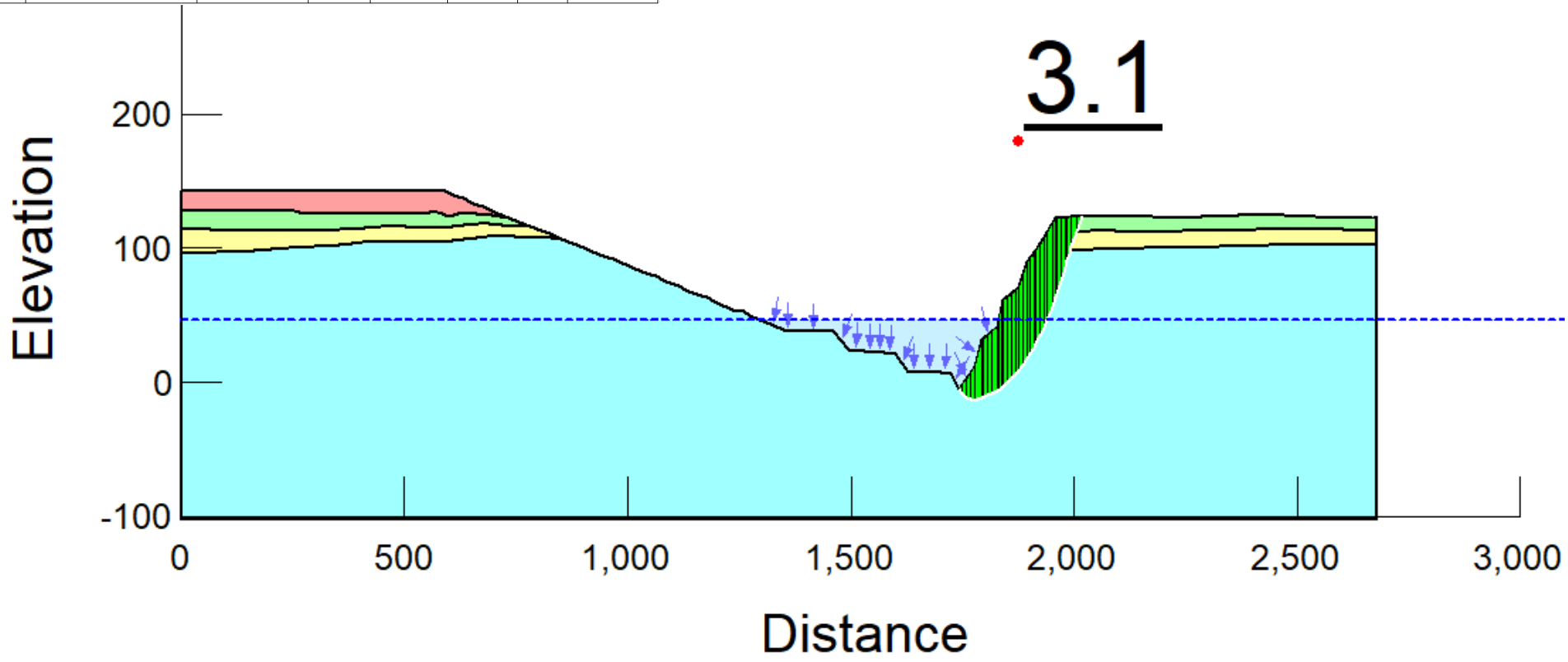


Foxleigh MINE

ENGENY

Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment
Drawn	ML	8-Aug-23	WC Pit Steady State Stability – Low Wall, Average Groundwater RL42.8m
Checked	MD	8-Aug-23	
Job No.	QC1025_010		Figure A.38 / Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1

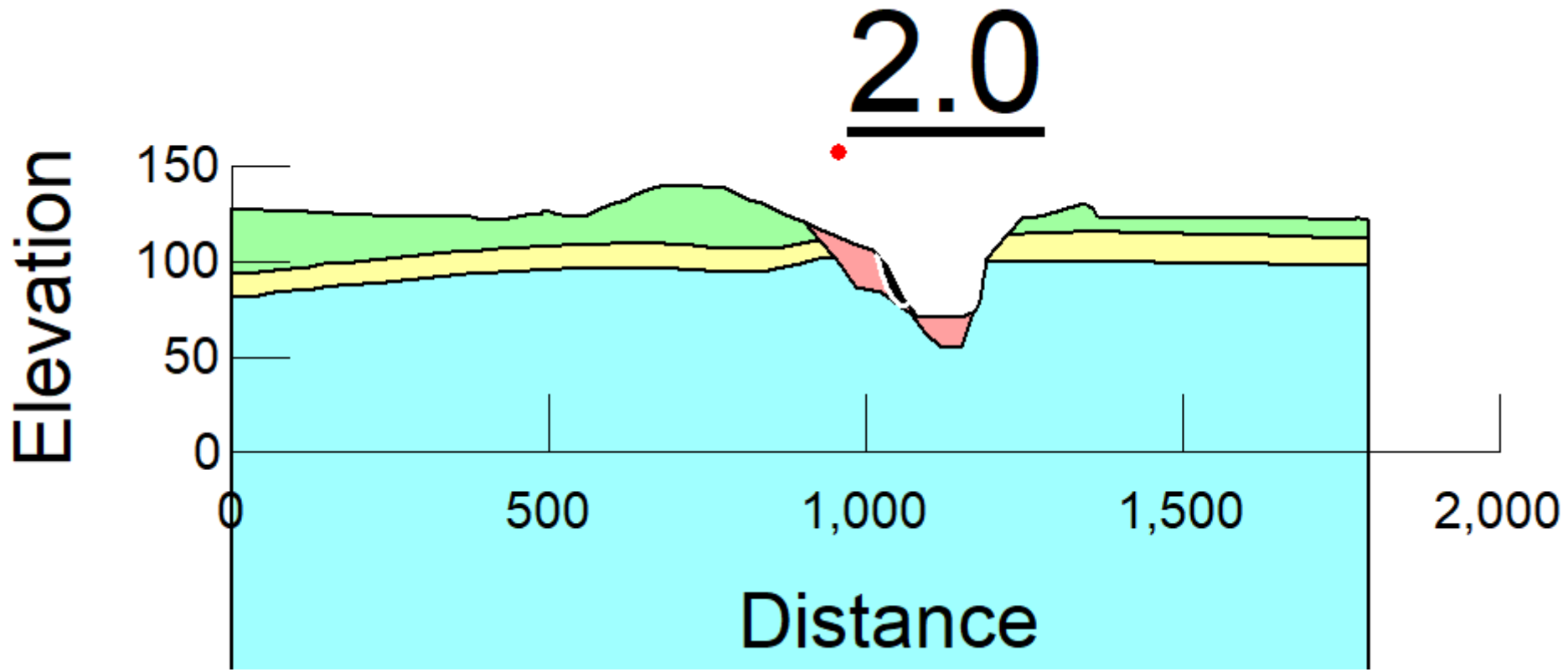


Foxleigh MINE

ENGENY

Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment	
Drawn	ML	8-Aug-23	WC Pit Steady State Stability – Low Wall, Peak Groundwater RL46.1m	
Checked	MD	8-Aug-23		
Job No.	QC1025_010		Figure A.39	Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1

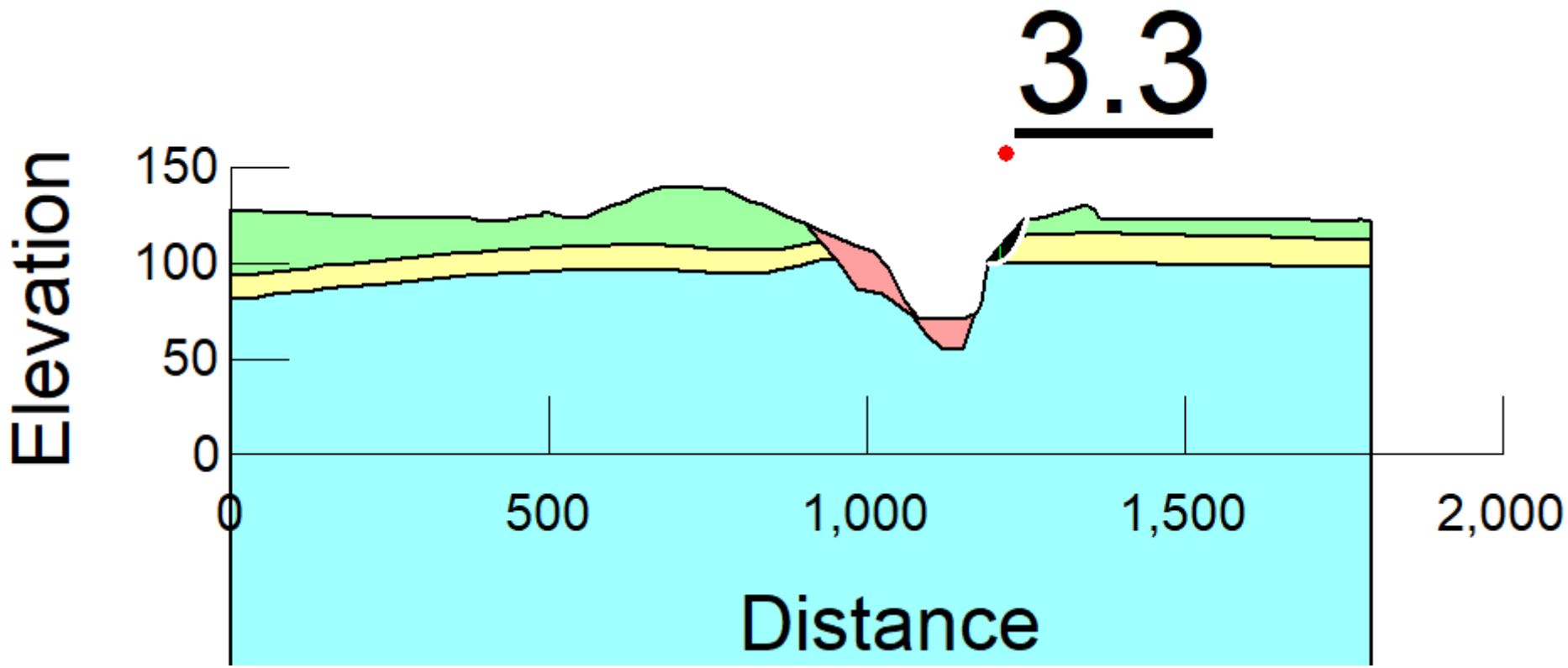


Foxleigh MINE

ENGENY

Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment	
Drawn	ML	8-Aug-23	Far Pit South Steady State Stability – Low Wall, No Groundwater	
Checked	MD	8-Aug-23		
Job No.	QC1025_010		Figure A.40	Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1

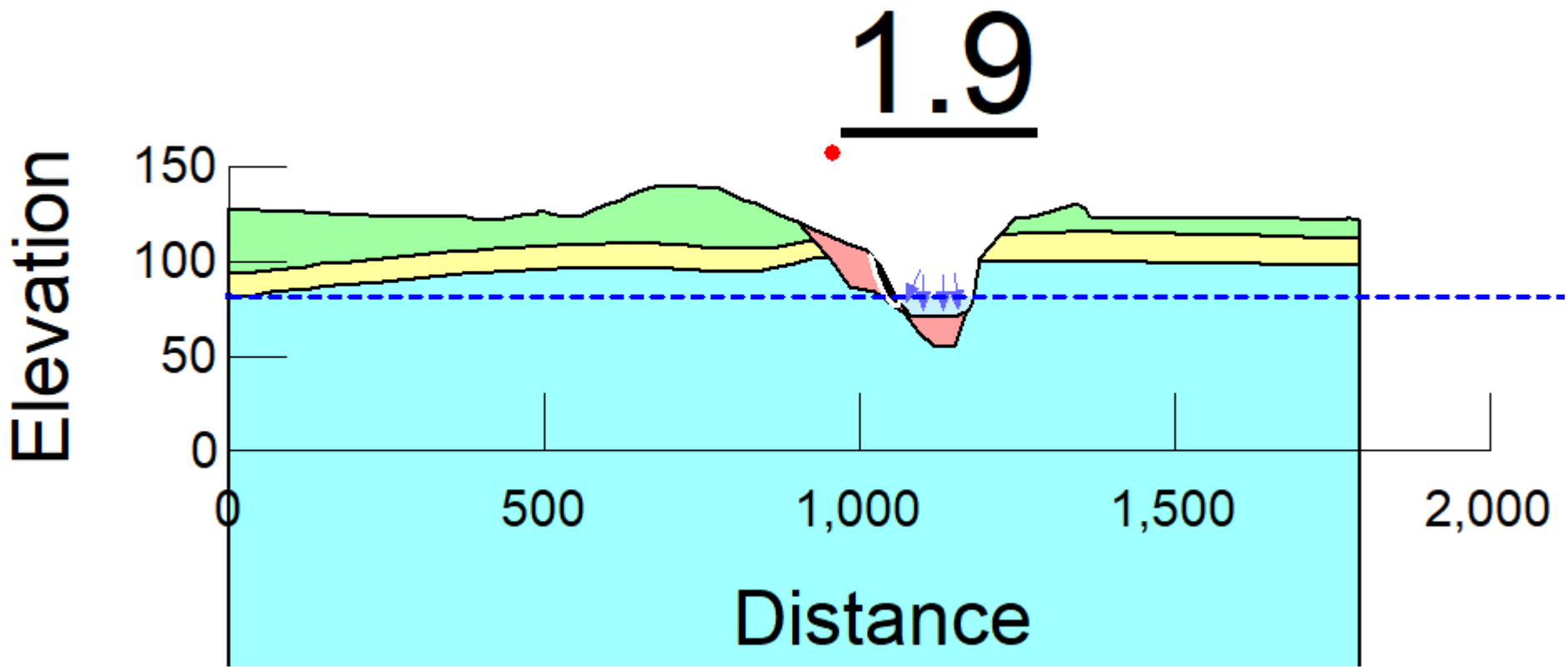


Foxleigh MINE

ENGENY

Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment	
Drawn	ML	8-Aug-23	Far Pit South Steady State Stability – High Wall, No Groundwater	
Checked	MD	8-Aug-23		
Job No.	QC1025_010		Figure A.41	Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1

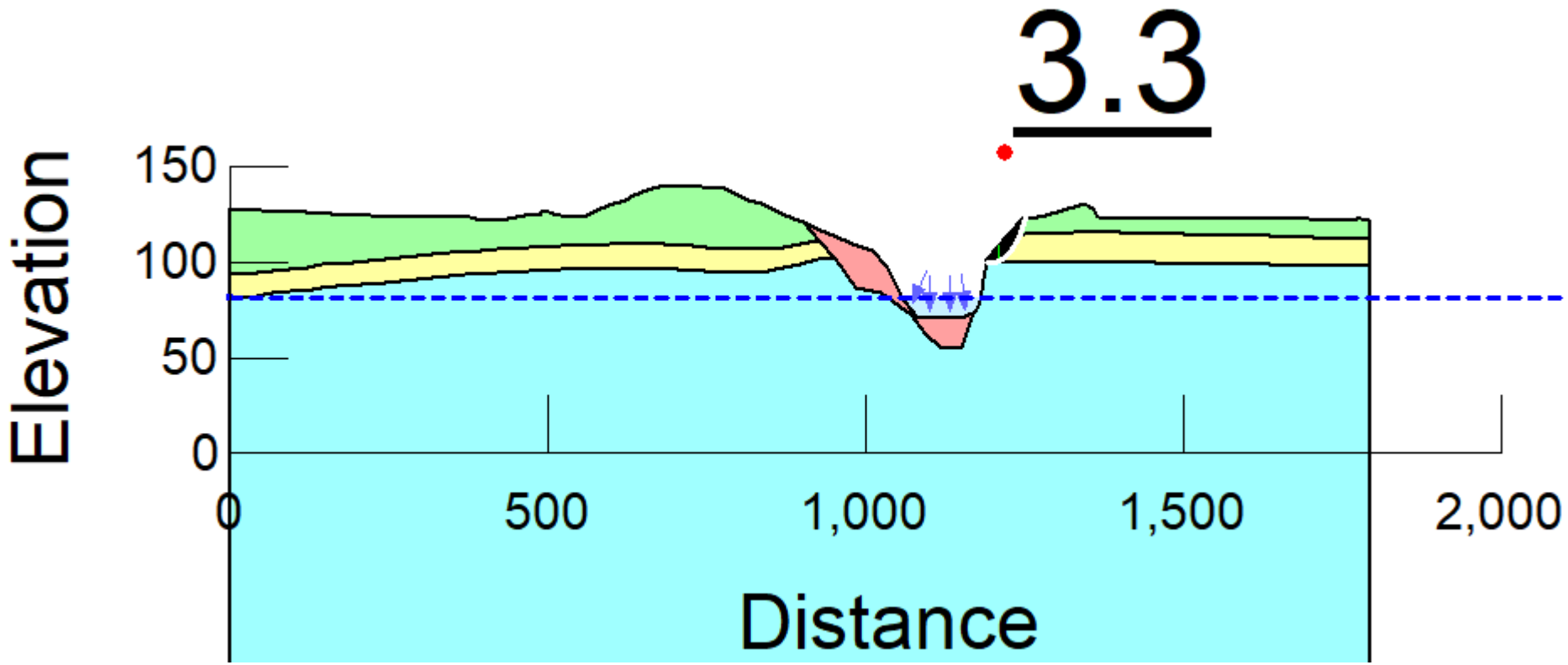


Foxleigh MINE

ENGENY

Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment	
Drawn	ML	8-Aug-23	Far Pit South Steady State Stability – Low Wall, Average Groundwater RL81.3m	
Checked	MD	8-Aug-23		
Job No.	QC1025_010		Figure A.42	Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1

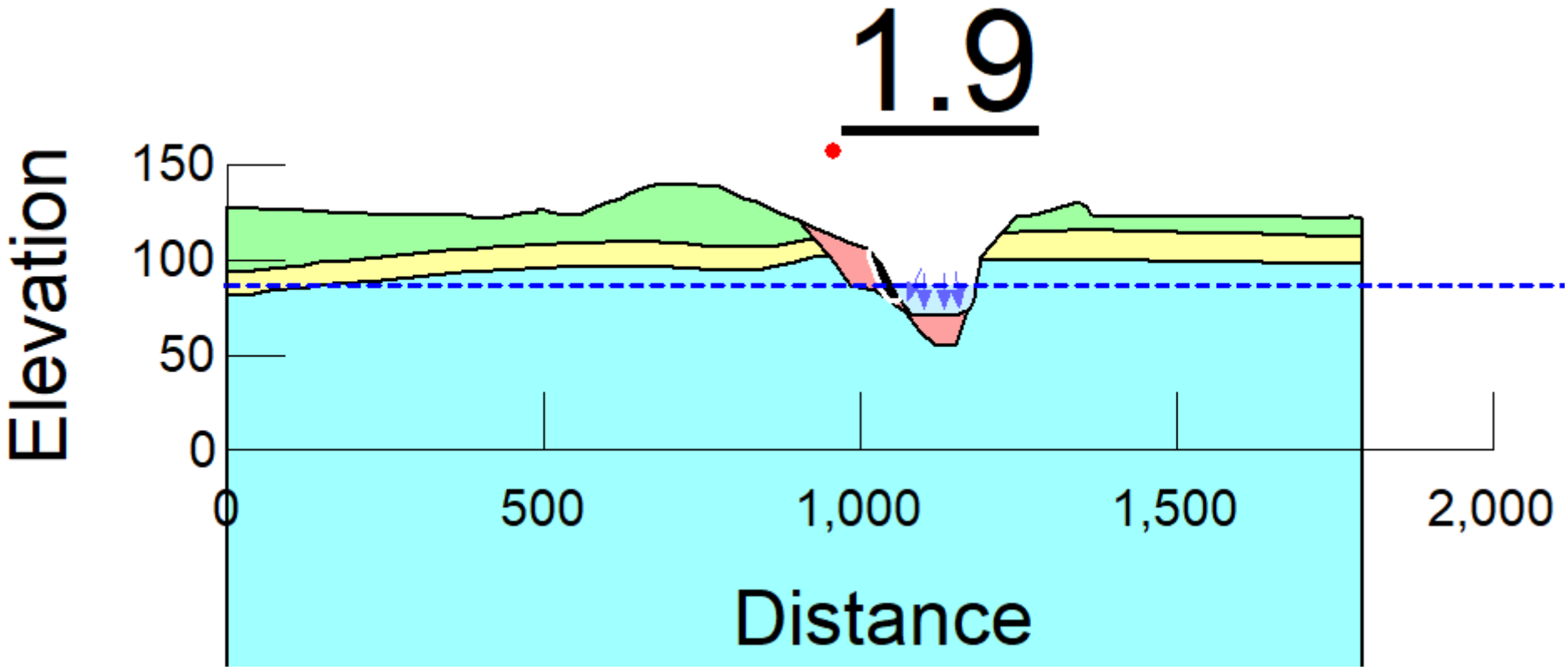


Foxleigh MINE

ENGENY

Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment	
Drawn	ML	8-Aug-23	Far Pit South Steady State Stability – High Wall, Average Groundwater RL81.3m	
Checked	MD	8-Aug-23		
Job No.	QC1025_010		Figure A.43	Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1

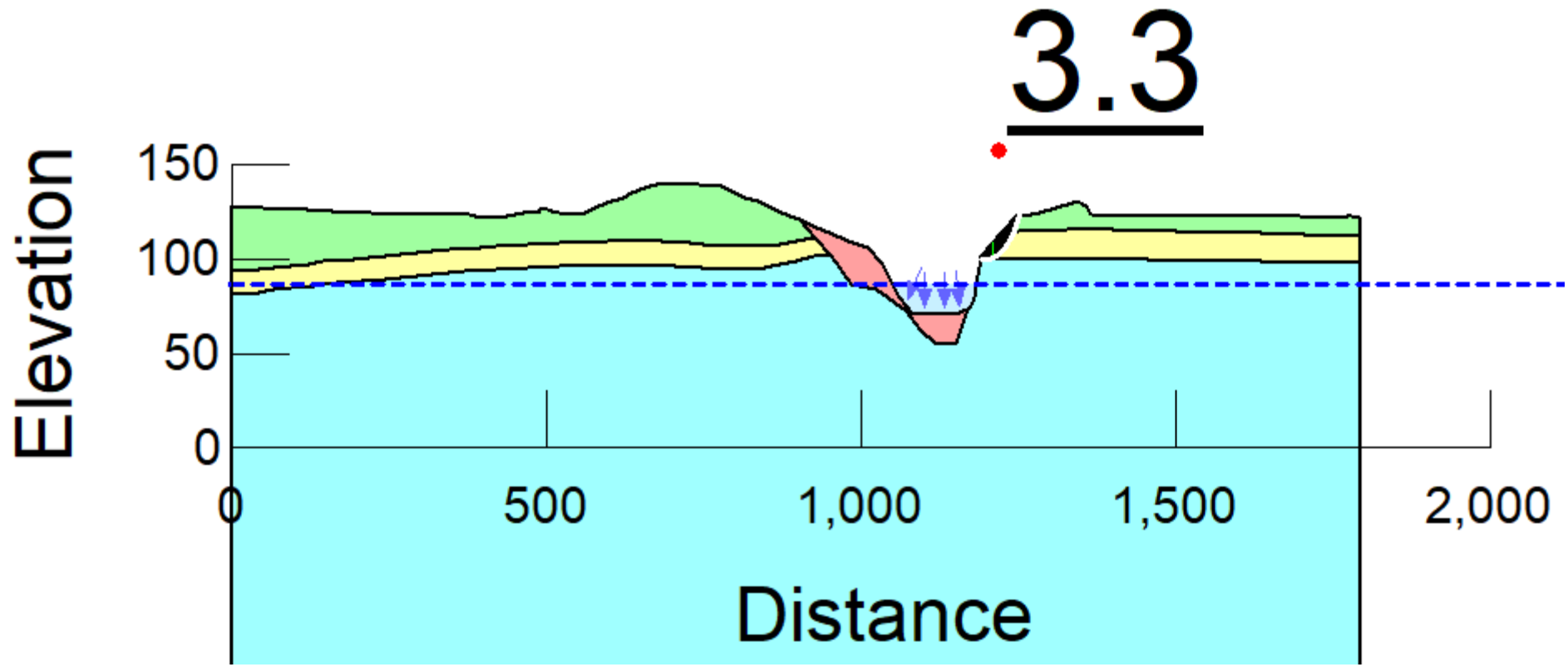


Foxleigh MINE

ENGENY

Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment	
Drawn	ML	8-Aug-23	Far Pit South Steady State Stability – Low Wall, Peak Groundwater RL86.4m	
Checked	MD	8-Aug-23		
Job No.	QC1025_010		Figure A.44	Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1

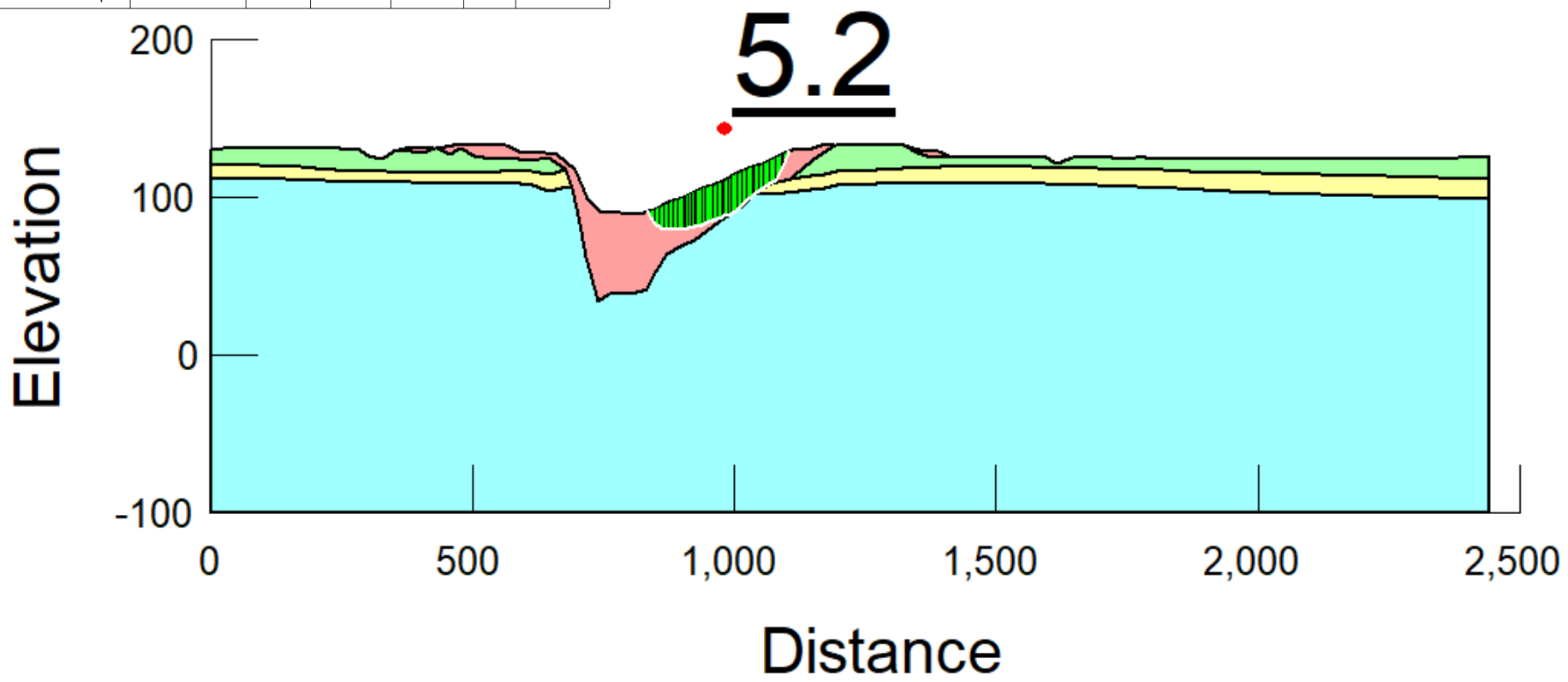


Foxleigh MINE

ENGENY

Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment	
Drawn	ML	8-Aug-23	Far Pit South Steady State Stability – High Wall, Peak Groundwater RL86.4m	
Checked	MD	8-Aug-23		
Job No.	QC1025_010		Figure A.45	Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1

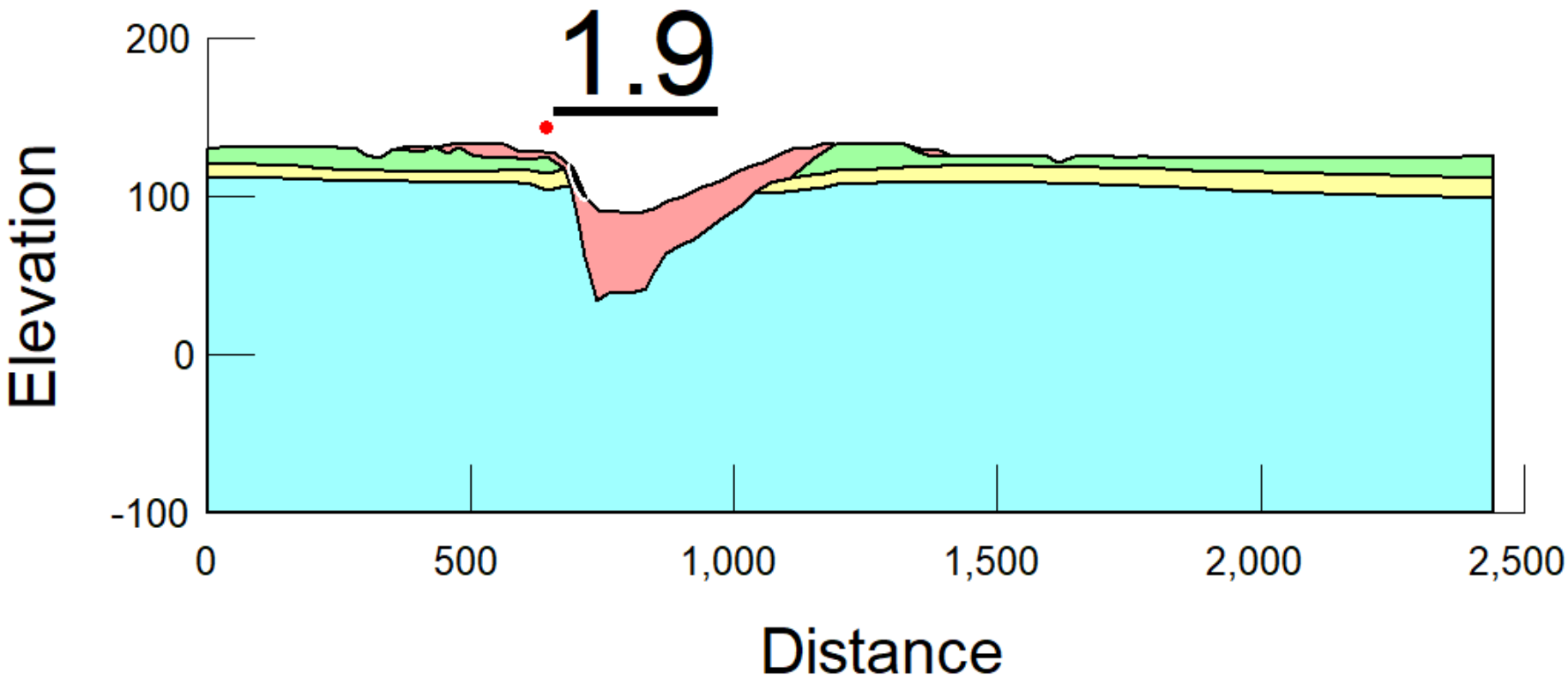


Foxleigh MINE

ENGENY

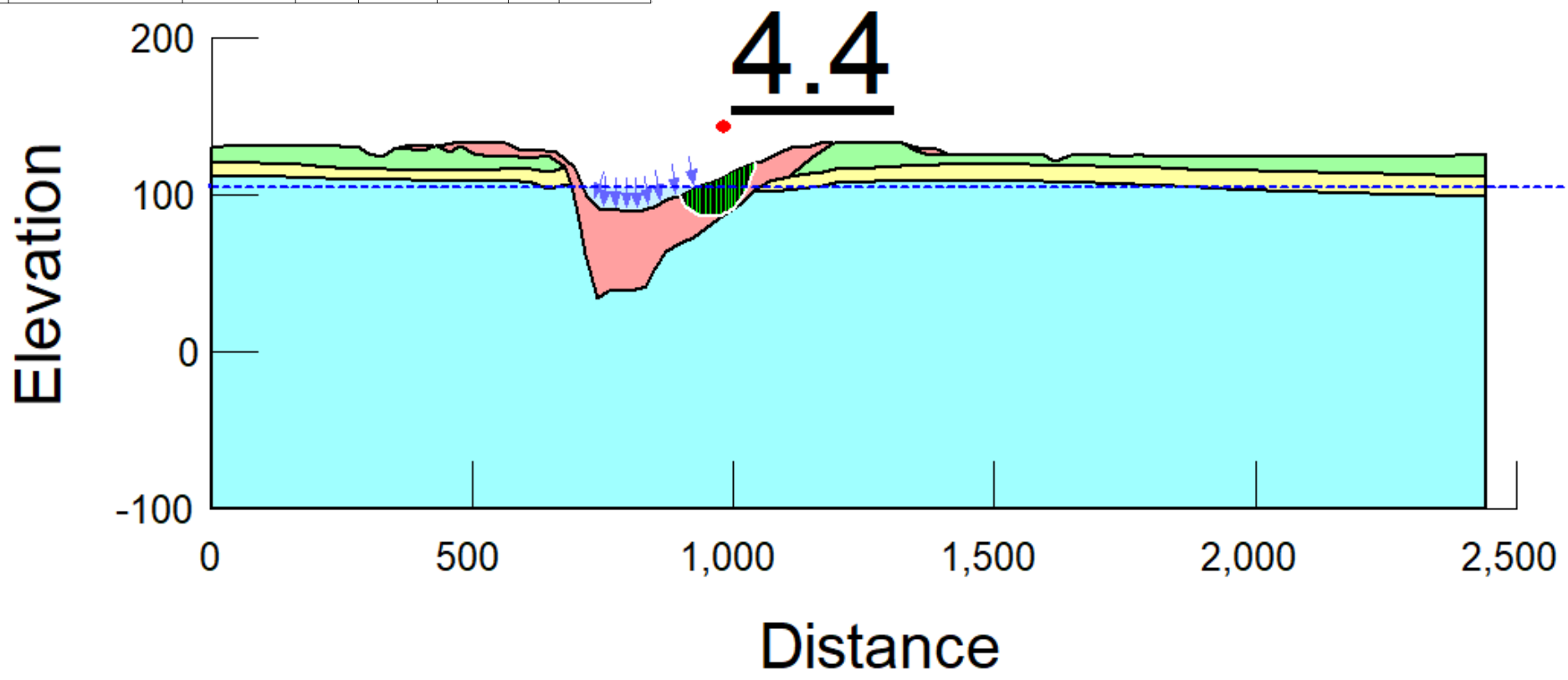
Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment	
Drawn	ML	8-Aug-23	Carlo Pit Steady State Stability – Low Wall, No Groundwater	
Checked	MD	8-Aug-23		
Job No.	QC1025_010		Figure A.46	Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1



Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment	
Drawn	ML	8-Aug-23	Carlo Pit Steady State Stability – High Wall, No Groundwater	
Checked	MD	8-Aug-23		
Job No.	QC1025_010		Figure A.47	Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1

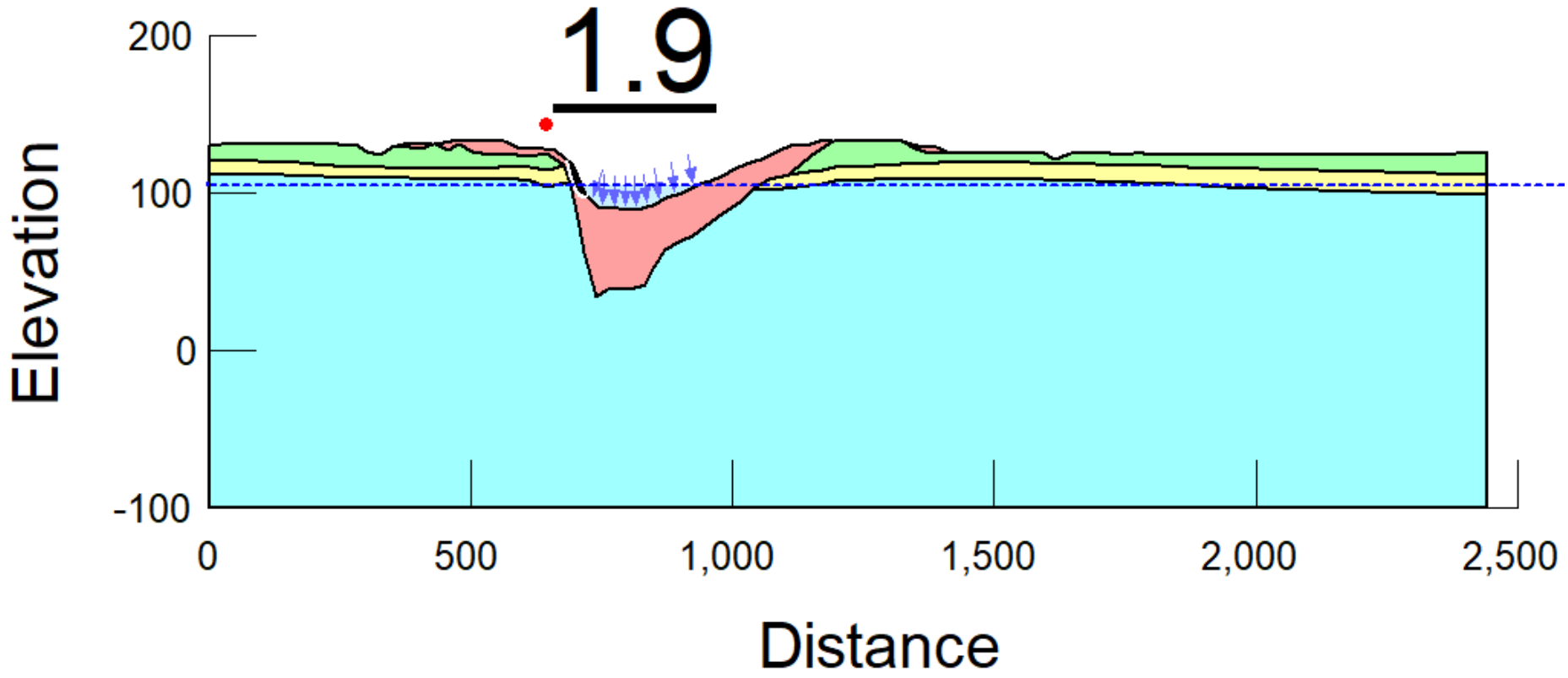


Foxleigh MINE

ENGENY

Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment	
Drawn	ML	8-Aug-23	Carlo Pit Steady State Stability – Low Wall, Average Groundwater RL105.6m	
Checked	MD	8-Aug-23		
Job No.	QC1025_010		Figure A.48	Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1

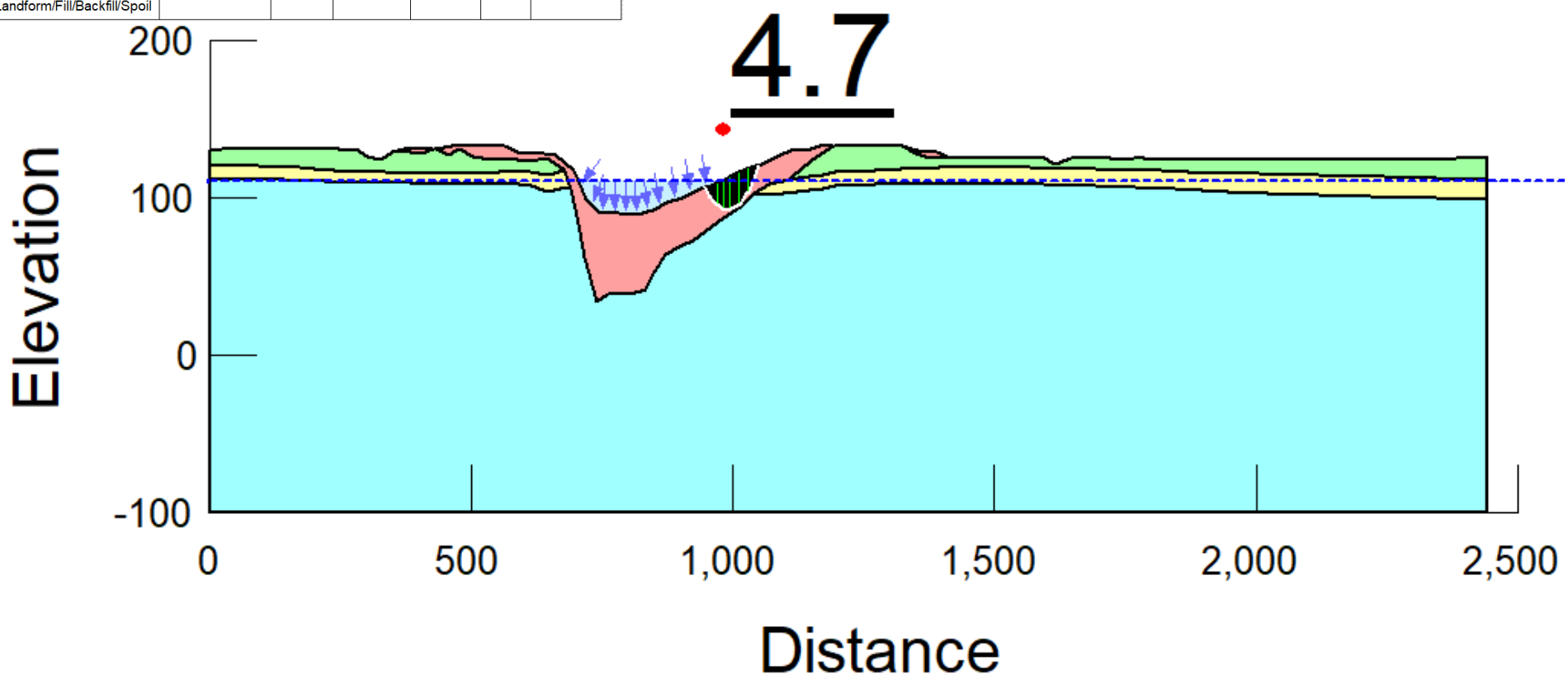


Foxleigh MINE

ENGENY

Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment	
Drawn	ML	8-Aug-23	Carlo Pit Steady State Stability – High Wall, Average Groundwater RL105.6m	
Checked	MD	8-Aug-23		
Job No.	QC1025_010		Figure A.49	Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1

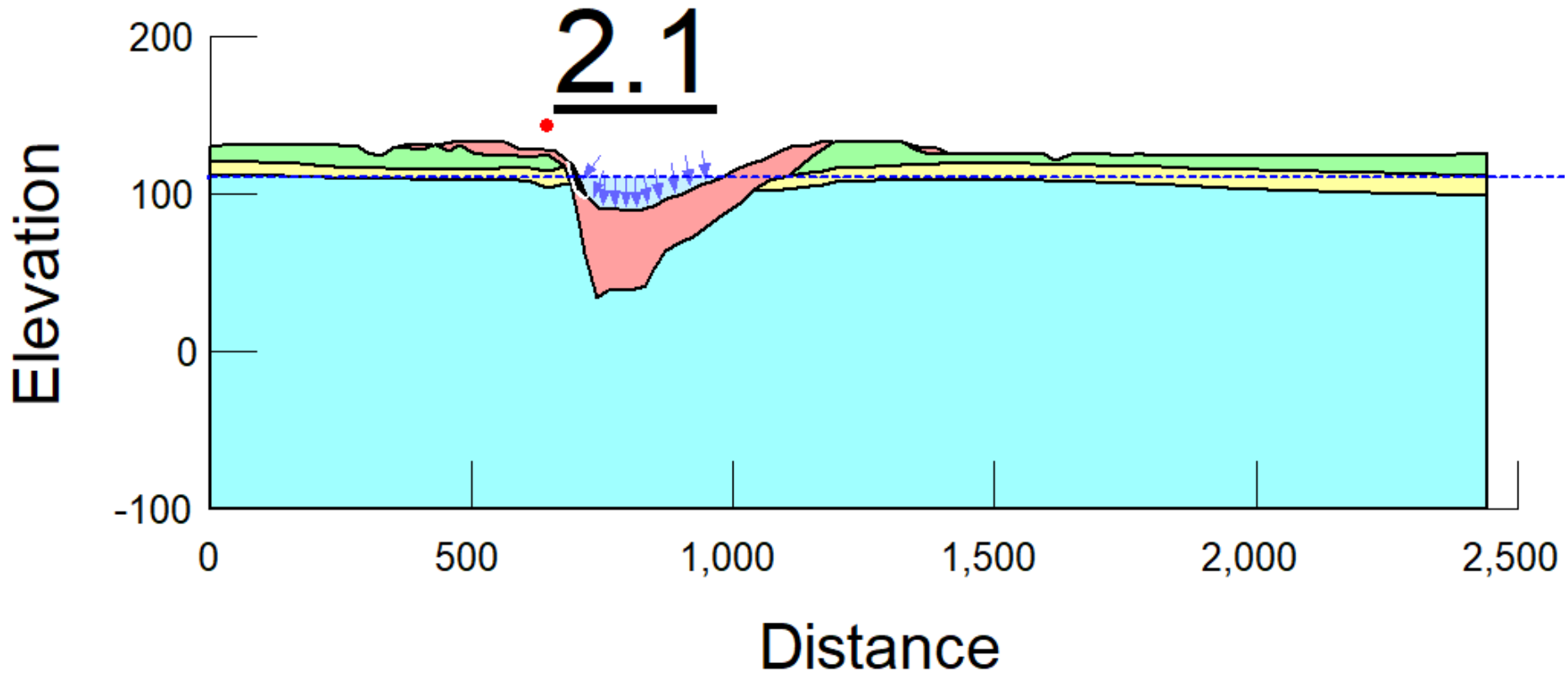


Foxleigh MINE

ENGENY

Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment	
Drawn	ML	8-Aug-23	Carlo Pit Steady State Stability – Low Wall, Peak Groundwater RL110.8m	
Checked	MD	8-Aug-23		
Job No.	QC1025_010		Figure A.50	Rev 0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	1.0 Tertiary	Mohr-Coulomb	20	50	30	0	1
	2.0 Fresh Permian	Mohr-Coulomb	24	450	42	0	1
	3.0 Highly Weathered Permian	Mohr-Coulomb	22	70	30	0	1
	5.0 Landform/Fill/Backfill/Spoil	Mohr-Coulomb	18	40	30	0	1



Client	Foxleigh Management Pty Ltd		Foxleigh Coal Mine PRCP– Desktop Stability Assessment	
Drawn	ML	8-Aug-23	Carlo Pit Steady State Stability – High Wall, Peak Groundwater RL110.8m	
Checked	MD	8-Aug-23		
Job No.	QC1025_010		Figure A.51	Rev 0

Appendix N: Standard Geotechnical Design Guidelines

CARTLEDGE
MINING AND GEOTECHNICS

Foxleigh Open Cut Coal Mine

Standard Geotechnical Design Guidelines

Report No.: MMS010002-AA_Rev 2

May 2022

QMETCO LIMITED

FOXLEIGH OPEN CUT COAL MINE

STANDARD GEOTECHNICAL DESIGN GUIDELINES

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1 Introduction

Mining is ongoing at QMetCo Limited's (QMetCo) Fox Plains North (FPN), Fox Plains (FP) and One tree (OT) pits at Foxleigh Coal Mine (Foxleigh) in the central Bowen Basin, Queensland. A geotechnical review of the proposed standard pit geometry for FP and OT was requested by the Technical Services Department. The proposed designs comprise the interim highwall and waste dump geometries.

The pit slope geometry at FP and FPN pits currently targets the Pisces 1b seam. At OTW pit, the proposed pit slope geometry targets the Middlemount and Tralee Seams which are coalesced in this pit. This report provide guidance on the design geometries for interim highwalls and in-pit dumps. Endwall and final highwall geometries are assessed individually due to the complex structural geology and bedding geometry bounding the pits.

1.1 Purpose

The purpose of this report is to provide recommendations for acceptable interim highwall and waste dump slope geometries for the Mining Engineers to use in design.

1.2 Relevant Information

The information is relevant to this report and should be read in conjunction with this report:

- CMG-MS-RPT-0002 Rev B – Fox Plains West Wall Interim Assessment, dated October 2016.
- CMG-MS-PRO-0011 Rev A – Fox Plains pit east wall x1 fault stability assessment, dated May 2019.
- CMG-MS-PRO-0015 Rev A – OT5 Western Endwall Stability Assessment, dated October 2019
- CMG-MS-LET-003 – OTW Preliminary Pit Review, dated March 13, 2017
- CMG-MS-LET-005 – Summary of Results for OTW Pit Geotechnical Stability Assessment, dated August 20, 2017
- MMS010001-BG_Rev 0 – Revision of the Material Parameters and Design Geometry for Alluvial Soils, dated February, 2021

1.3 Information Provided

The following information was provided by Middlemount as part of this study:

- Base of Weathering (BoW) surfaces received on 29 July 2019 in *dtm* format;
- Fox Plains and One Tree Pit Shells received on 29 July 2019 in *00t* format;
- Highwall and in-pit dump (Low Wall) proposed design geometries received on 29 July 2019 in *excel* spreadsheet; and,
- Coal Seam surfaces received on 29 July 2019 in *00t* format.

2 Methodology

To facilitate stability analysis of appropriate design geometries, the geotechnical model comprises four component models, these are:

- Geology Model;
- Structural Geology Model;
- Hydrogeology Model; and,
- Rockmass Model.

Development of each of these models is described below.

Note that no endwalls were analysed in this assessment as they are typically governed by structural geology controls at Foxleigh mines. Hence, seam geometries in these walls do not lend themselves to standard designs must be geotechnically assessed independently.

2.1 Geotechnical Model

2.1.1 Geology Model

Fox Plains currently targets the Roper, Middlemount and Tralee seams of the Rangal Coal Measures. It is understood that plans exist to mine the Pisces 1a seam in future strips.

One Tree pit geometry is designed to mine Middlemount and Tralee seams of the Rangal Coal Measures. Critical overburden and inter-burden units at Foxleigh are categorised into the following geological domains:

- Quaternary alluvium – alluvial clayey and sandy soil deposits associated with fluvial action from the Cockatoo and Roper Creeks.
- Weathered Permian – the weathered Permian is typically comprises completely weathered residual clayey soils grading into weathered sandstones and siltstone near the base of weathering. Claystone is occasionally encountered within this unit and is known to slake rapidly upon exposure to atmospheric conditions.
- Fresh Permian – the Permian is generally composed of interbedded sandstone, siltstone with minor mudstone and carbonaceous mudstone / siltstone. Siltstone is the most abundant rock type encountered on site with increasing occurrences of sandstone with depth. The mudstones have a tendency to slake when exposed to meteoric conditions.
- Coal measures – coal seams range in thickness from <1.0 m thick up to 4 m to 6 m thick, as shown below in Figure 1.

It is noted that volcanic intrusives are known to occur in the area and could exist within the Fox Plains and One Tree pits, but little is currently known about their condition and / or extent. Additionally, the Yarrabee tuff is known to underly the Pisces 1b seam at Foxleigh but does materially impact on any of the standard designs herein.

To undertake stability analysis, the following was undertaken:

- Assess distribution of lithotypes in fresh Permian; and,
- Assess seam floor conditions.

For the purpose of the standard designs, seams were assumed to be gently sloping at approximately 2° into the highwalls at both pits.

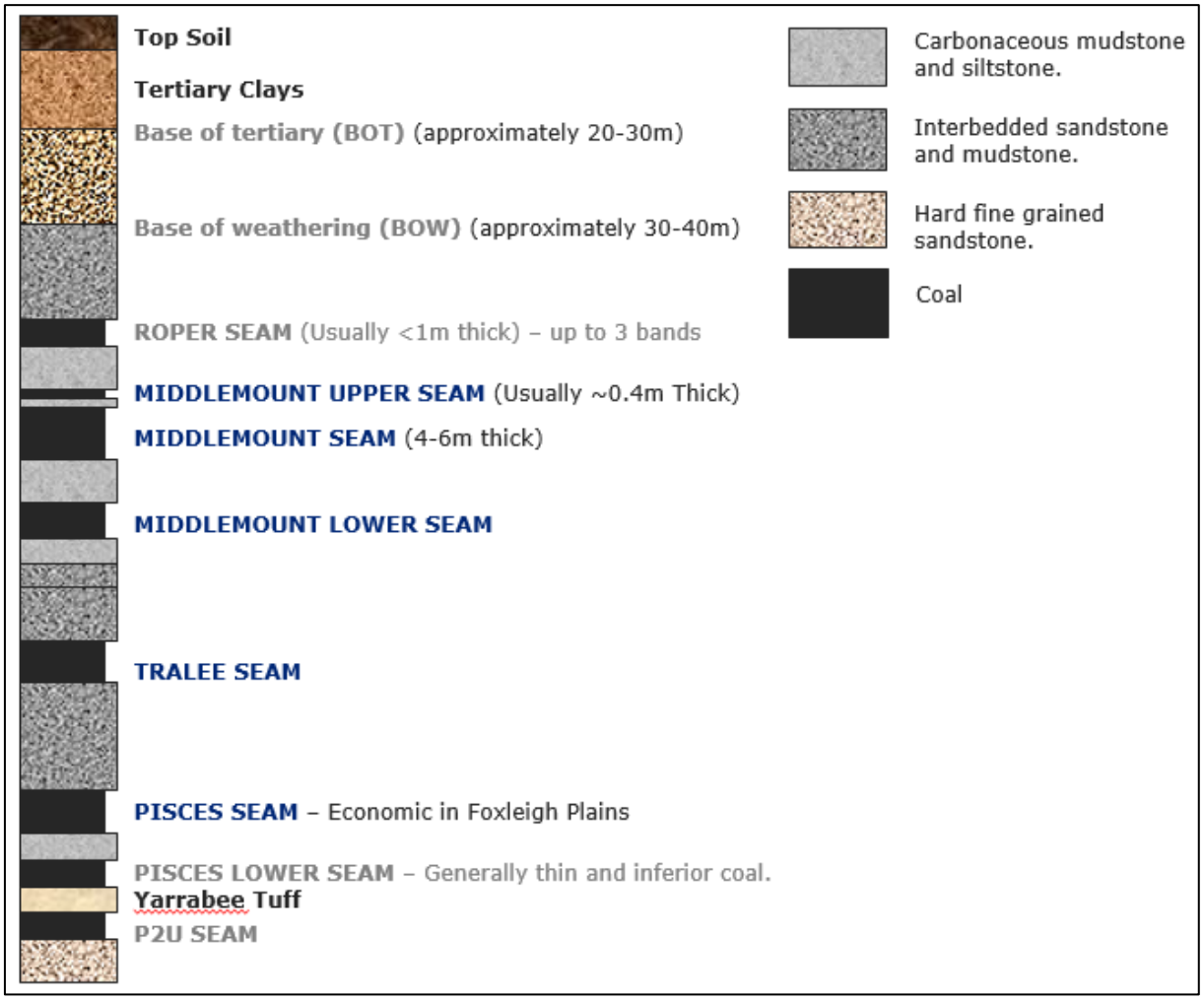


Figure 1 Typical profile of stratigraphic column encountered at Foxleigh

2.1.1.1 Lithotype Distribution

The fresh Permian rockmass was separated into inter-burden types by coal seam, e.g. inter-burden overlying the Middlemount Seam is classified 'Middlemount Inter-burden'. Percentage distributions of each lithotype were then used to develop weighted parameters for each unit.

2.1.1.2 Floor Conditions

Where coal measure rockmasses are disturbed, shearing to accommodate volume change within the rockmass commonly occurs at boundaries between materials of high difference in Young's Modulus (elastic properties). Thus, shearing is commonly encountered at the boundary between coal and the host lithological units and plays a critical role in pitwall and dump stability. To assess this risk, the floor conditions for each seam were assessed based on visual appraisal of core photos for select boreholes for use in stability analyses.

2.1.2 Structural Geology Model

Structural geology is a critical part of pitwall stability assessments as most failures are controlled by rockmass defects such as faults and joints. Rockmass defect data is used to determine bench and overall slope geometries considering the properties of these defects, including surface condition (frictional strength), spacing, linearity and persistence.

2.1.2.1 Faults

Faults typically control pit wall geometries due to their low frictional strength and persistence through the stratigraphic column. Therefore, understanding their location is critical in providing safe slope geometries, optimising coal recovery and hazard mitigating designs.

The current geology model has a number of faults contained within it but these been found to be inaccurate and have not identified all fault encountered on site. Due to these inaccuracies, the fault model interpretation was not considered in these analyses. CM&G is currently working on an update to the structural model interpretation and fault interaction. Further discussion of this will be provided under separate cover.

2.1.2.2 Joints and Bedding

Joints are typically less persistent than faults and are thus used to determine cut slope geometries within intact rock. For the purpose of this analysis, bedding planes were assumed to be parallel to the coal seams and shearing only occurs in the roof or floor of coal seams.

Some defect orientation data was available from 2014 and 2015 highwall mapping and acoustic televiewer data. This data was reduced to identify critical defect groups and use in kinematic analysis.

It is understood that there is additional acoustic televiewer data from more recent drilling campaigns, but this data has not been interpreted yet. When this data becomes available it will be considered in this assessment. Furthermore, photogrammetric highwall mapping processes have recently been setup at Foxleigh but no data was available at the time of publishing this report.

2.1.3 Hydrogeology Model

The water monitoring report by AGE (Australasian Groundwater and Environmental Consultants Pty Ltd, April 2016), indicates that the surficial alluvium is not hydraulically connected to the underlying rockmass. Measurements from installed (3 No.) vibrating-wire piezometers indicate that the water table is between 120 mAHD and 132 mAHD (10 mbgl to 25 mbgl) within the Rangal Coal Measures and about 8 mbgl within the alluvium at the monitoring location.

Having said this, water is rarely encountered at Foxleigh mine and is usually assumed to be ‘dry’. However, the phreatic surface for these analyses was inferred based on the authors experience and are considered conservative for the analyses.

2.1.4 Rockmass Model

The rockmass model comprises the strength of the rockmass and waste characteristics. For the purpose of this analyses, the rockmass strength properties were derived using the Generalised Hoek-Brown criterion. Waste characteristics were derived after Simmons & McManus (2004).

The following parameters are required to determine the parameters for the Hoek-Brown criterion:

- Unconfined Compressive Strength (UCS) of the intact rock;
- Geological Strength Index (GSI) of the rockmass; and,
- Dimensionless parameter m_i.

To determine appropriate values for use in design, weighted Hoek-Brown rockmass parameters were developed for each inter-burden unit based on percentages estimated from the Geology Model. In applying the Hoek and Brown criterion to “isotropic” rock masses, the GSI that relates

the properties of the intact rock elements to those of the overall rockmass. For each inter-burden, input parameters were derived from the following:

- The average UCS for each lithotype was derived from previous analyses (refer to Section 1.2);
- GSI values were estimated based on visual observation of core conditions and site experience after Marinos (2014); and,
- Insufficient triaxial data was avaialble to calcualte m_i so typcal published values were adotped.

2.2 Stability Analysis

The following methodologies were undertaken as part of the stability assessment:

- Kinematic analysis; and,
- Limit equilibrium analysis.

2.2.1 Kinematic Analysis

Kinematic analysis is the assessment of the ability of rockmass defects to resist dynamic failure due to gravitational forces based on their frictional strength and orientation relative to design pit slope geometries using stereographic projections. This type of analysis does not consider external forces such as seismicity or water forces.

The defect orientation data was used to undertake kinematic analysis of critical joint orientations susceptibility to planar, wedge and toppling failure mechanisms for Fox Plains Pit. These results were used to assess the appropriateness of existing slope geometries and whether opportunity exists to steepen current pit wall geometries.

2.2.2 Limit Equilibrium Analysis

Slope stability analyses were performed using “Slide” Version 2018 (Rocscience Inc. of Toronto, Ontario, Canada). Slide is equipped to carry out two-dimensional slope stability computations using the theory of limit equilibrium that satisfies both force and moment equilibrium. The analysis involves calculation of the estimated factors of safety for potential shear failure surfaces. The Factor of Safety (FoS) against shear failure is defined as the factor by which the shear strength of the soil must be reduced to bring the soil mass into a state of limiting equilibrium. The FoS is computed for all specified trial slip surfaces.

To assess the interim pit slope geometries, the ground was discretised into two geotechnical domains; natural ground to base of weathering (Domain 1); and Fresh Permian (Domain 2) based on previous analyses. Cross-sections were created based on current design geometries provided by Middlemount and stability analysis completed on typical ground conditions.

To undertake this geotechnical stability assessment of the highwall, limit equilibrium analysis to assess the following failure mechanisms were assessed for each scenario analysed:

- Bench scale failure using non-circular, Block search function was adopted to analyse sliding along basal weak planes, such as sliding along coal boundary shear planes. The Sarma method of non-vertical slices was used for block search methods; and,
- Global wall failure using non-circular, global search method (Cuckoo search). Spencer method was used for global failures after Sloan (2013).

After Simmons & McManus (2004) block search was also used for stability anlaysis of in-pit waste dumps.

The recommended Factor of Safety (FoS) for short-term operations (which is considered appropriate for active production areas within Queensland's open-cut coal mines) that was adopted for these analyses was 1.2.

2.3 Standard Design Guidelines

From the results of the stability analyses, standard design geometries were developed for each geotechnical domain where the coal seams are flat or dipping favourably (into the pit wall). Where coal seams are dipping into the pit or are significantly affected by geological structure, further advice should be sought from the geotechnical department and bespoke design options considered.

The results were then presented in a single document for use by Mining Engineers in developing interim pit slope angles.

Note that due to the structural complexity of Foxleigh Coal Mine, endwalls for this pit must to be assessed separately.

3 Geotechnical Model

3.1 Geology Model

3.1.1 Lithotype Distribution

Based on a review of boreholes, lithotype distributions were developed for each inter-burden and are summarised below in Table 1.

Table 1: Lithological Distribution of Seam Inter-burdens

Inter-burden	No of Borehole Data	Inter-burden Average Thickness (m)	Siltstone (%)	Sandstone (%)	XT / CM / MS / XH (%)
Roper	18	NA*	52	40	8
Middlemount	18	26	52	40	8
Tralee	25	29	40	50	10
Pisces	24	30	55	36	9

XT = Carbonaceous Siltstone, CM = Carbonaceous Mudstone, MS = Mudstone, XH = Carbonaceous Shale
**Average thickness of Roper unknown*

3.1.2 Coal Seam Floor Conditions

A review of boreholes was undertaken to determine the lithological conditions and visually assess the disturbance of the seam floors at Fox Plains pit. A copy of the core photographs is provided in Appendix A and a summary description of each seam is provided below:

Roper Floor:

A review of core photographs from borehole *KF389C* indicates that both sheared and intact rock exist at roper seam floor. Available core photographs show only approximately 1.5 m depth from floor surface. The floor mainly consists of siltstone and sandstone interbedded with carbonaceous siltstone. Examination of the first 1 m depth appears to have minimum disturbance. The floor could generally be regarded as slightly sheared rockmass.

Middlemount Floor:

Borehole *FK388C* and *FK389C* core photographs were examined to assess the degree of shearing at the floor of Middlemount seam. Visual assessment of the immediate floor up to 5 m depth indicates the presence of highly sheared rockmass. The floor consists of sandstone, siltstone with interbedded carbonaceous siltstone. The presence of sheared horizon is indicative of the existence of geological structures and could serve as potential failure plane.

Tralee Floor:

Examination of available core photographs (*KF388C*) indicates that sheared rockmass exist at Tralee floor. The examined depth extended to approximately 1 m below Tralee seam floor and consists of siltstone interbedded with carbonaceous siltstone.

Pisces 1a Floor:

The Pisces floor was examined using available core photographs from borehole *DD0518* which is located at the southern border of Fox Plains pit-shell. The immediate floor up to 2m depth was assessed from available core photographs. The assessment shows the presence of fresh

intact rockmass dominated by siltstone and sandstone with interbedded carbonaceous siltstone.

In-depth geotechnical classification methods and analysis for the degree of shearing exist, however it is beyond the scope of this work. A detailed seam floor condition analysis could be completed at a later stage.

3.1.3 Defect Orientation Data

The defect orientation data was used to undertake kinematic analysis of critical joint orientations. The two boreholes used for the kinematic analysis are LDF0889A and LDF0906 from a 2015 highwall mapping program (refer Figure 2). These results were used to assess the appropriateness of existing slope geometries and whether opportunity exists to steepen current pit wall geometries.

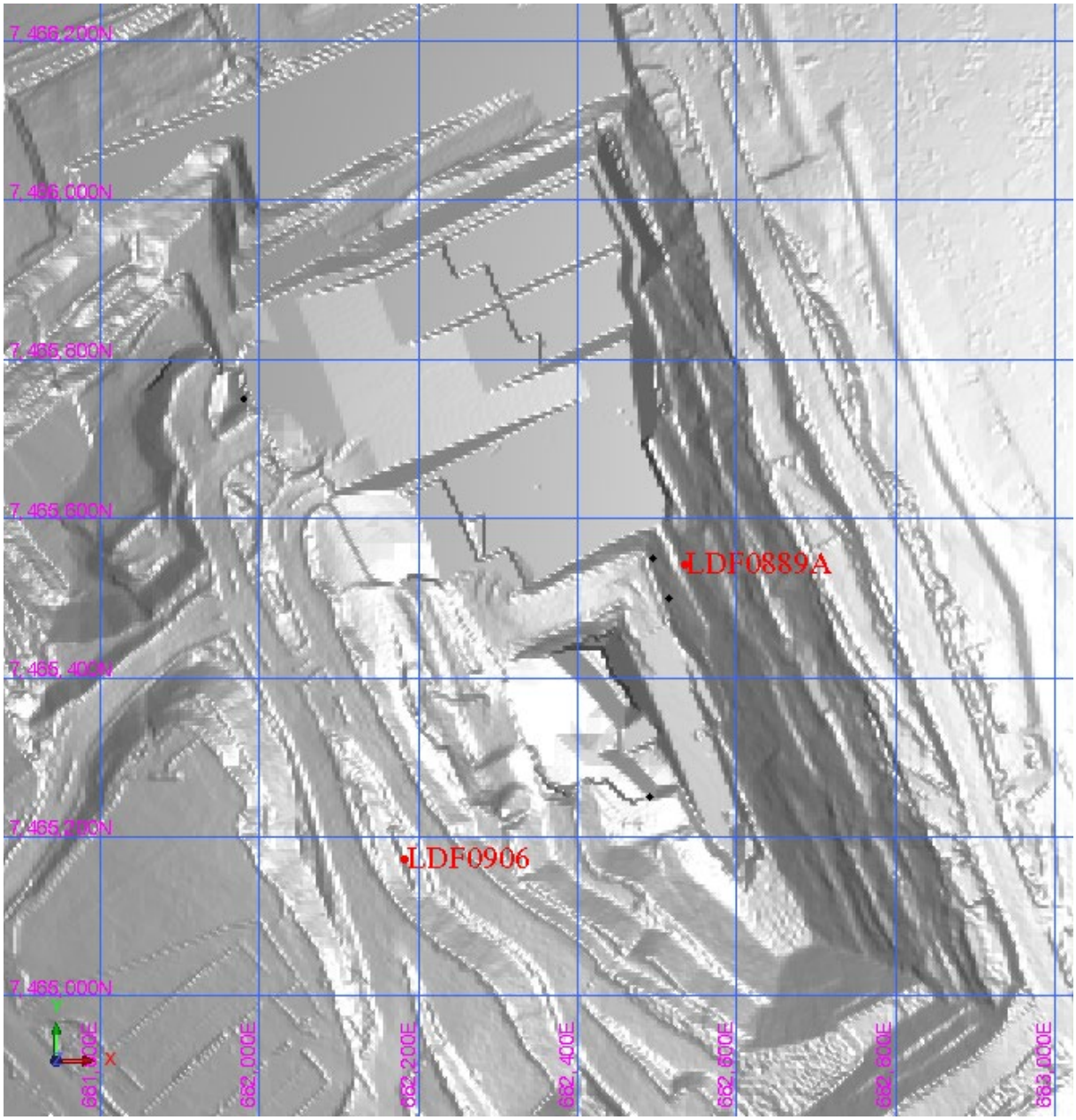


Figure 2: Fox Plains Pit-Shell with Borehole Locations

3.2 Hydrogeology Model

The phreatic surface within the in situ rockmass was inferred based on the engineering judgement.

The phreatic surface within the in-pit dumps was estimated to be about 5 m above the pit floor after Simmons & McManus (2004).

3.3 Geotechnical Model

The proposed highwall geometry comprises two domains which are discussed in the following paragraphs. Figure 3 to Figure 5 shows the proposed geotechnical model and slope geometry of the highwalls and in-pit dumps for FP and OT pits, respectively.

3.3.1 Geotechnical Domain 1 – Natural Surface to Base of Alluvium

3.3.2 Geotechnical Domain 2 - Base of Weathering

Strength parameters for this domain were assigned based on previous experience and engineering judgement (as described in Section 1.2). The selected strength parameters used in the analysis is presented in Section 3.3.6.

3.3.3 Geotechnical Domain 2 - Fresh Permian

The available triaxial data was evaluated and assessed to be insufficient to provide representative material properties for use in subsequent analyses. The adopted m_i values and the average UCS from laboratory test data were weighted, and reduction factors applied (Marinos & Hoek, 2001) to obtain weighted average values of m_i and UCS for the rock mass.

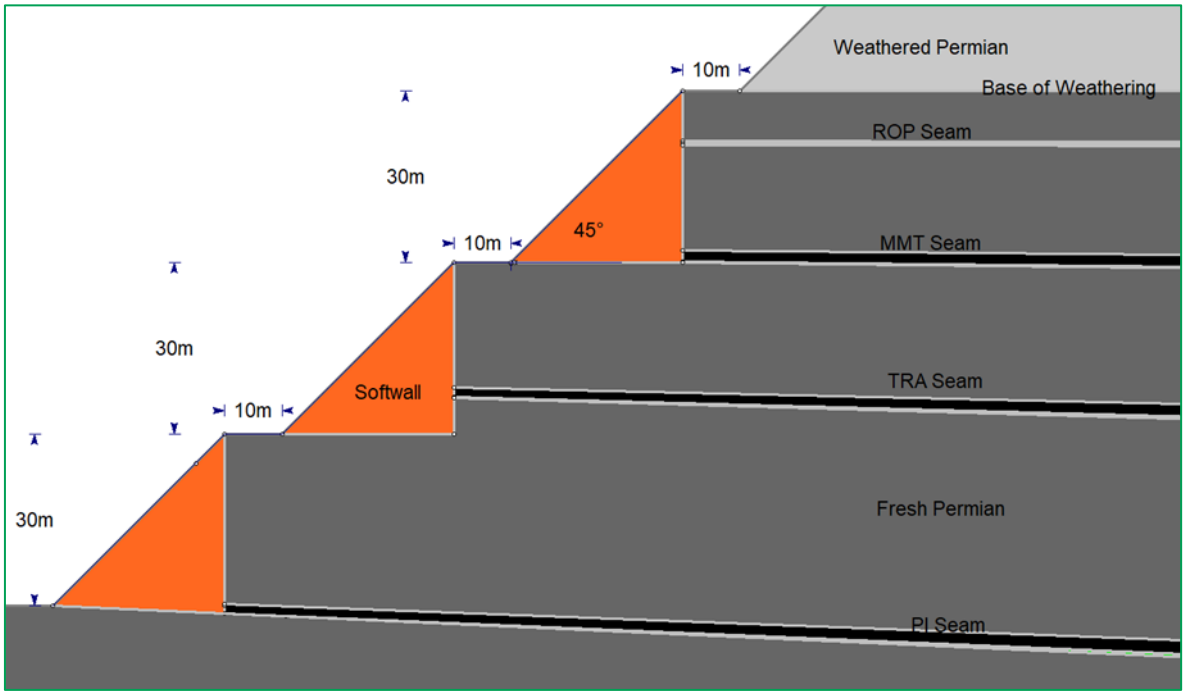


Figure 3: Screen Shot of Proposed Highwall Geometry for Fox Plains Pit

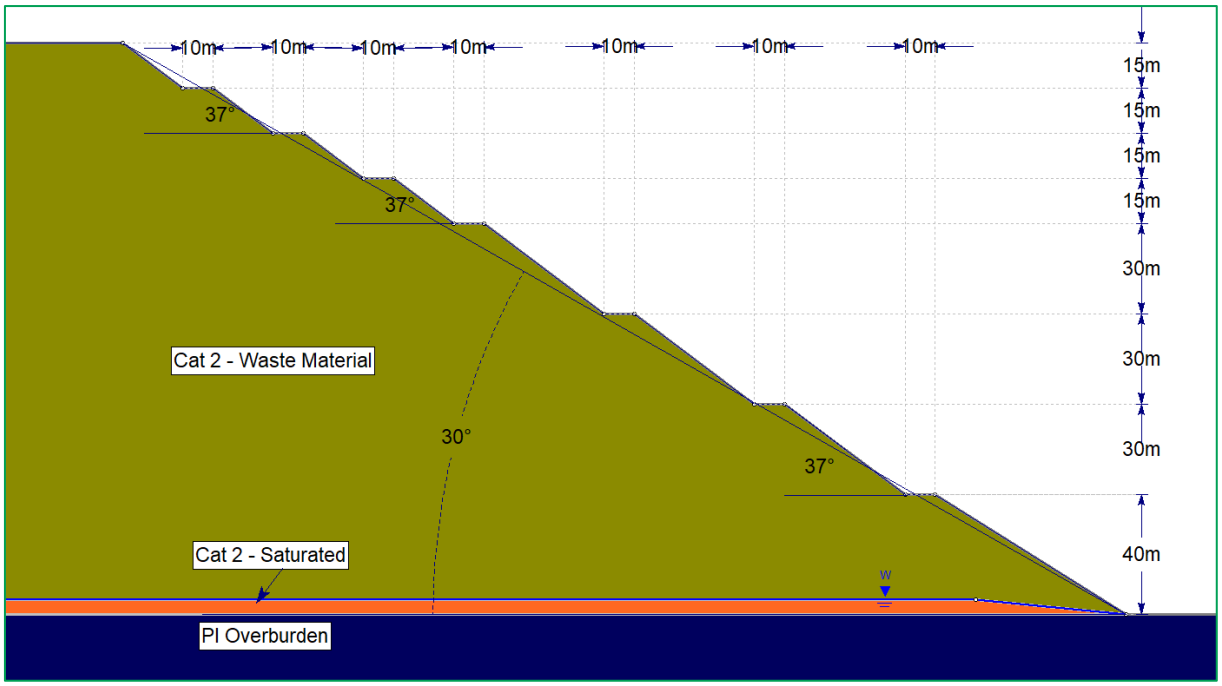


Figure 4: Screen Shot of Proposed In-pit Dump Geometry for Fox Plains Pit

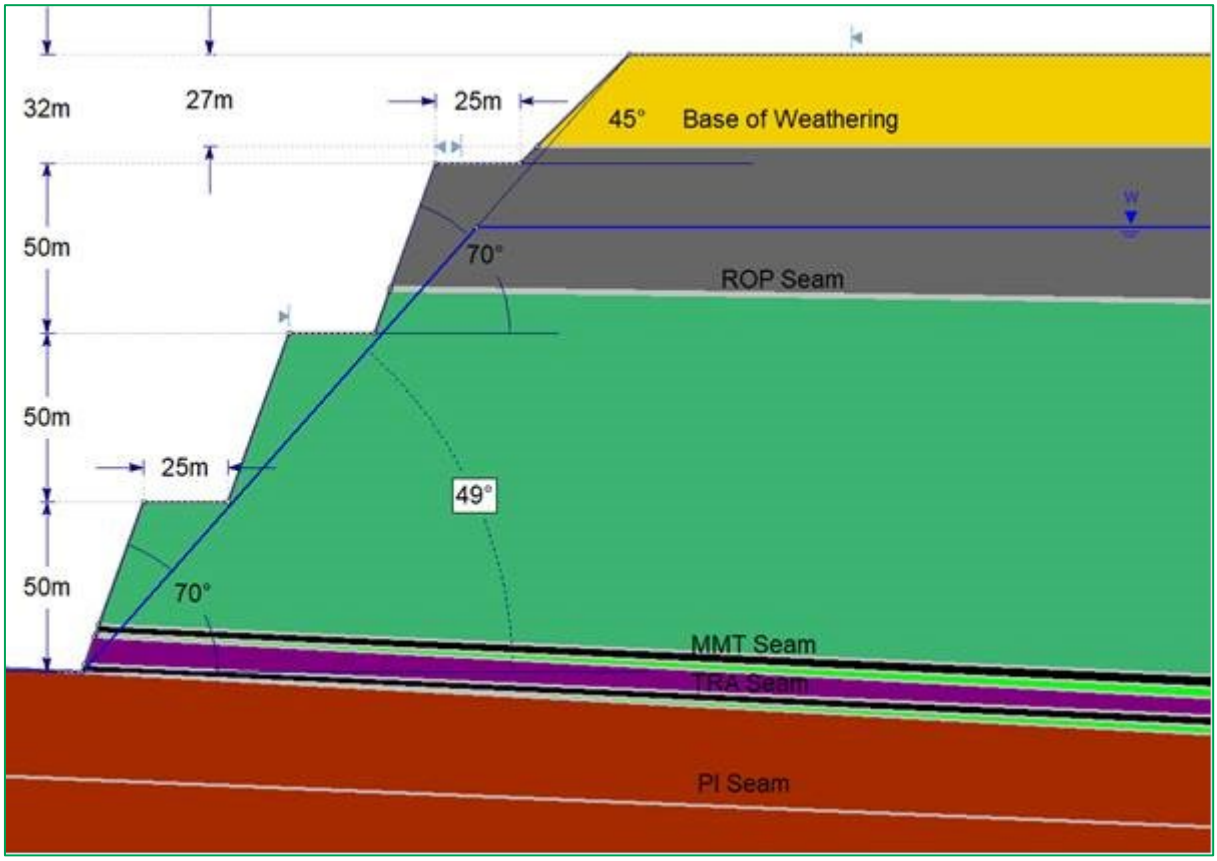


Figure 5: Screen Shot of Proposed Highwall Geometry for One Tree Pit

Based on physical observations and previous engineering experience from Foxleigh Coal Mine, GSI of 55 was selected for stability analyses.

3.3.4 Mine Spoil Dump Materials

Based on the observation of the mine spoil materials at FP and OT pits, the spoil appears consistent with Category 2 of Simmons and McManus classification scheme. Therefore, Category 2 strength parameters were adopted for the stability analyses of the in-pit dump (refer Section 3.3.6).

3.3.5 Material Assumptions

The following assumptions were adopted in developing the material strength parameters:

- Shear strength of the coal floor and sheared contact was assumed to be phi = 15^0, c = 0 kPa based on typical lower bound values for faults and shears within the Bowen Basin;

3.3.6 Material Strength Parameters

A summary of the material strength parameters used in the analysis are tabulated below.

Table 2: Material strength parameters used in the analysis of Fox Plains pit – Foxleigh Mine.

Material	Strength Type	Unit Weight (kN/m^3)	Cohesion (kPa)	Phi (°)	UCS (MPa)	GSI	mi
Cat 2.0 - Unsaturated	Mohr-Coulomb	18	30	28	N/A	N/A	N/A
Cat 2.0 - Saturated	Mohr-Coulomb	20	15	23	N/A	N/A	N/A
Weathered Permian Material (BoW)	Mohr-Coulomb	20	35	30	N/A	N/A	N/A
Sheared Contact	Mohr-Coulomb	25	0	15	N/A	N/A	N/A
Coal Seam	Mohr-Coulomb	15	30	35	N/A	N/A	N/A
MMT	Generalized Hoek-Brown	25	N/A	N/A	14.2	55	10
TRA	Generalized Hoek-Brown	25	N/A	N/A	16.2	55	10
PI1	Generalized Hoek-Brown	25	N/A	N/A	22.2	55	12

4 Stability Analysis

4.1 Kinematic Analysis

The results of the kinematic analysis were carried out using defect orientation data obtained from boreholes *LDF0889A* and *LDF0906*. The output of the analysis is presented in Appendix C and summarised in Table 3 and Table 4.

The results for borehole LDF0889A indicate the likelihood of medium to high planar failure for eastern interim endwalls at current defect orientations (refer Table 3). Results indicate that wedge sliding is also highly likely at the highwall and eastern interim endwalls but bedding defects dominated the input data and for that reason, this interpretation is considered invalid.

The results for borehole LDF0906 returned a medium likelihood of direct toppling for the western interim endwalls.

It should be noted that the above interpretations are based on two borehole data only and bedding and structure orientation is known to vary significant at Foxleigh, hence and may not represent in situ conditions.

Table 3: Kinematic Analysis Results from Borehole *LDF0889A*

Wall Type	Wall Bearing (°)	Planar (%)	Wedge (%)	Direct Toppling (%)
Highwall	151	0.47	28.56	0.07
	156	0.95	30.08	0.03
	161	0.95	32.15	0.02
Eastern Endwall	245	75.65	73.48	0.04
	250	51.3	67.89	0.04
	255	26.71	62.81	0.05
Western Endwall	60	1.42	1.35	14.81
	65	1.42	1.42	15.38
	70	0.95	1.64	15.18

Table 4: Kinematic Analysis Results from Borehole *LDF0906*

Wall Type	Wall Bearing	Planar	Wedge	Direct Toppling
Highwall	151	0.38	0.72	0.01
	156	0.38	0.86	0.01
	161	0.38	0.90	0.01
Eastern Endwall	245	0.75	0.84	0.08
	250	0.75	0.41	0.09
	255	1.13	0.54	0.08
Western Endwall	60	7.92	4.84	0.02
	65	8.68	4.47	0.02
	70	7.92	4.71	0.01

4.2 Limit Equilibrium Analysis

Limit equilibrium slope stability analyses were undertaken using "Slide" Version 2018 (Rocscience Inc. of Toronto, Ontario, Canada), for the proposed highwall geometry.

4.2.1 In-pit Dump Assessment

Slope stability analyses were also undertaken using the proposed in-pit dump geometries. Five in-pit dump floor scenarios were analysed for block sliding for intact and sheared floor conditions for both the FP and OT pits:

- In-pit dump floor at zero (0) degree;
- In-pit dump floor at five (5) degrees;
- In-pit dump floor at eight (8) degrees;
- In-pit dump floor at twelve (12) degrees; and,
- In-pit dump floor at fifteen (15) degrees.

Note: Floor dips >15° need specific geotechnical analysis.

4.2.2 Analysis Assumptions

The following assumptions were adopted for this analysis:

- The phreatic surface for the highwall was assumed based on engineering judgement and previous experience;
- Groundwater was assumed to be 5 m above floor of In-pit dump based on Simmons and McManus (2004).

4.2.3 Analysis Results

The summary of the analyses, as discussed above, are presented in Table 5 to Table 8. All models produced computed FoS results for critical failure surfaces in excess of 1.2. However, for 12° and 15° inclined in-pit dump floors, the FoS was less than the industry recommended 1.2.

4.2.3.1 Fox Plains Pit

Table 5: Summary of Calculated Factor of Safety for the Proposed Highwall with Shear Contact for Fox Plains Pit

Method	Recommended Minimum (FoS)	Standard Design (FoS)
Proposed Highwall		
Sarma (Block Search)	1.20	1.79
Sarma (Block Search)	1.20	1.91
Sarma (Block Search)	1.20	1.68
Sarma (Cuckoo Search) - Global failure	1.20	2.09
Spencer (Cuckoo Search)	1.20	1.97

Table 6: Summary of Calculated Factor of Safety for the Proposed Highwall without Shear Contact for Fox Plains Pit

Method	Recommended Minimum (FoS)[(1)]	Standard Design (FoS)
Proposed Highwall		
Sarma (Block Search)	1.20	2.73
Sarma (Block Search)	1.20	2.60
Sarma (Block Search)	1.20	2.47
Sarma (Cuckoo Search) - Global failure	1.20	2.28
Spencer (Cuckoo Search)	1.20	2.15

4.2.3.2 One Tree Pit

Table 7: Summary of Calculated Factor of Safety for the Proposed Highwall with Shear Contact for One Tree Pit

Method	Recommended Minimum (FoS)	Standard Design (FoS)
Proposed Highwall		
Sarma (Block Search)	1.20	2.86
Sarma (Block Search)	1.20	3.14
Sarma (Block Search)	1.20	3.61
Sarma (Cuckoo Search) - Global failure	1.20	2.36
Spencer (Cuckoo Search)	1.20	1.86

Table 8: Summary of Calculated Factor of Safety for the Proposed Highwall without Shear Contact for One Tree Pit

Method	Recommended Minimum (FoS)[1]	Standard Design (FoS)
Proposed Highwall		
Sarma (Block Search)	1.20	5.78
Sarma (Block Search)	1.20	3.51
Sarma (Block Search)	1.20	3.48
Sarma (Cuckoo Search) - Global failure	1.20	2.54
Spencer (Cuckoo Search)	1.20	2.28

4.2.3.3 Lowwall Analysis

Table 9: Summary of Calculated Factor of Safety for the Proposed In-pit Dump Floor with Shear Contact for Fox Plains Pit

Method	Description	Recommended Minimum (FoS)(1)	Proposed Design (FOS) - Sarma
Proposed In-pit Dump			
Sarma (Block Search)	In-pit dump floor @ 0°	1.20	1.15
Sarma (Block Search)	In-pit dump floor @ 5°	1.20	1.01
Sarma (Block Search)	In-pit dump floor @ 8°	1.20	0.94
Sarma (Block Search)	In-pit dump floor @ 12°	1.20	0.86
Sarma (Block Search)	In-pit dump floor @ 15°	1.20	0.77

Note:

1 Minimum FoS of 1.2 is generally accepted as appropriate for active production areas within Queensland's open-cut coal mines.

Table 10: Summary of Calculated Factor of Safety for the Proposed In-pit Dump Floor without Shear Contact at Fox Plains Pit

Method	Description	Recommended Minimum (FoS)(1)	Proposed Design (FOS) - Sarma
Proposed In-pit Dump			
Sarma (Block Search)	In-pit dump floor @ 0°	1.20	1.49
Sarma (Block Search)	In-pit dump floor @ 5°	1.20	1.36
Sarma (Block Search)	In-pit dump floor @ 8°	1.20	1.28
Sarma (Block Search)	In-pit dump floor @ 12°	1.20	1.17
Sarma (Block Search)	In-pit dump floor @ 15°	1.20	1.10

Note:

1 Minimum FoS of 1.2 is generally accepted as appropriate for active production areas within Queensland's open-cut coal mines.

4.2.3.4 Revised Lowwall Geometry

Results for the lowwall stability analysis indicates that not all slopes satisfy the required FoS of 1.2. Hence, lowwall slope geometries were modified to achieve the required FoS. A summary of the overall slope angles required to achieve a FoS of 1.2 for intact and sheared floor conditions is provided below:

Table 11: Summary of Calculated Factor of Safety for the Modified In-pit Dump Floor @ Fox Plains and One Tree Pits

Method	Description	Overall Slope Angle Proposed Design	Overall Slope Angle without Shear Contact
Modified In-pit Dump Geometry			
Sarma (Block Search)	In-pit dump floor @ 12°	30°	27°
Sarma (Block Search)	In-pit dump floor @ 15°	30°	26°

5 Standard Design Guidelines

Based on the results of the stability analyses, standard design guidelines have been developed for Fox Plains and One Tree pits. A copy of these guidelines is provided in Appendix A.

6 Discussion

6.1 Fox Plains Highwall

The current geometry is considered suitable based on the currently adopted geometry. Furthermore, kinematic analysis indicates that this geometry maybe conservative based on the results of ATV data from 2 (No.) boreholes. Considering the structural complexity of Foxleigh mine, the results indicate that adoption of intact interim slope angles maybe acceptable, if operations consider this advantageous. It is inferred that 45^{o} softwalls were adopted due to geotechnical failures of intact walls. Further data review is required before such an option should be considered.

6.2 In-Pit Dump Design

Review of core data indicates that sheared floor conditions for target basal seams (Tralee and Pisces 1a) occur intermittently across the site. The Pisces 1a seam identified as retaining poorer floor conditions and more frequent shearing than the Tralee seam. Shearing within the floor seam has a significant impact on the overall dump stability. Therefore, it is recommended that further study be undertaken to determine the extent of shearing within the target floor to provide greater confidence in dump design.

6.3 Structural Geology

The structural geology of coal mines is critical in managing geotechnical hazards. Recent experience at Foxleigh mine indicates that the current structural geology model is not sufficiently accurate with unexpected structures frequently encountered that impact on pit wall stability. CM&G is currently undertaking a review of the current structural model at Foxleigh and when this is complete, a review of the current standard design guidelines should be updated to consider geological structure.

6.4 Final Pit Wall Design

Final pit wall design is not considered in this report due to the structural complexity of Foxleigh Coal Mine. Final walls are typically steeply dipping and fault affected, where standard designs are not appropriate. Therefore, bespoke geotechnical designs are required to geotechnical optimise final wall designs to ensure geotechnical stability, optimal coal recovery and optimised slope geometries. It is recommended that final walls in all pits be reviewed following completion of the structural geology review currently being undertaken.

7 Summary of Recommendations

Considering the above discussion and findings of this assessment, the following recommendations are provided:

- The proposed highwall slope geometry for Fox Plains is satisfactory;
- The current highwall slope geometry for One Tree Pit is satisfactory;
- A detailed assessment of pit floor conditions is required to understand the extent of shearing and the impact on in-pit dump stability;
- A review of the standard design guidelines should be undertaken following completion of the current structural geology model review and update; and,
- Final pit wall designs should be reviewed for geotechnical stability, optimal coal recovery and slope geometries following completion of the structural geology model review.

8 Conclusion

The results indicate the currently adopted pit slope designs are geotechnically stable for the modelled conditions. The current analyses do not consider a detailed review of the structural geology and further analysis is required when the current review is complete. Furthermore, the current in-pit dump geometries are based on intact floor conditions which are intermittent across the site for target coal seams.

9 References

Australasian Groundwater and Environmental Consultants Pty Ltd. (April 2016). *Foxleigh Plains Groundwater Monitoring and Management Plan.*

Marinos, V. (2014). Tunnel behavious and support in associated with weak rock masses of flysch. *Journal of Rock Mechanics and Geotechnical Engineering*, 227-239.

Simmons, J. V., & McManus, D. A. (2004). Shear Strength Framework for Design of Dumped Spoil Slopes for Open Pit Coal Mines. *Advances in Geotechnical Engineering: The Skempton Conference*, (pp. 981-991). Thomas Telford.

Sloan, S. (2013). Geotechnical stability analysis (51st Rankine Lecture). *Geotechnique*, 531-572.

10 Document Administration

Version History

Version	Version Date	Version Summary	Author	Signature
0	24/12/2019	Issue for Comment	D. Alazigha	NA
1	6/1/2020	Add OT Guideline	D. Alazigha	NA
2	24/5/22	Add FPN and update geometries	T. Cartledge	
3				

Key Document Location

S:\03. Projects\Middlemount South\Foxleigh Mine\MMS010002 - Geotechnical design Guidelines\05. Reporting\FP & OT

Related Documents

Document Number	Document Title

Acceptance and Release

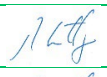
Author

Position	Incumbent	Release Date	Signature
Principal Geotechnical Engineer – CM&G	Tim Cartledge	24/5/22	

Stakeholders and Reviewers

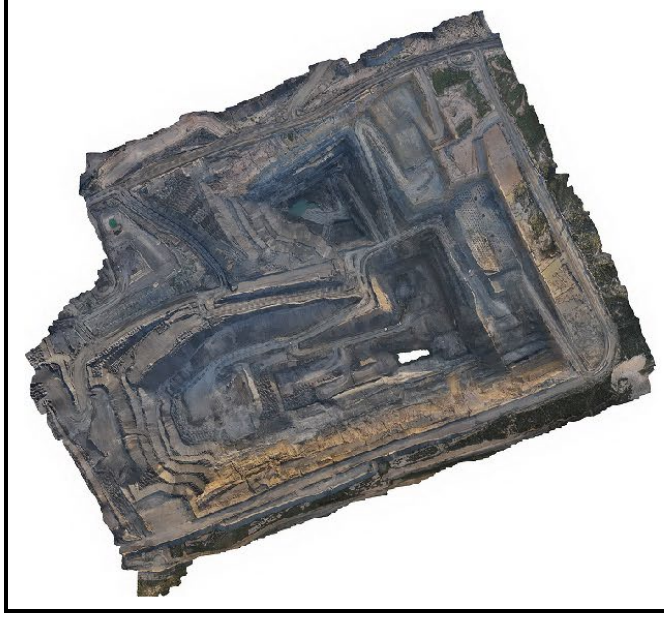
Position	Incumbent	Review Date	Signature
Technical Services Superintendent – Foxleigh	Travis Zolnikov		
Technical Services Manager – Foxleigh	Brandon May		

Approver(s)

Ver.	Position	Incumbent	Signature	Approval Date
2	Principal Geotechnical Engineer	Tim Cartledge		24/5/2022
1	Principal Geotechnical Engineer	Tim Cartledge		6/1/2020
0	Principal Geotechnical Engineer	Tim Cartledge		24/12/2019

Appendix A: Standard Design Guidelines

Geotech Standard Design Guideline	Fox Plains and Fox Plains North Pits	Middlemount South – Foxleigh Mine



General Pit Information

Domain: This pit consists of 4 domains:
Domain 1: Natural surface to base of Alluvium (BoA)
Domain 2: Alluvium to Base of Weathered Permian
Domain 3: Weathered Permian to Fresh Permian (MM, TL, PU)
Domain 4: In-pit soil dump design

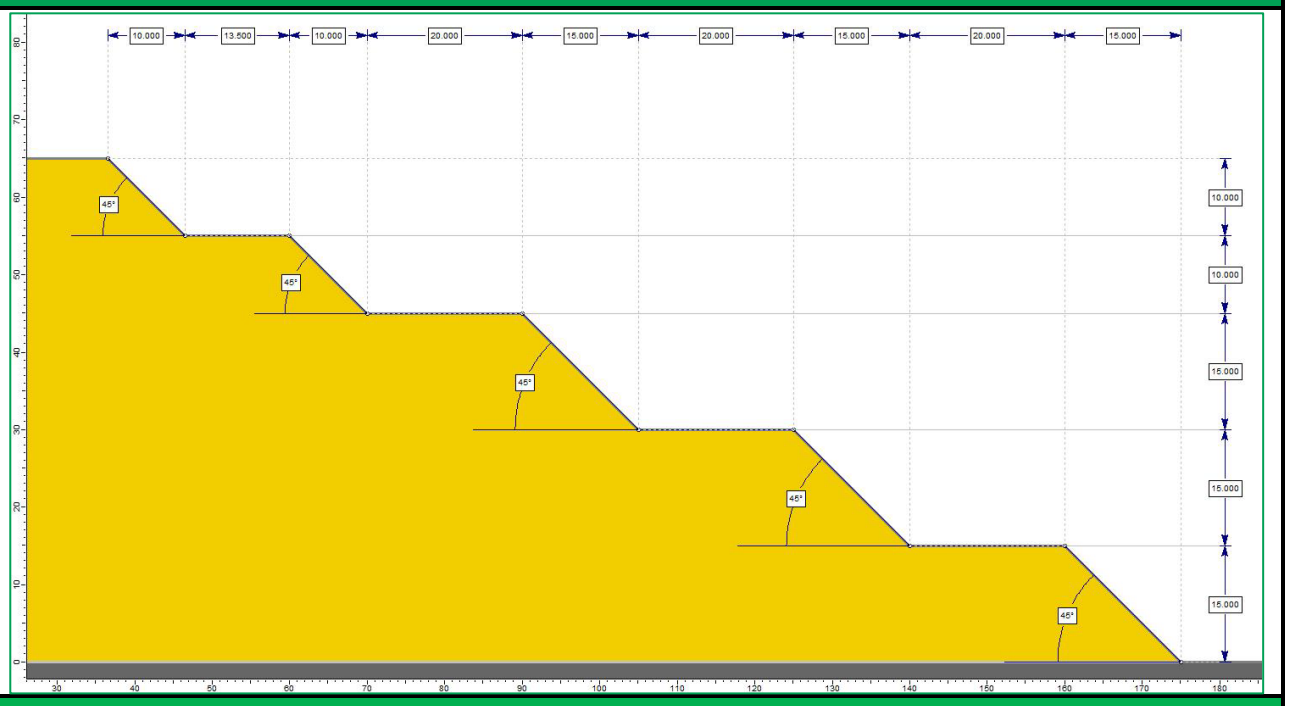
Blasted material categories:

- Above BoA : CAT 1.0 strength
- BoW : CAT 1.5 strength
- BoW to MM, TL, PU : CAT 2.0 strength

Domain 1 – Natural surface to base of Alluvium (BoA)

Excavator/Shovel – Max single batter height 15m, a designed batter angle of 45° and berm width of 10m.

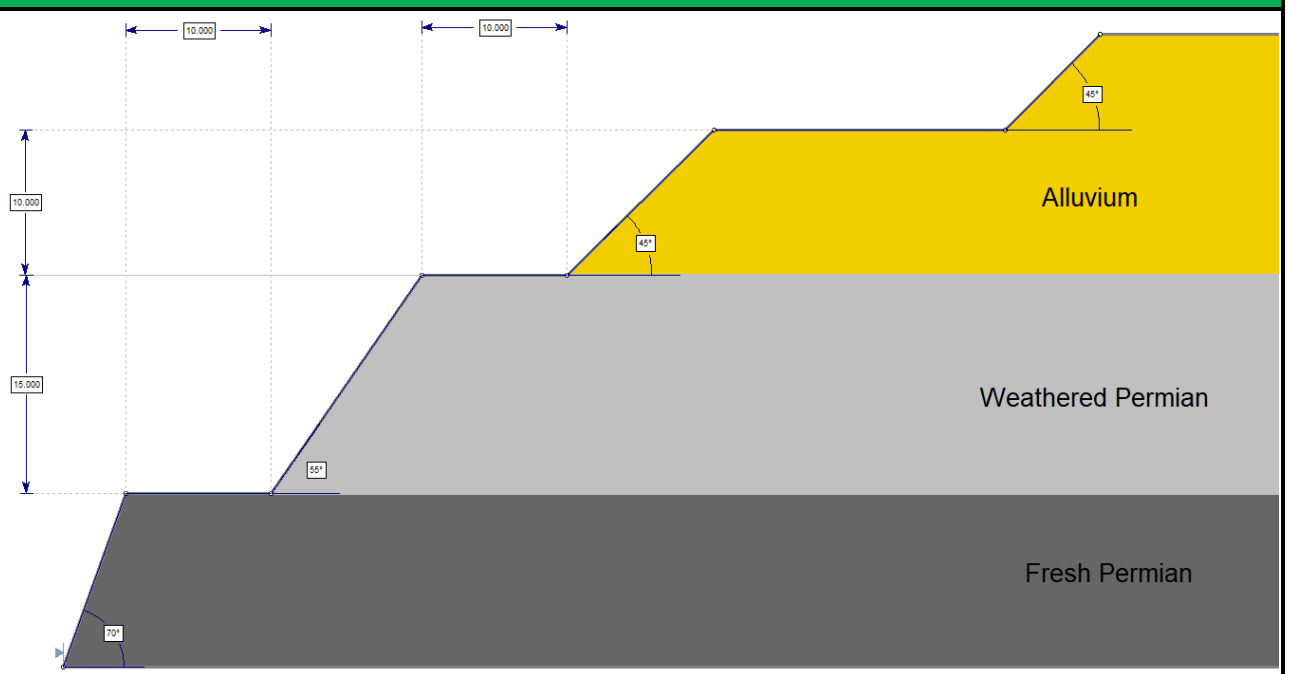
- Crest slumping is expected in Alluvium dig areas, restrict personnel access appropriately.
- Maintain effective drainage of surface water off benches, DO NOT allow water to pond on benches.
- Maintain a 10 m standoff.
- Maintain a minimum of 20 m of catch berm in the Alluvium horizon.
- Ensure a minimum 10 m wide bench at the base of the Tertiary Unit.



Domain 2 – Base of Alluvium (BoA) to Base of Weathering (BoW)

Excavator/Shovel – Max single batter height 25 m, a designed batter angle of 55° and berm width of 10 m highwall.

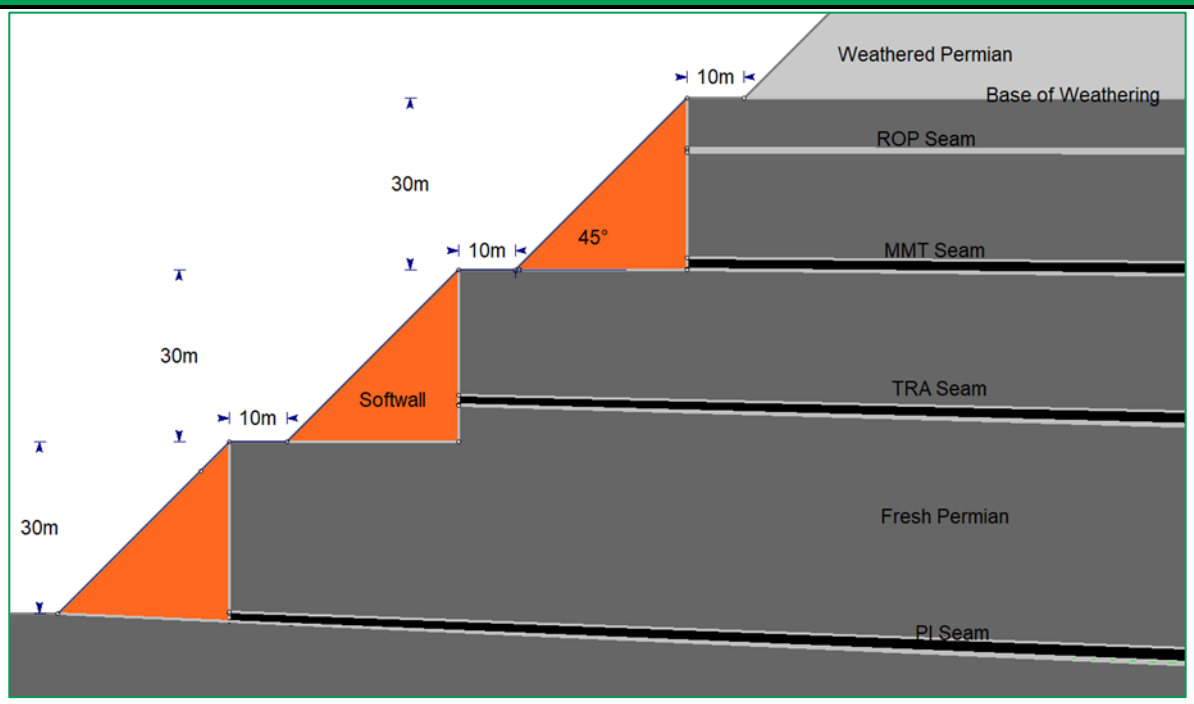
- Remove/ chamfer corner of weathered Permian to limit rockfall potential.
- Maintain effective drainage of surface water off benches, DO NOT allow water to pond on benches.
- Maintain a 10 m standoff.
- Maintain a minimum 10 m catch berm above the weathered Permian horizon.
- An overall slope angle of 38° (Base of weathered Permian to the crest of Alluvium).
- A geotechnical approval must be sought for a catch bench less than 10m.



Domain 3 – BoW to MMT seam and TRA seam to PI Seam (Fresh Permian)

Maximum single batter height 30 m, batter angle softwalled 45°, overall slope angle of 37° and berm width of 10m highwall.

- Minimise rockfall potential through adequate scaling, restrict personnel access.
- Maintain effective drainage of surface water off benches; DO NOT allow water ponding.
- Maintain a 10 m standoff.
- Ensure dig-to-design angle



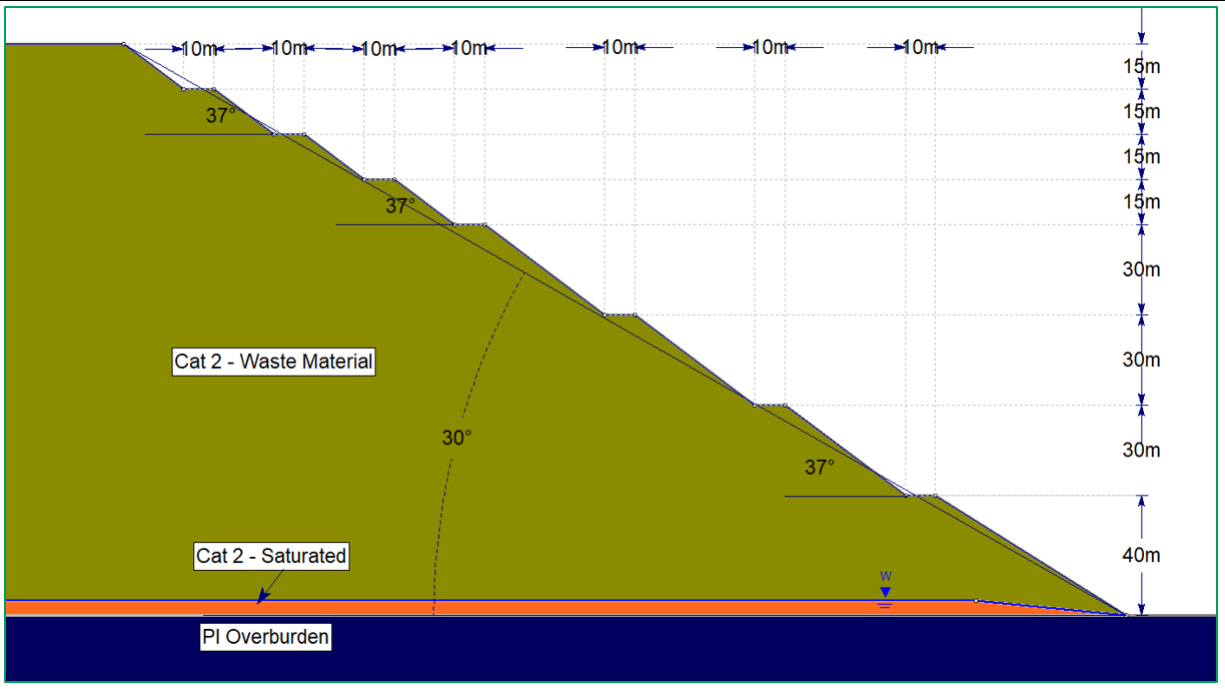
In-Pit Lowwall Dumps

- Max overall dump height is 195m with an overall slope angle defined below.
- Max single batter height of 30m is dependant of spoil category (Fresh Permian), a 10m minimum berm between each dump lift.
- CAT 1 and 1.5 spoil and ox coal is to be taken to the top tiers of the dump unless approved by a geotechnical engineer.
- Maintain drainage on dump benches to prevent water ponding.

Lowwall design for unsheared floor conditions

Floor Dip (°)	Overall Slope Angle (°)
<10	30
10 > 12	27
12 > 15	26
>15	NA*

* Seek geotechnical advice



Sources of Uncertainty

- Material strengths used
- No mud in previous strip and floor. Floor preparation was achieved.
- Geology model is accurate.
- Fault extents assumed from current exposures and model.

Monitoring and Validation

- Major Faults – Reconcile modelled faults on exposure.
- All areas – Reconcile geology model performance.
- All slopes are designed to achieve an overall Factor of Safety (FOS) ≥ 1.2.
- All Domains:
  - Ensure walls are dug to design (Operations).
  - Survey to assess compliance to design (Surveyors).
  - Assess pit performance and stability issues (Operations, OCEs, Geotechnical Engineers and Geologists).
- All personnel to monitor and report any signs of pit slope instability.

General Design Considerations

Maintain effective drainage behind slope crests and on benches to prevent water ponding. Drainage should be specified in the design to ensure that the work is completed.

Ensure the applicable Geotechnical Design checklists for Mine Planning are completed prior to the commencement of a design.

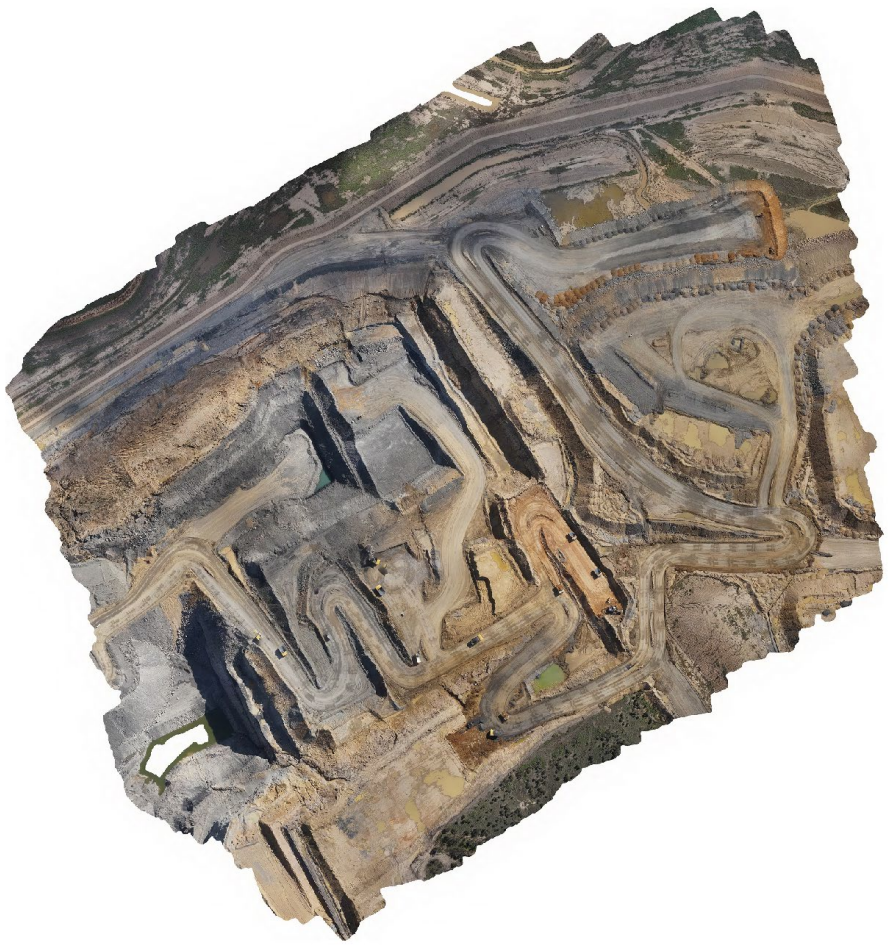
The initiation point, firing direction and size of overburden blasts needs to be considered carefully, to limit blast damage of faults and structure.

Blasting interaction/scheduling between mining horizons needs to be considered carefully to limit blast spillage.

Geotechnical approval must be obtained for designs that do not comply with the above recommendations

The endwalls and final highwalls must be assessed geotechnically for stability and to achieve long term requirements.

Geotech Standard Design Guideline	One Tree Pit	Middlemount South – Foxleigh Mine



General Pit Information

Domain: This pit consists of 4 domains:
Domain 1: Natural surface to base of Alluvium (BoA)
Domain 2: Alluvium to Base of Weathered Permian
Domain 3: Weathered Permian to Fresh Permian (MM, TL, PU)
Domain 4: In-pit soil dump design

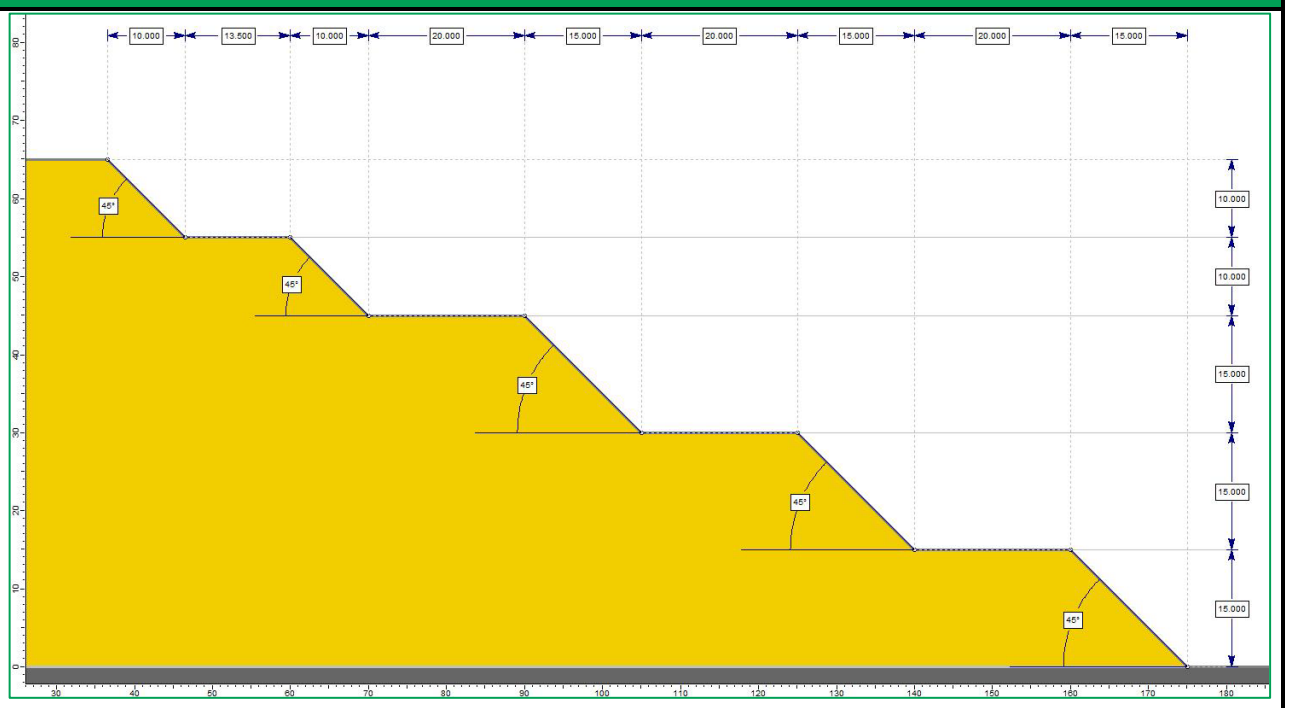
Blasted material categories:

- Above BoA : CAT 1.0 strength
- BoW : CAT 1.5 strength
- BoW to MM, TL, PU : CAT 2.0 strength

Domain 1 – Natural Surface to Base of Alluvium (BoA)

Excavator/Shovel – Max single batter height 15m, a designed batter angle of 45° and berm width of 10m.

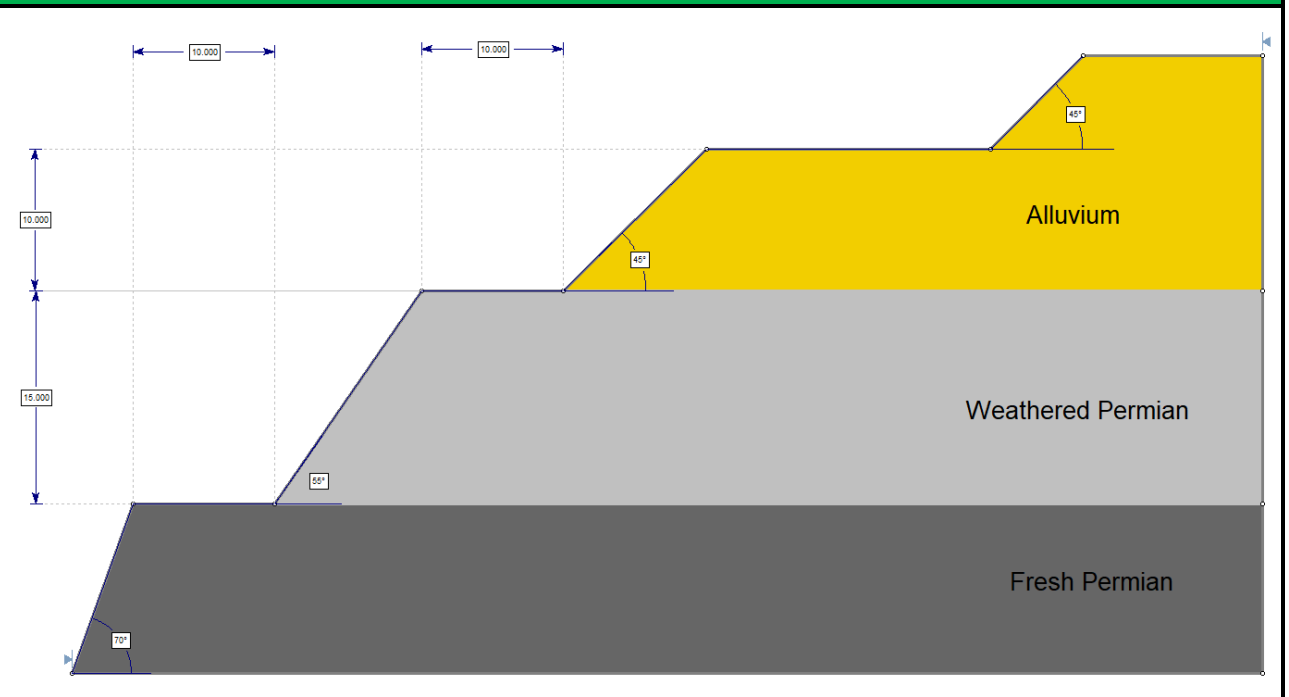
- Crest slumping is expected in Alluvium dig areas, restrict personnel access appropriately.
- Maintain effective drainage of surface water off benches, DO NOT allow water to pond on benches.
- Maintain a 10 m standoff.
- Maintain a minimum 20 m of catch berm in the Alluvium horizon.
- Ensure a minimum 10 m wide bench at the base of the Tertiary Unit.



Domain 2 – Base of Alluvium (BoA) to Base of Weathered Permian (BoW)

Excavator/Shovel – Max single batter height 25 m, a designed batter angle of 55° and berm width of 10 m highwall.

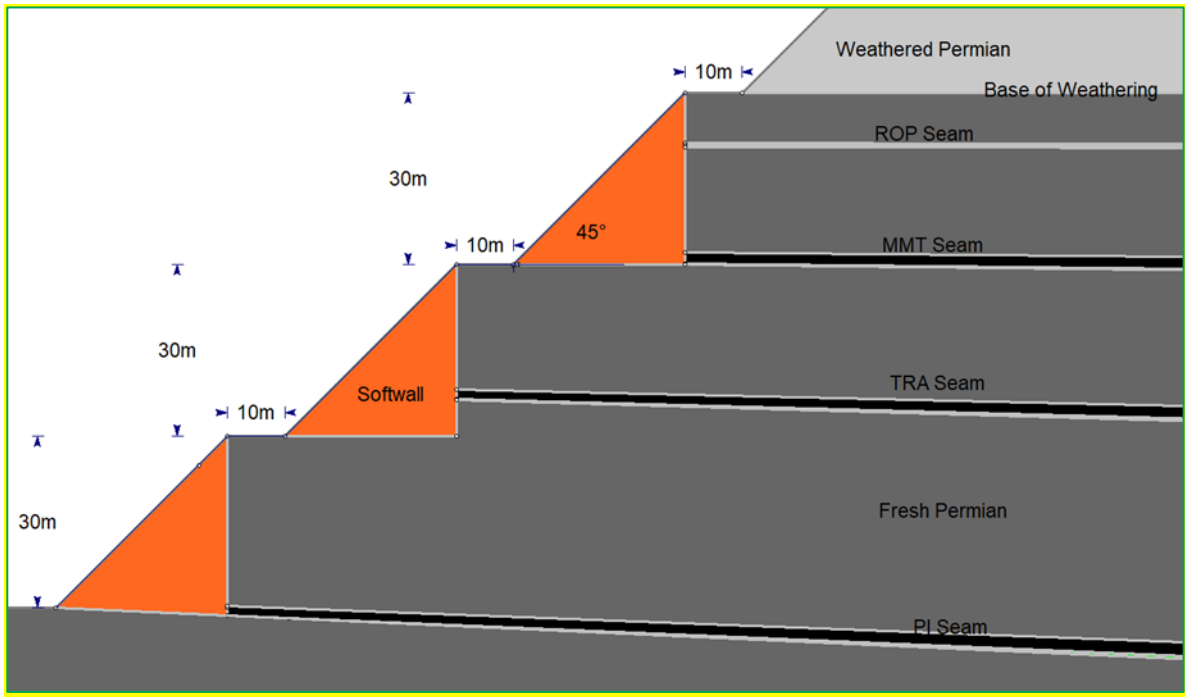
- Remove/ chamfer corner of weathered Permian to limit rockfall potential.
- Maintain effective drainage of surface water off benches, DO NOT allow water to pond on benches.
- Maintain a 10 m standoff.
- Maintain a minimum 10 m catch berm above the weathered Permian horizon.
- An overall slope angle of 38° (Base of weathered Permian to the crest of Alluvium).
- A geotechnical approval must be sought for a catch bench less than 10m.



Domain 3 – Base of Weathered Permian (BoW) to MMT Seam and Tralee Seam (Fresh Permian)

Maximum single batter height 30 m, batter angle softwalled 45°, and berm width of 10m highwall.

- Minimise rockfall potential through adequate scaling, restrict personnel access.
- Maintain effective drainage of surface water off benches; DO NOT allow water ponding.
- Maintain a 10 m standoff.
- Ensure dig-to-design angle



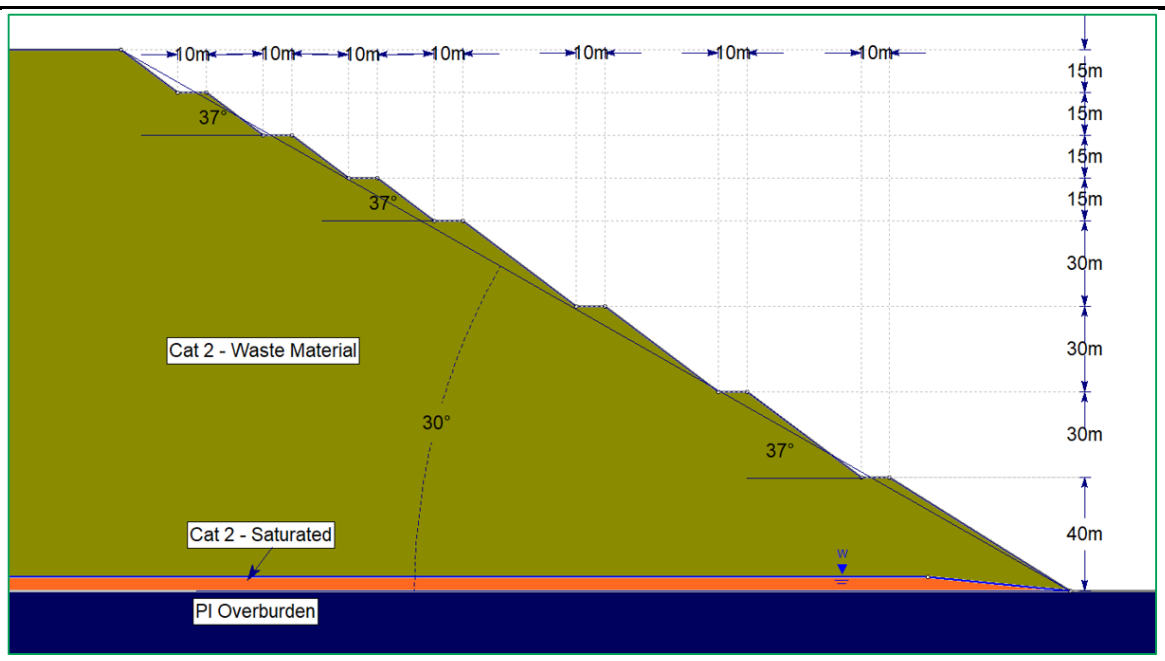
In-Pit Lowwall Dumps

- Max overall dump height is 195m with an overall slope angle defined below.
- Max single batter height of 30m is dependant of spoil category (Fresh Permian), a 10m minimum berm between each dump lift.
- CAT 1 and 1.5 spoil and ox coal is to be taken to the top tiers of the dump unless approved by a geotechnical engineer.
- Maintain drainage on dump benches to prevent water ponding.

Lowwall design for *unsheared* floor conditions

Floor Dip (°)	Overall Slope Angle (°)
<10	30
10 > 12	27
12 > 15	26
>15	NA*

* Seek geotechnical advice



Sources of Uncertainty

- Material strengths used
- No mud in previous strip and floor. Floor preparation was achieved.
- Geology model is accurate.
- Fault extents assumed from current exposures and model.

Monitoring and Validation

- Major Faults – Reconcile modelled faults on exposure.
- All areas – Reconcile geology model performance.
- All slopes are designed to achieve an overall Factor of Safety (FOS) ≥ 1.2.
- All Domains:
  - Ensure walls are dug to design (Operations).
  - Survey to assess compliance to design (Surveyors).
  - Assess pit performance and stability issues (Operations, OCEs, Geotechnical Engineers and Geologists).
- All personnel to monitor and report any signs of pit slope instability.

General Design Considerations

Maintain effective drainage behind slope crests and on benches to prevent water ponding. Drainage should be specified in the design to ensure that the work is completed.

Ensure the applicable Geotechnical Design checklists for Mine Planning are completed prior to the commencement of a design.

The initiation point, firing direction and size of overburden blasts needs to be considered carefully, to limit blast damage of faults and structure.

Blasting interaction/scheduling between mining horizons needs to be considered carefully to limit blast spillage.

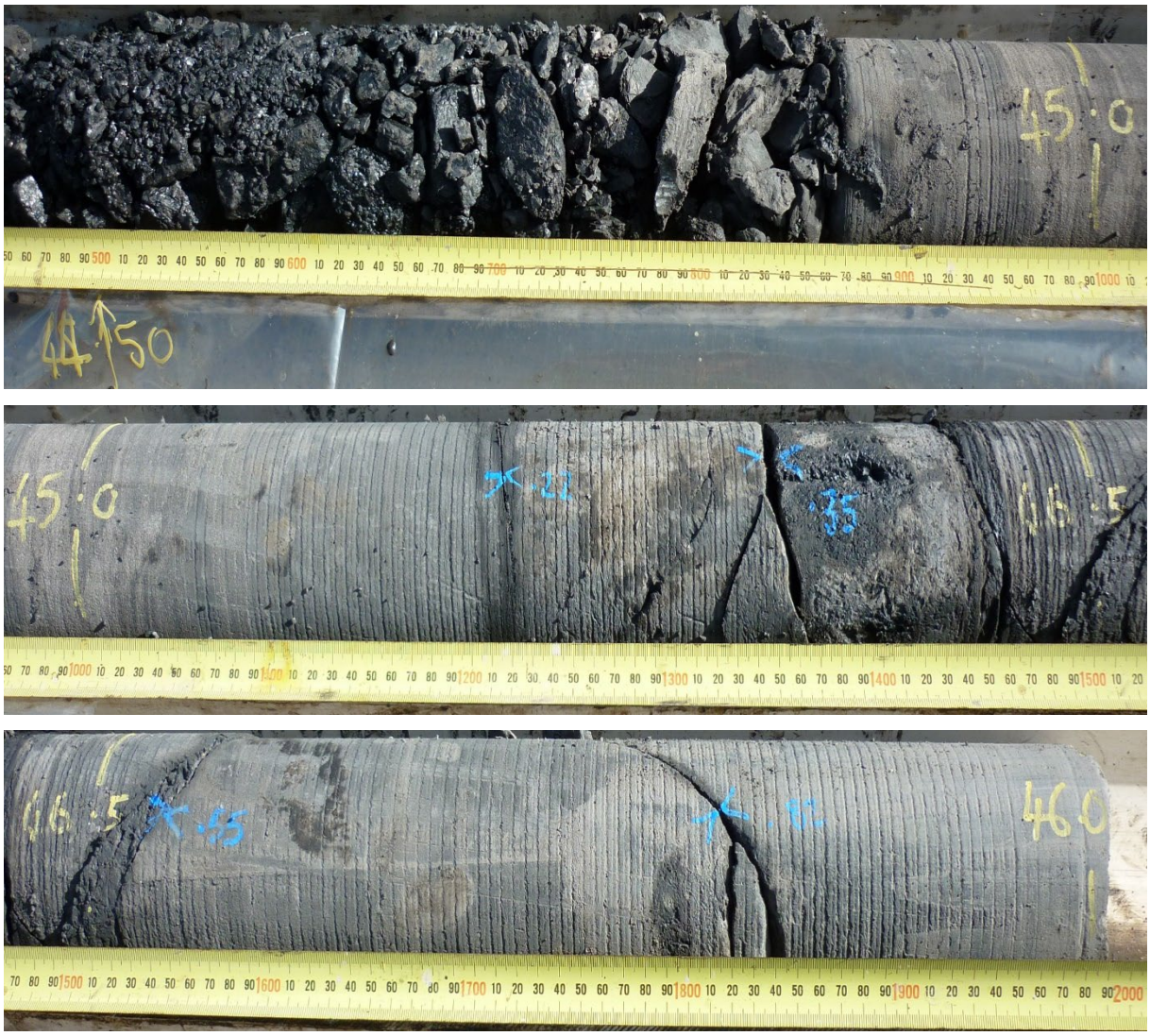
Geotechnical approval must be obtained for designs that do not comply with the above recommendations

The endwalls and final highwalls must be assessed geotechnically for stability and to achieve long term requirements.

Appendix B: Core Photographs Showing Seam Floor Condition

ROP1 SEAM FLOOR

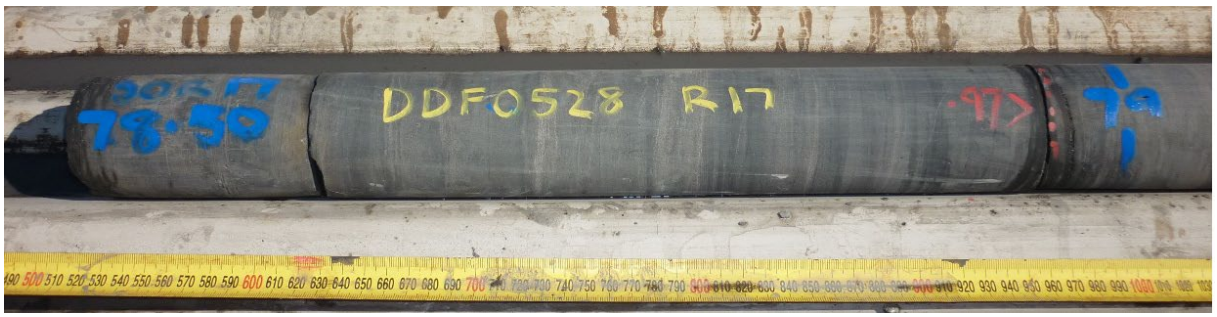
KF389C: ROP1, 44.1-45.11m – Siltstone interbedded with sandstone, medium strength



MMT SEAM FLOOR

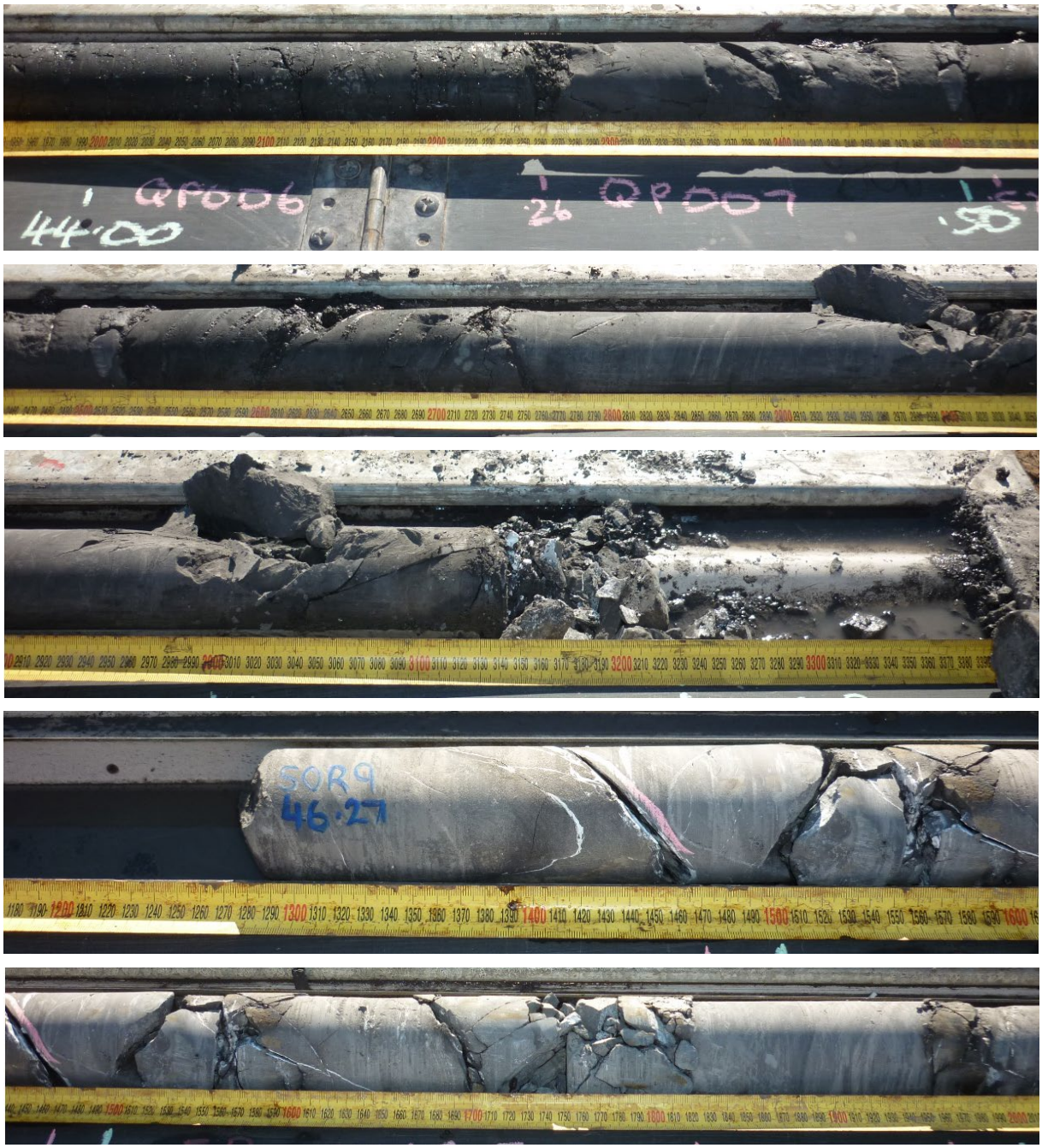
DD0528: MMT1, 65.93-70.11m – Sandstone interbedded with siltstone, high strength

DD0528: MMTL, 78.14-78.38m – Siltstone interbedded with sandstone, medium Strength

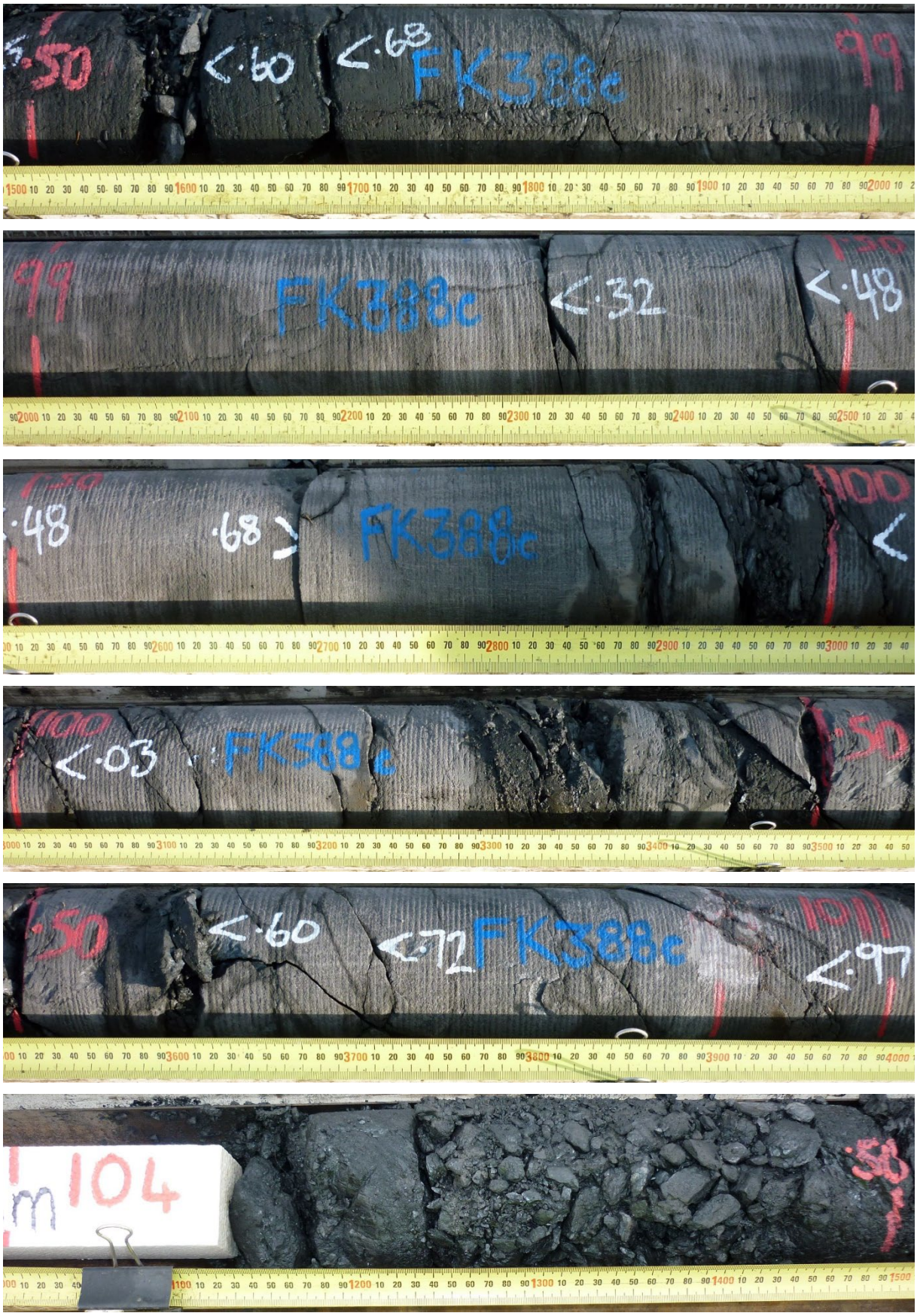


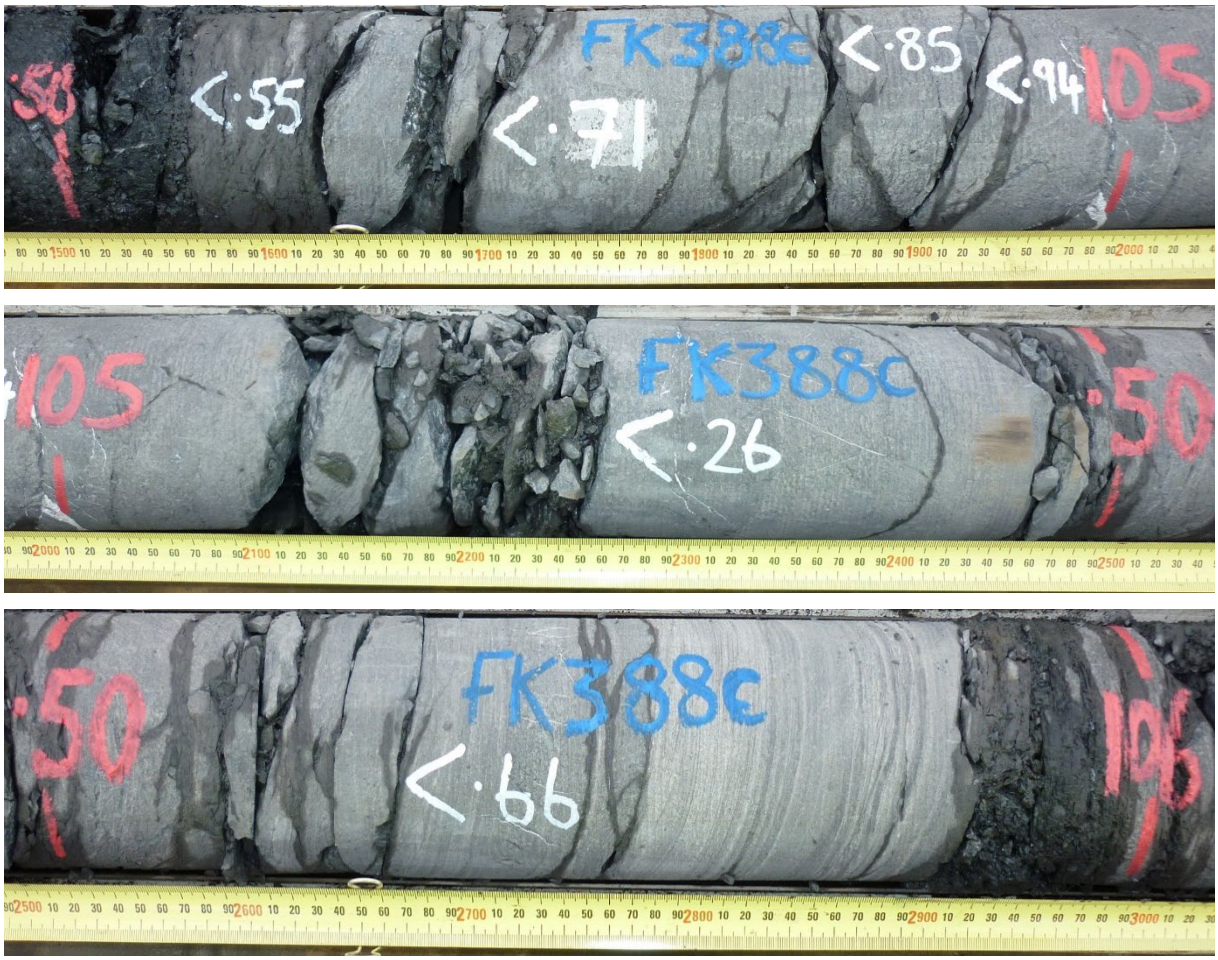
DD0549: MMT1, 32.62-37.48m – Siltstone interbedded with carbonaceous siltstone, medium strength

DD0549: MMTL, 43.59-44.37m – Sandstone, siltstone, carbonaceous siltstone, low to high strength, highly fractured sandstone

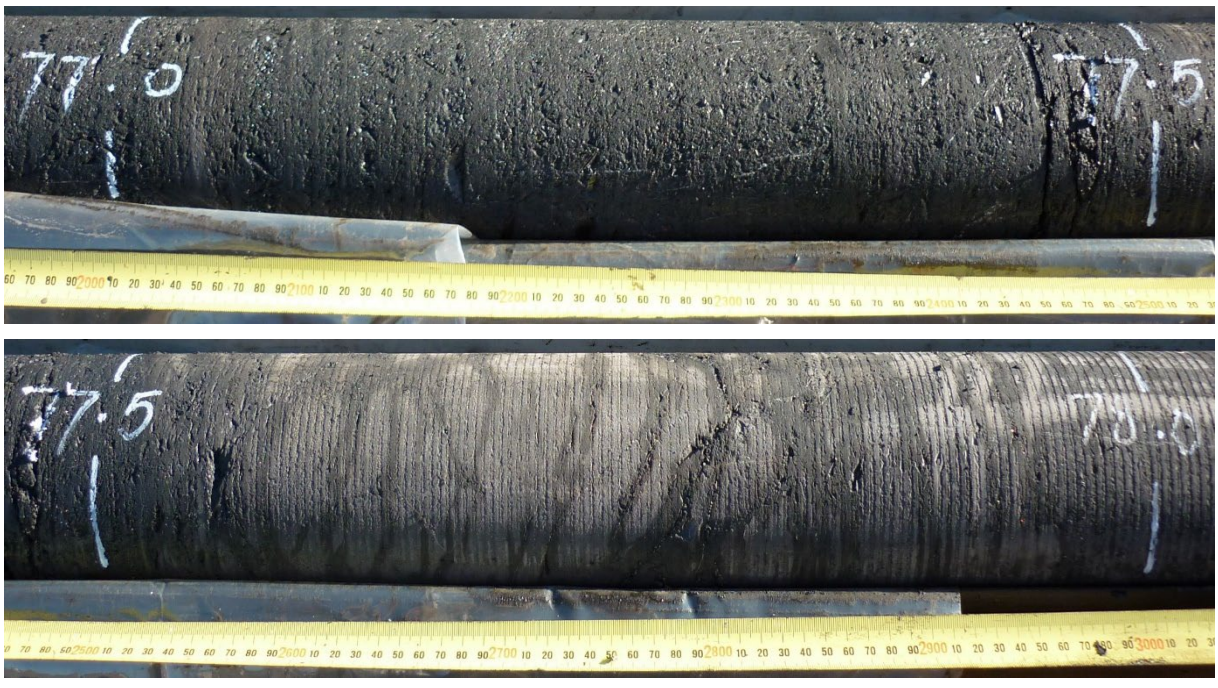


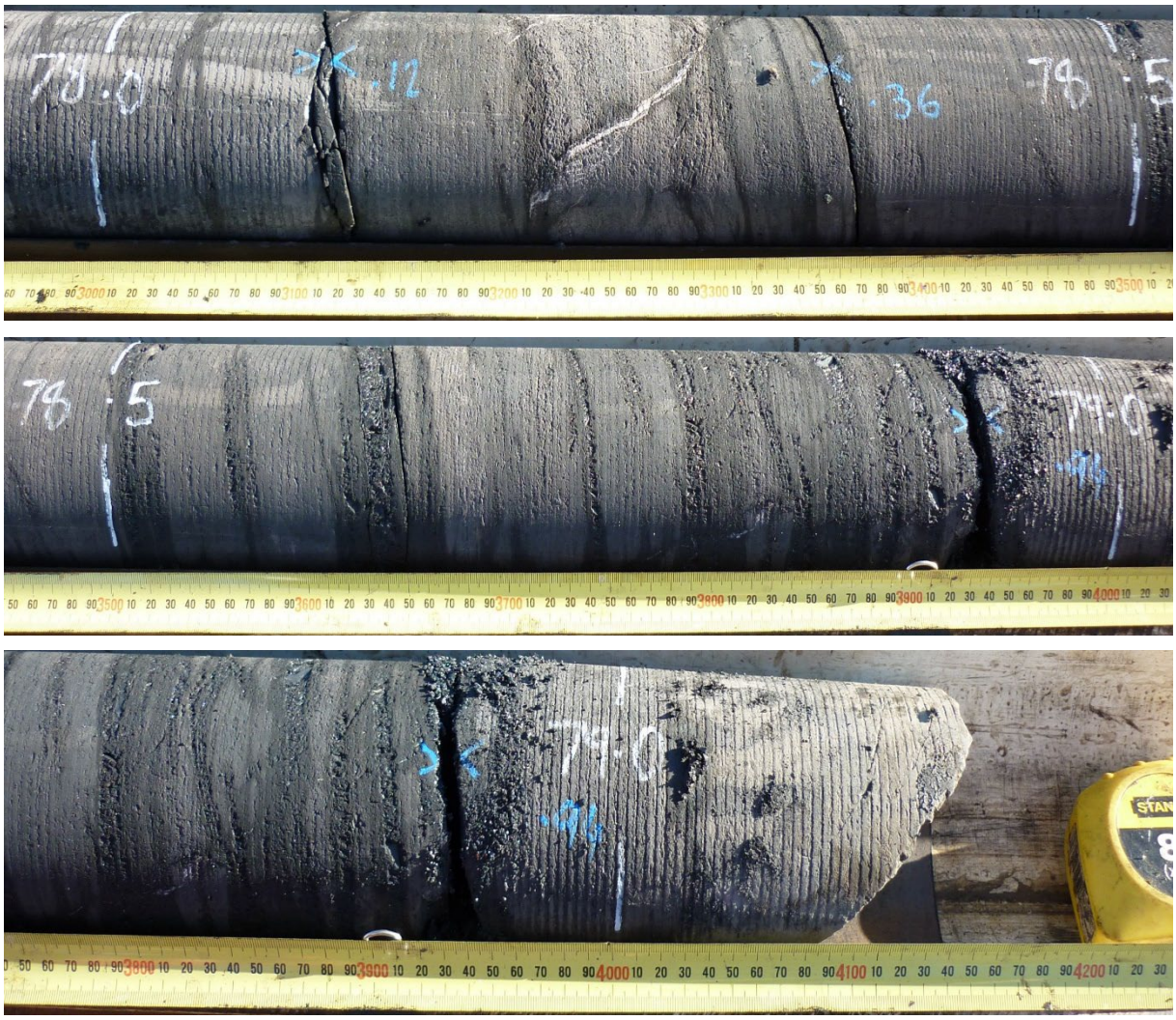
KF388C: MMT1, 93.37-104.54m – Sandstone interbedded with siltstone, low to high strength, sheared zone





KF389C: MMT1, 73.712-79.30m – Siltstone interbedded with sandstone, with beddings and laminations spaced 5 – 10mm, low to medium strength)

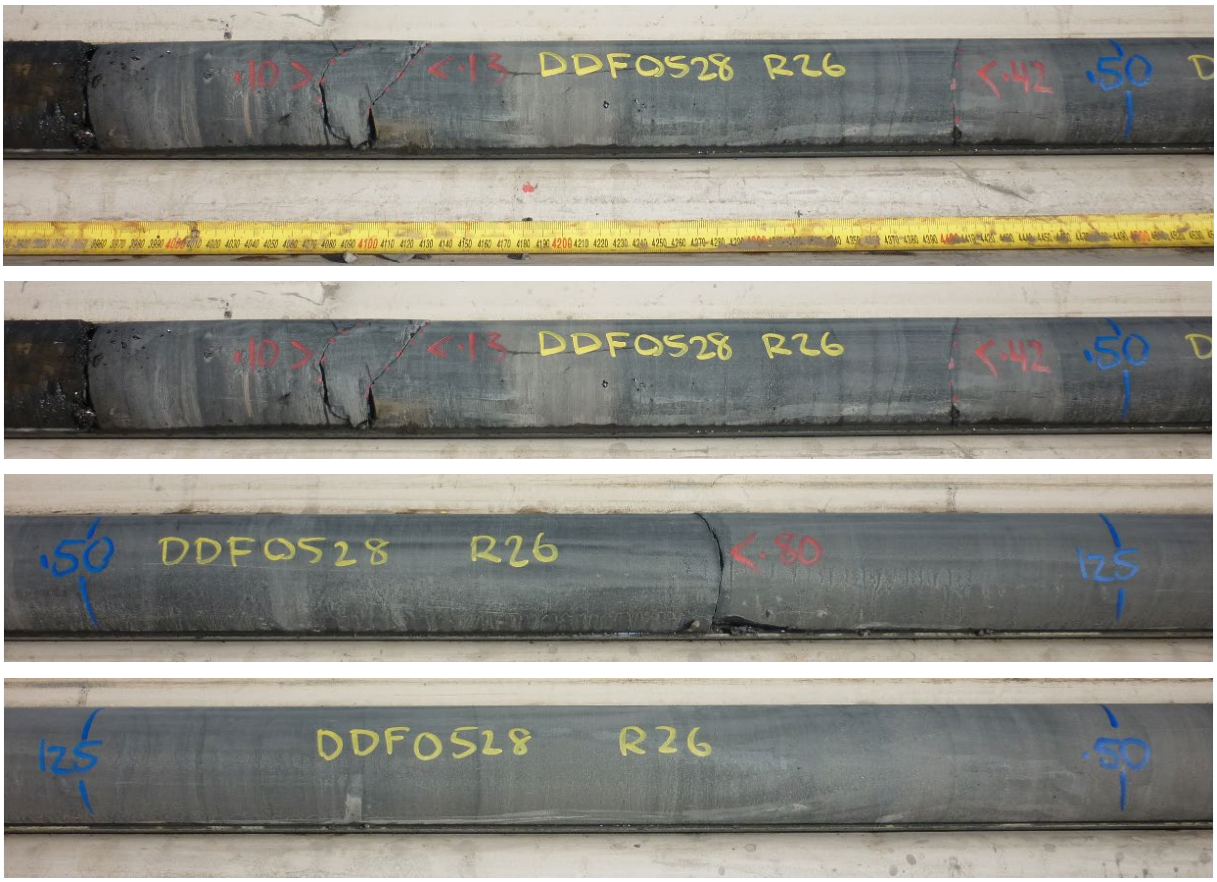



79.0
79.5

TRALEE SEAM FLOOR

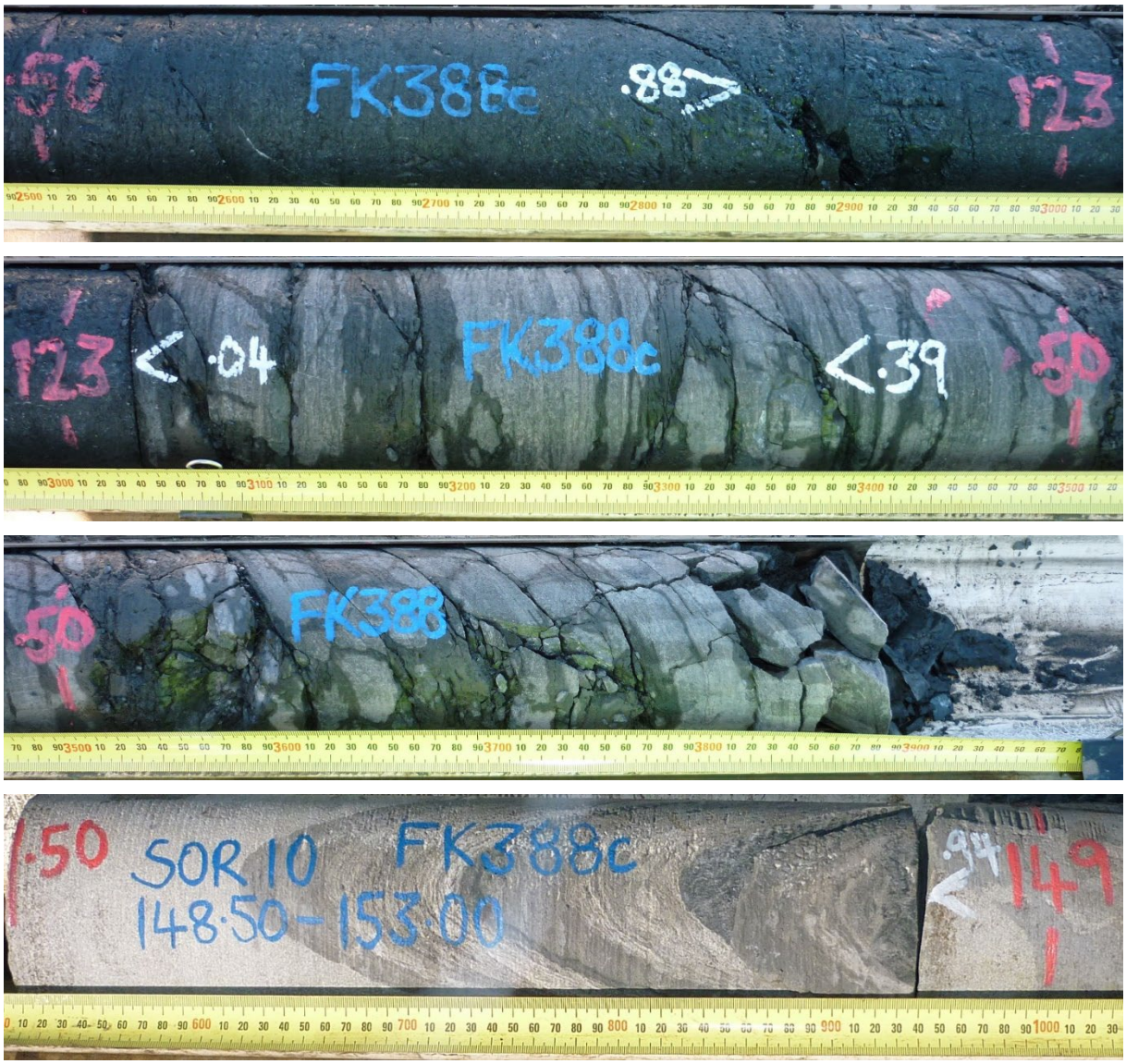
DD0528: TRA2, 91.18-93.39m – Siltstone, fractured, low to medium strength

DD0528: TRA1, 121.14-123.51m – Siltstone interbedded with sandstone, medium to high strength

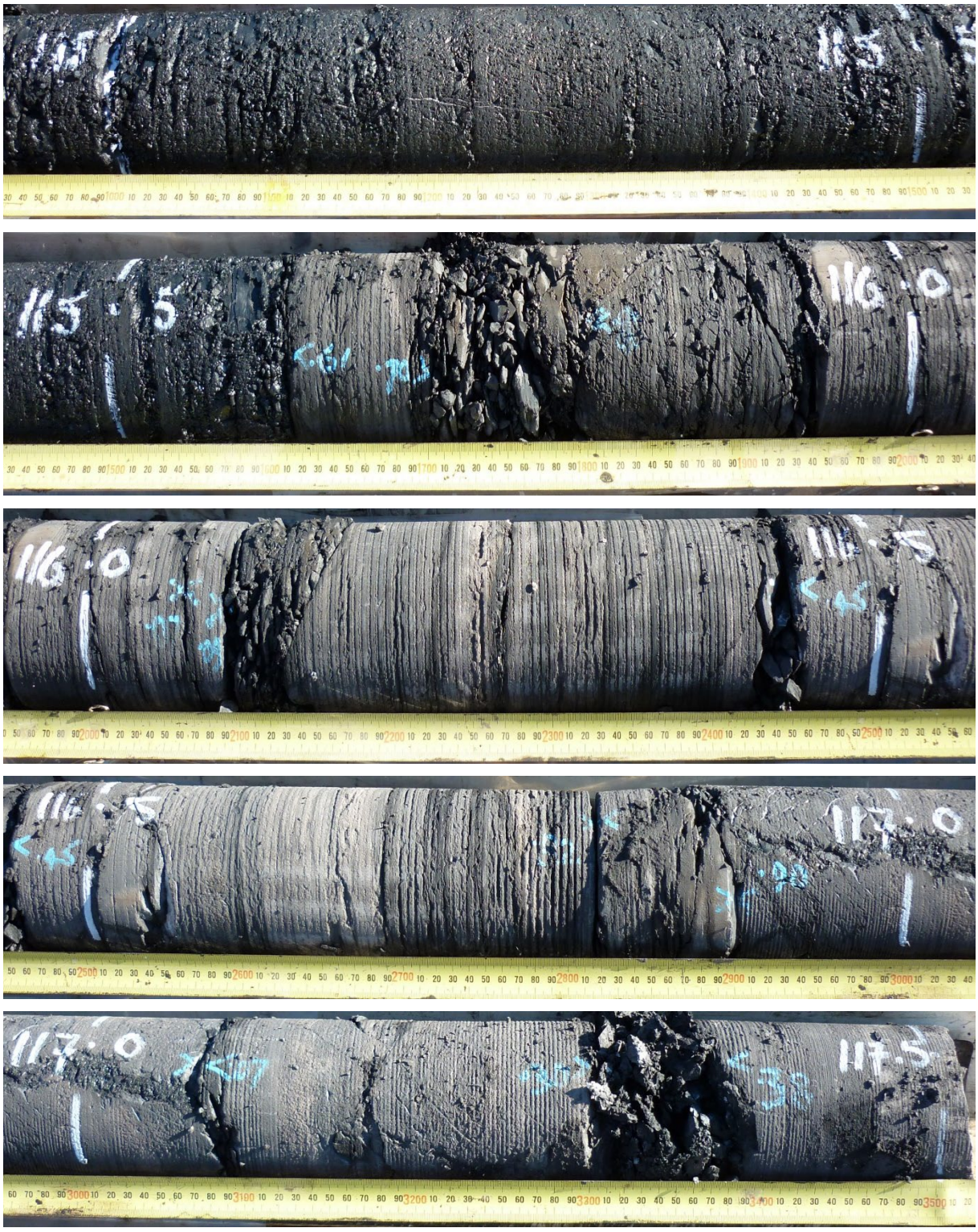


DD0549: TRA2, 62.47-64.51m – Siltstone, interbedded with sandstone, fractured, medium strength

KF388C: TRA2, 121.95-123.07m – Siltstone interbedded with sandstone, highly fractured, low to high strength

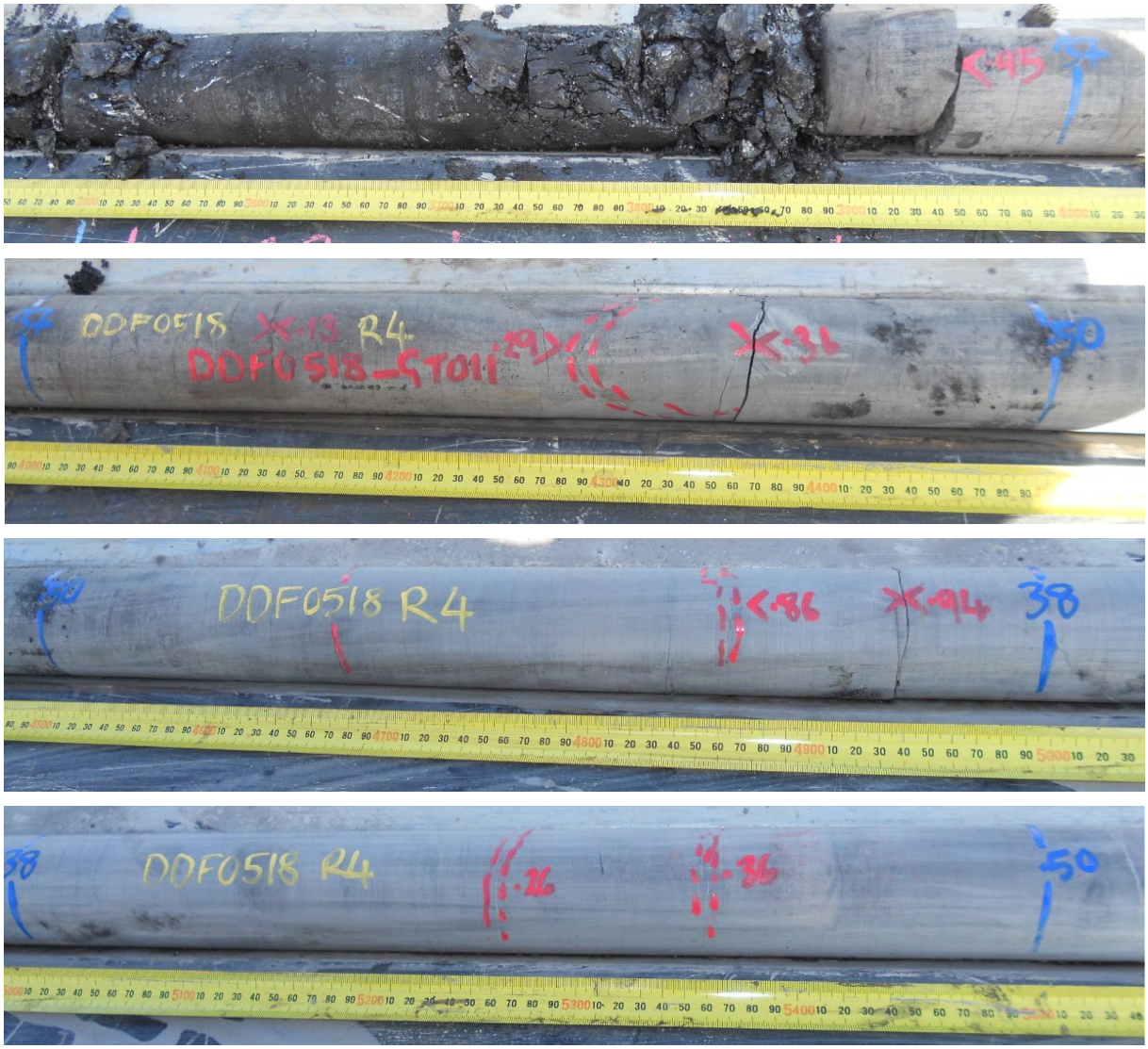


KF389C: TRA2, 115.06-117.28m – Siltstone interbedded with sandstone, with beddings and lamination spaced 5 – 10mm, highly fractured, low strength

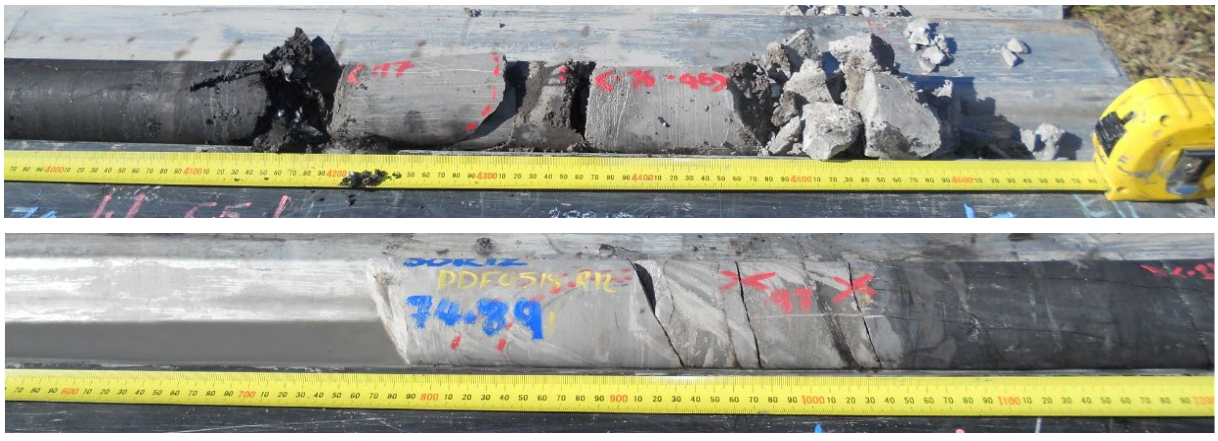

115.5
116.0
116.5
117.0
117.5

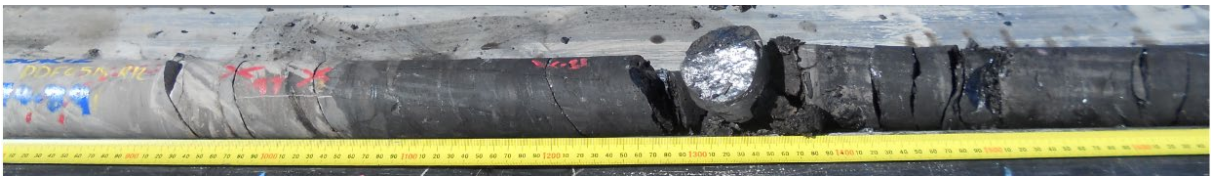
PI Seam Floor

DD0518: PI 1A, 34.17-36.77m – Siltstone, medium to high strength

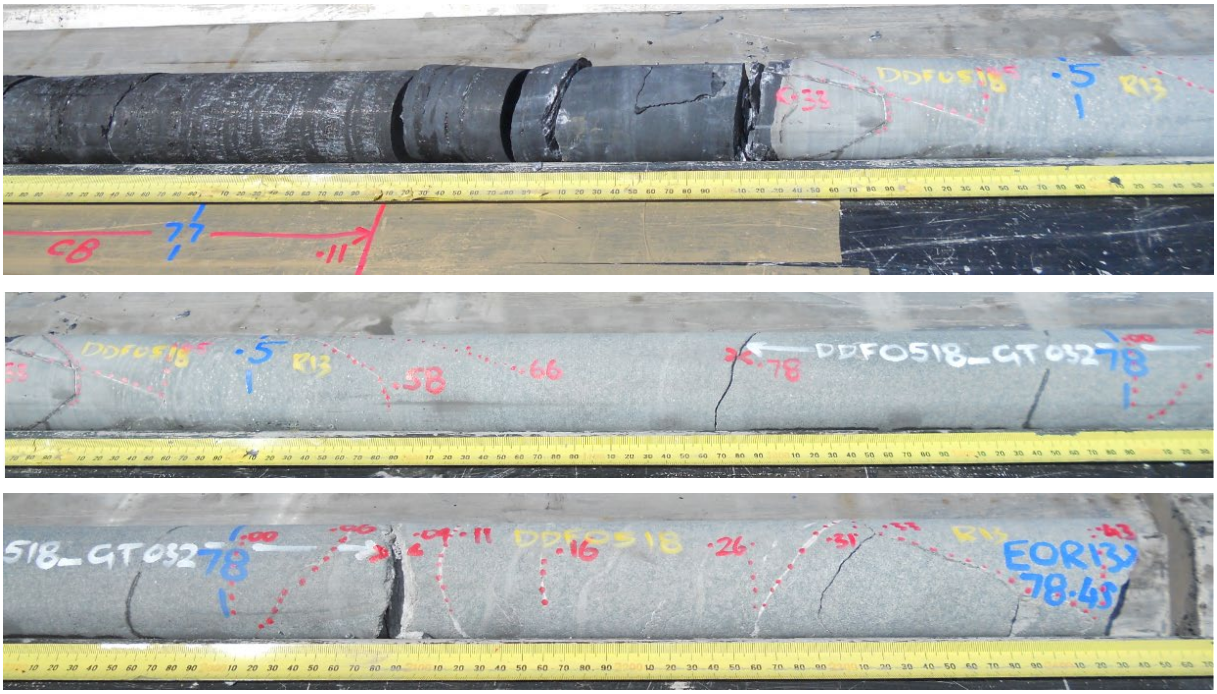


DD0518: PI 2A, 71.65-74.05m – Siltstone, carbonaceous siltstone, low to medium strength



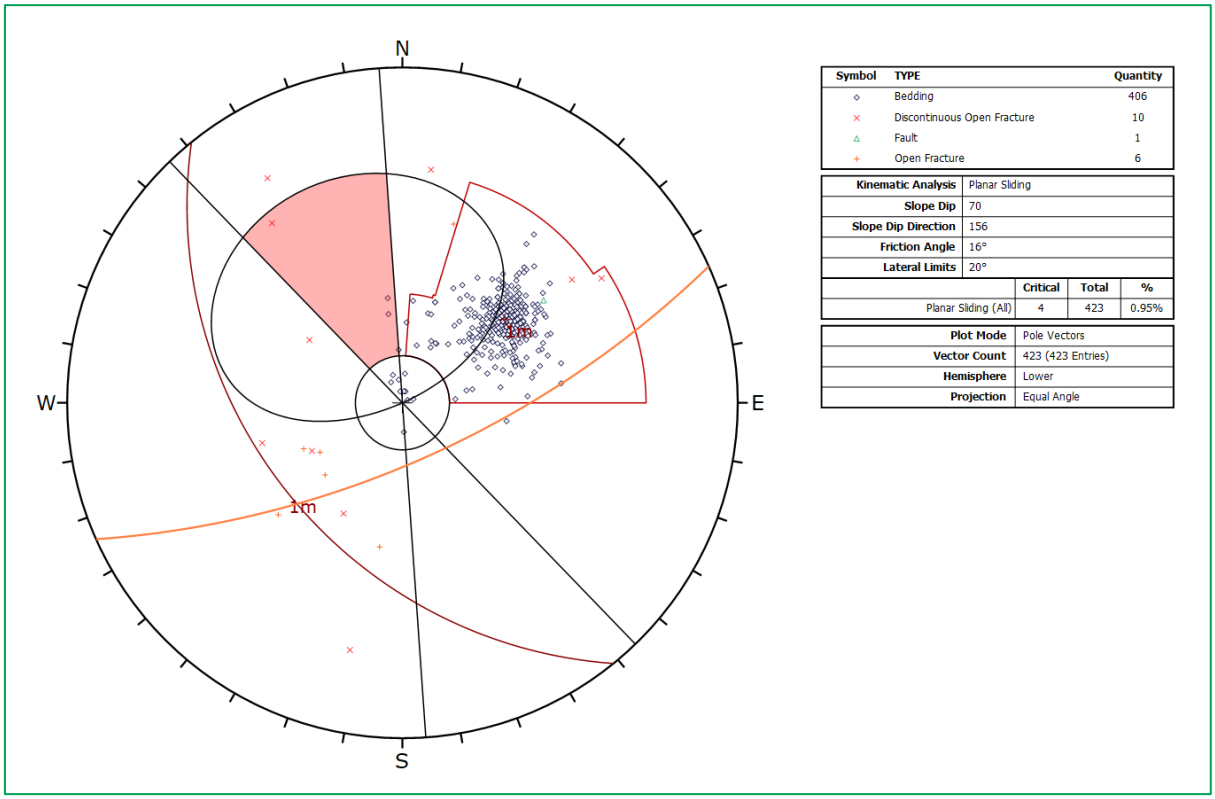


DD0518: PI 2B, 74.94-76.98m – Sandstone, high strength



Appendix C: Kinematic Analysis Results

BH ID: LDF0889A



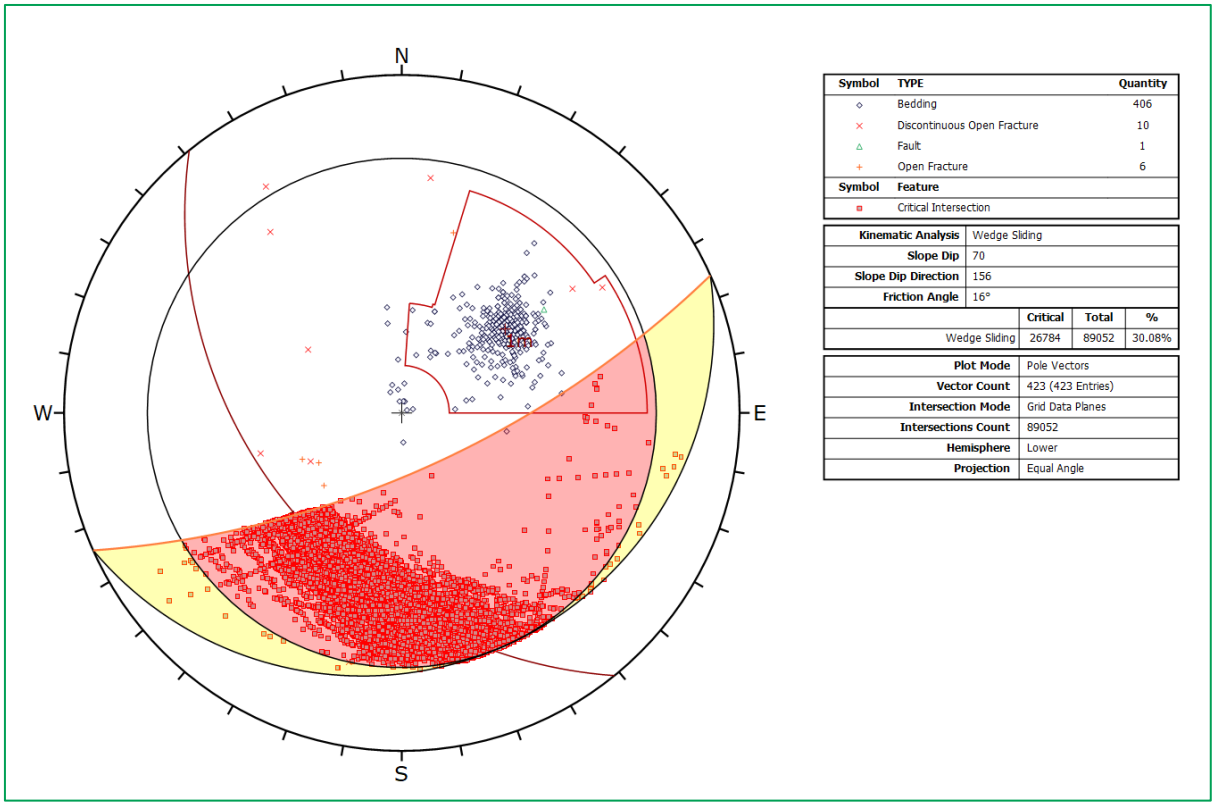
Symbol	TYPE	Quantity
◇	Bedding	406
×	Discontinuous Open Fracture	10
△	Fault	1
+	Open Fracture	6

Kinematic Analysis	Planar Sliding
Slope Dip	70
Slope Dip Direction	156
Friction Angle	16°
Lateral Limits	20°

	Critical	Total	%
Planar Sliding (All)	4	423	0.95%

Plot Mode	Pole Vectors
Vector Count	423 (423 Entries)
Hemisphere	Lower
Projection	Equal Angle

Appendix B 1: Highwall (Dip Direction @ 156°) – Planar Sliding



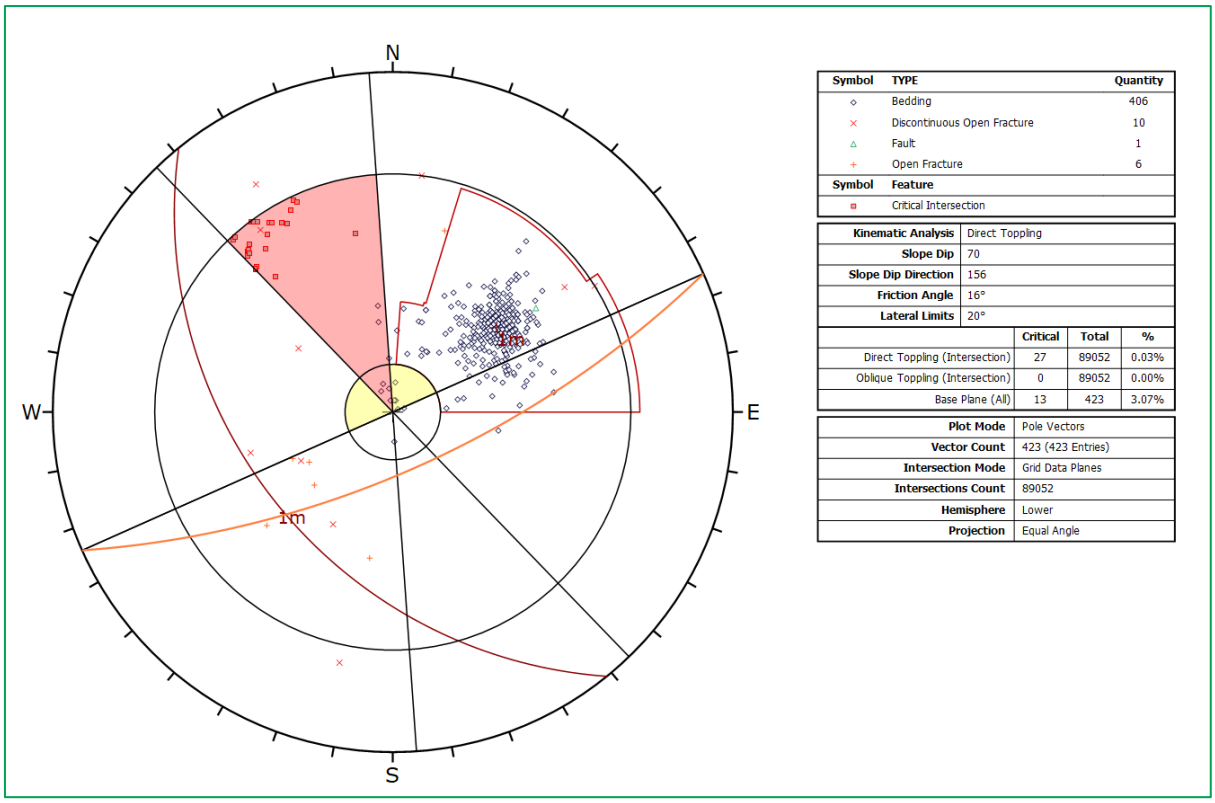
Symbol	TYPE	Quantity
◇	Bedding	406
×	Discontinuous Open Fracture	10
△	Fault	1
+	Open Fracture	6
Symbol	Feature	
▫	Critical Intersection	

Kinematic Analysis	Wedge Sliding
Slope Dip	70
Slope Dip Direction	156
Friction Angle	16°

	Critical	Total	%
Wedge Sliding	26784	89052	30.08%

Plot Mode	Pole Vectors
Vector Count	423 (423 Entries)
Intersection Mode	Grid Data Planes
Intersections Count	89052
Hemisphere	Lower
Projection	Equal Angle

Appendix B 2: Highwall, (Dip Direction @ 156°) – Wedge Sliding



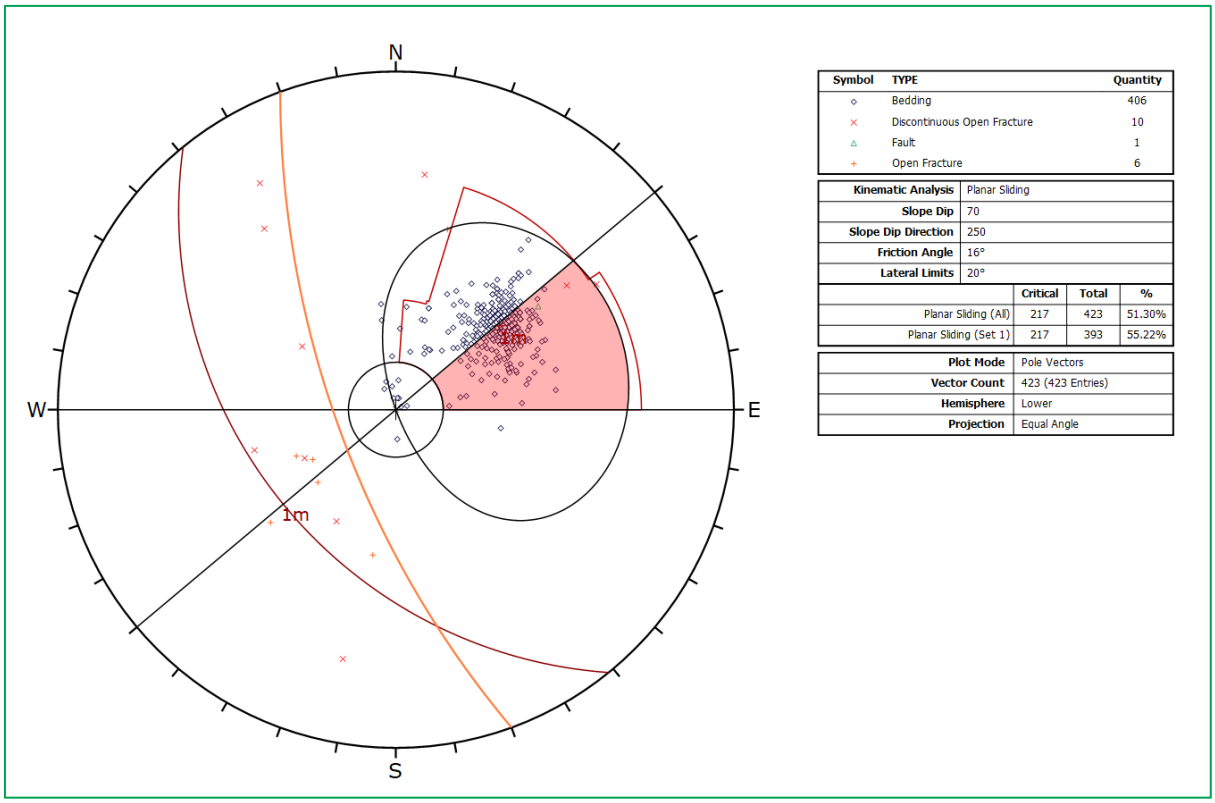
Symbol	TYPE	Quantity
◇	Bedding	406
×	Discontinuous Open Fracture	10
△	Fault	1
+	Open Fracture	6
Symbol	**Feature**	
▫	Critical Intersection	

Kinematic Analysis	Direct Toppling
Slope Dip	70
Slope Dip Direction	156
Friction Angle	16°
Lateral Limits	20°

	Critical	Total	%
Direct Toppling (Intersection)	27	89052	0.03%
Oblique Toppling (Intersection)	0	89052	0.00%
Base Plane (All)	13	423	3.07%

Plot Mode	Pole Vectors
Vector Count	423 (423 Entries)
Intersection Mode	Grid Data Planes
Intersections Count	89052
Hemisphere	Lower
Projection	Equal Angle

Appendix B 3: Highwall, (Dip Direction @ 156°) – Direct Toppling



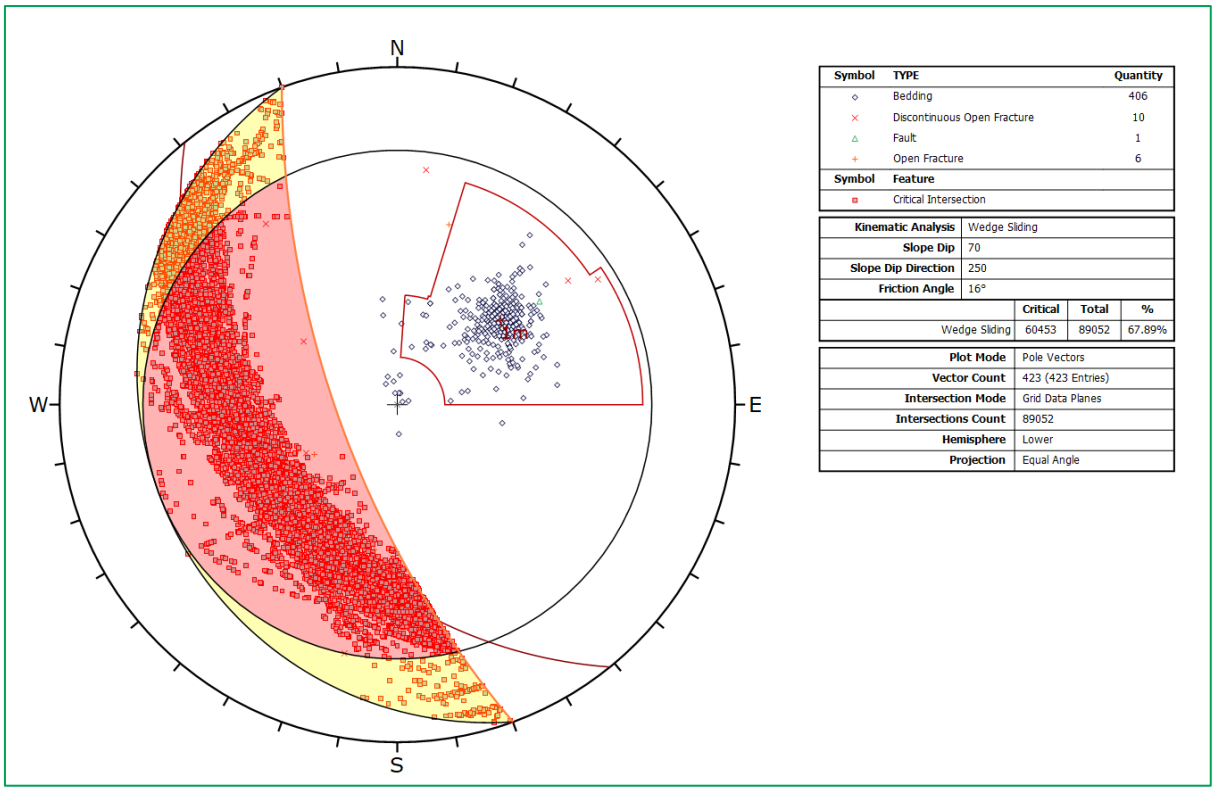
Symbol	TYPE	Quantity
◇	Bedding	406
×	Discontinuous Open Fracture	10
△	Fault	1
+	Open Fracture	6

Kinematic Analysis	Planar Sliding
Slope Dip	70
Slope Dip Direction	250
Friction Angle	16°
Lateral Limits	20°

	Critical	Total	%
Planar Sliding (All)	217	423	51.30%
Planar Sliding (Set 1)	217	393	55.22%

Plot Mode	Pole Vectors
Vector Count	423 (423 Entries)
Hemisphere	Lower
Projection	Equal Angle

Appendix B 4: Eastern Endwall, (Dip Direction @ 250°) – Planar Sliding



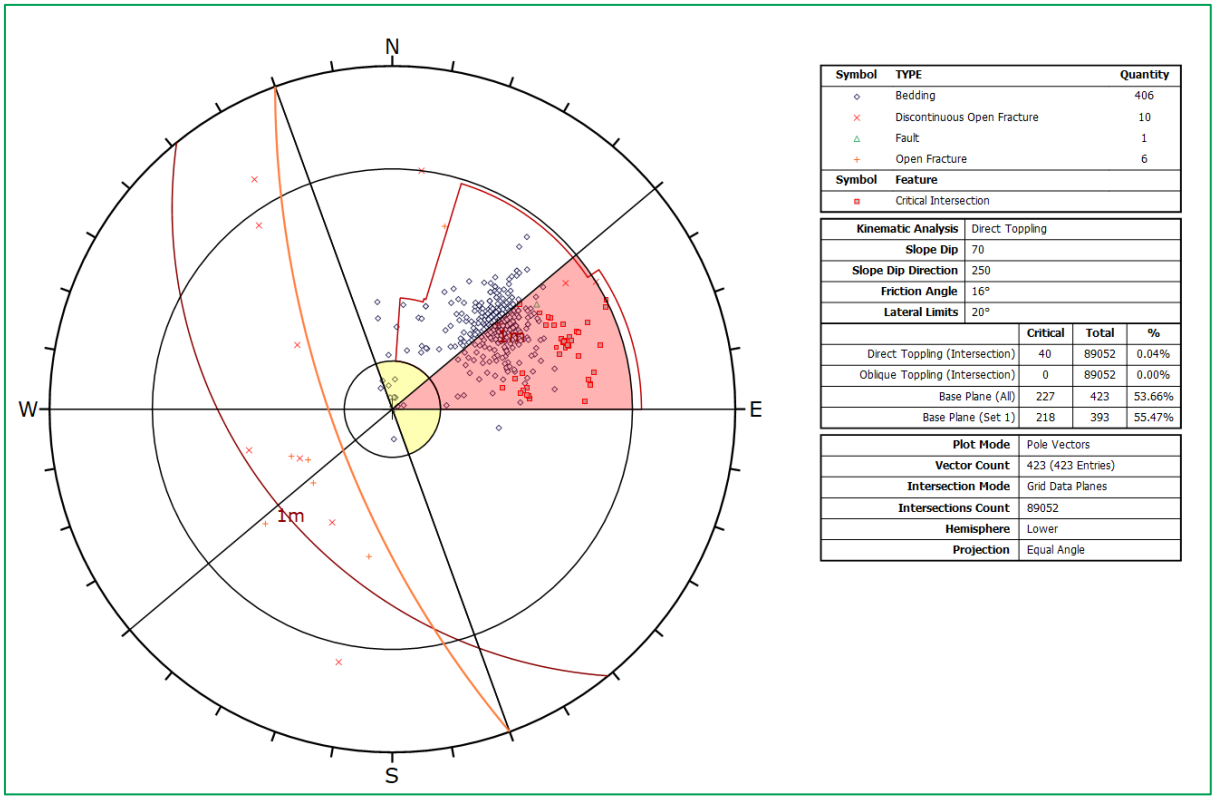
Symbol	TYPE	Quantity
◇	Bedding	406
×	Discontinuous Open Fracture	10
△	Fault	1
+	Open Fracture	6
Symbol	**Feature**	
▫	Critical Intersection	

Kinematic Analysis	Wedge Sliding
Slope Dip	70
Slope Dip Direction	250
Friction Angle	16°

	Critical	Total	%
Wedge Sliding	60453	89052	67.89%

Plot Mode	Pole Vectors
Vector Count	423 (423 Entries)
Intersection Mode	Grid Data Planes
Intersections Count	89052
Hemisphere	Lower
Projection	Equal Angle

Appendix B 5: Eastern Endwall, (Dip Direction @ 250°) – Wedge Sliding



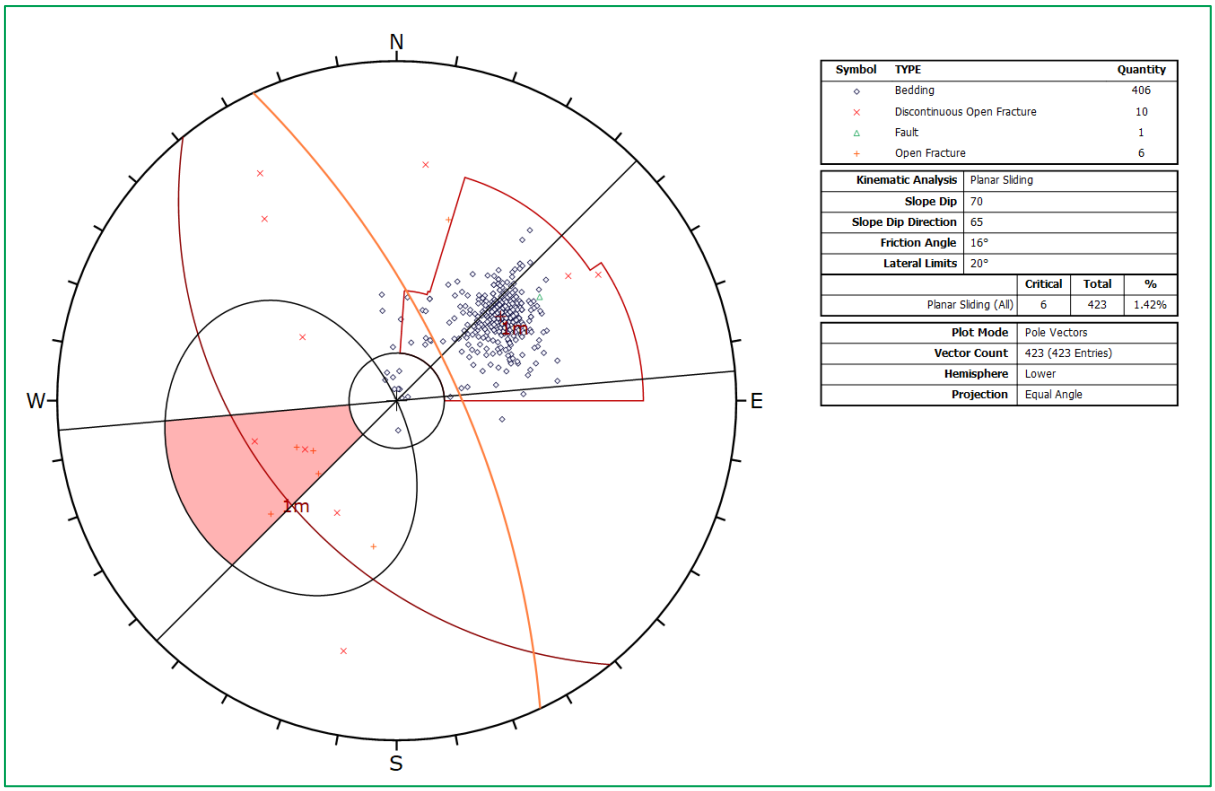
Symbol	TYPE	Quantity
◇	Bedding	406
×	Discontinuous Open Fracture	10
△	Fault	1
+	Open Fracture	6
Symbol	**Feature**	
▫	Critical Intersection	

Kinematic Analysis	Direct Toppling
Slope Dip	70
Slope Dip Direction	250
Friction Angle	16°
Lateral Limits	20°

	Critical	Total	%
Direct Toppling (Intersection)	40	89052	0.04%
Oblique Toppling (Intersection)	0	89052	0.00%
Base Plane (All)	227	423	53.66%
Base Plane (Set 1)	218	393	55.47%

Plot Mode	Pole Vectors
Vector Count	423 (423 Entries)
Intersection Mode	Grid Data Planes
Intersections Count	89052
Hemisphere	Lower
Projection	Equal Angle

Appendix B 6: Eastern Endwall, (Dip Direction @ 250°) – Direct Toppling



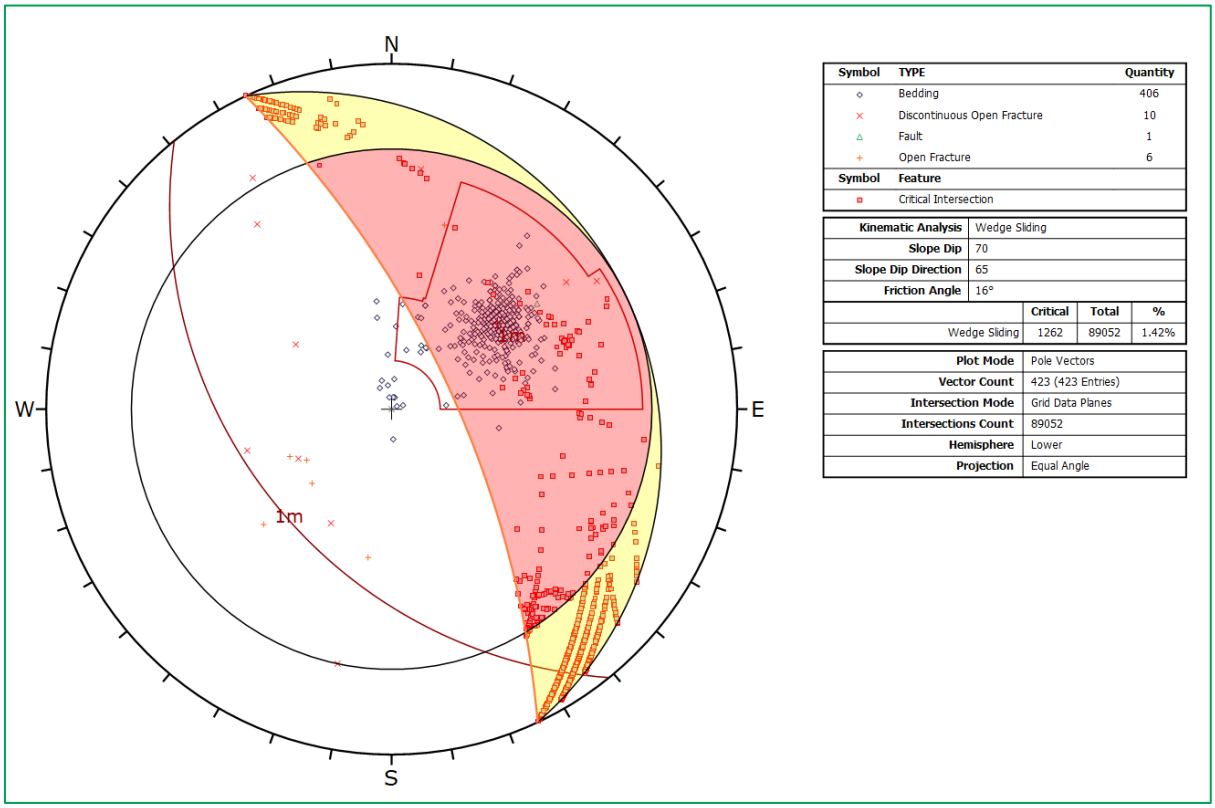
Symbol	TYPE	Quantity
◇	Bedding	406
×	Discontinuous Open Fracture	10
△	Fault	1
+	Open Fracture	6

Kinematic Analysis	Planar Sliding
Slope Dip	70
Slope Dip Direction	65
Friction Angle	16°
Lateral Limits	20°

	Critical	Total	%
Planar Sliding (All)	6	423	1.42%

Plot Mode	Pole Vectors
Vector Count	423 (423 Entries)
Hemisphere	Lower
Projection	Equal Angle

Appendix B 7: Western Endwall, (Dip Direction @ 65°) – Planar Sliding



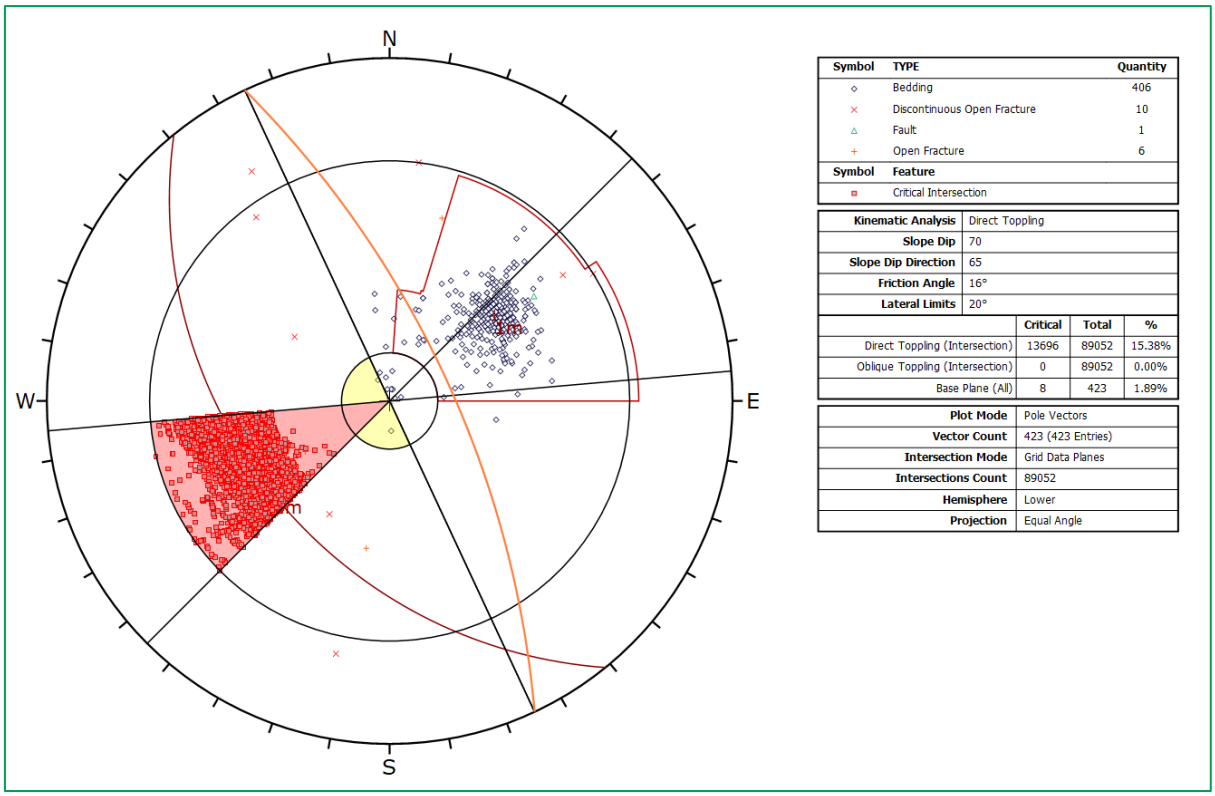
Symbol	TYPE	Quantity
◇	Bedding	406
×	Discontinuous Open Fracture	10
△	Fault	1
+	Open Fracture	6
Symbol	Feature	
▫	Critical Intersection	

Kinematic Analysis	Wedge Sliding
Slope Dip	70
Slope Dip Direction	65
Friction Angle	16°

	Critical	Total	%
Wedge Sliding	1262	89052	1.42%

Plot Mode	Pole Vectors
Vector Count	423 (423 Entries)
Intersection Mode	Grid Data Planes
Intersections Count	89052
Hemisphere	Lower
Projection	Equal Angle

Appendix B 8: Western Endwall, (Dip Direction @ 65°) – Wedge Sliding



Symbol	TYPE	Quantity
◇	Bedding	406
×	Discontinuous Open Fracture	10
△	Fault	1
+	Open Fracture	6
Symbol	**Feature**	
▫	Critical Intersection	

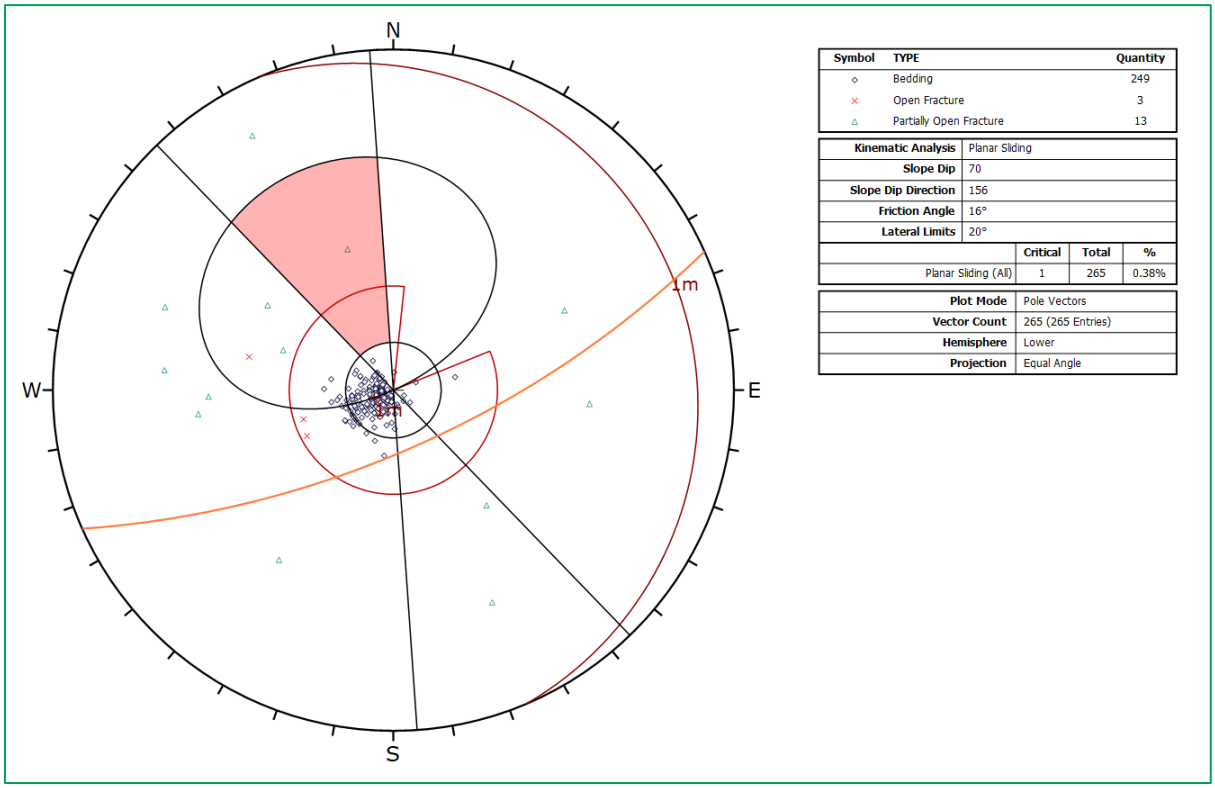
Kinematic Analysis	Direct Toppling
Slope Dip	70
Slope Dip Direction	65
Friction Angle	16°
Lateral Limits	20°

	Critical	Total	%
Direct Toppling (Intersection)	13696	89052	15.38%
Oblique Toppling (Intersection)	0	89052	0.00%
Base Plane (All)	8	423	1.89%

Plot Mode	Pole Vectors
Vector Count	423 (423 Entries)
Intersection Mode	Grid Data Planes
Intersections Count	89052
Hemisphere	Lower
Projection	Equal Angle

Appendix B 9: Western Endwall, (Dip Direction @ 65°) – Direct Toppling

BH ID: LDF0889A



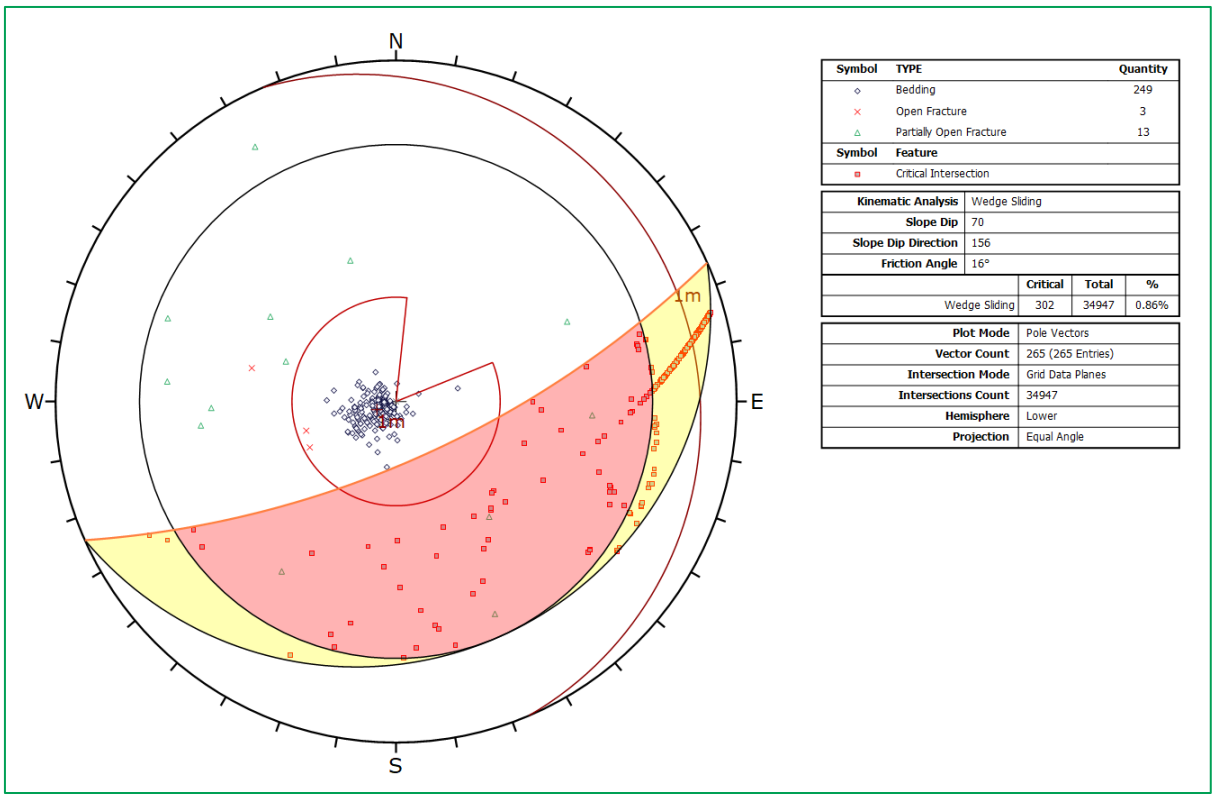
Symbol	TYPE	Quantity
◇	Bedding	249
×	Open Fracture	3
△	Partially Open Fracture	13

Kinematic Analysis	Planar Sliding
Slope Dip	70
Slope Dip Direction	156
Friction Angle	16°
Lateral Limits	20°

	Critical	Total	%
Planar Sliding (All)	1	265	0.38%

Plot Mode	Pole Vectors
Vector Count	265 (265 Entries)
Hemisphere	Lower
Projection	Equal Angle

Appendix B 10: Highwall (Dip Direction @ 156°) – Planar Sliding



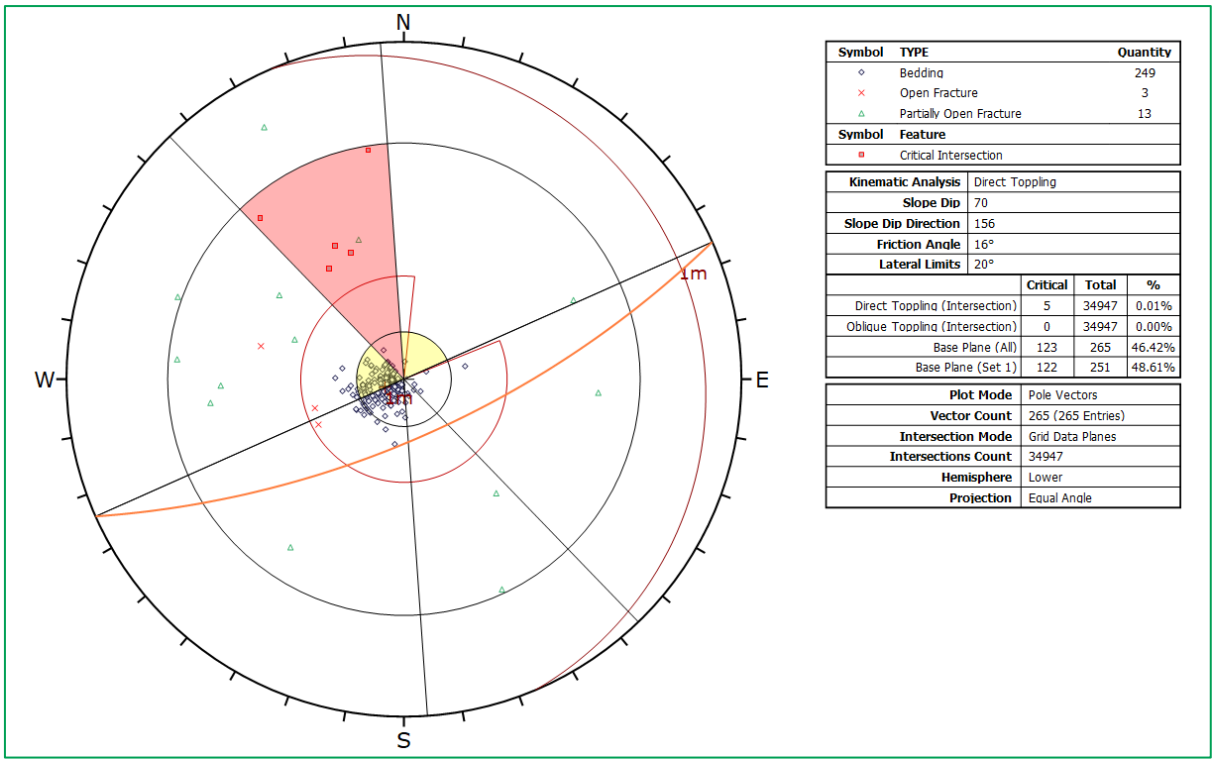
Symbol	TYPE	Quantity
◇	Bedding	249
×	Open Fracture	3
△	Partially Open Fracture	13
Symbol	Feature	
▫	Critical Intersection	

Kinematic Analysis	Wedge Sliding
Slope Dip	70
Slope Dip Direction	156
Friction Angle	16°

	Critical	Total	%
Wedge Sliding	302	34947	0.86%

Plot Mode	Pole Vectors
Vector Count	265 (265 Entries)
Intersection Mode	Grid Data Planes
Intersections Count	34947
Hemisphere	Lower
Projection	Equal Angle

Appendix B 11: Highwall (Dip Direction @ 156°) – Wedge Sliding



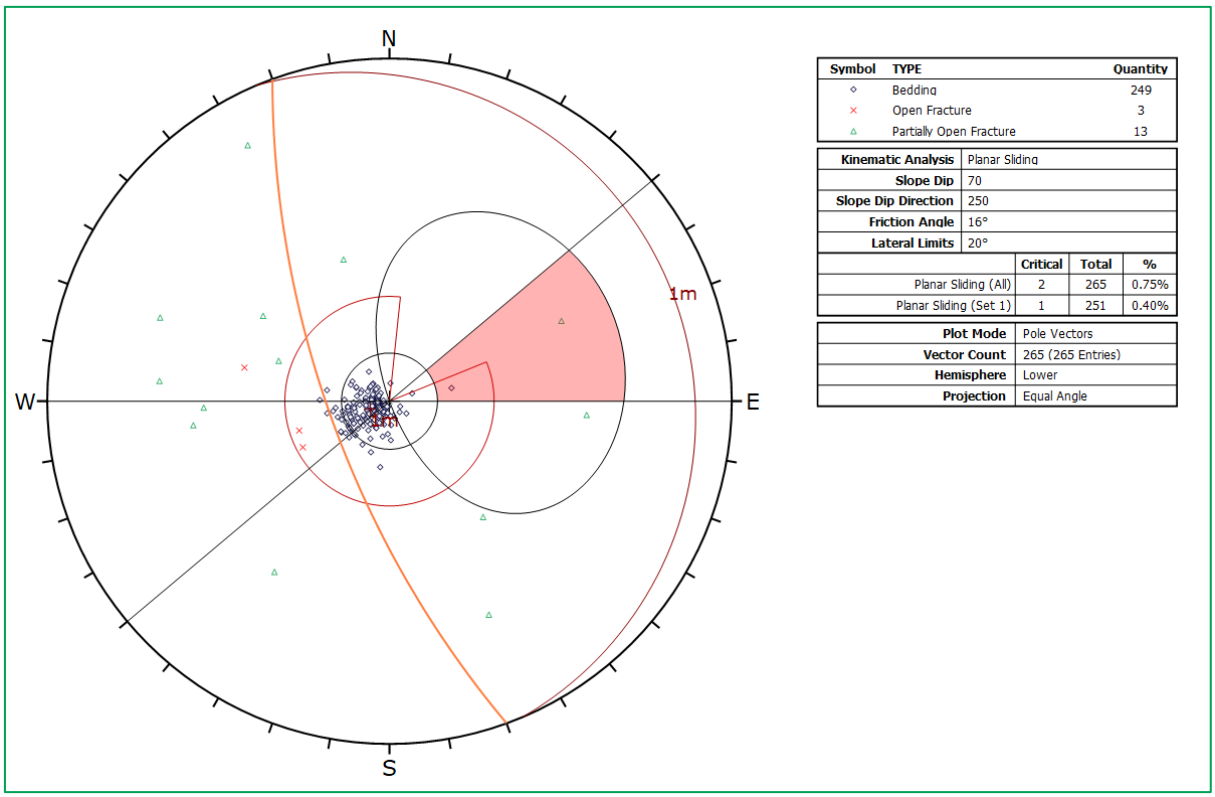
Symbol	TYPE	Quantity
◇	Bedding	249
×	Open Fracture	3
△	Partially Open Fracture	13
Symbol	**Feature**	
▫	Critical Intersection	

Kinematic Analysis	Direct Toppling
Slope Dip	70
Slope Dip Direction	156
Friction Angle	16°
Lateral Limits	20°

	Critical	Total	%
Direct Toppling (Intersection)	5	34947	0.01%
Oblique Toppling (Intersection)	0	34947	0.00%
Base Plane (All)	123	265	46.42%
Base Plane (Set 1)	122	251	48.61%

Plot Mode	Pole Vectors
Vector Count	265 (265 Entries)
Intersection Mode	Grid Data Planes
Intersections Count	34947
Hemisphere	Lower
Projection	Equal Angle

Appendix B 12: Highwall (Dip Direction @ 156°) – Direct Toppling



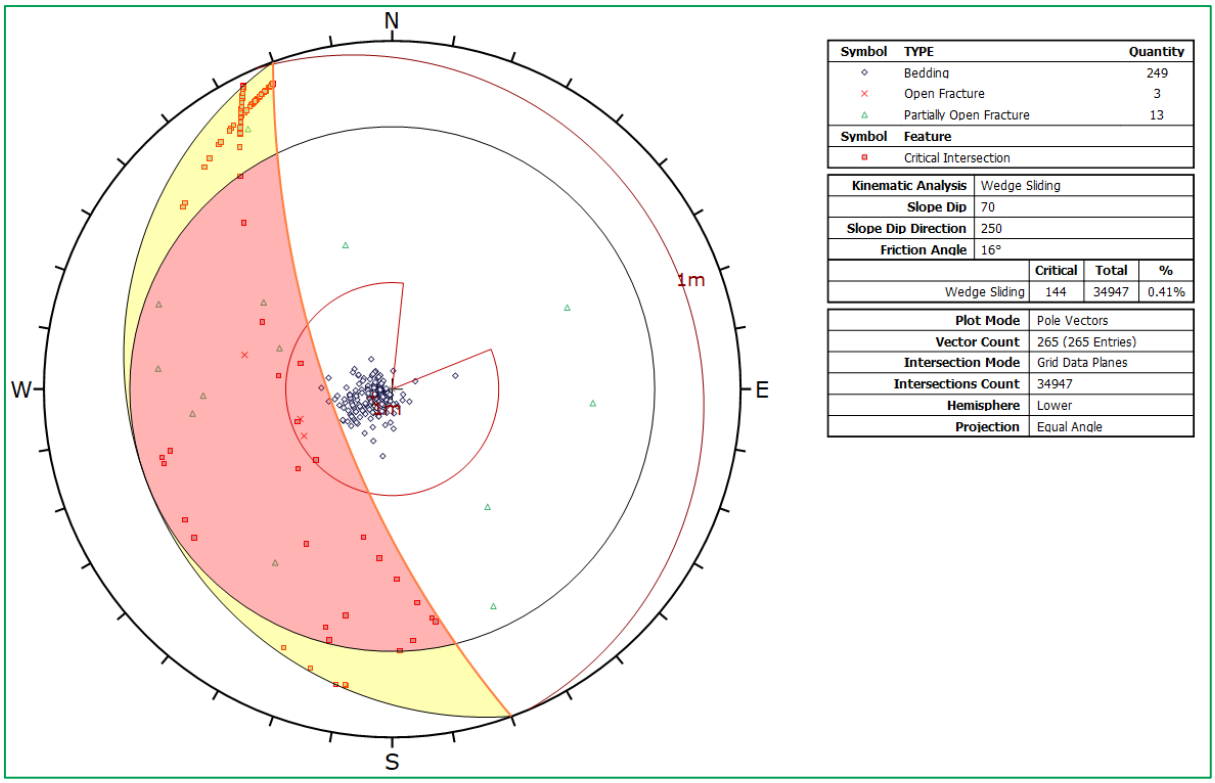
Symbol	TYPE	Quantity
◇	Bedding	249
×	Open Fracture	3
△	Partially Open Fracture	13

Kinematic Analysis	Planar Sliding
Slope Dip	70
Slope Dip Direction	250
Friction Angle	16°
Lateral Limits	20°

	Critical	Total	%
Planar Sliding (All)	2	265	0.75%
Planar Sliding (Set 1)	1	251	0.40%

Plot Mode	Pole Vectors
Vector Count	265 (265 Entries)
Hemisphere	Lower
Projection	Equal Angle

Appendix B 13: Eastern Endwall (Dip Direction @ 250°) – Planar Sliding



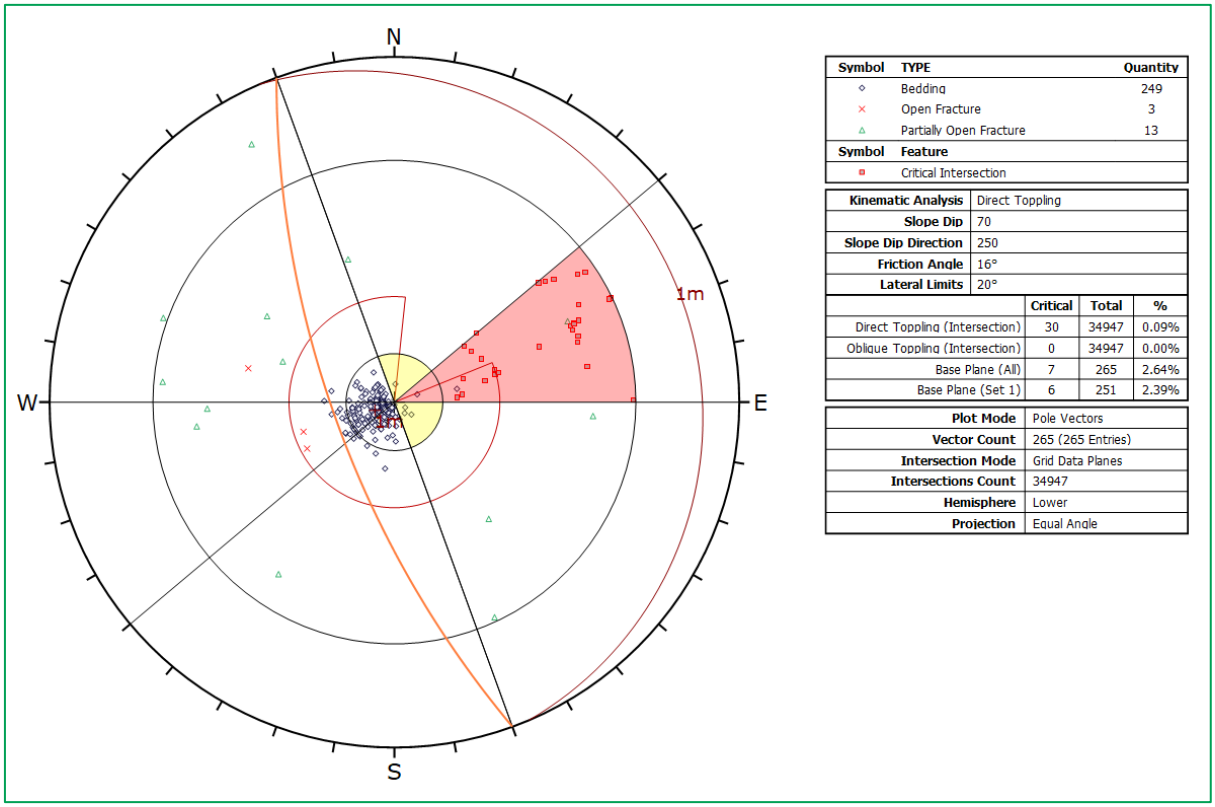
Symbol	TYPE	Quantity
◇	Bedding	249
×	Open Fracture	3
△	Partially Open Fracture	13
Symbol	**Feature**	
▫	Critical Intersection	

Kinematic Analysis	Wedge Sliding
Slope Dip	70
Slope Dip Direction	250
Friction Angle	16°

	Critical	Total	%
Wedge Sliding	144	34947	0.41%

Plot Mode	Pole Vectors
Vector Count	265 (265 Entries)
Intersection Mode	Grid Data Planes
Intersections Count	34947
Hemisphere	Lower
Projection	Equal Angle

Appendix B 14: Eastern Endwall (Dip Direction @ 250°) – Wedge Sliding



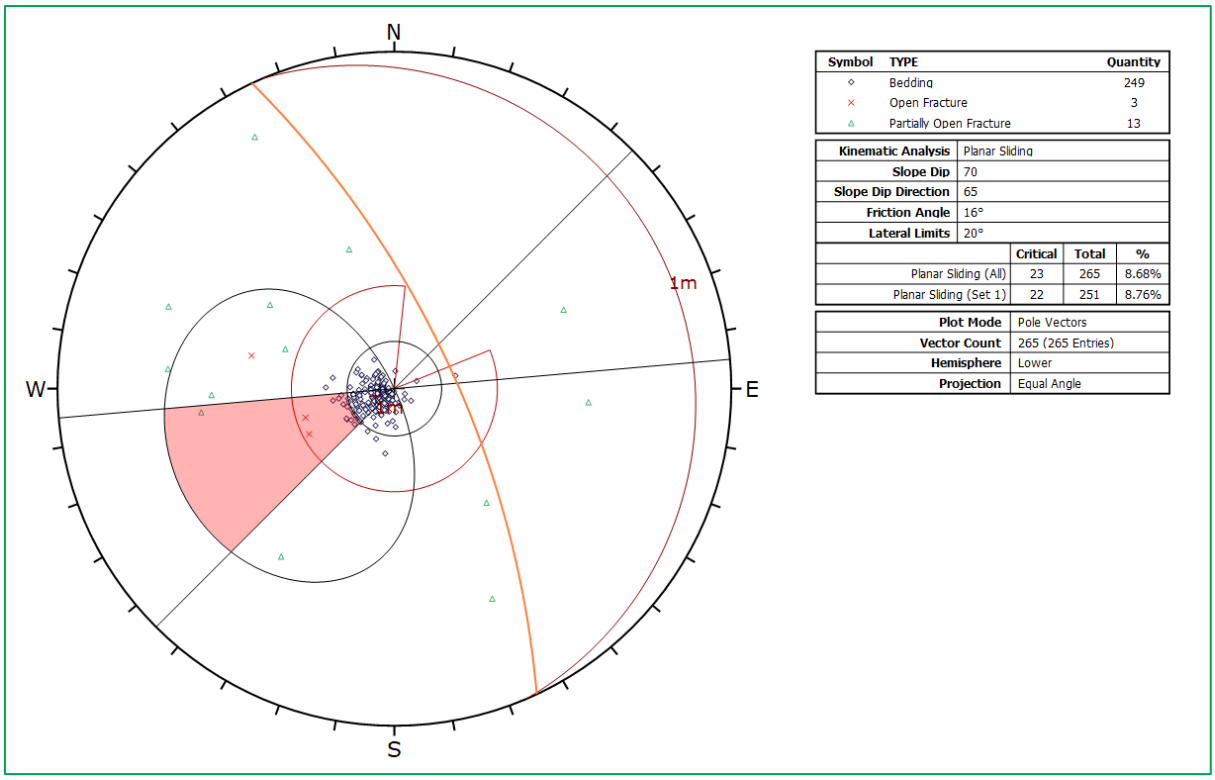
Symbol	TYPE	Quantity
◇	Bedding	249
×	Open Fracture	3
△	Partially Open Fracture	13
Symbol	**Feature**	
▫	Critical Intersection	

Kinematic Analysis	Direct Toppling
Slope Dip	70
Slope Dip Direction	250
Friction Angle	16°
Lateral Limits	20°

	Critical	Total	%
Direct Toppling (Intersection)	30	34947	0.09%
Oblique Toppling (Intersection)	0	34947	0.00%
Base Plane (All)	7	265	2.64%
Base Plane (Set 1)	6	251	2.39%

Plot Mode	Pole Vectors
Vector Count	265 (265 Entries)
Intersection Mode	Grid Data Planes
Intersections Count	34947
Hemisphere	Lower
Projection	Equal Angle

Appendix B 15: Eastern Endwall (Dip Direction @ 250°) – Direct Toppling



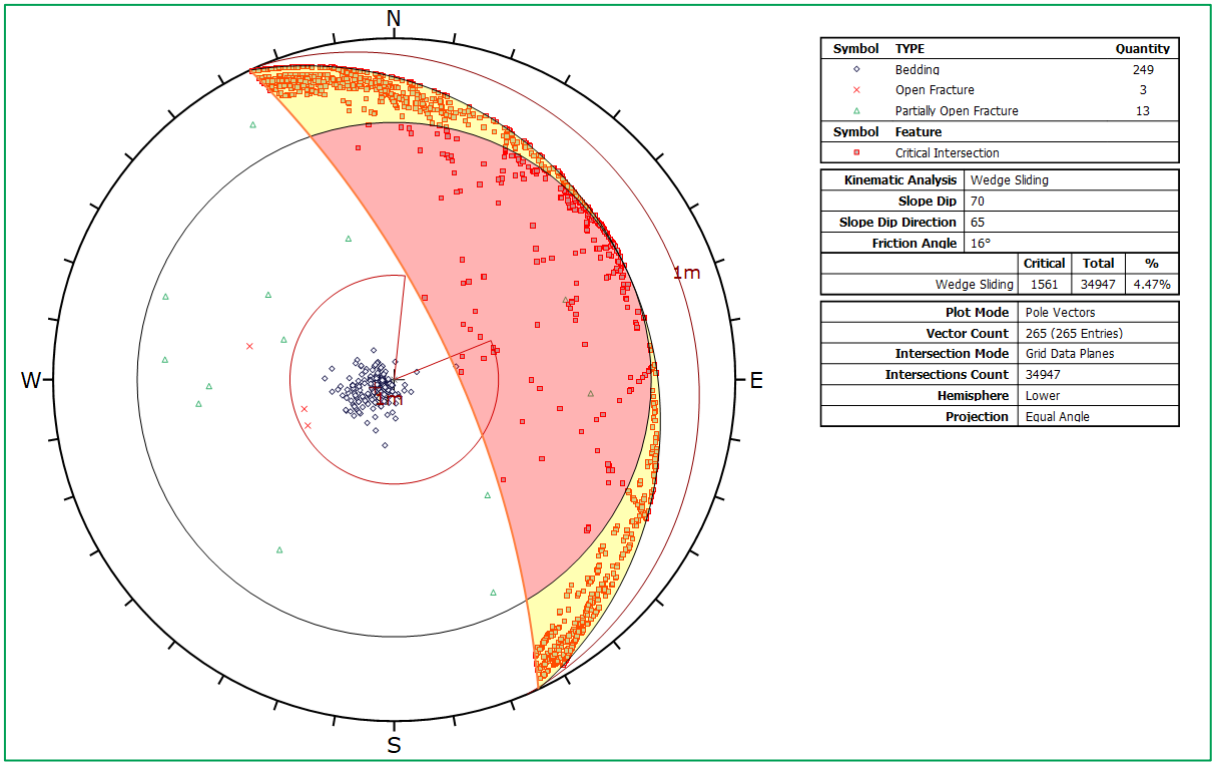
Symbol	TYPE	Quantity
◇	Bedding	249
×	Open Fracture	3
△	Partially Open Fracture	13

Kinematic Analysis	Planar Sliding
Slope Dip	70
Slope Dip Direction	65
Friction Angle	16°
Lateral Limits	20°

	Critical	Total	%
Planar Sliding (All)	23	265	8.68%
Planar Sliding (Set 1)	22	251	8.76%

Plot Mode	Pole Vectors
Vector Count	265 (265 Entries)
Hemisphere	Lower
Projection	Equal Angle

Appendix B 16: Western Endwall (Dip Direction @ 65°) – Planar Sliding



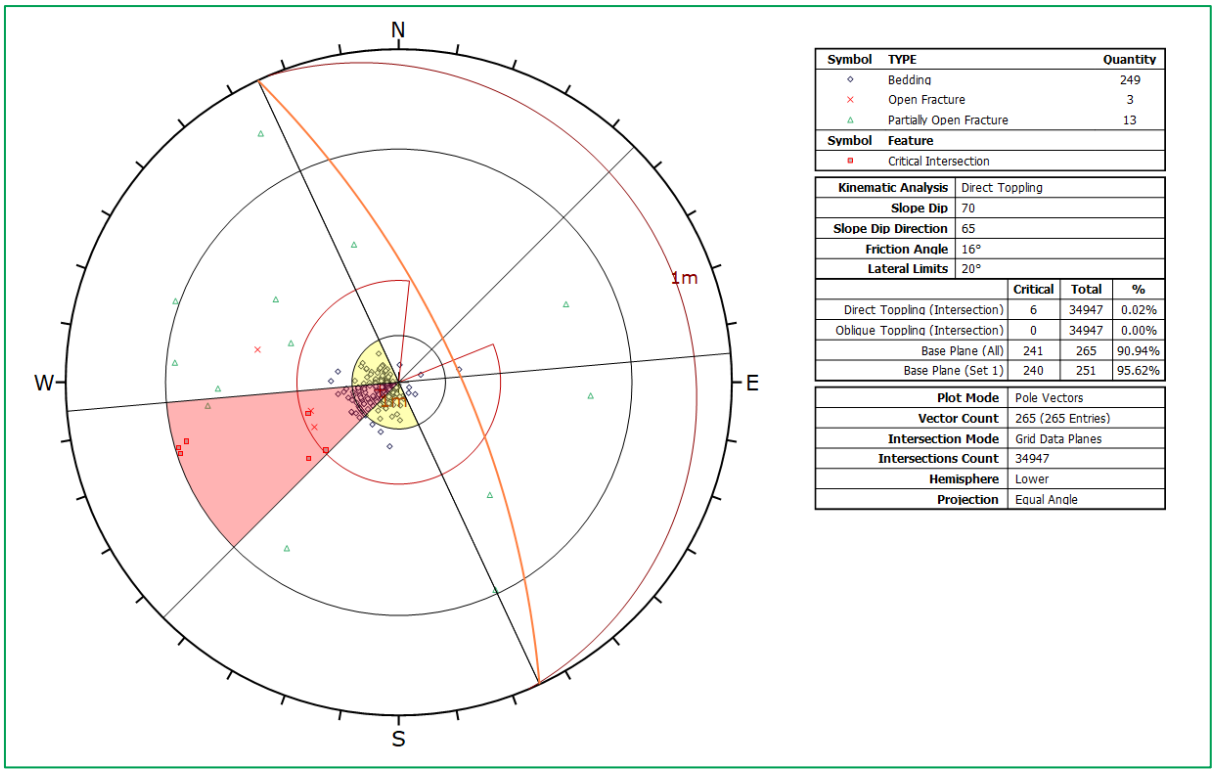
Symbol	TYPE	Quantity
◇	Bedding	249
×	Open Fracture	3
△	Partially Open Fracture	13
Symbol	Feature	
▫	Critical Intersection	

Kinematic Analysis	Wedge Sliding
Slope Dip	70
Slope Dip Direction	65
Friction Angle	16°

	Critical	Total	%
Wedge Sliding	1561	34947	4.47%

Plot Mode	Pole Vectors
Vector Count	265 (265 Entries)
Intersection Mode	Grid Data Planes
Intersections Count	34947
Hemisphere	Lower
Projection	Equal Angle

Appendix B 17: Western Endwall (Dip Direction @ 65°) – Wedge Sliding



Symbol	TYPE	Quantity
◇	Bedding	249
×	Open Fracture	3
△	Partially Open Fracture	13
Symbol	**Feature**	
▫	Critical Intersection	

Kinematic Analysis	Direct Toppling
Slope Dip	70
Slope Dip Direction	65
Friction Angle	16°
Lateral Limits	20°

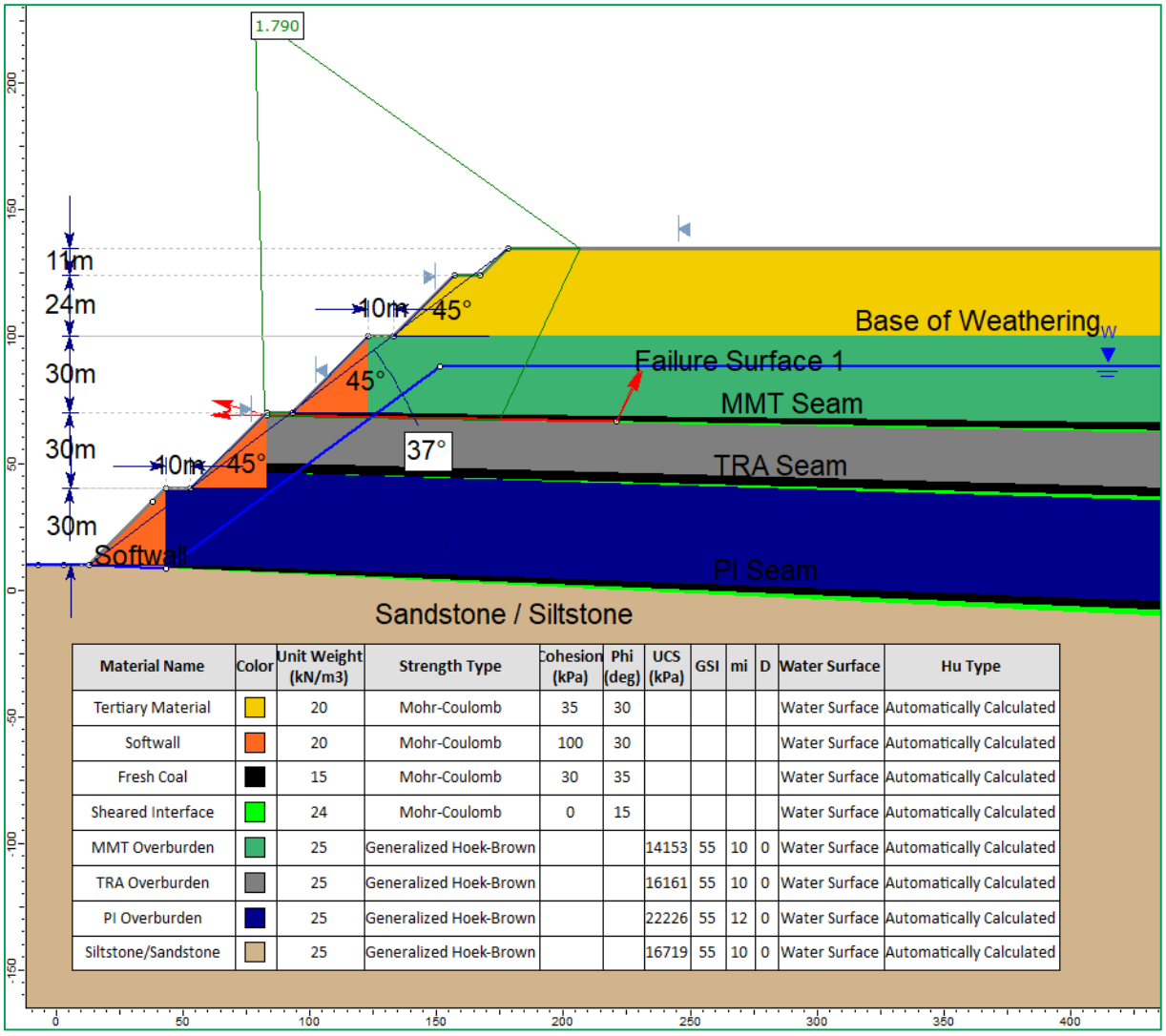
	Critical	Total	%
Direct Toppling (Intersection)	6	34947	0.02%
Oblique Toppling (Intersection)	0	34947	0.00%
Base Plane (All)	241	265	90.94%
Base Plane (Set 1)	240	251	95.62%

Plot Mode	Pole Vectors
Vector Count	265 (265 Entries)
Intersection Mode	Grid Data Planes
Intersections Count	34947
Hemisphere	Lower
Projection	Equal Angle

Appendix B 18: Western Endwall (Dip Direction @ 65°) – Direct Toppling

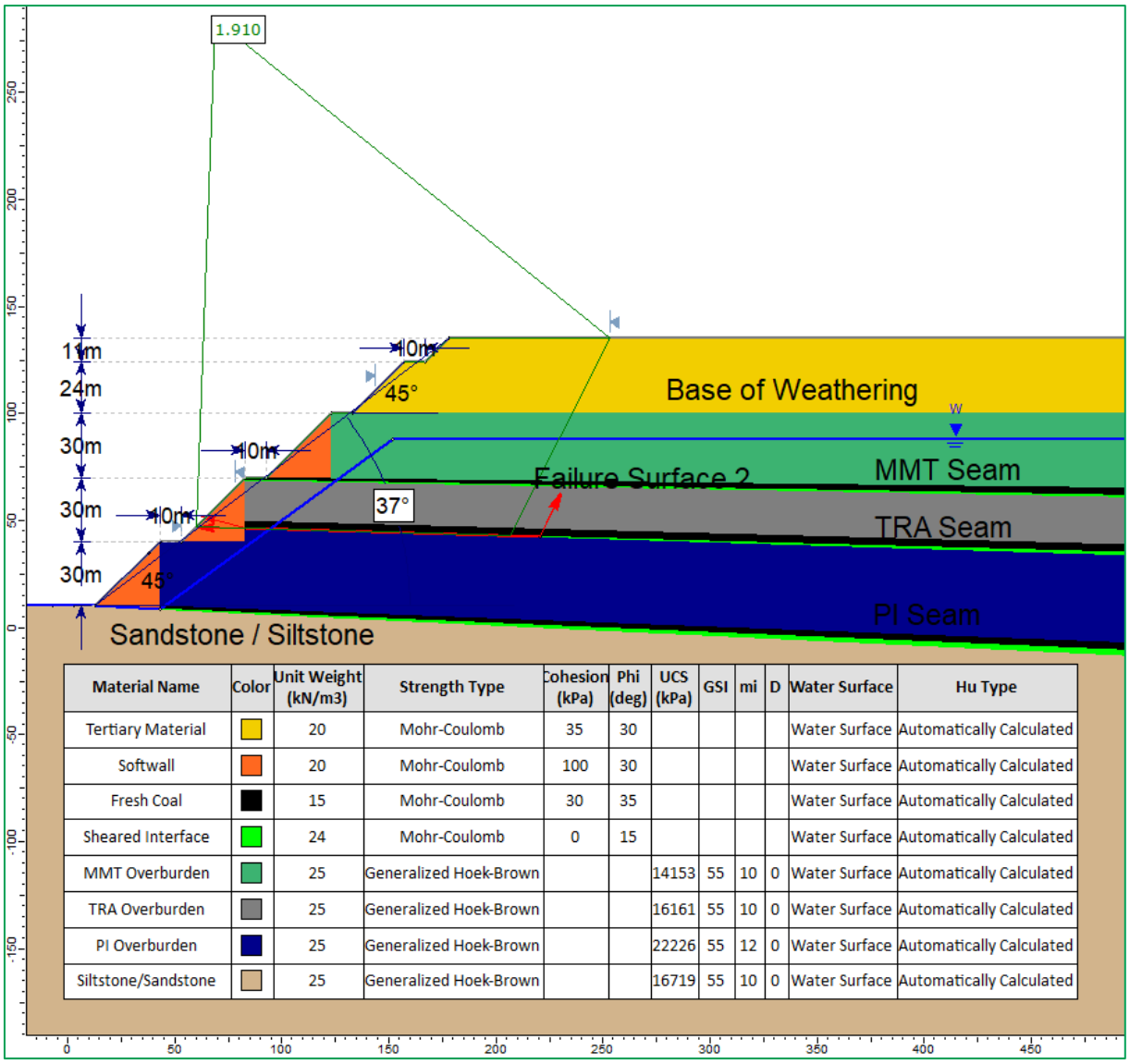
Appendix D: Pictorial View of Slope Stability Analysis

Fox Plains



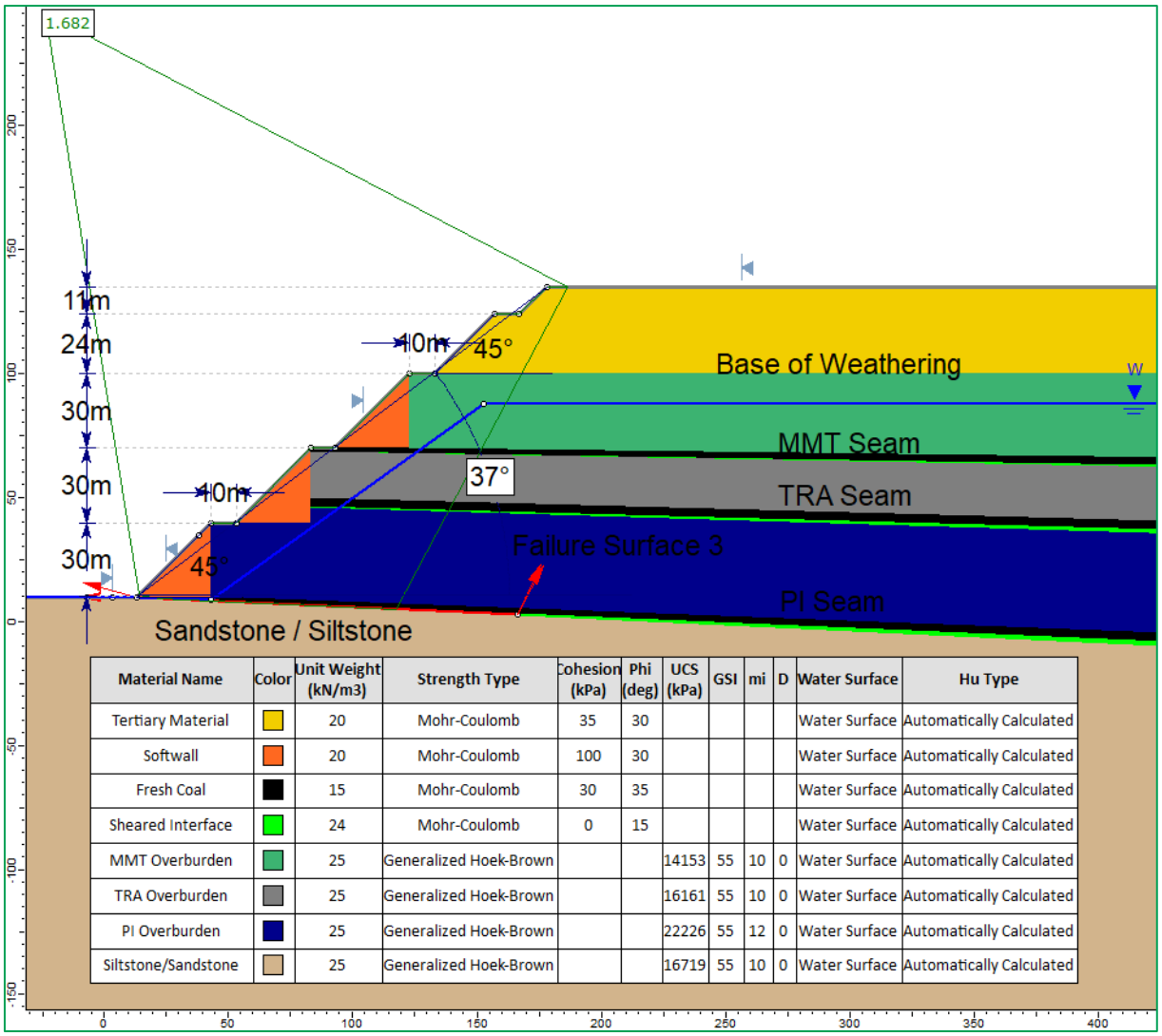
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	GSI	mi	D	Water Surface	Hu Type
Tertiary Material		20	Mohr-Coulomb	35	30					Water Surface	Automatically Calculated
Softwall		20	Mohr-Coulomb	100	30					Water Surface	Automatically Calculated
Fresh Coal		15	Mohr-Coulomb	30	35					Water Surface	Automatically Calculated
Sheared Interface		24	Mohr-Coulomb	0	15					Water Surface	Automatically Calculated
MMT Overburden		25	Generalized Hoek-Brown			14153	55	10	0	Water Surface	Automatically Calculated
TRA Overburden		25	Generalized Hoek-Brown			16161	55	10	0	Water Surface	Automatically Calculated
PI Overburden		25	Generalized Hoek-Brown			22226	55	12	0	Water Surface	Automatically Calculated
Siltstone/Sandstone		25	Generalized Hoek-Brown			16719	55	10	0	Water Surface	Automatically Calculated

Appendix C 19: Potential Block Failure Mechanism in Proposed Highwall Design with Shear Contact – Sarma (Block Search 1)



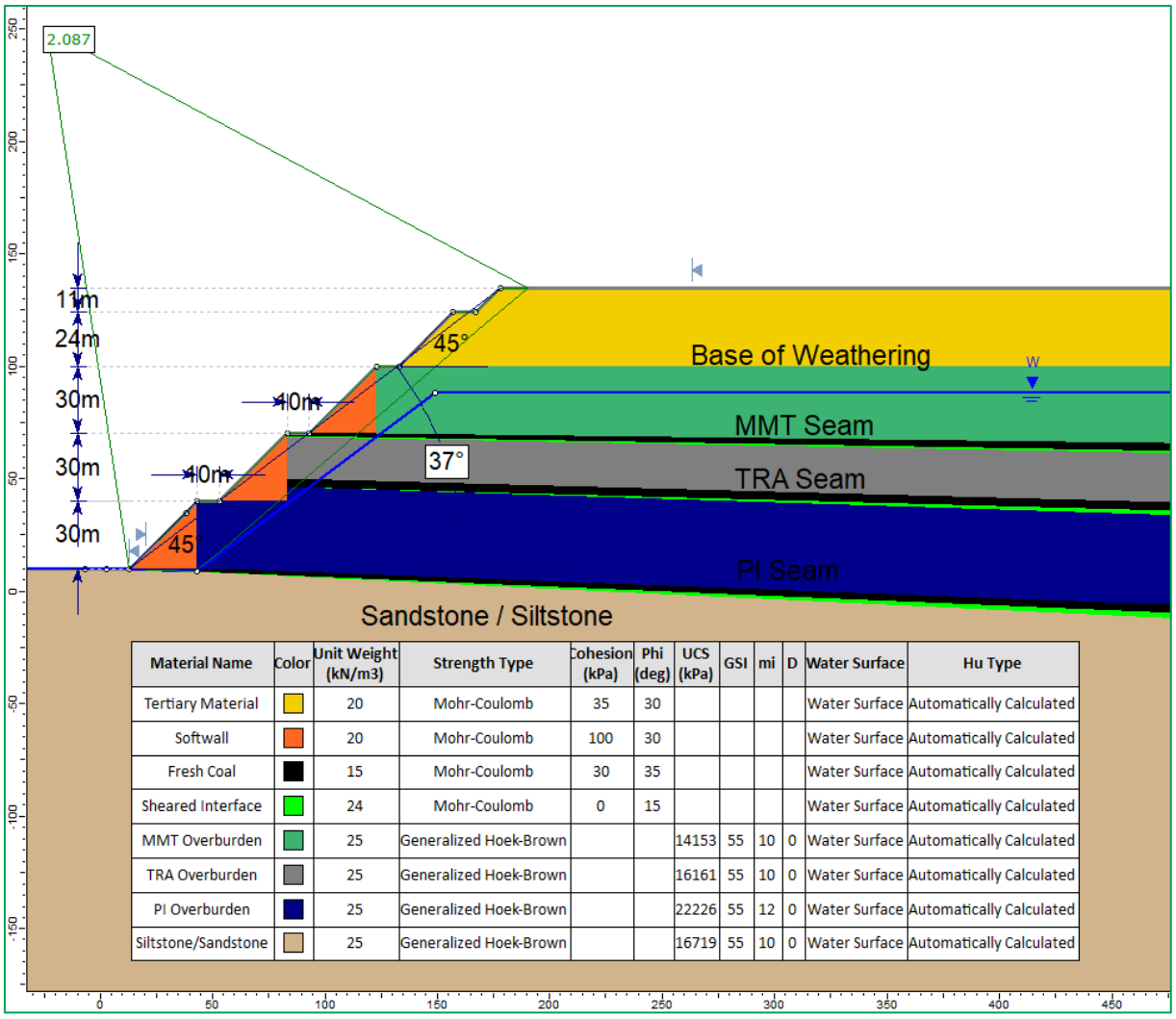
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	GSI	mi	D	Water Surface	Hu Type
Tertiary Material		20	Mohr-Coulomb	35	30					Water Surface	Automatically Calculated
Softwall		20	Mohr-Coulomb	100	30					Water Surface	Automatically Calculated
Fresh Coal		15	Mohr-Coulomb	30	35					Water Surface	Automatically Calculated
Sheared Interface		24	Mohr-Coulomb	0	15					Water Surface	Automatically Calculated
MMT Overburden		25	Generalized Hoek-Brown			14153	55	10	0	Water Surface	Automatically Calculated
TRA Overburden		25	Generalized Hoek-Brown			16161	55	10	0	Water Surface	Automatically Calculated
PI Overburden		25	Generalized Hoek-Brown			22226	55	12	0	Water Surface	Automatically Calculated
Siltstone/Sandstone		25	Generalized Hoek-Brown			16719	55	10	0	Water Surface	Automatically Calculated

Appendix C 20: Potential Block Failure Mechanism in Proposed Highwall Design with Shear Contact – Sarma (Block Search 2)



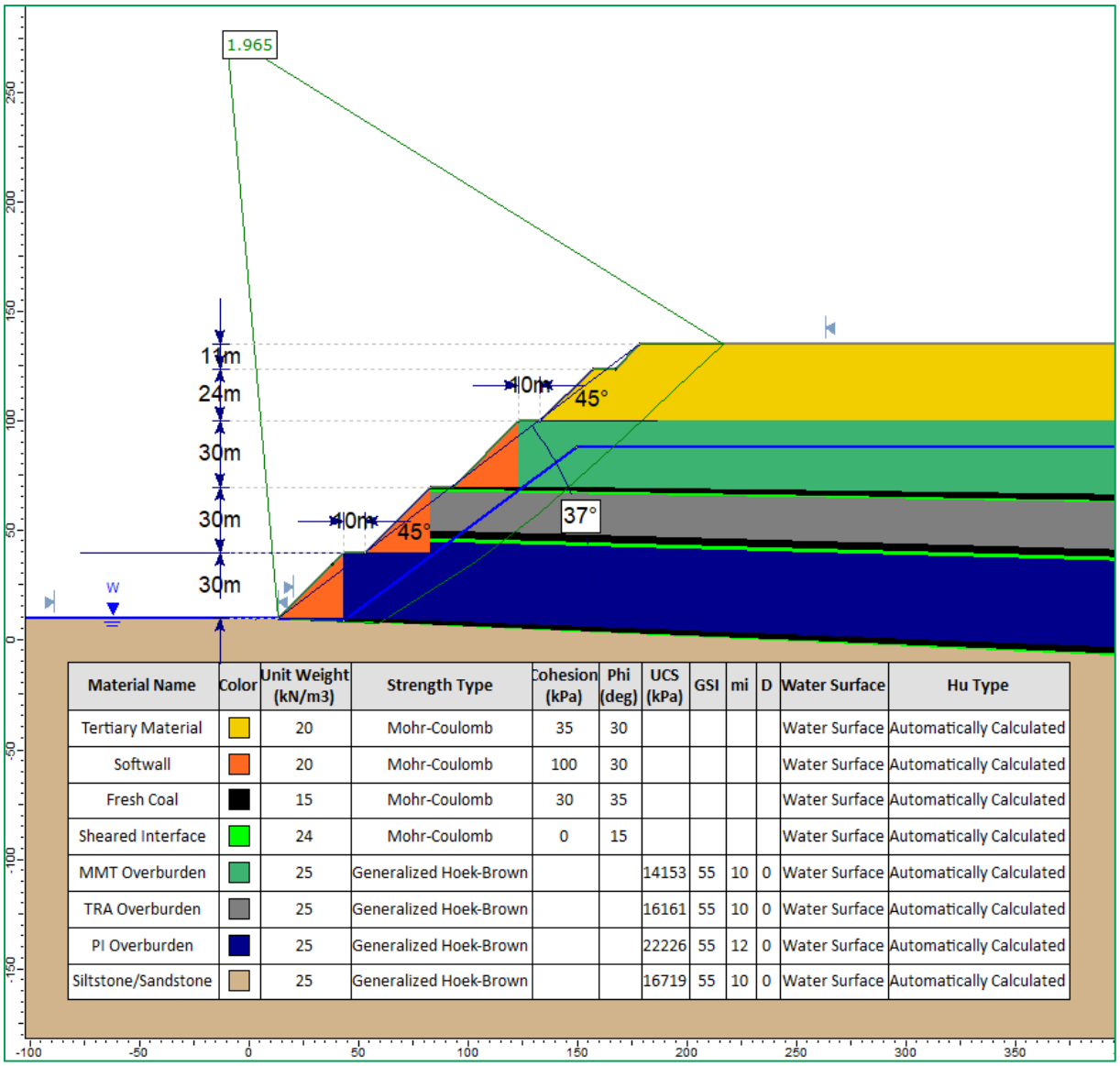
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	GSI	mi	D	Water Surface	Hu Type
Tertiary Material		20	Mohr-Coulomb	35	30					Water Surface	Automatically Calculated
Softwall		20	Mohr-Coulomb	100	30					Water Surface	Automatically Calculated
Fresh Coal		15	Mohr-Coulomb	30	35					Water Surface	Automatically Calculated
Sheared Interface		24	Mohr-Coulomb	0	15					Water Surface	Automatically Calculated
MMT Overburden		25	Generalized Hoek-Brown			14153	55	10	0	Water Surface	Automatically Calculated
TRA Overburden		25	Generalized Hoek-Brown			16161	55	10	0	Water Surface	Automatically Calculated
PI Overburden		25	Generalized Hoek-Brown			22226	55	12	0	Water Surface	Automatically Calculated
Siltstone/Sandstone		25	Generalized Hoek-Brown			16719	55	10	0	Water Surface	Automatically Calculated

Appendix C 21: Potential Block Failure Mechanism in Proposed Highwall Design with Shear Contact – Sarma (Block Search 3)



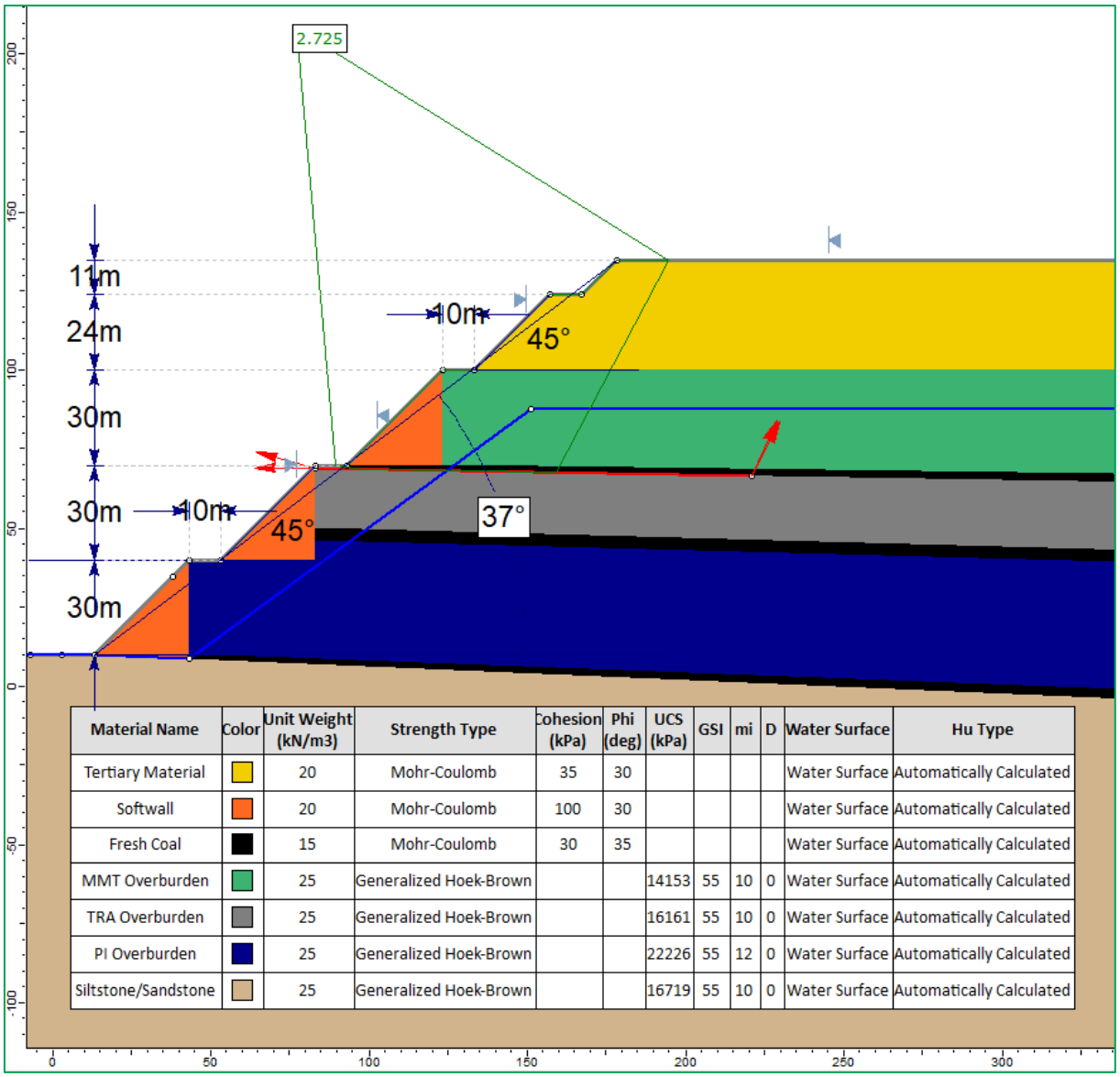
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	GSI	mi	D	Water Surface	Hu Type
Tertiary Material		20	Mohr-Coulomb	35	30					Water Surface	Automatically Calculated
Softwall		20	Mohr-Coulomb	100	30					Water Surface	Automatically Calculated
Fresh Coal		15	Mohr-Coulomb	30	35					Water Surface	Automatically Calculated
Sheared Interface		24	Mohr-Coulomb	0	15					Water Surface	Automatically Calculated
MMT Overburden		25	Generalized Hoek-Brown			14153	55	10	0	Water Surface	Automatically Calculated
TRA Overburden		25	Generalized Hoek-Brown			16161	55	10	0	Water Surface	Automatically Calculated
PI Overburden		25	Generalized Hoek-Brown			22226	55	12	0	Water Surface	Automatically Calculated
Siltstone/Sandstone		25	Generalized Hoek-Brown			16719	55	10	0	Water Surface	Automatically Calculated

Appendix C 22: Potential Block Failure Mechanism in Proposed Highwall Design with Shear Contact – Sarma (Global Stability - Cuckoo Search)



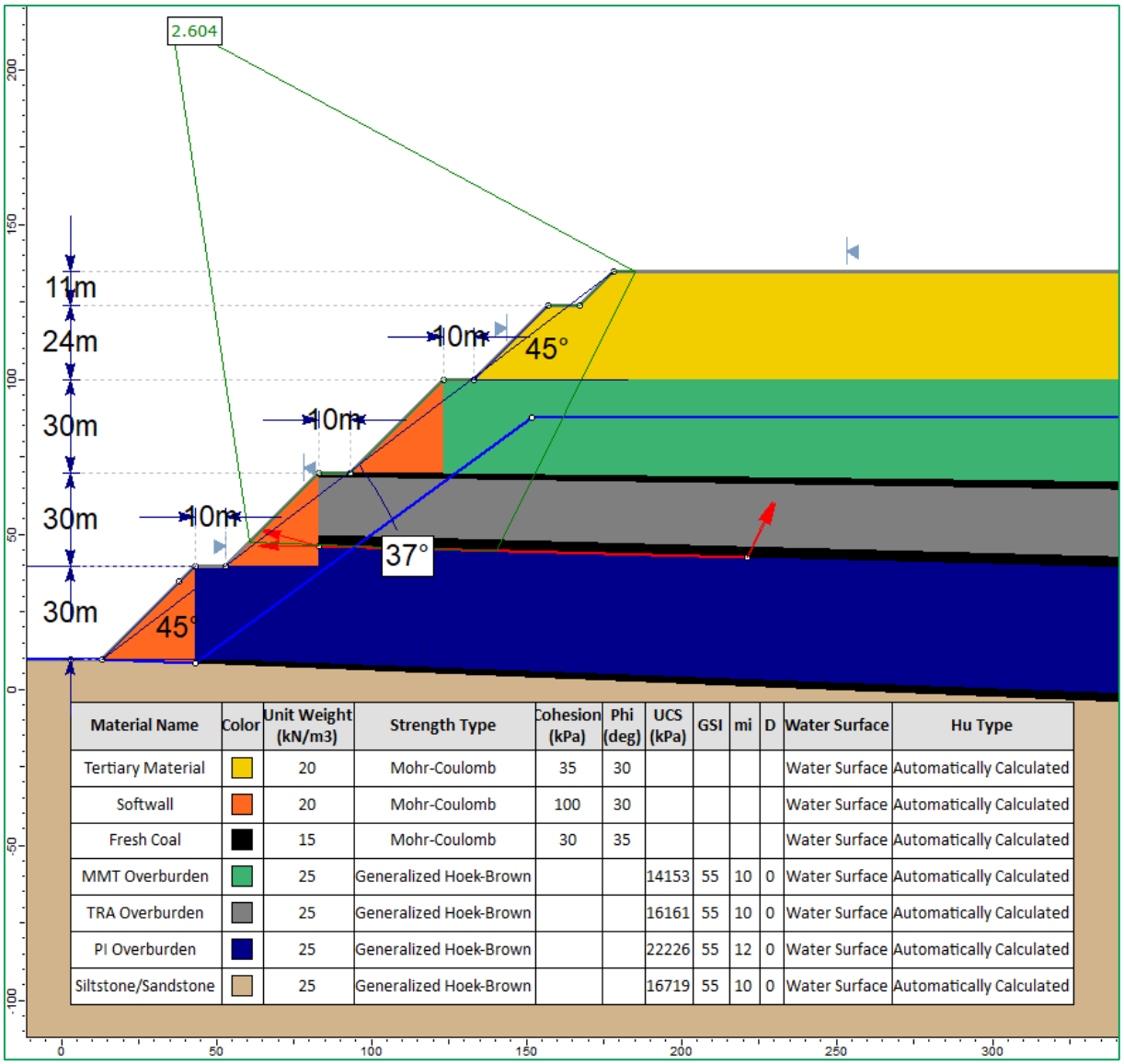
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	GSI	mi	D	Water Surface	Hu Type
Tertiary Material		20	Mohr-Coulomb	35	30					Water Surface	Automatically Calculated
Softwall		20	Mohr-Coulomb	100	30					Water Surface	Automatically Calculated
Fresh Coal		15	Mohr-Coulomb	30	35					Water Surface	Automatically Calculated
Sheared Interface		24	Mohr-Coulomb	0	15					Water Surface	Automatically Calculated
MMT Overburden		25	Generalized Hoek-Brown			14153	55	10	0	Water Surface	Automatically Calculated
TRA Overburden		25	Generalized Hoek-Brown			16161	55	10	0	Water Surface	Automatically Calculated
PI Overburden		25	Generalized Hoek-Brown			22226	55	12	0	Water Surface	Automatically Calculated
Siltstone/Sandstone		25	Generalized Hoek-Brown			16719	55	10	0	Water Surface	Automatically Calculated

Appendix C 23: Potential Block Failure Mechanism in Proposed Highwall Design with Shear Contact – Spencer (Global Stability – Cuckoo Search)



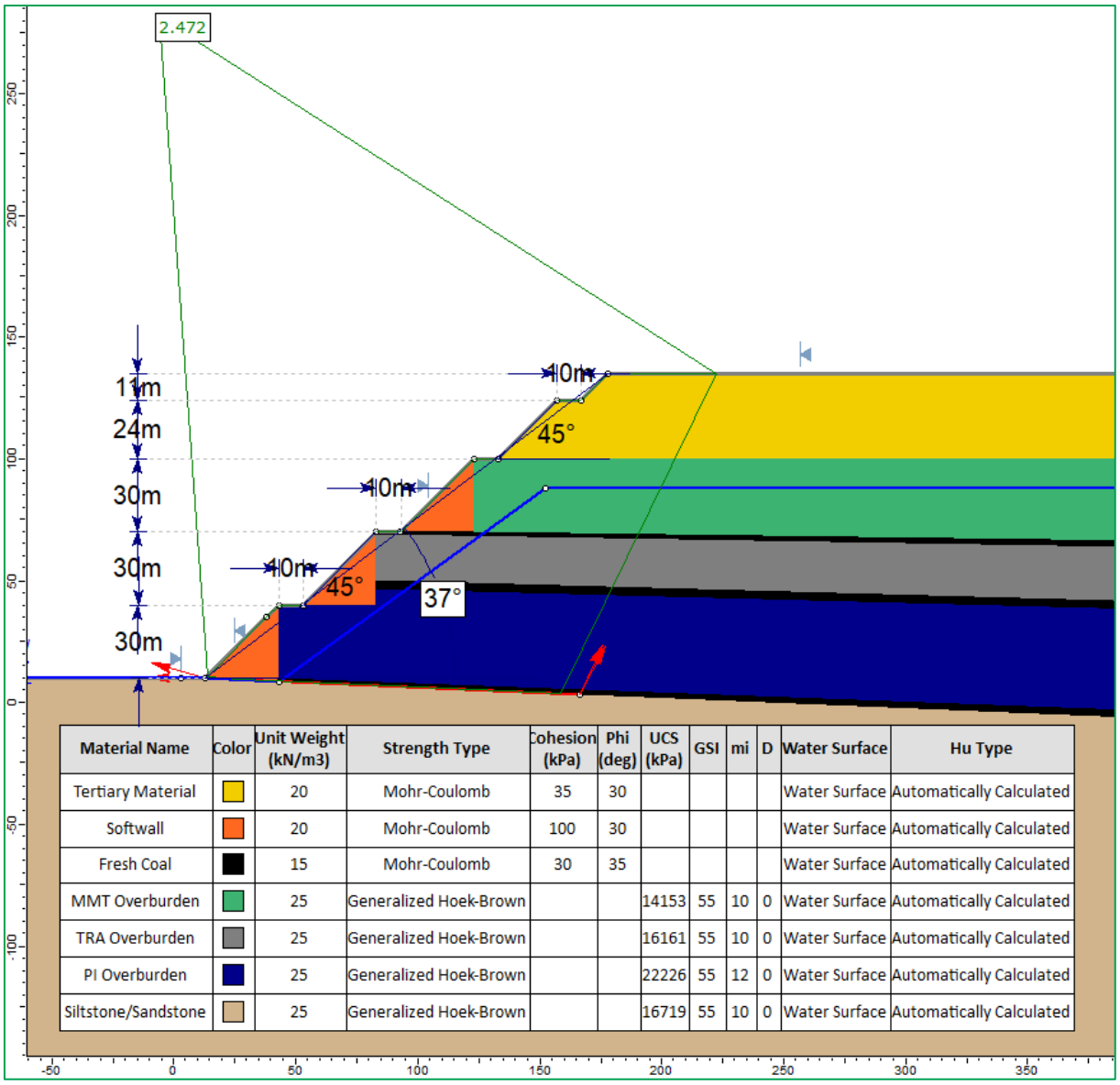
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	GSI	mi	D	Water Surface	Hu Type
Tertiary Material		20	Mohr-Coulomb	35	30					Water Surface	Automatically Calculated
Softwall		20	Mohr-Coulomb	100	30					Water Surface	Automatically Calculated
Fresh Coal		15	Mohr-Coulomb	30	35					Water Surface	Automatically Calculated
MMT Overburden		25	Generalized Hoek-Brown			14153	55	10	0	Water Surface	Automatically Calculated
TRA Overburden		25	Generalized Hoek-Brown			16161	55	10	0	Water Surface	Automatically Calculated
PI Overburden		25	Generalized Hoek-Brown			22226	55	12	0	Water Surface	Automatically Calculated
Siltstone/Sandstone		25	Generalized Hoek-Brown			16719	55	10	0	Water Surface	Automatically Calculated

Appendix C 24: Potential Block Failure Mechanism in Proposed Highwall Design without Shear Contact – Sarma (Block Search 1)



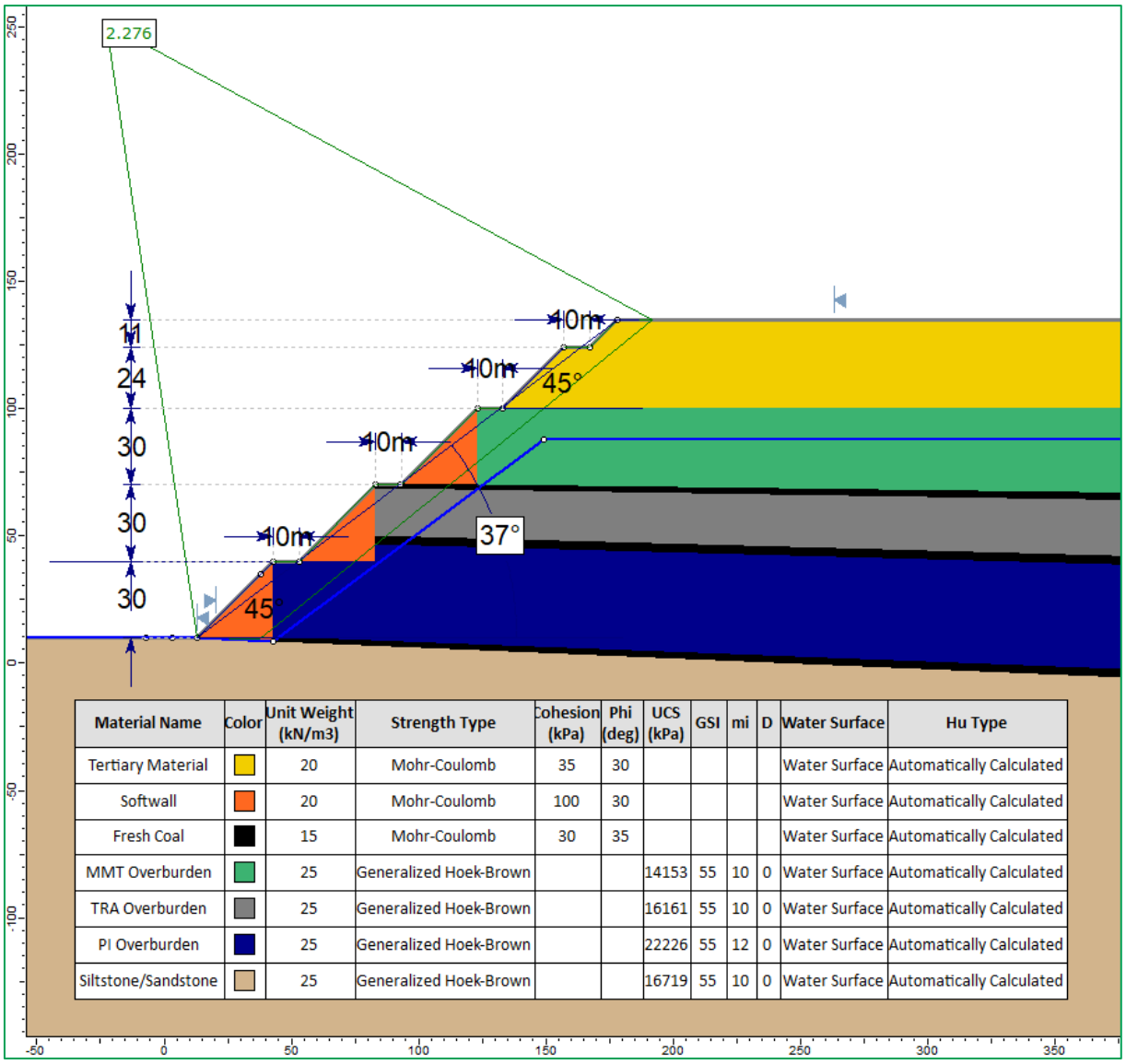
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	GSI	mi	D	Water Surface	Hu Type
Tertiary Material		20	Mohr-Coulomb	35	30					Water Surface	Automatically Calculated
Softwall		20	Mohr-Coulomb	100	30					Water Surface	Automatically Calculated
Fresh Coal		15	Mohr-Coulomb	30	35					Water Surface	Automatically Calculated
MMT Overburden		25	Generalized Hoek-Brown			14153	55	10	0	Water Surface	Automatically Calculated
TRA Overburden		25	Generalized Hoek-Brown			16161	55	10	0	Water Surface	Automatically Calculated
PI Overburden		25	Generalized Hoek-Brown			22226	55	12	0	Water Surface	Automatically Calculated
Siltstone/Sandstone		25	Generalized Hoek-Brown			16719	55	10	0	Water Surface	Automatically Calculated

Appendix C 25: Potential Block Failure Mechanism in Proposed Highwall Design without Shear Contact – Sarma (Block Search 2)



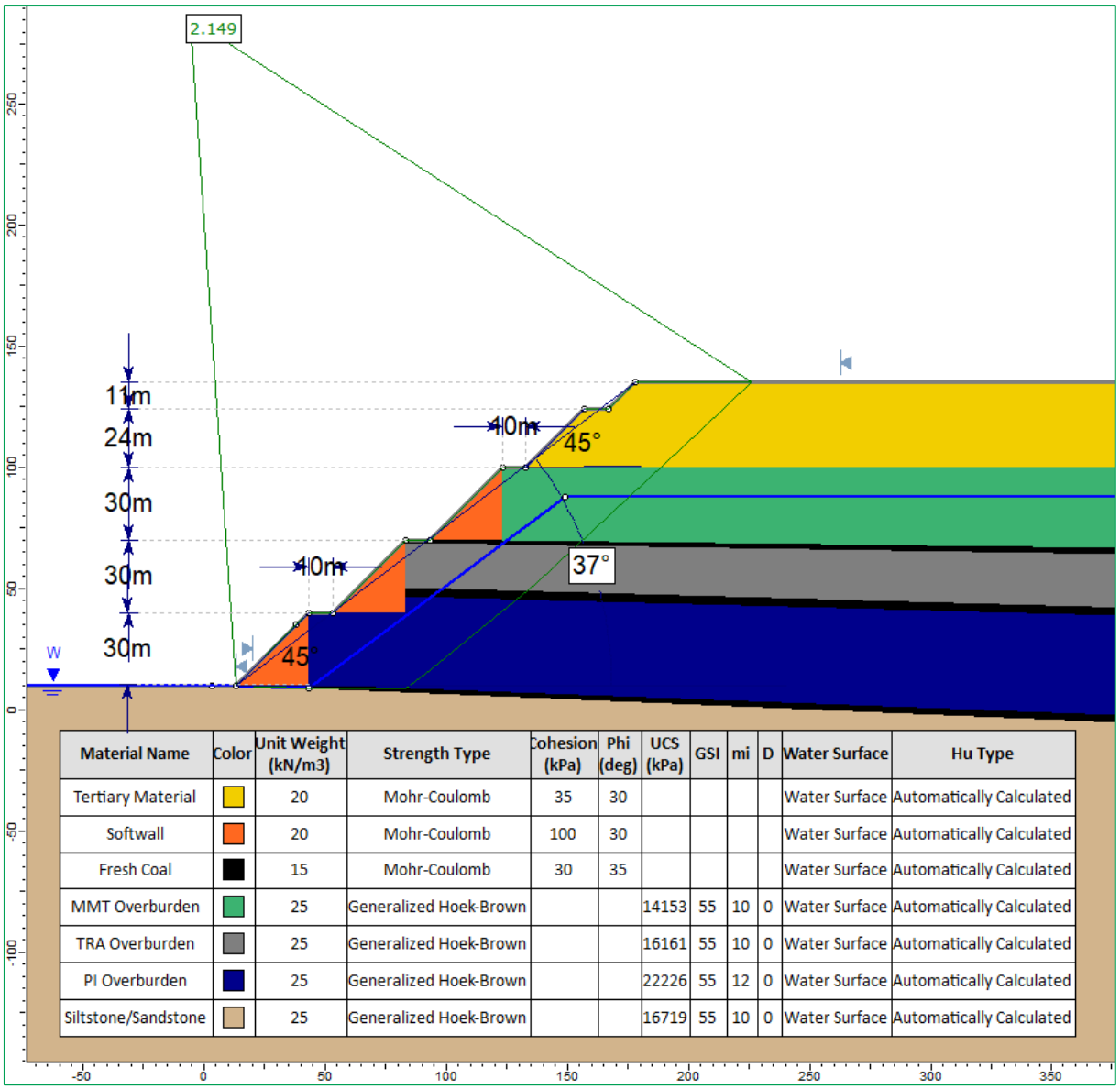
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	GSI	mi	D	Water Surface	Hu Type
Tertiary Material		20	Mohr-Coulomb	35	30					Water Surface	Automatically Calculated
Softwall		20	Mohr-Coulomb	100	30					Water Surface	Automatically Calculated
Fresh Coal		15	Mohr-Coulomb	30	35					Water Surface	Automatically Calculated
MMT Overburden		25	Generalized Hoek-Brown			14153	55	10	0	Water Surface	Automatically Calculated
TRA Overburden		25	Generalized Hoek-Brown			16161	55	10	0	Water Surface	Automatically Calculated
PI Overburden		25	Generalized Hoek-Brown			22226	55	12	0	Water Surface	Automatically Calculated
Siltstone/Sandstone		25	Generalized Hoek-Brown			16719	55	10	0	Water Surface	Automatically Calculated

Appendix C 26: Potential Block Failure Mechanism in Proposed Highwall Geometry without Shear Contact – Sarma (Block Search 3)



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	GSI	mi	D	Water Surface	Hu Type
Tertiary Material		20	Mohr-Coulomb	35	30					Water Surface	Automatically Calculated
Softwall		20	Mohr-Coulomb	100	30					Water Surface	Automatically Calculated
Fresh Coal		15	Mohr-Coulomb	30	35					Water Surface	Automatically Calculated
MMT Overburden		25	Generalized Hoek-Brown			14153	55	10	0	Water Surface	Automatically Calculated
TRA Overburden		25	Generalized Hoek-Brown			16161	55	10	0	Water Surface	Automatically Calculated
PI Overburden		25	Generalized Hoek-Brown			22226	55	12	0	Water Surface	Automatically Calculated
Siltstone/Sandstone		25	Generalized Hoek-Brown			16719	55	10	0	Water Surface	Automatically Calculated

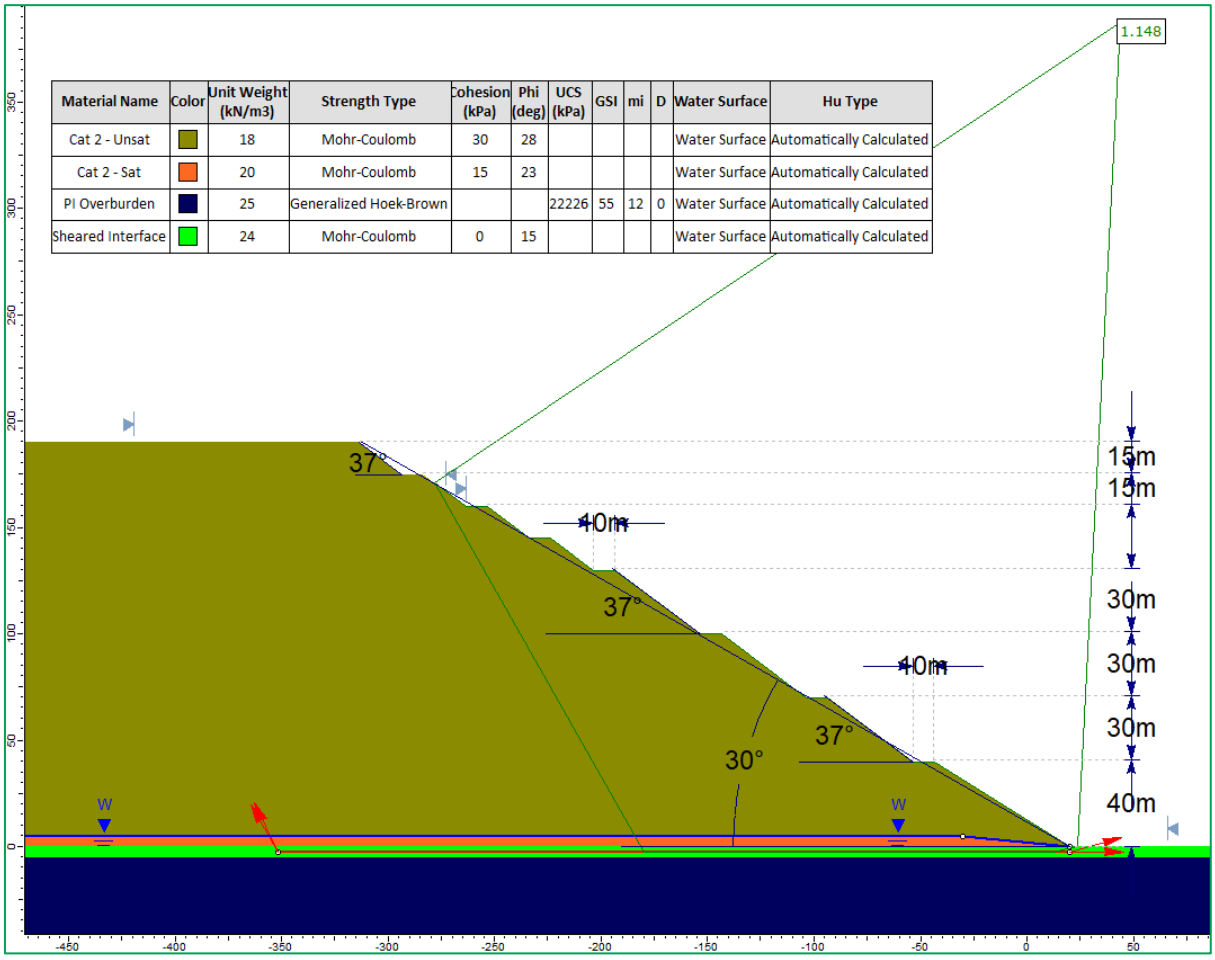
Appendix C 27: Potential Block Failure Mechanism in Proposed Highwall Geometry without Shear Contact – Sarma (Global Stability - Cuckoo Search)



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	GSI	mi	D	Water Surface	Hu Type
Tertiary Material		20	Mohr-Coulomb	35	30					Water Surface	Automatically Calculated
Softwall		20	Mohr-Coulomb	100	30					Water Surface	Automatically Calculated
Fresh Coal		15	Mohr-Coulomb	30	35					Water Surface	Automatically Calculated
MMT Overburden		25	Generalized Hoek-Brown			14153	55	10	0	Water Surface	Automatically Calculated
TRA Overburden		25	Generalized Hoek-Brown			16161	55	10	0	Water Surface	Automatically Calculated
PI Overburden		25	Generalized Hoek-Brown			22226	55	12	0	Water Surface	Automatically Calculated
Siltstone/Sandstone		25	Generalized Hoek-Brown			16719	55	10	0	Water Surface	Automatically Calculated

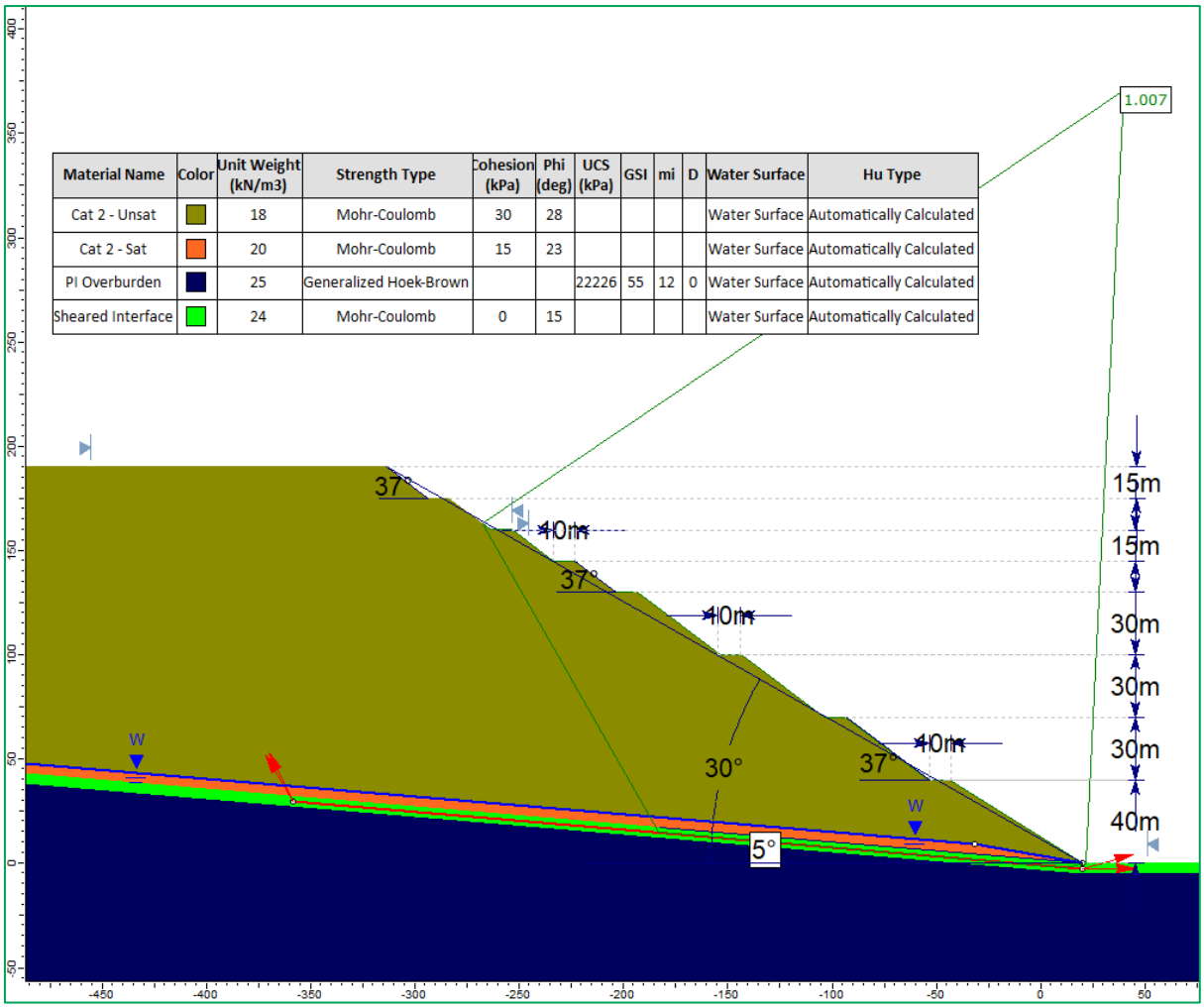
Appendix C 28: Potential Block Failure Mechanism in Proposed Highwall Design without Shear Contact – Spencer (Global Stability – Cuckoo Search)

In-pit Dump without Shear Contact



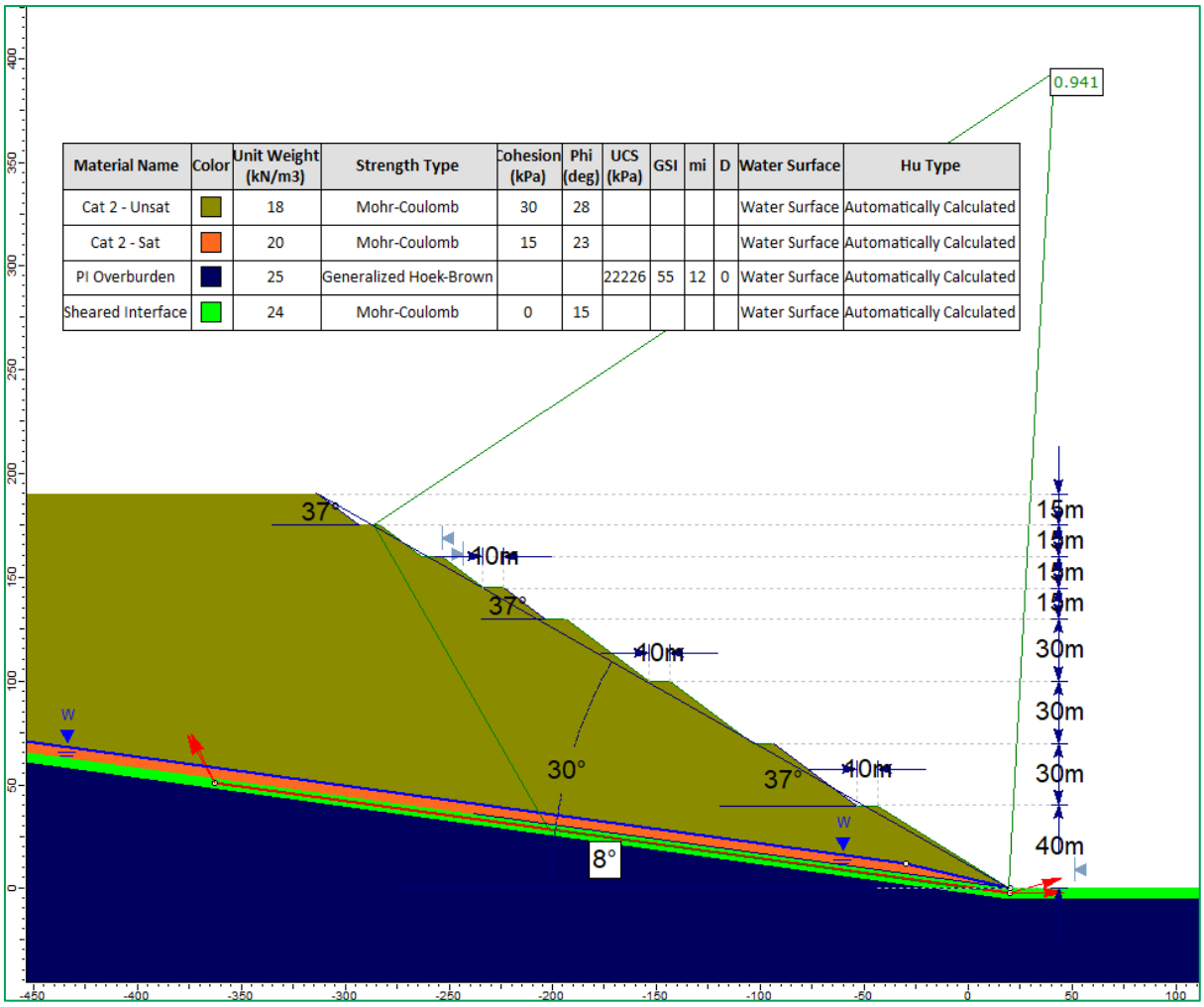
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	GSI	mi	D	Water Surface	Hu Type
Cat 2 - Unsat		18	Mohr-Coulomb	30	28					Water Surface	Automatically Calculated
Cat 2 - Sat		20	Mohr-Coulomb	15	23					Water Surface	Automatically Calculated
PI Overburden		25	Generalized Hoek-Brown			22226	55	12	0	Water Surface	Automatically Calculated
Sheared Interface		24	Mohr-Coulomb	0	15					Water Surface	Automatically Calculated

Appendix C 29: Potential Block Failure Mechanism in Proposed In-pit Dump Design @ 0º Inclined Floor – Sarma

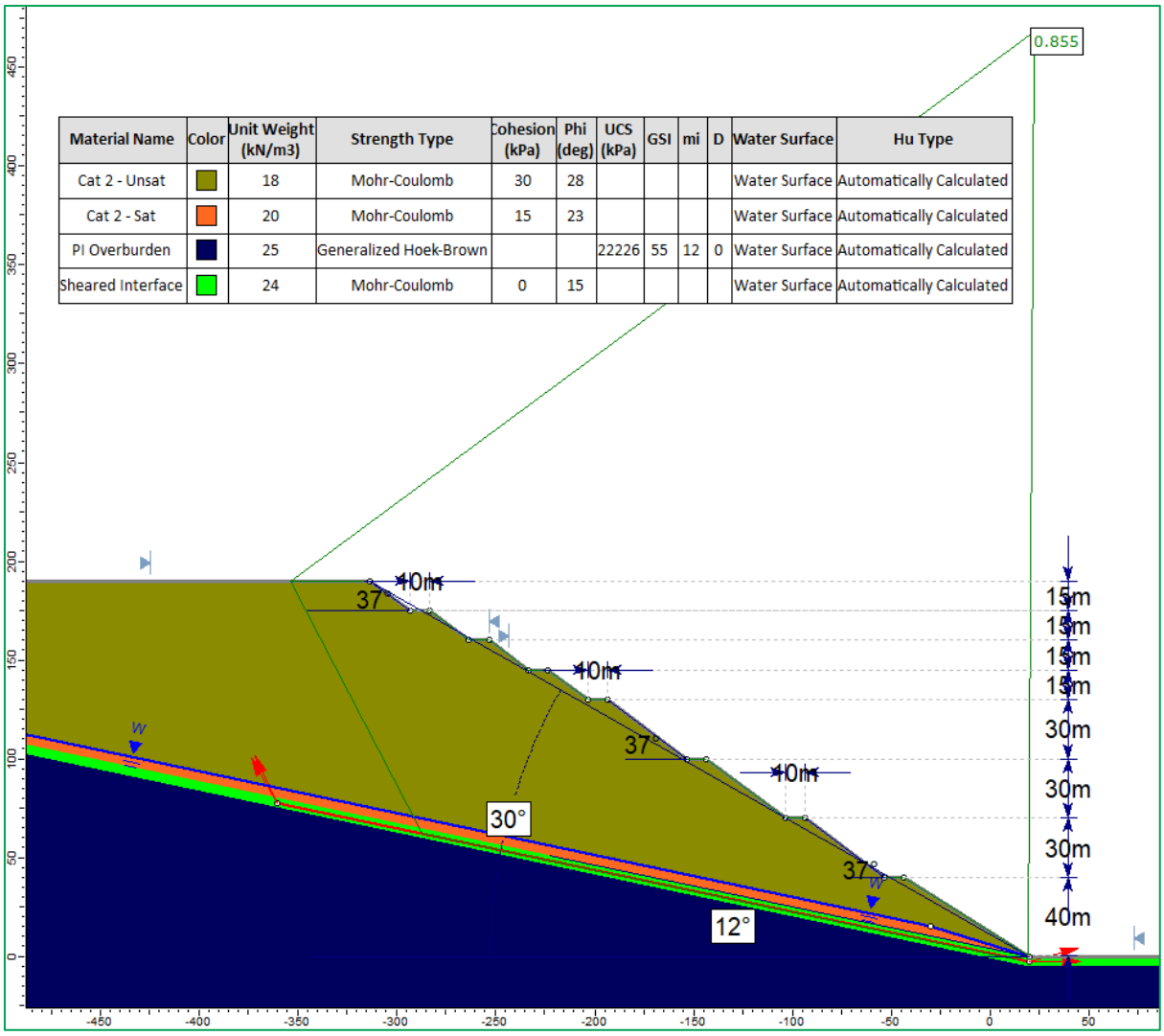


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	GSI	mi	D	Water Surface	Hu Type
Cat 2 - Unsat		18	Mohr-Coulomb	30	28					Water Surface	Automatically Calculated
Cat 2 - Sat		20	Mohr-Coulomb	15	23					Water Surface	Automatically Calculated
PI Overburden		25	Generalized Hoek-Brown			22226	55	12	0	Water Surface	Automatically Calculated
Sheared Interface		24	Mohr-Coulomb	0	15					Water Surface	Automatically Calculated

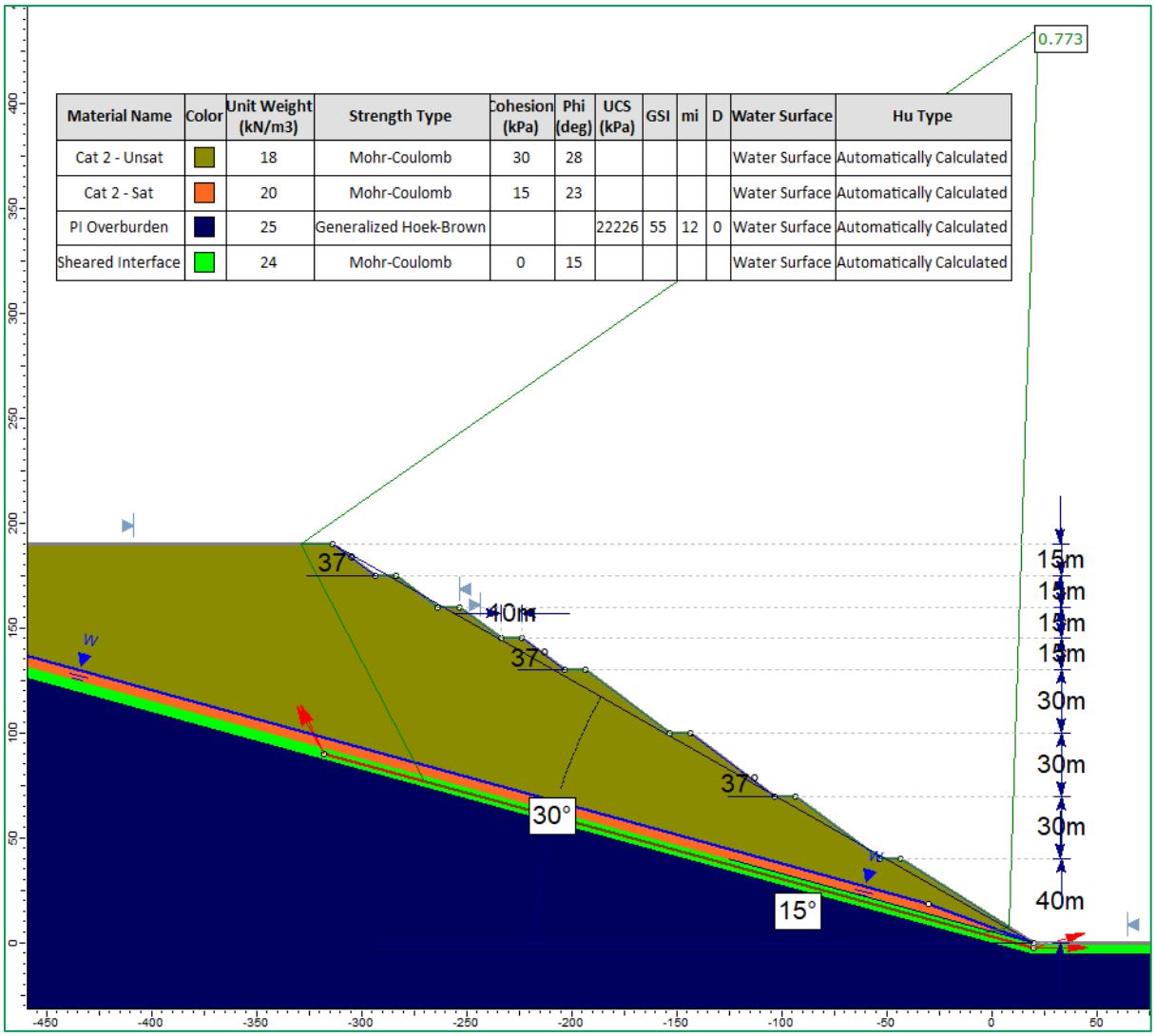
Appendix C 30: Potential Block Failure Mechanism in Proposed In-pit Dump Design @ 5^0 Inclined Floor – Sarma



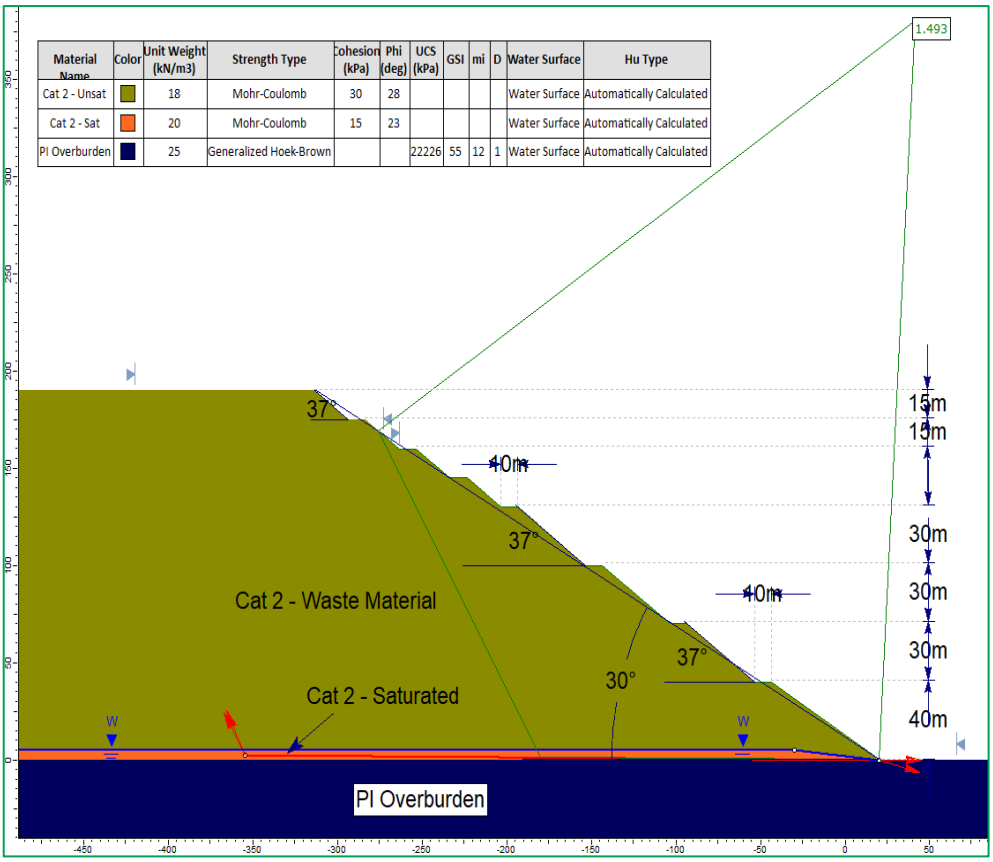
Appendix C 31: Potential Block Failure Mechanism in Proposed In-pit Dump Design @ 8^0 Inclined Floor – Sarma



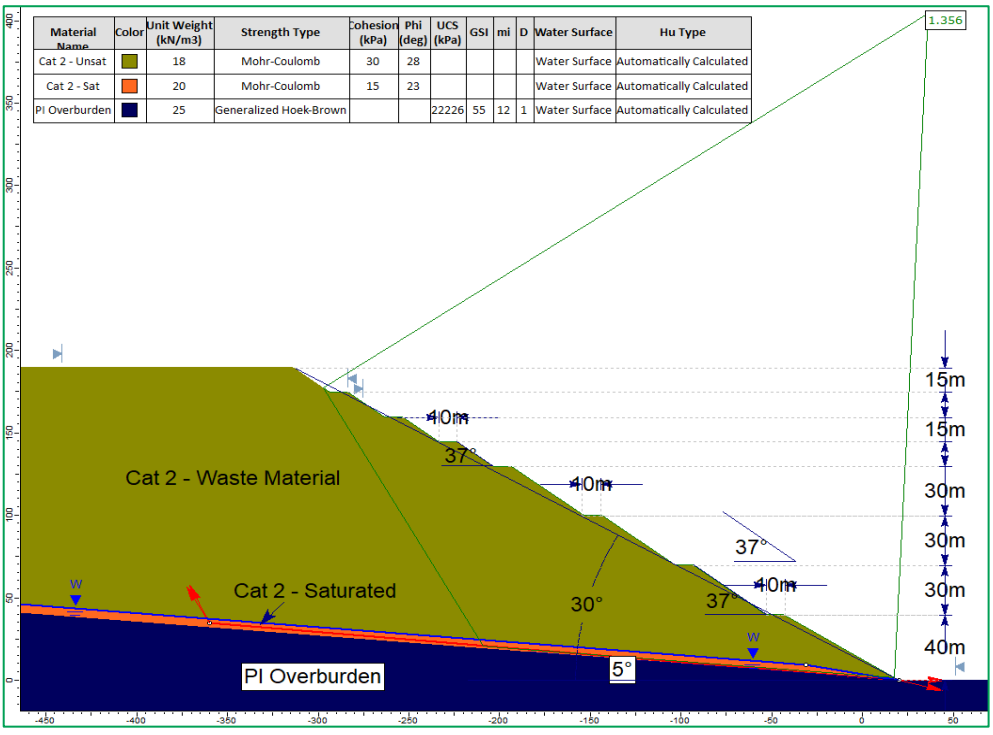
Appendix C 32: Potential Block Failure Mechanism in Proposed In-pit Dump Design @ 12^0 Inclined Floor – Sarma



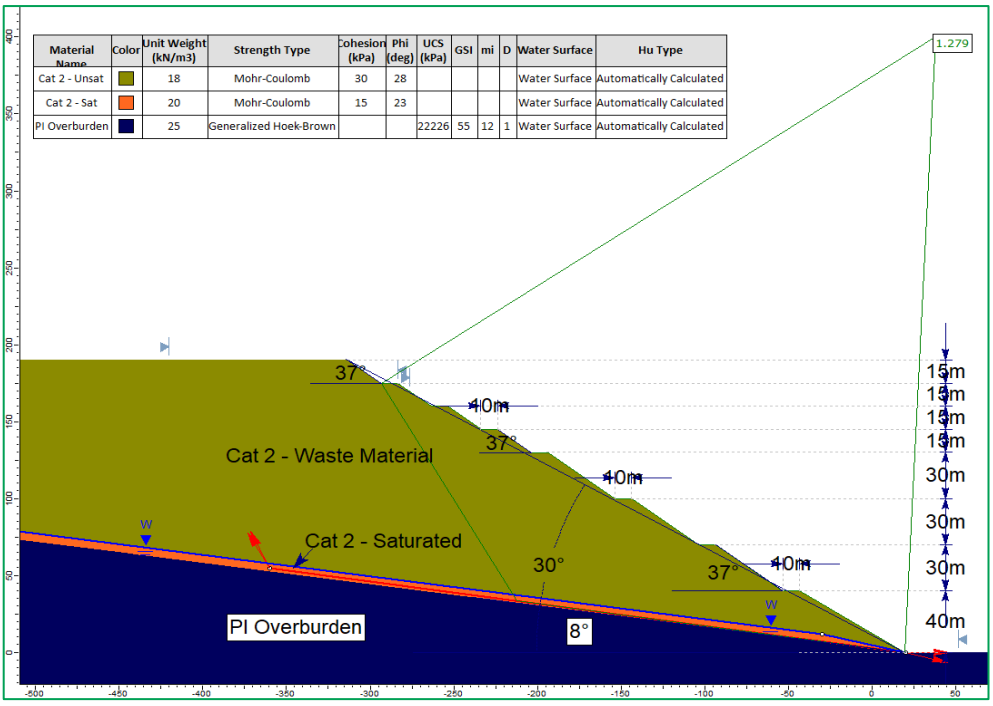
Appendix C 33: Potential Block Failure Mechanism in Proposed In-pit Dump Design @ 15^0 Inclined Floor – Sarma



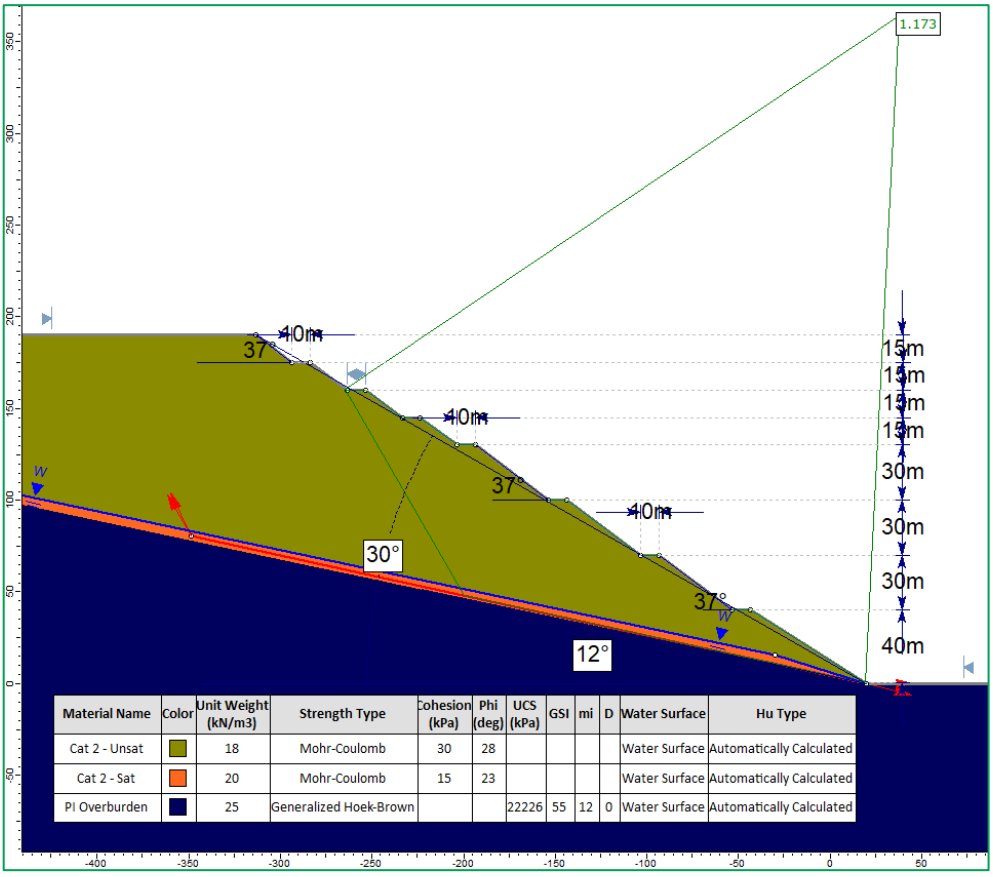
Appendix C 34: Potential Block Failure Mechanism in Proposed In-pit Dump Geometry @ 0^0 Inclined Floor – Sarma



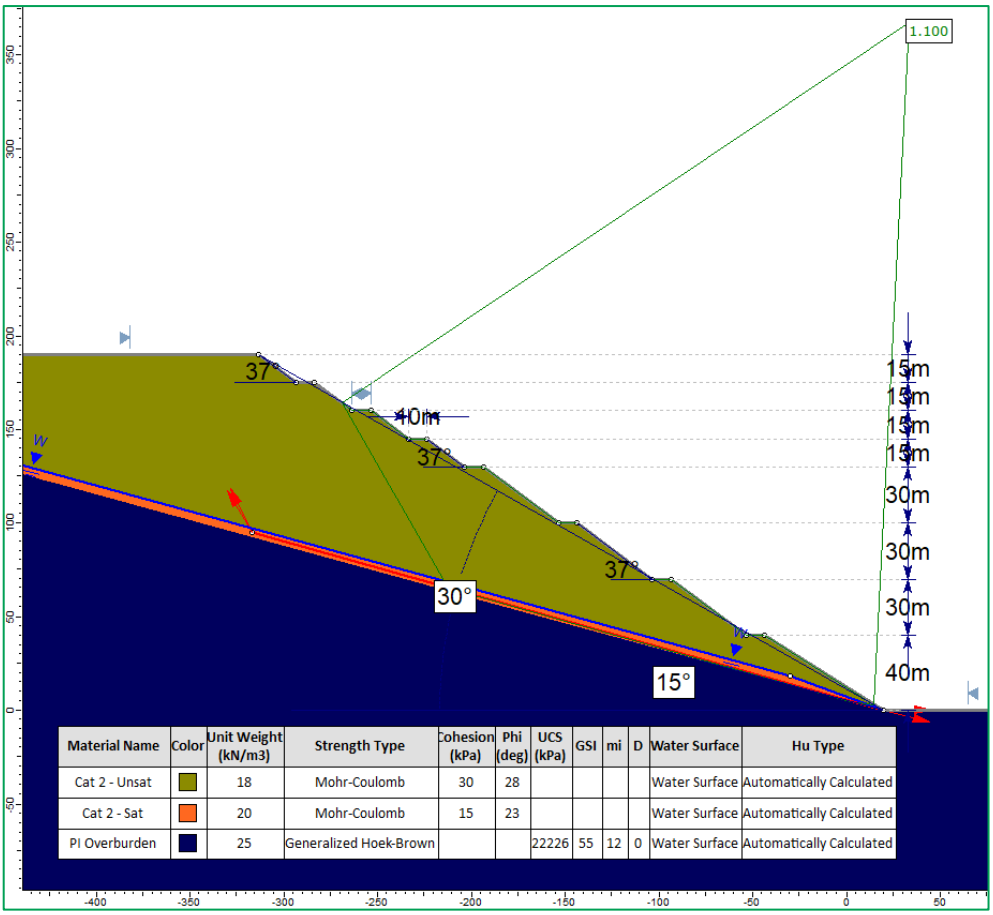
Appendix C 35: Potential Block Failure Mechanism in Proposed In-pit Dump Geometry @ 5^0 Inclined Floor - Sarma



Appendix C 36: Potential Block Failure Mechanism in Proposed In-Pit Dump Geometry @ 8^0 Inclined Floor – Sarma



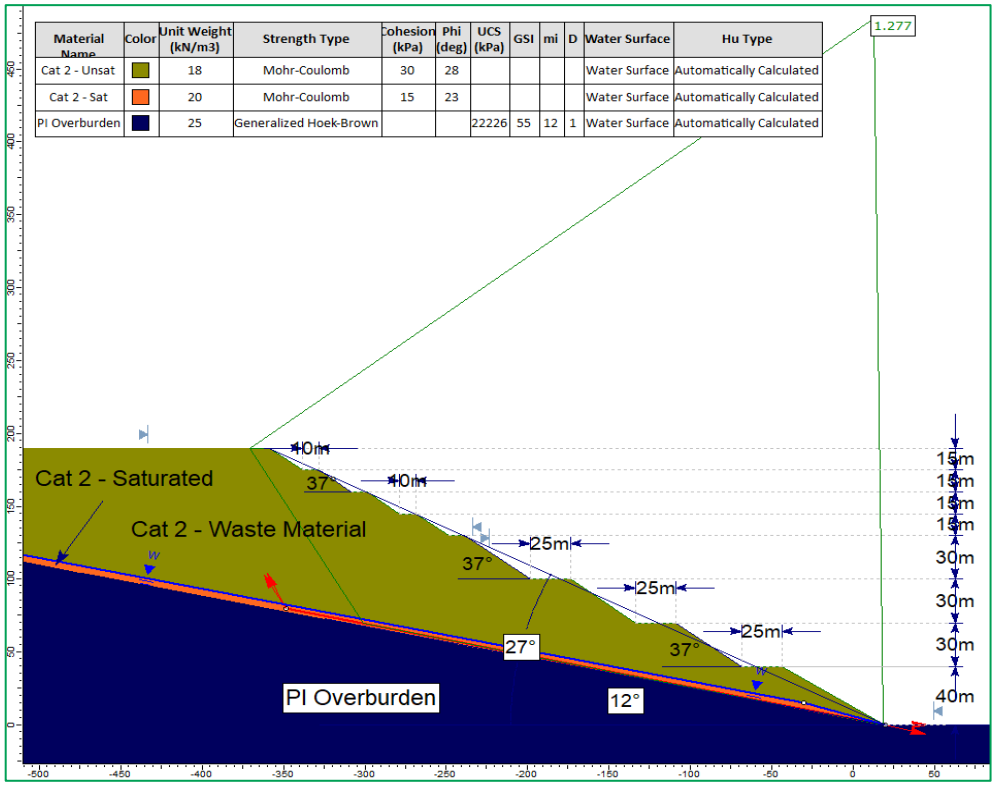
Appendix C 37: Potential Block Failure Mechanism in Proposed In-Pit Dump Geometry @ 12^0 Inclined Floor – Sarma



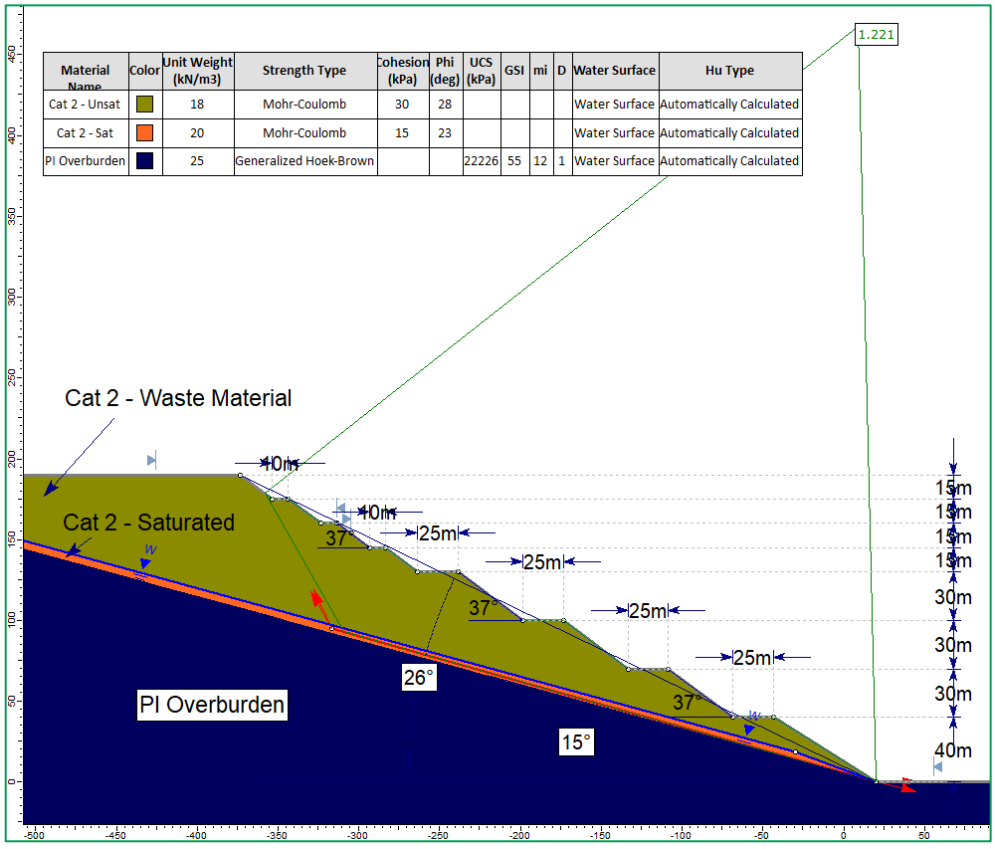
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	GSI	mi	D	Water Surface	Hu Type
Cat 2 - Unsat		18	Mohr-Coulomb	30	28					Water Surface	Automatically Calculated
Cat 2 - Sat		20	Mohr-Coulomb	15	23					Water Surface	Automatically Calculated
PI Overburden		25	Generalized Hoek-Brown			22226	55	12	0	Water Surface	Automatically Calculated

Appendix C 38: Potential Block Failure Mechanism in Proposed In-Pit Dump Geometry @ 15^0 Inclined Floor – Sarma

Modified In-pit Design for 12º and 15º Inclined Dump Floor

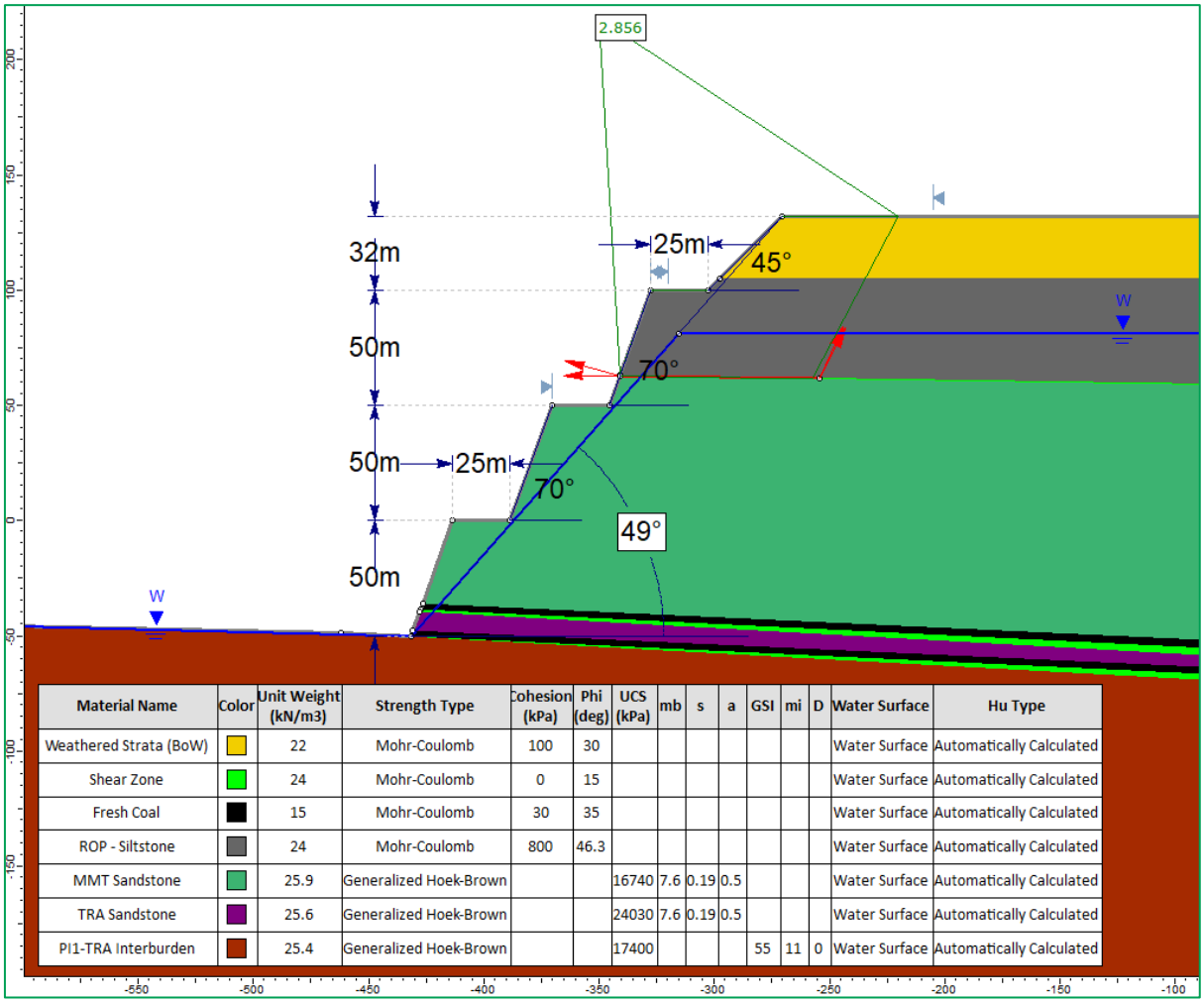


Appendix C 39: Potential Block Failure Mechanism in Revised In-pit Dump Design @ 12^0 Inclined Floor - Sarma



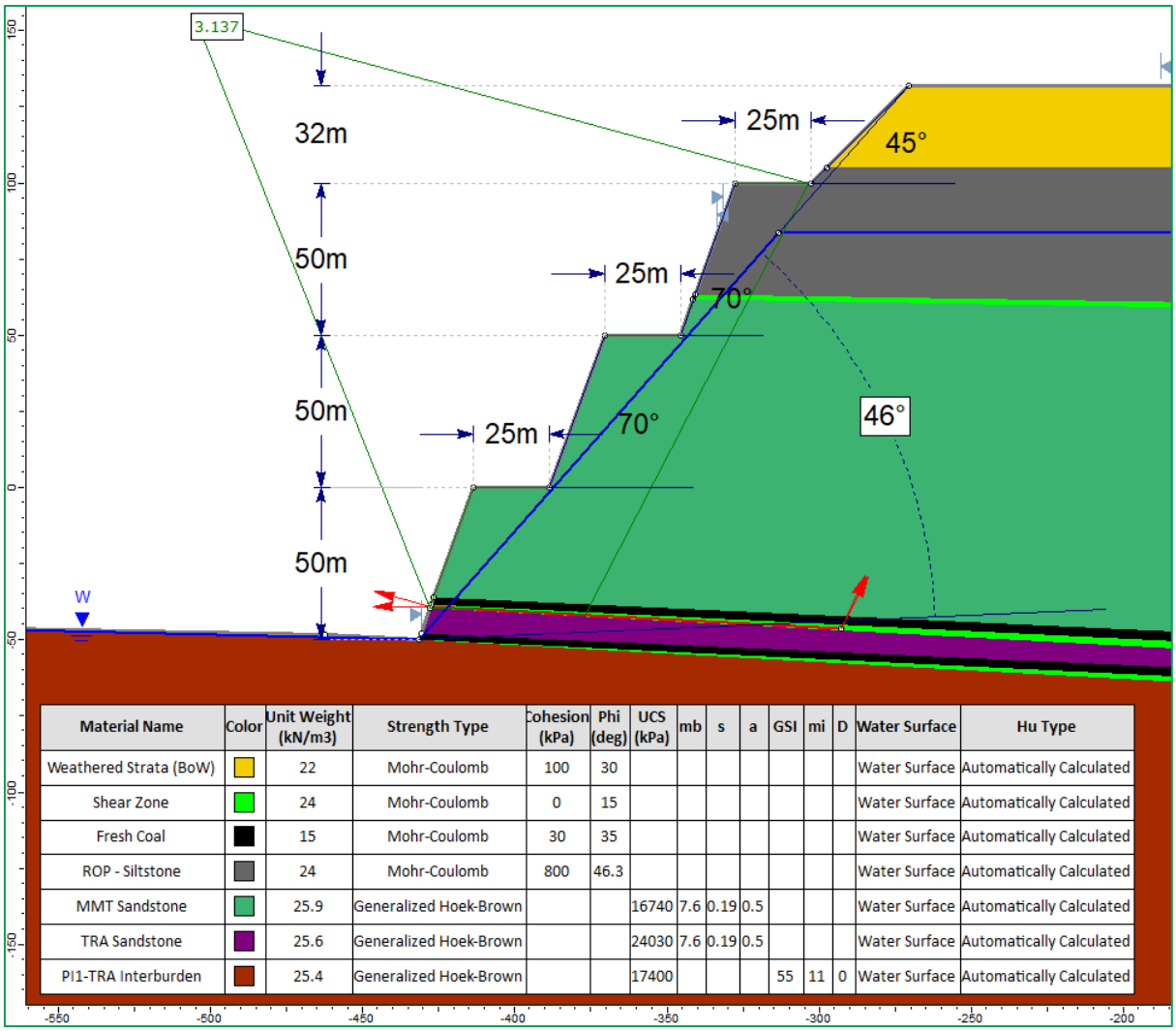
Appendix C 40: Potential Block Failure Mechanism in Revised In-pit Dump Design @ 15^0 Inclined Floor - Sarma

One Tree Pit Highwall with Shear Contact



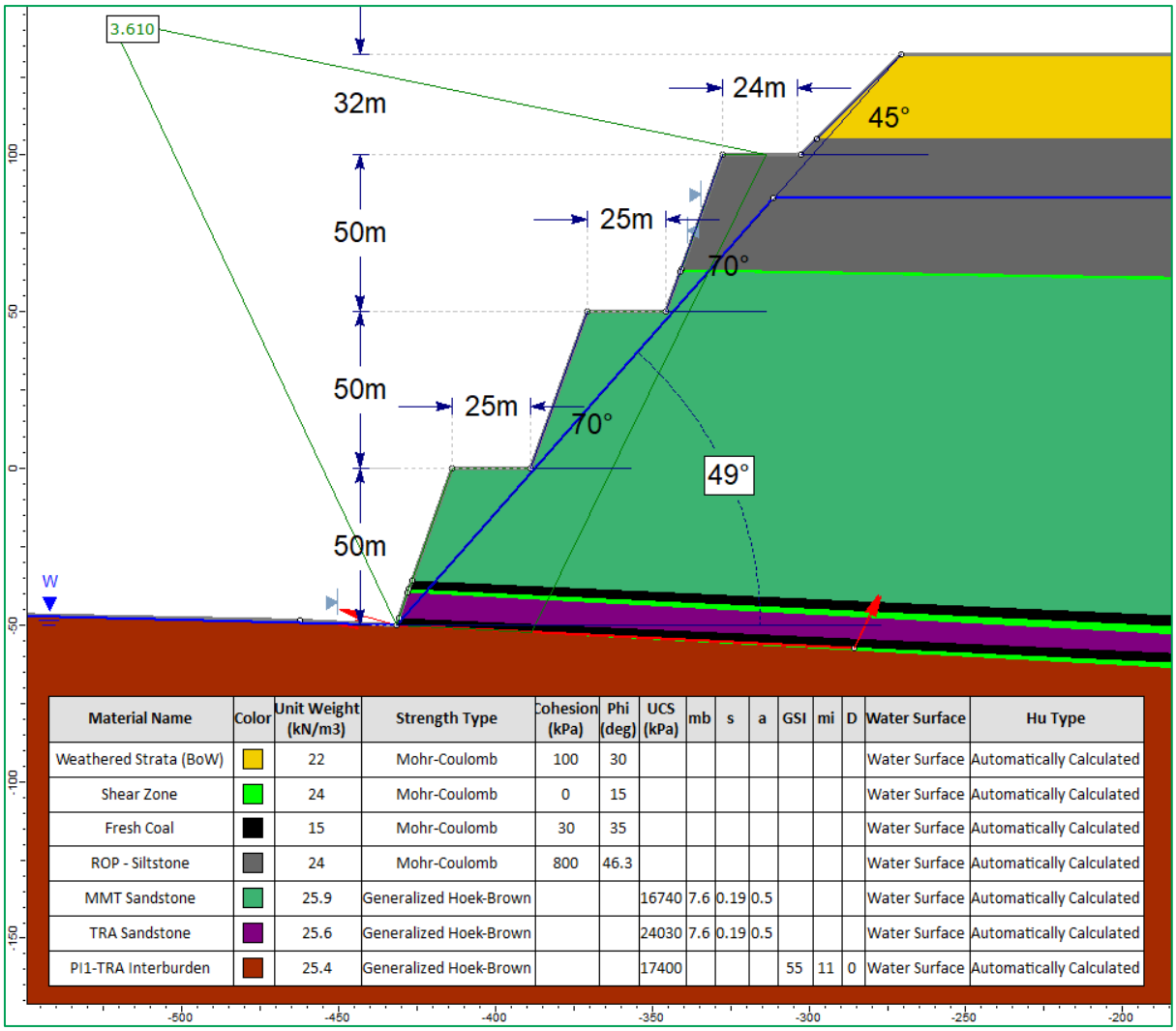
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	mb	s	a	GSI	mi	D	Water Surface	Hu Type
Weathered Strata (BoW)		22	Mohr-Coulomb	100	30								Water Surface	Automatically Calculated
Shear Zone		24	Mohr-Coulomb	0	15								Water Surface	Automatically Calculated
Fresh Coal		15	Mohr-Coulomb	30	35								Water Surface	Automatically Calculated
ROP - Siltstone		24	Mohr-Coulomb	800	46.3								Water Surface	Automatically Calculated
MMT Sandstone		25.9	Generalized Hoek-Brown			16740	7.6	0.19	0.5				Water Surface	Automatically Calculated
TRA Sandstone		25.6	Generalized Hoek-Brown			24030	7.6	0.19	0.5				Water Surface	Automatically Calculated
PI1-TRA Interburden		25.4	Generalized Hoek-Brown			17400				55	11	0	Water Surface	Automatically Calculated

Appendix C 41: Potential Block Failure Mechanism in Proposed Highwall Design with Shear Contact – Sarma (Block Search 1)



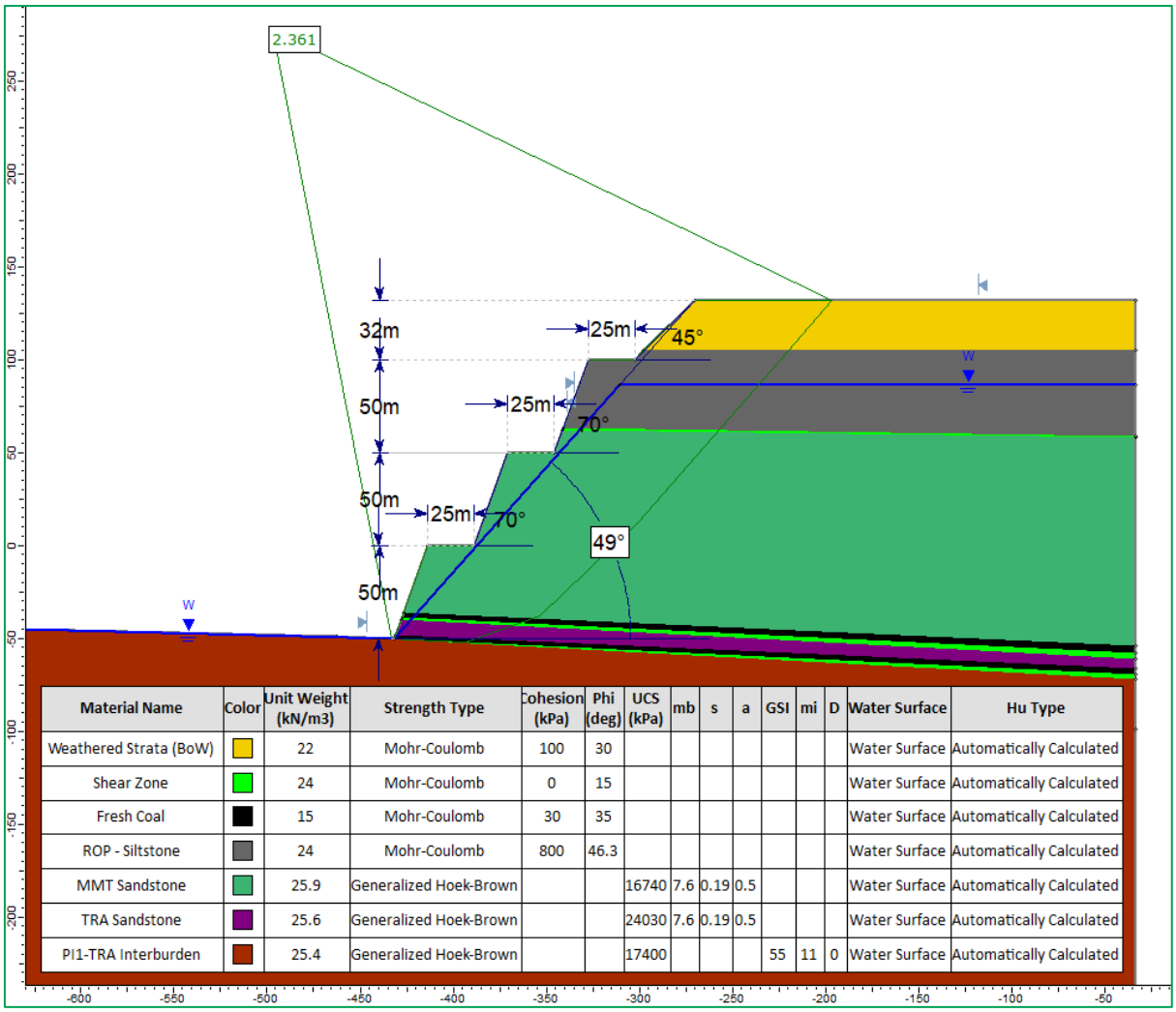
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	mb	s	a	GSI	mi	D	Water Surface	Hu Type
Weathered Strata (BoW)		22	Mohr-Coulomb	100	30								Water Surface	Automatically Calculated
Shear Zone		24	Mohr-Coulomb	0	15								Water Surface	Automatically Calculated
Fresh Coal		15	Mohr-Coulomb	30	35								Water Surface	Automatically Calculated
ROP - Siltstone		24	Mohr-Coulomb	800	46.3								Water Surface	Automatically Calculated
MMT Sandstone		25.9	Generalized Hoek-Brown			16740	7.6	0.19	0.5				Water Surface	Automatically Calculated
TRA Sandstone		25.6	Generalized Hoek-Brown			24030	7.6	0.19	0.5				Water Surface	Automatically Calculated
PI1-TRA Interburden		25.4	Generalized Hoek-Brown			17400				55	11	0	Water Surface	Automatically Calculated

Appendix C 42: Potential Block Failure Mechanism in Proposed Highwall Design with Shear Contact – Sarma (Block Search 2)



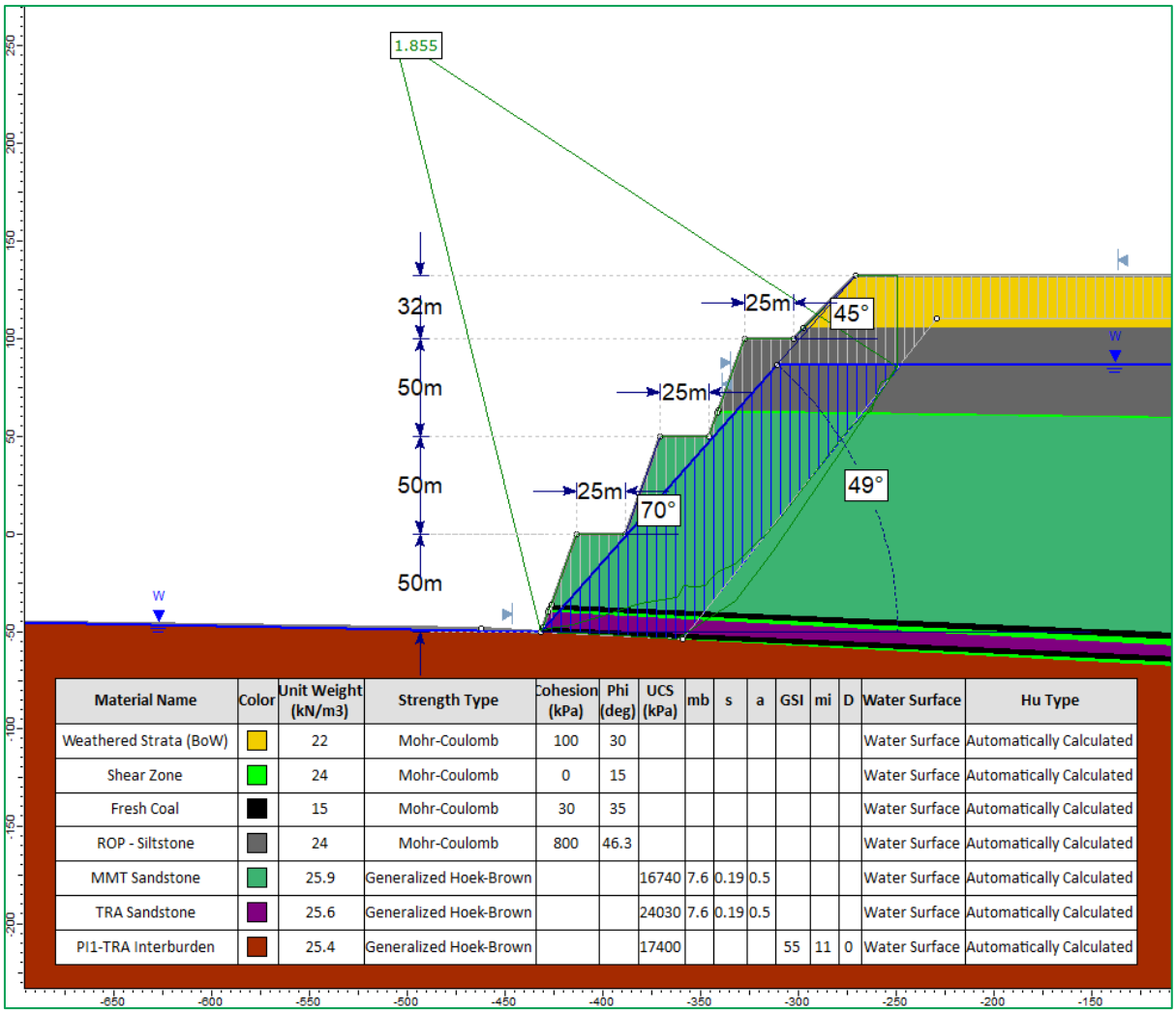
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	mb	s	a	GSI	mi	D	Water Surface	Hu Type
Weathered Strata (BoW)		22	Mohr-Coulomb	100	30								Water Surface	Automatically Calculated
Shear Zone		24	Mohr-Coulomb	0	15								Water Surface	Automatically Calculated
Fresh Coal		15	Mohr-Coulomb	30	35								Water Surface	Automatically Calculated
ROP - Siltstone		24	Mohr-Coulomb	800	46.3								Water Surface	Automatically Calculated
MMT Sandstone		25.9	Generalized Hoek-Brown			16740	7.6	0.19	0.5				Water Surface	Automatically Calculated
TRA Sandstone		25.6	Generalized Hoek-Brown			24030	7.6	0.19	0.5				Water Surface	Automatically Calculated
PI1-TRA Interburden		25.4	Generalized Hoek-Brown			17400				55	11	0	Water Surface	Automatically Calculated

Appendix C 43: Potential Block Failure Mechanism in Proposed Highwall Design with Shear Contact – Sarma (Block Search 3)



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	mb	s	a	GSI	mi	D	Water Surface	Hu Type
Weathered Strata (BoW)		22	Mohr-Coulomb	100	30								Water Surface	Automatically Calculated
Shear Zone		24	Mohr-Coulomb	0	15								Water Surface	Automatically Calculated
Fresh Coal		15	Mohr-Coulomb	30	35								Water Surface	Automatically Calculated
ROP - Siltstone		24	Mohr-Coulomb	800	46.3								Water Surface	Automatically Calculated
MMT Sandstone		25.9	Generalized Hoek-Brown			16740	7.6	0.19	0.5				Water Surface	Automatically Calculated
TRA Sandstone		25.6	Generalized Hoek-Brown			24030	7.6	0.19	0.5				Water Surface	Automatically Calculated
PI1-TRA Interburden		25.4	Generalized Hoek-Brown			17400				55	11	0	Water Surface	Automatically Calculated

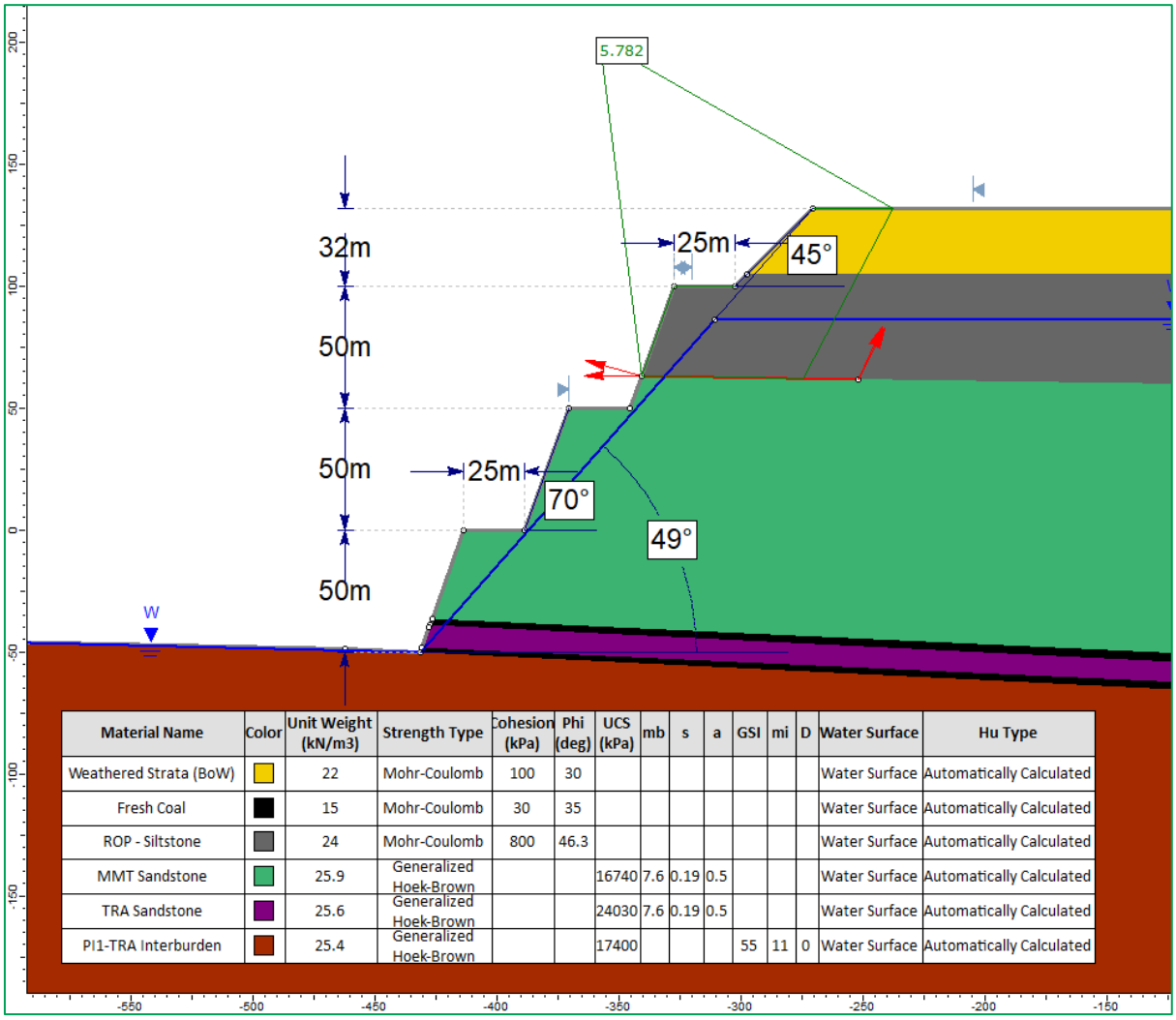
Appendix C 44: Potential Block Failure Mechanism in Proposed Highwall Design with Shear Contact – Sarma (Global Failure – Cuckoo Search)



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	mb	s	a	GSI	mi	D	Water Surface	Hu Type
Weathered Strata (BoW)		22	Mohr-Coulomb	100	30								Water Surface	Automatically Calculated
Shear Zone		24	Mohr-Coulomb	0	15								Water Surface	Automatically Calculated
Fresh Coal		15	Mohr-Coulomb	30	35								Water Surface	Automatically Calculated
ROP - Siltstone		24	Mohr-Coulomb	800	46.3								Water Surface	Automatically Calculated
MMT Sandstone		25.9	Generalized Hoek-Brown			16740	7.6	0.19	0.5				Water Surface	Automatically Calculated
TRA Sandstone		25.6	Generalized Hoek-Brown			24030	7.6	0.19	0.5				Water Surface	Automatically Calculated
PI1-TRA Interburden		25.4	Generalized Hoek-Brown			17400				55	11	0	Water Surface	Automatically Calculated

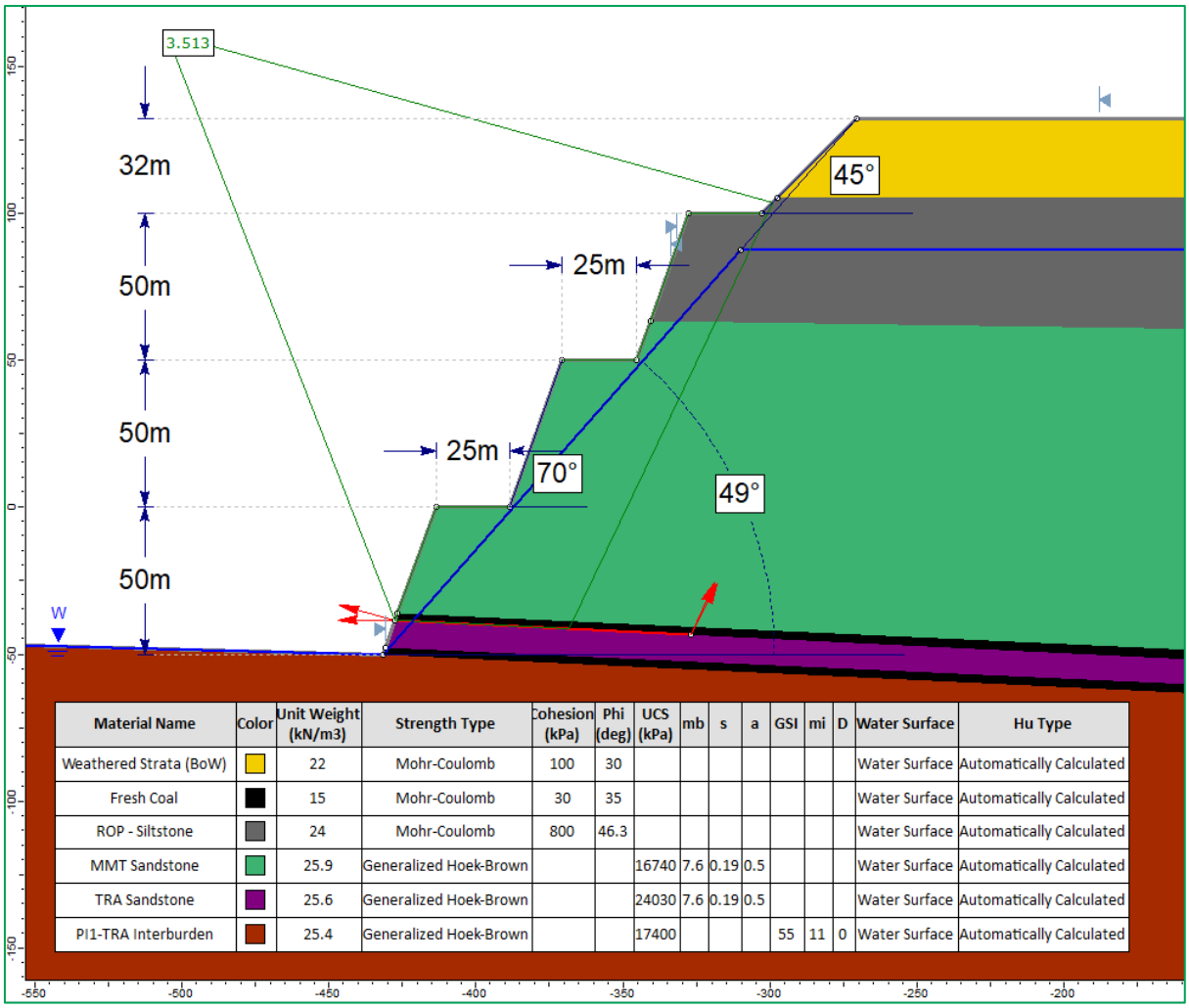
Appendix C 45: Potential Block Failure Mechanism in Proposed Highwall Design with Shear Contact – Spencer (Global Failure)

One Tree Pit Highwall without Shear Contact



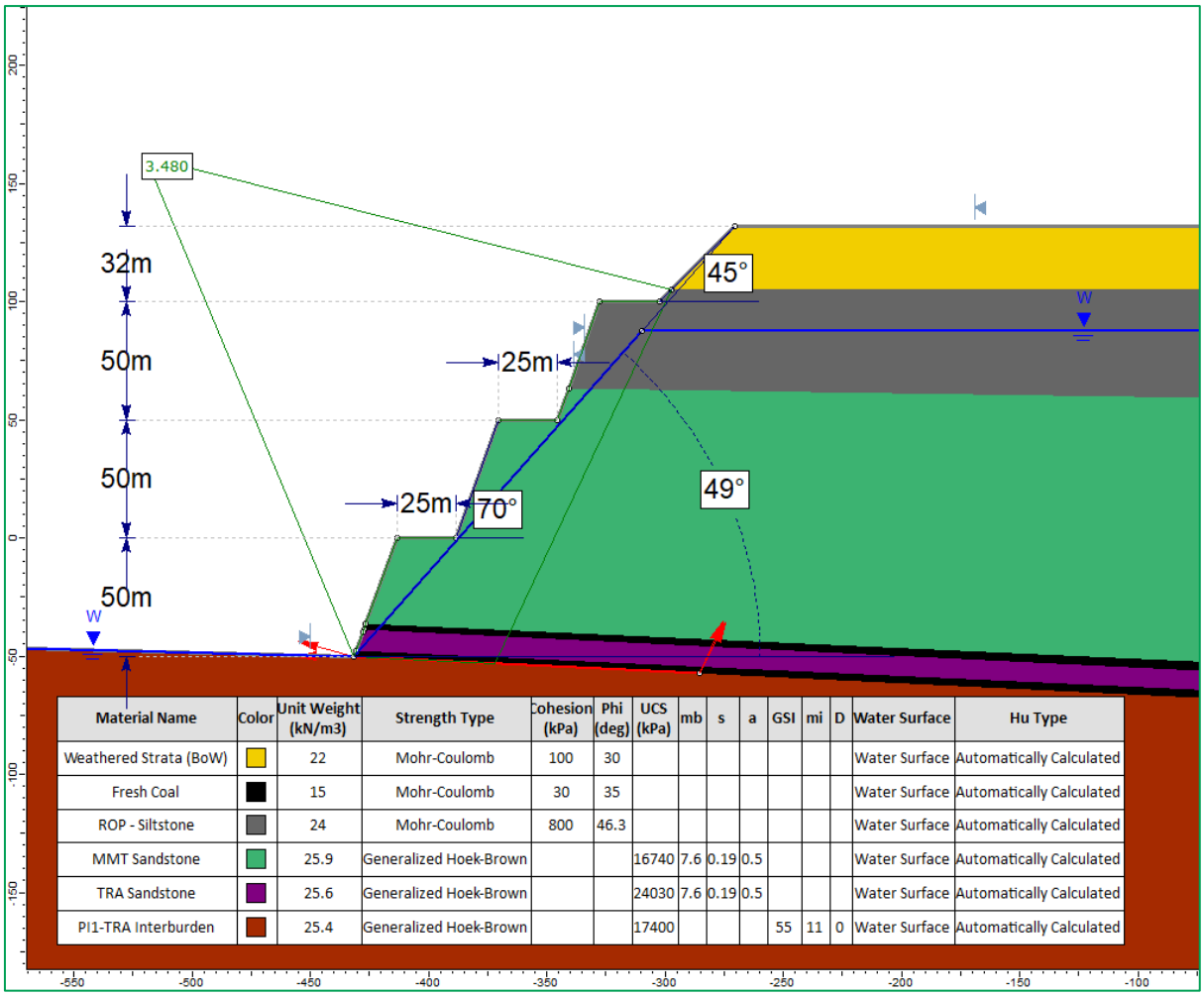
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	mb	s	a	GSI	mi	D	Water Surface	Hu Type
Weathered Strata (BoW)		22	Mohr-Coulomb	100	30								Water Surface	Automatically Calculated
Fresh Coal		15	Mohr-Coulomb	30	35								Water Surface	Automatically Calculated
ROP - Siltstone		24	Mohr-Coulomb	800	46.3								Water Surface	Automatically Calculated
MMT Sandstone		25.9	Generalized Hoek-Brown			16740	7.6	0.19	0.5				Water Surface	Automatically Calculated
TRA Sandstone		25.6	Generalized Hoek-Brown			24030	7.6	0.19	0.5				Water Surface	Automatically Calculated
PI1-TRA Interburden		25.4	Generalized Hoek-Brown			17400				55	11	0	Water Surface	Automatically Calculated

Appendix C 46: Potential Block Failure Mechanism in Proposed Highwall Design without Shear Contact – Sarma (Block Search 1)



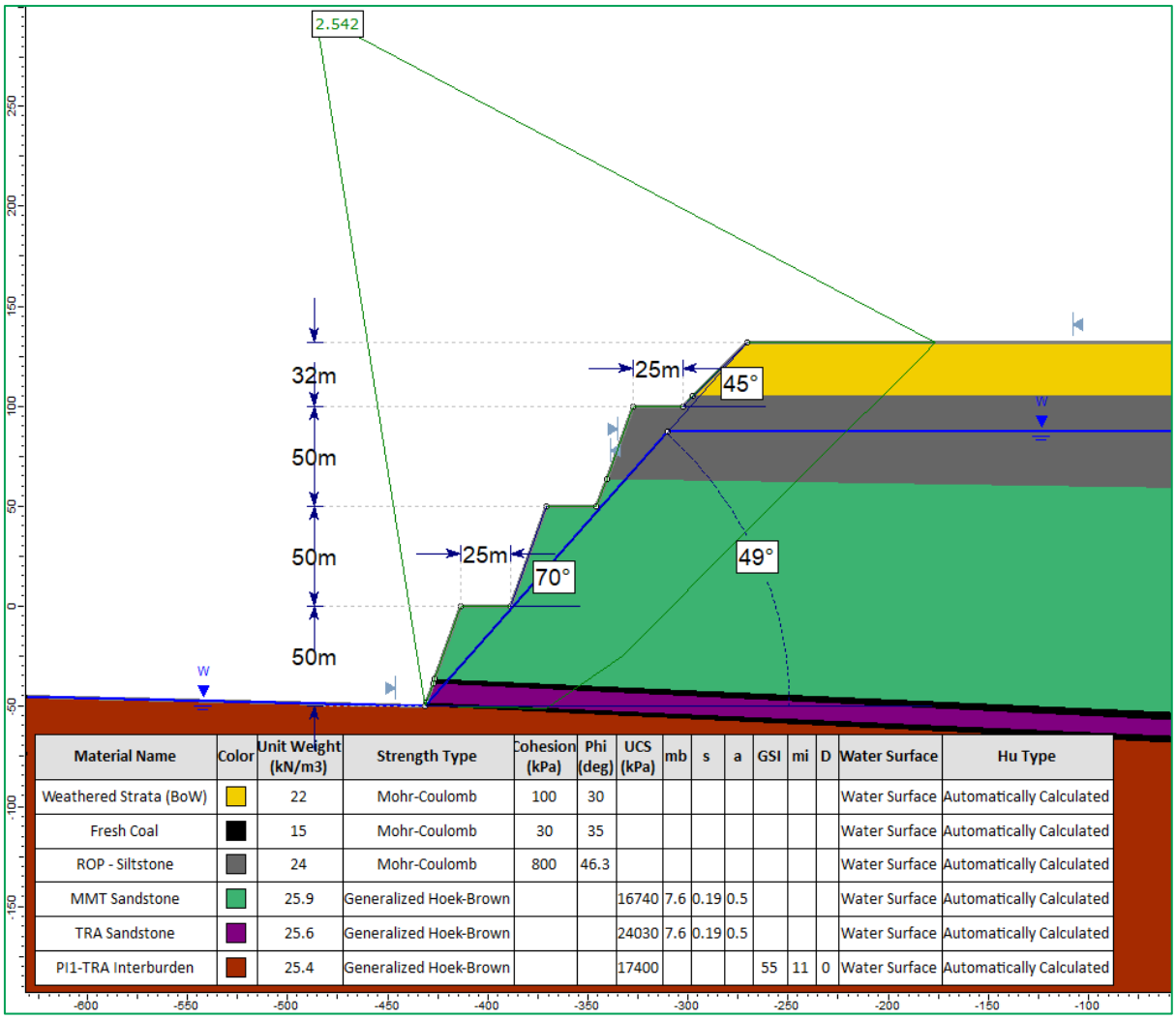
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	mb	s	a	GSI	mi	D	Water Surface	Hu Type
Weathered Strata (BoW)		22	Mohr-Coulomb	100	30								Water Surface	Automatically Calculated
Fresh Coal		15	Mohr-Coulomb	30	35								Water Surface	Automatically Calculated
ROP - Siltstone		24	Mohr-Coulomb	800	46.3								Water Surface	Automatically Calculated
MMT Sandstone		25.9	Generalized Hoek-Brown			16740	7.6	0.19	0.5				Water Surface	Automatically Calculated
TRA Sandstone		25.6	Generalized Hoek-Brown			24030	7.6	0.19	0.5				Water Surface	Automatically Calculated
PI1-TRA Interburden		25.4	Generalized Hoek-Brown			17400				55	11	0	Water Surface	Automatically Calculated

Appendix C 47: Potential Block Failure Mechanism in Proposed Highwall Design without Shear Contact – Sarma (Block Search 2)



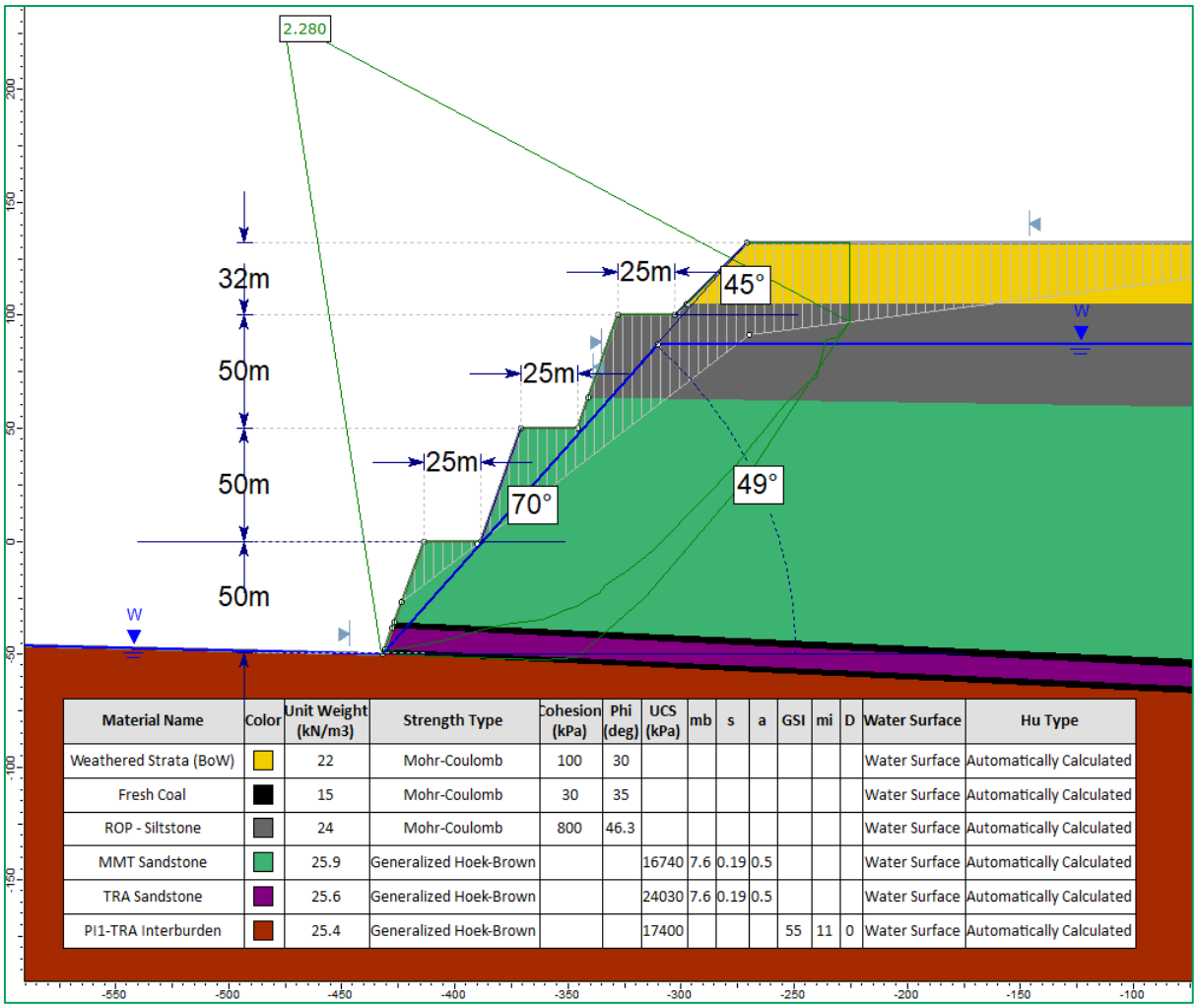
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	mb	s	a	GSI	mi	D	Water Surface	Hu Type
Weathered Strata (BoW)		22	Mohr-Coulomb	100	30								Water Surface	Automatically Calculated
Fresh Coal		15	Mohr-Coulomb	30	35								Water Surface	Automatically Calculated
ROP - Siltstone		24	Mohr-Coulomb	800	46.3								Water Surface	Automatically Calculated
MMT Sandstone		25.9	Generalized Hoek-Brown			16740	7.6	0.19	0.5				Water Surface	Automatically Calculated
TRA Sandstone		25.6	Generalized Hoek-Brown			24030	7.6	0.19	0.5				Water Surface	Automatically Calculated
PI1-TRA Interburden		25.4	Generalized Hoek-Brown			17400				55	11	0	Water Surface	Automatically Calculated

Appendix C 48: Potential Block Failure Mechanism in Proposed Highwall Design without Shear Contact – Sarma (Block Search 3)



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	mb	s	a	GSI	mi	D	Water Surface	Hu Type
Weathered Strata (BoW)		22	Mohr-Coulomb	100	30								Water Surface	Automatically Calculated
Fresh Coal		15	Mohr-Coulomb	30	35								Water Surface	Automatically Calculated
ROP - Siltstone		24	Mohr-Coulomb	800	46.3								Water Surface	Automatically Calculated
MMT Sandstone		25.9	Generalized Hoek-Brown			16740	7.6	0.19	0.5				Water Surface	Automatically Calculated
TRA Sandstone		25.6	Generalized Hoek-Brown			24030	7.6	0.19	0.5				Water Surface	Automatically Calculated
PI1-TRA Interburden		25.4	Generalized Hoek-Brown			17400				55	11	0	Water Surface	Automatically Calculated

Appendix C 49: Potential Block Failure Mechanism in Proposed Highwall Design without Shear Contact – Sarma (Cuckoo Search – Global Stability)



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	mb	s	a	GSI	mi	D	Water Surface	Hu Type
Weathered Strata (BoW)		22	Mohr-Coulomb	100	30								Water Surface	Automatically Calculated
Fresh Coal		15	Mohr-Coulomb	30	35								Water Surface	Automatically Calculated
ROP - Siltstone		24	Mohr-Coulomb	800	46.3								Water Surface	Automatically Calculated
MMT Sandstone		25.9	Generalized Hoek-Brown			16740	7.6	0.19	0.5				Water Surface	Automatically Calculated
TRA Sandstone		25.6	Generalized Hoek-Brown			24030	7.6	0.19	0.5				Water Surface	Automatically Calculated
PI1-TRA Interburden		25.4	Generalized Hoek-Brown			17400				55	11	0	Water Surface	Automatically Calculated

Appendix C 50: Potential Block Failure Mechanism in Proposed Highwall Design without Shear Contact – Sarma (Block Search 1)

Appendix O: WRM Final Void Hydrology Report

Final void hydrology report

Foxleigh Mine

Foxleigh Management Pty Ltd

1366-05-B2, 24 March 2023

For and on behalf of WRM Water & Environment Pty Ltd
Level 9, 135 Wickham Tce, Spring Hill
PO Box 10703 Brisbane Adelaide St Qld 4000
Tel 07 3225 0200

Ashleigh Clapper
Senior 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

WRM Water & Environment Pty Ltd (WRM) was engaged by Foxleigh Management Pty Ltd to undertake a final void hydrology assessment to support the Progressive Rehabilitation and Closure (PRC) Plan for the Foxleigh Mine (FM). FM is operated by Foxleigh Management Pty Ltd, on behalf of the Foxleigh Coal joint venture with POSCO Australia and Nippon Steel Australia Pty Ltd.

WRM has modelled the long-term final void hydrology and water quality behaviour of the FM final void over a 500-year period post-closure to inform whether the final void would be a non-polluting landform. This report outlines the methodology and assessment of the expected final void pit lake behaviour, which has been modelled using the GoldSim water balance simulation software.

2 Final void geometry

The final landscape of FM has 7 final voids shown in Figure 3.2, which are as follows:

- Eagles Nest;
- Fox Plains;
- One Tree West (OTW);
- Pipeline Pit;
- WC Pit;
- Far South; and
- Carlo.

The 7 final voids have formed from mining, incorporating in-pit backfilled spoil which sits atop a mined pit shell. The backfill spoil will be rehabilitated to prevent surface water contamination due to erosion. A digital elevation model (DEM) of the final landform (i.e. the final surface expected at the end of the mine life) was provided by Foxleigh Management Pty Ltd.

Any rainfall/runoff which flows through the area that drains to the final void (shown in Figure 3.2) would form a pit lake at the lowest elevation. The groundwater seeps into the void if the void water level is below the regional groundwater level. If the final void water level reaches above the regional groundwater level, the final void acts as a groundwater source. If however the final void water level stays below the regional groundwater level, the final void acts as a groundwater sink.

For this study, a stage-storage curve was generated using the DEM provided by Foxleigh Management Pty Ltd. Figure 2.1 to Figure 2.7 shows the stage-storage curve derived for the 7 final voids.

There are three existing voids at FM that would not remain post-closure (Void 251, NT Pit and Old NE Pit). Foxleigh Management Pty Ltd have advised that Void 251 and NT Pit will be filled with coarse and fine tailings and Old NE Pit would be fully backfilled with spoil. Each of these 3 existing voids will capped to create water-shedding landforms. Therefore, they have not be included in this assessment.

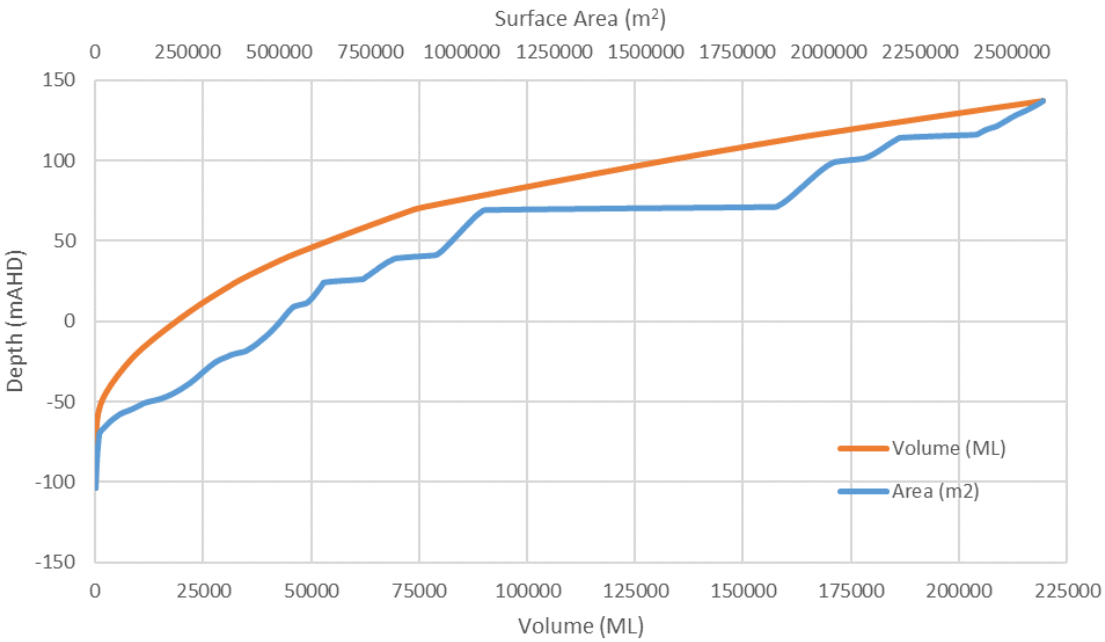

Figure 2.1 Eagles Nest void stage-storage and surface area curve

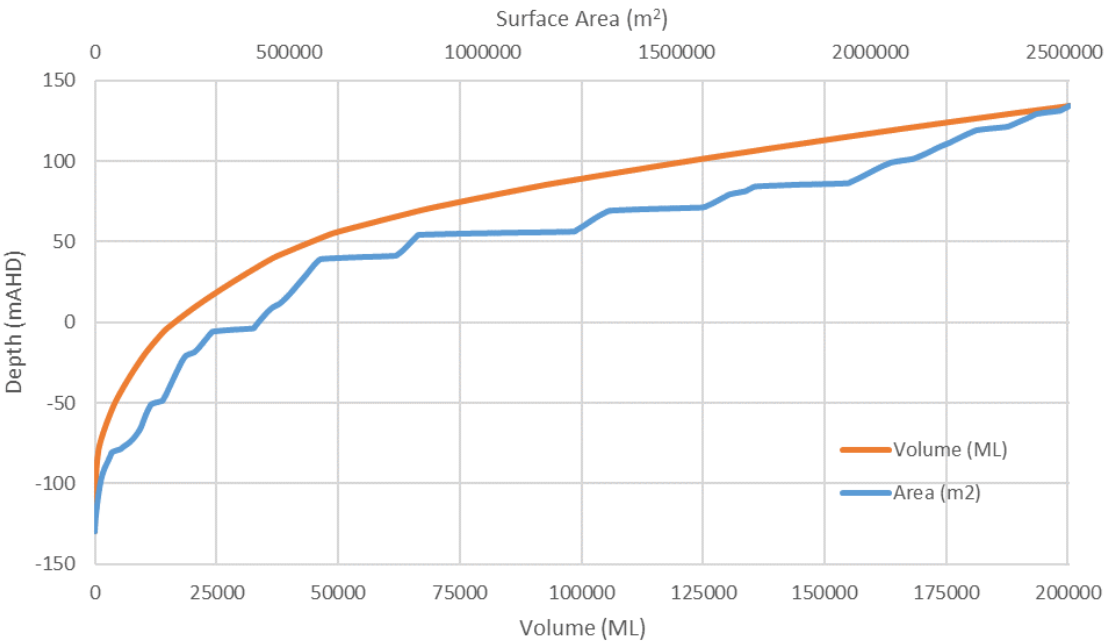

Figure 2.2 - Fox Plains final void stage-storage and surface area curve

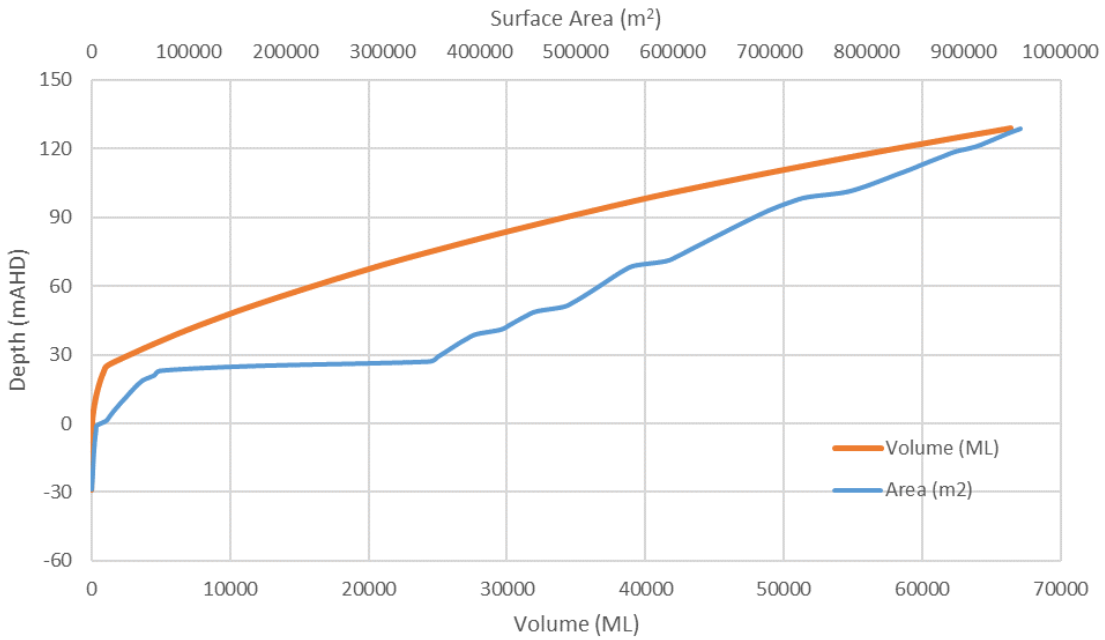

Figure 2.3 - One Tree West final void stage-storage and surface area curve

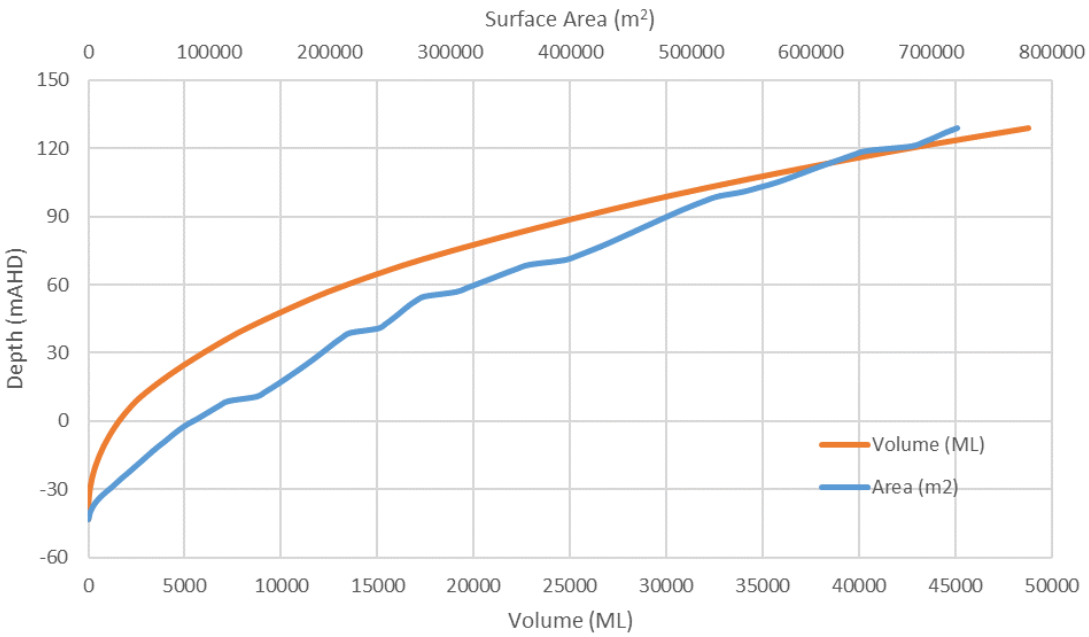

Figure 2.4 - Pipeline Pit final void stage-storage and surface area curve

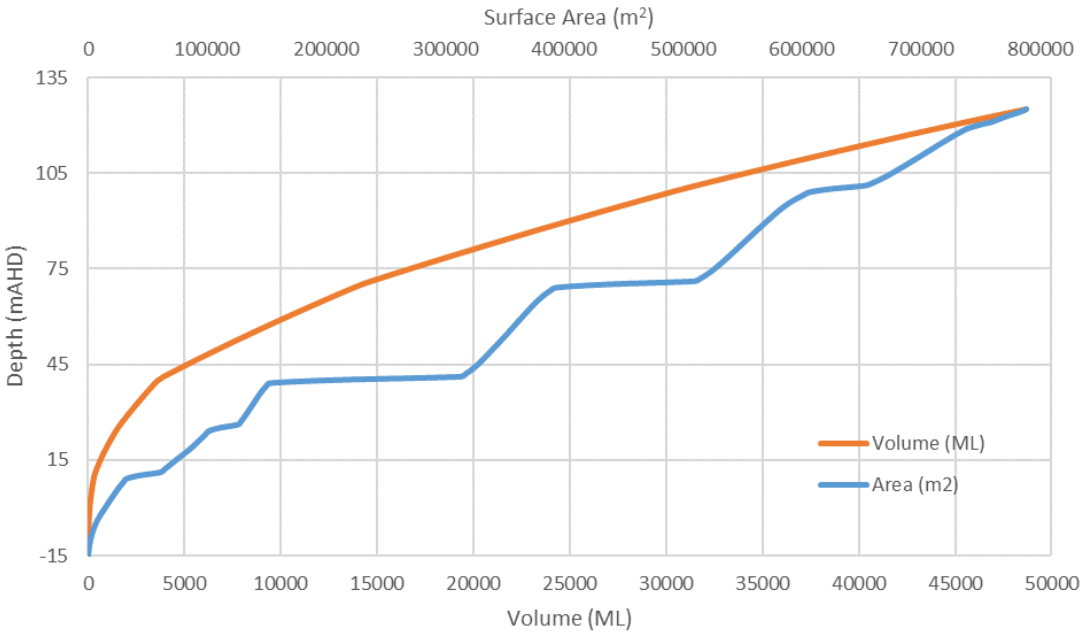

Figure 2.5 WC Pit Void stage-storage and surface area curve

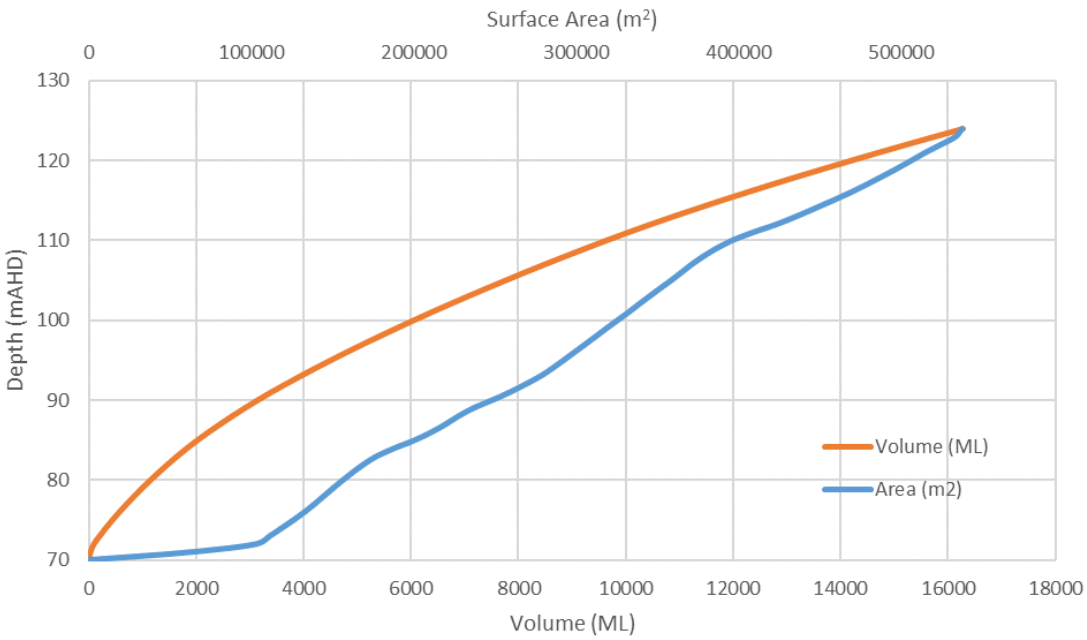

Figure 2.6 Far South void stage-storage and surface area curve

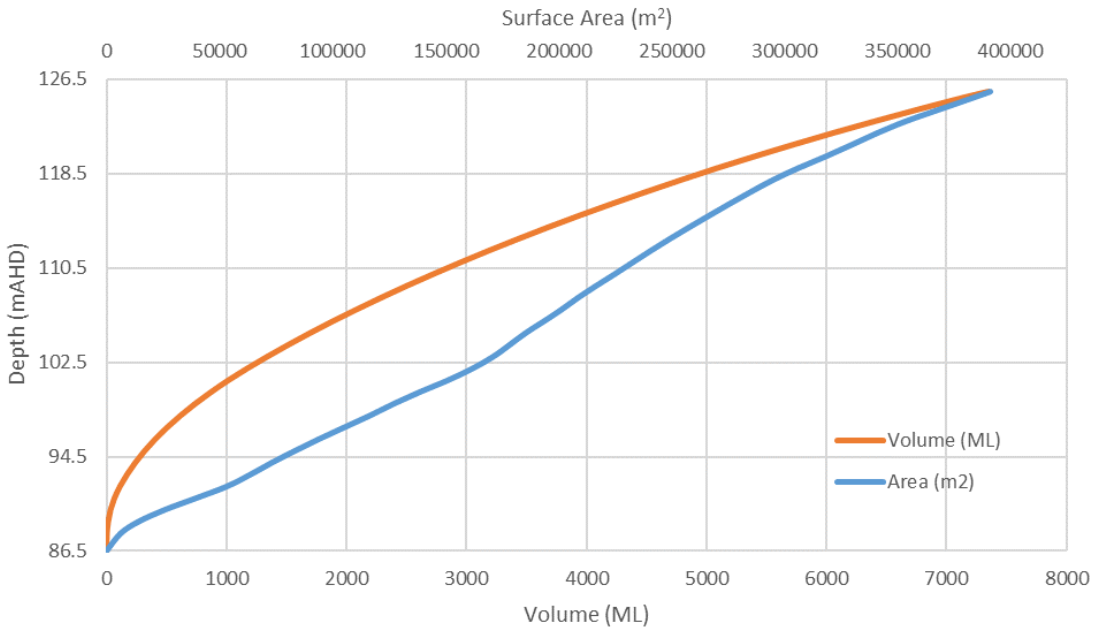

Figure 2.7 Carlo void stage-storage and surface area curve

3 Model configuration

3.1 MODELLING APPROACH

The GoldSim water balance simulation model was used to simulate the long-term void water level behaviour, salinity, and the interaction of the pit lake water with the surrounding groundwater table. Water levels in the residual voids would vary over time, depending on the prevailing climatic conditions, and the balance between evaporation losses and inflows from rainfall, surface runoff, and groundwater.

The GoldSim model was used to simulate the generation, movement, and loss of water on a daily time-step within the final void, over a 500-year period. The volume of water in the void was calculated at each time step as the sum of direct rainfall to the void surface, catchment runoff, and groundwater inflows, less evaporation losses. The model also tracks the quantity of salt captured and stored within the system.

Key components of the model are summarised in the following sub-sections, including descriptions of key model inputs, assumptions, and sensitivity parameters.

3.2 RAINFALL AND EVAPORATION

Long-term daily rainfall and evaporation data for the area from January 1889 to December 2022 (133 years) obtained from the Department of Environment and Science (DES) SILO database forms the basis of the simulation (DES, 2022).

Morton's Lake evaporation has been used to estimate evaporation losses from storages. Figure 3.1 shows the long-term monthly averages for Morton's lake evaporation and rainfall data.

The 133 years of SILO rainfall and evaporation data was repeated 4 times to create an indicative long-term (500 year) climate sequence.

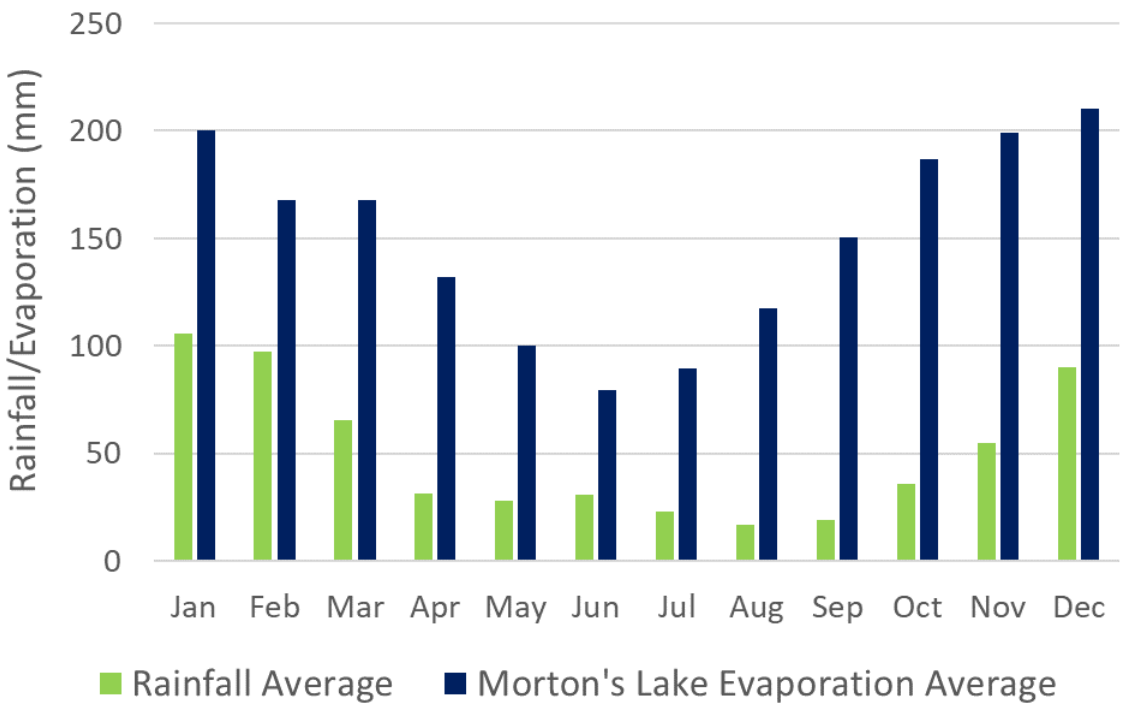

Figure 3.1 - Distribution of monthly rainfall and evaporation (SILO 1889 - 2022)

Evaporation from the final void pit lake is impacted by the final void geometry. The pit walls shade the pit lake which reduces the hours of direct sunlight on the pit lake and reduces evaporation. The depth of the pit lake below natural surface can reduce wind velocities, which increases humidity at the pit lake surface and reduces evaporation. A pit evaporation factor is applied to the daily evaporation to account for these factors.

To simulate this potential reduction in evaporation on the surface of the pit lake, the evaporation rate has been varied using a pit evaporation factor. A pit evaporation factor of 0.7 was applied for evaporation from the void.

3.3 CATCHMENT RUNOFF

3.3.1 Catchment areas

The final landform catchment area has been generated using the final landform surface provided by site personnel. The land use areas outside of the long-term void lakes were generated using the latest aerial and DEM of the site, which differentiates final void depression, rehabilitated spoil and undisturbed areas. The void catchments are defined with the assumption of additional bund walls planned around the final void.

The final void catchment has been characterised into the following land use types:

- natural/undisturbed, representing areas in their natural state;
- spoil, representing final void surface; and
- rehabilitated spoil, representing established rehabilitated spoil areas.

The area covered by the maximum water level of the void pit lake has been assumed as spoil. The spoil overburden outside the pit is considered rehabilitated spoil, as it is understood that these areas will be rehabilitated post-mining.

Figure 3.2 shows the catchment boundary and land uses assumed for the final void. The catchment and land use values used in the GoldSim model are shown in Table 3.1.

Table 3.1 - Final void catchment and land use areas

Void	Catchment area (ha)			
	Natural	Spoil	Rehab	Total
Eagles Nest	23.1	273.1	6.9	303.0
Fox Plains	5.1	391.7	117.6	514.4
OTW	40.9	109.8	93.5	244.2
Pipeline Pit	17.4	83.2	57.9	185.5
WC Pit	23.9	84.4	10.9	119.2
Far South	0.0	57.0	54.6	111.6
Carlo	25.4	42.3	80.7	148.4

3.3.2 AWBM parameters

Catchment runoff has been modelled using the AWBM rainfall-runoff model. The adopted rainfall runoff parameters are based on (WRM, 2021). The AWBM parameters from the model have been summarised in Table 3.2.

Table 3.2 - Adopted AWBM parameters

Parameter	Natural	Rehabilitated	Spoil
C1 (mm)	90	8	8
C2 (mm)	135	65	34
C3 (mm)	270	-	-
A1	0.2	0.1	0.1
A2	0.4	0.9	0.9
A3	0.4	-	-
BFI	0.2	0.9	0.9
Kbase	0.98	0.7	0.7
Ksurf	0	0	0

3.4 SALINITY OF THE PIT LAKE

Sources of salinity in the final void pit lake include:

- runoff and seepage from the final void catchments; and
- groundwater inflows.

The water balance model was configured to use salinity as an indicator of water quality. This was achieved by assigning representative Electrical Conductivity (EC) as concentrations to runoff from catchments and other sources of water.

The adopted salinity values for the adopted land uses are based on the calibrated values provided in Hatch (2015), which have been reproduced in Table 3.3. The average groundwater salinity has been based on a review recent of groundwater quality monitoring data undertaken by the Groundwater Functions Pty Ltd (GF, 2022).

Table 3.3 - Adopted salinity concentrations

Landuse	Salinity (mg/L)	Source/ Comments
Rainfall	20	QLD Gov (2008)
Natural Runoff	250	Hatch (2015)
Spoil	1,500	Hatch (2015)
Rehab	3,000	Hatch (2015)
Groundwater	55,000	GF (2022)

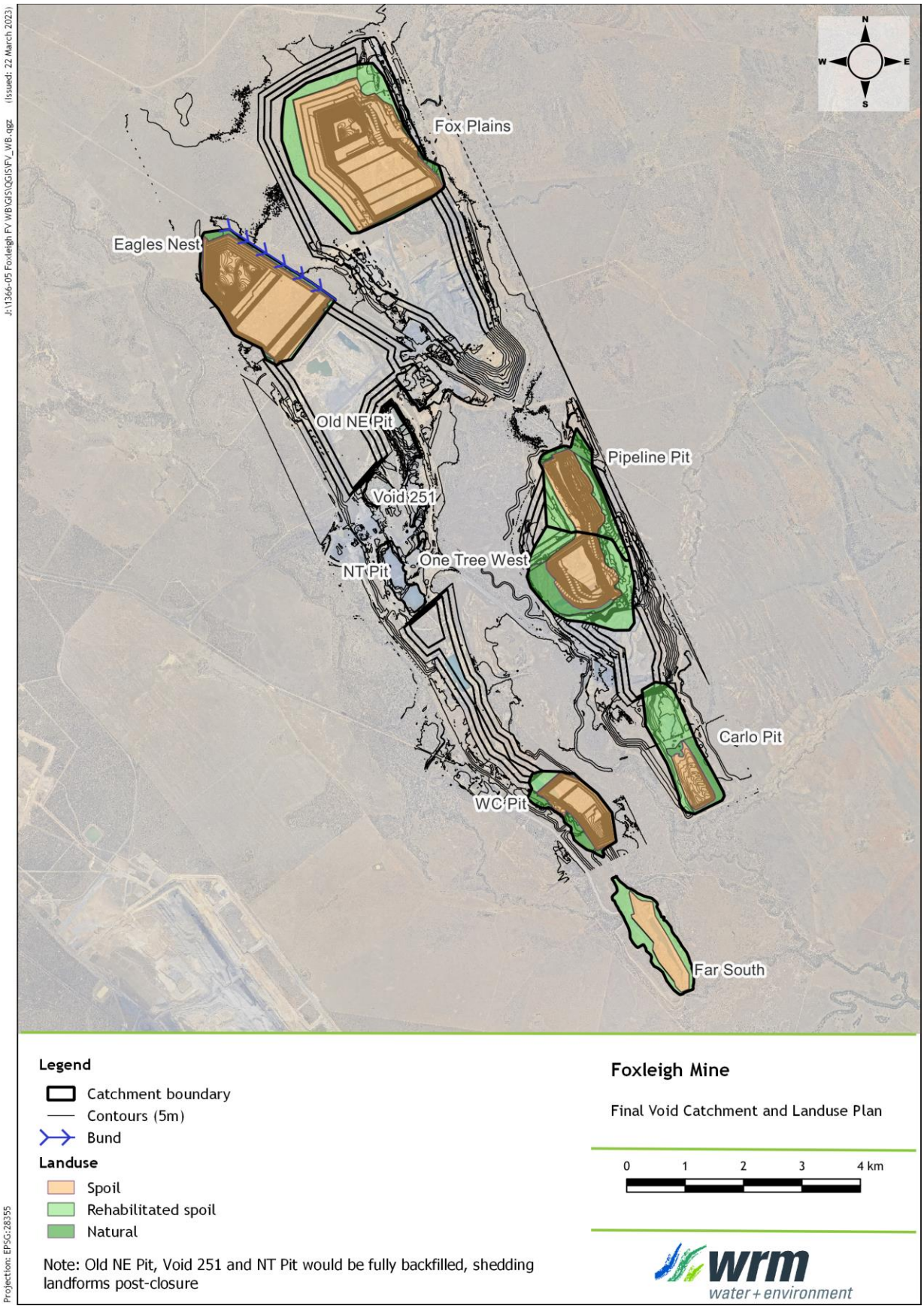

Figure 3.2 - Final void site catchment/land uses

3.5 GROUNDWATER INFLOWS

Groundwater inflow rates have been assumed as per Report on Groundwater Modelling of Foxleigh Coal Mine (GF, 2022). The maximum groundwater inflow rate of each void is used as the input for the GoldSim model. These values are provided in Table 3.4.

Table 3.4 - Maximum groundwater inflow rate to void

Pit Name	Maximum Flow Rate (L/s)
Far South pit	0.16
Eagles Nest pit	10.56
Fox Plains Pit	18.02
One Tree West pit	3.6
Pipeline pit	1.9
WC pit	3.6
Carlo Creek pit	0.48

3.6 CLIMATE CHANGE ASSESSMENT

3.6.1 Methodology and sensitivity parameters

The potential impacts of climate change on residual void behaviour were assessed using the projections and methodologies given in the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Commonwealth Bureau of Meteorology (BoM) report entitled Climate Change in Australia Technical Report (CSIRO, 2015). Projections are given for a number of climatic variables including (but not limited to) temperature, rainfall, wind speed and potential evapotranspiration. CSIRO (2015) presents a number of possible approaches to quantify risks associated with climate change impacts.

The predicted changes in climate beyond the life of mine have been obtained for the Year 2090, being approximately 50 years post mine life, and are provided in Table 3.5.

Rainfall is expected to vary by between -19.8% and +4.4% and evapotranspiration is expected to increase by between 5.5% and 6.9%.

The climate variable inputs (rainfall and evaporation) to the Project water balance model were adjusted to undertake the climate change impact assessment. Table 3.5 shows the adopted Year 2090 climate projections for the 'best', 'maximum consensus' and 'worst' case RCP4.5 climate change scenarios. The 'best' and 'worst' case scenarios have been assessed for the proposed final voids.

Table 3.5 - Projections of changes to climate - Year 2090

Scenario	Climate model	Rainfall	Evapotranspiration
		Annual change	Annual change
Best case	GFDL-ESM2M	-19.8	6.9%
Maximum Consensus	ACCESS1-0	-10.1%	7.8%
Worst case	NorESM1-M	4.4%	5.5%

The results of potential climate change impacts are provided in Figure 4.1 to Figure 4.7 and Section 4.

4 Final void results

4.1 OVERVIEW

The final void was modelled using the assumptions outlined in Section 3 and the results are outlined in Section 4.2.

4.2 FINAL VOID MODEL RESULTS

4.2.1 Long-term water level behaviour

The final void water level for the base case was modelled over a 500-year period and is shown in Figure 4.1 to Figure 4.7. Table 4.1 shows a summary of the storage details of the residual voids and the results of the water balance modelling.

Table 4.1 – Final void modelling results summary

Void	Elevation (mAHD)			
	Final landform floor level	Overflow level	Modelled average long-term water level	Modelled peak long-term water level
Eagle Nest	-104	137	41.5	45.1
Fox Plains	-130	134	71.6	75.1
One Tree West	-29	129	47.7	52.1
Pipeline Pit	-43	129	67.4	71.3
WC Pit	-15	125	42.8	46.1
Far South	70	124	81.3	86.4
Carlo	86	125	105.6	110.8

The model results show:

- Eagles Nest
    - The final void reaches equilibrium after about 200 years, with the void oscillating between 40 mAHD and 45 mAHD.
    - The final void forms a long-term groundwater sink based on the groundwater recharge level of around 122.5 mAHD (as shown on Figure 4.1).
    - The maximum modelled water level is about 92 metres below the pit overflow level.
- Fox Plains
    - The final void reaches equilibrium after around 200 years, with the void oscillating between 68 mAHD and 75 mAHD.
    - The final void forms a long-term groundwater sink based on the groundwater recharge level of around 122.5 mAHD (as shown on Figure 4.1).
    - The maximum modelled water level is about 59 metres below the pit overflow level.
- One Tree West

    - The final void reaches equilibrium after about 200 years, with the void oscillating between 42 mAHD and 52 mAHD.
    - The final void forms a long-term groundwater sink based on the groundwater recharge level of around 122.5 mAHD (as shown on Figure 4.1).
    - The maximum modelled water level is about 77 metres below the pit overflow level.
- Pipeline Pit
    - The final void reaches equilibrium after about 200 years, with the void oscillating between 62 mAHD and 71 mAHD.
    - The final void forms a long-term groundwater sink based on the groundwater recharge level of around 122.5 mAHD (as shown on Figure 4.1).
    - The maximum modelled water level is about 58 metres below the pit overflow level.
- WC Pit
    - The final void reaches equilibrium after within 50 years, with the void oscillating between 39 mAHD and 46 mAHD.
    - The final void forms a long-term groundwater sink based on the groundwater recharge level of around 122.5 mAHD (as shown on Figure 4.1).
    - The maximum modelled water level is about 79 metres below the pit overflow level.
- Far South
    - The final void reaches equilibrium after about 100 years, with the void oscillating between 76 mAHD and 86 mAHD.
    - The final void forms a long-term groundwater sink based on the groundwater recharge level of around 122.5 mAHD (as shown on Figure 4.1).
    - The maximum modelled water level is about 38 metres below the pit overflow level.
- Carlo
    - The final void reaches equilibrium after about 75 years, with the void oscillating between 100 mAHD and 110 mAHD.
    - The final void forms a long-term groundwater sink based on the groundwater recharge level of around 122.5 mAHD (as shown on Figure 4.1).
    - The maximum modelled water level is about 15 metres below the pit overflow level.

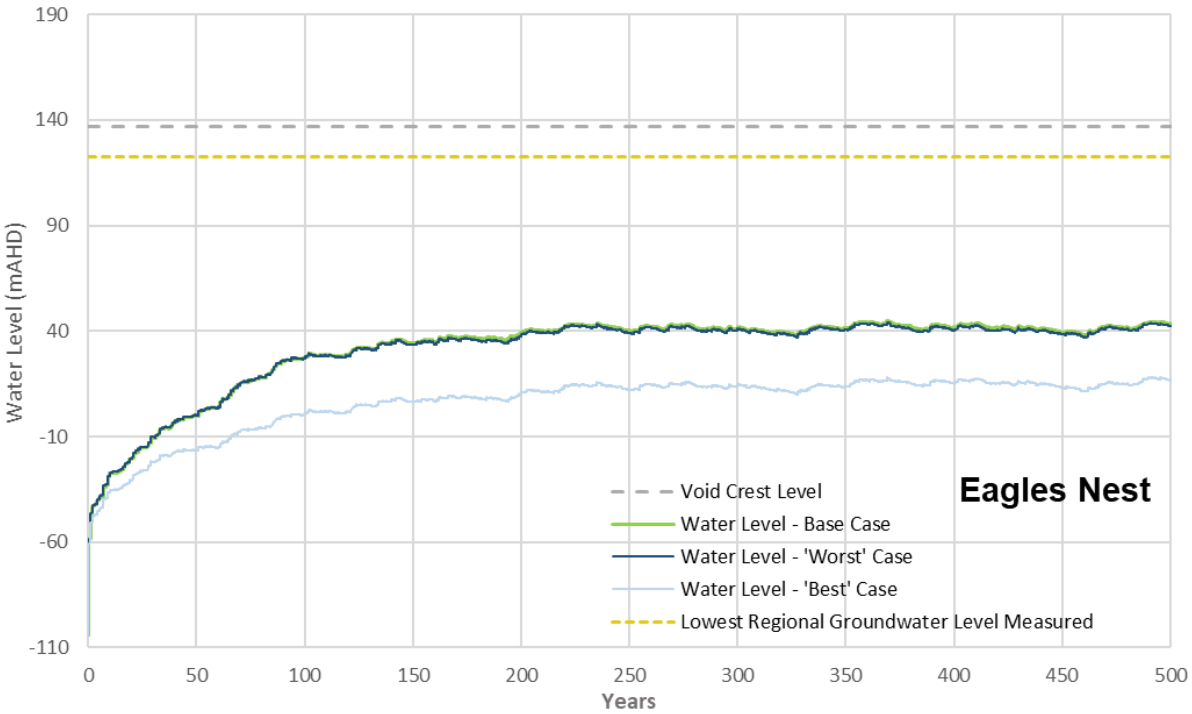

Figure 4.1 - Eagles Nest final void long-term predicted void water level

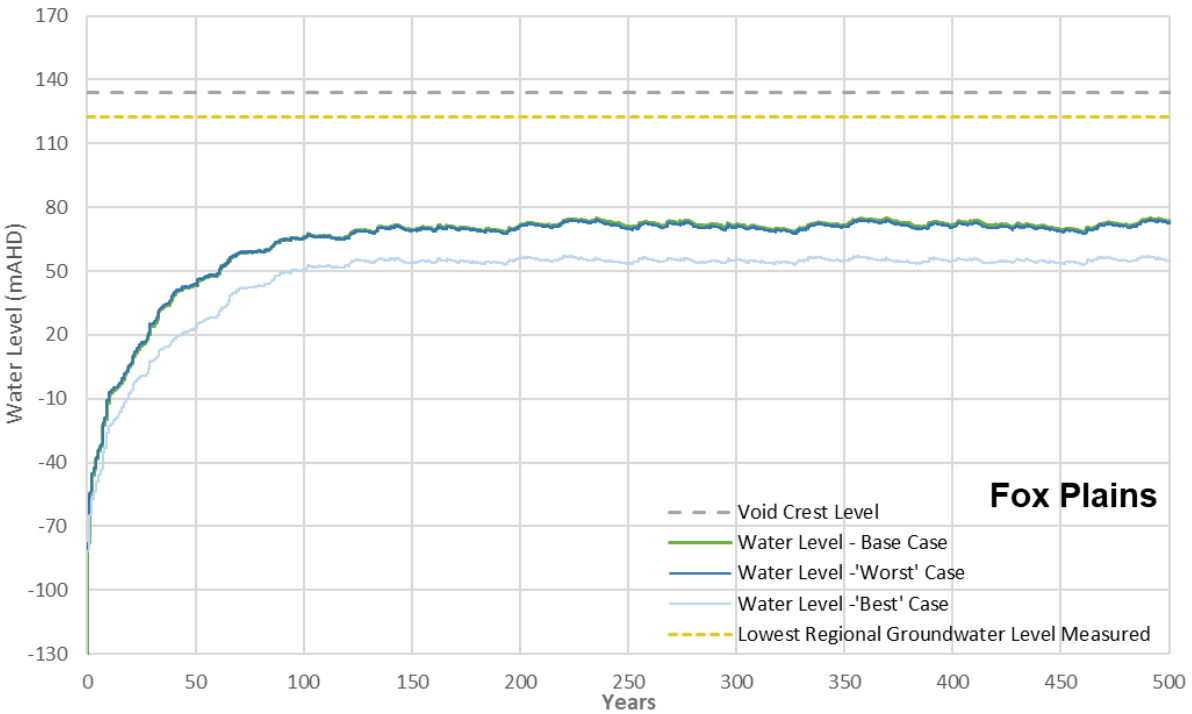

Figure 4.2 Fox Plains final void long term predicted void water level

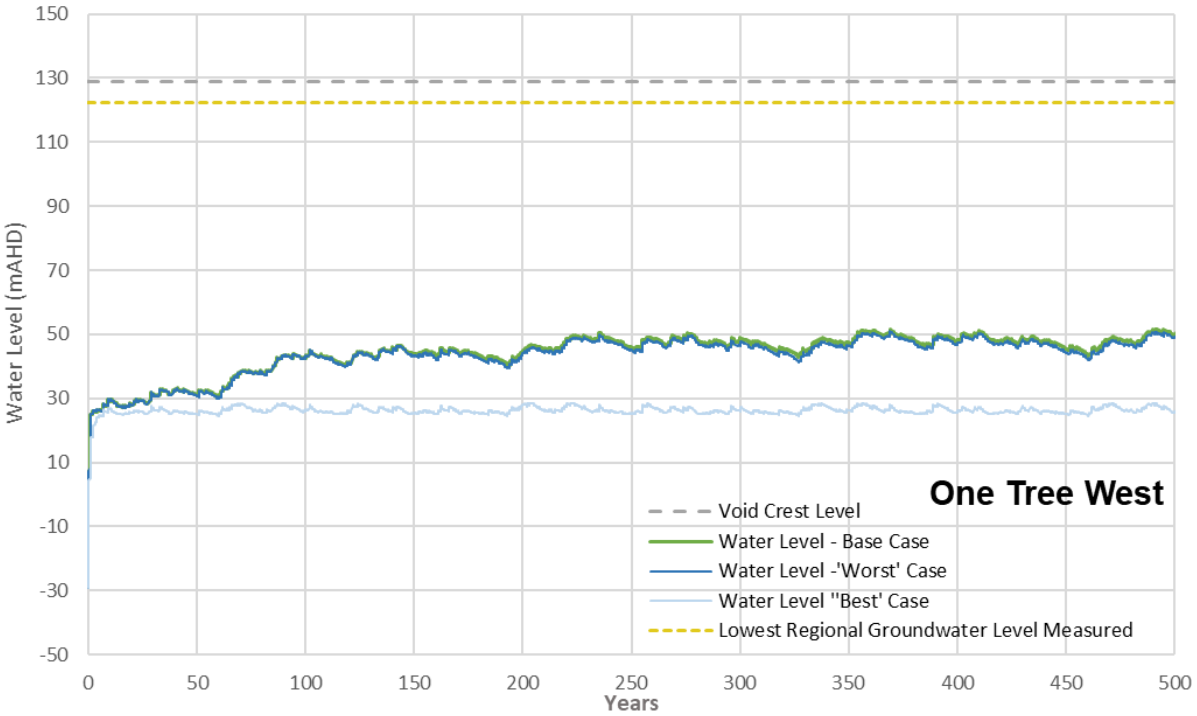

Figure 4.3 One Tree West final void long term predicted void water level

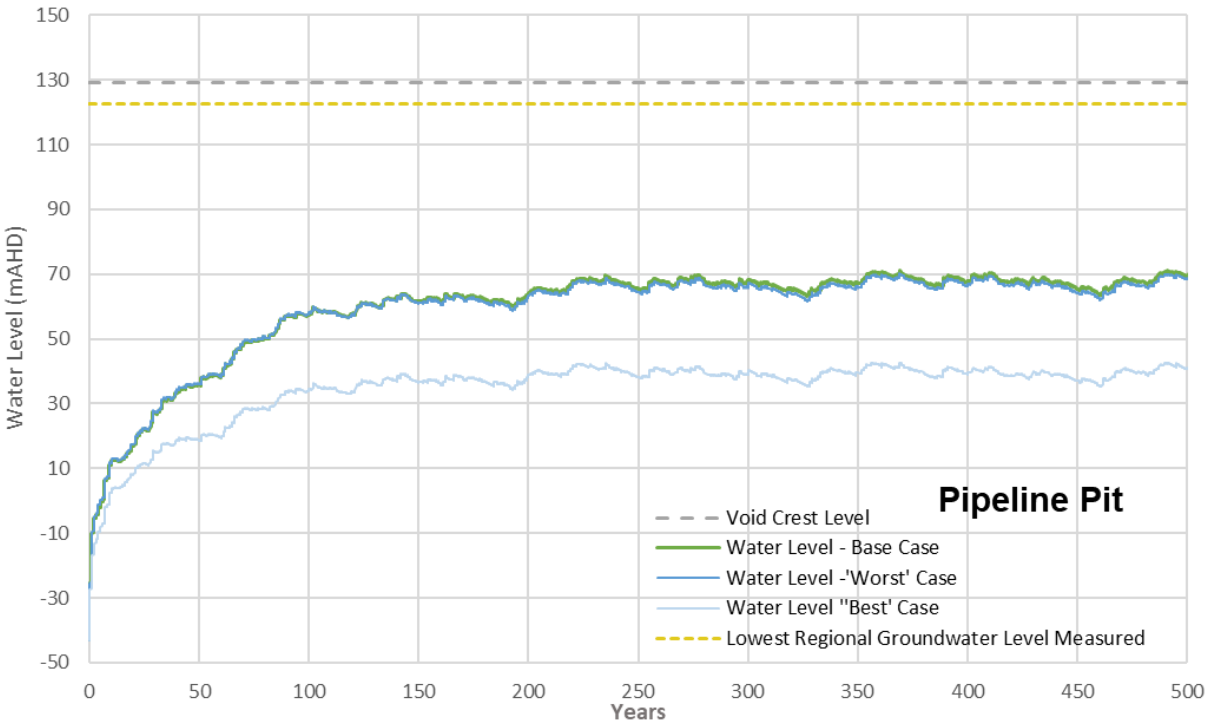

Figure 4.4 Pipeline Pit final void long term predicted void water level

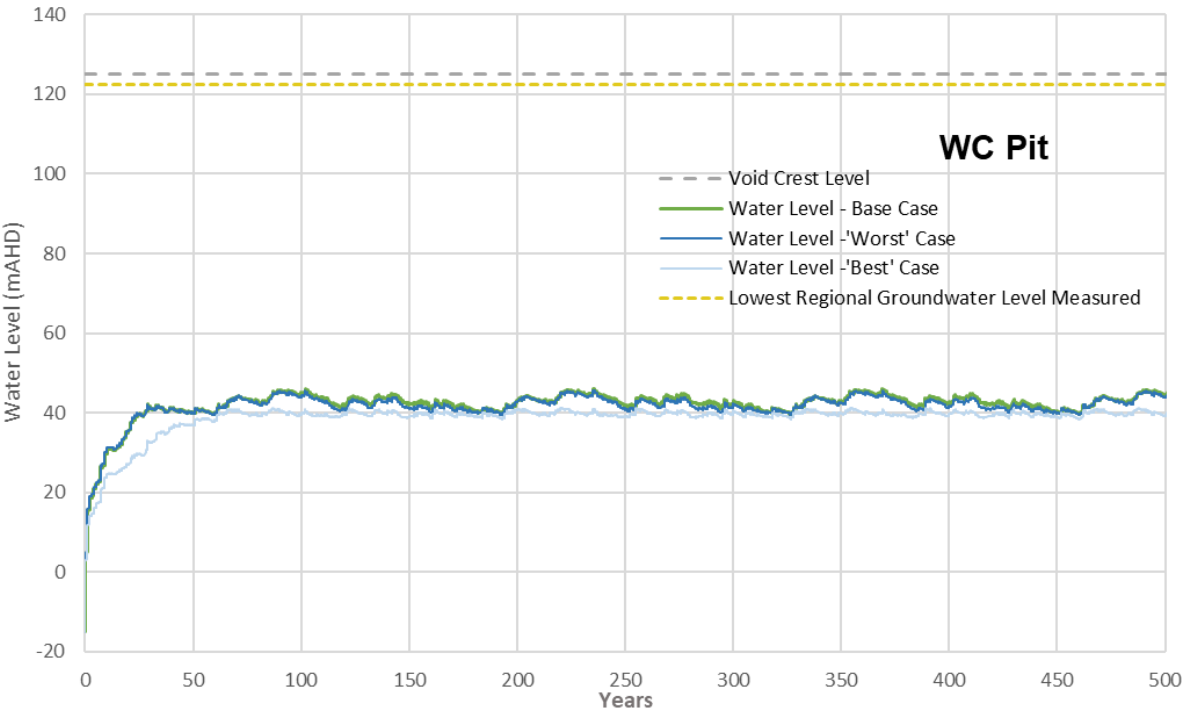

Figure 4.5 WC Pit final void long term predicted void water level

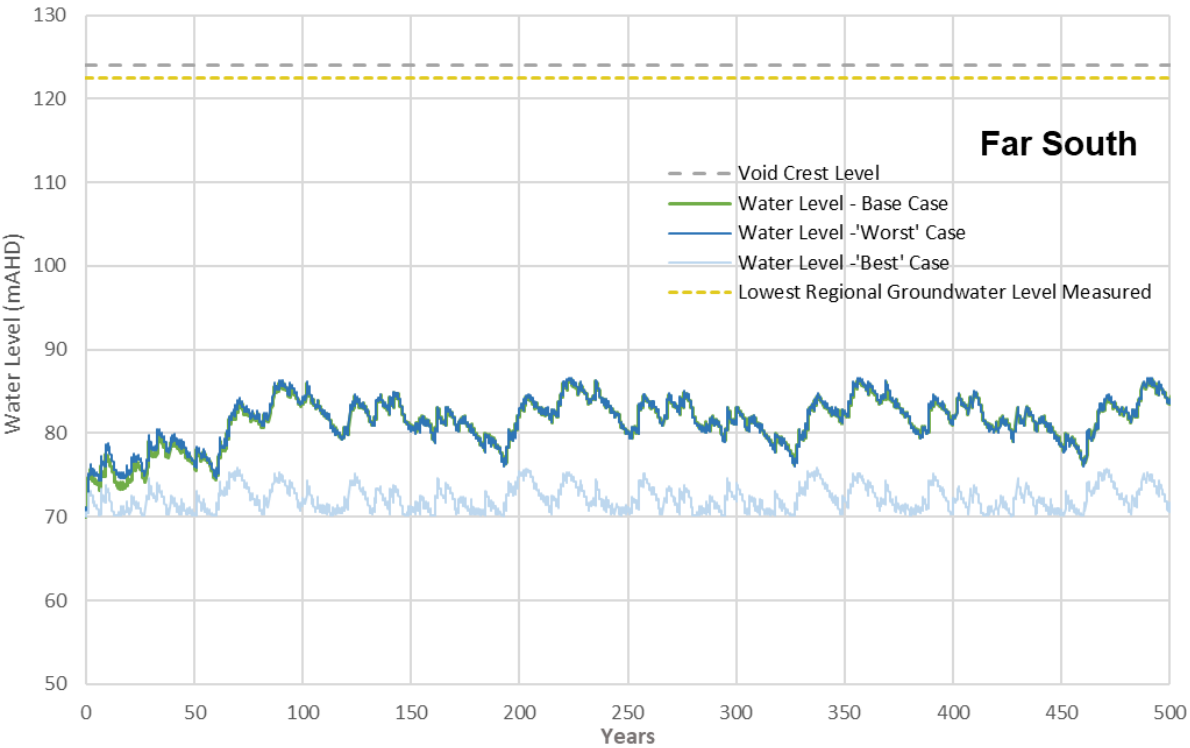

Figure 4.6 Far South final void long term predicted void water level

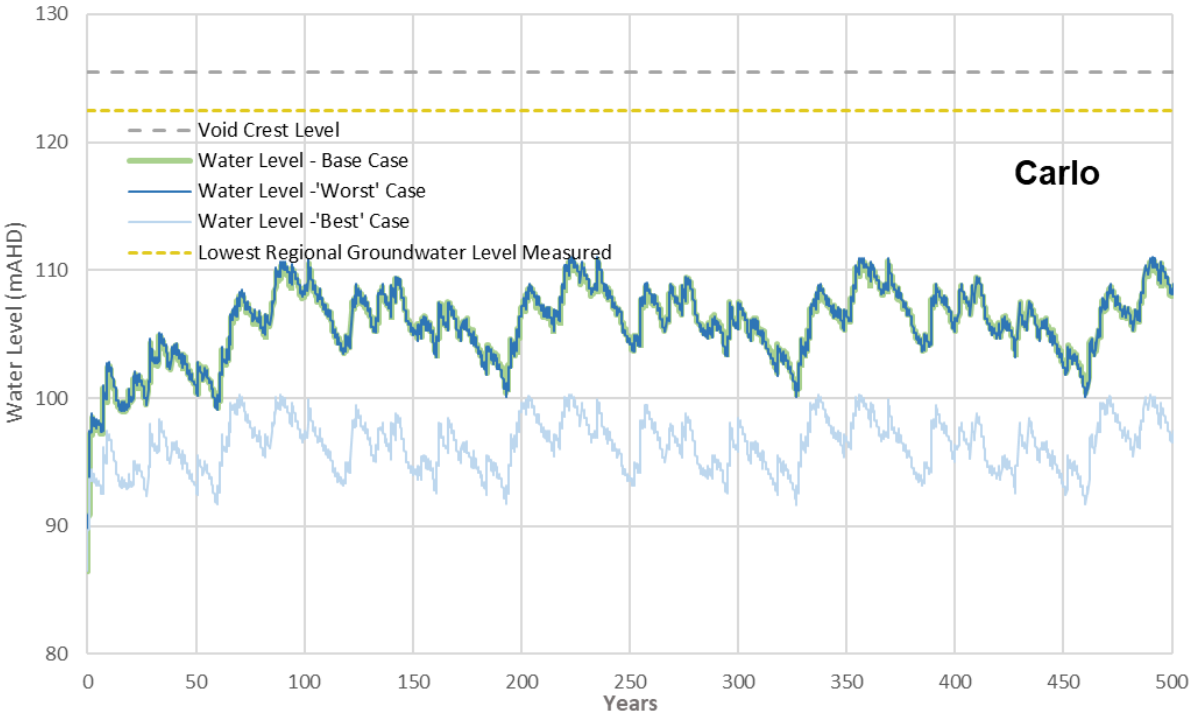

Figure 4.7 Carlo final void long term predicted void water level

4.2.2 Potential climate change impacts

4.2.2.1 Overview

Potential climate change impacts to the final void water balance were assessed by simulating the 'best' case and 'worst' case climate scenarios for the Year 2090 climate changes projection. The water balance model climate inputs (rainfall and evaporation) were factored by the values given in Table 3.5.

4.2.2.2 Potential impact on final void water levels

The impact of the potential changes in rainfall and evapotranspiration for the proposed final void is presented in Figure 4.1 to Figure 4.7. The results show the following (with the baseline results shown for reference):

- For the 'worst' case climate scenario:
    - There is no significant deviation from the base case scenario. The rate of increase in water level and equilibrium water level is close to the base case.
- For the 'best' case climate scenario:
    - The rate of increase in water level is lower than the base case until equilibrium is reached for all final voids.
    - Eagles Nest- equilibrium and peak water levels are around 26 m lower than under baseline climate conditions.
    - Fox Plains- equilibrium and peak water levels are around 17 to 18 m lower than under baseline climate conditions.
    - One Tree West- equilibrium and peak water levels are around 21 to 24 m lower than under baseline climate conditions
    - Pipeline Pit- equilibrium and peak water levels are around 28 m lower than under baseline climate conditions
    - WC Pit- equilibrium and peak water levels are around 3 to 5 m lower than under baseline climate conditions.
    - Far South- equilibrium and peak water levels are around 8 to 11 m lower than under baseline climate conditions.
    - Carlo- equilibrium and peak water levels are around 10 to 11 m lower than under baseline climate conditions.

4.2.3 Long-term salinity

The long-term salinity of the final void progressively increases with time. This is expected for closed-loop systems with no mechanism for salt removal.

The model results show the following:

- Eagles Nest
    - The salinity of the pit lake progressively increases, rising to a maximum salinity of approximately 197,000 mg/L in 500 years.
    - The salt load progressively increases, reaching 6,100 kilotonnes after the 500-year modelled period.
- Fox Plains
    - The salinity of the pit lake progressively increases, rising to a maximum salinity of approximately 219,000 mg/L in 500 years.
    - The salt load progressively increases, reaching 10,470 kilotonnes after the 500-year modelled period.
- One Tree West

    - The salinity of the pit lake progressively increases, reaching the solubility limit of salt in water (357,000 mg/L) around 460 years into the simulation.
    - The salt load progressively increases, reaching 2,170 kilotonnes after the 500-year modelled period.
- Pipeline Pit
    - The salinity of the pit lake progressively increases, rising to a maximum salinity of approximately 196,000 mg/L in 500 years.
    - The salt load progressively increases, reaching 2,120 kilotonnes after the 500-year modelled period.
- WC Pit
    - The salinity of the pit lake progressively increases, reaching the solubility limit of salt in water (357,000 mg/L) around 250 years into the simulation.
    - The salt load progressively increases, reaching 2,080 kilotonnes after the 500-year modelled period.
- Far South
    - The salinity of the pit lake progressively increases, reaching the solubility limit of salt in water (357,000 mg/L) around 460 years into the simulation.
    - The salt load progressively increases, reaching 170 kilotonnes after the 500-year modelled period.
- Carlo
    - The salinity of the pit lake progressively increases, reaching the solubility limit of salt in water (357,000 mg/L) around 325 years into the simulation.
    - The salt load progressively increases, reaching 362 kilotonnes after the 500-year modelled period.

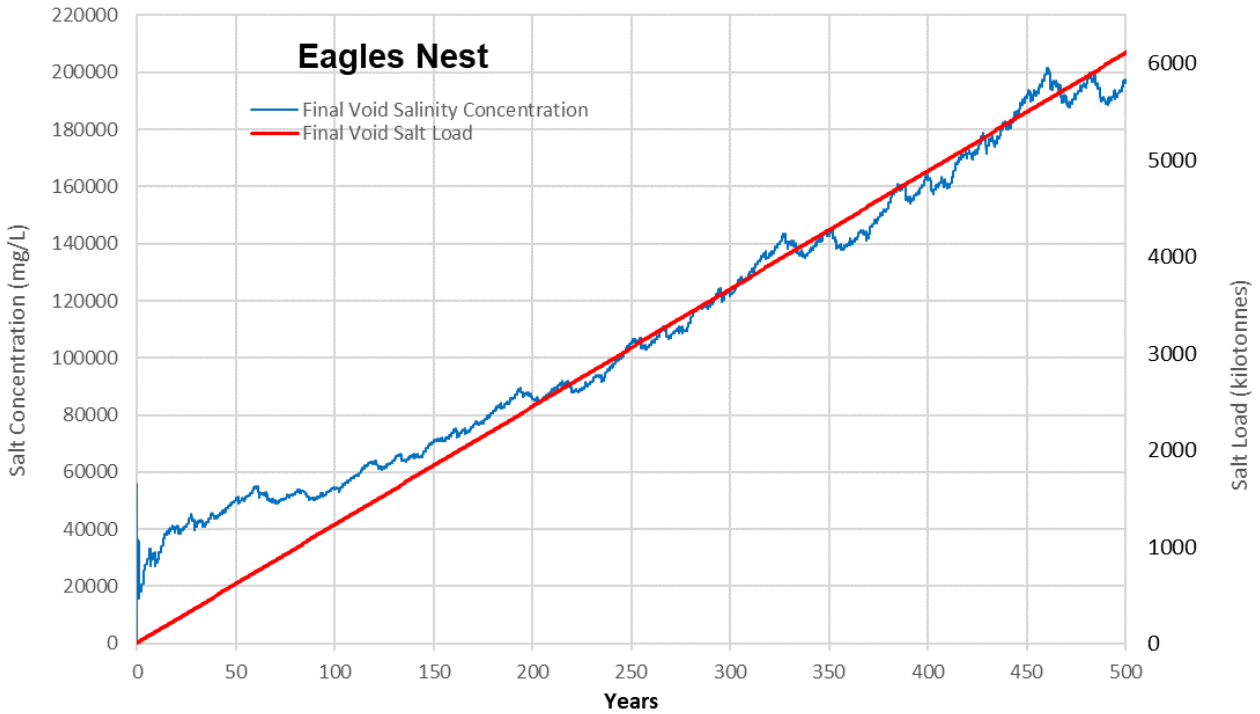

Figure 4.8 -Eagles Nest final void long-term predicted salinity concentration and load

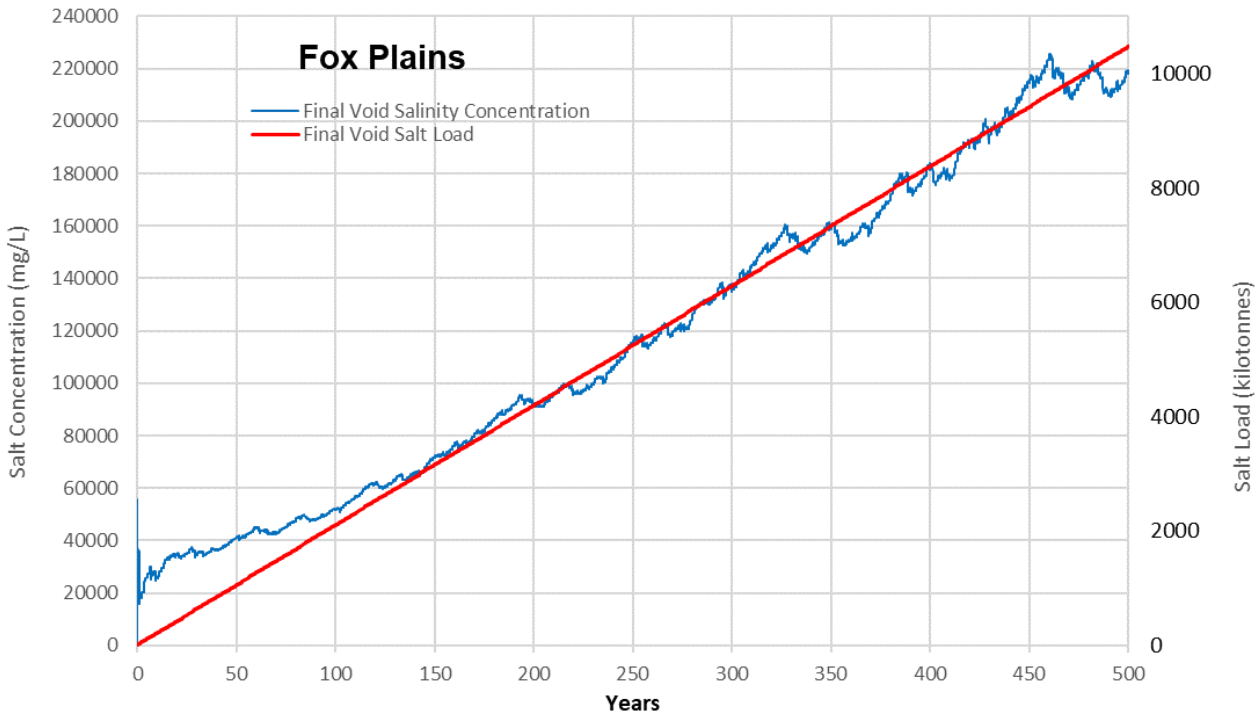

Figure 4.9 Fox Plains final void long-term predicted salinity concentration load

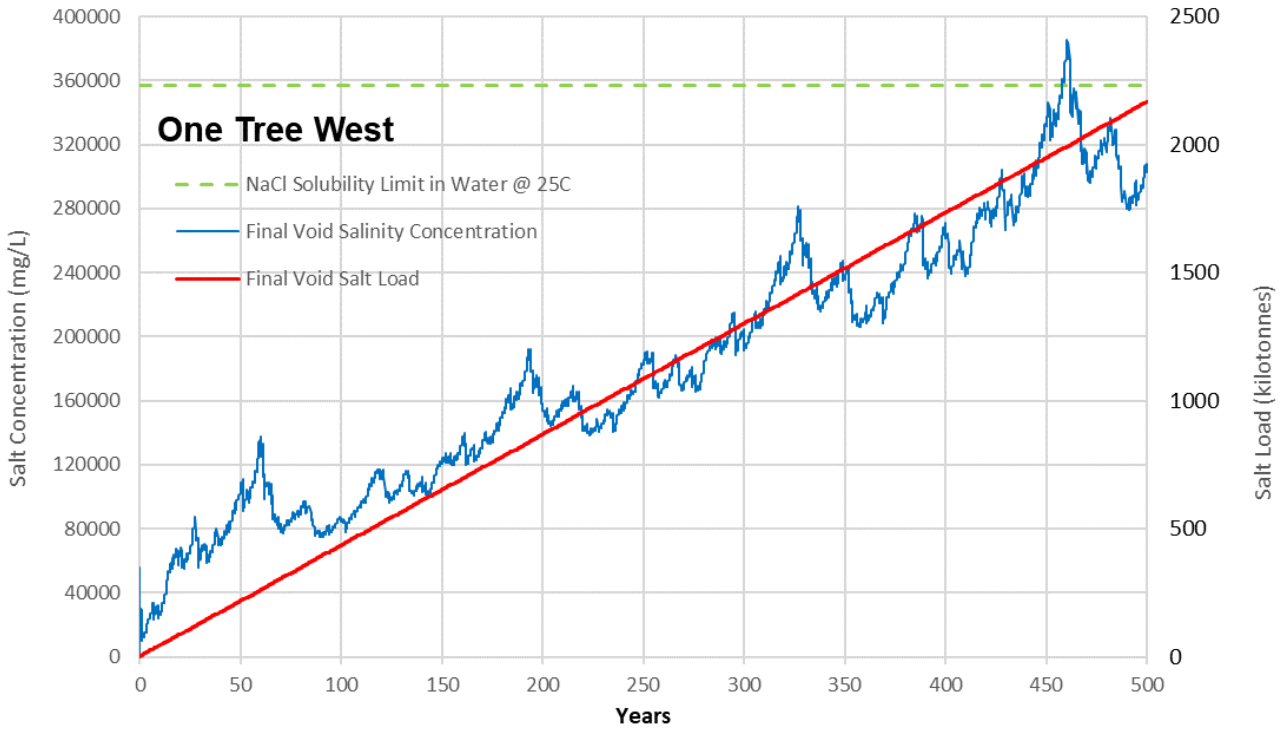

Figure 4.10 One Tree West final void long-term salinity and concentration load

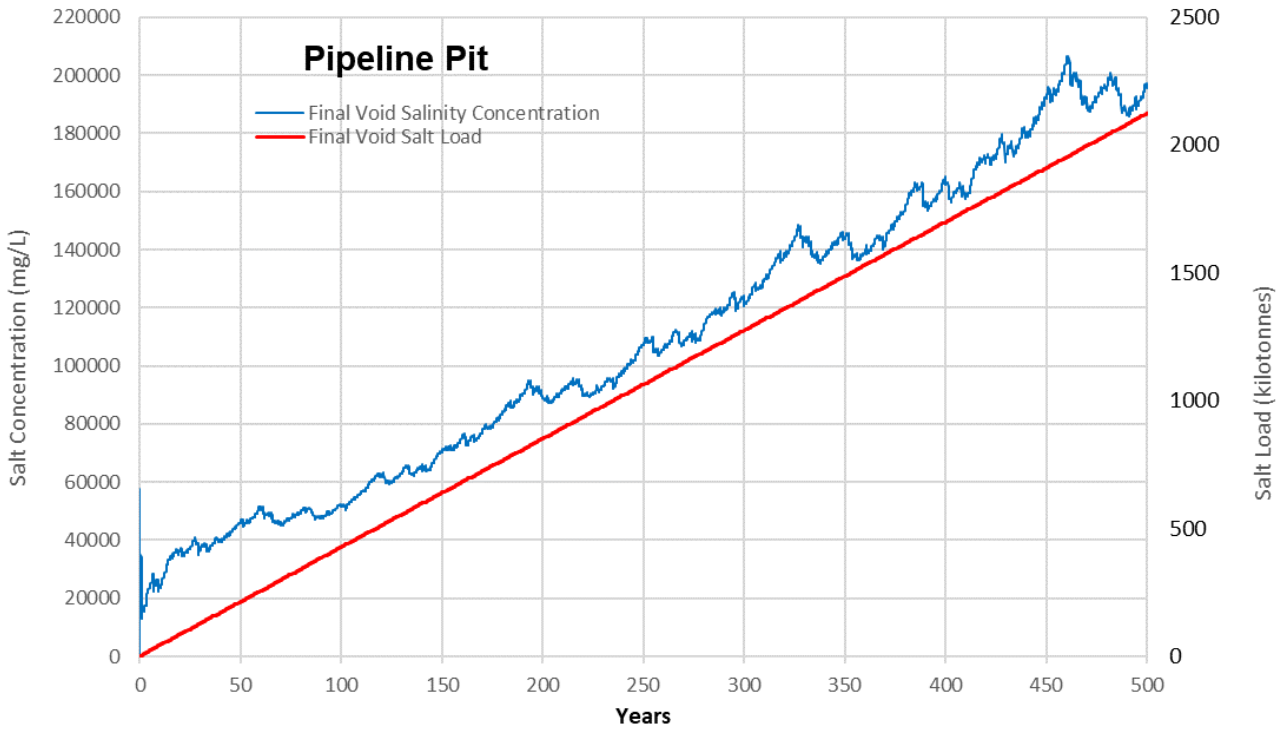

Figure 4.11 Pipeline Pit final void long-term salinity and concentration load

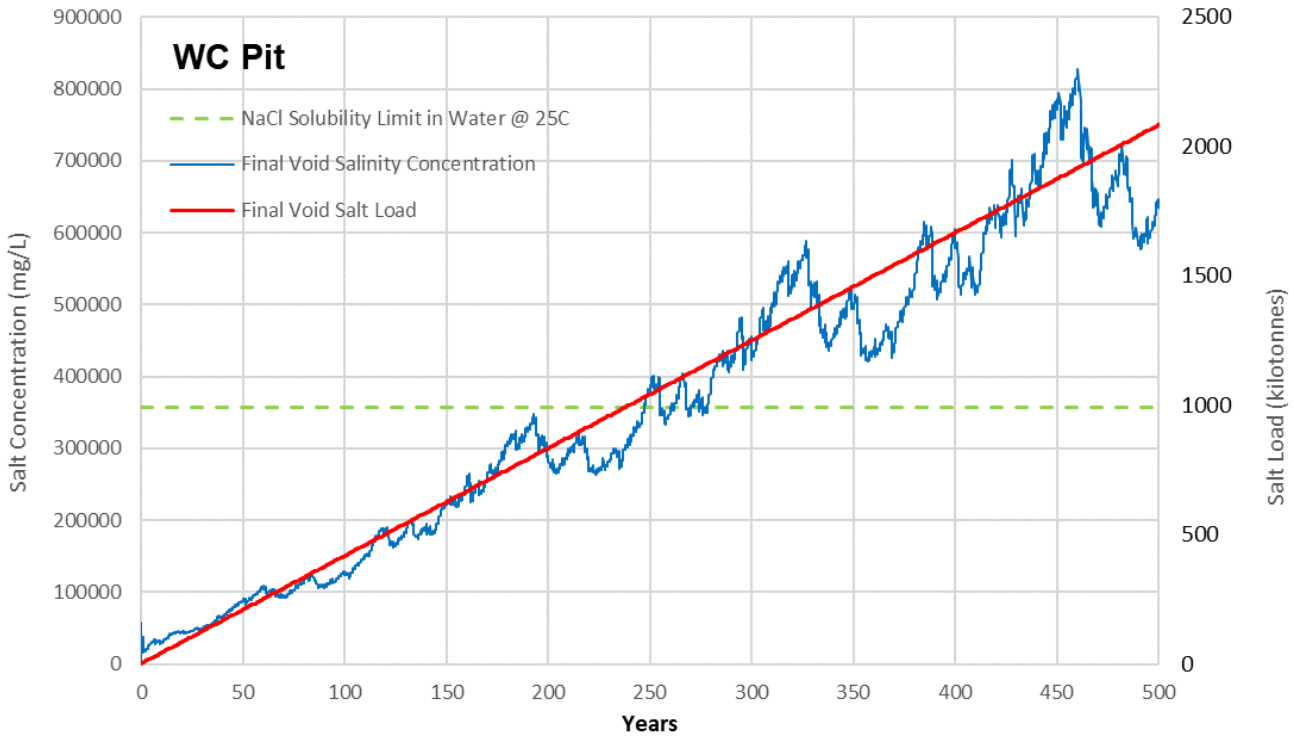

Figure 4.12 WC pit final void long-term salinity and concentration load

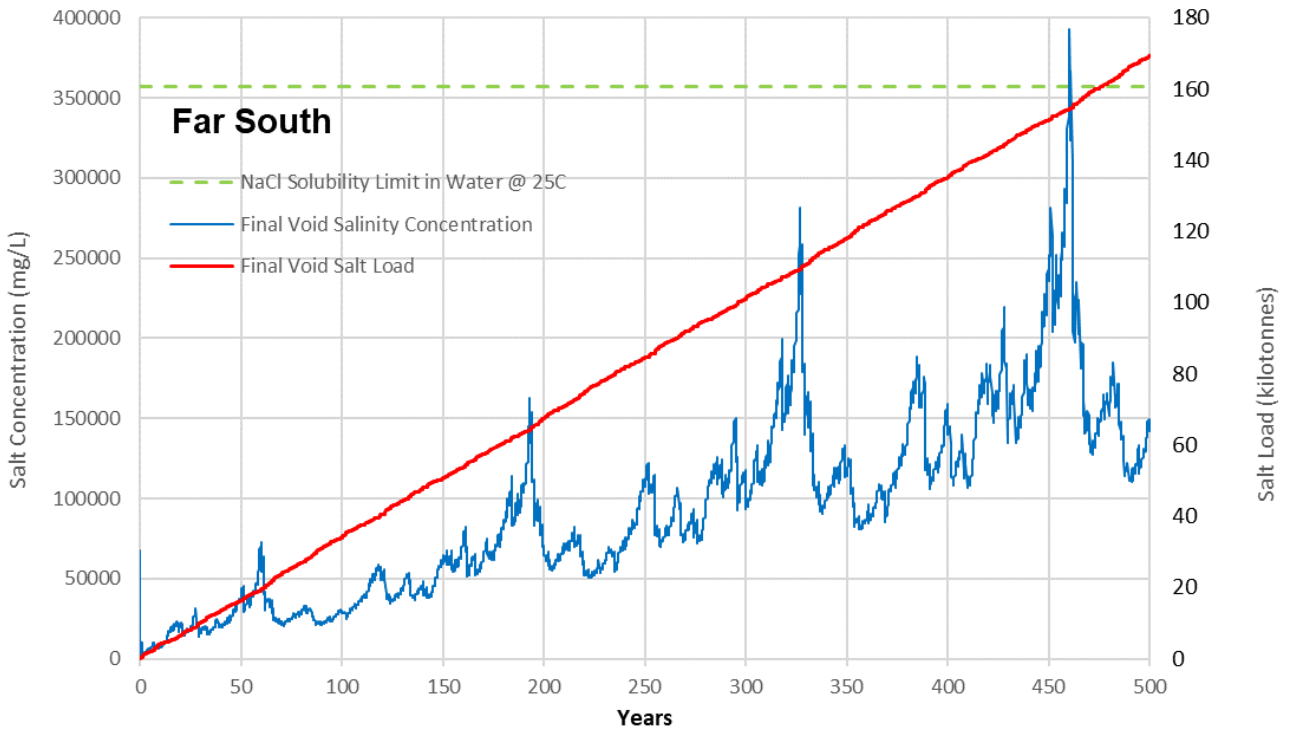

Figure 4.13 Far South final void long term salinity and concentration load

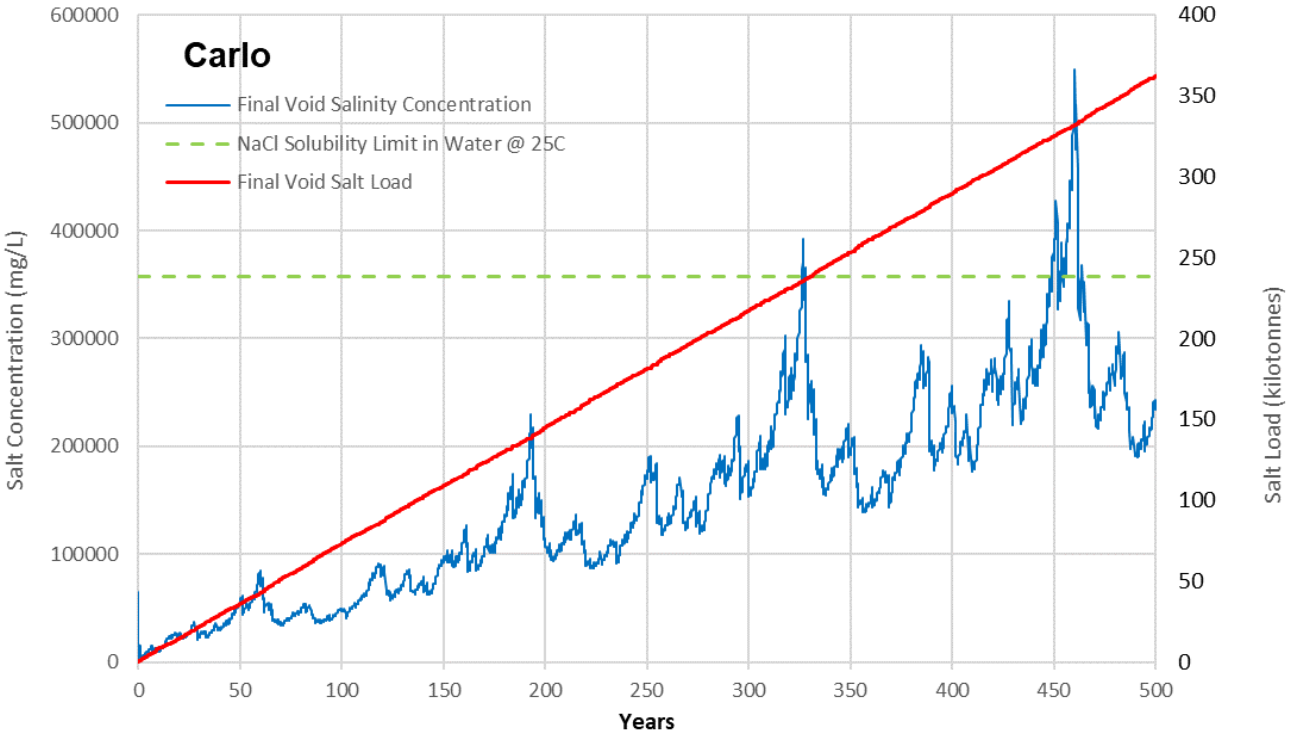

Figure 4.14 Carlo final void long term salinity and concentration load

4.3 LIMITATIONS OF THE MODEL

There is some uncertainty associated with the key inputs to the model, in particular the predicted groundwater inflows. The predicted groundwater inflows have been provided as steady-state rates, and hence do not vary based on the modelled void level. Due to this, there is degree of uncertainty in the groundwater inflows adopted in the water balance model.

Considering this uncertainty, we have undertaken a series of sensitivity analyses to assess the sensitivity of the final void equilibrium levels to higher groundwater inflows, as well as higher rainfall runoff rates. The outcomes from this assessment are presented in Section 4.4.

4.4 SENSITIVITY ANALYSIS

4.4.1 Selected sensitivity parameters

To assess the sensitivity of the final void analysis and modelled equilibrium levels, the "worst case" results for each void were analysed further using a sensitivity analysis approach to account for parameter uncertainty.

Three scenarios were modelled to test the following parameters:

- Scenario 1: AWBM rainfall runoff parameters – minus 20% soil moisture capacities (i.e. higher runoff); and
- Scenario 2: Higher groundwater inflows – 50% additional groundwater inflow
- Scenario 3: Scenario 1 + Scenario 2 = Scenario 3

The third scenario is highly conservative but provides an upper envelope to the potential pit lake equilibrium level.

4.4.2 Sensitivity analysis outcomes

The final void water level for each of the three sensitivity scenarios was modelled over a 500-year period and is shown in Figure 4.15 to Figure 4.21 (along with the "worst case" equilibrium level). Table 4.2 shows a summary of the peak long-term water levels from the sensitivity analysis.

Table 4.2 – Sensitivity analysis modelling results summary

Void	Elevation (mAHD)			
	"Worst case" peak long-term water level	Scenario 1 peak long-term water level	Scenario 2 peak long-term water level	Scenario 3 peak long-term water level
Eagle Nest	44.1	48.4	70.4	70.8
Fox Plains	74.3	77.8	88.0	89.8
One Tree West	51.4	57.3	62.2	71.7
Pipeline Pit	70.5	73.9	79.4	85.4
WC Pit	45.6	48.0	65.1	70.2
Far South	86.7	89.0	87.0	89.2
Carlo	111.0	114.4	112.0	115.3

The model results show:

- Eagles Nest
  - The Scenario 1 and Scenario 2 equilibrium levels are approximately 4.2 m and 26.3 m higher than the "worst case" scenario, respectively.
  - The Scenario 3 equilibrium level is approximately 26.6 m higher than the "worst case" scenario.
  - The maximum modelled sensitivity analysis water level is about 66 m metres below the groundwater recharge level.
  - Eagles Nest is predicted to be a long-term groundwater sink, even with the highly conservative parameters applied.
- Fox Plains
  - The Scenario 1 and Scenario 2 equilibrium levels are approximately 3.5 m and 13.6 m higher than the "worst case" scenario, respectively.

    - The Scenario 3 equilibrium level is approximately 15.5 m higher than the "worst case" scenario.
    - The maximum modelled sensitivity analysis water level is about 44 m metres below the groundwater recharge level.
    - Fox Plains is predicted to be a long-term groundwater sink, even with the highly conservative parameters applied.
- One Tree West
    - The Scenario 1 and Scenario 2 equilibrium levels are approximately 5.9 m and 10.8 m higher than the "worst case" scenario, respectively.
    - The Scenario 3 equilibrium level is approximately 20.3 m higher than the "worst case" scenario.
    - The maximum modelled sensitivity analysis water level is about 57 m metres below the groundwater recharge level.
    - One Tree West is predicted to be a long-term groundwater sink, even with the highly conservative parameters applied.
- Pipeline Pit
    - The Scenario 1 and Scenario 2 equilibrium levels are approximately 3.3 m and 8.9 m higher than the "worst case" scenario, respectively.
    - The Scenario 3 equilibrium level is approximately 14.9 m higher than the "worst case" scenario.
    - The maximum modelled sensitivity analysis water level is about 44 m metres below the groundwater recharge level.
    - Pipeline Pit is predicted to be a long-term groundwater sink, even with the highly conservative parameters applied.
- WC Pit
    - The Scenario 1 and Scenario 2 equilibrium levels are approximately 2.4 m and 19.5 m higher than the "worst case" scenario, respectively.
    - The Scenario 3 equilibrium level is approximately 24.5 m higher than the "worst case" scenario.
    - The maximum modelled sensitivity analysis water level is about 55 m metres below the groundwater recharge level.
    - WC Pit is predicted to be a long-term groundwater sink, even with the highly conservative parameters applied.
- Far South
    - The Scenario 1 and Scenario 2 equilibrium levels are approximately 2.3 m and 0.3 m higher than the "worst case" scenario, respectively.
    - The Scenario 3 equilibrium level is approximately 2.6 m higher than the "worst case" scenario.
    - The maximum modelled sensitivity analysis water level is about 35 m metres below the groundwater recharge level.
    - Far South is predicted to be a long-term groundwater sink, even with the highly conservative parameters applied.
- Carlo
    - The Scenario 1 and Scenario 2 equilibrium levels are approximately 3.4 m and 1.0 m higher than the "worst case" scenario, respectively.
    - The Scenario 3 equilibrium level is approximately 4.3 m higher than the "worst case" scenario.

- The maximum modelled sensitivity analysis water level is about 10 m metres below the groundwater recharge level.
- Carlo is predicted to be a long-term groundwater sink, even with the highly conservative parameters applied.

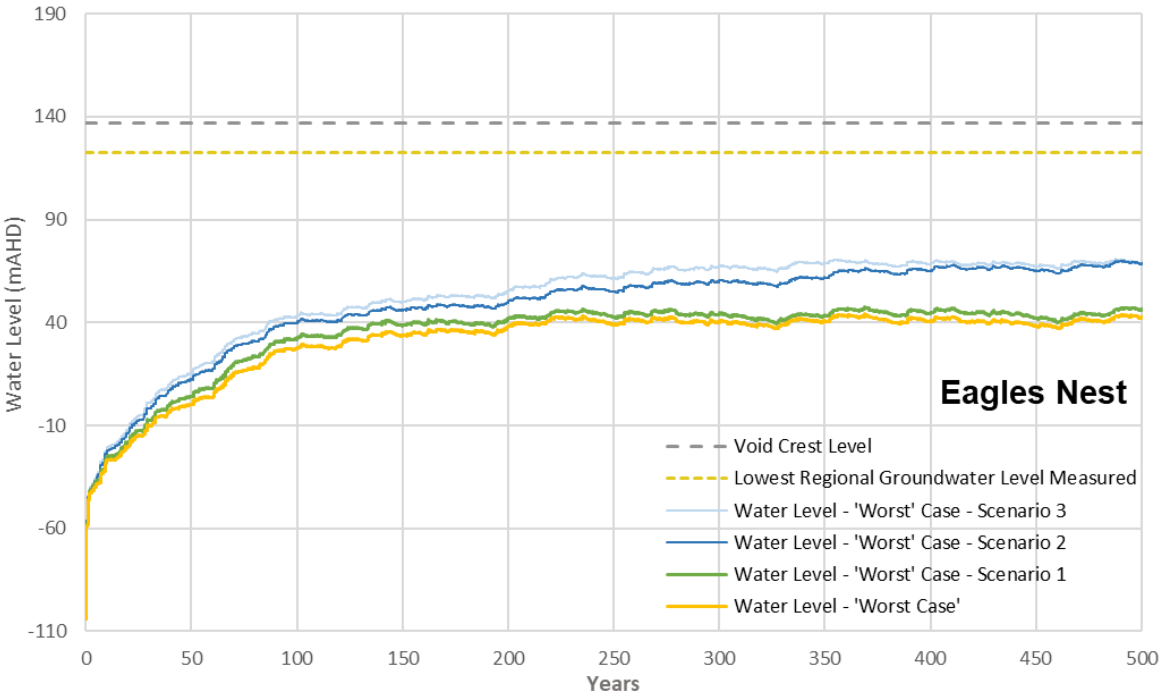

Figure 4.15 - Eagles Nest final void long-term predicted void water level - sensitivity analysis

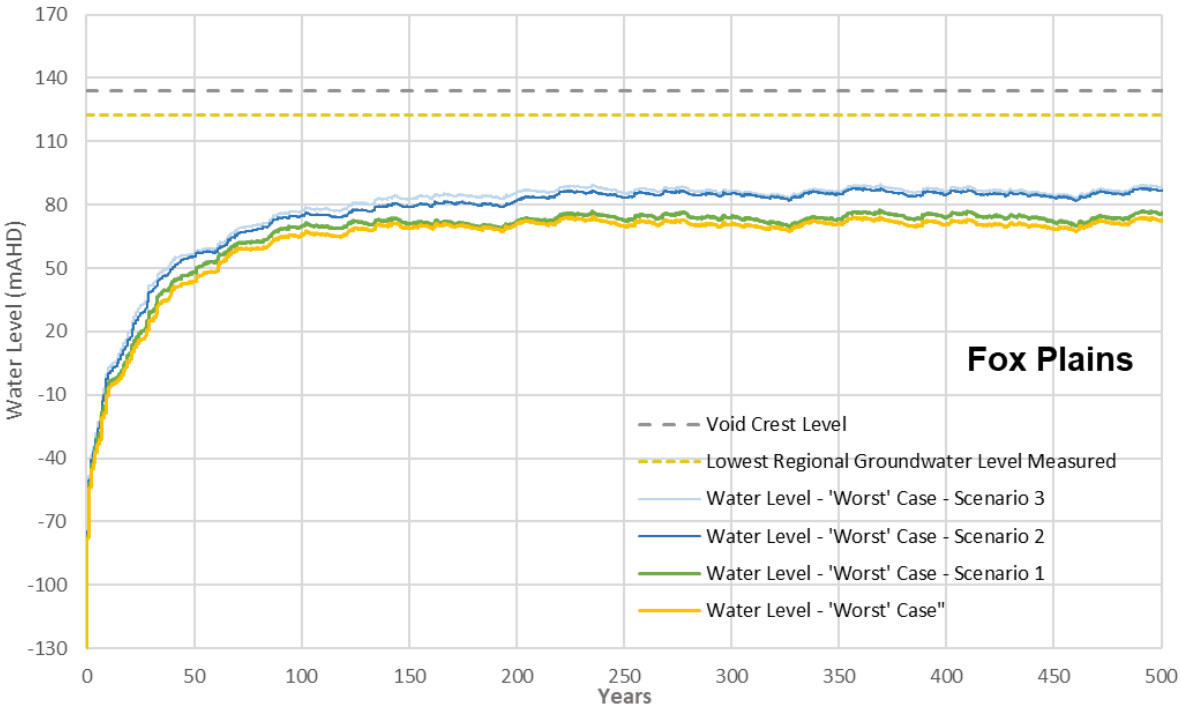

Figure 4.16 Fox Plains final void long term predicted void water level - sensitivity analysis

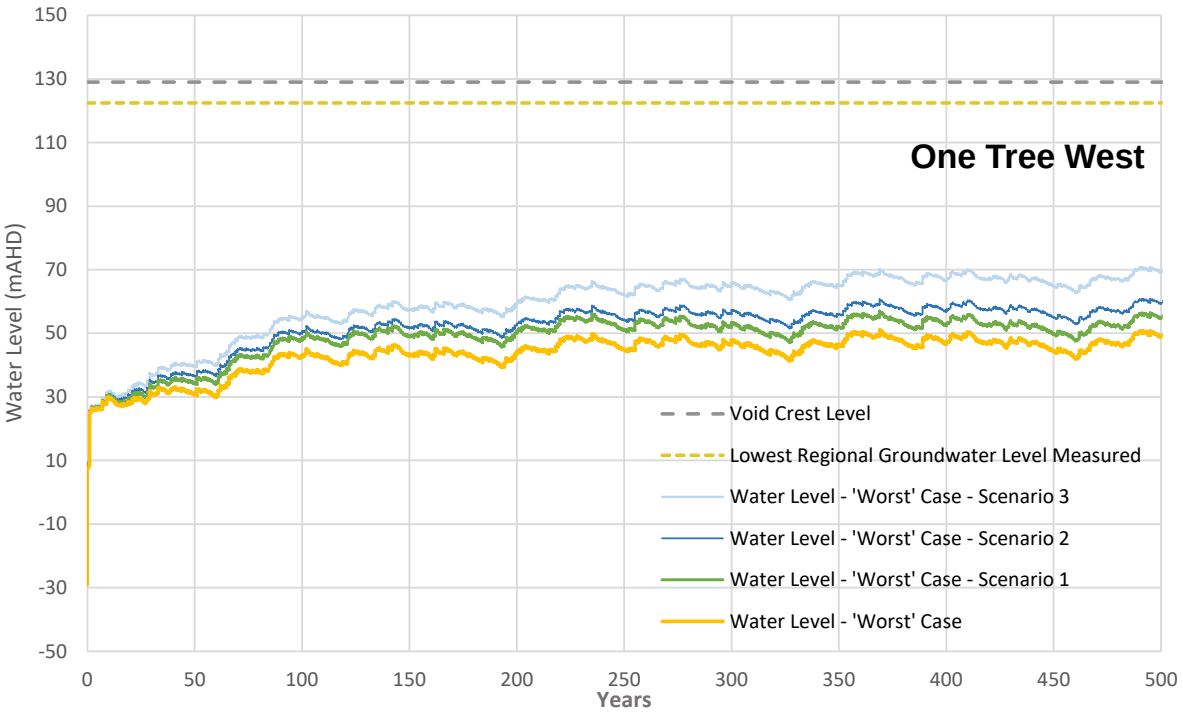

Figure 4.17 One Tree West final void long term predicted void water level - sensitivity analysis

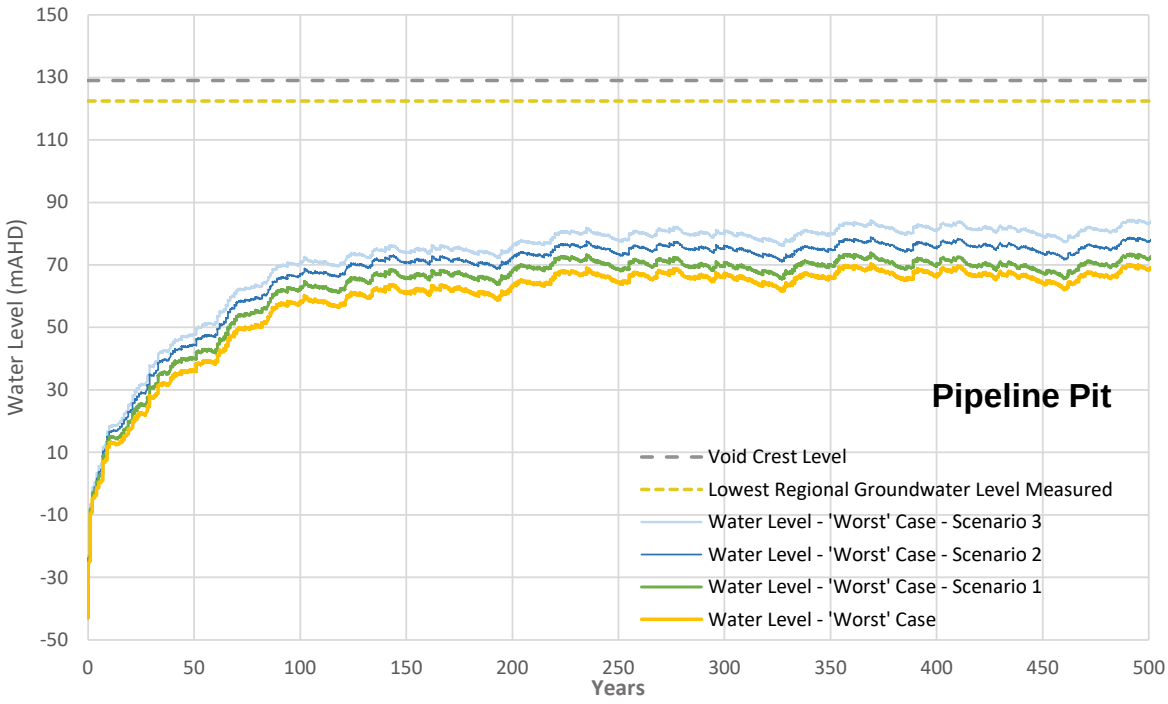

Figure 4.18 Pipeline Pit final void long term predicted void water level - sensitivity analysis

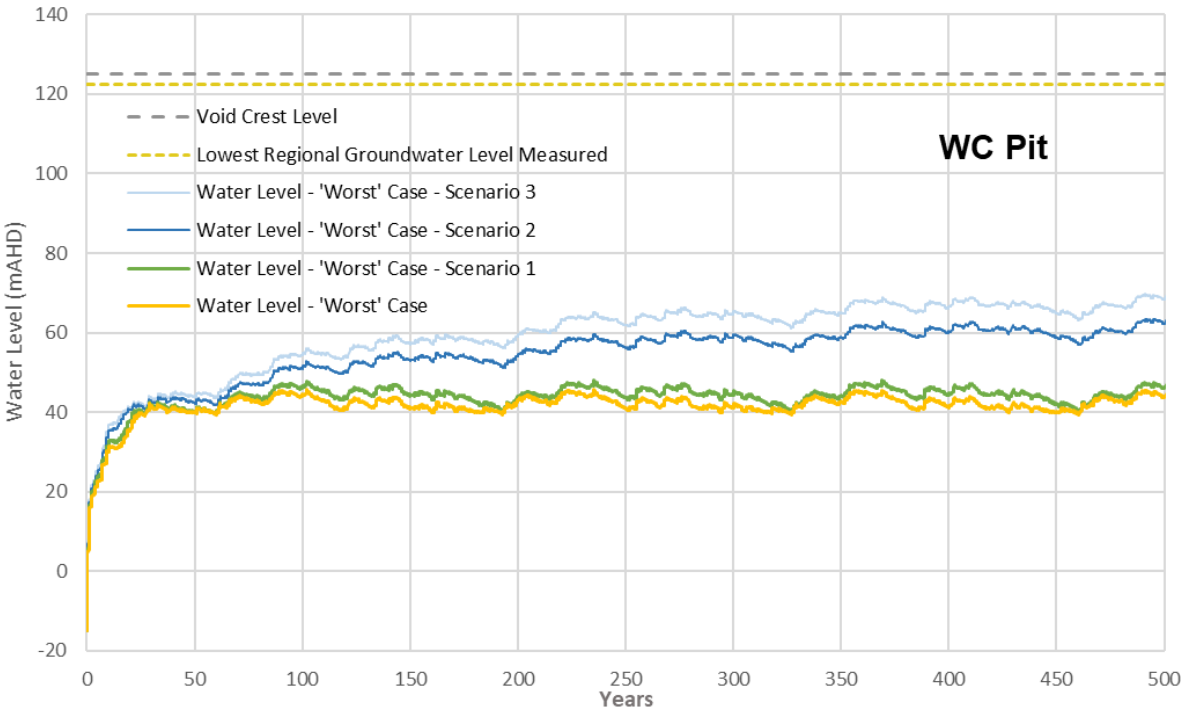

Figure 4.19 WC Pit final void long term predicted void water level - sensitivity analysis

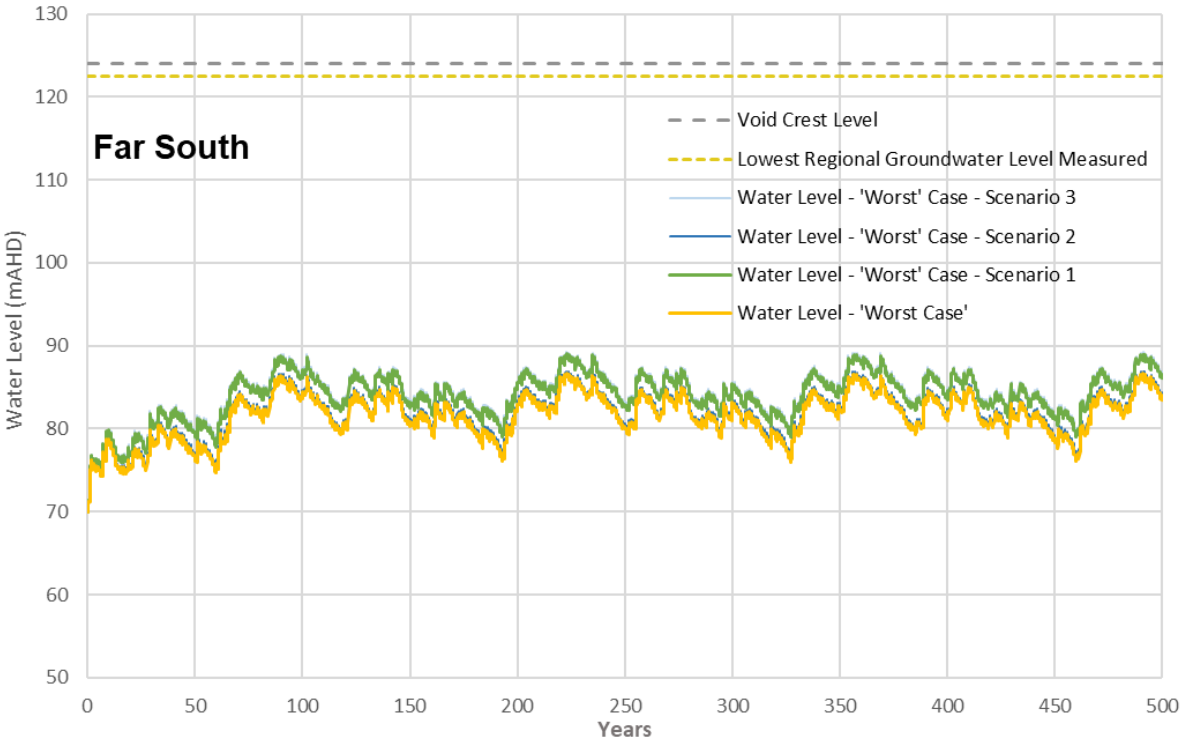

Figure 4.20 Far South final void long term predicted void water level - sensitivity analysis

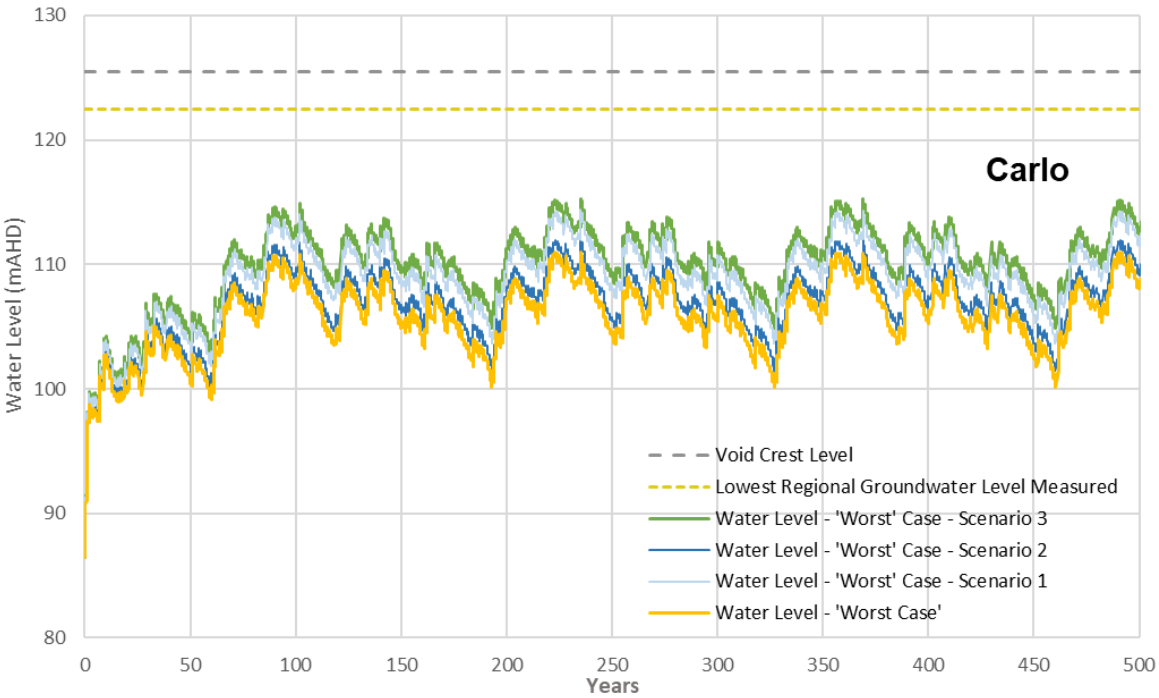

Figure 4.21 Carlo final void long term predicted void water level - sensitivity analysis

5 Summary and conclusions

A GoldSim water balance model was developed to assess the long-term water level and salinity behaviour at the proposed Foxleigh Mine final voids. The proposed final landscape of Foxleigh Mine incorporates 7 residual voids. The final voids are protected by bunds limiting the runoff catchment to the area of the voids. The final void was modelled for a 500-year period following mine closure.

The final void model results show the following:

- All 7 final voids reach their equilibrium levels within a period of 100 to 200 years post-mining.
- Based on an estimated regional groundwater recharge level of 122.5 mAHD (GF, 2022), in the long-term, all 7 voids act as a perpetual sink and does not contribute water or salinity to the surrounding groundwater system. Therefore forming a non-polluting landform.
- The maximum modelled water levels in all 7 voids are well below their respective void overflow levels and therefore the risk of overtopping to the surrounding environment is very low; and
- The salinity of the all 7 voids progressively increases over the simulation, which is as expected in a closed-loop system.

The sensitivity analysis modelled the potential impacts of uncertainly in rainfall runoff parameters and groundwater inflows. The modelling predicts that, even with conservatively high estimates of rainfall runoff and groundwater, all 7 voids continue to act as perpetual sinks.

6 References

Groundwater Functions Pty Ltd. (2022). Report on Groundwater Modelling of Foxleigh Coal Mine.

Hatch (2015). Foxleigh Mine – Water Balance Model Update (ref. H349877-00000-228-230-0001)

WRM. (2021). Water balance model update 2021 Foxleigh Mine.

Appendix P: PRCP Risk Assessment

Milestone	Risk/Hazard Description	Risk Outcome/ Consequence/ Impact	Likelihood	Consequence	Risk	Selected Control/Treatments	Required Resources	Performance Measures	Reporting and Monitoring	Likelihood	Consequence	Risk	Responsibility
Post Mining Land Use (PMLU)													
RM1: Infrastructure Decommissioning and Removal	Delays in Rehabilitation Areas (RAs) becoming progressively available	Rehabilitation Milestones (RM) not completed in the required timeframes, noncompliance with PRCP Schedule	**Possible**	**Minor**	**Medium (8)**	• Inclusion of rehabilitation activities in FoxMan Annual budget • Inclusion of rehabilitation activities in FoxMan Schedule/Forecast • Annual FoxMan PRCP Progress Technical Services review, in line with mine budget planning • PRCP Schedule Amendment	• Annual budget review • FoxMan scheduling support • FoxMan Technical Services personnel & FoxMan Management	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Minor	**Low (5)**	FoxMan Management Team Technical Services Team
	Failure to remove all infrastructure that is not to be retained post-closure (i.e., services, infrastructure, roads, carparks, hardstand areas, concrete footings)	Failure to remove all infrastructure in accordance with the PPRCP Schedule. Rehabilitation inadequate, requiring further works.	Unlikely	Moderate	**Medium (9)**	• Infrastructure decommission schedule to be incorporated into annual mine planning. • Regular progress meetings are to take place between management (i.e., responsible personnel) and work crews regarding infrastructure decommissioning and removal prior to schedule commitment date for planning and execution. • A register of infrastructure is to track which structures exist in each rehabilitation area and which have been removed. • Additional work team resourcing may be sought in the event that the completion of scheduled works is otherwise unlikely by the annual reporting date. • Have documented letters with landowners re infrastructure that is to remain	• Adequate time allocated for planning and progress meetings • funding for supplementary contractors, if required.			Rare	Moderate	**Low (5)**	Technical Services Team
	Infrastructure decommissioning and removal takes longer than anticipated	Achievement of Milestone 1 delayed	Unlikely	Minor	**Low (5)**	• Monthly progress meetings are to take place between management (i.e., responsible personnel) and work crews regarding infrastructure decommissioning and removal. • Additional work team resourcing may be sought in the event that the completion of scheduled works is otherwise unlikely by the annual reporting date.	• Adequate time allocated for planning and progress meetings • funding for supplementary contractors, if required.			Rare	Minor	**Low (3)**	Technical Services Team
RM2: Remediation and / or Management of Contaminated Land	Previously unidentified contamination source requiring investigation.	Contamination of groundwater, surface water, and/or soil. Additional costs associated with remediation. Delays to proposed timeframes for achievement of rehabilitation milestones.	Unlikely	Moderate	**Medium (9)**	• Initial consultation with an approved auditor to identify contamination targets for remediation or removal. • Maintain accurate records of incidents (i.e. spills and leaks) that have the potential to result in contamination. • Site investigation and remediation as required, e.g.: • Contaminated land site investigation undertaken in accordance with Schedule B2 (Guideline on Site Characterisation) of the National Environmental Protection (Assessment of Site Contamination) • Preparation of a Remediation Action Plan (RAP) • A validation program to confirm suitable remediation actions have been adequately implemented and the site is suitable for the final land-use	• General Environmental Management System (EMS) record management • funding for audits.	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Rare	Moderate	**Low (3)**	Technical Services Team
	Insufficient or poor waste characterisation	• Potential for acid mine drainage or saline mine drainage to reduce water quality in groundwater and surface water • High cost of remediation.	Unlikely	Major	**Low (5)**	• Waste characterisation to be undertaken when entering new un-tested areas • Ongoing testing of mine-affected water throughout operations. • Should waste rock material with reactive chemistry be identified during operations: • Geochemical specialists are to be consulted to advise about appropriate handling and management of the material.	• Adequate budget for geochemical testing. • Data from waste characterisation.			Rare	Major	**Low (5)**	Technical Services Team

RM3: Landform Development and Reshaping	Stability of final landform not being achieved	• Stability of landform not being achieved, meaning the PMLU cannot be achieved • Inherent greater erosion risks • Closure design or materials not adequate • Contaminated seepage • Un-sustainable ecosystems • Impacts to rehabilitation timing and achievement of rehabilitation milestones.	Possible	Major	**High (22)**	• Reject disposal runoff or seepage contained within mine water management system • Rehabilitate all temporary disturbance as soon as practical. • Mulching of cleared material for rehabilitation and revegetation, where applicable • Progressive rehabilitation of disturbed areas. • Adherence to the Rehabilitation Management Plan • Erosion and sediment controls until 60% ground cover is achieved • No invasive species are to be used in rehabilitation activities.	• Landform design • available material inventory • Equipment capabilities • survey/LiDAR • rehabilitation monitoring data • material characterisation data • field trials • rehabilitation trials	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Major	**Medium (9)**	Technical Services Team
	Heavy rainfall or extended periods of drought prior to and during surface preparation and revegetation	• Poor seed establishment • Erosion of rehabilitation areas • Loss of topsoil and scouring of land • Flooding of mine site causing surface water contamination	Likely	Moderate	**Significant (17)**	• Monitoring rehabilitated areas on a regular basis will ensure early detection of poor performance. Successful germination of grasses can be assessed at 6-18 months to determine viability. • During periods of drought, additional watering on rehab areas may be required • Correct stockpiling of topsoil to avoid sodic material • Inclusion of ESC where required • Supplementary seed may be required during years which experience extreme events (i.e. prolonged drought) • Earthworks timed to coincide with dry season & avoid earthwork during period of heavy predicted rainfall • Landform to be constructed to within 10% of design	• PRCP Schedule • climate data	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Moderate	**Medium (9)**	Technical Services Team
RM4: Installing Cover Systems/Capping	PMLU not structurally stable - erosional stability of TSF and capping designs	• poor landform design (capping depth, materials and thickness) • ineffective monitoring and inspection program	Possible	Moderate	**Significant (13)**	• Engineered design for capping stipulating capping depth, thickness and materials to be utilised (utilizing soil geochemistry) • Conformance to design testing • Surface water management system to contain water within close system until monitoring criteria is met • Periodic engineering assessments • Vegetation establishment per proposed rehabilitation criteria • Materials balance and characterization for material to be used for capping • Earthworks timed to coincide with dry-season & avoid earthwork during period of heavy predicted rainfall • Landform to be constructed to within 10% of design	• Technical specialist for design engineering • Personnel required for monitoring • Materials characterisation data • Survey/LiDAR • Equipment capabilities • Landform design	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Medium	**Medium (9)**	
RM5: Existing rehabilitation landform remediation	Deficit in stored topsoil required for closure	• Significant cost of topsoil importing • Poor rehabilitation outcomes	Possible	Major	**High (22)**	• Adherence to the Topsoil management plan (TMP) which includes topsoil stripping process • Maintain stockpile locations and inventory with annual review and update • Adherence to the Rehabilitation Monitoring Plan • Trials with subsoils and other approaches to provide suitable substrate	• Topsoil Management Plan • personnel required for monitoring of stockpile locations	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Major	**Significant (19)**	Technical Services Team

	Heavy rainfall or extended periods of drought prior to and during surface preparation and revegetation	• Poor seed establishment. • Erosion of rehabilitation areas. • Loss of topsoil and scouring of land. • Flooding of mine site causing surface water contamination.	Likely	Moderate	**Significant (17)**	• During periods of extended drought, additional watering on rehabilitated areas may be required • Proposed activities to occur during set time periods to coincide with suitable rainfall patterns to support seed germination • Implementation of ESC where applicable • Supplementary seed may be required during years which experience extreme events (i.e. prolonged drought). • All relevant site personnel and contractors to be trained in accordance with performed activities. • Earthworks timed to coincide with dry season • Design of landform to be prepared by suitable qualified persons • Job specific equipment to be utilised for landform design • Landform to be constructed to within 10% of design	• PRCP Schedule • climate data	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Moderate	**Medium (9)**	Technical Services Team
RM6: Surface Preparation (Cattle Grazing)	Deficit in stored topsoil required for closure	• Significant cost of topsoil. • Poor rehabilitation outcomes.	Possible	Major	**High (22)**	• Adherence to the Topsoil management plan (TMP) which includes topsoil stripping process • Maintain stockpile locations and inventory with annual review and update • Adherence to the Rehabilitation Monitoring Plan • Trials with subsoils and other approaches to provide suitable substrate	• Topsoil Management Plan • personnel required for monitoring of stockpile locations	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Major	**Significant (19)**	Technical Services Team and rehabilitation contractor
	Heavy rainfall or extended periods of drought prior to and during surface preparation and revegetation	• Poor seed establishment • Erosion of rehabilitation area • Loss of topsoil and scouring of land • Flooding of mine site causing surface water contamination.	Likely	Moderate	**Significant (17)**	• During periods of extended drought, additional watering on rehabilitated areas may be required • Proposed activities to occur during set time periods to coincide with suitable rainfall patterns to support seed germination • Implementation of ESC where applicable • Supplementary seed may be required during years which experience extreme events (i.e., prolonged drought). • All relevant site personnel and contractors to be trained in accordance with performed activities. • Earthworks timed to coincide with dry season • Design of landform to be prepared by suitable qualified persons • Job specific equipment to be utilised for landform design • Landform to be constructed to within 10% of design	• PRCP Schedule • climate data	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Moderate	**Medium (9)**	Technical Services Team
RM7: Surface Preparation (Watercourse)	Deficit in stored topsoil required for closure	• Significant cost of topsoil • Poor rehabilitation outcomes • Increased scrutiny from regulators.	Possible	Major	**High (22)**	• Adherence to the Topsoil management plan (TMP) which includes topsoil stripping process • Maintain stockpile locations and inventory with annual review and update • Adherence to the Rehabilitation Monitoring Plan	• Topsoil Management Plan • personnel required for monitoring of stockpile locations	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Major	**Significant (19)**	Technical Services Team and rehabilitation contractor

	Heavy rainfall or extended periods of drought prior to and during surface preparation and revegetation	• Poor seed establishment • Erosion of rehabilitation areas • Loss of topsoil and scouring of land • Flooding of mine site causing surface water contamination.	Likely	Moderate	**Significant (17)**	• During periods of extended drought, additional watering on rehabilitated areas may be required • Proposed activities to occur during set time periods to coincide with suitable rainfall patterns to support seed germination • Implementation of ESC where applicable • Supplementary seed may be required during years which experience extreme events (i.e. prolonged drought). • All relevant site personnel and contractors to be trained in accordance with performed activities. • Earthworks timed to coincide with dry season • Design of landform to be prepared by suitable qualified persons • Job specific equipment to be utilised for landform design • Landform to be constructed to within 10% of design	• PRCP Schedule • climate data	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Moderate	**Medium (9)**	Technical Services Team
RM8: Surface Preparation (Native ecosystem corridor)	Deficit in stored topsoil required for closure	• Significant cost of topsoil. • Poor rehabilitation outcomes. •	Possible	Major	**High (22)**	• adherence to the Topsoil management plan (TMP) which includes topsoil stripping process • Maintain stockpile locations and inventory with annual review and update • Adherence to the Rehabilitation Monitoring Plan • Trials with subsoils and other approaches to provide suitable substrate	• Topsoil Management Plan • personnel required for monitoring of stockpile locations	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Major	**Significant (19)**	Technical Services Team and rehabilitation contractor
	Heavy rainfall or extended periods of drought prior to and during surface preparation and revegetation	• Poor seed establishment • Erosion of rehabilitation area • Loss of topsoil and scouring of land • Flooding of mine site causing surface water contamination.	Likely	Moderate	**Significant (17)**	• During periods of extended drought, additional watering on rehabilitated areas may be required • Proposed activities to occur during set time periods to coincide with suitable rainfall patterns to support seed germination • Implementation of ESC where applicable • Supplementary seed may be required during years which experience extreme events (i.e., prolonged drought). • All relevant site personnel and contractors to be trained in accordance with performed activities. • Earthworks timed to coincide with dry season • Design of landform to be prepared by suitable qualified persons • Job specific equipment to be utilised for landform design • Landform to be constructed to within 10% of design	• PRCP Schedule • climate data	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Moderate	**Medium (9)**	Technical Services Team
RM9: Revegetation (Cattle Grazing)	Uncontrolled fire	• Natural fires may result in loss of vegetation density and variability • Loss of vegetation cover may result in increased erosion and soil loss • Failure to achieve milestone criteria pertaining to vegetation cover • Loss or alteration of habitat	Possible	Major	**High (22)**	• Permits to Burn process • Permits for Hot Work • Emergency response procedures (including fire) • Water cart availability • Pasture management in accordance with monitoring criteria • Fuel reduction or risk management fires, where applicable	• Personnel, procedures and machinery	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Major	**Significant (19)**	Technical Services Team
	Inadequate and/or inappropriate revegetation	• Failure to achieve milestone criteria of flora variability & density	Possible	Moderate	**Significant (13)**	• Management of topsoil stripping and application during rehabilitation in accordance with TMP and RMP • Ameliorants and fertiliser applied per approved ratio • Appropriate equipment to be utilised during activities • Purchase of seed from reputable supplier only and ensure Seed Verification certificate is received • Seeding at optimal time of year with respect to favourable rainfall conditions • Monitoring of rehabilitated areas in accordance with monitoring schedule to identify reduced germination early • Re-seeding where required in critical situations	• Topsoil inventory • Suitably qualified person for determining fertiliser and ameliorant ratios • Rehabilitation monitoring data	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Moderate	**Medium (9)**	Technical Services Team

	Seed unavailable	• Lack of seed of certain species can lead to long-term effects on the composition of the eventual plant communities that establish	Likely	Moderate	Significant (17)	• Variable seed criteria to allow for seasonal variation and availability • Annual rehabilitation planning to prepare to rehabilitation activities	• Annual budget allocations	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Moderate	Medium (9)	Technical Services Team
	Inappropriate quality of grass seed used in seed mix	• Insufficient protective cover of grass increases the risk of erosion.	Possible	Moderate	Significant (13)	• Approved seed mix to be used only • Appropriate timing of planned seeding activities to coincide with favourable weather conditions • In sites with insufficient grass cover, there is to be supplementary sowing and/or fertilising in bare patches to encourage grass growth, where applicable • Where applicable, additional ESC measures to be implemented • Continual improvement through annual review of completed rehabilitation activities	• Adequate time for reviewing the revegetation methodology on an annual basis	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Minor	Low (5)	Technical Services Team
	Inappropriate quality of tree and shrub seed used in seed mix.	• Insufficient or excessive canopy cover can cause eventual vegetative communities to fail.	Possible	Moderate	Significant (13)	• Approved seed mix to be used only • Appropriate timing of planned seeding activities to coincide with favourable weather conditions • In sites with insufficient grass cover, there is to be supplementary sowing and/or fertilising in bare patches to encourage grass growth, where applicable • Where applicable, additional ESC measures to be implemented • Continual improvement through annual review of completed rehabilitation activities	• Adequate time for reviewing the revegetation methodology on an annual basis.	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Minor	Low (5)	Technical Services Team
	Intruding livestock	• Premature grazing could lead to poor seedling establishment • Destruction of establishing vegetation	Likely	Moderate	Significant (17)	• Fencing surrounding Foxleigh is to be maintained to control external livestock access at all times	• Fencing materials and personnel for construction and inspection	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Rare	Insignificant	Low (1)	Technical Services Team
	Spread of invasive/ declared weed species	• Increased distribution of weeds • Interference with native species population - competition	Possible	Moderate	Significant (13)	• Adherence to Noxious Weed Management • Only authorised vehicles and persons to access rehabilitated areas • Permit to Disturb process • Only approved seeding mix from reputable supplier to be used on rehabilitated areas	• Annual weed survey and control strategies • Restricted access process	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Moderate	Medium (9)	All site personnel have General Biosecurity Obligation / Technical Services Team
RM10: Revegetation (Watercourse)	Uncontrolled fire	• Natural fires may result in loss of vegetation density and variability • Loss of vegetation cover may result in increased erosion and soil loss • Failure to achieve milestone criteria pertaining to vegetation cover • Loss or alteration of habitat	Possible	Major	High (22)	• Fire Management Plan • Permits for Hot Work • Permits to Burn process • Emergency response procedures (including fire) • Water cart availability • Directional cannon on water carts • Pasture management in accordance with monitoring criteria • Fuel reduction or risk management fires, where applicable • Implementation of Monitoring and Maintenance Program • Maintain a firebreak around mining lease/s.	• Personnel and machinery required to establish and maintain firebreak	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Major	Significant (19)	Technical Services Team
	Inadequate and/or inappropriate revegetation	• Failure to achieve milestone criteria of flora variability & density	Possible	Moderate	Significant (13)	• Management of topsoil stripping and application during rehabilitation in accordance with TMP and RMP • Topsoil assessment by suitably qualified person to determine ameliorant and fertiliser requirements as required • Ameliorants and fertilizers applied per approved ratio • Appropriate equipment to be utilised during activities • Purchase of seed from reputable supplier only and ensure Seed Verification certificate is received • Seeding at optimal time of year with respect to favourable rainfall conditions	• Topsoil inventory • Topsoil assessment • Rehabilitation monitoring data.	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Moderate	Medium (9)	Technical Services Team

						• Monitoring of rehabilitated areas in accordance with monitoring schedule to identify reduced germination early • Re-seeding where required in critical situations						
	Seed unavailable.	• Lack of seed of certain species can lead to long-term effects on the composition of the eventual plant communities that establish	Likely	Moderate	Significant (17)	• Variable seed criteria to allow to seasonal variation and availability • Purchase seed only from reputable suppliers • Annual rehabilitation planning to prepare to rehabilitation activities	• Annual budget allocations	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Moderate	Medium (9)	Technical Services Team
	Inappropriate quality of grass seed used in seed mix.	• Insufficient or excessive canopy cover can cause eventual vegetative communities to fail.	Possible	Moderate	Significant (13)	• Approved seed mix to be used only • Appropriate timing of planned seeding activities to coincide with favourable weather conditions • In sites with insufficient grass cover, there is to be supplementary sowing and/or fertilising in bare patches to encourage grass growth, where applicable • Where applicable, additional ESC measures to be implemented • Continual improvement through annual review of completed rehabilitation activities	• Adequate time for reviewing the revegetation methodology on an annual basis.	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Minor	Low (5)	Technical Services Team
	Inappropriate quality of tree and shrub seed used in seed mix.	Insufficient or excessive canopy cover can cause eventual vegetative communities to fail.	Possible	Moderate	Significant (13)	• Approved seed mix to be used only • Appropriate timing of planned seeding activities to coincide with favourable weather conditions • In sites with insufficient grass cover, there is to be supplementary sowing and/or fertilising in bare patches to encourage grass growth, where applicable • Where applicable, additional ESC measures to be implemented • Continual improvement through annual review of completed rehabilitation activities	Adequate time for reviewing the revegetation methodology on an annual basis.	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Minor	Low (5)	Technical Services Team
	Intruding livestock	• Premature grazing could lead to poor seedling establishment • Destruction of establishing vegetation	Likely	Moderate	Significant (17)	• Fencing surrounding Foxleigh is to be maintained to prevent external livestock access at all times • Neighboring grazier contacted if cattle observed on ML, faults immediately repaired and livestock immediately removed.	• Fencing materials and personnel for construction and inspection • Check for cattle outside of designated grazing paddocks	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Rare	Insignificant	Low (1)	Technical Services Team
	Spread of invasive/ declared weed species	• Increased distribution of weeds Interference with native species population - competition	Possible	Major	High (22)	• Adherence to Weed and Pest Management Plan • All vehicles/operational equipment entering rehabilitated areas must have completed a weed wash down process • Only authorised vehicles and persons to access rehabilitated areas • Annual Weed Survey and control strategy • Weed treatment prior to vegetation clearing, where applicable • Permit to Disturb process • Only approved seeding mix from reputable supplier to be used on rehabilitated areas • Training for all personnel on identifying declared weed species	• Annual weed survey and control strategies • Training for operational personnel • Restricted access process	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Major	Significant (19)	All site personnel have General Biosecurity Obligation / Technical Services Team
RM11: Revegetation (Native Ecosystem corridor)	Uncontrolled fire	• Natural fires may result in loss of vegetation density and variability • Loss of vegetation cover may result in increased erosion and soil loss • Failure to achieve milestone criteria pertaining to vegetation cover • Loss or alteration of habitat	Possible	Major	High (22)	• Permits for Hot Work • Permits to Burn process • Emergency response procedures (including fire) • Water cart availability • Directional cannon on water carts • Pasture management in accordance with monitoring criteria • Fuel reduction or risk management fires, where applicable • Implementation of Monitoring and Maintenance Program • Maintain a firebreak around mining lease/s.	• Personnel and machinery required to establish and maintain firebreak	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Major	Significant (19)	Technical Services Team

	Inadequate and/or inappropriate revegetation	• Failure to achieve milestone criteria of flora variability & density •	Possible	Moderate	Significant (13)	• Management of topsoil stripping and application during rehabilitation in accordance with TMP and RMP • Topsoil assessment by suitably qualified person to determine ameliorant and fertiliser requirements as required • Ameliorants and fertilizers applied per approved ratio • Appropriate equipment to be utilised during activities • Purchase of seed from reputable supplier only and ensure Seed Verification certificate is received • Seeding at optimal time of year with respect to favourable rainfall conditions • Monitoring of rehabilitated areas in accordance with monitoring schedule to identify reduced germination early • Re-seeding where required in critical situations	• Topsoil inventory • Topsoil assessment • Rehabilitation monitoring data.	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Moderate	Medium (9)	Technical Services Team
	Seed unavailable.	• Lack of seed of certain species can lead to long-term effects on the composition of the eventual plant communities that establish	Likely	Moderate	Significant (17)	• Variable seed criteria to allow to seasonal variation and availability • Purchase seed only from reputable suppliers • Annual rehabilitation planning to prepare to rehabilitation activities	• Annual budget allocations	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Moderate	Medium (9)	Technical Services Team
	Inappropriate quality of grass seed used in seed mix.	• Insufficient or excessive canopy cover can cause eventual vegetative communities to fail.	Possible	Moderate	Significant (13)	• Approved seed mix to be used only • Appropriate timing of planned seeding activities to coincide with favourable weather conditions • In sites with insufficient grass cover, there is to be supplementary sowing and/or fertilising in bare patches to encourage grass growth, where applicable • Where applicable, additional ESC measures to be implemented • Continual improvement through annual review of completed rehabilitation activities	• Adequate time for reviewing the revegetation methodology on an annual basis.	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Minor	Low (5)	Technical Services Team
	Inappropriate quality of tree and shrub seed used in seed mix.	• Insufficient or excessive canopy cover can cause eventual vegetative communities to fail.	Possible	Moderate	Significant (13)	• Approved seed mix to be used only • Appropriate timing of planned seeding activities to coincide with favourable weather conditions • In sites with insufficient grass cover, there is to be supplementary sowing and/or fertilising in bare patches to encourage grass growth, where applicable • Where applicable, additional ESC measures to be implemented • Continual improvement through annual review of completed rehabilitation activities	• Adequate time for reviewing the revegetation methodology on an annual basis.	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Minor	Low (5)	Technical Services Team
	Intruding livestock	• Premature grazing could lead to poor seedling establishment • Destruction of establishing vegetation	Likely	Moderate	Significant (17)	• Fencing surrounding Foxleigh is to be maintained to prevent external livestock access at all times • Fences are to be inspected, faults immediately repaired and livestock immediately removed.	• Fencing materials and personnel for construction and inspection • Check for cattle outside of designated grazing paddocks	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Rare	Insignificant	Low (1)	Technical Services Team
	Spread of invasive/ declared weed species	• Increased distribution of weeds • Interference with native species population - competition	Possible	Major	High (22)	• Adherence to Weed and Pest Management Plan • All vehicles/operational equipment entering rehabilitated areas must have completed a weed wash down process • Only authorised vehicles and persons to access rehabilitated areas • Annual Weed Survey and control strategy • Weed treatment prior to vegetation clearing, where applicable • Permit to Disturb process • Only approved seeding mix from reputable supplier to be used on rehabilitated areas • Training for all personnel on identifying declared weed species	• Annual weed survey and control strategies • Training for operational personnel • Restricted access process	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Major	Significant (19)	All site personnel have General Biosecurity Obligation / Technical Services Team

RM12: Achievement of Surface Requirements (Cattle Grazing)	Low pasture productivity	Failure to support economically viable cattle grazing	Possible	Moderate	**Significant (13)**	• Only approved seed mixes to be used • Seed to be purchased from reputable supplier and Seed Verification Certificate supplied • Grass seed application rates are to be modified pending the outcome of the initial rounds of rehabilitation • In sites with insufficient grass cover, there is to be supplementary sowing and/or fertilising in bare patches to encourage grass growth	• Personnel/contractors required for regular monitoring • adequate time for reviewing the revegetation methodology on an annual basis • additional seed stocks and fertiliser, as required.	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Minor	**Low (5)**	Technical Services Team
	Low pasture diversity	• Over-dominance of one or few pasture species increases the vulnerability of the pasture to extreme environmental events (flood, fire, drought, insect plagues) • Low pasture diversity is associated with reduced nutrient cycling and ecosystem stability • Failure to sustain cattle grazing in the long-term	Likely	High	**High (21)**	• Only approved seed mixes to be used • Seed to be purchased from reputable supplier and Seed Verification Certificate supplied • Grass seed application rates are to be modified pending the outcome of the initial rounds of rehabilitation • Monitoring of rehabilitated areas to be completed in accordance with monitoring criteria and identify re-work areas as applicable • Seeding to occur at optimal timing for favourable weather conditions • Protection from un-approved livestock access	• Personnel/contractors required for regular monitoring • adequate time for reviewing the revegetation methodology on an annual basis • additional seed stocks and fertiliser, as required.	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	High	**Significant (14)**	Technical Services Team
	Poor landscape function	• Failure of sites to develop adequate ground covert • Formation of a dysfunctional landscape that results in a loss of resources (nutrients, water, sediment) over the long term • Failure to achieve rehabilitation completion criteria pertaining to landscape function	Unlikely	Moderate	**Medium (9)**	• Low slope gradient in landform design to limit capacity for sediment loss • Only approved seed mix to be used • Rehabilitation activities to occur during optimal time periods to enhance germination • Landform to design within 10%	• Personnel/contractors required for regular monitoring • adequate time for reviewing the revegetation methodology on an annual basis • additional seed stocks and fertiliser, as required	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Minor	**Low (5)**	Technical Services Team
	Significant erosion of placed soils on final landform	• Failure to establish proposed vegetative cover and therefore stable PMLU • Loss of topsoil • Loss of sediment control structure performance • Water quality impacts	Likely	Moderate	**Significant (17)**	• Low slope gradient in landform design to limit capacity for sediment loss • Surface preparation and sowing is to take place with regard to optimal weather conditions (no predicted heavy rainfall or extended periods of drought) • Approved seed mix includes rapidly establishing grasses • Sediment management systems (drains and sediment dams) to be operational during surface preparation and revegetation • Amelioration measures proposed to assist with soil retention	• Adequate waste rock set aside for a protective cover • seed for pioneer grasses • amelioration materials and labour • appropriate time and personnel are required for construction of the sediment management system and final landform according to designs.	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Moderate	**Medium (9)**	Technical Services Team
RM13: Achievement of surface requirements (watercourse)	Low species diversity	• Over-dominance of one or few species increases the vulnerability of the ecosystem to extreme environmental events (flood, fire, drought, insect plagues) • Low species diversity is associated with reduced nutrient cycling and ecosystem stability	Likely	High	**High (21)**	• Only approved seed mixes to be used • Seed to be purchased from reputable supplier and Seed Verification Certificate supplied • Seed application rates are to be modified pending the outcome of the initial rounds of rehabilitation • Monitoring of rehabilitated areas to be completed in accordance with monitoring criteria and identify re-work areas as applicable • Seeding to occur at optimal timing for favourable weather conditions e.g. avoid high rainfall and flooding risk • Protection from un-approved livestock access • Potential for planting of key tube stock species to enhance dominant tree species if initial seeding is compromised	• Personnel/contractors required for regular monitoring • adequate time for reviewing the revegetation methodology on an annual basis • additional seed stocks and fertiliser, as required.	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	High	**Significant (14)**	Technical Services Team

	Poor landscape function	• Failure of sites to develop adequate sediment and leaf litter capture by groundcover features • Formation of a dysfunctional landscape that results in a loss of resources (nutrients, water, sediment) over the long term • Failure to achieve rehabilitation completion criteria pertaining to landscape function	Unlikely	Moderate	**Medium (9)**	• Low slope gradient in landform design to limit capacity for sediment loss • Only approved seed mix to be used • Rehabilitation activities to occur during optimal time periods to enhance germination • Landform to design within 10%	• Personnel/contractors required for regular monitoring • adequate time for reviewing the revegetation methodology on an annual basis • additional seed stocks and fertiliser, as required	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Minor	**Low (5)**	Technical Services Team
	Significant erosion of placed soils on final landform	• Failure to establish proposed vegetative cover and therefore stable PMLU • Loss of topsoil • Loss of sediment control structure performance • Water quality impacts	Likely	Moderate	**Significant (17)**	• Low slope gradient in landform design to limit capacity for sediment loss • Surface preparation and sowing is to take place with regard to optimal weather conditions (no predicted heavy rainfall or extended periods of drought) • Only approved seed mixes to be used • Approved seed mix includes rapidly establishing grasses • Sediment management systems (drains and sediment dams) to be operational during surface preparation and revegetation • Amelioration measures proposed to assist with soil retention	• Adequate waste rock set aside for a protective cover • seed for pioneer grasses • amelioration materials and labour • appropriate time and personnel are required for construction of the sediment management system and final landform according to designs	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Moderate	**Medium (9)**	Technical Services Team
RM14: Achievement of surface requirements (native ecosystem corridor)	Low pasture productivity	• Failure to support economically viable cattle grazing	Possible	Moderate	**Significant (13)**	• Only approved seed mixes to be used • Seed to be purchased from reputable supplier and Seed Verification Certificate supplied • Grass seed application rates are to be modified pending the outcome of the initial rounds of rehabilitation • In sites with insufficient grass cover, there is to be supplementary sowing and/or fertilising in bare patches to encourage grass growth	• Personnel/contractors required for regular monitoring • adequate time for reviewing the revegetation methodology on an annual basis • additional seed stocks and fertiliser, as required.	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Minor	**Low (5)**	Technical Services Team
	Low pasture diversity	• Over-dominance of one or few pasture species increases the vulnerability of the pasture to extreme environmental events (flood, fire, drought, insect plagues) • Low pasture diversity is associated with reduced nutrient cycling and ecosystem stability • Failure to sustain cattle grazing in the long-term	Likely	High	**High (21)**	• Only approved seed mixes to be used • Seed to be purchased from reputable supplier and Seed Verification Certificate supplied • Grass seed application rates are to be modified pending the outcome of the initial rounds of rehabilitation • Monitoring of rehabilitated areas to be completed in accordance with monitoring criteria and identify re-work areas as applicable • Seeding to occur at optimal timing for favourable weather conditions • Protection from un-approved livestock access	• Personnel/contractors required for regular monitoring • adequate time for reviewing the revegetation methodology on an annual basis • additional seed stocks and fertiliser, as required.	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	High	**Significant (14)**	Technical Services Team
	Poor landscape function	• Failure of sites to develop adequate ground covert • Formation of a dysfunctional landscape that results in a loss of resources (nutrients, water, sediment) over the long term • Failure to achieve rehabilitation completion criteria pertaining to landscape function	Unlikely	Moderate	**Medium (9)**	• Low slope gradient in landform design to limit capacity for sediment loss • Only approved seed mix to be used • Rehabilitation activities to occur during optimal time periods to enhance germination • Landform to design within 10%	• Personnel/contractors required for regular monitoring • adequate time for reviewing the revegetation methodology on an annual basis • additional seed stocks and fertiliser, as required	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Minor	**Low (5)**	Technical Services Team
	Significant erosion of placed soils on final landform	• Failure to establish proposed vegetative cover and therefore stable PMLU • Loss of topsoil • Loss of sediment control structure performance • Water quality impacts	Likely	Moderate	**Significant (17)**	• Low slope gradient in landform design to limit capacity for sediment loss • Surface preparation and sowing is to take place with regard to optimal weather conditions (no predicted heavy rainfall or extended periods of drought) • Approved seed mix includes rapidly establishing grasses	• Adequate waste rock set aside for a protective cover • seed for pioneer grasses • amelioration materials and labour • appropriate time and personnel are required for construction of the sediment management system	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Moderate	**Medium (9)**	Technical Services Team

						• Sediment management systems (drains and sediment dams) to be operational during surface preparation and revegetation • Amelioration measures proposed to assist with soil retention	and final landform according to designs.					
RM15: Achievement of post-mining land use to a stable condition (cattle grazing)	Settlement of landform impacting flow paths	• Installed drainage not functioning to design leading to erosion of final landform • milestone criteria unable to be achieved	Possible	Minor	**Medium (8)**	• Ad-hoc and routine 6-monthly visual inspections includes drainage structures	• Inspection schedule	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Minor	**Low (5)**	Technical Services Team
	Failure of ESC structures post establishment	• Erosion of final landform • milestone criteria unable to be achieved	Possible	Minor	**Medium (8)**	• Drainage/ESC to be designed for the no ground-cover scenario • Ad-hoc and routine 6-monthly visual inspections includes drainage structures	• Inspection schedule	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Minor	**Low (5)**	Technical Services Team
	Surface water contamination from unexpected waste rock material geochemical issue	• Run-off/seepage to surface waters exceeds water quality requirements • milestone criteria unable to be achieved	Possible	Moderate	**Significant (13)**	• Previous geochemical testing programs • Specific actions to be developed to address identified geochemical issues	• REMP and other surface water monitoring	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Minor	**Low (5)**	Technical Services Team
RM16: Achievement of post-mining land use to a stable condition (watercourse)	Settlement of landform impacting flow paths	• Installed drainage not functioning to design leading to erosion of final landform • milestone criteria unable to be achieved	Possible	Minor	**Medium (8)**	• Ad-hoc and routine 6-monthly visual inspections includes drainage structures	• Inspection schedule • Appropriately qualified persons to undertake inspection	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Minor	**Low (5)**	Technical Services Team
	Surface water contamination from unexpected waste rock material geochemical issue	• Run-off/seepage to surface waters exceeds water quality requirements • milestone criteria unable to be achieved	Possible	Moderate	**Significant (13)**	• Previous geochemical testing programs • Sampling at nominated locations in EA • Specific actions to be developed to address identified geochemical issues	• Inspection schedule • Appropriately qualified persons to undertake inspection	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Minor	**Low (5)**	Technical Services Team
RM17: Achievement of post-mining land use to a stable condition (native ecosystem corridor)	Settlement of landform impacting flow paths	• Installed drainage not functioning to design leading to erosion of final landform • milestone criteria unable to be achieved	Possible	Minor	**Medium (8)**	• Ad-hoc and routine 6-monthly visual inspections includes drainage structures	• Inspection schedule	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Minor	**Low (5)**	Technical Services Team
	Failure of ESC structures post establishment	• Erosion of final landform • milestone criteria unable to be achieved	Possible	Minor	**Medium (8)**	• Drainage/ESC to be designed for the no ground-cover scenario • Ad-hoc and routine 6-monthly visual inspections includes drainage structures	• Inspection schedule	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Minor	**Low (5)**	Technical Services Team
	Surface water contamination from unexpected waste rock material geochemical issue	• Run-off/seepage to surface waters exceeds water quality requirements • milestone criteria unable to be achieved	Possible	Moderate	**Significant (13)**	• Previous geochemical testing programs • Specific actions to be developed to address identified geochemical issues	• REMP and other surface water monitoring	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Minor	**Low (5)**	Technical Services Team

Milestone	Risk/Hazard Description	Risk Outcome/ Consequence/ Impact	Likelihood	Consequence	Risk	Selected Control/Treatments	Required Resources	Performance Measures	Reporting and Monitoring	Likelihood	Consequence	Risk	Responsibility
Non-Use Management Area (NUMA)													
MM1: Achievement of structural stability	NUMA is not structurally stable – geotechnical stability	• Steep slopes • Rock falls • Slope failure • Residual void extends beyond permitted EA domain limits	Possible	High	**Significant (18)**	• Surface water management system • Diversion drains • Minimal external catchment into pit lake • Monitoring of slip failure	• Monitoring systems and schedule • Water management system in place	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Moderate	**Significant (14)**	Technical Services Team
	NUMA is not structurally stable – erosional stability	• Steep slopes • Rock falls • Slope failure • Residual void extends beyond permitted EA domain limits • Impacts to adjacent PMLUs	Possible	High	**Significant (18)**	• Surface water management system • Diversion drains • Minimal external catchment into pit lake • External water is pumped into the pit lake • Monitoring of slip failure	• Monitoring systems and schedule • Water management system in place	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Moderate	**Significant (14)**	Technical Services Team
MM2: Achievement of landform design and surface requirements	NUMA design is not consistent with criteria	• Steep slopes • Safety bunds and setbacks not achieved	Unlikely	High	**Significant (14)**	• Restricted access to the pit lake (exclusion bund and fencing) - Signs (on order) for fencing • Construction of hard control barrier (i.e., safety bund) around perimeter of NUMA • Void slopes to be to design • Designed by suitably qualified persons • Assessment by suitably qualified person that water quality and volume in void will not cause environmental harm	• Fencing materials and personnel for construction and inspection • Personnel for inspections and repairs • Tools and equipment for fencing • Adequate resources allocated for certification	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Unlikely	Moderate	**Medium (10)_**	Technical Services Team
MM3: Achievement of sufficient improvement not to cause environmental harm, safe and stable	NUMA causing environmental harm	• Void switches from a sink to source to the groundwater aquifer	Unlikely	Major	**Significant (19)**	• Maximum pit lake fill level • Groundwater modelling and monitoring • Water balance model verification of water interception system to manage surface water flows into void (surface water interception system) • Water balance model verification of ability to maintain level required to manage potential groundwater impacts under 1 in 100 AEP • Certification by suitably qualified person that water quality and volume in void will not cause environmental harm	• Approved groundwater modelling • Water balance • Monitoring program and schedule	Performance measured by alignment with achievement of the PRCP Milestone Criteria as per PRCP Schedule	Monitoring & Maintenance as outlined in Section 3.8 of the PRCP	Rare	High	**Medium (10)**	Technical Services Team

Appendix Q: Contaminated Land Guidance

ENGENY

FOXLEIGH MANAGEMENT PTY LTD

Contaminated Land Guidance

Progressive Rehabilitation and Closure Plan

QC1025_005-RPT-001-1-Contaminated Land Guidance

3 MAY 2023

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This Report has been prepared on behalf of and for the exclusive use of FOXLEIGH MANAGEMENT PTY LTD and is subject to and issued in accordance with FOXLEIGH MANAGEMENT PTY LTD instruction to Engeny Australia Pty Ltd (Engeny). The content of this Report was based on previous information and studies supplied by FOXLEIGH MANAGEMENT PTY LTD.

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1. INTRODUCTION

This contaminated land guidance document is intended to support the development of the Foxleigh Management Pty Ltd (FoxMan) Mine transitional Progressive Rehabilitation Closure Plan (PRCP). This guidance has been developed in accordance with the Department of Environment and Science (DES) Guideline Progressive rehabilitation and closure plans (PRC plans) and the site assessment framework set out in the National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended in 2013) (ASC NEPM) and intends to assist FoxMan to identify and manage potential risks with regard to the determination of post-mining land uses (PMLU).

1.1 Background

The Foxleigh mine is located on former grazing land. Open cut coal mining operations commenced in 1999, with expansions occurring in 2004 and 2010 following the approval of additional mining leases.

In 2016, Middlemount South purchased Anglo American's 70% interest in the Foxleigh Joint Venture along with some 100% owned exploration tenement, resulting in the current ownership structure. Total Coal Resources (inclusive of Coal Reserves) were estimated at 335 megatonne (Mt) in November 2020[1].

Foxleigh Mine currently consists of Mining Leases (ML) ML70171, ML70309, ML70310, ML70429, ML70430, ML70431 and ML70470, operating under an environmental authority issued to CAML Resources Pty Ltd, Nippon Steel & Sumitomo Metal Australia Pty Ltd and Foxleigh Coal Pty Ltd.

1.2 Objectives

The objective of the guidance document is to identify:

- Activities that present a risk of contamination to the land and receiving environment.
- Potential contaminants of concern resulting from the identified activity.
- Areas where potentially contaminating activities have historically and are currently occurring on site.
- A framework to guide the management of potentially contaminated land and associated risks.

1.3 Scope of Works

The scope of work for this desktop study is limited to:

- Review of the Environmental Authority conditions for the site.
- Review of the existing Environmental Impact Assessment for mine operations.
- Review of readily available site history and surrounding land uses.
- Identification of surrounding sensitive receptors and the environmental values that apply to those receptors.
- Review of a maximum of ten (10) historical aerial photographs.
- Review of current reports provided to Engeny by FoxMan.
- Summary of potentially contaminating activities undertaken as part of current mine operations.
- Summary of contaminants of potential concern (COPC) resulting from the identified activities.
- Recommendations for ongoing management of contaminated land risk to the progressive rehabilitation plan and potential impacts for determination of the post-mining land use.

[1] https://www.qmetco.com.au/site/our-assets/foxleigh-coal-mine/tenements-and-resources

1.4 Reference and Guidance Documents

This report has been compiled in general accordance with the following reference materials and standards:

- State of Queensland (1994) Environmental Protection Act 1994 (EP Act 1994).
- National Environment Protection Council (NEPC) (1999) National Environment Protection (Assessment of Site Contamination) Measure, as amended (registered on 15 May 2013). This is referred to from here on as “the NEPM” or “ASC NEPM (2013)”.
- Standards Australia (1999) AS4482.2- 1999: Guide to the investigation and sampling of sites with potentially contaminated soil Part 2: Volatile substances (AS4482.2).
- Standards Australia (2005) AS4482.1- 2005: Guide to the investigation and sampling of sites with potentially contaminated soil Part 1: Non-volatile and semi-volatile compounds (AS4482.1).
- Department of Environment and Heritage Protection (DEHP) (now known as Department of Environment and Science (DES)) issued Environmental Authority EPML00744813, effective from 17 February 2017.
- Environmental Authority EPPR00449613 Department of Environment and Resource Management (DERM) Certificate of Registration No: ENRE00955009, issued 4 November 2009 for Lot 6 on plan SP189240 in replacement of Environmental Protection Agency Licence No. CW 0002, issued 15 October 2001 for Lot 16 on SP128608.
- Department of Environment and Science Guideline–Progressive rehabilitation and closure plans (PRC plans), (ESR/2019/4964 Version 2.00 Reviewed 17 March 2021).

1.5 Limitations

This document is limited, based on information provided by FoxMan.

This guidance is limited to the development of the PRCP and excludes the requirements for surrender of any Environmental Authorities (EAs) applicable to the land.

2. SITE IDENTIFICATION

2.1 Site Description

The site is located within a portion of the rural properties Tralee and Lake Lindsay in the Isaac Regional local government area, approximately 5km south-east of the town of Middlemount. The site location and locality are presented in Figure 1, Appendix A. Site identification details are presented in Table 2.1. The site is comprised of three (3) property lots, two (2) of which are listed on the Environmental Management Register (EMR). Copies of the EMR search results are presented in Appendix B. There are no Site Management Plans (SMPs) in place for the EMR listed lots. There are seven (7) mining leases within the site, with details available on GeoResGlobe presented in Table 2.2. The mining lease locations and cadastral boundaries are presented in Figure 2.1.

TABLE 2.1: SITE IDENTIFICATION

Item	Detail		
Address	5498 Dysart Middlemount Road, Mackenzie River, QLD	162 Lake Lindsay Road Mackenzie River Qld	No official address
Real Property Description	Lot 20 on SP276924	Lot 19 on SP276924	Lot 4 on SP293492
Lot area (ha)	5,381	6,785	12,080
Mining Lease	ML70309 ML70310 ML70431 ML70171 ML70470	ML70171 ML70310	ML70171 ML70429 ML70430 ML70431 ML70470
Current Use	Mining	Mining	Mining
Land Use Zoning	Rural	Rural	Rural
Current Owner	FOXLEIGH LAND PTY LTD A.C.N. 088 327 226	GREGORY WILLIAM SMALL ½ BRIAN JAMES SMALL ½ AS TENANTS IN COMMON	FOXLEIGH LAND PTY LTD A.C.N. 088 327 226
EMR Site ID	147886	147885	N/A
Site Management Plan	No	No	N/A
EMR Listing Detail	The site you have searched has been subdivided from the following site, which IS included on the EMR or the CLR. Lot: 6 Plan: SP189240 Address: BARWON PARK-MIDDLEMOUNT ROAD MACKENZIE RIVER 4705 The site has been subject to the following Notifiable Activity or Hazardous Contaminant. WASTE STORAGE, TREATMENT OR DISPOSAL - storing, treating, reprocessing or disposing of regulated waste (other than at the place it is generated), including operating a nightsoil disposal site or sewage treatment plant where the site or plant has a design capacity that is more than the equivalent of 50, 000 persons having sludge drying beds or on-site disposal facilities.		N/A
Environmental Authority	EPML00744813 EPPR00449613	EPML00744813 EPPR00449613	EPML00744813

TABLE 2.2: MINING LEASE PERMIT INFORMATION

ML Permit	Permit ID	Authorised Holder Name	Lodge Date	Grant Date	Expiry Date	Area (ha)
ML70171	109623	CAML Resources Pty Ltd	18 January 1999	4 November 1999	30 November 2034	2,495
ML70309	109670	CAML Resources Pty Ltd	18 December 2002	28 October 2004	30 November 2034	2,042
ML70310	109671	CAML Resources Pty Ltd	18 December 2002	2 October 2015	30 November 2034	171
ML70429	109772	CAML Resources Pty Ltd	18 March 2010	22 September 2014	30 November 2034	1,038
ML70430	109773	CAML Resources Pty Ltd	18 March 2010	22 September 2014	30 November 2034	123.1
ML70431	109774	CAML Resources Pty Ltd	6 May 2010	22 September 2014	30 November 2034	2,636
ML70470 (note this ML overlaps with ML70431)	111399	CAML Resources Pty Ltd	21 December 2011	13 November 2012	30 November 2034	434.8

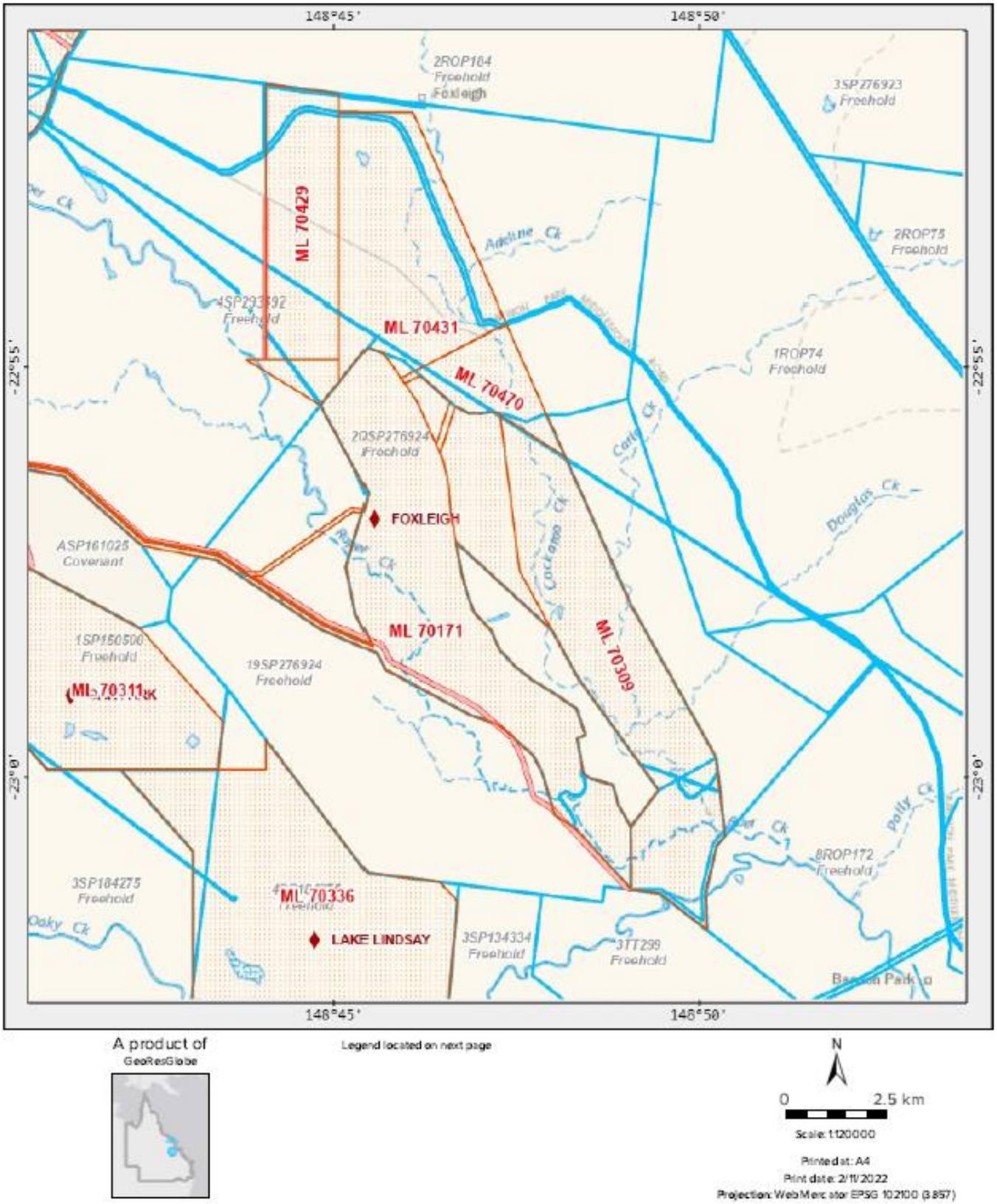


Figure 2.1: Foxleigh Mining Leases and Cadastral Boundaries (Source GeoResGlobe accessed 2 November 2022)

2.2 Surrounding Land Use

A search of the Isaac Regional Planning Scheme 2021 Zoning[2] shows the mine and surrounding area is zoned for Rural use. An extract of the Rural Areas (south-east) map with the approximate site location shown in red is presented in Figure 2.2 below. The complete map is provided in Appendix C.

The town of Middlemount is located approximately 5km north of the site.

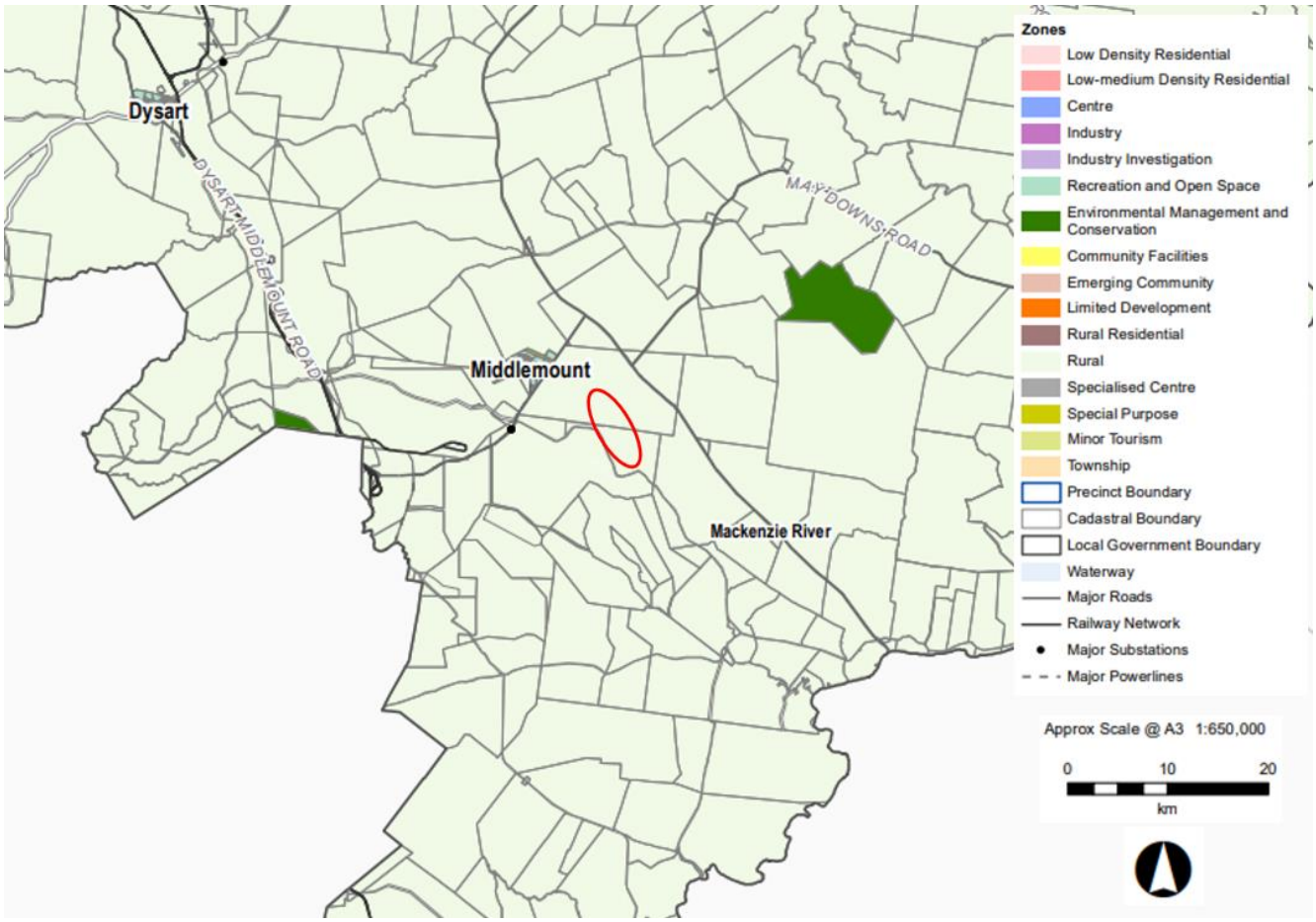


Figure 2.2: Surrounding Land Use

2.3 Sensitive Receiving Environments

The site is drained by a number of creeks including Roper Creek and its tributaries, Cockatoo and Carlo Creek. As part of mining operations, Cockatoo Creek has been subject to a diversion of approximately 4km in length. Sections of Foxleigh Mine are mapped on Queensland Globe[3] basin level flood modelling with 1% annual exceedance probability (AEP) flood level (map presented in Appendix C). Water generally flows south-south-eastwards to Mackenzie River.

Vegetation in the area is typical of the eucalypt woodland, which has been partially cleared. Queensland Globe matters of state environmental significance (MSES) mapping reports several areas of regulated vegetation and wildlife habitat within the mining lease areas (map presented in Appendix C).

[2] https://www.isaac.qld.gov.au/downloads/file/4636/zm1-planning-scheme-2021-zoning-gazettal-1-april-2021-pdf (accessed 2 November 2022)

[3] https://qldglobe.information.qld.gov.au/ (accessed 21 November 2022)

Foxleigh Mine is located close to the township of Middlemount, which is the base for Foxleigh Mine employee housing. The Australian Bureau of Statistics 2016 census data[4] reports the population of Middlemount at 1,841 residents. Middlemount sensitive environments include a Community School and childcare centre.

2.4 Environmental Values

Waters entering the receiving environment of the site are subject to the Environmental Values (EVs) and Water Quality Objectives (WQOs) applicable to that water body, as determined by the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019.*

The site is located within the Mackenzie River Sub-basin catchment. Environmental values for this catchment have been defined in *Environmental Protection (Water) Policy 2009 Mackenzie River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Mackenzie River Sub-basin September 2011*. Prepared by: Environmental Policy and Planning, Department of Environment and Heritage Protection (now known as the Department of Environment and Science). A copy of the WQ1304 - Mackenzie River Sub-basin Plan and Mackenzie River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Mackenzie River Sub-basin are included in Appendix C.

As per this document, the EVs for Mackenzie north-western tributaries—developed areas and the resulting WQOs selected to protect these environmental values are presented in Table 2.3.

Water Quality Objectives presented in Table 2.3 are derived from the following guideline documents:

- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian State and Territory Governments, Canberra ACT, Australia (ANZG 2018)[5].*
- *NHMRC (2008) Guidelines for Managing Risks in Recreational Water. National Health and Medical Research Council (NHMRC 2008)[6].*
- *NHMRC, NRMMC (2011) Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy. National Health and Medical Research Council, National Resource Management Ministerial Council, Commonwealth of Australia, Canberra. (NHMRC 2011)[7].*
- *PFAS National Environmental Management Plan Version 2.0 Heads of EPA Australia and New Zealand 2020 (NEMP V2 2020)[8].*
- *Department of Environment and Heritage Protection (2009) Queensland Water Quality Guidelines, Version 3, ISBN 978-0-9806986-0-2 (DEHP 2009[9]).*
- *Guidance on Per and Polyfluoroalkyl (PFAS) in Recreational Water, Canberra: National Health and Medical Research Council (2019) (NHMRC 2019)[10].*

[4] https://www.abs.gov.au/census/find-census-data/quickstats/2016/SSC31842 (accessed 21 November 2022)

[5] https://www.waterquality.gov.au/guidelines/anz-fresh-marine

[6] https://www.nhmrc.gov.au/about-us/publications/guidelines-managing-risks-recreational-water

[7] https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

[8] https://www.dcceew.gov.au/environment/protection/publications/pfas-nemp-2

[9] https://environment.des.qld.gov.au/__data/assets/pdf_file/0020/95150/water-quality-guidelines.pdf

[10] https://www.nhmrc.gov.au/sites/default/files/documents/attachments/guidance-on-PFAS-in-recreational-water.pdf

TABLE 2.3: ENVIRONMENTAL VALUES AND WATER QUALITY OBJECTIVES

Environmental Value (EV)	Aquatic ecosystems	Stock Water	Human Consumer	Primary recreation	Secondary recreation	Visual recreation	Drinking Water	Industrial use	Cultural and spiritual values
Mackenzie north-western tributaries—developed areas	✓	✓	✓	✓	✓	✓	✓	✓	✓
Water Quality Objective to protect the EV	ANZG (2018) 95% Species Protection levels for moderately disturbed systems. & NEMP V2 (2020) 99% Species Protection Criteria.	Objectives as per AWQG, including median faecal coliforms <100 organisms per 100 mL. WQOs for total dissolved solids and metals are provided in Tables 10 and 11, based on AWQG. For other objectives, such as cyanobacteria and pathogens, see AWQG.	Objectives as per AWQG and Australia New Zealand Food Standards Code7, Food Standards Australia New Zealand, 2007 and updates.	Objectives as per NHMRC (2008), including: • water free of physical (floating and submerged) hazards. • temperature range: 16–34°C. • pH range: 6.5–8.5. • DO: >80%. • intestinal enterococci: 95th percentile ≤ 40 organisms per 100 mL (for healthy adults) (NHMRC, 2008; Table 5.7). • reasonably free of, or protected from, venomous organisms. • waters contaminated with chemicals that are either toxic or irritating to the skin or mucous membranes. are unsuitable for recreational purposes.	NHMRC (2008), including: • intestinal enterococci: 95th percentile ≤ 40 organisms per 100mL (for healthy adults) (NHMRC, 2008; Table 5.7) • cyanobacteria/algae—refer objectives for primary recreation, NHMRC (2008) and Table 12. & NEMP V2 (2020) Recreational water Criteria	NHMRC (2008) • recreational water bodies should be aesthetically acceptable to recreational users. The water should be free from visible materials that may settle to form objectionable deposits; floating debris, oil, scum and other matter; substances producing objectionable colour, odour, taste or turbidity; and substances and conditions that produce undesirable aquatic life. • cyanobacteria/algae—refer objectives for primary recreation, NHMRC (2008) and Table 12. & NEMP V2 (2020) Recreational water Criteria	Local WQOs for drinking water supply are provided in Table 4. Note: For water quality after treatment or at point of use refer to legislation and guidelines, including: • Public Health Act 2005 and Regulations • Water Supply (Safety and Reliability) Act 2008, including any approved drinking water management plan under the Act • ADWG.	This EV is usually protected by other values, such as the aquatic ecosystem EV	Protect or restore indigenous and non-indigenous cultural heritage consistent with relevant policies and plans

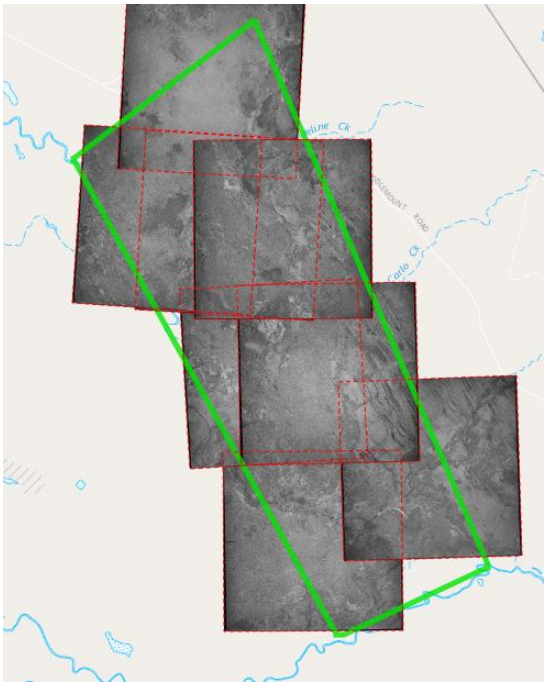
3. SITE HISTORY REVIEW

3.1 Historical Aerial Photograph Review

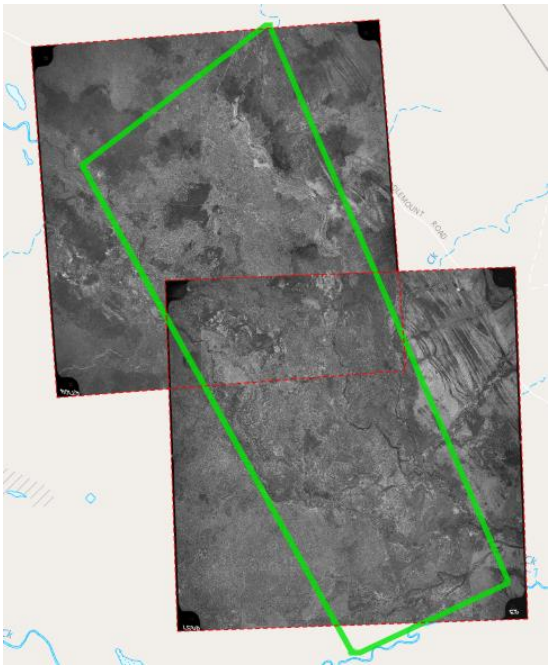
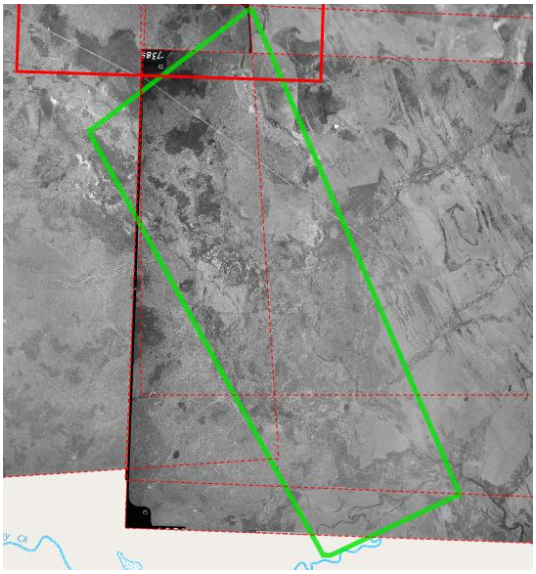
A review of available imagery from QImagery[11], Nearmap and Google Earth has been completed, with image extracts shown below. Due to the size of the site, the aerial images have been overlayed to allow the entire site to be viewed. The earliest images available for the site are dated 1 May 1956 and the latest image on Google Earth is from 2020. Complete images are presented in Appendix B.

The site is observed to be relatively undisturbed in the first available images from 1956, with initial signs of human activity noted in the 1978 images with land appearing to be cleared for cattle grazing and areas cleared for what appear to be transmission lines. Homesteads are observed in the 1984 images on Google Earth, assumed to be associated with cattle grazing activity. Further disturbance is noted in 1991 images, with mining operations underway by 2000. Mining operations continued to expand throughout the site over the following twenty years until the latest image available dated 2020.

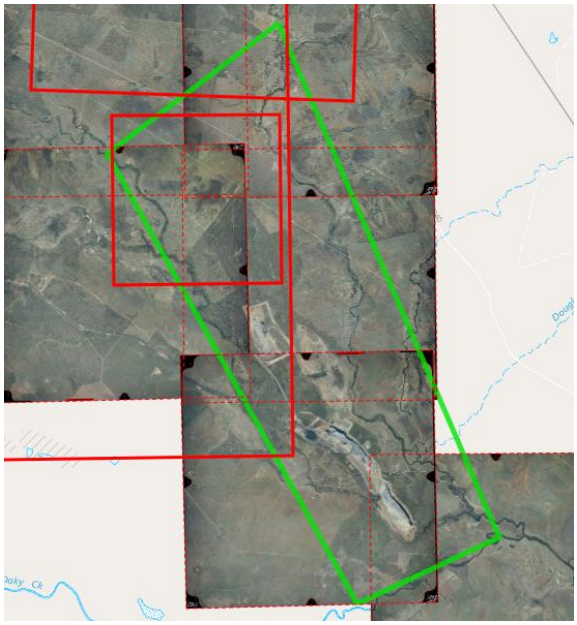
TABLE 3.1: AERIAL PHOTOGRAPH REVIEW

Source and Date	Photo Extract	Site Observations	Surrounding Area Observations
QImagery Roper 1956 series QAP610 Frame 85 01/05/1956 QAP609 Frame 127-129 01/05/1956 QAP595 Frame 39-40 01/05/1956 QAP585 Frame 114 01/04/1956 QAP612 Frame 86 01/05/1956		The site appears to be vegetated undisturbed land with no obvious signs of clearing and no visible access roads.	The limited surrounding area also appears to be undisturbed.

[11] https://qimagery.information.qld.gov.au/

Source and Date	Photo Extract	Site Observations	Surrounding Area Observations
QImagery Roper 1966 series QAP1704 Frame 96 01/09/1966 QAP1697 Frame 23 01/07/1966		The site appears to remain relatively undisturbed with no signs of earthworks. Access roads appear to be constructed in the northern portion of the site.	Several additional aerial images of the surrounding area are available. These show that the town of Middlemount and the associated surrounding roads are not yet established.
QImagery QAP3533 Frame 7385,7386 and 7388 20/08/1978		A view of much of the site is available in this series of images. The resolution of the images does not allow for much detail to be seen. A potential transmission line is present in the north-eastern portion of the site and there appears to be sections of land cleared to the north, potentially for grazing activity. Visible areas to the south appear to remain undisturbed, with Cockatoo and Roper Creeks visible.	The surrounding area that is visible appears to show the construction of Barwon Park Middlemount Road, indicating that the area has commenced development.

Source and Date	Photo Extract	Site Observations	Surrounding Area Observations
Google Earth 31/12/1984		This is the first available image on Google Earth and the first colour image for the site. A second line is observed in the north-east. Further land clearing is evident across the site. Structures are visible in the north, on the western side of Cockatoo Creek (assumed to be a homestead associated with cattle grazing activity) and in the south at the corner of two access roads between Roper Creek and Cockatoo Creek, just north of Lake Lindsay.	The surrounding area shows Middlemount town as being established including the main access roads and Mackenzie River Capella Road is clearly visible to the south. The surrounding area shows the Anglo Coal mine to the west and north-west is active (registered as granted on 5 July 1979).
Google earth 1991		Additional access tracks are noted in this image across the entire site. No evidence of mining activity is visible in the image. Several areas appear to have been cleared in the southern portion of the site to the west of Cockatoo Creek.	General expansion of the mining areas of the west are noted in the surrounding area.

Source and Date	Photo Extract	Site Observations	Surrounding Area Observations
Google Earth 31/12/2000		This is the first image showing significant activity on the site. Mining operations have commenced in the south-western portion of the site (ML70171), with an access road visible leading to the existing operations off-site to the west.	The mine sites to the west of the site appear to have expanded further. The area to the north of the site, south of Middlemount, appears to have been cleared of vegetation. The land east of the site does not appear to be significantly altered from the 1991 image.
QImagery Winderyers Hill 2001 series QAP6021 Frames 47, 49, 78,80,82 and 86 02/07/2002		Mining operations have extended into the northern portion of ML70171 in the images dated 02/07/2002. Several structures are noted as part of the mining infrastructure with mining activity appearing to be limited to the southern portion of the site. Areas in the northern portion of the site have been subject to clearing and there are several dirt access roads visible.	The surrounding area has been subject to significant clearing, with previously noted dirt access roads now appearing to be paved.

Source and Date	Photo Extract	Site Observations	Surrounding Area Observations
Nearmap 10/07/2011		Mining operations have expanded into the eastern portion of the site, east of Cockatoo Creek in ML70309, granted on 28 October 2004. Activities have expanded along the western boundary of the site. Additional access tracks are noted in the northern portion of the site, assumed to be associated with ML70429 -ML70431 exploration.	Anglo Coal mining operations within ML70336 are observed to be underway (ML granted in 2006).
Google Earth December 2020		Mining activity has expanded into the north-eastern portion of the site, encompassing a majority of the mining lease areas.	An additional mine is noted to the north of Dysart Middlemount Road. The mining operations to the south-west have further expanded. The remainder of the surrounding area appears similar to the 2011 image.

3.2 Current and Historical Titles

A search of the publicly available information was completed for land ownership, with cancelled titles not available for viewing. The environmental impact statement (EIS) dated April 2012 indicates that Lot 6 was previously owned by Foxleigh Land, the change in allotments is assumed to be associated with the acquisition of land from Kevin Kenny and Arthur Small for the extension of mining activity into the northern Fox Plains mining leases 70429, 70430 and 70431.

Copies of the title searches are provided in Appendix C and data is represented in Figure 3.1 below.

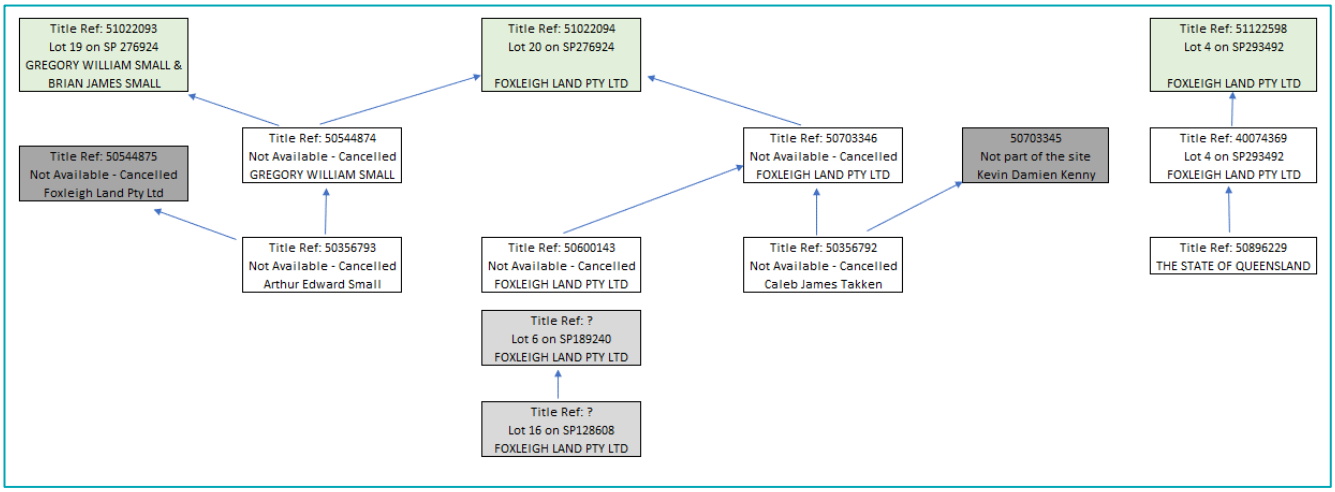


Figure 3.1: Current Titles and Previous Title References

3.3 Summary of Pre-Mining Potential Contaminants

Prior to mining activity commencing, the site appears to have been used exclusively for cattle grazing, with two (2) potential homesteads within the mining lease boundaries.

Cattle grazing activity implies that there is potential for the use of pesticides in cattle dips and for weed control. Buildings constructed prior to 2003 have the potential to contain asbestos, Polychlorinated biphenyls (PCBs) and lead based paint. Fuel and oils associated with equipment used for farming activities, along with the potential for onsite septic systems to be present.

3.4 Site Investigation Questionnaire

Foxleigh representative Murray vanTienhoven completed a Site Investigation Questionnaire (copy provided in Appendix C). Information provided to Engeny indicates the following:

Permits & Licenses applicable to the land:

- **Environmental Authorities:**
  - EA0001014 - MDL3028.
  - EPSX00841413 - EPC855.
  - EPVX00716813 - EPC1139.
  - EPML00744813 - ML70171, ML70309, ML70310, ML70429, ML70430, ML70431, ML70470.
- **Water Licenses:**
  - - WL103298 | Roper Creek.
  - - WL605014 | Carlo Creek.
  - - WL608515 | Cockatoo Creek.
- **Waste Management:**

Waste on site is managed in accordance with the Regulated Waste Management Plan. A licenced waste contractor (JJ's and Cleanaway) is contracted to remove waste from the site.

Details of all waste types produced on site and the respective disposal locations are presented in Table 3.2.

TABLE 3.2: SITE WASTE MANAGEMENT

Waste Type	Disposal
Coal rejects (coarse and fine) – volume is relative to coal volume processed though is in the kilotons at least.	Rejects dump (coarse) or tailings dam (fine).
Sewage is stored in temporary holding tanks onsite.	Removed by Cleanaway on a weekly basis.
Waste oil and greases – volume is relative to maintenance activities and scheduling / vehicle usage.	All waste oil and greases are taken offsite by the waste contractor.
Used tyres – volume is relative to servicing and vehicle usage.	Stockpiled in designated used tyre areas until a time when they can be / are needed to be disposed as per the Regulated Waste Management Plan.

3.5 Previous Report Review

3.5.1 Environmental Impact Statement

The Foxleigh Plains Project Draft Environmental Impact Statement (EIS) submitted to the department of Environment Heritage Protection (DEHP) (now known as The Department of Environment and Science) as part of the Fox Plains project approval process has been reviewed as part of this desktop assessment.

Section 4.5.5 of the Foxleigh Plains Project Environmental Impact Statement Assessment Report issued by DEHP in July 2013 states that "*The EIS stated that a site history for the project was conducted and that none of the project site was included on either the CLR nor the EMR, that there were no known contaminated sites on the site and no land issues relevant to contaminated land were identified for the site. The range of notifiable activities proposed for the project were listed, including petroleum product or oil storage, mine wastes, metal treating or coating, engine reconditioning, chemical storage, chemical manufacture or formulation and abrasive blasting. The EIS noted that the current 10 notifiable activities on the existing mine site would continue in order to support this project. A range of actions to prevent the contamination of the site were included in the EIS and the EIS stated that after decommissioning the site would be in a condition that it would not be registered on the EMR/CLR and a long-term site management plan for contamination would not be required.*"

The assumption in the EIS that the land is not registered on the EMR/CLR is integral to the outcome of the potential land uses once mining activities have ceased. As presented in Section 2 above, two of the current land parcels are listed on the EMR as a result of reallocation of lots completed between 2013 and 2016.

Table 6 of the Environmental Management Plan (presented as Attachment 1 of the EIS, dated April 2012) lists ten (10) Notifiable Activities as being undertaken at the Foxleigh Mine and Foxleigh Plains sites, as presented below:

- Abrasive blasting - Carrying out abrasive blast cleaning (other than cleaning carried out in fully enclosed booths) or disposing of abrasive blasting material.
- Chemical manufacturing or formulation - Manufacturing, blending, mixing or formulating chemicals if – (a) The chemicals are designated dangerous goods under the dangers goods code; and (b) The facility used to manufacture, blend, mix or formulate the chemicals has a design production capacity of more than 1t per week.
- Chemical storage - (Other than petroleum products or oil under item 29) storing more than 10t of chemicals (other than compressed or liquefied gases) that are dangerous goods under the dangerous goods code.
- Engine reconditioning works - Carrying out engine reconditioning work at a place where more than 500L of any of the following are stored— (a) halogenated and non-halogenated hydrocarbon solvents; (b) dangerous goods in class 6.1 under the dangerous goods code; (c) industrial degreasing solutions.
- Explosives production or storage - Operating an explosives factory under the Explosives Act 1999 (Qld).
- Landfill - Disposing of waste (excluding inert construction and demolition waste).

- Metal treatment or coating - Treating or coating metal including, for example, anodising, galvanising, pickling, electroplating, heat treatment using cyanide compounds and spray painting using more than 5L of paint per week (other than spray painting within a fully enclosed booth).
- Mine wastes - (a) Storing hazardous mine or exploration wastes, including, for example, tailings dams, overburden or waste rock dumps containing hazardous contaminants; or (b) Exploring for, or mining or processing, minerals in a way that exposes faces, or releases groundwater, containing hazardous contaminants.
- Mineral processing - Chemically or physically extracting or processing metalliferous ores.
- Petroleum product or oil storage - Storing petroleum products or oil— (a) in underground tanks with more than 200L capacity; or (b) in above ground tanks with— (i) for petroleum products or oil in class 3 in packaging groups 1 and 2 of the dangerous goods code—more than 2500L capacity; or (ii) for petroleum products or oil in class 3 in packaging groups 3 of the dangerous goods code—more than 5000L capacity; or (iii) for petroleum products that are combustible liquids in class C1 or C2 in Australian Standard AS 1940, 'The storage and handling of flammable and combustible liquids' published by Standards Australia—more than 25000L capacity.

3.5.2 Environmental Authority Audit

EnviroHaz Pty Ltd (EnviroHaz) Environmental Authority Audit – EPML00744813 Foxleigh Mine, Central Queensland FoxMan dated 20/04/2021 reviewed the 141 conditions associated with the EA EPML00744813 and identified:

- 58 Compliant Conditions.
- 19 Non-Compliant Conditions (A2, A16, E5, E7, E8, G2, G4, G5, G8, G11, H2, H8, J1, J2, J6, J11, J23, J26 and J35).
- 5 Minor Non-Compliant Conditions (A5, E3, F26, F30 and F31).
- 59 Not Applicable Conditions.

Recommendations included:

- A5: Continue environmental document suite review and update. It is suggested that a robust document management system and version control are implemented to ensure document history is appropriately managed and document review cycles are implemented.
- A14: Add a 'time' of complaint' field to the register.
- E2 & E3: Confirm that monitoring recommenced in March 2021 is conducted in accordance with Foxleigh Plains Groundwater Monitoring and Management Plan (April 2016).
- E3: Continue the Groundwater Monitoring Program started in March 2021.
- E9: Consider conducting a Bore Integrity Review.
- F10: Undertake a calculation to confirm that $2m^3/s$ (2,000l/s) could not occur and if it can install a measuring device to demonstrate compliance.
- F28: Consideration should be given to including field sampling sheets, laboratory reports etc as appendices to the REMP to clearly demonstrate the 'specified format' requirement in compliance with this condition.
- F30: The March 2021 Water Management Plan should be reviewed and amended (if necessary) by an appropriately qualified person and then implemented.
- F31: The March 2021 Erosion and Sediment Management Plan should be reviewed and amended (if necessary) by an appropriately qualified person and then implemented.
- H3: Re-reference when/if this Environmental Authority is amended.
- J11: Update this condition when/if this Environmental Authority is amended.
- J34: Add the words 'as being accurate and correct' to the Approval Statement. Also, consider adding an area for signature and date information.

4. EMR LISTED LAND

Chapter 7, Part 8 of the EP Act contains the contaminated land provisions. These provisions adopt the concept of risk management through the development of two registers for the recording of land, the Environmental Management Register (EMR) and the Contaminated Land Register (CLR). Land is placed on the EMR and/or CLR because a notifiable activity has been or is being conducted on the site or the land has been contaminated by a hazardous contaminant. The EMR is a land-use planning and management register. The EMR provides information on historic and current land-use including whether the land has been or is currently used for a notifiable activity or has been contaminated by a hazardous contaminant. The appropriate investigation and, if necessary, remediation will be required to be undertaken before any change in land use takes place.

EMR listed sites are subject to specific management regulations in accordance with the EP Act, including the requirement for a soil disposal permit (SDP) to be issued by DES if soil is proposed to be removed from the land parcel that is listed on the EMR. This aims to prevent the movement and spread of potentially contaminated material through the requirement for a suitably qualified person (SQP) in accordance with Sections 381, 395 and 410 of the EP Act to assess any soil proposed to be removed.

An application for a soil disposal permit must include:

- a completed soil disposal permit form.
- copy of certificate of title of site from which the soil is to be removed.
- copy of certificate of title of receiving site (only if soil is not going to an approved landfill).
- copies of all laboratory reports of soil analyses and leachate testing results.
- written acceptance of the soil from the owner of the disposal site.

As shown in Table 2.1, there are two (2) land parcels (Lots 19 and 20 on SP276924) that are registered on the EMR as a result of subdivision of the former Lot 6 on SP189240 for the notifiable activity of WASTE STORAGE, TREATMENT OR DISPOSAL - storing, treating, reprocessing or disposing of regulated waste (other than at the place it is generated), including operating a nightsoil disposal site or sewage treatment plant where the site or plant has a design capacity that is more than the equivalent of 50, 000 persons having sludge drying beds or on-site disposal facilities.

Any soil proposed to be removed from the two EMR listed land parcels on the site is therefore required to be assessed by an SQP to determine the contamination status, prior to removal.

4.1 Management of EMR Listed Land

Management of potentially contaminating activities is essential throughout the life of the mine, in all areas included in the environmental authority where there is potential for contamination. Records of activities undertaken, movement of materials and any assessments and testing completed are essential to be retained for the future assessment of land suitability for the proposed land use, should surrender of an Environmental Authority be required once activities cease. This encompasses all areas associated with the activity, both current and historical.

In order to assess land on the EMR, a contaminated land investigation document (CLID) is required to be produced in accordance with the ASC NEPM and EP Act. The CLID is required to provide evidence of the contamination status of the land, considering all historical activities and potential contaminants of concern and is required to be certified by a Contaminated Land Auditor (CLA). Therefore, good management practices throughout the life of a mine are essential to allow the appropriate assessment of the land, surface water and groundwater beneath the land. This includes the ability to demonstrate compliance with EA conditions that are imposed by the regulator to reduce the risk of contamination to the receiving environment based on the activities undertaken on the land. Soil and groundwater are required to meet the contaminated land provisions for the nominated post-mining land use in the PRCP.

5. POST-MINING LAND USE

Determining the appropriate PMLUs is a critical first step in mine rehabilitation planning. It will support and inform the remainder of the proposed PRC plan, including rehabilitation and management strategies, and the PRCP schedule.

Examples of potential PMLUs include (but are not limited to):

- Native ecosystem.
- Habitat and ecosystem services.
- Grazing.
- Agriculture.
- Forestry.
- Cropping.
- Industrial.
- land fill.
- Water storage.

PMLU's are required to consider:

- Any regulatory constraints on, or objectives for, the proposed land use (e.g. Indigenous Land Use Agreements, site management plan (contaminated land), local and regional land use plans, endangered species, or registered heritage places).
- Physical constraints (e.g. slopes, voids, geology).
- Chemical characteristics (e.g. residual contamination from tailings or other waste disposal).
- Available rehabilitation methods, including best practice (e.g. backfill, profile, capping).
- Relative costs of each rehabilitation option.
- Potential economic benefits of each option for the community or land holder (e.g. tourism, public use, grazing).
- Potential environmental benefits of each option; (e.g. create wildlife corridors, revegetation).
- Potential social benefits of each option (e.g. recreational use, public amenity, employment).
- Compatibility with surrounding land uses (e.g. agriculture, ecosystem).
- The land use before the mining activity commenced.
- Options for retaining/transitioning infrastructure and utilities such as road and rail transport accessibility as well as power, communications and water management systems.

Where a non—use management area (NUMA) has been pre-approved and is being translated into the PRC plan, the EA holder is not required to:

- Justify the proposed NUMA.
- Provide evidence to support the justification of the NUMA.
- Go through the Public Interest Evaluation process.
- Comply with the prohibition of voids located within a flood plain having to be rehabilitated to a stable condition.

5.1 Land Rehabilitation

All rehabilitated mined land must be safe, stable and non-polluting and meet the requirements of the Environmental Authority.

5.2 Remediation Requirements

Milestones for the remediation of contaminated land in accordance with the progressive rehabilitation framework require the following steps to be completed, as appropriate:

- Carry out preliminary and intrusive contaminated land investigations.
- Removal or onsite treatment of contaminated water (e.g. affected by hydrocarbons, brine, metals, etc).
- Removal and appropriate disposal of contaminated materials (PCBs, Dioxins, Mercury, hydrocarbon contaminated soils).
- On-site remediation of hydrocarbon contaminated soils.
- Removal and disposal of asbestos.
- Removal and disposal of plastic (geofabric) liners from dams, leach pads, etc.
- Conduct validation testing to confirm that contaminated soils have been removed/remediated.

6. POTENTIALLY CONTAMINATING ACTIVITIES

6.1 Environmental Authorities

Two (2) Environmental Authorities have been reviewed for the site operations within the Foxleigh Mine.

Environmental Authority permit number EPML00744813, issued to CAML Resources Pty Ltd, Nippon Steel & Sumitomo Metal Australia Pty Ltd and Foxleigh Coal Pty Ltd at registered address Level 12, 300 Queen Street, Brisbane City QLD 4000 effective from 17 February 2017.

EPPR00449613 issued to Foxleigh Land Pty Ltd at registered address GPO Box 2212 Brisbane QLD 4000 effective from 15 October 2001.

Details of the Environmentally Relevant Activities approved in the environmental authorities are presented in Table 6.1.

It is noted that the DES online record of the EA approved ERAs contains an error with the updated extraction and screening activities on site, with the original EA listed as "ERA 16 Extractive and screening activities, Threshold 3 – Screening, in one year, the following quantity of material – (c) more than 1,000,000t". The Ancillary 16 listing should therefore be listed as Ancillary 16 (3), not (1) as no dredging occurs on site, only screening of material.

TABLE 6.1: EA APPROVED ERAS

Activity	Site Location
Ancillary 08 - Chemical Storage. 3 - Storing more than 500 cubic metres of chemicals of class C1 or C2 combustible liquids under AS 1940 or dangerous goods class 3 under subsection (1)(c).	Industrial Area; Warehouse; CHPP. Fuel Farm (Diesel); Heavy Machinery Equipment Workshop (Lubricants).
Ancillary 15 - Fuel burning. Using fuel burning equipment that is capable of burning at least 500kg of fuel in an hour.	
Ancillary 16 - Extraction and Screening. 1(c) - Dredging, in a year, the following quantity of material - more than 100,000t but not more than 1,000,000t.	
Ancillary 31 - Mineral processing. 2(b) - Processing, in a year, the following quantities of mineral products, other than coke - more than 100,000t.	
Ancillary 33 - Crushing, milling, grinding or screening. Crushing, grinding, milling or screening more than 5000t of material in a year.	
Ancillary 60 - Waste disposal. 1(a) - Operating a facility for disposing of, in a year, the following quantity of waste mentioned in subsection (1)(a) - less than 50,000t.	OTW PD, Fox Plains South PD, Rejects Dump.
Ancillary 62 - Resource recovery and transfer facility operation. 1(c) - Operating a facility for receiving and sorting, dismantling, baling or temporarily storing category 2 regulated waste.	

Activity	Site Location
Ancillary 62 - Resource recovery and transfer facility operation. 1(d) - Operating a facility for receiving and sorting, dismantling, baling or temporarily storing category 1 regulated waste.	
Schedule 3. 13 - Mining black coal.	All pits and stockpiles.
ERA 16 - Extraction and Screening. 2(a) - Extracting, other than by dredging, in a year, the following quantity of material - 5,000t to 100,000t.	
ERA 16 - Extraction and Screening. 3(a) - Screening, in a year, the following quantity of material - 5,000t to 100,000t.	

6.2 Site Infrastructure

The major infrastructure within the EA at the Foxleigh Mine are:

- CHPP.
- Private haul road.
- Workshop and associated fuel storage and washdown bay.
- Administration offices and employee facilities.
- Mine operations and administration building.
- First aid, mine rescue and fire services facilities.
- Warehousing and storage areas.
- Sewage Holding Tanks.
- Explosive magazine.
- Haul road and stockpile hardstands.
- Raw water storage.
- Sedimentation dams.
- Tailings disposal facilities.
- Fuel storage.
- Power reticulation/substation and switchyard.
- Fencing.
- Car parks.

Locations of site infrastructure provided by Foxleigh are presented in Figure 2, Appendix A.

6.3 Site Registers

The Foxleigh Regulated Waste Burial Register was reviewed in preparation of this guidance and includes details of old tyres buried in the PDs and hydrocarbon spill impacted soils disposed to the rejects dump.

Five (5) asbestos registers were provided for review:

- Hygenics Pty Ltd *Asbestos Register Foxleigh Mining Pty Ltd Residential Single-Storey Houses* dated November 2008 identified asbestos as present at twenty (20) of the thirty-one (31) houses inspected. None of the single storey houses are located within the mine site EA.
- Hygenics Pty Ltd *Asbestos Register Foxleigh Mining Pty Ltd Residential Double-Storey Houses* dated November 2008 identified asbestos as present at all six (6) houses inspected. None of the double storey houses are located within the mine site EA.
- Hygenics Pty Ltd *Asbestos Register Foxleigh Mining Pty Ltd Residential Units* dated November 2008 identified asbestos present at all nine (9) units inspected. None of the units are located within the mine site EA.
- Hygenics Pty Ltd *Asbestos Register Foxleigh Mining Pty Ltd Village* dated November 2008 identified no asbestos to be present in the following locations: dining room, rec room, toilet blocks, laundries, office and linen, chemical store, gym and blocks A-P.
- Hygenics Pty Ltd *Asbestos Audit Review of Foxleigh Mining Pty Ltd Mine Site* dated 2011 identified no asbestos in the following locations: training building, safety building, toilets/store, orica, showers/safety store, first aid, administration, OCE building, technical service building, carlo creek crib hut, north west crib hut, central crib, pump crew containers, LCR mailbox, orica reload, explosive magazines, CHPP management office, contractor's crib room, lab building, warehouse, administration building, workshop, wash plant, ROM MCC, CPP MCC, TLO Crib room/control room, container, TLO toilets, tunnel, workshop administration, component room, parts store, tool storage container C6, crib room, pirtek container, CAT container, Hitachi container C3, Service Bay, Container C4 and C5, welding shed, LCR workshop, office/lunchroom, supervisors office/store/toilet and stores office.

6.4 Site Management Plans, Systems and Procedures

Various management plans and systems are in place at the Foxleigh Mine. These have been developed to mitigate, manage, and reduce risk and the potential for environmental harm from operations. The following plans have been referenced in the Site Investigation Questionnaire response:

- Environmental Management System.
- Biodiversity Offset Management Plan.
- Erosion and Sediment Management Plan.
- Groundwater Water Monitoring Management Plan.
- Noxious Weed Management Plan.
- Receiving Environment Monitoring Plan.
- Regulated Structures Operational Plan.
- Regulated Waste Management Plan.
- Rehabilitation Management Plan.
- Tailings Management Plan.
- Waste Rock and Spoil Disposal Management Plan.
- Water Management Plan.

Other processes include specific references in Standard Operating Procedures to hydrocarbon or chemical usage that considers the environment, especially with reference to spills and managing / mitigating their effects.

7. CONCEPTUAL SITE MODEL

In determining the key risks relevant to the contaminants of potential concern (CoPC) and priority areas for assessment, it is important to develop a conceptual site model (CSM) that describes the nature of the source of the contamination, and the pathways by which receptors (humans and ecosystems) might be affected by the contamination. Schedule B2 of the NEPM provides an outline of how to develop a CSM.

The main aspects to be considered in developing a preliminary CSM include identification of the:

- Source(s) of contaminants: Site uses that contained potential sources of contamination.
- Release mechanisms: Contaminants may enter the environment through deposition of fill material, groundwater, surface water runoff and dust.
- Impacted media and transport mechanisms: Contaminants may impact all elements of the environment, including the atmosphere, soils, sediments, groundwater and surface water as well as vapour phase migration.
- Beneficial uses (or environmental values) and potential receptors: the beneficial uses or environmental values that can be impacted by the contamination, and the corresponding human and ecological (terrestrial and aquatic) receptors that can potentially be affected; and
- Exposure pathways: Mechanisms by which receptors can be exposed include, for example, ingestion, dermal contact, and inhalation.

A CSM provides a summary of the key aspects of the risk framework that is relevant to the area being evaluated. The CSM can be presented in words, as a diagram or as a flow diagram.

PFAS is persistent in all environmental media, with high mobility in water and high potential to bioaccumulate in humans, plants and animals. It is for this reason that particular attention should be given to the risk of PFAS contamination and the subsequent impacts both on and off-site.

The CSM identifies potential sources of CoPC, sensitive receptors, and potential transport mechanisms that could expose sensitive receptors to unacceptable ecological and/or health risks. The objective of the preliminary CSM is to highlight actual or potential exposure pathways that may exist and identify any data gaps that may need to be addressed during the investigation.

For potential ecological and/or health risks to be present, all of the following elements of an exposure pathway are required:

(1) Contaminant source.

(2) Receptor; and

(3) Transport mechanism/exposure route between the source and receptor.

If all three elements are present, it is considered that a complete exposure pathway exists. Partial or incomplete exposure pathways may also be present.

Potential sources, pathways and receptors are identified in the following sections.

7.1 Potential Contamination Sources and Contaminants of Concern

Potential contamination sources identified in this desktop assessment are presented in Table 7.1 below. It is noted that this list is based on available information provided by Foxleigh and general contaminated land management provisions. All potential sources and contaminants of concern may not be identified. Site investigations using the risk-based approach outlined in the National Environment Protection (Assessment of Site Contamination) Measure (NEPM) are recommended to be completed prior to rehabilitation, including intrusive sampling and analysis of soils, sediment, surface water and groundwater to determine the actual contamination status of the site.

TABLE 7.1: POTENTIAL SOURCES AND CONTAMINANTS

Potential Source	Potential Contaminants of Concern
Cleared Areas	Heavy metals, pesticides.
Former homestead / cattle dip infrastructure	Asbestos, synthetic mineral fibres (SMF), lead based paint, Polychlorinated biphenyls (PCBs), petroleum hydrocarbons, arsenic, heavy metals, pesticides.
Spoil Dumps, stockpiles, tailings storage	Petroleum hydrocarbons, Methyl Isobutyl Carbinol (MIBC), Per and poly fluorinated substances (PFAS) and, if applicable, acid mine drainage (AMD), polycyclic aromatic hydrocarbons (PAH) and Dioxins are also potentially of concern.
Workshops / Wash Bays / Dangerous Goods Storage	Petroleum hydrocarbons, metals, PFAS, PCBs, phenols, solvents.
Fuel Storage Areas / Mobile refuelling areas	Petroleum hydrocarbons.
Substation	Petroleum hydrocarbons, metals, PFAS, PCBs, phenols, solvents.
Sewage Holding Tank Areas	Metals, PFAS, nitrogen species, microbiological.
Explosives Storage	Petroleum hydrocarbons, nitrogen species.
Roads and Carparks	Petroleum hydrocarbons, metals.
Voids containing Pit Water	Petroleum hydrocarbons, metals, AMD, PFAS, PCBs, phenols, solvents, nitrogen species, microbiological.
Waste Storage Areas	Petroleum hydrocarbons, metals, PFAS, PCBs, phenols, solvents.
Drainage Lines	Petroleum hydrocarbons, metals, AMD, PFAS, PCBs, phenols, solvents, nitrogen species, microbiological.
Water Storage Areas	Petroleum hydrocarbons, metals, AMD, PFAS, PCBs, phenols, solvents, nitrogen species, microbiological.
Process water	Petroleum hydrocarbons, metals, AMD, PFAS, PCBs, phenols, solvents, nitrogen species, microbiological.
Mine dewatering (Pit water from groundwater, direct rainfall and runoff from spoil and seepage.)	Petroleum hydrocarbons, metals, AMD, PFAS, PCBs, phenols, solvents, nitrogen species, microbiological.

7.2 Potentially Affected Media

Potentially affected media at the site includes all environmental media:

- Soil.
- Soil vapour.
- Sediment.
- Surface Water.
- Groundwater.

Intrusive sampling and analysis will provide further information regarding the contamination status of the various media across the site.

7.3 Potential Migration Pathways

Potential contamination migration pathways include a combination of:

- Windblown dust.
- Surface water runoff.
- Surface water infiltration to groundwater.
- Groundwater migration.
- Mine water transfer systems.
- Drainage and diversion channels.
- Discharge points.

7.4 Potential Receptors

Potential on-site receptors include workers, contractors and visitors along with terrestrial and aquatic flora and fauna. Off-site receptors include members of the public, recreational users of surrounding waterbodies, users and consumers of groundwater, and aquatic and terrestrial flora and fauna.

8. CONTAMINATION REMEDIATION CONSIDERATIONS

Elements to be considered when remediating former mining land are presented below.

Questions to consider:

(1) Has disturbance of the land occurred?

(2) Has the land been used for any mining activity (including hauls roads)?

(3) Have there been any spills or reported incidents in the area?

The recommended process for assessment and remediation is to:

- Remove any infrastructure.
- Conduct a preliminary site assessment including review of previous activities.
- Develop sampling and analysis plan.
- Determine assessment criteria based on the proposed PMLU.
- Sampling and analysis for potential contaminants of concern.
- Compare sampling results to relevant criteria.
- Determine if remedial works are required to achieve suitability for the proposed PMLU.
- Removal and appropriate disposal of contaminated materials – water, soils, asbestos, plastic and geofabric liners.
- Conduct validation testing.
- Report confirming successful removal of contaminated material and a statement on the contamination status.
- Retain report until mine closure as evidence of remediation works.

9. QUALIFICATIONS

(a) In preparing this document, including all relevant calculation and modelling, Engeny Water Management (Engeny) has exercised the degree of skill, care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering principles.

(b) Engeny has used reasonable endeavours to inform itself of the parameters and requirements of the project and has taken reasonable steps to ensure that the works and document is as accurate and comprehensive as possible given the information upon which it has been based including information that may have been provided or obtained by any third party or external sources which has not been independently verified.

(c) Engeny reserves the right to review and amend any aspect of the works performed including any opinions and recommendations from the works included or referred to in the works if:

  (i) Additional sources of information not presently available (for whatever reason) are provided or become known to Engeny; or

  (ii) Engeny considers it prudent to revise any aspect of the works in light of any information which becomes known to it after the date of submission.

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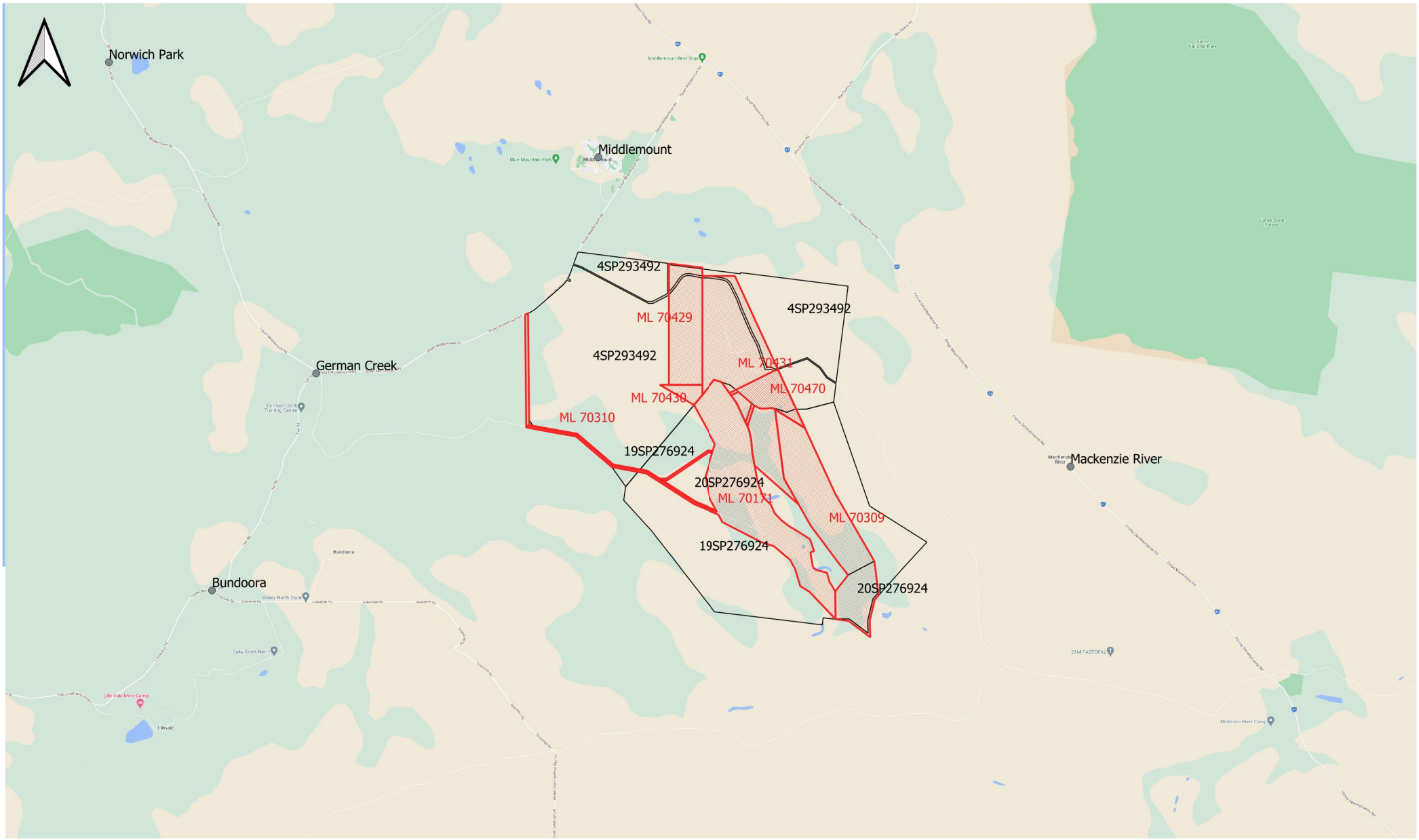
(g) This Report does not provide legal advice.

APPENDIX A: FIGURES



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0 100 200 m

Legend

- Mining Lease
- Cadastre
- Towns

Foxleigh MINE

ENGENY

FOR INFORMATION ONLY

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Level 2
500 Queen St
Brisbane QLD
www.engeny.com.au

FOXLEIGH MINE

Figure 1 - Site Location
SHEET 1 OF 1

0

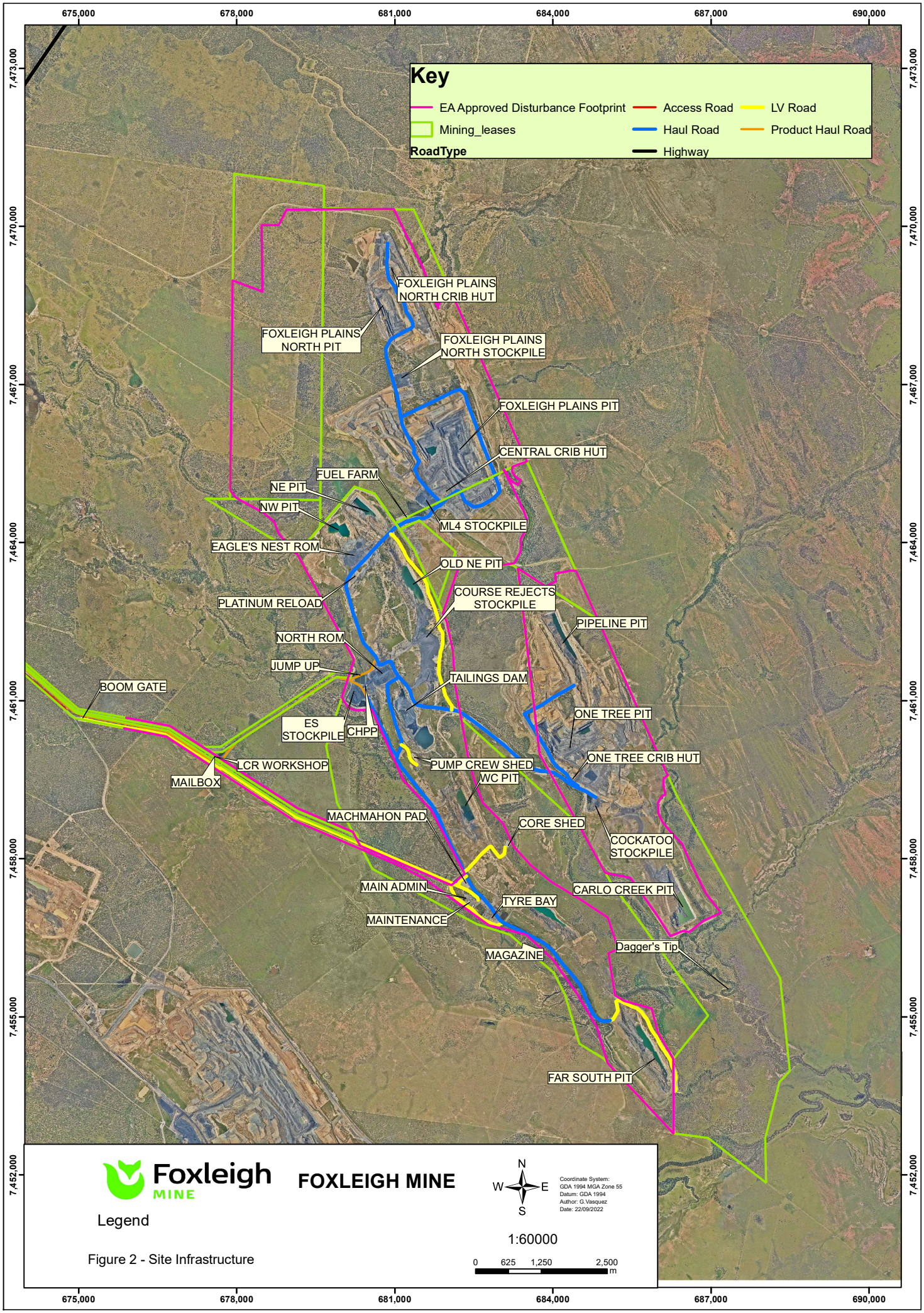

Figure 2 - Site Infrastructure

APPENDIX B: EMR SEARCH RESULTS

Department of Environment and Science (DES)
ABN 46 640 294 485
400 George St Brisbane, Queensland 4000
GPO Box 2454, Brisbane QLD 4001, AUSTRALIA
www.des.qld.gov.au

SEARCH RESPONSE
ENVIRONMENTAL MANAGEMENT REGISTER (EMR)
CONTAMINATED LAND REGISTER (CLR)

Rebecca Malaj
Level 2, 500 Queen Street
Brisbane QLD 4000

Transaction ID: 50818354 EMR Site Id: 147886 03 November 2022
Client Reference:
Cheque Number:

This response relates to a search request received for the site:
Lot: 20 Plan: SP276924

EMR RESULT

The above site IS included on the Environmental Management Register.

The site you have searched has been subdivided from the following site, which IS included on the EMR or the CLR.

Lot: 6 Plan: SP189240
Address: BARWON PARK-MIDDLEMOUNT ROAD
MACKENZIE RIVER 4705

The site has been subject to the following Notifiable Activity or Hazardous Contaminant.
WASTE STORAGE, TREATMENT OR DISPOSAL - storing, treating, reprocessing or disposing of regulated waste (other than at the place it is generated), including operating a nightsoil disposal site or sewage treatment plant where the site or plant has a design capacity that is more than the equivalent of 50, 000 persons having sludge drying beds or on-site disposal facilities.

CLR RESULT

The above site is NOT included on the Contaminated Land Register.

ADDITIONAL ADVICE

All search responses include particulars of land listed in the EMR/CLR when the search was generated.
The EMR/CLR does NOT include:-

1. land which is contaminated land (or a complete list of contamination) if DES has not been notified
2. land on which a notifiable activity is being or has been undertaken (or a complete list of activities) if DES has not been notified

If you have any queries in relation to this search please email emr.clr.registry@des.qld.gov.au

Administering Authority

Department of Environment and Science (DES)
ABN 46 640 294 485
400 George St Brisbane, Queensland 4000
GPO Box 2454, Brisbane QLD 4001, AUSTRALIA
www.des.qld.gov.au

SEARCH RESPONSE
ENVIRONMENTAL MANAGEMENT REGISTER (EMR)
CONTAMINATED LAND REGISTER (CLR)

Rebecca Malaj
Level 2, 500 Queen Street
Brisbane QLD 4000

Transaction ID: 50818353 EMR Site Id: 147885 03 November 2022
Client Reference:
Cheque Number:

This response relates to a search request received for the site:
Lot: 19 Plan: SP276924

EMR RESULT

The above site IS included on the Environmental Management Register.

The site you have searched has been subdivided from the following site, which IS included on the EMR or the CLR.

Lot: 6 Plan: SP189240
Address: BARWON PARK-MIDDLEMOUNT ROAD
MACKENZIE RIVER 4705

The site has been subject to the following Notifiable Activity or Hazardous Contaminant.
WASTE STORAGE, TREATMENT OR DISPOSAL - storing, treating, reprocessing or disposing of regulated waste (other than at the place it is generated), including operating a nightsoil disposal site or sewage treatment plant where the site or plant has a design capacity that is more than the equivalent of 50, 000 persons having sludge drying beds or on-site disposal facilities.

CLR RESULT

The above site is NOT included on the Contaminated Land Register.

ADDITIONAL ADVICE

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2. land on which a notifiable activity is being or has been undertaken (or a complete list of activities) if DES has not been notified

If you have any queries in relation to this search please email emr.clr.registry@des.qld.gov.au

Administering Authority

Department of Environment and Science (DES)
ABN 46 640 294 485
400 George St Brisbane, Queensland 4000
GPO Box 2454, Brisbane QLD 4001, AUSTRALIA
www.des.qld.gov.au

SEARCH RESPONSE
ENVIRONMENTAL MANAGEMENT REGISTER (EMR)
CONTAMINATED LAND REGISTER (CLR)

Rebecca Malaj
Level 2, 500 Queen Street
Brisbane QLD 4000

Transaction ID: 50818352 EMR Site Id: 03 November 2022
Cheque Number:
Client Reference:

This response relates to a search request received for the site:
Lot: 4 Plan: SP293492

MACKENZIE RIVER

EMR RESULT

The above site is NOT included on the Environmental Management Register.

CLR RESULT

The above site is NOT included on the Contaminated Land Register.

ADDITIONAL ADVICE

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The EMR/CLR does NOT include:-

1. land which is contaminated land (or a complete list of contamination) if DES has not been notified
2. land on which a notifiable activity is being or has been undertaken (or a complete list of activities) if DES has not been notified

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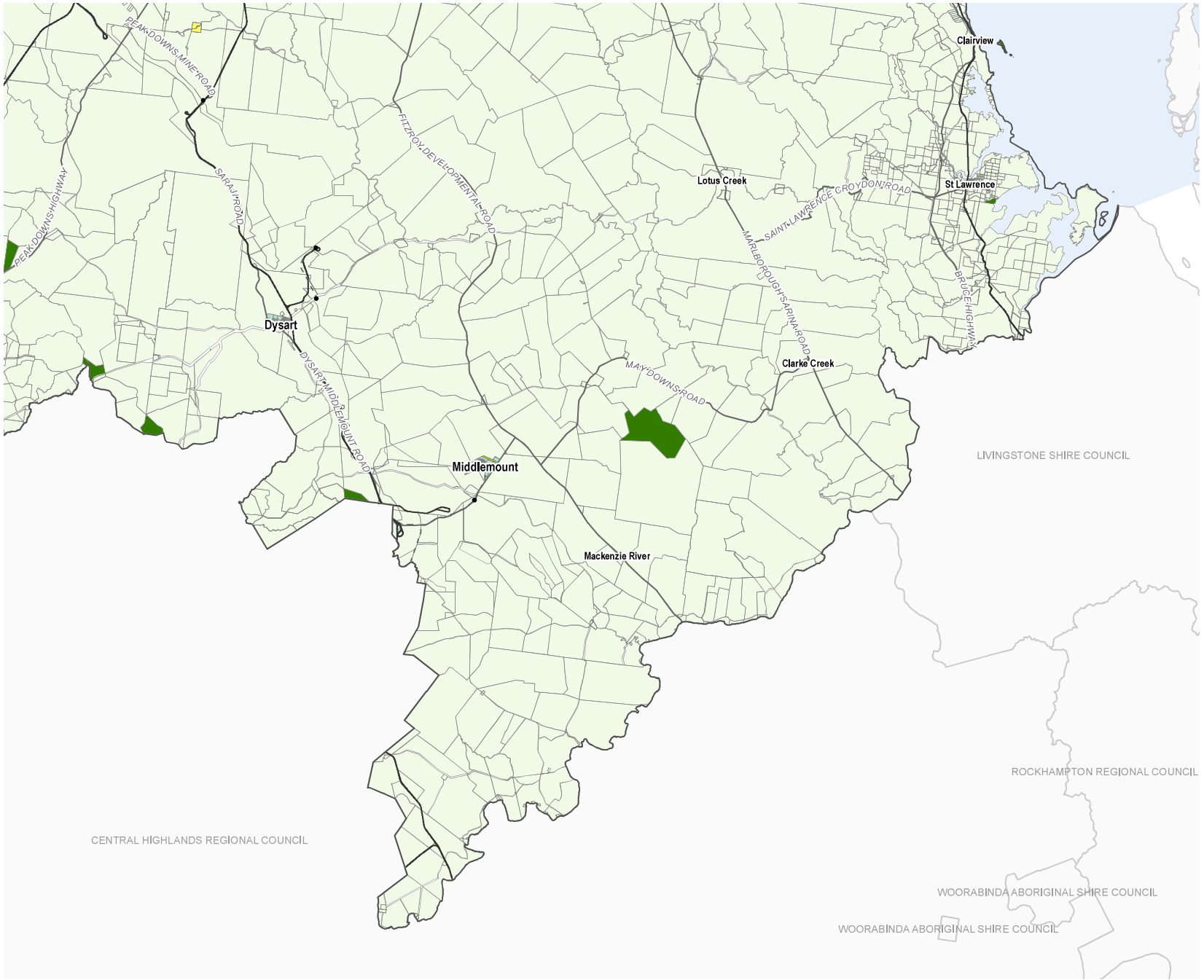
Administering Authority

APPENDIX C: REFERENCE MATERIAL



ISAAC REGION

Isaac Regional Planning Scheme 2021 Zoning Rural Areas (south-east)

Zones

- Low Density Residential
- Low-medium Density Residential
- Centre
- Industry
- Industry Investigation
- Recreation and Open Space
- Environmental Management and Conservation
- Community Facilities
- Emerging Community
- Limited Development
- Rural Residential
- Rural
- Specialised Centre
- Special Purpose
- Minor Tourism
- Township
- Precinct Boundary
- Cadastral Boundary
- Local Government Boundary
- Waterway
- Major Roads
- Railway Network
- Major Substations
- Major Powerlines

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Geocentric Datum of Australia (GDA94)

Version: 1.0
Gazettal Date: 01/04/2021
Approx Scale @ A3 1:650,000

0 10 20
km

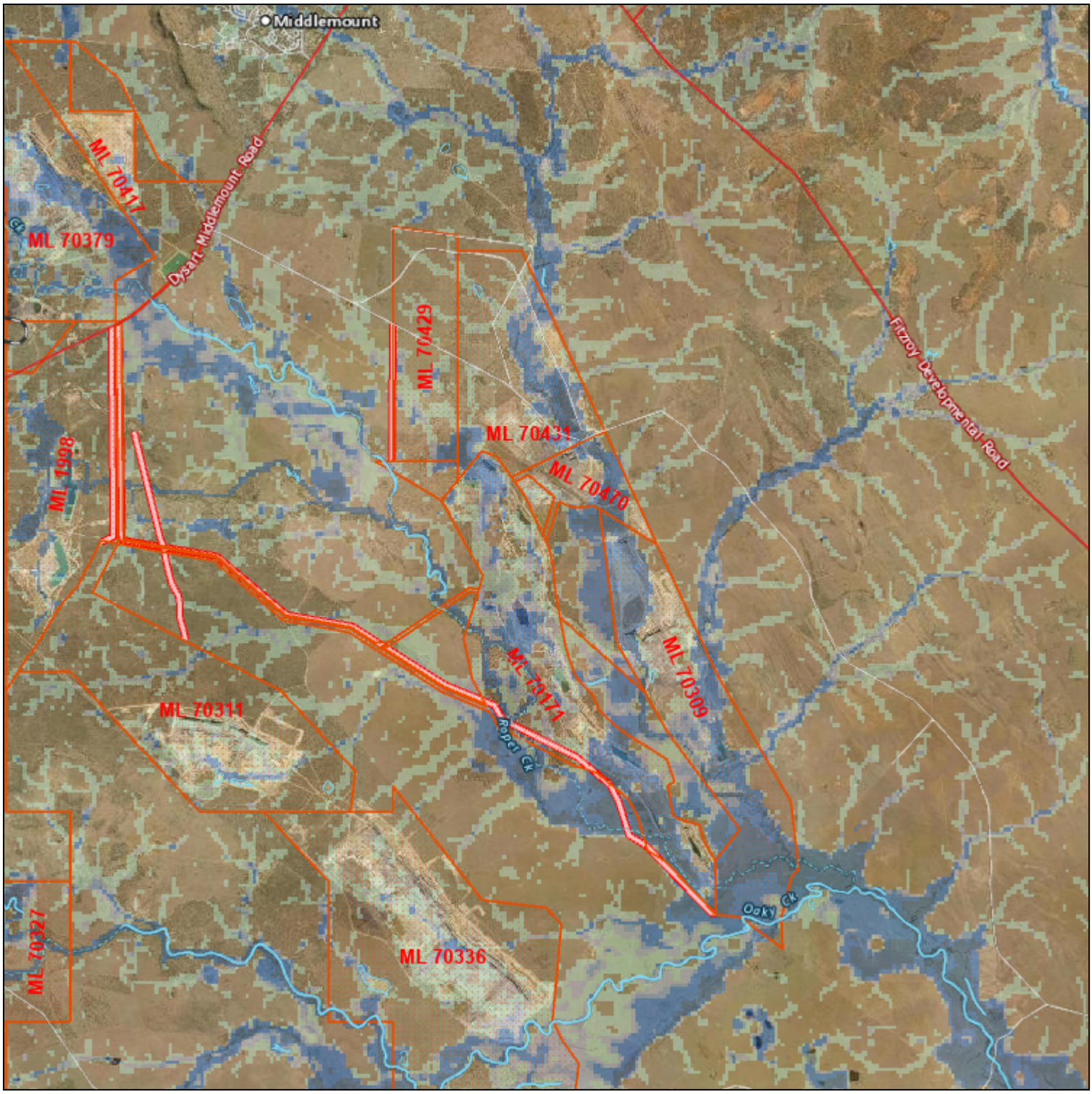
Sheet Index

Zoning - ZM1.3 Rural Areas (south-east)

Basin Flood Level Mapping

22°48'23"S 148°38'2"E

22°48'23"S 148°54'50"E



23°3'51"S 148°38'2"E

23°3'51"S 148°54'50"E

A product of Queensland Globe

Legend located on next page

N

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Scale: 1:157530

Printed at: A4

Print date: 21/11/2022

Projection: Web Mercator EPSG 102100 (3857)

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Basin Flood Level Mapping

Legend

ML permit application

ML surface area application

ML access application

ML permit granted

ML surface area granted

ML access granted

Coastline

Lake

Lake

Reservoir

Reservoir

Canal line

Canal

Canal area

Canal area

Watercourse line

Major - perennial

Major - non perennial

Minor - perennial

Minor - non perennial

Watercourse area

Watercourse area

Water area edge

Watercourse stream order

1974 Floodline Brisbane and Bremer Rivers

2010 Floodline Bundaberg

2011 Floodline Queensland towns - January

2011 Floodline Queensland towns - April

Attribution

Earthstar Geographics

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Basin Flood Level Mapping

Legend

2012 Floodline SW Queensland towns

2013 Floodline Bundaberg

2017 Floodline Fitzroy River

2017 Floodline Logan and Albert Rivers

2019 Floodline Western Queensland

Cities and Towns

Road crossing

- Bridge
- Tunnel

Railway

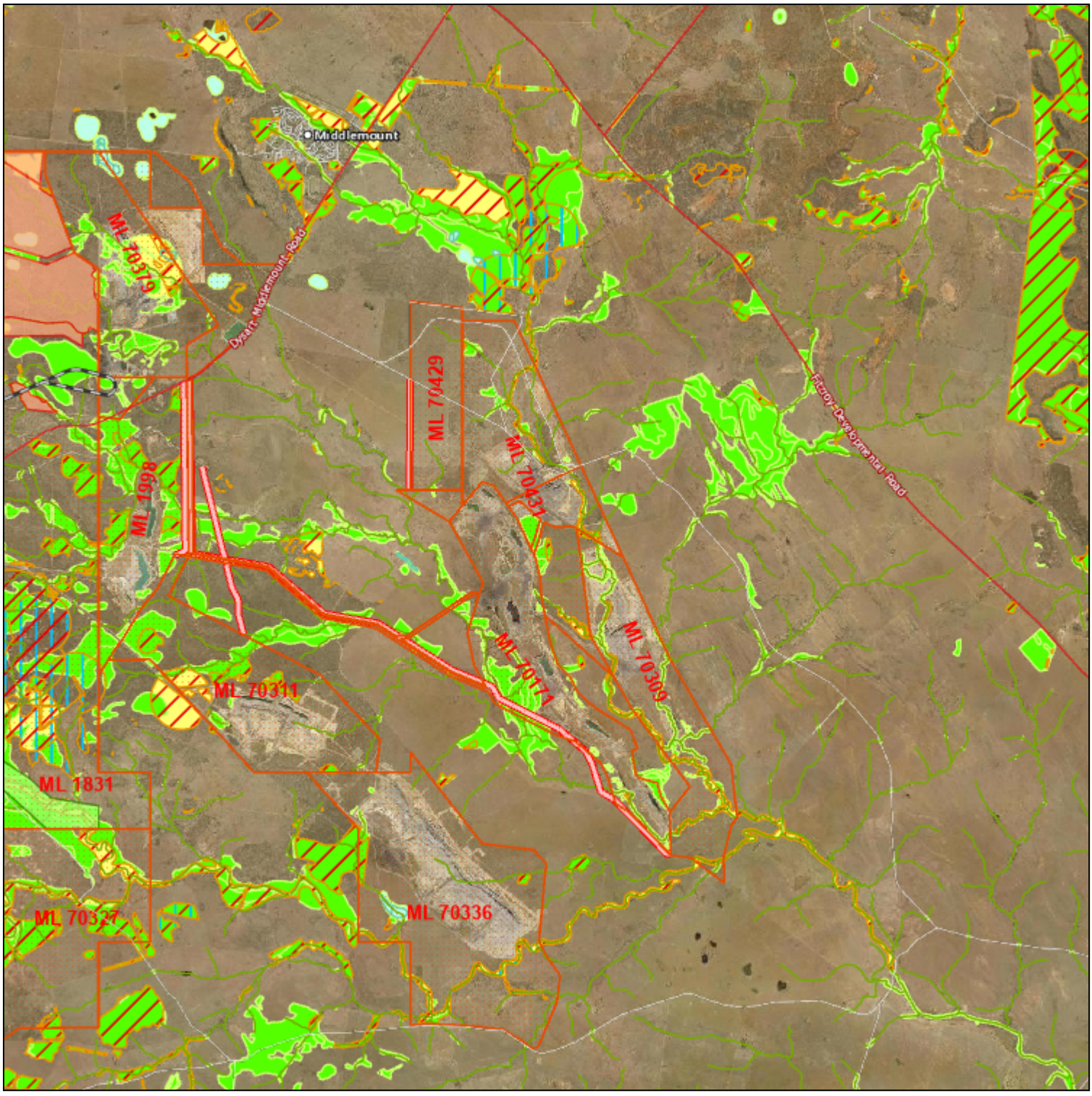
Road

- Highway
- Main
- Local
- Private

Matters of State Environmental Significance (MSES)

22°46'18"S 148°36'14"E

22°46'18"S 148°57'6"E



23°5'30"S 148°36'14"E

23°5'30"S 148°57'6"E

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Scale: 1:195537

Printed at: A4

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Matters of State Environmental Significance (MSES)

Legend

ML permit application

ML surface area application

ML access application

ML permit granted

ML surface area granted

ML access granted

MSES protected area [estates]

MSES protected area [nature refuges]

MSES marine park [highly protected]

MSES declared fish habitat area [A and B areas]

MSES legally secured offset area [offset register]

MSES legally secured offset area [vegetation offsets]

MSES regulated vegetation [defined watercourse]

MSES declared high ecological value waters [watercourse]

MSES declared high ecological value waters [wetland]

MSES high ecological significance wetlands

MSES strategic environmental area [designated precinct]

MSES regulated vegetation [category B - endangered or of concern]

MSES regulated vegetation [category C- endangered or of concern]

Attribution

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MSES regulated vegetation
[category R- GBR riverine]

Matters of State Environmental Significance (MSES)

Legend

MSES regulated vegetation [essential habitat]

MSES regulated vegetation [100m from wetland]

MSES wildlife habitat [endangered or vulnerable]

MSES wildlife habitat [special least concern animal]

MSES wildlife habitat [SEQ koala habitat - core]

MSES wildlife habitat [SEQ koala habitat - locally refined]

MSES protected area [special wildlife reserves]

MSES wildlife habitat [sea turtle nesting areas]

Cities and Towns

Railway

Road Crossing

Bridge

Tunnel

Road

Highway

Main

Local

Private

148°20'E 148°40'E 149°E 149°20'E 149°40'E

22°40'S 23°S 23°20'S 23°40'S 24°S

Connors
Upper Isaac
Lower Isaac
Mackenzie
Lower Nogoa / Theresa Creek
Comet
Fitzroy
Callide
Lower Dawson

ISAAC REGIONAL COUNCIL
ROCKHAMPTON REGIONAL COUNCIL
CENTRAL HIGHLANDS REGIONAL COUNCIL
WOORABINDA SHIRE COUNCIL
BANANA SHIRE COUNCIL

HEVm2063 HEVa2002 HEVm2064 HEVa2063 HEVa2062 HEVa2061 HEVm2062 HEVm2061 HEVa2064 HEVa2177 HEVm2174 HEVm2081

Mackenzie main channel
Mackenzie eastern tributaries
Mackenzie north-western tributaries
Mackenzie southern tributaries

Dysart Middlemount Tieri Blackwater Bluff Comet Dingo Duaringa Boolburra Ogmore Tooloombah Woorabinda

Styx River Isaac River Connors River Nogoa River Mackenzie River Fitzroy River Dawson River

Bundoora Dam Tartrus Weir Bingegang Weir Columbia Creek Weir Comet Weir McCosker's Weir Bedford Weir

Legend

- Town
- Dam / weir / barrage
- Coastline
- River / creek
- Subcatchment boundary
- Boundary of waters covered by the scheduling document
- Local government boundary

Management Intent for Waters

- High ecological value fresh waters (maintain)
- High ecological value fresh waters (achieve)

Water Types

Fresh waters

- Mackenzie River catchment fresh waters
- Connors River catchment fresh waters
- Upper Isaac River catchment fresh waters
- Lower Isaac River catchment fresh waters
- Lower Nogoa / Theresa Creek catchment fresh waters
- Comet River catchment fresh waters
- Fitzroy River catchment fresh waters
- Callide Creek catchment fresh waters
- Lower Dawson River catchment fresh waters
- Wetlands (palustrine)
- Lakes / reservoirs

Key to Environmental Values

Aquatic Ecosystems; Irrigation; Farm Supply; Stock Water; Aquaculture; Human Consumer; Primary Recreation; Secondary Recreation; Visual Recreation; Drinking Water; Industrial Use; Cultural & Spiritual Values

Notes:
1. For areas outside of the waters covered by the scheduling document please refer to the relevant plan.
2. Waterways in the catchment that are not shown on this map as having a management intent of high ecological values (maintain or achieve) have a **management intent of moderately disturbed.**
3. Refer to plan WQ1310 for mapping of groundwater chemistry zones.
4. Wetlands shown on this map are sourced from the Queensland Wetland Data Version 2.0 developed by the Queensland Wetlands Program. Refer to the *Wetland Info* website (www.ehp.qld.gov.au) for the most current information on Queensland wetlands.

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WQ1304 - Mackenzie River Sub-basin

Part of basin 130

Environmental Protection (Water) Policy 2009

Central Queensland Map Series

This plan forms part of the Mackenzie River Sub-basin Environmental Values and Water Quality Objectives scheduling document, prepared pursuant to the *Environmental Protection (Water) Policy 2009*.

QUEENSLAND GOVERNMENT

Publication date: September 2011 (Re-published in July 2013)

N

0 10 20 30 40

Kilometres

Scale: 1:300,000 @ A1

Projection: Mercator

Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)

Location Map

Environmental Protection (Water) Policy 2009
Mackenzie River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Mackenzie River Sub-basin

September 2011

Great state. Great opportunity.

Queensland Government

Prepared by: Environmental Policy and Planning, Department of Environment and Heritage Protection

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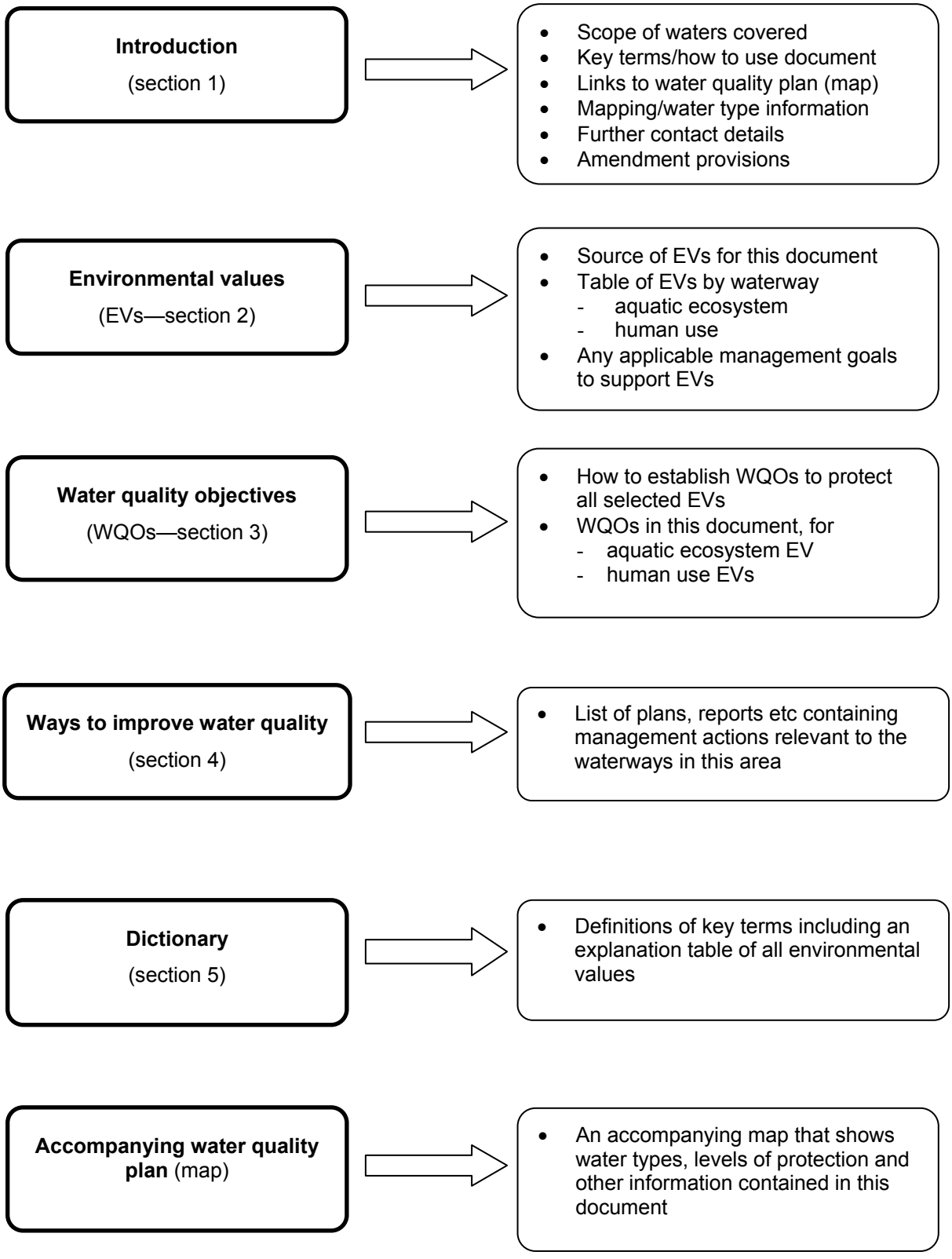
September 2011 (Re-published in July 2013)

Main parts of this document and what they contain



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1 Introduction

This document is made pursuant to the provisions of the Environmental Protection (Water) Policy 2009 (EPP (Water)), which is subordinate legislation under the *Environmental Protection Act 1994*. The EPP (Water) provides a framework for:

- identifying environmental values (EVs) for Queensland waters, and deciding the water quality objectives (WQOs) to protect or enhance those EVs
- including the identified EVs and WQOs under Schedule 1 of the EPP (Water).

This document contains EVs and WQOs for waters in the Mackenzie River Sub-basin, and is listed under schedule 1 of the EPP (Water).

1.1 Waters to which this document applies

This document applies to fresh surface waters and groundwaters draining the sub-basin of the Mackenzie River, as indicated in the accompanying plans (WQ1304—surface waters, WQ1310—Fitzroy Basin groundwaters)[1]. These waters fall within the broader Fitzroy Basin (basin 130)[2].

Waters covered by this document include:

- Mackenzie River
- north-western tributaries including Junee, Cockatoo, Carlo, Roper, Oaky, German, Back, Cooroora, Sandy and Red Rock creeks
- eastern tributaries, including Four Mile, Paddock, Boundary, Leura, Angle, Endrick and Apis creeks
- southern tributaries, including Bridgewater, Charlevue, Springton, Duckworth, Strathconan, Paddock, Falldown, Kaiuroo, Parker, Twelve Mile, Blackwater, Burngrove and Maria creeks
- other tributaries within the Mackenzie River catchment
- wetlands, lakes and reservoirs
- groundwaters.

The geographical extent of waters addressed by this document is shown in plan WQ1304, and is broadly:

- north to the boundary of the Mackenzie River Sub-basin with the Isaac River Sub-basin (comprising Isaac and Connors rivers catchments)
- west to the boundary of the Mackenzie River Sub-basin with the Nogoa River Sub-basin
- south to the boundary of the Mackenzie River Sub-basin with the Comet and Dawson River Sub-basins
- east to the boundary of the Mackenzie River Sub-basin with the Fitzroy River Sub-basin.

[1] This document and the accompanying plans are available from the department's website at www.ehp.qld.gov.au.

The boundaries in the accompanying plans WQ1306 and WQ1310 are indicative only. EVs, water types and aquatic ecosystem management intent (level of protection) depicted in the accompanying plans are stored in electronic form as part of the Central Queensland Environmental Values Schedule 1 Geodatabase September 2011, and held at the department's offices at 400 George Street Brisbane. Database regions are based on the regions established in the Queensland Water Quality Guidelines. Spatial (GIS) datasets can be downloaded free of charge from the Queensland Government Information Service (QGIS) at http://dds.information.qld.gov.au/dds. For further information, email the department at epa.ev@ehp.qld.gov.au.

[2] Australia's River Basins 1997—Product User Guide. Published by Geoscience Australia. Canberra, ACT (3rd edition, 2004).

1.2 Guidance on using this document

1.2.1 Key terms (refer to dictionary for additional terms)

ADWG means the Australian Drinking Water Guidelines (2011), prepared by the National Health and Medical Research Council (NHMRC) in collaboration with the Natural Resource Management Ministerial Council (NRMMC)[3].

AWQG means the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (October 2000), prepared by the Australian and New Zealand Environment and Conservation Council (ANZECC) and the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ)[4].

Environmental values (EVs) for water means the EVs specified in Table 1 of this document for the corresponding water.

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, waste releases, contaminated runoff and changed flows to ensure healthy aquatic ecosystems and waterways that are safe for community use. Particular waters may have different EVs. The range of EVs and the waters they can potentially apply to are listed below, and further details are provided in the dictionary (refer Section 5).

List of EVs and applicable waters

Environmental value (EV)	Potentially applicable to:	
	Tidal waters	Fresh (non-tidal) waters
Protection of aquatic ecosystems (aquatic ecosystem EV)		
Protection or enhancement of aquatic ecosystem values, under four possible levels of ecosystem conditions: • high ecological value (effectively unmodified) waters • slightly disturbed waters • moderately disturbed waters • highly disturbed waters. (Suitability for seagrass and wildlife habitat have also been specifically identified for some Queensland waters as a component of this EV).	✓	✓
EVs other than aquatic ecosystem EV (called human use EVs)		
Suitability for drinking water supplies		✓
Suitability for primary contact recreation (e.g. swimming)	✓	✓
Suitability for secondary contact recreation (e.g. boating)	✓	✓
Suitability for visual (no contact) recreation	✓	✓
Suitability for human consumers of wild or stocked fish, shellfish or crustaceans (suitability for oystering has also been specifically identified for some Queensland waters)	✓	✓

[3] The ADWG are available on the National Health and Medical Research Council website at www.nhmrc.gov.au .

[4] The AWQG are available on the Australian Government's National Water Quality Management Strategy website.

Environmental value (EV)	Potentially applicable to:	
	Tidal waters	Fresh (non-tidal) waters
Protection of cultural and spiritual values, including Traditional Owner values of water	✓	✓
Suitability for industrial use	✓	✓
Suitability for aquaculture (e.g. red claw, barramundi)	✓	✓
Suitability for crop irrigation		✓
Suitability for stock watering		✓
Suitability for farm supply/use		✓

Level of protection for a water (aquatic ecosystem EV) means the level of aquatic ecosystem condition specified in Table 2 of this document that the corresponding WQOs for that water are intended to achieve (refer to management intent definition below for further information).

Management goal means the goals (if any) stated in section 2 of this document to support the EVs for waters identified in Table 1.

Management intent (level of protection) for a water (aquatic ecosystem EV) means the level of aquatic ecosystem condition specified in Table 2 of this document that the corresponding WQOs for that water are intended to achieve. For example, the intent for high ecological value waters is that their effectively unmodified condition is maintained.

QWQG means the Queensland Water Quality Guidelines[5].

Water quality guidelines (defined in the EPP (Water)) are numerical concentration levels or statements for indicators that protect a stated environmental value. Under the EVs setting process contained in the EPP (Water), water quality guidelines are used as an input to the development of WQOs.

Water quality indicator (for an EV) a property that is able to be measured or decided in a quantitative way. Examples of water quality indicators include physical indicators (e.g. temperature), chemical indicators (e.g. nitrogen, phosphorus, metals), and biological indicators (e.g. macroinvertebrates, seagrass, fish).

Water quality objectives (WQOs) means the WQOs specified in Tables 2–12 and 14 of this document to support the EVs for waters identified in Table 1.

WQOs are long-term goals for water quality management. They are numerical concentration levels or narrative statements of indicators established for receiving waters to support and protect the designated EVs for those waters. They are based on scientific criteria or water quality guidelines but may be modified by other inputs (e.g. social, cultural, economic).

Examples of WQOs include:

- total phosphorus concentration less than 20 micrograms per litre (µg/L)
- chlorophyll a concentration less than 1 µg/L
- dissolved oxygen between 95 per cent and 105 per cent saturation
- family richness of macroinvertebrates greater than 12 families
- exotic individuals of fish less than five per cent.

[5] The QWQG are available on the department's website.

Water type means groupings of waters with similar characteristics, as shown in the accompanying plans. The water types covered by this document are based on mapping and definitional rules for water types established in the QWQG and, where available, other site-specific studies and documents. Water types can include fresh waters (lowland, upland, lakes/reservoirs), wetlands and groundwaters, estuarine waters (lower, middle and upper estuaries), tidal canals, constructed estuaries, marinas and boat harbours, and coastal marine waters (open coastal, enclosed coastal). WQOs applying to different water types are outlined in this document. More detail on water types is provided in section 1.4.

Refer to dictionary for additional terms.

1.2.2 Main components of this document

The main components of this document are:

- Plan WQ1304—showing the spatial extent and boundaries of surface water types covered by this document
- Plan WQ1310—showing the spatial extent and boundaries of groundwater types in the Fitzroy Basin
- Section 1—introduction and guidance on how to use the document
- Section 2 (Table 1)—EVs applying to waters covered by this document
- Section 3 (Tables 2–12 and 14)—WQOs applying to different EVs:
  - Tables 2 and 14 provide WQOs to protect the aquatic ecosystem EV, and closely link to the water types shown on plan WQ1304 and plan WQ1310 (groundwaters)
  - Tables 3 to 12 provide WQOs to protect human use EVs
- Section 4—ways to improve water quality: containing a list of relevant documents, provided for information purposes only
- Section 5—a dictionary of other terms relevant to EVs and WQOs.

1.2.3 Use of this document

Section 2 (Table 1) lists the identified EVs for protection for particular waters. The aquatic ecosystem EV is a default applying to all waters. Reference to section 3 (Tables 2 and 14) provides the corresponding WQOs to protect the aquatic ecosystem EV. Where relevant, different WQOs are specified to protect the aquatic ecosystem EV in different water types (refer to the tables and the accompanying plans). For the human use EVs specified in Table 1, Tables 3 onwards provide the corresponding WQOs to support these EVs.

Where reference to Table 1 indicates more than one EV applies to a given water, the adoption of the most stringent WQO for the identified EVs applies to each water quality indicator in order to protect all identified EVs. Further detail on selection of most stringent WQOs is provided in section 3.

This document also refers to a number of guidelines, codes and other reference sources on water quality. In particular, the QWQG prepared by the department provide a technical basis for the WQOs contained in this document. The QWQG also provide more detailed information on water types, water quality indicators, derivation of local water quality guidelines, application during flood events, monitoring, and predicting and assessing compliance.

1.3 Information about mapped areas and boundaries

The boundaries in the accompanying plans WQ1306 and WQ1310 are indicative only. EVs, water types and aquatic ecosystem management intent (level of protection) depicted in the accompanying plans are stored in electronic form as part of the Central Queensland Environmental Values Schedule 1 Geodatabase September 2011 and held at the department's offices at 400 George Street Brisbane. Geodatabase regions are based on the regions established in the QWQG. Spatial (GIS) datasets can be downloaded free of charge from the Queensland Government Information Service (QGIS) at http://dds.information.qld.gov.au/dds. For further information, email the department at epa.ev@ehp.qld.gov.au.

1.4 Water types and basis for boundaries

1.4.1 Water types

Waters in this document have been classified into the following different water types from the list below (not all water types are present in all areas).

- fresh waters—for the Fitzroy Basin, fresh waters (and corresponding WQOs) are mapped at the catchment scale. Where sufficient information is available, mapping includes water sub-types
- lowland fresh waters—this is the predominant water type identified in the Fitzroy Basin from local studies. It includes relatively slow flowing freshwater streams and rivers of the lowlands, as shown on the accompanying plan.
- upland fresh waters—upland streams, which are moderate–fast flowing with rocky substrates and steep gradients. These have not been mapped in the Fitzroy Basin. They are primarily located in catchment headwaters, including within national parks and other State estate.
- freshwater lakes/reservoirs
- groundwaters
- upper estuary—waters in the upper reaches of estuaries, with limited flushing. This water type is absent from short estuaries, less than 15 kilometres (km) total estuary length
- mid estuary—waters extending the majority of the length of estuaries with a moderate amount of water movement from either freshwater inflow or tidal exchange
- enclosed coastal/lower estuary: waters occurring at the downstream end of estuaries and including shallow coastal waters in adjacent enclosed bays
- tidal canals, constructed estuaries, marinas and boat harbours
- wetlands.

The water types are based on local water quality studies in the Fitzroy (refer to the source documents listed after Table 2), the AWQG and mapping and definitional rules contained in the QWQG. Further detail on water types is contained in these sources.

Water types identified in this document are shown in Tables 2 and 14 and in the accompanying plans (WQ1304, WQ1310).

1.4.2 Water type boundaries

The boundaries of different water types have been mapped using a variety of attributes, including:

1. geographic coordinates
2. catchment or sub-catchment boundaries
3. highest/lowest astronomical tide
4. tidal limiting structure (weirs)
5. maritime mapping conventions
6. coastline
7. surveyed terrestrial boundaries
8. altitude.

The basis of different boundaries is shown in the plan. The boundaries of water types may be confirmed or revised by site investigations. Refer to section 1.3 above.

1.5 Matters for amendment

Amendments of the following type may be made to this schedule 1 document for the purposes of replacement under section 12(2)(b) of the EPP (Water):

- changes to EVs
- changes to management goals
- changes to WQOs
- changes to management intent (level of protection) categories
- changes to waterway or water type boundaries/descriptions
- updates to information/data sources, websites and email contact details, agency/departmental names, other institutional names, references.

2 Environmental values

2.1 Environmental values

Table 1 and the accompanying plan WQ1304 outline the EVs for waters in the Mackenzie River Sub-basin. These are based on stakeholder consultations undertaken by the department and the Fitzroy Basin Association to identify EVs and WQOs in the Fitzroy Basin. Consultation results are reported in:

- Fitzroy Basin Association Inc (2011) Environmental values for the Fitzroy: community consultation. Final report. July 2011.

The dictionary to this document provides further explanation of EVs (refer section 5).

2.2 Management goals to support environmental values

There are no management goals specified under this document.

Table 1 Environmental values for Mackenzie River Sub-basin waters

	Environmental values[1, 2, 3, 4]											
	Aquatic ecosystems	Irrigation	Farm supply/use	Stock water	Aquaculture	Human consumer	Primary recreation	Secondary recreation	Visual recreation	Drinking water	Industrial use	Cultural and spiritual values
Water												
Mackenzie north-western tributaries—developed areas	✓			✓		✓	✓	✓	✓	✓	✓	✓
Mackenzie eastern tributaries —developed areas	✓			✓		✓	✓	✓	✓			✓
Mackenzie southern tributaries—developed areas	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓
Mackenzie main channel—developed areas (including weir pool waters, supplemented reaches)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fresh waters in undeveloped areas	✓			✓		✓	✓	✓	✓	✓		✓
Groundwaters	✓	✓	✓	✓						✓	✓	✓

Notes:

1. Refer to the accompanying plan WQ1304 for locations of EVs.
2. ✓ means the EV is selected for protection. Blank indicates that the EV is not chosen for protection.
3. Refer to the dictionary for further explanation of EVs.
4. Refer to section 3 for WQOs applying to the EVs in this table.

3 Water quality objectives to protect environmental values

This section provides WQOs to support and protect different EVs identified for waters within the Mackenzie River Sub-basin in Table 1.

This section is in two main parts:

- Section 3.1 (Tables 2 and 14) outlines WQOs to protect the aquatic ecosystem EV. The aquatic ecosystem EV is a default applying to all waters, and therefore the WQOs for aquatic ecosystems form the minimum WQOs for all waters. Where no human use EVs are identified, the WQOs identified for aquatic ecosystem protection remain applicable.
- Section 3.2 (Tables 3 to 12) provides WQOs for EVs other than aquatic ecosystem ('human use EVs') such as recreational water use, irrigating crops, and aquaculture.

Sources used in deriving WQOs are provided after the tables.

Reference to the identified EVs in Table 1 of this document provides guidance on the EVs applying to waters within the catchment. Where reference to Table 1 indicates more than one EV applies to a given water (for example aquatic ecosystem and recreational use), the most stringent WQO for each water quality indicator applies, which will then protect all identified EVs. Refer to the two following examples on selection of most stringent WQOs. Note that these are examples only and should not be directly adopted for use.

Example 1

For lowland freshwater streams with aquatic ecosystem and drinking water EVs, the respective turbidity WQOs are:

- aquatic ecosystem lowland freshwater stream: less than 10 nephelometric turbidity units (NTU)
- drinking water: less than 25 NTU.

In this case the aquatic ecosystem WQO for turbidity (less than 10 NTU) is the more stringent, and its adoption therefore supports both the aquatic ecosystem and drinking water EVs.

Example 2

In the following situation there are stock watering and irrigation EVs, with differing WQOs for thermotolerant (faecal) coliforms (measured as median number of organisms per 100 millilitre (mL)):

- stock watering: less than 100 organisms per 100 mL
- raw human food crops in direct contact with irrigation water: less than 10 organisms per 100 mL
- pasture and fodder for dairy animals: less than 100 organisms per 100 mL.

The most stringent WQO for faecal coliform in this example is that for direct irrigation of raw human food crops (less than 10 organisms per 100 mL) and its adoption would in turn provide faecal coliform WQOs that protect all the above-identified human use EVs.

3.1 Water quality objectives to protect aquatic ecosystems

This section provides physico-chemical, biological (section 3.1.1) and riparian (section 3.1.2) WQOs to support the aquatic ecosystem EV. Sources used in deriving locally relevant WQOs are provided after the tables in each of these sections.

Section 5 of the QWQG addresses procedures for the application of guidelines for aquatic ecosystem protection. For the comparison of test site monitoring data against WQOs, the median water quality value (e.g. concentration) of a number (preferably five or more) independent samples at a particular monitoring ('test') site should be compared against the water quality objective of the same indicator, water type and level of aquatic ecosystem protection, as listed in Tables 2 to 12 and 14 below.

3.1.1 Physico–chemical and biological water quality objectives

Table 2 includes the following information:

- water area or water type (column 1) (for boundaries of specified areas, refer to the accompanying plan)
- the corresponding management intent (level of protection) for the identified waters (column 2)
- the corresponding physico-chemical and biological WQOs to achieve the management intent (level of protection) for the identified waters.

The EPP (Water) s. 14 identifies the management intent (level of protection) for different waters.

In summary:

- it identifies some waters for which the management intent (level of protection) is to maintain or achieve an effectively unmodified waterway condition (high ecological value—HEV). These may include waters that are currently HEV, slightly disturbed, or potentially, more modified waters which can be progressively improved to achieve HEV condition. Any such waters are identified in columns 1 and 2 of Table 2 and are identified and labelled on the accompanying plan in cross-hatching
- the management intent (level of protection) for most waters is to achieve a moderately disturbed condition, for which corresponding WQOs have been derived
- the management intent (level of protection) for highly disturbed waters is that they be progressively improved. Some highly disturbed waters may require a long timeframe to return to a moderately disturbed condition level. In some circumstances, interim WOQs that reflect a more highly disturbed condition level (which is an improvement on current condition) may be determined for such waters. Any such locations and their corresponding management intent (level of protection) are also identified in the table and accompanying plan
- some objectives apply to specific areas or water types as indicated in Tables 2 and 14 and shown on plans WQ1304 and WQ1310, while others apply to more than one water type, as indicated in the table.

Table 2 Water quality objectives to protect aquatic ecosystem environmental value under baseflow (and, where specified, high flow) conditions

Water area/type (refer plans WQ1304, WQ1310)	Management intent (level of protection)	Water quality objectives to protect aquatic ecosystem EV[1-11]
Surface fresh waters (refer plan WQ1304)		
Waters in areas: **HEVm2061–2064, HEVm2081, HEVm2174**	Aquatic ecosystem—high ecological value	Maintain existing water quality (20th, 50th and 80th percentiles), habitat, biota, flow and riparian areas. Note: there is insufficient information available to establish current water quality for these waters. Refer to QWQG for details on how to establish a minimum water quality data set for deriving local 20th, 50th and 80th percentiles.
Waters in areas: **HEVa2002, HEVa2061–2064, HEVa2177**	Aquatic ecosystem—high ecological value	Achieve effectively unmodified water quality (20th, 50th and 80th percentiles of HEV waters), habitat, biota, flow and riparian areas. Note: there is insufficient information available to establish effectively unmodified water quality for these waters. Refer to QWQG for details on how to establish a minimum water quality data set for deriving local 20th, 50th and 80th percentiles.
Mackenzie River Sub-basin waters	Aquatic ecosystem—moderately disturbed	• ammonia N: <20 µg/L[a] • oxidised N: <60 µg/L[a] • organic N: <420 µg/L[a] • total nitrogen: <775 µg/L[b] • filterable reactive phosphorus (FRP): <20 µg/L[a] • total phosphorus: <160 µg/L[b] • chlorophyll a: <5.0 µg/L[a] • dissolved oxygen: 85%–110% saturation[a] • turbidity: <50 NTU[a] • suspended solids: <110 mg/L[b] • pH: 6.5–8.5 [b] • conductivity (EC) baseflow: <310 µS/cm[b] • conductivity (EC) high flow: <210 µS/cm[b] • sulfate: <10 mg/L[b] • Macroinvertebrates[c]: – Taxa richness (composite): 12–21 – Taxa richness (edge habitat): 23–33 – PET taxa richness (composite): 2–5 – PET taxa richness (edge habitat): 2–5 – SIGNAL index (composite): 3.33–3.85 – SIGNAL index (edge habitat): 3.31–4.20 – % tolerant taxa (composite): 25–50% – % tolerant taxa (edge habitat): 44–56%

Water area/type (refer plans WQ1304, WQ1310)	Management intent (level of protection)	Water quality objectives to protect aquatic ecosystem EV[1-11]
Mackenzie River Sub-basin main trunk	Aquatic ecosystem—moderately disturbed	• Native fish species observed/expected (O/E) ratio ≥ 1. Native species found to be present in ≥ 50% of sampling events in main river trunks/channels in this catchment are outlined below (additional native species may also be present)[d]: – *Arius graeffei* – *Nematolosa erebi* – *Melanotaenia splendida* – *Scortum hillii* – *Amniataba percoides* – *Macquaria ambigua oriens* – *Scleropages leichardti* – *Craterocephalus stercusmuscarum* • Exotic fish species: no increase in number of exotic species relative to current number of exotic species identified in main channel. Current sampled species: – *Hephaestus fuliginosus*
Freshwater lakes/reservoirs	Aquatic ecosystem—moderately disturbed	• ammonia N: <10 µg/L[a] • oxidised N: <10 µg/L[a] • organic N: <330 µg/L[a] • total nitrogen: <350 µg/L[a] • filterable reactive phosphorus (FRP): <5 µg/L[a] • total phosphorus: <10 µg/L[a] • chlorophyll a: <5.0 µg/L[a] • dissolved oxygen: 90%–110% saturation[a] • turbidity: 1–20 NTU[a] • Secchi depth: nd [a] • suspended solids: nd [a] • pH: 6.5–8.0[a] • conductivity (EC) no flow/ baseflow: <250 µS/cm[b]
For ALL fresh waters within this table	All	Toxicants in water and sediment as per AWQG: • Toxicants in water: refer to AWQG section 3.4—'water quality guidelines for toxicants' (including Tables 3.4.1, 3.4.2, and Figure 3.4.1), and AWQG volume 2 (section 8) • Toxicants in sediments: refer to AWQG section 3.5—'sediment quality guidelines' (including Table 3.5.1, Figure 3.5.1), and AWQG volume 2 (section 8) Comply with Code of Practice for Antifouling and In-water Hull Cleaning and Maintenance, ANZECC.
Freshwater riparian areas	Aquatic ecosystem—moderately disturbed	Protect or restore riparian areas. Refer section 3.1.2—riparian area WQOs.

Water area/type (refer plans WQ1304, WQ1310)	Management intent (level of protection)	Water quality objectives to protect aquatic ecosystem EV[1-11]
Wetlands	Aquatic ecosystem—moderately disturbed	Objectives as per AWQG and section 3.1.2. Note: for activities potentially impacting on wetlands refer to State Planning Policy 4/11: Protecting Wetlands of High Ecological Significance in Great Barrier Catchments, available from the department's website.
Groundwaters (refer plan WQ1310)		
Groundwaters	Aquatic ecosystem—high ecological value	Where groundwaters interact with surface waters, groundwater quality should not compromise identified EVs and WQOs for those waters. Note: the AWQG recommends that that the highest level of protection should be provided to underground aquatic ecosystems, given their high conservation value. Where groundwaters are in good condition the intent is to maintain existing water quality (20th, 50th and 80th percentiles). WQOs for Fitzroy Basin groundwaters are provided according to their chemistry zone (refer plan WQ 1310) and depth category in Table 14[e]. (For some areas there is insufficient information available to establish a WQO for this indicator. Refer to QWQG for details on how to establish a minimum water quality data set for deriving local values.)

Notes:

a) The values for these indicators are based on the QWQG Central Coast regional water quality guidelines.

b) The values for these indicators are based on sub-regional low flow water quality guidelines derived by the department as part of the process to establish EVs and WQOs in the Fitzroy Basin. Refer to 'sources' below for more details.

c) The values for these macroinvertebrate biological indicators are based on the QWQG Central Coast regional water quality guidelines. They apply to support waters at a moderately disturbed level of protection. Values are provided for 20th and 80th percentiles. The median value of biological indicators at test sites is to be compared and assessed against these values. More details on indicators and derivation of values are in the QWQG. Refer to 'sources' below.

Values are provided for two habitat types: edge (along the streambank) and composite (a mixture of all bed habitats). Taxa richness refers to the number of macroinvertebrate taxa collected in a sample. PET taxa richness refers to the total number of families from three orders of aquatic insects considered to be sensitive to changes in their environment (Plecoptera, Ephemeroptera, Trichoptera). SIGNAL index (stream invertebrate grade number—average level) gives an indication of water quality in the river from which the sample was collected, based on the sensitivity of taxa to water quality change. A higher number indicates greater sensitivity. The % tolerant taxa index was developed to assist in identifying taxa sensitivity to pollution. If a site is experiencing an impact from pollution it is expected that there would be a reduction in the percentage of sensitive taxa collected, and an increase in the percentage of tolerant taxa collected.

d) The fish species in the table are those species sampled/recorded in at least 50 per cent of fish sampling events in this catchment. The biological indicator used is the observed/expected (50) species ratio, where E (the 'expected' number of native species) equates to the number of species listed in the table (those sampled in at least 50 per cent of sampling events) and O is the number of species actually observed. The O/E ratio is used as a summary of ecosystem health on the basis of species composition. A ratio greater than or equal to 1 indicates that the 'expected' number of species have been identified in a sampling procedure. The data for this WQO are applicable for the moderately disturbed level of protection in main trunk stream reaches. Additional species (recorded in less than 50 per cent of samples) have been recorded in these waterways but are not shown in this table. Refer to the department's website for further details.

e) The categorisation of groundwater chemistry zones and derivation of corresponding water quality values are based on the department's groundwater monitoring data and analysis. Refer to 'sources' below for more details.

1. Oxidised N = NO_2 + NO_3. Units for nitrogen indicators are micrograms per litre (µg/L) N.
2. Units for phosphorus indicators are micrograms per litre (µg/L) P.
3. nd = no data, n/a = not applicable for this indicator and water type, ng = no guideline.
4. Dissolved oxygen (DO) objectives apply to daytime conditions. Lower values will occur at night in most waters. In estuaries, reductions should only be in the region of 10–15 per cent saturation below daytime values. In freshwaters, night-time reductions are more variable. Following significant rainfall events, reduced DO values may occur due to the influx of organic material. In estuaries post-event values as low as 40 per cent saturation may occur naturally for short periods but values well below this would indicate some anthropogenic effect. In freshwaters, post-event DO reductions are again more variable. In general, DO values consistently less than 50 per cent are likely to impact on the ongoing ability of fish to persist in a waterbody while short term DO values less than 30 per cent saturation are toxic to some fish species. Very high DO (supersaturation) values can be toxic to some fish as they cause gas bubble disease.
5. DO values for fresh waters should only be applied to flowing waters. Stagnant pools in intermittent streams naturally experience values of DO below 50 per cent saturation.
6. Wallum/tannin-stained waters contain naturally high levels of humic acids (and have a characteristic brown ti-tree stain). In these types of waters, natural pH values may range from 3.6 to 6.
7. During flood events or nil flow periods, pH values should not fall below 5.5 (except in wallum/tannin waters) or exceed 9.

8. Nutrient objectives do not apply during high flow events. See QWQG Section 5 and Appendix D for more information on applying guidelines under high flow conditions.
9. During periods of low flow and particularly in smaller creeks, build up of organic matter derived from natural sources (e.g. leaf litter) can result in increased organic N levels (generally in the range of 400 to 800μg/L). This may lead to total N values exceeding the WQOs. Provided that levels of inorganic N (i.e. NH_3 + oxidised N) remain low, then the elevated levels of organic N should not be seen as a breach of the WQOs, provided this is due to natural causes.
10. Conductivity, under natural conditions, is highly dependent on local geology and soil types. Where sufficient data were available, conductivity WQOs have been derived for different catchments in the Fitzroy and are shown in the table. In the absence of sub-regional conductivity WQOs, the QWQG (Appendix G) provides information on conductivity values in a set of 18 defined salinity zones throughout Queensland. For each zone, the QWQG provide a range of percentile values based on data from all the sites within that zone. This provides a useful first estimate of background conductivity within a zone. However, even within zones there is a degree of variation between streams and therefore the values for the zone would still need to be ground truthed against local values.
11. Temperature varies both daily and seasonally, it is depth dependent and is also highly site specific. It is therefore not possible to provide simple generic WQOs for this indicator. The recommended approach is that local WQOs be developed. Thus, WQOs for potentially impacted streams should be based on measurements from nearby streams that have similar morphology and which are thought not to be impacted by anthropogenic thermal influences.

    From an ecological effects perspective, the most important aspects of temperature are the daily maximum temperature and the daily variation in temperature. Therefore measurements of temperature should be designed to collect information on these indicators of temperature and, similarly, local WQOs should be expressed in terms of these indicators. Clearly, there will be an annual cycle in the values of these indicators and therefore a full seasonal cycle of measurements is required to develop guideline values.

Sources:

The WQOs were determined from a combination of documents (and supporting data), including:

- Developing water quality guidelines for the protection of the freshwater aquatic ecosystems in the Fitzroy Basin. Phase 1 (Queensland Government).
- Regional chemistry of the Fitzroy Basin groundwater (Raymond, M. A. A. and V. H. McNeil, 2011).
- Queensland Water Quality Guidelines (Queensland Government).
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000).
- Code of Practice for Antifouling and In-water Hull Cleaning and Maintenance (Australian and New Zealand Environment and Conservation Council, 1997).

3.1.2 Riparian water quality objectives

For vegetation management relating to waterways, reference should be made to the relevant regional vegetation management codes under the *Vegetation Management Act 1999*. These codes include performance requirements relating to watercourses and wetlands, aimed at maintaining water quality, bank stability, aquatic and terrestrial habitat. Codes include vegetation clearing controls that vary according to stream order.

To review the latest applicable VM code (and other explanatory information) for waters for this area contact the Department of Natural Resources and Mines.

Planning schemes under the *Sustainable Planning Act 2009* may also specify riparian buffers (for example under catchment protection or waterway codes). Contact the Department of State Development, Infrastructure and Planning website for further information about planning schemes.

3.1.3 Stormwater management design objectives

Stormwater management design objectives for urban development are detailed in the department's Urban Stormwater Quality Planning Guidelines 2010 (as amended). Stormwater quality and flow management design objectives are specified for both the construction and operational phases of development in accordance with landscape features and the regional location of proposed development. The guidelines are available on the department's website.

3.2 Water quality objectives for human use environmental values

This section outlines WQOs to protect human use EVs, which comprise those EVs other than the aquatic ecosystem EV (e.g. recreation, stock watering, aquaculture and crop irrigation). Table 1 of this document outlines the EVs that have been identified for different waters in the catchment. Where a human use EV has been identified, the following tables can be used to identify the WQOs to support that EV. Where Table 1 indicates more than one EV applies to a given water (for example aquatic ecosystem and recreational use), the adoption of the most stringent WQO for each water quality indicator will then protect all identified EVs.

WQOs in this section are, unless otherwise specified, based on relevant national water quality guidelines including AWQG and the ADWG[6]. Table 3 outlines human use EVs, applicable water types, and a selection of more commonly used WQOs to support those EVs. Tables 4 to 12 provide further WQOs to protect particular human use EVs (based on national guidelines or other more local studies). *Where national guidelines or other codes remain the primary source for WQOs, reference to those national guidelines or codes is necessary to obtain comprehensive listings of all indicators and corresponding WQOs.*

Table 3 Water quality objectives to protect human use environmental values

Environmental value	Water type/area (refer Table 1 and plans WQ1304, WQ1310)	Water quality objectives to protect EV (refer to specified codes and guidelines for full details)
Suitability for drinking water supply	All fresh waters including groundwaters	Local WQOs for drinking water supply are provided in Table 4. Note: For water quality after treatment or at point of use refer to legislation and guidelines, including: • *Public Health Act 2005* and Regulations • *Water Supply (Safety and Reliability) Act 2008*, including any approved drinking water management plan under the Act • ADWG.
Protection of the human consumer	Fresh waters (also estuarine and coastal waters)	Objectives as per AWQG and Australia New Zealand Food Standards Code[7], Food Standards Australia New Zealand, 2007 and updates.
Protection of cultural and spiritual values	Fresh waters, groundwaters (also estuarine and coastal waters)	Protect or restore indigenous and non-indigenous cultural heritage consistent with relevant policies and plans.
Suitability for industrial use	Fresh waters (also estuarine and coastal waters)	No WQOs are provided in this scheduling document for industrial uses. Water quality requirements for industry vary within and between industries. The AWQG do not provide guidelines to protect industries, and indicate that industrial water quality requirements need to be considered on a case-by-case basis. This EV is usually protected by other values, such as the aquatic ecosystem EV.
Suitability for aquaculture	Fresh waters (also estuarine and coastal waters)	Objectives as per: • Tables 5–7 • AWQG and Australia New Zealand Food Standards Code, Food Standards Australia New Zealand, 2007 and updates.
Suitability for irrigation	All fresh waters including groundwaters	ANZECC objectives for pathogens and metals are provided in Tables 8 and 9. For other indicators, such as salinity, sodicity and herbicides, see AWQG.

[6] The AWQG are available on the National Water Quality Management Strategy website.

The ADWG are available on the NHMRC website.

[7] The Australia New Zealand Food Standards Code is available on the Food Standards Australia and New Zealand website.

Environmental value	Water type/area (refer Table 1 and plans WQ1304, WQ1310)	Water quality objectives to protect EV (refer to specified codes and guidelines for full details)
Suitability for stock watering	All fresh waters including groundwaters	Objectives as per AWQG, including median faecal coliforms <100 organisms per 100 mL. WQOs for total dissolved solids and metals are provided in Tables 10 and 11, based on AWQG. For other objectives, such as cyanobacteria and pathogens, see AWQG.
Suitability for farm supply/use	All fresh waters including groundwaters	Objectives as per AWQG.
Suitability for primary contact recreation	Fresh waters (also estuarine and coastal waters)	Objectives as per NHMRC (2008) [8], including: • water free of physical (floating and submerged) hazards • temperature range: 16–34°C • pH range: 6.5–8.5 • DO: >80% • faecal contamination: designated recreational waters are protected against direct contamination with fresh faecal material, particularly of human or domesticated animal origin. Two principal components are required for assessing faecal contamination: - assessment of evidence for the likely influence of faecal material - counts of suitable faecal indicator bacteria (usually enterococci). These two components are combined to produce an overall microbial classification of the recreational water body. • intestinal enterococci: 95th percentile ≤ 40 organisms per 100 mL (for healthy adults) (NHMRC, 2008; Table 5.7) • direct contact with venomous or dangerous aquatic organisms should be avoided. Recreational water bodies should be reasonably free of, or protected from, venomous organisms • waters contaminated with chemicals that are either toxic or irritating to the skin or mucous membranes are unsuitable for recreational purposes.
Suitability for primary contact recreation	Fresh waters	• cyanobacteria/algae: Recreational water bodies should not contain: - Level 1 [1]: ≥ 10 µg/L total microcystins; or ≥ 50 000 cells/mL toxic *Microcystis aeruginosa*; or biovolume equivalent of ≥ 4 mm^3/L for the combined total of all cyanobacteria where a known toxin producer is dominant in the total biovolume; OR - Level 2 [1]: ≥ 10 mm^3/L for total biovolume of all cyanobacterial material where known toxins are not present; OR cyanobacterial scums consistently present. Further details are contained in NHMRC (2008) and Table 12.
Suitability for secondary contact recreation	Fresh waters (also estuarine and coastal waters)	Objectives as per NHMRC (2008), including: • intestinal enterococci: 95th percentile ≤ 40 organisms per 100mL (for healthy adults) (NHMRC, 2008; Table 5.7) • cyanobacteria/algae—refer objectives for primary recreation, NHMRC (2008) and Table 12.

[8] Guidelines for Managing Risks in Recreational Water are available from the NHMRC website.

Environmental value	Water type/area (refer Table 1 and plans WQ1304, WQ1310)	Water quality objectives to protect EV (refer to specified codes and guidelines for full details)
Suitability for visual recreation	Fresh waters (also estuarine and coastal waters)	Objectives as per NHMRC (2008), including: • recreational water bodies should be aesthetically acceptable to recreational users. The water should be free from visible materials that may settle to form objectionable deposits; floating debris, oil, scum and other matter; substances producing objectionable colour, odour, taste or turbidity; and substances and conditions that produce undesirable aquatic life. • cyanobacteria/algae—refer objectives for primary recreation, NHMRC (2008) and Table 12.

Sources:

The WQOs were determined from a combination of documents, including:

- Australian Drinking Water Guidelines (NHMRC, 2011)
- Australia New Zealand Food Standards Code (Australian Government)
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000)
- Guidelines for Managing Risks in Recreational Water (NHMRC, 2008).

Notes:

1. Level 1 recognises the probability of adverse health effects from ingestion of known toxins, in this case based on the toxicity of microcystins. Level 2 covers circumstances in which there are very high cell densities of cyanobacterial material, irrespective of the presence of toxicity or known toxins. Increased cyanobacterial densities increase the likelihood of non-specific adverse health outcomes, principally respiratory, irritation and allergy symptoms (NHMRC, 2008; 8).

Table 4 Drinking water EV: Priority water quality objectives for drinking water supply in the vicinity of off-takes, including groundwater, before treatment

This table outlines WQOs for water **before treatment**, unless otherwise stated. For water quality after treatment or at the point of use, refer to relevant legislation and guidelines, including *Public Health Act 2005* and Regulations, *Water Supply (Safety and Reliability) Act 2008*, including any approved drinking water management plan under the Act, and the Australian Drinking Water Guidelines (ADWG, 2011). Objectives are derived following advice from Queensland Health, Office of the Water Supply Regulator, and Fitzroy River Water.

Indicator	Water quality objective (For those objectives expressed as levels under the Hazard and critical control point (HACCP) rating, refer notes 1, 2 for explanation)
Giardia	0 cysts If *Giardia* is detected in drinking water then the health authorities should be notified immediately and an investigation of the likely source of contamination undertaken (ADWG).
Cryptosporidium	0 cysts If *Cryptosporidium* is detected in drinking water then the health authorities should be notified immediately and an investigation of the likely source of contamination undertaken (ADWG).
E.coli	No water quality objective specified for *E. coli* in raw water. Well designed treatment plants with effective barriers and disinfection are designed to address faecal contamination. *E. coli* or thermotolerant coliforms should not be present in any 100 mL sample of (treated) drinking water (ADWG).
Blue-green algae (cyanobacteria)	5000 cells/mL
Algal toxin	Level 1[1]: >1 µg/L Microcystin Level 2[2]: >10 µg/L Microcystin
Turbidity	Level 1[1]: >500 NTU Level 2[2]: >1000 NTU
Colour	Level 1[1]: 50 Hazen Units No Level 2
pH	6.5–8.5
Total hardness	Level 1[1]: >150 mg/L as $CaCO_3$ Level 2[2]: >200 mg/L
Conductivity	Level 1[1]: > 400 µS/cm Level 2[2]: same as Level 1 (no treatment options to remove salt)
Sodium	Raw water supply: 30 mg/L [3] General: The concentration of sodium in reticulated drinking water supplies should not exceed 180 mg/L (ADWG, based on threshold at which taste becomes appreciable). At-risk groups (medical): The concentration of sodium in water supplies for at-risk groups should not exceed 20 mg/L (ADWG). Sudden changes in sodium levels in raw water supplies should be advised to Queensland Health, as these can affect medical equipment.

Indicator	Water quality objective (For those objectives expressed as levels under the Hazard and critical control point (HACCP) rating, refer notes 1, 2 for explanation)
Sulfate	Raw water supply: 200 mg/L[4] The concentration of sulfate in drinking water should not exceed 250 mg/L (ADWG, based on taste/aesthetic considerations).
Dissolved oxygen	Level 1[1]: < 4 mg/L at surface No Level 2[2]
Pesticides	Refer to ADWG
Other indicators (including physico-chemical indicators)	Refer to ADWG

Source: Queensland Health, Fitzroy River Water, Office of Water Supply Regulator, Australian Drinking Water Guidelines (NHMRC, 2011).

Notes:

1. 'Level 1' means Level 1 Hazard and Critical Control Point (HACCP) response rating, namely—treatment plant process change required to ensure water quality and quantity to customers is not compromised.
2. 'Level 2' means Level 2 HACCP response rating, namely—treatment plant process change required but water quality and quantity to customers may still be compromised.
3. The value of 30 mg/L for raw drinking water supply is based on advice from Queensland Health and Fitzroy River Water. Sudden changes in sodium levels impact on medical equipment use, operation and calibration. Queensland Health should be advised of any such changes. The US EPA (2012 Drinking Water Standards and Health Advisories) health based value for sodium is 20 mg/L (for individuals on a 500mg/day restricted sodium diet). The ADWG notes that 50 mg/L is a '*typical value'* in reticulated supplies. The ADWG guideline value for sodium is 180 mg/L (based on level at which taste become appreciable) however '*sodium salts cannot be easily removed from drinking water*' and '*water authorities are strongly encouraged to keep sodium concentrations as low as possible*'. It further notes that '*medical practitioners treating people with severe hypertension or congestive heart failure should be aware if the sodium concentration in the patient's drinking water exceeds 20 mg/L*' (ADWG; sodium factsheet).
4. The value of 200 mg/L for raw drinking water supply is based on discussion with Fitzroy River Water. The ADWG states that an aesthetic guideline value for sulfate is 250 mg/L. A water quality objective of 200 mg/L for raw water is proposed due to the likely addition of sulfate through the use of water treatment chemicals such as aluminium sulfate. Each of these values remains significantly lower than the ADWG health guideline of 500 mg/L for sulfate in drinking water.

Table 5 Aquaculture EV: Water quality objectives for tropical aquaculture

Water parameter	Recommended range		Water parameter	Recommended range
	Fresh water	Marine		General aquatic
Dissolved oxygen	>4 mg/L	>4 mg/L	**Arsenic**	<0.05 mg/L
Temperature °C	21–32	24–33	**Cadmium**	<0.003 mg/L
pH	6.8–9.5	7–9.0	**Calcium/Magnesium**	10–160 mg/L
Ammonia (TAN, total ammonia-nitrogen)	<1.0 mg/L	<1.0 mg/L	**Chromium**	<0.1 mg/L
Ammonia (NH_3, un-ionised form)	<0.1 mg/L	<0.1 mg/L	**Copper**	<0.006 mg/L in soft water
Nitrate (NO_3)	1–100 mg/L	1–100 mg/L	**Cyanide**	<0.005 mg/L
Nitrite (NO_2)	<0.1 mg/L	<1.0 mg/L	**Iron**	<0.5 mg/L
Salinity	0–5 ppt	15–35 ppt	**Lead**	<0.03 mg/L
Hardness	20–450 mg/L		**Manganese**	<0.01 mg/L
Alkalinity	20–400 mg/L	>100 mg/L	**Mercury**	<0.00005 mg/L
Turbidity	<80 NTU		**Nickel**	<0.01 mg/L in soft water <0.04 mg/L in hard water
Chlorine	<0.003 mg/L		**Tin**	<0.001 mg/L
Hydrogen sulphide	<0.002 mg/L		**Zinc**	0.03–0.06 mg/L in soft water 1–2 mg/L in hard water

Source: Department of Primary Industries and Fisheries: Water Quality in Aquaculture—DPI Notes April 2004.

Table 6 Aquaculture EV: Water quality objectives for optimal growth of particular species in fresh water

Water parameter	Barramundi	Eel	Silver perch	Jade perch	Sleepy cod	Redclaw
Dissolved oxygen	4–9 mg/L	>3 mg/L	>4 mg/L	>3 mg/L	>4 mg/L	>4 mg/L
Temperature °C	26–32	23–28	23–28	23–28	22–31	23–31
pH	7.5–8.5	7.0–8.5	6.5–9	6.5–9	7.0–8.5	7.0–8.5
Ammonia (TAN, Total ammonia-nitrogen)		<1 mg/L			<1 mg/L	<1 mg/L
Ammonia (NH_3, un-ionised form)*pH dependent.	<0.46 mg/L	<0.1 mg/L	<0.1 mg/L	<0.1 mg/L	<0.1 mg/L	<0.1 mg/L
Nitrate (NO_3)			<100 mg/L			
Nitrite (NO_2)	<1.5 mg/L	<1.0 mg/L	<0.1 mg/L		<1.0 mg/L	<1.0 mg/L
Salinity (extended periods)	0–35 ppt		<5 ppt	<5 ppt		<4 ppt
Salinity bath	0–35 ppt		5–10ppt for one hour		max. 20 ppt for one hour	
Hardness ($CaCO_3$)			>50 mg/L	>50 mg/L	>40 mg/L	>40 mg/L
Alkalinity	>20mg/L		100–400 ppm	100–400 ppm	>40 mg/L	>40 mg/L
Chlorine	<0.04 mg/L				<0.04 mg/L	
Hydrogen sulphide	0–0.3 mg/L				0–0.3 mg/L	
Iron	<0.1 mg/L		<0.5 mg/L	<0.5 mg/L	<0.1 mg/L	<0.1 mg/L
Spawning temperature	Marine		23–28	23–28	>24 for more than three days	

Source: Department of Primary Industries and Fisheries: Water Quality in Aquaculture—DPI Notes April 2004.

Table 7 Aquaculture EV: Water quality objectives for optimal growth of particular marine species

Water parameter	Barramundi		Tiger prawn		Kuruma prawn
	Hatchery	Grow out	Hatchery	Grow out	Grow out
Dissolved oxygen	Saturation	>4 mg/L	>4 mg/L	>3.5 mg/L	>4 mg/L
Temperature °C	28–30 optimum 25–31 range	28–30 optimum		26–32	24
pH	~8	~8	~8	7.5–8.5	7.5–8.5
Ammonia (TAN, total ammonia-nitrogen)		0.1–0.5 mg/L			
Ammonia (NH_3, un-ionised form)	<0.1 mg/L	<0.1 mg/L	<0.1 mg/L	<0.1 mg/L	<0.1 mg/L
Nitrate (NO_3)	<1 mg/L	<1 mg/L	<1 mg/L	<1 mg/L	<1 mg/L
Nitrite (NO_2)	<0.2 mg/L	<1 mg/L	<0.2 mg/L	<0.2 mg/L	<0.2 mg/L
Salinity	28–31ppt	0–35ppt		10–25 ppt optimum	30–35 ppt optimum
Alkalinity		105–125 mg/L $CaCO_3$			
Clarity				30–40 cm Secchi disk	30–40 cm Secchi disk
Hydrogen sulphide		<0.3 mg/L			
Iron		<0.02 mg/L		<1.0 mg/L	
Spawning temperature		28–32		27–32	

Source: Department of Primary Industries and Fisheries—Water Quality in Aquaculture—DPI Notes April 2004 (as amended).

Table 8 Irrigation EV: Water quality objectives for thermotolerant (faecal) coliforms in irrigation waters used for food and non-food crops[1]

Intended use	Median values of thermotolerant coliforms (colony forming units—cfu)[2]
Raw human food crops in direct contact with irrigation water (e.g. via sprays, irrigation of salad vegetables)	<10 cfu/100 mL
Raw human food crops not in direct contact with irrigation water (edible product separated from contact with water, e.g. by peel, use of trickle irrigation); or crops sold to consumers cooked or processed	<1000 cfu/100 mL
Pasture and fodder for dairy animals (without withholding period)	<100 cfu/100 mL
Pasture and fodder for dairy animals (with withholding period of five days)	<1000 cfu/100 mL
Pasture and fodder (for grazing animals except pigs and dairy animals, i.e. cattle, sheep and goats)	<1000 cfu/100 mL
Silviculture, turf, cotton, etc. (restricted public access)	<10 000 cfu/100 mL

Source: AWQG, Volume 1, Section 4.2.3.3, Table 4.2.2.

Notes:

1. Adapted from ARMCANZ, ANZECC and NHMRC (1999).
2. Refer to AWQG, Volume 1, Section 4.2.3.3 for advice on testing protocols.

Table 9 Irrigation EV: Water quality objectives for heavy metals and metalloids in agricultural irrigation water[1]—long-term trigger value (LTV), short-term trigger value (STV) and soil cumulative contamination loading limit (CCL)

Element	Soil cumulative contaminant loading limit (CCL) (kg/ha)[2]	Long-term trigger value (LTV) in irrigation water (up to 100 years) (mg/L)	Short-term trigger value (STV) in irrigation water (up to 20 years) (mg/L)
Aluminium	ND	5	20
Arsenic	20	0.1	2.0
Beryllium	ND	0.1	0.5
Boron	ND	0.5	Refer to AWQG Vol 3, Table 9.2.18
Cadmium	2	0.01	0.05
Chromium	ND	0.1	1
Cobalt	ND	0.05	0.1
Copper	140	0.2	5
Fluoride	ND	1	2
Iron	ND	0.2	10
Lead	260	2	5
Lithium	ND	2.5 (0.075 for citrus crops)	2.5 (0.075 for citrus crops)
Manganese	ND	0.2	10
Mercury	2	0.002	0.002
Molybdenum	ND	0.01	0.05
Nickel	85	0.2	2
Selenium	10	0.02	0.05
Uranium	ND	0.01	0.1
Vanadium	ND	0.1	0.5
Zinc	300	2	5

Source: AWQG, Volume 1, Section 4.2.6, Table 4.2.10.

Notes:

1. Concentrations in irrigation water should be less than the trigger values. Trigger values should only be used in conjunction with information on each individual element and the potential for off-site transport of contaminants (refer AWQG, Volume 3, Section 9.2.5).
2. ND = Not determined; insufficient background data to calculate CCL.

Table 10 Stock watering EV: Water quality objectives for tolerances of livestock to total dissolved solids (salinity) in drinking water[1]

Livestock	Total dissolved solids (TDS) (mg/L)		
	No adverse effects on animals expected.	Animals may have initial reluctance to drink or there may be some scouring, but stock should adapt without loss of production	Loss of production and decline in animal condition and health would be expected. Stock may tolerate these levels for short periods if introduced gradually
Beef cattle	0–4000	4000–5000	5000–10 000
Dairy cattle	0–2500	2500–4000	4000–7000
Sheep	0–5000	5000–10 000	10 000–13 000[2]
Horses	0–4000	4000–6000	6000–7000
Pigs	0–4000	4000–6000	6000–8000
Poultry	0–2000	2000–3000	3000–4000

Source: AWQG, Volume 1, Section 4.3.3.5, Table 4.3.1.

Notes:

1. From ANZECC (1992), adapted to incorporate more recent information.
2. Sheep on lush green feed may tolerate up to 13 000 mg/L TDS without loss of condition or production.

Table 11 Stock watering EV: Water quality objectives (low risk trigger values) for heavy metals and metalloids in livestock drinking water

Metal or metalloid	Trigger value (low risk)[1, 2] (mg/L)
Aluminium	5
Arsenic	0.5 (up to 5[3])
Beryllium	ND
Boron	5
Cadmium	0.01
Chromium	1
Cobalt	1
Copper	0.4 (sheep), 1 (cattle), 5 (pigs), 5 (poultry)
Fluoride	2
Iron	not sufficiently toxic
Lead	0.1
Manganese	not sufficiently toxic
Mercury	0.002
Molybdenum	0.15
Nickel	1
Selenium	0.02
Uranium	0.2
Vanadium	ND
Zinc	20

Source: AWQG, Volume 1, Section 4.3.4, Table 4.3.2.

Notes:

1. Higher concentrations may be tolerated in some situations (further details provided in AWQG, Volume 3, Section 9.3.5).
2. ND = not determined, insufficient background data to calculate.
3. May be tolerated if not provided as a food additive and natural levels in the diet are low.

Table 12 Recreational waters: Alert levels and corresponding actions for management of cyanobacteria

When cyanobacteria are present in large numbers they can present a significant hazard, particularly to primary contact users of waters. Water quality objectives for cyanobacteria in recreational waters are provided in Table 3. Monitoring/action requirements relative to cyanobacteria 'alert' levels are summarised below, and are explained more fully in the Guidelines for Managing Risks in Recreational Water (NHMRC, 2008). Further details on the process to determine suitability of waters for recreation, relative to historical cyanobacterial levels and susceptibility to cyanobacterial contamination, are contained in sections 6 and 7 of the NHMRC guidelines.

Green level surveillance mode[1]	Amber level alert mode[1]	Red level action mode[1]
Fresh waters		
≥ 500 to <5000 cells/mL *M. aeruginosa* or biovolume equivalent of >0.04 to <0.4 mm^3/L for the combined total of all cyanobacteria.	≥ 5000 to <50 000 cells/mL *M. aeruginosa* or biovolume equivalent of ≥ 0.4 to <4 mm^3/L for the combined total of all cyanobacteria where a known toxin producer is dominant in the total biovolume [2]. or[3] ≥ 0.4 to <10 mm^3/L for the combined total of all cyanobacteria where known toxin producers are not present.	Level 1 guideline[4]: ≥ 10 µg/L total microcystins or ≥ 50 000 cells/mL toxic *M. aeruginosa* or biovolume equivalent of ≥ 4 mm^3/L for the combined total of all cyanobacteria where a known toxin producer is dominant in the total biovolume. or[3] Level 2 guideline[4]: ≥ 10 mm^3/L for total biovolume of all cyanobacterial material where known toxins are not present. or cyanobacterial scums are consistently present[5].
Nodularia spumigena: See NHMRC, Chapter 6 (Cyanobacteria and algae in fresh water) for details.		

Source: Based on NHMRC, 2008. Guideline for Managing Risks in Recreational Water (Tables 6.2, 6.6, 7.3).

Notes:

1. Recommended actions at different alert levels are outlined below (based on NHMRC, 2008, Table 6.6—fresh waters. Similar actions are outlined for coastal/estuarine waters in NHMRC Table 7.6):

   Green: Regular monitoring. Weekly sampling and cell counts at representative locations in the water body where known toxigenic species are present (i.e. *Microcystis aeruginosa, Anabaena circinalis, Cylindrospermopsis raciborskii, Aphanizomenon ovalisporum, Nodularia spumigena*); or fortnightly for other types including regular visual inspection of water surface for scums.

   Amber: Notify agencies as appropriate. Increase sampling frequency to twice weekly at representative locations in the water body where toxigenic species (above) are dominant within the alert level definition (i.e. total biovolume) to establish population growth and spatial variability in the water body. Monitor weekly or fortnightly where other types are dominant. Make regular visual inspections of water surface for scums. Decide on requirement for toxicity assessment or toxin monitoring.

   Red: Continue monitoring as for (amber) alert mode. Immediately notify health authorities for advice on health risk. ('In action mode the local authority and health authorities warn the public of the existence of potential health risks; for example, through the media and the erection of signs by the local authority.' NHMRC, 2008; 114). Make toxicity assessment or toxin measurement of water if this has not already been done. Health authorities warn of risk to public health (i.e. the authorities make a health risk assessment considering toxin monitoring data, sample type and variability).

2. The definition of 'dominant' is where the known toxin producer comprises 75 per cent or more of the total biovolume of cyanobacteria in a representative sample.

3. This applies where high cell densities or scums of 'non toxic' cyanobacteria are present i.e. where the cyanobacterial population has been tested and shown not to contain known toxins (mycrocystins, nodularian, cylindrospermopsin or saxitoxin).

4. Health risks and levels: Level 1 is developed to protect against short-term health effects of exposure to cyanobacterial toxins ingested during recreational activity, whereas the Level 2 applies to the circumstance where there is a probability of increased likelihood of non-specific adverse health outcomes, principally respiratory, irritation and allergy symptoms, from exposure to very high cell densities of cyanobacterial material irrespective of the presence of toxicity or known toxins (NHMRC, 2008; 114).

5. This refers to the situation where scums occur at the recreation site each day when conditions are calm, particularly in the morning. Note that it is not likely that scums are always present and visible when there is a high population as the cells may mix down with wind and turbulence and then reform later when conditions become stable.

4 Ways to improve water quality

The following documents are relevant in considering ways to improve water quality in the Fitzroy Basin. The document list below is additional to the plans, guidelines and other sources referred to in previous sections, **and is provided for information only**.

Local plans, studies

- Council planning scheme and supporting codes, policies, available from council websites.

Regional plans, studies

- Fitzroy Basin Association. Central Queensland Strategy for Sustainability—2004 and Beyond (CQSS2), available from the Fitzroy Basin Association.
- Fitzroy Basin Association. Water Quality Improvement Report, 2008, available from the Fitzroy Basin Association.
- Marsden Jacob Associates (2011) The economic and social impacts of protecting the environmental values of the Fitzroy Basin Waters, available on the department's website.

State plans, policies, guidelines, agreements etc

- State Planning Policy 4/10: Healthy Waters, available from the department's website.
- Urban Stormwater Quality Planning Guidelines, available from the department's website.
- State Planning Policy 4/11: Protecting Wetlands of High Ecological Significance in Great Barrier Catchments, available from the department's website.
- Queensland Water Quality Guidelines, available from the department's website.
- Monitoring and Sampling Manual, available from the department's website.

Other supporting technical information—riparian management

- Managing riparian widths to achieve multiple objectives, fact sheet 13. Land and Water Australia, Australian Government, 2004.
- Improving water quality, fact sheet 3. Land & Water Australia, Australian Government, 2002.
- Riparian Land Management Technical Guidelines—Volume 1 and 2, November 1999. Land and Water Resources Research and Development Corporation (LWRRDC).
- Guidelines for Queensland Streambank Stabilisation with Riparian Vegetation, available from the Cooperative Research Centre for Catchment Hydrology.
- Restoration of Fish Habitats – Fisheries Guidelines for Marine Areas, FHG002, available from the Department of Agriculture, Fisheries and Forestry.
- Fisheries Guidelines for Fish Habitat Buffer Zones, FHG003, available from the Department of Agriculture, Fisheries and Forestry.
- Guidelines for Riparian Filter Strips for Queensland Irrigators, available from the CSIRO.

5 Dictionary

AMTD means the adopted middle thread distance which is the distance in kilometres, measured along the middle of a watercourse, that a specific point in the watercourse is from the watercourse's mouth or junction with the main watercourse (definition based on Water Regulation 2002).

ANZECC means the Australian and New Zealand Environment and Conservation Council.

Aquatic ecosystems (defined in the AWQG): comprise the animals, plants and micro-organisms that live in water, and the physical and chemical environment and climatic regime in which they interact. It is predominantly the physical components (e.g. light, temperature, mixing, flow, habitat) and chemical components (e.g. organic and inorganic carbon, oxygen, nutrients) of an ecosystem that determine what lives and breeds in it, and therefore the structure of the food web. Biological interactions (e.g. grazing and predation) can also play a part in structuring many aquatic ecosystems.

ARMCANZ means the Agriculture and Resource Management Council of Australia and New Zealand.

Basin means the basin name and number provided by Geoscience Australia, Canberra (3rd edition, 2004).

Biological integrity, of water, means the water's ability to support and maintain a balanced, integrative, adaptive community of organisms having a species composition, diversity and functional organisation comparable to that of the natural habitat of the locality in which the water is situated.

Biotoxin (defined in the AWQG) means a toxin (poison) which originates from a living thing (a plant, animal, fungi, bacteria, etc.).

Catchment means the total area draining into a river, creek, reservoir or other body of water. The limits of a given catchment are the heights of land (such as hills or mountains) separating it from neighbouring catchments. Catchments can be made up of smaller sub-catchments.

Ecological health (defined in the AWQG) means the 'health' or 'condition' of an ecosystem. It is the ability of an ecosystem to support and maintain key ecological processes and organisms so that their species compositions, diversity and functional organisations are as comparable as possible to those occurring in natural habitats within a region (also termed ecological integrity).

Environmental value (EV) means:

(a) a quality or physical characteristic of the environment that is conducive to ecological health or public amenity or safety; or

(b) another quality of the environment identified and declared to be an environmental value under an Environmental Protection Policy or Regulation (e.g. water suitable for swimming in or drinking).

The EVs for water that can be identified for protection are outlined in Table 13.

Highest astronomical tide (HAT) (defined in Marine Parks (Declaration) Regulation 2006): means the highest level of the tides that can be predicted to occur under average meteorological conditions and under any combination of astronomical conditions.

High water mark (defined in *Coastal Protection and Management Act 1995*): means the ordinary high water mark at spring tides.

Mean high water spring: refer high water mark.

Queensland waters (as defined in *Acts Interpretation Act 1954*): means all waters that are a) within the limits of the State; or b) coastal waters of the State.

Sub-basin means part of a basin.

Sub-catchment means part of a catchment.

Toxicant (defined in the AWQG) means a chemical capable of producing an adverse response (effect) in a biological system at concentrations that might be encountered in the environment, seriously injuring structure or function or producing death. Examples include pesticides, heavy metals and biotoxins.

Table 13 Suite of environmental values that can be chosen for protection

Environmental values and definitions	ICON
Aquatic ecosystem 'A community of organisms living within or adjacent to water, including riparian or foreshore area.' (EPP (Water), schedule 2) The intrinsic value of aquatic ecosystems, habitat and wildlife in waterways and riparian areas, for example, biodiversity, ecological interactions, plants, animals, key species (such as turtles, platypus, seagrass and dugongs) and their habitat, food and drinking water. Waterways include perennial and intermittent surface waters, groundwaters, tidal and non-tidal waters, lakes, storages, reservoirs, dams, wetlands, swamps, marshes, lagoons, canals, natural and artificial channels and the bed and banks of waterways. (This EV incorporates the 'wildlife habitat' EV used in the South East Queensland Regional Water Quality Management Strategy (SEQRWQMS)). See below for more details on aquatic ecosystems, based on the EPP (Water).	
High ecological/conservation value waters 'Waters in which the biological integrity of the water is effectively unmodified or highly valued.' (EPP (Water), schedule 2)	None
Slightly disturbed waters 'Waters that have the biological integrity of high ecological value waters with slightly modified physical or chemical indicators but effectively unmodified biological indicators.' (EPP (Water), schedule 2)	None
Moderately disturbed waters 'Waters in which the biological integrity of the water is adversely affected by human activity to a relatively small but measurable degree.' (EPP (Water), schedule 2)	None
Highly disturbed waters 'Waters that are significantly degraded by human activity and have lower ecological value than high ecological value waters or slightly or moderately disturbed waters.' (EPP (Water), schedule 2)	None
Seagrass (goal within the aquatic ecosystem EV): Maintenance or rehabilitation of seagrass habitat. (Applies only to tidal waterways.)	

Environmental values and definitions	ICON
Irrigation Suitability of water supply for irrigation, for example, irrigation of crops, pastures, parks, gardens and recreational areas.	
Farm water supply/use Suitability of domestic farm water supply, other than drinking water. For example, water used for laundry and produce preparation.	
Stock watering Suitability of water supply for production of healthy livestock.	
Aquaculture Health of aquaculture species and humans consuming aquatic foods (such as fish, molluscs and crustaceans) from commercial ventures.	
Human consumers of aquatic foods Health of humans consuming aquatic foods, such as fish, crustaceans and shellfish from natural waterways. Note that in some areas oystering is a more specific goal identified under the human consumer EV (see below).	
Oystering (goal within the EV of human consumers of aquatic foods): Health of humans consuming oysters from natural waterways and commercial ventures. (Applies only to tidal waterways.)	
Primary recreation Health of humans during recreation which involves direct contact and a high probability of water being swallowed, for example, swimming, surfing, windsurfing, diving and water-skiing. Primary recreational use, of water, means full body contact with the water, including, for example, diving, swimming, surfing, waterskiing and windsurfing. (EPP (Water), s. 6).	
Secondary recreation Health of humans during recreation which involves indirect contact and a low probability of water being swallowed, for example, wading, boating, rowing and fishing. Secondary recreational use, of water, means contact other than full body contact with the water, including, for example, boating and fishing. (EPP (Water), s. 6).	
Visual recreation Amenity of waterways for recreation which does not involve any contact with water—for example, walking and picnicking adjacent to a waterway. Visual recreational use, of a water, means viewing the water without contact with it. (EPP (Water), s. 6).	

Environmental values and definitions	ICON
Drinking water supply Suitability of raw drinking water supply. This assumes minimal treatment of water is required, for example, coarse screening and/or disinfection.	
Industrial use Suitability of water supply for industrial use, for example, food, beverage, paper, petroleum and power industries. Industries usually treat water supplies to meet their needs.	
Cultural and spiritual values Indigenous and non-indigenous cultural heritage, for example: • custodial, spiritual, cultural and traditional heritage, hunting, gathering and ritual responsibilities • symbols, landmarks and icons (such as waterways, turtles and frogs) • lifestyles (such as agriculture and fishing). Cultural and spiritual values, of water, means its aesthetic, historical, scientific, social or other significance, to the present generation or past or future generations. (EPP (Water), s. 6).	

Table 14 Fitzroy groundwater: water quality objectives (aquatic ecosystem) according to water chemistry zones (refer plan WQ1310)[1-4]

Zone[1]	Depth[2] (±30m)	Percentile[3]	EC[4] (μScm^{-1})	Hardness (mgL^{-1} as $CaCO_3$)[4]	pH	Alkalinity (mgL^{-1})	Ca[4] (mgL^{-1})	Mg[4] (mgL^{-1})	Na[4] (mgL^{-1})	Cl[4] (mgL^{-1})	SO_4[4] (mgL^{-1})	HCO_3[4] (mgL^{-1})	NO_3[4] (mgL^{-1})	SiO_2[4] (mgL^{-1})	F[4] (mgL^{-1})	Fe[4] (mgL^{-1})	Mn[4] (mgL^{-1})	Zn[4] (mgL^{-1})	Cu[4] (mgL^{-1})	SAR[4]	RAH[4] (meqL-1)	EH[4] (mV)
1	Deep	20th	345	109	7.05	171	22	12	63	56	5	208	0.28	45	0.203	0.001	0.010	0.005	0.005	2.55	0.38	-28.40
1	Deep	50th	565	132	7.80	228	29	15	71	82	12	271	2.00	48	0.270	0.010	0.045	0.010	0.010	3.10	1.22	20.50
1	Deep	80th	901	204	8.05	279	41	26	140	113	35	327	3.41	54	0.350	0.195	0.385	0.040	0.030	4.85	2.15	75.00
1	Shallow	20th	490	187	6.70	217	38	21	41	47	5	263	0.10	48	0.150	0.010	0.020	0.000	0.000	1.30	0.17	33.30
1	Shallow	50th	640	243	6.90	280	47	29	81	85	9	341	0.50	54	0.200	0.020	0.085	0.000	0.020	2.30	0.54	38.50
1	Shallow	80th	984	304	7.20	330	59	39	113	144	11	402	0.50	61	0.300	0.060	0.400	0.020	0.030	3.00	1.17	115.10
2	Deep	20th	332	101	6.99	115	24	10	32	22	1	140	0.40	27	0.151	0.000	0.000	0.051	0.000	1.30	0.27	ID
2	Deep	50th	410	121	7.40	135	29	11	36	32	15	163	4.05	32	0.200	0.020	0.010	0.080	0.010	1.50	0.55	ID
2	Deep	80th	493	140	7.90	160	32	14	43	38	22	193	19.75	36	0.239	0.091	0.015	0.138	0.019	1.60	0.64	ID
2	Shallow	20th	559	170	7.50	175	38	17	38	40	6	212	0.00	36	0.229	0.000	0.000	0.011	0.000	1.29	0.00	ID
2	Shallow	50th	892	305	7.70	309	52	41	69	83	19	373	1.30	42	0.270	0.010	0.000	0.085	0.015	1.60	0.10	ID
2	Shallow	80th	1047	375	8.00	371	80	45	75	111	38	450	7.90	48	0.310	0.020	0.039	0.129	0.020	2.00	1.02	ID
3	Deep	20th	660	198	7.60	251	23	28	59	37	8	305	0.00	12	0.100	0.000	0.005	0.010	0.030	1.80	1.04	ID
3	Deep	50th	780	244	7.90	326	34	37	76	52	13	397	0.50	14	0.170	0.010	0.010	0.010	0.030	2.10	1.82	ID
3	Deep	80th	1036	292	8.20	432	48	45	120	80	22	519	0.50	16	0.300	0.020	0.015	0.010	0.030	3.19	2.98	ID
3	Shallow	20th	746	152	7.70	299	19	22	80	53	6	349	0.00	11	0.100	0.000	0.000	ID	ID	2.10	1.87	ID
3	Shallow	50th	858	223	7.90	385	39	36	92	62	14	455	0.50	13	0.105	0.010	0.010	ID	ID	2.60	2.84	ID
3	Shallow	80th	926	316	8.23	441	48	47	132	76	17	538	0.90	15	0.215	0.015	0.010	ID	ID	4.70	3.53	ID
4	Deep	20th	765	152	7.50	250	25	16	76	65	6	325	0.50	31	0.100	0.010	0.010	0.010	0.010	1.70	0.74	ID
4	Deep	50th	938	219	7.70	315	48	31	98	100	13	399	1.00	34	0.105	0.135	0.020	0.010	0.010	2.50	2.09	ID
4	Deep	80th	1243	437	8.00	400	65	67	137	215	20	487	5.35	43	0.200	1.400	0.060	0.010	0.010	4.80	2.69	ID
4	Shallow	20th	625	118	7.81	266	26	13	57	35	6	324	8.14	28	0.028	0.003	0.003	0.020	ID	1.53	0.68	ID
4	Shallow	50th	740	251	7.95	289	48	33	82	51	8	348	22.00	38	0.110	0.020	0.010	0.040	ID	2.30	2.25	ID
4	Shallow	80th	1012	321	8.28	357	52	49	143	100	18	435	27.62	40	0.200	0.044	0.024	0.060	ID	6.56	2.88	ID
5	Deep	20th	914	273	7.73	429	43	39	100	41	20	517	ID	ID	0.183	ID	ID	ID	ID	2.44	0.87	ID
5	Deep	50th	2400	475	7.90	516	55	82	350	381	173	621	ID	ID	0.335	ID	ID	ID	ID	7.10	1.09	ID
5	Deep	80th	4219	594	8.00	591	61	109	684	860	319	713	ID	ID	0.410	ID	ID	ID	ID	12.18	3.78	ID
5	Shallow	20th	633	182	7.39	242	35	23	44	53	5	294	0.38	17	0.127	0.000	0.000	ID	ID	1.09	0.18	ID
5	Shallow	50th	680	286	7.70	280	60	24	68	80	21	342	3.20	23	0.200	0.010	0.070	ID	ID	2.00	1.06	ID

Zone[1]	Depth[2] (±30m)	Percentile[3]	EC[4] (μScm^{-1})	Hardness (mgL^{-1} as $CaCO_3$)[4]	pH	Alkalinity (mgL^{-1})	Ca[4] (mgL^{-1})	Mg[4] (mgL^{-1})	Na[4] (mgL^{-1})	Cl[4] (mgL^{-1})	SO_4[4] (mgL^{-1})	HCO_3[4] (mgL^{-1})	NO_3[4] (mgL^{-1})	SiO_2[4] (mgL^{-1})	F[4] (mgL^{-1})	Fe[4] (mgL^{-1})	Mn[4] (mgL^{-1})	Zn[4] (mgL^{-1})	Cu[4] (mgL^{-1})	SAR[4]	RAH[4] (meqL-1)	EH[4] (mV)
5	Shallow	80th	750	322	7.82	417	75	38	195	137	45	506	9.89	33	1.010	0.020	0.203	ID	ID	6.89	4.00	ID
6	Deep	20th	1100	338	7.67	380	49	53	89	80	19	455	0.09	10	0.100	0.001	0.000	ID	ID	1.80	0.00	ID
6	Deep	50th	1350	499	8.00	500	64	86	97	148	33	580	4.10	20	0.400	0.020	0.010	ID	ID	2.15	1.08	ID
6	Deep	80th	2300	698	8.50	581	108	101	246	426	136	693	9.82	34	0.600	0.058	0.010	ID	ID	4.03	1.80	ID
6	Shallow	20th	650	234	7.50	195	46	27	43	75	10	240	0.50	27	0.110	0.000	0.000	0.000	0.003	1.20	ID	ID
6	Shallow	50th	910	314	7.80	255	58	39	73	123	16	310	1.80	31	0.200	0.010	0.010	0.020	0.020	1.70	ID	ID
6	Shallow	80th	1293	460	8.10	370	76	69	106	181	30	445	4.37	36	0.300	0.030	0.010	0.067	0.050	2.10	ID	ID
7	Deep	20th	744	205	8.30	354	13	40	51	21	5	410	0.18	47	0.110	ID	ID	ID	ID	1.22	1.04	ID
7	Deep	50th	780	293	8.30	390	17	64	55	47	6	463	0.90	50	0.200	ID	ID	ID	ID	1.40	1.93	ID
7	Deep	80th	807	343	8.57	395	19	72	101	56	7	468	2.43	55	0.290	ID	ID	ID	ID	3.11	2.98	ID
8	Deep	20th	31	83	8.20	83	12	11	30	28	16	12	ID	ID	0.100	ID	ID	ID	ID	1.32	0.00	ID
8	Deep	50th	310	99	8.20	99	16	17	31	50	20	119	ID	ID	0.100	ID	ID	ID	ID	1.50	0.00	ID
8	Deep	80th	641	203	8.20	197	52	18	80	111	22	241	ID	ID	0.370	ID	ID	ID	ID	2.40	0.33	ID
9	Deep	20th	18117	4491	6.90	535	353	888	3024	6030	1216	645	0.00	ID	ID	0.037	0.635	ID	ID	18.43	ID	ID
9	Deep	50th	19800	4685	7.10	542	365	920	3091	6870	1240	658	0.55	ID	ID	0.170	1.150	ID	ID	19.50	ID	ID
9	Deep	80th	20372	5074	7.35	618	437	963	3216	6907	1325	671	1.00	ID	ID	8.585	1.455	ID	ID	20.45	ID	ID
9	Shallow	20th	526	139	6.80	106	18	22	47	70	32	126	0.00	19	0.110	0.000	0.000	0.010	0.001	1.63	0.00	ID
9	Shallow	50th	642	165	7.40	129	21	26	65	95	47	157	0.70	22	0.140	0.010	0.010	0.030	0.020	2.20	0.00	ID
9	Shallow	80th	889	243	7.90	182	30	39	91	143	55	210	3.30	30	0.224	0.065	0.010	0.060	0.030	2.48	0.05	ID
10	Deep	20th	475	30	7.80	123	6	2	73	53	2	147	0.22	15	0.074	0.010	0.010	ID	ID	2.68	0.44	ID
10	Deep	50th	800	36	7.80	175	7	5	82	87	9	210	0.50	15	0.200	0.010	0.010	ID	ID	5.90	2.13	ID
10	Deep	80th	1200	366	8.50	383	55	56	173	225	44	462	14.15	55	0.200	0.028	0.010	ID	ID	14.23	2.80	ID
10	Shallow	20th	485	103	6.70	128	20	13	46	64	4	155	0.00	40	0.100	0.000	0.000	0.000	0.000	1.60	0.00	78.90
10	Shallow	50th	739	221	7.30	205	40	28	96	130	8	250	0.50	46	0.200	0.010	0.010	0.010	0.000	2.90	0.00	106.00
10	Shallow	80th	2360	711	7.90	415	109	99	272	578	25	503	4.47	57	0.290	0.045	0.085	0.020	0.030	6.17	0.71	131.40
11	Deep	20th	386	81	7.00	102	18	6	60	68	9	85	ID	18	0.100	ID	0.390	ID	ID	2.10	0.51	ID
11	Deep	50th	569	130	7.80	121	29	10	78	93	17	141	ID	57	0.175	ID	0.405	ID	ID	3.30	0.88	ID
11	Deep	80th	696	146	8.10	169	39	16	108	133	33	165	ID	71	0.500	ID	0.420	ID	ID	5.25	1.57	ID
11	Shallow	20th	0	73	7.50	86	20	6	47	57	7	0	ID	ID	ID	ID	ID	ID	ID	2.40	ID	ID
11	Shallow	50th	625	159	7.65	91	42	13	101	191	17	59	ID	ID	ID	ID	ID	ID	ID	3.35	ID	ID
11	Shallow	80th	1250	244	7.80	96	64	20	155	324	27	117	ID	ID	ID	ID	ID	ID	ID	4.30	ID	ID

Zone[1]	Depth[2] (±30m)	Percentile[3]	EC[4] (μScm^{-1})	Hardness (mgL^{-1} as $CaCO_3$)[4]	pH	Alkalinity (mgL^{-1})	Ca[4] (mgL^{-1})	Mg[4] (mgL^{-1})	Na[4] (mgL^{-1})	Cl[4] (mgL^{-1})	SO_4[4] (mgL^{-1})	HCO_3[4] (mgL^{-1})	NO_3[4] (mgL^{-1})	SiO_2[4] (mgL^{-1})	F[4] (mgL^{-1})	Fe[4] (mgL^{-1})	Mn[4] (mgL^{-1})	Zn[4] (mgL^{-1})	Cu[4] (mgL^{-1})	SAR[4]	RAH[4] (meqL-1)	EH[4] (mV)
12	Deep	20th	1298	212	7.79	552	11	45	172	80	39	660	0.00	ID	0.232	ID	ID	ID	ID	3.91	3.49	ID
12	Deep	50th	1835	266	8.15	782	29	47	304	148	48	933	0.00	ID	0.265	ID	ID	ID	ID	7.95	8.25	ID
12	Deep	80th	2085	467	8.37	867	55	81	430	170	97	1034	0.98	ID	0.361	ID	ID	ID	ID	12.41	12.96	ID
12	Shallow	20th	690	164	7.70	113	26	24	44	13	10	117	ID	ID	0.190	0.000	ID	ID	ID	1.20	ID	ID
12	Shallow	50th	761	219	8.00	237	42	28	77	91	30	277	ID	ID	0.270	0.400	ID	ID	ID	2.45	ID	ID
12	Shallow	80th	832	273	8.30	360	58	31	109	168	50	436	ID	ID	0.350	0.800	ID	ID	ID	3.70	ID	ID
13	Deep	20th	720	136	7.50	262	21	15	75	54	8	315	0.00	18	0.157	0.000	0.000	0.010	0.000	2.00	0.51	ID
13	Deep	50th	1256	326	7.90	355	40	51	139	141	25	429	1.00	37	0.200	0.020	0.010	0.035	0.010	3.50	2.23	ID
13	Deep	80th	1950	540	8.20	560	72	88	279	327	67	673	4.93	56	0.370	0.090	0.040	0.135	0.035	8.96	3.98	ID
13	Shallow	20th	630	145	7.50	249	21	21	56	30	5	295	0.50	28	0.200	0.000	0.000	0.000	0.000	1.60	0.30	ID
13	Shallow	50th	1150	350	8.00	409	40	54	135	110	24	490	3.00	46	0.310	0.010	0.010	0.015	0.010	3.15	1.79	ID
13	Shallow	80th	2509	650	8.30	626	73	119	326	400	125	754	16.39	60	0.594	0.040	0.020	0.050	0.030	7.01	4.08	ID
14	Deep	20th	756	209	7.50	270	24	28	66	68	15	314	0.47	31	0.165	0.000	0.000	0.020	0.001	1.77	0.00	ID
14	Deep	50th	1420	433	7.80	380	64	57	135	147	32	450	2.50	47	0.350	0.000	0.010	0.040	0.020	2.70	0.49	ID
14	Deep	80th	2150	777	8.10	507	129	129	212	382	99	615	6.49	80	0.545	0.020	0.057	0.139	0.050	4.10	1.63	ID
14	Shallow	20th	1006	294	7.50	284	51	36	88	129	29	343	0.50	40	0.200	0.000	0.000	0.010	0.010	2.00	0.00	ID
14	Shallow	50th	1619	458	7.90	377	80	61	164	260	52	454	3.00	69	0.350	0.005	0.000	0.030	0.020	3.20	0.00	ID
14	Shallow	80th	2765	743	8.10	507	125	108	308	604	103	609	13.20	84	0.530	0.030	0.020	0.091	0.050	5.49	1.27	ID
15	Deep	20th	330	74	6.69	67	19	4	19	35	25	61	0.00	11	0.100	0.000	0.049	0.010	ID	0.99	0.00	ID
15	Deep	50th	1200	111	7.45	135	32	12	166	190	110	142	0.35	19	0.180	0.000	0.220	0.060	ID	3.95	0.02	ID
15	Deep	80th	1340	263	8.00	188	57	31	216	290	151	224	3.10	24	0.313	0.018	0.220	0.110	ID	9.33	1.90	ID
15	Shallow	20th	229	50	6.61	74	8	7	33	33	0	91	0.32	15	0.065	ID	ID	ID	ID	1.25	0.24	ID
15	Shallow	50th	1050	464	7.95	280	18	69	56	43	0	262	0.50	28	0.200	ID	ID	ID	ID	2.20	1.00	ID
15	Shallow	80th	1515	500	8.17	525	70	96	133	259	49	632	0.95	38	0.370	ID	ID	ID	ID	3.10	1.29	ID
16	Deep	20th	1859	513	7.80	385	78	76	202	311	45	459	0.58	22	0.260	0.000	0.000	0.028	0.009	3.70	0.00	ID
16	Deep	50th	2000	580	8.00	461	101	81	225	331	89	550	4.60	29	0.300	0.010	0.010	0.650	0.030	4.10	0.00	ID
16	Deep	80th	2285	634	8.30	543	114	86	294	434	130	650	7.32	35	0.489	0.049	0.078	1.183	0.052	5.38	0.79	ID
16	Shallow	20th	1000	310	7.40	194	58	38	86	177	22	235	0.00	28	0.140	0.000	0.000	0.010	0.000	2.00	ID	ID
16	Shallow	50th	1700	527	7.80	335	90	70	165	350	45	405	1.50	35	0.210	0.020	0.010	0.020	0.010	3.10	ID	ID
16	Shallow	80th	2800	810	8.10	476	136	120	310	650	97	570	5.00	41	0.300	0.040	0.040	0.174	0.030	4.90	ID	ID
17	Deep	20th	2370	630	7.42	460	62	108	284	473	105	560	0.73	28	0.443	0.010	0.025	0.010	0.030	4.95	ID	ID

Zone[1]	Depth[2] (±30m)	Percentile[3]	EC[4] (μScm^{-1})	Hardness (mgL^{-1} as $CaCO_3$)[4]	pH	Alkalinity (mgL^{-1})	Ca[4] (mgL^{-1})	Mg[4] (mgL^{-1})	Na[4] (mgL^{-1})	Cl[4] (mgL^{-1})	SO_4[4] (mgL^{-1})	HCO_3[4] (mgL^{-1})	NO_3[4] (mgL^{-1})	SiO_2[4] (mgL^{-1})	F[4] (mgL^{-1})	Fe[4] (mgL^{-1})	Mn[4] (mgL^{-1})	Zn[4] (mgL^{-1})	Cu[4] (mgL^{-1})	SAR[4]	RAH[4] (meqL-1)	EH[4] (mV)
17	Deep	50th	3000	781	7.60	481	90	128	366	620	151	586	10.25	42	0.600	0.015	0.070	0.010	0.030	5.80	ID	ID
17	Deep	80th	4925	908	7.80	576	170	166	540	795	450	702	35.95	48	0.770	0.216	0.214	0.010	0.030	7.80	ID	ID
17	Shallow	20th	414	128	6.55	134	23	16	63	87	5	153	0.00	27	0.101	0.000	0.000	0.010	0.000	2.42	0.00	ID
17	Shallow	50th	900	394	7.20	333	51	57	191	318	31	393	0.90	49	0.250	0.000	0.020	0.010	0.000	4.25	0.00	ID
17	Shallow	80th	2276	945	7.90	622	120	145	563	1052	124	754	3.60	56	0.500	0.056	0.283	0.019	0.009	8.99	0.58	ID
18	Deep	20th	3310	343	7.90	397	13	72	635	532	59	475	1.00	30	0.400	ID	ID	ID	ID	9.80	12.66	ID
18	Deep	50th	4675	989	8.05	690	119	172	790	905	731	818	2.05	31	0.600	ID	ID	ID	ID	12.10	13.03	ID
18	Deep	80th	5900	1628	8.27	1003	215	265	910	1250	1400	1188	3.80	32	0.800	ID	ID	ID	ID	15.38	13.40	ID
18	Shallow	20th	1532	466	7.70	413	43	82	143	191	23	501	1.00	38	0.330	0.005	0.003	ID	ID	2.20	0.00	ID
18	Shallow	50th	2400	696	7.90	582	72	126	190	390	95	690	4.75	50	0.520	0.020	0.010	ID	ID	3.20	0.71	ID
18	Shallow	80th	4440	1230	8.20	683	144	203	521	966	351	813	9.85	59	0.770	0.035	0.020	ID	ID	7.20	1.43	ID
19	Deep	20th	2721	551	7.20	206	74	64	347	690	46	243	0.50	29	0.100	0.010	0.000	0.010	0.000	5.50	0.00	ID
19	Deep	50th	3900	928	7.80	351	137	120	495	1095	100	425	2.50	42	0.140	0.050	0.010	0.010	0.030	7.70	0.00	ID
19	Deep	80th	7200	1643	8.10	449	320	230	1050	2285	296	544	7.00	64	0.210	0.140	0.109	0.020	0.030	11.60	1.85	ID
19	Shallow	20th	2000	577	7.30	180	99	70	170	466	40	217	0.50	32	0.100	0.010	0.000	0.010	0.000	2.90	ID	ID
19	Shallow	50th	3500	1112	7.70	243	180	155	306	890	140	292	2.20	40	0.200	0.050	0.010	0.010	0.030	3.90	ID	ID
19	Shallow	80th	5100	1676	8.00	421	299	225	495	1400	530	506	6.51	53	0.290	0.130	0.050	0.081	0.030	6.00	ID	ID
20	Deep	20th	317	41	7.18	140	9	3	79	75	0	142	0.00	12	0.085	0.001	0.010	ID	ID	4.02	1.02	ID
20	Deep	50th	595	66	7.70	154	12	6	105	100	2	183	0.50	14	0.120	0.015	0.010	ID	ID	5.50	2.00	ID
20	Deep	80th	743	114	8.01	196	24	11	143	164	6	237	1.05	17	0.200	0.030	0.015	ID	ID	7.56	2.58	ID
20	Shallow	20th	90	35	7.25	48	12	1	57	64	0	16	0.03	13	0.170	0.000	0.000	ID	ID	2.53	0.35	ID
20	Shallow	50th	785	91	7.80	186	23	10	132	145	2	218	0.50	17	0.210	0.010	0.020	ID	ID	4.35	1.75	ID
20	Shallow	80th	1195	413	8.11	337	87	46	171	305	29	355	1.93	22	0.330	0.053	0.031	ID	ID	6.60	2.35	ID
21	Deep	20th	217	21	6.60	47	6	1	42	55	0	27	0.00	11	0.100	0.000	0.000	0.100	0.030	2.80	0.10	ID
21	Deep	50th	585	84	7.40	143	20	3	145	170	5	168	0.00	13	0.200	0.020	0.080	0.125	0.045	5.40	2.02	ID
21	Deep	80th	2060	428	7.92	317	126	35	324	572	112	242	1.00	16	0.400	0.495	0.268	0.150	0.060	15.20	3.37	ID
21	Shallow	20th	1033	272	7.40	223	61	30	103	153	16	269	0.00	29	0.157	0.000	0.000	0.020	0.030	2.50	0.00	ID
21	Shallow	50th	2000	522	7.90	345	96	63	237	445	45	416	1.00	37	0.210	0.020	0.010	0.020	0.050	4.10	0.02	ID
21	Shallow	80th	4609	1566	8.20	478	300	200	715	1765	125	570	5.88	44	0.400	0.060	0.224	0.040	0.050	9.00	0.95	ID
22	Deep	20th	1507	433	7.40	365	62	47	161	253	15	438	0.79	27	0.152	0.000	0.000	0.010	0.000	2.70	0.00	ID
22	Deep	50th	2735	830	7.90	570	101	134	275	721	44	655	6.90	41	0.400	0.000	0.000	0.060	0.010	4.25	0.00	ID

Zone[1]	Depth[2] (±30m)	Percentile[3]	EC[4] (μScm^{-1})	Hardness (mgL^{-1} as $CaCO_3$)[4]	pH	Alkalinity (mgL^{-1})	Ca[4] (mgL^{-1})	Mg[4] (mgL^{-1})	Na[4] (mgL^{-1})	Cl[4] (mgL^{-1})	SO_4[4] (mgL^{-1})	HCO_3[4] (mgL^{-1})	NO_3[4] (mgL^{-1})	SiO_2[4] (mgL^{-1})	F[4] (mgL^{-1})	Fe[4] (mgL^{-1})	Mn[4] (mgL^{-1})	Zn[4] (mgL^{-1})	Cu[4] (mgL^{-1})	SAR[4]	RAH[4] (meqL-1)	EH[4] (mV)
22	Deep	80th	5276	1861	8.10	636	181	283	809	1973	218	775	16.29	57	0.697	0.010	0.030	0.695	0.050	12.36	2.20	ID
22	Shallow	20th	1403	367	7.20	245	60	41	145	218	30	295	0.00	35	0.163	0.000	0.000	0.010	0.000	3.00	0.00	ID
22	Shallow	50th	2220	591	7.70	360	105	76	240	475	61	439	1.30	45	0.300	0.000	0.010	0.020	0.010	4.40	0.00	ID
22	Shallow	80th	3722	1001	8.00	510	175	145	420	979	95	610	9.20	64	0.560	0.050	0.100	0.080	0.037	6.93	1.01	ID
23	Deep	20th	2496	350	7.51	233	50	55	312	553	42	282	0.00	20	0.149	0.014	0.000	ID	ID	5.50	0.00	ID
23	Deep	50th	3465	1098	7.80	463	138	165	587	851	100	565	0.00	47	0.370	0.040	0.025	ID	ID	10.45	0.73	ID
23	Deep	80th	7450	1621	7.99	618	260	244	1106	1930	520	753	2.25	54	1.020	0.382	0.340	ID	ID	13.00	10.83	ID
23	Shallow	20th	3333	461	7.60	445	51	70	501	558	50	543	0.00	13	0.680	0.006	0.020	ID	ID	5.71	1.83	ID
23	Shallow	50th	3850	793	7.75	650	100	140	561	750	95	793	0.50	21	0.800	0.035	0.035	ID	ID	8.40	2.85	ID
23	Shallow	80th	4506	1146	8.45	903	223	185	599	989	832	1091	1.65	48	1.200	0.085	0.176	ID	ID	14.36	9.36	ID
24	Shallow	20th	1790	559	7.90	360	73	88	194	328	45	433	0.09	36	0.480	0.000	0.000	ID	ID	3.84	ID	ID
24	Shallow	50th	3140	762	8.00	402	126	109	350	605	160	485	7.30	52	0.650	0.000	0.010	ID	ID	5.50	ID	ID
24	Shallow	80th	6908	1400	8.23	601	176	234	1151	1935	318	729	12.76	62	1.060	0.015	0.025	ID	ID	15.39	ID	ID
25	Deep	20th	791	15	7.90	301	4	1	159	67	11	358	0.00	17	0.150	0.000	0.000	0.012	0.000	5.50	2.46	ID
25	Deep	50th	1037	40	8.35	332	10	3	198	96	20	391	0.00	19	0.260	0.000	0.000	0.030	0.000	14.15	5.32	ID
25	Deep	80th	1345	229	8.50	457	30	41	263	178	38	544	0.60	37	0.379	0.100	0.020	0.507	0.000	23.80	6.07	ID
25	Shallow	20th	685	49	7.70	251	11	5	68	37	6	300	0.20	19	0.190	0.000	0.000	ID	ID	1.83	0.84	ID
25	Shallow	50th	1085	171	7.90	350	27	22	142	118	10	421	2.20	28	0.300	0.010	0.010	ID	ID	4.70	3.90	ID
25	Shallow	80th	1420	370	8.19	579	59	55	267	194	48	630	8.62	34	0.400	0.020	0.020	ID	ID	15.47	6.70	ID
26	Deep	20th	450	13	7.38	197	4	1	111	27	0	208	0.91	10	0.500	0.000	0.000	ID	ID	10.15	3.39	ID
26	Deep	50th	550	18	8.00	240	4	2	128	58	0	256	1.00	12	0.600	0.000	0.000	ID	ID	12.95	4.18	ID
26	Deep	80th	667	38	8.20	254	9	4	159	89	5	303	2.00	14	0.600	0.000	0.000	ID	ID	15.39	4.69	ID
27	Deep	20th	158	4	6.90	63	1	0	32	9	0	70	0.00	12	0.100	0.010	0.000	0.000	0.010	3.93	1.15	ID
27	Deep	50th	210	8	7.50	91	2	1	45	12	0	103	0.00	13	0.200	0.040	0.010	0.010	0.010	7.70	1.64	ID
27	Deep	80th	297	24	7.90	151	7	1	68	36	2	142	0.50	14	0.300	0.245	0.030	0.020	0.030	10.34	2.35	ID
27	Shallow	20th	177	4	7.13	79	1	0	38	7	0	94	0.00	11	0.159	0.007	0.007	0.000	0.003	4.80	1.50	ID
27	Shallow	50th	215	5	7.40	99	2	0	45	8	1	120	0.00	12	0.200	0.010	0.010	0.005	0.010	8.20	1.76	ID
27	Shallow	80th	284	24	7.97	144	9	1	66	10	2	170	0.50	14	0.238	0.023	0.013	0.010	0.024	9.25	2.00	ID
28	Deep	20th	308	24	7.10	74	5	3	28	32	0	85	0.00	13	0.100	0.010	0.010	0.010	0.030	1.89	0.83	ID
28	Deep	50th	425	45	7.80	156	9	5	73	45	2	186	0.50	15	0.200	0.010	0.010	0.020	0.030	4.60	2.25	ID
28	Deep	80th	723	66	8.20	219	16	9	128	74	5	257	0.50	17	0.230	0.040	0.210	0.030	0.045	9.73	3.54	ID

Zone[1]	Depth[2] (±30m)	Percentile[3]	EC[4] (μScm^{-1})	Hardness (mgL^{-1} as $CaCO_3$)[4]	pH	Alkalinity (mgL^{-1})	Ca[4] (mgL^{-1})	Mg[4] (mgL^{-1})	Na[4] (mgL^{-1})	Cl[4] (mgL^{-1})	SO_4[4] (mgL^{-1})	HCO_3[4] (mgL^{-1})	NO_3[4] (mgL^{-1})	SiO_2[4] (mgL^{-1})	F[4] (mgL^{-1})	Fe[4] (mgL^{-1})	Mn[4] (mgL^{-1})	Zn[4] (mgL^{-1})	Cu[4] (mgL^{-1})	SAR[4]	RAH[4] (meqL-1)	EH[4] (mV)
28	Shallow	20th	300	22	7.10	73	4	3	28	42	0	85	0.00	15	0.114	0.000	0.010	0.000	0.000	2.20	0.19	ID
28	Shallow	50th	615	51	7.70	196	9	6	128	57	2	230	0.50	17	0.200	0.020	0.010	0.010	0.005	5.50	2.80	ID
28	Shallow	80th	1644	261	8.20	416	30	32	252	241	11	495	0.50	25	0.400	0.093	0.096	0.019	0.019	13.50	4.91	ID
29	Deep	20th	689	8	7.60	187	2	0	186	115	0	136	0.00	12	0.100	0.000	0.000	0.000	0.000	13.52	2.13	ID
29	Deep	50th	1200	17	8.10	301	5	1	286	178	5	317	0.00	15	0.300	0.000	0.010	0.000	0.010	32.30	4.92	ID
29	Deep	80th	2205	108	8.60	500	29	8	568	600	23	568	1.00	18	1.000	0.068	0.030	0.010	0.030	51.49	9.36	ID
29	Shallow	20th	890	9	7.60	231	3	0	201	129	0	252	0.00	12	0.100	0.000	0.000	ID	ID	15.60	2.62	ID
29	Shallow	50th	1565	25	8.30	358	8	2	348	220	16	347	0.60	14	0.400	0.000	0.010	ID	ID	30.40	5.82	ID
29	Shallow	80th	2515	138	8.50	517	35	11	530	653	38	586	7.28	18	0.917	0.040	0.040	ID	ID	48.21	9.58	ID
30	Deep	20th	530	15	7.85	164	4	1	95	45	2	179	0.00	ID	0.079	ID	ID	ID	ID	5.05	2.74	ID
30	Deep	50th	665	65	8.15	243	8	10	113	60	12	296	0.00	ID	0.200	ID	ID	ID	ID	9.30	3.16	ID
30	Deep	80th	960	106	8.70	290	19	16	173	75	66	354	0.09	ID	0.300	ID	ID	ID	ID	12.15	4.17	ID
30	Shallow	20th	536	17	7.56	232	5	1	119	25	9	269	0.00	21	0.009	ID	ID	ID	ID	5.37	3.99	ID
30	Shallow	50th	1030	45	8.30	309	8	6	169	81	16	350	0.80	26	0.100	ID	ID	ID	ID	11.30	4.25	ID
30	Shallow	80th	1689	242	8.71	454	31	40	298	278	41	549	6.70	46	0.264	ID	ID	ID	ID	18.83	8.25	ID
31	Deep	20th	2151	79	7.70	357	9	14	375	414	0	412	0.00	15	0.100	ID	0.000	0.000	0.000	9.10	2.86	ID
31	Deep	50th	3150	198	7.95	575	27	28	589	554	10	683	0.50	17	0.105	ID	0.005	0.015	0.015	20.10	5.85	ID
31	Deep	80th	3540	610	8.20	632	70	106	734	954	64	763	2.44	47	0.380	ID	0.010	0.382	0.103	25.59	9.87	ID
31	Shallow	20th	874	107	7.51	342	13	18	200	34	12	406	0.50	54	0.187	0.000	0.000	0.000	0.000	5.23	0.72	ID
31	Shallow	50th	2450	296	8.00	594	37	55	481	565	72	710	2.50	71	0.450	0.010	0.010	0.010	0.010	11.55	4.67	ID
31	Shallow	80th	4200	649	8.30	805	80	107	805	951	152	956	8.19	90	0.715	0.050	0.030	0.033	0.030	17.20	9.90	ID
32	Deep	20th	0	14	7.60	165	3	1	360	185	0	0	0.00	13	0.200	0.000	0.000	0.007	0.000	32.07	2.43	ID
32	Deep	50th	2050	49	8.10	351	11	4	700	830	4	284	0.10	16	0.600	0.035	0.010	0.010	0.010	51.90	6.48	ID
32	Deep	80th	5165	156	8.60	605	46	12	1802	2476	34	628	2.64	19	1.195	0.200	0.033	0.230	0.033	77.96	11.56	ID
32	Shallow	20th	371	26	7.40	172	7	2	144	130	0	100	0.00	10	0.165	0.000	0.000	ID	0.000	5.67	1.17	ID
32	Shallow	50th	1440	105	7.95	237	28	8	508	385	6	275	0.00	15	0.400	0.060	0.000	ID	0.005	40.55	3.90	ID
32	Shallow	80th	6040	277	8.40	493	74	30	1868	2780	21	590	1.00	20	0.769	2.350	0.020	ID	0.010	61.89	9.14	ID
33	Deep	20th	0	247	7.27	144	53	0	401	405	2	0	0.11	9	0.100	0.007	0.000	ID	ID	8.27	0.00	ID
33	Deep	50th	6310	469	7.60	233	114	30	1420	2181	11	174	1.05	13	0.300	0.055	0.010	ID	ID	27.50	0.02	ID
33	Deep	80th	8712	734	8.22	574	263	62	2095	3286	96	391	8.70	33	0.601	0.292	0.050	ID	ID	38.70	4.12	ID
33	Shallow	20th	878	221	7.30	256	46	22	126	135	2	307	0.00	23	0.100	0.010	0.000	0.010	0.030	3.60	0.00	ID

Zone[1]	Depth[2] (±30m)	Percentile[3]	EC[4] (μScm^{-1})	Hardness (mgL^{-1} as $CaCO_3$)[4]	pH	Alkalinity (mgL^{-1})	Ca[4] (mgL^{-1})	Mg[4] (mgL^{-1})	Na[4] (mgL^{-1})	Cl[4] (mgL^{-1})	SO_4[4] (mgL^{-1})	HCO_3[4] (mgL^{-1})	NO_3[4] (mgL^{-1})	SiO_2[4] (mgL^{-1})	F[4] (mgL^{-1})	Fe[4] (mgL^{-1})	Mn[4] (mgL^{-1})	Zn[4] (mgL^{-1})	Cu[4] (mgL^{-1})	SAR[4]	RAH[4] (meqL-1)	EH[4] (mV)
33	Shallow	50th	3700	645	7.80	499	97	94	610	1169	62	600	2.00	29	0.200	0.030	0.045	0.020	0.050	8.70	0.93	ID
33	Shallow	80th	12158	1964	8.20	785	345	293	2944	4061	416	933	5.25	40	0.395	0.200	0.970	0.035	0.090	25.22	3.64	ID
34	Deep	20th	3419	359	7.40	156	46	35	480	753	25	188	0.01	16	0.020	0.000	0.000	0.010	0.017	10.50	0.00	ID
34	Deep	50th	6100	919	7.80	275	145	115	1100	1900	138	330	2.15	25	0.155	0.050	0.050	0.025	0.030	15.60	0.24	ID
34	Deep	80th	16000	3208	8.03	536	442	491	2565	5905	398	650	14.92	36	0.400	0.246	0.291	0.317	0.030	24.65	6.25	ID
34	Shallow	20th	498	163	7.10	154	18	27	135	171	12	187	0.00	21	0.100	0.000	0.000	0.000	0.000	4.37	0.00	ID
34	Shallow	50th	2150	674	7.75	435	84	108	747	1309	140	536	0.95	36	0.280	0.030	0.010	0.015	0.010	10.85	0.00	ID
34	Shallow	80th	8910	2228	8.10	752	215	389	1500	3185	318	878	5.30	52	0.500	0.140	0.160	0.060	0.030	18.21	2.30	ID
35	Deep	20th	4103	401	7.37	92	33	45	465	1079	0	126	0.00	9	0.060	0.000	0.010	0.010	0.000	16.51	0.00	ID
35	Deep	50th	9375	1216	7.60	189	146	204	1750	3316	20	268	0.10	18	0.300	0.010	0.040	0.140	0.005	21.20	0.05	ID
35	Deep	80th	13604	1905	8.01	311	366	226	2555	5368	122	376	0.50	76	0.500	0.047	2.495	0.270	0.010	28.31	1.91	ID
35	Shallow	20th	84	37	7.59	122	6	3	59	54	5	42	0.15	43	0.100	ID	ID	ID	ID	1.99	0.48	ID
35	Shallow	50th	870	124	7.60	320	14	27	113	86	11	333	1.40	68	0.200	ID	ID	ID	ID	4.15	2.40	ID
35	Shallow	80th	1983	430	7.93	556	81	58	256	392	25	646	9.60	72	0.500	ID	ID	ID	ID	9.72	4.92	ID
36	Deep	20th	3475	288	8.21	460	23	44	520	793	84	541	0.65	32	0.310	0.020	0.020	ID	ID	9.39	4.34	ID
36	Deep	50th	4150	354	8.30	572	45	74	830	1000	115	640	2.00	43	0.400	0.020	0.020	ID	ID	19.20	13.40	ID
36	Deep	80th	7255	619	8.66	1322	75	106	1748	1945	210	1549	2.90	81	1.120	0.047	0.047	ID	ID	45.12	22.45	ID
36	Shallow	20th	3100	323	7.70	316	42	46	590	610	2	372	1.00	25	0.285	0.020	0.020	ID	ID	13.00	1.83	ID
36	Shallow	50th	6300	363	7.80	600	53	56	1404	1885	5	732	4.25	43	0.300	0.020	0.045	ID	ID	26.80	6.84	ID
36	Shallow	80th	7410	528	8.35	843	105	72	1511	2373	120	1021	7.50	60	0.390	0.020	0.070	ID	ID	34.95	10.60	ID
37	Shallow	20th	544	169	7.53	154	27	22	82	83	15	186	0.15	41	0.219	0.000	0.007	ID	ID	3.53	0.00	ID
37	Shallow	50th	3400	428	8.00	318	57	64	430	300	92	380	0.80	59	0.600	0.020	0.010	ID	ID	6.20	1.35	ID
37	Shallow	80th	4418	841	8.10	680	114	137	807	1110	293	811	37.77	79	1.547	0.335	0.029	ID	ID	13.95	3.32	ID
38	Deep	20th	1333	217	7.66	273	21	38	125	133	17	332	0.00	19	0.200	0.005	0.000	0.010	0.010	2.60	0.00	ID
38	Deep	50th	1675	430	8.10	540	50	74	246	314	31	630	0.50	27	0.400	0.020	0.010	0.015	0.020	4.95	0.95	ID
38	Deep	80th	2450	561	8.57	580	61	105	355	423	70	695	3.23	39	0.710	0.035	0.015	0.020	0.030	9.55	2.94	ID
38	Shallow	20th	693	230	7.30	135	48	24	53	130	20	165	0.23	18	0.100	0.000	0.000	0.000	0.000	1.40	ID	ID
38	Shallow	50th	1050	357	7.70	187	72	41	81	200	36	225	0.80	26	0.160	0.015	0.010	0.030	0.010	1.95	ID	ID
38	Shallow	80th	1610	491	8.10	295	97	58	156	320	106	352	1.97	33	0.250	0.030	0.020	0.314	0.050	3.30	ID	ID
39	Deep	20th	665	437	7.85	427	7	89	31	66	8	513	1.20	79	0.045	0.000	ID	0.000	0.000	0.50	0.00	ID
39	Deep	50th	1270	710	8.30	693	7	169	32	69	10	817	1.40	80	0.080	0.000	ID	0.060	0.030	0.50	0.00	ID

Zone[1]	Depth[2] (±30m)	Percentile[3]	EC[4] (μScm^{-1})	Hardness (mgL^{-1} as $CaCO_3$)[4]	pH	Alkalinity (mgL^{-1})	Ca[4] (mgL^{-1})	Mg[4] (mgL^{-1})	Na[4] (mgL^{-1})	Cl[4] (mgL^{-1})	SO_4[4] (mgL^{-1})	HCO_3[4] (mgL^{-1})	NO_3[4] (mgL^{-1})	SiO_2[4] (mgL^{-1})	F[4] (mgL^{-1})	Fe[4] (mgL^{-1})	Mn[4] (mgL^{-1})	Zn[4] (mgL^{-1})	Cu[4] (mgL^{-1})	SAR[4]	RAH[4] (meqL-1)	EH[4] (mV)
39	Deep	80th	1422	773	8.55	705	31	182	59	143	20	819	5.30	87	0.285	0.030	ID	0.120	0.060	1.40	0.14	ID
39	Shallow	20th	1314	515	7.45	456	14	114	63	129	16	540	0.50	61	0.100	0.000	0.000	0.000	0.010	1.10	0.00	ID
39	Shallow	50th	1646	679	7.90	493	31	135	126	247	26	581	2.10	71	0.155	0.005	0.000	0.030	0.020	2.25	0.00	ID
39	Shallow	80th	2725	889	8.40	579	61	190	255	653	41	701	3.61	86	0.300	0.010	0.020	0.088	0.020	3.85	0.02	ID
40	Deep	20th	805	185	4.05	0	30	24	58	76	256	0	0.00	15	0.139	0.000	0.462	ID	ID	1.51	ID	ID
40	Deep	50th	1363	438	4.45	62	86	54	85	147	473	0	0.25	16	0.265	0.000	1.200	ID	ID	2.35	ID	ID
40	Deep	80th	1616	556	6.81	123	112	69	128	188	505	104	1.27	27	0.398	0.018	1.209	ID	ID	2.77	ID	ID
41	Deep	20th	974	251	7.15	206	46	33	74	53	18	251	0.85	12	0.160	0.000	0.000	0.010	0.000	1.42	0.02	ID
41	Deep	50th	1356	434	7.50	417	92	49	129	132	91	502	1.45	40	0.330	0.000	0.010	0.030	0.015	2.55	0.22	ID
41	Deep	80th	1656	574	8.13	451	132	60	152	216	192	543	24.06	45	0.403	0.000	0.041	0.491	0.058	3.19	1.55	ID
41	Shallow	20th	1611	611	7.30	111	116	74	100	193	252	132	0.50	30	0.100	0.010	0.000	0.010	0.000	1.70	ID	ID
41	Shallow	50th	2020	797	7.70	159	160	98	150	335	465	190	1.60	34	0.100	0.040	0.010	0.010	0.010	2.30	ID	ID
41	Shallow	80th	2600	979	7.90	246	205	120	205	520	580	293	5.23	43	0.200	0.070	0.010	0.045	0.030	3.10	ID	ID
42	Deep	20th	8080	1239	7.01	320	176	189	1376	2517	181	383	2.50	40	0.100	0.037	0.100	ID	ID	14.50	ID	ID
42	Deep	50th	11500	2310	8.00	369	315	312	1610	4020	185	450	3.75	43	0.200	0.190	0.105	ID	ID	16.30	ID	ID
42	Deep	80th	12220	2401	8.18	403	437	364	1781	4227	325	477	5.00	45	0.300	0.208	0.110	ID	ID	17.47	ID	ID
42	Shallow	20th	465	101	6.66	108	19	13	40	57	15	132	0.00	30	0.100	0.000	0.007	ID	ID	1.50	0.01	ID
42	Shallow	50th	560	133	7.00	134	22	19	157	219	34	162	0.20	33	0.130	0.000	0.120	ID	ID	6.00	0.16	ID
42	Shallow	80th	1738	2552	7.61	400	294	424	2473	5005	332	485	0.71	37	0.195	0.029	0.260	ID	ID	18.95	2.82	ID
43	Deep	20th	3460	511	7.70	393	48	96	617	690	58	474	0.00	14	0.047	0.019	0.000	ID	ID	7.30	0.00	ID
43	Deep	50th	5500	1360	8.20	442	184	217	748	1510	181	527	0.00	16	0.100	0.190	0.000	ID	ID	9.65	3.04	ID
43	Deep	80th	7720	3050	8.40	954	368	436	1259	3616	362	1113	0.94	46	0.310	0.856	0.054	ID	ID	14.40	12.38	ID
43	Shallow	20th	2725	307	7.09	291	29	56	537	446	60	351	0.00	23	0.194	0.000	0.000	0.010	0.000	9.77	0.00	ID
43	Shallow	50th	6300	978	7.80	544	118	123	712	960	121	633	3.00	56	0.350	0.010	0.010	0.030	0.010	14.40	0.00	ID
43	Shallow	80th	15495	5051	8.20	841	480	856	2628	6492	387	989	25.89	94	0.910	0.115	3.755	0.115	0.090	18.73	10.37	ID
44	Deep	20th	7380	1706	7.50	146	114	268	962	2385	207	176	4.61	17	0.056	0.100	0.000	ID	ID	9.64	ID	ID
44	Deep	50th	13500	2505	7.70	345	358	438	2075	4875	395	418	12.40	27	0.100	0.155	0.100	ID	ID	14.40	ID	ID
44	Deep	80th	17350	5443	7.90	663	1250	567	3450	6430	833	792	18.50	44	0.200	0.240	0.815	ID	ID	21.10	ID	ID
44	Shallow	20th	3900	736	7.47	270	37	142	438	996	67	322	0.00	10	0.100	0.000	0.000	0.020	0.000	6.80	ID	ID
44	Shallow	50th	7235	1287	7.80	540	110	280	1200	2140	223	645	1.30	35	0.200	0.050	0.060	0.340	0.015	14.30	ID	ID
44	Shallow	80th	12175	2558	8.30	813	288	435	2250	4000	478	960	10.00	45	0.400	0.260	0.413	2.688	0.063	20.35	ID	ID

Source: Regional chemistry of the Fitzroy Basin groundwater. (Raymond, M. A. A. and V. H. McNeil, 2011).

Notes:

1. Refer to plan WQ1310 to locate the relevant chemistry zone.
2. Within each chemistry zone, groundwater quality values are provided for two depths (shallow <30m, and deep >30m).
3. The management intent is to maintain 20th, 50th and 80th percentile values. Values are provided for each of these percentiles.
4. Abbreviations: EC: Electrical conductivity, $CaCO_3$: Calcium carbonate, Ca: Calcium, Mg: Magnesium, Na: Sodium, Cl: Chloride, SO_4: Sulfate, HCO_3: Bicarbonate, NO_3: Nitrate, SiO_2: Silica, F: Fluoride, Fe: Iron, Mn: Manganese, Zn: Zinc, Cu: Copper, SAR: Sodium adsorption ratio, RAH: Residual alkali hazard, EH: Redox (oxidation/reduction) potential, ID: insufficient data to perform statistical summaries, or the parameter was not tested.

Current Title Search

Queensland Titles Registry Pty Ltd
ABN 23 648 568 101

Title Reference:	**51022093**	**Search Date:**	03/11/2022 14:35
Date Title Created:	19/01/2016	**Request No:**	42726004
Previous Title:	50544874		

ESTATE AND LAND

Estate in Fee Simple

LOT 19 SURVEY PLAN 276924
Local Government: ISAAC

REGISTERED OWNER — INTEREST

Dealing No: 721140275 01/10/2021

GREGORY WILLIAM SMALL	1/2
BRIAN JAMES SMALL	1/2

AS TENANTS IN COMMON

EASEMENTS, ENCUMBRANCES AND INTERESTS

1. Rights and interests reserved to the Crown by
Deed of Grant No. 40022929 (Lot 5 on CP ROP23)

2. EASEMENT No 602798728 (A1242) 17/09/1981
burdening the land to
UTAH DEVELOPMENT COMPANY
OVER EASEMENT J ON PLAN ROP128

3. EASEMENT No 602798729 (A2221) 18/06/1987
burdening the land to
UTAH DEVELOPMENT COMPANY LIMITED
MITSUBISHI DEVELOPMENT PTY. LTD.
AUSTRALIAN MUTUAL PROVIDENT SOCIETY
UMAL CONSOLIDATED LIMITED
UTAH QUEENSLAND COAL LIMITED
UB MINERALS INC.
BOWEN BASIN MINERALS PROPRIETARY LIMITED
QCT INVESTMENT PTY. LTD.
QCT MINING PTY. LTD.
BELL COAL PTY. LTD.
PANCONTINENTAL MINING LIMITED
CAPRICORN COAL MANAGEMENT PTY. LTD.
OVER EASEMENT J ON PLAN ROP128

4. EASEMENT No 704795162 30/05/2001 at 15:50
benefiting
PART OF THE LAND FORMERLY
LOT 15 ON SP128608
OVER EASEMENT B ON SP128608

5. EASEMENT No 709965025 26/09/2006 at 09:24
burdening the land to
LOT 16 ON SP181611
OVER EASEMENT D ON SP178463

6. EASEMENT No 711410608 08/02/2008 at 15:01
burdening the land to
LOT 6 ON SP189240 OVER
EASEMENT C ON SP193685

COPYRIGHT QUEENSLAND TITLES REGISTRY PTY LTD [2022]
Requested by: D-ENQ CITEC CONFIRM

Queensland Titles Registry Pty Ltd
ABN 23 648 568 101

Title Reference: 51022093

EASEMENTS, ENCUMBRANCES AND INTERESTS (Continued)

7. EASEMENT No 716121516 05/11/2014 at 12:49
benefiting the land over
EASEMENT Y ON SP256884

8. EASEMENT No 716121517 05/11/2014 at 12:50
benefiting
EASEMENT S ON SP256884

9. EASEMENT No 716121524 05/11/2014 at 12:50
benefiting the land over
EASEMENTS U, V, W, X, ON SP256884

10. EASEMENT No 720696574 01/04/2021 at 13:16
burdening the land to
LOT 11 ON CP TT443
LOT 1 ON SP150500
LOT 2 ON SP293509 AND
LOT 4 ON SP184275 OVER
EASEMENT O ON SP276928

ADMINISTRATIVE ADVICES

Dealing	Type	Lodgement Date	Status
713748239	VEG NOTICE VEGETATION MANAGEMENT ACT 1999	08/03/2011 12:22	CURRENT
720724153	CON COM AGMT MINERAL AND ENERGY RESOURCES (COMMON PROVISIONS) ACT 2014	15/04/2021 11:19	CURRENT
720724179	CON COM AGMT MINERAL AND ENERGY RESOURCES (COMMON PROVISIONS) ACT 2014	15/04/2021 11:20	CURRENT

UNREGISTERED DEALINGS

NIL

Caution - Charges do not necessarily appear in order of priority

** End of Current Title Search **

COPYRIGHT QUEENSLAND TITLES REGISTRY PTY LTD [2022]
Requested by: D-ENQ CITEC CONFIRM

Current Title Search

Queensland Titles Registry Pty Ltd
ABN 23 648 568 101

Title Reference:	**51022094**	**Search Date:**	03/11/2022 14:35
Date Title Created:	19/01/2016	**Request No:**	42726002
Previous Title:	50544874, 50703346		

ESTATE AND LAND

Estate in Fee Simple

LOT 20 SURVEY PLAN 276924
Local Government: ISAAC

REGISTERED OWNER

Dealing No: 716980911 24/12/2015

FOXLEIGH LAND PTY LTD A.C.N. 088 327 226

EASEMENTS, ENCUMBRANCES AND INTERESTS

1. Rights and interests reserved to the Crown by
Deed of Grant No. 40022929 (Lot 5 on CP ROP23)
Deed of Grant No. 40023088 (Lot 4 on CP ROP188)

2. EASEMENT No 602798728 (A1242) 17/09/1981
burdening the land to
UTAH DEVELOPMENT COMPANY
OVER EASEMENT J ON PLAN ROP128

3. EASEMENT No 602798729 (A2221) 18/06/1987
burdening the land to
UTAH DEVELOPMENT COMPANY LIMITED
MITSUBISHI DEVELOPMENT PTY. LTD.
AUSTRALIAN MUTUAL PROVIDENT SOCIETY
UMAL CONSOLIDATED LIMITED
UTAH QUEENSLAND COAL LIMITED
UB MINERALS INC.
BOWEN BASIN MINERALS PROPRIETARY LIMITED
QCT INVESTMENT PTY. LTD.
QCT MINING PTY. LTD.
BELL COAL PTY. LTD.
PANCONTINENTAL MINING LIMITED
CAPRICORN COAL MANAGEMENT PTY. LTD.
OVER EASEMENT J ON PLAN ROP128

4. EASEMENT No 704795162 30/05/2001 at 15:50
burdening the land to
LOT 15 ON SP128608
OVER EASEMENT B ON SP128608

5. EASEMENT No 704795165 30/05/2001 at 15:51
benefiting
PART OF THE LAND
FORMERLY LOT 16 ON SP128608
OVER EASEMENT A ON SP128608

6. EASEMENT No 704873395 04/07/2001 at 15:51
benefiting part of the land
FORMERLY LOT 16 ON SP128608
EASEMENTS C,D AND E ON SP138787

7. AMENDMENT No 704873402 04/07/2001 at 15:53
EASEMENT: 704873395

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Requested by: D-ENQ CITEC CONFIRM

EASEMENTS, ENCUMBRANCES AND INTERESTS (Continued)

8. EASEMENT No 704873398 04/07/2001 at 15:52
benefiting part of the land
FORMERLY LOT 16 ON SP128608
EASEMENT A ON SP138787

9. AMENDMENT No 704873405 04/07/2001 at 15:53
EASEMENT: 704873398

10. EASEMENT No 709480729 30/03/2006 at 11:57
benefiting
PART OF THE LAND
FORMERLY LOT 16 ON SP181611
OVER EASEMENT B ON SP178461

11. EASEMENT No 709965025 26/09/2006 at 09:24
benefiting
PART OF THE LAND
FORMERLY LOT 16 ON SP181611
OVER EASEMENT D ON SP178463

12. EASEMENT No 710747958 25/06/2007 at 16:17
benefiting
PART OF THE LAND FORMERLY
LOT 16 ON SP181611
EASEMENT B ON SP189252

13. EASEMENT No 710747969 25/06/2007 at 16:19
benefiting
PART OF THE LAND FORMERLY
LOT 16 ON SP181611
EASEMENT C ON SP189253

14. EASEMENT No 710747979 25/06/2007 at 16:21
benefiting
PART OF THE LAND FORMERLY
LOT 16 ON SP181611
EASEMENTS F AND G ON SP189254

15. EASEMENT No 711410608 08/02/2008 at 15:01
benefiting
PART OF THE LAND FORMERLY
LOT 6 ON SP189240
EASEMENT C ON SP193685

16. EASEMENT No 716121516 05/11/2014 at 12:49
burdening the land to
LOT 15 ON SP178417 OVER
EASEMENT Y ON SP256884

17. EASEMENT No 716121517 05/11/2014 at 12:50
burdening the land to
LOT 15 ON SP178417 OVER
EASEMENT S ON SP256884

18. EASEMENT No 716121524 05/11/2014 at 12:50
burdening the land to
LOT 15 ON SP178417 OVER
EASEMENTS U, V, W, X, ON SP256884

ADMINISTRATIVE ADVICES

Dealing	Type	Lodgement Date	Status
709456068	VEG NOTICE VEGETATION MANAGEMENT ACT 1999	22/03/2006 10:13	CURRENT
713748239	VEG NOTICE VEGETATION MANAGEMENT ACT 1999	08/03/2011 12:22	CURRENT

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Queensland Titles Registry Pty Ltd
ABN 23 648 568 101

Title Reference: 51022094

ADMINISTRATIVE ADVICES (Continued)

Dealing	Type	Lodgement Date	Status
721788936	VEG NOTICE VEGETATION MANAGEMENT ACT 1999	24/06/2022 16:11	CURRENT

UNREGISTERED DEALINGS

NIL

Caution - Charges do not necessarily appear in order of priority

** End of Current Title Search **

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Requested by: D-ENQ CITEC CONFIRM

Current Title Search

Queensland Titles Registry Pty Ltd
ABN 23 648 568 101

Title Reference:	**51022093**	**Search Date:**	03/11/2022 14:35
Date Title Created:	19/01/2016	**Request No:**	42726004
Previous Title:	50544874		

ESTATE AND LAND

Estate in Fee Simple

LOT 19 SURVEY PLAN 276924
Local Government: ISAAC

REGISTERED OWNER — INTEREST

Dealing No: 721140275 01/10/2021

GREGORY WILLIAM SMALL	1/2
BRIAN JAMES SMALL	1/2

AS TENANTS IN COMMON

EASEMENTS, ENCUMBRANCES AND INTERESTS

1. Rights and interests reserved to the Crown by
Deed of Grant No. 40022929 (Lot 5 on CP ROP23)

2. EASEMENT No 602798728 (A1242) 17/09/1981
burdening the land to
UTAH DEVELOPMENT COMPANY
OVER EASEMENT J ON PLAN ROP128

3. EASEMENT No 602798729 (A2221) 18/06/1987
burdening the land to
UTAH DEVELOPMENT COMPANY LIMITED
MITSUBISHI DEVELOPMENT PTY. LTD.
AUSTRALIAN MUTUAL PROVIDENT SOCIETY
UMAL CONSOLIDATED LIMITED
UTAH QUEENSLAND COAL LIMITED
UB MINERALS INC.
BOWEN BASIN MINERALS PROPRIETARY LIMITED
QCT INVESTMENT PTY. LTD.
QCT MINING PTY. LTD.
BELL COAL PTY. LTD.
PANCONTINENTAL MINING LIMITED
CAPRICORN COAL MANAGEMENT PTY. LTD.
OVER EASEMENT J ON PLAN ROP128

4. EASEMENT No 704795162 30/05/2001 at 15:50
benefiting
PART OF THE LAND FORMERLY
LOT 15 ON SP128608
OVER EASEMENT B ON SP128608

5. EASEMENT No 709965025 26/09/2006 at 09:24
burdening the land to
LOT 16 ON SP181611
OVER EASEMENT D ON SP178463

6. EASEMENT No 711410608 08/02/2008 at 15:01
burdening the land to
LOT 6 ON SP189240 OVER
EASEMENT C ON SP193685

COPYRIGHT QUEENSLAND TITLES REGISTRY PTY LTD [2022]
Requested by: D-ENQ CITEC CONFIRM

Queensland Titles Registry Pty Ltd
ABN 23 648 568 101

Title Reference: 51022093

EASEMENTS, ENCUMBRANCES AND INTERESTS (Continued)

7. EASEMENT No 716121516 05/11/2014 at 12:49
benefiting the land over
EASEMENT Y ON SP256884

8. EASEMENT No 716121517 05/11/2014 at 12:50
benefiting
EASEMENT S ON SP256884

9. EASEMENT No 716121524 05/11/2014 at 12:50
benefiting the land over
EASEMENTS U, V, W, X, ON SP256884

10. EASEMENT No 720696574 01/04/2021 at 13:16
burdening the land to
LOT 11 ON CP TT443
LOT 1 ON SP150500
LOT 2 ON SP293509 AND
LOT 4 ON SP184275 OVER
EASEMENT O ON SP276928

ADMINISTRATIVE ADVICES

Dealing	Type	Lodgement Date	Status
713748239	VEG NOTICE VEGETATION MANAGEMENT ACT 1999	08/03/2011 12:22	CURRENT
720724153	CON COM AGMT MINERAL AND ENERGY RESOURCES (COMMON PROVISIONS) ACT 2014	15/04/2021 11:19	CURRENT
720724179	CON COM AGMT MINERAL AND ENERGY RESOURCES (COMMON PROVISIONS) ACT 2014	15/04/2021 11:20	CURRENT

UNREGISTERED DEALINGS

NIL

Caution - Charges do not necessarily appear in order of priority

** End of Current Title Search **

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Current Title Search

Queensland Titles Registry Pty Ltd
ABN 23 648 568 101

Title Reference:	**51122598**	**Search Date:**	03/11/2022 14:35
Date Title Created:	17/11/2017	**Request No:**	42726003
Previous Title:	40074369		

ESTATE AND LAND

Estate in Fee Simple

LOT 4 SURVEY PLAN 293492
Local Government: ISAAC

REGISTERED OWNER

Dealing No: 718403179 17/11/2017

FOXLEIGH LAND PTY LTD A.C.N. 088 327 226

EASEMENTS, ENCUMBRANCES AND INTERESTS

1. Rights and interests reserved to the Crown by
Deed of Grant No. 40023088 (Lot 4 on CP ROP188)

2. EASEMENT IN GROSS No 602798732 (A1165) 24/07/1978
burdening the land to
UTAH DEVELOPMENT COMPANY
OVER EASEMENT K ON PLAN ROP130

3. EASEMENT IN GROSS No 602798733 (A1698) 27/01/1984
burdening the land to
UTAH DEVELOPMENT COMPANY
CAPRICORN COAL MANAGEMENT PTY. LTD.
OVER EASEMENT K ON PLAN ROP130

4. EASEMENT No 704795165 30/05/2001 at 15:51
burdening the land to
LOT 16 ON SP128608
OVER EASEMENT A ON SP128608

5. EASEMENT No 709480729 30/03/2006 at 11:57
burdening the land to
LOT 16 ON SP181611
OVER EASEMENT B ON SP178461

6. EASEMENT IN GROSS No 710031652 19/10/2006 at 15:30
burdening the land
ERGON ENERGY CORPORATION LIMITED A.C.N. 087 646 062
over
EASEMENT E ON SP178460

ADMINISTRATIVE ADVICES

Dealing	Type	Lodgement Date	Status
711591051	VEG NOTICE VEGETATION MANAGEMENT ACT 1999	21/04/2008 08:46	CURRENT
717918481	CON COM AGMT MINERAL AND ENERGY RESOURCES (COMMON PROVISIONS) ACT 2014	24/03/2017 09:43	CURRENT
721353144	CON COM AGMT MINERAL AND ENERGY RESOURCES (COMMON PROVISIONS) ACT 2014	17/12/2021 11:17	CURRENT
721788936	VEG NOTICE VEGETATION MANAGEMENT ACT 1999	24/06/2022 16:11	CURRENT

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Queensland Titles Registry Pty Ltd
ABN 23 648 568 101

Title Reference: 51122598

UNREGISTERED DEALINGS

NIL

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721788936	VEG NOTICE VEGETATION MANAGEMENT ACT 1999	24/06/2022 16:11	CURRENT

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ABN 23 648 568 101

Title Reference: 51122598

UNREGISTERED DEALINGS

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[Form 1.3]

Title Reference:40074369

40074369

QUEENSLAND

DEED OF GRANT OF LAND

Land Act 1994

Elizabeth the Second, by the Grace of God, Queen of Australia, and Her other Realms and Territories, Head of the Commonwealth:-

TO ALL TO WHOM THESE PRESENTS SHALL COME, GREETING:

WE, with the advice of the Executive Council, under Section 358 and Section 109A of the Land Act 1994, grant in fee simple all that parcel of land described in Item 2 to the person described in Item 3,

SUBJECT TO the reservations and conditions specified, and such other reservations and conditions as may be contained in and declared by the laws of the State, and to the reservations and conditions as set out in Original Deed of Grant Reference 40023088 and Previous Title Reference 50896229.

IN TESTIMONY WHEREOF, WE have caused this OUR grant to be sealed with the Seal of the State of Queensland.

Witness our Trusty and Well-beloved His Excellency the Honourable Paul de Jersey, Companion of the Order of Australia, Governor in and over the State of Queensland and its Dependencies, in the Commonwealth of Australia, this 16th day of November in the 66th Year of Our Reign and in the year of Our Lord 2017

ITEM 1 - TERMINOLOGY

- 'The Act' means the *Land Act 1994* (Q), as amended from time to time and if that Act is repealed, any Act which replaces that Act
- 'Approval' means any approval, consent or permission required by law, including under the Act

ITEM 2 - PARTICULARS OF LAND

Lot /Plan
4/SP293492

Area: Surveyed 12080.0000 Ha.

Paul de Jersey

Note: For details of description, dimensions and marking of boundaries refer to plan mentioned above.

ITEM 3 - GRANTEE DETAILS

The holders of the Deed of Grant are to be recorded as:-

FOXLEIGH LAND PTY LTD ACN 088327226

Department of Natural Resources and Mines Reference: 2013/006669-6
Previous Title Reference: 50896229

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Current Title Search

Queensland Titles Registry Pty Ltd
ABN 23 648 568 101

Title Reference:	**50703346**	**Search Date:**	18/11/2022 17:35
Date Title Created:	25/01/2008	**Request No:**	42879560
Previous Title:	50356792, 50600143		

This title has been fully cancelled.

ADMINISTRATIVE ADVICES

NIL

UNREGISTERED DEALINGS

NIL

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Current Title Search

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Title Reference:	**50544874**	**Search Date:**	18/11/2022 17:35
Date Title Created:	10/03/2005	**Request No:**	42879559
Previous Title:	50356793		

This title has been fully cancelled.

ADMINISTRATIVE ADVICES

NIL

UNREGISTERED DEALINGS

NIL

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Requested by: D-ENQ CITEC CONFIRM

SITE INVESTIGATION QUESTIONNAIRE

Project:	Foxleigh Contaminated Land Guidance	Date:	23 November 2022
Client:	Foxleigh Management Pty Ltd	Client Representative:	Murray vanTienhoven
Site Address:	5498 Dysart Middlemount Road, Mackenzie River	Engeny Representative:	Rebecca Malaj

General	Response
Current owners and operators? Name? Activity?	CAML Resources Pty Ltd Level 12, 300 Queen Street BRISBANE CITY QLD 4000 Nippon Steel Australia Pty Ltd Level 14, 115 Pitt Street SYDNEY NSW 2000 Foxleigh Coal Pty Ltd Level 12, 300 Queen Street BRISBANE CITY QLD 4000 activity is metallurgical coal mining.
How long has the current operator been present at the site?	2016
Who were the previous operators if known and how long were they present?	Anglo American was the previous operator of the Foxleigh Mine.
What age are the buildings and when were they constructed?	Production commenced c. 1999, much of the site's buildings and infrastructure would be from this time.
What are the present and past uses of the buildings?	Offices, crib rooms, toilet facilities, warehouse and storage, cattle yards and dip, unoccupied homestead and other facilities. Homestead planned to be demolished/disposed of in Feb 2023.
What are the present and past uses of the site in general?	Livestock grazing initially, coal mining more recently, coal mining currently. Grazing has been ongoing on ML areas not impacted by mining.
Do any of the buildings contain Asbestos, Lead based paints, hazardous chemicals? If so in what quantities	Kenny's Farm is an unoccupied rural property that comprises an area within the mine footprint. There are two dwellings, a primary house and smaller granny flat, as well as three main ancillary structures, an external workshop area, a small metal shed and an external BBQ / entertaining area. These areas were part of a recent Hazardous Materials Assessment, and both dwellings were found to contain asbestos, with the main house also found to contain SMF. The ancillary structures were not found to contain any ACM or other hazardous material. All asbestos planned to be removed by licenced contractor in Feb 2023.
Can you provide a summary site plan of the historical location of activities at the site (if one is available to copy get a copy).	Map provided. 22---- Map Site.pdf In general, mining started from the south and has moved toward the north.
What activities are currently being carried out at the site?	Mining for metallurgical coal, drilling and blasting of overburden, removal and stockpiling of topsoil, rehabilitation earthworks, etc.
What activities were undertaken at the site prior to the current activities being undertaken?	Livestock grazing
Historically what activities/activity types have occurred at the site?	Livestock grazing, coal exploration and coal mining.

Describe and confirm the current condition of the site with regard to environmental spillages/environmental condition.	Foxleigh has progressively rehabilitated ~1500ha of disturbance since mining commenced. Hydrocarbon spillages are contained and disposed of in the coarse reject dump. Spills are recorded in the Regulated Waste Burial Register. (Regulated Waste Burial Register.xlsx)
Is there any history of contamination or spillages at the site?	Yes, recorded in Regulated Waste Burial Register
Are there any buried wastes/history of filling at the site?	Only waste burial records found are included in Regulated Waste Burial Register.
Are there any drains, creeks or other waterways for which the site discharges to? If so name them, details of the discharge location, frequency and volume, what is discharged and do they have a license to do so?	Discharge of Mine Affected Water can only be made from designated release points RP1, RP2 and RP3. RP1 and RP2 are situated to release into Cockatoo Creek (RP1 is upstream of RP2), whereas RP3 is situated to release into Roper Creek before the confluence of Roper Creek and Cockatoo Creek. RP2 is the only release point at Foxleigh that is available for use. RP2 releases through Cockatoo Ck Sediment Basin 1, works since 2020 have reduced catchment and installed pumping infrastructure so it is unlikely a release would occur. RP1 is located within an area of backfilled void and RP3 is located in Far South Pit which has not infrastructure set up to facilitate a release. Unable to find any records showing discharges from Foxleigh Mine.
Is stormwater currently segregated at the sites clean/from contaminated/mine affected water?	Water on site is managed under the site Water Management Plan and describes three types of water quality: - Clean surface water or non-mine-affected water - Erosion Sediment Control (ESC) water - Mine-Affected Water (MAW) ESC water is defined in the WMP, section 2.5 as, “rainfall runoff that has been in contact with disturbed areas such as topsoil stripped areas or freshly rehabilitated areas/establishing rehabilitation areas”. “Wherever possible, clean water is directed around the mining operations into natural systems. ESC water is directed and captured on site and managed via the *Erosion and Sediment Management Plan (ESMP)* or released as per EA conditions. MAW is contained on site in dams for use within the operations.”

Environmental Management	Response
Is the site listed on any statutory registers with regard to contamination past or present	Lots 19 and 20 on SP276924 are listed on the EMR as a result of division from Lot 6 on SP189240 for waste storage, treatment or disposal
Is there an aspects and impacts register at the site (either past or present) if so provide?	***Not sure what this is
Does the site operate under any existing environmental licences and permits? Are there any records of historical licences and permits available?	Environmental Authority EPML00744813 Environmental Authority EPPR00449613 Historical EAs have been previously provided.
What Licenses and permits are held by the facility (including notices and demands from environmental authorities relating to the operations or properties of the company, air, water, waste, sewer and discharge permits and licenses, chemical storage, air and water permits, development approvals etc.)?	**Permits & Licenses** EA0001014 - MDL3028 EPSX00841413 - EPC855 EPVX00716813 - EPC1139 EPML00744813 - ML70171 - ML70309 - ML70310 - ML70429 - ML70430 - ML70431 - ML70470 Water Licenses - WL103298 | Roper Creek - WL605014 | Carlo Creek - WL608515 | Cockatoo Creek
Has the site ever been non-compliant? If so when and how? Describe remedial action if known?	The last compliance report has been provided. EA Compliance Audit.zip
Are there any known records of compliance history with environmental permits including air, water, waste, and sewer permits under federal, state and local regulations?	A review of Fox Files was completed. Aside from the matters of concern letter that was received from DES last year after their pre-wet season inspection: There was an audit of the EA at the beginning of 2022 – there were several non-compliances and minor non-compliances.
What processes are in place to manage the environmental risks resulting from operation?	Site management plans and systems regarding mitigating, managing, and reducing risk and potential for environmental harm from operations: - Environmental Management System. - Biodiversity Offset Management Plan - Erosion and Sediment Management Plan - Groundwater Water Monitoring Management Plan - Noxious Weed Management Plan - Receiving Environment Monitoring Plan - Regulated Structures Operational Plan - Regulated Waste Management Plan - Rehabilitation Management Plan - Tailings Management Plan - Waste Rock and Spoil Disposal Management Plan - Water Management Plan Other processes include specific references in Standard Operating Procedures to hydrocarbon or chemical usage that considers the environment, especially with reference to spills and managing / mitigating their effects.
Have there been any environmental incidents at the site?	Request has been made to safety for an Environmental Incident report.

Water & Air Quality	Response

Is the site listed on any statutory registers with regard to contamination past or present	Regulated Waste Burial Register
Is there an aspects and impacts register at the site (either past or present) if so provide?	Not aware of an aspects and impacts register for Foxleigh
Does the site operate under any existing environmental licences and permits? Are there any records of historical licences and permits available?	Licences detailed previously in this document.
What Licenses and permits are held by the facility (including notices and demands from environmental authorities relating to the operations or properties of the company, air, water, waste, sewer and discharge permits and licenses, chemical storage, air and water permits, development approvals etc.)?	As above.
Has the site ever been non-compliant? If so when and how? Describe remedial action if known?	No evidence of non-compliance was found in a review of Fox Files.
Are there any known records of compliance history with environmental permits including air, water, waste, and sewer permits under federal, state and local regulations?	Records required by the EA are stored on Fox Files and updated as required.
What processes are in place to manage the environmental risks resulting from operation?	Site management plans and systems regarding mitigating, managing, and reducing risk and potential for environmental harm from operations: - Environmental Management System. - Biodiversity Offset Management Plan - Erosion and Sediment Management Plan - Groundwater Water Monitoring Management Plan - Noxious Weed Management Plan - Receiving Environment Monitoring Plan - Regulated Structures Operational Plan - Regulated Waste Management Plan - Rehabilitation Management Plan - Tailings Management Plan - Waste Rock and Spoil Disposal Management Plan - Water Management Plan Other processes include specific references in Standard Operating Procedures to hydrocarbon or chemical usage that considers the environment, especially with reference to spills and managing / mitigating their effects.
Have there been any environmental incidents at the site?	Request has been made to safety for an Environmental Incident report.

Waste	Response
What type of waste and waste liquids are generated on site? Volume of waste generated and where is it disposed of?	<table><tr><th>Waste Type</th><th>Disposal</th></tr><tr><td>Coal rejects (coarse and fine) – volume is relative to coal volume processed though is in the kilotons at least.</td><td>Rejects dump (coarse) or tailings dam (fine).</td></tr><tr><td>Waste oil and greases – volume is relative to maintenance activities and scheduling / vehicle usage.</td><td>All waste oil and greases are taken offsite by the waste contractor.</td></tr><tr><td>Used tyres – volume is relative to servicing and vehicle usage.</td><td>Stockpiled in designated used tyre areas until a time when they can be / are needed to be disposed as per the Regulated Waste Management Plan.</td></tr></table>
How is the waste managed?	As per the Regulated Waste Management Plan.
Is any of the waste generated hazardous?	Hazardous waste is managed using a licenced waste contractor and disposed off site.
What control measures are in place to reduce waste?	There are recycling bins (large front-lifts as well as smaller wheelie bins) for recyclables, and there is also a program called lids for kids, where the plastic lids from water bottles are donated to be used to make prosthetics.
Who is responsible for the removal and disposal of waste? General or regulated waste? Is the waste disposal licensed by statutory agencies?	JJ's has been the waste contractor responsible for waste removal and disposal offsite – as of 3rd January 2023 Cleanaway will replace JJ's as the waste contractor and their responsibilities. General and regulated waste is removed from site. Any waste disposal that occurs on site is only by approval of select conditions that allow for the disposal of certain waste types within dumps – contractors that remove waste from site operate under their respective statutory approvals, guidelines, and obligations.

Hazardous Chemicals	Response
Are there any chemical substances, including hydrocarbons, stored onsite?	Yes.
If so, where are these located, are they in bunded designated areas, and where are the locations of any on-site and off-site hazardous waste disposal sites?	The coarse rejects dump is an area where coarse coal rejects from the CHPP process are disposed of; contaminated soil / ground material resulting from a hydrocarbon spill may be disposed of in this area. Tailings, or fine coal rejects, are sent to the tailings dam. No other contaminated hydrocarbon waste (i.e., old drums, oil filters) are permitted to be buried on site – they are disposed of in designated receptacles and removed by a waste contractor. There is a Using Hazardous Substances Standard Operating Procedure that instructs on how hazardous substances are to be used on site.
Are there designated chemical loading and unloading areas? If so where?	There is designated loading and unloading areas for bulk explosives and hydrocarbons. - Platinum Blasting reload yard is the location of the bulk explosives storage and loading into the Mobile Manufacturing Unit/s. - Diesel deliveries are transported to bulk tanks which service trucks then draw from to complete refuelling activities across the site. Light, medium and some heavy vehicles may fuel directly from these bulk tanks.;
Are spill kits present, inspected and maintained? Is there a spill kit schedule?	Spill kits are required in places which SOPs or Procedures identify the need or requirement (e.g., refuelling bays, maintenance / workshop areas, etc.). They are the responsibility of that department or group of operations to ensure the kits are complete.
Is there an up-to-date register of chemicals and hazardous materials available onsite, including emergency contact details?	The site uses Chemalert as a register for all chemicals on site.
Are you aware of any past or present underground or aboveground storage tanks located on or adjacent to the site?	Only bulk hydrocarbons (e.g., diesel, lubricants and greases, etc.) and explosives are or have been stored on site in above ground storage tanks.
If yes are they certified and have they undergone integrity testing?	Hydrocarbon storage tanks were purchased as compliant to AS1940. It is not known if integrity testing has been done on these storages in the past

Is there a history of spillages, leakages or accidents occurring at the site? If so what are they, when did they occur and are there records for them?	Incidents report has been requested by safety. Regulated waste disposal register has been provided.

Complaints and Incident Management	Response
Have there been any complaints in the past? Are there any ongoing complaints?	There is a complaints register that was created 22/02/2021 and was last updated 23/11/2021. There are no complaint records in the register.
How are the complaints managed?	As per condition A14 of the EA: "… must record all environmental complaints received about the mining activities including: - Name, address, and contact number for of the complainant - Time and date of complaint - Reasons for the complaint - Investigations undertaken - Conclusions formed - Actions taken to resolve the complaint - Any abatement measures implemented - Any person responsible for resolving the complaint"
Are the relevant details provided at the site entrance?	A sign indicating the operator is present at the entrance to the site access road.
How are/were incidents managed? How are they classified and dealt with? What is the formal process to report or notify incidents?	Incidents are managed using the Incident Reporting and Investigation Hazard Management Plan.
What records of complaints are kept and where?	All environmental complaints are to be recorded in a register that is kept on SharePoint.

Appendix R: EIS Statement Assessment

Environmental Impact Statement Assessment Report under the *Environmental Protection Act 1994* for the Foxleigh Plains Project

Proposed by Anglo Coal (Foxleigh) Pty Ltd, CAML Resources Pty Ltd and Nippon Steel Australia Pty Ltd

Prepared by: Statewide Environmental Assessments, Department of Environment and Heritage Protection

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July 2013

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1 Introduction

This report provides an evaluation of the environmental impact statement (EIS) process for the Foxleigh Plains Project (the project) according to Chapter 3 of the *Environmental Protection Act 1994* (EP Act). The project proponent is a joint venture originally comprised of CAML Resources Pty Ltd (60 per cent), Anglo Coal (Foxleigh) Pty Ltd (30 per cent) and at the time of the original application ICRA Foxleigh Pty Ltd. In 2012 ICRA was replaced by Nippon Steel Australia Pty Ltd (10 per cent).

The EIS process was initiated by an application made by the proponent on 8 March 2010 for approval to voluntarily prepare an EIS under the EP Act for the proposed expansion of the existing Foxleigh coal mine.

On 28 May 2010 the project was declared a controlled action (EPBC2010/5421) under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), the Commonwealth decided that the project was to be assessed through the EP Act EIS process under An Agreement Between the Commonwealth and the State of Queensland Under Section 45 of the *Environment Protection And Biodiversity Conservation Act 1999* Relating to Environmental Assessment (the bilateral agreement). The controlling provisions are listed threatened species and communities (sections 18 and 18A) (clearing of up to 2276ha of habitat for the threatened Squatter pigeon).

This EIS assessment report therefore contains an assessment of the significance of impacts of the project on the controlling provisions (refer to Chapter 4.13). A copy of this report will be given to the Commonwealth Environment Minister, who will decide whether to approve or refuse the controlled action under Part 9 of the EPBC Act.

The Department of Environment and Heritage Protection (EHP) as the administering authority, has coordinated the EIS process for project under the EP Act. This assessment report has been prepared pursuant to sections 58 and 59 of the EP Act. Section 58 of the EP Act lists the criteria that EHP must consider when preparing an EIS assessment report and Section 59 states that the content of the report must:

- address the adequacy of the EIS in addressing the final terms of reference (TOR)
- address the adequacy of the environmental management plan (EM plan)
- make recommendations about the suitability of the project
- recommend any conditions on which any approval required for the project may be given
- contain another matter prescribed under a regulation.

The purpose of this EIS assessment report is to:

- Provide an assessment of the project EIS documentation to complete the EIS process under Section 60 of the EP Act.
- Provide information for assessment of the project under the bilateral agreement for the purposes of the EPBC Act.

This report summarises the key issues associated with the potentially adverse and beneficial environmental, economic and social impacts of the project. It discusses the management, monitoring, planning and other measures proposed to minimise any adverse environmental impacts of the project. It notes those issues of particular concern that were either unresolved or require specific conditions in order for the project to proceed.

The giving of this report to the proponent will complete the EIS process under the EP Act.

2 Project description

The project is an expansion of the current Foxleigh Mine that would increase run of mine (ROM) production to four million tonnes per annum (Mtpa), generate 3.2Mtpa of product coal and increase the life of the mine by up to 15 years. The development of the project would require the proponent to apply for an amendment of its environmental authority (EA)(MIN100734308) for the existing Foxleigh open cut mine. The EIS initially proposed to include Foxleigh Area 4, however that element of the project was later withdrawn from the EIS process to be advanced in another process. There are co-development agreements being drafted with separate parties for the purpose of accessing the gas resources across the project site. Those agreements are not finalised but the EIS stated that they will be executed at the time of determining the mining lease applications (MLA) for this project. The EIS did not include an assessment of potential actions under co-development arrangements.

2.1 Site description

The project site comprises three MLA areas (MLA 70429, MLA 70430 and MLA 70431) which cover approximately 3900ha across two separate pastoral properties. The northern boundary of the project site is located approximately 5.3km south-east of the township of Middlemount. The project site adjoins the existing Foxleigh Mine site to the south and is surrounded by grazing land to the north, west and east. The project site is in the Isaac Regional Council (IRC) area.

The project site is generally flat to undulating and is traversed by two ephemeral creeks, Cockatoo Creek in the east and Roper Creek in the west. Much of the project site has been cleared in the past for grazing, although there are areas of remnant woodland vegetation remaining, particularly along Cockatoo Creek and other drainage lines. The project site is currently used for beef cattle grazing and is surrounded by other mining operations and pastoral properties.

The majority of the land within the project site forms part of grazing properties owned by two private landowners. There are smaller parcels of land within the project site owned by the following entities: the IRC, Ergon Energy Corporation Ltd, Arrow Energy Pty Ltd and AGL Energy Ltd (for the proposed Central Queensland gas pipeline), and BHP Coal Pty Ltd and partners (for the Bingegang Weir water pipeline).

The Foxleigh Plains Project site is traversed by two roads, namely the Barwon Park–Middlemount Road and the Foxleigh Road. A water pipeline, an electricity transmission line, access tracks and the approved route for the Central Queensland gas pipeline traverse the project site. The EIS states that roads, a stock route and possibly the water pipeline will require realignment as a result of the project; however the EIS does not consider the potential impacts of those unresolved actions.

The project would involve expansion of the existing Foxleigh open cut mining operations, through development of new mining areas referred to as Foxleigh Plains and Eagles Nest. Coal would be extracted using truck and shovel mining methods similar to the mining methods at the existing Foxleigh Mine. An additional workforce of 90 employees would be required during project operations.

The project would involve the following activities:

- Clearing of any vegetation
- Stripping and stockpiling of topsoil
- Drilling and blasting of overburden
- Overburden removal using truck and shovel
- Coal mining using truck and shovel
- Progressive rehabilitation of overburden emplacement areas.

The project would make use of the current Foxleigh Mine infrastructure for processing and exporting coal, however new facilities and infrastructure would be required on site including:

- a mine industrial area (MIA)
- ROM coal stockpiles
- mine access and haul roads
- development of open cut pits and overburden emplacement areas
- water and flood management infrastructure.

Coal would be hauled by truck from the open cut pits to the existing Foxleigh coal handling and preparation plant (CHPP). The existing CHPP has sufficient capacity for 4Mtpa of ROM so no upgrade would be required. Rejects from the CHPP would continue to be stored in pit voids. Tailings generated by the CHPP would continue to be pumped via pipeline to the existing in-pit tailings storage within the existing Foxleigh Mine site (at ML70171).

Approximately 3.2Mtpa of product coal would be transported from the CHPP to the train load out facility at German Creek Mine, via an existing privately owned haul road. The train load out facility has sufficient capacity to load product coal from the expanded operations, no upgrading of this facility would be required. Coal would be transported by rail to Dalrymple Bay Coal Terminal (DBCT) for export. The EIS states that the current rail and port agreements allow for the product coal to be transported without the need for upgrades to either rail or port infrastructure.

The project would require an approximately 4.5km long diversion of Cockatoo Creek and the construction of two flood protection levees to minimise the risk of pit flooding.

The Foxleigh Plains pit would be approximately 700m wide with a total length of approximately 7km. This pit would be mined in blocks ranging from approximately 630–920m in length. Pit depth would average approximately 150m. The two Eagles Nest pits would each be approximately 750m wide with a total length of approximately 4.2km. These pits would be mined in blocks ranging from approximately 600–980m in length. Pit depths would average approximately 150m. Three final voids of approximately 150m depth would remain at the end of operations.

Each 4Mtpa of ROM extracted would require approximately 100Mtpa of overburden to be mined and generate 0.5Mtpa of coarse rejects, 0.15Mm^3pa of tailings and approximately 3.2Mtpa of product coal.

The project would require approximately:

- 22.8GWhpa of electrical power, supplied via the existing Foxleigh mine 11Kv transmission line
- 24.75MLpa of diesel provided under contract and stored and used on site
- 2GLpa of external raw water provided by Sunwater through the Bingegang Weir pipeline
- 90MLpa of potable water provided under contract.

The proposed project would operate 24 hours per day 7 days per week and require a 15-year operation phase. A decommissioning phase will commence at year 16 and continue till an unspecified completion date.

The EIS stated that the project will target mainly the Middlemount seam within the Rangal Coal Measures, but also recover coals from the Pisces, Tralee and Roper seams when economic. The EIS states that the principal economic driver in deciding what seams to recover was ash content and the ability to wash the coal sufficiently to generate a suitable product.

3 The EIS process

3.1 Timeline

The EIS process was initiated by the proponent applying to EHP for approval to prepare a voluntary EIS under Section 70 of the EP Act. That application was received on 8 March 2010 and approved on 9 March 2010. The proponent submitted draft TOR on 23 March 2010. EHP reviewed the draft TOR and advised the proponent on 23 March 2010 that the draft TOR were not sufficient to allow the purposes of the EIS to be achieved and were not suitable for public notification. The proponent amended and re-submitted the draft TOR in June 2010. On 18 June 2010 EHP notified the proponent of its decision to publish the draft TOR in: *The Courier-Mail* on Saturday 19 June 2010; the Miners Midweek on Wednesday 23 June 2010; and the *Central Queensland News* on Wednesday 23 June 2010. Copies of the draft TOR were circulated to all advisory bodies. The comment period for the draft TOR extended from Monday 21 June 2010, until close of business on Friday 30 July 2010.

EHP received comments on the draft TOR from 13 advisory bodies/stakeholders during the comment period and three after the comment period ended. All comments, together with those provided by EHP itself, were forwarded to the proponent on 16 August 2010. EHP finalised the TOR on 7 October 2010, taking into account all comments and the proponent's response to those comments.

On 30 November 2011, EHP met with the proponent to discuss a potential amendment to the proposed EIS. The proponent requested that the portion of land referred to as the Foxleigh Area 4 MLA be excised from the EIS application. EHP agreed to this request and the TOR were subsequently amended (16 January 2012) to reflect the change to the project. The proponent also amended the Initial Advice Statement (IAS).

At that time the joint venture nominated as the proponent was modified to include Nippon Steel Australia Pty Ltd replacing ICRA Foxleigh Pty Ltd as included in the original application.

Because the change to the project would not result in any additional significant environmental impact, EHP did not consider it necessary to readvertise the amended TOR. Both the amended versions of the TOR and IAS were uploaded to EHP's website on 7 February 2012.

On 5 April 2012, the proponent submitted a draft EIS for EHP review. EHP compared the draft EIS to the final TOR and, on 9 May 2012, decided to allow the EIS to proceed. On 23 May 2012, EHP issued a notice of that decision to the proponent. The public submission period for the EIS was set at 30 business days, starting on Monday 4 June 2012 and continuing until close of business on Monday 16 July 2012.

EHP publicly notified the start of the submission period for the EIS on its website on Monday 4 June 2012, and the proponent publicly notified in the *Central Queensland News* on Friday 1 June 2012 and *The Australian* and *The Courier-Mail* on Saturday 2 June 2012. The proponent also provided copies of the public notice of the EIS to affected and interested persons.

EHP received 14 submissions on the EIS within the submission period. These included 10 submissions from state government departments and agencies, the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (SEWPaC), the Mackay Regional Council, the Mackay Conservation Group, the Fitzroy Basin Association and the Capricorn Conservation Council. All 14 submissions were accepted in accordance with Section 55 of the EP Act. The submissions, together with a submission from EHP were forwarded to the proponent on 30 July 2012 for consideration and response.

The proponent was then required to provide a supplementary report (SEIS) responding to those submissions by 28 August 2012. On 23 August 2012 the proponent sought an extension of time to submit the SEIS by 9 October 2012. On 28 August 2012 that extension was agreed to under Section 56(3)(b) of the EP Act.

On 8 October 2012 the proponent sought a second extension of time to submit the SEIS by 15 November 2012. On 28 August 2012 that extension was agreed to under Section 56(3)(b) of the EP Act.

On 15 November 2012 the proponent provided a SEIS that included a response to submissions and an amended environmental management plan (EM plan). Copies of the SEIS were distributed for review to those advisory bodies/submitters who had made a submission on the EIS.

Reviewers advised EHP that there was a range of outstanding matters not adequately resolved by the SEIS. Consequently the proponent requested an extension to the EIS decision period in order to address the outstanding matters prior to EHP making a decision on the suitability of the EIS under Section 56A. That request was granted by EHP and (under Section 555 of the EP Act) a new decision date set at 25 February 2013, on the condition that the proponent would provide the outstanding information by 25 January 2013.

On 23 January 2013 the proponent made a second request to extend that time, proposing to submit the additional information by 22 February 2013. On 24 January 2013, EHP again agreed under Section 555 to extend its decision

period until 22 March 2013, on the condition that the proponent would provide the additional information by 22 February 2013.

On 20 February 2013, the proponent made a third request to extend that time, proposing to submit the additional information by 5 April 2013. On 21 February 2013 EHP agreed under Section 555 to extend its decision period until 6 May 2013, on the condition that the proponent would provide the additional information by 5 April 2013.

On 5 April 2013, the proponent provided the additional information and EHP circulated it to all advisory bodies/submitters having outstanding concerns. Taking account of responses, on 6 May 2013 a decision under S56A was made that the EIS could proceed under Division 5 (EIS assessment report) and Division 6 (Completion of process) of the EP Act. That decision was made on the basis that, while there were still some unresolved matters, those matters could suitably be addressed either prior to the granting of an EA for the project or otherwise within the decision making period for the EPBC decision for the project. Outstanding matters are specifically discussed in further chapters of this report. A notice of the decision to allow the submitted EIS to proceed was issued to the proponent on 20 May 2013.

In the preparation of this EIS assessment report, EHP considered submissions and comments from members of the advisory body (refer Chapter 3.3.2 for advisory body constituents) and other submitters made at all stages of the EIS process. The EIS assessment report will be made available on EHP's website (www.ehp.qld.gov.au).

3.2 Approvals

Development of the project would require an amendment under the EP Act to EA MIN100734308 for the existing Foxleigh Mine. The relevant environmentally relevant activities (ERAs) associated with the expansion are shown in Table 1—Project approvals, along with other approvals required for the project. The range of relevant ERA's has changed since the EIS was originally prepared because of amendments to the EP Act and regulations, only current ERA's are listed here.

Table 1—Project approvals

Approval	Legislation (administering authority)
Environmental authority (mining activities) inclusive of environmentally relevant activities for: Drilling, costeaning, pitting or carrying out geological surveys causing significant disturbance (ERA 1), Mining black coal (ERA 5), Chemical storage (ERA 8), Fuel burning (ERA 15), Surface coating (ERA 38), Regulated waste storage (ERA 56), Waste disposal (ERA 60) and Sewage treatment (ERA 63).	*Environmental Protection Act 1994* (Department of Environment and Heritage Protection)
Plan of Operations	*Environmental Protection Act 1994* (Department of Environment and Heritage Protection)
Mining Leases (MLA 70429, MLA 70430 and MLA 70431 for mining and infrastructure)	*Mineral Resources Act 1989* (Department of Natural Resources and Mines)
Cultural Heritage Management Plan	*Aboriginal Cultural Heritage Act 2003* (Department of Natural Resources and Mines)
Diversion of Cockatoo Creek.	*Water Act 2000* (Department of Natural Resources and Mines)
Approval to undertake action that may impact on a matter of national environmental significance (nationally listed threatened species and ecological communities)	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth Department of Sustainability, Environment, Water, Population and Communities)
Exemption for removal of least concern species	*Nature Conservation Act 1992* (Department of Agriculture, Fisheries and Forestry)

Note: Table 1 does not necessarily list all legislative approvals required.

3.3 Consultation program

3.3.1 Public consultation

In addition to the statutory requirements for advertising of the TOR and EIS and providing written notification to interested and affected parties, the proponent consulted members of the public and held meetings in Brisbane and the region during the public submission period of the EIS.

The proponent's EIS consultation process included the following phases:

- stakeholder identification
- issue scoping
- issue response and feedback.

3.3.2 Advisory body

EHP invited the following organisations to assist in the assessment of the TOR and EIS by participating as members of the advisory body for the project EIS:

- former Department of Environment and Resource Management
- former Department of Housing
- former Department of Infrastructure and Planning
- former Department of Mines and Energy
- former Department of Primary Industries and Fisheries
- former Commonwealth Department of the Environment, Water, Heritage and the Arts
- former Department of Employment, Economic Development and Innovation
- former Queensland Rail
- former Treasury Department
- former Department of Communities
- Queensland Health
- Queensland Police Service
- Department of Community Safety
- Department of Transport and Main Roads
- Queensland Treasury and Trade
- Department of Aboriginal and Torres Strait Islander and Multicultural Affairs
- Department of Education Training and Employment
- Department of State Development, Infrastructure & Planning
- Department of Housing and Public Works
- Department of Agriculture, Fisheries and Forestry
- Department of Natural Resources and Mines
- Department of Science, Information Technology, Innovation and the Arts
- QR National/Aurizon
- Commonwealth Department of Sustainability, Environment, Water, Population and Communities
- Isaac Regional Council
- Mackay Regional Council
- Capricorn Conservation Council
- Fitzroy Basin Association

- Mackay Conservation Group Inc.
- SunWater
- Ergon Energy
- Construction, Forestry, Mining & Energy Union
- Southern Barada Barna & Kabalbara (SBK) People
- Mackay and Whitsunday Bird Observation and Conservation Australia.

Advisory body briefings were held in Middlemount on 12 June 2012 and in Brisbane on 19 June 2012.

3.3.2.1 Queensland Government changes

In accordance with the Public Service Departmental Arrangements Notice (No.1) 2012, numerous changes to the names and roles of Queensland Government departments became effective on 3 April 2012. A table of the changes of the departments relevant to this assessment is provided as Annexure A to assist in interpreting the pre- and post-name relationships.

3.3.3 Public notification

In accordance with the statutory requirements of the EP Act EIS process, public notices of the draft TOR and EIS were advertised in *The Courier-Mail*, the *Central Queensland News* and on EHP's website.

The draft TOR and EIS were placed on public display at the following locations during their respective public comment and submission periods:

- EHP website (draft TOR only)
- EHP business centre, Level 3, 400 George Street, Brisbane (draft TOR only)
- EHP office, 99 Hospital Road, Emerald
- Isaac Regional Council Library, Shopping Centre, Middlemount
- Anglo Coal (Foxleigh) Pty Ltd, Level 11, 201 Charlotte Street, Brisbane.

3.4 Matters considered in the EIS assessment report

Section 58 of the EP Act requires that an EIS assessment report consider the following matters:

- the final TOR for the EIS
- the submitted EIS (including the proponent's responses, addendum and amended EM plan)
- all properly made submissions and any other submissions accepted by the chief executive
- the standard criteria
- any other matter prescribed under a regulation.

These are addressed in the following subsections.

3.4.1 The final TOR

The final TOR, issued on 16 January 2011 and amended on 16 January 2012, were considered when preparing this EIS assessment report. Although compiled to include all the likely significant issues, the TOR stated that if other significant matters arose during the preparation of the EIS then such issues should be fully included. All such matters have been considered in the EIS assessment report.

3.4.2 The submitted EIS

An EIS was submitted in May 2012 and released for public submissions.

EHP accepted 14 submissions on the EIS from the following:

- Department of Aboriginal and Torres Strait Islander and Multicultural Affairs
- Department of Natural Resources and Mines
- Department of Energy and Water Supply

- Department of Transport and Main Roads
- Department of Community Safety
- Department of Housing and Public Works
- Department of Education, Training and Employment
- Commonwealth Department of Sustainability, Environment, Water, Population and Communities
- Department of State Development, Infrastructure and Planning
- Queensland Police Service
- Mackay Conservation Group
- Mackay Regional Council
- Fitzroy Basin Association
- Capricorn Conservation Council.

EHP also made its own submission on the EIS.

The proponent responded to those submissions and all submitters were given the opportunity to provide a follow-up response to EHP on their view of the suitability of the proponent's response to their submissions.

The proponent's initial response was not considered adequate, so an additional supplementary report was sought. That was distributed to stakeholders for assessment before the EIS was accepted as suitable to proceed.

The submitted EIS that is assessed here was therefore comprised of:

- the EIS that was made available for public submissions on 4 June 2012
- all properly made submissions
- responses to submissions and amendments to the EIS and draft Environmental Management Plan (supplementary reports) received on 15 November 2012 and 5 April 2013.

3.4.3 The standard criteria

Section 58 of the EP Act requires that, among other matters, the standard criteria listed in Schedule 3 of the EP Act must be considered when preparing the EIS assessment report. The department has considered the standard criteria when assessing the project.

3.4.4 Prescribed matters

Section 58 of the EP Act requires that the following prescribed matters, under the Environmental Protection Regulation 2008, are considered when making an environmental management decision for this project:

- Section 51, matters to be considered for environmental management decisions
- Section 52, conditions to be considered for environmental management decisions
- Section 53, matters to be considered for decisions imposing monitoring conditions
- Section 55, release of water or waste to land
- Section 56, release of water, other than stormwater, to surface water
- Section 57, release of stormwater
- Section 60, activity involving storing or moving bulk material
- Section 62, activity involving acid-producing rock
- Section 64, activity involving indirect release of contaminants to groundwater.

3.4.5 Notifiable activities

The EIS identified and listed notifiable activities that would apply to the project under schedule 3 of the EP Act. Those activities are:

- Notifiable activity 1 - Abrasive blasting
- Notifiable activity 6 - Chemical manufacture or formulation
- Notifiable activity 7 - Chemical storage
- Notifiable activity 14 - Engine reconditioning works
- Notifiable activity 23 - Metal treatment or coating
- Notifiable activity 24 - Mine wastes
- Notifiable activity 29 - Petroleum product or oil storage.

The proponent is required to notify EHP of all notifiable activities so that impacted sites can be included on the Environmental Management Register (EMR) or the Contaminated Lands Register (CLR). The identified notifiable activities should be clearly listed in the EM plan. Land contamination is discussed in more detail in Chapter 4.5.5.

3.5 Environment Protection and Biodiversity Conservation Act 1999

On 29 March 2010, the proponent referred the project to the Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) in accordance with the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). On 28 May 2010, SEWPaC determined the project to be a controlled action pursuant to Section 75 of the EPBC Act. The relevant controlling provisions related to listed threatened species and ecological communities (Sections 18 and 18A of the EPBC Act). The decision included that the project has the potential to impact matters of national environmental significance (MNES) as it would involve the clearing of up to 2,276 ha of suitable habitat for the nationally threatened Squatter Pigeon (*Geophaps scripta scripta*).

MNES are further discussed in Chapter 4.13 of this EIS assessment report.

This EIS process is accredited for the assessment under Part 8 of the EPBC Act in accordance with the bilateral agreement. SEWPaC was included as an advisory body for the assessment of the project and provided its comments on the draft TOR and EIS documents. A copy of this EIS assessment report will be given to the Commonwealth Environment Minister to assist in making a decision on the project under the EPBC Act.

4 Adequacy of the EIS in addressing the TOR

4.1 Introduction

The EIS provided an adequate introduction to the project, its objectives and scope. It also adequately identified the necessary approvals and outlined the assessment and approvals process.

4.2 Project need and alternatives

This section of the EIS adequately described the project need and alternatives and briefly outlined its social, economic and environmental benefits and costs, which were also addressed in more detail in later sections of the EIS. Alternatives were discussed, including alternative resources and feasible mining methods and the advantages of the preferred (open cut) method. The EIS stated that underground mining was unsuitable due to the steeply dipping and variable thickness of the target coal seams and the presence of complex faults.

The positive and negative impacts, appropriate mitigation and management measures and environmental protection commitments of the project were addressed in later sections of the EIS.

4.3 Project description

The EIS adequately described the location, scope and schedule for the project. The EIS included a detailed discussion of the geology, resource utilisation and mine infrastructure. A brief outline of the project as reported in the EIS is provided in Chapter 2 of this report.

4.4 Climate

The EIS suitably described the local sub-tropical climate of the site. The principal climatic aspects were the effect of extremely variable seasonal rainfall on water management on site and need for management measures to prevent the release of unauthorised contaminants from the site, flood protection levee design and the effect of wind on dust and noise. Climatic aspects that could affect the potential for environmental impacts and risks and the management of operations at the site were addressed in other chapters of the EIS.

4.5 Land

The EIS adequately described those aspects of the site and project related to the existing and proposed qualities and characteristics of the land. The following subsections summarise some of the conclusions.

4.5.1 Land disturbance

The project will result in significant land disturbance. Over approximately 2166ha of land will be directly disturbed by clearing activities associated with the project. The final landform will have significant impacts to the future use of the site, aspects of that issue are addressed in the following chapters.

4.5.2 Land use

The northern boundary of the project site is located approximately 5.3km south-east of the township of Middlemount. The project site adjoins the existing Foxleigh Mine site to the south and is surrounded by grazing land to the north, west and east. The project site is in the Isaac Regional Council (IRC) local government area and development is controlled by the provisions of the Broadsound Shire planning scheme. The project site and most of the surrounding land is zoned ‘rural’ under that scheme.

The majority of the land within the project site forms part of grazing properties owned by two private landowners. There are smaller parcels of land within the project site owned by the following entities: the IRC, Ergon Energy Corporation Ltd, Arrow Energy Pty Ltd and AGL Energy Ltd (for the proposed Central Queensland gas pipeline), and BHP Coal Pty Ltd and partners (for the Bingegang Weir water pipeline).

A stock route traverses the site. Much of the project site has been cleared for grazing, although there are areas of remnant woodland vegetation remaining, particularly along Cockatoo Creek and other drainage lines. The project site is currently used for beef cattle grazing and is surrounded by other mining operations and pastoral properties. EIS identified that there was no Strategic Cropping land on the site.

The project site is traversed by two roads, namely the Barwon Park–Middlemount Road and the Foxleigh Road. A water pipeline, an electricity transmission line, access tracks and the approved route for the Central Queensland

gas pipeline traverse the project site. The EIS stated that roads, a stock route and possibly the water pipeline will require realignment as a result of the project; however the EIS did not consider the potential impacts of those unresolved actions.

The region was historically dominated by cattle grazing, now coal mining is also regionally important. Middlemount is the closest town (~5km away) and Emerald the regional centre approximately 95km away, the EIS states that the project is compatible with existing land uses including the township of Middlemount and that for example dust and noise impacts will not have a significant impact on amenity at the town.

4.5.3 Soils and land suitability

The EIS did not suitably address some requirements relating to soils set out in the TOR. A number of matters (such as soil testing and mapping intensity, soil properties such as plant available water capacity, topsoil management plan and land suitability) were not fully resolved during the EIS process.

However the EIS included a commitment to complete the agreed scope of works, analysis and interpretation and to appropriately manage all soils encountered on the site if the operation proceeds.

Soil types and land suitability and agricultural land classes were assessed and the EIS determined that there were 12 soil types across the site and 1354ha of good quality agricultural land (Class C). The EIS states that the existing land suitability includes grazing and that the area is generally unsuitable for broadacre rainfed cropping.

Decommissioning strategies were not detailed in the EIS but a commitment was included that they would follow those for the existing Foxleigh Mine. Existing decommissioning strategies were stated to include demonstration of achieving site rehabilitation success criteria, bunding and fencing of high wall and end walls of final voids for safety purposes, reprofiling voids and ramps to be geotechnically stable, removal of infrastructure and reseeding MIA areas except where infrastructure deliberately remains for future land owners (for example roads).

4.5.3.1 Potential impacts

The EIS concluded that the risk of acid and saline runoff from overburden was low and would diminish further over time. Metal contents were found to be below relevant soil criteria and unlikely to present any significant rehabilitation or environmental issues. However, the EIS noted that overburden has lower organic content, poorer nutrient status, poorer structure and other properties adverse to vegetation growth, and concluded that the final landform would have an altered (reduced) capacity to support the original vegetation. Slope angles and lengths would be increased and this would result in an increased risk of soil erosion. Soil profiles and geotechnical stratigraphy would be altered resulting in lower quality material in the plant root zones. The EIS stated that overburden material would therefore require specific management to deliver rehabilitation outcomes.

Coal reject materials were similarly assessed and found to be low acid and low metal generating, however rejects would generate excess sulphate and salinity in runoff. Rehabilitation of tailings and rejects would require capping and finally topsoil dressing. There was no mention in the EIS of the success or practicality of this approach to presumably very moist and fine materials that may not dry or consolidate for extended periods of time.

The EIS stated that land suitability across the site would be degraded post-closure despite the proposed rehabilitation.

Post mining the area of good quality agricultural land (GQAL) will be reduced by 430ha and, after rehabilitation, land suitability generally would be degraded compared to pre mining case. The EIS stated that rehabilitated areas would support grazing apart from areas such as final voids, diversions, levees, and landform slopes which would all be unsuitable for pastoral activities. The EIS did not address the issue of grazing access to the significant areas of elevated landforms. The upper surfaces of those landforms may be confirmed as suitable for grazing but it appears that stock would not be able to access them as slopes are likely to create a barrier to stock movement. Consequently there are likely to be significant areas of the site that would effectively be unsuitable for grazing, despite their land suitability.

4.5.4 Resource utilisation

The project would target the Rangal coal measures and in particular the Middlemount seam, which is one of four seams in those measures. The EIS states that the seams are of variable thickness and that all are of economic interest. A summary of the Rangal coal measures at the project site is:

- Roper group between 0.5 and 1.8m thickness comprised of four seams at approximately 18m above the Middlemount seams.
- Middlemount group of average approximate thickness of 4.7m comprised of three seams at approximately 30m above the Tralee seams.

- Tralee group with two seams of average thickness of 4m at approximately 26m above the Pisces seams.
- Pisces group of two seams of average thickness of 3.2 .

The EIS described the site geology as a broad syncline that plunges and opens to the north, with the proposed mining areas based on the eastern and western limbs of that syncline. The project site coals include significant faulting and seam thickening and thinning, particularly in the eastern areas, and the EIS stated that typical seam thicknesses are hard to predict.

The EIS stated that additional close spaced drilling would be required to interpret and confirm the resource for the purposes of mine planning.

The EIS concluded that, based primarily on the Middlemount seam, the project would produce a high quality, mid-volatile pulverised coal injection (PCI) washed coal with an ash content of about 8.5 per cent. The Tralee seam in particular is stated to contain high ash content making washing to a suitable product less economic.

The EIS stated that the reserves have been calculated according to the JORC code and the estimated total resource across the four groups in the Rangal measures is 21.3Mt. A further blue sky estimate of 50Mt is included outside that JORC resource. The mine plan reserve presented in the EIS was 13.5Mt based on the pit and block plan, the EIS noted that the pit design would change as information was improved. Principal factors for resource utilisation were the stability of batters and the need for washing to reduce ash content in the final product.

The EIS stated that the Tralee and Pisces seams underlying the Middlemount seam would be sterilised where exploration data shows only the Middlemount seam would be economic for utilisation.

4.5.5 Land contamination

The EIS stated that a site history for the project was conducted and that the none of the project site was included on either the CLR nor the EMR, that there were no known contaminated sites on the site and no land uses relevant to contaminated land were identified for the site.

The range of notifiable activities proposed for the project were listed, including petroleum product or oil storage, mine wastes, metal treating or coating, engine reconditioning, chemical storage, chemical manufacture or formulation and abrasive blasting. The EIS noted that the currently 10 notifiable activities on the existing mine site would continue in order to support this project.

A range of actions to prevent the contamination of the site were included in the EIS and the EIS stated that after decommissioning the site would be in a condition that it would not be registered on the EMR/CLR and a long-term site management plan for contamination would not be required.

4.5.6 Landscape character and visual amenity

The EIS identified that the project would impact on residential amenity through dust, noise, odour and visual changes (profile of final landform and vegetation clearing) but concluded that none of those was likely to be significant.

The EIS included a visual impact assessment that considered the impacts of the project including screening of views, contrast between the project and landscape and the effects on views. The existing site was described as gently undulating with about 40m of vertical relief. The site includes two creeks and whilst predominantly cleared, does include vegetated stands of riparian vegetation mainly along Cockatoo Creek.

The local landscape is dominated by grazing land and some open cut mining operations. The main road is stated as being used for predominantly mining and agricultural traffic. The township of Middlemount was considered a sensitive visual receptor for the project and traffic on the Dysart-Middlemount road stated as a low sensitivity visual receptor.

The EIS noted that the post-mining landscape would change with the inclusion of the elevated landforms and the three final voids. The post mine landforms would include rehabilitated overburden piles revegetated primarily with grasses, and some smaller areas that would be planted with trees. The EIS states that the overburden emplacement features would be linear, with an approximately 30m maximum height, running parallel to the topographic trend for the area and that slopes would be controlled primarily for erosion purposes. The EIS committed to rehabilitation that would soften the landforms and ensure that they would not form conspicuous features.

The visual impact of the project was assessed as low due to the low relief of the landscape, low relief of the project (10m maximum for MIA and 40m maximum for the overburden emplacement areas) and screening by woodland vegetation that surrounds the town and some vegetation between the town and site. The EIS stated that mine lighting would not be visible from Middlemount other than a faint glow above the facilities.

A range of mitigation measures were proposed to minimise visual amenity impacts including limiting vegetation clearing, lighting design, selection of colours for infrastructure and progressive rehabilitation.

The preferred use of final voids was not specified and consequently the EIS did not identify conclusive management strategies for final void rehabilitation nor specify water quality objectives and drainage strategies. The EIS committed to preparing a final void report to resolve those matters.

4.6 Transport

4.6.1 Road

The EIS identified that the Barwon Park–Middlemount road would need to be realigned to the north however the environmental impacts of realignment of the road were not addressed in the EIS.

The EIS stated that the stock route that traverses the site (U408) would be managed to remain in operation across part of the mining lease and that an agreement would be established to manage that. No detail about that agreement was provided in the EIS.

4.6.2 Rail

The EIS stated that the project would utilise the existing Foxleigh Mine train load out facilities and rail loop for the loading and transport of product coal. These facilities have sufficient capacity to handle the predicted 3.2Mtpa of product coal from the project and would not require upgrading. Based on a typical coal train capacity of 9800t this would result in approximately 330 trains per year and an average of less than one additional train per day.

QR National/Aurizon was generally satisfied with the EIS, however has requested ongoing consultation on:

- dust control, particularly at the rail load out facility
- potential impacts of increased train movements on the rail system.

4.6.3 Port

The EIS stated that the preferred port for the export of the projects coal is Dalrymple Bay Coal Terminal (DBCT) and that DBCT is expected to reach a capacity of 85Mtpa following the completion of its expansion Stages 2 and 3. The EIS stated that the terminal currently has adequate rail, storage and shipping capacity to handle the 3.2Mtpa of product coal from this project.

4.6.4 Air

The EIS stated that no air services would be required by the project and that regional airport infrastructure and flights would not be impacted by the project.

4.7 Waste

The EIS stated that the project's environmental management objective for waste disposal would be to manage waste to avoid direct or indirect impacts to land, air and water. The EIS identified that the project's major sources of waste have the potential to cause impacts to the environment, including ecological processes and to human health and well-being if not appropriately managed.

4.7.1 Mine waste/waste rock and overburden

4.7.1.1 Overburden

Approximately 100Mt of waste rock and overburden would be generated each year to produce 4Mt of ROM coal. The waste is the consolidated and unconsolidated material including, topsoil strata that overlays the targeted coal resource. The EIS stated that overburden material would be generally alkaline, with low salinity, not acid-forming and therefore no acid mine drainage is expected from the overburden. The EIS stated that waste rock and overburden material is strongly sodic and likely to be prone to dispersion and unbalanced nutrient ratios, which may lead to macronutrient deficiencies and may influence the suitability of the material for use in revegetation and rehabilitation.

The EIS stated that during the operation of the Foxleigh Plains pit, overburden may be stored in an out-of-pit emplacement area, west of the Foxleigh Plains mining area. Subsequent mined overburden will be stored in in-pit emplacement areas. The EM plan did not set out a clear management regime for the disposal of potentially sodic

overburden.

4.7.1.2 Rejects and tailings

Approximately 0.5Mt of coarse rejects and 0.15Mm^3 of fine tailings would be generated per year, or 7.7Mt and 2.5Mm^3 respectively over the life of the project. Waste streams from the CHPP may produce poor quality saline and sulfate water runoff/seepage/leachate when placed. The EIS stated that coarse rejects may be blended with overburden for disposal or if not will be disposed with fine tailings within pits at the existing Foxleigh Mine area. The EIS stated that there is sufficient pit storage for those waste streams on the existing mine site.

4.7.2 Regulated waste

Regulated wastes generated by the project would include; hydrocarbon contaminated wastes/materials, batteries, tyres, spent fluorescent lighting tubes, ozone depleting substances, air conditioners, cleaning chemicals, vehicle wash down waters and detergents and paints and solvents from workshop activities.

The EIS adequately addressed the management of regulated waste generated by the project. The EIS committed that all regulated waste generated by the project would be segregated, stored and managed in accordance with relevant legislation and then collected and transport by an appropriately licensed contractor and disposed of or recycled at a waste management facility licensed to accept such waste.

4.7.3 Other waste

The EIS noted that the project would generate the following other waste streams:

- General waste including, timber and wooden pallets, green waste domestic, food scraps and non-recyclable plastics from crib rooms, office administration and workshops areas.
- Recyclable materials including, paper and cardboard, aluminium and steel cans, scrap metal from workshop, office administration areas and infrastructure maintenance.
- Green waste, including vegetation clearing from the development of the mine pits and associated infrastructure. Green waste would be either mulched, stockpiled in timber stacks to provide habitat or burnt.
- Sewage waste including sewage effluent and sewage sludge and residues from crib rooms and office administration areas.

4.7.4 Mitigation

The EIS included commitments to managing waste generated by the project in accordance with the waste management hierarchy (i.e. avoidance, reuse, recycling and disposal) and in accordance with relevant legislation including the Queensland Environmental Protection (Waste Management) Policy 2000 (EPP Waste).

The EIS committed to managing all waste so as to avoid any direct or indirect impacts on health and well-being of people and the environment on and surrounding the mine site, including a review of waste management practices on the mine site and keeping a register of hazardous material and their location on-site.

However the EIS did not provide a Waste Management Plan (WMP) for the project, nor a clear commitment to developing and implementing a WMP incorporating a program of best practice waste management including the ongoing assessment of cleaner production and waste management opportunities for the life of the project.

4.8 Water resources

4.8.1 Surface water

The project is located in the Mackenzie River catchment and the site is traversed by two ephemeral watercourses, Roper Creek and Cockatoo Creek. Roper Creek enters the Mackenzie River approximately 25km downstream from the project and this ultimately enters the Fitzroy River.

The Roper and Cockatoo Creek sub catchments to the downstream boundary of the project site are approximately 700 and 300km^2 respectively.

Environmental values for the surface waters were stated in the EIS as including human consumption and agricultural, industrial and recreational uses.

Water quality was assessed in the EIS as typical for lowland streams with slightly to moderately disturbed waters. Specifically the waters measured demonstrated low dissolved oxygen, high turbidity and high aluminium, though that was stated as typical of Fitzroy Basin conditions.

The EIS noted that numerous mines discharge to the watercourses and including the existing operation at Foxleigh. The monitoring data assessed was interpreted as generally meeting the ANZECC guideline levels for slightly to moderately disturbed ecosystems. There were significant differences between upstream and downstream sites for some parameters including pH, sulphate and EC. The differences were not well explained in the EIS but stated to be either natural or related to mine discharges.

The EIS stated that the primary mitigation of impacts to surface water would be achieved through:

- Internal drainage of mine affected areas to sedimentation dams or mine water storages.
- Segregation of unaffected water and its discharge off site.
- Sufficient storages for mine-affected water to minimise the need for controlled discharges.
- Integrated water management with the existing Foxleigh Mine.
- Minimising risk of controlled discharge through transfer of the mine affected water to other off site users.

4.8.2 Mine water management

The project would require additional water. Water management for the project would be integrated with the existing mine water management system. The EIS stated the principal strategies for water management would include minimisation of use of external raw water supply, minimise the risk of discharge of poor quality water and maximise the reuse of mine affected water. Water management on site would involve mine affected water, surface waters and externally supplied raw water. Mine affected water includes pit water, runoff from mine affected areas and process water including from the CHPP. Surface waters include in watercourses on site and runoff from rehabilitated and undisturbed areas.

The EIS stated that the tailings, overburden and waste rock from the site are acid consuming or non-acid forming and consequently runoff would not be acidic or contain dissolved metals. The diversion of waters around the mine areas and the storage of tailings in-pit with return of decant water for use as process water were stated as important parts of water management. Pit dewatering would be continual with mine affected water going to a range of in-pit and out-of-pit storages.

Excess water would be either transferred to adjacent mines or discharged to either Roper or Cockatoo Creeks under the EA for the existing operation. The maintenance of the existing discharge points at the existing operation was planned to allow for the management of any expansion related discharges to the same standard as the existing operation.

A raw water dam and ‘admin’ dam would accept raw water piped from Bingegang Weir. The existing raw water allocation is 980 megalitres per annum (MLpa) and an optional 309MLpa. An additional external allocation of 700MLpa raw water is stated as being necessary to adequately address the increased rate of production. The source of that water has not been confirmed, however a range of options including SunWater, adjacent mining operations and improved efficiencies were suggested in the EIS.

The EIS stated that overburden emplacement areas would be progressively rehabilitated, that rehabilitated areas would be drained offsite via sediment control devices and that active mine areas, unrehabilitated areas and ROM coal stockpile areas would drain to the pit.

Infrastructure areas would be segregated into internally draining to a dedicated MIA dam and for uncontaminated areas and roadways external drainage via sediment control devices.

Surface flows from undisturbed areas would be diverted to flow to natural drainage systems.

4.8.2.1 Water storages

A range of new water storages would be required over the life of the project including catch dams, highwall dams and a single MIA dam. The proposed integrated mine water management system is a complex network of pits, voids, existing dams and new storages. New storages would include:

- MIA dam from which water would be primarily used for dust suppression.
- Up to four highwall dams at any one stage and these would be moved as the project proceeds. Highwall dams would accept pit water and their water would be used for dust suppression.
- A minimum of three overburden catch dams at any stage. These would accept runoff from un-rehabilitated overburden emplacement areas. Their water would primarily be used for dust suppression.

An operational mine water simulation, including 121 years of rainfall data, was used in the EIS to assess water containment and water release needs, including regulatory compliance. It was noted that the average evaporation at the site was three times the long-term average rainfall.

The EIS committed to the design of the storages by a suitably experienced and qualified person in accord with the EHP guidelines and that all deigns would include that spills and dam break scenarios would drain to a pit void and that all storages individually would not exceed 25 ML capacity or embankment heights of 8m. The EIS stated storages would be considered 'low' hazard category structures and not require regulation. The design storage allowance (DSA) calculation for the project was based on the combined capacity of the integrated water management system, the EIS noted that some individual storages did not meet the DSA required.

The proposed conditions in the EM plan indicated that the hazard categories, design storage allowance and mandatory reporting levels are not yet determined. That level of detail will be required at the EA application stage by way of a finalised EM plan.

The EIS stated that modelling indicated a low probability of uncontrolled discharge under long term rainfall scenarios and that there was a high probability of operational continuity without compromising DSA requirements.

The existing raw water supply allocation was modelled to provide for 90 per cent operational reliability under the increased production proposed. An additional external allocation of 700MLpa raw water is stated as necessary to adequately address the increased production. The source of that water has not been confirmed however a range of options including Sunwater, adjacent mining operations and improved efficiencies were suggested in the EIS.

4.8.3 Water discharges

The EIS stated that controlled discharge of mine affected water from the project is unlikely. However it was noted that the existing operation has approval for three discharge locations and the proposal is to integrate the water management of the project with that of the existing mine. An option to prevent discharges proposed in the EIS is to truck or transfer excess water to other operations, though no information about the reality of that was provided. The maintenance of the three discharge points at the existing operation was stated in the EIS as allowing any expansion contribution to water discharge to be managed to the same standard as the existing operation.

Discharges to Roper and Cockatoo Creeks could occur from sediment dams and it appears from schematics provided in the EIS that an uncontrolled spill from the process water dam could reach Roper Creek via a sediment dam, though the potential for this has not been discussed in the EIS.

Secondary treated sewage effluent is currently irrigated on the existing mine site and the EIS proposed a continuation of this, or the introduction of a package treatment plant on the project site.

4.8.4 Water monitoring

The current monitoring includes four upstream and three downstream monitoring locations to be monitored daily during waste water releases. Monitoring of water in storages would be quarterly. Monitoring proposed in the EIS would be similar to the existing operational water quality monitoring program, including development/augmentation of the existing Receiving Environment Monitoring Plan (REMP), with amendments as required to incorporate the submissions received on the EIS. A commitment was made in the EIS that the REMP would be finalised as part of the EA process after completion of the EIS. A Water Management Plan must also be developed for the project, to indicate how operational management of water and potential contamination would be conducted and reviewed.

4.8.5 Diversion and flood protection levees

The EIS assessed the surface water aspects of the project including geomorphology, hydrology and hydraulics.

The project would require an approximately 4.5km long diversion of Cockatoo Creek (disturbance footprint of approximately 125ha), to the east of the mine pit, and construction of two flood protection levees - one for each watercourse, approximately 5km for Foxleigh Plains/Cockatoo Creek and approximately 2km for Eagles Nest/Roper Creek.

The focus of the design of the diversion, stated in the EIS, was in developing a self-sustaining waterway that would re-establish Cockatoo Creek, to not impact off-site reaches and to ensure designs were suitable in the modelled flood events.

The Foxleigh diversion was designed to have an upstream section of low flow channel section with a downstream series of pools with no defined channel. The upstream section would be low to moderate sinuosity to match the geomorphology of the off take point, the downstream channel widened to accommodate the loss of flood plain associated with the pit mining. The channel was stated to be 15–20m top with a base width of 5–8m in the initial reach narrowing to a low flow channel with base channel of 2–4m where present. Channel depth would be approximately 3–4m throughout. The diversion would be maintained as close to the mine (west as possible) to maximise the area of existing flood plain that lies to the east of the diversion. In two-year ARI events the pools and channel would overtop and an ARI 20-year event would fill most of the flood plain (out to a 1km wide flood plain in 2000 year ARI).

The design proposed generally increased stream energy levels from existing values of low to moderate in the diversion. Whilst the EIS stated that the conceptual design achieved guideline criteria, reviewers noted locations of the diversion that would exceed the appropriate guideline criteria. These were associated with the off-take (commencement of diversion) end of the modelled diversion, as there had been no attempt to transition either end of the diversion and the existing creek. The EIS acknowledged this and stated that a detailed design would be completed to achieve full compliance and consideration of mitigation such as armouring at a later date.

Levee design was at a conceptual level of detail in the EIS, including: using compacted earth embankments; that there was a need to confirm the suitability of material on site to construct them; and that depending on materials the design would change at a detailed design stage.

The Eagles Nest levee was proposed to be at a height to suit either 2000 year ARI plus 0.1m freeboard, or 1000 year ARI plus 0.5m free board. No level was provided in the EIS for the Foxleigh levee. Both levees were shown by modelling to be engaged at the 20 year ARI event. There was a commitment in the EIS that flood protection levels would be redefined per EHP hazard categories guidelines prior to construction.

Reviewers of the EIS identified that there are ongoing issues at the existing operation related to the highly erodible nature of the on-site materials used in existing flood and surface water diversion levees and cracking zones at the top of pit walls. The EIS committed to the future detailed design of the levees prior to construction, including development of design, construction operational and decommissioning plans to be certified by suitably qualified and experienced person to meet the requirements of the EA and EHP guidelines where relevant.

Detailed revegetation and stabilisation was not presented, but the EIS included a commitment to completing that work at the detailed design stage.

A monitoring program was proposed to address all stages, from pre mining until post closure, to show whether the diversion was operating as a waterway in equilibrium and not impacting adjoining reaches, however no monitoring details were provided. A commitment was made in the EIS to provide the diversion monitoring program as part of the water diversion licence application.

4.8.6 Groundwater

The EIS considered groundwater on the basis of exploration bore hole data, groundwater monitoring on site, EHP data and a review of the local use of groundwater resources. The EIS stated that, whilst the site contained some geology that resembled that of the Great Artesian Basin (GAB), the project would not impact on the GAB because the site was 70km from the GAB management area and the geology is discontinuous with the GAB formations. The project would require the excavation of the Cockatoo Creek flood plain and a diversion of Cockatoo Creek.

The groundwater conceptualisation model utilised to interpret potential impacts of the project stated that the site included a synclinal basin and series of faults that effectively isolated the groundwater of the site to the immediate Foxleigh mining operation.

The principal groundwater resource identified was within the Permian coal measures. This groundwater was described in the EIS as having high electrical conductivity (EC) ranging from 29000–45000µS/cm, interpreted as resulting from high residence time of the water in the coals and stated as not suitable for use in stock watering.

There was found to be sparse groundwater within the alluvial Tertiary and Quaternary sediments across the site and directly associated with the creeks traversing the sites. The EIS stated that groundwater in those alluvial sediments would be recharged by direct rainfall and would flow according to topographical gradients and surface flows. The EIS also stated that there were no bores in or extraction from this alluvial groundwater resource within 5km of the site.

Groundwater recharge of the coal measures was stated to occur in areas of sub cropping where the coal seams intersected alluvial sediments, particularly, the stream bed sediments. Flows would be downward and North-west to the centre of the synclinal basin and therefore away from the local watercourses of Roper and Cockatoo Creeks. The EIS stated this prediction was supported by the significantly higher EC of the coal measures groundwater than the surface waters of those creeks and other pools.

Three private groundwater bores were identified as accessing groundwater within the coal measure aquifer within 5km of the site. One was in use for stock watering, one not serviced and one unused due to poor water quality. The EIS reported that the relevant property owner has access to alternative water supplies and that significant groundwater extraction did not occur within the area of potential groundwater influence of the proposal.

A principal statement in the EIS was that coal seams would act as the preferred pathway for groundwater flows and that the groundwater within the proposed expansion was going to interact with the existing Foxleigh mining operation, however the impact of the proposal on groundwater would not extend off site because the site geology included a syncline and major faulting that contained the groundwater boundaries to the site. The project's cumulative impact would be limited to an existing lowering of the groundwater within that synclinal basin that

commenced with the existing mining operation. The EIS stated that the areas of drawdown of the groundwater through pit dewatering would be laterally limited and could interact with that from the existing operation however would be limited to the site by the geology. The EIS did not state the level of groundwater drawdown nor specify the actual lateral extent of predicted groundwater drawdown.

Surface flows and pools were found to be ephemeral on the project site and the EIS interpreted this as demonstrating that groundwater from the coal measures does not provide base flow to surface waters. Consequently the EIS predicted that the project would not impact on surface flows or groundwater dependant ecosystems.

The EIS stated that post-mining, the final voids would receive limited groundwater inflow given the basin and faults and the principal water inputs would be from direct rainfall. Impacts from runoff from overburden and other areas would be avoided through rehabilitation design and erosion and sedimentation controls. The geology of the site would also limit any flow of pit water including potential contaminants to groundwater off site.

Reviewers of the EIS including (DEWS and DNRM) identified that the greatest risk of groundwater impacts from the project would be associated with the excavations at the northern limit and as water rose in the final void that groundwater levels could rise in the connected down dip Rangal coal measures and that therefore groundwater impacts could migrate northward toward Middlemount.

A groundwater monitoring program was proposed in the EIS, primarily to confirm the expectations of impact as estimated in the EIS. The program would include the northern area of the site as that is the direction of dip of the syncline and that is the expected area of greatest risk of off-site impacts. The EIS included commitments that the proposed monitoring program would include assessments of:

- groundwater interactions with surface waters of Cockatoo Creek
- impacts on potential shallow alluvial stygofauna
- impacts on potential groundwater dependant ecosystems across the site
- the role of the Renwan formation and groundwater storage in associated sediments.

The monitoring program was not detailed in the EIS, however a commitment was provided to install four bores at three location, three with vibrating wire piezometers and one as a stand pipe. The EIS also gave a commitment that the proponent would commence monitoring pre-mining and to continue post-mining. Details of the monitoring program will be required by EHP prior to an EA being considered for the project.

4.9 Air quality

The EIS generally addressed the air quality matters raised in the TOR, including dust and greenhouse gas emissions.

The EIS stated that the local airshed was of high quality, compromised only infrequently, especially during periods of drought, by diffuse particulates and dust haze through pastoral operations and mining on surrounding land. Existing air pollution was mostly confined to dust. Prevailing winds at the Foxleigh Mine would be predominantly moderate (4–8m/s) and from a south-east to north-east direction.

The EIS stated that the nearest sensitive receptor was a residential area on the south-eastern fringe (centenary Drive East) in Middlemount, located approximately 5.3km north-west of the project site. Three rural residential properties are located closer to the project site: Tralee Homestead, located within the project site and the nearby Lake Lindsay Residence and Foxleigh Homestead. The EIS stated that legal agreements with the owners of these three properties were being negotiated. Therefore, these residences had not been included as sensitive receptors in the EIS.

4.9.1 Dust

The EIS identified particulate matter, i.e. dust, as the main potential air pollutant. Odour may be a potential issue associated with the existing sewage treatment plant on site, however the EIS stated that no odour complaints had been received to date regarding sewage odour and consequesntly odour was not expected to cause any unacceptable impacts.

The major sources of particulate emissions from the project would include:

- ROM coal excavation
- overburden blasting and transfer.

Wind erosion would be expected from:

- overburden and ROM coal stockpiles
- haul roads and through road grading
- the coal handling train load out facility.

Air quality modelling was undertaken for the worst-case dust impact scenario for year 10 (2022) based on:

- mining occurring simultaneously in the Foxleigh Plains and Eagles Nest pits
- operations in the Foxleigh Plains pit occurring in the north-west corner of the project site in closest proximity to Middlemount (5.3km)
- maximum surface area of unrehabilitated (exposed) overburden.

The EIS described how air modelling conducted for the proponent showed that unmitigated concentrations of both suspended particulates (i.e. particulate matter less than 2.5 micrometres and total suspended particulates) and deposited particulates would be within the Environmental Protection (Air) Policy 2008 (EPP Air) air quality objectives (except for PM10 modelled without any mitigation measures being applied). The model predicted that unmitigated PM10 concentrations would exceed the EPP Air by approximately four per cent on two occasions in year 10. However, the EIS proposed a number of dust mitigation measures, including a Dust Control Procedure (i.e. watering of exposed surfaces and minimising the area of exposed surfaces at any one time) and concluded that those measures would prevent EPP Air exceedances in Middlemount due to the mine. The EIS committed to the proponent conducting real-time dust monitoring of PM10 over the project life and to put corrective actions in place to prevent unacceptable dust nuisance.

The EIS identified an ambient air quality objective for this project as being five exceedances per year of the 24-hour PM10 concentrations (of 50 micrograms/cubic metre) and proposed a compliance limit of the sixth-highest 24-hour PM10 concentration at nearby sensitive receptors. The department cannot accept that proposal as it is based on standards applicable to bushfires, dust storms and fuel reduction burning for fire management. The proposal was considered to be inappropriate for the project in that it could reduce the level of protection for public health to an unacceptable level. PM10 emissions would be regulated in the EA by adopting the department's standard condition which prohibits exceedances of PM10 emissions of 50 micrograms per cubic metre (24-hour average) at any sensitive or commercial receptor.

4.9.2 Greenhouse gas

The EIS described how greenhouse gas (GHG) would be generated by the project. An assessment of GHG emissions was undertaken in accordance with the National Greenhouse and Energy Reporting Act 2007 (NGER Act) for each year of the life of the project. Greenhouse gas emission rates were estimated using the National Greenhouse Accounts Factors (Department of Climate Change and Energy Efficiency 2010).

The EIS stated that 183,605 tonnes CO2-e/year would be generated through the following sources:

- coal production fugitive emissions
- stationary combustion
- transport combustion
- additional stationary fuel consumption
- electricity.

The EIS committed to implementing the following measures for energy efficiency evaluation:

- selection of energy efficient motors
- adoption of a mining method that uses large equipment and economies of scale to significantly reduce GHG emissions
- extracting and transporting coal and overburden efficiently minimising the number of trips and fuel consumption
- recycling of refrigerants in equipment and air conditioning
- segregation of general waste into recycling materials and general waste
- minimising burning of vegetation
- development and maintenance of an inventory of emissions and sinks

- energy conservation and GHG audits with results compiled into annual progress reports.

Cumulative impacts may occur from the proposed Middlemount Coal Project, Stage 2, if both projects operated at the same time. The EIS stated that due to project locations, operational stages and proposed mitigation measures, cumulative impacts would be unlikely.

4.10 Noise and vibration

The EIS adequately addressed the noise and vibration matters raised in the TOR.

The EIS again stated that legal agreements were being negotiated with the owners of three nearby properties and that therefore, those residences had not been included as sensitive receptors in the EIS.

The EIS stated that the nearest sensitive receptor to the project site would be the residential area on the south-eastern edge of the township of Middlemount. Modelling of noise levels undertaken for the EIS concluded that the noise sensitive places would not be impacted by noise or vibration from the project at any time of day, evening or night.

Noise modelling including of blasting, low frequency noise and road and rail traffic concluded that all noise levels from the proposed mining operations would meet regulatory requirements. In order to minimise the impact of noise and vibration, the proponent committed to only undertake blasting during daylight hours.

Cumulative noise impacts, when assessed along with noise data and reporting from the Middlemount Coal Project was predicted to comply with regulatory requirements at all assessed sensitive receptors.

4.11 Ecology

The project site covers an area of approximately 3363ha located in the Northern Bowen Basin Province of the Brigalow Belt north Bioregion. The project site is generally flat to undulating and is traversed by the ephemeral Cockatoo Creek in the east and Roper Creek in the west. Much of the project site has been cleared in the past for grazing, however there are areas of remnant woodland vegetation remaining, particularly along Cockatoo Creek and other drainage lines. The site includes endangered Brigalow and Queensland Blue Gum regional ecosystems. There were no Category A environmentally sensitive areas identified on the site.

The project site is currently used for beef cattle grazing and is surrounded by other mining operations and pastoral properties. The site is traversed by two roads, a water pipeline, an electricity transmission line, access tracks and the approved route for the Central Queensland gas pipeline.

4.11.1 Flora

Much of the project site has been cleared previously for grazing. However, there are areas of remnant woodland vegetation remaining, particularly along Cockatoo Creek and other drainage lines. The EIS stated that the riparian vegetation along Cockatoo Creek is nearly continuous and provides habitat for fauna species and operates as a narrow fauna movement corridor. Vegetation was particularly fragmented to the south of the site.

Flora species identified on site included 168 native and 22 exotic species, of which six were declared State weeds. The identified vegetation was assessed as supporting a diverse range of vegetation communities including Brigalow, Poplar Box, Queensland Blue Gum, and Coolabah.

Vegetation communities identified on site are summarised as:

Vegetation Management status Endangered—156ha, Brigalow (*Acacia harpophylla*) dominant and co-dominant communities, including discrete areas of:

- Brigalow: RE 11.3.1 Open forest of *Acacia harpophylla* and/or *Casuarina cristata* on alluvial plains
- Brigalow: RE 11.4.8 *Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains
- Brigalow: RE 11.4.9 *Acacia harpophylla* shrubby open forest to woodland with *Terminalia oblongata* on Cainozoic clay plains
- Queensland Blue Gum: RE 11.5.17 *Eucalyptus tereticornis* woodland in depressions on Cainozoic sand plains/remnant surfaces
- Brigalow: RE 11.9.5 *A. harpophylla* and *C. cristata* open forest on fine-grained sedimentary rocks.

Vegetation Management status Of Concern—69.1ha, including:

- Poplar Box: RE 11.3.2 *Eucalyptus populnea* woodland on alluvial plains

- Coolabah: RE 11.3.3 *Eucalyptus coolabah* woodland on alluvial plains
- Queensland Blue Gum: RE 11.3.4 *Eucalyptus tereticornis* and /or *Eucalyptus spp.* tall woodland on alluvial plains.

Vegetation Management status Of Least Concern—135.5ha, including:

- Queensland Blue Gum: RE 11.3.25 and 11.3.25g *Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines
- Poplar Box: RE 11.5.3 *Eucalyptus populnea* and /or *Eucalyptus melanophloia spp* and /or *Corymbia clarksoniana* on Cainozoic sand plains/remnant surfaces.

Solanum elachophyllum, listed as endangered under the *Nature Conservation Act 1992* (NC Act), was found to be present in four populations across the site and assessed as being potentially present in other habitat on the site. The EIS stated that the project would not directly impact those identified species, however it would impact other areas of suitable habitat. *Cerbere dumicola, Desmodium macrocarpum* and *Paspalidium scabrifolium* listed as endangered under the NC Act were not identified in surveys and were all assessed as being of low likelihood of occurring on site.

The proportion of exotic species identified on site was stated as indicative of the high level of disturbance of the project site.

4.11.1.1 Potential impacts

The EIS stated that approximately 2166ha of vegetation would be cleared, including approximately 117.1ha of remnant vegetation and 79.8ha of high value regrowth (HVR) vegetation from within the project site. This represents 54.6 per cent and 54.5 per cent of the remnant and HVR vegetation within the project site, respectively.

Under the *Vegetation Management Act 1999* (VM Act) status, the project would require the removal of approximately 11.2ha of remnant Endangered vegetation, 12.3ha of remnant Of Concern vegetation and 93.6ha of remnant Least Concern vegetation within the project site.

The EIS stated that Cockatoo Creek provides a continuous vegetated corridor with substantial numbers of mature hollow bearing trees through the largely cleared, agricultural landscape. The diversion of an approximate 4km section of Cockatoo Creek and removal of all riparian vegetation would remove the habitat and cease the current fauna movement currently occurring within and beyond the project site through that corridor. The EIS stated that Cockatoo Creek is mapped in the EHP biodiversity planning assessments (BPA) mapping as a corridor of regional significance and that removal of the vegetation along Cockatoo Creek is likely to require an offset under the Biodiversity Offsets Policy as it is located within the stream protection zone and forms part of an important link in the landscape.

4.11.1.2 Mitigation

The following mitigation measures were proposed in the EIS to minimise potential impacts on vegetation within the Foxleigh Plains disturbance footprint:

- Clearing of vegetation would be undertaken in accordance with the requirements of the NC Act, including the development and implementation of a Species Management Program. The Species Management Program would outline actions to be taken to minimise impacts on animal breeding places and would be submitted to EHP for approval. The program would include prescriptions on the nature and duration of pre-clearing translocation surveys as well as measures to be employed during clearing activities such as direction of clearing, management of habitat trees, etc. The Species Management Program would also describe the role of a spotter catcher and the necessary permits for any relocation of fauna (e.g. Rehabilitation Permit or Damage Mitigation Permit).
- The EIS and draft EM plan outlined the management strategies to be implemented during the construction and operation of the mine to minimise the impact on remnant vegetation, including minimising the area to be cleared for the safe operation of the mine and a commitment to provide vegetation offsets similar to vegetation being cleared as part of the mine plan.
- Targeted surveys for Solanum elachophyllum wold be undertaken within areas of potential habitat for this species prior to any disturbance occurring.
- Permits required under the NC Act in relation to disturbance of flora and fauna species would be sought from EHP prior to taking relevant actions, for example disturbance to Endangered, Vulnerable and Near Threatened protected plants.

4.11.1.3 Offsets

The EIS stated that the project would disturb approximately 11.2ha of remnant Endangered vegetation, 42.9ha of remnant Of Concern vegetation, 79.8ha of HVR Endangered vegetation and 0.8ha of HVR Of Concern vegetation. The disturbance of this vegetation would require an offset under the Queensland Biodiversity Offset Policy. The Brigalow disturbed by the project would also require offsets under the EPBC Act and the two policies align so that the disturbed Brigalow would only need to be offset once.

A biodiversity offset management plan was not provided in the EIS, although a proposed Brigalow offset area in an area on ML70171 was included as a figure in the EM plan.

4.11.2 Fauna

The EIS stated that 134 species of terrestrial vertebrate fauna were recorded at the site including six introduced species and comprising 94 species of bird, eight amphibians, 11 reptiles and 21 mammals.

The EIS stated that three NC Act Threatened and Near Threatened Fauna Species, the Little Pied Bat, Cotton Pygmy-goose and Squatter Pigeon were all present on site and that no additional fauna species listed as Threatened or Near Threatened under the NC Act were identified as potentially occurring within the project site from database searches.

Generally the extensive cleared areas of the site were stated as of low habitat value for fauna and the remaining vegetated areas of low to moderate habitat value. The greatest species diversity during the survey was recorded on Cockatoo Creek. The low activity levels of introduced species was interpreted to mean that that the site contains only small populations of introduced species.

The EIS stated that the fauna assemblage recorded within the project site is typical of the central Brigalow Belt and the project site is not considered to have any particularly significant values for fauna such as high biodiversity, important feeding areas, high endemism, unusual fauna assemblages, or unique habitat types or assemblages.

4.11.2.1 Impacts

The most significant areas of fauna habitat within the project site are the vegetation that fringes Cockatoo Creek, and the Poplar Box and regrowth Brigalow woodlands scattered across the project site. The project involves the diversion of an approximate 4.5km section of Cockatoo Creek and the removal of approximately 119.5ha (or 56 per cent) of the remnant vegetation and 80.6ha of HVR vegetation. That clearing includes 50ha of the 56ha identified riparian vegetation on Cockatoo Creek. The removal of this vegetation would result in a reduction in the area of habitat available for fauna within the immediate vicinity of the project site. Fauna may also be potentially impacted indirectly through noise, vibration and lighting as well as increased levels of pest plants or animals.

Noise, vibration and habitat loss are the principal impacts of the project on fauna species. The EIS noted the potential impact of noise and vibration on fauna, however was unable to quantify the potential impacts to fauna species or the area of habitat that whilst remaining uncleared would be lost as suitable habitat due to impacts of noise, dust and operational activities.

4.11.2.2 Mitigation

The EIS proposed mitigation measures specifically for fauna including:

- Cleared vegetation would be placed in stockpiles and utilised, where practicable, for rehabilitation/remediation of disturbance areas.
- The Cockatoo Creek diversion channel would be designed following good practice design principles. These design principles would seek to replicate, as far as practicable, the natural features of a diverted waterway including channel width and sinuousity, pools and rifles in order to maximise the diversion channel's habitat values for a variety of fauna species.
- The Cockatoo Creek diversion channel and surrounds would be revegetated with native species representative of the natural vegetation types of the project site and logs from cleared vegetation should be placed within the revegetation area to provide fauna habitat.

4.11.2.3 Pest plants and animals

The EIS noted that the project may introduce and spread weed species and facilitate the establishment and expansion of existing populations of pest animals. The invasion of pest plants could degrade the quality of fauna habitats, increase pest animals such as rabbits, foxes and pigs and result in direct predation of native fauna species.

At the time of the field survey, six declared pest plants were detected within the study area as isolated individuals or small clumps and evidence of pest animals such as pig diggings and rabbit scats were small and scattered suggesting that these species are not currently present in large numbers within the study area.

4.11.3 Mitigation measures

The EIS committed to develop and implement a Pest Animal and Weed Management Plan to control pest plant and animal species in the project site and include monitoring of levels of infestation and control when required, and vehicle and plant washdown procedures.

The EIS noted the need for a Species Management Plan to be developed and implemented in accordance with the requirements of the NC Act. The Species Management Plan would be required to outline actions to be taken to minimise impacts on animal breeding places. The actions may include prescriptions on the nature and duration of pre-clearing translocation surveys as well as measures to be employed during clearing activities such as direction of clearing, leaving habitat trees overnight, clearing surrounding vegetation, nudging habitat trees prior to felling and to describe the role of a spotter catch and the necessary permits for any relocation of fauna. The Species management Plan was not provided and will be required as part of the approval of the project.

4.11.4 Aquatic ecosystems

The EIS stated that Cockatoo Creek was a third order ephemeral stream with approximately 20–70m of riparian vegetation on its banks. It was typically characterised by a dry stream bed with disconnected waterholes, rainfall would create flow and aquatic ecosystems would therefore be adapted to that wet and dry cycle. An approximately 7ha farm dam is also on site adjacent to the creek.

The site includes approximately 7.3ha of Wetland RE (RE 11.5.17—Queensland Blue Gum), 26.6km of watercourses and approximately 56ha of riparian vegetation.

A single aquatic flora and fauna survey was undertaken in October 2010 during a flow event in the ephemeral Cockatoo Creek. The water quality observed was stated as typical for a slightly to moderately disturbed lowland stream in central Queensland. Eight fish, 49 macroinvertebrate and two turtle species were recorded on the site.

The creek and dam were both noted as turtle breeding habitat under the Nature Conservation (Wildlife Management) Regulation 2006.

The EIS noted that impacts to aquatic ecosystems would occur through:

- Clearing of 50 of the 56ha of the riparian vegetation along Cockatoo Creek.
- Removal of the 7ha dam and breeding habitat for the Cotton Pygmy-goose.
- Removal of the 4km of Cockatoo Creek including the loss of aquatic fauna including fish, macroinvertebrates and turtles and the loss of their aquatic habitat and food sources.

The EIS and EM plan proposed a range of mitigation measures to reduce the negative impacts to aquatic values including:

- the diversion of uncontaminated water away from active mining and infrastructure areas
- capture, diversion and storage of runoff from active mine areas
- erosion and sediment control measures to be implemented for disturbed mine areas, haul roads , crossings and exposed soils near or adjacent to waterways.

The EIS committed to the designing of the Cockatoo Creek diversion in a way seeking to replicate the natural features of the waterway, including channel width, sinuosity, pools and riffles in order to maximise the diversions habitat values for fauna species. The design was stated that it would also include revegetating the Cockatoo Creek diversion and surrounds with native species representative of the natural vegetation on the site and placement of cleared vegetation (logs) as habitat for fauna. The design has not been developed for the EIS but a diversion design and management plan is required prior to the diversion occurring.

The EIS committed to develop and implement a REMP to monitor, identify and describe any adverse impacts to surface water, quality and flows and aquatic ecosystem values.

4.11.5 Stygofauna

Assessment of stygofauna for the site was conducted through analysis of groundwater samples taken from the Rangal coal measures and a literature review relevant for the site. The limited stygofauna assessment did not record any fauna in the samples taken from groundwater in the coal measures. DNRM requested that additional

consideration of stygofauna impacts post EIS and prior to approval of the project.

4.12 Cultural heritage

The EIS has met the TOR requirements for Indigenous and non-Indigenous cultural heritage.

4.12.1 Indigenous cultural heritage

The EIS stated that no declarations in relation to Aboriginal heritage had been made under Commonwealth legislation for the project site and no sites had been listed on Commonwealth heritage lists. The Southern Barada Barna and Kabalbara People (SBK) had been identified as affected Aboriginal parties for the project in accordance with the *Aboriginal Cultural Heritage Act 2003* (ACH Act). The EIS stated that a Cultural Heritage Management Plan (CHMP) was being developed with the SBK in accordance with the ACH Act. A commitment was given to finalise the CHMP to manage any impacts on Indigenous cultural heritage prior to any disturbance.

4.12.2 Non-Indigenous cultural heritage

A non-Indigenous historical cultural heritage assessment was undertaken for the project. The assessment included a literature review, examination of historic aerial photography and field surveys. No state or locally significant historical cultural heritage items or places are likely to be impacted by the project. The Old Barwon Yards Complex was the only historical cultural heritage site within the study area. It was assessed in the EIS as of low heritage value. The site would not be disturbed by the project and therefore would not require any mitigation measures. The EIS committed to implementing a mitigation strategy in the event that sites of historical cultural heritage significance would be identified during ground disturbance. The mitigation strategy was included in the EIS.

4.13 Matters of National Environmental Significance

4.13.1.1 Process

On 29 March 2010, the proponent referred the project to SEWPaC in accordance with the EPBC Act. On 28 May 2010, SEWPaC determined the project to be a controlled action pursuant to Section 75 of the EPBC Act to be assessed through an EIS in accordance with the bilateral agreement.

This EP Act EIS process is accredited for assessment under Part 8 of the EPBC Act in accordance with the bilateral agreement. The Commonwealth was included as an advisory body for the project and provided its comments on the draft TOR and EIS documents.

The relevant controlling provisions are Sections 18 and 18 (A) (listed threatened species and ecological communities) of the EPBC Act. The decision included that project has the potential to impact matters of national environmental significance (MNES) as it involves the clearing of up to 2276 ha of suitable habitat for the nationally threatened Squatter Pigeon (*Geophaps scripta scripta*).

4.13.1.2 Site

The EIS stated that the project site is generally flat to undulating and is traversed by the ephemeral Cockatoo Creek in the east and Roper Creek in the west. Much of the site is cleared however there are areas of remnant vegetation especially along Cockatoo Creek and drainage lines.

The EIS reported on MNES, based on desktop studies, field surveys for flora and fauna and geological and topological information.

A single late wet season flora and fauna survey was conducted in May 2011, the results of which were combined with earlier fauna surveys (May 2009, January and May 2010) and the desktop data review. A single aquatic flora and fauna survey was conducted in October 2010.

4.13.1.3 Fauna

Thirteen threatened fauna species were listed as potentially occurring on site. Of those, the Squatter Pigeon was present, Ornamental Snake assessed as highly likely but not found and the Australian Painted Snipe and Brigalow Scaly-foot assessed as moderately likely but not found.

On the basis of fieldwork to assess the fauna species and vegetation communities of conservation significance present on-site and database searches, the EIS noted that a number of EPBC Act listed threatened flora and fauna species were either found on-site or have the potential to occur on-site.

The EIS confirmed that the project has the potential to impact matters of national environmental significance (MNES), as the project site contains:

- 148.7ha of an endangered ecological community (EEC) listed under the EPBC Act, namely brigalow (*Acacia harpophylla*) dominant and co-dominant communities. The total area of Brigalow was comprised of individual areas ranging from 1 ha to over 20ha of four discrete regional ecosystems: RE 11.3.1 Open forest of *Acacia harpophylla* and/or *Casuarina cristata* on alluvial plains; RE 11.4.8 *Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains; RE 11.4.9 *Acacia harpophylla* shrubby open forest to woodland with *Terminalia oblongata* on Cainozoic clay plains; and RE 11.9.5 *A. harpophylla* and *C. cristata* open forest on fine-grained sedimentary rocks.
- Species listed under the EPBC Act as vulnerable including:
    - squatter pigeon (southern) (*Geophaps scripta scripta*) known to occur within project site
    - The Ornamental Snake was highly likely to occur on site
    - Australian Painted Snipe and Brigalow Scaly-foot were likely to occur on site
    - The Red Goshawk, Star Finch, Northern Quoll, Greater Lond Eared Bat, Collared Delma, Yaka Skink, Dunmall's Snake, Retro Slider and Fitzroy Turtle were stated as potentially occurring but with a moderate or low likelihood.

4.13.1.4 Migratory species

Two migratory species were found on site, the Great Egret and the Rainbow Bee-eater.

Two migratory species were assessed as highly likely to occur on site: the White-throated Needletail and Fork-tailed Swift.

Eight migratory species were assessed as moderately to low likelihood to occur on site: Cattle Egret, Latham's Snipe; Magpie Goose; Painted Snipe; White-bellied Sea-eagle; Barn Swallow; Black-faced Monarch; and Satin Flycatcher.

4.13.1.5 Potential impacts

The EIS included a MNES impact assessment report that assessed the potential impacts to MNES by the project under the SEWPaC Significant Impact Guidelines.

The assessment concluded that:

- The project could result in a significant impact to the Brigalow TEC; as approximately 83.7ha of the 148.7ha on site would be cleared.
- No threatened flora species were likely to occur in the footprint.
- That whilst 119.5ha of remnant vegetation and 80.6ha of regrowth will be cleared, the Squatter Pigeon is not expected to be adversely impacted due to its utilisation of disturbed areas for feeding and that significant offsite areas of its habitat in the region remain undisturbed.
- The habitat for listed species potentially occurring on site was to be cleared however the impacts to the species were assessed as not significant due to:
    - the occurrences were not anticipated to represent an important population
    - the site did not represent critical habitat for the species
    - the project related clearing would not significantly impact the availability or quality or the remaining habitat to the extent the species would decline
    - the habitat disturbance was not anticipated to result in long term disruption, fragmentation or reduction of any populations that may be present.
- There would not be a significant impact on migratory species because whilst habitat would be cleared on site, the project area did not support significant breeding or feeding grounds for those species.

SEWPaC reviewed the EIS and noted that an offset management plan for MNES had not been included. However, the EIS did contain a commitment to provide an offset management plan outline prior to a decision being made about the project under the EPBC. SEWPaC has advised that the plan will be required before any decision about the project can be made under the EPBC Act. The provision of an offset management plan for MNES remains an outstanding matter.

SEWPaC referred the EIS and the draft supplementary EIS to the Independent Expert Scientific Committee on

Coal Seam Gas and Large Coal Mining Development (the committee) for its April 2013 meeting. The committee provided advice on a range of matters largely related to groundwater modelling and predictions, the design of the Cockatoo Creek diversion channel, riparian habitats, water quality and impacts on listed threatened species and ecological communities (particularly Brigalow listed ecological community) both within the project site and downstream. On 29 April 2013, the proponent was asked to address the committee's advice however, to date the proponent has not provided an adequate response.

4.14 Social

The EIS has generally addressed the TOR requirements for social issues, however has not sufficiently addressed Indigenous and mine closure aspects or cumulative impacts.

4.14.1 Area of impact

The EIS stated that social impacts would be predominantly felt in the town of Middlemount, as it is located only 5.3km from the project site. Middlemount has a large proportion of non-resident workers, mainly mine workers, who permanently reside outside of Middlemount and undertake their jobs on a fly-in fly-out (FIDO) drive in-drive-out (DIDO) basis. Many of these non-resident workers are accommodated in large scale housing villages located on the perimeter of Middlemount servicing local mines. The project would result in both positive and negative impacts as further explained in the sections below.

4.14.2 Project workforce

242 persons are currently working at the Foxleigh Mine, 40 additional persons would be required on a temporary basis during the establishment phase and 90 additional persons would be required during operations. The EIS expected the majority of workers to FIDO or DIDO mostly from coastal cities like Rockhampton or Mackay.

4.14.3 Housing and accommodation

The EIS stated that the project workforce would be housed in existing accommodation villages in Middlemount and in housing provided predominantly by Anglo American. It stated that the community had expressed its concerns at the population increase associated with this project as Middlemount would increasingly become a 'contractor town' rather than a 'family town'.

The EIS acknowledged the limited availability of housing in Middlemount and the associated lack of housing choice for potential mine employees as a limiting factor to support a more permanent population of Middlemount. Limited population growth would, in turn, impact the sustainability of the community. However, the local housing market would not be impacted because all workers could be housed in accommodation villages.

4.14.4 Social infrastructure and accessibility

The EIS identified that community, recreational, retail and health facilities were available in Middlemount at a scale consistent with the size of the town. However, Middlemount would generally experience high staff turnovers at some of these facilities and struggle to provide a consistent service to the community. In particular, child care providers, child health and family support service providers are currently unable to meet demands in Middlemount. There is growing demand for a range of support services, particularly mental health services. The EIS concluded that the Middlemount community did not currently have the capacity to respond to the impacts associated with growth in the non-resident worker population.

4.14.5 Social order and community safety

The EIS stated that social order and community safety were identified as important values within the community. Feedback during consultation indicated that residents perceived Middlemount to be a relatively safe place to live, with low crime and vandalism rates. This was confirmed during an interview with Queensland Police Service (QPS) representatives in Middlemount.

A number of stakeholders interviewed for the EIS raised concerns in relation to driver fatigue and potential implications for safety both within Middlemount and on the regional road network.

QPS indicated that traffic infringements (largely speeding and drink driving) were the most common recorded incidents in the local area. Incidents associated with antisocial behaviour (drunk and disorderly) did not have a particularly high police response rate. QPS also indicated that whilst QPS response rates to domestic violence incidents in Middlemount were low this did not mean the issue was not significant in the community.

The EIS stated that there is growing concern in the Middlemount community regarding alcohol consumption.

QPS stated in its submission that additional funding from the proponent to would be desirable as QPS would have to increase its police force to be able to maintain social order and community safety.

4.14.6 Community and lifestyle

The EIS stated that Middlemount had a range of sporting facilities, restaurants and cafés. The EIS consultation identified a number of key annual community events in the town (e.g. Anzac Day Ceremony). In response to the 2007 Capcoal Community Outlook Survey conducted as part of the SEAT study for the 2007–08 Capcoal CEP, 52 per cent of Middlemount residents generally gave a positive account of community life in Middlemount. Twenty per cent made comments about the lack of community connectedness (e.g. loss of family unit, impact of the transient population), 23 per cent disliked the lack of services and retail choices and 22 per cent said there were too many mining villages and the community lacked permanent housing.

4.14.7 Mine closure

The project would have a life of approximately 15 years. The EIS stated that the closure of the mine may have the following impacts:

- loss of economic stimulus through a loss of procurement opportunities for local and regional businesses
- loss of investment in local and regional education and training initiatives
- decrease in demand for accommodation in Middlemount following mine closure leading to lower house prices and higher property vacancy rates
- departure of permanent residents from Middlemount, with corresponding reduced demand for service provision
- loss of services.

The EIS committed to managing these impacts, however did not provide further details of how these impacts would be managed. The EIS provided a number of mitigation measures to address the identified impacts. A social impact management plan (SIMP) was included with the EIS. DSDIP has requested some changes to that plan including about mine closure, housing and subsidisation of health services. The SIMP contained a range of commitments and proposed government partnerships designed to both mitigate the social impacts caused by the project and to enhance the liveability of the local and regional communities. Areas of particular emphasis within the SIMP include housing availability and affordability, community services, employment and economic development.

DATSIMA stated that the EIS had not proposed mitigation measures or offsets to address training, education and employment opportunities for Indigenous people, and as such does not sufficiently address the TOR requirements for Indigenous people.

The EIS committed to developing an Indigenous People's Participation Plan in the future, in consultation with Indigenous people. DATSIMA does not support this approach as it is a TOR requirement to support this plan as part of the EIS and not to defer it into the future.

4.15 Economy

The EIS did not adequately address the economic impact matters raised in the TOR.

Traditionally the economic base of the region is supported by agricultural activities such as beef production. More recently the economy of the region has been influenced by coal mining followed by the construction industry.

The EIS stated that the economy of the Isaac Regional Council (IRC) local government area (LGA) is based on mining activity, followed by construction and agricultural activities. The IRC LGA is therefore us sensitive to economic impacts from the resources sector. Employment in Middlemount is concentrated in mining, mine services, retail trade and accommodation sectors. Mining employees make up the majority of the town's permanent resident population.

The current land use at the Foxleigh Mine site is coal mining and low intensity cattle grazing. While, some of the land could be rehabilitated for a mix of cattle grazing and some small area will be planted with trees and shrubs (not quantified), the expansion of the Foxleigh Mine will result in the permanent alienation of some land from the pre-mining land use. For example, unsuitable steep slopes of final landforms (out-of-pit spoil dumps), the three final voids, the constructed diversion channel and flood protection levees would remain at the end of the mine operations. These structures will be unsuitable for agricultural or pastoral activities. The EIS did not estimate the size, total area and final depth of the residual voids at the end of mine life. This EIS stated that the elevated landforms and final voids will impact substantially on post mine land capability, but did not quantify what that might

be.

The EIS did not estimate the capacity of grazing land that would be would be reduced post mining nor the opportunity cost of the lost cattle grazing over the life of the mine and post mining. The EIS did not assess or estimate the value of lost ecosystem services for the remnant and riparian vegetation to be cleared for the project. Therefore the EIS did not provide a net projected opportunity cost of the project.

The EIS assessed that there would be a positive economic impact to the local, regional, state and national economies. However the EIS stated that some level of caution needs to be attached to its estimates, particularly those relating to employment impacts.

At a local level the town of Middlemount would be most affected by the project. The EIS reported that the IRC area would receive a direct increase in the demand for employees, local services and supplies, whilst noting that most employees would:

- commute from the regional centre of Mackay to the local area
- reside in temporary accommodation (65 per cent) for the duration of their shifts and 35 per cent would be housed in Middlemount.

Some negative impacts would include an increased cost of living for local and regional residents, felt mainly by families not employed in the mining industry and a reinforcement of the region's specialisation in the mining sector.

The value of the coal resource to be mined is subject to the exchange rate and coal price fluctuations. The royalty payment to the State was estimated in the EIS as $26–$31 million per year. The EIS estimated that the project would employ an additional 90 additional workers in addition to the 242 existing employees.

The EIS concluded that the negative impacts would be offset by the positive economic impacts of the project and that there would be a net positive economic impact to the local, regional, state and national economies.

4.16 Health and safety

The TOR requirements for health and safety have generally been met. They include consideration of blasting, dangerous goods/hazardous materials and catastrophic climatic events such as flooding, landslides and bushfires.

The EIS identified the following community values to be at risk:

- safety in relation to impacts that could affect public spaces or private property
- amenity
- continuity of services (including emergency services)
- clean air and water.

Amenity, clean air and water have been addressed in previous chapters in this report.

The EIS stated that sensitive receptors would be mainly associated with surrounding land uses such as grazing, mining and residences/commercial activities in Middlemount. The EIS stated that health and safety issues would be addressed in an updated Safety and Health Management System (SHMS) prior to the commencement of the project. The SHMS was not included in the EIS however, a commitment was provided that it would be based on the existing Foxleigh Mine SHMS and address the construction, operations and decommissioning phases of the project.

The EIS committed that the SHMS would:

- meet the requirements of the *Coal Mining Safety and Health Act 1999* and Regulation, AS/NZS4801–2001 and ISO14001:2004
- align and comply with existing corporate standards and be comparable to systems used at other open cut mining operations within the company (e.g. German Creek Mine)
- integrate site emergency response with the emergency services response
- include an operational hazard analysis, regular hazard audits, fire safety, emergency response plans, qualitative risk assessment and construction safety.

The EIS committed to adopting the Principle Hazard Management Plans (PHMP) currently implemented at Foxleigh Mine to manage and mitigate impacts on health and safety. PHMPs would create the framework for addressing the requirements of a high level Integrated Risk Management Plan (IRMP) for the project.

The EIS provided numerous controls to manage and mitigate identified health and safety issues.

4.17 Hazard and risk

The TOR requirements for hazard and risk have been met.

The EIS included a preliminary hazard assessment (PHA) in accordance with the TOR to identify, manage and mitigate any catastrophic events that may have serious off-site impacts on surrounding land use such as mining, grazing, farming, roads and the town of Middlemount. The EIS committed to undertaking a final appraisal prior to any works commencing.

Risks that need to be controlled have been identified for the following events:

- transport, storage and use of hazardous materials/dangerous goods
- storage of mine-affected/contaminated water
- floods and bushfires
- vehicle impact on infrastructure
- vandalism and sabotage.

In the worst case, the above events may result in explosions and/or contaminant releases to land, air and water. The highest risks were identified as loss of containment and combustion of dangerous goods. These events were assed to be of moderate consequences and a low likelihood of occurrence, resulting in a medium risk.

The EIS stated that production rates would increase, resulting in greater vehicle movements and increased consumption of some hazardous materials, however the potential risks associated with would be largely confined to the project site and a safe operating distance from sensitive human receptors.

Potential risk sources that may impact on the project include neighbouring mine sites and commercial/industrial premises in Middlemount. The hazardous materials storage area and the hazardous materials transport route would be located at a safe distance from external sources of high risk.

The EIS concluded that the overall risk profile for the project was low due to proposed controls and no significant cumulative risks were identified.

The EIS committed to updating the existing Foxleigh Mine Major Emergency Incident Plan (MEIP) and any other management plans prior to operations commencing. The EIS committed to liaising with Queensland government authorities to coordinate, manage and respond to incidents where required.

4.18 Rehabilitation

The EIS stated that rehabilitation of the project would be integrated into the existing Foxleigh mine rehabilitation program. The EIS proposed progressive rehabilitation that would include stripping of useable topsoil in advance of mining, progressive construction of final landform profiles and topsoiling and revegetation of reshaped emplacement areas.

The EIS stated that the rehabilitation objectives are to:

- Ensure that post-mining landforms are safe, stable, non-polluting, self-sustaining for final use and require minimal maintenance.
- Return the majority of disturbed land to an appropriate Land Capability/Suitability Classification Class.
- Make disturbed areas geotechnically and erosionally stable to ensure that the proposed subsequent land use is not compromised by surface instability.

The EM plan outlined the principal aspects that should be considered in rehabilitation, such as:

- landform design
- rehabilitation methods
- topsoil management
- revegetation and rehabilitation monitoring and success.

The EIS stated that the following areas on the project site would be rehabilitated: overburden emplacement areas; mine access and haul roads; MIA; final voids; ROM stockpiles; and water management infrastructure. CHPP and tailings storage facilities on the Foxleigh mine site would also be impacted by the project and so will also require rehabilitation as part of the proposed expansion. The EIS committed to rehabilitation of pit diversion and flood protection levees as part of their construction and implementation rather than leaving their revegetation and

stabilisation to a later time.

Soil types and land suitability and agricultural land class were assessed as part of the rehabilitation planning. The EIS stated that there is more than 6 million m^3 of topsoil available on site for use in rehabilitation. Topsoil placement would be to a minimum of 15cm in rehabilitated areas, on that basis approximately 3 million m^3 of top soil is required for the modelled rehabilitation.

Topsoil management proposed includes immediate use where possible, otherwise stockpiling to a maximum thickness of 4m to maintain soil quality. The application of dust suppression water during topsoil management is proposed, however there is no indication in the EIS of the impact of the likely highly saline water on rehabilitation success.

Sampling of overburden and coal reject materials was conducted on samples taken from either the proposed site or on samples from the adjacent mine and assessed to determine a range of factors influencing their rehabilitation potential and management needs for example, the risk of acid generation and solubility of metals. The EIS concluded that the risk of acid and saline runoff from overburden was low and would diminish further over time. Metal contents were below soil criteria and stated as not likely to present any rehabilitation or environmental issues.

However, the EIS noted that overburden has lower organic content, poorer nutrient status, poorer structure and other properties adverse to vegetation growth and concluded that the final landform will have an altered (reduced) capacity to support the original vegetation.

Slope angles and lengths will be increased and this will result in an increased risk of soil erosion. Soil profiles and geotechnical stratigraphy will be altered resulting in lower quality material in the plant root zones. The EIS stated that overburden material would therefore require specific management to deliver rehabilitation outcomes. The EIS stated that similar strategies to those currently applied on the existing mine would be applied to this project. For example overburden emplacement would require slope management to manage erosion and topsoil cover would be inclusive of grassed pasture and fertiliser and soil treatment as required.

Coal reject materials were similarly assessed and expected to be low acid and low metal generating, however rejects would generate excess sulphate and salinity in runoff. Rehabilitation of tailings and rejects would require capping and finally topsoil dressing. There was no mention in the EIS of the success or practicality of this approach to presumably very moist and fine materials that may not dry or consolidate for extended periods of time. Coarse rejects were stated as being suitable for mixing with overburden and application in overburden emplacement and rehabilitation.

The EIS noted that the post-mining landscape would change with the inclusion of the elevated landforms and the three final voids. The preferred use of final voids was not specified and consequently the EIS did not identify conclusive management strategies for final void rehabilitation nor specify water quality objectives and drainage strategies. The EIS did commit to preparing a final void report to resolve those matters.

Rehabilitation acceptance criteria were outlined in the EM plan, however the detail required in a rehabilitation plan was not complete. The EIS committed to the development of a Rehabilitation Management Plan including a schedule of works and success criteria according to the Departmental guidelines. The EIS indicated that the majority of the proposed actions and strategies would mirror those currently applied on the Foxleigh Mine site.

Decommissioning strategies were not detailed in the EIS but stated as following those for the existing Foxleigh mine. Those include demonstration of achieving site rehabilitation success criteria, bunding and fencing of high wall and end walls of final voids for safety purposes, reprofiling voids and ramps to be geotechnically stable, removal of infrastructure and reseeding MIA areas except where infrastructure deliberately remains for future land owners (for example roads).

4.18.1 Potential impacts

Land suitability across the site would be degraded post closure despite the proposed rehabilitation. The EIS identified the existing land suitability includes grazing and that the area is generally unsuitable for broadacre rainfed cropping. The site was assessed as having 1354ha of good quality agricultural land (Class C). Post mining the areas of GQAL would be reduced by 430ha. The EIS stated that the majority of those impacted areas would remain suitable for grazing post rehabilitation. The EIS also stated that, after rehabilitation, land suitability generally would be degraded compared to pre mining case, but that the rehabilitated site would support grazing apart from areas such as final voids, diversions, levees, and landform slopes that would be unsuitable pastoral activities. However as the landform slopes would be likely to create a barrier to stock movement, it would be unlikely that grazing would occur across much of the site despite the land suitability. However the EIS did not address that issue.

4.18.2 Monitoring

A rehabilitation monitoring program was committed to in the EIS but was not provided. The EIS committed that monitoring of rehabilitation would occur and that maintenance activities including: ripping and reseeding to ensure germination success; and maintenance and augmentation of drainage and erosion control works would be conducted as required.

The EIS stated that the program would be based on the existing rehabilitation monitoring program underway at the original mine site and that the existing monitoring program is based on the then Department of Minerals and Energy Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland (1995). The program focuses on vegetation ground cover, foliage projective cover, visible indicators of erosion and vegetation recruitment, rehabilitation reference sites will be used to develop success criteria and that monitoring will be undertaken to confirm the long term stability of final landforms.

5 Adequacy of the environmental management plan

An outline of the environmental management plan (EM plan) for the project was provided with the EIS and upgraded on two occasions with supplementary information during the EIS assessment process. The EM plan included the expected range of information on the proposal including:

- the operational aspects and rehabilitation proposed
- consultation
- notifiable activities
- approvals
- environmental values of the site
- potential impacts
- management strategies
- proposed conditions.

The EM plan was proposed for the combined operation of the existing mine and the proposed expansion (this project), it was based primarily on the EM plan prepared for the existing operation. The EM plan outline, in conjunction with the EIS main reports, did provide sufficient information to describe the impacts of the proposal and the means of managing and minimising those impacts and was therefore suitable for this EIS process.

Many of the outstanding matters identified in this report are focused on resolving aspects of the EM plan, consequently the EM plan will require significant improvement before it is suitable and before a decision could be made to grant an EA for the project. Guidance on the content of an EM plan is available at section 203 of the EP Act and in departmental guidelines.

For example reviewers identified the need to revise the EM plan to make it measurable, enforceable and auditable in line with current EHP expectations and regulatory strategy and many of the conditions proposed in the EM plan were not suitable for direct application to the EA, for example in relation to dust. More discussion around conditioning of the project is provided in Chapter 7.

6 Outstanding matters

The EIS process has compiled information about the proposed project, the values of the site and the potential impacts to those values. A range of mitigation and management measures, including environmental protection commitments, were proposed in the EIS and are summarised in this assessment report. Importantly, one of the principal tools to implement those mitigation measures and environmental commitments is the EM plan. The EM plan sets out how each matter is to be managed to deliver the acceptable environmental outcome.

The EIS identified specific actions that were required to ensure the project was suitable to proceed however, in many cases it did not provide the identified action/information rather deferred that by committing to provide it post EIS as part of the project approvals (for example EA application process). Details of those commitments or requirements are provided in the preceding chapters of this report.

This report therefore recommends that the following outstanding matters be addressed prior to decisions being made about granting an EA for the project.

6.1 Sensitive receptors

There are three isolated rural residential properties in proximity to the project site, the Tralee Homestead, Lake Lindsay Residence and the Foxleigh Homestead. The Tralee Homestead is located within the project site. The EIS stated in numerous sections that legal agreements were currently being negotiated with the owners of these three properties. These residences were therefore not considered to be sensitive receptors and were not discussed further in the EIS. The potential for these properties to be influenced by noise and vibration, dust, lighting, groundwater, surface water and other impacts has therefore not been assessed. The resolution of the arrangements for these receptors and if necessary potential impact assessments must be finalised prior to any approvals being granted.

6.2 Flood levees and diversion of Cockatoo Creek

There was a commitment in the EIS that prior to construction the following would be completed prior to a water diversion licence application:

- redefining of flood protection levels per EHP hazard categories
- detailed design of the levees
- development of design, construction, operational and decommissioning plans
- detailed revegetation and stabilisation plans for levees
- develop a diversion monitoring program to address all stages from pre mining until post closure to confirm that the diversion is operating as a waterway in equilibrium and not impacting adjoining reaches.

6.3 Final voids

The preferred use of the three final voids was not specified and consequently the EIS does not identify conclusive management strategies for final void rehabilitation nor specify water quality objectives and drainage strategies. The EIS did commit to preparing a final void report to resolve those matters. That final void report should be provided as part of the EA application process.

6.4 Containment systems

The proposed conditions in the EM plan indicated that the hazard categories, design storage allowance and mandatory reporting levels for the proposed containment systems/dams are not yet determined. That level of detail will be required as part of the EA application process.

6.5 Soils

The EIS did not suitably address the requirements for soils in the TOR. A number of matters such as soil testing and mapping intensity and soil properties such as plant available water capacity (PAWC) were not fully resolved during the EIS. However the EIS included a commitment to complete the agreed scope of works, analysis and interpretation and to appropriately manage all soils encountered on the site if the operation proceeds.

There is a need to develop full site soils information including completion of sampling and mapping, developing the topsoil management plan and recalculation of PAWC in conjunction with DNRM and EHP. That should be

completed as part of the EA application process.

6.6 Visual amenity

The EIS commits to rehabilitation of post mine landforms that will soften the landforms and ensure that they will not form conspicuous features and a range of mitigation measures were proposed including limiting vegetation clearing, lighting design, selection of colours for infrastructure and progressive rehabilitation. Those commitments should be formalised into the EM plan as part of the EA application process.

6.7 Stock route

The EIS stated that the stock route (U408) that traverses the site will be managed to remain in operation across part of the mining lease and that an agreement will be established to manage that. No detail about that agreement was provided in the EIS. That commitment should be formalised in conjunction with DNRM and IRC as part of the EA application process.

6.8 Rail

QR National/Aurizon has requested ongoing consultation on dust control, particularly at the rail load out facility and potential impacts of increased train movements on the rail system.

6.9 Waste

The EM plan should set out a clear management regime for the disposal of potentially sodic overburden.

The proponent has committed to managing waste, including regulated waste, generated by the project in accordance with the waste management hierarchy (i.e. avoidance, reuse, recycling and disposal) and in accordance with relevant legislation including the Queensland Environmental Protection (Waste Management) Policy 2000 (EPP Waste). However the EIS did not provide a Waste Management Plan (WMP) for the project nor a clear commitment to developing and implementing a WMP incorporating a program of best practice waste management including the ongoing assessment of cleaner production and waste management opportunities for the life of the project. The WMP should be provided as part of the EA application process.

6.10 Water

The hazard categories, design storage allowance and mandatory reporting levels are not yet determined for the range of water storages proposed. That level of detail will be required at the EA application stage to finalise the EM plan.

An additional external allocation of 700MLpa raw water is stated as necessary for the project. The source of that water has not been confirmed, therefore resolving a suitable water supply and addressing any potential impacts of that supply should be resolved as part of the EA application process.

6.10.1.1 Groundwater

A groundwater monitoring program was proposed in the EIS primarily to confirm the expectations of impact as estimated in the EIS.

The program would take into account that the northern area of the site has the greatest risk of off-site impacts and include:

- assessments of groundwater interactions with surface waters of Cockatoo Creek
- impacts on potential shallow alluvial stygofauna and potential groundwater dependant ecosystems across the site
- monitor the role of the Renwan formation and groundwater storage in associated sediments.

The commitment includes to commence monitoring pre mining and to continue post mining. Details of the program will be required as part of the EA application process.

6.10.1.2 Water monitoring

A commitment is made in the EIS to develop a REMP and a Water Management Plan to demonstrate how operational management of water and potential contamination will be conducted and reviewed. These actions should be completed for the project as part of the EA application process.

6.11 Air

EIS proposed a number of dust mitigation measures, including a Dust Control Procedure, watering of exposed surfaces and minimising the area of exposed surfaces at any one time which would prevent any PM10 exceedances in Middlemount. The EIS committed to real-time dust monitoring of PM10 over the project life to put corrective actions in place to prevent dust nuisance. Those commitments should be detailed in the EA application process and any dust matters involving rail should include engagement with Aurizon.

6.12 Flora

THE EIS made a range of commitments relating to management of impacts to flora the identified outstanding action include to develop:

- a Pest Animal and Weed Management Plan
- offset management plan
- rehabilitation management plan.

For listed species under the EPBC Act and NC Act that are confirmed as present or likely to be present in the project area, develop:

  - Species specific management plans. The Species Management Plans will, where relevant, outline:
    - actions to be taken to minimise impacts on animal breeding places including prescriptions on the nature and duration of pre-clearing translocation surveys
    - measures to be employed during clearing activities such as direction of clearing, management of habitat trees, etc.
    - describe the role of a spotter catcher and the necessary permits for any relocation of fauna (e.g. Rehabilitation Permit or Damage Mitigation Permit).
  - Offset programs, including for the approximately 11.2ha of remnant Endangered vegetation, 42.9ha of remnant Of Concern vegetation, 79.8ha of HVR Endangered vegetation and 0.8ha of HVR Of Concern vegetation.

- An outline of the management strategies to be implemented during the construction and operation of the mine to minimise the impact on remnant vegetation, including minimising the area to be cleared for the safe operation of the mine and a commitment to provide vegetation offsets similar to vegetation being cleared as part of the mine plan
- A program of targeted surveys for *Solanum elachoph*yllum to be undertaken within areas of it potential habitat prior to any disturbance occurring.

Those outstanding actions for flora should be completed as part of the EA application process.

6.13 Aquatic ecosystems

The EIS committed to the designing of the Cockatoo Creek diversion seeking to replicate the natural features and characteristics of the waterway including channel width, sinuosity, pools and riffles in order to maximise the diversions habitat values for fauna species. The design was stated to also include revegetating the Cockatoo Creek diversion and surrounds with native species representative of the natural vegetation on the site and placement of cleared vegetation (logs) as habitat for fauna. That design has not been developed for the EIS but a diversion design and management plan is therefore required prior to the action occurring.

The EIS committed to developing and implementing a receiving environment monitoring program (REMP) to monitor, identify and describe any adverse impacts to surface water, quality and flows and aquatic ecosystem values. However, that REMP was not provided with the EIS and is therefore required as part of the EA application process.

6.13.1.1 Stygofauna

The DNRM has requested additional consideration of stygofauna impacts post EIS and pre approval of the project. Those requirements should be confirmed with DNRM and addressed as part of the EA application process.

6.14 Cultural heritage

The EIS stated that a Cultural Heritage Management Plan (CHMP) was being developed to manage any impacts on Indigenous cultural heritage. The CHMP should finalised as part of the EA application process.

6.15 Socio-economic

DATSIMA has requested that an Indigenous People's Participation Plan be provided. Changes to the SIMP should be further discussed with DSDIP.

6.16 Health and safety

The EIS made a commitment that a Safety and Health Management System (SHMS) and Principle Hazard Management Plans (PHMP) would be provided prior to the commencement of the project. They would address the construction, operation and decommissioning phases of the project and include an operational hazard analysis, regular hazard audits, fire safety, emergency response plans, qualitative risk assessment and construction safety.

Those should be completed as part of the EA application process.

6.17 Hazard and risk

The EIS committed to updating the existing Foxleigh Mine Major Emergency Incident Plan (MEIP) and any other management plans prior to operations commencing and to liaise with Queensland government authorities to coordinate, manage and respond to incidents where required. Details of the updated program and response arrangements should be provided as part of the EA application process.

6.18 Decommissioning and rehabilitation

Decommissioning strategies and a rehabilitation program were not detailed in the EIS.

The EIS committed to rehabilitation that would soften the landforms and ensure that they would not form conspicuous features and that monitoring of rehabilitation would occur and that maintenance activities including: ripping and reseeding to ensure germination success; and maintenance and augmentation of drainage and erosion control works would be conducted as required. The EIS stated that the rehabilitation program would be based on the program underway at the original mine site and would focus on vegetation ground cover, foliage projective cover, visible indicators of erosion and vegetation recruitment, that rehabilitation reference sites will be used to develop success criteria and that monitoring will be undertaken to confirm the long-term stability of final landforms.

Those rehabilitation and decommissioning management plans should be provided as part of the EA application process.

7 Recommended conditions of approval

Throughout this EIS process a range of environmental impacts and relevant mitigation measures have been identified. Where the EIS has shown that such impacts are likely (and where legislation, policy or guidelines dictate) some activities associated with the project will need to be constrained, for example through conditions of approval, to achieve acceptable environmental outcomes. In the absence of detail about a particular matter the EIS has made certain commitments to achieve suitable outcomes. A significant amount of additional information is required for those commitments to be converted into measureable and auditable conditions. This report has made note of the range of commitments and they are listed above. The draft EM plan also included a range of proposed conditions, some of those conditions appeared suitable, others were not and some were incomplete.

To suitably implement the project and as required under section 59 of the EP Act, this report includes a set of recommended conditions for approval at Annexure B.

7.1 Environmental Protection Act 1994

EHP recently released its Regulatory Strategy that changes the way that projects such as this will be managed and conditioned. The strategy recognises that:

- EHP's role is to set the limits on what an approval holder can do
- business and industry are best-placed to work out how to stay within those limits
- the responsibility for managing the risk from an activity sits with the person carrying out the activity, rather than with EHP.

So rather than responding directly to each of the proposed conditions within the EMP, noting that they were in a form established prior to the regulatory strategy being released and that future conditioning will be significantly different; the recommended conditions proposed here (Annexure B) are the range of relevant approved standard conditions under the regulatory strategy including the model mining conditions and standard conditions for containment systems (e.g. dams and levees).

Due to the lack of suitably detailed information in the EIS the conditions have been provided generically as recommendations in order to provide guidance about the departments change in approach to conditioning and to provide specific examples of the type of conditions that would be applied once the level of available information is improved.

This project will require an amendment of the existing EA for the Foxleigh Mine, it is intended here that, where suitable, the conditions of the existing operation are also amended to reflect these model mining conditions. The conditions are not considered complete nor finalised and are provided for consideration when deciding to grant an EA with conditions for the project under the EP Act. At that time the administering authority will decide, under section 210 of the EP Act, what conditions are necessary or desirable.

7.2 Water Act 2000

A number of separate water licences under the *Water Act 2000* would be required for the project, for example relating to the construction of the Cockatoo Creek diversion and flood protection levees.

The EIS provided insufficient detail about the engineering designs, rehabilitation and monitoring for the diversion and levees for this EIS assessment report to be able to include recommended conditions for those water licences. Conditions for these activities will need to be decided (should they be approved) when the proponent lodges water licence applications with DNRM after this EIS process is completed.

7.3 Nature Conservation Act 1992

A clearing application must be made for plants that are listed as 'endangered', 'vulnerable' or 'near threatened', unless otherwise authorised under the protected plant exemption under section 41(1)(a)(ii) of the Nature Conservation (Protected Plants) Conservation Plan 2000.

For loss of ecological values, any offsets proposal, including any species management plans should be developed in accordance with the Queensland Government's Environmental Offset Policy 2008.

8 Suitability of the project

The department has considered the TOR, the submitted EIS, all properly made submissions and the standard criteria. The project is assessed here as being suitable, on the condition that the EM plan is refined and completed in the manner directed in this report and that the subsequent environmental authority, if granted, is conditioned suitably to implement the specific environmental protection commitments set out in the EIS and summarised in this EIS assessment report.

Consequently, the project is considered suitable to proceed to the next stage of the approval process, noting that the recommendations of this EIS assessment report should be fully implemented.

Approved by

Lindsay Delzoppo	2 July 2013
Signature	Date

Lindsay Delzoppo
Director, Statewide Environmental Assessments
Department of Environment and Heritage Protection

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Annexure A

Queensland Government name changes

New department (as of 3 April 2012)	Previous department(s)/amalgamations
Department of State Development, Infrastructure and Planning	Department of Employment, Economic Development and Innovation
Queensland Treasury and Trade	Treasury Department/ Department of Employment, Economic Development and Innovation
Department of Science, Information Technology, Innovation and the Arts;	Department of Employment, Economic Development and Innovation/Department of Public Works
Department of Natural Resources and Mines	Department of Employment, Economic Development and Innovation/ Department of Environment and Resource Management
Department of Agriculture, Fisheries and Forestry	Department of Employment, Economic Development and Innovation/ Department of Environment and Resource Management
Department of Environment and Heritage Protection	Department of Environment and Resource Management
Department of National Parks, Recreation, Sport and Racing	Department of Environment and Resource Management
Queensland Police Service	Department of Police
Department of Education, Training and Employment	Department of Education and Training
Department of Housing and Public Works	Department of Communities
Department of Local Government	Department of Local Government and Planning
Department of Communities, Child Safety and Disability Services	Department of Communities

Annexure B

This Annexure is comprised of two parts that should be inserted completely:

1. Model mining conditions per the Departmental Guideline - Model Mining Conditions (130626 EM944 Version 4).
2. Containment and levee conditions per the Departmental Guideline – Structures which are dams or levees constructed as part of environmentally relevant activities (130331 EM634 Version 3).

Guideline

Mining

Model mining conditions

The purpose of this guideline is to provide a set of model conditions to form general environmental protection commitments given for mining activities, and environmental authority conditions for resource activities - mining activities imposed by the administering authority under the Environmental Protection Act 1994.

Introduction

The *Environmental Protection Act 1994* (EP Act) provides for the granting of environmental authorities for resource activities - mining activities.

In giving approval under the EP Act, the administering authority must address the regulatory requirements set out in the Environmental Protection Regulation 2008 and the standard criteria contained in the EP Act. The administering authority will give consideration to these regulatory requirements in the context of specific information about the environmental impacts of a particular project provided through an environmental impact statement or application documents.

The following model conditions may be used as a basis for proposing environmental protection commitments in the application documents. They may also be used to expedite the process of developing appropriate conditions for an environmental authority for a mining project in consultation with the administering authority.

The model conditions can be modified to suit the specific circumstances of a mining project subject to the assessment criteria outlined above. In such circumstances, variants of these conditions and/or different conditions may be applied at the discretion of the administering authority delegate and in consultation with the applicant. It is unlikely the administering authority will accept less rigorous environmental protection commitments or environmental authority conditions without clear evidence that the risk of the particular type of environmental harm addressed by those model conditions is otherwise addressed to at least the same extent by:

a) the specific environmental management practices to be implemented

b) technologies to be used; or

c) the nature of the environmental values impacted by the project.

To meet the test of ‘necessary or desirable’ it is considered that a condition will meet this test if a demonstrable link exists to achieving the object of the EP Act. It is considered that conditions relating to monitoring and reporting under the issued authority allow the administering authority to assess the accuracy of information and assumptions made in the application and allow the detection of any trend toward environmental harm resulting from the activity.

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The conditions in this guideline do not cover all the conditions necessary for regulating a resource activity - mining activity. Officers should also refer to the separate guidelines: *Structures which are dams or levees constructed as part of environmentally relevant activities* (EM634). The water schedule has been based on the model water conditions for coal mines in the Fitzroy basin. As a result the surface water schedule conditions may not be applicable to other catchments or to other types of mines. The water schedule may also be subject to change as a result of the Isaac River mine water release pilot.

How to use this guideline

New project applications

The model conditions should be applied to all new mining project applications lodged after the guideline is approved.

Applications for new projects in progress

For applications in progress on the date this guideline is approved, the applicant should be advised of the availability of the model conditions. If public notification has been completed on the basis of different draft conditions from the model conditions, the model conditions cannot be used unless the applicant wishes to re-notify.

Amendments

For amendment applications where the amendment involves altering activities covered in the model mining conditions, negotiation with the EA holder should take place such that the original conditions are amended to reflect the model mining conditions to the extent of the changed impacts as a result of the alteration to activities. If there is no increase in impacts or only a trivial increase in impacts as a result of the change, this is not an opportunity to impose the model conditions on an existing project, except to the extent that the applicant seeks to adopt the model conditions.

Compulsory amendments

Where there are continual non-compliance issues and the model conditions would clearly alleviate the non-compliance then they can be used without negotiation, to the extent of the changed impacts as a result of the non-compliance. If there is no increase in impacts or only a trivial increase in impacts as a result of the non-compliance, this is not an opportunity to impose the model conditions on an existing project, except to the extent that the applicant seeks to adopt the model conditions.

The guidance above about not imposing model conditions on an existing mine without the consent of the holder obviously does not apply if the particular model conditions are considered necessary to address 1 or more of the circumstances listed in section 215(2) of the EP Act, for example, if an existing condition was on the basis of materially misleading information or it would overcome contraventions of the EP Act. However, in that situation, the model conditions should only be compulsorily imposed to the extent necessary to address the particular circumstance triggered by section 215.

Transfer of environmental authority holder

The model conditions should not be imposed upon a transfer, unless at the request of the transferee.

Holders may choose to apply

Holders of environmental authorities for existing mines may apply to adopt model conditions either in whole or on a schedule by schedule basis (or even part of a schedule, for example, if the existing mine has some site-specific conditions on a particular topic and other pro forma conditions). However, if a holder for an existing mine applies to adopt model conditions on 1 topic, this does not mean that model conditions on a different topic can be imposed in response to that amendment application. Similarly, if an application for an extension project is lodged, this should not be seen as an opportunity to impose the model conditions retrospectively on the existing mine except with the agreement of the holder.

If additional conditions are needed to manage particular site-specific or project-specific risks, they may be included. A company may also propose alternative conditions for particular site circumstances for negotiations with the department.

Further information

The latest version of this publication can be found at www.ehp.qld.gov.au using the publication number EM944 as a search term.

Note:

Explanatory notes are in green. Please delete prior to issue of EA.

Insertions required by applicants and/or the administering authority are in blue. Please delete prior to issue.

If an impact is not objectively relevant to the particular location or the project, then, unless the applicant has specifically requested the model conditions on that topic, there is no need to include conditions about it (for example, if the application does not include sewage treatment plants, there is no need to include conditions about them). Potentially, an applicant may request model conditions relating to an impact even if it is not relevant at the time of the decision, in case it becomes relevant later for reasons beyond the control of the applicant, such as residential development encroaching in future in the direction of a mine.

The terms 'sensitive place' and 'commercial place' used in these model conditions do not include places that are within the boundaries of the mining lease, nor places that are owned or leased by the holder of the authority or its related companies. For example, a mining camp operated by the holder of the authority would not be a sensitive place.

Schedule A - General

A1 This environmental authority authorises environmental harm referred to in the conditions. Where there is no condition or this environmental authority is silent on a matter, the lack of a condition or silence does not authorise environmental harm.

Explanatory note – The first version of A2 may be used where the supporting EIS or application documents have enough information to demonstrate that an acceptable level of ground-truthing has been done on potential for flora/fauna impacts and other risk assessment so that EHP is comfortable that the right areas have been identified to indicate no go areas. If the EIS or other supporting information only proposes 2 types of areas (those to be disturbed and those not to be disturbed), it is only necessary to use paragraphs a) and b) below. However, if the EIS or other supporting information addresses and justifies limited disturbance within a mapped area, paragraph c) may be added, on the basis that the conditions for that limited disturbance are set out elsewhere in the conditions or in a report that is adopted by the conditions. If the limited disturbance relates to flora and fauna, refer to condition A3.

Where there is not enough information to show that an acceptable level of ground-truthing has been done, the second version of A2 should be used.

A2 EITHER:

In carrying out the mining activity authorised by this environmental authority, disturbance of land:

a) may occur in the areas marked 'A'

b) must not occur in the areas marked 'B'

c) may occur in the areas marked 'C' on the map that is annexure 1 to this environmental authority, but only in accordance with condition A3.

OR

In carrying out the mining activity authorised by this environmental authority, the holder of this environmental authority must comply with Schedule K—Figure 1a (Project Infrastructure Layout—Mine Area) and Schedule K—Figure 1b (Project Infrastructure Layout—Support Infrastructure).

Explanatory note: Condition A3 should only be used if condition A2 includes optional paragraph c) authorising limited disturbance within a mapped area. These conditions are not to be used in relation to paragraphs a) and b) of condition A2. The model conditions below are examples only. Any authorisation of limited disturbance should be site-specific and based on an assessment of the EIS or other supporting information, including ground-truthing of the areas.

Option 1 (for limited surface infrastructure)

A3 Any disturbance within the areas marked 'C' on the map that is annexure 1 to this environmental authority:

a) is only authorised to the extent reasonably necessary for a road, fence, underground service, low-impact telecommunications facility, electrical sub-station, transmission grid works and supply network works, storage depots, similar minor infrastructure and ancillary facilities for any of the above minor infrastructure

b) any disturbance within areas marked 'A' or 'C' is not to impact adversely on areas marked 'B'.

Option 2 (authorising sub-surface disturbance)

A3 Only sub-surface disturbance is authorised within the areas marked 'C' on the map that is annexure 1 to this environmental authority.

A4 The holder of this environmental authority must:

a) install all measures, plant and equipment necessary to ensure compliance with the conditions of this environmental authority

b) maintain such measures, plant and equipment in a proper and efficient condition

c) operate such measures, plant and equipment in a proper and efficient manner

d) ensure all instruments and devices used for the measurement or monitoring of any parameter under any condition of this environmental authority are properly calibrated.

Monitoring

A5 Except where specified otherwise in another condition of this environmental authority, all monitoring records or reports required by this environmental authority must be kept for a period of not less than 5 years.

Financial assurance

A6 The activity must not be carried out until the environmental authority holder has given financial assurance to the administering authority as security for compliance with this environmental authority and any costs or expenses, or likely costs or expenses, mentioned in section 298 of the Act.

A7 The amount of financial assurance must be reviewed by the holder of this environmental authority when a plan of operations is amended or replaced or the authority is amended.

Risk management

Explanatory note—risk management

Holders have the option of providing a risk management plan which is structured differently from the ISO provided that the alternative approach is reasonably justified.

A8 The holder of this environmental authority must develop and implement a risk management system for mining activities which mirrors the content requirement of the Standard for Risk Management (ISO31000:2009), or the latest edition of an Australian standard for risk management, to the extent relevant to environmental management, by <<Insert date 3 months from date of issue>>

Notification of emergencies, incidents and exceptions

Explanatory note—notification

If notification is given under an alternative notification condition of the environmental authority it is taken to be notification under this condition. If notification is required under sections 320–320G of the EP Act the additional requirements under sections 320–320G apply.

A9 The holder of this environmental authority must notify the administering authority by written notification within 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.

A10 Within 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 recurrence of the emergency or incident.

Complaints

A11 The holder of this environmental authority must record all environmental complaints received about the mining activities including:

a) name, address and contact number for 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

h) person responsible for resolving the complaint.

A12 The holder of this environmental authority 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 10 business days of completion of the investigation, or no later than 10 business days after the end of the timeframe nominated by the administering authority to undertake the investigation.

Third-party reporting

A13 The holder of this environmental authority must:

a) within 1 year of the commencement of this environmental authority, obtain from an appropriately qualified person a report on compliance with the conditions of this environmental authority

b) obtain further such reports at regular intervals, not exceeding 3 yearly intervals, from the completion of the report referred to above; and

c) provide each report to the administering authority within 90 days of its completion.

A14 Where a condition of this environmental authority requires compliance with a standard, policy or guideline published externally to this environmental authority and the standard is amended or changed subsequent to the issue of this environmental authority, the holder of this environmental authority must:

a) comply with the amended or changed standard, policy or guideline within 2 years of the amendment or change being made, unless a different period is specified in the amended standard or relevant legislation, or where the amendment or change relates specifically to regulated structures referred to in condition XX, the time specified in that condition

b) until compliance with the amended or changed standard, policy or guideline is achieved, continue to remain in compliance with the corresponding provision that was current immediately prior to the relevant amendment or change.

Schedule B - Air

Point source releases to air

B1 Discharges of contaminants to air from the activity, other than dust and particulate matter addressed by condition B4, must be in accordance with **Tables B1—release points (air)** and **B2—contaminant limits (air)**.

B2 Conduct a monitoring program of contaminant releases to the atmosphere at the release points, frequency and for the contaminants specified in **Table B2—contaminant limits (air)** and which complies with the most recent edition of AS4323.1 Stationary source emissions method 1: Selection of sampling positions, and the most recent edition of the administering authority's air quality sampling manual.

Table B1—release points (air)

Release point	Release point description	Source description	Minimum release height (metres above ground)	Minimum exit gas temperature (^{o}C)	Minimum efflux velocity (m/s)
RP1	Processor mainstack	Mineralprocessor			
RP2	Drier stack	Crusher and drier			

Table B2—contaminant limits (air)

Contaminant	Release point	Limit type	Release limit	Release limit units	Minimum monitoring frequency

B3 The release of point source and fugitive emissions from the mining activities must not cause the concentrations of the contaminants listed in Table XX, when measured at [a sensitive place or at specified monitoring stations], to exceed the levels shown in Table XX.

Dust and particulate matter monitoring

Explanatory note—sources of PM2.5 are primarily from combustion sources and PM2.5 is unlikely to be elevated if significant combustion sources are not present. Condition B4(c) will therefore only be required if there is a significant source of air emissions from combustion sources.

The 5 exceedances for the PM10 standard outlined in B4 (b) were introduced to account for the impact of bushfires, dust storms and fuel reduction burning for fire management purposes. The 5 exceedances are in essence arbitrary in that the number was chosen as it is difficult to determine exactly the number of times these events may happen in any one year. More than 5 exceedances as a result of one or more of these events would not be considered to be a breach of condition.

B4 The Proponent shall ensure that all reasonable and feasible avoidance and mitigation measures are employed so that the dust and particulate matter emissions generated by the mining activities do not cause exceedances of the following levels when measured at any sensitive or commercial place:

a) Dust deposition of 120 milligrams per square metre per day, averaged over 1 month, when monitored in accordance with the most recent version of Australian Standard AS3580.10.1 Methods for sampling and analysis of ambient air—Determination of particulate matter—Deposited matter – Gravimetric method.

b) A concentration of particulate matter with an aerodynamic diameter of less than 10 micrometres (PM10) suspended in the atmosphere of 50 micrograms per cubic metre over a 24-hour averaging time, for no more than 5 exceedances recorded each year, when monitored in accordance with the most recent version of either:

1. Australian Standard AS3580.9.6 Methods for sampling and analysis of ambient air—Determination of suspended particulate matter—PM_{10} high volume sampler with size-selective inlet – Gravimetric method; or

2. Australian Standard AS3580.9.9 Methods for sampling and analysis of ambient air—Determination of suspended particulate matter—PM_{10} low volume sampler—Gravimetric method.

c) A concentration of particulate matter with an aerodynamic diameter of less than 2.5 micrometres (PM2.5) suspended in the atmosphere of 25 micrograms per cubic metre over a 24-hour averaging time, when monitored in accordance with the most recent version of AS/NZS3580.9.10 Methods for sampling and analysis of ambient air—Determination of suspended particulate matter—PM (sub)2.5(/sub) low volume sampler—Gravimetric method.

d) A concentration of particulate matter suspended in the atmosphere of 90 micrograms per cubic metre over a 1 year averaging time, when monitored in accordance with the most recent version of AS/NZS3580.9.3:2003 Methods for sampling and analysis of ambient air—Determination of suspended particulate matter—Total suspended particulate matter (TSP)—High volume sampler gravimetric method.

Schedule C - Waste management

C1 General waste must only be disposed of into the waste disposal trench facility of <insert tenement number> and identified in Schedule # Figure # – Site Map.

Explanatory note—burning

If it can be demonstrated that other possible options have been considered in accordance with the waste management hierarchy, burning may also be permitted for mining activities in addition to clearing for extraction activities.

C2 Unless otherwise permitted by the conditions of this environmental authority or with prior approval from the administering authority and in accordance with a relevant standard operating procedure, waste must not be burnt.

C3 The holder of this environmental authority may burn vegetation cleared in the course of carrying out extraction activities provided the activity does not cause environmental harm at any sensitive place or commercial place.

Tailings disposal

C4 Tailings must be managed in accordance with procedures contained within the current plan of operations. These procedures must include provisions for:

a) containment of tailings

b) the management of seepage and leachates both during operation and the foreseeable future

c) the control of fugitive emissions to air

d) a program of progressive sampling and characterisation to identify acid producing potential and metal concentrations of tailings

e) maintaining records of the relative locations of any other waste stored within the tailings

f) rehabilitation strategy

g) monitoring of rehabilitation, research and/or trials to verify the requirements and methods for decommissioning and final rehabilitation of tailings, including the prevention and management of acid mine drainage, erosion minimisation and establishment of vegetation cover.

Acid sulphate soils

C5 Treat and manage acid sulphate soils in accordance with the latest edition of the Queensland Acid Sulfate Soil Technical Manual.

Schedule D - Noise

Noise limits

D1 The holder of this environmental authority must ensure that noise generated by the mining activities does not cause the criteria in **Table D1 – Noise limits** to be exceeded at a sensitive place or commercial place.

Table D1 – Noise limits

Sensitive Place						
Noise level dB(A) measured as:	**Monday to Saturday**			**Sundays and Public Holidays**		
	7am to 6pm	**6pm to 10pm**	**10pm to 7am**	**9am to 6pm**	**6pm to 10pm**	**10pm to 9am**
LAeq, adj, 15 mins	CV = 50 AV = 5	CV = 45 AV = 5	CV = 40 AV = 0	CV = 45 AV = 5	CV = 40 AV = 5	CV = 35 AV = 0
LA1, adj, 15 mins	CV = 55 AV = 10	CV = 50 AV = 10	CV = 45 AV = 5	CV = 50 AV = 10	CV = 45 AV = 10	CV = 40 AV = 5
Commercial Place						
Noise level dB(A) measured as:	**Monday to Saturday**			**Sundays and Public Holidays**		
	7am to 6pm	**6pm to10pm**	**10pm to7am**	**7am to 6pm**	**6pm to 10pm**	**10pm to 7am**
LAeq, adj, 15 mins	CV = 55 AV = 10	CV = 50 AV = 10	CV = 45 AV = 5	CV = 50 AV = 10	CV = 45 AV = 10	CV = 40 AV = 5

Table D1 – Noise limits notes:

1. *CV = Critical Value*
2. *AV = Adjustment Value*
3. *To calculate noise limits in Table D1:*

   If bg ≤ (CV – AV):

   Noise limit = bg + AV

   If (CV – AV) < bg ≤ CV:

   Noise limit = CV

   If bg > CV:

   Noise limit = bg + 0
4. *In the event that measured bg (**LA90, adj, 15 mins**) is less than 30 dB(A), then 30 dB(A) can be substituted for the measured background level*
5. *bg = background noise level (**LA90, adj, 15 mins**) measured over 3-5 days at the nearest sensitive receptor*
6. *If the project is unable to meet the noise limits as calculated above alternative limits may be calculated using the processes outlined in the "Planning for Noise Control" guideline.*

Airblast overpressure nuisance

D2 The holder of this environmental authority must ensure that blasting does not cause the limits for peak particle velocity and air blast overpressure in **Table D2 – Blasting noise limits** to be exceeded at a sensitive place or commercial place.

Table D2 – Blasting noise limits

Blasting noise limits	**Sensitive or commercial Blasting noise limits place limits**	
	7am to 6pm	**6pm to 7am**
Airblast overpressure	115 dB (Linear) Peak for 9 out of 10 consecutive blasts initiated and not greater than 120 bB (Linear) Peak at any time	<insert either no blasting or limits justified by proponent not less stringent than 7am – 6pm>
Ground vibration peak particle velocity	5mm/second peak particle velocity for 9 out of 10 consecutive blasts and not greater than 10 mm/second peak particle velocity at any time	<insert either no blasting or limits justified by proponent not less stringent than 7am – 6pm>

Monitoring and reporting

D3 Noise monitoring and recording must include the following descriptor characteristics and matters:

a) LAN,T (where N equals the statistical levels of 1, 10 and 90 and T = 15 mins)

b) background noise LA90

c) the level and frequency of occurrence of impulsive or tonal noise and any adjustment and penalties to statistical levels

d) atmospheric conditions including temperature, relative humidity and wind speed and directions

e) effects due to any extraneous factors such as traffic noise

f) location, date and time of monitoring

g) if the complaint concerns low frequency noise, Max LpLIN,T and one third octave band measurements in dB(LIN) for centre frequencies in the 10 – 200 Hz range.

D4 The holder of this environmental authority must develop and implement a blast monitoring program to monitor compliance with **Table D2 – Blasting noise limits** for:

a) at least <insert number> % of all blasts undertaken on this site in each <insert period for example, month or year> at the nearest sensitive place or commercial place <at insert a place nominated in this authority>

b) all blasts conducted during any time period specified by the administering authority at the nearest sensitive place or commercial place.

Schedule E - Groundwater

Contaminant release

Explanatory note— the first version of condition E1 is only to be used when it has been identified that no release of contaminants to groundwater is to occur as a result of mining activities. The definition of a 'contaminant' is set out in Section 11 of the EP Act and relevantly includes any 'gas, liquid or solid', not just hazardous contaminants. For example, it would include the replenishment of aquifers with water of the same quality or higher quality than the aquifers.

The term 'release' is defined in Schedule 4 of the EP Act and relevantly, it should be noted that this includes passive releases and not merely controlled releases. Accordingly, if it is likely that the activity will lead to the passive replenishment of aquifers, even with good quality water, version 1 of condition E1 should not be used.

In relation to version 2 of condition E1 - Section 63 of the Environmental Protection Regulation 2008 addresses the topic of the release of 'waste' to groundwater. The term 'waste' is defined in Section 13 of the EP Act. Section 63 of the EP Regulation requires the administering authority to refuse an application if:

a) the waste is not being, or may not be, released entirely within a confined aquifer (except for petroleum activities); or

b) the release of the waste is affecting adversely, or may affect adversely, a surface ecological system; or

c) the waste is likely to result in a deterioration in the environmental values of the receiving groundwater.

Paragraph b) is not intended to apply to a surface ecological system which is authorised to be cleared for the purpose of the mining activities. Paragraphs b) and c) are not intended to apply to trivial impacts.

Where contaminants are proposed to be released to groundwater the limits set out in the condition must not be exceeded at the release point. All the potential contaminants generated as part of the mining activity that have a release limit will be included in this table. The limit type and value will need to be determined in consultation with the administering authority.

E1 EITHER

The holder of this environmental authority must not release contaminants to groundwater.

Or

The holder of this environmental authority is authorised to release contaminants at the release points and at the release frequencies specified in **Table E1 - Groundwater release points, frequency** and comply with the release limits specified in **Table E2 - Groundwater release quality**.

Table E1 - Groundwater release points, frequency

Release points	Release Frequency	Location	
		Easting (GDA94 – Zone 54)	Northing (GDA94 – Zone 54)

Table E2 - Groundwater release quality

Parameter	Release limit

Monitoring and reporting

E2 All determinations of groundwater quality and biological monitoring must be performed by an appropriately qualified person.

E3 Groundwater quality and levels must be monitored at the locations and frequencies defined in **Table - E3 Groundwater monitoring locations and frequency** and Schedule # – Figure # (Groundwater Bore Monitoring Locations) for quality characteristics identified in **Table E4 - Groundwater quality triggers and limits**.

Table E3 - Groundwater monitoring locations and frequency

Monitoring Point	Location		Surface RL (m)[1]	Monitoring Frequency
	Easting (GDA94 – Zone 54)	Easting (GDA94 – Zone 54)		
Reference Bores[2]				
Compliance Bores				

1. Monitoring is not required where a bore has been removed as a direct result of the mining activity.
2. RL must be measured to the nearest 5cm from the top of the bore casing.
3. Reference sites must:
   (a) have a similar flow regime;
   (b) be from the same bio-geographic and climatic region;
   (c) have similar geology, soil types and topography; and
   (d) not be so close to the test sites that any disturbance at the test site also results in a change at the reference site.

Table E4 - Groundwater quality triggers and limits

Parameter	Contaminant Triggers	Contaminant Limit

E4 Groundwater levels when measured at the monitoring locations specified in **Table E3 -Groundwater monitoring locations and frequency** must not exceed the groundwater level trigger change thresholds specified in **Table E5 - Groundwater level monitoring** below.

Table E5 - Groundwater level monitoring

Monitoring location	Level trigger threshold

Monitoring location	Level trigger threshold

Exceedance Investigation

E5 If quality characteristics of groundwater from compliance bores identified in **Table E3 - Groundwater monitoring locations and frequency** exceed any of the trigger levels stated in **Table E4 - Groundwater quality triggers and limits** or exceed any of the groundwater level trigger threshold stated in **Table E5 - Groundwater level monitoring**, the holder of this environmental authority must compare the compliance monitoring bore results to the reference bore results and complete an investigation in accordance with the ANZECC and ARMCANZ 2000.

E6 Results of monitoring of groundwater from compliance bores identified in **Table E3 - Groundwater monitoring locations and frequency**, must not exceed any of the limits defined in **Table E4 - Groundwater quality triggers and limits**.

Bore construction and maintenance and decommissioning.

E7 The construction, maintenance and management of groundwater bores (including groundwater monitoring bores) must be undertaken in a manner that prevents or minimises impacts to the environment and ensures the integrity of the bores to obtain accurate monitoring

Schedule F - Water (Fitzroy model conditions)

Explanatory note—the model conditions in this schedule are based on the Model Water conditions for coal mines in the Fitzroy River Basin. Alterations to the conditions will be necessary in different catchments to capture the environmental values, use of water resources and the quality characteristics of those catchments. Similarly, alterations will be required for mines other than coal mines.

An alternative approach to the surface water release conditions contained within this guideline is available based on the Isaac River mine water release pilot. Certain prerequisites will have to be met before a mining activity may apply to adopt the pilot water release conditions.

It should also be noted that these conditions may be subject to amendments that are dependent on the outcome of the Isaac River mine water release pilot.

Contaminant release

Explanatory note—the definition of 'mine affected water' is set out in the Definitions Schedule. The release of waters other than mine affected waters does not need to be listed in Table F1 (eg: overland flow water that has been diverted around mine infrastructure). 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 run-off containing sediment only that is not likely to have properties that would cause environmental harm based on the water quality parameters for mine affected water in Tables ##, do not need to be identified in Table F1.

There is no intention to prevent the internal transfer of waters on mine sites. Where this is adequately addressed in a water management plan, condition F3 is not required.

In addition, there is no requirement to list in Table F1 the holder's or third parties' artificial storage or transfer structures or other beneficial re-use points which are authorised under condition F24 (Water re-use).

F1 Contaminants that will, or have the potential to cause environmental harm must not be released directly or indirectly to any waters as a result of the authorised mining activities, except as permitted under the conditions of this environmental authority.

F2 Unless otherwise permitted under the conditions of this environmental authority, the release of mine affected water to waters must only occur from the release points specified in **Table F1 - Mine affected water release points, sources and receiving waters** and depicted in Figure 1 attached to this environmental authority.

F3 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 F28 is permitted.

Table F1 - Mine affected water release points, sources and receiving waters

Release Point (RP)	Latitude (decimal degree, GDA94)	Longitude (decimal degree, GDA94)	Mine Affected Water Source and Location	Monitoring Point	Receiving waters description
RP 1	XXXX	XXXX	e.g. Stormwater Dam Spillway Overflow	Dam Spillway	Wet Creek
RP 2	XXXX	XXXX	e.g. Dam overflow pipe	Sampling Tap on pipe where the pipe enters Sandy Creek	Sandy Creek

F4 The release of mine affected water to waters in accordance with condition F2 must not exceed the release limits stated in **Table F2 - Mine affected water release limits** when measured at the monitoring points specified in **Table F1 - Mine affected water release points, sources and receiving waters** for each quality characteristic.

Table F2 - Mine affected water release limits

Quality Characteristic	Release Limits	Monitoring frequency	Comment
Electrical conductivity (uS/cm)	Release limits specified in Table F4 for variable flow criteria or condition F11.	Daily during release (the first sample must be taken within 2 hours of commencement of release)	
pH (pH Unit)	6.5 (minimum) 9.0 (maximum)	Daily during release (the first sample must be taken within 2 hours of commencement of release)	
Turbidity (NTU)	Current limit or limit derived from suspended solids limit and demonstrated correlation between turbidity to suspended solids historical monitoring data for dam water*	Daily during release* (first sample within 2 hours of commencement of release)	Turbidity is required to assess ecosystems impacts and can provide instantaneous results.

F5 The release of mine affected water to waters from the release points must be monitored at the locations specified in **Table F1 - Mine affected water release points, sources and receiving waters** for each quality characteristic and at the frequency specified in **Table F2 - Mine affected water release limits** and **Table F3 - Release contaminant trigger investigation levels, potential contaminants**.

Note: the administering authority will take into consideration any extenuating circumstances prior to determining an appropriate enforcement response in the event condition F5 is contravened due to a temporary lack of safe or practical access. The administering authority expects the environmental authority holder to take all reasonable and practicable measures to maintain safe and practical access to designated monitoring locations.

Explanatory note— the quality characteristics listed in **Table F3 - Release contaminant trigger investigation levels, potential contaminants** should be assessed on a site by site basis by each mine prior to finalisation of amendment applications. The assessment should take into account such characteristics as the geology and chemical characteristics of the land to be disturbed, the types of contaminants likely to be found in processing and quality characteristics of receiving waters.

Based on this assessment, the quality characteristic should be either not be included in **Table F3 - Release contaminant trigger investigation levels**, potential contaminants if below trigger levels; or included as priority contaminants in **Table F3 - Release contaminant trigger investigation levels, potential contaminants** if above trigger levels. Assessment should involve comparison of representative data from dams that have historically been discharged or likely to be discharged from contaminant release points in **Table F1 - Mine affected water release points, sources and receiving waters**. Data may include historical results or sampling undertaken for this specific purpose.

It could also be demonstrated based on existing water quality information that the water source and relative water quality of some dams are the same, in which case such dams may not need to be sampled individually. For metals and metalloids, trigger levels apply if dissolved results exceed trigger levels. However, total (unfiltered) results for metals and metalloids can be used to disregard a characteristic for inclusion in **Table F3 - Release contaminant trigger investigation levels, potential contaminants**.

Table F3 - Release contaminant trigger investigation levels, potential contaminants

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	*For aquatic ecosystem protection, based on SMD guideline*	
Copper	2	*For aquatic ecosystem protection, based on LOR for ICPMS*	
Iron	300	*For aquatic ecosystem protection, based on low reliability guideline*	
Lead	4	*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	*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	*For aquatic ecosystem protection, based on LOR for ICPMS*	
Uranium	1	*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	100		

(C10-C36)			
Fluoride (total)	2000	*Protection of livestock and short term irrigation guideline*	
Sodium	TBA		
Suspended Solids	Limit to be determined based on receiving water reference data and achievable best practice sedimentation control and treatment*		
Sulphate (SO42-) (mg/L)	Limit to be determined based on receiving water reference data and achievable best practice sedimentation control and treatment*	*Drinking water environmental values from NHMRC 2006 guidelines OR ANZECC*	

Table F3 - Release contaminant trigger investigation levels, potential contaminants *notes:*

1. *All metals and metalloids must be measured as total (unfiltered) and dissolved (filtered). Trigger levels for metal/metalloids apply if dissolved results exceed trigger.*
2. *The quality characteristics required to be monitored as per* ***Table F3 - Release contaminant trigger investigation levels, potential contaminants*** *can be reviewed once the results of 2 years monitoring data is available, or if sufficient data is available to adequately demonstrate negligible environmental risk, and it may be determined that a reduced monitoring frequency is appropriate or that certain quality characteristics can be removed from* ***Table F3 - Release contaminant trigger investigation levels, potential contaminants*** *by amendment.*
3. *SMD – slightly moderately disturbed level of protection, guideline refers ANZECC & ARMCANZ (2000).*
4. *LOR – typical reporting for method stated. ICPMS/CV FIMS – analytical method required to achieve LOR.*

F6 If quality characteristics of the release exceed any of the trigger levels specified in **Table F3 - Release contaminant trigger investigation levels, potential contaminants** during a release event, the environmental authority holder must compare the down stream results in the receiving waters to the trigger values specified in **Table F3 - Release contaminant trigger investigation levels, potential contaminants** and:

a) where the trigger values are not exceeded then no action is to be taken; or

b) where the down stream results exceed the trigger values specified **Table F3 - Release contaminant trigger investigation levels, potential contaminants** for any quality characteristic, compare the results of the down stream site to the data from background monitoring sites and

1. if the result is less than the background monitoring site data, then no action is to be taken; or

2. 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 within 90 days of receiving the result , outlining

   (i) details of the investigations carried out

   (ii) actions taken to prevent environmental harm.

Note: Where an exceedance of a trigger level has occurred and is being investigated, in accordance with F6 b (2) of this condition, no further reporting is required for subsequent trigger events for that quality characteristic.

F7 If an exceedance in accordance with condition F6 b (2) is identified, the holder of the environmental authority must notify the administering authority in writing within 24 hours of receiving the result.

Mine Affected Water Release Events

F8 The holder must ensure a stream flow gauging station/s is installed, operated and maintained to determine and record stream flows at the locations and flow recording frequency specified in **Table F3 - Release contaminant trigger investigation levels, potential contaminants**.

F9 Notwithstanding any other condition of this environmental authority, the release of mine affected water to waters in accordance with condition F2 must only take place during periods of natural flow in accordance with the receiving water flow criteria for discharge specified in **Table F4 - Mine affected water release during flow events** for the release point(s) specified in **Table F1 - Mine affected water release points, sources and receiving waters**.

F10 The release of mine affected water to waters in accordance with condition F2 must not exceed the Maximum Release Rate (for all combined release point flows) for each receiving water flow criterion for discharge specified in **Table F4 - Mine affected water release during flow events** when measured at the monitoring points specified in **Table F1 - Mine affected water release points, sources and receiving waters**.

or

F11 The 80th percentile of electrical conductivity (EC) values recorded at the downstream monitoring points listed in **Table F4 - Mine affected water release during flow events** must not exceed XXXuS/cm over the duration of the release influence period and have a maximum value of no greater than 20 per cent of XXXuS/cm. The 80th percentile must be calculated using all EC values recorded by the monitoring station during the release influence period.

Note: The release influence period is the period during which the downstream monitoring points are influenced by mine affected water releases and includes both the duration of release and any lag time between release point/s and downstream monitoring points.

Explanatory note— Table F4 – Mine affected water release during flow events

Gauging station description:

The intent here is that every release point in **Table F1 - Mine affected water release points, sources and receiving waters** is associated with a gauging station that measures flow upstream of the discharge point. More than 1 discharge point may be associated with the same gauging station. The gauging station should be at a minimum distance from the discharge point such that water flow under trigger flow events will not significantly diminish by the time it reaches the discharge point.

The location of the gauging station should ideally be such that it is not significantly affected by other upstream point source releases or times of discharge are limited to periods of "natural" flow. In the situation where there is an existing gauging station that is capable of performing all the monitoring functions required by these conditions, this gauging station may be used instead of having to install a new gauging station. Agreement to access the gauging stations is the responsibility of the environmental authority holder and is to be provided in writing to the administering authority.

Under certain circumstances it may be appropriate to have a downstream gauging station in addition to or in replacement of an upstream gauging station. The location should ideally not be affected by the discharge (for example, be measured off the main waterway). The need for this must be demonstrated on a case by case basis to show why an upstream gauging station is insufficient. This may be the case when mines are located in the upper parts of catchments or near the downstream confluence or a major waterway. Similarly, the gauging station should be at a distance from the discharge point such that water flow during triggered flow events will not significantly diminish between the discharge point and the measuring point (or the confluence with the creek being measured). For downstream flow triggers, some changes to calculation for flow triggers and maximum release flows would typically be required based on the relative sizes of the waterways involved.

Flow Triggers and EC Quality Criteria:

The intent for flow triggers is that the times of discharge are limited to times around natural flow events only. Different flow regime methodologies are used to define mine affected water release opportunities, provide flexibility for site operators and to protect identified environmental values within receiving waters. The expectation is that where flow gauging data is available, it is used to calculate flow triggers. Where gauging data is not available or is insufficient, flow triggers should be based on runoff/stream flow estimates using appropriate hydrological calculations or models and known catchment area, rainfall estimations etc.

Separate methodologies for discharges which occur to local waterways rather than regional waterways will be applied as part of this revised approach. Due to the increased flexibility of the revised approach and consideration of a wider range of local factors the application of these model conditions to individual sites will require case-by case assessment and require sufficient background information to be provided. For example, it should be noted that discharges upstream of dams or lakes may require special considerations and generally stricter controls. Also, where multiple mines discharge to the same or closely connected waterways consideration of cumulative impacts will be necessary as part of the assessment process.

Model conditions do not preclude applicants from proposing alternative or additional conditions, nor restrict the administering authority from using alternative conditions where the case warrants. However, applications proposing alternative approaches will need to be supported by sufficient environmental risk assessment and contingency planning information to allow the administering authority to adequately consider the proposal.

There may be instances where case-by-case proposals can be considered for conditions to address management of particularly heavy rainfall and flooding that is similar to previous events, where there is sufficient information available based on: previous transitional environmental programs, monitoring and analysis, the environmental values of the receiving environment together with the experience of impacts on those environmental values, rigorous contingency and disaster response planning, and with particular regard to actual and potential cumulative impacts. For example, there may be potential to tailor a schedule of conditions to be triggered upon reaching nominated thresholds of rainfall, flow, flooding (or a combination) based on learning from an event that has occurred in the past; possibly adopting a similar framework to previous discharge permissions granted in similar circumstances, provided the framework was demonstrated to adequately address environmental risk to the satisfaction of the delegate.

No/low flow stream conditions (best quality / low EC mine affected water):

Discharge water quality will need to meet or be better than water quality objectives (or long term background reference 75th / 80th percentile) for EC and will only be permitted for temporary periods after periods of significant flow. The focus of this is to allow "good" quality water to be released when collected rather than having it stored over long durations resulting in deteriorating water quality. Any discharges made under no/low flow stream conditions must not contribute to or cause erosion and due consideration should be given to road/rail access, stock crossings etc. (particularly in relation to multiple mines discharging under no/low flow stream conditions on connected waterways). General principles include:

a) Release at times when flow is on tail end of flow event only that is, following a flow above specified event flow trigger and when the flow reduces below the flow trigger again. This trigger will commence a discharge window of 4-6 weeks for good quality water only

b) End of pipe WQ ≤ WQO (or long term background reference 75th/80th percentile). May require assessment of downstream environmental values where WQO is more stringent (for example, drinking water supply)

c) Duration of release is limited (dry ephemeral stream, 4 weeks after flow event ceases, use time after flow trigger for below – add additional time)

d) Volume/rate will be considered on a case by case basis.

Medium flow stream conditions (medium quality mine affected water):

A flow trigger for the stream is required and will be set to avoid discharge of medium quality water during periods of no or low flow. General principles include:

a) Requires the use of a stream flow trigger above which release can occur. The stream flow trigger must be representative of event flow and be above base/low flow (typically determined from hydrographs, historical flow/water quality data and/or modeling)

b) End-of pipe EC <3500uS/cm. Options for either <1500us/cm and <3500uS/cm as maximum limits can be considered which will result in different maximum discharge rates for different quality water. The better the quality of water to be released, the greater the volume that can be permitted

c) The design dilution/maximum discharge rate should be based on a site specific risk assessment. These should be designed to achieve an in-stream EC based on the location – upper (Zone 1), mid (Zone 2) or lower (Zone 3) catchment. The EC $_{WQO\ high\ flow}$ should be adopted as background EC for design calculations

   - Zone 1, upper catchment mines, approximately <10km from top of waterway catchment.

   EC $_{in\ stream}$ = 1000uS/cm (toxicity guideline).

   - Zone 2, mid catchment mines, zones not within Zone 1 or Zone 3

   EC $_{in\ stream}$ = 700uS/cm

   - Zone 3, lower catchment mines (All regional waterways are considered Zone 3 from distance >50km from top of waterway catchment, refer to Zone 3 map) –

   EC $_{in\ stream}$ = EC $_{high\ flow\ WQO}$ + multiplier x (EC $_{WQO\ low\ flow}$ – EC $_{WQO\ high\ flow}$)

   for example, multiplier = 0.2 for Isaac, Nogoa, Dawson

d) EC in stream for calculations may vary according to other locally relevant environmental values that may need to be considered.

High flow stream conditions (poorer quality water):

This option might be used in some cases for mines that need to discharge higher EC wastewater than is allowable under medium flow stream conditions. Any discharge is required to have a higher level of dilution than with medium flow cases but still achieve a maximum incremental increase in the waterway. This option is most feasible for mines situated on regional waterways as the window for discharge is likely to be limited for local waterways. Some additional considerations on management of mixing zones and acute/chronic toxicity may be required in this case. General principles include:

a) Requires the use of a stream flow trigger above which release can occur. The stream flow trigger must be representative of high event flow and be above medium flow (typically determined from hydrographs, historical flow/water quality data and/or modeling)

b) End-of pipe EC must be > 3500uS/cm (but <10,000uS/cm). The better the quality of water to be released, the greater the volume that can be permitted

c) The design dilution/maximum discharge rate should be based on a site specific risk assessment. These should be designed to achieve an in-stream EC based on the location – upper (Zone 1), mid (Zone 2) or lower (Zone 3) catchment as described above

d) May need some additional indicators/requirements and requires case by case assessment

This option is likely to be less feasible for Zone 1 and 2 mines.

Using condition F11 in place of F10

Where condition F11 has been used instead of F10, Table F4 is to be modified to remove references to electrical conductivity release limits. The low, medium and high flow criteria and maximum release rate are also to be removed and replaced with minimum flow in receiving water criteria.

Table F4 - Mine affected water release during flow events

Receiving waters/ stream	Release Point (RP)	Gauging station	Gauging Station Latitude (decimal degree, GDA94)	Gauging Station Longitude (decimal degree, GDA94)	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
e.g. Wet Creek	Insert all release points that will release based on this gauging station flow. e.g. RP1, RP2 & RP3	e.g. Gauging station 1	XXXX	XXXX	Continuous (minimum daily)	Low Flow <XX m3/s for a period of <insert number of days> after natural flow events that exceed XX m3/s (where XX is a specified event flow trigger)	Insert < xx ML/day or < xx m3/s Volume/rate to be determined on case by case basis	Electrical conductivity (uS/cm): <insert water quality objective or 75th percentile of long term background reference data>
						Medium Flow > XX m3/s (where XX is specified event flow trigger)	< XX m3/s (where XX is the maximum release rate determined on case by case basis)	Electrical conductivity (uS/cm) <insert value determined on case specific basis but typically <1500
							< YY m3/s (where YY is the maximum release rate determined on case by case basis)	Electrical conductivity (uS/cm) <insert value determined on case specific basis but typically <3500
						High Flow > ZZ m3/s (where ZZ is a specified high flow event trigger)	< ZZ m3/s (where ZZ is the maximum release rate determined on case by case basis)	Electrical conductivity (uS/cm) <insert value determined on case specific basis but typically within a range of <3500 to <10,000

F12 The daily quantity of mine affected water released from each release point must be measured and recorded.

F13 Releases to waters must be undertaken so as not to cause erosion of the bed and banks of the receiving waters, or cause a material build up of sediment in such waters.

Notification of Release Event

F14 The environmental authority holder must notify the administering authority as soon as practicable and no later than 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 Department Interest: Water of this environmental authority (that is, contaminant limits, natural flow, discharge volume)

c) release point/s

d) release rate

e) release salinity

f) receiving water/s including the natural flow rate.

Note: Notification to the administering authority must be addressed to the Manager and Project Manager of the local Administering Authority via email or facsimile.

F15 The environmental authority holder must notify the administering authority as soon as practicable and nominally no later than 24 hours after cessation of a release event of the cessation of a release notified under Condition F14 and within 28 days provide the following information in writing:

a) release cessation date/time

b) natural flow rate in receiving water

c) volume of water released

d) details regarding the compliance of the release with the conditions of Department Interest; Water of this environmental authority (i.e. contaminant limits, natural flow, discharge volume)

e) all in-situ water quality monitoring results

f) any other matters pertinent to the water release event.

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 conditions F14 and F15, provided the relevant details of the release are included within the notification provided in accordance with conditions F14 and F15.

Notification of Release Event Exeedance

F16 If the release limits defined in **Table F2 - Mine affected water release limits** are exceeded, the holder of the environmental authority must notify the administering authority within 24 hours of receiving the results.

F17 The environmental authority holder must, within 28 days of a release that is not compliant with the conditions of this environmental authority, provide a report to the administering authority detailing:

a) the reason for the release

b) the location of the release

c) the total volume of the release 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) all water quality monitoring results (including all laboratory analyses)

f) identification of any environmental harm as a result of the non compliance

g) all calculations

h) any other matters pertinent to the water release event.

Receiving Environment Monitoring and Contaminant Trigger Levels

F18 The quality of the receiving waters must be monitored at the locations specified in **Table F6 - Receiving water upstream background sites and down stream monitoring points** for each quality characteristic and at the monitoring frequency stated in **Table F5 - Receiving waters contaminant trigger levels**.

Table F5 - Receiving waters contaminant trigger levels

Quality Characteristic	Trigger Level	Monitoring Frequency
pH	6.5 – 9.0	Daily during the release
Electrical Conductivity (µS/cm)	TBA Note: for protection against toxicity this may need to be reduced in some circumstances e.g. where in close proximity upstream of a drinking water dam or regional waterway	
Suspended solids (mg/L)	To Be Determined. Turbidity may be required to assess ecosystems impacts and can provide instantaneous results.	
Sulphate (SO_4^{2-}) (mg/L)	250 (Protection of drinking water Environmental Value)	

Table F6 - Receiving water upstream background sites and down stream monitoring points

Monitoring Points	Receiving Waters Location Description	Latitude (decimal degree, GDA94)	Longitude (decimal degree, GDA94)
Upstream Background Monitoring Points			
Monitoring Point XX	XXXX Creek XX metres upstream of RP XX	XXXX	XXXX
Monitoring Point XX	XXXX Creek XX metres upstream of RP XX	XXXX	XXXX
Downstream Monitoring Points			
Monitoring Point XX	XXXX Creek XX metres downstream of RP XX	XXXX	XXXX
Monitoring Point XX	XXXX Creek XX metres downstream of RP XX	XXXX	XXXX

Table F6 - Receiving water upstream background sites and down stream monitoring points notes:

a) The upstream monitoring point should be within X km the release point.

b) The downstream point should not be greater than X m from the release point.

c) *The data from background monitoring points must not be used where they are affected by releases from other mines.*

F19 If quality characteristics of the receiving water at the downstream monitoring points exceed any of the trigger levels specified in **Table F5 - 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; or

b) where the down stream results exceed the upstream results complete an investigation into the potential for environmental harm and provide a written report to the administering authority in the next annual return, outlining

1. details of the investigations carried out
2. actions taken to prevent environmental harm.

Note: Where an exceedance of a trigger level has occurred and is being investigated, in accordance with F19 b) of this condition, no further reporting is required for subsequent trigger events for that quality characteristic.

F20 All determinations of water quality and biological monitoring must be performed by an appropriately qualified person.

Receiving Environment Monitoring Program (REMP)

F21 The environmental authority holder must develop and implement a Receiving Environment Monitoring Program (REMP) to monitor, identify and describe any adverse impacts to surface water environmental values, quality and flows due to the authorised mining activity. This must include monitoring the effects of the mine on the receiving environment periodically (under natural flow conditions) and while mine affected water is being discharged from the site. For the purposes of the REMP, the receiving environment is the waters of the *XX* and connected or surrounding waterways within *XX* (for example, *X*km) downstream of the release. The REMP should encompass any sensitive receiving waters or environmental values downstream of the authorised mining activity that will potentially be directly affected by an authorised release of mine affected water.

F22 A REMP Design Document that addresses the requirements of the REMP must be prepared and made available to the administrating authority upon request.

F23 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 must include an assessment of background reference water quality, the condition of downstream water quality compared against water quality objectives, and the suitability of current discharge limits to protect downstream environmental values.

Water reuse

Explanatory notes—Water reuse conditions

Mine affected water reuse conditions acknowledge that there is beneficial potential for using mine affected water. How the water is to be reused is not to be stipulated, this is for the third party to determine as they are better placed to make this decision.

F24 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).

Annual Water Monitoring Reporting

F25 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:

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 mine affected water 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 exceedances of the conditions of this environmental authority

g) water quality monitoring data must be provided to the administering authority in the specified electronic format upon request.

Temporary Interference with waterways

F26 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*.

Water Management Plan

F27 A Water Management Plan must be developed by an appropriately qualified person and implemented.

Stormwater and Water sediment controls

F28 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.

F29 Stormwater, other than mine affected water, is permitted to be released to waters from:

a) erosion and sediment control structures that are installed and operated in accordance with the Erosion and Sediment Control Plan required by condition F28

b) water management infrastructure that is installed and operated, in accordance with a Water Management Plan that complies with condition F27, for the purpose of ensuring water does not become mine affected water.

Schedule G - Sewage treatment

Explanatory note—G1 may need amendment if other contaminants are permitted to be released to land. Monthly monitoring of E-coli may be revised based on location/remoteness of mine site.

G1 The only contaminant permitted to be released to land is treated sewage effluent in compliance with the release limits stated in **Table G1 - Contaminant release limits to land.**

Table G1 - Contaminant release limits to land

Contaminant	Unit	Release limit	Limit type	Frequency
5 day Biochemical oxygen demand (BOD)1	mg/L	20	Maximum	Monthly
Total suspended solids	mg/L	30	Maximum	Monthly
Nitrogen	mg/L	30	Maximum	Monthly
Phosphorus	mg/L	15	Maximum	Monthly
E-coli	Organisms/100ml	1000	Maximum	Monthly
pH	pH units	6.0 – 9.0.	Range	Monthly

G2 Treated sewage effluent may only be released to land in accordance with the conditions of this approval at the following locations:

(a) within the nominated area(s) identified in Schedule ##—Figure ## (sewage treatment plant and effluent disposal)

(b) other land for the purpose of dust suppression and/or fire fighting.

G3 The application of treated effluent to land must be carried out in a manner such that:

(a) vegetation is not damaged

(b) there is no surface ponding of effluent

(c) there is no run-off of effluent.

G4 If areas irrigated with effluent are accessible to employees or the general public, prominent signage must be provided advising that effluent is present and care should be taken to avoid consuming or otherwise coming into unprotected contact with the effluent.

G5 All sewage effluent released to land must be monitored at the frequency and for the parameters specified in **Table G1 - Contaminant release limits to land**.

G6 The daily volume of effluent release to land must be measured and records kept of the volumes of effluent released.

G7 When circumstances prevent the irrigation or beneficial reuse of treated sewage effluent such as during or following rain events, waters must be directed to a wet weather storage or alternative measures must be taken to store/lawfully dispose of effluent.

G8 A minimum area of <<insert area>> of land, excluding any necessary buffer zones, must be utilised for the irrigation and/or beneficial reuse of treated sewage effluent.

Explanatory note — the supply of treated wastewater for re-use is regulated under the *Water Supply (Safety and Reliability) Act 2008.*

G9 Treated sewage effluent must only be supplied to another person or organisation that has a written plan detailing how the user of the treated sewage effluent will comply with their general environmental duty under section 319 of the Act whilst using the treated sewage effluent.

Schedule H - Land and rehabilitation

Explanatory note—Table H1 - Rehabilitation Requirements

Tables should be kept as concise as reasonably practicable, without losing clarity. For example, if requirements for more than 1 domain are the same, there is no need to set out a separate row for each domain. The components shown in the table below are only examples of rehabilitation requirements. Only mine features that are present in the mines should be listed. The contents of **Table H1 - Rehabilitation Requirements** below are included as examples only.

H1 Land disturbed by mining must be rehabilitated in accordance with **Table H1 - Rehabilitation Requirements**.

Table H1 - Rehabilitation Requirements

Mine Domain	Mine Feature Name	Rehabilitation Goal	Rehabilitation Objectives	Indicators	Completion Criteria
Dams ML XXXX	Tailings dam	1. Safe	(a) Site safe for humans and animals	(a) Structural, geotechnical and hydraulic adequacy of the dam	
		2. Non-polluting	(a) Acid mine drainage will not cause environmental harm	(a) Technical design of capping (b) Surface and groundwater monitoring	e.g. Monitoring meeting release limits
		3. Stable	(a) Minimise erosion	(a) Engineered structure to control water flow (b) Vegetation cover	e.g. Surface armour/ engineered drop structures in place and functioning e.g. X% foliage cover recorded over a period of X years
		4. Self-sustaining	Describe post mine land use of land suitability or land capability	(a) Species diversity (b) Presence of key species	e.g. Certification that X% species diversity achieved and maintained for X years e.g. Certification that key species present over a period of X years
Waste rock dump					
Infrastructure					
Voids					
Roads					

H2 Rehabilitation must commence progressively in accordance with the plan of operations.

Contaminated Land

H3 Before applying for surrender of a mining lease, the holder must (if applicable) provide to the administering authority a site investigation report under the Act, in relation to any part of the mining lease which has been used for notifiable activities or which the holder is aware is likely to be contaminated land, and also carry out any further work that is required as a result of that report to ensure that the land is suitable for its final land use.

H4 Before applying for progressive rehabilitation certification for an area, the holder must (if applicable) provide to the administering authority a site investigation report under the Act, in relation to any part of the area the subject of the application which has been used for notifiable activities or which the holder is aware is likely to be contaminated land, and also carry out any further work that is required as a result of that report to ensure that the land is suitable for its final land use under condition H1.

H5 Minimise the potential for contamination of land by hazardous contaminants.

Biodiversity offsets

H6 The holder of this environmental authority must provide an offset for impacts on applicable state significant biodiversity values, in accordance with Queensland Biodiversity Offset Policy. The biodiversity offset must be consistent with the requirements for an offset as identified in the Biodiversity Offset Strategy (as per condition H7) and must be provided:

a) prior to impacting on state significant biodiversity values; or

b) where a land based offset is to be provided, within 12 months of the later of either of the following

   1. the date of issue of this environmental authority; or

   2. the relevant stage identified in the Biodiversity Offset Strategy submitted under condition H7; or

c) where an offset payment is to be provided, within 4 months of the later of either of the following

   1. the date of issue of this environmental authority; or

   2. the relevant stage identified in the Biodiversity Offset Strategy submitted under conditions H7.

H7 A Biodiversity Offset Strategy must be developed and submitted to the administering authority within either 30 days, or a lesser period agreed to by the administering authority, prior to impacting on the applicable state significant biodiversity values.

End of conditions

ADVICE - OTHER AREAS OF CONCERN TO BE CONSIDERED

Monitoring

Upon request from the administering authority, copies of monitoring records and reports should be made available and provided to the administering authority's nominated office within 10 business days or an alternative timeframe agreed between the administering authority and the holder.

Any management or monitoring plans, systems or programs required to be developed and implemented by a condition of this environmental authority should be reviewed for effectiveness in minimising the likelihood of environmental harm on an annual basis, and amended promptly if required, unless a particular review date and amendment program is specified in the plan, system or program.

Light

A condition about light should not be imposed unless this is likely to be a relevant issue for the mine due to the proximity of sensitive places. If so, the following condition may be included:

AXX In the event of a complaint about light from any mining activity that, after investigation, is in the opinion of an authorised person causing a nuisance at a sensitive place, the holder of this environmental authority must take appropriate action to mitigate the nuisance. The holder of this environmental authority must take the action within the reasonable time set by the administering authority.

Chemicals and flammable or combustible liquids

All explosives, hazardous chemicals, corrosive substances, toxic substances, gases and dangerous goods should be stored and handled in accordance with the current Australian standard where such is applicable.

Flammable and combustible liquids, including petroleum products, should be stored and handled in accordance with the latest edition of AS1940—The storage and handling of flammable and combustible liquids.

Where no relevant Australian standard exists store such materials within an effective on-site containment system.

Minimise the potential for contamination of land and waters by diverting stormwater around contaminated areas and facilities used for the storage of chemicals and flammable or combustible liquids.

Meteorological monitoring

Environmental authority holders are encouraged to establish and maintain an automatic weather station to measure and record wind speed, wind direction, temperature and rainfall intensity to aid in the compliance with conditions of approval.

It is possible for environmental authority holders to utilise relevant and available weather monitoring information collected by other parties as reference data.

Waste rock

A waste rock and spoil disposal plan should be developed and include, where relevant, at least:

a) effective characterisation of the waste rock and spoil to predict under the proposed placement and disposal strategy the quality of runoff and seepage generated concerning potentially environmentally significant effects including salinity, acidity, alkalinity and dissolved metals, metalloids and non-metallic inorganic substances

b) a program of progressive sampling and characterisation to identify dispersive and non-dispersive spoil and the salinity, acid and alkali producing potential and metal concentrations of waste rock

c) a materials balance and disposal plan demonstrating how potentially acid forming and acid forming waste rock will be selectively placed and/or encapsulated to minimise the potential generation of acid mine drainage

d) where relevant, a sampling program to verify encapsulation and/or placement of potentially acid-forming and acid-forming waste rock

e) how often the performance of the plan will be assessed

f) the indicators or other criteria on which the performance of the plan will be assessed

g) rehabilitation strategy.

Monitoring or rehabilitation, research and/or trials to verify the requirements and methods for decommissioning and final rehabilitation of the placed materials, including the prevention and management of acid mine drainage, erosion minimisation and establishment of vegetation cover.

Transportation

It is recommended that the holder of the environmental authority ensure that vehicles (including trains) used for transporting bulk materials from mining lease(s), leave the mining lease(s) with appropriate load preparation to prevent the spillage and/or loss of particulate matter and/or windblown dust during transport.

Definitions

Words and phrases used throughout this environmental authority are defined below. Where a definition for a term used in this environmental authority is not provided within this environmental authority, but is provided in the EP Act 1994 or subordinate legislation, the definition in the EP Act or subordinate legislation must be used.

'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.

'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).

'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 relating to the subject matter using the relevant protocols, standards, methods or literature.

'background', with reference to the water schedule means the average of samples taken prior to the commencement of mining from the same waterway that the current sample has been taken.

Explanatory note— **'certification', 'certifying'** or **'certified'**

Only include regulated structures version of this definition if environmental authority controls regulated structures in the conditions.

'certification', 'certifying' or **'certified'** by an appropriately qualified and experienced person in relation to a design plan or an annual report regarding dams/structures, 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 is being certified and the precise nature of that certification;

b) the relevant legislative, regulatory and technical criteria on which the certification has been based;

c) the relevant data and facts on which the certification 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 certification has been based using the relevant data and facts, and the relevant criteria.

'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.

'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 Australian Code for the Transport of Dangerous Goods by Road and Rail approved by the Australian Transport Council; or

c) a lead hazardous substance within the meaning of the Workplace Health and Safety Regulation 1997;

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

(v) a substance used for, or intended for use for mineral processing or treatment of metal, pulp and paper, textile, timber, water or wastewater; or

(vi) manufacture of plastic or synthetic rubber.

'commercial place' means a workplace 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.

'construction' or **'constructed'** in relation to a regulated structure includes building a new regulated structure and lifting or otherwise modifying an existing regulated structure, but does not include investigations and testing necessary for the purpose of preparing a design plan.

'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; or

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.

'EC' means electrical conductivity.

'effluent' treated waste water released from sewage treatment plants.

'hazard 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 'Manual for Assessing Hazard Categories and Hydraulic Performance of Dams'.

'infrastructure' means water storage dams, levees,, roads and tracks, buildings and other structures built for the purpose of the mining activity.

'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 use' –means the selected post mining use of the land, which is planned to occur after the cessation of mining operations.

'leachate' means a liquid that has passed through or emerged from, or is likely to have passed through or emerged from, a material stored, processed or disposed of at the operational land which contains soluble, suspended or miscible contaminants likely to have been derived from the said material.

'licensed place' means the mining activities carried out at the mining tenements detailed in Table # (page #) of this environmental authority.

'm' means metres.

'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 2008 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;
   vi) a mix of mine affected water (under any of paragraphs i)-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.

'measures' includes any measures to prevent or minimise environmental impacts of the mining activity such as bunds, silt fences, diversion drains, capping, and containment systems.

'NATA' means National Association of Testing Authorities, Australia.

'natural flow' means the flow of water through waters caused by nature.

'non polluting' means having no adverse impacts upon the receiving environment.

'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 (mm/s).

'protected area' means – a protected area under the *Nature Conservation Act 1992*; or

a) a marine park under the *Marine Parks Act 1992*; or

b) a World Heritage Area.

'receiving environment' in relation to an activity that causes or may cause environmental harm, means the part of the environment to which the harm is, or may be, caused. The receiving environment includes (but is not limited to):

a) a watercourse;

b) groundwater; and

c) an area of land that is not specified in Schedule # – Table # (Authorised Activities) of this environmental authority.

The term does not include land that is specified in Schedule # – Table # (Authorised Activities) of this environmental authority.

'receiving waters' means the waters into which this environmental authority authorises releases of mine affected water.

'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.

'RL' means reduced level, relative to mean sea level as distinct from depths to water.

'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.

'saline drainage' The movement of waters, contaminated with salts, as a result of the mining activity.

'sensitive place' means:

a) a dwelling, residential allotment, mobile home or caravan park, residential marina or other residential premises; or

b) a motel, hotel or hostel; or

c) an educational institution; or

d) a medical centre or hospital; or

e) a protected area under the *Nature Conservation Act 1992*, the *Marine Parks Act 1992* 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 EPP Noise. That is, a sensitive place is inside or outside on a dwelling, library & educational institution, childcare or kindergarten, school or playground, hospital, surgery or other medical institution, commercial & retail activity, protected area or an area identified under a conservation plan under *Nature Conservation Act 1992* as a critical habitat or an area of major interest, marine park under *Marine Parks Act 2004*, park or garden that is outside of the mining lease and open to the public for the use other than for sport or organised entertainment. A commercial place is inside or outside a commercial or retail activity.

A mining camp (i.e., accommodation and ancillary facilities for mine employees or contractors or both, associated with the mine the subject of the environmental authority) is not a sensitive place for that mine or mining project, whether or not the mining camp is located within a mining tenement that is part of the mining project the subject of the environmental authority. For example, the mining camp might be located on neighbouring land owned or leased by the same company as one of the holders of the environmental authority for the mining project, or a related company. Accommodation for mine employees or contractors is a sensitive place if the land is held by a mining company or related company, and if occupation is restricted to the employees, contractors and their families for the particular mine or mines which are held by the same company or a related company.

For example, a township (occupied by the mine employees, contractors and their families for multiple mines that are held by different companies) would be a sensitive place, even if part or all of the township is constructed on land owned by one or more of the companies.

'the Act' means the *Environmental Protection Act 1994*.

'µS/cm' means micro siemens per centimetre.

'watercourse' has the same meaning given in the *Water Act 2000*.

'water quality' means the chemical, physical and biological condition of water.

'waters' includes 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, and groundwater and any part thereof.

Disclaimer:

While this document has been prepared with care it contains general information and does not profess to offer legal, professional or commercial advice. The Queensland Government accepts no liability for any external decisions or actions taken on the basis of this document. Persons external to the administering authority should satisfy themselves independently and by consulting their own professional advisors before embarking on any proposed course of action.

Approved by

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Appendix

Guidance on compliance with model mining conditions

This section provides guidance on how to comply with the general conditions outlined in Model mining conditions guideline, EM944. Officers should also refer to the separate guidelines: Structures which are dams or levees constructed as part of environmentally relevant activities (EM634).

Generally the conditions do not outline 'how' the environmental authority (EA) holder must achieve the required environmental outcomes. This is referred to as outcome focused conditioning. With outcome focused conditioning, it is the responsibility of the EA holder to assess the most efficient and effective way to achieve the outcome for their own particular circumstance.

In addition to outcome-focussed conditions, in some instances 'how to' conditions may be appropriate for site-specific or project-specific reasons. While these 'how' conditions are by nature not outcome focused, they are required to ensure that a clear environmental value that has been identified can be protected.

The following information has been provided to aid the EA holder in determining the most effective and efficient method to achieve compliance with each model condition of an environmental authority. Possible solutions to achieving compliance with each condition are provided but they are not an exhaustive source. It is possible for the EA holder to decide to achieve the condition outcomes in a manner that is different to that outlined below. The EA holder will need to be satisfied that they can demonstrate, if required, that the outcome of the condition can still be achieved by the alternate approach.

Guidance on how to comply with conditions is not provided for every condition. Where there is no guidance provided on how to comply with a condition there may be details of the requirements to meet the desired outcome within the condition.

Please note, if amended conditions are imposed or agreed which involve changes to existing infrastructure, consideration should be given to an appropriate transitional period enabling the infrastructure work to be undertaken and this should be included in the condition, on a case-by-case basis.

Schedule A – General

A1 This environmental authority authorises environmental harm referred to in the conditions. Where there is no condition or this environmental authority is silent on a matter, the lack of a condition or silence does not authorise environmental harm.

How do I comply?

No further guidance provided to that outlined in the condition.

A2 Either:

In carrying out the mining activity authorised by this environmental authority, disturbance of land

a) may occur in the areas marked 'A'

b) must not occur in the areas marked 'B'

c) may occur in the areas marked 'C' but only in accordance with the conditions in Schedule Z on the map that is annexure 1 to this environmental authority.

OR

In carrying out the mining activity authorised by this environmental authority, the holder of this environmental authority must comply with Schedule K—Figure 1a (Project Infrastructure Layout—Mine Area) and Schedule K—Figure 1b (Project Infrastructure Layout—Support Infrastructure).

How do I comply?

The first version of A2 may be used where the supporting EIS or application documents have enough information to demonstrate that an acceptable level of ground-truthing has been done on potential for flora/fauna impacts and other risk assessment so that EHP is comfortable that the right areas have been identified to indicate no go areas. If the EIS or other supporting information only proposes 2 types of areas (those to be disturbed and those not to be disturbed), it is only necessary to use paragraphs a) and b) below. However, if the EIS or other supporting information addresses and justifies limited disturbance within a mapped area, paragraph c) may be added, on the basis that the conditions for that limited disturbance are set out elsewhere in the conditions or in a report that is adopted by the conditions. If the limited disturbance relates to flora and fauna, refer to Schedule Z.

Where there is not enough information to show that an acceptable level of ground-truthing has been done, the second version of A2 should be used.

Option 1 (for limited surface infrastructure)

A3 Any disturbance within the areas marked 'C' on the map that is annexure 1 to this environmental authority:

a) is only authorised to the extent reasonably necessary for a road, fence, underground service, low-impact telecommunications facility, electrical sub-station, transmission grid works and supply network works, storage depots, similar minor infrastructure and ancillary facilities for any of the above minor infrastructure

b) any disturbance within areas marked 'A' or 'C' is not to impact adversely on areas marked 'B'.

Option 2 (authorising sub-surface disturbance)

A3	Only sub-surface disturbance is authorised within the areas marked 'C' on the map that is annexure 1 to this environmental authority.

How do I comply?

Condition A3 should only be used if condition A2 includes optional paragraph c) authorising limited disturbance within a mapped area. These conditions are not to be used in relation to paragraphs a) and b) of condition A2. The model conditions are examples only. Any authorisation of limited disturbance should be site-specific and based on an assessment of the EIS or other supporting information, including ground-truthing of the areas.

A4	The holder of this environmental authority must: a) install all measures, plant and equipment necessary to ensure compliance with the conditions of this environmental authority b) maintain such measures, plant and equipment in a proper and efficient condition c) operate such measures, plant and equipment in a proper and efficient manner d) ensure all instruments and devices used for the measurement or monitoring of any parameter under any condition of this environmental authority are properly calibrated.

How do I comply?

No further guidance provided other than that outlined in the condition.

Monitoring

A5	Except where specified otherwise in another condition of this environmental authority, all monitoring records or reports required by this environmental authority must be kept for a period of not less than 5 years.

How do I comply?

The holder of the environmental authority should implement a monitoring program that enables the holder and administering authority to determine compliance with this approval.

Financial assurance

A6	The activity must not be carried out until the environmental authority holder has given financial assurance to the administering authority as security for compliance with this environmental authority and any costs or expenses, or likely costs or expenses, mentioned in section 298 of the Act.

How do I comply?

Refer to the latest version of the Financial assurance under the EP Act guideline, which can be located on the administering authority's website at www.ehp.qld.gov.au (search for EM1010).

A7	The amount of financial assurance must be reviewed by the holder of this environmental authority when a plan of operations is amended or replaced or the authority is amended.

How do I comply?

No further guidance provided to that outlined in the condition.

Risk management

A8	The holder of this environmental authority must develop and implement a risk management system for mining activities which mirrors the content requirement of the Standard for Risk Management (ISO31000:2009), or the latest edition of an Australian standard for risk management, to the extent relevant to environmental management, by <<Insert date 3 months from date of issue>>

How do I comply?

Companies have the option of providing a risk management plan which is structured differently from the ISO provided that the alternative approach is reasonably justified.

Notification of emergencies, incidents and exceptions

A9	The holder of this environmental authority must notify the administering authority by written notification within 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.

How do I comply?

If notification is given under an alternative notification condition of the environmental authority it is taken to be notification under this condition. If notification is required under sections 320–320G of the EP Act the additional requirements under sections 320–320G apply.

The notification should include, but not be limited to:

a) the environmental authority number and name of the holder

b) the name and telephone number of the designated contact person

c) the location of the emergency or incident

d) the date and time of the emergency or incident

e) the time the holder of the environmental authority became aware of the emergency or incident

f) where known

   1. the estimated quantity and type of substances involved in the emergency or incident
   2. the actual or potential cause of the emergency or incident
   3. a description of the nature and effects of the emergency or incident including environmental risks, and any risks to public health or livestock

g) any sampling conducted or proposed, relevant to the emergency or incident

h) immediate actions taken to prevent or mitigate any further environmental harm caused by the emergency or incident

i) what notification of owners and occupiers who may be affected by the emergency or incident has occurred or is being undertaken.

A10 Within 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 recurrence of the emergency or incident.

How do I comply?

No further guidance provided to that outlined in the condition.

Complaints

A11 The holder of this environmental authority must record all environmental complaints received about the mining activities including:

a) name, address and contact number for 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

h) person responsible for resolving the complaint.

How do I comply?

No further guidance provided other than that outlined in the condition.

A12 The holder of this environmental authority 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 10 business days of completion of the investigation, or no later than 10 business days after the end of the timeframe nominated by the administering authority to undertake the investigation.

How do I comply?

No further guidance provided to that outlined in the condition.

Third-party reporting

A13 The holder of this environmental authority must:

a) within 1 year of the commencement of this environmental authority, obtain from an appropriately qualified person a report on compliance with the conditions of this environmental authority

b) obtain further such reports at regular intervals, not exceeding 3 yearly intervals, from the completion of the report referred to above; and

c) provide each report to the administering authority within 90 days of its completion.

How do I comply?

The holder must, at its cost, arrange for independent certification by the third party within 1 year to report on compliance with the conditions of the environmental authority. Within 90 days of completing the report required under condition A13, provide the written report to the administering authority which should contain details of any non-compliance issues that were found (if no non-compliance issues were found this should be stated in the report). If non-compliance issues were found the report must also address:

a) actions taken, or being undertaken, by the holder of this environmental authority to ensure compliance with this environmental authority

b) actions taken, or being undertaken, to prevent a recurrence of non-compliance.

A14 Where a condition of this environmental authority requires compliance with a standard, policy or guideline published externally to this environmental authority and the standard is amended or changed subsequent to the issue of this environmental authority the holder of this environmental authority must:

a) comply with the amended or changed standard, policy or guideline within 2 years of the amendment or change being made, unless a different period is specified in the amended standard or relevant legislation, or where the amendment or change relates specifically to regulated structures referred to in condition XX, the time specified in that condition

b) until compliance with the amended or changed standard, policy or guideline is achieved, continue to remain in compliance with the corresponding provision that was current immediately prior to the relevant amendment or change.

How do I comply?

No further guidance provided to that outlined in the condition.

Schedule B - Air

Point source releases to air

B1 Discharges of contaminants to air from the activity, other than dust and particulate matter addressed by condition B4, must be in accordance with **Tables B1—release points (air)** and **B2—contaminant limits (air)**.

How do I comply?

The release of contaminants specified in condition should be:

a) directed vertically upwards, with no impedance

b) in accordance with the criteria in **Table B1—Release points (air)**

c) at a mass emission rate and concentration that do not exceed the limits stated in **Table B2—Contaminant limits (air)**.

B2	Conduct a monitoring program of contaminant releases to the atmosphere at the release points, frequency and for the contaminants specified in Table **B2—Contaminant limits (air)** and which complies with the most recent edition of AS4323.1 'Stationary source emissions method 1: Selection of sampling positions' and the most recent edition of the administering authority's air quality sampling manual.

Table B1—Release points (air)

Table B2—Contaminant limits (air)

How do I comply?

A monitoring program of contaminant releases to the atmosphere at the release points, frequency and for the contaminants specified in Table B2—Contaminant limits (air) should be conducted to comply with the following:

a) Monitoring at the release points should comply with the most recent edition of AS4323.1 Stationary source emissions method 1: Selection of sampling positions

b) The following tests should be performed and recorded for each sample taken at each release point specified in Table B1 - Point Source Air Emissions

   1. gas velocity, volume and mass flow rate
   2. temperature
   3. water vapour concentration (for non-continuous sampling)
   4. the actual test methods and accuracy

c) During the sampling period the following additional information should be gathered

   1. plant throughput rate at time of sampling
   2. fuel type and consumption rate
   3. any factors that may influenced odour and particular emissions
   4. the odour and/or particulates treatment system operating status

d) Monitoring of contaminant release should be carried out in accordance with the most recent edition of the administering authority's air quality sampling manual.

B3	The release of point source and fugitive emissions from the mining activities must not cause the concentrations of the contaminants listed in Table XX, when measured at [a sensitive place or at specified monitoring stations], to exceed the levels shown in Table XX.

How do I comply?

No further guidance provided to that outlined in the condition.

B4 The Proponent shall ensure that all reasonable and feasible avoidance and mitigation measures are employed so that the dust and particulate matter emissions generated by the mining activities do not cause exceedances of the following levels when measured at any sensitive or commercial place:

a) Dust deposition of 120 milligrams per square metre per day, averaged over 1 month, when monitored in accordance with the most recent version of Australian Standard AS3580.10.1 Methods for sampling and analysis of ambient air – Determination of particulate matter – Deposited matter – Gravimetric method.

b) A concentration of particulate matter with an aerodynamic diameter of less than 10 micrometres (PM10) suspended in the atmosphere of 50 micrograms per cubic metre over a 24 hour averaging time, for no more than 5 exceedances recorded each year, when monitored in accordance with the most recent version of either

1. Australian Standard AS3580.9.6 Methods for sampling and analysis of ambient air Determination of suspended particulate matter – PM10 high volume sampler with size-selective inlet – Gravimetric method; or

2. Australian Standard AS3580.9.9 Methods for sampling and analysis of ambient air Determination of suspended particulate matter – PM10 low volume sampler– Gravimetric method.

c) A concentration of particulate matter with an aerodynamic diameter of less than 2.5 micrometres (PM2.5) suspended in the atmosphere of 25 micrograms per cubic metre over a 24 hour averaging time, when monitored in accordance with the most recent version of AS/NZS3580.9.10 Methods for sampling and analysis of ambient air - Determination of suspended particulate matter – PM (sub)2.5(/sub) low volume sampler – Gravimetric method.

d) A concentration of particulate matter suspended in the atmosphere of 90 micrograms per cubic metre over a 1 year averaging time, when monitored in accordance with the most recent version of AS/NZS3580.9.3:2003 Methods for sampling and analysis of ambient air - Determination of suspended particulate matter – Total suspended particulate matter (TSP) – High volume sampler gravimetric method.

How do I comply?

Sources of PM2.5 are primarily from combustion sources and PM2.5 is unlikely to be elevated if significant combustion sources are not present. Condition B4 c) will therefore only be required if there is a significant source of air emissions from combustion sources.

The 5 exceedances allowed each year within in B4 b) are only permitted to allow for events that are known to occur, but which cannot be managed by the environmental authority holder. Such events could include emissions from bushfires, fuel reduction burning for fire management purposes or dust storms. More than 5 exceedances due to such events would not be considered to be in breach of B4 b) if the environmental authority holder can demonstrate that the exceedance was cause by such events outlined above.

Schedule C - Waste management

To achieve the outcomes of the waste management conditions section, the holder of this environmental authority should develop, implement and maintain a waste management program that should include:

a) a description of the mining activities that may generate waste

b) waste management control strategies including

1. the types and amounts of wastes generated by the mining activities
2. segregation of the wastes
3. storage of the wastes
4. transport of the wastes
5. monitoring and reporting matters concerning the waste

c) the hazardous characteristics of the wastes generated including disposal procedures for hazardous wastes

d) a program for reusing, recycling or disposing of all wastes

e) how the waste will be dealt with in accordance with the waste management hierarchy, including a description of the types and amounts of waste that will be dealt with under each of the waste management practices in the waste management hierarchy (that is, avoidance, reuse, recycling, energy recovery, disposal)

f) procedures for identifying and implementing opportunities to minimise the amount of waste generated, promote efficiency in the use of resources and improve the waste management practices employed

g) procedures for dealing with accidents, spills and other incidents

h) details of any accredited management system employed, or planned to be employed, to deal with waste

i) how often the performance of the waste management program will be assessed

j) the indicators or other criteria on which the performance of the waste management program will be assessed

k) staff training and induction to the waste management program.

General waste deposited in the active waste disposal trench should be compacted and covered with a layer of inert material following placement of the waste into the trench.

Litter control methods should be implemented at the active waste disposal trench.

The active waste disposal trench should be constructed and operated to minimise the generation of leachate including a system of diversion drains or embankments to divert surface waters away from any area where contact with wastes or sources of contamination may occur.

Completed waste disposal trenches should be capped with a low permeability material and compacted and contoured to effectively minimise water infiltration.

The holder of this environmental authority should maintain a record of the location of trenches used for waste disposal. Notwithstanding any other condition of this authority, such records be maintained until the administering authority approves the surrender of this authority.

All general and regulated waste (other than for example, waste rock, scats , rejects, tailings, construction and demolition waste, putrescibles and domestic wastes, minor quantities of regulated wastes incidental to and commingled with domestic waste, green wastes, tyres) must be removed from the site to a facility that is lawfully able to accept the waste under the EP Act.

Regulated waste, other than that authorised to be disposed of on site under this authority, must only be removed and transported from the site by a person who holds a current authority to transport such wastes to a facility that is lawfully able to accept the waste under the EP Act.

Regulated waste generated in the mining activity can be temporarily stored on site awaiting removal provided it is stored to ensure there is minimal risk of causing fire or contamination to land or waters.

Each container of regulated waste stored awaiting movement off-site must be clearly marked to identify the contents.

For the disposal and storage of scrap tyres, reference to Operational policy—Disposal and storage of scrap tyres at mine sites EM729 should be made on the administering authority's website at www.ehp.qld.gov.au.

C1	General waste must only be disposed of into the waste disposal trench facility of <insert tenement number> and identified in Schedule # Figure # – Site Map.

How do I comply?

No further guidance provided other than that outlined in the condition.

C2	Unless otherwise permitted by the conditions of this environmental authority or with prior approval from the administering authority and in accordance with a relevant standard operating procedure, waste must not be burnt.

How do I comply?

If it can be demonstrated that other possible options have been considered in accordance with the waste management hierarchy, burning may also be permitted for mining activities in addition to clearing for extraction activities.

C3	The holder of this environmental authority may burn vegetation cleared in the course of carrying out extraction activities provided the activity does not cause environmental harm at any sensitive place or commercial place.

How do I comply?

No further guidance provided to that outlined in the condition.

Tailing disposal

C4	Tailings must be managed in accordance with procedures contained within the current plan of operations. These procedures must include provisions for: a) containment of tailings b) the management of seepage and leachates both during operation and the foreseeable future c) the control of fugitive emissions to air d) a program of progressive sampling and characterisation to identify acid producing potential and metal concentrations of tailings e) maintaining records of the relative locations of any other waste stored within the tailings f) rehabilitation strategy g) monitoring of rehabilitation, research and/or trials to verify the requirements and methods for decommissioning and final rehabilitation of tailings, including the prevention and management of acid mine drainage, erosion minimisation and establishment of vegetation cover.

How do I comply?

No further guidance provided to that outlined in the condition.

Acid sulfate soils

C5	Treat and manage acid sulphate soils in accordance with the latest edition of the Queensland Acid Sulfate Soil Technical Manual.

How do I comply?

No further guidance provided to that outlined in the condition.

Schedule D- Noise

Noise limits

D1	The holder of this environmental authority must ensure that noise generated by the mining activities does not cause the criteria in **Table D1 – Noise limits** to be exceeded at a sensitive place or commercial place.

Table D1 – Noise limits

How do I comply?

The definition of ‘sensitive place’ and ‘commercial place’ is based on Schedule 1 of EPP Noise. That is, a sensitive place is inside or outside on a dwelling, library & educational institution, childcare or kindergarten, school or playground, hospital, surgery or other medical institution, commercial & retail activity, protected area or an area identified under a conservation plan under *Nature Conservation Act 1992* as a critical habitat or an area of major interest, marine park under *Marine Parks Act 2004*, park or garden that is outside of the mining lease and open to the public for the use other than for sport or organised entertainment. A commercial place is inside or outside a commercial or retail activity.

A mining camp (i.e., accommodation and ancillary facilities for mine employees or contractors or both, associated with the mine the subject of the environmental authority) is not a sensitive place for that mine or mining project, whether or not the mining camp is located within a mining tenement that is part of the mining project the subject of the environmental authority. For example, the mining camp might be located on neighbouring land owned or leased by the same company as one of the holders of the environmental authority for the mining project, or a related company. However, accommodation for mine employees or contractors is a sensitive place, even if the land is held by a mining company or related company, if occupation is not restricted to the employees, contractors and their families for the particular mine or mines which are held by the same company or a related company.

For example, a township (occupied by the mine employees, contractors and their families for multiple mines that are held by different companies) would be a sensitive place, even if part or all of the township is constructed on land owned by 1 or more of the companies.

Where there are 2 or more potential noise sources, it can be difficult to differentiate between them to determine if the mining activity is in exceedance of its noise limits. In these circumstances a site specific condition and monitoring requirements may need to be developed.

Noise is not considered to be a nuisance if monitoring demonstrates that noise from the activity does not exceed the limits outlined in **Table D1 – Noise limits** or equivalent site specific noise limit condition. It is recommended that if model condition A1, authorising of environmental harm, does not form part of the approval, than a similar condition be included within the adopted noise conditions.

Airblast overpressure nuisance

D2 The holder of this environmental authority must ensure that blasting does not cause the limits for peak particle velocity and air blast overpressure in **Table D2 – Blasting noise limits** to be exceeded at a sensitive place or commercial place.

Table D2 – Blasting noise limits

How do I comply?

No further guidance provided other than that outlined in the condition.

Monitoring and reporting

D3 Noise monitoring and recording must include the following descriptor characteristics and matters:

a) LAN,T (where N equals the statistical levels of 1, 10 and 90 and T = 15 mins)

b) background noise LA90

c) the level and frequency of occurrence of impulsive or tonal noise and any adjustment and penalties to statistical levels

d) atmospheric conditions including temperature, relative humidity and wind speed and directions

e) effects due to any extraneous factors such as traffic noise

f) location, date and time of monitoring

g) if the complaint concerns low frequency noise, Max LpLIN,T and one third octave band measurements in dB(LIN) for centre frequencies in the 10 – 200 Hz range.

How do I comply?

The method of measurement and reporting of noise levels must comply with the latest edition of the administering authority's Noise Measurement Manual or the most recent version of AS1055 Acoustics – description and measurement of environmental noise. Where the conditions do not specify that noise limits are to be achieved at the boundary, monitoring can be undertaken at the noise sensitive place or the boundary. If the monitoring identifies exceedances of limits, monitoring at the noise sensitive place may however pose difficulties for the mining activity when trying to demonstrate that they are not the source of the noise when there are multiple noise sources.

Where the noise nuisance complaint relates to a sensitive place or commercial place that is less than 5 kilometres (5km) from the activity, monitoring will need to be undertaken for a period of at least 3 days.

For continuous/ongoing/multiple complaints originating at the same sensitive or commercial place, noise monitoring should be implemented such that exceedance of noise criteria outlined in **Table D1 – Noise limits** can be identified immediately. This may involve the implementation of real time directional noise monitoring stations. These monitoring stations should continuously monitor noise levels and the direction of that noise relative to the monitor. Procedures should be implemented such that the appropriate persons are notified immediately upon identification of noise limit exceedance.

D4 The holder of this environmental authority must develop and implement a blast monitoring program to monitor compliance with **Table D2 – Blasting noise limits** for:

a) at least <insert number> % of all blasts undertaken on this site in each <insert period e.g. month or year> at the nearest sensitive place or commercial place <at insert a place nominated in this authority>

b) all blasts conducted during any time period specified by the administering authority at the nearest sensitive place or commercial place.

How do I comply?

The method of measurement and reporting of vibration levels must comply with the most recent edition of the administering authority's guideline Noise and vibration from blasting guideline.

Where blast monitoring detects non-compliance with **Table D2 – Blasting noise limits** the holder of this environmental authority should:

a) take steps to ensure compliance is achieved by subsequent blasts; and

b) continue to monitor all consecutive blasts until at least 3 successive blasts comply with **Table D2 – Blasting noise limits**.

Schedule E - Groundwater

Contaminant release

E1	The holder of this environmental authority must not release contaminants to groundwater.

How do I comply?

This condition is only to be used when it has been identified that no release of contaminants to groundwater is to occur as a result of mining activities. The definition of a 'contaminant' is set out in Section 11 of the EP Act and relevantly includes any 'gas, liquid or solid', not just hazardous contaminants. For example, it would include the replenishment of aquifers with water of the same quality or higher quality than the aquifers. The term 'release' is defined in Schedule 4 of the EP Act and relevantly, it should be noted that this includes passive releases and not merely controlled releases. Accordingly, if it is likely that the activity will lead to the passive replenishment of aquifers, even with good quality water, this condition should not be used.

OR

E1	The holder of this environmental authority is authorised to release contaminants at the release points and at the release frequencies specified in **Table E1 - Groundwater release points, frequency** and comply with the release limits specified in **Table E2 - Groundwater release quality**.

Table E1 - Groundwater release points, frequency

Table E2 - Groundwater release quality

How do I comply?

This condition is only to be used when it has been identified that release of contaminants to groundwater is authorised to occur as a result of mining activities.

Section 63 of the Environmental Protection Regulation 2008 addresses the topic of the release of 'waste' to groundwater. The term 'waste' is defined in Section 13 of the EP Act. Section 63 of the EP Regulation requires the administering authority to refuse an application if:

(a) the waste is not being, or may not be, released entirely within a confined aquifer (except for petroleum activities); or

(b) the release of the waste is affecting adversely, or may affect adversely, a surface ecological system; or

(c) the waste is likely to result in a deterioration in the environmental values of the receiving groundwater.

Paragraph (b) is not intended to apply to a surface ecological system which is authorised to be cleared for the purpose of the mining activities. Paragraphs (b) and (c) are not intended to apply to trivial impacts.

Where contaminants are proposed to be released to groundwater the limits set out in the condition must not be exceeded at the release point. All the potential contaminants generated as part of the mining activity that have a release limit will be included in this table. The limit type and value will need to be determined in consultation with the administering authority.

Monitoring and reporting

E2	All determinations of groundwater quality and biological monitoring must be performed by an appropriately qualified person.

How do I comply?

Monitoring methods should be in accordance with the latest edition of the Queensland Monitoring and Sampling Manual, AS/NZS 5667:11 1998 Water Sampling Guidelines – Part 11 Guidance on groundwater, and the Australian Governments Groundwater Sampling and Analysis – A Field Guide (2009:27 GeoCat#6890.1). Analyses should be carried out on representative samples, at a laboratory accredited (for example, NATA) for the method of analysis being used.

E3	Groundwater quality and levels must be monitored at the locations and frequencies defined in **Table E3 - Groundwater monitoring locations and frequency** and Schedule # – Figure # (Groundwater Bore Monitoring Locations) for the quality characteristics identified in **Table E4 - Groundwater quality triggers and limits**.

Table E3 - Groundwater monitoring locations and frequency

Table E4 - Groundwater quality triggers and limits

How do I comply?

Monitoring locations must be suitably positioned to detect any impacts caused by the activity and ensure compliance with the conditions of the environmental authority.

Monitoring methods should be in accordance with the latest edition of the Queensland Monitoring and Sampling Manual, AS/NZS 5667:11 1998 Water Sampling Guidelines – Part 11 Guidance on groundwater, and the Australian Governments Groundwater Sampling and Analysis – A Field Guide (2009:27 GeoCat#6890.1)

Generic parameters and associated triggers and limits have not been provided given they would vary from site to site. This does not suggest though that any and every parameter should be included within this table. Only parameters that are relevant to groundwater quality associated with the activity should be included.

E4	Groundwater levels when measured at the monitoring locations specified in **Table E3 - Groundwater monitoring locations and frequency** must not exceed the groundwater level trigger change thresholds specified in **Table E5 - Groundwater level monitoring** below.

Table E5 - Groundwater level monitoring

How do I comply?

The level trigger thresholds will be site specific and dependent upon what type of aquifer is present. A 5 metre reduction in water level for consolidated aquifers such as sandstone or a 2 metre reduction in water level for unconsolidated aquifers such as shallow aquifers may be appropriate.

Depending upon site specifics, it could be possible that the level trigger threshold can be based on a percentage of annual average change of the aquifer rather than the 5 metre or 2 metre outline above.

Where there are localities that have known external influences on the fluctuation of groundwater levels, these should also be taken into account when setting the trigger level thresholds. This will avoid unnecessary investigations into exceedances being required by condition E6.

Exceedance Investigation

E5	If quality characteristics of groundwater from compliance bores identified in **Table E3 - Groundwater monitoring locations and frequency** exceed any of the trigger levels stated in **Table E4 - Groundwater quality triggers and limits** or exceed any of the groundwater level trigger threshold stated in **Table E5 - Groundwater level monitoring**, the holder of this environmental authority must compare the compliance monitoring bore results to the reference bore results and complete an investigation in accordance with the ANZECC and ARMCANZ 2000

How do I comply:

If the level of contaminants at the compliance monitoring bore does not exceed the reference bore results, then no action is to be taken. If however the level of contaminants at the compliance monitoring bore is greater than the reference bore results, an investigation is to be completed in accordance with the ANZECC and ARMCANZ 2000 into the potential for environmental harm and a written report is to be provided to the administering authority within 3 months, outlining:

a) details of the investigations carried out

b) details of environmental impacts observed

c) actions taken to prevent environmental harm.

Where an exceedence of a trigger level has occurred and is being investigated, then no further reporting is required for subsequent trigger events for that quality characteristic within the 3 month investigation period.

E6	Results of monitoring of groundwater from compliance bores identified in **Table E3 - Groundwater monitoring locations and frequency**, must not exceed any of the limits defined in **Table E4 - Groundwater quality triggers and limits**.

How do I comply:

No further guidance provided other than that outlined in the condition.

Bore construction and maintenance and decommissioning.

E7	The construction, maintenance and management of groundwater bores (including groundwater monitoring bores) must be undertaken in a manner that prevents or minimises impacts to the environment and ensures the integrity of the bores to obtain accurate monitoring

How do I comply?

As a minimum, groundwater bores (including groundwater monitoring bores) must be constructed, maintained and decommissioned in accordance with methods prescribed in the latest edition of the National Uniform Drillers Licensing Committee manual titled Minimum Construction Requirements for Water Bores in Australia.

Oil-based drilling fluids, oil-based additives, synthetic based drilling fluids or synthetic based additives must not be used in the construction of groundwater bores.

Current Material Safety Data Sheets for all substances used for the drilling of groundwater bores must be made available to the administering authority promptly upon request.

Corrective measures must be taken immediately if the holder of this environmental authority becomes aware that bore construction, maintenance or decommissioning have resulted in a change in groundwater quality or groundwater levels or have caused interconnection of aquifers.

Schedule F – Water (Fitzroy model conditions)

Contaminant Release

F1	Contaminants that will, or have the potential to cause environmental harm must not be released directly or indirectly to any waters as a result of the authorised mining activities, except as permitted under the conditions of this environmental authority.

F2	Unless otherwise permitted under the conditions of this environmental authority, the release of mine affected water to waters must only occur from the release points specified in **Table F1 - Mine affected water release points, sources and receiving waters** and depicted in Figure 1 attached to this environmental authority.

F3	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 F28 is permitted.

How do I comply?

No further guidance to that outlined in the conditions and associated explanatory notes.

Table F1 - Mine affected water release points, sources and receiving waters

F4	The release of mine affected water to waters in accordance with condition F2 must not exceed the release limits stated in **Table F2 - Mine affected water release limits** when measured at the monitoring points specified in **Table F1 - Mine affected water release points, sources and receiving waters** for each quality characteristic.

Table F2 - Mine affected water release limits

F5	The release of mine affected water to waters from the release points must be monitored at the locations specified in **Table F1 - Mine affected water release points, sources and receiving waters** for each quality characteristic and at the frequency specified in **Table F2 - Mine affected water release limits** and **Table F3 - Release contaminant trigger investigation levels, potential contaminants**. *Note: the administering authority will take into consideration any extenuating circumstances prior to determining an appropriate enforcement response in the event condition F5 is contravened due to a temporary lack of safe or practical access. The administering authority expects the environmental authority holder to take all reasonable and practicable measures to maintain safe and practical access to designated monitoring locations.*

Table F3 - Release contaminant trigger investigation levels, potential contaminants

How do I comply?

No further guidance to that outlined in the conditions and associated explanatory notes.

F6 If quality characteristics of the release exceed any of the trigger levels specified in **Table F3 - Release contaminant trigger investigation levels, potential contaminants** during a release event, the environmental authority holder must compare the down-stream results in the receiving waters to the trigger values specified in **Table F3 - Release contaminant trigger investigation levels, potential contaminants** and:

a) where the trigger values are not exceeded then no action is to be taken; or

b) where the down-stream results exceed the trigger values specified **Table F3 - Release contaminant trigger investigation levels, potential contaminants** for any quality characteristic, compare the results of the down-stream site to the data from background monitoring sites

1. if the result is less than the background monitoring site data, then no action is to be taken; or
2. 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 within 90 days of receiving the result , outlining
   i. details of the investigations carried out
   ii. actions taken to prevent environmental harm.

Note: Where an exceedance of a trigger level has occurred and is being investigated, in accordance with F6 b (2) of this condition, no further reporting is required for subsequent trigger events for that quality characteristic.

F7 If an exceedance in accordance with condition F6 b (2) is identified, the holder of the environmental authority must notify the administering authority in writing within 24 hours of receiving the result.

How do I comply?

No further guidance provided to that outlined in the condition.

Mine Affected Water Release Events

F8 The holder must ensure a stream flow gauging station/s is installed, operated and maintained to determine and record stream flows at the locations and flow recording frequency specified in **Table F3 - Release contaminant trigger investigation levels, potential contaminants**.

F9 Notwithstanding any other condition of this environmental authority, the release of mine affected water to waters in accordance with condition F2 must only take place during periods of natural flow in accordance with the receiving water flow criteria for discharge specified in **Table F4 - Mine affected water release during flow events** for the release point(s) specified in **Table F1 - Mine affected water release points, sources and receiving waters**.

F10	The release of mine affected water to waters in accordance with condition F2 must not exceed the Maximum Release Rate (for all combined release point flows) for each receiving water flow criterion for discharge specified in **Table F4 - Mine affected water release during flow events** when measured at the monitoring points specified in **Table F1 - Mine affected water release points, sources and receiving waters**.

or

F11	The 80th percentile of electrical conductivity (EC) values recorded at the downstream monitoring points listed in **Table F4 - Mine affected water release during flow events** must not exceed XXXuS/cm over the duration of the release influence period and have a maximum value of no greater than 20 per cent of XXXuS/cm. The 80th percentile must be calculated using all EC values recorded by the monitoring station during the release influence period.

Table F4 - Mine affected water release during flow events

How do I comply?

No further guidance to that outlined in the conditions and associated explanatory notes.

F12	The daily quantity of mine affected water released from each release point must be measured and recorded.

F13	Releases to waters must be undertaken so as not to cause erosion of the bed and banks of the receiving waters, or cause a material build up of sediment in such waters.

How do I comply?

No further guidance provided to that outlined in the condition.

Notification of Release Event

F14	The environmental authority holder must notify the administering authority as soon as practicable and no later than 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 Department Interest: Water of this environmental authority (that is, contaminant limits, natural flow, discharge volume) c) release point/s d) release rate e) release salinity f) receiving water/s including the natural flow rate. Note: Notification to the administering authority must be addressed to the Manager and Project Manager of the local Administering Authority via email or facsimile.

F15 The environmental authority holder must notify the administering authority as soon as practicable and nominally no later than 24 hours after cessation of a release event of the cessation, of a release notified under Condition F14 and within 28 days provide the following information in writing:

a) release cessation date/time

b) natural flow rate in receiving water

c) volume of water released

d) details regarding the compliance of the release with the conditions of Department Interest: Water of this environmental authority (that is, contaminant limits, natural flow, discharge volume)

e) all in-situ water quality monitoring results

f) any other matters pertinent to the water release event.

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 conditions F14 and F15, provided the relevant details of the release are included within the notification provided in accordance with conditions F14 and F15.

How do I comply?

The administering authority will take into consideration any extenuating circumstances prior to determining an appropriate enforcement response, in the event condition F14 is contravened due to extenuating circumstances, such as in emergencies which prevent communications, applicable monitoring equipment has been destroyed as a result of the emergency or access is prevented. The administering authority expects the environmental authority holder though to take all reasonable and practicable measures to maintain safe and practical access to designated monitoring locations.

Notification of Release Event Exceedance

F16 If the release limits defined in **Table F2 - Mine affected water release limits** are exceeded, the holder of the environmental authority must notify the administering authority within 24 hours of receiving the results.

How do I comply?

It should be noted however that a release which has exceeded release limits is no longer compliant and should cease. Any release that continues when limits in **Table F2 - Mine affected water release limits** have been breached will be subject to compliance action by the administering authority.

F17 The environmental authority holder must, within 28 days of a release that is not compliant with the conditions of this environmental authority, provide a report to the administering authority detailing:

a) the reason for the release

b) the location of the release

c) the total volume of the release 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) all water quality monitoring results (including all laboratory analyses)

f) identification of any environmental harm as a result of the non compliance

g) all calculations

h) any other matters pertinent to the water release event.

Receiving Environment Monitoring and Contaminant Trigger Levels

F18 The quality of the receiving waters must be monitored at the locations specified in **Table F6 - Receiving water upstream background sites and down stream monitoring points** for each quality characteristic and at the monitoring frequency stated in **Table F5 - Receiving waters contaminant trigger levels**.

Table F5 - Receiving waters contaminant trigger levels

Table F6 - Receiving water upstream background sites and down stream monitoring points

How do I comply?

The intent is that that each discharge point has both an upstream and downstream monitoring point associated with it. These monitoring points should be located as close as practicable to the release point and the distances should be defined in the footnotes in **Table F6 - Receiving water upstream background sites and down stream monitoring points**. The location of flow monitoring points should also be considered in selecting upstream monitoring points. Other considerations include accessibility, particularly during wet weather conditions.

F19 If quality characteristics of the receiving water at the downstream monitoring points exceed any of the trigger levels specified in **Table F5 - Receiving waters contaminant trigger levels** during a release event the environmental authority holder must compare the down stream 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; or

b) where the down stream results exceed the upstream results complete an investigation into the potential for environmental harm and provide a written report to the administering authority in the next annual return, outlining

1. details of the investigations carried out

2. actions taken to prevent environmental harm.

Note: Where an exceedance of a trigger level has occurred and is being investigated, in accordance with F19 b) of this condition, no further reporting is required for subsequent trigger events for that quality characteristic.

F20	All determinations of water quality and biological monitoring must be performed by an appropriately qualified person.

How do I comply?

All determinations of water quality and biological monitoring should be made in accordance with methods prescribed in the latest edition of the Department of Environment and Heritage Protection (or its successor) Monitoring and Sampling Manual. Samples should be collected from monitoring locations identified within this environmental authority. Analyses should be carried out on representative samples, at a laboratory accredited (for example, NATA) for the method of analysis being used.

Receiving Environment Monitoring Program (REMP)

F21	The environmental authority holder must develop and implement a Receiving Environment Monitoring Program (REMP) to monitor, identify and describe any adverse impacts to surface water environmental values, quality and flows due to the authorised mining activity. This must include monitoring the effects of the mine on the receiving environment periodically (under natural flow conditions) and while mine affected water is being discharged from the site. For the purposes of the REMP, the receiving environment is the waters of the XX and connected or surrounding waterways within XX (for example, Xkm) downstream of the release. The REMP should encompass any sensitive receiving waters or environmental values downstream of the authorised mining activity that will potentially be directly affected by an authorised release of mine affected water.

F22	A REMP Design Document that addresses the requirements of the REMP must be prepared and made available to the administrating authority upon request.

F23	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 must include an assessment of background reference water quality, the condition of downstream water quality compared against water quality objectives, and the suitability of current discharge limits to protect downstream environmental values.

How do I comply?

The Receiving Environment Monitoring Program (REMP) should be used to assess the local receiving waters for the specified discharge locations. The monitoring should not be specifically designed to assess compliance of the release – this is covered by other conditions. The key purpose of the REMP is to assess the overall condition of the local receiving waters and assessment should be against water quality objectives and relevant guidelines.

Note that in some cases where discharge occurs to ephemeral streams, there may be a need to include downstream sensitive receiving waters or environmental values outside of the specified REMP area. An example of this would be where there are no semi-permanent /permanent waterholes in the specific area but 1 is located further downstream prior to the confluence with the next major waterway. For further guidance on what to include in a REMP, please refer to the Draft EHP REMP Document for Fitzroy Coal Mines and Additional Information. There is a potential for beneficial linkages of REMP monitoring to regional waterway monitoring programs, such as the Fitzroy Partnership monitoring program. For example EHP intends to maintain monitoring information compiled through individual REMP programs through an internal database under development. Industry has indicated its willingness to see this data shared with the Fitzroy Partnership for the purpose of a regional water monitoring program. Likewise it is possible for environmental authority holders to utilise relevant and available water monitoring information collected by other parties, such as the Fitzroy Partnership, as reference data for the purposes of the REMP required by this section.

The REMP should:

a) assess the condition or state of receiving waters, including upstream conditions, spatially within the REMP area, considering background water quality characteristics based on accurate and reliable monitoring data that takes into consideration temporal variation (for example, seasonality)

b) be designed to facilitate assessment against water quality objectives for the relevant environmental values that need to be protected

c) include monitoring from background reference sites (for example, upstream or background) and downstream sites from the release (as a minimum, the locations specified in Table 6)

d) specify the frequency and timing of sampling required in order to reliably assess ambient conditions and to provide sufficient data to derive site specific background reference values in accordance with the *Queensland Water Quality Guidelines* 2006. This should include monitoring during periods of natural flow irrespective of mine or other discharges

e) include monitoring and assessment of dissolved oxygen saturation, temperature and all water quality parameters listed in Table 2 and 3)

f) include, where appropriate, monitoring of 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*)

g) include, where appropriate, monitoring of macroinvertebrates in accordance with the AusRivas methodology

h) apply procedures and/or guidelines from ANZECC & ARMCANZ 2000 and other relevant guideline documents

i) describe sampling and analysis methods and quality assurance and control

j) incorporate stream flow and hydrological information in the interpretations of water quality and biological data.

Water reuse

F24	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).

How do I comply?

Note that the definition of 'wastewater' under the *Water Supply (Safety and Reliability) Act 2008* specifically exempts spent or used water generated from mining activities. In addition, there is an exemption from water service provider registration requirements if there is no charge for the water supply. Mines are encouraged to provide water to their neighbours and communities. Previous versions of these model water conditions specified terms to be included in agreements with those third parties, but current policy is that the commercial terms of these agreements, including the purposes for which the third parties require the water, are a matter for direct negotiation between the parties.

The provision of re-use water to artificial water storage structures, or direct application to land for purposes such as dust suppression in road maintenance and construction work, constitutes an authorised 'release' which does not need to be addressed under condition F2. However, as part of the annual review of water management plans, an outline should be included about beneficial re-use arrangements, for water balance purposes.

Annual Water Monitoring Reporting

F25 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:

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 mine affected water 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 exceedances of the conditions of this environmental authority

g) water quality monitoring data must be provided to the administering authority in the specified electronic format upon request.

How do I comply?

No further guidance provided to that outlined in the condition.

Temporary Interference with waterways

F26 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.

How do I comply?

No further guidance provided to that outlined in the condition.

Water Management Plan

F27	A Water Management Plan must be developed by an appropriately qualified person and implemented.

How do I comply?

The Water Management Plan should be developed in accordance with Department of Environment and Resource Management guideline *Preparation of water management plans for mining activities* and 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) measures to manage and prevent acid rock drainage

f) contingency procedures for emergencies

g) a program for monitoring and review of the effectiveness of the water management plan.

The Water Management Plan should be reviewed annually to assess the adequacy of the plan, ensure actual and potential environmental impacts are managed, and identify any necessary amendments to the plan.

Stormwater and Water sediment controls

F28	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.

F29	Stormwater, other than mine affected water, is permitted to be released to waters from: a) erosion and sediment control structures that are installed and operated in accordance with the Erosion and Sediment Control Plan required by condition F28 b) water management infrastructure that is installed and operated, in accordance with a Water Management Plan that complies with condition F27 for the purpose of ensuring water does not become mine affected water.

How do I comply?

Stormwater, other than mine affected water, is permitted to be released to waters from erosion and sediment control structures that are installed and operated in accordance with the Erosion and Sediment Control Plan required by condition F28. Stormwater is permitted to be released from water management infrastructure that is installed and operated in accordance with a Water Management Plan required by condition F27, for the purpose of ensuring water does not become mine affected.

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.

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.

Schedule G- Sewage treatment

G1	The only contaminant permitted to be released to land is treated sewage effluent in compliance with the release limits stated in **Table G1 - contaminant release limits to land.**

Table G1 - Contaminant release limits to land

How do I comply?

F1 may need amendment if other contaminants are permitted to be released to land. Monthly monitoring of E coli may be revised based on location/remoteness of mine site.

G2	Treated sewage effluent may only be released to land in accordance with the conditions of this approval: a) within the nominated area(s) identified in Schedule ## – Figure ## (Sewage Treatment Plant and Effluent Disposal) b) on other land for the purpose of dust suppression and/or fire fighting.

How do I comply?

No further guidance provided to that outlined in the condition.

G3	The application of treated effluent to land must be carried out in a manner such that: a) vegetation is not damaged b) there is no surface ponding of effluent c) there is no run-off of effluent.

How do I comply?

No further guidance provided to that outlined in the condition.

G4	If areas irrigated with effluent are accessible to employees or the general public, prominent signage must be provided advising that effluent is present and care should be taken to avoid consuming or otherwise coming into unprotected contact with the effluent.

How do I comply?

No further guidance provided to that outlined in the condition.

G5	All sewage effluent released to land must be monitored at the frequency and for the parameters specified in **Table G1 - contaminant release limits to land**.

How do I comply?

No further guidance provided to that outlined in the condition.

G6	The daily volume of effluent release to land must be measured and records kept of the volumes of effluent released.

How do I comply?

No further guidance provided to that outlined in the condition.

G7	When circumstances prevent the irrigation or beneficial reuse of treated sewage effluent such as during or following rain events, waters must be directed to a wet weather storage or alternative measures must be taken to store/lawfully dispose of effluent.

How do I comply?

No further guidance provided to that outlined in the condition.

G8	A minimum area of <<insert area>> of land, excluding any necessary buffer zones, must be utilised for the irrigation and/or beneficial reuse of treated sewage effluent.

How do I comply?

No further guidance provided to that outlined in the condition.

G9	Treated sewage effluent must only be supplied to another person or organisation that has a written plan detailing how the user of the treated sewage effluent will comply with their general environmental duty under section 319 of the Act whilst using the treated sewage effluent.

How do I comply?

The supply of treated wastewater for re-use is regulated under the *Water Supply (Safety and Reliability) Act 2008.*

Schedule H – Land and rehabilitation

H1	Land disturbed by mining must be rehabilitated in accordance with **Table H1 - Rehabilitation Requirements**.

Table H1 - Rehabilitation Requirements

How do I comply:

In addition to the criteria listed above, holders should be aware that section 276 of the *Mineral Resources Act 1989* includes a requirement that it is a condition of mining leases that: 'the holder, prior to the termination of the mining lease for whatever cause, shall remove any building or structure purported to be erected under the authority of the mining lease and all mining equipment and plant, on or in the area of the mining lease unless otherwise approved by the Minister.'

There are occasions when the post-mining landholder wishes to retain specified mine infrastructure, such as roads, clean water dams, amenities and the like. It is not unusual for the mining lease holder to submit a copy of a written agreement with the landholder about these issues for the consent of the Minister administering the *Mineral Resources Act 1989*.

H2	Rehabilitation must commence progressively in accordance with the plan of operations.

How do I comply:

Rehabilitation must commence progressively as soon as areas become available and in accordance with the plan of operations. For more information, please refer to the most recent edition of the administering authority's guideline rehabilitation requirements for mining projects (EM1122).

Contaminated Land

H3	Before applying for surrender of a mining lease, the holder must (if applicable) provide to the administering authority a site investigation report under the Act, in relation to any part of the mining lease which has been used for notifiable activities or which the holder is aware is likely to be contaminated land, and also carry out any further work that is required as a result of that report to ensure that the land is suitable for its final land use under condition H1.

H4	Before applying for progressive rehabilitation certification for an area, the holder must (if applicable) provide to the administering authority a site investigation report under the Act, in relation to any part of the area the subject of the application which has been used for notifiable activities or which the holder is aware is likely to be contaminated land, and also carry out any further work that is required as a result of that report to ensure that the land is suitable for its final land use under condition H1.

How do I comply?

For more information, please refer to the most recent edition of the administering authority's guideline surrender applications and progressive rehabilitation.

H5	Minimise the potential for contamination of land by hazardous contaminants.

How do I comply?

The following activities have a risk of releasing dust fallout which can accumulate and be a source of contamination if not managed adequately, so care should be taken to manage these accordingly:

a) crusher

b) concentrate handling, storage and transport

c) dry tailings

d) transport of ore.

All explosives, hazardous chemicals, corrosive substances, toxic substances, gases, flammable or combustible liquids and dangerous goods should be stored and handled in accordance with the current, relevant Australian Standard where such is applicable.

Notwithstanding the requirements of any applicable Australian Standard, any liquids stored on licensed place that have the potential to cause environmental harm should be stored and serviced by an effective containment system that is impervious to the materials stored and managed to prevent the release of liquids to waters or land. The following could be applied:

a) storage tanks must be bunded such that the capacity and construction of the bund is sufficient to contain at least 110% of a single storage tank or 100% of the largest storage tank plus 10% of the second largest storage tank in multiple storage areas

b) drum storages must be bunded such that the capacity and construction of the bund is sufficient to contain at least 25% of the maximum design storage volume within the bund.

All containment systems should be designed to minimise rainfall collection within the system.

Any spillage of hazardous contaminants should be cleaned up promptly. Dry methods of clean up are generally preferable to minimise the risk of release to land.

Biodiversity Offsets

H6 The holder of this environmental authority must provide an offset for impacts on applicable state significant biodiversity values, in accordance with Queensland Biodiversity Offset Policy. The biodiversity offset must be consistent with the requirements for an offset as identified in the Biodiversity Offset Strategy (as per condition H7) and must be provided:

a) prior to impacting on state significant biodiversity values; or

b) where a land based offset is to be provided, within 12 months of the later of either of the following

1. the date of issue of this environmental authority; or
2. the relevant stage identified in the Biodiversity Offset Strategy submitted under condition H7; or

c) where an offset payment is to be provided, within 4 months of the later of either of the following

1. the date of issue of this environmental authority; or
2. the relevant stage identified in the Biodiversity Offset Strategy submitted under conditions H7.

How do I comply?

No further guidance provided to that outlined in the condition.

H7 A Biodiversity Offset Strategy must be developed and submitted to the administering authority within either 30 days, or a lesser period agreed to by the administering authority, prior to impacting on the applicable state significant biodiversity values.

How do I comply?

The Biodiversity Offset Strategy must include, as a minimum:

a) demonstration that the activity has avoided or minimised impacts to applicable state significant biodiversity values

b) where there will be impacts to applicable State significant biodiversity values, a detailed description of the values that will be impacted, and the extent of that impact

c) mapping that details the surveyed locations of any applicable State significant biodiversity values at the licensed place

d) results of a flora and fauna assessment of the affected area to determine if the operations will directly impact on any applicable State significant biodiversity values detailed in the *Queensland Biodiversity Offset Policy*

e) project stages for the provision of offsets

f) the proposed offset delivery mechanism for each stage

g) where an offset transfer is proposed, or where a land based offset is to be secured within 12 months of commencement of the relevant stage, evidence that an offset can be located within the landscape

h) an ecological equivalence assessment where required by the *Queensland Biodiversity Offset Policy.*

Guideline

Environmental Protection Act 1994

Structures which are dams or levees constructed as part of environmentally relevant activities

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1 Scope

This document provides information about the procedures of the administering authority when authorising structures which are dams, or levees that are constructed as part of an activity under an environmentally relevant activity (ERA) pursuant to the *Environmental Protection Act 1994*.

Environmental authorities and development approvals (both referred to hereafter as an 'authority') will include conditions that require holders of the authority to have the hazard category of any structures which are dams or levees that are constructed as part of a project assessed by a 'suitably qualified and experienced person'.

The hazard assessment will determine whether a structure is a 'regulated structure' for the purpose of the authority. Regulated structures will require certified design plans to be submitted to the administering authority, and will be subject to annual inspection and reporting by a suitably qualified and experienced person.

The responsibility for ensuring the accurate hazard assessment, documentation of the design, and the adequate performance of regulated structures rests with the holder of the authority and its consultants (i.e. the suitably qualified and experienced person).

The administering authority will rely on the certification(s) given by suitably qualified and experienced persons of documentation submitted to the administering authority. This places considerable onus on both the holder of the authority and the suitably qualified person(s) providing certification(s) to ensure that hazard assessments are rigorously carried out and that regulated structures are designed and operated in accordance with the regulatory requirements.

The administering authority may, from time to time, review documentation and certification(s) in detail for conformance with prevailing engineering and environmental management practices, and the provisions of the law.

2 Related document

This guideline relates to, and should be read in conjunction with, the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (EM635)* (the manual) published by the administering authority.

The *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (EM635)* does not limit, amend or change in any way, any other requirements to be complied with under authority conditions and/or regulations for the design and operation of a dam[1]. Further, it does not negate any lawful requirements of the *Environmental Protection Act 1994*, other Commonwealth, state or local government laws or requirements under relevant standards or agreements.

3 Background

In the context of regulated structures which are dams or levees constructed as part of environmentally relevant activities; protecting human life and the environment requires that the standards used for the design, construction, operation, modification and decommissioning of regulated structures mitigate the hazards arising from potential failure or collapse of those structures.

[1] An example of other legislative requirements that may be relevant are those relating to referrable dams under the *Water Supply (Safety and Reliability) Act 2008*.

The administering authority requires that any regulated structure be designed, constructed, operated and maintained to an engineering standard appropriate to the nature of the contents of the dam, the purpose for which it is to be used, and the environment in which it is located and will discharge. The administering authority also requires that the condition of regulated structures and their operations will be monitored on a regular basis, and that timely action will be taken to prevent or minimise any actual or potential environmental harm.

4 Essential elements of a design plan and certification for a regulated structure

A '**design plan**' is a document setting out how all identified hazard scenarios are addressed in the planned design and operation of a regulated structure. The document must describe the physical dimensions of the regulated structure, the materials and standards to be used for construction of the regulated structure, and the criteria to be used for operating the regulated structure.

The design plan must include all investigation and design reports, plans and specifications sufficient to hand to a contractor for construction, and planned decommissioning and rehabilitation outcomes; so as to address all hazard scenarios that would be identified by a properly conducted hazard assessment for the regulated structure.

Documentation must be such that an independent review could be conducted without seeking further information from the designer.

A design plan for a regulated structure should address a range of issues including:

- the hazard scenarios that have been used in undertaking a hazard assessment;
- the hydrology/hydraulics used to estimate and deal with flood events, internal and external to the regulated structure, at probabilities appropriate to address identified hazard scenarios, including containment of contaminants;
- seepage and stability issues, including containment of contaminants; and
- any assumptions relating to the design and safety of the regulated structure.

A '**certification'** is required in the form set out in the attached Appendix A (and in the manual), from a suitably qualified and experienced person. The certification must be accompanied by a statement of reasons setting out how the facts documented in the design plan support the conclusion that the regulated structure is capable of providing the specific performance required of that structure.

4.1 Environmental objectives for regulated dams containing contaminants

Key performance objectives for regulated dams containing contaminants assessed as a hazard by a suitably qualified and experienced person, with the potential to cause environmental harm include that the contaminants are safely contained within the regulated dam during the operational life of that dam, and that upon decommissioning such contaminants are, either removed for safe disposal elsewhere, or securely encapsulated for the foreseeable future.

Flood protection levees are also to be classified as regulated structures as they have an important environmental objective of minimising the risk of excessive flood water inflows to a site on which an environmentally relevant activity is being conducted, and the consequent potential for contamination of the flood waters and overloading of containment performance.

Key performance criteria for design elements of regulated dams may be required for certain applications.

Regulated dams must be able to withstand seasonal rainfall events without releasing contaminants from the dam in an unauthorised manner. A minimum available storage, called a **design storage allowance** (DSA), is required to be estimated for regulated dams in accordance with the manual, in order to accommodate seasonal rainfall to a specified annual probability. On-site water management must allow for and provide the DSA volume in each regulated dam, going into each new wet season (that is, on the 1 November each year).

The intent of a DSA volume is to provide reasonable certainty that design performance criteria for containment will be met in any forthcoming wet-season. Failure to operate a regulated dam so that it meets the requirement to provide the DSA volume at the onset of each wet-season (that is, on the 1 November each year) should be an alert to the holder of an authority that it risks the likelihood that a spillway discharge from a regulated dam during the wet-season may not be authorised.

The intent of a **mandatory reporting level** (MRL) is to provide a level at which it is mandatory that the holder of an authority communicate to the administering authority that there is a possibility of a spillway discharge from a regulated dam.

Even where a regulated dam is designed and operated in compliance with the conditions of an authority and the certification provided, there may still be instances where there is associated spillway discharge during the wet season. If these requirements are met and the discharge meets the water quality conditions in the environmental authority (EA), it will be considered to be authorised. If water quality conditions in the environmental authority are exceeded, but all other requirements are met, then the operator may be able to demonstrate that they have met the general environmental duty which is a defence to a charge of environmental harm.

4.2 Environmental objectives for regulated dams—people and communities

Environmental harm includes physical and chemical risks to human life. In particular, this may occur where dams may have the potential—as a result of discharges—to chemically interfere with waters that may be used as sources of drinking water, or lives can be at risk due to dwellings or workplaces being in the path of a dam break flood.

These regulated dams must be designed, constructed, operated and decommissioned to mitigate those hazards. The taking of appropriate actions to mitigate hazards does not remove the responsibility of the holder of an authority to also mitigate consequences where it is practical and reasonable to do so.

Consultation with affected persons should occur prior to the construction of a dam which is assessed as being a high or significant hazard category. In situations where a hazard remains, consultation with affected persons must be undertaken by the holder, and emergency action plans, including response procedures, must be in place prior to operation of the regulated dam. For dams that are declared regulated structures after construction, consultation with affected persons must be undertaken by the holder, and emergency action plans, including response procedures, must be in place by a timeframe specified by a condition of the EA.

5 Applications for environmental authorities or development approvals that involve dams

Any application involving dams must include a copy of the most recent hazard assessment undertaken, with the accompanying certification.

Contemporary conditions applicable to regulated dams will be inserted by the administering authority in current authorities when amendment applications for projects involving dams are made, and in any application for a new authority.

Regulated dams that are authorised as part of resource activities that are not mining projects require details to be entered in a Register of Regulated Dams kept by the holder of the authority (the 'holder'), and an electronic copy provided annually to the administering authority[2]. Details of all other regulated dams must be recorded on the relevant authority.

It is the responsibility of the holder of the authority to ensure any Register of Regulated Dams is accurately maintained.

5.1 Lodgement of design plans for regulated structures

Before operation of a regulated structure can commence, one paper copy and one electronic copy of a design plan, must be submitted to the administering authority.

5.2 Lodgement of annual inspection reports for regulated structures

Annual inspection reports on the condition and adequacy of any regulated structure must be made available to the administering authority on request.

To ensure that the administering authority is aware of the action to be taken by the holder of an authority as a result of the annual inspection report, the holder must, within 20 business days following receipt of the report, notify the administering authority of the findings of the report and the actions that are to be taken to implement the recommendations.

5.3 Form of certification

Any hazard assessment report, design plan or annual inspection report must be certified in accordance with the form of certification provided referenced in Appendix A to this guideline.

Disclaimer

While this document has been prepared with care it contains general information and does not profess to offer legal, professional or commercial advice. The Queensland Government accepts no liability for any external decisions or actions taken on the basis of this document. Persons external to the Department of Environment and Heritage Protection should satisfy themselves independently and by consulting their own professional advisors before embarking on any proposed course of action.

Approved by:

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Department of Environment and Heritage Protection
Date: 31 March 2013

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[2] A copy of the register template can be obtained by contacting the Department of Environment and Heritage Protection.

Appendix A

For Minimum requirements of certification/certification report and Form of certification (Hazard assessment/design plan), see: Appendix C of *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (EM635)* constructed as part of environmentally relevant activities pursuant to the *Environmental Protection Act 1994* – Version 3.

Appendix B—Model conditions schedule 'X' structures

General notes:

Explanatory notes for assessing officer guidance are in green. DELETE prior to issue of an authority.

Insertions required by applicants and/or the administering authority are in blue. DELETE appropriate parts or include relevant information prior to issue of an authority.

Model conditions are in black with defined terms indicated by **bold** text.

1. Preamble

The *Environmental Protection Act 1994* requires that any condition imposed be necessary or desirable to achieve the objects of the Act. In conditioning an environmental authority (authority), delegates should consider whether any condition, (model or otherwise) is necessary or desirable based on the particular facts and circumstances of the application to which the proposed authority relates. These model conditions have been prepared to indicate the administering authority's position on and expectations of authority holders in managing potential environmental risk posed by structures which are dams or levees that are of a high or significant hazard category. They also allow for consistency in conditioning of authorities across the state. The conditions are able to be modified where evidence supplied indicates that such modification, removal or replacement would achieve the same objective and is deemed necessary or desirable by the delegate.

It is the departments' position that the requirement for a condition to be 'necessary or desirable' has been met where a demonstrable link exists to achieving the object of the Act or discharging a duty or obligation imposed on the administering authority.

Officers should review the final conditions intended to be applied in a particular authority to ensure there is consistency in numbering, cross referencing and structure of conditions.

START OF CONDITIONS

2. Explanatory notes—all structures:

The model conditions under this section are expected to apply to all structures. Some parts of these model conditions are specific only to dams associated with a resource activity - non mining activity and this may affect the final structure and content of any particular authority.

The objective of the following conditions is to ensure that **all** structures are appropriately assessed to determine the applicable hazard category and a certificate provided by the suitably qualified and experienced person who undertook the assessment. Following this, appropriate conditioning can occur based of whether the structure is a regulated structure.

Where a structure is assessed as a low hazard structure, and later assessment results in the structure being determined to be a significant or high hazard category structure, this will require an amendment to the existing environmental authority or the Register of Regulated Dams.

Note that a dam includes all appurtenances that are connected with ensuring preservation of the integrity of the structure (e.g. spillways, catchment diversions). Also, a levee may be subject to regulation, depending on the consequences associated with failure as assessed in accordance with the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams* published by the administering authority.

A hazard assessment report may include details in relation to more than one structure.

Assessment of hazard category

(X 1) The **hazard category** of any **structure** must be **assessed** by a **suitably qualified and experienced person**:

a) in accordance with the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (EM365)*; and

b) in any of the following situations:

i) prior to the design and **construction** of the **structure**; or

ii) prior to any change in its purpose or the nature of its stored contents; and

iii) in accordance with the *Manual for assessing Hazard Categories and Hydraulic Performance of Dams.*

(X 2) A **hazard assessment** report and **certification** must be prepared for any **structure assessed** and the report may include a **hazard assessment** for more than one **structure**.

(X 3) The holder must, on receipt of a **hazard assessment** report and **certification**, provide to the administering authority one paper copy and one electronic copy of the **hazard assessment** report and **certification**.

(X 4) **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 Hazard Categories and Hydraulic Performance of Dams (EM635)*.

(X 5) The holder must take reasonable and practical measures so that each dam associated with the mining activity is designed, constructed, operated and maintained in accordance with accepted engineering standards and is fit for the purpose for which it is intended.

3. Explanatory notes—all regulated structures

The following model conditions relate to **all structures that have been assessed as regulated structures** (that is, structures in a high or significant hazard category).

Depending on the nature of the authority, some or all conditions may be applicable to the authority.

Regulated structures must not be constructed or operated unless an assessment of the hazard category, and a report and certification of the assessment has been prepared by a suitably qualified and experienced person.

A regulated structure must not be constructed or operated unless a suitably qualified and experienced person has prepared a design plan and certification for the regulated structure and this has been provided to the holder of the authority. Operation of the regulated structure is not permitted unless the holder has provided the administering authority with a copy of the design plan and certification.

The administering authority is not an approval body for the hazard category of a structure or design plans for a structure. Accordingly, acceptance by the administering authority of any report and certification (whether relating to the hazard category or design plan) does not indicate the administering authority approves the assessment carried out or the plans. The administering authority has set out requirements for suitably qualified and experienced persons to undertake this activity to ensure that the assessments and engineering works are conducted appropriately and in accordance with applicable standards.

Due to the number of dams associated with a resource activity - non mining activity, the administering authority has agreed to the use of a Register of Regulated Dams which is managed and maintained by the holder of an authority. For all other dams that are regulated dams, the details must be included in the authority itself.

Note that conditions X6 to X13 are not required if the proposal only covers existing structures that are declared regulated structures. In the case of existing structures that are declared to be regulated structures condition X39 must be included with transitional conditions X37 and X38.

If the project contains both new regulated structures and existing structures that are declared to be regulated structures after construction conditions X6 to X13 should contain the following ‘excluding regulated structures listed in table X of condition X37.

Design and construction[3] of a regulated structure

(X 6) All **regulated structures** [excluding structures listed in condition X38] must be designed by, and **constructed**[4] under the supervision of, a **suitably qualified and experienced person** in accordance with the requirements of the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (EM635)*.

(X 7) **Construction** of a **regulated structure** [excluding structures listed in condition X38] is prohibited unless the **holder** has:

a) submitted a **hazard category assessment** report and **certification** to the administering authority;

b) commissioned a **suitably qualified and experienced person** to prepare a design plan for the **structure**; and

c) received the **certification** from a **suitably qualified and experienced person** for the **design and design plan and** the associated operating procedures in compliance with the relevant condition of this **authority**. [if appropriate insert reference to all conditions relating to X5 to X13 and if relevant, any conditions relating to design and construction that apply to dams associated with a resource activity - non mining activity (X33 to X35)]

(X 8) 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 Hazard Categories and Hydraulic Performance of Dams (EM635)*.

(X 9) **Regulated structures** [excluding structures listed in condition X38] must:

a) be designed and constructed in accordance with and conform to the requirements of the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams;*

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) [Insert only in environmental authorities for regulated dams that are dams associated with a resource activity - non mining activity] 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**.

(X 10) The design plan for a **regulated structure** [excluding structures listed in condition X38] must include, but is not limited to:

a) **certification** that the design plan:

i) is in accordance with the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams*, including subsidiary certifications if necessary; and

ii) addresses the requirements in X10(b) to (i)

[3] Construction of a dam includes modification of an existing dam—refer to the definitions.

[4] Certification of design and construction may be undertaken by different persons.

b) A design report which provides:
   i) a description of all the documents which constitute the design plan;
   ii) a statement of:
      a) the applicable standards including engineering criteria, industry guidelines, relevant legislation and regulatory documents, relied upon in preparing the design plan; and
      b) all relevant facts and data used in preparing the design plan, including any efforts made to obtain necessary facts and data, and any limitations or assumptions to facts and data used in preparing the design plan;
      c) the **hazard category** of the regulated **structure**; and
      d) setting out the reasoning of the **suitably qualified and experienced person** who has certified the design plan, as to how the design plan provides the necessary required performance;
   iii) documentation of hydrological analyses and estimates required to determine all elements of the design including volumes and flow capacities;
   iv) detailed criteria for the design, operation, maintenance and decommissioning of the regulated **structure**, including any assumptions;
   v) design, specification and operational rules for any related structures and systems used to prevent failure scenarios;

c) Drawings showing the lines and dimensions, and locations of built structures and land forms associated with the regulated **structure**;

d) Consideration of the interaction of the pit design with the levee or regulated dam design;

e) [Insert only in environmental authorities for dams that are associated with a resource activity - non mining activity] A description of the containment system implemented.

f) An **operational plan** that includes:
   i) normal operating procedures and rules (including clear documentation and definition of process inputs in the DSA allowance);
   ii) 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**;

g) A plan for the decommissioning and rehabilitation of the regulated **structure** at the end of its operational life;

h) Details of reports on investigations and studies done in support of the design plan;

i) Any other matter required by the **suitably qualified and experienced person**.

(X 11) **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;**

b) **construction** of the regulated structure is in accordance with the design plan;

(X 12) Where a regulated dam is to be managed as part of an integrated containment system and the DSA volume is to be shared across the integrated containment system, the design and operating rules for the system as a whole must be documented in a **system design plan** that is **certified** by a **suitably qualified and experienced person**.

(X 13) The system design plan must contain:

a) the design plans, and

b) the 'as constructed' plans, and

c) the operational rules for each individual regulated dam that forms part of the integrated system, and

d) the standards of serviceability and accessibility of water transfer equipment or structures, and

e) the operational rules for the system as a whole.

Operation of a regulated structure

(X 14) Operation of a **regulated structure** is prohibited unless:

a) the **holder** has submitted to the administering authority:

i) one paper copy and one electronic copy of the design plan and **certification** of the 'design plan' in accordance with condition ##, and

ii) a set of 'as constructed' drawings and specifications, and

iii) **certification** of those 'as constructed drawings and specifications' in accordance with condition ##, and

iv) where the regulated structure is to be managed as part of an integrated containment system for the purpose of sharing the DSA volume across the system, a copy of the certified system design plan.

b) the requirements of this **authority** relating to the **construction** of the regulated **structure** have been met; and

c) [Insert only in environmental authorities for regulated dams that are dams associated with a resource activity - non mining activity] The **holder** has entered the details required under this **authority**, into a Register of Regulated Dams; [**OR**]

d) [Insert only in authorities for regulated dams that are not dams associated with a resource activity - non mining activity] Relevant details for the **dam** have been included in Schedule X Table 1 and Schedule X Table 2 of this **authority**.

(X 15) Each **regulated structure** must be maintained and operated in a manner that is consistent with the current design plan, the current operational plan, and the associated **certified** 'as constructed' drawings for the duration of its operational life until decommissioned and rehabilitated.

(X 16) The **holder** must take reasonable and practicable control measures to prevent the causing of harm to persons, livestock or wildlife through the **construction** and operation of a **regulated structure**. Reasonable and practicable control measures may include, but are not limited to:

a) the secure use of fencing, bunding or screening; and

b) escape arrangements for trapped livestock and fauna.

4. Explanatory notes—all regulated structures (continued)

All regulated dams must have a clearly observable mandatory reporting level (determined in accordance with the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (EM635)*). The holder must notify the administering authority on becoming aware of the dam contents reaching the MRL and take appropriate action to prevent or minimise the potential for environmental harm.

Each calendar year, an annual inspection and assessment of any regulated structure must be undertaken by a suitably qualified and experienced person, and a report prepared with recommendations for ensuring the integrity of the regulated structure is maintained. This inspection may indicate that the hazard category of a dam is potentially changed and identifies

amongst other things, whether there are any instances of failing to meet the conditions of an authority and the likelihood of insufficient capacity of a dam leading up to a wet season.

The holder of an authority must ensure there is sufficient capacity within the dam on 1 November of every year, to meet the design storage allowance (DSA) determined in accordance with the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams*. This is to minimise the risk of contaminants being released from the dam during a high rainfall wet season.

The intent of a DSA volume is to provide reasonable assurance that design performance criteria for containment will be met in any forthcoming wet-season. Failure to operate a regulated dam so that it meets the requirement to provide the DSA volume at the onset of each wet-season (that is, on the 1 November each year) should be an alert to the holder of an authority that it risks the likelihood that a spillway discharge from a regulated dam during the wet-season may not be authorised.

The intent of a mandatory reporting level (MRL) is to provide a level at which it is mandatory that the holder of an authority communicate to the administering authority that there is a possibility of a spillway discharge from a regulated dam.

Mandatory reporting level

(X 17) 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.

(X 18) 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**[5].

(X 19) 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.

Annual inspection report

(X 20) Each **regulated structure** must be inspected each calendar year by a **suitably qualified and experienced person**.

(X 21) At each annual inspection, the condition and adequacy of all components of the **regulated structure** must be assessed:

a) against the most recent **hazard assessment** report and design plan (or system design plan);

b) against recommendations contained in previous annual inspections reports;

c) against recognised dam safety deficiency indicators;

d) for changes in circumstances potentially leading to a change in **hazard category**;

e) for conformance with the conditions of this **authority**;

f) for conformance with the 'as constructed' drawings;

g) 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);

h) for evidence of conformance with the current operational plan.

(X 22) A **suitably qualified and experienced person** must prepare an annual inspection report containing details of the assessment and including recommended actions to ensure the integrity of the regulated **structure.**

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[5] Please note that for some model conditions, such as model conditions for dams that are 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).

(X 23) The **suitably qualified and experienced person** who prepared the annual inspection report must **certify** the report in accordance with the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (EM635)*.

(X 24) The **holder** must:

a) upon receipt of the annual inspection report, consider the report and its recommendations and take action to ensure that the **regulated structure** will safely perform its intended function; and

b) within twenty (20) business days of receipt of the annual inspection report, notify the administering authority in writing, of the recommendations of the inspection report and the actions being taken to ensure the integrity of each **regulated structure**.

(X 25) A copy of the annual inspection report must be provided to the administering authority upon request and within ten (10) business days[6].

Design storage allowance

(X 26) On 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 **Design Storage Allowance** (**DSA**) volume for the **dam** (or network of linked containment systems).

(X 27) 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.

(X 28) 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.

Performance review

(X 29) 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.

(X 30) The **holder** must take action to modify its water management or linked containment system so as to ensure that the **regulated dam** or linked containment system will perform in accordance with the requirements of this authority, for the subsequent November to May period.

Note: Action may include seeking the necessary approvals for physical modification of a regulated dam.

Transfer arrangements

(X 31) 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, hazard assessment, design plan and other supporting documentation, to a new **holder** and the administering authority on transfer of this **authority**.

Decommissioning and rehabilitation

(X 32) Prior to the cessation of the environmentally relevant activity, each **regulated structure** must be decommissioned such that:

[6] Please 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).

1. ongoing environmental harm is minimised by the regulated structure:
   i) becoming a safe site for humans and animals at the completion of rehabilitation; or
   ii) becoming a stable landform, that no longer contains flowable substances and minimises erosion impacts; or
   iii) not allowing for acid mine drainage; or
   iv) being approved or authorised under relevant legislation for a beneficial use; or
   v) being a **void** authorised by the administering authority to remain after decommissioning; and
2. the regulated structure is compliant with all other relevant rehabilitation requirements of this **authority**[7].

5. Explanatory notes—regulated structures other than dams associated with a resource activity - non mining activity

The following model conditions are intended to apply to all regulated structures (which are dams or levees) except for dams associated with a resource activity - non mining activity, which have separate additional model conditions set out later in this document. For regulated structures other than those which are dams associated with a resource activity - non mining activity, details of the regulated structure must be inserted into the authority itself. These details include location details of any regulated structure, details such as the hazard category, MRL and DSA and the hydraulic performance of the dam. Any change in these specifications will require an amendment to the authority or application for a transitional environmental plan (TEP).

These requirements are for new structures assessed as regulated structures, but may also apply to existing structures on amendment of an existing authority, or where an existing structure is being used under a new authority. In those instances only, transitional arrangements are able to be set out in the authority, providing for a transitional period within which the existing structure must be altered or modified to meet the new requirements. The term of three years is used as a benchmark only, and less time may be provided for, or alternatively a TEP may be applied for if more than three years is required.

Where the transitional arrangements provided for by X37 and X38 call up previous conditions of approval, the relevant schedule is to include the definitions that were applicable at the time that the conditions were imposed. Where there were no previous conditions of approval, the relevant schedule is to specify the applicable existing standards with which the regulated structure must comply.

Where a regulated structure ceases to be a regulated structure by being decommissioned and rehabilitated or having its hazard category re-assessed and certified by a suitably qualified and experienced person, an application may be made to amend the approval to remove the requirements in relation to that particular regulated structure.

Regulated structures location and performance

(X 33) Each **regulated structure** named in Column 1, of Schedule D - Table 1 must be wholly located within the control points noted in columns 2 and 3 of Schedule D - Table 1, below, for that **structure**.

[7] There may be additional specific conditions relating to rehabilitation and decommissioning that apply to a dam. Note it is possible to accept modification of condition X32 if a dam is accepted as an asset by a new landholder.

Schedule D—Table 1 (Location of Regulated structures)

Column 1	Column 2	Column 3	Column 4 Levees only
Name of Regulated Structure[1]	**Latitude**[2] **(GDA 94)**	**Longitude**[2] **(GDA 94)**	**Unique Location ID**[3]
<XXX>	<XXX> <XXX> <XXX>	<XXX> <XXX> <XXX>	<XXX> <XXX> <XXX>
<XXX>	<XXX> <XXX> <XXX>	<XXX> <XXX> <XXX>	<XXX> <XXX> <XXX>

[1] The 'name of the regulated structure' should refer to the name for example, process residue facility and decant dam.

[2] A minimum of three control points is required to constrain the location of all activities associated with the regulated structure. Additional infrastructure which forms part of any regulated dam may include appurtenant works consisting of seepage collections systems, runoff diversion bunds, containment systems, pressure relief wells, decant and recycle water systems. Note that details on tailing discharge pipelines would be included in this table only if they have not been included in the design plan required in condition x10.

[3] This location reference is the reference for schedule D table 4 flood level and crest level.

(X 34) Each **regulated dam** named in column 1 of Schedule D—Table 2, must be consistent with the details noted in columns 2 through to and including 7 of Schedule D - Table 2, below, for that **dam**.

Schedule D—Table 2 (Basic Details of Regulated Dams)

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7
Name of Regulated dam[1]	**Hazard Category**	**Surface area of dam at spillway (ha)**	**Max. volume of dam at spillway (m^3)**	**Max. depth of dam[2] at spillway (m)**	**Spillway Level (mAHD)**	**Use of dam[3]**
<XXX>	<XXX>	<XXX>	<XXX>	<XXX>	<XXX>	<XXX>
<XXX>	<XXX>	<XXX>	<XXX>	<XXX>	<XXX>	<XXX>

[1] The name of the regulated dam should refer to the name of the dam, for example, process residue facility and decant dam and should be the same name used in Schedule D Table 1 for the dam.

[2] For regulated dams which do not require a dam wall, input the maximum void depth, for example, where dams are formed by excavating below the land surface or backfilling a residual void.

[3] The use or purpose of the regulated dam should outline the designed function, for example, 'the permanent containment of tailings resulting from the extraction of nickel, cobalt and other metals at the XYZ refinery'.

(X 35) Each **regulated dam** named in column 1 of Schedule D – Table 1, must meet the **hydraulic performance** criteria noted in columns 2 through to and including 4 of Schedule D - Table 3, below, for that **dam**.

Schedule D—Table 3 (Hydraulic Performance of Regulated Dams)

Column 1	Column 2	Column 3	Column 4
Name of Regulated dam	**Spillway Capacity AEP**	**Design Storage Allowance AEP**	**Mandatory Reporting Level AEP**
<XXX>	<XXX>	<XXX>	<XXX>
<XXX>	<XXX>	<XXX>	<XXX>

(X 36) Each **regulated levee** named in column 1 of Schedule D – Table 1, must be consistent with the details noted in columns 2 through to and including 6 of Schedule D - Table 4, below, for that **levee**.

Schedule D—Table 4 (Basic Details of Regulated Levees)

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Name of Regulated Levee	**Design AEP**	**Design Flood Level[1] (mAHD)**	**Minimum Levee Level[1] (mAHD)**	**Schedule D Table 1 Location ID[1]**	**Use of levee**
<XXX>	<XXX>	<XXX>	<XXX>	<XXX>	<XXX>
<XXX>	<XXX>	<XXX>	<XXX>	<XXX>	<XXX>

[1] Design flood levels, and hence regulated levee levels, are expected to vary along the length of that levee. The location IDs listed (Column 5) must correspond with location IDs listed in Schedule D Table 1 and, together with Columns 3 and 4, define the minimum design level envelope for the longitudinal crest of the structure.

[Only insert the below model conditions into authorities for existing regulated dams that do not meet the requirements for basic details (Schedule D—Table 2) and hydraulic performance (Schedule D—Table 3), or if a levee (Schedule D—Table 4)]

Transitional arrangements

(X 37) Each **regulated structure** specified below must, within a period of three years (the transitional period) from [insert the date of the commencement of this condition], meet the performance requirements of conditions X34 and X35 or if a levee, condition X36:

a) [<XXX>]; and

b) [<XXX>].

(X 38) During the transitional period, each **regulated structure** specified in condition X37 must comply with either conditions X34 and X35 or if a levee, condition X36 of this **authority,** or the conditions set out in Schedule [<XXX>] of this **authority** which schedule expires at the end of the transitional period.

(X 39) **During the transitional period**, for each declared regulated structure listed in condition X##, either:

a) Certification must be provided, by a suitably qualified and experienced person, in the form set out in the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams:*

i) that the declared regulated structure is suitable for use as a regulated structure and can be transitioned to meet with either conditions X34 and X35 or if a levee, condition X36 of this **authority**; and

ii) of any design plans for the modification of the declared regulated structure where modification is required to meet with either conditions X34 and X35 or if a levee, condition X36 of this **authority**; or

b) The declared regulated structure must be decommissioned.

6. Explanatory notes—regulated dams that are dams associated with a resource activity – non mining

The below model conditions are only intended to apply to regulated dams that are dams associated with a resource activity - non mining activity.

The objective of these model conditions is to ensure the chances of any leaching, seepage or unintended release of Coal Seam Gas water, saline effluent or brine is minimised. The conditions also provide for a register of regulated dams to be developed and maintained by the holder of the authority rather than have details specified in the authority itself.

[Only insert the following conditions in environmental authorities for regulated dams that are associated with a resource activity – non mining]

(X 40) **Aggregation dams** must:

a) have the floor and sides of the **dam** designed with material that will contain the wetting front and any entrained contaminants during the operational life of the **dam** and for any period of decommissioning and rehabilitation of the **dam**; and

b) have a system to detect any passage of the wetting front or entrained contaminants through either the floor or sides of the **dam**; and

(X 41) **Brine dams** must:

a) have the floor and sides of the **dam** designed with material that will contain the wetting front and any entrained contaminants during the operational life of the **dam** and for any period of decommissioning and rehabilitation of the **dam**; and

b) have a system to detect any passage of the wetting front or entrained contaminants through either the floor or sides of the **dam**; and

c) have a system for the collection and proper disposal of any contaminants that move beyond the bounds of the containment system; and

d) that brine dams must be constructed with the capacity to continuously remove any leachate from beneath the floor or beyond the sides of the **dam**

[Only insert the following conditions in environmental authorities for regulated dams that are associated with a resource activity - non mining activity]

Register of Regulated Dams

(X 42) A Register of Regulated Dams must be established and maintained by the **holder** and include, as a minimum, the following information for each **regulated dam**[8]:

a) Date of entry in the register;

b) Name of the **dam**, its purpose and intended/actual contents;

c) Location of the **dam** defined by coordinates (latitude and longitude in GDA94) within five metres at any point from the outside of the **dam** including its storage area;

d) The **hazard category** of the **dam** as **assessed** using the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (EM635)*;

e) Dates, names, and reference numbers of all document(s) lodged as part of a design plan for the **dam**;

f) Name and qualifications of the **suitably qualified and experienced person** who **certified** the design plan and 'as constructed' drawings;

g) 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) **Dam crest volume** (megalitres);

iii) Spillway crest level (metres AHD).

iv) Maximum operating 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);

h) The design plan title and reference relevant to the **dam**;

i) The date **construction** was **certified** as compliant with the design plan;

j) The name and details of the **suitably qualified and experienced** person who **certified** that the constructed **dam** was compliant with the design plan;

k) Details of the composition and construction of any liner;

l) The system for the detection of any leakage through the floor and sides of the **dam**;

m) Dates when the regulated **dam** underwent an annual inspection for structural and operational adequacy, and to ascertain the available storage volume for 1 November of any year;

n) Dates when recommendations and actions arising from the annual inspection were provided to the administering authority;

o) Dam water quality as obtained from monitoring required under this **authority** as at 1 November of each year.

(X 43) The **holder** must provisionally enter the required information in the Register of Regulated Dams when a **design plan** for a **regulated dam** is submitted to the administering authority.

(X 44) The **holder** must make a final entry of the required information in the Register of Regulated Dams once compliance with condition (X14) has been achieved.

[8] Note: The regulated dam register in the approved departmental format is available for download at: <www.ehp.qld.gov.au/management/coal-seam-gas/csg-water.html>.

(X 45) The **holder** must ensure that the information contained in the Register of Regulated Dams is current and complete on any given day.

(X 46) All entries in the Register of Regulated Dams must be approved by the chief executive officer for the holder of this authority, or their delegate, as being accurate and correct.

(X 47) 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 Dams, in the electronic format required by the administering authority.

[Only insert the following conditions in environmental authorities for regulated dams that are associated with a resource activity - non mining activity]

Repair requirements

(X 48) Where the **holder** detects any passage of the wetting front through the floor or sides of a **regulated dam** they must, as soon as practicable:

a) repair the regulated **dam** to rectify the detected passage of the wetting front or entrained contaminants through the floor or sides of the regulated **dam**; or

b) decommission and rehabilitate the regulated **dam**.

Definitions

Aggregation dam means a regulated dam that receives and contains coal seam gas water or coal seam gas concentrate. The primary purpose of the dam must not be to evaporate the water even though this will naturally occur.

Annual exceedance probability or AEP the probability that at least one event in excess of a particular magnitude will occur in any given year.

Assessed and assessment by a suitably qualified and experienced person in relation to a hazard assessment of a dam, 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 of the assessment:

(a) exactly what has been assessed and the precise nature of that determination;

(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.

Brine means saline water with a total dissolved solid concentration greater than 40,000 mg/L.

Brine dam means a regulated dam that is designed to receive, contain or evaporate brine.

Certification means assessment and approval must be undertaken by a suitably qualified and experienced person in relation to any assessment or documentation required by this manual, 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 RPEQs (ID: 1.4 (2A)).

Certifying, **certify or certified** have a corresponding meaning as 'certification'.

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.

Coal seam gas water means groundwater that is necessarily or unavoidably brought to the surface in the process of coal seam gas exploration or production. Coal seam gas water typically contains significant concentrations of salts, has a high sodium adsorption ratio and may contain other contaminants that have the potential to cause environmental harm if released to land or **waters** through inappropriate management. Coal seam gas water is a waste, as defined under s. 13 of the *Environmental Protection Act 1994*.

Coal seam gas water concentrate means the concentrated saline water waste stream from a water treatment process that does not exceed a total dissolved solid concentration of 40 000 mg/L.

Coal seam gas evaporation dam is defined as a impoundment, enclosure or structure that is designed to be used to hold coal seam gas water for evaporation.

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**. A dam does not mean 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.

Dam crest volume means the volume of material (liquids and/or solids) that could be within the walls of a dam at any time when the upper level of that material is at the crest level of that dam. That is, the instantaneous maximum volume within the walls, without regard to flows entering or leaving (eg via spillway).

Design storage allowance or DSA means an available volume, estimated in accordance with the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (EM635)* 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 (AEP) specified in that manual.

Designer for the purposes of a regulated dam, means the certifier of the design plan for the regulated dam.

Development approval means a development approval under the *Integrated Planning Act 1997* or the *Sustainable Planning Act 2009* in relation to a matter that involves an environmentally relevant activity under the *Environmental Protection Act 1994*.

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 downstream communities and the implementation of protection measures. The plan must require dam owners to annually update contact details that are part of the plan, and to comprehensively review the plan at least every five years.

[Only insert the following definitions in authorities for regulated dams that are associated with a resource activity - non mining activity]

Existing aggregation dam means <INSERT names and locations of aggregation dams that are constructed and/or whose construction had substantially commenced on the approval date of this environmental authority>.

Existing brine dam means <INSERT names and locations of brine dams that are constructed and/or whose construction had substantially commenced on the approval date of this environmental authority>.

Existing coal seam gas evaporation dam means <INSERT names and locations of existing dams containing coal seam gas water for the primary purpose of evaporation that are constructed and/or whose construction had substantially commenced on the approval date of this environmental authority>.

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.

Hazard in relation to a dam as defined, means the potential for environmental harm resulting from the collapse or failure of the dam to perform its primary purpose of containing, diverting or controlling flowable substances.

Hazard 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 Hazard Categories and Hydraulic Performance of Dams (EM635)*.

Holder means:

(a) where this document is an environmental authority, any person who is the holder of, or is acting under, that environmental authority; or

(b) where this document is a development approval, any person who is the registered operator for that development approval.

Hydraulic performance means the capacity of a regulated dam to contain or safely pass flowable substances based on a probability (AEP) of performance failure specified for the relevant hazard category in the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (EM635)*.

Levee means an embankment that only provides for the containment and diversion of stormwater or flood flows from a contributing catchment, or containment and diversion of flowable materials resulting from releases from other works, during the progress of those stormwater or flood flows or those releases; and does not store any significant volume of **water** or **flowable substances** at any other times.

Low hazard dam means any dam that is not a high or significant hazard category as assessed using the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (EM635)*; and

Mandatory reporting level or MRL means a warning and reporting level determined in accordance with the criteria in the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (EM635)* published by the administering authority.

Modification or modifying (see definition of 'construction')

Operational plan for a dam means a document that amongst other things sets out procedures and criteria to be used for operating a dam during a particular time period. The operational plan as defined herein may form part of a plan of operations or plan otherwise required in legislation.

Regulated dam means any dam in the significant or high hazard category as assessed using the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (EM635)* published by the administering authority.

Structure means dam or levee.

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.

Suitably qualified and experienced person in relation to regulated structures 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 required 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 volume across the integrated containment system.

Void means any constructed, open excavation in the ground.

Watercourse has the same meaning given in the *Water Act 2000*.

Waters includes all or any part of a river, stream, lake, lagoon, pond, swamp, wetland, unconfined surface water, unconfined water in natural or artificial watercourses, bed and banks of a watercourse, dams, non-tidal or tidal waters (including the sea), stormwater channel, stormwater drain, roadside gutter, stormwater run-off, and groundwater.

Water year means the 12-month period from 1 July to 30 June.

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.

Appendix S: Part B – PRCP Schedule

Legislative Requirement

In accordance with section 126D (1) of the EP Act, the PRCP Schedule in the PRC Plan must: a. Describe the area of each resource tenure either a post-mining land use or non-use management area, and b. For each post-mining land use state: i. Each rehabilitation milestone required to achieve a stable condition, and ii. When each rehabilitation milestone is to be achieved, and c. For each non-use management area state: i. Each management milestone, and ii. When each management milestone is to be achieved, and d. Include maps showing the land mentioned in (a), (b) and (c).

Final Site Design

The final site design for Fox, including maximum disturbance, tenure boundaries and the PMLUs, is shown in Figure 4-1.

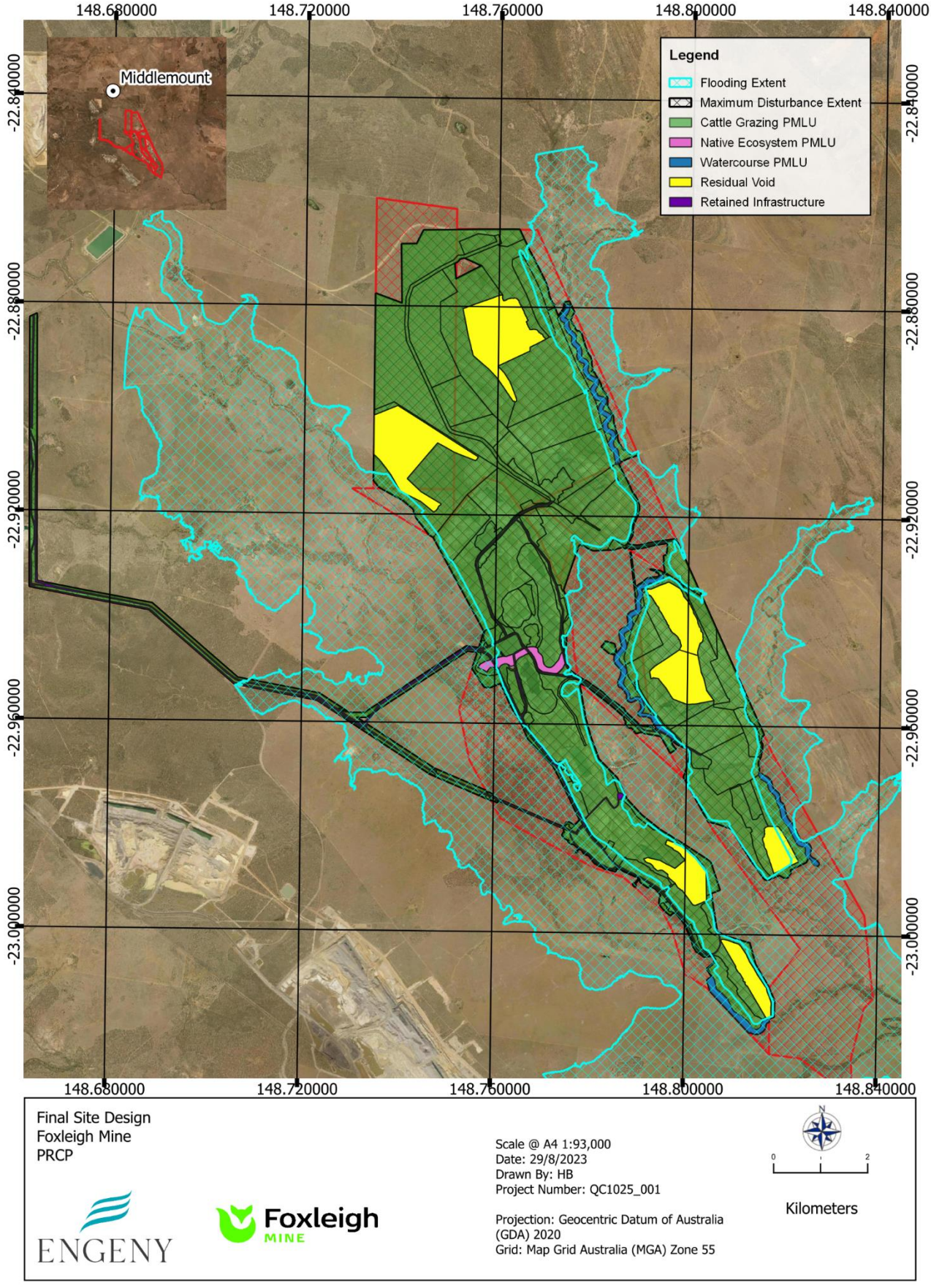

Figure 4-1: Final Site Design of Foxleigh Mine

Reference Map

The Fox reference map showing the rehabilitation areas is shown in Figure 4-2.

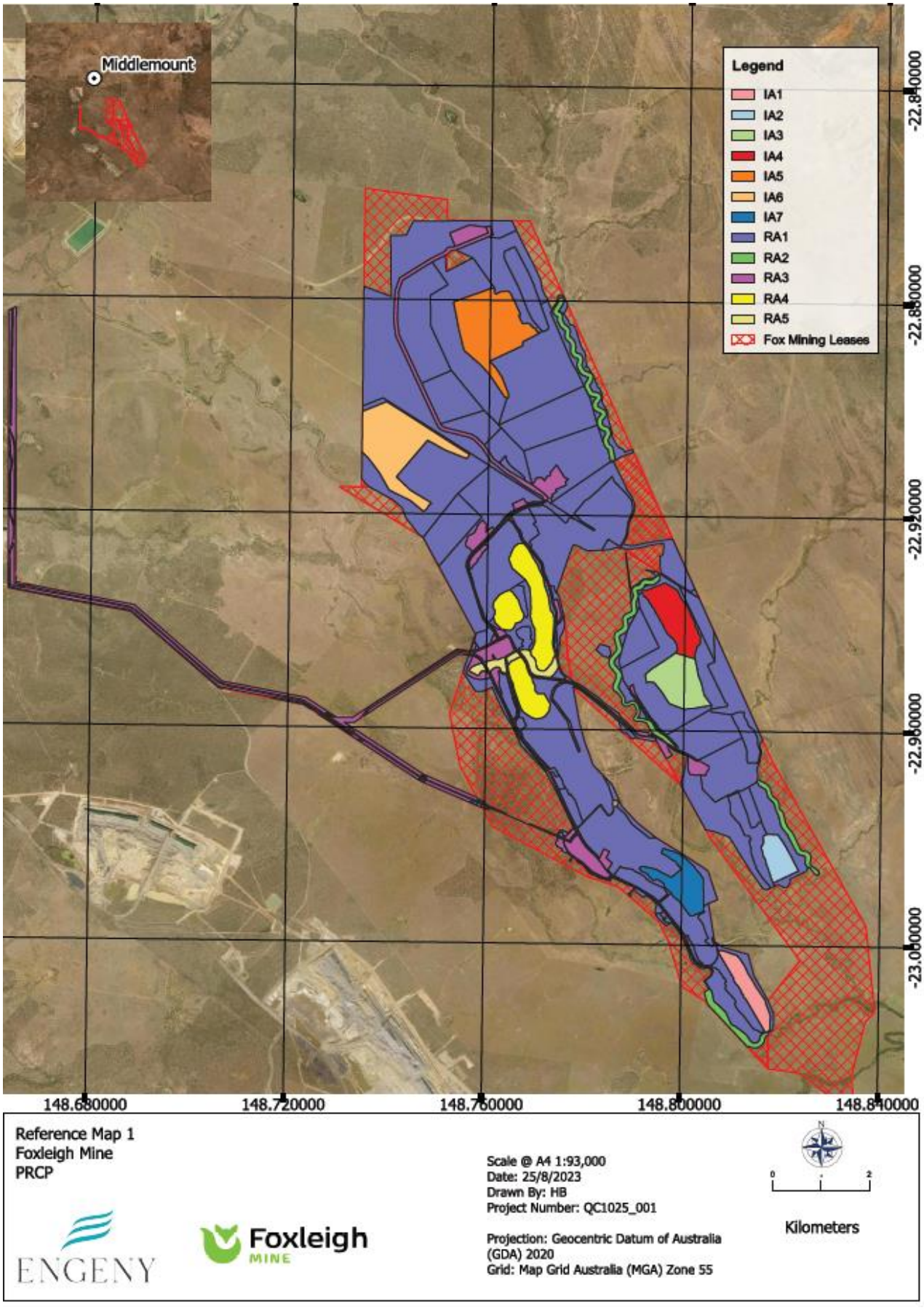

Figure 4-2: Rehabilitation Areas Reference Map

Rehabilitation Milestones

The rehabilitation milestones and milestones criteria for Fox are shown in PRCP Schedule EPML00744813.

Schedule

The schedule is based on the land being rehabilitated as soon as practicable after the land becomes available, as required under section 126D (4) of the EP Act. For Fox, areas become progressively available once the coal mining is complete, with final land becoming available once coal processing has ended. Rehabilitation milestones RM1 – RM3 will be completed in the same time period for each RA, while completion of RM4 – RM11 is dependent on the final proposed PMLU. Achievement of rehabilitation milestones RM12 – RM17 will be demonstrated prior to the scheduled date if possible. The PRCP Schedule is provided PRCP Schedule EPML00744813.

(RA1) Rehabilitation Area 1

Post-mining land uses (PMLU)																
Rehabilitation area	RA1															
Relevant activities	Mining and Mine Dump Areas															
Total rehabilitation area size (ha)	4315															
Commencement of first milestone: RM1	2023															
PMLU	Grazing															
Date area is available	2023	2024	2025	2026	2027	2028	2033	2038	2043	2048	2053	2058	2063	2068	2073	2078
Cumulative area available (ha)	746	1151	1151	1151	1229	1538	1787	1787	2212	2776	4269	4315	4315	4315	4315	4315
Milestone completed by	2023	2024	2025	2026	2027	2028	2033	2038	2043	2048	2053	2058	2063	2068	2073	2078
Milestone reference	**Cumulative area achieved (ha)**															
RM1	746	843	943	1033	1085	1145	1452	1787	2212	2776	3441	3885	4315	4315	4315	4315
RM2	746	843	943	1033	1085	1145	1452	1787	2212	2776	3441	3885	4315	4315	4315	4315
RM3	746	843	943	1033	1085	1145	1452	1787	2212	2776	3441	3885	4315	4315	4315	4315
RM5	746	843	943	1033	1085	1145	1452	1787	2212	2776	3441	3885	4315	4315	4315	4315
RM6	746	843	943	1033	1085	1145	1452	1787	2212	2776	3441	3885	4315	4315	4315	4315
RM9	746	843	943	1033	1085	1145	1452	1787	2212	2776	3441	3885	4315	4315	4315	4315
RM12						746	1145	1452	1787	2212	2776	3441	3885	4315	4315	4315
RM15									746	1145	1452	1787	2212	2776	3441	3885

(RA2) Rehabilitation Area 2

Rehabilitation area	RA2													
Relevant activities	Creek diversions & levees													
Total rehabilitation area size (ha)	137													
Commencement of first milestone: RM1	2023													
PMLU	Watercourse													
Date area is available	2023	2024	2025	2026	2027	2028	2033	2038	2043	2048	2053	2058	2063	2068
Cumulative area available (ha)	137	137	137	137	137	137	137	137	137	137	137	137	137	137
Milestone completed by	2023	2024	2025	2026	2027	2028	2033	2038	2043	2048	2053	2058	2063	2068
Milestone reference	**Cumulative area achieved (ha)**													
RM1	137	137	137	137	137	137	137	137	137	137	137	137	137	137
RM2	137	137	137	137	137	137	137	137	137	137	137	137	137	137
RM3	137	137	137	137	137	137	137	137	137	137	137	137	137	137
RM5	137	137	137	137	137	137	137	137	137	137	137	137	137	137
RM7	137	137	137	137	137	137	137	137	137	137	137	137	137	137
RM10	137	137	137	137	137	137	137	137	137	137	137	137	137	137
RM13						137	137	137	137	137	137	137	137	137
RM16										137	137	137	137	137

(RA3) Rehabilitation Area 3

Post-mining land uses (PMLU)														
Rehabilitation area	RA3													
Relevant activities	Mine Infrastructure													
Total rehabilitation area size (ha)	646													
Commencement of first milestone: RM1	2038													
PMLU	Grazing													
Date area is available	2048	2053	2058	2063	2068	2073	2078	2083	2088	2093	2098	2103	2108	2113
Cumulative area available (ha)	0	219	548	548	548	548	548	548	548	548	548	548	548	548
Milestone completed by	2033	2038	2043	2048	2053	2058	2063	2068	2073	2078	2083	2088	2093	2098
Milestone reference	**Cumulative area achieved (ha)**													
RM1		219	548	548	548	548	548	548	548	548	548	548	548	548
RM2		219	548	548	548	548	548	548	548	548	548	548	548	548
RM3		219	548	548	548	548	548	548	548	548	548	548	548	548
RM6		219	548	548	548	548	548	548	548	548	548	548	548	548
RM9		219	548	548	548	548	548	548	548	548	548	548	548	548
RM12			548	548	548	548	548	548	548	548	548	548	548	548
RM15					548	548	548	548	548	548	548	548	548	548

(RA4) Rehabilitation Area 4

Post-mining land uses (PMLU)														
Rehabilitation area	RA4													
Relevant activities	Mineral residue areas													
Total rehabilitation area size (ha)	199													
Commencement of first milestone: RM1	2048													
PMLU	Cattle Grazing													
Date area is available	2043	2048	2053	2058	2063	2068	2073	2078	2083	2088	2093	2098	2103	2108
Cumulative area available (ha)	0	57	162	199	199	199	199	199	199	199	199	199	199	199
Milestone completed by	2043	2048	2053	2058	2063	2068	2073	2078	2083	2088	2093	2098	2103	2108
Milestone reference	**Cumulative area achieved (ha)**													
RM1	0	57	162	199	199	199	199	199	199	199	199	199	199	199
RM3			57	162	199	199	199	199	199	199	199	199	199	199
RM4				57	162	199	199	199	199	199	199	199	199	199
RM6					57	162	199	199	199	199	199	199	199	199
RM9					57	162	199	199	199	199	199	199	199	199
RM12						57	162	162	199	199	199	199	199	199
RM15								57	162	199	199	199	199	199

(RA5) Rehabilitation Area 5

Post-mining land uses (PMLU)														
Rehabilitation area	RA5													
Relevant activities	Native ecosystem corridor													
Total rehabilitation area size (ha)	35													
Commencement of first milestone: RM1	2028													
PMLU	Native ecosystem													
Date area is available	2028	2033	2038	2043	2048	2053	2058	2063	2068	2073	2078	2083	2088	2093
Cumulative area available (ha)	17	17	17	17	17	35	35	35	35	35	35	35	35	35
Milestone completed by	2028	2033	2038	2043	2048	2053	2058	2063	2068	2073	2078	2083	2088	2093
Milestone reference	**Cumulative area achieved (ha)**													
RM1	17	17	17	17	17	35	35	35	35	35	35	35	35	35
RM2	17	17	17	17	17	35	35	35	35	35	35	35	35	35
RM3	17	17	17	17	17	35	35	35	35	35	35	35	35	35
RM8	17	17	17	17	17	35	35	35	35	35	35	35	35	35
RM11	17	17	17	17	17	35	35	35	35	35	35	35	35	35
RM14			17	17	17	17	17	35	35	35	35	35	35	35
RM17					17	17	17	17	17	17	35	35	35	35

Milestone Reference	Rehabilitation Milestone	Milestone Criteria
RM1	Infrastructure decommissioning and removal	h) All services disconnected. Underground services remain buried and surface points sealed. i) All buildings either demolished and removed or relocated off the mining leases. j) Concrete slabs and footings removed or buried within overburden dump final rehabilitation areas. k) Sumps or dams that do not form part of final landform as sediment control structures dewatered and where applicable contaminated silt removed for licensed disposal. l) Sealed asphalt roads, car parks and hardstand areas will have the asphalt removed for reuse of the mining leases or removed for licensed disposal. m) Mine water dams are decommissioned. n) Watercourse crossings and culverts removed.
RM2	Remediation and/or management of contaminated land	f) Hydrocarbon and chemical storage areas removed and/or remediated by on-site treatment, if required. g) Contaminated Land Investigation Document completed in accordance with the Environmental Protection Act 1994, including: h) Site Suitability Statement confirming the suitability of the property for the PMLUs i) Audit Certification j) Contaminated Land Investigation Document including a Site Investigation Report and, where required, a Validation Report and/or a draft Site Management Plan
RM3	Landform development and reshaping	d) Landforms reshaped maximum 10% slopes (coarse reject) (RA4) e) Landforms requiring reshaping are reshaped to be free-draining with maximum 17% slopes (RA1, RA3; RA5) f) Disturbed natural watercourse bed and banks returned to a profile similar to the pre-disturbance condition (RA2)

Milestone Reference	Rehabilitation Milestone	Milestone Criteria
RM4	Installing Cover Systems/Capping	*if required, removal of residual water from facility Tailing Storage Facility (TSF): e) Low clay content NAF spoil will be used for an initial 2m layer in contact with tailings to create the bulk landform shape. The spoil will have minimal compaction to limit moisture suction potential; Course Reject and Tailing: f) 1m minimum thickness layer of selected weathered Permian and/or Tertiary spoil, will be spread and worked so as to be more than ten times less permeable than spoil above it. The surface will be shaped to shed any deep infiltration out of the landform; g) 2m minimum thickness of more permeable material such as gravelly fresh Permian spoil will be placed over the low permeability layer. The thickness may be greater than 2m as needed to maintain separation between the vegetation rooting zone and the low permeability layer, and to provide a final ground surface that will shed rainfall without ponding with slopes not greater than those on rehabilitated spoil emplacement areas; h) Topsoil and erosion management practices consistent with those on rehabilitated spoil emplacement areas. Noting an additional avoidance of deep rooted tree species is not to be used within this PMLU *a minimum of 10 years is required for settlement form the end of use of the TSF to installation of the cover.
RM5	Existing rehabilitation landform remediation	g) Landforms requiring maintenance or remediation that are existing historical rehabilitation landforms are reshaped to maximum 17% slopes. h) Where appropriate, addition of rock and/or natural materials (logs) cover to assist erosion resistance of eventual vegetative ground cover. i) Topsoil placed at minimum depth of 150 mm j) Addition of growth media and ameliorants to ensure no bare areas greater than 100m2. k) Cultivation and keying of topsoil to subsoil with suitable multi-type ripper and performed parallel to slope contours. l) Where appropriate, addition of rock and/or natural materials (logs) cover to assist erosion resistance of eventual vegetative ground cover.

Milestone Reference	Rehabilitation Milestone	Milestone Criteria
RM6	Surface preparation (cattle grazing)	e) Topsoil placed at minimum depth of 150 mm f) Addition of growth media and ameliorants to ensure no bare areas greater than 100m2. g) Cultivation and keying of topsoil to subsoil with suitable multi-type ripper and performed parallel to slope contours. h) Where appropriate, addition of rock and/or natural materials (logs) cover to assist erosion resistance of eventual vegetative ground cover.
RM7	Surface preparation (watercourse)	e) Topsoil placed at minimum depth of 150 mm f) Addition of growth media and ameliorants to ensure no bare areas greater than 100m2. g) Where appropriate, cultivation and keying of topsoil to subsoil with suitable multi-type ripper and performed parallel to slope contours. h) Where appropriate, addition of rock and/or natural materials (logs) cover to assist erosion resistance of eventual vegetative ground cover.
RM8	Surface preparation (native ecosystem)	e) Topsoil placed at minimum depth of 150 mm f) Addition of growth media and ameliorants to ensure no bare areas greater than 100m2. g) Where appropriate, cultivation and keying of topsoil to subsoil with suitable multi-type ripper and performed parallel to slope contours. h) Where appropriate, addition of rock and/or natural materials (logs) cover to assist erosion resistance of eventual vegetative ground cover.
RM9	Revegetation (cattle grazing)	b) Completed seeding of target pasture species across areas with a suitable species mix for the agreed final land use of grazing.
RM10	Revegetation (watercourse)	b) Completed seeding of target species across areas with a suitable species mix for the agreed final land use of grazing or native ecosystem.
RM11	Revegetation (native ecosystem corridor)	b) Completed seeding of target species across areas with a suitable species mix for the agreed final land use of native ecosystem.

Milestone Reference	Rehabilitation Milestone	Milestone Criteria
RM12	Achievement of surface requirements (cattle grazing)	g) Vegetation established across areas with a suitable species mix for the agreed final land use of grazing. h) Areas where agricultural land use applies, have pasture grass species present and provide stock with nutritional requirements, as well as being capable of setting viable seed and flowering similar to reference sites in the Middlemount area and/or with a land suitability class (grazing) of 4. i) >60% of the area has a vegetative groundcover[2] achieved. j) No new invasive plants[2] and infestation density of invasive plants within the area are contained or reduced and consistent with reference sites. k) Water control structures are either removed or free of active erosion and integrated into permanent landforms. l) No erosion classifications of 'Severe' or 'Extreme' (>30 rills/gullies and any are >0.3 m deep) and no active erosion present as demonstrated by no increase in erosion over time [2]Groundcover: anything in contact with the soil surface, for example, live cover, standing dry cover, organic littler (including leaves, hay, coarse woody debris) or rocks
RM13	Achievement of surface requirements (watercourse)	g) Vegetation established across areas with a suitable species mix for the agreed final land use of grazing or native ecosystem. h) Riparian vegetation index score: greater than or equal to upstream or downstream values (RARC method[3]) i) No new invasive plants[3] and infestation density of invasive plants within the area are contained or reduced and consistent with reference sites. j) Water control structures are either removed or free of active erosion and integrated into permanent landforms. k) No erosion classifications of 'Severe' or 'Extreme' (>30 rills/gullies and any are >0.3 m deep) and no active erosion present as demonstrated by no increase in erosion over time l) Evidence of fauna habitat features for invertebrate and vertebrate species (e.g., logs, rock piles). [3]Rehabilitated watercourse - Modified RARC method with a reduced number of monitoring points within each reach

Milestone Reference	Rehabilitation Milestone	Milestone Criteria
RM14	Achievement of surface requirements (native ecosystem)	e) Vegetation established across areas with a suitable species mix for the agreed final land use of native ecosystem. f) No new invasive plants[2] and infestation density of invasive plants within the area are contained or reduced and consistent with reference sites. g) Water control structures are either removed or free of active erosion and integrated into permanent landforms. h) No erosion classifications of 'Severe' or 'Extreme' (>30 rills/gullies and any are >0.3 m deep) and no active erosion present as demonstrated by no increase in erosion over time [3]Groundcover: anything in contact with the soil surface, for example, live cover, standing dry cover, organic littler (including leaves, hay, coarse woody debris) or rocks
RM15	Achievement of post-mining land use to a stable condition (cattle grazing)	j) Provide a final rehabilitation report including monitoring records k) Assessment of carrying capacity by an AQP[1] demonstrates a sustainable grazing outcome has been achieved l) >75% of groundcover vegetation comprises of species density and diversity consistent with the agreed final land use of grazing. m) If deemed required, either LiDAR or ground survey to confirm settlement levels <10 mm/annum. n) Erosion classification to be comparable with erosion classifications from nearby equivalent land uses with similar landform parameters to be determined by establishing analogue sites at suitable comparable sites o) No erosion classifications of 'Severe' or 'Extreme' (>30 rills/gullies and any are >0.3 m deep) and no active erosion present as demonstrated by no increase in erosion over time p) Hazard assessment completed by an AQP[1] to confirm safety hazards in rehabilitation are not significantly different to surrounding unmined landscapes subject to the same land use q) Water quality in retained structures will meet livestock drinking water criteria as defined in Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018) r) Water quality from direct rainfall runoff or surface seepage from rehabilitated spoil has: v. pH 6.5–9.0; and vi. EC <2,000 µS/cm.

Milestone Reference	Rehabilitation Milestone	Milestone Criteria
RM16	Achievement of post-mining land use to a stable condition (watercourse)	e) Hazard assessment completed by an AQP[1] to confirm safety hazards in rehabilitation are not significantly different to surrounding unmined landscapes subject to the same land use f) Rainfall runoff from rehabilitated areas is not significantly different to upstream values for the following: pH, EC and turbidity. g) Riparian vegetation index score: greater than or equal to upstream or downstream values (modified RARC method) h) Erosion classification to be comparable with erosion classifications from nearby equivalent land uses with similar landform parameters to be determined by establishing analogue site
RM17	Achievement of post-mining land use to a stable condition (native ecosystem)	i) Provide a final rehabilitation report including monitoring records j) assessment of carrying capacity by an AQP[1] demonstrates a sustainable grazing outcome has been achieved k) >75% of groundcover vegetation comprises of species density and diversity consistent with the agreed final land use of native ecosystem. l) If deemed required, either LiDAR or ground survey to confirm settlement levels <10 mm/annum; m) Erosion classification to be comparable with erosion classifications from nearby equivalent land uses with similar landform parameters to be determined by establishing analogue sites at suitable comparable site; n) No erosion classifications of 'Severe' or 'Extreme' (>30 rills/gullies and any are >0.3 m deep) and no active erosion present as demonstrated by no increase in erosion over time o) Hazard assessment completed by an AQP[1] to confirm safety hazards in rehabilitation are not significantly different to surrounding unmined landscapes subject to the same land use p) Water quality from direct rainfall runoff or surface seepage from rehabilitated spoil has: vii. pH 6.5–9.0; and viii. EC <2,000 µS/cm.

(IA1) Improvement Area 1

Non-use management area (NUMA)														
Rehabilitation area	IA1 (Far South)													
Relevant activities	Open cut mining / void													
Total rehabilitation area size (ha)	54													
Commencement of first milestone: MM1	2033													
PMLU	NUMA													
Date area is available	2024	2025	2026	2027	2028	2033	2038	2043	2048	2053	2058	2063	2068	2073
Cumulative area available (ha)	54	54	54	54	54	54	54	54	54	54	54	54	54	54
Milestone completed by	2028	2033	2038	2043	2048	2053	2058	2063	2068	2073	2078	2083	2088	2093
Milestone reference	**Cumulative area achieved (ha)**													
MM1		54	54	54	54	54	54	54	54	54	54	54	54	54
MM2			54	54	54	54	54	54	54	54	54	54	54	54
MM3				54	54	54	54	54	54	54	54	54	54	54

(IA2) Improvement Area 2

Non-use management area (NUMA)														
Rehabilitation area	IA2 (Carlo Creek)													
Relevant activities	Open cut mining / void													
Total rehabilitation area size (ha)	46													
Commencement of first milestone: MM1	2033													
PMLU	NUMA													
Date area is available	2024	2029	2034	2039	2044	2049	2054	2059	2064	2069	2074	2079	2084	2089
Cumulative area available (ha)	46	46	46	46	46	46	46	46	46	46	46	46	46	46
Milestone completed by	2028	2033	2038	2043	2048	2053	2058	2063	2068	2073	2078	2083	2088	2093
Milestone reference	**Cumulative area achieved (ha)**													
MM1		46	46	46	46	46	46	46	46	46	46	46	46	46
MM2			46	46	46	46	46	46	46	46	46	46	46	46
MM3				46	46	46	46	46	46	46	46	46	46	46

(IA3) Improvement Area 3

Non-use management area (NUMA)														
Rehabilitation area	IA3 (One Tree)													
Relevant activities	Open cut mining / void													
Total rehabilitation area size (ha)	94													
Commencement of first milestone: MM1	2038													
PMLU	NUMA													
Date area is available	2033	2038	2043	2048	2053	2058	2063	2068	2073	2078	2083	2088	2093	2098
Cumulative area available (ha)	94	94	94	94	94	94	94	94	94	94	94	94	94	94
Milestone completed by	2033	2038	2043	2048	2053	2058	2063	2068	2073	2078	2083	2088	2093	2098
Milestone reference	**Cumulative area achieved (ha)**													
MM1		94	94	94	94	94	94	94	94	94	94	94	94	94
MM2			94	94	94	94	94	94	94	94	94	94	94	94
MM3				94	94	94	94	94	94	94	94	94	94	94

(IA4) Improvement Area 4

Non-use management area (NUMA)														
Rehabilitation area	IA4 (Pipeline)													
Relevant activities	Open cut mining / void													
Total rehabilitation area size (ha)	89													
Commencement of first milestone: MM1	2038													
PMLU	NUMA													
Date area is available	2033	2038	2043	2048	2053	2058	2063	2068	2073	2078	2083	2088	2093	2098
Cumulative area available (ha)	89	89	89	89	89	89	89	89	89	89	89	89	89	89
Milestone completed by	2033	2038	2043	2048	2053	2058	2063	2068	2073	2078	2083	2088	2093	2098
Milestone reference	**Cumulative area achieved (ha)**													
MM1		89	89	89	89	89	89	89	89	89	89	89	89	89
MM2			89	89	89	89	89	89	89	89	89	89	89	89
MM3				89	89	89	89	89	89	89	89	89	89	89

(IA5) Improvement Area 5

Non-use management area (NUMA)														
Rehabilitation area	IA5 (Fox Plains)													
Relevant activities	Open cut mining / void													
Total rehabilitation area size (ha)	185													
Commencement of first milestone: MM1	2053													
PMLU	NUMA													
Date area is available	2048	2053	2058	2063	2068	2073	2078	2083	2088	2093	2098	2103	2108	2113
Cumulative area available (ha)	185	185	185	185	185	185	185	185	185	185	185	185	185	185
Milestone completed by	2048	2053	2058	2063	2068	2073	2078	2083	2088	2093	2098	2103	2108	2113
Milestone reference	**Cumulative area achieved (ha)**													
MM1		185	185	185	185	185	185	185	185	185	185	185	185	185
MM2			185	185	185	185	185	185	185	185	185	185	185	185
MM3				185	185	185	185	185	185	185	185	185	185	185

(IA6) Improvement Area 6

Non-use management area (NUMA)														
Rehabilitation area	IA6 (Eagles Nest)													
Relevant activities	Open cut mining / void													
Total rehabilitation area size (ha)	187													
Commencement of first milestone: MM1	2063													
PMLU	NUMA													
Date area is available	2058	2063	2068	2073	2078	2083	2088	2093	2098	2103	2108	2113	2118	2123
Cumulative area available (ha)	187	187	187	187	187	187	187	187	187	187	187	187	187	187
Milestone completed by	2058	2063	2068	2073	2078	2083	2088	2093	2098	2103	2108	2113	2118	2123
Milestone reference	**Cumulative area achieved (ha)**													
MM1		187	187	187	187	187	187	187	187	187	187	187	187	187
MM2			187	187	187	187	187	187	187	187	187	187	187	187
MM3				187	187	187	187	187	187	187	187	187	187	187

(IA7) Improvement Area 7

Non-use management area (NUMA)														
Rehabilitation area	IA7 (WC Pit)													
Relevant activities	Open cut mining / void													
Total rehabilitation area size (ha)	75													
Commencement of first milestone: MM1	2063													
PMLU	NUMA													
Date area is available	2058	2063	2068	2073	2078	2083	2088	2093	2098	2103	2108	2113	2118	2123
Cumulative area available (ha)	75	75	75	75	75	75	75	75	75	75	75	75	75	75
Milestone completed by	2058	2063	2068	2073	2078	2083	2088	2093	2098	2103	2108	2113	2118	2123
Milestone reference	**Cumulative area achieved (ha)**													
MM1		75	75	75	75	75	75	75	75	75	75	75	75	75
MM2			75	75	75	75	75	75	75	75	75	75	75	75
MM3				75	75	75	75	75	75	75	75	75	75	75

Milestone reference	Management milestone	Milestone criteria
MM1	Achievement of structural stability	b) Highwall crest battered back where required to achieve a stable slope angle as specified by an AQP[1] (geotechnical engineer)
MM2	Achievement of landform design and surface requirements	g) Highwall as mined weathered average slope angle of 1V and 1.7H (30°) and low wall as backfilled at angle of repose at 1V:0.8H (50°). h) Abandonment safety bund setback distance is in accordance with calculated geotechnical factor of safety determined at MM1. i) Abandonment safety bund constructed of competent rock and to geometry specified (height = 2m, width top = 2m, batters = 1V:3H, width base = 14m) to prevent traversing by vehicles. j) Certification from an AQP[1] that the residual void is sufficiently protected from probable maximum flood levels k) Abandonment safety bund is revegetated with pasture seed. l) Pit lake water level is stabilise. Safety bund (minimum 2m height and 4m base width) is constructed, where required, at the geotechnical set-back distance. Fencing erected around perimeter of safety bund, where required. Appropriate signage placed to clearly identify and convey the purpose (e.g., EP Act 1994 Non-Use Management Area No Entry).
MM3	Achievement of sufficient improvement not to cause environmental harm and that will be safe and structurally stable	g) Access to highwall, low wall and ramp batter is restricted by physical barriers. Fencing erected on the outside of the abandonment safety bund to specification (five strand barbed stock fencing) h) Safety signage designed in accordance with Australian Standard is erected at 100m intervals along the fence line i) Certification from an AQP[1] that the residual void will not cause environmental harm outside of the relevant tenure boundary j) Residual void acts as a groundwater sink to the receiving environment into perpetuity ii. Groundwater monitoring confirms modelling of no contamination evidence over five (5) year monitoring program k) Certification from an AQP[1] that the residual void is safe to humans and livestock l) Final void walls confirmed to drain internally to the final void