Central Queensland Coal Project

Chapter 8 - Waste Rock and Rejects

Central Queensland Coal

CQC SEIS, Version 3

October 2020

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Terms and Abbreviations

%S	Per cent sulfur
µm	Micrometres
µS/cm	Microsiemens per centimetre
ABA	Acid Base Accounting
ALS	ALS Environmental Laboratory
AMD	Acid and Metalliferous Drainage
ANC	Acid Neutralising Capacity
ANZECC	Australian and New Zealand Environment and Conservation Council
ARD	Acid Rock Drainage
ARMCANZ	Agriculture and Resources Management Council of Australia and New Zealand
As	Arsenic
AWQG	Australian Water Quality Guidelines
Ca	Calcium
$CaCO_3$	Calcium Carbonate
$CaCO_3$/L	Calcium Carbonate per Litre
$CaSO_4$	Calcium Sulfate
CEC	Cation Exchange Capacity
CHPP	Coal Handling and Preparation Plant
CLR	Contaminated Land Register
CQC	Central Queensland Coal
DES	Department of Environment and Science
DME	Department of Minerals and Energy
dS/m	Deci Siemens per metre
EA	Environmental Authority
EC	Electrical conductivity
EIS	Environmental Impact Statement
EMP	Environmental Management Plan (EMP)
EMR	Environmental Management Register
EP	Equivalent Persons
EP Act	*Environmental Protection Act 1994*
EP Regulation	Environmental Protection Regulation 2019

ERA	Environmentally Relevant Activity
ESP	Exchangeable Sodium Percentage
g	Grams
g/cm^3	Grams per cubic centimetre
GAI	Global Abundance Index
GARD	Global Acid Rock Drainage
GBRCMP	Great Barrier Reef Coastal Marine Park
GBRMP	Great Barrier Reef Marine Park
H_2SO_4/t	Sulphuric Acid per tonne
INAP	International Network on Acid Prevention
kg	Kilograms
kg H_2SO_4/t	Kilograms of Sulphuric Acid per tonne
kg $O_2/m^3/s$	Kilograms of oxygen per cubed metre per second
KLC	Kinetic Leach Column
km	Kilometres
km^2	Square kilometres
LC	Low capacity
LoR	Limit of Reporting
LPSDP	Leading Practice Sustainable Development Program
m	Metres
Mg	Magnesium
Mbcm	Million bank cubic metres
Mbgl	Metres below ground level
meq/100g	Milliequivalents per 100 grams
mg	Milligrams
mg/kg/week	Milligrams per kilograms per week
mg/L	Milligrams per litre
MIA	Mine Infrastructure Area
ML	Mining Lease Application
Mlcm	Million loose cubic metres
mm	Millimetres

Mo	Molybdenum
MPA	Maximum Potential Acidity
mS/cm	Millisiemens per centimetre
Mtpa	Million tonne(s) per annum
MWMP	Mineral Waste Management Plan
NAF	Non-Acid Forming
NAPP	Net Acid Producing Potential
NEPM	National Environment Protection Measure
NMD	Neutral Mine Drainage
O_2	Oxygen
PAF	Potentially Acid Forming
pH	Potential for Hydrogen
ppm	Parts per million
PRCP	Progressive Rehabilitation and Closure Plan
RL	Reduced Level
ROM	Run of Mine
Scr	Chromium reducible sulfur
Se	Selenium
SEIS	Supplementary Environmental Impact Statement
SMD	Saline Mine Drainage
STP	Sewage Treatment Plant
The Project	Central Queensland Coal Project
ToR	The Project Terms of Reference
V	Vanadium
WQO	Water Quality Objectives
WRR Act	*Waste Reduction and Recycling Act 2011*
Yr	Year

8 Waste Rock and Rejects

8.1 Introduction

This chapter addresses the potential impacts of waste rock and reject materials management during the construction and operation of the Central Queensland Coal (CQC) Project (the Project), and describes the management measures to be implemented for the Project to ensure that these potential risks are appropriately managed.

Matters raised in submissions to the Environmental Impact Statement (EIS) and the original Supplementary Environmental Impact Statement (SEIS) relating to Chapter 8 – Waste Rock and Rejects were predominately focused on:

- appropriateness of the sampling intensity
- geotechnical characterisation and
- context of the data (i.e. regional or local).

This chapter has been updated for this Version 3 of the SEIS to provide a consolidated chapter including previous information provided in the original EIS (October 2017), and subsequent SEIS documents (SEIS, May 2018 and SEIS v2, December 2018) together with recent work undertaken to support this version of the SEIS (SEIS v3). This chapter is also supported by two stand-alone technical reports prepared by RGS Environmental in 2020 - *Geochemical Assessment of Waste Rock and Coal Rejects* (RGS 2020a) and *Land Stability Assessment* (RGS 2020b). These technical reports are provided within Appendices 3b and 3c respectively, and Chapter 3 - Response to Agency Comments and SEIS Changes provides a detailed response to submissions for the Project.

8.1.1 Environmental Objectives and Outcomes

The environmental objectives and performance outcomes relevant to the management of waste rock are those given for land, surface water and groundwater given in Schedule 8, Part 3, Division 1 of the Environmental Protection Regulation 2019 (EP Regulation). Objectives and outcomes for land and water that are relevant to the management of waste rock and reject, and are specific to the Project are provided in Table 1 of the Project Terms of Reference (ToR). The overarching objective with reference to the management of waste rock and rejects is to operate the Project in a way that protects, to the greatest extent possible, the environmental values of land, surface water and groundwater as well as the associated flora and fauna.

8.1.1.1 EP Regulation Environmental Objectives and Performance Outcomes

The environmental objectives and performance outcomes relating to the management of waste rock as outlined in the EP Regulation are described below.

8.1.1.1.1 Environmental Objectives

Land

The activity is operated in a way that protects the environmental values of land, including soils, subsoils, landforms and associated flora and fauna.

Water

The activity will be operated in a way that protects environmental values of waters.

Groundwater

The activity will be operated in a way that protects the environmental values of groundwater and any associated surface ecological systems.

8.1.1.1.2 Performance Outcomes

Land

1. There is no actual or potential disturbance or adverse effect to the environmental values of land as part of carrying out the activity.
2. All of the following apply:
    a. activities that disturb land, soils, landforms and the land use, flora and fauna associated with the land will be managed in a way that prevents or minimises adverse effects on the environmental values of land
    b. areas disturbed will be rehabilitated or restored to achieve sites:
        i. that are safe and stable
        ii. where no environmental harm is being caused by anything on or in the land and
        iii. that are able to sustain an appropriate land use after rehabilitation or restoration.
    c. the activity will be managed to prevent or minimise adverse effects on the environmental values of land due to unplanned releases or discharges, including spills and leaks of contaminants and
    d. the application of water or waste to the land is sustainable and is managed to prevent or minimise adverse effects on the composition or structure of soils and subsoils.

Water

1. There is no actual or potential discharges to waters of contaminants that may cause an adverse effect on an environmental value from the operation of the activity.
2. All of the following:
    a. the storage and handling of contaminants will include effective means of secondary containment to prevent or minimise releases to the environment from spillage or leaks
    b. contingency measures will prevent or minimise adverse effects on the environment due to unplanned releases or discharges of contaminants to water
    c. the activity will be managed so that stormwater contaminated by the activity that may cause an adverse effect on an environmental value will not leave the site without prior treatment
    d. the disturbance of any acid sulfate soil, or potential acid sulfate soil, will be managed to prevent or minimise adverse effects on environmental values
    e. acid producing rock will be managed to ensure that the production and release of acidic waste is prevented or minimised, including impacts during operation and after the environmental authority has been surrendered
    f. any discharge to water or a watercourse or wetland will be managed so that there will be no adverse effects due to the altering of existing flow regimes for water or a watercourse or wetland

- g. for a petroleum activity, the activity will be managed in a way that is consistent with the coal seam gas water management policy, including the prioritisation hierarchy for managing and using coal seam gas water and the prioritisation hierarchy for managing saline waste and
- h. the activity will be managed so that adverse effects on environmental values are prevented or minimised.

Groundwater

1. Both of the following apply -
    - a. there will be no direct or indirect release of contaminants to groundwater from the operation of the activity
    - b. there will be no actual or potential adverse effect on groundwater from the operation of the activity and
2. The activity will be managed to prevent or minimise adverse effects on groundwater or any associated surface ecological systems.

8.1.1.2 Objectives and Performance Outcomes Relevant to the Project

The objectives and outcomes relevant to waste rock and rejects specific to the Project are those given for land, water and water resources in Table 1 of Section 8 of the Project TOR. These are summarised below.

Land

- The activity is operated in a way that protects to the greatest extent possible the environmental values of land including soils, subsoils, and landforms.
- The choice of the site, at which the activity is to be carried out, avoids or minimises serious environmental harm on areas of high conservation value and special significance and sensitive land uses at adjacent places.
- The location for the activity on a site protects all environmental values relevant to adjacent sensitive use.
- The design of the facility permits the operation of the activity in accordance with best practice environmental management.

Water

- The activity will be operated in a way that protects environmental values of waters.
- The activity will be operated in a way that protects the environmental values of groundwater and any associated surface ecological systems.
- The activity will be managed in a way that prevents or minimises adverse effects on wetlands.

Water resources

- Ensure an equitable, sustainable and efficient use of water resources.
- Maintain environmental flows and water quality to support the long-term condition and viability of terrestrial, riverine, wetland, lacustrine, estuarine, coastal and marine ecosystems, in a way that maintains the ecological processes on which aquatic biota depend.
- Identify environmental values and establishment of pre-disturbance (baseline) water quality objectives (WQOs) for surface- and ground- waters suitable for use as assessment criteria in accordance with appropriate national and state guidelines and policies.

- Maintain the stability of beds and banks of watercourses, and the shores of waterbodies, estuaries and the coast.
- Maintain supply to existing users of surface and groundwater resources, including during construction, operation and decommissioning of the project.

8.1.2 Terms of Reference Addressed in this Chapter

Table 8-1: summarises the requirements from the ToR for the Project relevant to this Chapter, and where in this chapter they are addressed.

Table 8-1: ToR cross-reference

Terms of Reference	Section of the EIS
8.12 Waste management	
Conduct impact assessment in accordance with the EHP's EIS information guidelines – Waste management.	Noted, and information guideline referenced in Section 8.1.4
Describe all the expected waste streams from the proposed project activities during the construction, operational, rehabilitation and decommissioning phases of the project. Waste streams for resource projects would typically include: waste rock, tailings and coarse rejects from mining and mineral processing; salt from petroleum and gas projects; and brackish, saline or mine affected water from all types of resource projects.	Sections 8.2 and 8.4.3, and Chapter 7 – Waste Management
Describe the quantity, and physical and chemical characteristics; hazard and toxicity of each significant waste, as well as any attributes that may affect its dispersal in the environment, and its associated risk of causing environmental harm.	Section 8.5 and Chapter 7 – Waste Management
Define and describe the objectives and practical measures for protecting or enhancing environmental values from impacts by wastes.	Section 8.6
Assess the proposed management measures against the preferred waste management hierarchy, namely: avoid waste generation; cleaner production; recycle; reuse; reprocess and reclaim; waste to energy; treatment; disposal. This includes the generation and storage of waste.	Chapter 7 – Waste Management
Describe how nominated quantitative standards and indicators may be achieved for waste management, and how the achievement of the objectives would be monitored, audited and managed.	Section 8.6
Detail waste management planning for the proposed project especially how measures have been applied to prevent or minimise environmental impacts due to waste at each stage of the project.	Sections 8.6
Use a material/energy flow analysis to provide details of natural resource use efficiency (such as energy and water), integrated processing design, and any co-generation of power and by-product reuse.	Chapter 7 – Waste Management
Identify the quantity, quality and location of all potential discharges of water and contaminants (including treated wastewater/sewage) by the project. Describe whether the discharges would be from point sources (whether controlled and uncontrolled discharges) or diffuse sources (such as irrigation to land of treated wastewater/sewage effluent) and describe the receiving environment (such as land or surface waters).	Chapter 9 – Surface Water
Provide a risk assessment of the potential impacts on surface waters (in the near-field or far-field) due to any controlled or uncontrolled discharges from the site. The	Chapter 9 – Surface Water

Terms of Reference	Section of the EIS
EIS should address the following matters with regard to every potential discharge of contaminated water: - Describe the circumstances in which controlled and uncontrolled discharges might occur.	
- Provide stream flow data and information on discharge water quality (including any potential variation in discharge water quality) that will be used in combination with proposed discharge rates to estimate in-stream dilution and water quality. Chemical and physical properties of any waste water (including concentrations of constituents) at the point of entering natural surface waters should be discussed along with toxicity of effluent constituents to human health, flora and fauna.	Chapter 9 – Surface Water
- Provide an assessment of the available assimilative capacity of the receiving waters given existing background levels and other potential point source discharges in the catchment. Options for controlled discharge at times of natural stream flow should be investigated to ensure that adequate flushing of waste water is achieved.	Chapter 9 – Surface Water
- Provide water quality limits that are appropriate to maintain background water quality and protect water users.	Chapter 9 – Surface Water
- Describe the necessary streamflow conditions in receiving water under which controlled discharges will be allowed.	Chapter 9 – Surface Water
Provide relevant information on existing and proposed sewage infrastructure (related to environmentally relevant activity (ERA) 63) by referring to relevant EHP policies and guidelines[1], depending on the proposed collection (sewer infrastructure), treatment of sewage, and proposed reuse/disposal of treated wastewater and sewage wastes generated. For activities associated with ERA 63, the EIS must include: - the preferred location and capacity of the proposed sewage treatment plant (STP) system(s) with specific reference to the 'daily peak design capacity' of equivalent persons (EP)	No STP is proposed as part of the EIS. See Chapter 7 – Waste Management
- inputs the STP would receive from the mine camp(s) (e.g. any infiltration of groundwater into the sewer collection system, trade waste from camp cafeteria), whether the effluent coming from the Mine Infrastructure Area (MIA) would be contaminated with other industrial pollutants, and whether these contaminants would have any adverse effects on wastewater treatment	
- the expected effluent quality and quantity, and suitable calculations showing the volume of any wet weather storage(s) and area(s) for sustainable effluent irrigation based on the EPs of the facility/ies and location of the irrigation area(s)	
- avoidance and mitigation measures associated with the generation, treatment and disposal/reuse of sewage generated	
- identify any risks to the receiving environment including land and water quality.	
Identify beneficial use options under the *Waste Reduction and Recycling Act 2011* as per the relevant guidelines for irrigation, drilling mud, and associated water. The uses might include aquaculture, coal washing, dust suppression, construction, landscaping and revegetation, industrial and manufacturing operations, research and development and domestic, stock, stock intensive and incidental land management. If effluent is to be used for dust suppression or other uses,	There is no proposal or requirement to dispose of associated water as part of Project mineral waste management

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[1] E.g. https://www.ehp.qld.gov.au/licences-permits/guidelines.html

Terms of Reference	Section of the EIS
demonstrate that the water quality is appropriate for that used from an environmental and public health perspective.	
Provide maps and plans describing composting activities to produce a 'soil conditioner'; identify any risks to the receiving environment, and any potential impacts on water quality or land and how these would be managed. Demonstrate that the composted material (as 'soil conditioner') is suitable for its intended use in any proposed rehabilitation by referring to appropriate guidelines and Australian Standards.	No composting is proposed as part of the EIS

8.1.3 Relevant Legislation and Guidelines

Chapter 2 outlines the regulatory framework relevant to the Project. Those that relate to the management of mineral waste generated by the Project are:

- *Environmental Protection Act 1994* and
- *Waste Reduction and Recycling Act 2011*.

The following sections provide a summary of the above legislation and how these pertain to the mineral waste management components of the Project.

8.1.3.1 Environmental Protection Act 1994

The *Environmental Protection Act 1994* (EP Act) is one of the key legislative instruments for environmental management and protection in Queensland. It describes the requirements of applications for a site-specific Environmental Authority (EA), defines regulated waste, and is the primary piece of legislation addressing contaminated land in Queensland. It defines notifiable activities (in Schedule 3) as activities that have been identified as likely to cause land contamination, which includes:

- 24 Mine wastes - storing hazardous mine or exploration wastes, including, for example, tailings dams, overburden or waste rock dumps containing hazardous contaminants, or exploring for, or mining or processing, minerals in a way that exposes faces, or releases groundwater, containing hazardous contaminants.
- 25 Mineral processing—chemically or physically extracting or processing metalliferous ores.

Land parcels that have historically or are currently used for notifiable activities and are reported to the government are recorded on the Department of Environment and Science (DES) Environmental Management Register (EMR). Inclusion of a land parcel on the EMR does not necessarily mean that the land is contaminated, as it may or may not pose a risk to human health and/or the environment. Sites that have been demonstrated to pose a risk to human health and/or the environment will be included on the DES Contaminated Land Register (CLR). Land parcels are recorded on the CLR when an investigation has identified that contaminants are present at concentrations that represent a risk to human health and, as such, action is required to remediate or manage the land to prevent adverse environmental and human health impacts.

8.1.3.2 Waste Reduction and Recycling Act 2011

The *Waste Reduction and Recycling Act 2011* (WRR Act) prioritises waste management practices to achieve the best possible environmental outcome via the waste and resource management hierarchy, and aims to minimise the overall impact of waste generation and disposal.

8.1.4 Relevant Policies and Guidelines

The following outlines the key guidelines relevant to the characterisation and management of mineral waste on the Project site:

- Acid Rock Drainage (ARD) Test Handbook P387A Prediction and Control of Acid Rock Drainage (AMIRA 2002).
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018).
- The Commonwealth's Leading Practice Sustainable Development Program (LPSDP) for the Mining Industry: Preventing Acid and Metalliferous Drainage (AMD) (COA 2016a).
- Application Requirements for Activities with Impacts to Land Guideline (EHP 2013).
- Draft Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland, Technical Guideline – Assessment and Management of Acid Drainage and Saline/Sodic Wastes (DME 1995a and DME 1995b).
- International Network on Acid Prevention (INAP) Global Acid Rock Drainage (GARD) Guide (INAP 2009).
- Department of Industry, Innovation and Science Australia, Tailings Management, Leading Practice Sustainable Development Program for the Mining Industry (COA 2016b) and
- Western Australia Department of Mines and Petroleum Draft Guidance - Materials Characterisation Baseline Data Requirements for Mining Proposals DMPMAR15_3596 (WA DMP 2016).

The National Environment Protection (Assessment of Site Contamination) Measure (NEPM) is also relevant to contaminant levels, related to contaminated land management in Queensland. Soil investigation thresholds referred to in Queensland to evaluate whether land may be contaminated are based on these NEPM values, which includes investigation and screening levels reflecting the protection of environmental and human health. These investigations and screening levels are not intended for use as default remediation trigger criteria, rather they are intended to prompt an appropriate site-specific assessment when they are exceeded.

This assessment has also been undertaken with reference to the following guideline documents:

- The DES 'EIS Information Guideline – Waste'[2].

8.2 Waste Rock Overview

8.2.1 Waste Rock

Waste rock comprises overburden and interburden material extracted as part of mining operations. Overburden is rock that sits above the uppermost target coal seam and is required to be removed to access the coal. Interburden is the rock material between the targeted coal seams. Waste rock generally consists of large sized, blocky material.

Rejects are the processing waste which includes rock and a very small amount of low-grade coal particulates that naturally occur within the deposit and are extracted as part of the Run of Mine (ROM) coal. Rejects are removed during the crushing, screening and washing of the ROM coal at the Coal Handling and Preparation Plant (CHPP). The outputs from the CHPP are product coal, coarse

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[2] https://www.qld.gov.au/environment/pollution/management/eis-process/about-the-eis-process/developing-an-eis

rejects (particles sized between 1 mm and 120 mm) and fine rejects (particles less than 1 mm in size). All rejects will be mechanically dewatered before leaving the CHPP, which minimises risks associated with storage of wet fine rejects.

Coal deposits often occur in areas of sulfide-bearing rocks. When these rocks are broken and exposed by mining and processing there is the potential for the sulfide minerals to oxidise (if oxygen is present). When sulfides are exposed to air and water, they oxidise to produce an acidic solution. The low pH in the acidic solution then dissolves heavy metals and metalloids present in the rock or water. This process is known as Acid and Metalliferous Drainage (AMD) (Lottermoser 2007). Releases or leaching of this acid mine water can adversely affect the surrounding environment, particularly by lowering the pH and leaching of metals and other constituents into solution and then into surface and groundwater. This may consequently impact on aquatic vegetation, fauna and drinking water.

The potential for AMD depends on the presence of sulfide bearing materials, the reactivity of the sulfide and the buffering capacity of the waste rock to neutralise the acid release. Where some natural neutralisation occurs, for example at pH levels greater than 6 pH units, saline mine drainage (SMD) or neutral mine drainage (NMD) can occur. NMD can also occur where the exposed waste materials are sodic (exchangeable sodium percentage (ESP) greater than six) and highly erodible, leading to both saline and sediment-laden mine drainage. The impacts of SMD and NMD are like those of AMD.

8.2.2 Regional Geology

The Styx Coal reserves lie in the Styx Basin, a small, Early Cretaceous, intracratonic sag basin that covers an area of approximately 300 km^2 onshore and 500 km^2 offshore. The known coal bearing strata of the basin are referred to as the Styx Coal Measures (see Figure 8-1) and consist of quartzose, calcareous, lithic and pebbly sandstones, pebbly conglomerate, siltstone, carbonaceous shale and coal. The environment of deposition was freshwater, deltaic to paludal with occasional marine incursions (Taubert 2002).

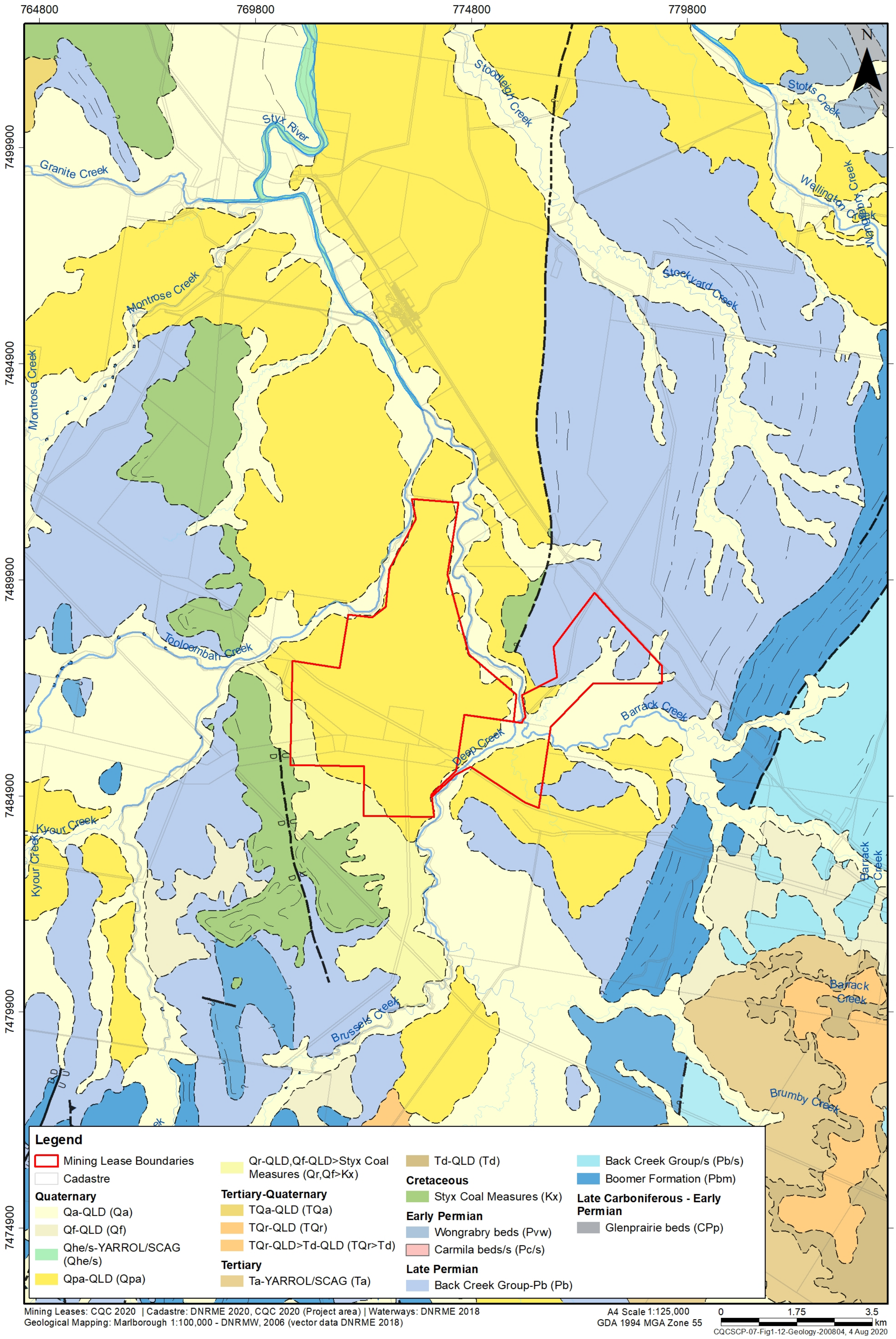
The Styx Coal Measures are preserved as basin infill in a half graben geometry which has an overall plunge to the north. The Styx Basin is relatively undeveloped, except for two small scale, government owned mines that were in operation from 1919 to 1963. The Ogmore and Bowman collieries, located close to the north and northeast of Mining Lease Application (ML) 80187 respectively, produced small qualities of low-quality coal for use in steam trains and other boiler requirements (see EIS Chapter 18 - Cultural Heritage).

A more complete description of the geology and stratigraphy of the Project area is provided in Chapter 1 – Introduction and Project Description (resource description) and Chapter 5 – Land (geology).

8.2.3 Local Stratigraphy

The stratigraphy of the Project area is described in Table 8-2 and shown in Figure 8-2. The coal seams are relatively shallow, and the average cumulative thickness of the full sequence of coal (Grey to V_L2 seams) is approximately 6 m, contained within a sequence of approximately 120 m of coal bearing strata.

The coal seams dip generally to the east, with the Violet seam, the lowest coal seam in the sequence, sub-cropping in the western part of ML80187. The deposit structure is currently



Mining Leases: CQC 2020 | Cadastre: DNRME 2020, CQC 2020 (Project area) | Waterways: DNRME 2018
Geological Mapping: Marlborough 1:100,000 - DNRMW, 2006 (vector data DNRME 2018)

Figure 8-1: Regional geological map

interpreted to be a syncline structure, the axis of which runs northwest / southeast through the mine area. This structural interpretation follows the deposit structure originally described by Morten (1955).

Some regional faulting is also mapped in the areas further to the south-west of the Project associated with the inlier of Connors Volcanics. Of most relevance for the purposes of this SEIS is the fault / interface to the east of the Project. This mapped fault throw is estimated to be greater than the thickness of the Styx Coal Measures (e.g. in order of hundreds of metres).

Table 8-2: Stratigraphic units of the Project mine

Period	Group	Sub-group/formation	Dominant lithology
Quaternary	Surficial	Quaternary Alluvial	Alluvium, coastal swamp deposits
Cainozoic	Surficial	Undifferentiated sediment	Sand, soil, alluvium, lateritic gravel
Lower Cretaceous	-	Styx Coal Measures	Quartz sandstone, conglomerate, siltstone, carbonaceous shale, coal
Upper Permian	Back Creek Group	Boomer Formation	Volcanolithic sandstone, claystone, siltstone, pebble conglomerate
Permian	Back Creek Group	Back Creek Group	Undifferentiated: fossiliferous volcanolithic sandstone, siltstone, limestone

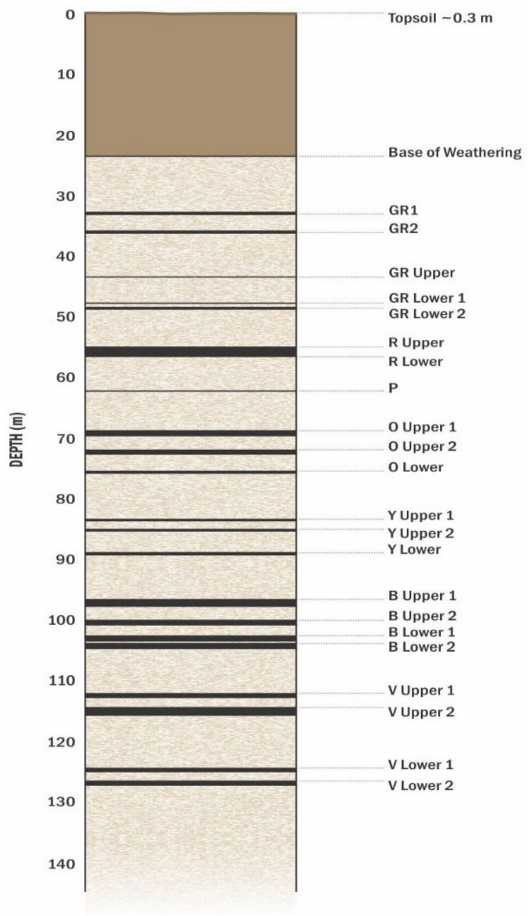


Figure 8-2: Schematic stratigraphic section

8.2.4 Mineral Waste Generation

Overburden and coarse and fine rejects disposal will be conducted in accordance with the Project's Mineral Waste Management Plan (MWMP), a draft of which is included in the draft Environmental Management Plan (EMP) in Appendix 12. Over the life of the mine, the total volume of excavated waste rock from open cut activities (i.e. overburden, interburden and fine rejects from the CHPPs) is expected to be approximately 740 million bank cubic metres (Mbcm). This equates to approximately 900 million loose cubic metres (Mlcm) due to an average swell factor of 22%. The estimation of tonnage and volumes of waste rock and subsoils to be excavated during each year both annually and cumulatively is presented in Chapter 1 – Introduction and Project Description, and summarised in Table 8-3.

Table 8-3: Summary of Waste rock and subsoil volumes by Project year

Project Period	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10
ROM Coal (Mtpa)	1	2	2	2	4	4	4	4	4	4
Waste Volume (Mbcm)	17.8	22	21.6	23.2	45.2	40.9	49.1	51.2	51.1	54.3
Reject Volume (Mlcm)	0.16	0.32	0.30	0.31	0.65	0.65	0.65	0.66	0.62	0.59
Project Period	**Yr 11**	**Yr 12**	**Yr 13**	**Yr 14**	**Yr 15**	**Yr 16**	**Yr 17**	**Yr 18**	**Yr 19**	***Total***
ROM Coal (Mtpa)	7	10	4	4	2	2	2	2	0.1	***64.1***
Waste Volume (Mbcm)	86.6	108.5	48.6	42.8	13.5	24.5	19.1	21.7	0.8	***743***
Reject Volume (Mlcm)	0.92	1.0	0.59	0.62	0.33	0.32	0.31	0.31	0.02	***9.3***

During initial open cut mining activities, waste rock and rejects are to be trucked to ex-pit waste rock stockpile areas. As the open cut mining areas are developed and progressed, the waste rock and reject materials will be emplaced into the completed mining areas in-pit. Reject materials will be hauled as back loads to disposal areas using coal haulage trucks after they deliver ROM coal to the ROM stockpile.

Initial out-of-pit dumping to waste rock stockpiles is required as the box cuts are developed, and is detailed in Table 8-4 and Figure 8-3 to Figure 8-5.

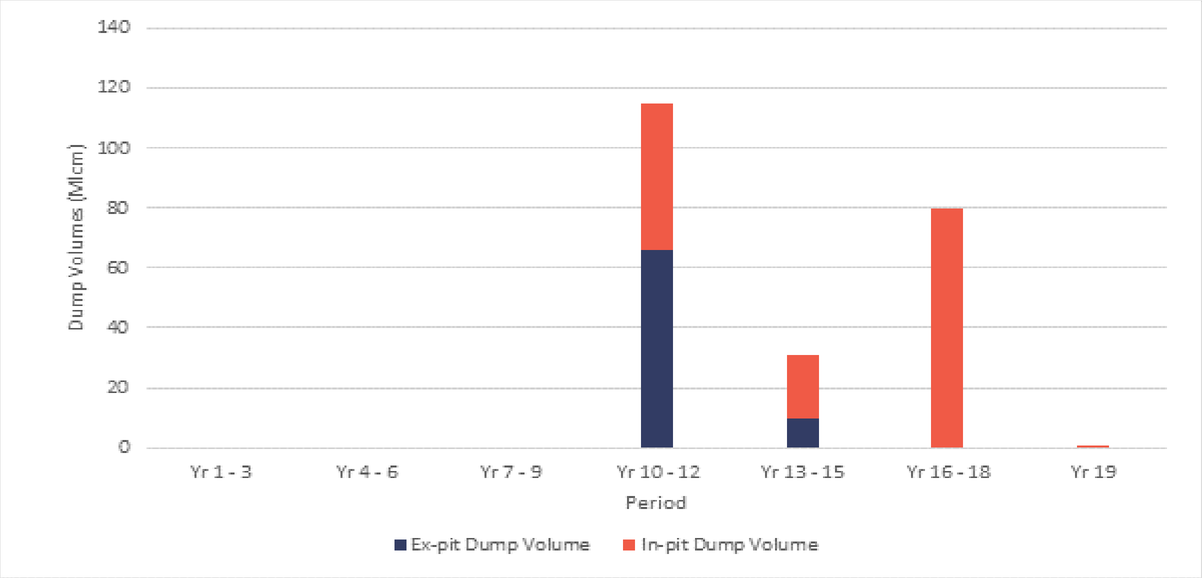


Figure 8-3: Waste material dump schedule – Open Cut 1

Table 8-4: Waste Dump schedule

Year	Volume (Mbcm)	Accumulative Volume (Mbcm)	In-Pit Dump (Mlcm)*	Ex-Pit Dump (Mlcm)*	In-Pit Pit-2 (Mlcm)*	In-Pit Pit-1 (Mlcm)*	Ex-Pit Pit-2 (Mlcm)*	Ex-Pit Pit-1 (Mlcm)*	CHPP Total Reject (Mlcm)*	CHPP-1 (Mlcm)*	CHPP-2 (Mlcm)*
Year 1	17.8	17.8	3.7	18.1	3.7		18.1		0.16	0.00	0.16
Year 2	22.0	39.8	14.3	12.6	14.3		12.6		0.32	0.00	0.32
Year 3	21.6	61.4	22.9	3.4	22.9		3.4		0.30	0.00	0.30
Year 4	23.2	84.6	28.3	0.0	28.3				0.31	0.00	0.31
Year 5	45.2	129.8	55.2	0.0	55.2				0.65	0.00	0.65
Year 6	40.9	170.7	47.2	2.7	47.2		2.7		0.65	0.00	0.65
Year 7	49.1	219.7	59.9	0.0	59.9				0.65	0.00	0.65
Year 8	51.2	271.0	57.2	5.3	57.2		5.3		0.66	0.00	0.66
Year 9	51.1	322.1	57.7	4.7	57.7		4.7		0.62	0.00	0.62
Year 10	54.3	375.1	53.9	12.4	53.9			12.4	0.59	0.07	0.52
Year 11	86.6	462.9	76.2	29.5	54.7	21.5		29.5	0.92	0.39	0.53
Year 12	108.5	571.4	108.2	24.1	81.0	27.3		24.1	1.01	0.40	0.60
Year 13	48.6	618.5	59.2	0.0	59.2				0.59	0.00	0.59
Year 14	42.8	655.4	52.2	0.0	37.6	14.6			0.62	0.16	0.46
Year 15	13.5	676.1	6.9	9.6		6.9		9.6	0.33	0.33	0.00
Year 16	24.5	695.0	29.9	0.0		29.9			0.32	0.32	0.00
Year 17	19.1	719.3	23.3	0.0		23.3			0.31	0.31	0.00
Year 18	21.7	739.6	26.5	0.0		26.5			0.31	0.31	0.00
Year 19	0.8	742.4	1.0	0.0		1.0			0.02	0.02	0.00
Total	***742***	***742***	***784***	***122***	***633***	***151***	***47***	***76***	***9.3***	***2.3***	***7.0***

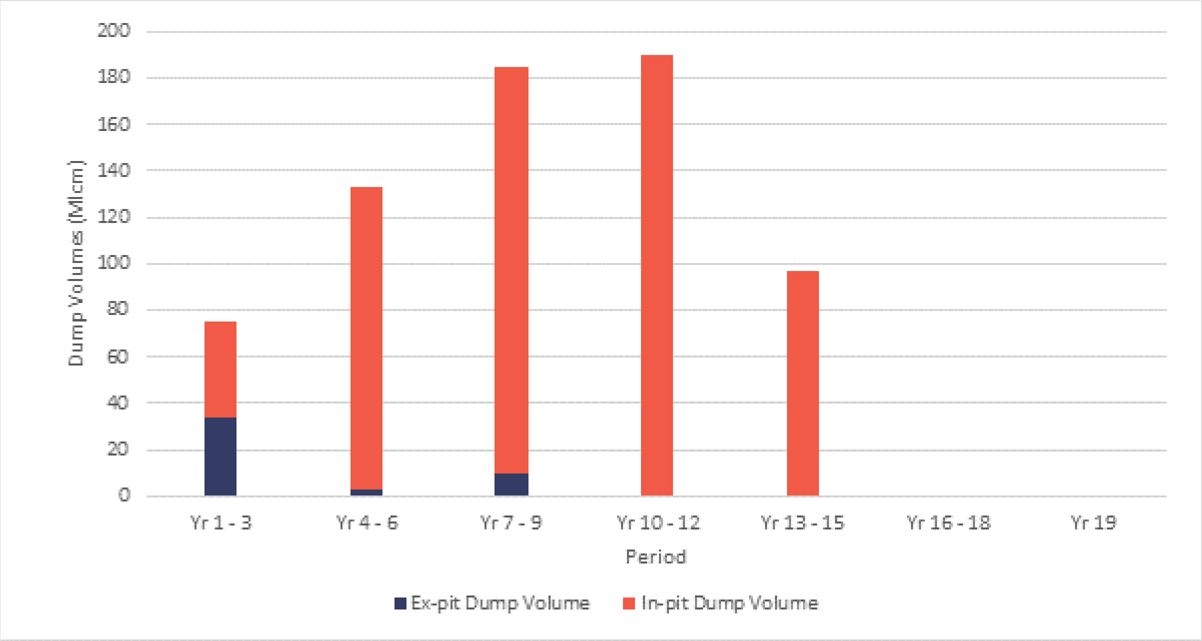


Figure 8-4: Waste material dump schedule – Open Cut 2

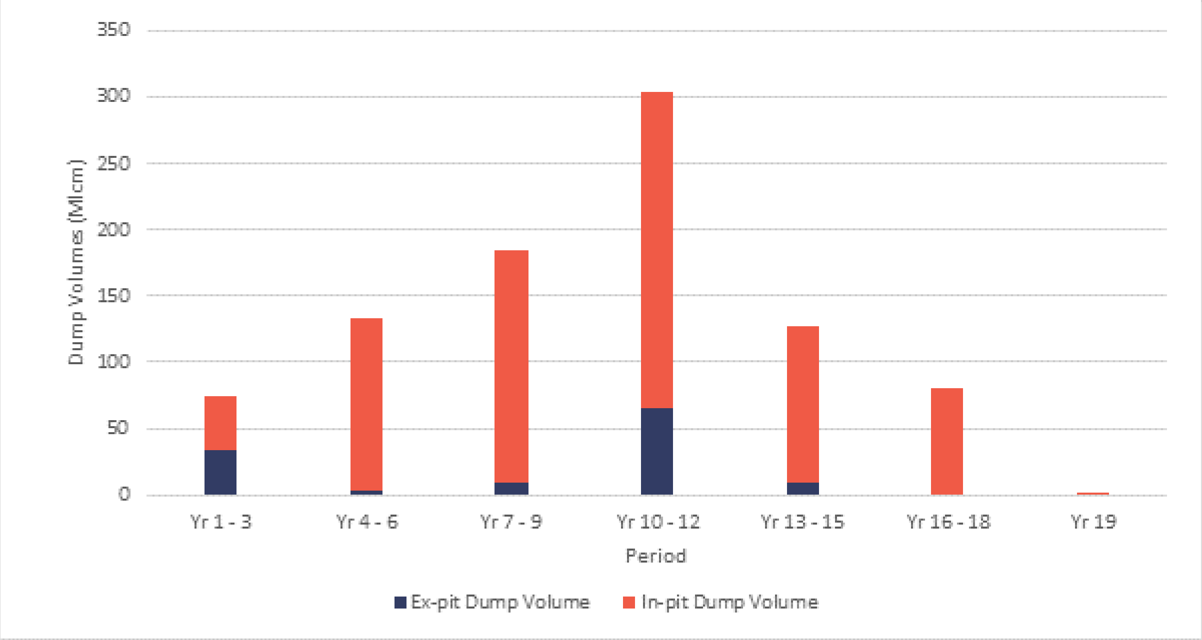


Figure 8-5: Waste material dump schedule – total volume (both open cut pits)

The ex-pit dumping for Open Cut 2 will be undertaken from Project years 1 to 3, with minor infill anticipated in years 6 to 9, to an indicative maximum height of 105 m (Reduced Level [RL] 135 m). The ex-pit dumping for Open Cut 1 occurs in Project years 10 to 12, and again in year 15, to an indicative maximum height of approximately 90 m (RL 125 m). Rehabilitation of the out-of-pit dumps will continue through the life of the mine (refer to Chapter 11 – Rehabilitation and Decommissioning for discussion about the rehabilitation approach for the Project).

8.3 Study Methodology

The physical and chemical characteristics of the waste rock and other materials to be handled have been determined through a progressive geochemical sampling and analysis program undertaken since 2012, including representative waste rock and potential coal reject samples in 2012, fine reject samples in 2018 and supplemented with total sulfur data throughout the 2012 – 2018 period.

The previous EIS and SEIS incorporated the earlier RGS Environmental work from 2012 (RGS 2012) and supplemented it with the additional data collected since that time. For this SEISv3, RGS Environmental prepared a stand-alone geochemical assessment report detailing their earlier 2012 work and incorporating additional sampling and test work conducted for these earlier EIS and SEIS versions. A full copy of this report is provided within Appendix 3b and this Chapter has been amended to draw from this technical report, which is summarised within the following sections.

8.3.1 Material Sampling

Representative samples of waste rock (overburden and interburden) and potential coal reject were identified and collected as drill core from the 2012 exploration drilling program. A total of 174 waste rock and potential coal reject samples were collected from 15 drill holes at the Project as illustrated in Figure 2-1. A further 21 fine reject samples were collected and tested in 2018 (CDM Smith 2018), making a total of 195 waste rock and coal reject samples. In addition, total sulfur data was available for a further 292 coal samples from the Project and included in the assessment program.

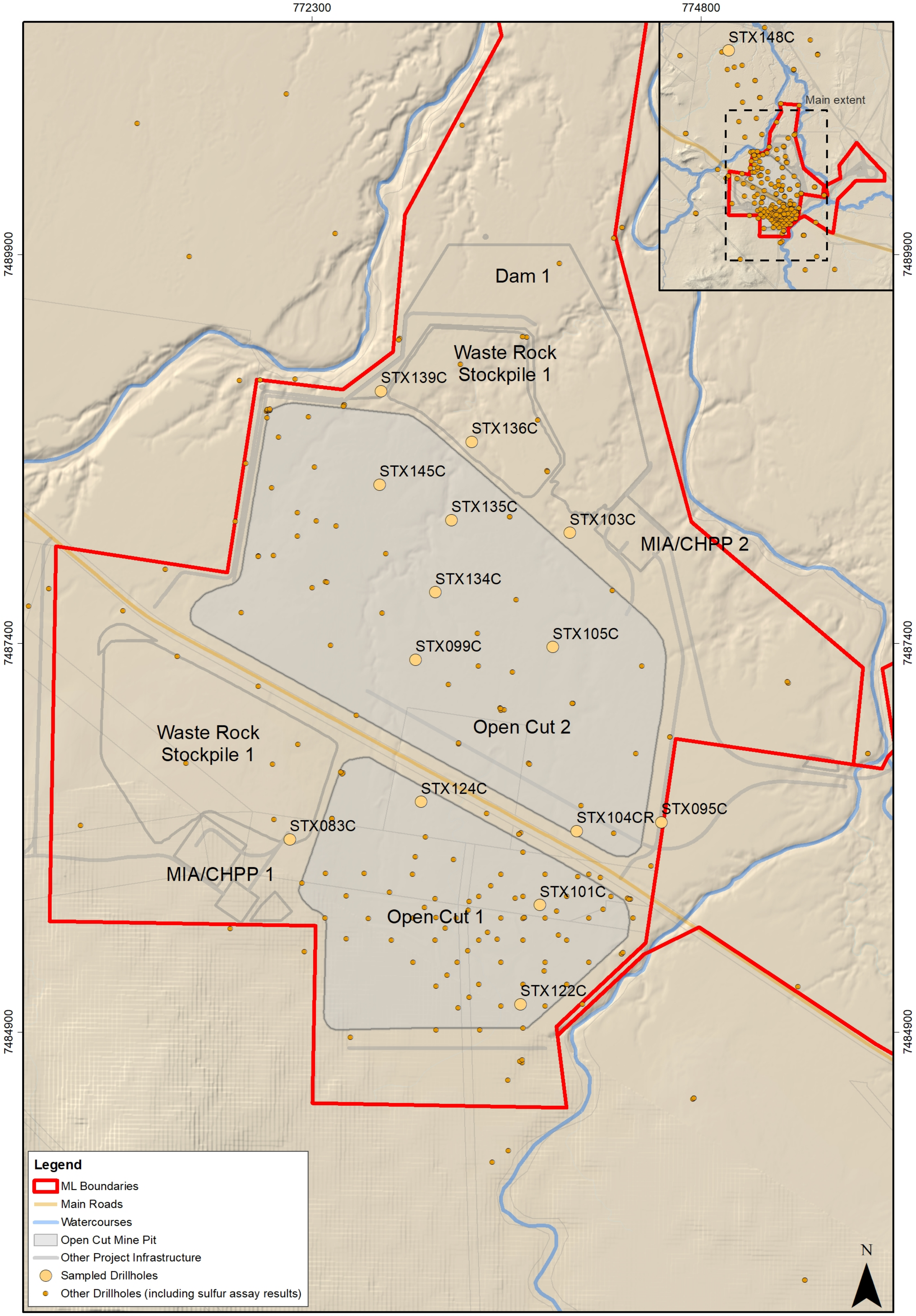
An outline of the drill hole, sample depth and lithology of samples analysed as part of the geochemical assessments completed for the Project is provided in the Geochemical Assessment in Appendix 3b. The 15 exploration drill hole locations from the geotechnical and resource definition drilling programs undertaken by CQC in 2011-2012 which were subject of the geochemical sampling are presented in Figure 8-6.

The samples represented the waste rock (overburden and interburden); potential coal reject (including roof, floor and parting materials), fine coal reject, and coal materials expected to be encountered during development activities. Table 8-5 provides the number of samples of each type of material collected from the Project and used in the geochemical assessment. 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 this and other similar coal mining projects.

Table 8-5: Sample Materials Used for Geochemical Testing

Sample Description	Sample Type	Number of Samples
Mudstone, Sandstone, Siltstone	Waste Rock	147
Sandstone, siltstone and claystone	Potential Coal Reject	27
Mainly coal fines and other mixed lithologies	Fine Coal Reject	21
Coal seam material	Coal	292
	Total	***487***

Source: RGS Environmental (2020a)



Mining Leases: CQC 2020 | Infrastructure: CQC 2020 | Watercourses: DNRME 2018 | Roads: DNRME 2018
Drillholes: CQC 2020

A4 Scale 1:35,000 0 0.35 0.7 km
GDA 1994 MGA Zone 55
CQCSCP-07-Fig8-06-SampleLocations-200920, 20 Sep 2020

Figure 8-6: Location of sampled drillholes

While there are no specific regulatory guidelines regarding the number of samples required for such assessments in Queensland, existing risk-based technical guidelines for the geochemical assessment of mining waste materials in Australia (AMIRA 2002 and COA 2016a) and worldwide (INAP 2009) were used by RGS as a framework for the sampling program. Further to this, the lack of variability (sulfidic sample results) across the samples taken suggest that the frequency of sampling undertaken for the Project is adequate.

8.3.2 Sample Preparation

The waste rock and coal reject samples were sent to ALS Environmental Laboratory (ALS) in Stafford, Queensland for geochemical testing. Once received, the 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.

8.3.3 Geochemical Test Program

A series of geochemical tests were completed on the waste rock and coal reject samples, 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 and calculation of standard soil parameters including salinity, sodicity, cation exchange capacity, ESP and major metal concentrations. A detailed summary of the testwork is provided in the geochemical assessment in Appendix 3b, and summarised below.

8.3.3.1 Static tests

Static tests (tests providing a snapshot of current sample conditions) were conducted on samples using the Acid Base Accounting (ABA) method as a screening procedure to assess the acid-neutralising and acid-generating characteristics of the materials, which included testing for pH, Electrical conductivity (EC), total sulfur and Acid Neutralising Capacity (ANC).

After the results of the ABA screening tests were received and interpreted, 43 waste rock samples and seven potential coal reject samples were also tested for sulfide sulfur, using the chromium reducible sulfur (Scr) method. From these screening tests, 12 composite samples for waste rock and three composite samples for potential coal reject materials were prepared. These composite samples and the additional 21 fine reject samples from 2018 were sent for whole rock multi-element testing. Additional geochemical testing was undertaken on the composite samples for pH, EC, major cations and anions, exchangeable cations, acidity and alkalinity and soluble metals.

Further detail on these composite samples and the associated multi-element scans and water extract testing is described in Appendix 3b.

8.3.3.2 Kinetic Tests

Kinetic leach column (KLC) testing was undertaken using six composite samples comprising four waste rock and two potential coal reject samples. The testing simulated worst case weathering under laboratory-controlled conditions to provide information on the time dependent rate of acid generation and acid neutralising reactions, metal release and drainage / seepage quality.

Under these conditions, water is added to ‘leach’ through the samples, with heat lamps to simulate sunshine and ensure the KLC test materials were unsaturated and subject to oxidising conditions between leaching events. The KLC testing included seven leaches fortnightly (22 May 2012 to 14 August 2012), with analysis at each leach including:

- pH and EC
- acidity, alkalinity and net alkalinity (as mg $CaCO_3$/L) and
- multi-element composition (solutions, mg/L).

It is important to note that when comparing the results of the multi-element testing of water extracts from the KLC tests to water quality guideline values (ANZG 2018, ANZECC and ARMCANZ 2000), the 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 recognised that direct comparison of geochemical data with guideline values can be misleading. Using sample pulps (ground to passing 75 µm) provides a very high surface area to solution ratio, which encourages mineral reaction and dissolution of the solid phase. As such, the results of screening tests on water extract solutions are assumed to represent a ‘worst case’ scenario for initial surface runoff and seepage from waste rock materials.

8.4 Description of Environmental Values

8.4.1 Surface Water

The Project is wholly contained within the Styx River Basin, a small basin of around 3,000 km^2 which discharges to the Great Barrier Reef Marine Park (GBRMP) and the Great Barrier Reef Coastal Marine Park (GBRCMP). The boundary of the GBRCMP is located approximately 10 km downstream of the ML area (General purpose zone) and the marine National Park zone 40 km downstream of the ML area. The Project is bordered by two watercourses as defined under the *Water Act 2000*, namely Tooloombah Creek and Deep Creek. These small low energy ephemeral creeks join at a confluence downstream of the Project area, with the named Styx River (under the *Water Act 2000*) starting 1 km downstream of the confluence.

Landuse in the basin is predominantly ‘Production from relatively natural environments’ (91%) – predominantly grazing - followed by ‘Conservation and natural environments’ (8%) and ‘Intensive uses’ (1%) which comprise transport and communication, residential and farm infrastructure, services and mining (DES 2019a). The Styx basin has been extensively cleared for grazing.

The most recent catchment condition assessment related to water quality for the Styx basin is included in the Reef Water Quality Report Card 2017 and 2018 (DES 2019b). This found that water quality targets were largely met (current target is to maintain current loads); catchment management targets were graded B for wetland extent (slightly below target) and D for riparian extent (small loss against a no loss target); and land management targets were graded D for low adoption of gully, pasture and streambank management targets.

The Project is located predominantly within the Deep Creek sub-catchment with a smaller area within the Tooloombah Creek sub-catchment, within the Southern Styx Freshwaters EPP (Water) catchment area. Observations in the Deep and Tooloombah Creek catchments have identified areas of potentially severe erosion with a number of gullies identified as potential sources of high sediment loads (Gippel 2020). Water quality shows relatively high total nutrient, suspended solids and turbidity levels in Deep Creek and generally better quality in Tooloombah Creek, with bioavailable forms very low in both systems.

In terms of geochemically relevant parameters (as assessed in this Chapter), both creeks are relatively low in sulfate and salinity (as EC) is ~350 µS/cm in Deep Creek and ~820 µS/cm in Tooloombah Creek, though EC increases moving downstream within Tooloombah Creek, due to minerology (sulfate in particular does not increase downstream until the tidal reaches, indicating a non-seawater source) (refer to the Surface Water Quality Technical Report in Appendix A5a). The pH is above neutral, at 7.7 – 7.9, and the key metals identified as being potentially elevated in leachate tests (aluminium, arsenic and selenium) are either above the current default guideline values (aluminium), below (arsenic) or below detection levels (selenium) (refer Appendix A5a).

8.4.2 Groundwater

At the regional scale, the Styx River basin contains usable groundwater supplies in shallow water-table aquifers that are hosted in the unconsolidated Cenozoic surface deposits, particularly within the alluvial infill sediments associated with surface drainage, and within fractured and weathered zones of outcropping Cretaceous rocks (Styx Basin) and older Permian rocks (Back Creek Group, Lizzie Creek Volcanics Group and Connors Volcanic Group). The deeper sediments underlying the Cenozoic surface deposits and below the zone of surface fracturing and weathering have much lower permeability and are not known to yield useable groundwater supplies.

Shallow unconfined groundwater flow in Cenozoic sediments and fractured and weathered rocks within the Styx River Basin is driven by diffuse groundwater recharge from rainfall within the basin. The water table slopes generally toward the ocean but locally follows topographic relief, with depth to water table from ground surface typically in the range 2 to 15 m in existing groundwater bores dependent on location.

Most groundwater discharge is thought to occur by evapotranspiration from topographic lows, particularly along valleys of the surface drainage network, including evaporation of surface pools and bank seepage, and transpiration by riparian vegetation communities that access groundwater within their root zones. The main processes for interaction between groundwater and surface water are episodic groundwater recharge along flowing watercourses during wet conditions, and groundwater discharge from bank storage to watercourses during dry conditions.

Groundwater salinity ranges from fresh to brackish. Groundwater use in the area is generally limited to stock watering, with some domestic use, however the salinity levels encountered in the monitoring bores indicate that much of the available groundwater is too saline for stock watering or other similar uses. Stygofauna have been recorded within some groundwater bores constructed within the alluvial aquifer associated with the Styx River and located more than 8 km away from the Project boundary.

8.4.3 Mineral Waste

The largest volume and mass of waste associated with the Project will be waste rock (estimated at approximately 740 Mbcm over the life of the mine) generated from the removal of the overburden and interburden material in the open cut mining areas to enable the seams to be extracted. Waste will also be generated in the form of fine and coarse reject material from the processing of ROM coal within the two CHPPs.

Waste generated throughout mining operations in the form of waste rock (from overburden and interburden removal and ex-pit emplacement) and rejects from coal processing (i.e. coarse and dewatered fine rejects) has been defined as mineral or mine waste.

The geochemical assessments undertaken for the Project have entailed comprehensive testing of representative samples obtained across the Project area to characterise the qualities of these mine wastes and to identified the necessary management and mitigation measures required during the handling and rehabilitation of these materials to minimise adverse impacts to the environment.

Ongoing geochemical analysis will be undertaken prior to and throughout the life of mining operations to supplement the current understanding of the geochemical qualities of mining wastes. This ongoing work will also assist in identifying and appropriately managing any waste materials of concern to ensure the best chance of success of the final site rehabilitation activities.

8.5 Assessment Results

The characterisation of the waste rock and CHPP waste streams for the Project is based on the geochemical assessments completed by RGS Environmental and CDM Smith since 2012. The results of the geochemical assessments completed for the Project are described within the Geochemical Assessment in Appendix 3a and summarised in the following sections.

8.5.1 Acid Generation Potential

The 195 waste rock, potential coal reject and fine reject samples described in Section 8.3 underwent ABA assessment, allowing sampled geologies to be classified into non-acid forming (NAF), Potentially Acid Forming (PAF) and uncertain categories. The results of this classification process are summarised in Table 8-6.

Table 8-6: Geochemical classification of waste rock and coal reject materials

Category	Total Sulfur (%)	NAPP value (kg H_2SO_4/t)	ANC / MPA	Waste Rock Samples (n = 147)	Coal Reject Samples (n = 48)
Potentially Acid Forming (PAF)	>0.1	> 10	<2	1	0
Potentially Acid Forming – Low Capacity (PAF-LC)	>0.1	> 5 ≤ 10	<2	2	0
Uncertain	>0.1	≥ -5 ≤ 5	<2	1	2
Non-acid Forming (NAF)	>0.1	< -5	> 2	17	22
Non-acid Forming (NAF) (Barren)	≤ 0.1	-	-	126	24

Source: inferred based on RGS Environmental 2020
Table notes
NAPP - Net Acid Producing Potential; ANC – Acid Neutralising Capacity; MPA - Maximum Potential Acidity

Overall, the risk of acid generation from waste rock and coal reject materials from the Project is low, with over 97% of waste rock samples and over 96% of reject samples being classified as NAF. Statistical evaluation of the ABA classification of waste rock and coal reject materials is presented in Table 8-7 and Table 8-8 respectively.

Table 8-7: Statistical evaluation of ABA of waste rock materials tested

Parameter	pH	EC	Total Sulfur	SCr	MPA	ANC	NAPP	ANC/MPA
	units	mS/cm	%		kg H_2SO_4/t			
Minimum	4.8	106.0	0.0	0.0	0.2	5.3	-389.7	0.2
Maximum	10.2	2780.0	8.2	7.6	233.4	390.0	197.2	1273.5
Mean	9.8	612.3	0.2	0.3	3.7	53.7	-50.0	122.5
Median	9.9	612.0	0.0	0.1	0.9	39.8	-38.2	34.0

Source: based on RGS Environmental 2020

Table notes

EC – Electrical Conductivity; SCr - chromium reducible sulfur; MPA - Maximum Potential Acidity; ANC – Acid Neutralising Capacity; NAPP - Net Acid Producing Potential

Table 8-8: Statistical evaluation of ABA of coal reject materials tested

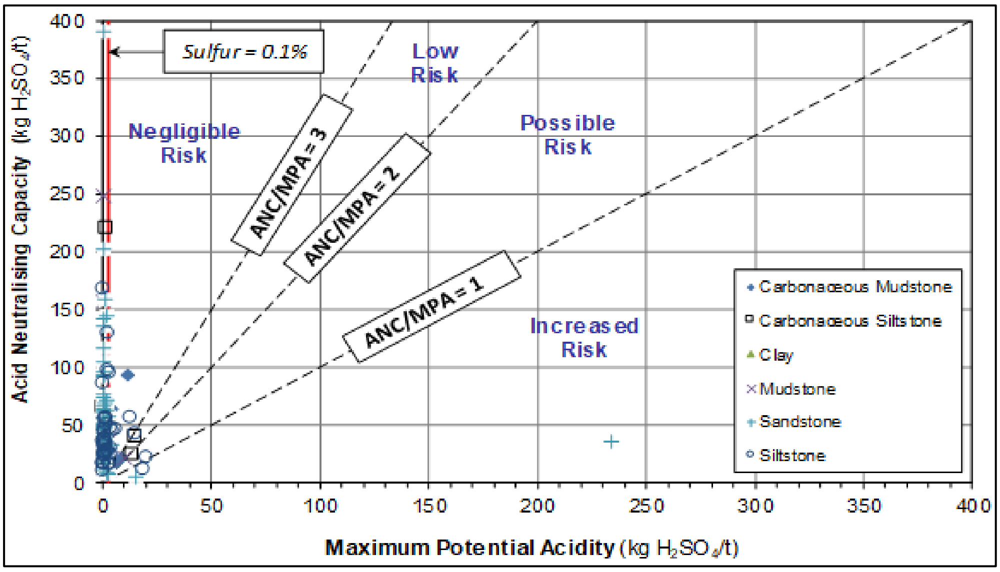
Parameter	pH	EC	Total Sulfur	SCr	MPA	ANC	NAPP	ANC/MPA
	units	mS/cm	%		kg H_2SO_4/t			
Minimum	8.8	326.0	0.0	0.1	0.2	10.0	-319.1	0.9
Maximum	10.1	768.0	0.7	0.6	18.2	320.0	1.4	348.3
Mean	9.5	538.6	0.1	0.2	2.5	40.3	-37.8	40.6
Median	9.6	510.0	0.1	0.1	1.7	20.1	-19.2	15.5

Source: based on RGS Environmental 2020

Table notes

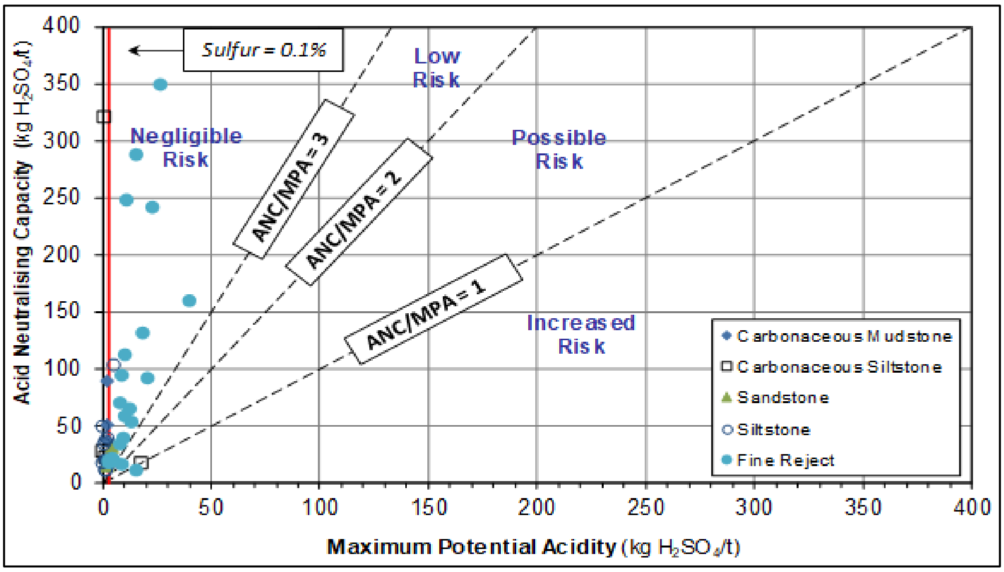
EC – Electrical Conductivity; SCr - chromium reducible sulfur; MPA - Maximum Potential Acidity; ANC – Acid Neutralising Capacity; NAPP - Net Acid Producing Potential

The mean NAPP values for waste rock and coal reject samples tested were -50.0 and -37.8 kg H_2SO_4/t, respectively, whilst the mean ANC / MPA ratios were 122.5 and 40.6, respectively. This indicates NAF and “low risk” (ANC / PA) acid forming characteristics (see Figure 8-7). The cumulative distribution of total sulfur (%S) in waste rock and coal reject samples containing ≤0.3% S was 93% and 96%, respectively (see Figure 8-8).



Source: RGS Environmental 2020

Figure 8-7: Acid-base account - waste rock



Source: RGS Environmental 2020

Figure 8-8: Acid-base account - coal reject samples

8.5.1.1 Coal Resource Sulfur Assay Data

In addition to the ABA completed on waste rock and coal reject samples, RGS Environmental also completed a review of the sulfur assay data for 292 coal samples. The samples were split at the coal quality laboratory (ALS Richlands Laboratory) based on particle size (i.e., ± 0.125 mm) with the + 0.125 mm size fraction split again based on the density of the particles.

The results show that most of the coal samples (83%) have total sulfur values in the range 0.3 to 0.7 %S and approximately 8.5% have a total sulfur value greater than 1 %S.

It is important to note, that these total sulfur concentrations include all forms of sulfur, including sulfate, organic sulfur (sulfur comprising organic compounds within the coal) and sulfide sulfur. It is only the sulfide sulfur (e.g., pyrite and/or marcasite) which can contribute to the generation of acidity. In many coal samples, a significant proportion of the sulfur species is likely to be organic sulfur, which does not contribute to potential acid generation.

The sub-0.125 mm fraction contains the largest range of total sulfur concentrations, excluding outliers, of approximately 0.08 % to 1.38 % total sulfur with a median of 0.54 % total sulfur. Sub-samples of material larger than 0.125 mm show decreasing total sulfur ranges and medians with increasing material density. The density of pyrite (the primary acid producing sulfide) is approximately 5.0 g/cm^3. These results suggest that the total sulfur content of the coal materials is skewed towards the fine fraction. Fine coal reject materials are mainly comprised of coal fines which generally contain a higher proportion of organic sulfur than coarse coal reject material. The ABA (and NAG) test results for fine coal reject materials described above tend to confirm this finding in that most fine reject samples are classified as NAF and none are classified as PAF.

8.5.2 Geochemical Characterisation

Geochemical characterisation has been undertaken for 195 samples (including overburden and potential coal reject samples) from 15 bore holes covering a range of depths from 11.6 meters below ground level (Mbgl) to 147 Mbgl in various lithologies.

The majority of waste rock samples were classifiable as NAF. A total of four waste rock samples had positive NAPP, one of which was classifiable as PAF, two as low capacity PAF and one sample classified as uncertain. The majority of the potential coal reject and fine reject samples were also classifiable as NAF. A total of two coal reject samples had positive NAPP, which were both classified as uncertain. No coal reject material samples were classified as PAF.

A summary of the geochemical characterisation (for all 195 samples) is provided in Table 8-9 and the location and classifications shown in Figure 8-9. Although coal reject samples are likely to be treated separately (in terms of their handling / storage) they were considered together with overburden in the following summary to consider the risk of acid generation and potential trends for mine waste overall.

Table 8-9: Summary of geochemical characterisation

Borehole	No. of Samples	Depth Range	Max NAPP kg H2SO4/t	Lithology for Samples with Positive NAPP (and depth of sample)	Sample Classifications
STX083	10	12.1 -75	-9.8	-	100% Samples NAF
STX095	14	24.4 -79	-13.5	-	
STX099C	11	20.5 -69	-5.4	-	
STX101C	20	19.6 -73.7	-10.3	-	
STX103C	14	15.4 -71.2	-16.8	-	
STX104CR	4	30.2 -98.1	-33.4	-	
STX105	10	26 -69.2	-12.6	-	
STX122C	11	22 -75.1	-8.3	-	
STX124	11	23.6 -76.2	-26.7	-	
STX134C	11	23.2 -78.1	-10.6	-	
STX135C	10	11.6 -70.4	-10.8	-	
STX136C	11	14 -74.6	214.3	Sandstone (Pyritic) (20.35 – 20.6 m)	91% NAF and 9% PAF
STX139C	9	33.9 -72.5	-15.4	-	100% NAF
STX145C	17	14 -128.6	4.3 9.3	Mudstone/Siltstone (64 – 64.5 m) and Siltstone (87.8 – 88.2 m)	94% NAF and 6% PAF
STX148C	11	59.6 -147	18.9	Sandstone (Pyritic)	79% NAF, 14% uncertain and 7% PAF (low capacity)
A1 S1.50	1	N/A	-70.5	-	NAF
A2 S1.50	1	N/A	-112.6	-	NAF
A3 S1.50	1	N/A	-48.2	-	NAF
A4 S1.50	1	N/A	-237.0	-	NAF
A5 S1.50	1	N/A	-271.4	-	NAF
A6 S1.50	1	N/A	-322.7	-	NAF
A7 S1.50	1	N/A	-120.2	-	NAF
A8 S1.50	1	N/A	-61.8	-	NAF
A9 S1.50	1	N/A	-39.4	-	NAF
A10 S1.50	1	N/A	-85.2	-	NAF

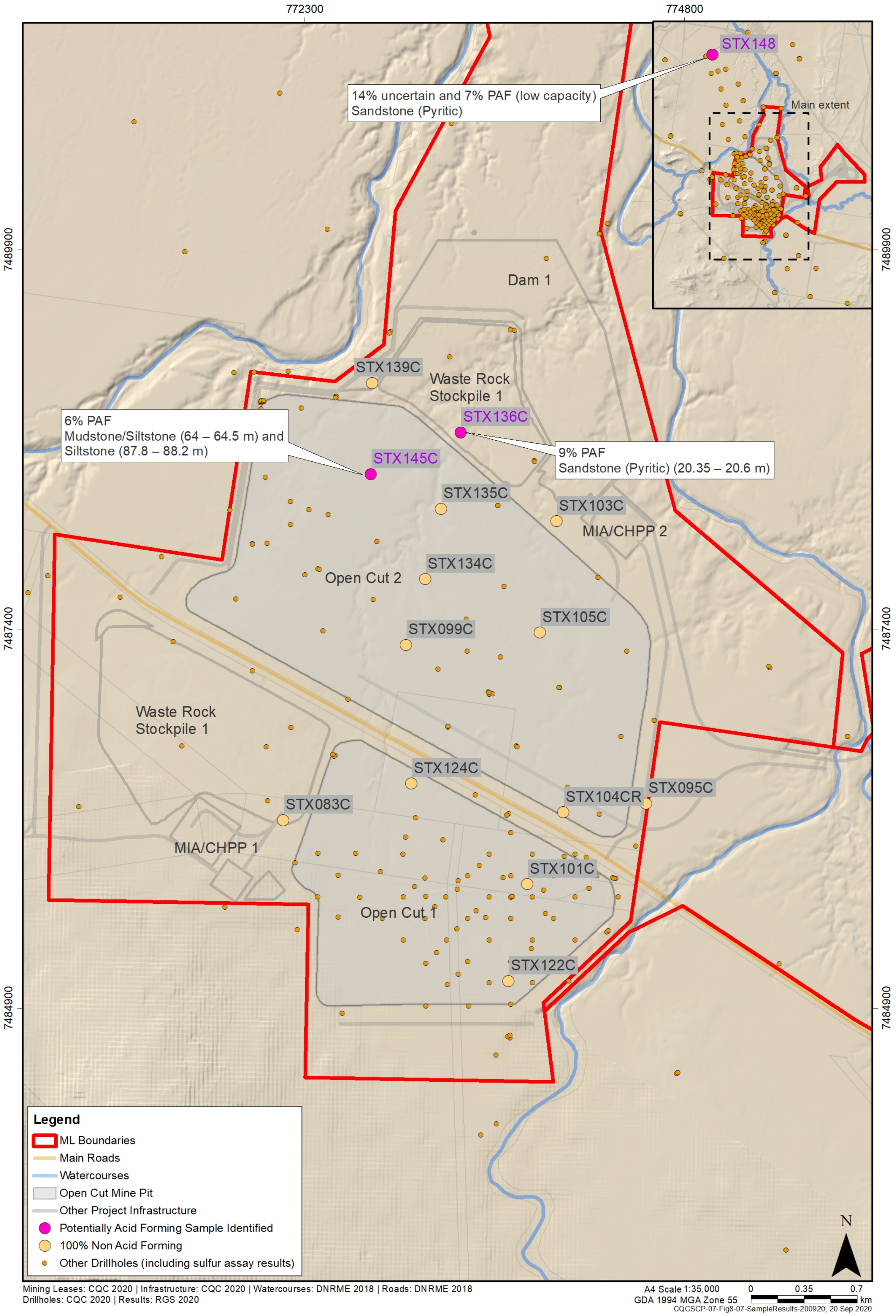
Borehole	No. of Samples	Depth Range	Max NAPP kg H2SO4/t	Lithology for Samples with Positive NAPP (and depth of sample)	Sample Classifications
A11 S1.50	1	N/A	-51.4	-	NAF
B1 S1.50	1	N/A	-101.6	-	NAF
B2 S1.50	1	N/A	-29.8	-	NAF
B3 S1.50	1	N/A	-218.7	-	NAF
B4 S1.50	1	N/A	-26.0	-	NAF
C1	1	N/A	-16.7	-	NAF (Barren)
C2	1	N/A	4.2	Unknown	Uncertain
C3	1	N/A	-17.0	-	NAF
C4	1	N/A	-15.5	-	NAF
C5	1	N/A	-14.3	-	NAF (Barren)
C6	1	N/A	-6.9	-	NAF

The only clear indicator for the presence of acid generating materials based on the geochemical data collected to date is the presence of pyritic materials amongst the samples. In terms of acid generation, the coal reject samples were similar (sulfur content and acid neutralisation capacity) to overburden samples (one sample was identified as having acid production potential > ANC).

The data distribution shows that the frequency of samples with sulfur content (acid generation capacity) in excess of its neutralising capacity is very low. The majority of samples had low total sulfur content with some neutralising capacity (generally greater than its acid production potential) (refer to Figure 8-10).

Overall, over 97 % of mining waste materials tested were classifiable as NAF. Whilst some material may occur with uncertain or PAF characteristics, the PAF materials appear to be visually distinguishable in the field (through the rare occurrence of pyrite). When pyritic materials are identified, it is recommended these materials are managed by selective handling and encapsulation.

A kinetic leach study was also undertaken to support the conclusion for low acid generation potential. Although no visual indicators were noted for presence of pyrite, the oxidation of composite materials showed no indication of acidification over the study period. Previous experience has shown that when a small amount of acid generating materials is mixed with NAF materials (with acid neutralisation potential), the net acid generation potential of the overall mixture may be effectively buffered.



14% uncertain and 7% PAF (low capacity)
Sandstone (Pyritic)

6% PAF
Mudstone/Siltstone (64 – 64.5 m) and
Siltstone (87.8 – 88.2 m)

9% PAF
Sandstone (Pyritic) (20.35 – 20.6 m)

Mining Leases: CQC 2020 | Infrastructure: CQC 2020 | Watercourses: DNRME 2018 | Roads: DNRME 2018
Drillholes: CQC 2020 | Results: RGS 2020

Figure 8-9: Location and sample classifications

Considering the above, the data collected to date is considered sufficient to support the conclusion that the risk of acid generation from waste rock is low.

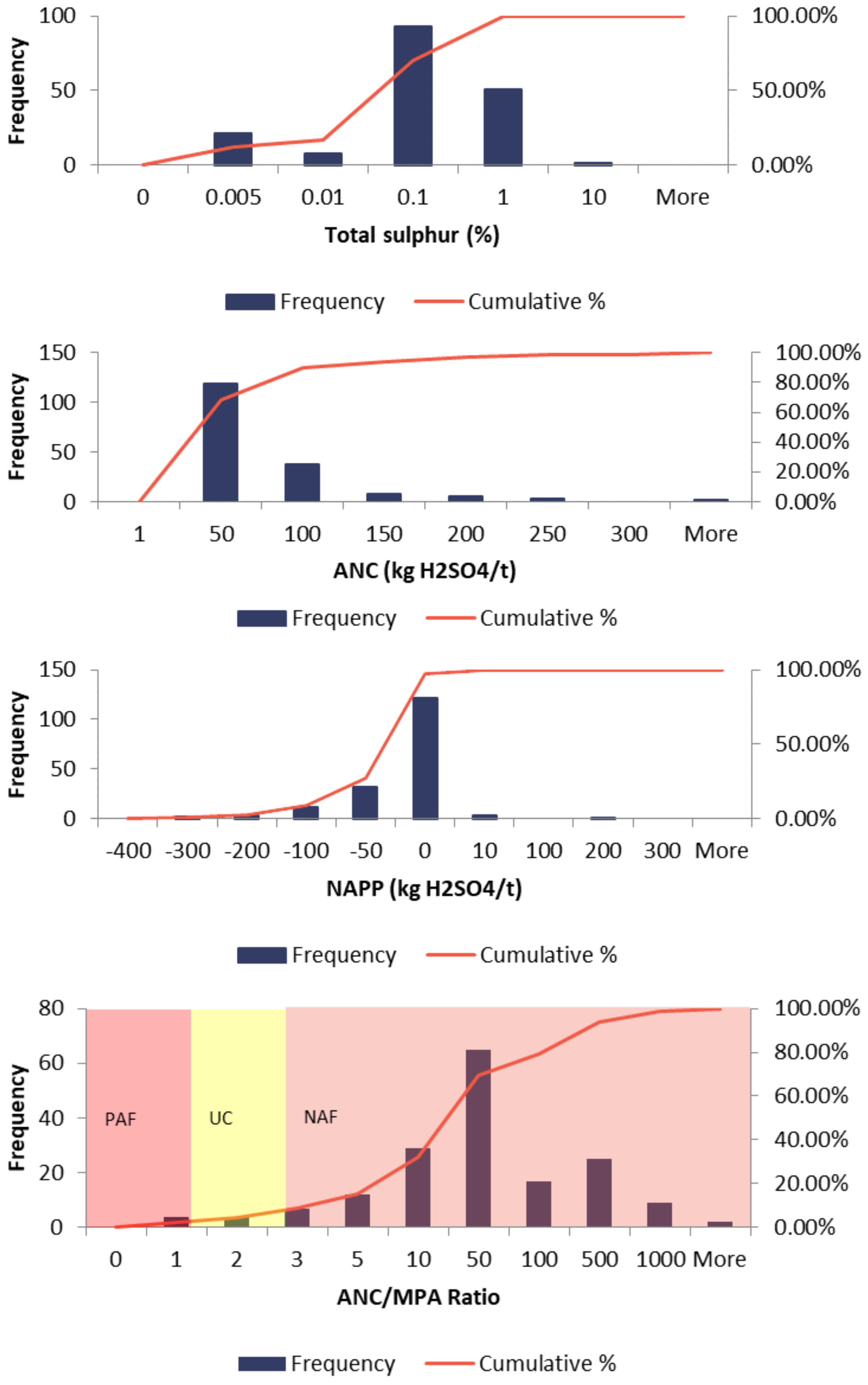


Figure 8-10: Geochemical data distribution

8.5.3 Multi-element Solid and Solutions (Leachate Potential)

A total of 15 composite samples were analysed for solid and solution concentrations of multi-elements to determine the level of risk associated with leachate generated from waste rock (12 composite samples) and coal rejects (three composite samples). A further 21 individual fine reject samples were subjected to multi-element scans in 2018 in response to stakeholder comments on the SEIS. The multi-element scans were completed to identify any elements (metals/metalloids) present in the mine waste materials at concentrations that may be of environmental concern with respect to materials handling, storage and water quality.

In order to provide some context, the multi-element results for the waste rock and coal reject samples were compared to the median background concentration (median crustal abundance) of those elements (metal/metalloids) in unmineralised soil.

The concentration of multi-elements in composite samples was also compared to the average abundance of the element, based on Bowen (1979). The comparison methodology used the Global Abundance Index (GAI), with the following formula:

$$GAI = Int\left(log_2\left(\frac{Measured\ Concentration}{1.5\ x\ Average\ Abundance}\right)\right)$$

A zero or positive GAI value indicates enrichment of the element in the sample when compared to average-crustal abundances. Generally, a GAI greater than or equal to 3 indicates enrichment to a level that may warrant further investigation. The actual enrichment ranges for the GAI values are as follows (from GARD Guide):

- GAI = 0 represents <3 times median soil content
- GAI = 1 represents 3 to 6 times median soil content
- GAI = 2 represents 6 to 12 times median soil content
- GAI = 3 represents 12 to 24 times median soil content
- GAI = 4 represents 24 to 48 times median soil content
- GAI = 5 represents 48 to 96 times median soil content and
- GAI = 6 represents more than 96 times median soil content.

The GAI results indicate that all of the waste rock and coal reject samples tested have GAI values less than 3 for all elements and are not significantly enriched with metals/metalloids compared to unmineralised soils (INAP 2019 and Bowen 1979).

The leachate analysis results of the 15 composite samples undertaken by RGS Environmental were compared to the following assessment criteria:

- ANZECC / ARMCANZ 2000 Trigger Values for slightly to moderately disturbed aquatic ecosystems (95% level of protection)
- ANZECC / ARMCANZ 2000 Primary Industries (Irrigation) and General Water Use, Long Term Trigger Values and
- ANZECC / ARMCANZ 2000 Primary Industries Livestock Drinking Water Quality.

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 were 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. As such, the results of screening tests on water extract solutions are assumed to represent a 'worst case' scenario for initial surface runoff and seepage from waste rock materials.

The concentration of major ions in the water extracts is dominated by sodium, chloride and sulfate whereas the concentration of calcium, magnesium and potassium is below the laboratory limit of reporting (LoR). The concentrations of calcium and sulfate in the water extracts are also well below the applied livestock drinking water quality guideline values for these ions (1,000 mg/L) (ANZECC & ARMCANZ 2000).

The concentration of trace metals/metalloids tested in the water extracts is typically low, predominantly below the laboratory LoR, and generally below the applied water quality guideline criteria where these exist. The concentrations of aluminium (3 samples), arsenic (13 samples) and selenium (11 samples) is elevated in some of the water extracts compared to the applied freshwater aquatic ecosystem guideline concentration trigger values (95% species protection level). However, the only elements that are greater than the applied livestock drinking water guidelines are arsenic (1 sample), and selenium (5 samples) (ANZECC & ARMCANZ 2000).

Due to a number of factors in the field (compared to the laboratory), including scale-up, particle size distribution, hydrology, preferential flow paths, surface reactions and dilution, any direct comparison of soluble multi-element concentrations in laboratory leachate with water quality guidelines is strictly not valid and should be used with caution.

Notwithstanding, a range of parameters including soluble metals/metalloid concentrations will be regularly monitored in the surface water and groundwater quality monitoring program for the Project.

8.5.4 Saline and Sodic Drainage Potential

The characterisation of the waste rock was undertaken in accordance with the Assessment and Management of Saline and Sodic Waste Guideline of the Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland series (DME 1995c). Salinity and sodicity affect the erodibility of mining waste, with salinity generally supressing the degree of dispersion and sodicity increasing the likelihood of clay dispersion when wet. Sodic waste can also have extremely low permeability, impeded drainage, hard-set when dry and have potential for tunnel erosion.

Composite waste rock and potential coal reject samples were analysed and classified in accordance with the indicative criteria (Table 8-10) for saline and sodic material summarised in Table 8-11.

Table 8-10: Indicative saline and sodic material

Parameter	Very low	Low	Medium	High	Very high
pH (1:5)	<4.5	4.5-5.5	5.5-7.0	7.0-9.0	>9.0
Electrical conductivity (EC) (dSm-1) (1:5)	<0.15	0.15-0.45	0.45-0.9	0.9-2.0	>2.0
Electrical conductivity (dSm-1) (saturation extract)	<2	2-4	4-8	8-16	>16
Chloride (ppm)	<100	100-300	300-600	600-2000	>2000
Exchangeable Sodium Percentage ESP (%)	<2	2-6	6-12	12-20	>20

Parameter	Very low	Low	Medium	High	Very high
Cation Exchange Capacity (CEC) (meq/100g)	<6*	6-12	12-25	25-40	>40
Calcium /Magnesium Ratio (Ca:Mg ratio)	<1	1-2	2-5	>5	

Source: DME 1995c

Table 8-11: Saline and sodic drainage potential results

Parameter	Composite Sample														
	Overburden												Potential Coal Reject		
	1	2	4	5	6	7	9	10	11	12	13	14	3	8	15
pH (1:5)	9.6	9.8	9.9	9.8	9.6	9.9	9.9	10.0	9.6	8.6	10.0	9.0	9.2	9.5	9.8
EC (dS/m) (1:5)	0.63	0.65	0.66	0.57	0.64	0.53	0.61	0.61	0.55	0.65	0.56	0.42	0.51	0.59	0.55
ESP (%)	34.6	39.5	41.8	31.7	34.7	42.8	28.9	32.2	33.1	34.2	42.7	34.4	36.3	36.6	39.2
CEC (meq/100g)	69	80.2	78.7	58.4	70	61.8	75.4	72.9	67.4	76.1	65.5	55.2	57.9	74.5	70
Ca:Mg ratio	2.3	10.4	6.7	5.7	1.9	5.3	3.6	4.7	13.6	2.4	5.4	14.5	0.9	4.8	3.4
Salinity Classification	Medium														
Sodicity Classification	Very High														

Composite waste rock and potential coal reject samples were alkaline (greater than pH 7) displaying a very high pH (8.6 to 10.0 pH). The salinity (measured using EC) (1:5) of the samples was generally moderate (0.42 to 0.66 dS/m).

Sodicity of waste rock and coal reject composite samples, in the form of Exchangeable Sodium Percentage (ESP: %), were very high (28.9% to 42.7%). Strongly sodic materials are likely to have structural stability problems related to potential dispersion, leading to erosion of materials. Surface water runoff collected from dispersive materials is typically high in suspended sediments. In addition to potential dispersion, sodic materials often have unbalanced nutrient ratios that can lead to macro-nutrient deficiencies. The addition of gypsum to sodic waste rock materials, covering with a well vegetated subsoil/topsoil cover and or use of a surface rock mulch as part of rehabilitation has the potential to lower the sodicity and reduce the potential for dispersion and erosion.

8.5.5 Kinetic Leach Column Results

KLC tests were completed on six composite samples of mine waste materials (four waste rock and two potential coal reject samples). The KLC tests were operated for a period of three months from May to August 2012 under a fortnightly watering and leaching regime. The results of the KLC testing program for the six composite samples of mine waste materials is described in further detail in the Geochemical Assessment in Appendix 3a, with a summary provided below.

Leachate from the six KLC tests showed a pH value in a relatively narrow range of 8.7 to 9.6 over the test period. The lowest pH value was greater than the pH range of the deionised water used in the test program (typically pH 5 to 6.5). Therefore, it is likely that the mine waste materials add some alkalinity to contact/leaching water. These results suggest that pH values from bulk mine waste materials exposed to oxidising conditions will likely be in the range pH 8.5 to 9.5.

Leachate from the six KLC tests showed EC values in the range of 117 to 1,004 µS/cm over the test period. Most EC values in leachate show a downward trend over time, such that all EC values were less than 500 µS/cm at the end of the test period. These results indicate EC values from bulk mine waste materials exposed to oxidising conditions will be low to moderate. The slightly elevated EC value in the first few flushes from some of the mine waste sample materials is probably due to the increased solubility of minerals through crushing 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 2 mg/L. The alkalinity values in leachate from the KLC tests were more than sufficient to create positive net alkalinity values (i.e., the alkalinity is greater than the acidity) during the test period.

The concentration of major ions in leachate from the six KLC tests was typically dominated by variable concentrations of sodium, chloride and sulfate. The concentrations of the remaining major ions tested (calcium, magnesium and potassium) are less than the laboratory LoR (<1 mg/L).

The sulfate release rate from the six KLC samples typically shows a relatively stable trend over the test period. The sulfate concentration in leachate from all of the KLC tests is generally an order of magnitude below the applied guideline value of 1,000 mg/L (ANZECC & ARMCANZ 2000).

The six composite samples used in the KLC tests retain at least ~82.3 % of their inherent total sulfur content after three months of exposure to idealised oxidising conditions, which reflects the slow rate of sulfide oxidation (and low potential for acid generation) for these materials.

The six composite KLC samples retained at least ~99.95 % 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 concentration of trace metals/metalloids in the leachate from the KLC tests is generally low and 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). The only exception is selenium in some of the leachate samples, which show concentrations above the livestock drinking water low risk trigger level (0.02 mg/L).

Compared to the site-specific trigger values detailed in Chapter 9 – Surface Water, exceedances are identified for aluminium, arsenic, molybdenum and selenium, with only some of the sample results exceeding for zinc and vanadium. As also described in Chapter 9, modelling of releases of select metals, including arsenic, selenium and vanadium indicated no impacts to downstream receiving waters.

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 mine waste materials (AMIRA 2002).

The sulfate generation rate from the KLC samples ranged from 9.59 to 29.00 mg/kg/week which is equivalent to a sulfide oxidation rate ranging from 7.96 x 10^{-9} to 2.45 x 10^{-8} kg $O_2/m^3/s$. Mine 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 2002 and Bennett et al. 2000). Hence, all of the mine waste materials tested in the KLC test program fall into this category. Overall, the KLC results reflect the range of material characteristics predicted from the static geochemical test results discussed above.

8.5.6 CHPP Fine Rejects Analysis

In addition to potential coal rejects, CHPP fine rejects were analysed in order to obtain a better understanding of the process waste stream composition and chemistry. Twenty-one process (pulp) samples were analysed for pH, NAPP, EC, NAG and composition (total sulfur and metals). The following sections provide a brief overview of the fines composition and chemistry.

8.5.6.1 EC and pH

The fine reject samples were alkaline with pH ranging from pH 9 - 10.1. There was no significant difference between the pH values of fine rejects and the samples from the various coal seams tested or the waste rock materials (refer to Figure 8-11).

Based on the Department of Minerals and Energy (DME) criteria EC of the fine reject samples ranged from very low to moderate (0.137 - 0.764 dS/m), with a median EC of 0.5 dS/m, with samples generally being low to moderately saline (refer to Figure 8-11). The fine rejects did not differ from other material types tested.

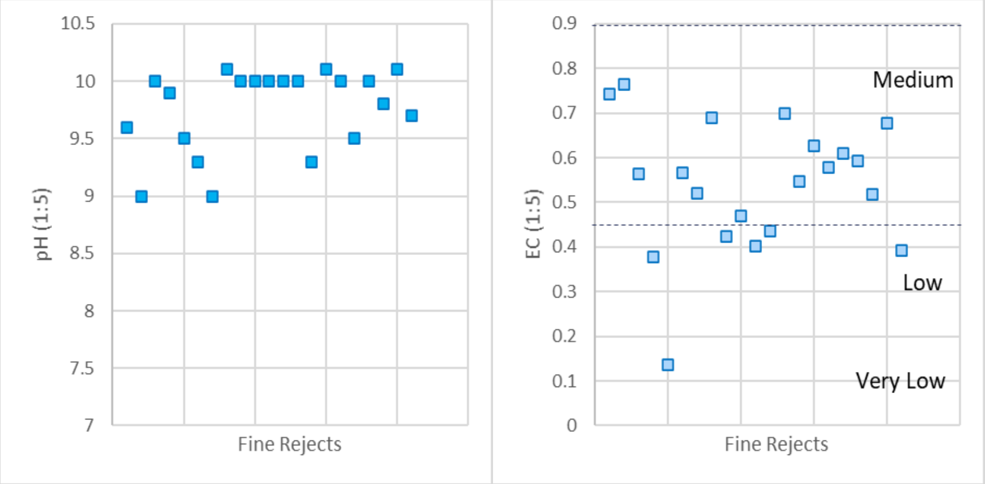


Figure 8-11: Fine Reject Analysis: pH and EC

8.5.6.2 Acidity

In general, the fine reject samples showed low acid production potential. Although some samples had slightly elevated total sulfur contents (up to 1.3%), all but one fine reject sample had net negative acid production potential (refer to Table 8-12). This is likely due to the high buffering capacity present in these materials. Figure 8-12 provides an overview of the ABA for the fine rejects.

Table 8-12: Statistical evaluation of ABA of coal reject materials tested

Parameter	pH OX units	EC mS/cm	Total S %	MPA kg H_2SO_4/t	ANC	NAPP	ANC/MPA
Minimum	3.3	0.14	0.1	3.1	11.4	-322.7	0.73
Maximum	11.1	0.76	1.3	39.8	349	4.2	22.5
Mean	8.5	0.5	0.4	13.1	101.8	-88.7	7.5
Median	8.7	0.6	0.3	10.4	64.3	-51.4	5.6

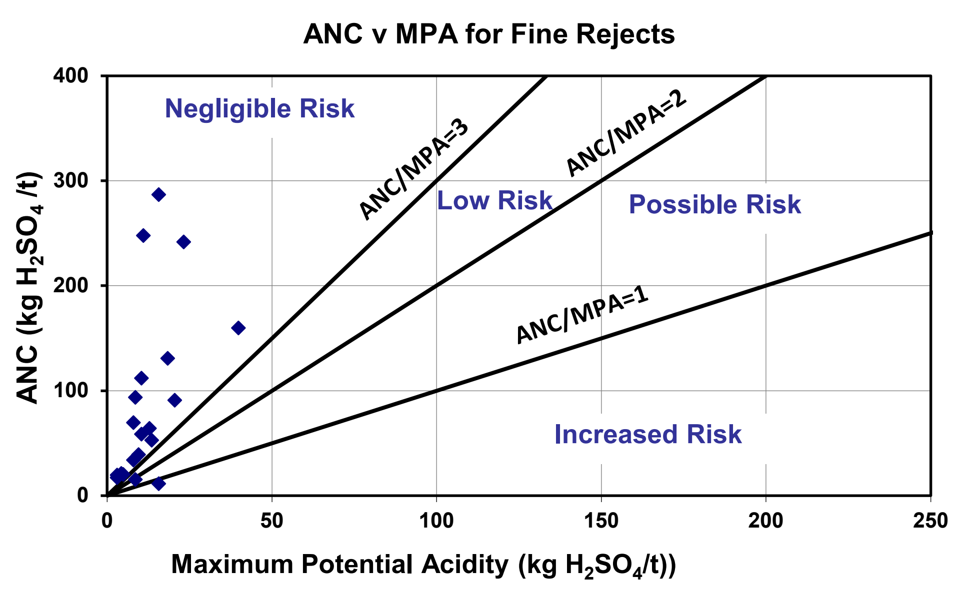


Figure 8-12: Acid-base account – fine rejects

Similar to the potential rejects and waste rock the fine rejects were largely classifiable as NAF with ANC/MPA ratios indicative of negligible risk (refer to Figure 8-12). The acid potential for the fine rejects (tested to date) can be summarised as follows:

- one sample was (PAF-low capacity) (with NAPP 4.2 kg H_2SO_4/t)
- all other samples were NAF (most with relatively high buffering capacity) and
- seven samples were acid consuming with acid neutralization capacity greater than 100 kg H_2SO_4/t.

8.5.6.3 Metals

The elemental composition of fine rejects was similar to the potential rejects and waste rock samples. Comparison to the GAI showed that all elements except mercury were equal to or less than zero. This would suggest that metals do not concentrate as a result of processing.

No leachate analysis was conducted on the fine reject samples; however, it would be expected that leaching properties would remain similar to the untreated potential coal rejects and waste rock. Depending on the particle size distribution, the fine rejects may show a minor increase in leaching due to increased surface area. The leaching of metals and salts from fine rejects would be expected to decrease over time.

8.5.7 Summary

The waste rock and rejects assessment included ABA to allow sampled geologies to be classified into NAF, PAF and uncertain categories; analysis of the sulfur assay data; multi-element testing and KLC testing of samples. The results indicated that:

- In total, 97% of waste rock samples and 96% of coal rejects were NAF. One waste rock sample was PAF, two PAF (low capacity), and one uncertain, while two coal reject samples were classified as uncertain. The PAF samples are identified on Figure 8-9. The PAF material was identified as pyritic which were visually distinguishable in the field, and selective handling and encapsulation is therefore achievable. Overall, however, the bulk material can be considered NAF, confirmed by the results of composite leachate tests which confirm that mixing a small amount of PAF with NAF the net acid generating potential of the overall mixture can be effectively buffered.
- Multi-element testing of composite samples of waste rock and rejects showed that all of the samples tested have are not significantly enriched with metals/metalloids compared to unmineralised soils, and leachate data (based on pulped samples providing conservative results) indicate the leachate is dominated by sodium, chloride and sulfate, with trace metals and metalloids predominantly below the laboratory LoR, with the exception of aluminium (3 samples), arsenic (13 samples) and selenium (11 samples) elevated in some of the samples compared to ANZG default guideline values.
- Composite testing of waste rock and reject drainage potential indicated samples were alkaline (greater than pH 7), with moderate salinity and were classified as strongly sodic.
- KLC testing on composite waste rock and coal reject samples indicate leachate from bulk mine waste materials exposed to oxidising conditions would have a pH in the range 8.5 to 9.5; a low to moderate salinity; very low acidity (with net positive alkalinity); be dominated by sodium, chloride and sulfate ions, with very low calcium, magnesium and potassium; low sulfate (compared to ANZG default guideline values); low metal / metalloid concentrations, with the exception of aluminium, arsenic, molybdenum and selenium, and to a lesser extent zinc and vanadium, in some of the samples.
- Fine rejects were found to be alkaline (pH 9 - 10); low to moderate salinity; low acid production potential with net negative acid production potential and classified largely as NAF; low metal concentrations, indicating metals do not concentrate as a result of processing.

Overall, the bulk waste rock and rejects are anticipated to be NAF with net acid neutralising capacity, have low to moderate salinity and generally low metals concentrations, although most samples were identified as sodic.

8.6 Potential Impacts and Mitigation Measures

Waste rock has the potential to impact on the environmental values presented in Section 8.4 depending on the waste rock size and characteristics. However, the waste rock is expected to have a low capacity to be PAF and moderate saline drainage potential, although it has potential to be highly sodic.

If not appropriately managed, surface runoff and the leaching of mine water into waterways can result in negative impacts on aquatic organisms, changes in water quality which can in turn affect water availability for humans, and livestock.

Sodic and highly sodic materials have potential to cause slaking, are dispersive, and tend to be highly erodible. Surface runoff from highly sodic materials is typically high in suspended sediment loads, leading to high turbidity in mine water dams. Mine waste (overburden and interburden) materials, particularly those placed ex-pit, need to be appropriately shaped and monitored to create structurally and chemically suitable landforms for successful rehabilitation.

Should AMD / SMD enter groundwater, then the following impacts may occur:

- changes to the salinity of groundwater within the water table
- changes to pH of groundwater and the mobilisation of dissolved metals and/or
- effects on stock watering and aquatic ecology dependent on shallow groundwater.

The salinity of rejects is expected to be low and the sodicity is variable. Surface salinity contents of exposed reject surfaces can increase by oxidisation, capillary action and surface evaporation. No deleterious metal concentrations have been detected in tested reject samples.

Rainfall on the reject disposal areas is unlikely to cause any significant mobilisation of contaminants within the solid reject material given geochemistry of rejects.

The management measures for the potential impacts are discussed in the following sections.

8.6.1 Waste Rock Stockpiles Design and Disposal Method

The design and management that has been adopted for waste rock stockpiles in previous versions of the EIS and SEIS has been augmented through the assessment presented in the Geochemical Assessment report in Appendix A3b, and through commissioning of a Land Stability Assessment provided in Appendix A3c. The Land Stability Assessment primarily relates to the stability of mine waste landforms, both during mining and particularly post mining, both geotechnically and geochemically.

Design Considerations

Prior to mining commencing (and therefore movement and stockpiling of waste rock), a detailed geo-environmental block model and detailed landform haulage schedule will be developed to optimise the construction and rehabilitation sequence, and aid in efficient and safe design of the Project. The detailed design of the management of waste rock generated by the Project will account for:

- climate, topography and location of sensitive receptors within the Project area i.e. Tooloombah Creek and Deep Creek
- the geochemical characteristics of the waste rock and its variations across the mine
- expected water balance and water quality controls within the waste rock stockpiles
- measures that provide for safe operations
- compliance requirements of the Project’s EA and minimum performance standards for the mining industry
- costs (in terms of net present value)

- temporary storage of waste rock materials required for the final infilling of all mine void areas at the completion of mining operations, whilst minimising surface footprints and
- facilitating progressive rehabilitation and optimising for mine closure outcomes.

Waste rock management will occur as part of the overall mine plan and the Progressive Rehabilitation and Closure Plan (PRCP). Accordingly, any changes to the PRCP will also require review and, if necessary, updates to the MWMP. This will ensure that any staging requirements are adequately financed and timed to occur as part of site operations, rather than as two separate, unintegrated operations.

The proposed method for waste rock is to initially truck rejects to an out-of-pit waste rock stockpile area during the development phase of each open cut. This area would be graded, compacted and temporarily rehabilitated (including the installation of appropriate water management structures within and surrounding these landforms) to ensure no internal pooling of water and to minimise erosion impacts and the infiltration of water into spoils within the waste rock stockpile areas. Given the potentially sodic nature of waste rock materials to be stored within these waste rock stockpile areas, external stockpile faces and temporary upper landform terraces will be armoured with competent and durable rock which is proposed to be sourced from the mining area.

An area of approximately 8.4 ha of the western most portion of Waste Rock Stockpile 2 will be shaped down and rehabilitated to the final landform design in Project Year 4. This rehabilitated area will be subject to ongoing monitoring and review throughout the mining operations to assist in refining and optimising the final landform design and associated rehabilitation activities to be undertaken during the later years of the mine life.

Surface water runoff from these temporary waste rock stockpile areas will be contained within the mine water management system. Reject materials will be emplaced either at the core of the waste rock stockpiles or deep within the completed mining areas (below the final landform heights). Surface runoff will be diverted away from these materials prior to these areas being covered with waste rock.

As operations progress through the open cuts, the area behind the working face will receive the waste rock and reject materials, where it will be permanently disposed of to fill the mining void. At the completion of open cut operations, materials from the waste rock stockpiles will be used to infill the remaining void areas to ensure that no final void remains within the landscape. Any surplus materials remaining within the waste rock stockpile areas will be shaped down to the final landform design and rehabilitated (see Chapter 11 – Rehabilitation and Decommissioning).

The use of the waste rock stockpiles to temporarily store these materials required for the final rehabilitation of the site provides an opportunity to minimise land disturbance by the Project whilst also ensuring a final landform with no residual void at the end of the mine life. The siting of the waste rock stockpile areas has accounted for sensitive site receptors, surface and groundwater drainage impacts, proximity to the CHPPs and health and safety risks. These factors will continue to be considered during detailed design of the waste rock stockpiles.

In terms of environmental risk, overburden, interburden and potential coal reject materials tested to date are expected to have a very high potential for dispersion (erosion). The disposal of these mining wastes whether out-of-pit or in-pit will be designed in a manner that avoids and minimises the potential for the waste rock to cause environmental harm through erosion.

The Land Stability Assessment in Appendix 3c has identified the use of the regolith (i.e. the weathered zone) to be used to underly and support the growth medium over deep cut and waste rock stockpile areas on the final landform. The regolith within the project area is variable and has been recorded around 25 Mbgl at most locations. The regolith includes sand, and clay lenses, and weathered claystone, siltstone, and sandstone. Geotechnical analysis completed for the Project (AMEC 2017 and Cardno 2018) verify that the weathered profile is deep and is dominated by fines. The regolith was predominantly categorised as NAF and observed to exhibit low to moderate salinity. The fine-grained nature of the regolith units would make them suitable to retain soil moisture and provide high quality rehabilitated soil profiles. There is also the potential for regolith to be utilised for primary growth media (i.e. top and/or subsoils) with suitable amelioration, although the soil mass balance presented in Chapter 5 – Land indicates that no additional soil material will be required.

Sourcing of material with low sodicity will be important for the final shaping and rehabilitation of the waste rock stockpiles. Thus, it is proposed that materials characterised and validated as non-dispersive and non-sodic, and materials that are competent and durable are preferentially used for the outer slopes of waste rock stockpiles to limit the potential for dispersion and erosion. Materials identified as sodic will be disposed of within the central (inner) zones of waste rock stockpiles, wherever possible. Where required, sodic materials requiring emplacement on the outer slopes may need to be treated with gypsum (or other suitable material) to facilitate vegetation establishment and minimise the potential for dispersion and erosion of these materials.

Surface run-off and seepage from waste rock stockpiles and any rehabilitated areas will be contained within the mine water management system and monitored for a standard suite of water monitoring parameters in accordance with the Project-specific MWMP.

In terms of mine closure planning, this approach means that the waste rock used for the final landform covering should comprise material that has a relatively low salinity and low potential for dispersion. All waste rock stockpiles will initially be placed at angle of repose for geotechnical stability. The remaining materials within the waste rock stockpiles at the completion of mining will be flattened to the landform design prior to final rehabilitation.

Waste rock stockpile embankments will be monitored for performance. This will ensure stability of the embankments during and following operations. Piezometers may be installed within and surrounding the waste rock stockpiles to monitor groundwater levels (see Chapter 10 – Groundwater regarding groundwater monitoring).

A meteorological station is installed at the site and will continue to be used throughout the life of the Project to monitor and record rainfall and evaporation data.

Survey monuments would be installed along each embankment of the waste rock stockpiles. These monuments would be surveyed on a regular basis to detect any embankment movements. The information derived from both piezometers and monuments will be used to assess the overall stability of the embankments.

The waste rock materials generated during the life of the Project will therefore be appropriately managed to minimise the potential for adverse dispersion and erosion issues.

Where rock from the Project area is used in the construction of roads and hard-standing areas, for example, engineering and geotechnical testing will be undertaken to prior to their use to determine the propensity of the materials to erode given their potential sodicity. More sodic and dispersive materials will be identified and selectively handled and managed.

8.6.2 Coarse and Fine Rejects Disposal Method and Containment

The management of coarse and fine rejects will follow the same principles for waste rock as described above. It will also follow the management principles set out in the Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland (DME 1995c). It should be noted that the majority of overburden is inert, with only a very small portion of overburden having potential to generate acidic drainage. Rejects management will:

- produce stable rejects that will be mixed with overburden and buried at the core of the waste rock stockpiles and/or in-pit
- minimise disturbance to the environment by strategically and heavily diluting all rejects with overburden material in a centre location at the core of the out-of-pit waste rock stockpiles in the initial years of operation, prior to Steady State Mining and all rejects in the open cut mine void, after mining operations have reach Steady State and
- minimise risks to the environment through appropriate design and construction of rejects management facilities and waste rock stockpiles.

Dried coarse rejects and filter pressed rejects will be mixed with overburden waste and strategically placed within both the out-of-pit waste rock stockpiles and in the open cut mine void. All overburden will be characterised and the benign material will be preferentially placed in the upper layers and on the surface of the waste rock stockpiles, ensuring the surface material contains a percentage of clay, prior to top soiling and seeding. If PAF or saline reject material is unavoidably placed near the surface of the waste rock stockpiles, this area will be capped with inert material prior to topsoiling and seeding. The reject solids will be monitored to determine pH, EC, sulfur species and acid neutralising capacity (initially monthly) until geochemical trends have been established. Monitoring will then continue annually.

All of this material will be placed and capped below the final landform surface so that no rehandling is required.

In terms of mine closure planning, the management of reject materials as described above will ensure that the final landform will not contain carbonaceous materials at the surface and the salinity and dispersion potentials will be appropriate managed.

8.6.3 Water and Fine Rejects

Fine rejects will be dewatered prior to their disposal using filter press technology. The coal fraction of the fine reject materials will be beneficiated using spirals with desliming cyclone overflow being pumped to the fine rejects thickener, where flocculent will be added. The thickened fine rejects are then passed through a filter press where the moisture content is reduced to approximately 26%. A dry paste like material is produced. These pressed fine rejects are then discharged onto the rejects conveyor for disposal with coarse rejects via the reject bin.

Haul trucks which offload coal at the ROM stockpiles, will be backloaded at the reject bin to transport the coarse and fine rejects to the pit. A more detailed description is provided in Chapter 1 – Introduction and Project Description.

Filtering fine rejects is not new and more mines are choosing the process to reduce water consumption, limit seepage from the fine rejects and build a stable stack not subject to slope failure or flow (Murphy and Caldwell 2012). Within Australia, the following mines use this membrane filter press technology: Dartbrook Coal Mine (Bickert 2004) Daunia, Bengalla, Maules Creek, Moolarben and Cavil Ridge. Several mines located overseas also use this technology including:

- Alamo Dorado and El Sauzal mines in Mexico
- Greens Creek and Pogo mines in Alaska
- La Coipa in Chile
- Raglan in Canada
- Coeur Manquiri mine in Boliva and
- South African coal mines (Murphy and Caldwell 2012).

CQC proposes to manage rejects through design measures that avoid the production of a fine rejects slurry stream and measures to achieve the reuse of the solids. This approach is consistent with the adopted waste management hierarchy (see EIS Chapter 7 – Waste Management). The proposed management of rejects further meets the objectives of the Tailings Management Guideline of the Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland series (DME 1995c). These objectives being:

- Filter press produces stable fine rejects which are rehabilitated within the landform.
- The process of creating a solid waste minimises and avoids additional disturbance required for traditional wet slurry disposal cells.
- It minimises the threats to the environment both during mining and after rehabilitation. Dry overburden integration and stacking minimises seepage, removing the risks of groundwater contamination. This waste management option has a higher operational cost; however, lower rehabilitation costs and avoids lengthy ongoing closure monitoring requirements of traditional tailings settlement ponds.
- Adequate environmental protection is achieved through the minimisation of water consumption, as water is recovered and reused in processing. It also negates the need for storage structures and can provide for concurrent reclamation.

This process has considerable long-term economic, social and environmental benefits.

8.6.4 Mineral Waste Management Plan

Waste rock and coarse and fine rejects generated during the extraction of the resource have the potential to impact upon the environmental values described in Section 8.4 if they are not appropriately managed. Management measures have been determined in response to these potential impacts and best reflect the requirements for land management throughout the construction, operation and rehabilitation phases of the Project.

As summarised in Section 8.5.7, waste rock and rejects are expected to be, and to generate leachate that can be described as, NAF with net acid neutralising capacity, have low to moderate salinity and generally low metals concentrations, although most samples were identified as sodic. As such, the key risk in waste rock and rejects management is sodicity and therefore erosion. As identified within the Land Stability Assessment in Appendix A3c, landform structural stability and shape is also important to consider.

Prior to construction commencing, a detailed geo-environmental block model of the mining domain will be developed, using the existing CQC geological block model, the soil profile data (refer Chapter 5 – Land) and the 3D hydrogeological model prepared for the numerical groundwater model (refer Chapter 10 – Groundwater), infilled with additional drilling where required. From this landform design will be undertaken alongside a detailed landform haulage schedule to ensure material is excavated, hauled and dumped with the overall end in mind (i.e. a safe, stable, and non-polluting final landform). The block model will be updated throughout the mine life as new information becomes available through the mining process.

The above works will include further geochemical investigations both prior to and during mining operations to refine the current knowledge of the overburden and interburden geology within the proposed open cut mine areas.

A draft MWMP is included in the draft EMP in Appendix 12 and will be updated and finalised prior to works commencing on-site. The plan includes the following key elements:

- Characterisation of the mining waste to predict, under the proposed placement and disposal strategy, the quality of run-off and seepage generated including salinity, acidity, alkalinity and dissolved metals, metalloids and non-metallic inorganic substances.
- Mineral waste field and laboratory testing procedure for validation of the acid-forming and potential erodibility characterisations of each phase.
- Classifying waste rock zones (based on acid forming potential, salinity and sodicity), placement and use of waste rock materials and appropriate disposal of PAF waste or waste designated as not suitable for use on final surfaces.
- Ex-situ waste rock stockpile design criteria, including preferred selective placement of each waste domain, stockpile heights, stockpile profiles, conceptual final landform design.
- Monitoring and management of erosion, groundwater and surface water (including runoff and seepage) from the waste rock stockpiles and stability monitoring, such as placement of monuments on and around waste rock stockpiles.
- Progressive rehabilitation strategies, including development and continuous update of the site wide geo-environmental block model, the groundwater model, and hydrological / water balance models to assist with waste rock stockpile design, water management and closure planning.

8.7 Qualitative Risk Assessment

Potential impacts on the land resulting from a combination of construction of the proposed infrastructure and ongoing mining activities within the Project area have been assessed utilising the risk assessment framework outlined in Chapter 1 – Introduction. The risk impact assessment at Table 8-13 is a qualitative risk assessment that outlines the potential impacts, the initial risk, mitigation measures and the residual risk following the implementation of the mitigation measures. Soil management strategies in the form of mitigation measures are also identified.

For the purposes of this risk assessment, risk levels are defined as follows:

- Extreme – Extensive long-term harm with widespread impacts that are irreversible in 5-10 years. Significant non-compliances with the EA and / or other approval conditions that result in significant degradation to environmental values.

- High – Major long-term and widespread harm that are reversible in <5 years. Non-compliances with the EA and / or other approval conditions that result in major degradation to environmental values.
- Medium – Moderate environmental harm that is contained onsite or minor widespread harm that are reversible in <1 year. Non-compliances with the EA and / or other approval conditions that result in minimal degradation to environmental values.
- Low – Minor unplanned onsite harm that does not extend off-site. No non-compliances with the EA and / or other approval conditions.

Table 8-13: Qualitative risk assessment

Issue and associated Project phase	Potential impacts	Potential risk	Mitigation measures	Residual risk
Waste rock				
Surface water, AMD from overburden resulting in contamination of waterways Land Contamination (Construction Operation and Decommissioning)	The waste rock is expected to have a low capacity to be PAF and has a moderate saline drainage potential. The majority of the waste rock has potential to be highly sodic. There is some potential for surface runoff (and leachate) from the waste rock and fine rejects to enter local waterways and degrade water quality. The release of mine water into waterways can result in negative impact on aquatic organisms, changes in water quality which can in turn affect water availability for humans, and livestock. Sodic and highly sodic materials have potential to cause slaking, are dispersive, and tend to be highly erodible. Mine waste (overburden and interburden) materials, particularly those placed ex-pit, need to be appropriately shaped and compacted to create structurally and chemically suitable landforms for successful rehabilitation. The temporary waste rock stockpiles will be armoured with competent and durable rock materials to manage water runoff and ensure stability of these temporary landform designs. Landforms will be monitored to ensure that they are structurally and chemically stable landforms that will support the preferred post mining land use (i.e. low intensity cattle grazing operations).	**Medium**	The following measures are provided to specifically manage impacts from the waste rock stockpiles to local waterways: • Ongoing testing of the waste rock and reject materials for acid drainage potential and selectively handling any materials of particular concern • Divert clean water catchments around mining affected catchments • All contaminated water on-site will be collected using site environmental dams, preventing the water from entering local waterways. These dams and associated water management structures will collect surface runoff water from the waste rock stockpile areas • Water quality monitoring will be undertaken at the environmental dams, mine-affected water dams, discharge locations and locations both upstream and downstream of the Project area to identify compliance with receiving water guideline values • Characterisation of the mining waste to predict, under the proposed placement and disposal strategy, the quality of run-off and seepage generated including salinity, acidity, alkalinity and dissolved metals, metalloids and non-metallic inorganic substances • Treatment of sodic materials (i.e. application of gypsum or other suitable material) which are required to be emplaced on the outer slopes of the waste rock stockpile areas to minimise the potential for dispersion and erosion impacts	**Low**

Issue and associated Project phase	Potential impacts	Potential risk	Mitigation measures	Residual risk
			- More competent and durable rock and non-reactive / non-sodic materials will be preferentially emplaced on the outer slopes of the temporary waste rock stockpile areas to minimise the occurrence of erosion. - Ongoing monitoring and review of the initial rehabilitation of the western portion of waste rock stockpile 2 to be completed in Project Year 4 to refine the current knowledge for the ongoing rehabilitation activities for the mine site - Management of water quality or leaching if impacts detected above trigger levels - Visual inspections of disposal areas and water quality for seepage and vegetation die back - All containment dams and disposal areas will be designed, constructed and monitored for their structural integrity and - All water that discharges to a waterway will meet nominated Project-specific water quality criteria.	
Groundwater Contamination (Construction Operation and Decommissioning)	The waste rock is expected to have a low capacity to be PAF, and has a moderate saline drainage potential. However, the majority of the waste rock material is highly sodic and therefore has the potential to be dispersive and prone to erosion. Should AMD / SMD enter groundwater, then the following impacts may occur: - Changes to the salinity of groundwater (although most groundwater is already highly saline) - Changes to pH of groundwater and the mobilisation of dissolved metals (although the	**Medium**	Ongoing testing of the waste rock and reject materials for acid drainage potential and selectively handling any materials of particular concern to avoid impacts to the neighbouring environment. The potentially sodic nature of the waste rock material would be managed with appropriate erosion and sediment control measures managed as part of the site Erosion and Sediment Control Plan, with highly sodic material being covered with benign material prior to rehabilitation activities. Waste rock and reject materials characterised as moderately saline will be selectively handled and emplaced at the core of the waste rock stockpiles or deep within the open cut pit.	**Low**

Issue and associated Project phase	Potential impacts	Potential risk	Mitigation measures	Residual risk
	leachate is alkaline and unlikely to result in enhanced dissolution of metals) and - Effects on aquatic ecology dependent on shallow groundwater.		Regular monitoring of neighbouring groundwater quality will take place during the life of mine, comprising the following: - Quarterly field measurements of EC and pH of groundwater from the monitoring bores and monthly field measurements of the same parameters for water pumped from the mine, with samples sent to a NATA laboratory - Six monthly sampling of groundwater from monitoring bores and selected landholder bores for laboratory analyses of major ions, total dissolved solids and metals, with samples sent to a NATA laboratory - Regular sampling of groundwater dependent ecosystems and - Further monitoring of water quality if impacts detected above trigger levels and implementation of management measures if impacts recorded.	
Process Waste				
Salinity from Reject Fines Management (Operation)	The salinity of rejects is expected to be low and the sodicity is variable. Surface salinity contents of exposed reject surfaces can increase by oxidisation, capillary action and surface evaporation. No deleterious metal concentrations have been detected in tested reject samples.	**Medium**	Where necessary, surfaces will be progressively capped with benign spoil prior to topsoiling and rehabilitation. Co-disposal of dried coarse and fine rejects with waste rock into waste rock stockpiles and open cut pits will be undertaken, below the final landform surface (where reworking will be undertaken). Filter cake is suitable for rehabilitation and has a low risk of causing water pollution. Highly sodic waste rock materials will be preferentially emplaced either at the core of the waste rock stockpiles or deep within the mining areas and covered with benign material prior to rehabilitation activities, at a level below the final landform surface to avoid exposure when reworking. Those highly sodic materials which cannot be appropriately covered with benign materials will be treated with gypsum (or other	**Low**

Issue and associated Project phase	Potential impacts	Potential risk	Mitigation measures	Residual risk
		🟧	alternate ameliorant) to prepare these materials for rehabilitation. Waste rock monitoring will be conducted during construction and operation to test for EC, pH, NAPP and ESP to identify any materials requiring selective handling and emplacement and/or amelioration and Sodic and dispersive materials will be identified, selectively handled and preferentially placed within the core of the waste rock stockpiles or returned to mining areas away from the final surface.	🟩
Water infiltrating or seeping from reject disposal cells (Operation)	Rainfall on the reject disposal cells is unlikely to cause any significant mobilisation of contaminants within the solid reject material given geochemistry of rejects.	Low	Use of thickeners and filter press technology and dry stacking significantly reduces the risk of seepage from the filter press waste storage. Monitoring of surface water and groundwater quality within and adjacent to disposal cells. Management of water quality or leaching if impacts detected above trigger levels.	Low

8.8 Conclusion

Geochemical characterisation was undertaken for a total of 195 samples (including waste rock and potential fine coal reject samples) from 15 bore holes covering a range of depths from 11.6 Mbgl to 147 Mbgl in various lithologies.

The results found that the bulk waste rock and rejects are anticipated to be NAF with net acid neutralising capacity, have low to moderate salinity and generally low metals concentrations, although most samples were identified as sodic. Very few PAF samples were identified, and can be visually distinguished in the field as pyritic material, which will be selectively handled (although inclusion in the bulk material is expected to have little overall effect).

Based on works to date, the waste rock and coarse / fine rejects generated during the extraction and processing of the resource have limited potential to impact upon the environmental values described in Section 8.4.

Without appropriate management there is some potential for sediment laden surface runoff and leachate from the extracted waste rock and fine rejects to enter local waterways and degrade water quality. Although the waste rock is expected to have a low capacity to generate acidity, it does have moderate saline drainage and sodic potential and the KLC results indicated that leachate may contain elevated concentrations of dissolved As, Mo, Se and V when compared to potential water quality monitoring criteria. The leachate derived from the kinetic leach study generally showed that there is an initial flush of soluble metals / metalloids and salts which decreased after the first two to three flushes. This initial flush is likely related to the particle size; the fine materials with smaller particle size have a larger surface area for chemical reactions to occur and thus tend to yield higher leached metals / metalloids and salts concentrations.

There is likely to be a smaller average grain-size in the laboratory experiments compared to the average grain-size in the waste rock stockpiles. This will likely result in a comparatively reduced ‘first flush effect’. The KLC study, although a short-term study, indicates a reduction in leached concentrations of most species with time. The study appears to show that the release of aluminium, arsenic, molybdenum, selenium and vanadium are not controlled by pyrite oxidation, indicated by the steady decline in leached concentrations.

The waste rock management plan incorporates filter pressing (to reduce water content) and co-disposal with overburden, which is likely to decrease infiltration and subsequent leaching potential of these materials. According to the management plan, the dried coarse rejects and filter pressed rejects will be mixed with overburden waste and strategically placed within both the out-of-pit waste rock stockpiles and in the open cut mine void. The waste water generated by the filter press process will be captured and treated (sedimentation or other process). Discharge of mine affected water as part of the mine water management system assessed as part of Chapter 9 – Surface Water, which included specific consideration of several of the elements identified in the KLC assessment, found no impacts (negligible changes) to downstream surface water quality.

Management measures have been determined in response to mitigating potential impacts and best reflects the requirements for land management through the construction, operation and rehabilitation phases of the Project. These measures include further characterisation of overburden and waste materials which will inform the placement strategy (or treatment) of any PAF and potentially sodic materials.

In addition to engineering controls, water monitoring will be undertaken at the environmental dams, mine-affected water dams, discharge locations and locations both upstream and downstream of the Project area to identify potential risks as they may arise. As identified in the risk assessment, although potential risks and impacts have been identified (associated with the waste rock and coal reject materials) through implementation of adequate controls and monitoring measures the residual risks will be adequately mitigated.

8.9 Commitments

In relation to managing waste rock ad rejects, CQC's commitments are provided in Table 8-14.

Table 8-14: Commitments - Waste Rock and Coal Reject Materials

Commitment
To ensure safe, stable and low maintenance final landforms, CQC will develop a detailed geo-environmental block model and detailed landform haulage schedule to optimise the construction and rehabilitation sequence.
Prepare and implement a Mineral Waste Management Plan prior to commencing operations, setting out design requirements for waste rock stockpiles and management of potential acidic, metalliferous, saline and sodic materials and the design measures to assist with achieving the overall rehabilitation objectives.
Ongoing revision and update of Mineral Waste Management Plan during mining operations and implementation for the life of the mine.
Overburden and coarse and fine rejects disposal will be conducted in accordance with the Project's Mineral Waste Management Plan.
Coarse and fine rejects to be dewatered prior to disposal.
Waste rock and dewatered coarse and fine rejects to be co-disposed.
Materials with risk of dispersal or sodicity to preferentially be placed at the base of waste rock stockpiles and capped beneath unweathered material. Where this is not possible, these materials will be treated with gypsum (or other ameliorant) to minimise dispersion and/or erosion issues within the final landform.
Environmental Manager to ensure surface water and groundwater is monitored according to appropriate guidelines within and adjacent to mine disturbance areas for changes in water quality, in particular salinity and pH, and through visual inspections for seepage.
Outer slopes of the waste rock stockpile areas to be monitored for movement using survey monuments.