TECHNICAL REPORT

Vulcan South Tailing and Coarse Reject Disposal Plan

Vulcan South Coal Mine

Prepared for: Vitrinite Pty Ltd

MINE WASTE AND
WATER MANAGEMENT

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Glossary of terms and acronyms

AMD	Acid and metalliferous drainage from mine waste materials characterised by low pH, elevated metal concentrations, high sulfate concentrations and high salinity.
ANC	Acid Neutralising Capacity expressed as kg H_2SO_4 per tonne of sample. A measure of a sample's maximum potential ability to neutralise acid.
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.
EA	Environmental Authority.
EC	Electrical Conductivity expressed as µS/cm.
EPRP	Emergency Planning and Response Plan.
ESCP	Erosion and Sediment Control Plan.
Interburden	The material found in between coal seams and considered to be of low economic value (i.e., a type of waste material).
MIA	Mine Infrastructure Area.
ML	Mining Lease.
MWMP	Mineral Waste Management Plan.
NAF	Non-Acid Forming. Geochemical classification criterion for a sample that will not generate acid conditions.
NAF(Barren)	Non-acid forming and barren of sulfur (i.e. less than or equal to 0.1% sulfur).
NATA	National Association of Testing Authorities, Australia.
Overburden	The waste rock material found overlying the first coal horizon within the stratigraphic profile.
PAF	Potentially Acid Forming. Geochemical classification criterion for a sample that has the potential to generate acid conditions.
PRCP	Progressive Rehabilitation and Closure Plan.
ROM	Run-of-Mine.
SD	Saline Drainage. Water that is elevated in dissolved salts (e.g., Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-, and SO_4^{2-}), but may have acidic, neutral, or alkaline pH.
Sodic	Sodic soil and rock materials are characterised by a disproportionately high concentration of sodium (Na) in their cation exchange complex and are innately unstable, exhibiting poor physical and chemical properties, which impede water infiltration, water availability, and ultimately plant growth.
SO_4^{2-}	Sulfate.
Static test	Procedure for characterising the geochemical nature of a sample at a single point in time. Static tests may include measurements of mineral and chemical composition of a sample and the Acid Base Account.
TCRDP	Tailing and Coarse Reject Disposal Plan.
TS	Total sulfur content of a sample generally measured using a 'LECO' analyser expressed as total sulfur%.
WRD	Tailing and coarse Reject dumps.
WMP	Water Management Plan.
w:v	Weight to volume ratio.

1 INTRODUCTION

RGS Environmental Consultants Pty Ltd (RGS) was commissioned by Mining & Energy Technical Services Pty Ltd (METServe) to create a Tailing and Coarse Reject Disposal Plan (TCRDP) for the Vitrinite Pty Ltd (Vitrinite) Vulcan South Project (the Project). The Environmental Authority (EA) conditions for the Project require that a TCRDP is developed and implemented before commencing authorised activities at the Project.

1.1 Purpose

Vitrinite plans to develop the Project as a small-scale mining operation within Mining Lease (ML) 700073. The Project is approved under EA P-EA-100265081 (DESI, 2024) to carry out environmentally relevant activities, including mining black coal, mineral processing and crushing, grinding, milling or screening. The EA permits the extraction of up to 1.95 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal within ML700073. Although the Project is nearby to Vitrinite's initial mining project, Vulcan Coal Mine (VCM) in ML 700060, the proposed activities at the Project will be implemented separately (**Figure 1-1**).

As a part of the initial baseline studies for the approval process, mine materials (including waste rock, coal, and coal reject materials) from the Project, were subjected to a geochemical testing program (RGS, 2022) to assess the potential for any acid and metalliferous drainage[1] (AMD) or other salinity/erosion/dispersion issues related to waste rock, coal reject and coal at the Project.

Conditions C13 and **C14** of the EA issued for the Project (P-EA-100265081) detail the requirements to create a TCRDP. The required inclusions in this plan are shown in **Table 1-1**.

Table 1-1: Required inclusions for the Tailing and Coarse Reject Management Plan (DESI, 2024)

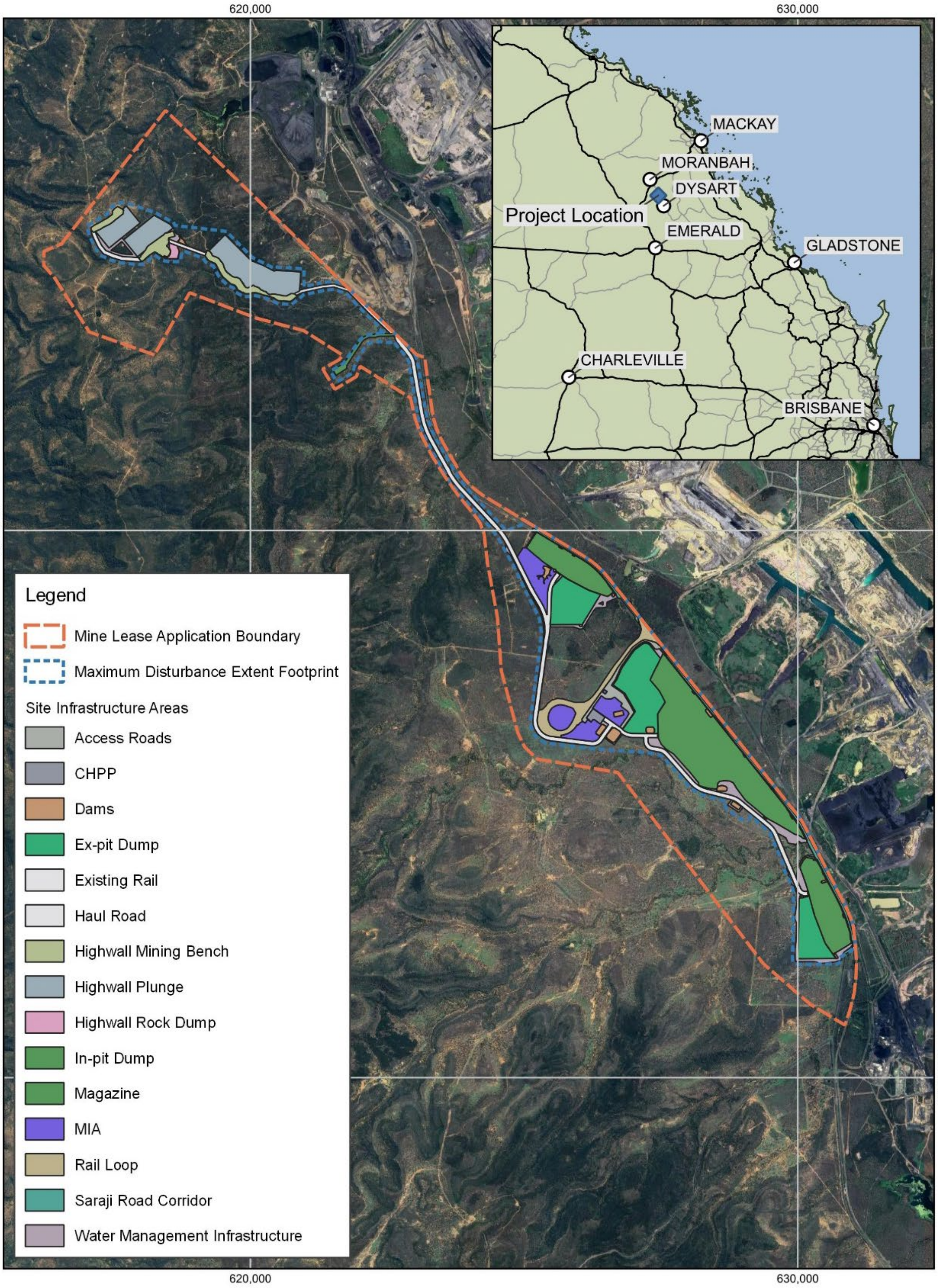
Requirement	Source	Report Section
Develop and implement a tailing and coarse reject management plan (TCRDP) prior to the commencement of authorised activities and reviewed and updated at regular intervals, not exceeding two (2) years.	C13	5.3
Characterise CHPP tailing and coarse reject to predict runoff and seepage quality.	C14a	5.1, 5.3
Sample and characterise tailing and coarse rejects to determine spoil type and properties.	C14b	5.1
Create a materials balance and disposal plan to minimise acid and metalliferous drainage (AMD)	C12c, C14c	5.2, 5.3
Re-test tailing and coarse reject geochemistry and water quality limits of parameters	C14d	5.1, 5.3
Sample program to verify encapsulation/placement of potentially acid-forming waste.	C14e	5.1, 5.3, 6.1
Data for run-off water quality	C14f	5.1, 5.2, 5.3
Plan suitability assessment and triggers for plan revisions	C14g	5.3
Indicators or other criteria to assess the suitability of the plan	C14h	5.3
Dry tailing must only be disposed to in-pit waste rock dumps	C16 b	5.2, 5.3
Reject must only be disposed to in-pit waste rock dumps	C16 c	5.2, 5.3

1.2 Project Summary

The Project site (ML 700073) is located north of Dysart and approximately 35 km south of Moranbah in Queensland's Bowen Basin (**Figure 1-1**). The Project lies to the immediate west of several established mining operations and abuts Vitrinite's initial mining project, Vulcan Coal Mine (VCM) in ML 700060.

Three separate open cut pits targeting coking coal will be developed as the primary mining focus of the Project, with an additional small-scale highwall mining trial program in the north of ML 700073. The Project will extract approximately 13.5 Mt of ROM coal predominately comprising hard coking coal with an incidental thermal secondary product produced at a rate of up to 1.95 Mtpa. The Project will target the Alex and multiple Dysart Lower coal seams using truck and shovel techniques.

[1] Acid and metalliferous drainage referred to in this plan collectively includes acidic, saline, and metalliferous (containing metals and/or metalloids) drainage.



Source: METServ Pty Ltd; Vitrinite Pty Ltd; Google Satellite

RGS	Scale 1:100,000 Datum: GDA2020 / MGA zone 55	Tailing and Coarse Reject Disposal Plan	1 0 1 2 3 km
	2024064_Vulcan South Spatial Data.qgz; Project Location and Layout	**Project location and layout**	Figure: 1-1 Job Number: 2024064 13/11/2024 N

Figure 1-1: Project layout

At each of the three pits, out-of-pit and in-pit waste rock dumps (WRDs) will be established. The out-of-pit WRDs will be established prior to commencing in-pit dumping activities. Once sufficient space is available within the pits for the creation of in-pit dumps, in-pit dumping will continue for the life of the operation. In-pit dumping will fill most of the pit's volumes during operations. The remaining final voids will be backfilled upon cessation of mining, establishing WRD landforms above the former pit areas. Following the backfill of the final voids, remaining material stored in the initial out-of-pit WRDs will be rehabilitated in-situ.

The Project also includes a small-scale highwall mining trial program in the north of ML 700073. The trial will involve the establishment of four highwall mining benches across several hillsides to facilitate coal extraction using a highwall miner. The highwall mining trial will target up to 750 kt of coal, which will be transported by truck to the Project coal handling and preparation plant (CHPP) via a dedicated haul road within the ML 700073 area. The trial will be completed within the first year of mining operations.

The primary rehabilitation works of the Project will follow the two-year construction period and the mine will operate for approximately nine years. A mine infrastructure area (MIA) will be established along with a modular CHPP, rail loop and train load-out facility at a location between the northern and central pits. The CHPP will include tailing dewatering technologies to maximise water recycling and to produce a dry tailing waste product (along with a reject product) for permanent storage within active in-pit WRDs.

Ancillary infrastructure, including a ROM pad, offices, roads and surface water management infrastructure will be established to support the operation. Construction of infrastructure associated with the mining operation, including the CHPP and the rail loop, is expected to be completed within two years of the Project's commencement. Construction of the realigned Saraji Road sections will be completed as required as the project progresses. Ongoing establishment of internal road networks, surface water management infrastructure and other ancillary infrastructure will continue to be developed as the pits and in-pit dumps advance.

1.3 Overview of the Project

1.3.1 Open Pit Mining

The Project will develop three separate open cut pits: Vulcan North, Vulcan Main and Vulcan South pits within ML700073 (**Figure 1-1**). The three open cut pits will extend to approximately 60 m deep, following the coal seams as they dip eastwards. The footprints of the proposed open cut pits are provided in **Table 1-2.**

Table 1-2 Open pit characteristics

Open Cut Pit	Approximate Footprint (ha)	Mining Direction	Target Seams
Vulcan North	66	North to south	Alex and multiple Dysart Lower
Vulcan Main	334	North to south	Alex and multiple Dysart Lower
Vulcan South	77	North to south	Alex and multiple Dysart Lower

1.3.2 Tailing and Coarse Reject Removal and Placement

Tailing and coarse reject produced from the CHPP at the Project will be placed within cells in in-pit WRDs. The in-pit dumps will extend up to approximately 60 m above the surrounding ground level, with batters shaped up to a maximum slope of 15 percent. A central plateau will drain to the west to minimise the requirement for significant drainage infrastructure along the eastern toe of the dump (where space is limited).

A geochemical assessment of tailing and coarse reject materials concluded that the bulk co-disposed materials pose a low risk of generating acid and negligible risk of generating saline or metalliferous drainage at circum-neutral pH values (RGS, 2022). Notwithstanding, the tailing and coarse reject materials will be encapsulated within in-pit WRDs and preferably will be stored below the predicted post-mining groundwater level to reduce the potential oxidation of materials in the longer-term, post-closure (RGS, 2023).

1.3.3 Coal Extraction

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

1.3.4 High Wall Mining Trial

The Project includes a small-scale highwall mining trial program in the north of the MIA. The trial will involve the establishment of four highwall mining benches across a series of hillsides to facilitate coal extraction using a CAT HW300 highwall miner or similar and will target up to 750 kt of coal within the first year of mining operations. Mined coal will be loaded by a front-end loader and transported by truck to the Project CHPP via a dedicated haul road within the MIA. The trial will test proposed highwall mining equipment in local conditions to assist Vitrinite with decision making on the methodology's suitability for other assets held within the region.

The target areas for the trial present competent roof and floor materials and target seams that are relatively flat dipping and non-undulating. The coal seams are of a thickness that is appropriate for highwall mining (0.9 to 1.5 m), and the coal itself is of reasonable strength while still being easily cut by a highwall continuous miner. The depth of cover ranges between 12 and 50 m.

Minimal infrastructure will be required to support the highwall mining trial. This will include mobile diesel fuel tanks, workshop containers and portable bathroom amenities. Earthmoving equipment will be required for the development of benches for the highwall miner to operate on, as well as road construction and maintenance equipment to build and maintain the haul road to the CHPP/ROM stockpile area. For the trial, the benches will form part of the haul road and be connected by sections linking the haul road.

ROM coal will be loaded from the discharge conveyor of the highwall miner onto a stacker belt for stockpiling on the active bench. Loaders will manage the stockpile and load B-triple trucks for haulage to the Project CHPP facilities. Tailing and coarse rejects from the benches will be temporarily stockpiled during high wall mining activities prior to being backfilled into the bench areas during progressive rehabilitation.

One of the benches will require the establishment of a small WRD that will be rehabilitated in situ.

Mine affected water will be contained on each bench and allowed to drain to completed highwall plunges (voids). Following rehabilitation earthworks, runoff will be managed by erosion and sediment control structures before being allowed to flow to the receiving environment at an acceptable quality.

1.3.5 Production Rate

The Project will commence operations at the Vulcan North and Vulcan Main pits in close succession. The Vulcan Main pit operations will continue for the full mine life. Mining activities at the Vulcan North pit are anticipated to be completed after three years. Activities at the Vulcan South pit will commence in Year 6 of operations and conclude three years later. An indicative annual mining schedule is provided in **Table 1-3**.

Throughout the Project life, the average annual ROM coal production rate is less than 1.7 Mtpa. During peak production periods, the Project will produce up to 1.95 Mtpa. Product coal will be railed from the Project rail loop onto the Goonyella Rail network. Export options include Dalrymple Bay to the north and RG Tanna in Gladstone to the south.

Table 1-3: Indicative mining schedule

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Total (t)
Highwall Mining									
Topsoil (t)	622,557								**622,557**
Waste Rock (t)	6,246,343								**6,246,343**
ROM Coal (t)	750,000								**750,000**
Vulcan North Pit									
Topsoil (t)	58,734	313,019	40,004						**411,757**
Waste Rock (t)	4,001,234	24,117,467	1,616,789						**29,735,489**
ROM Coal (t)	26,137	1,202,385	585,592						**1,814,114**
Vulcan Main Pit									
Topsoil (t)	35,686	298,486	298,079	305,290	389,958	183,329	257,856	141,396	**1,910,079**
Waste Rock (t)	1,261,637	17,067,931	38,929,456	40,431,863	40,855,127	33,106,442	23,798,147	11,652,257	**207,102,860**
ROM Coal (t)		687,965	1,223,774	1,841,120	1,728,933	1,560,844	1,304,554	1,027,403	**9,374,594**
Vulcan South Pit									
Topsoil (t)						142,196	198,534	131,741	**472,471**
Waste Rock (t)						8,100,351	17,179,435	13,883,816	**39,163,602**
ROM Coal (t)						249,607	647,113	451,034	**1,347,754**
Annual total									
Topsoil (t)	716,977	611,505	338,083	305,290	389,958	325,525	456,390	273,137	**3,416,865**
Waste Rock (t)	11,509,214	41,185,398	40,546,244	40,431,863	40,855,127	41,206,793	40,977,582	25,536,073	**282,248,294**
ROM Coal (t)	776,137	1,890,350	1,809,366	1,841,120	1,728,933	1,810,451	1,949,667	1,488,437	**13,294,461**

1.3.6 Waste Rock Dumps

Initial waste rock extracted during the early stages of the development of the open cut pits will be placed in an out-of-pit dump to the west of the pits. Following this initial out-of-pit placement and once sufficient pit space has been established, in-pit placement of waste rock will commence. This will continue for the life of the project as the pits advance, forming six WRDs in the Project area as follows:

- Out-of-pit WRD's:
  - Vulcan North ex-pit WRD;
  - Vulcan Main ex-pit WRD; and
  - Vulcan South ex-pit WRD.
- In-pit WRD's:
  - Vulcan North in-pit WRD;
  - Vulcan Main in-pit WRD; and
  - Vulcan South in-pit WRD.

Tailing and coarse reject material will be placed in cells within the in-pit WRDs. The in-pit WRDs will extend approximately 60 m above the surrounding ground level, with batters shaped at a maximum slope angle of 15%. A central plateau will drain to the west to minimise the requirement for significant drainage infrastructure along the eastern toe of the dump (where space is limited). **Figure 1-2** presents the conceptual WRD post–closure designs for the Project (WRM, 2023).

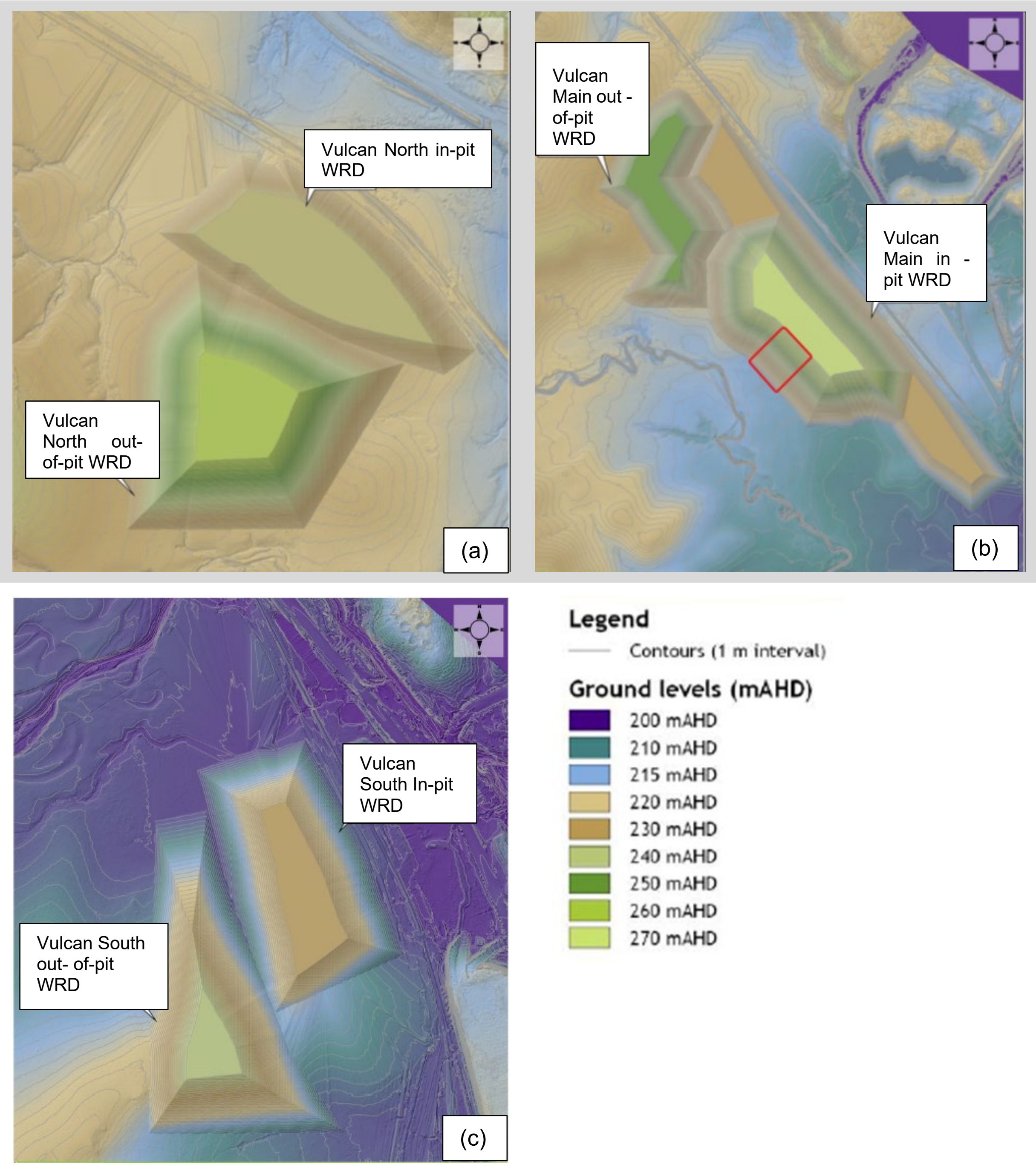


Figure 1-2: Vulcan South final landform and rehabilitation area (a) Vulcan North pit, (b) Vulcan Main pit, (c) Vulcan South pit (Source: WRM, 2023)

1.3.7 Ancillary Infrastructure

The ancillary infrastructure required to support mining operations will be progressively established as the pits, dumps and highwall trial progress.

A new mine access road will be established from Saraji Road in the centre of the MIA, between the rail loop and the northern extent of the Vulcan Main pit. This will lead to the site offices and administration, and on to the MIA. The MIA will include heavy vehicle workshops and park-up, equipment laydown areas and project offices and facilities.

An explosives magazine will be established west of the Vulcan North pit, a suitable distance from operational areas and critical infrastructure.

Surface water management infrastructure will be established progressively to divert clean water catchments around operational areas and to manage runoff from disturbed areas. A series of mine water dams will be established to manage raw water supply, pit water and supply water for dust suppression. A series of drains and bunds will be established to direct runoff to sediment control structures.

Linking roads, tracks, and pipelines will be established around the site as required. Similarly, temporary stockpiles of useful materials (e.g., topsoil, subsoil, gravel) will be established as required in available and appropriate locations. A conservative disturbance footprint has been proposed and assessed to facilitate the flexible establishment of such infrastructure.

1.3.8 Progressive Rehabilitation

A Progressive Rehabilitation and Closure Plan (PRCP) was prepared to support the Environmental Authority and meet Vitrinite's obligations under the *Environmental Protection Act 1994*, as amended by the Mineral Resources and Energy (Financial Provisioning) Act 2018 (METServe, 2020). In summary, the PRCP describes the proposed final landform, post-mine land uses, rehabilitation planning information and a schedule of progressive rehabilitation activities.

1.4 Regulation and Permit Conditions

1.4.1 Environmental Authority P-EA-100265081

The Project will be operated to comply with the conditions of the Project EA (P-EA-100265081) and the associated Environmentally Relevant Activities. These are:

- Schedule 3, 13: Mining black coal;
- Ancillary 31 - Mineral processing 2: processing, in a year, the following quantities of mineral products, other than coke— (b) more than 100,000t; and
- Ancillary 33 - Crushing, grinding, milling or screening more than 5,000 t of material in a year.

This TCRDP specifically addresses **Conditions C12, C13, C14** and **C16** of P-EA-100265081 relating to tailing and coarse reject management on ML700073, as previously described in **Section 1.1**.

Whilst there are a number of additional conditions in P-EA-100265081 that are related to tailing and coarse reject, such as mineralised waste management, erosion and sediment control, dust and particulate matter, groundwater and surface water management, and rehabilitation, these are not a specific focus of this TCRDP.

Further information on planning associated with these aspects is contained in current versions of the following documents:

- VSP Mineralised Waste Management Plan (MWMP);
- VSP Erosion and Sediment Control Plan (ESCP);
- VSP Water Management Plan (WMP); and
- VSP Progressive Rehabilitation and Closure Plan (PRCP).

1.5 Document Control and Review Process

This TCRDP will be reviewed and updated by the Vitrinite Technical Services Department, as required with intervals between reviews not exceeding 2 years.

Revision 001 of this TCRDP is a final document that was certified by Dr Alan McLeod Robertson, Director of RGS, on 15 November 2024. Dr. Robertson has over 30 years of experience in mine waste management and mine rehabilitation. The information in **Table 1-4** documents the version control and sign off by RGS and Vitrinite.

Table 1-4: TCRDP Version Control and Approval

Document Control			
Revision	**Signatory**	**Role**	**Company approval (Signed and dated)**
Revision 001	Alan Robertson (RGS)	Document Author	Alan M. Robertson 19/12/2024
Revision 001	Technical Services Superintendent (Vitrinite)	Document Owner	

Table 1-5 allows for future amendments to the TCRDP to be progressively tracked over the life of the project, and, if any substantive changes have been made or are proposed to be recorded in the Plan.

It is recommended to document how and why changes are made to the Plan to allow subsequent managers to understand the history of the site and follow the progressive management and operation of the mine areas.

Table 1-5: TCRDP Amendment History

Document Control			
Revision	**Signatory**	**Amendment**	**Company approval (Signed and dated)**

RGS certifies that this TCRDP is feasible and would meet the intent of the current conditions of P-EA-100265081 (i.e., the TCRDP will enable Vitrinite to continue to progressively characterise, mine and place the mined materials so that their potential to contribute to (or to mitigate) environmental harm can be determined).

This TCRDP makes use of the existing geochemical characterisation data for materials generated (and proposed to be generated) at the VSM, as described in **Section 1.1**.

1.6 Integration of the TCRDP with other Departments

Effective coal processing and appropriate environmental management of tailing and coarse reject materials requires communication between the environmental, geology, mine planning and technical services departments.

Without effective communication and clear workflow designation, it is possible that the TCRDP may not meet its objectives. **Table 1-6** provides the planned workflow and communication within and between Vitrinite departments.

Connection arrows in **Table 1-6** pointing toward a department name indicate that the outcomes of the adjacent task and responsibility will need to be communicated to that department (e.g. → Geology). Connection arrows pointing away from a department name indicates that the named department will need to provide input on the adjacent task and responsibility (e.g., ← Mine Planning). Double-headed connection arrows beside a department name indicate that collaboration is required with the named department to complete the adjacent task and responsibility (e.g., ←→ Geology).

Table 1-6: TCRDP Departmental Work Flow

Department	Role	Tasks and responsibilities	Connections
Environment Department	Document control	Owner of the TCRDP	→ Geology
		Compilation and updating the TCRDP and ensuring that the aim and objectives will be met, i.e., the auditing process	→ Geology
		Ensuring the TCRDP is integrated with the Plans being managed by other departments, e.g., the Water Management Plan	→ Planning → Environmental → Geology → Tech. Services
		Ensure scheduled Tailing and coarse reject material sampling and analytical programs are planned ahead of mining on an as-required basis.	← Planning ←→ Geology
		Work with the Geology Department to develop the TCRDP to obtain necessary samples from in-fill drilling programs and/or blast hole drilling programs.	→ Geology
		Document how changes to the TCRDP will be tracked over time.	←→ Geology
	Life of mine planning	Aligning the PRCP with the short-, medium-, and long-term rehabilitation goals for the site.	← Planning
		The Environment Department must work with other departments and guide them to ensure that the operational mine plans to mine and produce coal align with the legislative requirements of the Queensland Government Guideline for *Progressive Rehabilitation and Closure Plans (PRCP)* – (DES, 2021) and amendments to the *Environmental Protection Act 1994*.	←→ Planning ←→ Geology
	Material characterisation	Define the material types that will be processed and need to be managed and rehabilitated to attain minimal financial liability and relinquishment. In general, all materials, including mine reject and tailing materials should be included in the TCRDP.	← Geology
		Document the specific sampling processes and the physical and geochemical analytical methods that will be adopted in consultation with the Geology Department.	←→ Geology
		Define the geochemical and physical criteria that will be used to classify the samples from drilling and sampling programs in consultation with the Geology Department.	←→ Geology
		Manage the interpretation and classification of the analytical data.	← Geology
	Financial Provisioning	Environmental Departments are typically required to manage environmental provisioning for rehabilitation and closure, which requires reliable outputs from short, medium and long-term mine plans.	← Planning
Geology Department	Drilling and sampling	Utilise the TCRDP to develop scheduled exploration and operational drilling and sampling plans.	← Environmental (←→ Planning)
		Implement the exploration and operation drilling and sampling plans.	
	Update geology models	Compile the material characterisation data into the geology model(s).	← Environmental
		Provide the raw data and interpreted data to the Environmental Department.	→ Environmental
		Develop and report annual material balances and provide these to the Environmental Department.	→ Environmental
		Provide the revised geology model to the mine planning team.	→ Planning
	Issue geology model and material balances	Provide updated material balances for all mined units to the Environment team to verify that the overall aim of the rehabilitation and closure plan can continue to be met, e.g., for the active (current iteration) of the mine plan, is there enough topsoil, subsoil and other necessary material to achieve complete rehabilitation over the life of mine.	→ Environmental
Mine Planning Department	Life of mine planning	Development and maintenance of schedule in the Operational Mine Plan and PRC Plan	←→ Geology ←→ Environmental
	Scheduling	Utilise revised geology models to develop short, medium, and long-term mine plans, including plans for progressive rehabilitation and closure.	← Geology
		Mine planners will need to align with environmental design criteria associated with constructed landforms to ensure that the landforms are rehabilitated to a safe and stable landform that does not cause environmental harm and will conform to the Queensland Government Guideline for Progressive *Rehabilitation and Closure plans (PRCP)* – (DES, 2021) and amendments to the *Environmental Protection Act 1994*.	→ Environmental
		Mine planners will provide the numerical basis from the Operational Mine Plan and PRCP to the environmental department for annual financial reporting (internally and externally).	→ Environmental
		Mine planners will provide the schedules and plan to technical services to implement on the ground.	→ Tech. Services
Technical Services	Design and construction	Operation of the mine, including implementation of the PRCP.	← Planning ← Environmental ← Geology

2 SCOPE, AIM AND OBJECTIVES OF THE TCRDP

2.1 Scope

The scope of this TCRDP is to effectively plan for and manage tailing and reject streams generated through the beneficiation of coal at the Project CHPP.

To achieve effective management of the tailing and reject materials, this TCRDP specifically addresses Conditions **C13**, **C14** and **C16** of P-EA-100265081 (as detailed in **Section 1.4**) and/or references where more detailed information is available.

2.2 Aim

The aim of the TCRDP is to enable coal processing, coal reject and tailing disposal and mine rehabilitation to be completed economically with minimal adverse environmental and social impacts on the land and water resources and to lead to successful post-rehabilitation beneficial reuse. To achieve this aim, an integrated planning approach will be implemented, coupling the work programs undertaken by technical services, environmental, geology, and planning departments.

With an integrated, cross-discipline planning approach at the site, implementation of the management aims will be effective and eliminate any subsequent environmental issues.

This TCRDP is a key point of a broader set of plans and procedures, including the Mineralised Waste Management Plan (MWMP), that will be used to achieve the aim. Site procedures for some tasks, such as re-testing of tailing and coarse reject and water quality parameters, would be documented and managed by the custodian of the Plan.

Other tasks such as exploration and operational geological programs, short, medium and long-term mine planning (including landform design), water management, and rehabilitation programs are detailed in other Vitrinite management plans as outlined in **Section 1.4**.

2.3 Objectives

The objectives of the TCRDP are to document and map out:

- Why the Plan is required and when the Plan will need to be updated;
- How changes to the TCRDP will be tracked to enable the reasons for changes to the Plan over the life of mine to be understood;
- Who will plan and implement the tasks required to be undertaken by each department;
- How the data collected from departmental tasks such as tailings and coarse rejects characterisation, retesting and run-off water quality testing will be stored and made accessible to other departments who are required to make use of the data;
- How the data are to be used and which other management plans and data will need to integrate with the TCRDP (e.g., Mineralised Waste Management Plan, Erosion and Sediment Control Plan, Water Management Plan, and Mine Plan); and
- When the tasks in the TCRDP are required to be undertaken and what the outputs will be.

2.4 Data Management

The tailing and coarse reject material characterisation program compiles static and kinetic geochemical data. Typically, these data are provided by a commercial laboratory in portable document format (.pdf) and spreadsheet files that are then stored on a server. This can lead to the eventual loss of the data. All geochemical, physical and any other relevant data associated with the characterisation of tailing and coarse reject will be stored in the Geology Department geological database.

3 GEOLOGY AND STRATIGRAPHY

The Project will target the Alex and multiple Dysart Lower coal seams within the Permian-aged Moranbah Coal Measures. A surficial Tertiary waste rock (overburden) sequence is present in the Project area, consisting of unconsolidated soils and sands. Underlying this is Permian-aged rock (overburden), which is comprised of sandstone and siltstone.

The Permian waste rock (interburden) materials in the Project area generally comprise sandstone, siltstone, claystone, and coal, which were deposited in a fluvial floodplain environment within the Bowen Basin. Significant mesa hills formed by highly resistant sandstones have provided target coal seams throughout the centre of the study area. The typical stratigraphic profile encountered in the Project area is provided in **Figure 3-1.**

The Alex seam is generally quite shallow and occurs just below the base of weathering in the stratigraphic profile. The Dysart Lower Seam comprises several plys with the waste rock (interburden/parting) in between generally consisting of fine-grained sedimentary units such as siltstone, mudstone and claystone, with the occasional carbonaceous or coaly unit.

The May Seam (consisting of carbonaceous claystone) and Matilda Seam (consisting of interbedded coal and siltstone) underlie the Dysart seam and are not considered economic.

The uniform stratigraphy/geology at the Project area is typical of coal mines in this part of the Bowen Basin, where the stratigraphic profile is laterally consistent and predictable.

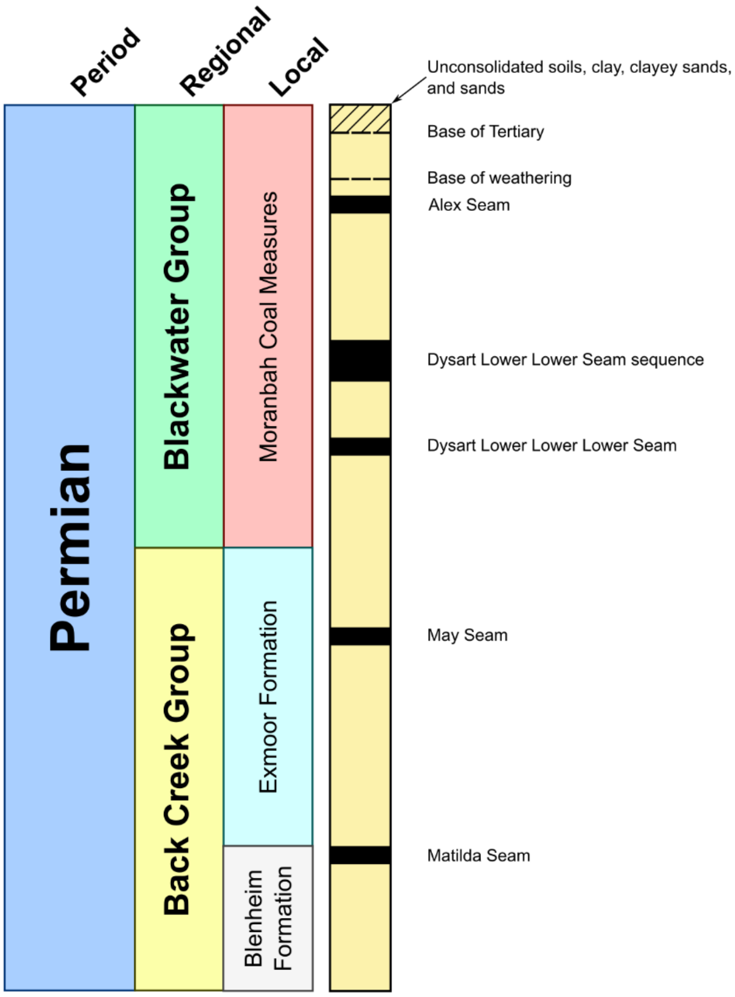


Figure 3-1: Typical Stratigraphic Profile at Vulcan South Coal Mine

4 RISK ASSESSMENT

4.1 Previous Mine Waste Characterisation Studies

<u>**Geochemical Assessment of Waste Rock, Coal Reject and Coal (RGS, 2022)**</u>

RGS completed an assessment of the geochemical characteristics of mine materials for the Project area including representative samples from coal reject streams, in accordance with appropriate technical guidelines (AMIRA, 2002, COA, 2016 and INAP, 2024). Seven samples from two size fractions (coarse: Wash 2, <50 to >2 mm; and fine: Wash 3 & fines, <2 to >0.25 mm & <0.25 to >0 mm) of coal reject materials were selected to best represent the two coal reject streams that will be produced from the CHPP at the Project. A program of static and kinetic geochemical tests was used to determine the likely geochemical characteristics of the materials represented by the samples tested, and the following key findings were reported:

- Bulk tailing and coarse reject materials are likely to have excess Acid Neutralising Capacity (ANC) relative to Maximum Potential Acidity (MPA).
- As a bulk material, the tailing and coarse reject is expected to be classified as NAF and have a relatively low risk with respect to the potential for the generation of acidity.
- The bulk tailing and coarse reject materials are not significantly enriched with metals/metalloids compared to median crustal abundance in unmineralised soils.
- Most metals/metalloids are sparingly soluble at the neutral to slightly alkaline pH of leachate expected from bulk tailing and coarse reject materials. Dissolved metal/metalloid concentrations in surface runoff and leachate from these materials are expected to be low and unlikely to pose a significant risk to the quality of surface and groundwater resources at relevant storage facilities.

A copy of the geochemical assessment technical report is provided in **Attachment A**.

4.2 Potential Environmental Issues, Impacts and Controls

Potential environmental issues, impacts and controls associated with the storage of tailing and coarse reject materials at the Project out-of-pit and in-pit WRD areas are described in **Table 4-1**.

The bulk tailing and coarse reject materials from the Project are likely to have a relatively low risk of generating AMD (RGS, 2022). Notwithstanding, active management measures during operations and at closure will be implemented as described in **Table 4-1**. Essentially, tailing and coarse reject materials generated from the Project will be co-disposed in the open pit profile as backfill in the in-pit WRD (preferably below the pre-mining groundwater level) no closer than 10 m to external batters and be progressively covered with at least 10 m of NAF waste rock materials.

Because of the sodicity of most waste rock materials, potential dispersion and erosion is considered a risk to containment structures that will be addressed by following the processes described in the MWMP as well as those contained in the ESCP.

The following hierarchy of control strategies in order of priority can be categorised as:

- prevention of impact;
- minimisation of impact and/or likelihood through rehabilitation trials; and
- interception and control of impact.

The control measures will depend on topography, mining method, material type, soil/rock types, mineralogy, and available amelioration resources, if required (e.g., gypsum, fertilizer and rock mulch). Potential control measures are documented in **Table 4-1**.

Monitoring of tailing and reject material management and placement, surface water quality, and groundwater quality will be completed to review performance and ensure that key performance indicators are being met.

Table 4-1: Potential Environmental Issues, Impacts and Controls

Potential Issue	Potential Impact	Control Measures
AMD	• Contamination of surface water and groundwater from WRDs. • Contamination of stock, irrigation and domestic groundwater supplies. • Degradation of aquatic ecosystems. • Impact on recreation and aesthetics.	• Coal tailing and reject materials from the Project have a relatively low risk of AMD from the WRD. Notwithstanding, tailing and coarse reject materials, generated from mining at the Project, will be placed as backfill in the in-pit WRDs (preferably below the pre-mining groundwater level), no closer than 10 m from external batters, and be progressively covered with at least 10 m of NAF waste rock materials. • Monitoring of fine and coarse reject placement, surface water quality and groundwater quality will be used to ensure that key performance indicators are met.
Salinity	• Contamination of surface water and seepage from WRD areas.	• Low salinity levels and low concentrations of dissolved solids are expected to be generated from the WRD areas. Notwithstanding, tailing and reject materials generated from the Project will be placed in the open pit profile as backfill in the in-pit WRDs (preferably below the pre-mining groundwater level), no closer than 10 m from external batters, and be progressively covered with at least 10 m of NAF waste rock materials. Monitoring of waste rock and tailing/reject placement, surface water quality and groundwater quality will be used to ensure that key performance indicators are met.
Dust from tailing and coarse reject materials	• Dust interaction with workforce and the receiving environment.	• Vitrinite will employ all reasonable and feasible avoidance and mitigation measures so that dust and particulate matter emissions generated from fine and coarse reject disposal do not cause exceedances of levels described in the EA. Measures may include dust suppression, monitoring and analysis of dust and particulate emissions and rehabilitation of the WRD areas.
Metals/metalloids in leachate	• Leaching of metals/metalloids into surface runoff and groundwater.	• Metals/metalloids are sparingly soluble from tailing and coarse reject materials at circum-neutral pH levels and therefore low concentrations of dissolved metals/metalloids are expected to be generated from the in-pit WRD areas. Any tailing and coarse reject materials generated from the Project will be placed in the open pit profile as backfill in the in-pit WRDs (preferably below the pre-mining groundwater level), no closer than 10 m from external batters, and be progressively covered with at least 10 m of NAF waste rock materials. • Monitoring of tailing and coarse reject placement, surface water quality and groundwater quality will be used to ensure that key performance indicators are met.
Dispersion and erosion	• Loss of sediment from WRD areas and potential release to surface run-off	• Progressive rehabilitation of the WRD areas to minimise loss of sediment in accordance with the ESCP. • Installation and maintenance of drainage and sediment and erosion control structures to control and treat surface run-off from the WRD.

5 MATERIAL MANAGEMENT

5.1 Material Characterisation

To address **Condition C14 (a)** a program to effectively characterise tailing and coarse reject materials generated by the Project to predict the quality of runoff and seepage generated was undertaken. **Section 4.1** of this TCRDP describes the geochemical characteristics of tailing and coarse reject materials that will be produced at the Project CHPP.

A geochemical assessment of tailing and coarse reject materials concluded that the bulk co-disposed materials pose a low risk of generating acid and negligible risk of generating saline or metalliferous drainage at circum-neutral pH values (RGS, 2022). Notwithstanding, the tailing and coarse reject materials will be encapsulated within in-pit WRDs and preferably will be stored below the predicted post-mining groundwater level to reduce the potential oxidation of materials in the longer-term, post-closure.

Progressive sampling and characterisation of tailing and coarse reject materials will continue throughout operations. To meet **Condition C14 (b)** and **C14 (d)** progressive characterisation works will identify the salinity, sulfate, acid and alkali producing potential of tailing and coarse reject materials. Representative samples of tailing and coarse reject materials will be collected ahead of mining from exploration, resource definition, and blast hole drill cores and from the waste stream of CHPP for characterisation.

Additional confirmatory sampling and testing will be completed on tailing and coarse reject materials when available during the operational phase of the Project to determine the best management option for progressive rehabilitation of these materials during operations and at mine closure. The re-testing of tailing and coarse reject materials and ongoing monitoring of both groundwater and surface water, in line with the monitoring program described in **Section 6** of this TCRDP will address the requirements of **Condition C14 (d), C14 (e)** and **C14 (f)** of P-EA-100265081.

The drillhole samples and tailing and coarse reject materials will be sent to an external National Association of Testing Authorities, Australia, (NATA) accredited laboratory for testing (**Table 5-1**).

Table 5-1: Recommended analyses for tailing and coarse reject materials

Sample Type	Geochemical Property to be Assessed	Recommended Analysis
Tailing and coarse reject materials	• Potential for AMD generation. • Sodicity	• pH (1:5 w:v). • Electrical Conductivity (1:5 w:v). • Total Sulfur (Combustion Analysis Method). • Exchangeable Sodium Percentage (not applicable as all materials are encapsulated in in-pit WRD).

Table 5-2 shows the recommended classification of materials based on the result values of each analysis. Acidic, alkaline, and saline drainage and potential for AMD generation classification values are based on previous geochemical characterisation work undertaken (RGS, 2022) and sodicity classification values are derived from Northcote and Skeene (1972).

Project materials have been demonstrated to pose a low risk of generating elevated metal/metalloid concentrations in drainage at the circum-neutral pH values expected in seepage from tailing and coarse reject materials. Therefore, materials with $pH_{(1:5)}$ values that lie outside the range of pH 5 to 10 or sulfide sulfur concentrations greater than 0.3 %S will be considered to have the potential to generate metalliferous drainage.

Table 5-2: Material classification criteria

Sample Type	Geochemical Property Assessed	Result Values	Classification
Tailing and coarse reject materials	• Potential for AMD generation. • Sodicity	$pH_{(1:5)}$ <4.5	Potential for initially acidic drainage
		$pH_{(1:5)}$ >10.5	Potential for initially alkaline drainage
		$EC_{(1:5)}$ >2,500 µS/cm	Potential for saline drainage
		Total sulfur >0.3%	Potential to generate AMD
		ESP	Not applicable for these materials

5.2 Disposal Plan

Material balance

Approximately 282 Mt of waste rock is expected to be generated over the life of the Project (**Table 1-3**). A total of 422.5 m of Project material sample intervals underwent geochemical assessment. Of these sample intervals, 0.1 % of the total length sampled had a very low risk of generating acidic drainage. It is expected that there will be a sufficient balance of NAF waste rock to encapsulate the relatively small volume of tailing and coarse reject materials produced in a manner that minimises the potential generation of AMD (**Condition C12 (c)** and **Condition C14 (c)**).

Management of tailing and coarse reject materials

Based on the geochemical data summarised in this section of this TCRDP, tailing and coarse reject materials generated by the Project will only be emplaced within cells in in-pit waste rock dumps (**Condition C12 (c)**, **Condition C14 (c), C16 (b)** and **C16 (c)**).

Tailing and coarse reject materials will be buried in the core of the waste rock emplacements, at least 10 m away from the final outer surfaces of the emplacements and under at least 10 m of NAF waste rock materials. Where practical, tailing and coarse reject materials will be preferentially stored below the predicted post-mining groundwater level to reduce the potential oxidation of materials in the longer-term post-closure (**Figure 5-1**). The tailing and coarse reject materials will be co-disposed in waste rock cells and traffic compacted before being covered by NAF materials to limit the infiltration of air and water into covered materials.

The extent of tailing and coarse reject materials transferred to emplacement areas will be tracked with regular surveys. Spatial data files in an appropriate format will be created to record the extent/dimension of the storage areas.

Management of seepage and leachate

Appropriately designed water management structures will be used to capture seepage and leachate from WRDs (**Condition C14 (f)**). Captured seepage and leachate will be managed in the same manner as other mine impacted water as described in the Water Management Plan. Captured seepage and leachate will be monitored as described in **Section 6**.

5.3 Performance Review/Indicators

The performance of the in-pit WRDs will be assessed annually or when any non-compliance incidents occur. This will be achieved by reviewing monitoring data acquired through the implementation of the monitoring program for the Project and any non-compliance incidents associated with emergency and contingency plans described in **Sections 6** and **7** of this TCRDP.

Parameters to be monitored as described in relevant sections of P-EA-100265081 include;

- Particulate matter and dust, if required in response to a complaint or request from the administering authority (**Schedule B**);
- Surface water quality (**Schedule F**); and
- Groundwater (**Schedule E**).

The performance review and performance indicators for the TCRDP described in this section address the requirements of **Conditions C13** and **C14** (**clauses (a)** to **(h)**) and **C16 (b)** and **(c)** of P-EA-100265081.

5.4 Rehabilitation of Structures Containing Tailing and Reject Materials

In-pit dumping will fill the majority of the pit volumes during operations at the Project site. The remaining Project open cut voids will be backfilled with stockpiled waste rock, to create a stable final landform over the former open cut footprint. The final landform will utilise the waste material to backfill the void via dozer push. This will be re-contoured at a maximum slope of 15 percent with fall to existing water courses. The top of the in-pit dump will drain to the west to ensure no pooling of water in this catchment area.

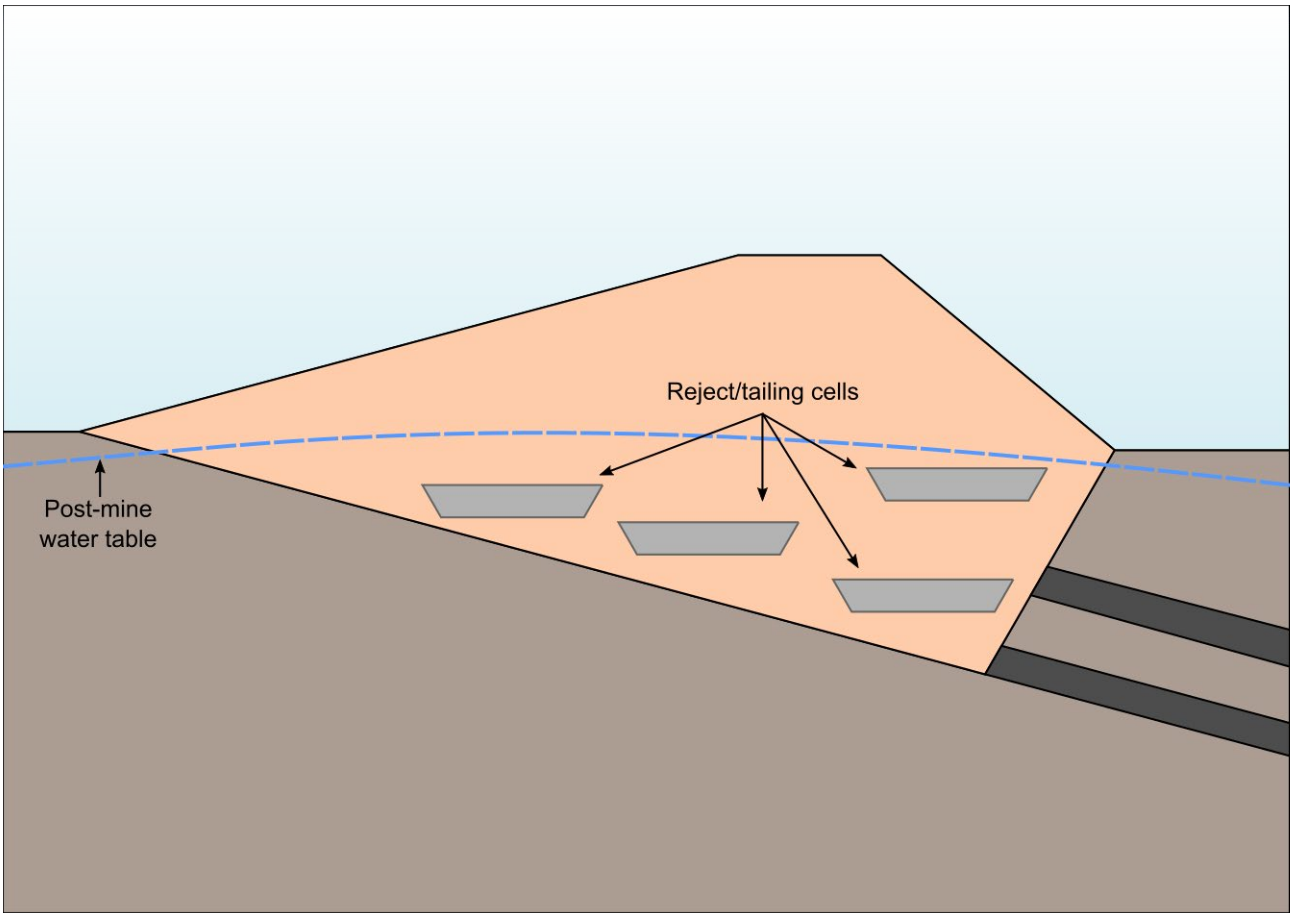


Figure 5-1: Schematic cross-section of in-pit reject/tailing material emplacements (not to scale)

6 MONITORING

6.1 Monitoring Programs

Monitoring of solid materials and contact water associated with the WRD areas forms an important part of the on-site management of waste rock and encapsulated tailing and coarse reject materials and will be completed in accordance with P-EA-100265081, the ESCP, the Water Management Plan, MWMP, and this TCRDP.

The monitoring program is primarily aimed at identifying potential impacts to ensure that management practices are appropriate or are modified accordingly. Monitoring will be conducted by trained, on-site personnel or by specialist consultants as engaged by Vitrinite.

Characterisation of tailing and coarse reject materials was completed in 2022 and additional sampling and progressive characterisation will be completed over the mine life. Additionally, sampling and characterisation of materials will be undertaken if water quality monitoring indicates that the WRD areas are not performing according to predictions. Leachate from any planned WRDs and ROM pad areas will be included in the site water quality monitoring program, which will consist of pH, EC, acidity/alkalinity, Al, As, Cd, Co, Cu, Cr, Fe, Hg, Mg, Mn, Mo, Ni, Pb, Se, SO_4, and Zn to monitor for effects of any pyrite oxidation and AMD. Leachate from the WRD areas will be included in the site water quality monitoring program and will be monitored in accordance with the relevant conditions of P-EA-100265081 and relevant site plans.

To confirm the effectiveness of the tailing and coarse reject materials management procedures, strategic sampling and sulfur testing of emplaced materials will be undertaken on an annual basis over the operational life of the Project (**Condition C14 (e)**). The results of this process will be used to validate that emplacements are being constructed according to design specifications and that all tailing and coarse reject materials are encapsulated with at least 10 m of NAF waste rock materials.

Representative samples of emplaced materials will be collected and analysed externally by a NATA accredited laboratory for total sulfur. As mentioned above, samples with a sulfide sulfur concentration of less than or equal to 0.3 %S will be classified as NAF and greater than 0. 3 %S will be classified as PAF.

Ongoing characterisation of the tailing and coarse reject materials will be completed on an as required basis for the Project using relevant site procedures. If any new areas of the site are planned to be mined, additional samples will be taken and subjected to geochemical screening tests including water extract water quality tests and kinetic tests if required. Input from an experienced geochemist may be needed to assist with the sample selection and testing program and interpretation of results.

6.2 Monitoring Records

Monitoring records for tailing and coarse reject materials will be maintained by the Vitrinite Technical Services Department and will be stored in a geological database.

6.3 Integrated Monitoring and Management

Monitoring that may interact with tailing and coarse reject materials management includes surface water, groundwater, and rehabilitation monitoring and general inspections. Items considered may include:

- Water quality – surface water;
- Water quality – groundwater;
- Seepage/leachate production and quality;
- Visual inspections;
- Geochemistry of co-disposed tailing and coarse reject materials at WRDs; and
- Vegetation coverage and establishment.

Monitoring results will be used to continuously improve the tailing and coarse reject materials management strategy.

6.4 TCRDP Review

The Vitrinite Technical Services Department is responsible for communicating the outcomes of a review of the WRD performance to site personnel and contractors. A review will be undertaken by the Technical Services

Department and/or suitably qualified specialist consultants every 2 years. If management practices are not effective, changes to the management will be made and implemented for the Project, if approved.

The review process will include consideration of monitoring results. Any changes in operational practices will be incorporated into the documentation and communicated to responsible employees and contractors.

Suitable criteria to establish whether tailing and coarse reject management practices are effective are as follows:

- No complaints in relation to tailing and coarse reject materials management;
- Full compliance with the requirements of P-EA-100265081, relevant site plans and this TCRDP;
- No uncontrolled release of leachate with elevated turbidity or other water quality issues; and
- Continual improvement in tailing and coarse reject management practices.

All matters relating to tailing and coarse reject materials will be managed by the Technical Services Department.

7 CONTINGENCY AND ENVIRONMENTAL INCIDENT PLANS

7.1 Operational Contingencies

Vitrinite has developed operational contingencies for scenarios that may occur throughout the life of the Project WRD operations. Each scenario may have more than one contingency of which a portion of the contingencies may be enacted in that event based on the site conditions at the time. The scenarios and contingencies are presented in **Table 7-1**.

Table 7-1: Operational Contingencies

Scenario	Possible Contingencies
Insufficient capacity in WRDs for tailing and coarse reject	• Temporary in-pit dumping, potentially with agricultural lime dosing and encapsulation in NAF waste rock material.
Incorrect placement of tailing and coarse reject within NAF materials at WRDs	• Removal and relocation of tailing and coarse reject to the core of WRDs. • Incident Investigation. • Assessment of potential or real impacts.
Wet weather preventing access to WRD disposal location	• Temporary storage of tailing and coarse reject at a temporary stockpile area.
Lack of water for dust suppression at WRD	• If dust and particulate matter monitoring indicates a potential issue, review tailing and coarse reject dumping practices. • Implement changes to tailing and coarse reject dumping practices (e.g., based on climatic conditions).
Abnormal monitoring results	• Investigation into cause of results and potential mitigation measures required. • Implement mitigation measures.
Elevated sediment loss from WRD	• Review WRD construction methodology and dumping practices. • Review WRD drainage and sediment pond design. • Implement any required mitigation measures.

7.2 Environmental Incident Response

If any Vitrinite personnel suspect that the WRD is not operating as planned, this will be reported to the Technical Services Department and Site Senior Executive (SSE) (or SSE delegate) as soon as practicable within 24 hours. Any non-compliance with the conditions of the EA will be investigated, and the administering authority will be notified as required.

During certain climatic events, such as prolonged drought or storm/flood events, release of dust and particulate matter or any uncontrolled release of turbid water from tailing and/or coarse reject materials withing the WRD that have not yet been encapsulated containing elevated sediment or any other relevant water quality parameters, that monitoring indicates do not meet EA conditions, will be managed in accordance with the following general principles:

1. **Investigate, Review and Mitigate**
    - Investigate the incident, review monitoring data and implement any required mitigation measures, where possible.
2. **Notify**
    - Notify the Supervisor and Technical Services Department and/or SSE.
    - The Vitrinite Technical Services Department, in consultation with the SSE, will consider the need to contact downstream landholders, the Department of the Environment, Tourism, Science and Innovation (DETSI) and other stakeholders in accordance with the requirements of the EA. The Emergency Planning and Response Plan (EPRP) will also be consulted.
3. **Contain**
    - Prevent poor quality water from spreading or entering waterways (e.g., by clay bunding). Amelioration with agricultural limestone, if required.
4. **Control the release**

- Control the release source (e.g., sediment dam). May be completed in conjunction with Principle 1.

5. Reclaim

- Reclaim material where the impact is justified. Caution is to be applied around watercourses and with potentially acidic water/material; specialist advice may need to be sought.

The Technical Services Department (TSD) will be responsible for commencement of an investigation into any uncontrolled release of dust and particulate matter or turbid water/water quality from tailing and/or coarse reject materials that does not meet EA condition requirements and may include visual inspections and additional water quality monitoring. Potential mitigation measures will then be implemented to prevent further impacts, where practical. The TSD will also review this TCRDP, related operational plans, site procedures and monitoring records. If required, management plans and site procedures will be amended.

Where an incident occurs which results in an emergency or incident which results in, or may result in, environmental harm or the release of contaminants not in accordance with the EA, the administering authority will be notified in writing within 24 hours.

Written advice will be provided to the administering authority, no more than 10 business days following the initial notification of an emergency, incident or information about circumstances which result or may result in environmental harm or the release of contaminants, including the following:

- Results and interpretation of any samples taken and analysed;
- Outcomes of actions taken at the time to prevent or minimise environmental harm; and
- Proposed actions to prevent a recurrence of the emergency or incident.

8 CERTIFICATION

As described in **Section 1.4**, RGS certifies that this TCRDP is feasible and would meet the intent of the relevant EA conditions (i.e. the successful implementation of the TCRDP will minimise the potential for environmental harm). The Qualifications of the suitably qualified RGS personnel are provided below.

8.1 Suitably Qualified Persons – RGS Company Details

The core business of RGS is to undertake static and kinetic chemical and physical material characterisation studies and produce certified mine material, mine rehabilitation and mine closure plans that include sampling, analytical and monitoring programs.

RGS is an owner-operated leading environmental consulting company that has been operating successfully for the past 18 years. RGS provides timely and cost-effective solutions to complex environmental management issues from exploration through the planning, operational and closure phases of small to large scale mining projects. The company has gained an international reputation as a leading provider of environmental management services to the mining and mineral processing industry and takes pride in being flexible, practical and innovative. RGS is committed to delivering on time and within budget, technical excellence, consistent quality, and continual improvement of our service delivery and skills.

RGS personnel have provided services to more than 600 mining and mineral processing projects in Algeria, Argentina, Australia, Bangladesh, Botswana, Brazil, China, Ghana, India, Indonesia, Laos, Malaysia, Mozambique, Namibia, New Caledonia, New Zealand, Papua New Guinea, Philippines, Romania, Thailand, Turkey and Vietnam. RGS has worked on more than 150 coal mine projects in Queensland, New South Wales, Western Australia, Africa, New Zealand, Indonesia, Laos and Bangladesh. Our clients range from small to large mining companies including Anglo American, BHP Billiton, CS Energy, Evolution Mining, Glencore, MMG, Rio Tinto, Stanwell Corporation and Vale.

8.2 Suitably Qualified Persons – Relevant Experience

RGS Personnel

Alan Robertson has a PhD in Pure and Applied Chemistry and has over 30 years of experience completing geochemical studies for the mining and mineral processing industry. He has worked on projects for major mining companies (e.g., Anglo American, BHP Billiton, Glencore, Rio Tinto and Vale) in Australia, Asia, Africa, Europe and South America for both coal and hard rock mines. Alan has expertise in mine waste characterisation, development of AMD management plans, and design of mine waste storage facilities from conception through to closure. Alan is regularly engaged to provide independent environmental advice and legal expert witness services on mine closure and rehabilitation aspects of mining operations.

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Attachments

Attachment A: Geochemical Assessment of Waste Rock, Coal Reject and Coal

TECHNICAL REPORT

Geochemical Assessment of Waste Rock, Coal Reject and Coal

Vulcan South

Prepared for: Vitrinite Pty Ltd

MINE WASTE AND
WATER MANAGEMENT

TECHNICAL REPORT

Geochemical Assessment of Waste Rock, Coal Reject and Coal

Vulcan South

Prepared for: Vitrinite Pty Ltd

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1 INTRODUCTION

1.1 Project Overview

Vitrinite Pty Ltd (Vitrinite) is the proponent of Vulcan South (the Project), located north of Dysart and approximately 33 km south-east of Moranbah in Queensland's Bowen Basin (**Figure 1-1**). The Project lies to the immediate west of several established mining operations including BHP's Peak Downs and Saraji mines.

The Project is located immediately to the south of Vitrinite's initial mining project, the Vulcan Coal Mine (VCM), located on ML700060. The Vulcan South mining lease application area abuts ML700060, however proposed activities will be implemented separately.

The Vulcan hard coking coal target has been defined and selected for open cut development via three separate open cut pits that form the primary mining focus of the Project. The Project includes primary rehabilitation works, following a two-year construction period and will operate for approximately nine years. The Project will extract approximately 13.5 Mt of run of mine (ROM) coal consisting predominately of hard coking coal with an incidental thermal secondary product at a rate of up to 1.95 Mtpa. The Project will target the Alex and multiple Dysart Lower coal seams. Truck and shovel mining operations will be employed to develop the pits. A mine infrastructure area (MIA) will be established along with a modular coal handling and preparation plant (CHPP), rail loop and train load-out facility at a location between the northern and central pits. The CHPP will include tailings dewatering technologies to maximise water recycling and to produce a dry tailings waste product (along with a reject product) for permanent storage within active waste rock dumps.

Out-of-pit waste rock dumps will be established prior to commencing in-pit dumping activities that will continue for the life of the operation. Ancillary infrastructure, including a ROM pad, offices, roads and surface water management infrastructure will be established to support the operation.

A realignment of the existing Saraji Road and services infrastructure to the eastern boundary of the proposed Mining Lease Application (MLA) area, adjacent to the existing rail easement, is also proposed in a number of locations. The re-alignment will occur within the MLA area.

In-pit dumping will fill the majority of the pit volumes during operations with the remaining final voids to be backfilled upon cessation of mining, resulting in the establishment of waste rock dump landforms above the former pit areas. Following backfill of the final voids, the remaining material stored in the initial out-of-pit waste rock dumps will be rehabilitated in-situ.

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

The Project is a small-scale mining operation, with coal extraction planned for approximately eight years, followed by completion of primary rehabilitation activities in year nine. Construction of infrastructure associated with the mining operation, including the CHPP and the rail loop, is expected to be completed within 2 years. Construction of the realigned Saraji Road sections will be completed intermittently as the project progresses, as required. Ongoing establishment of internal road networks, surface water management infrastructure and other ancillary infrastructure will continue to be developed as the pits and in-pit dumps advance.

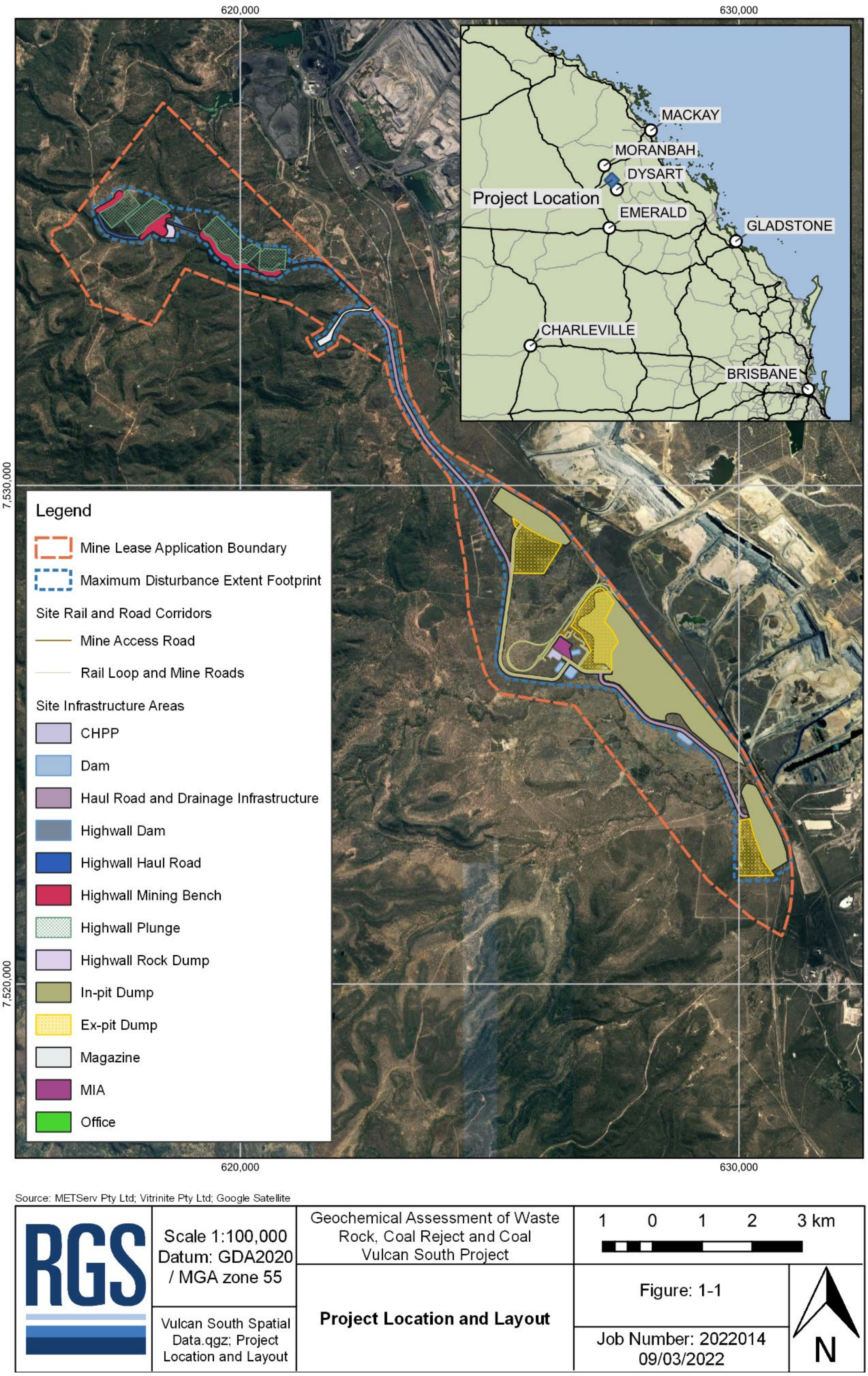


Figure 1-1: Project location and layout

1.2 Open Cut Mining Activities

1.2.1 Overview

The three open cut pits will extend to a depth of approximately 60 metres (m), following the seams as they dip eastwards. The footprints of the proposed open cut pits are provided in **Table 1-1**.

Table 1-1: Open cut pit characteristics

Open Cut Pit	Approximate Footprint (ha)	Mining Direction	Target Seams
Vulcan North	66	North to south	Alex and multiple Dysart Lower
Vulcan Main	334	North to south	Alex and multiple Dysart Lower
Vulcan South	77	North to south	Alex and multiple Dysart Lower

1.2.2 Waste rock removal and placement

Initial waste rock extracted during the early stages of each open pit will be placed in out-of-pit dumps to the west of the open pits. Following this initial out-of-pit placement and once sufficient pit space has been established, in-pit placement of waste rock will commence. This will continue for the life of each pit as it is developed. The in-pit dumps will extend up to approximately 60 m above the surrounding ground level, with batters shaped up to a maximum slope of 15%. A central plateau will drain to the west to minimise the requirement for significant drainage infrastructure along the eastern toe of the dump (where space is limited).

An assessment of waste rock geochemistry has concluded that the waste rock does not propose a significant risk of generating acid, saline or metalliferous drainage. Therefore, no selective handling and treatment measures are proposed. Furthermore, low permeability capping over the dump surface is considered not to be required.

1.2.3 Coal extraction

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

1.3 High Wall Mining Trial

The Project includes a small-scale highwall mining trial program in the north of the MLA. The trial will involve the establishment of four highwall mining benches across a series of hillsides to facilitate extraction of coal utilising a CAT HW300 highwall miner or similar and will target up to 750 kt of coal within the first year of mining operations. Mined coal will be loaded by front-end-loader and transported by truck to the Project CHPP via a dedicated haul road within the MLA. Whilst common in other coal mining regions, the trial will test the proposed highwall mining equipment in local conditions to assist Vitrinite decision making on the methodology's suitability for other assets held within the region.

The target areas for the trial present competent roof and floor materials and target seams that are relatively flat dipping and non-undulating. The coal seams are of a thickness that is appropriate for highwall mining (0.9 to 1.5 m) and the coal itself is of reasonable strength whilst still being easily cut with a highwall continuous miner. The depth of cover ranges between 12 and 50 m.

Minimal infrastructure will be required to support the highwall mining trial. This will include mobile diesel fuel tanks, workshop containers and portable bathroom amenities. Earthmoving equipment will be required for the development of benches for the highwall miner to operate on as well as road construction and maintenance equipment to build and maintain the haul road to the CHPP/ROM stockpile area. For the trial, the benches will form part of the haul road and will be connected by sections of linking haul road.

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

One of the benches will require establishment of a small waste rock dump that will be rehabilitated in situ.

Mine affected water will be contained on each bench and allowed to drain to completed highwall plunges (voids). Following rehabilitation earthworks, runoff will be managed by erosion and sediment control structures before being allowed to flow to the receiving environment at an acceptable quality.

1.4 Production Rate

The Project will commence operations at the Vulcan North and Vulcan Main pits in close succession. Operations at the Vulcan Main pit will continue for the full 8-year mine life. Mining activities at the Vulcan North pit are anticipated to be completed after three years. Activities at the Vulcan South pit will commence in Year 6 of operations and will conclude three years later in Year 8.

Throughout the Project life, the average annual ROM coal production rate is less than 1.7 Mtpa. During peak production periods, the Project will produce up to 1.95 Mtpa.

1.5 Coal Processing

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

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

The CHPP will produce dual products at any one time with different products produced in campaigns via control of different ROM feed materials.

1.5.1 Processing wastes

All processing wastes, including reject material and dry process tailings, will be stored within active waste rock dumps, removing the requirement for a tailings storage facility at the site. Priority will be given to disposal of processing wastes within in-pit dumps at depth; however scheduling constraints may necessitate storage of some material in ex-pit waste rock dumps.

Wastewater will be recycled within the CHPP circuit to minimise raw water demand and storage and disposal requirements.

1.6 Product Handling

A single CHPP product conveyor will deliver product coal to a radial product stacker. The system will be able to deliver different products to two different stockpiles. Each of the stockpiles will have a capacity of 200,000 tonnes.

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

1.6.1 Product Rail

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

1.7 Progressive Rehabilitation

A Progressive Rehabilitation and Closure Plan (PRCP) has been prepared to support the Environmental Authority Application and to meet Vitrinite's obligations under the *Environmental Protection Act, 1994* as amended by the *Mineral Resources and Energy (Financial Provisioning) Act 2018 Act*. In summary, the PRCP describes the proposed final landform, post-mine land uses, rehabilitation planning information and a schedule of progressive rehabilitation activities.

1.8 Ancillary Infrastructure

The ancillary infrastructure required to support mining operations will be progressively established as the pits, dumps and highwall trial progress.

A new mine access road will be established from Saraji Road in the centre of the MLA, between the rail loop and the northern extent of the Vulcan Main pit. This will lead to the site offices and administration and on to the MIA. The MIA will include heavy vehicle workshops and park-up, equipment laydown areas and Project offices and facilities.

An explosives magazine will be established to the west of the Vulcan north pit, a suitable distance from operational areas and critical infrastructure.

Surface water management infrastructure will be established progressively to divert clean water catchments around operational areas and to manage runoff from disturbed areas. A series of mine water dams will be established to manage raw water supply, pit water and supply water for dust suppression. A series of drains and bunds will be established to direct runoff to sediment control structures.

Linking roads, tracks and pipelines will be established around site as required. Similarly, temporary stockpiles of useful materials (e.g., topsoil, subsoil, gravels) will be established as required in available and appropriate locations. To facilitate flexible establishment of such infrastructure, a conservative disturbance footprint has been proposed and assessed.

1.9 Scope of Work

RGS has completed a Geochemical Assessment of waste rock, coal reject and coal for the Project in accordance with relevant legislation, guidelines, and policies[1,2,3,4]. RGS has produced this technical report for inclusion in the Project baseline studies and approvals process. The study was completed to address the following items:

- Review of available geochemical and geological data and existing drill hole database (including plans, drill hole logs and drill core photographs) associated with the Project;
- Coordination of the material sampling and geochemical characterisation programs;

[1] COA (2016). Commonwealth of Australia. Leading Practice Sustainable Development Program for the Mining Industry. Preventing Acid and Metalliferous Drainage. September, Canberra ACT.

[2] DEHP (2013). Application Requirements for Activities with Impacts to Land Guideline. Queensland Department of Environment and Heritage Protection.

[3] DME (1995). 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).

[4] INAP (2022). Global Acid Rock Drainage Guide (GARD Guide). Document prepared by Golder Associates on behalf of the International Network on Acid Prevention (INAP). June 2022 (http://www.inap.com.au/).

- Refinement of any necessary environmental management measures related to waste rock and coal reject emplacement and rehabilitation and ROM coal stockpile management; and
- Preparation of a Geochemical Assessment Report (this report) largely based on existing information that will be supplemented by additional geochemical information on samples from the Project, when available. The Geochemical Assessment Report has assessed the potential for any Acid and Metalliferous Drainage (AMD) or other salinity/erosion/ dispersion issues related to waste rock, coal reject and coal at the Project.

2 GEOLOGY, MINING ACTIVITIES AND REHABILITATION

The Project is located north of Dysart to the immediate west of several established mining operations including Peak Downs and Saraji coal mines.

2.1 Geology and Stratigraphy

The Project will target the Alex and multiple Dysart Lower coal seams within the Permian-aged Moranbah Coal Measures. A surficial Tertiary waste rock (overburden) sequence is present in the Project area, consisting of unconsolidated soils and sands. Underlying this is Permian-aged waste rock (overburden), which is comprised of sandstone and siltstone.

The Permian waste rock (interburden) materials at the Project generally comprise sandstone, siltstone, claystone and coal, that were deposited in a fluvial flood plain environment within the Bowen Basin. Significant mesa hills formed by highly resistant sandstones have provided target coal seams throughout the centre of the study area. The typical stratigraphic profile encountered at the Project is provided in **Figure 4**.

The Alex seam is generally quite shallow and occurs just below the base of weathering in the stratigraphic profile. The Dysart Lower Seam comprises several plys with the waste rock (interburden/parting) in between generally consisting of fine-grained sedimentary units such as siltstone, mudstone and claystone, with the occasional carbonaceous or coaly unit.

The May Seam (consisting of carbonaceous claystone) and Matilda Seam (consisting of interbedded coal and siltstone) underlie the Dysart seam, but are not considered economic.

2.2 Mining Activities

2.2.1 Overview

The open cuts will extend to a depth of approximately 60 m, following the seams as they dip eastwards. The total footprint of the proposed open cuts is approximately 477 ha (**Table 1-1**). Development of the open cuts will progress from the west of the pits mining from north to south, toward the eastern boundary of the proposed MLA. Truck and shovel mining methods and blasting will be employed to extract waste rock and coal from the pit.

2.2.2 Waste rock removal and placement

Initial waste rock extracted during the early stages of the development of the open cut pits will be placed in an out-of-pit dump to the west of the pits. Following this initial out of pit placement and once sufficient pit space has been established, in-pit placement of waste rock will commence. This will continue for the life of the project as the pits advance. The in-pit dumps will extend approximately 60 m above the surrounding ground level, with batters shaped at a maximum of 15%. A central plateau will drain to the west to minimise the requirement for significant drainage infrastructure along the eastern toe of the dump (where space is limited).

Assessment of waste rock geochemistry (RGS, 2019; 2020) showed that the waste rock does not pose a significant risk of generating acid, saline or metalliferous drainage. Therefore, no selective handling and treatment measures are proposed and low permeability capping over the dump is unlikely to be required.

2.2.3 Coal extraction

Once waste rock has been removed to expose the coal seams, coal will be extracted via truck and shovel. The coal will be hauled to the ROM pad. Crushing and screening will be completed as part of the CHPP raw coal handling circuit. Depending on mining and market conditions, ROM coal may be trucked to the Vulcan Coal Mine CHPP located on ML700060 to the north of the project. If this is the case, haulage would be via private haul road and would not need to utilise public roadways.

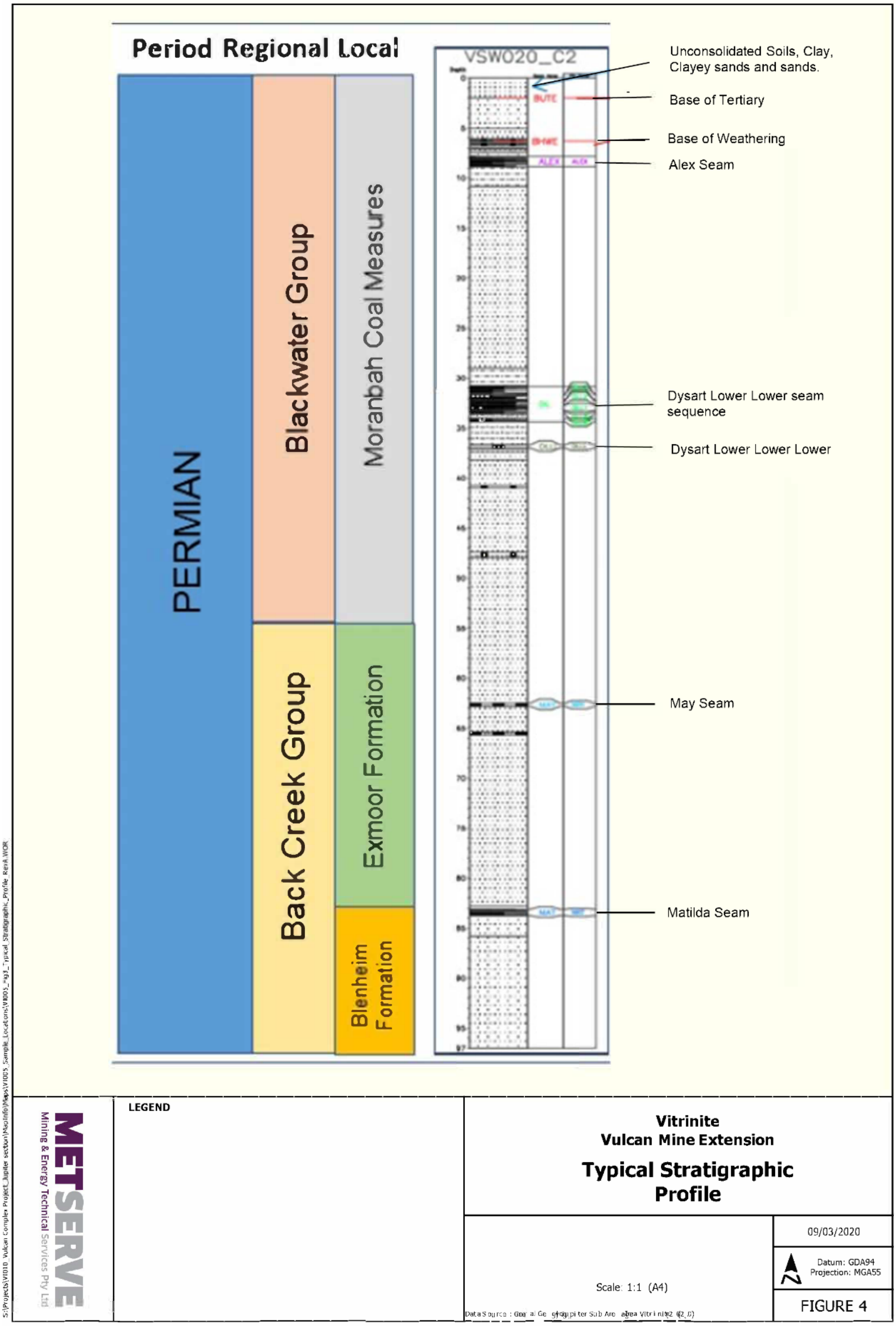


Figure 2-1: Typical stratigraphic profile

2.2.4 Production rate and schedule

An indicative annual mining schedule is provided in **Table 2-1**.

Table 2-1: Indicative mining schedule

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	
	2023	2024	2025	2026	2027	2028	2029	2030	Total (t)
Highwall Mining									
Topsoil (t)	622,557								**622,557**
Waste Rock (t)	6,246,343								**6,246,343**
ROM Coal (t)	750,000								**750,000**
Vulcan North Pit									
Topsoil (t)	58,734	313,019	40,004						**411,757**
Waste Rock (t)	4,001,234	24,117,467	1,616,789						**29,735,489**
ROM Coal (t)	26,137	1,202,385	585,592						**1,814,114**
Vulcan Main Pit									
Topsoil (t)	35,686	298,486	298,079	305,290	389,958	183,329	257,856	141,396	**1,910,079**
Waste Rock (t)	1,261,637	17,067,931	38,929,456	40,431,863	40,855,127	33,106,442	23,798,147	11,652,257	**207,102,860**
ROM Coal (t)		687,965	1,223,774	1,841,120	1,728,933	1,560,844	1,304,554	1,027,403	**9,374,594**
Vulcan South Pit									
Topsoil (t)						142,196	198,534	131,741	**472,471**
Waste Rock (t)						8,100,351	17,179,435	13,883,816	**39,163,602**
ROM Coal (t)						249,607	647,113	451,034	**1,347,754**
Annual total									
Topsoil (t)	716,977	611,505	338,083	305,290	389,958	325,525	456,390	273,137	**3,416,865**
Waste Rock (t)	11,509,214	41,185,398	40,546,244	40,431,863	40,855,127	41,206,793	40,977,582	25,536,073	**282,248,294**
ROM Coal (t)	776,137	1,890,350	1,809,366	1,841,120	1,728,933	1,810,451	1,949,667	1,488,437	**13,294,461**

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

2.2.5 Ancillary Infrastructure

A new mine access road will be established from Saraji Road in the centre of the MLA, between the rail loop and the northern extent of the Vulcan Main pit. This will lead to the site offices and administration and then on to the Mine Infrastructure Are (MIA).The MIA will include heavy vehicle workshops and park-up, equipment laydown areas, project offices and facilities. An explosives magazine will be established to the west of the Vulcan North pit, away from operational areas and critical infrastructure.

Surface water management infrastructure will be established progressively to divert clean water catchments around operational areas and to manage runoff from disturbed areas. A series of mine water dams will be established to manage raw water supply, pit water and supply water for dust suppression. A series of drains and bunds will be established to direct runoff to sediment control structures.

Linking roads, tracks and pipelines will be established around site as required. Similarly, temporary stockpiles of useful materials (e.g., topsoil, subsoil and gravels) will be established as required in available and appropriate locations. To facilitate flexible establishment of such infrastructure, a conservative disturbance footprint has been proposed and assessed.

2.3 Progressive Rehabilitation

A Progressive Rehabilitation and Closure Plan (PRCP) has been prepared to support the Environmental Authority Application and to meet Vitrinite's obligations under the *Environmental Protection Act, 1994* as amended by the *Mineral and Energy Resources (Financial Provisioning) Act 2018*. In summary, the PRCP describes the proposed final landform, post-mine land uses, rehabilitation planning information and a schedule of progressive rehabilitation activities.

3 METHODOLOGY

RGS personnel worked closely with Vitrinite (geological) personnel to develop an appropriate sampling and geochemical testing plan, which was used to obtain representative samples of waste rock (overburden and interburden) and coal reject materials associated with the VCM and Vulcan South. This was supplemented with total sulfur data for a range of coal samples from the VCM/Vulcan South target seams (Alex and Dysart Lower).

3.1 Sample Selection and Preparation

The sampling methodology used to obtain representative samples of waste rock and coal reject materials for the Project was undertaken in accordance with relevant technical guideline documents. While there are no specific regulatory guidelines regarding the number of samples required, existing risk-based technical guidelines for the geochemical assessment of mining waste materials in Australia (AMIRA, 2002; COA, 2016c) and worldwide (INAP, 2022) were used by RGS as a framework for the sampling program.

3.1.1 Waste Rock (Overburden and Interburden)

Representative samples of waste rock (overburden and interburden) materials were identified and collected as drill chips from the 2018-2019 exploration drilling program. A total of 138 waste rock samples were collected from 21 drill holes at the Project. Seven of these holes were drilled within the Jupiter target area and 14 within the Vulcan target area. The locations of the Jupiter and Vulcan drill holes with respect to the Project are shown in **Figure 3-1**.

The samples represented the waste rock (overburden and interburden; including roof, floor and parting materials, i.e., potential coal reject material) expected to be encountered during development activities, from the surface to a depth of approximately 45 m. This covers the entire stratigraphic profile that is currently under consideration for mining at the Project. **Table 3-1** provides the number of samples of each type of material collected from the Jupiter and Vulcan targets and used in the geochemical assessment. Further information on the identity of the 138 individual waste rock samples is provided in **Table B1** (**Attachment B**). The number of samples was selected to provide a good statistical representation of the amount and type of mined material expected to be encountered at the Project, considering the risk profile indicated from the geology and geochemical information from nearby coal projects.

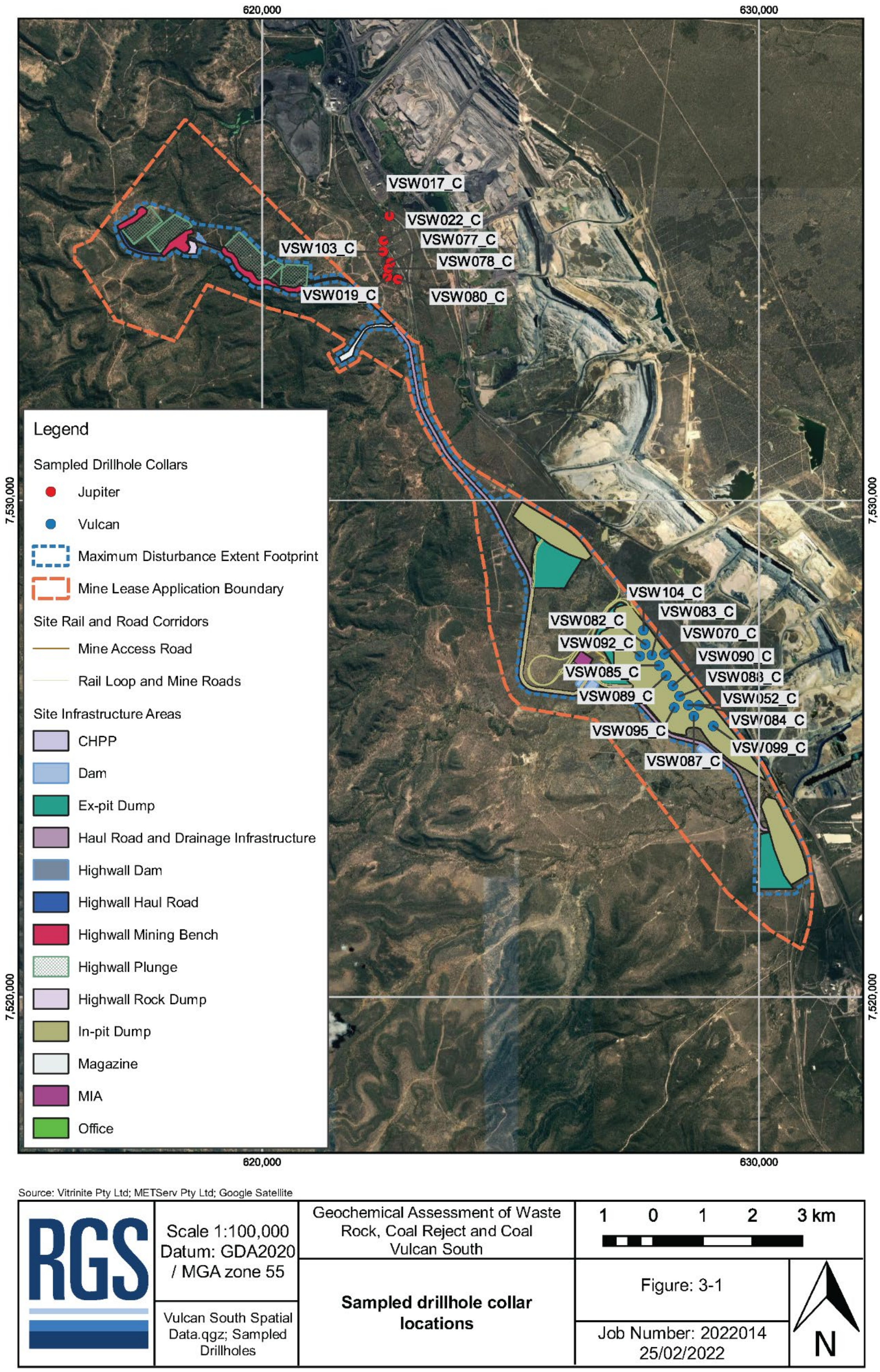


Figure 3-1: Sampled drillhole collar locations

3.1.2 Coal Reject

Two size fractions (coarse: Wash 2, <50 to >2 mm; and fine: Wash 3 & fines, <2 to >0.25 mm & <0.25 to >0 mm) of coal reject materials were selected to best represent the two coal reject streams that will be produced from coal washing on site. Coal core from a total of six holes was collected by Vitrinite personnel and delivered to the ALS coal quality laboratory in Richlands, Queensland. This core was composited into 11 samples of coarse and fine reject material (four from Jupiter and seven from Vulcan) and sent to ALS Environmental Laboratory (ALS) in Stafford, Queensland for geochemical testing.

Table 3-1: Sample materials used for geochemical testing

Sample Description	Sample Type	Number of samples	
Waste Rock and Potential Coal Reject		Vulcan Target	Jupiter Target
Soil, clay, sandstone, siltstone, claystone and conglomerate	Overburden	83	17
Sandstone, siltstone and claystone	Interburden	12	1
Sandstone, siltstone and claystone; carbonaceous sandstone, siltstone, claystone and coal	Roof, floor and parting	20	5
	Total	**115**	**23**
Coal Reject		Coarse	Fine
Coarse and fine reject	Coal Reject	5	6
	Total	**5**	**6**

3.1.3 Sample Preparation

Once received, the waste rock and coal reject samples were prepared by crushing and pulverising to less than 75 µm size, where necessary. This method of sample preparation results in a homogenous sample, but also generates a large sample surface area in contact with the assay solution. This provides a greater potential for dissolution and reaction and represents an assumed initial 'worst case' scenario for these materials. A list describing the source of all of the 149 waste rock and coal reject samples included in this study is provided in **Table B1** (**Attachment B**).

3.2 Geochemical Test Program

A series of geochemical and physical tests were completed on the 149 waste rock and coal reject samples described in detail in **Section 3.1**. The test program was designed to assess the degree of risk from the presence and potential oxidation of sulfides, as well as the generation and the presence/leaching of soluble metals/metalloids and salts. The assessment also included characterisation of standard soil parameters including salinity, sodicity, cation exchange capacity, exchangeable sodium percentage and major metal concentrations.

A detailed summary of the parameters involved in completing a static and kinetic geochemical characterisation and assessment of 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. All 149 samples 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, two waste rock (interburden) samples and 11 coal reject 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 primarily forms from the oxidation of reactive sulfide measured by this method.

After the results of the initial static geochemical tests were received and reviewed, 122 of the original 149 samples were used to create six composite samples for waste rock and four composite samples for coal reject materials. For the Vulcan target, soil, sandstone, clay and claystone composites were prepared; while sandstone and siltstone composites were prepared for the Jupiter target. All ten composite samples were sent for whole rock multi-element testing at ALS Stafford laboratory. The composite samples were tested for:

- Paste pH and EC [1:5 w:v. sample: deionised water];
- Major cations (Ca, Mg, K, Na) [HCl and HNO3 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 (Ag, Al, As, B, Cd, Cr, Co, Cu, F, Fe, Hg, Pb, Mn, Mo, Ni, Sb, Se, U, V and Zn) [HCl and HNO_3 acid digest followed by FIMS and/or ICP-AES/MS]; and
- Soluble metals (Ag, Al, As, B, Cd, Cr, Co, Cu, F, Fe, Hg, Pb, Mn, Mo, Ni, Sb, Se, U, V and Zn) [ICPAES/MS and FIMS (1:5 w:v water extracts)].

The six composite waste rock samples were also tested for exchangeable cations (Ca, Mg, Na and K) [ICP-AES], and results were used to calculate the cation exchange capacity (CEC) and exchangeable sodium percentage (ESP). Summary geochemical results tables for the static geochemical test program are provided in **Attachment B**. The ALS laboratory certificates of analysis are provided in **Attachment D**.

3.2.2 Kinetic Tests

Following receipt and interpretation of the static geochemical test results, six kinetic leach column (KLC) tests were set up at the RGS 'in-house' laboratory using composite waste rock and coal reject materials from the Vulcan and Jupiter targets. The KLC tests for waste rock were completed from June to December 2019 and from December 2019 to June 2020 for coal reject materials. A summarised description of the material represented by each KLC test is shown below in **Table 3-2**. The identities of the specific individual samples included in composite samples used for the KLC test program are detailed in **Table B7** (**Attachment B**).

Table 3-2: KLC material description

KLC Sample #	Description
KLC1	Mainly Sandstone waste rock (Vulcan target)
KLC2	Mainly Claystone waste rock (Vulcan target)
KLC3	Mainly Sandstone waste rock (Jupiter target)
KLC4	Mainly Siltstone waste rock (Jupiter target)
KLC 5	Coarse Reject (Jupiter/Vulcan Target)
KLC 6	Fine Reject (Jupiter/Vulcan Target)

Approximately 2 kg of each composite sample was 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, EC, Acidity and alkalinity [PC Titrator and pH/ EC probes];
- Dissolved metals/metalloids (Al, As, B, Cd, Co, Cr, Cu, Fe, 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 raw ALS laboratory test results received for the KLC test program are provided in **Attachment D**.

4 GEOCHEMICAL AND PHYSICAL CHARACTERISATION RESULTS

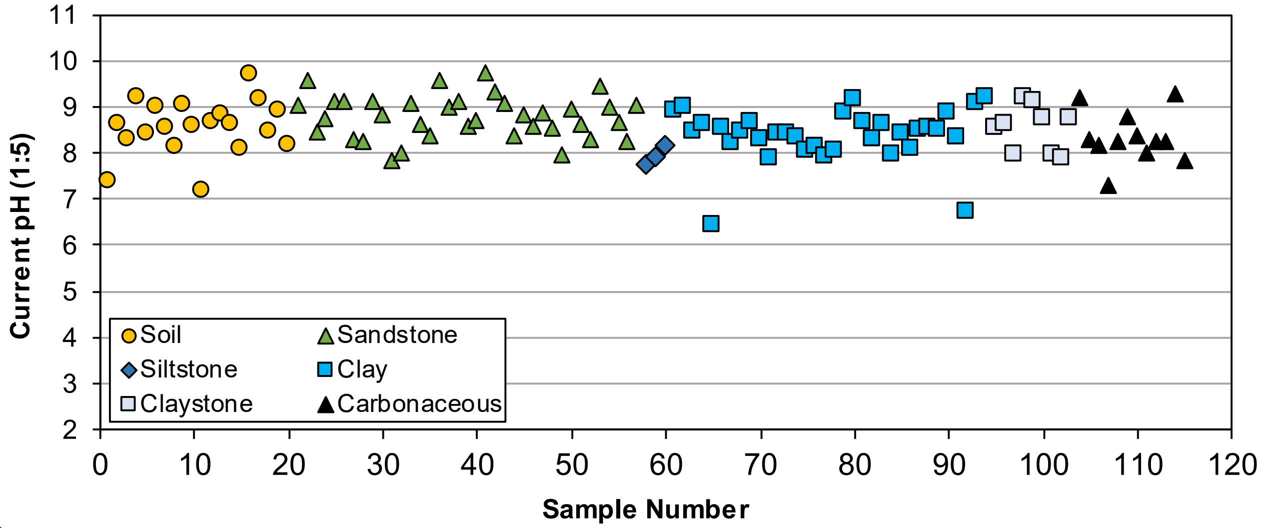
4.1 Acid Base Account

4.1.1 Overburden/Interburden

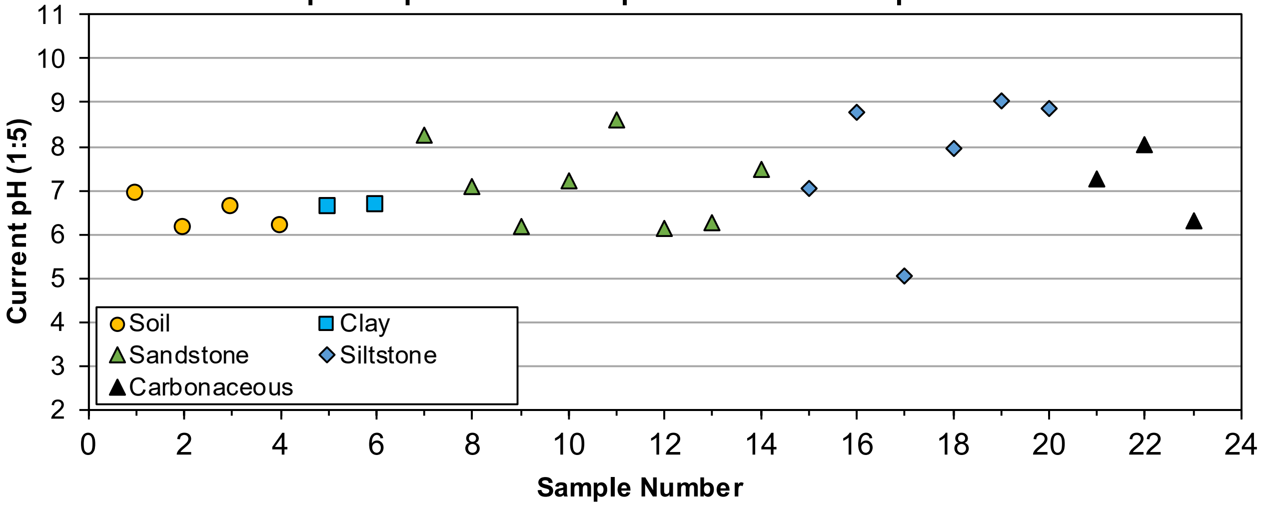
Acid Base Account results for the 138 waste rock (overburden/interburden) samples (115 from the Vulcan target; 23 from the Jupiter target) are presented in **Table B2** (**Attachment B**) and summarised below. The results are shown by target and lithology to facilitate interpretation.

- **pH:** The $pH_{(1:5)}$ of the 115 samples from the Vulcan target ranges from 6.4 to 9.7, with a median pH value of 8.6 (**Graph 4-1**). The $pH_{(1:5)}$ of the 23 samples from the Jupiter target ranges from 5.1 to 9.0, with a median value of 7.0 (**Graph 4-2**). The pH results indicate that waste rock material at the Vulcan and Jupiter targets will add some alkalinity to any contact water as the pH of deionised water used in the pH tests is typically in the pH range of 5.0 to 6.5.

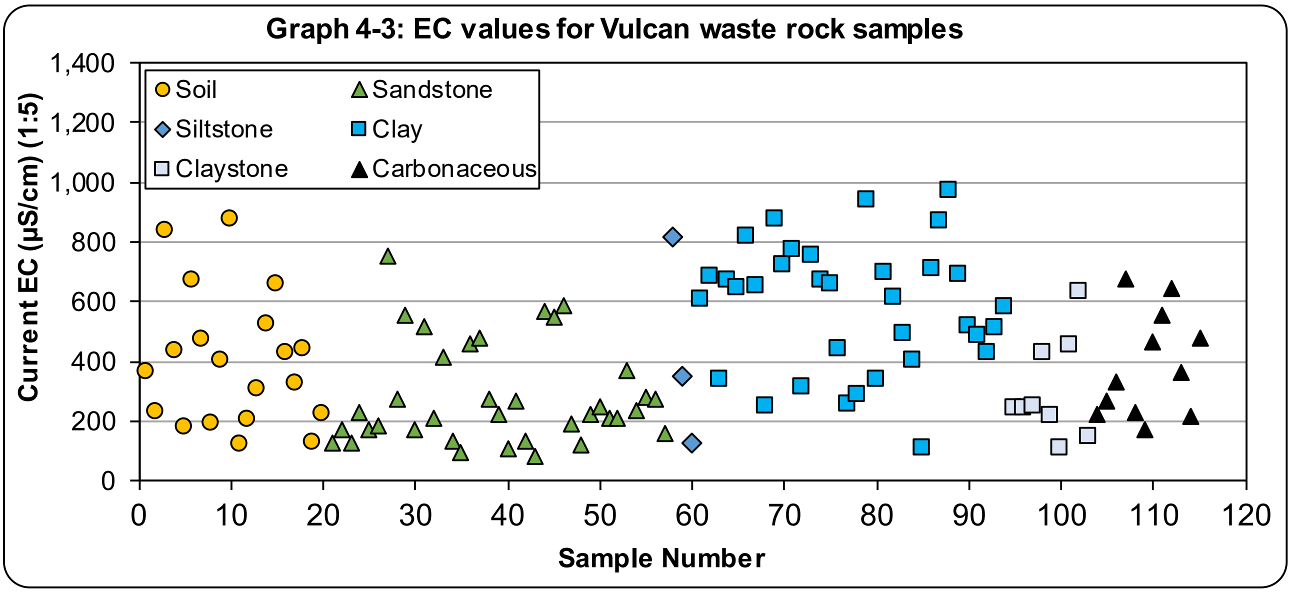
Graph 4-1: pH values for Vulcan waste rock samples

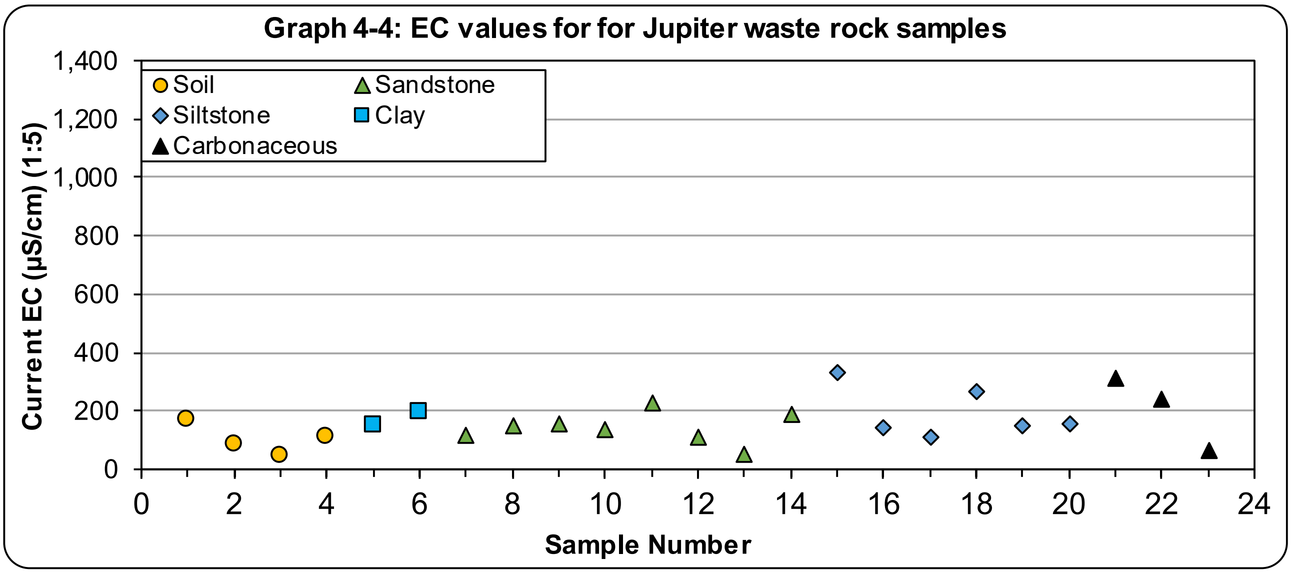


Graph 4-2: pH values for Jupiter waste rock samples



- **EC:** The current EC$_{(1:5)}$ of the Vulcan target samples ranges from 85 to 972 µS/cm, with a median value of 365 µS/cm (**Graph 4-3**). The current EC$_{(1:5)}$ of the Jupiter target samples ranges from 43 to 331 µS/cm, with a median value of 152 µS/cm (**Graph 4-4**). The highest EC values tend to be associated with some of the soil and clay materials at the Vulcan target.





To provide additional context, the pH$_{(1:5)}$ and EC$_{(1:5)}$ results for waste rock (overburden and interburden) are classified against pH and salinity criteria for mining waste materials, as defined by the Queensland DME (1995) technical guidelines for the environmental management of exploration and mining in Queensland (**Table 4-1**).

Based on the median pH and EC values, the waste rock (overburden/interburden) samples tested are generally regarded as having a 'Medium' to 'High' soil pH and 'Low' salinity characteristics, as indicated by the distribution of samples corresponding to each pH and salinity class. Samples from the Jupiter target have a slightly lower (neutral) median pH value than samples from the Vulcan target.

Table 4-1: Salinity and pH criteria for assessment of waste rock samples

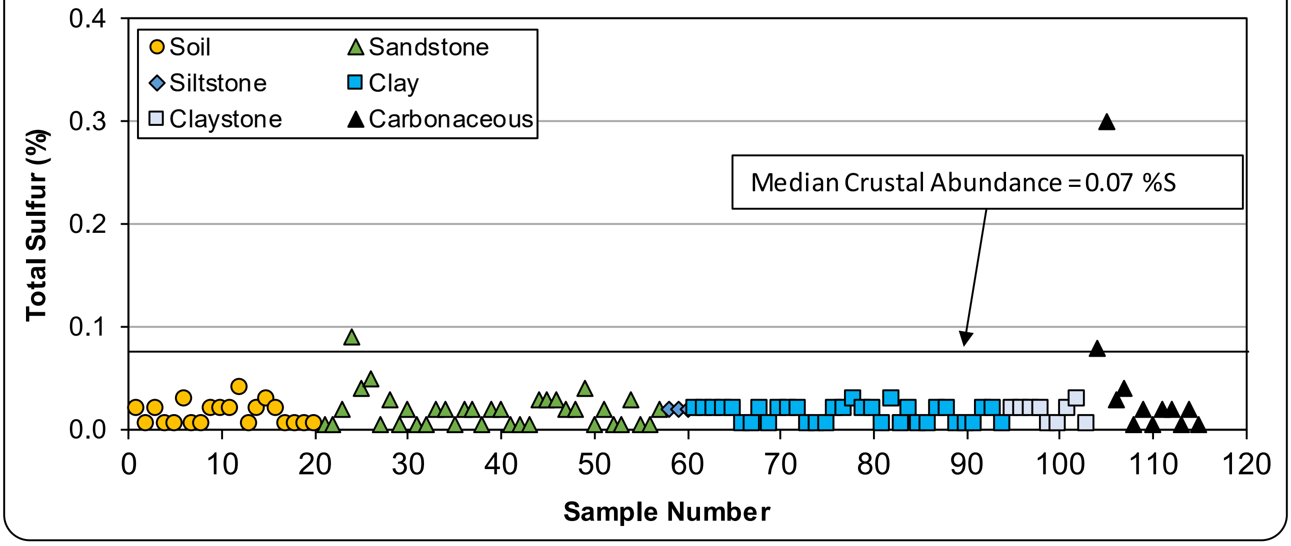
Vulcan Target	Very Low	Low	Medium	High	Very High
$pH_{1:5}$	< 4.5	4.5 – 5.5	5.5 – 7.0	7.0 – 9.0 (Median – 8.6)	> 9.0
$EC_{1:5}$ (µS/cm)	< 150	150 – 450 (Median – 365)	450 – 900	900 – 2,000	> 2,000
Jupiter Target	**Very Low**	**Low**	**Medium**	**High**	**Very High**
$pH_{1:5}$	< 4.5	4.5 – 5.5	5.5 – 7.0 (Median 7.0)	7.0 – 9.0	> 9.0
$EC_{1:5}$ (µS/cm)	< 150	150 – 450 (Median – 152)	450 – 900	900 – 2,000	> 2,000

Note: Adapted from DME, 1995. Highlighted cells show the category corresponding to the median pH and EC values (orange shading) for the waste rock (overburden/interburden) samples.

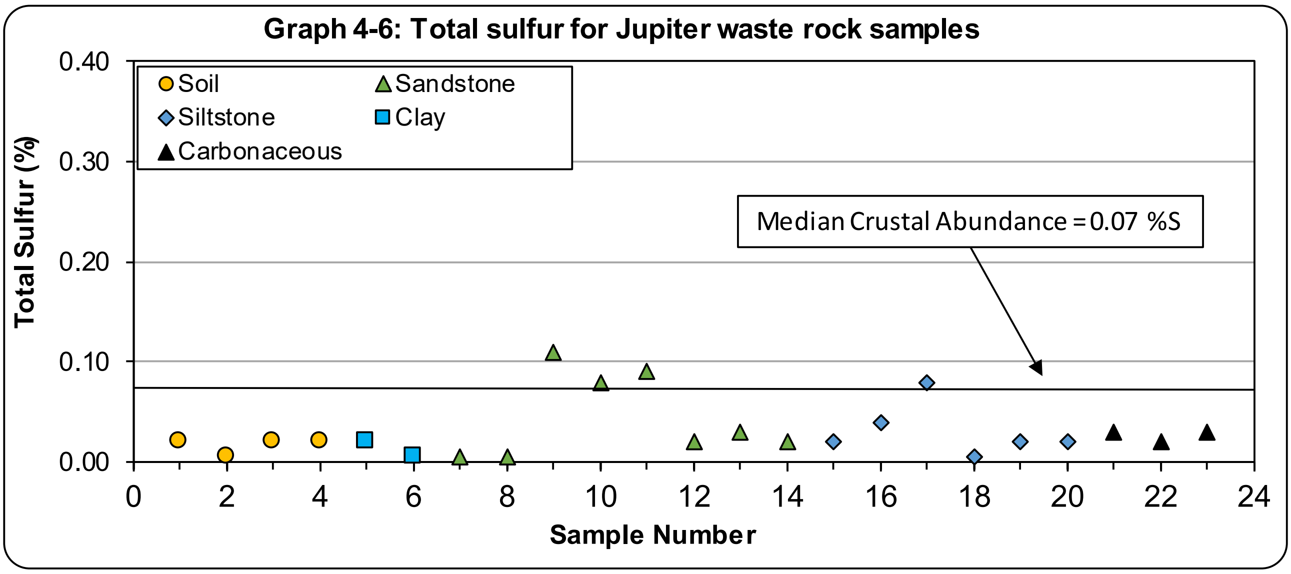
The pH and EC tests were completed on pulverised samples (≤ 75 µm) with a large surface area in contact with the leaching solution, thereby providing greater potential for dissolution and reaction, and represent an assumed 'worst case' scenario. It is also expected that the salinity of leachate from 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 samples from the two targets ranges from below the laboratory limit of reporting (LoR) to 0.30% 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, 2022). 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[5]. **Graphs 4-5 and 4-6** illustrate the total sulfur content of the sample materials from the Vulcan and Jupiter targets, respectively. The results demonstrate that most samples have a total sulfur concentration well below median crustal abundance.

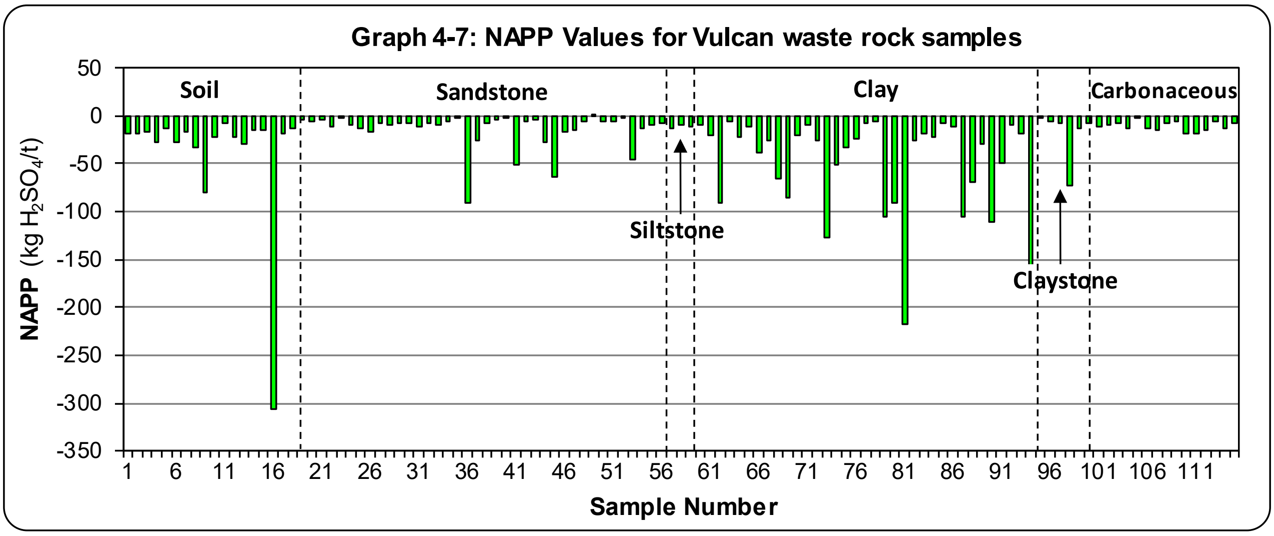
Graph 4-5: Total sulfur for Vulcan waste rock samples

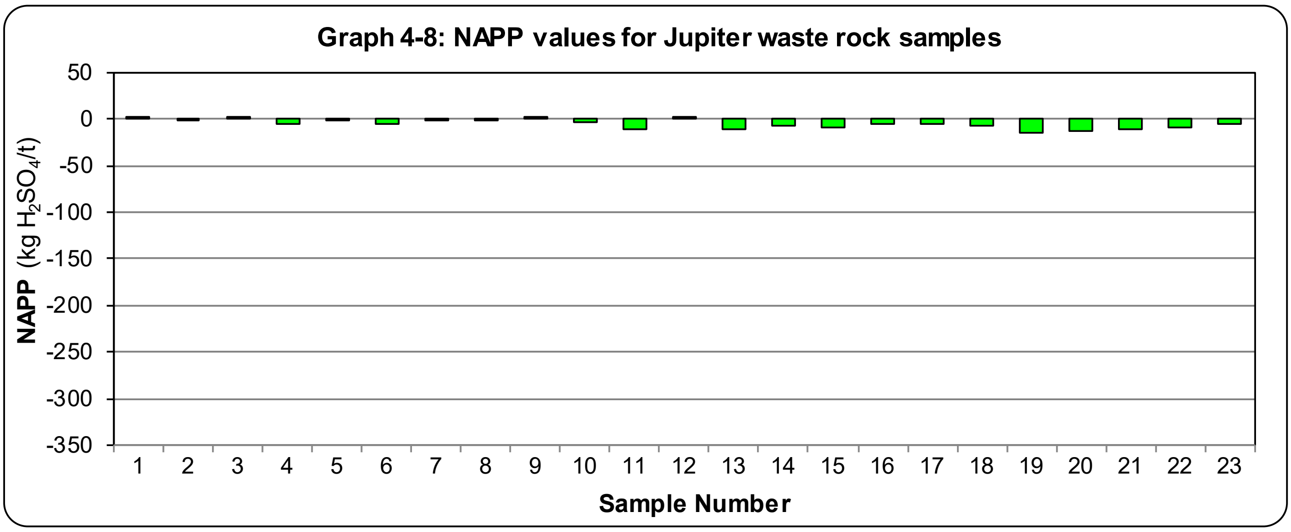


[5] The median crustal abundance of sulfur (0.07% S) has been rounded up to 0.1% (INAP, 2022).



- **Sulfide sulfur:** Due to the very low total sulfur content of most of the waste rock (overburden/interburden) samples, only two samples (a weathered coal sample from the Alex coal seam at Vulcan and a sandstone sample from Jupiter) were tested for sulfide sulfur using the Scr method. The test results show that only the weathered coal sample from Vulcan contains any appreciable sulfide sulfur and approximately half of the total sulfur content is likely to be 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 Vulcan and Jupiter waste rock samples ranges from below the laboratory LoR to 4.7 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 138 samples ranges from 0.25 to 307 kg H_2SO_4/t and has a median value of 13.6 kg H_2SO_4/t, which is approximately 20 times the median MPA.
- **ANC:MPA ratio:** The ANC:MPA ratio of the 138 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 -306.4 to 1.0 kg H_2SO_4/t, with a negative median value of -12.7 kg H_2SO_4/t. The NAPP data is presented in **Graphs 4-7 and 4-8**.

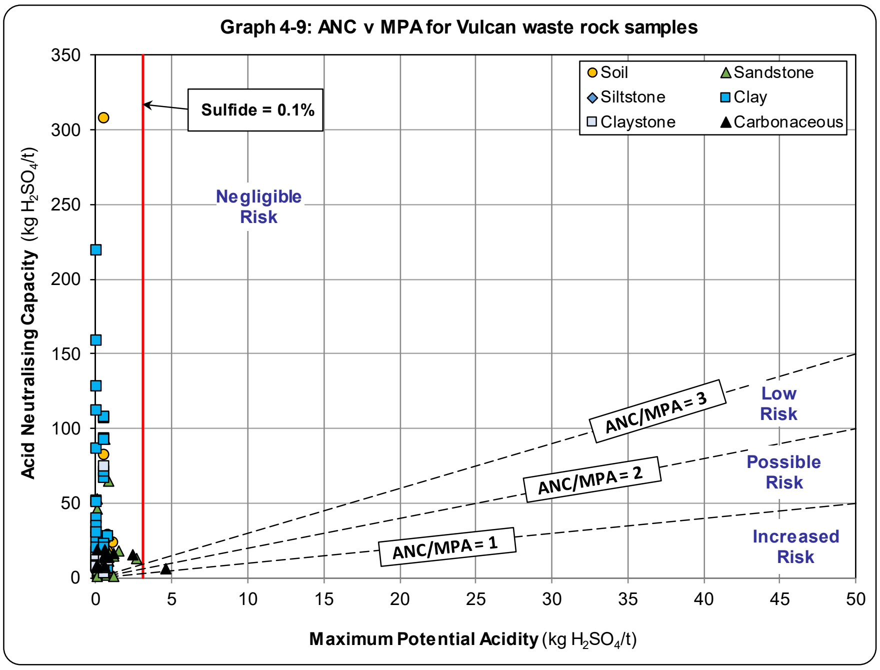




Given the very low sulfur content of the waste rock tested and the generally negative NAPP values, the risk of generating any significant amounts of acidity from these materials is considered to be negligible.

Graphs 4-9 and **4-10** show plots of ANC versus MPA for the waste rock samples tested by material type from the Vulcan and Jupiter targets, respectively. ANC:MPA ratio lines have been plotted on the figures 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, 2022).

The Acid Base Account results show that all but one sample (a weathered coal sample from the Alex seam at Vulcan) plots in the negligible risk domain shown in the figures and therefore the overwhelming majority of samples tested represent waste rock materials that have a high factor of safety and a very low risk of generating acidity. If economic, it is likely that the Alex seam will be mined and report as coal to the ROM pad. As can be seen in **Figure 3**, the Alex seam covers a depth interval of only 1 m and therefore is expected to represent a small fraction (up to 2%) of waste rock materials at the Vulcan target if found to be uneconomic and reports as waste rock.



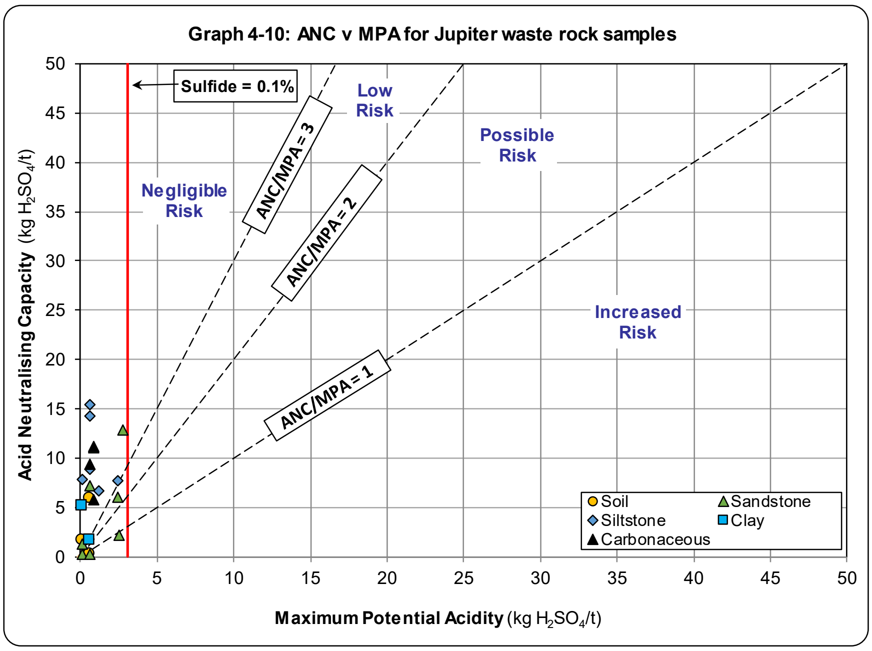


Table 4-2 provides a summary of the geochemical classification criteria used by RGS to classify the acid forming nature of the waste rock and a breakdown of the number of samples in each classification category. The classification criteria reflect Australian (COA, 2016c) and international (INAP, 2022) guidelines for the classification of mining waste materials.

The Acid Base Account test data presented in **Table C2 (Attachment C)** and discussed in this section have been used to classify the acid forming nature of the 138 waste rock samples. The results in **Table 4-2** demonstrate that of the 138 samples tested, 137 samples (~99.3%) are classified as Non-Acid Forming (NAF) (Barren) and one sample (~1%) is classified as Uncertain. None of the samples are classified as Potentially Acid Forming (PAF).

Table 4-2: Geochemical classification criteria for waste rock materials

Geochemical Classification	Total Sulfur[1] (%)	NAPP (kg H_2SO_4/t)	ANC:MPA Ratio	No. Samples (n = 138)
Non-Acid Forming (Barren)[2]	≤ 0.1	-	-	137
Non-Acid Forming	> 0.1	≤ -5	≥ 2	0
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.

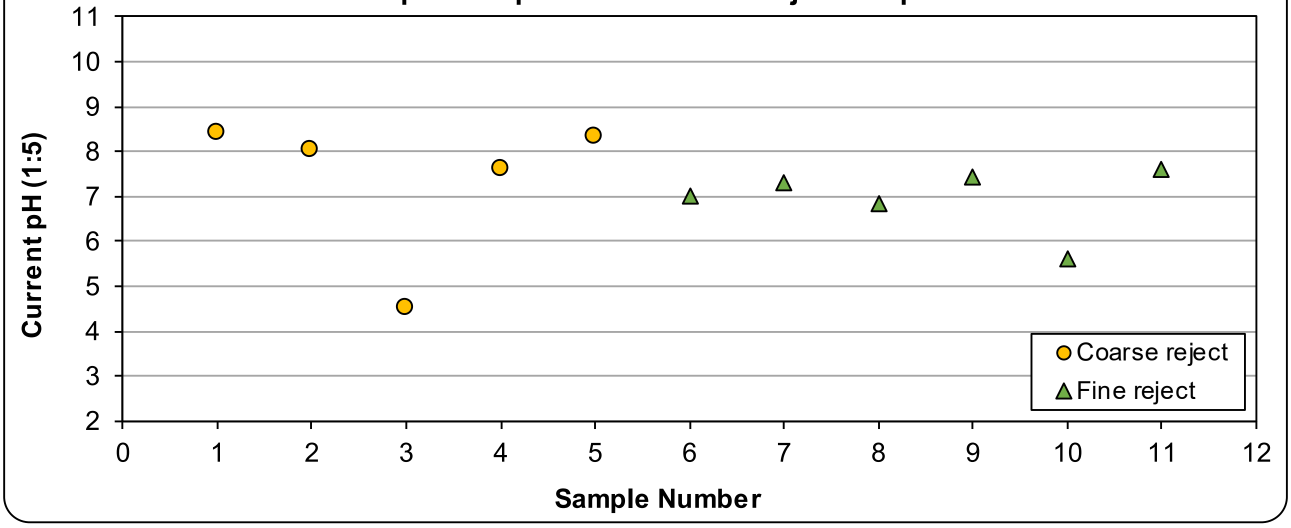
Overall, the Acid Base Account results confirm that the overwhelming majority of the waste rock materials represented by the samples tested have low sulfur content, excess ANC, and are classified as NAF. These materials have a high factor of safety and a very low risk of generating acidic drainage. One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

4.1.2 Coal Reject

Acid Base Account results for the 11 coal reject samples from the Project (five coarse reject and six fine reject samples) are presented in **Table B3** (**Attachment B**) and summarised below. The results are shown by material type to facilitate interpretation.

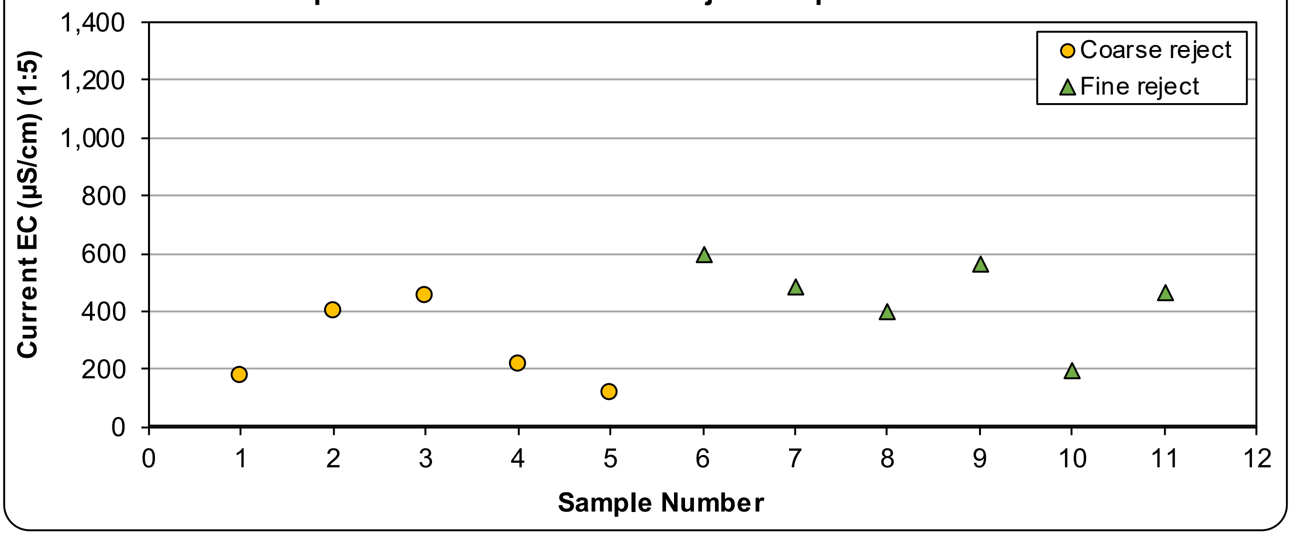
- **pH:** The $pH_{(1:5)}$ of the 11 coal reject samples ranges from 4.5 to 8.4 and has a median pH value of 7.4 (**Graph 4-11**). The pH results indicate that bulk coal reject material generated at the Project will most likely add some alkalinity to any contact water as the pH of deionised water used in the pH tests is typically in the pH range of 5.0 to 6.5. The lowest pH value was obtained for one of the coarse reject samples however the remaining four coarse reject samples have a neutral to slightly alkaline pH value. On the basis of these results, it is expected that leachate from bulk coal reject materials will be pH neutral.

Graph 4-11: pH values for coal reject samples



- **EC:** The current $EC_{(1:5)}$ of the coal reject samples ranges from 116 to 595 µS/cm and has a median value of 401 µS/cm (**Graph 4-12**). The highest EC is measured for the fine reject materials.

Graph 4-12: EC values for coal reject samples



To provide additional context, the $EC_{(1:5)}$ and $pH_{(1:5)}$ results for coal reject are classified against pH and salinity criteria for mining waste materials, as defined by the Queensland DME (1995) technical guidelines for the environmental management of exploration and mining in Queensland (see **Table 4-3**).

Table 4-3: Salinity and pH criteria for assessment of coal reject samples

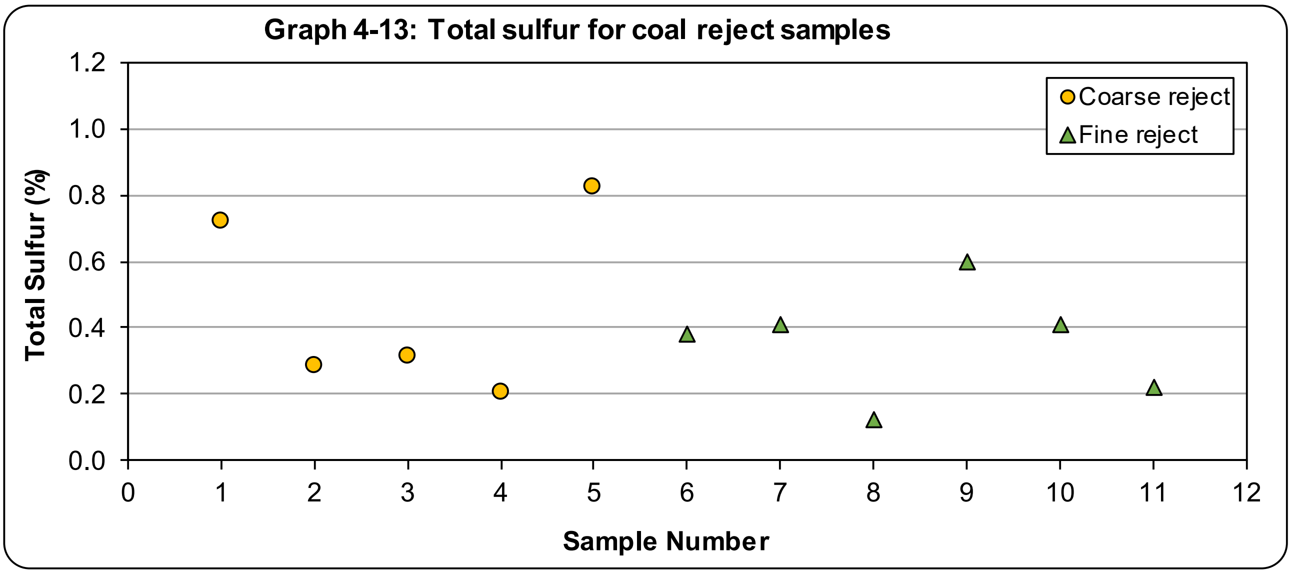
Coal Reject	Very Low	Low	Medium	High	Very High
$pH_{1:5}$	< 4.5	4.5 – 5.5	5.5 – 7.0	7.0 – 9.0 (Median – 7.4)	> 9.0
$EC_{1:5}$ (µS/cm)	< 150	150 – 450 (Median – 401)	450 – 900	900 – 2,000	> 2,000

Note: Adapted from DME, 1995. Highlighted cells show the category corresponding to the median pH and EC values (orange shading) for the coal reject samples.

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

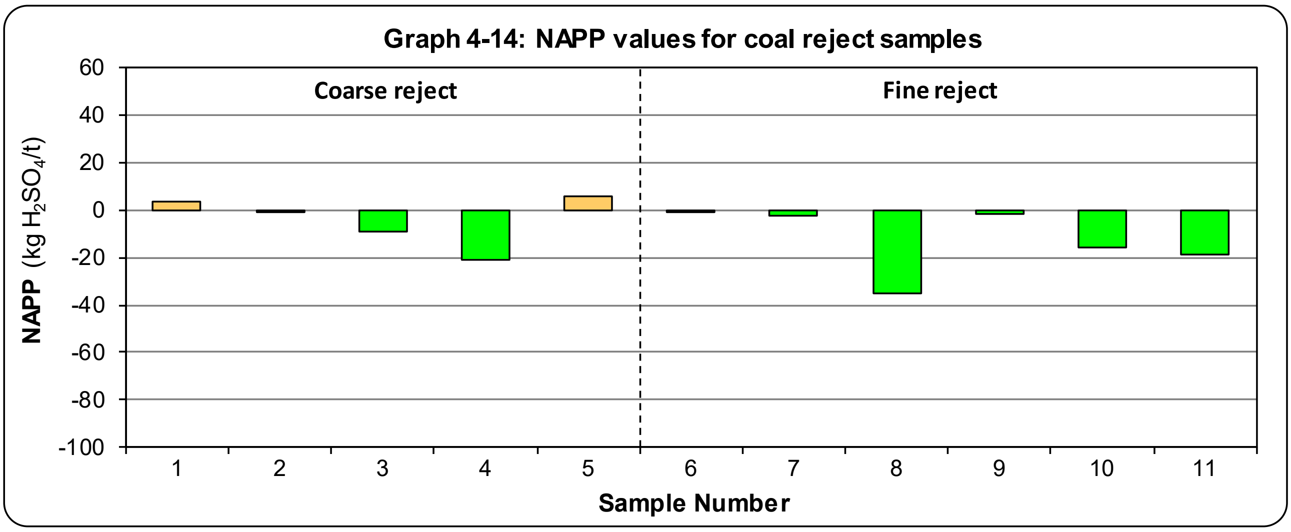
The pH and EC tests were completed on pulverised samples (≤ 75 µm) with a large surface area in contact with the leaching solution, thereby providing greater potential for dissolution and reaction, and represent an initial 'worst case' scenario. While sulfide oxidation in some coal reject materials may contribute to increases in the salinity of leachate in the short term, it is expected that in the longer term the salinity from bulk coal reject materials will stabilise and potentially diminish over time at a concentration relative to the weathering/erosion of the materials as salts are flushed from the material matrix and a state of equilibrium develops.

- **Sulfur:** The total sulfur content of the 11 coal reject samples ranges from 0.12 to 0.82% S and has an elevated median value of 0.38% S, compared with the median crustal abundance value of 0.07% S in unmineralised soils (Bowen, 1979; INAP, 2022). **Graph 4-13** illustrates the total sulfur content of the coal reject materials. The results demonstrate that most samples have a total sulfur concentration greater than median crustal abundance.

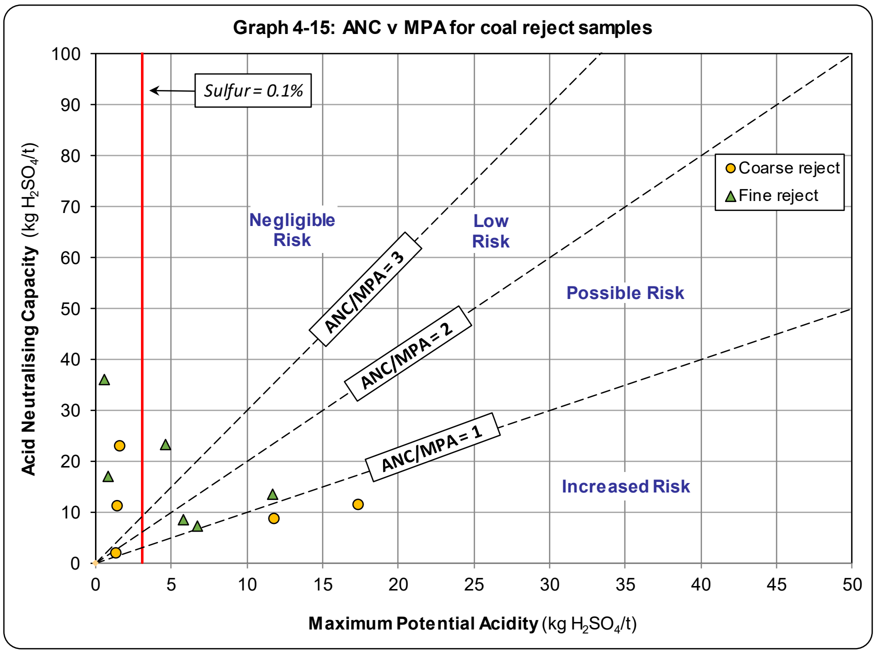


- **Sulfide sulfur:** Due to the elevated total sulfur content of most of the coal reject samples, all of the samples were tested for sulfide using the Scr method. The test results show that on average, approximately 40% of the total sulfur is present as sulfide and the remainder of the total sulfur is likely to be present as organic sulfur or sulfate.
- **MPA:** Based on the sulfide content, the MPA that could be generated by the 11 coal reject samples ranges from 0.6 to 17.4 kg H_2SO_4/t, and has a moderate median value of 4.7 kg H_2SO_4/t.

- **ANC:** The ANC for the 11 coal reject samples ranges from 1.8 to 36 kg H_2SO_4/t and has a median value of 11.3 kg H_2SO_4/t, which is over twice the median MPA.
- **ANC:MPA ratio:** The ANC:MPA ratio of the 11 coal reject samples ranges from 0.6 to 65.3 (median of 1.5). In simplistic terms, this means that most coal reject materials have excess ANC over MPA.
- **NAPP:** The calculated NAPP values range from -35.4 to +6.1 kg H_2SO_4/t, with a negative median value of -2.7 kg H_2SO_4/t. The NAPP data is presented in **Graph 4-14** and shows that while most of the coal reject samples have negative NAPP value or a value that is close to zero, two coarse reject samples have a slightly positive NAPP value. Overall, as a bulk mixed material, the risk of generating any significant amounts of acidity from these materials is considered to be low.



Graph 4-15 shows a plot of ANC versus MPA for the 11 samples tested by material type from the Vulcan and Jupiter targets, respectively. ANC:MPA ratio lines have been plotted on the figures to illustrate the factor of safety associated with the samples in terms of potential for generation of acidity. 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, 2022).



The Acid Base Account result show that six coal reject samples plot in the negligible to low-risk domains, three samples plot in the possible risk domain (i.e., the ANC:MPA ratio is between 1 and 2) and two (coarse reject) samples plot in the increased risk domain (i.e., the ANC:MPA ratio is less than 1). Overall, as a bulk mixed material it is expected that the coal reject materials will have a relatively low risk of generating acidity.

Coal rejects produced at the Project will be co-disposed with waste rock material. From a geochemistry viewpoint, co-disposal of any coarse and fine reject materials would be beneficial. 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). Similarly, disposal of a small amount of mixed coarse and fine reject materials within waste rock cells would be beneficial as waste rock typically has very low sulfur content and excess ANC. This approach to coal reject management has been successfully used at a number of existing coal mining operations in the Bowen Basin including Middlemount Coal Mine (RGS, 2013).

Table 4-4 provides a summary of the geochemical classification criteria used by RGS to classify the acid forming nature of the coal reject samples, and a breakdown of the number of samples in each classification category.

Table 4-4: Geochemical classification criteria for coal reject materials

Geochemical Classification	Total Sulfur[1] (%)	NAPP (kg H_2SO_4/t)	ANC:MPA Ratio	No. Samples (n = 11)
Non-Acid Forming (Barren)[2]	≤ 0.1	-	-	5
Non-Acid Forming	> 0.1	≤ -5	≥ 2	1
Uncertain	> 0.1	> -5 and ≤ +5	< 2	4
Potentially Acid Forming	> 0.1	> +5	< 2	1

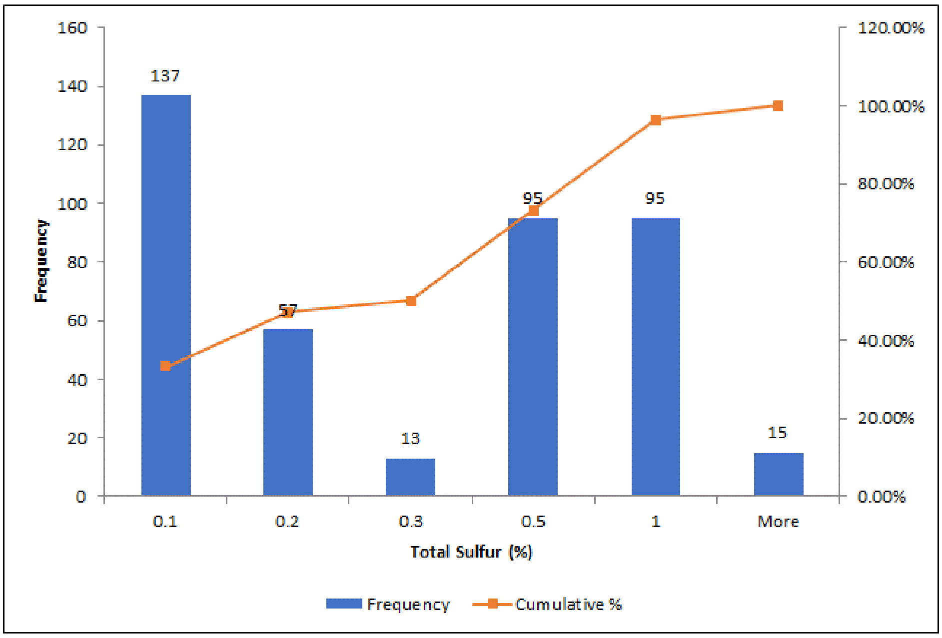
Notes:
1. If total sulfur is less than or equal to 0.1% S, the NAPP and ANC:MPA ratio are not required for material classification as the sample is essentially barren of oxidisable sulfur.
2. A sample classified as NAF can be further described as 'barren' if the total sulfur and/or sulfide sulfur content is less than or equal to 0.1% S, as the sample essentially has negligible acid generating capacity.

The Acid Base Account test data presented in **Table B3 (Attachment B)** and discussed in this section have been used to classify the acid forming nature of the 11 coal reject samples tested. The results in **Table 4-4** demonstrate that of the 11 samples tested, five samples are classified as NAF (Barren), one sample is classified as NAF, four samples are classified as Uncertain and one sample is classified as PAF. The classification criteria reflect Australian (COA, 2016c) and international (INAP, 2022) guidelines for the classification of mining waste materials.

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

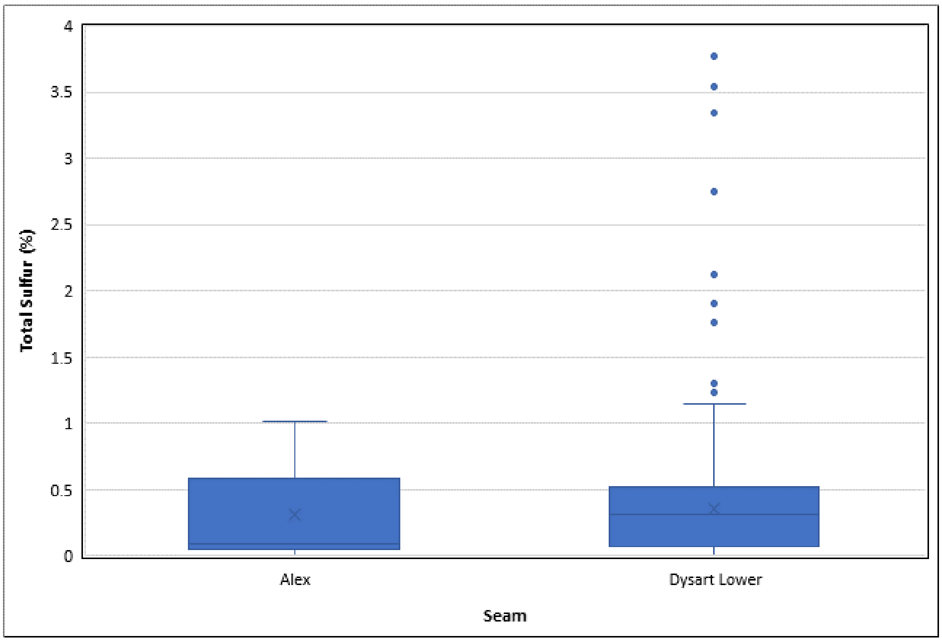
4.1.3 Coal

Seepage may occur from mined coal temporarily stockpiled at the ROM area prior to processing at the CHPP. Based on the total sulfur content of a range of coal samples from the target seams (Alex and Dysart Lower) (412 samples) it is likely that the coal materials will have similar geochemical characteristics to the coal reject materials described in **Section 4.1.2**. **Graph 4-16** shows the total sulfur distribution in raw coal materials for the target coal seams. The results demonstrate that approximately 75% of the raw coal material represented by the samples tested has a relatively low total sulfur content <0.5% S. It should also be noted that approximately half of the total sulfur content is likely to be present as organic sulfur which has negligible capacity to generate acid.



Graph 4-16: Total sulfur distribution for raw coal samples

Graph 4-17 shows a "box and whisker" total sulfur plot for the target Alex and Dysart Lower coal seams using the same dataset (412 samples) used to generate **Graph 4-16**. The results show that the mean, median and 75th percentile total sulfur values in coal are low and generally at or below 0.5% S. While a small number of higher total sulfur outliers occur for the Dysart Lower seam most samples have lower total sulfur content, Available sulfur speciation indicates that approximately half of the total sulfur will be present as organic sulfur, which has negligible capacity to generate acid.



Graph 4-17: Total sulfur "box and whisker" plot for raw coal samples

In terms of potential impacts from the ROM coal stockpile, it is expected that the quality of any leachate will be similar to that of coal reject materials described in **Section 4.1.2**. As is standard practice at coal mining operations in the Bowen Basin, any surface runoff and seepage from the ROM coal stockpile will be monitored for quality and managed in the mine water management system as part of the Water Management Plan.

4.2 Multi-Element Concentration in Solids

Multi-element scans were carried out on 10 mining waste samples (i.e., six composite samples of waste rock and four composite samples of coal reject materials) 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 relevant context, RGS has compared the total metal/metalloid concentration in samples to 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 10 selected mining waste samples are presented in **Table B4 (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 10 selected mining waste samples are discussed with respect to median crustal abundance in un-mineralised soils in **Section 4.3**.

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, 2022). 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 B4 (**Attachment B**) provides total metal/metalloid concentrations for the 10 composite mining waste 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 B5** (**Attachment B**).

The GAI results indicate that of the metals/metalloids measured, none of the 10 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.

A total of six composite waste rock samples were selected for physical characterisation as they are classified as NAF (Barren) and 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 B4** (**Attachment B**) and summarised below.

4.3 Soil Characteristics and Sodicity

4.3.1 Soil Characteristics

The effective cation exchange capacity (eCEC) results for the six composite waste rock samples are presented in **Table B4** (**Attachment B**). The results indicate that the eCEC of the six samples ranges from 4.8 to 18.6 meq/100g and is typically in the low to moderate range as described in **Table 4-6** (Hazelton and Murphy, 2007). The calcium:magnesium ratio is low and less than unity in all samples tested. For waste rock materials with a low to moderate eCEC value and low calcium:magnesium ratio, some fertiliser and gypsum addition may be required to provide a reasonable growth medium for vegetation roots as part of revegetation and rehabilitation activities.

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

4.3.2 Sodicity

The exchangeable sodium percentage (ESP) results for the six composite waste rock samples are presented in **Table B4** (**Attachment B**). The ESP results for the samples range from 10.8 to 24.6% and are typically elevated as would be expected for waste rock (overburden/interburden) 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, 2002; and Northcote and Skene, 1972). Sodicity can result in surface crusting and low infiltration and hydraulic conductivity within the affected soils (Hazelton and Murphy, 2007).

Overall, the results of the ESP tests indicate that most waste rock materials represented by these samples are likely to be moderately to strongly sodic; and consequently, may be susceptible to dispersion and erosion and should be managed appropriately. The addition of gypsum to sodic waste rock materials has the potential to reduce the sodicity and reduce the potential for dispersion and erosion.

4.4 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 ten composite mining waste samples (six waste rock and four coal reject) from the Project, described in **Section 4.2**, with Australian guidelines for livestock drinking water and aquatic freshwater ecosystems (ANZECC & ARMCANZ, 2000; ANZG, 2018) guideline values. These guidelines are provided for context only and are not intended to be interpreted as “maximum permissible levels” for site water storage or discharge.

It should also be recognised that direct comparison of geochemical data with guideline values can be misleading. For the 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 a ‘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 10 mining waste samples are presented in **Table B6** (**Attachment B**). The pH of the water extracts for the waste rock samples representing the Vulcan target ranges from pH 8.2 to 8.6 and is considered to be slightly alkaline. The pH of the water extracts for the waste rock samples representing the Jupiter target ranges from 6.8 to 7.1 and is considered to be neutral. The pH of the water extracts for the four coal reject samples ranges from 5.8 to 8.6. 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 ranged from pH 5.4 to 5.7. The pH results for all samples (except one coarse reject sample) are within the range (pH 6 to 9) for 95% species protection in freshwater aquatic ecosystems as set out in ANZECC & ARMCANZ (2000) and ANZG (2018).

The water extracts from the 10 mining waste samples have moderate EC values ranging from 54 to 788 µS/cm, with higher values seen in the samples representing the Vulcan target (median 544 µS/cm) than those representing the Jupiter target (median 216 µS/cm) or coal reject (median 91 µS/cm), indicating low to moderate salinity levels (and low to moderate concentrations of dissolved solids).

The total alkalinity in the water extracts from the Vulcan waste rock samples ranges from moderate to elevated (564 to 2,980 mg $CaCO_3$/L). The total alkalinity from the two composite samples from the Jupiter target is lower and ranges from 34 to 144 mg $CaCO_3$/L. For the coal reject samples, the total alkalinity ranges from 24 to 1,032 mg $CaCO_3$/L. All of the alkalinity in the water extract samples is in the form of bicarbonate (HCO_3), with carbonate values being less than the laboratory LoR (1 mg/L). The acidity in the water extracts from the waste rock samples is generally low, ranging from less than the laboratory LoR (1 mg/L) to 3 mg $CaCO_3$/L for Vulcan samples, 5 to 8 mg $CaCO_3$/L for Jupiter samples, and 19 to 178 mg $CaCO_3$/L for coal reject samples, respectively, 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 sulfate. The concentration of sulfate in the water extracts from all 10 samples ranges from 18 to 46 mg/L (median 29 mg/L), and therefore is more than an order of magnitude below the applied (ANZECC & ARMCANZ, 2000; 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 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 (four samples) and copper (three samples), which have concentrations in some of the water extracts above the applied freshwater aquatic ecosystem water quality guideline value for 95% species protection (ANZECC & ARMCANZ, 2000; ANZG, 2018), but are below the applied guideline values for livestock drinking water.

Given that the pH values in the relevant water extracts are pH neutral to slightly alkaline, the elevated aluminium concentrations in these water extracts may in some part be 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 waste materials at the Project will be low. Based on the water extract results presented in this section, the quality of any leachate from any co-disposed coal reject materials would be similar to leachate at areas of the dumps where co-disposal does not occur.

The dynamic quality of mining waste contact water (if these materials are left exposed to atmospheric i.e., oxidising conditions) and any potential risk to water resources at the site was investigated further using KLC tests in **Section 4.5.**

4.5 Water Quality Kinetic Tests

KLC tests were completed on six composite samples of mining waste materials (four waste rock and two coal reject samples) using the methodology described in **Section 3.2.2** and **Attachment A**. The composition of the six composite samples used in the KLC tests is summarised in **Table 4-7** and detailed in **Table B7** (**Attachment B**). The six KLC tests cover the range of waste rock (sandstone, claystone and siltstone) and coal reject (coarse and fine reject) likely to be generated by the Project. The KLC tests on waste rock were operated for a period of six months from June 2019 to December 2019 under a monthly watering and leaching regime. The KLC tests on coal reject were operated from December 2019 to June 2020 under a monthly watering and leaching regime. The KLC tests were operated following mining industry guidelines for such tests (AMIRA, 2002; COA, 2016).

The leachate results from the KLC test program are presented alongside Australian water quality guideline values for livestock drinking water quality (ANZECC & ARCANZ, 2000; ANZG, 2018). These guidelines are provided for context only and are not intended to be interpreted as “maximum permissible levels” for site water storage or discharge. It should be noted that the KLC samples were crushed to pass a 10 mm sieve size, where required, and therefore have a high surface area for potential geochemical reaction. The ratio of sample to water in the KLC tests was approximately 3:1 (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 over an order of magnitude more dilute at 1:5 (w/v). Whilst arbitrary comparisons against guideline concentrations can be helpful in some situations to provide relevant context, such comparisons cannot be directly extrapolated to the field situation at the Project.

Table 4-7: Composite mining waste samples selected for KLC tests

KLC Sample Number	RGS Composite ID	Description
KLC1	Composite 2 Waste Rock	Mainly Vulcan sandstone
KLC2	Composite 4 Waste Rock	Mainly Vulcan claystone
KLC3	Composite 5 Waste Rock	Mainly Jupiter sandstone
KLC4	Composite 6 Waste Rock	Mainly Jupiter siltstone
KLC5	Composite Fine Reject	Vulcan Fine Reject
KLC6	Composite Coarse Reject	Vulcan Coarse Reject

The monthly KLC test results for the four composite waste rock samples are presented in **Attachment C**. Tables **KLC 1** to **KLC 4** provide the KLC test data for seven leach events on waste rock samples (over six months), selected components of which are also shown graphically. For the two coal reject samples (**KLC 5** and **KLC 6**), data from the seven leach events (over six months) is provided in **Attachment C**. The KLC test results indicate that:

- Leachate from the six KLC tests has a pH in the range of 5.55 to 8.27 over the test period. Whilst some pH fluctuations are noted within this range, the majority of pH values generally lie in the range pH 6 to 8. The lowest pH value is still greater than the deionised water used in the test program. Therefore, it is likely that the mining waste materials add some alkalinity to contact/leaching water. These results suggest that pH values in any surface runoff and seepage from bulk mining waste materials exposed to oxidising conditions will be in the range pH 6 to 8.

- Leachate from the six KLC tests has an EC value in the range of 54 to 1,796 µS/cm over the test period. Most EC values in leachate show a downward trend over time however leachate from KLC1 (Vulcan Sandstone) shows and increasing EC trend, before reducing again at the end of the test period. These results indicate EC values from most bulk mining waste materials exposed to oxidising conditions will be low to moderate.

  The slightly elevated EC value in the initial 'first flush' from the some of the mining waste sample materials is probably due to the increased solubility of minerals through crushing/preparation of the sample materials before loading into the KLC test columns.

- The acidity value in leachate from the six KLC tests over the test period is very low, ranging from below the laboratory LoR (<1 mg/L, as $CaCO_3$) to 8 mg/L. The alkalinity values in leachate from the KLC tests are also relatively low, but generally more than sufficient to create net alkalinity values that are either positive or close to zero (i.e., the alkalinity is predominantly greater than the acidity) during the test period.
- The concentration of major ions in leachate from the six KLC tests is typically dominated by variable concentrations of sodium, chloride and sulfate (and bicarbonate). Lower concentrations of other major ions are also likely to be present in leachate from these materials. The concentration of calcium in leachate from the fine rejects (KLC 5) is an order of magnitude greater than observed in leachate from the other KLC tests.
- The sulfate release rate from the six KLC samples generally shows a relatively stable trend over the test period for most samples. The exception is the sulfate release rate from the fine rejects sample which increases before decreasing towards the end of the test period. The highest sulfate release rate is displayed by the fine rejects (KLC 5). Notwithstanding, the sulfate concentration in leachate from all of the KLC tests is well below the applied guideline value of 1,000 mg/L (ANZECC & ARMCANZ, 2000; ANZG, 2018).
- The four waste rock materials used in the KLC tests retain at least ~81.3% of their inherent total sulfur content after six months of exposure to idealised oxidising conditions, which reflects slow rate of sulfide oxidation (and low potential for acid generation) for these materials. The two coal reject samples show similar sample characteristics and retain at least 95% of their inherent total sulfur content at the end of the six month test period.
- The four KLC waste rock samples retain at least ~99.1% of their inherent ANC value after six months of exposure to idealised oxidising conditions, which reflects the slow release of alkalinity from these materials. The two coal reject samples show similar sample characteristics and retain at least 88% of their inherent ANC value at the end of the six month test period.
- The concentration of trace metals/metalloids in the leachate from the six KLC tests is generally low and typically below the laboratory LoR. Most trace metals/metalloids are therefore sparingly soluble at the current pH of the KLC leachate. The concentrations of all metals/metalloids are typically below the applied water quality guideline criteria for livestock drinking water (ANZECC & ARMCANZ, 2000; ANZG, 2018). The only exception is selenium in some of the leachate collected from the two coal reject samples, which show concentrations marginally above the livestock drinking water low risk trigger levels (0.02 mg/L). Based on the KLC results presented in this section, the quality of leachate from any co-disposed coal reject materials in terms of trace metal/metalloid concentrations would be similar to leachate at areas of the dumps where co-disposal in cells was not used.
- The sulfate generation rate results obtained for the six KLC test samples have been used to determine the rate of sulfide oxidation in these materials. Most sulfate salts generated from sulfide reaction involving materials with a relatively low sulfide sulfur concentration are highly soluble, and therefore will be collected in column leachate. The dissolved sulfate (and calcium) concentrations in most of the KLC leachate are

typically much less than the solubility limit of gypsum ($CaSO_4$), for example, which indicates that sulfate generation is not controlled by gypsum dissolution in the KLC test materials. Therefore, the sulfate concentrations and oxidation rate calculations provide reasonable estimates of these parameters and the results align well with existing static and dynamic geochemical data derived from a wide range of mining waste materials (AMIRA, 1995). The sulfate generation rate and associated sulfide oxidation rate for the KLC tests are shown in **Table 4-8**.

- The sulfate generation rate from the KLC samples ranges from 1.71 to 24.78 mg/kg/week which is equivalent to a sulfide oxidation rate ranging from 6.99 x 10^{-10} to 1.01 x 10^{-8} kg $O_2/m^3/s$. Mining waste materials with an oxidation rate less than 5 x 10^{-8} kg $O_2/m^3/s$ and a moderate ANC level have an increased factor of safety and are likely to generate leachate that is pH neutral and/or has a low level of acidity (AMIRA, 1995; Bennett *et al*., 2000). Hence, all of the mining waste materials tested fall into this category. Overall, the KLC results reflect the range of material characteristics predicted from the static geochemical test results shown in **Section 4.1**.

Potential implications of these results with respect to the management of the mining waste materials at the Project are discussed further in **Section 5.**

Table 4-8: Sulfate generation and sulfide oxidation rates for KLC tests

KLC Sample Number	Sample Description	Sulfate Generation Rate (mg/kg/week)	Oxidation Rate (kg $O_2/m^3/s$)
KLC1	Vulcan sandstone	3.42	1.37 x 10^{-9}
KLC2	Vulcan claystone	1.71	6.99 x 10^{-10}
KLC3	Jupiter sandstone	3.97	1.66 x 10^{-9}
KLC4	Jupiter siltstone	4.32	1.78 x 10^{-9}
KLC5	Fine reject	24.78	1.01 x 10^{-8}
KLC6	Coarse reject	7.82	3.18 x 10^{-9}

5 DISCUSSION

5.1 AMD Potential and Management

The results of the static and kinetic geochemical tests demonstrate that the overwhelming majority of the waste rock materials contain negligible sulfide content, have 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 acidic drainage.

The static and kinetic geochemical test results for coal reject demonstrate that most of the coal reject materials represented by the samples tested have relatively low sulfide content and excess ANC. As a bulk mixed material, it is expected that coal reject will be classified as NAF and have a relatively low risk of generating acidic drainage. Based on the KLC results presented in **Section 4.5**, apart from slightly elevated sulfate, it is expected that the quality of leachate from any coal reject materials co-disposed with waste rock would be similar to leachate from areas of the dumps where co-disposal does not occur.

It is expected that from a geochemistry viewpoint, co-disposal of coarse and fine reject materials within waste rock dumps 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 rejects also would also provide some geotechnical stability to a mixed reject cell structure. The disposal of mixed coarse and fine reject materials within waste rock dumps is also a low-risk strategy as the much larger volume of waste rock typically has very low sulfur content and excess ANC. This mining waste management strategy is currently used at a number of coal mines in the Bowen Basin.

Further management measures to reduce the risk of the generation of AMD are presented in **Section 5.4**.

5.2 Multi-Element Composition and Water Quality

5.2.1 Multi-Element Composition and Enrichment

The multi-element concentrations of metal/metalloids in mining waste materials are presented in **Section 4.2**, along with a comparison against applied guideline values and median crustal abundance in soils. The results indicate that the mining waste materials are not significantly enriched with metals/metalloids compared to guideline values and median crustal abundance in un-mineralised soils.

5.2.2 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 is likely to be pH neutral to slightly alkaline and have a low to moderate EC value indicating low to moderate salinity levels (and low to moderate concentrations of dissolved solids). Surface runoff and seepage from mining waste materials is likely to fall within the range for 95% species protection in freshwater aquatic ecosystems (pH 6 to 9) as set out in ANZECC & ARMCANZ (2000) and ANZG (2018).

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

The water extract and KLC test results for mining waste materials indicate that most trace metals/metalloids are sparingly soluble, and that the concentration of dissolved metals/metalloids in surface runoff and seepage is relatively low, predominantly below the laboratory LoR, and below the applied water quality guideline criteria. Minor exceptions may include aluminium, copper and selenium in pore water, which can occasionally be greater than the applied guideline concentrations (ANZECC & ARMCANZ, 2000; ANZG, 2018) in selected samples. The KLC test data over the test period indicates that the concentrations of most dissolved trace metal/metalloid in contact water are typically low and well within applied livestock drinking water guideline values.

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.

It is recommended that samples of surface runoff and seepage from areas used to store mining waste materials and coal be included in the site water quality monitoring program.

5.3 Revegetation and Rehabilitation

From a soil chemistry viewpoint, bulk waste rock materials are classified as NAF and are likely to be pH neutral to slightly alkaline and have low to moderate levels of salinity. Most waste rock materials 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 supplementation may also need to be considered for surface mining waste materials for the purpose of providing a reasonable growth medium for revegetation and rehabilitation.

Additional confirmatory sampling and testing should be completed on bulk mining waste materials when available during the operational phase of the Project to determine the best management option for progressive rehabilitation of these materials during operations and at mine closure. Sampling should focus on collecting representative samples of any waste rock (i.e., spoil) materials planned to be used at the surface of final landforms to supplement any existing subsoil and topsoil salvaged 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 Management Measures

Table 5-1 provides a summary how the waste rock, coal reject and coal materials will be managed through all stages of the mine life including construction, operations, rehabilitation and decommissioning.

Table 5-1: Material management over mine life

Project Phase	Waste Rock	Coal Rejects	Coal
Construction	Stored at out-of-pit WRD	None produced	None produced
Operations	Stored at out-of-pit WRD and/or backfilled in-pit.	Co-disposed / backfilled within cells in-pit or ex-pit waste rock dumps. Contact water monitored for quality and managed in the mine water management system as part of Water Management Plan	Temporarily stockpiled at ROM and product coal stockpiles. Contact water monitored for quality and managed in the mine water management system as part of Water Management Plan
Rehabilitation	Final landforms rehabilitated/ revegetated	Final landforms rehabilitated/ revegetated	ROM removed and footprint rehabilitated/revegetated
Decommissioning	Final landform performance monitoring moving towards lease relinquishment	Final landform performance monitoring moving towards lease relinquishment	None

5.4.1 Waste Rock

5.4.1.1 Monitoring of waste rock material

This geochemical assessment has found that waste rock has low sulfur content, excess ANC, and is classified as NAF. Bulk waste rock has a high factor of safety and a very low risk of generating acid, saline or metalliferous drainage. Notwithstanding, monitoring of waste rock will continue throughout operations. Representative samples of any carbonaceous waste rock materials will be collected ahead of mining from blast hole drill cuttings to be assessed to identify any PAF material.

The drillhole cutting samples will be sent to an external National Association of Testing Authorities, Australia, (NATA) accredited laboratory for total sulfur (LECO analyser) analysis.

The geochemical assessment has demonstrated that bulk waste rock materials have very low total sulfur content and samples with a total sulfur content up to 0.3 %S are either NAF or very low risk. This finding is consistent with other open cut coal mines in this area of the Bowen Basin, which mine similar coal measures within similar stratigraphy. Therefore, a total sulfur cut-off value of 0.3 % will be used to identify any carbonaceous waste rock that may have a reduced factor of safety (possibly PAF).

5.4.1.2 Management of PAF waste rock material

Any carbonaceous waste rock that is identified as having a reduced factor of safety (possibly PAF) through sampling and total sulfur analysis will be selectively handled and buried within NAF waste rock in a manner similar to that described for coal rejects in **Table 5-1**. Short term planning and truck management planning will be updated upon identification of any carbonaceous waste rock that is possibly PAF to ensure that this material are hauled directly to the correct emplacement areas used for storing coal rejects and without storage in temporary stockpiles.

Any carbonaceous waste rock material identified as possibly PAF (and all coal reject materials) will be preferentially stored in in-pit waste rock dumps when sufficient capacity is available and below predicted post-mining groundwater level, where practical, to reduce the potential oxidation of materials in the longer term post-closure (**Figure 5-1**). Early in the mine life when there is insufficient storage capacity within the open pit areas, possibly PAF carbonaceous waste rock (and all coal rejects) will be stored in ex-pit emplacements (**Figure 5-2**). In all cases, these materials will be buried in the core of the waste rock emplacements, at least 10 m away from final outer surfaces of the emplacements and under at least 10 m of NAF waste rock materials. To further minimise any risk associated with out-of-pit emplacements, possibly PAF carbonaceous waste rock (and all coal reject materials) will be placed within areas that slope/drain toward the open pit and any seepage will be monitored and managed within the mine water management system as part of the Water Management Plan.

The extents of any possibly PAF carbonaceous waste rock (and all coal reject materials) transferred to emplacement areas will be tracked with regular surveys. Spatial data files in an appropriate format will be created to record the extents/dimensions of the storage areas.

All possibly PAF carbonaceous waste rock and all coal reject materials will be paddock dumped, traffic compacted and covered by NAF overburden to limit the infiltration of air and water into covered materials.

5.4.1.3 Emplacement sampling and testing

To confirm the effectiveness of the waste rock (and coal reject) management procedures, strategic sampling and total sulfur testing of emplaced materials will be undertaken on an annual basis over the operational life of the Project. The results of this process will be used to validate that emplacements are being constructed according to design specifications and that any possibly PAF carbonaceous waste rock (and all coal reject materials) are encapsulated with at least 10 m of NAF waste rock materials.

Representative samples of emplaced materials will be collected and analysed externally by a NATA accredited laboratory for total sulfur . As above, samples with a total sulfur concentration a total sulfur concentration of less than or equal to 0.3 %S will be classified as NAF and greater than 0. 3 %S will be classified as PAF.

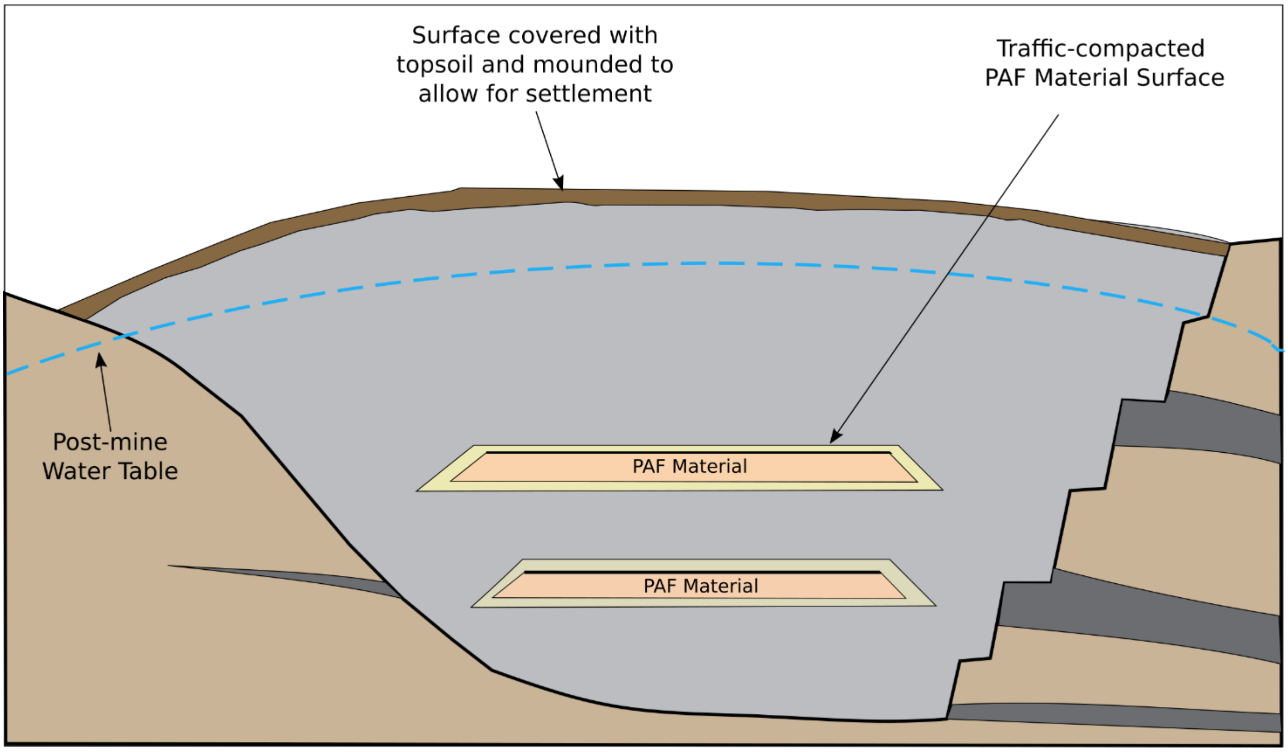


Figure 5-1: Schematic cross-section of in-pit PAF material emplacements

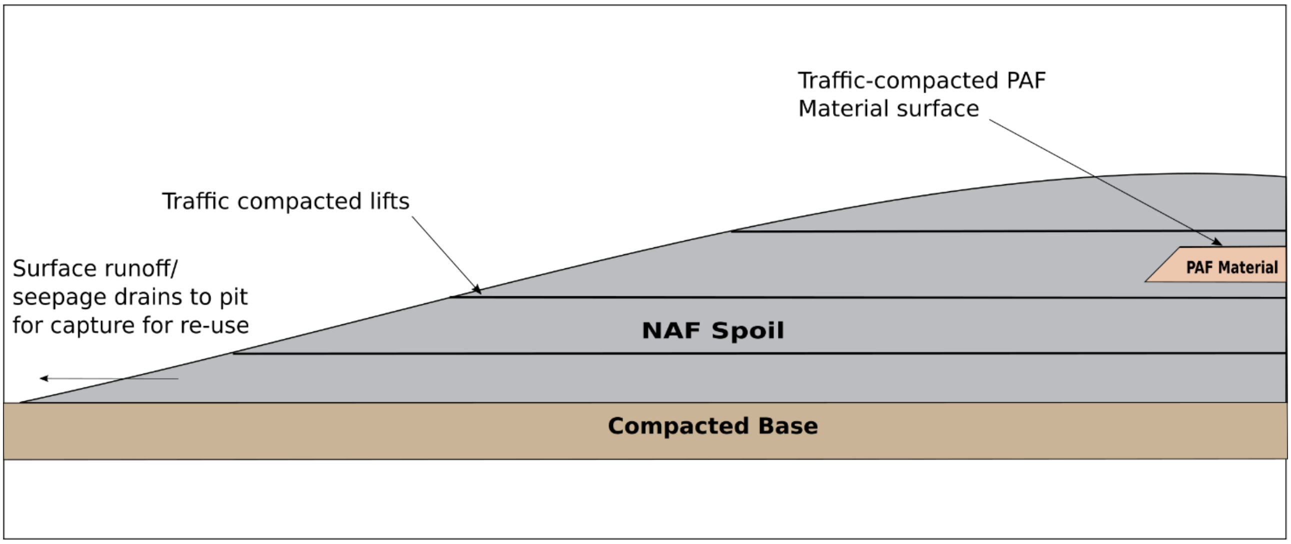


Figure 5-2: Schematic cross-section of ex-pit PAF material emplacement

5.4.2 Coal Rejects

As a bulk mixed material, it is expected that coal reject will have a relatively low risk of generating acidic drainage. Notwithstanding, co-disposal of coarse and fine reject materials and subsequent encapsulation within NAF waste rock materials is likely to be beneficial and eliminate any residual risk.

If it is assumed that up to 10 % of ROM coal will become coal reject at the CHPP, less than 2 % by volume of the materials in the emplacements will be coal rejects. As described in **Table 5-1** and **Section 5.4.1.2**, coal rejects will be preferentially placed within in-pit dumps, below the predicted post-mining groundwater table. Coal rejects will be co-disposed with any identified possibly PAF carbonaceous waste rock materials and traffic compacted which will minimise the available pore space within any PAF materials, reducing the risk of the any AMD generation by limiting the ingress of oxygen and water into the pore spaces. Rejects will be placed sufficiently deep within the emplacements that they are covered with a minimum of 10 m of NAF material and no closer than 10 m to the external surfaces of the emplacements. If coal rejects are placed in ex-pit dumps they will be traffic compacted and covered as soon as practicable. Drainage from ex-pit dumps will be captured and directed toward the mine void. A risk assessment of the emplacement of coal rejects within ex-pit dumps is included in **Attachment E**.

5.4.3 Coal Rejects

As a bulk mixed material, it is expected that coal will have a relatively low reactive sulfur content and subsequently a low risk of generating AMD. Notwithstanding, seepage may occur from mined coal temporarily stockpiled at the ROM area prior to processing and in coal product stockpiles following processing at the CHPP.

Any water seeping from the coal stockpiles will be monitored for quality and managed in the mine water management system as part of Water Management Plan as described in **Table 5-1**.

5.4.4 Water Quality Monitoring

Surface run-off and seepage from the waste rock and coal reject emplacement areas and coal stockpiles will be monitored for quality and managed in the mine water management system as part of Water Management Plan as described in Table 5-1.

5.4.5 Contingency Measures

In the unlikely event that AMD is identified in surface runoff and/or seepage from emplacement areas or coal stockpiles, Vitrinite will investigate the potential source of the issue and implement any required additional sampling and testing measures. Remediation options may include addition of agricultural limestone to any identified PAF materials during placement and/or reducing the amount of time that any identified PAF material is exposed to weathering conditions prior to covering with NAF material.

6 CONCLUSIONS AND MITIGATION MEASURES

6.1 Conclusions

RGS has completed a geochemistry assessment of mining waste (waste rock and coal reject) and coal materials at the Project. The main findings of the assessment are as follows:

- The overwhelming majority of the waste rock materials have low sulfide content, excess ANC, and are classified as NAF (Barren). These materials have a very low risk of acid generation and a high factor of safety with respect to potential for generation of acidity.
- Coal reject materials have relatively low sulfide content and excess ANC. As a bulk mixed material, it is expected that coal reject will be classified as NAF and have a relatively low risk of generating acidic drainage. Co-disposal of reject materials in waste rock dumps is likely to have a beneficial impact on the quality of the reject leachate.
- Coal is likely to have similar geochemical characteristics to coal reject materials and will be temporarily stockpiled at the ROM area prior to being transferred to the CHPP. As is standard practice at coal mining operations in the Bowen Basin, any surface runoff and seepage from the ROM coal stockpile will be monitored for quality and managed in the mine water management system as part of the Water Management Plan.
- Initial and ongoing surface runoff and seepage from mining waste materials is expected to be pH neutral to slightly alkaline and have a low level of salinity.
- There is no significant metal/metalloid enrichment in mining waste materials compared to applied guideline values and median crustal abundance in un-mineralised soils.
- Most metals/metalloids are sparingly soluble at the neutral to slightly alkaline pH of leachate expected from bulk NAF mining waste materials. Dissolved metal/metalloid concentrations in surface runoff and leachate from bulk NAF mining waste materials are expected to be low and unlikely to pose a significant risk to the quality of surface and groundwater resources at relevant storage facilities.
- NAF waste rock materials should be amenable to revegetation as part of rehabilitation activities, although, gypsum and fertiliser addition may need to be considered for sodic materials to limit dispersion and erosion and to provide a reasonable growth medium for revegetation and rehabilitation.

6.2 Mitigation Measures

Based on the conclusions drawn from the geochemical assessment work completed on waste rock, coal reject and coal materials at the Project, the following mitigation strategies will be implemented to minimise the risk of any significant environmental harm to the immediate and downstream environment.

- Confirmatory sampling and testing will be undertaken when the mine is operational and bulk materials become available to confirm the most appropriate management methodology for progressive rehabilitation of these materials during mine operations and at mine closure.
- The placement of any coal reject materials at or near the final surfaces of emplacement facilities will be avoided.
- Surface water and seepage from the proposed open pit, ROM coal and mining waste storage areas will 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, the suite of metals/metalloids described in the static and KLC test in this report will be included from time to time, where appropriate, in the site water quality monitoring program and Water Management Plan.

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Attachment A Geochemical Assessment of 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 assay results are used to calculate the potential acidity that could be generated by the sample typically by determining the sulfidic S content directly. Pyrite reacts under oxidising conditions to generate acid according to the following overall reaction:

$$FeS_2 + 15/4\ O_2 + 7/2\ H_2O \dashrightarrow Fe(OH)_3 + 2\ H_2SO_4$$

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 minerals. 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 waste material when initially exposed in a waste emplacement area.

Total sulfur content and Maximum Potential Acidity (MPA)

Total sulfur content is determined by the Leco high temperature combustion method. The total sulfur content is then used to calculate the MPA, which assumes that the entire sulfur content is present as reactive pyrite. Direct determination of the pyritic sulfur content can provide a more accurate estimate of the MPA.

Acid neutralising capacity (ANC)

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.

Net Acid Generation (NAG)

The net acid generation (NAG) test involves the addition of hydrogen peroxide to a sample of mine rock or process residue to oxidise reactive sulfide, then measurement of pH and titration of any net acidity produced by the acid generation and neutralisation reactions occurring in the sample. A significant NAG result (i.e., final $NAG_{pH} < 4.5$) indicates that the sample is potentially acid forming (PAF) and the test provides a direct measure of the net amount of acid remaining in the sample after all acid generating and acid neutralising reactions have taken place. A $NAG_{pH} > 4.5$ indicates that the sample is non-acid forming (NAF). The NAG test can provide a direct assessment of the potential for a material to produce acid after a period of exposure and weathering and is used to refine the results of the theoretical NAPP predictions. The NAG test can be used as a stand-alone test but it is recommended that this only be considered after site specific calibration work is carried out. The standard NAG test is generally unsuitable for coal mining projects as the high organic content of some materials can cause erroneous results (Stewart et al., 2003; ACARP, 2008).

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 relevant state or national environmental and health-based concentration guideline criteria to determine the 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 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 mining waste materials. The major objectives of kinetics tests are to:

- Provide time-dependent data on the kinetics and rate of acid generation and acid neutralising reactions under laboratory controlled (or onsite conditions);
- Investigate metal release and drainage/seepage quality; and
- Assess treatment options such as addition of alkaline materials.

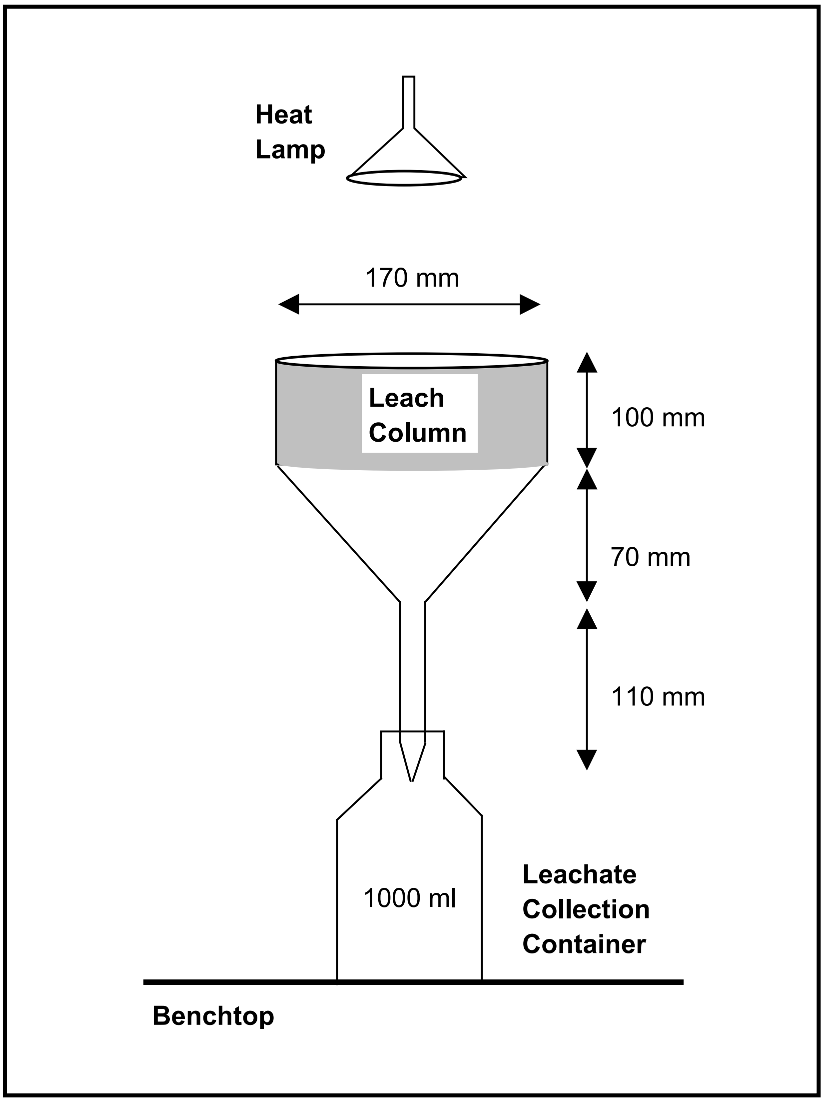
The KLC tests simulate the weathering process that leads to acid and base generation and reaction under laboratory controlled or site conditions. The kinetic tests allow an assessment of the acid forming characteristics and indicate the rate of acid generation, over what period it will occur, and what management controls may be required.

In KLC tests, water is added to a sample and the mixture allowed to leach products and by-products of acid producing and consuming reactions. Samples of leachate are then collected and analysed. Intermittent water application is applied to simulate rainfall and heat lamps are used to simulate sunshine. These tests provide real-time information and may have to continue for months or years. Monitoring includes trends in pH, sulfate, acidity or alkalinity, and metals, for example. The pH of the collected leachate simulates the acid drainage process, acidity or alkalinity levels indicate the rate of acid production and acid neutralisation, and sulfate production can be related to the rate of sulfide oxidation. Metal concentration data provides an assessment of metal solubility and leaching behaviour.

Figure A1 shows the kinetic leach column set up typically used by RGS 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^{o}C.

Figure A1: Kinetic leach column setup



Attachment B Static Geochemical Test Results

Attachment C Kinetic Geochemical Test Results

Attachment D ALS Laboratory Results

(Certificates of Analysis)

Attachment E Risk Assessment for the Ex-Pit Emplacement of Coal Rejects

Descriptions of Likelihood Rankings

Likelihood	Description
Rare (1)	Unlikely to occur in a lifetime; or very unlikely to occur; or no known occurrences in broader worldwide community.
Unlikely (2)	Could occur about once during a lifetime; or more likely not to occur than to occur; or has occurred at least once in the broader worldwide industry.
Possible (3)	Could occur more than once during a lifetime; or as likely to occur as not to occur; or has occurred at least once in the mining/commodities trading industry.
Likely (4)	May occur about once per year; or more likely to occur than not occur; or has occurred at least once on a mine site in the Bowen Basin.
Almost Certain (5)	May occur several times per year; or expected to occur; or has occurred several times on a mine site in the Bowen Basin.

Descriptions of Consequence Rankings

Consequence	Description
Negligible (1)	No lasting impact; requires minor or no remediation; minor management intervention may be required.
Minor (2)	Short-term impact; requires minor remediation or intervention.
Moderate (3)	Medium-term (<2 years) impact; requires moderate intervention.
Major (4)	Long-term (2-10 years) impact; major remediation measures required.
Catastrophic (5)	Unconfined and widespread environmental damage; impacts reaching into surrounding areas; major remediation measures required.

Risk Rating Matrix

RISK CALCULATOR (Risk Rating = Consequences x Likelihood)					
	CONSEQUENCE				
LIKELIHOOD	Negligible (1)	Minor (2)	Moderate (3)	Major (4)	Catastrophic (5)
Rare (1)	L (1)	L (3)	M (6)	M (10)	H (15)
Unlikely (2)	L (2)	L (5)	M (9)	H (14)	E (19)
Possible (3)	L (4)	M (8)	H (13)	E (18)	E (22)
Likely (4)	M (7)	H (12)	H (17)	E (21)	E (24)
Almost Certain (5)	M (11)	H (16)	E (20)	E (23)	E (25)

Hazard	Impact	Inherent Risk			Risk Control Measures	Residual Risk		
		Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
Loss of acidic, saline, and/or metalliferous drainage to the surrounding environment.	Increased acidity, increased salinity, and/or increased dissolved metal/metalloid concentrations in receiving groundwater or surface water.	3	2	**M (9)**	**Engineering** – Any identified PAF materials with be placed in the central core of the ex-pit emplacement facility and encapsulated with at least 10 m of NAF waste rock materials The PAF materials will be placed at a location that allows any seepage to be directed toward the open pits. PAF materials will be paddock dumped and traffic compacted to reduce the ingress of oxygen and water. Drains to catch seepage from selected locations at the ex-pit emplacements will be created to direct seepage back into the pits. **Administration** - Seepage from the ex-pit dumps will be monitored as part of the site Water Management Plan.	2	1	**L (3)**
Uncovering of previously covered PAF materials during landform reshaping.	Reduced stability of the final landform due to erosion and sediment loss. Downstream/downgradient areas impacted by sediment load. The inability to establish, or reduced performance of, vegetation to be established on the surface of the final landform.	3	3	**H (13)**	**Isolation** - Tailings and rejects will not be placed closer than 50 m to the external batters of the ex-pit dumps and under at least 2 m of NAF waste rock. **Administration** - The extents of dumped coal tailings and rejects within the ex-pit waste rock dumps will be surveyed and recorded.	3	1	**M (6)**

Hazard	Impact	Inherent Risk			Risk Control Measures	Residual Risk		
		Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
Poor mixing of coal reject and spoil.	Altered geotechnical properties (reduced bearing capacity) leading to landform instability.	3	3	**H (13)**	**Administration** - The timing of dumping will be scheduled to ensure that both waste rock and coal rejects are adequately combined when emplaced in the ex-pit dumps. Visual inspection of the co-disposed material in ex-pit dumps will be undertaken periodically to confirm the adequate mixture of materials.	3	1	**M (6)**
Drying process at the CHPP is less effective than planned.	Altered material handling characteristics. Altered geotechnical properties leading to landform instablility.	3	3	**H (13)**	**Administration** - Waste materials from the CHPP will be periodically assessed to ensure the materials have moisture contents within the appropriate bounds.	3	1	**M (6)**
Coal rejects exposed at the surface of the emplacements	Reduced stability of the final landform due to erosion and sediment loss. Downstream/downgradient areas impacted by sediment load.	3	3	**H (13)**	**Isolation** – Coal Rejects will not be placed closer than10m to the external surface of the ex-pit dumps and under at least 10 m of NAF waste rock. **Administration** - The extents of dumped coal rejects within the ex-pit waste rock dumps will be surveyed and recorded.	2	1	**L (3)**
Capillary rise of acidic, saline, and/or metalliferous drainage generated by PAF materials.	The inability to establish, or reduced performance of, vegetation to be established on the surface of the final landform.	3	3	**H (13)**	**Isolation** - Tailings and rejects will not be placed closer than 50 m to the external batters of the ex-pit dumps and under at least 2 m of NAF waste rock below the cover of the final landfrom to create a capillary break.	2	1	**L (3)**

Hazard	Impact	Inherent Risk			Risk Control Measures	Residual Risk		
		Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
Saturation of exposed PAF materials during rain events.	Generation of acidic, saline, and/or metalliferous drainage from the tailings and rejects materials. Altered geotechnical properties.	3	3	**M (9)**	**Engineering** - The coal rejects and waste rock will be traffic compacted after paddock dumping and covered with NAF waste rock to further reduce the size of the pore spaces in the dump, reducing the ingress of air and water.	2	1	**L (3)**
Drying of uncovered, unconsolidated PAF materials generating dust.	Contamination of downwind areas by PAF material dust.	2	1	**L (3)**	**Isolation** – PAF materials will not be placed closer than 10m to the surface of the ex-pit emplacement and will be covered at least 10 m of NAF waste rock. **Engineering** - PAF materials will be traffic compacted as soon as possible after paddock dumping	1	1	**L (1)**

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MINE WASTE AND
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