

Mine waste and rehabilitation assessment

Carmichael Mine

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Executive summary

The Carmichael Coal Mine (CCM) is a large open cut and underground mining project that will be producing export thermal coal. It is in the northern part of the Galilee Basin, approximately 160 km north-west of the town of Clermont in Central Queensland.

This report addresses material characterisation within the Year 1 to Year 5 mine footprint. The CCM operates under Environmental Authority (EA) EPML01470513 and is approved with a coal extraction rate of up to 74.5 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal in accordance with the EA (DES, 2019).

The aim of this report is to address points (a) and (b) within condition H9 of the EA, relating to Mining Waste and Rejects Management, which state that: "A waste rock, spoil and rejects disposal plan must be developed and include:

- a) effective characterisation of the waste rock, spoil and rejects to predict under the proposed placement and disposal strategy the quality of runoff and seepage generated concerning potentially environmentally significant effects including salinity, acidity, alkalinity and soluble metals, metalloids and non-metallic inorganic substances; and
- b) a program of progressive sampling and characterisation to identify dispersive and nondispersive spoil and the salinity, acid and alkali producing potential and metal concentrations of waste rock, spoil and rejects.

This report presents the findings from previous geochemical reports, and a geochemical assessment of 63 mine waste samples (including soil, subsoil, transition, and overburden materials). The results are used to characterise the materials into beneficial material for rehabilitation or deleterious material that will require active management to reduce the potential for adverse environmental effects.

The strategy for characterising the mine waste materials from the CCM was guided by Australian and international technical guidelines for the geochemical assessment of mining wastes. A range of static geochemical tests were completed on solid samples and leachate produced from a 1:3 rock to water ratio and 16-hour digestion. The geochemical tests were used to assess the degree of risk from oxidation of reactive sulfide minerals and leaching of soluble major ions (salts) and metal(loids).

The main findings of the geochemical characterisation program are as follows:

- 62 of the 63 samples (98 %) are classified as Non-Acid Forming (NAF) and are barren of total sulfur (Barren). NAF_{BARREN} materials will not produce acid or leach sulfate due to the low concentration of sulfide and sulfate minerals.
- The remaining sample (2%) is classified as NAF. NAF materials will not produce acid but may leach sulfate and some metals due to the presence of low sulfide bearing material. Overall, the materials have a very low risk of acid generation and a high factor of safety with respect to potential for Acid and Metalliferous Drainage (AMD).
- NAF and NAF_{BARREN} material still have the potential to leach saline drainage dominated by sodium chloride or sodium carbonate.
- Soil, subsoil, and regolith materials from depths of 0 – 25 m are likely to be dispersive and contribute to saline drainage. They are strongly sodic, have a low effective cation exchange capacity (eCEC), are deficient in exchangeable Ca²⁺, and very high in exchangeable Na. These materials are unlikely to be suitable as cover materials (without amendment), as strong sodicity can result in surface crusting and low infiltration within affected soils.
- The acid-neutralising capacity (ANC) for the samples has a very low median value of 8.8 kg H₂SO₄/t. However, there are a few sandstone samples which have moderate ANC (up to 364 kg H₂SO₄/t). The lithological units with elevated ANC will also have elevated Ca²⁺. This material could be used to amend the exchangeable sodium percentage (ESP) of the low Ca²⁺ soil, subsoil and regolith units and as a rock mulch on soil covers.
- Initial and ongoing surface runoff and seepage from bulk NAF overburden materials is expected to produce water quality that has a neutral pH (median 6.5) and a relatively low EC (median 341 µS/cm).
- The major ion concentrations in the static leach samples are dominated by Na⁺ and Cl⁻.

- The dissolved soluble metal(loid) concentrations in the water leach tests are below the limit of reporting (LoR) for most analytes.
- Slight enrichment was observed for water-soluble Al, B, Ba, Fe, Mn, Sr and Zn. These results can be used to verify baseline conditions and establish rehabilitation criteria.

As a result of the geochemical characterisation work, five recommendations are provided for these materials to minimise the risk of any significant environmental harm, including:

- Implement the 2020 Geochemical Sampling and Analysis Procedure (GaPSaAP) provided to CCM in Q1 2020. The core components of the 2020 GaPSaAP are to:
 - Develop a regolith, overburden and interburden geology model (Geo-Environmental Block Model (GBM)) to quantify the material balance for each of the major units that will be mined.
 - Use the material balance to quantify and apportion the number of samples that should be targeted in each GaPSaAP i.e. units with a large volume of material should have a larger number of samples and vice versa.
 - Use the GBM to schedule the movement and placement of the material that will be mined to minimise rehandling and optimise the financial aspects of the rehabilitation program.
 - Implement a physical testing program into the GaPSaAP to quantify the physical properties of the soil and regolith and the degradation rate of weathered and fresh waste rock to assess the suitability of these materials for rehabilitation. Physical testing may include:
 - Soil water characteristic curve (to test how strongly soil holds onto water);
 - Falling Head permeability test;
 - Particle Size Distribution (PSD) and hydrometer analysis;
 - Point load measurement;
 - Sodium sulphate sound test to test rock strength (include PSD after 3-6 months); and
 - Emmerson Aggregate Test.
- Analysing representative samples of coal and coal reject materials (when available) using static and kinetic geochemical tests to verify the nature of these materials.
- Compiling total sulfur (TS) data from coal quality analyses to produce TS maps to show the concentration, distribution and variability of TS in the coal seams and coal roof and floor units. This could be used to verify the low TS content in the coal and verify the potential for acid drainage is also very low.
- There is a need for a site water quality model to quantify how the water quality in the mine area will evolve over time as the mined material weathers and releases major ions and metal(loids). This model will need to account for the release of major ions over time, and the effects of evaporation and rainfall.
- Additional overburden testing and rehabilitation field trials should be completed when the mine is operational and through each working phase to confirm the most appropriate management option for progressive rehabilitation of these materials during mine operations and at mine closure.

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Glossary of terms and acronyms

ABA	Acid Base Account. Evaluation of the balance between acid generation and acid neutralisation processes. Determines the maximum potential acidity (MPA) and the inherent acid neutralising capacity (ANC), as defined below.
AC	Acid consuming mine waste that has the potential to consume substantial acidity.
ADANI	Adani Mining Pty Ltd.
ALS	Australian Laboratory Services.
AMD	Acid and metalliferous drainage from mine waste materials characterised by low pH, elevated metal concentrations, high sulfate concentrations and high salinity.
ANC	Acid Neutralising Capacity expressed as kg H ₂ SO ₄ per tonne of sample. A measure of a sample's maximum potential ability to neutralise acid.
ANC:MPA	The ratio of the acid neutralising capacity to the maximum potential acidity of a sample. Used to assess the risk of a sample generating acid conditions.
CCM	Carmichael Coal Mine.
CHP	Coal handling plant.
EA	Environmental authority EPML01470513.
EC	Electrical Conductivity, expressed as µS/cm.
EO	Test pit with descriptive notation 'EO' that has been assigned by the geological drilling team.
eCEC	Effective cation exchange capacity provides a measure of the mass of exchangeable cations (Ca, Mg, Na and K) in a sample.
EIS	Environmental impact statement.
ERC	Estimated rehabilitation cost.
ESP	Exchangeable sodium percentage provides a measure of the sodicity of a material and propensity to erode.
EAT	Emmerson Aggregate Test.
FIMS	Flow Injection Mercury System.
GaPSaAP	Geochemical Sampling and Analysis Procedure.
ICP-MS	Inductively Coupled Plasma Mass Spectrometry.
ICP-AES	Inductively Coupled Plasma Atomic Emission Spectrometry.
LoR	Limit of Reporting. Laboratory detection limit for the reporting of results for a particular geochemical test.
MAW	Mine affected water.
MPA	Maximum Potential Acidity. Calculated by multiplying the total sulfur or sulfide-sulfur (CRS) content of a sample by 30.6 (stoichiometric factor) and expressed as kg H ₂ SO ₄ per tonne.
Mtpa	Million tonnes per annum.
MWRM	Mining waste and rejects management plan.

NAF	Non-Acid Forming. Geochemical classification criterion for a sample that will not generate acid conditions.
NAPP	Net Acid Producing Potential, expressed as kg H ₂ SO ₄ per tonne. Calculated by subtracting the ANC from the MPA.
NMD	Neutral and metalliferous drainage typically caused by exposure of sulfide minerals in mine waste materials to oxygen and water and then neutralisation by gangue minerals. Typically characterised by neutral pH and elevated concentrations of salts, sulfate and metals.
NPR	Neutralisation potential ratio. Also referred to as the ANC: MPA ratio.
PAF	Potentially Acid Forming. Geochemical classification criterion for a sample that has the potential to generate acid conditions.
PC Titrator	Potentiometric Compact Titrator. PC Titrators are specially designed for routine applications and simple operation, allowing basic titration analysis from a single device.
pH	A measure of hydrogen ion (H ⁺) concentration; generally expressed as pH.
PRCP	Progressive Rehabilitation and Closure Plan
PSD	Particle size distribution.
ROM	Run-of-Mine. Ore as it comes from the mine prior to screening or processing.
S	Sulfur.
S_{CR}	Chromium reducible sulfur.
SD	Saline Drainage. Water that is elevated in dissolved salts (e.g. Na ⁺ , K ⁺ , Ca ²⁺ , Mg ²⁺ , Cl ⁻ , and SO ₄ ²⁻), but may have acidic, neutral, or alkaline pH.
SO₄²⁻	Sulfate.
Static test	Procedure for characterising the geochemical nature of a sample at a single point in time. Static tests may include measurements of mineral and chemical composition of a sample and the Acid Base Account.
TS	Total sulfur content of a sample generally measured using a 'LECO' analyser expressed as total sulfur%.
w:v	Weight to volume ratio.

1 Introduction

1.1 Project description

The Carmichael Coal Mine (CCM) is 160 km NW of the town of Clermont in the northern part of the Galilee Basin, Central Queensland (**Figure 1-1**). It is a large open cut and underground coal mining project that will produce export thermal coal (**Figure 1-2**). The CCM operates under Environmental Authority (EA) EPML01470513 and is approved with a coal extraction rate of up to 74.5 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal in accordance with the EA (DES, 2019).

1.2 Aim

The aim of this report is to:

- undertake a geochemical characterisation program to increase the knowledge base of the geochemical properties of the material that will be mined within the Year 1 to Year 5 footprint;
- identify and/or assess the risk of material producing AMD;
- develop the database that will be required to produce a Progressive Rehabilitation and Closure Plan (PRCP); and,
- assist with ongoing approvals in relation to the estimated rehabilitation cost (ERC).

1.3 Objectives

The objectives for this mine waste and rehabilitation material assessment are to:

- sample, analyse and classify all materials from the topsoil through to the deepest mined surface within the 5-year footprint for the CCM;
- provide an analytical program that will address the potential for acid, neutral or alkaline drainage, saline drainage and metalliferous drainage;
- address and provide recommendations for managing:
 - deleterious mine waste units (e.g. rejects, tailings, overburden / interburden);
 - beneficial rehabilitation units that will be required for progressive rehabilitation (e.g. topsoil, subsoil units, weathered overburden units for developing growth medium in soil cover systems and competent NAF rock that may be required for lining drains).

The data from ongoing geochemical analyses will be provided to CCM as information becomes available to assist with the planning and scheduling aspects of the project.

With an integrated, cross-discipline planning approach at site, the implementation of the AMD management strategy can be effective and eliminate subsequent environmental issues.

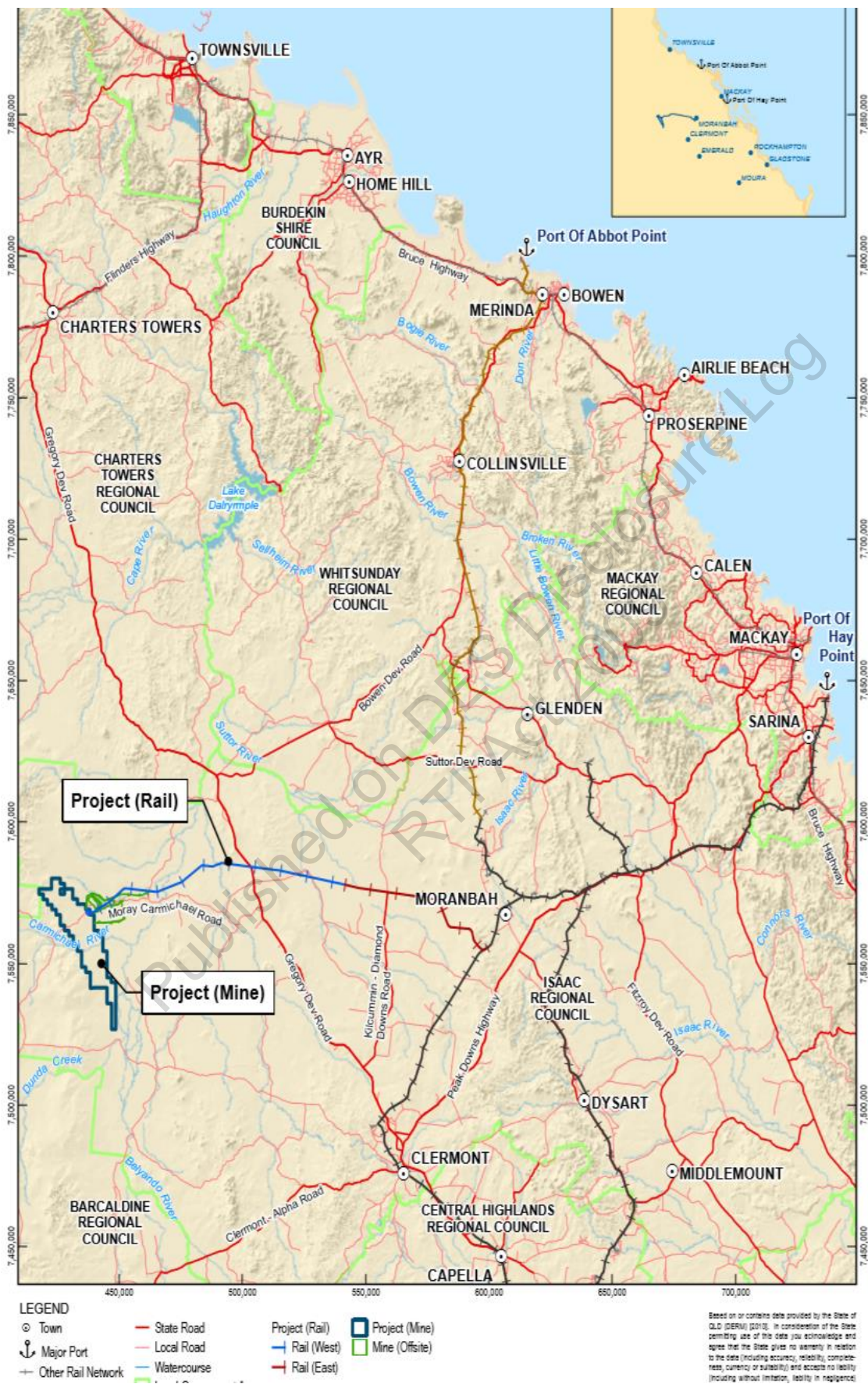


Figure 1-1: Carmichael Coal Mine Project Location

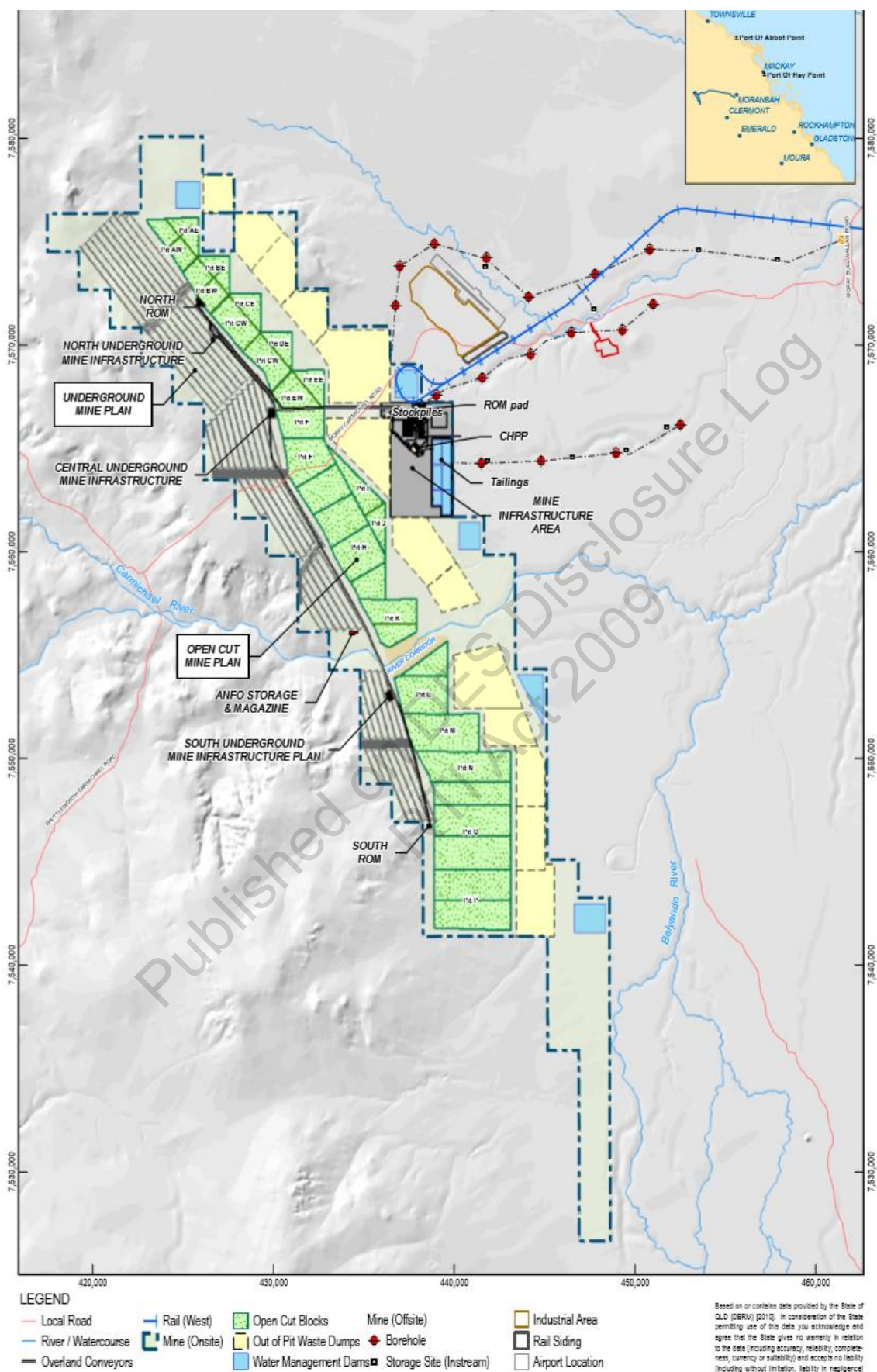


Figure 1-2: Project infrastructure and out of pit waste dumps

1.4 Geology and coal

The mining tenure for the operation consists of ML70505, ML70441 and ML70506. The coal seams are contained within the Permian coal measures. These are overlain across the total area by a poorly consolidated to unconsolidated cover of Tertiary materials, ranging from 50 m thickness in the east to 200 m in the northwest (**Figure 1-3**). Coal seams occur in six main seam groups, the AB, C, D, E, F and G and have a maximum cumulative coal thickness of 54 m. The overburden and interburden includes conglomerate, sandstone, mudstone and carbonaceous claystone.

Sulfur in coal and in mining waste materials is important as it can be present in a reactive sulfide form (such as pyrite or marcasite) and is typically the main contributor to the generation of Acid and Metalliferous Drainage (AMD) at mining operations. In general, sulfur concentrations can be elevated in coal and coal reject materials due to the genesis of these materials but can also be available in other stratigraphic units. Sulfur in coal is derived from two sources that include the original plant materials and ambient fluids in the coal forming environment. Abundance of sulfur in coal is controlled by depositional environments and the genesis of the coal seams and overlying strata. Typically, low-sulfur coal seams are formed by deposition in an alluvial environment not influenced by seawater. The sulfur in these low-sulfur coals is derived mostly from its parent plant materials. In contrast, high sulfur coal seams are generally associated with marine strata where sulfate in the seawater diffuses into the initial peat and is reduced by microorganisms to form hydrogen sulfide, elemental sulfur and polysulfides. During early genesis in a reducing environment, ferric iron is reduced to ferrous iron, which reacts with hydrogen sulfide to form iron monosulfide. Iron monosulfide is later transformed by reaction with elemental sulfur into minerals such as pyrite or marcasite, which upon exposure to oxidising conditions are typically reactive and generate acid and metalliferous drainage. Organic sulfur is formed by reaction of reduced sulfur species with the humic substances formed by bacterial decomposition of the initial peat. Organic sulfur species in coals are mainly thiols, sulfides, di-sulfides, and thiophene and its derivatives. The thiophenic fraction of organic sulfur increases with the carbon content of coals. Organic sulfur compounds formed in peat are mostly thiols and sulfides, which gradually convert to thiophenes with increasing coal maturation. Thus, the organic sulfur species in coal evolve during the history of coal formation and, upon exposure to oxidising conditions, are typically not a source of acidity.

The depositional environment of the coal in the CCM sequence is understood to have been an alluvial environment with negligible marine influences at a regional level, therefore the magnitude of any acid generation is expected to be limited compared to coal formed in marine dominated strata and this will be verified through plotting sulfur data.

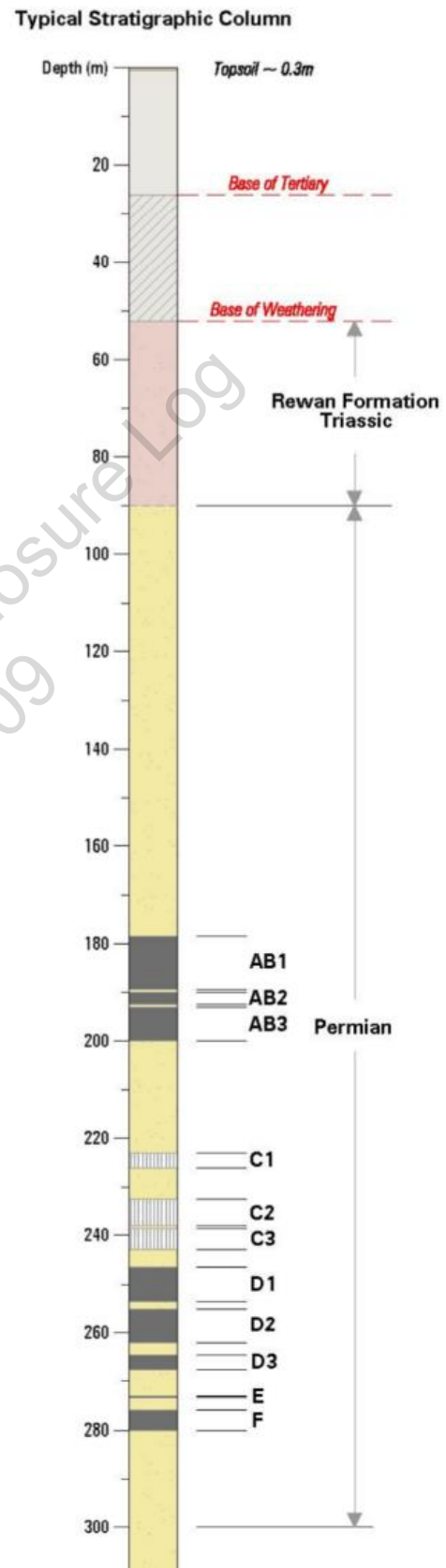


Figure 1-3: Typical stratigraphic column at Carmichael Coal Mine

2 Summary of previous reports

2.1 McClurg (2013)

A soil chemistry study entitled “Soils, Pre-mining Land Suitability and Stripping Recommendations for Carmichael Coal Mine” was completed by McClurg (2013). In the report, 51 samples of soil were analysed for pH (Min. 5.9 and Max. 9.3), EC $\mu\text{S}/\text{cm}$ (Min. 100 and Max. 1,310), Olsen P mg/kg (Min. 2 and Max. 19), CEC meq/100g (Min. 2 and Max. 36) and ESP % (Min. 0 and Max. 31) (McClurg, 2013). This research helped to identify information gaps in the MWRM associated with the characterisation of the topsoil and subsoil units and the underlying regolith units. In order to achieve detailed design of the spoil dumps leading to sustainable revegetation, these information gaps were addressed in the 2020 GaPSaAP, highlighting the current need for a mine waste and rehabilitation material assessment.

2.2 SRK (2013)

An extensive mine waste characterisation program was completed by SRK (2013). The geochemical characterisation program included 470 samples of which 413 were overburden and interburden samples, 26 were roof and floor samples and 31 were coal samples. Coal reject samples were not available for analysis. The locations of the 60 drill holes had good coverage within the mine footprint (**Figure 2-1**).

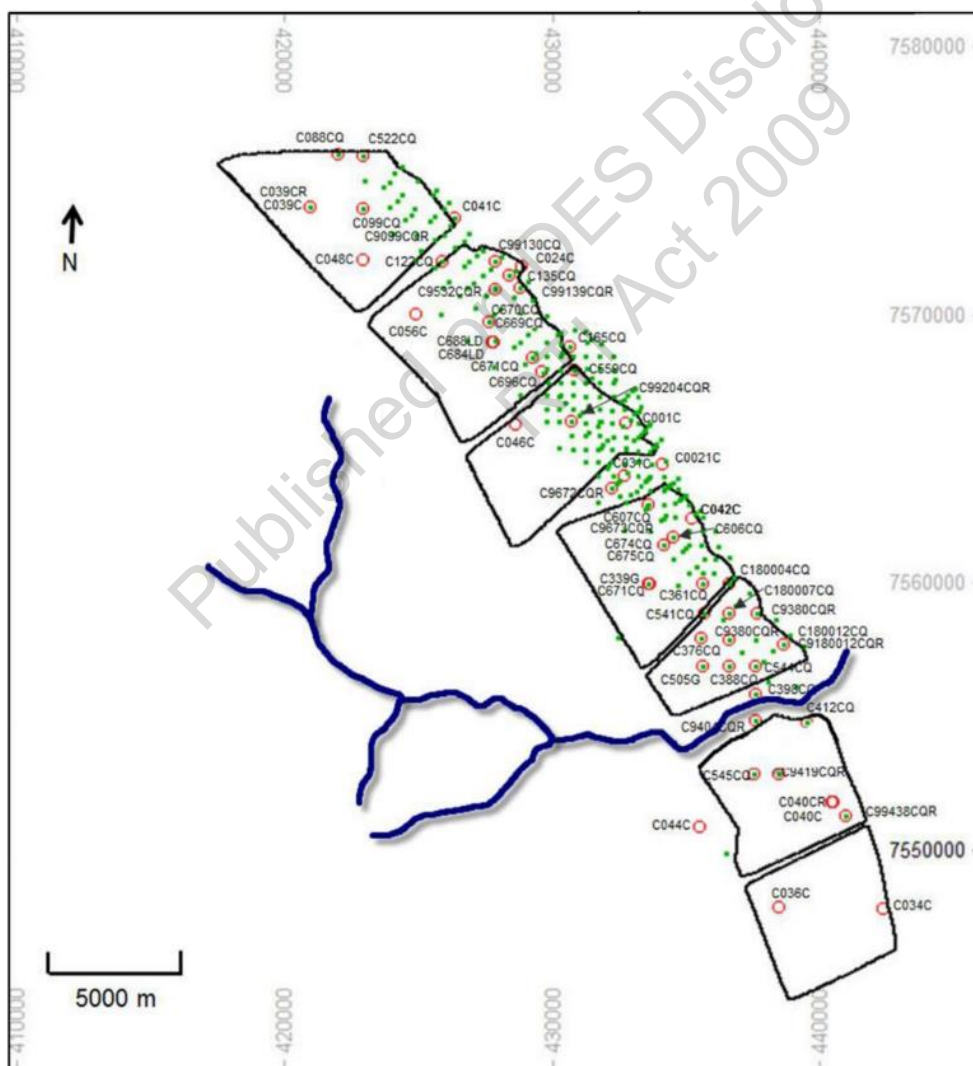


Figure 2-1: Drill hole locations from the 2013 exploration program

Standard static geochemical tests were conducted to characterise the coal, overburden and interburden samples. The range of lithologies sampled (carbonaceous mudstone, carbonaceous siltstone, claystone, coal, sandstone, and siltstone) provided a good representation of the types of materials likely to be encountered within the 5-year mine footprint. The exception was coal rejects, which will be tested in a future geochemical study when samples become available. Neutralisation potential ratio (NPR) and AMIRA (2002) methods were used to classify the materials into potentially acid forming or non-acid forming categories. Results from SRK (2013) are compared to the new data in **Section 5.4**.

Statistical analysis showed that the selection of samples was large enough to draw conclusions about average values of the total sulfur content, acid neutralising capacity (ANC) and net acid producing potential (NAPP) across the site for several lithological units (**Figure 2-2**). The average NAPP and the upper 95% confidence interval for the average NAPP was less than 0 kg (H₂SO₄)/t for carbonaceous mudstone, clay, clayey sand, claystone, coal, mudstone, sandstone, siltstone and tuff. The upper 95% confidence limit was above 0 kg (H₂SO₄)/t for carbonaceous siltstone. The 95% confidence intervals for the average NAPP could not be determined for carbonaceous sandstone, conglomerate, soil and shale because there were too few samples of these types. The fraction of samples representing each lithological group was approximately proportional to the fraction of the waste in the respective lithological group. The carbonaceous group was over sampled as part of this characterisation program as this unit has the highest potential to contribute to AMD.

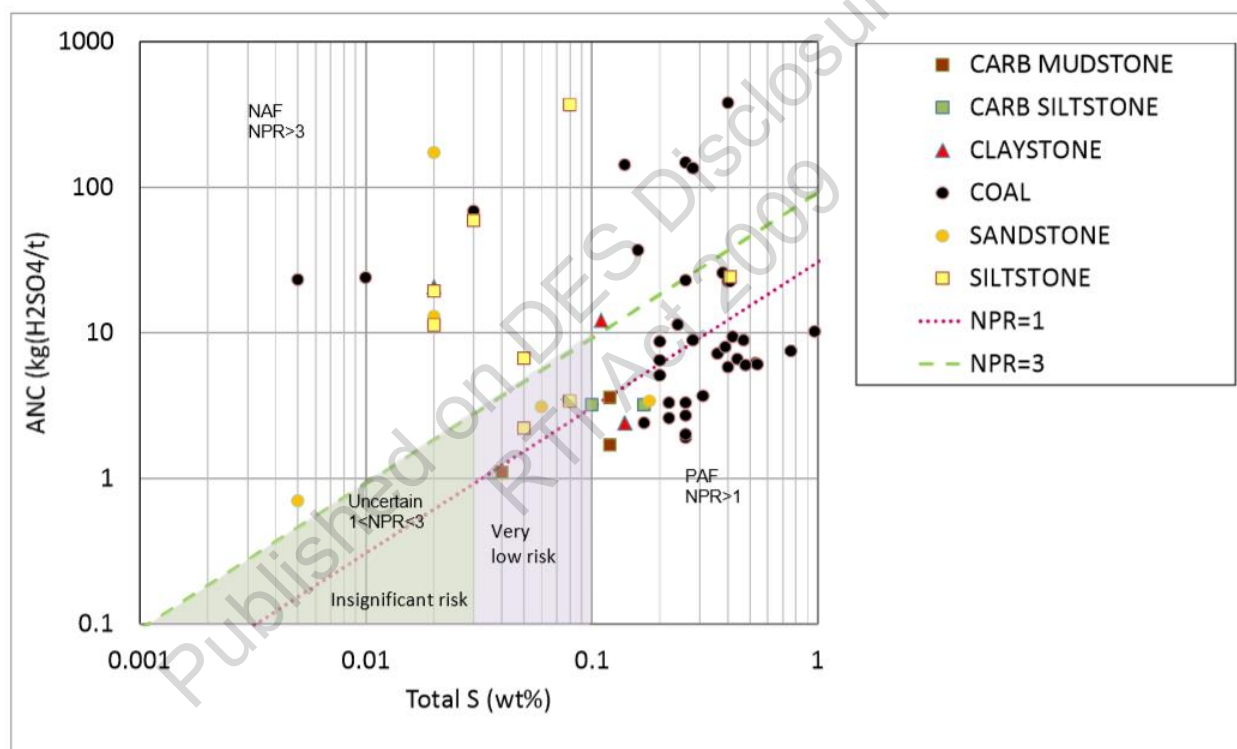


Figure 2-2: ABA plot of coal, roof, and floor samples

Physical testing was also completed on 92 mining waste samples to determine their potential to be dispersive. The test results indicated that the clays, weathered rocks (including mudstone, claystone, carbonaceous mudstone and siltstone) may have dispersive behaviour. Slightly weathered siltstone may show very slight potential for dispersivity. The weathered sandstone did not show any indication of dispersive behaviour. Soil samples showed non-dispersive properties due to the presence of calcite.

The fresh rocks were generally non-dispersive, although some claystone and siltstone had a very low potential for dispersion. There was variability in dispersion results within each group. Weathered rock, siltstone and sandstone showed potential for deterioration and breakdown after exposure to water. The siltstone showed moderate rate deterioration, and sandstone showed a slow rate of deterioration. This may indicate that although the fresh rock units were not dispersive, they were not durable, and with time may degrade to sand, silt or clay. The degraded material may be more prone to physical erosion than the original fresh rock.

Dispersion testing was only one of several physical analytical methods that were required to quantify how the materials would perform physically (to quantify how water and salts would move through the spoil or how they may erode) as they are placed into ex-pit waste dumps or if they are placed in-pit.

Other analytical methods used include:

- particle size distribution (PSD) to quantify the fines content;
- soil water characteristic curve (SWCC) to measure how the material will retain water;
- sodium sulfate soundness method to determine how the sedimentary rock may break down under chemical and physical processes; and,
- Los Angeles Abrasion method to qualify rock strength.

2.3 RGS (2019)

In June 2019, RGS produced a Mining Waste and Rejects Management Plan (MWRM Plan) for the CCM. The MWRM Plan addresses the requirement in the CCM EA relating to Mining Waste and Rejects Management: Condition H9 and H10.

The 2019 MWRM Plan included a geochemical and physical sampling and analytical program (Q4 2019 GaPSaAP) that was implemented by CCM and RGS in November 2019 and that is the subject of this report.

2.4 RGS (2020)

In Q1 2020, RGS provided a GaPSaAP that is to be implemented by CCM and RGS in Q2 to Q4 2020.

3 AMD characterisation

The purpose of the static geochemical characterisation program is to enable the regolith, weathered regolith, transition, and overburden samples from the mine pit (designated “EO” by CCM) to be classified into six geochemical classes ranging from acid consuming (AC) to potentially acid forming (PAF).

3.1 Sampling program

The CCM geologists collected 63 diamond drill core samples from drill holes C19400G, C19401G, and C19402G in Q4 2019 (**Figure 3-1**). Photographs of the intact drill core samples evaluated by RGS during samples receipt are in **Attachment 9.2**.

A summary of the number of samples and lithological units obtained from the sampling program is shown in **Table 3-1**.

Table 3-1: Drill core sampling program

Depth	Type	Number of Samples	Lithologies
0 – 5 m	Extremely Weathered Regolith	3	Sandstone
5 – 15 m	Weathered Regolith	4	Sandstone
15 – 25 m	Transition	12	Siltstone, sandstone, and carbonaceous sandstone
25 – 126 m	Overburden	44	Siltstone, sandstone, mudstone, and tuff

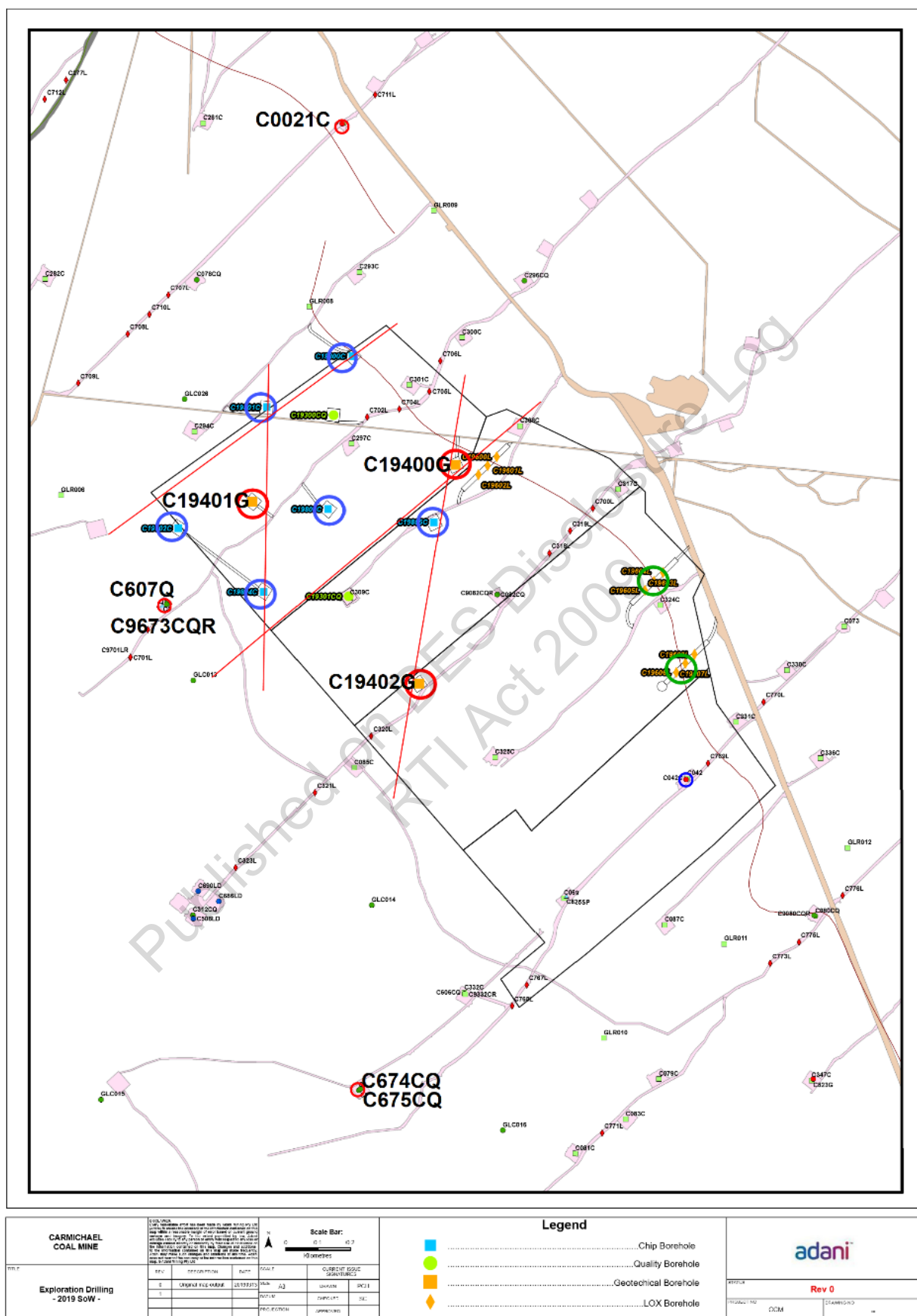


Figure 3-1: Selected drill hole locations from 2019 sampling program

3.2 Analytical program

The drill hole descriptions, depth data, sample numbers, and a brief description of the analytical work undertaken by RGS in Q4 2019 – Q1 2020 is shown in **Table 3-2**.

Table 3-2: Summary of Geochemical Analyses

Drill Hole	Samples Collected				Samples Analysed				
	Depth (m)		Depth Interval (m)	Number of Samples	1:5 pH and EC	TS and ANC	CEC	S _{CR}	Dissolved Soluble Metals
	From	To							
171451-A to 171458-C	3.29	64.89	61.6	21	63	63	19	2	9
171471-A to 171476-C	12.7	55.2	42.5	16					
171477-A to 171477-C	103.3	105.4	2.1	3					
209351-A to 209360-B	9.32	126.62	117.3	20					
209365-A to 209365-C	52.15	54.48	2.33	3					
TOTAL			225.83	63	63	63	19	2	9

All 63 samples received by ALS were crushed, sub-sampled and pulverised prior to the commencement of static geochemical testing on the pulverised (<75 µm) size fractions. The geochemical test program was coordinated by RGS personnel and designed to assess the degree of risk from potential oxidation of sulfides, acid generation, and the presence of (and leaching of) soluble metals/metalloids and salts.

Each of the 63 samples underwent static geochemical testing for:

- pH (1:5 w:v);
- Electrical conductivity (EC) (1:5 w:v);
- Total sulfur [Leco method]; and
- Acid neutralising capacity (ANC) [AMIRA, 2002].

After reviewing the initial static geochemical tests, samples with a TS > 0.1% were re-tested for chromium reducible sulfur (S_{CR}) [AS 4969.7-2008 method]. This provides a better estimate of the maximum potential acidity (MPA) as it distinguishes between reactive sulfides that may contribute to acidity, and elemental sulfur, sulfate and organic sulfur, which upon exposure to oxidising conditions, are typically not a source of AMD.

Representative sample lithologies from each material type (regolith, weathered regolith, transition, and overburden) were subsequently selected for 1:3 water soluble metal(loid) and major ion analyses after a 16-hour leaching period:

- Soluble metals/metalloids (Ag, Al, As, Ba, Be, Bi, B, Cd, Ce, Cs, Cr, Co, Cu, Dy, Er, Eu, Gd, Ga, Hf, Hg, Ho, In, Fe, La, Li, Lu, Mn, Mo, Nd, Ni, Pb, Pr, Rb, Sm, Se, Sr, Te, Tb, Tl, Th, Tm, Sb, Sn, Ti, U, V, Y, Yb, Zn, and Zr) [ICP-AES/MS and FIMS (1:3 w:v water extracts)];
- Major cations (Ca, Mg, Na, and K) [ICP-AES/MS (1:3 w:v water extracts)]; and
- Major anions (Cl, F, and SO₄) [ICP-AES/MS and PC Titrator (1:3 w:v water extracts)].

The regolith, weathered regolith, and transition samples were measured for cation exchange capacity (CEC). The CEC results were then used to calculate Effective Cation Exchange Capacity (eCEC) and Exchangeable Sodium Percentage (ESP).

3.3 Acid base accounting

The Acid Base Account (ABA) estimates the balance between the potential for a material to generate acid and to neutralise acid. One output from an ABA is the net acid producing potential (NAPP), expressed in units of kilograms of sulfuric acid per tonne (kg H₂SO₄/t). The NAPP test involves determining the maximum potential acidity (MPA) and the maximum inherent acid-neutralising capacity (ANC) of a sample. The total sulfur content is commonly used as a conservative estimate of pyritic sulfur (that is, all S is assumed to be present in the form of pyrite) to calculate the MPA (MPA = weight% sulfur x 30.625). The use of total sulfur is a conservative approach because some sulfur may be present in forms other than pyrite.

Two parameters are calculated from the MPA and ANC: the NAPP and the ANC/MPA ratio. The NAPP is a qualitative measure of the difference between the capacity of a sample to generate acid (MPA) and its capacity to neutralise acid (ANC). The NAPP, MPA and ANC are expressed in units of kg H₂SO₄/t and the NAPP is calculated as $NAPP = MPA - ANC$. If the MPA is less than the ANC, then the NAPP is negative, indicating that the sample may have sufficient ANC to prevent acid generation. Conversely, if the MPA exceeds the ANC, then the NAPP is positive, indicating that the material may be acid-generating. The ANC/MPA ratio provides an indication of the relative margin or factor of safety (or lack thereof) for a given material. Various ANC/MPA values are referenced in the literature for indicating safe values for the prevention of acid generation. Those values typically range from 1.5 to 3. As a rule, an ANC/MPA ratio of 2 or more signifies that there is an increased probability that the material will remain near-neutral in pH and should not be problematic in terms of acidity generation and resultant acidic drainage. However, the neutral and metalliferous drainage (NMD) and saline drainage (SD) components of AMD may still be an issue that needs to be addressed.

Several assumptions are generally made when using ABA data relating to the net acid producing potential (NAPP) of mined materials and include the following:

- Total sulfur is used to calculate the maximum potential acidity (MPA);
- All total sulfur is assumed to be present as acid producing sulfide minerals such as pyrite or marcasite;
- All total sulfur will oxidise to produce acidity;
- All ANC can react to neutralise acidity;
- NAPP is calculated as $MPA - ANC$; and
- Neutralisation potential ratio (NPR) is derived as the ratio of MPA divided by ANC.

The standard approach to define acid producing and neutralising potential can overestimate both components of the ABA and does not consider the physical properties of the materials. The use of total sulfur to calculate MPA can overestimate MPA because some of the sulfur is present as sulfate minerals and/or organic sulfur that will generally not produce any significant acidity. The chromium reducible sulfur (S_{CR}) method can be used to verify sulfide sulfur content in samples of mine materials (AS 4969.7, 2008; Schumann et al., 2012; and Stewart et al, 2009). RGS has found this method to be very reliable over 15 years, and the S_{CR} method is the preferred method in the acid sulfate soils technical area.

In addition, RGS recommends that kinetic leach testing is used to calibrate static ABA assumptions. Kinetic leach testing subjects the sample to monthly leaching cycles in free leach or saturated conditions, and generally provides a more reliable long-term representation of the behaviour of mine waste materials under natural field conditions.

In this study RGS has used the total sulfur content and the neutralisation potential ratio (NPR) to classify mined materials including regolith, weathered regolith, transition, and overburden. The geochemical classification system used by RGS to classify the mine waste materials into different material types is summarised in **Table 3-3**.

Table 3-3: Geochemical classification system for mine waste materials

Material Type	Classification Criteria
Acid Consuming (AC)	TS% < 0.05 and NPR > 10 & > 50 kg H ₂ SO ₄ /t
Non-Acid Forming (NAF)	TS% < 0.05 and NPR > 3
Non-Acid Forming Uncertain (NAF-UC)	TS% < 0.05 and NPR < 3
Potentially Acid Forming Uncertain (PAF-UC)	TS% > 0.05 and < 0.2% and NPR > 1 < 3
Potentially Acid Forming - Low Capacity (PAF-LC)	TS% > 0.05 and < 0.2% and NPR < 1
Potentially Acid Forming (PAF)	TS% > 0.2%

TS = total sulfur

4 Results

The $pH_{1:5}$, $EC_{1:5}$, ABA, CEC, ESP and water-soluble leach test results are discussed, and presented in figures and summary tables, in this section of the report. Detailed tabulated results are in **Attachment 9.3**. The results from ALS are in **Attachment 9.4**.

4.1 AMD classification

4.1.1 Actual acidity and alkalinity

The $pH_{(1:5)}$ of 63 samples was circum-neutral to mildly alkaline at pH 5.4 to 9.4 (arithmetic median of 6.5) (**Figure 4-1** and **Table 4-1**). Of the 63 samples, 47 (75%) were between pH 5 and pH 7. Acidic samples were generally from shallow depths less than 50 m. The carbonaceous sandstone and sandstone lithologies produced the lowest pH values although no measured pH values were less than pH 5. The remaining 16 samples (25%) were mildly alkaline at pH 7 to 9.4, and were commonly from depths greater than 50 m.

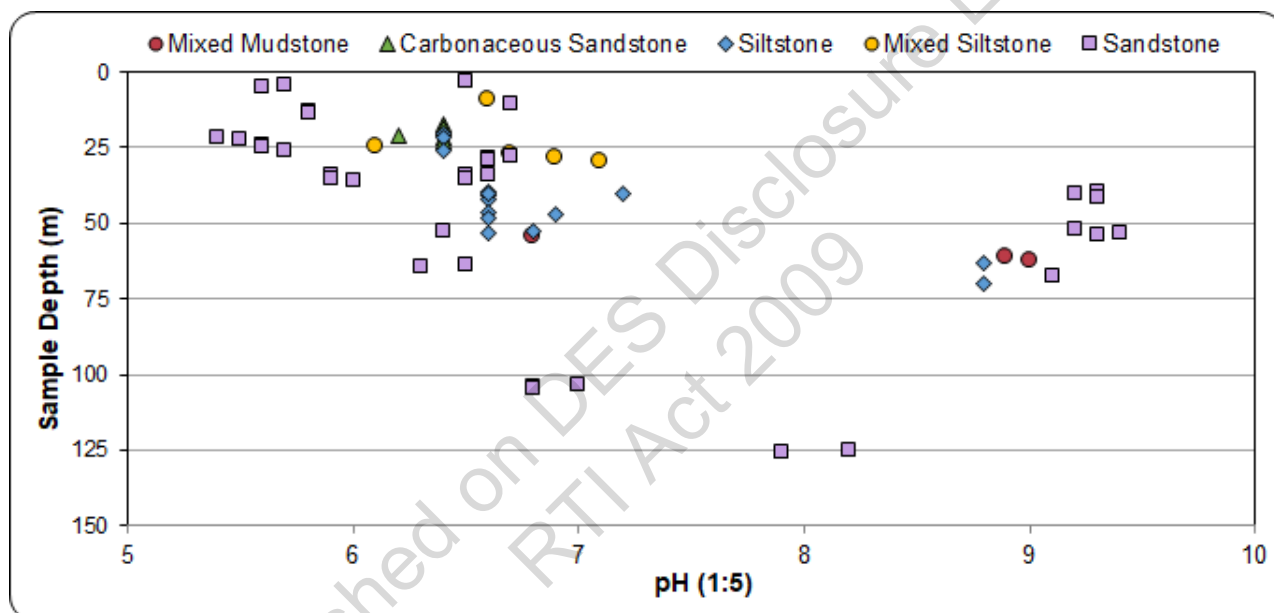


Figure 4-1: $pH_{1:5}$ concentrations

Table 4-1: Summary of pH results

	Very Low	Low	Medium	High	Very High
$pH_{1:5}$	< 4.5	4.5 – 5.5	5.5 – 7.0 (median=6.5)	7.0 – 9.0	> 9.0
Number and (%) of samples corresponding to each soil pH classification	0 (0%)	1 (1%)	46 (73%)	8 (13%)	8 (13%)

4.1.2 Potential acidity and acid base accounting

Acid base account (ABA) results for the 63 samples are in **Section 9.3**. The total sulfur (TS) content on the samples was 0.005% TS to 0.14% TS with a median value of 0.01% TS (**Figure 4-2**). Materials with a TS content less than or equal to 0.1% are considered barren of sulfur, represent background concentrations, and have negligible capacity to generate acidity¹. All but two samples have > 0.1% TS. One overburden siltstone sample had 0.12% TS, and a mixed mudstone/tuff sample had 0.14% TS.

¹ The average crustal abundance of sulfur (0.07 %S) has been rounded up to 0.1 % (INAP, 2009).

The sulfide sulfur content of the two samples with total sulfur content greater than 0.1 % S underwent further testing for chromium reducible sulfur (SCR). The results infer in the siltstone that only 0.005% of material is sulfide sulfur, indicating that the remainder is most likely associated with non-acid generating forms of sulfur, such as organic sulfur, sulfate or secondary mineral sulfates e.g. gypsum.

In contrast, the mixed mudstone/tuff sample is 0.104% sulfide sulfur, compared to a total sulfur content of 0.14%. This may infer that a large proportion of the sulfur in the mixed mudstone/tuff sample is reactive sulfide sulfur. Based on the total sulfur content (and sulfide sulfur content where available), the maximum potential acidity (MPA) that could be generated by the mining waste samples ranges from 0.2 (below laboratory limit of reporting - LoR) to 3.2 kg H₂SO₄/t; and has a low median value of 0.6 kg H₂SO₄/t. In general, MPA was higher in siltstone and mudstone lithological units, but there is no correlation with depth.

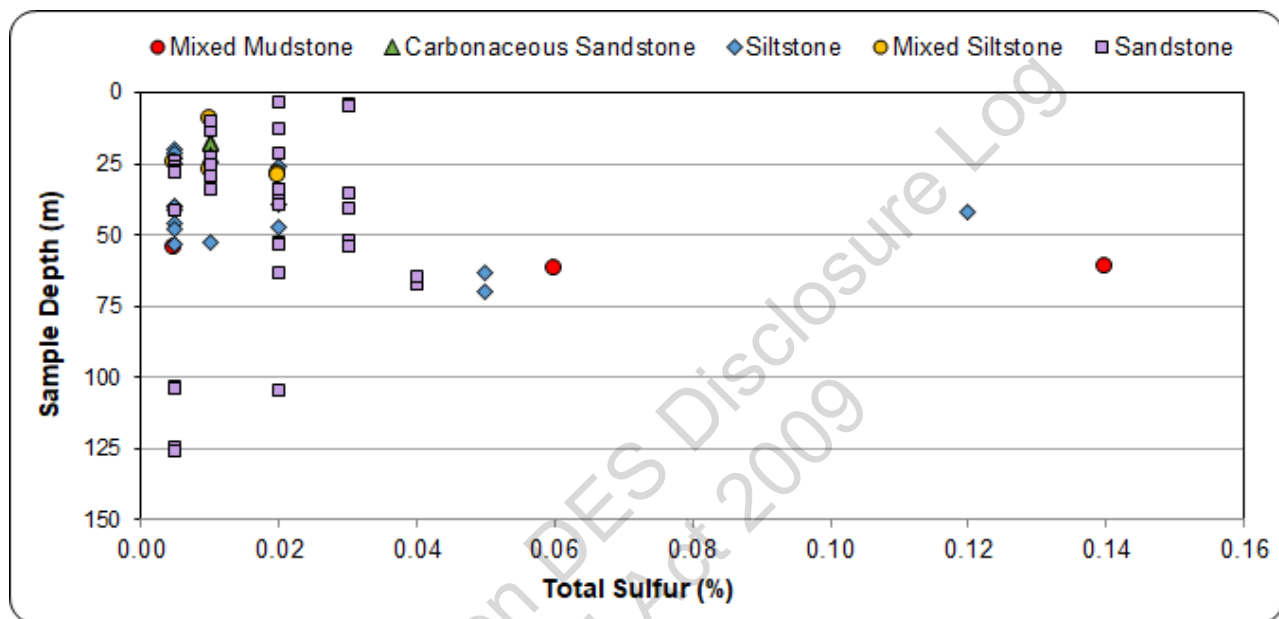


Figure 4-2: Total sulfur concentrations

The ANC for the mining waste samples ranges from 5.5 to 364 kg H₂SO₄/t and has a low median value of 8.8 kg H₂SO₄/t. In comparison, the average value for ANC is moderate (25.7 H₂SO₄/t), indicating that there are several outliers that have a high ANC. The high ANC values are generally measured from sandstones. The ANC of the mixed mudstone / tuff sample with 0.104% sulfide sulfur is 25.5 H₂SO₄/t, indicating that the sample has good acid neutralising capacity.

The ANC:MPA ratio for the samples ranges from 6.4 to 2,377 and has a high median value of 29.1, and a very high mean value of 79.1. In simplistic terms, this means that most materials have excess ANC over MPA. The ANC:MPA ratio for the mixed mudstone/tuff sample with 0.104% sulfide sulfur is 8.0. The calculated NAPP value for the samples is calculated by subtracting the ANC from the MPA and ranges from -364 to -4.9 kg H₂SO₄/t, and has a median value of -8.4 kg H₂SO₄/t. All of the mining waste samples have negative NAPP values as illustrated in **Figure 4-3**.

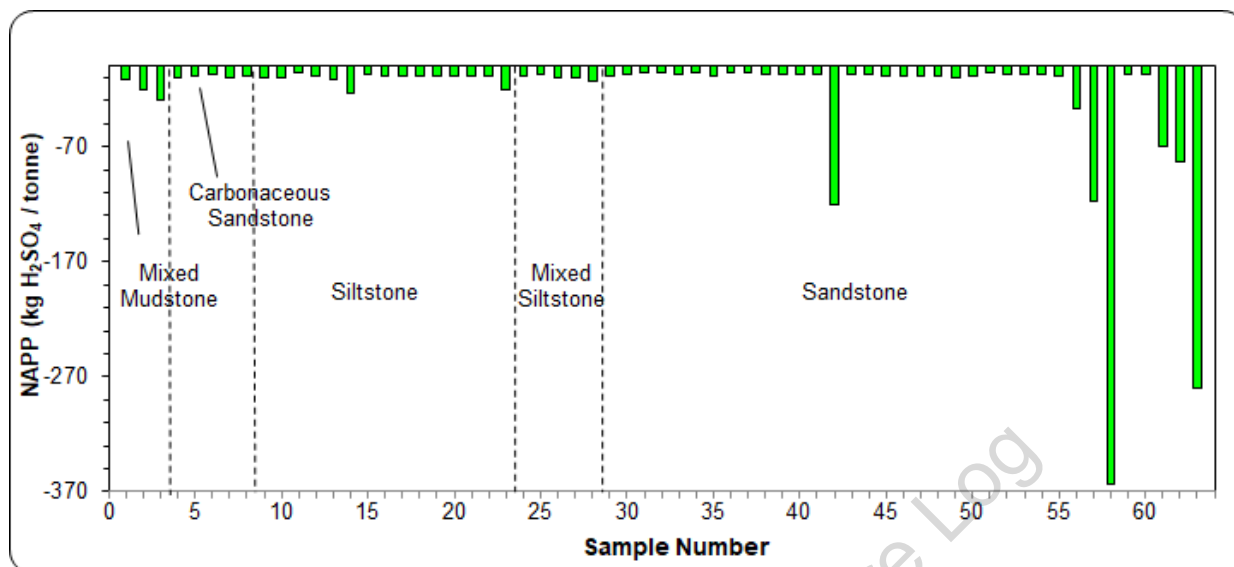


Figure 4-3: NAPP values for waste rock

Figure 4-4 shows a plot of ANC versus MPA for the 63 mine waste samples classified by lithology. ANC:MPA ratio lines have been plotted on the graph to illustrate the factor of safety associated with the samples. Generally, those samples with an ANC:MPA ratio greater than 2 (or with a total or sulfide sulfur content ≤ 0.1 %) are considered to have a low to negligible risk of acid generation and a high factor of safety in terms of potential for generating acidic drainage (INAP, 2009²; COA, 2016).

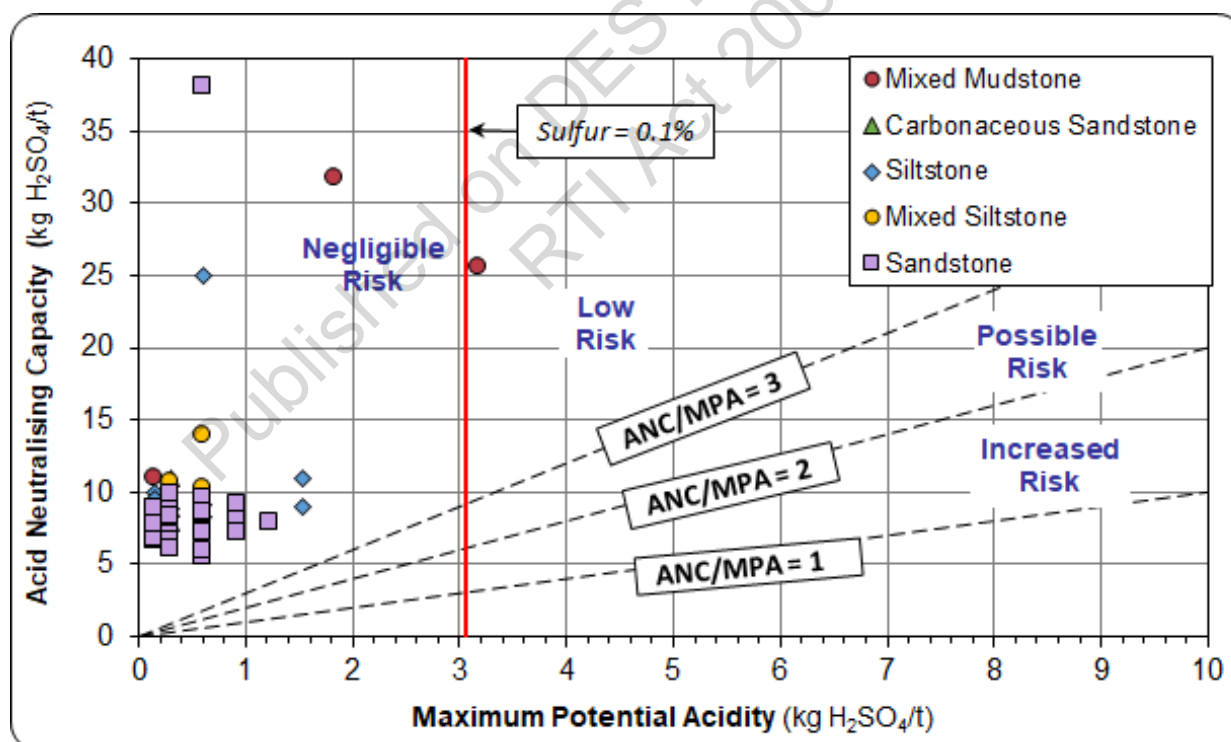


Figure 4-4: ANC v MPA for waste rock

² INAP considers that mine materials with an ANC/MPA ratio greater than 2 are likely to be NAF unless significant preferential exposure of sulfides along fracture planes occurs in combination with insufficiently reactive ANC.

The results indicate that all the samples plot in the negligible risk domain shown in the graph and represent material with a very low risk of acid generation and a high factor of safety with respect to potential for generating acidic drainage.

Table 4-2 summarises the geochemical classification criteria used by RGS to classify the acid forming nature of the 63 mining waste samples, and a breakdown of the number of samples in each classification category by lithology.

Table 4-2: Geochemical classification

Geochemical Classification	Total Sulfur ¹ (%)	ANC: MPA Ratio	NAPP (kg H ₂ SO ₄ /t)	Samples (n=63)
Non-Acid Forming (Barren)	≤ 0.1	-	-	62
Non-Acid Forming	> 0.1	≥ 2	≤ -5	1
Uncertain ²	> 0.1	< 2	> -5 and ≤ +5	0
Potentially Acid Forming	> 0.1	< 2	> +5	0

Notes:

1. Sulfide sulfur (using the Scr test) has been measured for selected waste rock samples and where available, sulfide sulfur has been used in place of total sulfur for sample classification and to calculate MPA.
2. Samples that fall outside the stated NAF/PAF classifications based on the criteria provided are classified as Uncertain.

The ABA test data presented in **Attachment 9.3.1** and discussed in this section have been used to classify the acid forming nature of the 63 samples. The results in **Table 4-2** verify that 62 of the 63 samples (98 %) are classified as Non-Acid Forming (NAF_{BARREN}). One mixed mudstone/tuff sample is classified as Non-Acid Forming (NAF), as it has sufficient ANC to neutralise the reactive sulfides contained within the sample.

None of the samples are classified as Uncertain, or Potentially Acid Forming (PAF). Overall, the ABA results confirm that the majority of the samples have low sulfur content, excess ANC, a high factor of safety and a low risk of generating acidic drainage.

4.2 Salinity and sodicity

4.2.1 Electrical conductivity

The EC_(1:5) for the samples was 36 to 932 µS/cm with a median of 341 µS/cm (**Figure 4-5** and **Table 4-3**). Units classified as carbonaceous sandstone had a moderate EC (average 1,082 µS/cm). The EC of mixed mudstone, mixed siltstone, and sandstone decreased with depth; however, siltstone tended to be variable.

Table 4-3: Summary of EC_{1:5} results

	Very Low	Low	Medium	High	Very High
EC _{1:5} (µS/cm)	< 150	150 – 450 (median 341 µS/cm)	450 – 900	900 – 2,000	> 2,000
Number and (%) of samples corresponding to each salinity classification	9 (14%)	30 (48%)	20 (32%)	7 (11%)	0 (0%)

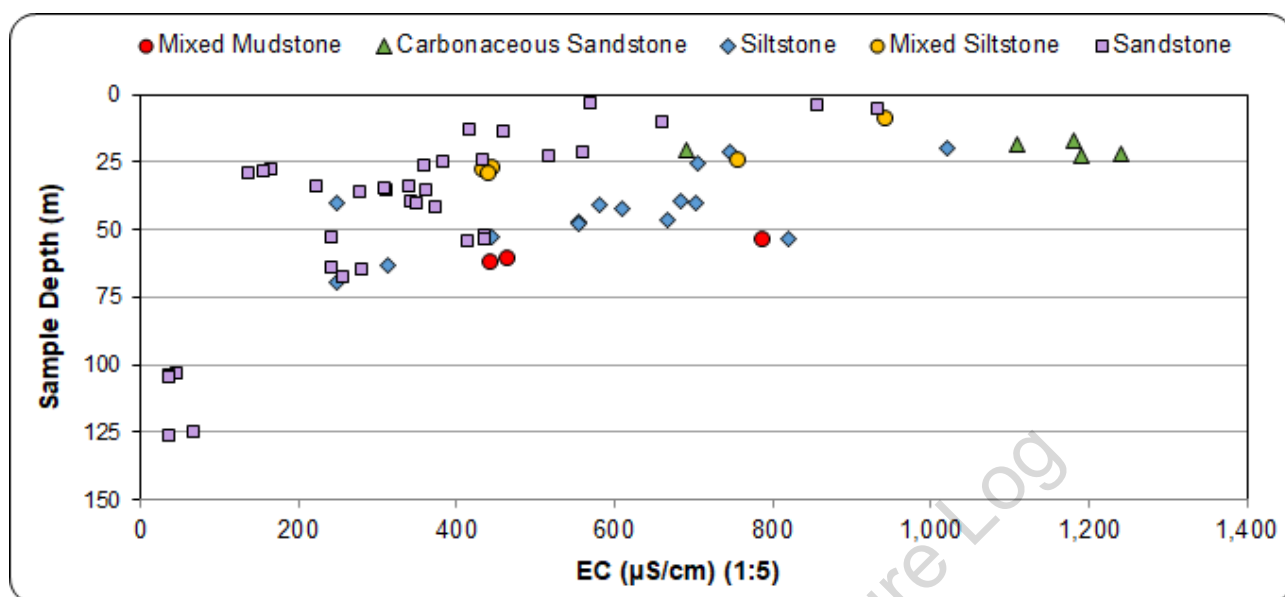


Figure 4-5: EC_{1:5} concentrations

4.2.2 Cation exchange capacity

Cation exchange capacity (CEC) measures the capacity of a soil to hold and exchange cations, which provides a buffering effect to changes in pH and available nutrient levels (Hazelton and Murphy, 2007). CEC results for the topsoil, subsoil, and transition material range from 1.9 to 15.1 meq/100g (median = 4.5 meq/100g) and typically infer a very low effective cation exchange capacity (eCEC). Ratings for the effective cation exchange capacity (eCEC) range from Very Low (<6 meq/100 g) to Very High (>40 meq/100 g) (**Table 4-4**) (Hazelton and Murphy, 2007).

The individual exchangeable cation results show that the samples are low in calcium, but very high in sodium, with a moderate amount of magnesium and potassium. The Ca:Mg ratio ranges from <0.1 to 0.8, and the samples are considered to be calcium deficient. As a result, plant growth may be limited (Hazelton and Murphy, 2007). The low Ca:Mg ratio also supports the finding in **Section 4.2.2** that some mine waste materials may be prone to dispersion.

4.2.3 Exchangeable sodium percentage and soil sodicity

Sodicity occurs when the mass of exchangeable sodium exceeds the other cations on the cation-exchange complex leading to clay dispersion in the soil (Hazelton and Murphy, 2007). Dispersion leads to rapid degradation of soil peds and the mobilisation of clays into low permeability horizons in the soil profile. Soils are considered non-sodic if the ESP is < 6%, marginally sodic if the ESP is 6-14% and strongly sodic if the ESP is > 14%. The subsoil samples are strongly sodic. The regolith samples are moderately to strongly sodic.

Table 4-4: Cation exchange capacity and exchangeable sodium percentage

Drill hole ID, Sample ID & depth from - to	Lithological Unit	pH Value	Electrical Conductivity @ 25°C	Exchange Acidity	Exchangeable Aluminium	Exchangeable Calcium	Exchangeable Magnesium	Exchangeable Potassium	Exchangeable Sodium	Exchangeable Sodium Percent	Calcium/Magnesium Ratio	Magnesium/Potassium Ratio	Cation Exchange Capacity
		pH Unit	µS/cm	meq/100g						%			meq/100g
		0.1	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0	0.1	0.1
171451-A 3.29-4.02	Subsoil	5.8	573	0.3	0.10	1.6	5.2	0.7	3.7	32.4	0.3	7.0	11.7
171451-B 4.02-4.93	Subsoil	5.6	876	0.5	0.40	1.6	6.9	1.0	4.8	33.3	0.2	6.5	15.1
171451-C 4.93-5.88	Subsoil	5.5	976	0.6	0.40	1.3	6.7	1.2	5.0	34.9	0.2	5.8	14.9
209351-A 9.32-10.25	Subsoil	6.9	890	----	----	0.5	2.3	0.3	0.7	16.2	0.2	7.0	4.1
209351-B 10.25-11.2	Subsoil	6.9	667	----	----	0.4	1.6	0.3	0.4	14.6	0.2	5.5	2.9
171471-A 12.7-13.63	Subsoil	5.9	389	0.2	0.05	0.2	2.5	0.3	1.2	27.5	0.1	7.8	4.6
171472-A 13.63-14.58	Regolith	5.9	457	0.1	0.05	0.3	2.6	0.3	1.0	22.6	0.1	8.5	4.5
171472-B 21.39-22.37	Regolith	5.5	551	0.2	0.05	0.5	1.9	0.2	0.4	13.1	0.3	12.8	3.4
171472-C 22.37-23.3	Regolith	5.5	520	0.2	0.05	0.5	2.0	0.2	0.4	11.9	0.2	12.2	3.5
171473-A 24.26-25	Regolith	5.6	429	0.2	0.05	0.5	2.0	0.2	0.4	11.7	0.2	12.5	3.9
171452-A 17.37-18.32	Regolith	6.6	1220	----	----	0.8	4.7	0.3	2.6	29.0	0.2	15.6	9.0
171452-B 18.32-19.23	Regolith	6.6	1160	----	----	0.7	3.8	0.2	2.1	29.4	0.2	16.6	7.2
171453-A 21.91-22.84	Regolith	6.6	1200	----	----	0.5	2.8	0.2	1.7	32.3	0.2	15.4	5.4
171453-B 22.84-23.76	Regolith	6.5	1160	----	----	0.4	2.4	0.1	1.6	33.0	0.2	16.4	4.9
209352-A 20.2-20.77	Regolith	6.6	987	----	----	0.8	1.2	0.1	0.2	9.9	0.7	10.8	2.6
209352-B 20.77-21.32	Regolith	6.2	676	----	----	0.5	0.8	<0.1	0.2	13.0	0.6	----	1.9
209352-C 21.32-22.08	Regolith	6.5	720	----	----	0.7	0.9	<0.1	0.2	10.1	0.8	----	2.2

Green = relatively low risk/concern; yellow = moderate risk/concern; orange = relatively high risk/concern.

4.3 Metalliferous leach tests

Water soluble leach tests were carried out using a 1:3 sample to water ratio tumbled for 16 hours. The purpose of this test is to (i) quantify the water-soluble baseline conditions in soil, regolith and overburden and interburden samples (ii) identify any elements (particularly metals/metalloids) present at concentrations that may be of environmental concern with respect to soil fertility or water quality and (iii) use the results as an input to water quality models. The results from multi-element testing of water extracts are in **Figure 4-6** to **Figure 4-7**.

The water-soluble tests were undertaken on 9 samples that were representative of each of the main lithological units in the sampling program i.e. mixed mudstone, carbonaceous sandstone, siltstone, mixed siltstone, and sandstone).

The pH of the water extracts ranges from 6.9 to 8.8, with a median value of 7.0. The water extracts have low to moderate EC values of 476 to 1,940 µS/cm, with a median value of 937 µS/cm.

The major ions are dominated by Na⁺, Cl⁻ and lower concentrations of SO₄²⁻, Ca²⁺, Mg²⁺, F⁻ (**Figure 4-6**).

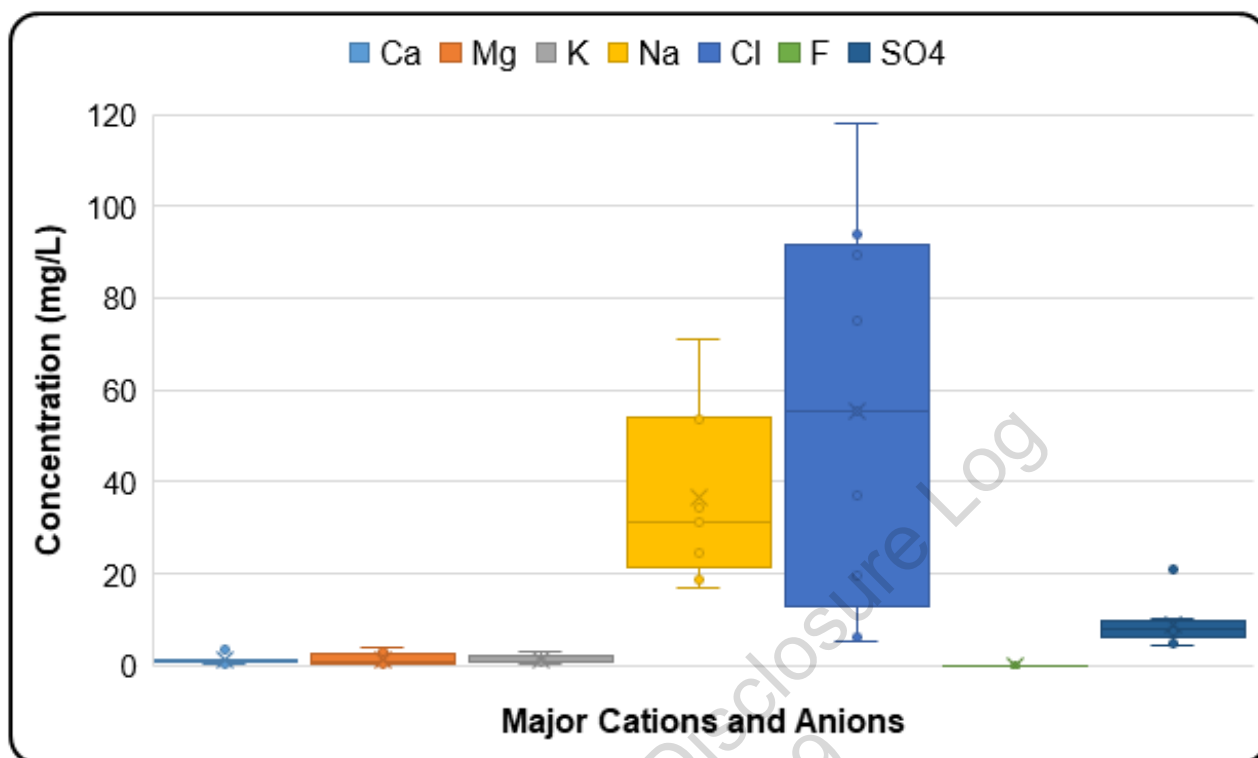


Figure 4-6: Major ion concentrations in selected Carmichael mine waste samples

The concentration of metal(oids) in leachate from the 9 samples is low and typically below the laboratory limit of reporting (LoR). Of the 50 elements tested, only 13 are above the LoR (**Figure 4-7**). This suggests that most metal(oids) are not present, are present at very low concentrations, or are sparingly soluble at the pH of the samples.

Of the 13 elements that were present above the LoR, aluminium (Al), boron (B), barium (Ba), iron (Fe), manganese (Mn), strontium (Sr), and zinc (Zn) are present at concentrations above 0.01 mg/L. The measured water-soluble concentrations are representative of baseline conditions in the soil, regolith and mine waste at the CCM.

Of these elements the presence of soluble Al is significant because at elevated concentrations soluble and exchangeable Al induces acidity in the soil profile that can affect root development and plant growth: the measured Al is detectable but not elevated. The other consideration when interpreting the water-soluble data is that the samples have moderate to high ESP that induces dispersion of clay colloids (**Table 4-4**). The presence of dispersive clays means that Al that is sorbed to the clay colloids can pass through the 0.45µm filter. Future work by RGS will include the use of 0.1µm filtration on water soluble metal(oids) to quantify the mass of Al that is sorbed on clay colloids.

Aluminium ranged from 0.002 – 0.096 mg/L (median 0.02 mg/L). The highest dissolved Al measurement (0.096 mg/L) is from sample 171451-B which is taken from a depth of 4.02 – 4.93 m (**Figure 4-7**). The lowest Al concentrations were measured from depths between 10 – 30 m. Samples taken from deeper than 40 m also seem to be relatively elevated. There appeared to be no correlation between Al concentration and lithology.

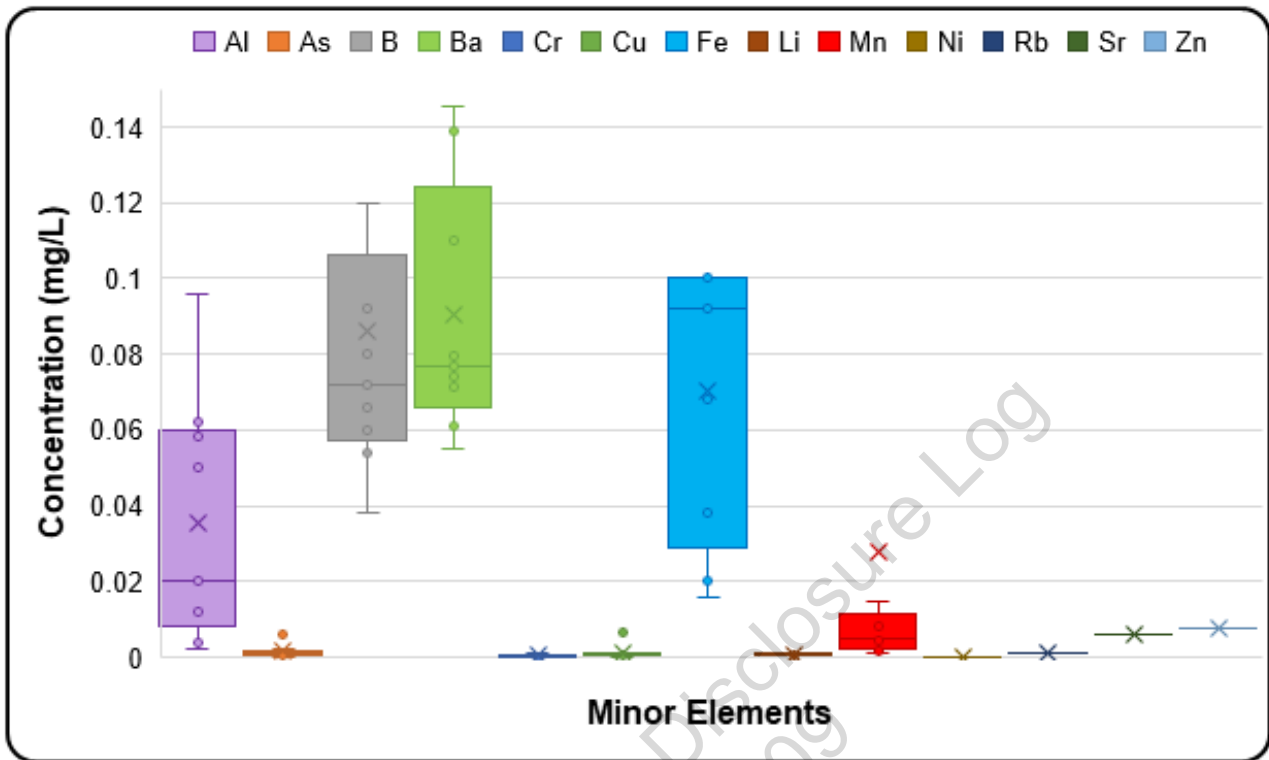


Figure 4-7: Minor element concentrations in selected Carmichael mine waste samples

5 Discussion

5.1 Acid drainage assessment

The results of the ABA tests presented in **Section 4** verify that all of the samples are classified as NAF (barren) or NAF, and have excess ANC. Two samples were measured to have a total sulfur content > 0.1%, which led to S_{CR} analysis to quantify reactive sulfide content. The siltstone sample was found to contain 0.005% sulfide sulfur, inferring that the material is benign. The mixed mudstone/tuff sample contained 0.14% sulfide sulfur and at this sulfide content there is the potential for this sample to oxidise and produce acid at the surface of the sulfide mineral. However, this sample also had an ANC of 25.5 kg H_2SO_4/t , that would neutralise the acid and produce neutral pH drainage. This sample has been classified as NAF.

None of the 63 samples tested are classified as Uncertain or PAF. The mine waste samples represent materials with a very low risk of acid generation and a high factor of safety with respect to the production of acid drainage.

As no coal or coal reject samples were available to be included in this assessment, it is recommended that some representative samples of these materials are subjected to both static and kinetic geochemical tests in future. In RGS's experience, geochemical results for parting, roof and floor materials are often elevated in sulfur; however, total sulfur content will depend strongly upon the environmental conditions when the coal is deposited. In addition, rejects generated from a coal handling plant (CHP) will have increased reactivity due to fine particle sizes and a relatively large surface area. This risk increases when the coal is processed through a wash plant.

5.2 Saline drainage assessment and sodic soils

From a geochemistry viewpoint, the mine waste materials are classified as NAF and produce a neutral pH and low EC.

However, not all NAF materials will be suitable for use in rehabilitation. Dispersive materials are structurally weak and prone to erosion, and do not provide sufficient nutrients to make them suitable as a plant growth medium. Alternatively, NAF rock may be competent, durable, and resistant to physical weathering for decades, effectively locking-up nutrients and making them unavailable to be taken up by plants. The coarse particle size distribution of these materials will also produce material with a very low capacity to retain soil moisture.

The results from the ESP and CEC tests in **Sections 4.2.2** and **4.2.2** verify that the soil, subsoil, and transition materials from depths of 0 – 25 m are strongly sodic, and deficient in exchangeable Ca. The materials are also very high in exchangeable Na and contain moderate Mg and K. The Ca/Mg ratio is low. Strong sodicity can result in surface crusting and low infiltration and hydraulic conductivity within affected soils.

These soil characterisation tests indicate that although the soil, subsoil, and transition materials are NAF, they will provide a poor growth medium due to dispersion and lack essential nutrients for plant growth. While these materials may be suitable to encapsulate PAF units at depth, mine waste samples from depths of 0 – 25 m tested in this report are unlikely to be suitable as cover materials without amendment.

RGS (2019) observed that weathered rock (soil and subsoil materials), as well as deeper units such as siltstone and sandstone showed potential for deterioration and breakdown after exposure to water. The siltstone showed a moderate rate of deterioration, and the sandstone showed a slow rate of deterioration. It was noted that while the fresh rock units were not dispersive, they were not durable, and with time may degrade to sand, silt or clay. It is possible that these deeper units may provide a suitable growth medium, if time is allowed for degradation. However, physical testing would be required to confirm whether this is the case.

5.3 Metalliferous drainage assessment

Static water-soluble leach test results indicate that initial surface run-off and seepage from most NAF mine waste samples is pH neutral and has low salinity. The major ion concentrations are low and dominated by Na, Cl, with lower SO₄. Low concentrations of other major ions are present in leachate from these materials.

The mine waste samples have low water-soluble metal(loid) concentrations, although there is some minor elevation of Al, B, Ba, Fe, Mn, Sr and Zn. One observation is that the dissolved Al concentration appears to increase at shallow depths less than 5m and at depths greater than 40 m.

The water-soluble data can be used to develop a baseline database and as an input to a site water quality model.

5.4 Comparison with SRK (2013) data

The SRK (2013) results included coal, floor, and roof materials, as well as clay material and shale that were not represented in the RGS (2019) sample set. The data confirms that the overwhelming majority of samples are non-acid forming (NAF) and do not present any significant environmental risk associated with acid drainage.

The data in **Table 5-1** presents the SRK (2013) and RGS (2019) ABA database for the project.

Table 5-1: ABA database for the CCM

		No. of Samples	NAF	UC	PAF
Mixed Mudstone	SRK, 2013	2	100	0	0
	RGS, 2019	3	100	0	0
Carbonaceous Sandstone	SRK, 2013	4	75	0	25
	RGS, 2019	5	100	0	0
Clay	SRK, 2013	15	80	0	20
Mixed Siltstone	SRK, 2013	1	100	0	0
	RGS, 2019	5	100	0	0
Mudstone	SRK, 2013	14	85.7	7.1	7.1
Claystone	SRK, 2013	19	94.7	0	5.3
Sandy Clay	SRK, 2013	10	90	0	10
Tuff	SRK, 2013	12	91.7	0	8.3
Siltstone	SRK, 2013	88	96.6	23	1.1
	RGS, 2019	15	100	0	0
Sandstone	SRK, 2013	183	97.3	0	2.7
	RGS, 2019	35	100	0	0

Geochemistry results from 413 overburden and interburden samples from SRK (2013) and 63 overburden samples from the RGS (2019) data have been summarised in

Table 5-2. An MPA of 324.4 H₂SO₄/t was measured in the SRK (2013) data set, which was significantly higher than 3.2 H₂SO₄/t measured in the RGS (2019) samples. Overall, however, the median MPA value for both data sets was 0.6 H₂SO₄/t. The SRK (2013) data generally produced higher and lower values for ANC, and the median value of 6.8 H₂SO₄/t was comparable with the ANC of 8.8 H₂SO₄/t measured for the RGS (2019) samples.

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Table 5-2: Comparison of geochemistry results for key parameters

		Minimum	Maximum	Median
pH	SRK, 2013 pH _{1:2}	3.0	9.7	8.1
	RGS, 2019 pH _{1:5}	5.4	9.4	6.5
EC ($\mu\text{S}/\text{cm}$)	SRK, 2013 EC _{1:2}	26	6,200	264
	RGS, 2019 EC _{1:5}	36	932	341
MPA ($\text{H}_2\text{SO}_4/\text{t}$)	SRK, 2013	0.2	324	0.6
	RGS, 2019	0.2	3.2	0.6
ANC ($\text{H}_2\text{SO}_4/\text{t}$)	SRK, 2013	0.3	555	6.8
	RGS, 2019	5.5	364	8.8

The comparison of RGS (2019) results with the existing data from SRK (2013) validates and confirm trends. For example, SRK (2013) observed that EC from the overburden and interburden materials was generally low (median 264 $\mu\text{S}/\text{cm}$), and a similar finding was produced by RGS (2019). The lack of PAF material in the RGS (2019) samples indicates that higher concentrations of total sulfur are confined to stratigraphic units close to coal seams.

In general, overburden and interburden material is NAF Barren or NAF and is unlikely to present any significant environmental risk from acid drainage. However, SRK (2013) also noted that mudstone, claystone, carbonaceous mudstone, and siltstone units were dispersive, which agreed with observations by RGS (2019) (**Section 4.2.2**). Major ion imbalances in the soil and shallow regolith will need to be amended to reduce soil dispersion and erosion. This can be achieved by increasing soluble Ca and Mg and by increasing the organic matter and organic carbon content in the soil profile.

SRK (2013) suggested that surface water quality may be elevated in sulfate, fluoride, boron, molybdenum, and zinc, based on preliminary results from the EIS kinetic leach tests. Water soluble leach tests by RGS (2019) verified that that Al, B, Ba, Fe, Mn, Sr and Zn is present in the samples.

6 Conclusions

RGS has completed geochemical characterisation of 63 mine waste samples from the CCM. The main findings of the static geochemical tests are as follows:

- Of the 62 of the 63 samples (98 %) are classified as non-acid forming and barren of sulfur (NAF_{BARREN}). The remaining sample (2%) is classified as non-acid forming (NAF). These materials have a very low risk of acid generation and a high factor of safety with respect to producing acid drainage.
- Two samples had a total sulfur content >0.1% and were re-tested for SCR to assess the proportion of total sulfur present as reactive sulfides. The siltstone sample measured very low (0.005%) in reactive sulfides, while the mixed mudstone/tuff sample had excess ANC to neutralise the acidity likely to be produced.
- Soil, subsoil, and transition materials from surface to depths of 25 m are likely to be dispersive. They are strongly sodic, have a low eCEC, are deficient in exchangeable Ca and Mg, and are very high in exchangeable Na.
- These materials are unlikely to be suitable as cover materials (without amendment), as strong sodicity can result in surface crusting and low infiltration and hydraulic conductivity within affected soils.
- From previous reports, RGS (2019) noted that while the deeper fresh rock units were not dispersive, they were not durable, and with time may degrade to sand, silt or clay. It is possible that these units may provide a suitable growth medium after a period of degradation unless they become dispersive as they weather. However, physical and chemical testing would be required to adequately assess this.
- The acid-neutralising capacity (ANC) for the mining waste samples has a low median value of 8.8 kg H₂SO₄/t. However, there are a few sandstone samples which have high ANC (up to 364 kg H₂SO₄/t).
- The lithological units with elevated ANC will also have elevated Ca²⁺. This material could be used to amend the ESP of the low Ca²⁺ soil, subsoil and regolith units i.e. mined rock with high ANC could be used as a rock mulch on soil covers to (i) provide surface roughness to reduce erosion rates and (ii) provide a long term source of soluble Ca²⁺ that would be adsorbed by the clay minerals and reduce the ESP.
- The results from the sample analyses indicate that initial surface runoff and seepage from bulk NAF overburden materials is expected to produce water quality that has a neutral pH (median 6.5) and a relatively low EC (median 341 µS/cm).
- The dissolved soluble metal/metalloid concentrations are below the detection limit (LoR) for most analytes and unlikely to pose a significant risk to the quality of local surface and groundwater resources.
- Slight enrichment was observed for water-soluble Al, B, Ba, Fe, Mn, Sr and Zn. These results can be used to verify baseline conditions.
- Work done in 2013 (**Figure 2-2**) verifies that coal, coal, roof and coal floor units are likely to be PAF.

7 Recommendations

As a result of the static geochemical characterisation work completed on mining waste samples from the CCM, the following recommendations are provided to minimise the risk of any environmental harm and to plan future rehabilitation strategies.

- Implement the 2020 Geochemical Sampling and Analysis Procedure (GaPSaAP) provided to CCM in Q1 2020. The core components of the 2020 GaPSaAP are to:
 - Develop a regolith, overburden and interburden geology model (Geo-Environmental Block Model (GBM)) to quantify the material balance for each of the major units that will be mined.
 - Use the material balance to quantify and apportion the number of samples that should be targeted in each GaPSaAP i.e. units with a large volume of material should have a larger number of samples and vice versa.
 - Use the GBM to schedule the movement and placement of the material that will be mined to minimise rehandling and optimise the financial aspects of the rehabilitation program.
- Implement a physical testing program into the GaPSaAP to quantify the physical properties of the soil and regolith and the degradation rate of weathered and fresh waste rock to assess the suitability of these materials for rehabilitation. Physical testing may include:
- Soil water characteristic curve (to test how strongly soil holds onto water);
 - Falling Head permeability test;
 - Particle Size Distribution (PSD) and hydrometer analysis;
 - Point load measurement;
 - Sodium sulphate sound test to test rock strength (include PSD after 3-6 months); and
 - Emmerson Aggregate Test.
- Analysing representative samples of coal and coal reject materials (when available) using static and kinetic geochemical tests to verify the nature of these materials.
- Compiling total sulfur (TS) data from coal quality analyses to produce TS maps to show the concentration, distribution and variability of TS in the coal seams and coal roof and floor units. This could be used to verify the low TS content in the coal and verify the potential for acid drainage is also very low.
- There is a need for a site water quality model to quantify how the water quality in the mine area will evolve over time as the mined material weathers and releases major ions and metal(loids). This model will need to account for the release of major ions over time, and the effects of evaporation and rainfall.
- Additional overburden testing and rehabilitation field trials should be completed when the mine is operational and through each working phase to confirm the most appropriate management option for progressive rehabilitation of these materials during mine operations and at mine closure.
- More work is required to quantify the geochemical properties of the waste coal (e.g. partings) coal seams and associated coal roof and floor units. This is being addressed through targeted drilling, sampling and analysis in the Q2 to Q4 GaPSaAP.

8 References

- AS 4969.7-2008. *Analysis of acid sulfate soil – Dried samples – Methods of test. Method 7: Determination of chromium reducible sulfur (Scr)*. Standards Australia, June 2008.
- Chitombo, G., Murphy, T., & Webster, T. (2016). Beyond rock-mass characterisation: the impact of geology on block-caving.
- Chitombo, G. (2011). Total deposit knowledge: geology, underground mass mining and the future. A mining engineer's perspective. *Australasian Institute of Mining and Metallurgy Publication Series*, 8, 11-14.
- Commonwealth of Australia (2016a). *Leading Practice Sustainable Development Program for the Mining Industry. Preventing Acid and Metalliferous Drainage*. September, Canberra ACT.
- Commonwealth of Australia (2016b). *Leading Practice Sustainable Development Program for the Mining Industry. Mine Rehabilitation*. September, Canberra ACT.
- Commonwealth of Australia (2016c). *Leading Practice Sustainable Development Program for the Mining Industry. Tailings Management*. September, Canberra ACT.
- Commonwealth of Australia (2016d). *Leading Practice Sustainable Development Program for the Mining Industry. Mine Closure*. September, Canberra ACT.
- de Caritat, P., & Braun, J. (1992). Cyclic development of sedimentary basins at convergent plate margins. Structural and tectono-thermal evolution of some Gondwana basins of eastern Australia. *Journal of Geodynamics*, 16(4), 241-282.
- DES (2019) Environmental authority EPML01470513 - Carmichael Coal Mine. Environmental Authority effective date: 23 September 2019. Department of Environment and Science.
- DME (1995). Draft Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland, Technical Guideline – Assessment and Management of Acid Drainage and Saline/Sodic Wastes. Queensland Department of Minerals and Energy.
- Hazleton, P and Murphy, B. (2007). *Interpreting Soil Test Results: What do all the numbers mean?* CSIRO Publishing.
- l'Anson, Amy; Heine, Christian, Ian Deighton, R. Dietmar Müller, Adriana Dutkiewicz (2017). "Burial and exhumation history of the Galilee Basin, Australia: Implications for unconventional hydrocarbon prospectivity". *AAPG Bulletin*. 0 (20, 170, 615).
- INAP (2009). *Global Acid Rock Drainage Guide (GARD Guide)*. Document prepared by Golder Associates on behalf of the International Network on Acid Prevention (INAP). June 2009 (<http://www.inap.com.au/>).
- Isbell, R. F. (2002). *The Australian soil classification.*, 2nd edn (CSIRO Publishing: Melbourne).
- Jackson, K.S., Horvath, Z. and Hawkins, P.J. 1981. An assessment of the petroleum prospects for the Galilee Basin, Queensland. *APEA Journal* 21, 172–186.
- McClurg, J. (2013) Soils, Pre-mining Land Suitability and Stripping Recommendations for Carmichael Coal Mine, Central Queensland. North Queensland Soil Assessment (NQSA)
- Northcote, K. H., & Skene, J. K. M. (1972). Australian soils with saline and sodic properties. *Soil Publ. Div. Soils CSIRO Aust*, (27).
- RGS (2019) Management Plan: Mining Waste and Rejects. Technical report prepared for Adani Mining Pty Ltd. Project Number 2018058.
- ROM Resources (2014) Carmichael Coal Deposit, Queensland Minescape Model Report and 2014 Resource Statement
- Schumann R., Stewart W., Miller S., Kawashima J.L. and Smart R. (2012). Acid-Base Accounting Assessment of Mine Wastes using the Chromium Reducible Sulfur Method. *Science of the Total Environment* 424, 289-296.
- SRK (2011) Carmichael Coal Mine and Rail Project: Mine Waste Characterisation. SRK Project Number: GHD003.
- Stewart, A.J., 2011, Galilee Basin, Australian Government Geoscience Australia. Viewed 18 November 2016 <http://www.ga.gov.au/provexplorer/provinceDetails.do?eno=550790>

- Stewart W., Schumann R., Miller. and Smart R. (2009). *Development of Prediction Methods for ARD Assessment of Coal Process Wastes*. In Proceedings of Securing the Future and 8th International Conference on Acid Rock Drainage (ICARD), June 22-26, Skelleftea, Sweden.
- Vine, R. R. (1976). Galilee Basin. *Economic geology of Australia and Papua New Guinea, Australasian Institute Mining Metallurgy (AIMM): AIMM Monograph Series*, 7, 316-321
- Waschbusch, P., Korsch, R. J., & Beaumont, C. (2009). Geodynamic modelling of aspects of the Bowen, Gunnedah, Surat and Eromanga Basins from the perspective of convergent margin processes. *Australian Journal of Earth Sciences*, 56(3), 309-334.

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9 Attachments

9.1 Attachment A – Acid and metalliferous drainage

The use of consistent terminology is required so the potential for misunderstanding is reduced.

Mined materials may include:

- **rehabilitation materials** – material to be utilised for cover systems and water management drains that could include oxide (e.g. soil, or fully weathered non-consolidated units such as clay that can be free dug without blasting), transition (include oxide and fresh material) or fresh (competent un-weathered rock) geological units.
- **cover materials** – material selectively placed within the upper profile of the rehabilitated landform in a cover system. Cover systems are constructed from rehabilitation materials. Cover systems should be designed and constructed to meet specific objectives and design criteria. Chemical and physical characterisation of rehabilitation materials is required to ensure that the cover system will meet the objectives and design criteria.

In Australia, the term **Acid and Metalliferous Drainage (AMD)** is defined as incorporating acidic metalliferous drainage, neutral metalliferous drainage and saline drainage (COA, 2016).

Standard industry terms used to classify the **net acid producing potential (NAPP)** of **mined materials** include the following:

- **PAF** (Potentially Acid Forming) - has the potential to produce acid;
- **PAF- LC** (Potentially Acid Forming - Low Capacity) - has the potential to produce minor acid;
- **NAF** (Non-Acid Forming) - will not produce acid but may leach salts and some metals due to the presence of low sulfide bearing material;
- **NAF-B** (Non-Acid Forming-Barren) - will not produce acid or leach salts due to the absence of sulfide minerals; and
- **AC** (Acid Consuming) – has some acid neutralising capacity (ANC) that will contribute to ongoing acid neutralisation e.g. calcite in basalt.

General industry terms that can be used to **describe water quality** at mines include the following:

- Acid Mine Drainage;
- Acid Rock Drainage;
- Acid and Metalliferous Drainage;
- Neutral Mine Drainage;
- Saline Drainage; and
- Mine Affected Water.

Water on mines includes surface water and groundwater. Groundwater can be considered as water that is present in non-mined ground that has the potential to enter pits (operational pits, backfilled pits or decommissioned pits). After groundwater enters a pit, it will become mine affected water. Mine affected water could leave a pit and enter the groundwater system in the receiving environment or become surface water that may then be pumped from the pit. Surface water is present in dams, creeks, and process plants. Seepage from landforms can drain to groundwater or it may appear as resurgent seepage to surface water.

The term **mine affected water** is used as a general term to describe water which contacts disturbed ground and that may include water in:

- seepage from waste rock dumps or low-grade ore stockpiles (in-pit or ex-pit);
- operating pits;
- decommissioned pits;

- back-filled pits;
- tailings;
- rejects stockpiles; and
- product stockpiles.

Mine affected water can be classified as having:

- acid, neutral or alkaline pH;
- variable concentrations of major ions (salts e.g. calcium, magnesium, potassium, sodium, chloride, sulfate, boron or fluoride); and
- variable concentrations of metals (e.g. Al, Fe, Mn and Zn) or metalloids (e.g. Mo, Se and V) with the concentrations often linked to pH.

Potential **sources of acid** in mine affected water at mine sites can include:

- oxidation of sulfide minerals such as pyrite that produce sulfuric acid (INAP, 2009);
- rainfall and leaching of cations such as calcium (Ca^{2+}), magnesium (Mg^{2+}), potassium (K^+) and sodium (Na^+) that reduce soil acidification by atmospheric carbonic, nitric or sulfuric acid; and
- organic matter decay

Potential **sources of salts** in mine affected water at mine sites that can include:

- oxidation of sulfide minerals, the production of sulfuric acid and subsequent neutralisation reactions that mobilise major ions such as sulfate (SO_4^{2-}) and calcium;
- chemical weathering of adjacent soil and rock by sulfuric acid that releases major ions such as sodium, potassium, magnesium and chloride; and
- the mobilisation of sodium chloride (NaCl) or sodium bi-carbonate (NaHCO_3) that are present within geological units and groundwater and then released in fluxes as mined materials are extracted (blasted), processed (crushed) and placed into mine landforms.

Potential **sources of metals** (e.g. Al, Fe, Mn, and Zn) and metalloids (oxyanions such as Mo, Se and V) in water at mine sites can include elements present:

- as ancillary minerals within primary sulfide minerals like pyrite or marcasite;
- in the solid phase of geological units in a range of minerals; and
- in pore water.

Pathways by which AMD is mobilised

AMD is mobilised by water and is transported from the source materials along aqueous physical pathways into the receiving environment. The salts, metals and metalloids in aqueous phases can be taken up by aqueous flora and fauna via aqueous biophysical pathways.

Salts, metals and metalloids present as exchangeable or less soluble fractions (e.g. carbonate or oxide fractions) can also be relocated via physical pathways in the aqueous environment as suspended sediment or bedload sediment.

Salts, metals and metalloids present in soluble or exchangeable fractions within mined material or process waste can also be taken up by plants via terrestrial biophysical pathways.

Wind borne erosion is another pathway whereby salts, metals and metalloids can be moved from the source to the receiving environment.

9.2 Attachment B – As received drill core samples

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9.3 Attachment C – Tables

9.3.1 Table C1: Acid Base Account test results

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Acid Base Account and NAG Test Results for Waste Rock Samples from the Carmichael Coal Mine Project

RGS Sample No.	Drill Hole ID	ALS Sample ID	Sample Lithology	Alteration	From (m)	From (m)	Depth Interval (m)	Weathering	Pit	Sample Location in Pit	pH ¹	EC ¹	Total S	CRS	MPA ²	ANC ²	NAPP ²	ANC: MPA Ratio	Sample Classification ³
16	171476-C	EB1933053016	Mudstone/Carb SS		54.29	55.2	0.91				6.8	790	0.005		0.2	11	-11.0	71.8	Non-Acid Forming (Barren)
20	209357-A	EB1933053020	Mudstone/Tuff		61.33	62.26	0.93				8.9	467	0.14	0.104	3.2	25.5	-21.2	8.0	Non-Acid Forming
21	209357-B	EB1933053021	MS/Tuff/Carb MS/ST		62.26	63.22	0.96				9	445	0.06		1.8	31.7	-29.9	17.3	Non-Acid Forming (Barren)
27	171452-A	EB1933053027	Carbonaceous Sandstone		17.37	18.32	0.95				6.4	1180	0.01		0.3	11	-10.7	35.9	Non-Acid Forming (Barren)
28	171452-B	EB1933053028	Carbonaceous Sandstone		18.32	19.23	0.91				6.4	1110	0.01		0.3	8.9	-8.6	29.1	Non-Acid Forming (Barren)
29	171453-A	EB1933053029	Carbonaceous Sandstone		21.91	22.84	0.93				6.4	1240	0.01		0.3	7.8	-7.5	25.5	Non-Acid Forming (Barren)
30	171453-B	EB1933053030	Carbonaceous Sandstone		22.84	23.76	0.92				6.4	1190	0.005		0.2	9.5	-9.5	62.0	Non-Acid Forming (Barren)
48	209352-B	EB1933053048	Carbonaceous Sandstone		20.77	21.32	0.55				6.2	690	0.005		0.2	8.9	-8.9	58.1	Non-Acid Forming (Barren)
11	171475-A	EB1933053011	Siltstone		40.1	41.05	0.95				7.2	248	0.005		0.2	10	-10.0	65.3	Non-Acid Forming (Barren)
12	171475-B	EB1933053012	Siltstone		41.05	41.97	0.92				6.6	582	0.005		0.2	9.4	-9.4	61.4	Non-Acid Forming (Barren)
13	171475-C	EB1933053013	Siltstone		41.97	42.26	0.29				6.6	610	0.12	0.005	0.2	8.9	-5.2	58.1	Non-Acid Forming (Barren)
14	171476-A	EB1933053014	Siltstone		52.47	53.38	0.91				6.8	444	0.01		0.3	8.4	-8.1	27.4	Non-Acid Forming (Barren)
15	171476-B	EB1933053015	Siltstone		53.38	54.29	0.91				6.6	820	0.005		0.2	11	-11.0	71.8	Non-Acid Forming (Barren)
22	209357-C	EB1933053022	Siltstone		63.22	63.48	0.26				8.8	314	0.05		1.5	25	-23.5	16.3	Non-Acid Forming (Barren)
37	171456-A	EB1933053037	Siltstone		39.36	40.26	0.9				6.6	684	0.02		0.6	7.3	-6.7	11.9	Non-Acid Forming (Barren)
38	171456-B	EB1933053038	Siltstone		40.26	41.19	0.93				6.6	702	0.005		0.2	8	-8.0	52.2	Non-Acid Forming (Barren)
39	171457-A	EB1933053039	Siltstone		46.28	47.23	0.95				6.6	668	0.005		0.2	9.1	-9.1	59.4	Non-Acid Forming (Barren)
40	171457-B	EB1933053040	Siltstone		47.23	48.15	0.92				6.9	554	0.02		0.6	9.6	-9.0	15.7	Non-Acid Forming (Barren)
41	171457-C	EB1933053041	Siltstone		48.15	48.32	0.17				6.6	555	0.005		0.2	8.8	-8.8	57.5	Non-Acid Forming (Barren)
47	209352-A	EB1933053047	Siltstone		20.2	20.77	0.57				6.4	1020	0.005		0.2	8.9	-8.9	58.1	Non-Acid Forming (Barren)
49	209352-C	EB1933053049	Siltstone		21.32	22.08	0.76				6.4	746	0.005		0.2	8.3	-8.3	54.2	Non-Acid Forming (Barren)
51	209353-B	EB1933053051	Siltstone		25.71	26.66	0.95				6.4	705	0.02		0.6	9	-8.4	14.7	Non-Acid Forming (Barren)
58	209359-A	EB1933053058	Siltstone		69.64	70.9	1.26				8.8	248	0.05		1.5	21.4	-19.9	14.0	Non-Acid Forming (Barren)
45	209351-A	EB1933053045	Sandstone/Siltstone		9.32	10.25	0.93				6.6	944	0.01		0.3	8.7	-8.4	28.4	Non-Acid Forming (Barren)
50	209353-A	EB1933053050	Siltstone/Carb SS		24.8	25.71	0.91				6.1	757	0.005		0.2	6.8	-6.8	44.4	Non-Acid Forming (Barren)
52	209354-A	EB1933053052	Siltstone/Sandstone		27.48	28.43	0.95				6.7	447	0.01		0.3	10.7	-10.4	34.9	Non-Acid Forming (Barren)
53	209354-B	EB1933053053	Siltstone/Sandstone		28.48	29.38	0.9				6.9	434	0.02		0.6	10.2	-9.6	16.7	Non-Acid Forming (Barren)
54	209354-C	EB1933053054	Siltstone/Sandstone		29.38	30.24	0.86				7.1	443	0.02		0.6	13.9	-13.3	22.7	Non-Acid Forming (Barren)
1	171471-A	EB1933053001	Sandstone		12.7	13.63	0.93				5.8	415	0.02		0.6	9.5	-8.9	15.5	Non-Acid Forming (Barren)
2	171472-A	EB1933053002	Sandstone		13.63	14.58	0.95				5.8	459	0.01		0.3	7	-6.7	22.9	Non-Acid Forming (Barren)
3	171472-B	EB1933053003	Sandstone		21.39	22.37	0.98				5.4	560	0.02		0.6	5.7	-5.1	9.3	Non-Acid Forming (Barren)
4	171472-C	EB1933053004	Sandstone		22.37	23.3	0.93				5.5	516	0.01		0.3	6.6	-6.3	21.6	Non-Acid Forming (Barren)
5	171473-A	EB1933053005	Sandstone		24.26	25	0.74				5.6	433	0.005		0.2	6.8	-6.8	44.4	Non-Acid Forming (Barren)
6	171473-B	EB1933053006	Sandstone		25	25.89	0.89				5.6	383	0.01		0.3	6	-5.7	19.6	Non-Acid Forming (Barren)
7	171473-C	EB1933053007	Sandstone		25.89	26.18	0.29				5.7	359	0.005		0.2	8.3	-8.3	54.2	Non-Acid Forming (Barren)
8	171474-A	EB1933053008	Sandstone		34.14	35.09	0.95				5.9	340	0.02		0.6	5.5	-4.9	9.0	Non-Acid Forming (Barren)
9	171474-B	EB1933053009	Sandstone		35.09	36.02	0.93				5.9	311	0.02		0.6	5.9	-5.3	9.6	Non-Acid Forming (Barren)
10	171474-C	EB1933053010	Sandstone		36.02	36.22	0.2				6	277	0.02		0.6	7.8	-7.2	12.7	Non-Acid Forming (Barren)
17	171477-A	EB1933053017	Sandstone		103.3	103.8	0.51				7	46	0.005		0.2	6.6	-6.6	43.1	Non-Acid Forming (Barren)
18	171477-B	EB1933053018	Sandstone		103.8	104.7	0.89				6.8	36	0.005		0.2	7.7	-7.7	50.3	Non-Acid Forming (Barren)
19	171477-C	EB1933053019	Sandstone		104.7	105.4	0.7				6.8	36	0.02		0.6	7.3	-6.7	11.9	Non-Acid Forming (Barren)
23	209358-A	EB1933053023	Sandstone		67.37	68.29	0.92				9.1	257	0.04		1.2	121	-120.0	98.8	Non-Acid Forming (Barren)
24	171451-A	EB1933053024	Sandstone		3.29	4.02	0.73				6.5	569	0.02		0.6	7.4	-6.8	12.1	Non-Acid Forming (Barren)
25	171451-B	EB1933053025	Sandstone		4.02	4.93	0.91				5.7	855	0.03		0.9	8.2	-7.3	8.9	Non-Acid Forming (Barren)
26	171451-C	EB1933053026	Sandstone		4.93	5.88	0.95				5.6	932	0.03		0.9	9.2	-8.3	10.0	Non-Acid Forming (Barren)
31	171454-A	EB1933053031	Sandstone		27.62	28.2	0.58				6.7	165	0.005		0.2	8.8	-8.8	57.5	Non-Acid Forming (Barren)
32	171454-B	EB1933053032	Sandstone		28.2	29.11	0.91				6.6	155	0.005		0.2	8.8	-8.8	57.5	Non-Acid Forming (Barren)
33	171454-C	EB1933053033	Sandstone		29.11	30.03	0.92				6.6	136	0.01		0.3	8.7	-8.4	28.4	Non-Acid Forming (Barren)
34	171455-A	EB1933053034	Sandstone		33.71	34.29	0.58				6.6	222	0.01		0.3	9.9	-9.6	32.3	Non-Acid Forming (Barren)
35	171455-B	EB1933053035	Sandstone		34.29	35.19	0.9				6.5	308	0.02		0.6	8.6	-8.0	14.0	Non-Acid Forming (Barren)
36	171455-C	EB1933053036	Sandstone		35.19	36.18	0.99				6.5	360	0.03		0.9	7.2	-6.3	7.8	Non-Acid Forming (Barren)
42	171458-A	EB1933053042	Sandstone		52.76	63.57	10.81				6.4	242	0.02		0.6	7.3	-6.7	11.9	Non-Acid Forming (Barren)
43	171458-B	EB1933053043	Sandstone		63.57	64.51	0.94				6.5	242	0.02		0.6	7.2	-6.6	11.8	Non-Acid Forming (Barren)
44	171458-C	EB1933053044	Sandstone		64.51	64.89	0.38				6.3	279	0.04		1.2	7.8	-6.6	6.4	Non-Acid Forming (Barren)
46	209351-B	EB1933053046	Sandstone		10.25	11.2	0.95				6.7	661	0.01		0.3	8.3	-8.0	27.1	Non-Acid Forming (Barren)
55	209355-A	EB1933053055	Sandstone		39.39	40.33	0.94				9.3	341	0.02		0.6	38	-37.4	62.0	Non-Acid Forming (Barren)
56	209355-B	EB1933053056	Sandstone		40.33	41.3	0.97				9.2	349	0.03		0.9	119	-118.0	129.5	Non-Acid Forming (Barren)
57	209355-C	EB1933053057	Sandstone		41.3	42.45	1.15				9.3	373	0.005		0.2	364	-364.0	2377.1	Non-Acid Forming (Barren)
59	209360-A	EB1933053059	Sandstone		124.8	125.8	0.93				8.2	66	0.005		0.2	6.7	-6.7	43.8	Non-Acid Forming (Barren)
60	209360-B	EB1933053060	Sandstone		125.8	126.6	0.86				7.9	36	0.005		0.2	7.7	-7.7	50.3	Non-Acid Forming (Barren)
61	209365-A	EB1933053061	Sandstone		52.15	53.11	0.96				9.2	435	0.03		0.9	70.7	-69.8	77.0	Non-Acid Forming (Barren)
62	209365-B	EB1933053062	Sandstone		53.11	54.07	0.96				9.4	434	0.02		0.6	83.7	-83.1	136.7	Non-Acid Forming (Barren)
63	209365-C	EB1933053063	Sandstone		54.07	54.48	0.41				9.3	413	0.03		0.9	281	-280.0	305.9	Non-Acid Forming (Barren)

Notes

- Current pH, EC, Alkalinity and Acidity provided for 1:5 sample:water extracts
- CRS = Chromium Reducible Sulfur; MPA = Maximum Potential Acidity; ANC = Acid Neutralising Capacity; NAPP = Net Acid Producing Potential; NAG = Net Acid Generation.
- Sample classification criteria detail provided in report text.

* Where total sulfur or ANC results are less than the laboratory LoR a value of half of the LoR is used .

9.3.2 Table C2: Static leach test results

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Multi-Element Test Results for Water Extracts from the Carmichael Coal Mine project

		RGS Sample Number →										
		ALS Laboratory ID →										
		Client Sample ID →										
		Water Quality Guidelines:										
Parameters	Limit of Reporting	Aquatic Ecosystems (freshwater) ¹	Livestock Drinking Water ²									
pH	0.01 pH unit	6 to 9	-	6.89	6.97	7.18	8.53	6.92	6.92	7.53	7.04	8.83
Electrical Conductivity	1 µS/cm	<1,000 [#]	3,580 [^]	697	937	477	659	1500	1940	1600	1220	476
Carbonate Alkalinity (mgCaCO ₃ /L)	0.2 mg/L	-	-	<0.2	<0.2	<0.2	2	<0.2	<0.2	<0.2	<0.2	5
Bicarbonate Alkalinity (mgCaCO ₃ /L)	0.2 mg/L	-	-	2	2	2	26	1	2	1	1	25
Total Alkalinity (mgCaCO ₃ /L)	0.2 mg/L	-	-	2	2	2	28	1	2	1	1	31
Acidity (mgCaCO ₃ /L)	0.2 mg/L	-	-	0	0	0	<0.2	0	1	0	0	<0.2
Net Alkalinity (mgCaCO ₃ /L)		-	-	2	2	2	28	1	1	1	1	31
Major Ions	All units mg/L			All units mg/L								
Calcium (Ca)	2	-	1,000	<2	1	<2	1	0	1	1	4	1
Magnesium (Mg)	2	-	-	0	2	<2	0	1	2	3	4	0
Potassium (K)	2	-	-	1	1	0	3	2	1	2	1	2
Sodium (Na)	2	-	-	25	31	17	25	54	71	55	35	19
Chloride (Cl)	2	-	-	37	55	20	6	90	118	94	75	5
Fluoride (F)	0.2	-	1	0	0	0	0	0	0	0	0	0
Sulfate (SO ₄)	2	-	1,000	7	5	9	21	8	8	10	5	8
Trace Metals/Metalloids	All units mg/L			All units mg/L								
Silver (Ag)	0.02			<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Aluminium (Al)	0.002	0.055	5	0.014	0.004	0.062	0.050	0.096	0.020	0.012	0.002	0.058
Arsenic (As) - pentavalent	0.002	0.013 **	0.1	0.000	0.000	0.000	0.006	<0.002	<0.002	<0.002	<0.002	0.002
Boron (B)	0.002	0.37	0.5	0.038	0.054	0.120	0.080	0.2	0.1	0.1	0.1	0.1
Barium (Ba)	0.002	-	-	0.061	0.110	0.077	0.055	0.1	0.1	0.1	0.1	0.1
Beryllium (Be)	0.2		0.1	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Bismuth (Bi)	0.02	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cadmium (Cd)	0.002	0.0002	0.01	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cerium (Ce)	0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cobalt (Co)	0.002	-	0.05	<0.002	0.0004	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium (Cr) - total	0.002	0.001 (hex)*	0.1	0.0002	0.0002	0.0004	0.0004	0.0002	<0.002	0.0004	<0.002	0.0004
Caesium (Cs)	0.2	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Copper (Cu)	0.002	0.0014	0.2	0.0008	0.0008	0.0066	0.0004	0.0010	0.0004	0.0004	0.0002	0.0004
Dysprosium (Dy)	0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Erbium (Er)	0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Europium (Eu)	0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Iron (Fe)	0.2	-	0.2	0	<0.2	0.02	0.02	0.09	<0.2	<0.2	<0.2	0
Gallium (Ga)	0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Gadolinium (Gd)	0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Hafnium (Hf)	0.0001	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Mercury (Hg)	0.00002	0.0006	0.002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Holmium (Ho)	0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Iodine (I)	0.002	-	-	0.02	0.12	<0.002	<0.002	0.04	0.04	0.08	0.10	<0.002
Lanthanum (La)	0.02	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Lithium (Li)	0.2	-	-	0.0008	0.0006	0.0006	0.0006	0.0020	0.0006	0.0008	0.0004	0.0004
Lutetium (Lu)	0.2	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Manganese (Mn)	0.002	1.90	0.2	0.015	0.206	0.001	0.003	0.004	0.008	0.005	0.006	0.002
Molybdenum (Mo)	0.002	-	0.01	<0.002	<0.002	<0.002	0.0472	0.0004	<0.002	<0.002	<0.002	0.0028
Neodymium (Nd)	0.02	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Nickel (Ni)	0.01	0.011	0.2	0.0002	0.0004	0.0002	<0.01	0.001	<0.01	<0.01	<0.01	<0.01
Lead (Pb)	0.02	0.0034	2	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Praseodymium (Pr)	0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Rubidium (Rb)	0.002	-	-	0.0008	0.0010	0.0004	0.0030	0.0024	0.0014	0.0018	0.0006	0.0022
Antimony (Sb)	0.002	-	-	<0.002	<0.002	0.0060	0.0008	<0.002	<0.002	<0.002	<0.002	<0.002
Selenium (Se)	0.002	0.011	0.02	<0.002	<0.002	<0.002	0.014	<0.002	<0.002	<0.002	<0.002	<0.002
Samarium (Sm)	0.2	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Strontium (Sr)	0.002	-	-	0.006	0.021	0.004	0.028	0.011	0.020	0.038	0.109	0.013
Terbium (Tb)	0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Tellurium (Te)	0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Thorium (Th)	0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Titanium (Ti)	0.2	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Thallium (Tl)	0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Tin (Tm)	0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Thulium (Tm)	0.0001	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Uranium (U)	0.002	-	0.01	<0.002	<0.002	<0.002	0.0004	<0.002	<0.002	<0.002	<0.002	<0.002
Vanadium (V)	0.002	-	0.1	<0.002	<0.002	<0.002	0.008	<0.002	<0.002	<0.002	<0.002	0.004
Yttrium (Y)	0.02	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Ytterbium (Yb)	0.2	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Zinc (Zn)	0.2	0.008	2	0.008	0.010	0.015	0.011	0.065	0.008	0.003	0.003	0.005
Zirconium (Zr)	0.002	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

* Cr (VI) = hexavalent. ** 0.024 mg/L for trivalent Arsenic (III).
for still water bodies only, moving rivers at low flow rates should not exceed 2,200µS/cm
^ calculated based on total dissolved solids (TDS) conversion rate of 0.67% of EC. TDS is an approximate measure of inorganic dissolved salts and should not exceed 2,400mg/L for livestock drinking water.

Notes: < indicates concentration less than the detection limit. Shaded cells exceed applied guideline values.
1. ANZECC & ARMCANZ (2000). Trigger values for aquatic ecosystems (95% species protection level)
2. ANZECC & ARMCANZ (2000). Recommended guideline limits for Livestock Drinking Water. Long term trigger
1 + 2. both taken from the "Australian and New Zealand Guidelines for Fresh and Marine Water Quality", National Water Quality Management Strategy, 2000, compilation by ANZECC and ARMCANZ.

9.3.3 Table C3: Sodicity and exchangeable cation test results

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Soil Fertility Test Results for Waste Rock from the Carmichael Coal Mine Project											
	RGS Sample Number →		22	23	24	25	26	1	2	3	4
	ALS Laboratory ID →		EB2000789001	EB2000789002	EB2000789003	EB2000789004	EB2000789005	EB2000789009	EB2000789010	EB2000789011	EB2000789012
	Client Sample ID →		171471-A 12.7-1	171472-A 13.63-	171472-B 21.39-	171472-C 22.37-	171473-A 24.26-	71451-A 3.29-4.0	71451-B 4.02-4.9	71451-C 4.93-5.8	1452-A 17.37-18.
Parameters	Limit of Reporting	NEPC ¹ Health-Based Investigation Level (HILs)-C									
pH	0.1		5.9	5.9	5.5	5.5	5.6	5.8	5.6	5.5	6.6
Electrical Conductivity (µS/cm)	1		389	457	551	520	429	573	876	976	1220
Exchangable Cations			All units meq/100g (except Exchangable Sodium & Aluminium Percentage (%))								
Exch. Calcium	0.1		0.2	0.3	0.5	0.5	0.5	1.6	1.6	1.3	0.8
Exch. Magnesium	0.1		2.5	2.6	1.9	2.0	2.0	5.2	6.9	6.7	4.7
Exch. Potassium	0.1		0.3	0.3	0.2	0.2	0.2	0.7	1.0	1.2	0.3
Exch. Sodium	0.1		1.2	1.0	0.4	0.4	0.4	3.7	4.8	5.0	2.6
Exch. Aluminium	0.1		<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.4	0.4	----
Cation Exchange Capacity	0.1		4.6	4.5	3.4	3.5	3.9	11.7	15.1	14.9	9.0
Calcium:Magnesium Ratio	-		<0.1	0.1	0.3	0.2	0.2	0.3	0.2	0.2	0.2
Magnesium:Potassium Ratio	-		7.8	8.5	12.8	12.2	12.5	7.0	6.5	5.8	15.6
Exchangable Sodium Percentage	0.1%		27.5	22.6	13.1	11.9	11.7	32.4	33.3	34.9	29.0
Exchangable Aluminium Percentage	0.1%										
	RGS Sample Number →		5	6	7	41	42	43	44	45	
	ALS Laboratory ID →		EB2000789013	EB2000789014	EB2000789015	EB2000789016	EB2000789017	EB2000789018	EB2000789019	EB2000789020	
	Client Sample ID →		1452-B 18.32-19	1453-A 21.91-22	1453-B 22.84-23	9351-A 9.32-10.2	9351-B 10.25-11	9352-A 20.2-20	9352-B 20.77-21	9352-C 21.32-22.08	
Parameters	Limit of Reporting	NEPC ¹ Health-Based Investigation Level (HILs)-C									
pH	0.1		6.6	6.6	6.5	6.9	6.9	6.6	6.2	6.5	
Electrical Conductivity (µS/cm)	1		1160	1200	1160	890	667	987	676	720	
Exchangable Cations			All units meq/100g (except Exchangable Sodium & Aluminium Percentage (%))								
Exch. Calcium	0.1		0.7	0.5	0.4	0.5	0.4	0.8	0.5	0.7	
Exch. Magnesium	0.1		3.8	2.8	2.4	2.3	1.6	1.2	0.8	0.9	
Exch. Potassium	0.1		0.2	0.2	0.1	0.3	0.3	0.1	<0.1	<0.1	
Exch. Sodium	0.1		2.1	1.7	1.6	0.7	0.4	0.2	0.2	0.2	
Exch. Aluminium	0.1		----	----	----	----	----	----	----	----	
Cation Exchange Capacity	0.1		7.2	5.4	4.9	4.1	2.9	2.6	1.9	2.2	
Calcium:Magnesium Ratio	-		0.2	0.2	0.2	0.2	0.2	0.7	0.6	0.8	
Magnesium:Potassium Ratio	-		16.6	15.4	16.4	7.0	5.5	10.8	----	----	
Exchangable Sodium Percentage	0.1%		29.4	32.3	33.0	16.2	14.6	9.9	13.0	10.1	
Exchangable Aluminium Percentage	0.1%										

9.4 Attachment D – ALS results

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Release

CERTIFICATE OF ANALYSIS

Work Order : **EB1933053**
Client : **RGS ENVIRONMENTAL PTY LTD**
Contact : sch4p4(6) Personal information
Address : PO Box 3091
 SUNNYBANK SOUTH QLD, AUSTRALIA 4109
Telephone : +61 07 3344 1222
Project : 2019056 - Adani Geochemistry
Order number : ----
C-O-C number : ----
Sampler : 4p4(6) Personal information
Site : ----
Quote number : EN/222
No. of samples received : 64
No. of samples analysed : 64

Page : 1 of 15
Laboratory : Environmental Division Brisbane
Contact : 4p4(6) Personal information
Address : 2 Byth Street Stafford QLD Australia 4053
Telephone : +61 7 3552 8616
Date Samples Received : 09-Dec-2019 16:24
Date Analysis Commenced : 08-Jan-2020
Issue Date : 10-Jan-2020 11:07



Accreditation No. 825
 Accredited for compliance with
 ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	Position	Accreditation Category
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD



General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ASS: EA013 (ANC) Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong; 5- Lime.

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Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	171471-A 12.7-13.63	171472-A 13.63-14.58	171472-B 21.39-22.37	171472-C 22.37-23.3	171473-A 24.26-25
Client sampling date / time					17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00
Compound	CAS Number	LOR	Unit		EB1933053-001	EB1933053-002	EB1933053-003	EB1933053-004	EB1933053-005
				Result	Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		5.8	5.8	5.4	5.5	5.6
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		-8.9	-6.7	-5.1	-6.3	-6.8
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		415	459	560	516	433
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		9.5	7.0	5.7	6.6	6.8
ANC as CaCO3	----	0.1	% CaCO3		1.0	0.7	0.6	0.7	0.7
Fizz Rating	----	0	Fizz Unit		1	1	1	1	1
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		0.02	0.01	0.02	0.01	<0.01

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Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	171473-B 25-25.89	171473-C 25.89-26.18	171474-A 34.14-35.09	171474-B 35.09-36.02	171474-C 36.02-36.22
Client sampling date / time					17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00
Compound	CAS Number	LOR	Unit		EB1933053-006	EB1933053-007	EB1933053-008	EB1933053-009	EB1933053-010
				Result	Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		5.6	5.7	5.9	5.9	6.0
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		-5.7	-8.3	-4.9	-5.3	-7.2
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		383	359	340	311	277
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		6.0	8.3	5.5	5.9	7.8
ANC as CaCO3	----	0.1	% CaCO3		0.6	0.8	0.6	0.6	0.8
Fizz Rating	----	0	Fizz Unit		1	1	1	1	1
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		0.01	<0.01	0.02	0.02	0.02

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Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	171475-A 40.1-41.05	171475-B 41.05-41.97	171475-C 41.97-42.26	171476-A 52.47-53.38	171476-B 53.38-54.29
Client sampling date / time					17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00
Compound	CAS Number	LOR	Unit		EB1933053-011	EB1933053-012	EB1933053-013	EB1933053-014	EB1933053-015
				Result	Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		7.2	6.6	6.6	6.8	6.6
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		-10.0	-9.4	-5.2	-8.1	-11.0
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		248	582	610	444	820
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		10.0	9.4	8.9	8.4	11.0
ANC as CaCO3	----	0.1	% CaCO3		1.0	1.0	0.9	0.8	1.1
Fizz Rating	----	0	Fizz Unit		1	1	1	1	1
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		<0.01	<0.01	0.12	0.01	<0.01

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Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	171476-C 54.29-55.2	171477-A 103.3-103.81	171477-B 103.81-104.7	171477-C 104.7-105.4	209357-A 61.33-62.26
Client sampling date / time					17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00
Compound	CAS Number	LOR	Unit		EB1933053-016	EB1933053-017	EB1933053-018	EB1933053-019	EB1933053-020
				Result	Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		6.8	7.0	6.8	6.8	8.9
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		-11.0	-6.6	-7.7	-6.7	-21.2
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		790	46	36	36	467
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		11.0	6.6	7.7	7.3	25.5
ANC as CaCO3	----	0.1	% CaCO3		1.1	0.7	0.8	0.7	2.6
Fizz Rating	----	0	Fizz Unit		1	1	1	1	1
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		<0.01	<0.01	<0.01	0.02	0.14

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Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	209357-B 62.26-63.22	209357-C 63.22-63.48	209358-A 67.37-68.29	171451-A 3.29-4.02	171451-B 4.02-4.93
Client sampling date / time					17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00
Compound	CAS Number	LOR	Unit		EB1933053-021	EB1933053-022	EB1933053-023	EB1933053-024	EB1933053-025
				Result	Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		9.0	8.8	9.1	6.5	5.7
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		-29.9	-23.5	-120	-6.8	-7.3
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		445	314	257	569	855
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		31.7	25.0	121	7.4	8.2
ANC as CaCO3	----	0.1	% CaCO3		3.2	2.6	12.4	0.8	0.8
Fizz Rating	----	0	Fizz Unit		1	1	2	1	1
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		0.06	0.05	0.04	0.02	0.03

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Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	171451-C 4.93-5.88	171452-A 17.37-18.32	171452-B 18.32-19.23	171453-A 21.91-22.84	171453-B 22.84-23.76
Client sampling date / time					17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00
Compound	CAS Number	LOR	Unit		EB1933053-026	EB1933053-027	EB1933053-028	EB1933053-029	EB1933053-030
				Result	Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		5.6	6.4	6.4	6.4	6.4
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		-8.3	-10.7	-8.6	-7.5	-9.5
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		932	1180	1110	1240	1190
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		9.2	11.0	8.9	7.8	9.5
ANC as CaCO3	----	0.1	% CaCO3		0.9	1.1	0.9	0.8	1.0
Fizz Rating	----	0	Fizz Unit		1	1	1	1	1
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		0.03	0.01	0.01	0.01	<0.01

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Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	171454-A 27.62-28.2	171454-B 28.2-29.11	171454-C 29.11-30.03	171455-A 33.71-34.29	171455-B 34.29-35.19
Client sampling date / time					17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00
Compound	CAS Number	LOR	Unit		EB1933053-031	EB1933053-032	EB1933053-033	EB1933053-034	EB1933053-035
				Result	Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		6.7	6.6	6.6	6.6	6.5
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		-8.8	-8.8	-8.4	-9.6	-8.0
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		165	155	136	222	308
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		8.8	8.8	8.7	9.9	8.6
ANC as CaCO3	----	0.1	% CaCO3		0.9	0.9	0.9	1.0	0.9
Fizz Rating	----	0	Fizz Unit		1	1	1	1	1
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		<0.01	<0.01	0.01	0.01	0.02

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Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	171455-C 35.19-36.18	171456-A 39.36-40.26	171456-B 40.26-41.19	171457-A 46.28-47.23	171457-B 47.23-48.15
Client sampling date / time					17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00
Compound	CAS Number	LOR	Unit		EB1933053-036	EB1933053-037	EB1933053-038	EB1933053-039	EB1933053-040
				Result	Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		6.5	6.6	6.6	6.6	6.9
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		-6.3	-6.7	-8.0	-9.1	-9.0
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		360	684	702	668	554
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		7.2	7.3	8.0	9.1	9.6
ANC as CaCO3	----	0.1	% CaCO3		0.7	0.7	0.8	0.9	1.0
Fizz Rating	----	0	Fizz Unit		1	1	1	1	1
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		0.03	0.02	<0.01	<0.01	0.02

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Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	171457-C 48.15-48.32	171458-A 52.76-63.57	171458-B 63.57-64.51	171458-C 64.51-64.89	209351-A 9.32-10.25
Client sampling date / time					17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00
Compound	CAS Number	LOR	Unit		EB1933053-041	EB1933053-042	EB1933053-043	EB1933053-044	EB1933053-045
				Result	Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		6.6	6.4	6.5	6.3	6.6
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		-8.8	-6.7	-6.6	-6.6	-8.4
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		555	242	242	279	944
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		8.8	7.3	7.2	7.8	8.7
ANC as CaCO3	----	0.1	% CaCO3		0.9	0.7	0.7	0.8	0.9
Fizz Rating	----	0	Fizz Unit		1	1	1	1	1
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		<0.01	0.02	0.02	0.04	0.01

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Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	209351-B 10.25-11.2	209352-A 20.2-20.77	209352-B 20.77-21.32	209352-C 21.32-22.08	209353-A 24.8-25.71
Client sampling date / time					17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00
Compound	CAS Number	LOR	Unit		EB1933053-046	EB1933053-047	EB1933053-048	EB1933053-049	EB1933053-050
				Result	Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		6.7	6.4	6.2	6.4	6.1
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		-8.0	-8.9	-8.9	-8.3	-6.8
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		661	1020	690	746	757
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		8.3	8.9	8.9	8.3	6.8
ANC as CaCO3	----	0.1	% CaCO3		0.8	0.9	0.9	0.8	0.7
Fizz Rating	----	0	Fizz Unit		1	1	1	1	1
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		0.01	<0.01	<0.01	<0.01	<0.01

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Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	209353-B 25.71-26.66	209354-A 27.48-28.43	209354-B 28.48-29.38	209354-C 29.38-30.24	209355-A 39.39-40.33
Client sampling date / time					17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00
Compound	CAS Number	LOR	Unit		EB1933053-051	EB1933053-052	EB1933053-053	EB1933053-054	EB1933053-055
				Result	Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		6.4	6.7	6.9	7.1	9.3
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		-8.4	-10.4	-9.6	-13.3	-37.4
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		705	447	434	443	341
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		9.0	10.7	10.2	13.9	38.0
ANC as CaCO3	----	0.1	% CaCO3		0.9	1.1	1.0	1.4	3.9
Fizz Rating	----	0	Fizz Unit		1	1	1	1	1
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		0.02	0.01	0.02	0.02	0.02

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Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Client sample ID

				209355-B 40.33-41.3	209355-C 41.3-42.45	209359-A 69.64-70.9	209360-A 124.83-125.76	209360-B 125.76-126.62
Client sampling date / time				17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00
Compound	CAS Number	LOR	Unit	EB1933053-056	EB1933053-057	EB1933053-058	EB1933053-059	EB1933053-060
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.2	9.3	8.8	8.2	7.9
EA009: Nett Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-118	-364	-19.9	-6.7	-7.7
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	349	373	248	66	36
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	119	364	21.4	6.7	7.7
ANC as CaCO3	----	0.1	% CaCO3	12.2	37.2	2.2	0.7	0.8
Fizz Rating	----	0	Fizz Unit	2	4	1	1	1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.03	<0.01	0.05	<0.01	<0.01

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Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	209365-A 52.15-53.11	209365-B 53.11-54.07	209365-C 54.07-54.48	PH & EC Deionised Water	----
Client sampling date / time					17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	----
Compound	CAS Number	LOR	Unit	EB1933053-061	EB1933053-062	EB1933053-063	EB1933053-064	-----	
				Result	Result	Result	Result	----	
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit	9.2	9.4	9.3	5.9	----	
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t	-69.8	-83.1	-280	----	----	
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm	435	434	413	<1	----	
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	70.7	83.7	281	----	----	
ANC as CaCO3	----	0.1	% CaCO3	7.2	8.5	28.7	----	----	
Fizz Rating	----	0	Fizz Unit	2	2	4	----	----	
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%	0.03	0.02	0.03	----	----	

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CERTIFICATE OF ANALYSIS

Work Order	: EB2000789	Page	: 1 of 12
Client	: RGS ENVIRONMENTAL PTY LTD	Laboratory	: Environmental Division Brisbane
Contact	: sch4p4(6) Personal information	Contact	: p4(6) Personal inform
Address	: PO Box 3091 SUNNYBANK SOUTH QLD, AUSTRALIA 4109	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3344 1222	Telephone	: +61 7 3552 8616
Project	: 2019056 - Adani Geochemistry	Date Samples Received	: 09-Dec-2019 16:24
Order number	: ----	Date Analysis Commenced	: 14-Jan-2020
C-O-C number	: ----	Issue Date	: 21-Jan-2020 16:11
Sampler	: p4(6) Personal inform		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 21		
No. of samples analysed	: 20		



Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	Position	Accreditation Category
sch4p4(6) Personal informat	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD



General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.

LOR = Limit of reporting

^ = This result is computed from individual analyte detections at or above the level of reporting

Ø = ALS is not NATA accredited for these tests.

~ = Indicates an estimated value.

- ALS is not NATA accredited for the analysis of Exchangeable Aluminium and Exchange Acidity in soils when performed under ALS Method ED005.
- ALS is not NATA accredited for the analysis of Exchangeable Cations on Alkaline Soils when performed under ALS Method ED006.
- ED008 (Exchangeable Cations by ICP-AES): Unable to calculate Magnesium/Potassium Ratio result for some samples as required Exchangeable Magnesium and/or Potassium results are less than the limit of reporting.
- ED007 and ED008: When Exchangeable Al is reported from these methods, it should be noted that Rayment & Lyons (2011) suggests Exchange Acidity by 1M KCl - Method 15G1 (ED005) is a more suitable method for the determination of exchange acidity (H⁺ + Al³⁺).
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.



Analytical Results

Sub-Matrix: LEACHATE
 (Matrix: WATER)

Client sample ID

				171471-A 12.7-13.63	171472-B 21.39-22.37	171475-C 41.97-42.26	209357-A 61.33-62.26	171451-B 4.02-4.93
Client sampling date / time				17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00
Compound	CAS Number	LOR	Unit	EB2000789-001	EB2000789-003	EB2000789-006	EB2000789-008	EB2000789-010
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	6.89	6.97	7.18	8.53	6.92
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	697	937	477	659	1500
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO ₃	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO ₃	3812-32-6	1	mg/L	<1	<1	<1	12	<1
Bicarbonate Alkalinity as CaCO ₃	71-52-3	1	mg/L	10	11	11	130	6
Total Alkalinity as CaCO ₃	----	1	mg/L	10	11	11	142	6
ED038A: Acidity								
Acidity as CaCO ₃	----	1	mg/L	2	2	2	<1	2
ED041G: Sulfate (Turbidimetric) as SO₄ 2- by DA								
Sulfate as SO ₄ - Turbidimetric	14808-79-8	1	mg/L	37	24	44	105	39
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	185	277	98	31	448
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	<1	4	<1	5	1
Magnesium	7439-95-4	1	mg/L	2	10	<1	2	3
Sodium	7440-23-5	1	mg/L	123	156	84	124	269
Potassium	7440-09-7	1	mg/L	4	5	2	16	11
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.07	0.02	0.31	0.25	0.48
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.030	0.004	<0.001
Arsenic	7440-38-2	0.001	mg/L	0.002	0.002	0.001	0.030	<0.001
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L	0.304	0.550	0.385	0.274	0.726
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cerium	7440-45-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	0.001	0.001	0.002	0.002	0.001
Cobalt	7440-48-4	0.001	mg/L	<0.001	0.002	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	0.004	0.004	0.033	0.002	0.005
Dysprosium	7429-91-6	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Erbium	7440-52-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001



Analytical Results

Sub-Matrix: LEACHATE
 (Matrix: WATER)

Client sample ID

				171471-A 12.7-13.63	171472-B 21.39-22.37	171475-C 41.97-42.26	209357-A 61.33-62.26	171451-B 4.02-4.93
Client sampling date / time				17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00
Compound	CAS Number	LOR	Unit	EB2000789-001	EB2000789-003	EB2000789-006	EB2000789-008	EB2000789-010
				Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued								
Europium	7440-53-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Gadolinium	7440-54-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Gallium	7440-55-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium	7440-58-6	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Holmium	7440-60-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Lanthanum	7439-91-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Lithium	7439-93-2	0.001	mg/L	0.004	0.003	0.003	0.003	0.010
Lutetium	7439-94-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	0.073	1.03	0.006	0.015	0.022
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	0.236	0.002
Neodymium	7440-00-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	0.001	0.002	0.001	<0.001	0.003
Praseodymium	7440-10-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Rubidium	7440-17-7	0.001	mg/L	0.004	0.005	0.002	0.015	0.012
Samarium	7440-19-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	0.07	<0.01
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L	0.030	0.106	0.020	0.140	0.054
Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Terbium	7440-27-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Thulium	7440-30-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	0.002	<0.001
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	0.04	<0.01
Ytterbium	7440-64-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Yttrium	7440-65-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L	0.039	0.052	0.075	0.053	0.325
Zirconium	7440-67-7	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	mg/L	0.19	0.27	0.60	0.40	0.97
Iron	7439-89-6	0.05	mg/L	0.34	<0.05	0.10	0.08	0.46
Iodine	7553-56-2	0.1	mg/L	0.1	0.6	<0.1	<0.1	0.2



Analytical Results

Sub-Matrix: LEACHATE (Matrix: WATER)				Client sample ID	171471-A 12.7-13.63	171472-B 21.39-22.37	171475-C 41.97-42.26	209357-A 61.33-62.26	171451-B 4.02-4.93
Client sampling date / time					17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00
Compound	CAS Number	LOR	Unit		EB2000789-001	EB2000789-003	EB2000789-006	EB2000789-008	EB2000789-010
				Result	Result	Result	Result	Result	Result
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		0.3	0.3	0.7	0.9	0.3
EN055: Ionic Balance									
∅ Total Anions	----	0.01	meq/L		6.19	8.53	3.90	5.90	13.6
∅ Total Cations	----	0.01	meq/L		5.62	7.94	3.70	6.22	12.3
∅ Ionic Balance	----	0.01	%		4.84	3.63	2.57	2.63	4.99

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Analytical Results

Sub-Matrix: LEACHATE (Matrix: WATER)				Client sample ID	171453-A 21.91-22.84	209351-A 9.32-10.25	209352-C 21.32-22.08	209355-C 41.3-42.45	----
Client sampling date / time					17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	----
Compound	CAS Number	LOR	Unit		EB2000789-014	EB2000789-016	EB2000789-020	EB2000789-021	-----
				Result	Result	Result	Result	Result	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		6.92	7.53	7.04	8.83	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		1940	1600	1220	476	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO ₃	DMO-210-001	1	mg/L		<1	<1	<1	<1	----
Carbonate Alkalinity as CaCO ₃	3812-32-6	1	mg/L		<1	<1	<1	25	----
Bicarbonate Alkalinity as CaCO ₃	71-52-3	1	mg/L		9	5	6	127	----
Total Alkalinity as CaCO ₃	----	1	mg/L		9	5	6	153	----
ED038A: Acidity									
Acidity as CaCO ₃	----	1	mg/L		3	2	2	<1	----
ED041G: Sulfate (Turbidimetric) as SO₄ 2- by DA									
Sulfate as SO ₄ - Turbidimetric	14808-79-8	1	mg/L		42	52	23	38	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		591	470	375	26	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		3	6	18	4	----
Magnesium	7439-95-4	1	mg/L		9	15	20	1	----
Sodium	7440-23-5	1	mg/L		356	273	173	93	----
Potassium	7440-09-7	1	mg/L		4	11	4	8	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		0.10	0.06	0.01	0.29	----
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	0.011	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Barium	7440-39-3	0.001	mg/L		0.371	0.398	0.694	0.357	----
Bismuth	7440-69-9	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	----
Cerium	7440-45-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Caesium	7440-46-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Chromium	7440-47-3	0.001	mg/L		<0.001	0.002	<0.001	0.002	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Copper	7440-50-8	0.001	mg/L		0.002	0.002	0.001	0.002	----
Dysprosium	7429-91-6	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Erbium	7440-52-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----



Analytical Results

Sub-Matrix: LEACHATE
 (Matrix: WATER)

Client sample ID

				171453-A 21.91-22.84	209351-A 9.32-10.25	209352-C 21.32-22.08	209355-C 41.3-42.45	----
Client sampling date / time				17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	----
Compound	CAS Number	LOR	Unit	EB2000789-014	EB2000789-016	EB2000789-020	EB2000789-021	-----
				Result	Result	Result	Result	----

EG020F: Dissolved Metals by ICP-MS - Continued

Europium	7440-53-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Gadolinium	7440-54-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Gallium	7440-55-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Hafnium	7440-58-6	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Holmium	7440-60-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Lanthanum	7439-91-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Lithium	7439-93-2	0.001	mg/L	0.003	0.004	0.002	0.002	----
Lutetium	7439-94-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Manganese	7439-96-5	0.001	mg/L	0.040	0.023	0.028	0.008	----
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	0.014	----
Neodymium	7440-00-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Praseodymium	7440-10-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Rubidium	7440-17-7	0.001	mg/L	0.007	0.009	0.003	0.011	----
Samarium	7440-19-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Strontium	7440-24-6	0.001	mg/L	0.098	0.189	0.547	0.067	----
Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	----
Terbium	7440-27-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Thulium	7440-30-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	0.02	----
Ytterbium	7440-64-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Yttrium	7440-65-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Zinc	7440-66-6	0.005	mg/L	0.041	0.014	0.016	0.026	----
Zirconium	7440-67-7	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	----
Boron	7440-42-8	0.05	mg/L	0.46	0.33	0.36	0.30	----
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	0.19	----
Iodine	7553-56-2	0.1	mg/L	0.2	0.4	0.5	<0.1	----



Analytical Results

Sub-Matrix: LEACHATE (Matrix: WATER)				Client sample ID	171453-A 21.91-22.84	209351-A 9.32-10.25	209352-C 21.32-22.08	209355-C 41.3-42.45	----
Client sampling date / time					17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	----
Compound	CAS Number	LOR	Unit		EB2000789-014	EB2000789-016	EB2000789-020	EB2000789-021	-----
					Result	Result	Result	Result	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		0.5	0.5	0.6	0.9	----
EN055: Ionic Balance									
∅ Total Anions	----	0.01	meq/L		17.7	14.4	11.2	4.58	----
∅ Total Cations	----	0.01	meq/L		16.5	13.7	10.2	4.53	----
∅ Ionic Balance	----	0.01	%		3.65	2.67	4.71	0.55	----

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Analytical Results

Sub-Matrix: PULP
 (Matrix: SOIL)

Client sample ID

				171471-A 12.7-13.63	171472-A 13.63-14.58	171472-B 21.39-22.37	171472-C 22.37-23.3	171473-A 24.26-25
Client sampling date / time				17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00
Compound	CAS Number	LOR	Unit	EB2000789-001	EB2000789-002	EB2000789-003	EB2000789-004	EB2000789-005
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	5.9	5.9	5.5	5.5	5.6
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	389	457	551	520	429
ED005: Exchange Acidity								
∅ Exchange Acidity	----	0.1	meq/100g	0.2	0.1	0.2	0.2	0.2
∅ Exchangeable Aluminium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	0.2	0.3	0.5	0.5	0.5
Exchangeable Magnesium	----	0.1	meq/100g	2.5	2.6	1.9	2.0	2.0
Exchangeable Potassium	----	0.1	meq/100g	0.3	0.3	0.2	0.2	0.2
Exchangeable Sodium	----	0.1	meq/100g	1.2	1.0	0.4	0.4	0.4
Cation Exchange Capacity	----	0.1	meq/100g	4.6	4.5	3.4	3.5	3.9
Exchangeable Sodium Percent	----	0.1	%	27.5	22.6	13.1	11.9	11.7
Calcium/Magnesium Ratio	----	0.1	-	<0.1	0.1	0.3	0.2	0.2
Magnesium/Potassium Ratio	----	0.1	-	7.8	8.5	12.8	12.2	12.5

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Analytical Results

Sub-Matrix: PULP
 (Matrix: SOIL)

Client sample ID

				171475-C 41.97-42.26	209357-A 61.33-62.26	171451-A 3.29-4.02	171451-B 4.02-4.93	171451-C 4.93-5.88
Client sampling date / time				17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00
Compound	CAS Number	LOR	Unit	EB2000789-006	EB2000789-008	EB2000789-009	EB2000789-010	EB2000789-011
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	----	----	5.8	5.6	5.5
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	----	----	573	876	976
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	0.005	0.104	----	----	----
ED005: Exchange Acidity								
∅ Exchange Acidity	----	0.1	meq/100g	----	----	0.3	0.5	0.6
∅ Exchangeable Aluminium	----	0.1	meq/100g	----	----	0.1	0.4	0.4
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	----	----	1.6	1.6	1.3
Exchangeable Magnesium	----	0.1	meq/100g	----	----	5.2	6.9	6.7
Exchangeable Potassium	----	0.1	meq/100g	----	----	0.7	1.0	1.2
Exchangeable Sodium	----	0.1	meq/100g	----	----	3.7	4.8	5.0
Cation Exchange Capacity	----	0.1	meq/100g	----	----	11.7	15.1	14.9
Exchangeable Sodium Percent	----	0.1	%	----	----	32.4	33.3	34.9
Calcium/Magnesium Ratio	----	0.1	-	----	----	0.3	0.2	0.2
Magnesium/Potassium Ratio	----	0.1	-	----	----	7.0	6.5	5.8

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Analytical Results

Sub-Matrix: PULP
 (Matrix: SOIL)

Client sample ID

				171452-A 17.37-18.32	171452-B 18.32-19.23	171453-A 21.91-22.84	171453-B 22.84-23.76	209351-A 9.32-10.25
Client sampling date / time				17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00
Compound	CAS Number	LOR	Unit	EB2000789-012	EB2000789-013	EB2000789-014	EB2000789-015	EB2000789-016
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	6.6	6.6	6.6	6.5	6.9
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	1220	1160	1200	1160	890
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	0.8	0.7	0.5	0.4	0.5
Exchangeable Magnesium	----	0.1	meq/100g	4.7	3.8	2.8	2.4	2.3
Exchangeable Potassium	----	0.1	meq/100g	0.3	0.2	0.2	0.1	0.3
Exchangeable Sodium	----	0.1	meq/100g	2.6	2.1	1.7	1.6	0.7
Cation Exchange Capacity	----	0.1	meq/100g	9.0	7.2	5.4	4.9	4.1
Exchangeable Sodium Percent	----	0.1	%	29.0	29.4	32.3	33.0	16.2
Calcium/Magnesium Ratio	----	0.1	-	0.2	0.2	0.2	0.2	0.2
Magnesium/Potassium Ratio	----	0.1	-	15.6	16.6	15.4	16.4	7.0

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Analytical Results

Sub-Matrix: PULP (Matrix: SOIL)			Client sample ID	209351-B 10.25-11.2	209352-A 20.2-20.77	209352-B 20.77-21.32	209352-C 21.32-22.08	----
Client sampling date / time				17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	17-Dec-2019 00:00	----
Compound	CAS Number	LOR	Unit	EB2000789-017	EB2000789-018	EB2000789-019	EB2000789-020	-----
				Result	Result	Result	Result	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	6.9	6.6	6.2	6.5	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	667	987	676	720	----
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	0.4	0.8	0.5	0.7	----
Exchangeable Magnesium	----	0.1	meq/100g	1.6	1.2	0.8	0.9	----
Exchangeable Potassium	----	0.1	meq/100g	0.3	0.1	<0.1	<0.1	----
Exchangeable Sodium	----	0.1	meq/100g	0.4	0.2	0.2	0.2	----
Cation Exchange Capacity	----	0.1	meq/100g	2.9	2.6	1.9	2.2	----
Exchangeable Sodium Percent	----	0.1	%	14.6	9.9	13.0	10.1	----
Calcium/Magnesium Ratio	----	0.1	-	0.2	0.7	0.6	0.8	----
Magnesium/Potassium Ratio	----	0.1	-	5.5	10.8	----	----	----

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